Controlled Flight Into Terrain

Education and Training Aid

ICAO • OACI • ИКАО

Flight Safety Foundation

U.S. Department of Transportation

Federal Aviation Administration

Welcome to the Controlled Flight Into Terrain (CFIT) Education and Training Aid

Preventing CFIT accidents is the major goal of this training aid. The training aid includes a document (two volumes) and a video. They are stored on this CD-ROM to provide a readily available source of information and to easily enable the user to develop a program to prevent CFIT accidents. This training aid was developed by an international CFIT Task Force composed of representatives from organizations that possess extensive aviation expertise: airplane manufacturers, aviation training organizations, airplane equipment manufacturers, airlines, pilot groups and government and regulatory agencies.

The document includes five sections. Section One provides top-level management with a concise, broad view of the document. Section Two identifies areas where those people who govern, regulate, and run the industry can best put their efforts to prevent CFIT. Section Three provides the history of CFIT, along with causal factors, traps and solutions. This section is specifically aimed at the operator end of the scale. Section Four provides specific academic and simulator training programs aimed at informing the flight crews of their responsibilities and duties in preventing CFIT. Appendices include ground briefings, video script, and airplane-specific examples of the CFIT escape maneuver. Section Five contains selected readings, including the latest CFIT accident/incident information. The video "CFIT: An Encounter Avoided" addresses the CFIT problem in its entirety.

Management is encouraged to take appropriate steps to ensure that a viable, effective CFIT training program is in place within its organization.

MESSAGE FROM THE PRESIDENT OF THE COUNCIL OF THE INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO)

I wish to express my sincere appreciation for the work completed in the preparation of the controlled flight into terrain (CFIT) prevention material by the International Civil Aviation Organization (ICAO) and the Industry Controlled Flight Into Terrain (CFIT) Task Force. It has always been by conviction that all personnel involved in civil aviation must understand the CFIT problem and must be aware of the risk of such accidents. The training aid will provide a major contribution to the prevention of CFIT. I strongly recommend that those in positions of responsibility in civil aviation apply the recommendations of the CFIT Task Force and make the best use of this education and training aid. ICAO will continue to assist States in their efforts and provide, through its Annexes, the regulatory framework which will permit the improvement of the use of ground proximity warning system (GPWS) in operations worldwide.

Assad Kotaite

Notice

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Units of Measurement

°	degree (temperature)
deg	degree (angle)
deg/s	degrees per second
ft	feet
ft/min	feet per minute
ft/s	feet per second
hPa	hectoPascal
hr	hour
in	inch
inHg	inches of mercury
kt	knot
m	meter
mbar	millibar
mi	mile
min	minute
nm	nautical mile
sec	second

Acronyms

ADF	automatic direction finding
AGL	above ground level
ASRS	Aviation Safety Reporting System
ATC	air traffic control
ATCRBS	Air Traffic Control Radar Beacon System
ATIS	automatic terminal information service
CFIT	Controlled Flight Into Terrain
CRM	Crew Resource Management
DA/H	decision altitude/height
EAS	Emergency Safe Altitude
FAA	Federal Aviation Administration
FAF	final approach fix
FMC	flight management computer
FMS	flight management system
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
HAA	Height Above Airport
HAT	Height Above Touchdown
IAF	initial approach fix
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
ILS	Instrument Landing System
IMC	instrument meteorological conditions
INS	Inertial Navigation System
MAP	Missed Approach Point
MCA	Minimum Crossing Altitude
MDA/H	minimum descent altitude/height
MEA	Minimum Enroute Altitude
MIA	Minimum IFR Altitude
MOCA	Minimum Obstruction Clearance Altitude
MRA	Minimum Reception Altitude
MSA	Minimum Safe Altitude
MSAWS	Minimum Safe Altitude Warning System
MSL	mean sea level
MVA	Minimum Vectoring Altitude
NOTAM	Notice To Airmen
PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
PAPI	precision approach path indicator
PAR	precision approach radar
PT	procedure turn
RVV	runway visibility point
SID	standard instrument departure
SOP	standard operating procedure
STAR	standard terminal arrival
TCAS	Traffic Alert and Collision Avoidance System
TCH	threshold crossing height
TERPS	Terminal Instrument Procedures
VASI	Visual Approach Slope Indicator
VDP	visual descent point
VFR	visual flight rules
VMC	visual meteorological conditions
VOR	VHF Omnidirectional Radio Station
VOR/DME	VOR Distance Measuring Equipment

CFIT Glossary

Certain definitions are needed to explain the concepts discussed in this training aid. Some of the definitions are from regulatory documents or other references, and some are defined in the aid. Not all of the defined words or phrases are used within the training aid; however, they are associated with the subject of CFIT and are included to provide a readily available source for the reader.

Altitude (USA)

The height of a level, point, or object measured in feet Above Ground Level (AGL) or from Mean Sea Level (MSL).

1. MSL Altitude - Altitude expressed in feet measured from mean sea level.
2. AGL Altitude - Altitude expressed in feet measured above ground level.
3. Indicated Altitude - The altitude as shown by an altimeter. On a pressure or barometric altimeter it is altitude as shown uncorrected for instrument error and uncompensated for variation from standard atmospheric conditions.

Altitude (ICAO)

The vertical distance of a level, a point, or an object considered as a point, measured from mean sea level (MSL).

Appropriate Obstacle Clearance Minimum Altitude

Any of the following:

1. Minimum IFR Altitude (MIA)
2. Minimum Enroute Altitude (MEA)
3. Minimum Obstruction Clearance Altitude (MOCA)
4. Minimum Vectoring Altitude (MVA)

Appropriate Terrain Clearance Minimum Altitude

Any of the following:

1. Minimum IFR Altitude (MIA)
2. Minimum Enroute Altitude (MEA)
3. Minimum Obstruction Clearance Altitude (MOCA)
4. Minimum Vectoring Altitude (MVA)

Automatic Terminal Information Service (ATIS)

The provision of current, routine information to arriving and departing airplanes by means of continuous and repetitive broadcasts throughout the day or a specified portion of the day.

Ceiling

The heights above the earth's surface of the lowest layer of clouds or obscuring phenomena that is reported as "broken," "overcast," or "obscuration," and not classified as "thin" or "partial."

CFIT (Controlled Flight Into Terrain)

An event where a mechanically normally functioning airplane is inadvertently flown into the ground, water, or an obstacle.

Controlled Airspace

An airspace of defined dimensions within which air traffic control service is provided to IFR flights and VFR flights in accordance with the airspace classification.

Decision Height (DH) (USA)

With respect to the operation of aircraft, means the hight at which a decision must be made, during an ILS or PAR instrument apporach, to either continue the approach or to execute a missed approach.

Decision Altitude/Height (DA/H) (ICAO)

A specified altitude or height (A/H) in the precision approach at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.

Note 1: Decision altitude (DA) is referenced to mean sea level (MSL) and decision height (DH) is referenced to the threshold elevation.

Note 2: The required visual reference means that section of the visual aids or of the approach area that should have been in view for sufficient time for the pilot to have made an assessment of the airplane position and rate of change of position, in relation to the desired flight path.

Direct

Straight line flight between two navigational aids, fixes, points, or any combination thereof. When used by pilots in describing off airway routes, points defining direct route segments become compulsory reporting points, unless the airplane is under radar contact.

Distance Measuring Equipment (DME)

Equipment (airborne and ground) used to measure, in nautical miles, the slant range distance of an aircraft from the DME navigational aid.

Final Approach

The part of an instrument approach procedure that commences at the specified final approach fix, or point, or where such a fix or point is not specified.

1. At the end of the last procedure turn, base turn, or inbound turn of a racetrack procedure, if specified; or
2. At the point of interception of the last track specified in the approach procedure; ends at a point in the vicinity of an aerodrome from which:
   a. A landing can be made; or
   b. A missed approach procedure is initiated.

Final Approach Fix (FAF)

The fix from which the final approach (IFR) to an airport is executed and that identifies the beginning of the final approach segment.

Fix

A geographical position determined by visual reference to the surface, by reference to one or more radio NAVAIDs, by celestial plotting, or by another navigational device.

Flight Crew or Flight Crew Member

A pilot, flight engineer or flight navigator assigned to duty in an aircraft during flight time.

Flight Level

A level of constant atmospheric pressure related to a reference datum of 29.92 inches of mercury. Each is stated in three digits that represent hundreds of feet. For example, Flight Level 250 represents a barometric altimeter indication of 25,000 ft; flight level 255, an indication of 25,500 ft.

Flight Management Systems (FMS)

A computer system that uses a large database to allow routes to be preprogrammed and fed into the system by means of a data loader. The system is constantly updated with respect to position accuracy by reference to conventional navigation aids. The sophisticated program and its associated data base ensures that the most appropriate aids are automatically selected during the information update cycle.

Flight Recorder

A general term applied to any instrument or device that records information about the performance of an aircraft in flight or about conditions encountered in flight.

Glide Slope

Provides vertical guidance for airplanes during approach and landing. The glide slope/glide path is based on the following:

1. Electronic components emitting signals that provide vertical guidance by reference to airborne instruments during instrument approaches, such as ILS/MLS, or
2. Visual ground aids, such as VASI, that provide vertical guidance for a VFR approach or for the visual portion of an instrument approach and landing.
3. Precision Approach Radar (PAR). Used by ATC to inform an airplane making a PAR approach of its vertical position (elevation) relative to the descent profile.

Glide Path (ICAO)

A descent profile determined for vertical guidance during a final approach.

Glide Slope Intercept Altitude

The minimum altitude to intercept the glide slope/glide path on a precision approach.

Global Positioning System (GPS)

A space-base radio positioning, navigation, and time-transfer system. The system provides highly accurate position and velocity information, and precise time, on a continuous global basis, to an unlimited number of properly equipped users.

Height Above Airport (HAA)

The height of the Minimum Descent Altitude above the published airport elevation. This is published in conjunction with circling minimums.

Height Above Touchdown (HAT)

The height of the Decision Height or Minimum Descent Altitude above the highest runway elevation in the touchdown zone (first 3,000 ft of the runway). HAT is published on instrument approach charts in conjunction with all straight-in minimums.

IFR (Instrument Flight Rules) Aircraft

An airplane conducting flight in accordance with instrument flight rules.

IFR Conditions

Weather conditions below the minimum for flight under visual flight rules.

ILS (Instrument Landing System) Categories

1. ILS Category I - An ILS approach procedure that provides for approach to a height above touchdown of not less than 200 ft and with runway visual range of not less than 1,800 ft.
2. ILS Category II - An ILS approach procedure that provides for approach to a height above touchdown of not less than 100 ft and with runway visual range of not less than 1,200 ft.
3. ILS Category III—
   a. IIIA - An ILS approach procedure that provides for approach without a decision height minimum and with runway visual range of not less than 700 ft.
   b. IIIB - An ILS approach procedure that provides for approach without a decision height minimum and with runway visual range of not less than 150 ft.
   c. IIIC - An ILS approach procedure that provides for approach without a decision height minimum and without runway visual range minimum.

Inertial Navigation System (INS)

An RNAV system that is a form of self-contained navigation.

Initial Approach Fix (IAF)

The fixes depicted on instrument approach procedure charts that identify the beginning of the initial approach segment(s).

Instrument Flight Rules (IFR)

Rules governing the procedures for conducting instrument flight. Also a term used by pilots and controllers to indicate the type of flight plan.

Instrument Landing System (ILS)

A precision instrument approach system that normally consists of the following electronic components and visual aids:

1. Localizer.
2. Glide slope.
3. Outer marker.
4. Middle marker.
5. Approach lights.

Instrument Meteorological Conditions (IMC)

Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling less than the minimums specified for visual meteorological conditions.

International Civil Aviation Organization (ICAO)

A specialized agency of the United Nations whose objectives are to develop the principles and techniques of international air navigation and foster planning and development of international civil air transport.

Landing Minimums

The minimum visibility prescribed for landing a civil airplane while using an instrument approach procedure.

1. Straight-in landing minimums - A statement of MDA and visibility, or DH and visibility, required for a straight-in landing on a specified runway, or
2. Circling minimums - A statement of MDA and visibility required for the circle-to-land maneuver.

Descent below the established MDA or DH is not authorized during an approach unless the airplane is in a position from which a normal approach to the runway of intended landing can be made and adequate visual reference to required visual cues is maintained.

Localizer

The component of an ILS that provides course guidance to the runway.

MCA (Minimum Crossing Altitude)

The lowest altitude at certain fixes at which an airplane must cross when proceeding in the direction of a higher minimum enroute IFR altitude (MEA).

MDA (Minimum Descent Altitude)

The lowest altitude, expressed in feet above mean sea level, to which descent is authorized on final approach or during circle-to-land maneuvering in execution of a standard instrument approach procedure where no electronic glideslope is provided.

MEA (Minimum Enroute IFR Altitude)

The lowest published altitude between radio fixes that ensures acceptable navigational signal coverage and meets obstacle clearance requirements between those fixes.

MOCA (Minimum Obstruction Clearance Altitude)

The lowest published altitude in effect between radio fixes on VOR airways, off airway routes, or route segments that meets obstacle clearance requirements for the entire route segment and that ensures acceptable navigational signal coverage only within 25 statute (22 nautical) miles of a VOR.

MRA (Minimum Reception Altitude)

The lowest altitude at which an intersection can be determined.

MSA (Minimum Safe Altitude)

1. The minimum altitude specified in FAR Part 91 for various aircraft operations.
2. Altitudes depicted on approach charts that provide at least 1,000 ft of obstacle clearance for emergency use within a specified distance from the navigation facility upon which a procedure is predicated. These altitudes will be identified as Minimum Sector Altitudes or Emergency Safe Altitudes and are established as follows:
   a. Minimum Sector Altitudes - Altitudes depicted on approach charts that provide at least 1,000 ft of obstacle clearance within a 25-mi radius of the navigation facility upon that the procedure is predicated. Sectors depicted on approach charts must be at least 90 deg in scope. These altitudes are for emergency use only and do not necessarily ensure acceptable navigational signal coverage.
   b. Emergency Safe Altitudes - Altitudes depicted on approach charts that provide at least 1,000 ft of obstacle clearance in nonmountainous areas and 2,000 ft of obstacle clearance in designated mountainous areas within a 100-mi radius of the navigation facility upon which the procedure is predicated and normally used only in military procedures. These altitudes are identified on published procedures as “Emergency Safe Altitudes.”

Minimums

Weather condition requirements established for a particular operation or type of operation.

MVA - (Minimum Vectoring Altitude)

The lowest MSL altitude at which an IFR aircraft will be vectored by a radar controller, except as otherwise authorized for radar approaches, departures, and missed approaches. The altitude meets IFR obstacle clearance criteria.

Missed Approach

1. A maneuver conducted by a pilot when an instrument approach cannot be completed to a landing. The route of flight and altitude are shown on instrument approach procedure charts. A pilot executing a missed approach prior to the Missed Approach Point (MAP) must continue along the final approach to the MAP. The pilot may climb immediately to the altitude specified in the missed approach procedure.
2. A term used by the pilot to inform ATC that he is executing the missed approach.
3. At locations where ATC radar service is provided, the pilot should conform to radar vectors when provided by ATC in lieu of the published missed approach procedure.

MAP (Missed Approach Point)

A point prescribed in each instrument approach procedure at which a missed approach procedure shall be executed if the required visual reference does not exist.

Night

The time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the American Air Almanac, converted to local time.

Nonprecision Approach Procedure

A standard instrument approach procedure in which no electronic glide slope is provided.

NOTAM - Notice To Airmen

A notice containing information (not known sufficiently in advance to publicize by other means) concerning the establishment, condition, or change in any component (facility, service, or procedure of, or hazard in the National Airspace System), the timely knowledge of which is essential to personnel concerned with flight operations.

Obstacle

An existing object, object of natural growth, or terrain at a fixed geographical location or that may be expected at a fixed location within a prescribed area with reference to which vertical clearance is or must be provided during flight operation.

Off Course

A term used to describe a situation in which an airplane has reported a position fix or is observed on radar at a point not on the ATC approved route of flight.

Off Route Vector

A vector by ATC that takes an aircraft off a previously assigned route. Altitudes assigned by ATC during such vectors provide required obstacle clearance.

Operators

The people who are involved in all operations functions required for the flight of commercial airplanes that carry at least 10 passengers, including airplanes involved in cargo operations. This includes such functions as air traffic systems, flight crew, flight dispatch, flight scheduling, flight training, and other supporting flight operations functions.

Precision Approach Path Indicator (PAPI)

An airport lighting facility providing vertical visual approach slope guidance to airplanes during approach to landing by radiating a directional pattern of high-intensity red and white focused light beams. Four PAPI units located on one side or on both sides of the runway adjacent to the glide slope origin indicate to the pilot that he or she is (1) “on path” if he or she sees (from each set of units) two reds and two whites, (2) marginally below or marginally above if he or she sees three reds and one white or three whites and one red (respectively), or (3) below or above if he or she sees four reds or four whites (respectively).

Precision Approach Procedure

A standard instrument approach procedure in which an electronic glide slope/glide path is provided.

Procedure Turn (PT)

The maneuver prescribed when it is necessary to reverse direction to establish an airplane on the intermediate approach segment or final approach course. The outbound course, direction of turn, distance within which the turn must be completed, and minimum altitude are specified in the procedure.

Procedure Turn Inbound

That point of a procedure turn maneuver where course reversal has been completed and an airplane is established inbound on the intermediate approach segment or final approach course. A report of "procedure turn inbound" is normally used by ATC as a position report for separation purposes.

QNE

The barometric pressure used for the standard altimeter setting (29.92 inches of mercury or 1013.2 hectoPascals).

QNH

The barometric pressure as reported by a particular station.

Radar Approach

An instrument approach procedure that utilizes Precision Approach Radar (PAR) or Airport Surveillance Radar (ASR).

Radar Contact

Used by ATC to inform an airplane that it is identified on the radar display and that radar flight following will be provided until radar identification is terminated. Radar service may also be provided within the limits of necessity and capability. When a pilot is informed of "radar contact," he automatically discontinues reporting over compulsory reporting points.

Radar Vectoring

Provision of navigational guidance to airplanes in the form of specific headings, based on the use of radar.

Radio Altimeter

Airplane equipment that makes use of the reflection of radio waves from the ground to determine the height of the airplane above the surface.

RNAV Approach

An instrument approach procedure that relies on airplane area navigation equipment for navigational guidance.

Runway Profile Descent

An instrument flight rules (IFR) air traffic control arrival procedure to a runway published for pilot use in graphic and/or textual form and may be associated with a STAR. Runway Profile Descents provide routing and may depict crossing altitudes, speed restrictions, and headings to be flown from the enroute structure to the point where the pilot will receive clearance for and execute an instrument approach procedure. A Runway Profile Descent may apply to more than one runway if so stated on the chart.

Special VFR Conditions

Meteorological conditions that are less than those required for basic VFR flight in Class B, C, D, or E surface areas and in which some airplanes are permitted flight under visual flight rules.

Standard Instrument Departure (SID)

A preplanned instrument flight rule (IFR) air traffic control departure procedure printed for pilot use in graphic and/or textual form. SIDs provide transition from the terminal to the appropriate enroute structure.

Standard Terminal Arrival (STAR)

A preplanned instrument flight rule (IFR) air traffic control arrival procedure published for pilot use in graphic and/or textual form. STARs provide transition from the enroute structure to an outer fix or an instrument approach fix/arrival waypoint in the terminal area.

Threshold

The beginning of that portion of the runway usable for landing.

Threshold Crossing Height (TCH)

The theoretical height above the runway threshold at which the airplane's glide slope antenna would be if the airplane maintains the trajectory established by the mean ILS glide slope or MLS glide path.

Touchdown Zone

The first 3,000 ft of the runway beginning at the threshold.

Traffic Alert and Collision Avoidance System (TCAS)

An airborne collision avoidance system based on radar beacon signals that operates independent of ground-based equipment. TCAS-I generates traffic advisories only. TCAS-II generates traffic advisories and resolution (collision avoidance) advisories in the vertical plane.

Transponder

The airborne radar beacon receiver/transmitter portion of the Air Traffic Control Radar Beacon System (ATCRBS) that automatically receives radio signals from interrogators on the ground and selectively replies with a specific reply pulse or pulse group only to those interrogations being received on the mode to which it is set to respond.

Turbojet Aircraft

Airplanes having a jet engine in which the energy of the jet operates a turbine that in turn operates the air compressor.

Turboprop Aircraft

Airplanes having a jet engine in which the energy of the jet operates a turbine that drives the propeller.

Visual Approach Slope Indicator (VASI)

An airport lighting facility providing vertical visual approach slope guidance to airplanes during approach to landing by radiating a directional pattern of high intensity red and white focused light beams that indicate to the pilot that he is "on path" if he sees red/white, "above path" if whiter/white, and "below path" if red/red. Some airports serving large airplanes have three-bar VASIs that provide two visual glidepaths to the same runway.

Visual Descent Point (VDP)

A defined point on the final approach course of a nonprecision straight-in approach procedure from which normal descent from the MDA to the runway touchdown point may be commenced, provided the approach threshold of that runway, or approach lights, or other markings identifiable with the approach end of that runway are clearly visible to the pilot.

Vector

A heading issued to an airplane to provide navigational guidance by radar.

Visibility

The ability, as determined by atmospheric conditions and expressed in units of distance, to see and identify prominent unlighted objects by day and prominent lighted objects by night. Visibility is reported as statute miles, hundreds of feet or meters.

1. Flight Visibility - The average forward horizontal distance from the cockpit of an aircraft in flight, at which prominent unlighted objects may be seen and identified by day and prominent lighted objects may be seen and identified by night.
2. Ground Visibility - Prevailing horizontal visibility near the earth's surface as reported by the United States National Weather Service or an accredited observer.
3. Prevailing Visibility - The greatest horizontal visibility equaled or exceeded throughout at least half the horizon circle which need not necessarily be continuous.
4. Runway Visibility Value (RVV) - The visibility determined for a particular runway by a transmissometer. A meter provides a continuous indication of the visibility (reported in miles or fractions of miles) for the runway. RVV is used in lieu of prevailing visibility in determining minimums for a particular runway.
5. Runway Visual Range (RVR) - An instrumentally derived value, based on standard calibrations, that represents the horizontal distance a

pilot will see down the runway from the approach end. It is based on the sighting of either high-intensity runway lights or on the visual contrast of other targets, whichever yields the greater visual range. RVR, in contrast to prevailing or runway visibility, is based on what a pilot in a moving aircraft should see looking down the runway. RVR is horizontal visual range, not slant visual range. It is based on the measurement of a transmissometer made near the touchdown point of the instrument runway and is reported in hundreds of feet. RVR is used in lieu of RVV and/or prevailing visibility in determining minimums for a particular runway.

a. Touchdown RVR - The RVR visibility readout values obtained from RVR equipment serving the runway touchdown zone.
b. Mid-RVR - The RVR readout values obtained from RVR equipment located midfield of the runway.
c. Rollout RVR - The RVR readout values obtained from RVR equipment located nearest the rollout end of the runway.

Visual Approach

An approach conducted on an instrument flight rules (IFR) flight plan that authorizes the pilot to proceed visually and clear of clouds to the airport. The pilot must, at all times, have either the airport or the preceding aircraft in sight. This approach must be authorized and under the control of the appropriate air traffic control facility. Reported weather at the airport must be ceiling at or above 1,000 ft and visibility of 3 mi or greater.

Visual Flight Rules (VFR)

Rules that govern the procedures for conducting flight under visual conditions.

Visual Meteorological Conditions (VMC)

Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling equal to or better than specified minimums.

VHF Omnidirectional Range Stations (VOR)

A ground-based electronic navigation aid transmitting very high frequency navigation signals, 360 deg in azimuth, oriented from magnetic north. Used as the basis for navigation in the National Airspace System. The VOR periodically identifies itself by Morse Code, and it may have an additional voice identification feature.

Waypoint

A predetermined geographical position used for route/instrument approach definition, or progress reporting purposes, that is defined relative to a VORTAC station or in terms of latitude/longitude coordinates.

Overview for Management
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Overview for Management

1.0 Introduction

Controlled Flight Into Terrain (CFIT) has been and continues to be the dominant reason for accidents involving airplane hull losses and fatalities. CFIT is defined as an event in which a mechanically normally functioning airplane is inadvertently flown into the ground, water, or an obstacle. Since the beginning of commercial jet operations, more than 9,000 people have died worldwide because of CFIT. ***It is imperative that the CFIT accident rate be lowered.*** This is essential because the number of commercial airplane departures is increasing greatly. If the current rate is applied to the forecast number of departures, CFIT could cause one major airline hull loss, and associated fatalities, per week by the year 2010.

The Flight Safety Foundation organized an international CFIT Task Force in 1993 that was dedicated to reducing CFIT accidents. Five teams were formed to study the causes and factors of CFIT accidents and make recommendations to prevent these accidents. The Task Force was composed of representatives from organizations that possess extensive aviation expertise: airplane manufacturers, aviation training organizations, airplane equipment manufacturers, airlines, pilot groups, and government and regulatory agencies. This document, the CFIT Education and Training Aid, is one product of the Task Force's overall effort to reduce CFIT accidents.

Because of the number of factors that contribute to CFIT accidents, the Task Force Training and Procedures Team concluded that operators must be made aware of the CFIT problem as well as trained to avoid these accidents. Therefore, this CFIT Education and Training Aid was produced for operators. However, the Task Force also recognized that in a great many CFIT accidents, systemic factors made the flight crew the final link in the accident chain of events. Thus, in order to significantly reduce CFIT accidents, existing aviation systems must also be improved. Many of these potential system improvements are addressed in Section 2, Decision Makers Guide.

The responsibility for aviation safety within a company is at the top level of management. There must be a commitment at this level to reducing CFIT accidents. This is where the safety culture is established, and this is where many of the contributing factors to a CFIT accident must be eliminated. Typically, the role of management is to ensure the survival of the company. If, in fact, the current accident rate remains unchanged and departures continue to increase, public confidence in air transportation could be lost, first in individual companies and eventually in the total industry. Furthermore, lack of public confidence and government intervention alone could place an airline company in jeopardy. It is hoped by the Task Force that when the CFIT accident problem is put in this perspective, management will be convinced to support the education and training identified in this aid as an integral part of its overall accident prevention program.

The cost of implementing the CFIT training presented in this training aid is expected to be minimal. Regardless of how operators adopt this material, a significant return is expected on funds spent on CFIT prevention. The CFIT accident rate has been greatly reduced in some areas of the world where specific CFIT training is already occurring and there is a common effort between the ground and flight infrastructures. Operators who are currently offering credible training will find the addition of these suggestions to be principally a change in emphasis rather than an overall replacement of existing training. Other operators may find that using this aid will add only slightly to their training budgets.

Effective training to improve CFIT awareness and knowledge will help eliminate CFIT accidents and incidents. This training aid, together with the accompanying video, is intended to assist all operators in creating or updating their own individual CFIT prevention training programs. Management must ensure that a viable and effective CFIT accident prevention program is in place within its organization.

1.1 General Goals and Objectives

Preventing CFIT is the major goal of this training aid. This goal can be accomplished by improving the knowledge and the decision making of the people who operate the aviation system. Operators and flight crews will benefit from increased knowledge and awareness of the factors involved in preventing CFIT.

Objectives in support of this goal are to:
- Educate both operational and management personnel on CFIT hazards.
- Provide specific, appropriate educational material.
- Propose an example training program that will provide a basis for individual operators to formulate training programs.
- Provide managers with an effective CFIT avoidance strategy by adoption of appropriate operating policies, procedures, and airplane equipment.

The Flight Safety Foundation has other CFIT avoidance materials available. Included are the CFIT Awareness Checklist, various videos, and other written material. (Flight Safety Foundation, 601 Madison Street, Suite 300, Alexandria, VA 22314, USA telephone: 703-739-6700, fax: 703-739-6708)

1.2 Documentation Overview

This CFIT Education and Training Aid includes the following sections:

Section One: Overview for Management
- Provides top-level management with a concise, broad view of the document.

Section Two: Decision Makers Guide
- Identifies areas where those people who govern, regulate, and run the industry can best put their efforts to prevent CFIT.

Section Three: Operators Guide
- Provides the history of CFIT, along with causal factors, traps, and solutions. This section is specifically aimed at the operator end of the scale.

Section Four: Example CFIT Training Program
- Provides specific academic and simulator training programs aimed at informing the flight crews of their responsibilities and duties in preventing CFIT. Appendices include ground briefings, video script, and airplane-specific examples of the CFIT escape maneuver.

Section Five: CFIT Background Material
- Contains selected readings, including the latest CFIT accident/incident information.

1.3 Industry Consensus

The educational material and recommendations provided in this training aid were developed by the CFIT Task Force Training and Procedures Team. Through an extensive multiple review process, the team achieved a consensus within the air transportation industry to include representatives from organizations possessing extensive aviation expertise: airplane manufacturers, aviation training organizations, airplane equipment manufacturers, airlines, pilot groups, and government and regulatory agencies. The participants in the development and/or review of this training aid include the following:

Airbus Industries
Airline Pilot Association
Air Transport Association
Alaska Airlines
AlliedSignal Corporation
America West Airlines
American Airlines
The Boeing Company
Britannia Airways
British Airways
Civil Aviation Authority—United Kingdom
Delta Air Lines
Federal Aviation Administration
Flight Safety Foundation
FlightSafety International
Gulfstream Aerospace
Honeywell Technology
International Air Transport Association
International Civil Aviation Organization
Intnl. Federation of Airline Pilots Association
Japan Air Lines
Jeppesen-Sandersen
Joint Aviation Authorities—Europe
Lockheed Martin
McDonnell Douglas Corporation
National Business Aircraft Association
National Transportation Safety Board
Regional Aircraft Association
Scandinavian Airlines System
United Airlines
USAir
VARIG Brazilian Airlines

1.4 Resource Utilization

This training aid is designed for use in its current form or as a basis for operators to modify existing CFIT training programs. Operators should use both the academic and simulator training programs to achieve a well-balanced, effective CFIT training program.

For some operators, the adoption of the CFIT Education and Training Aid into their existing training programs will require little more than a shift in emphasis. For others, especially those in the process of formulating complete training programs, this training aid will readily provide the foundation for a thorough and efficient program.

The allocation of training time for CFIT within both recurrent and transition programs will vary with each operator. Integration into a typical program is expected to take up to 5 min in each of two simulator sessions and at least 0.5 hr of academic training. The academic program should precede the simulator program.

1.5 Conclusion

Effective training to improve CFIT knowledge and awareness will help to reduce CFIT accidents. This document and the accompanying video are intended to assist all operators in creating or updating their own individual CFIT training. Management is encouraged to take appropriate steps to ensure that a viable, effective CFIT training program is in place within its organization.

Decision Makers Guide
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Decision Makers Guide

2.0 Introduction

In any critical review of Controlled Flight Into Terrain (CFIT) incidents or accidents, it becomes evident that there many interrelated factors that contribute to the causes of CFIT accidents. All of these factors are derived from some level of decision making. It is accepted that the flight crew is the last line of defense in preventing a CFIT accident, and that they make operational decisions that are critical to a safe flight. However, this section will address the responsibility and influence associated with higher level decision making.

For the purposes of this discussion, Decision Makers are those people and organizations who make or influence policy matters. They are:

- Political leaders.
- Aviation regulatory agencies, including air traffic control (ATC) authorities.
- International aviation organizations.
- Airline management.
- National safety advisory and investigation agencies.
- Pilot associations and unions.
- Aircraft manufacturers.
- Aircraft lessors.
- Aircraft insurers.
- Financial institutions.

Many contributing factors associated with CFIT accidents are embedded in policies and decisions made by these Decision Makers. ***Therefore, the goals of this CFIT Education and Training Aid can only be achieved with the endorsement and support of Decision Makers, not just the flight crews and other operators.*** In fact, many recommendations or strategies made in Section 3, Operators Guide, can only be successful if they are supported and implemented by the Decision Makers.

The underlying goal of all aviation industry Decision Makers should be system safety; the public expects it and assumes it. The reality is that humans make errors and always will, and, therefore, there will always be some level of risk associated with the aviation industry. The goal at the Decision Makers level must be management of this risk. Each level of authority has the capacity to implement the recommended CFIT avoidance strategies and achieve worthwhile results independently of other levels. When all levels do so in coordination with one another, the maximum effect can be achieved.

Reducing CFIT accidents requires recognition that such accidents are system induced; that is, that they are generated by shortcomings in the aviation system, including deficiencies in the organizations that constitute that system. In discussing the principle of joint causation and the influence of the organization, Arostegui and Maurino[1] state: "Such understanding will preclude the piecemeal approaches based on design, training, or regulations which have plagued past safety initiatives. Looking into the organizational context will permit one to evaluate whether organizational objectives and goals are consistent or conflicting with the design of the organization, and whether operational personnel have been provided with the necessary means to achieve such goals."

While we acknowledge the broadness in the spectrum of those organizations we include as Decision Makers, it is important not to overlook the great influence that airline management has on safety in general, and specifically on preventing CFIT accidents. ***Airline management creates the safety culture of the organization. This culture then affects everyone within the organization.*** In an article by the ICARUS Committee[2], safety is placed in perspective with other organization goals: "Accidents and incidents are preventable through effective management: doing so is cost effective.

[1] **Human Factors and Training Issues in CFIT Accidents and Incidents**, Captain Roberto Arostegui and Captain Daniel Maurino.

[2] **The Dollars and Sense of Risk Management And Airline Safety**, Flight Safety Foundation, Flight Safety Digest, December 1994.

An airline is formed to achieve practical objectives. Although frequently so stated, safety is not, in fact, the primary objective. The airline's objectives are related to production: transporting passengers or transporting goods and producing profits. Safety fits into the objectives, but in a supporting role: to achieve the production objectives without harm to human life or damage to property. Management must put safety into perspective, and must make rational decisions about where safety can help meet the objectives of the organization. From an organizational perspective, safety is a method of conserving all forms of resources, including controlling costs. Safety allows the organization to pursue its production objectives without harm to human life or damage to equipment. Safety helps management achieve objectives with the least risk."

This article also makes the point that, historically, safety initiatives have originated at the institutional levels closest to the accident, i.e., operators. This has improved performance, and it has resulted in enhanced aviation safety; however, the industry has reached the point of diminishing returns from this approach. A greater expenditure of resources at the operational end of the system will not result in proportionate safety benefits. Therefore, it is now necessary for prevention strategies to take into account the total aviation industry and infrastructure.

2.1 Recommendations to Decision Makers

Section 3, Operators Guide, contains many recommendations that, when implemented, can mitigate CFIT accident risk by addressing systemic and other factors that lead to this type of accident. Systemic problems may remain undetected for years before they surface as a contributing factor of a CFIT accident. What may initially appear to be an operational breakdown in reality may have been the result of omitting CFIT prevention training from the overall training program or perhaps having a marginal safety awareness program within the organization.

Decision Makers must be involved in order to implement these recommendations, as well as those applicable to nonoperators. In order to provide consistency and ease of identification, most of the recommendations are summarized in this Decision Makers section. ***A full report of the Training and Procedures Work Group and Aircraft Equipment Team is included in Section 5. Decision Makers should review these items and the other information included in these secs. 3 and 5 and incorporate the policies and recommendations into their organizations, if appropriate.***

2.1.1 Measurement and Evaluation of System Performance

Many operators currently have insufficient methods to provide systems and infrastructure for monitoring and evaluating the operational performance of management, flight crews, and equipment. All operators should provide these systems, with the objective of enhancing operational integrity. This can be accomplished by means of some, or preferably, all, of the following:

- Flight data recorder analysis.
- Quick access recorder analysis.
- Flight Operations Quality Assurance Programs.
- Databases for safety analysis.
- Defined criteria for safety reporting.
- Establishment and encouragement of a "no blame" reporting culture.
- Effective application by the management process/culture of accumulated data.
- Implementation of an independent quality audit function to achieve operational integrity.

2.1.2 Use of Autopilots

Flight crews do not take full advantage of automatic systems to manage the progress of a flight and reduce workload. The use of autopilots is encouraged during all approaches and missed approaches, in instrument meteorological conditions (IMC), when suitable equipment is installed. It is incumbent upon operators to develop specific procedures for the use of autopilots and autothrottles during precision approaches, nonprecision approaches, and missed approaches and to provide simulator-based training in the use of these procedures to all flight crews. Autopilot and autothrottle functionality and limitations also need to be thoroughly understood by flight crews.

2.1.3 Acceptance of ATC Clearances

From time to time, ATC issues flawed instructions that do not ensure adequate terrain clearance. Such clearances are too often accepted by flight crews without considering consequences and/or questioning instructions. Flight crews should not assume that ATC clearances will ensure terrain clearance. If an ATC clearance is given that conflicts with the flight crew assessment of terrain criteria relative to known position, the clearance should be questioned and, if necessary, refused, and suitable action should be taken. Training programs should address this issue.

2.1.4 Chart Supply

The failure of operators to provide flight crews with adequate supplies of current navigation and approach charts is a significant barrier to safety. In some instances, current charting standards do not provide adequate information to flight crews about potential terrain hazards, or they are so complex as to make clear interpretation difficult. Each flight crew should be provided with accurate, current charts with clear depiction of hazardous terrain and minimum safe altitudes. Such charts should depict hazardous terrain or minimum safe altitudes, preferably in color, in a manner that is easy to recognize, understand, and read under cockpit lighting at night. Electronic displays should resemble printed charts to the maximum extent feasible.

2.1.5 Use of Checklists

Poorly conceived procedures for use of checklists can result in task saturation of flight crews during critical phases of flight. Incidents and accidents have occurred as a result of noncompletion of relevant checklist(s). It is recommended that a detailed policy on the use of checklists be formulated by each operator and that a strict discipline regarding their use be maintained. Such policies should require that checklists be completed early in the approach phase to minimize distraction while maneuvering close to the ground. In the absence of other guidance, checklists should be completed no later than 1,000 ft AGL.

2.1.6 Allocation of Flight Crew Duties, Use of Monitored Approach Procedures

The majority of CFIT incidents/accidents are known to occur in IMC and at night, when the pilot flying the approach also lands the aircraft. Proper management of flight crew workload at night and during IMC requires that precise and unambiguous procedures be established. It is recommended that operators consider adopting a monitored approach procedure during approaches and missed approaches conducted in these conditions. In this case, the First Officer will fly approaches and missed approaches. The Captain will monitor approach progress and subsequently land the aircraft after obtaining sufficient visual reference.

2.1.7 Rate of Descent Policy

High rates of descent in close proximity to terrain are dangerous. They result in increased risk of CFIT, high flight crew workload, and reduced margins of safety. A policy should be established that restricts the rate of descent allowed within a prescribed vertical distance of (1) the applicable Minimum Enroute Altitude (MEA) and (2) the Minimum Sector Altitude, as defined by ICAO Procedures for Air Navigation Services—Aircraft Operations/Terminal Instrument Procedures (PANS-OPS/TERPS). As an example, the restriction could be 2,000 ft/min maximum rate of descent at or below 2,000 ft above either of these altitudes.

2.1.8 Route and Destination Familiarization

Flight crews may be inadequately prepared for CFIT critical conditions, both enroute and at destination. Flight crews should be provided with adequate means to become familiar with enroute and destination conditions for routes deemed CFIT critical. One or more of the following methods are considered acceptable for this purpose:

- When making first flights along routes or to destinations deemed CFIT critical, Captains should be accompanied by another pilot familiar with the conditions.
- Suitable simulators can be used to familiarize flight crews with airport critical conditions when those simulators can realistically depict the procedural requirements expected of flight crew members.
- Written guidance, dispatch briefing material, and video familiarization using actual or simulated representations of destination and alternatives should be provided.

2.1.9 Stabilized Approaches

Unstable approaches contribute to many incidents/accidents. Pilots should establish a stabilized approach profile for all instrument and visual approaches. A stabilized approach has the following characteristics:

- A constant rate of descent along an approximate 3-deg approach path that intersects the landing runway approximately 1,000 ft beyond the approach end and begins not later than the final approach fix or equivalent position.
- Flight from an established height above touchdown should be in a landing configuration with appropriate and stable airspeed, power setting, trim, and constant rate of descent and on the defined descent profile.
- Normally, a stabilized approach configuration should be achieved no later than 1,000 ft AGL in IMC. However, in all cases if a stabilized approach is not achieved by 500 ft AGL, an immediate missed approach shall be initiated.

2.1.10 Crew Resource Management

Decision Makers should support effective Crew Resource Management (CRM) and ensure that it is the normal way that flight crews operate within their organization. This is essential for safe, orderly, and profitable operation of an airline's flights.

2.1.11 Standard Operating Procedures

Many studies show that airlines with established, well thought out and implemented standard operating procedures (SOP) have consistently safer operations. Clear, concise, and understandable SOPs need to be developed by each airline. Through these procedures and behaviors, the airline sets the standards that the flight crews are required to follow. Flight crews, on the other hand, must be able to inform management when these procedures are not producing the desired results.

All levels of decision making throughout the airlines must ensure that appropriate SOPs are in place and flight crews are trained to use them. These SOPs must address not only the needs of the airline, but the responsibilities of both management and operations. If these policies are not understood by either party, changes must be proposed, agreed to by all concerned, and implemented. Remember, this is an ongoing process. As situations change, the policies must be reevaluated for comparable change. Flight crews need to know what is required of them.

2.2 Communication

The link between Decision Makers and operations is communication and training. This should be two-way communication. Decision Makers are responsible for the broad scope of the operation, and they set the tone for the everyday routine. They must listen to those people who accomplish the day-to-day tasks, take appropriate action based on data obtained from operational performance monitoring systems, and be able to adjust the overall scope to meet the operational challenges.

All who are involved in the aviation industry must work as a team to prevent CFIT. This includes the flight crew and cabin staff, the mechanic, the airline CEO, the cockpit designer, ATC, the airplane manufacturers, and perhaps a nation's elected or appointed official or a sales representative. To fix systemic problems, it takes a broad approach that includes many people. All of these people have a vested interest in the success of aviation, all are rightfully proud of their contribution to the common goal, and all are inexorably tied to one another. We are all in this together. We share the successes. We must also shoulder the responsibility for the shortcomings. We must work to mold everyone into a highly professional and dedicated team.

Managing flight crew resources means the dissemination of information—integrating and using the entire flight crew aboard an airplane to bring about a safe and smoothly running flight. This CFIT team concept is just as applicable to the broad spectrum of the aviation industry as it is to the flight crew of a single airplane. With everyone's commitment, this industry can make airplane travel even safer than it is now.

2.3 Short-Term Goals

To help stop CFIT from continuing to claim lives, the entire aviation industry should work together to institute some immediate measures.

2.3.1 ATC Issues

At the highest levels, there should be a commitment to installation of modern communication facilities throughout the world. Upgraded radio communication, radar, civilian air traffic control of the airways, addition of precision instrument approaches and addition of VASI or PAPI lights to runways, and standardization of approach design criteria and procedures should also be implemented. Language training for both flight crews and air traffic controllers should be improved and intensified to enhance ATC's ability to absorb the increasing number of airplanes. If this is not possible, then remedial measures should be considered.

2.3.2 Sharing Information

Airline management, ATC, and regulatory agencies can do their part by being more open with information. Any mistrust between these parties needs to be addressed. Change occurs even faster today than just 5 years ago, and the rate is increasing. All parties involved need to be more open to the new technologies and thinking. Safety in aviation comes about, in part, by freely sharing information. This means allowing flight crews to learn from others' experiences. Currently, the exchange of this information is too highly restricted, partly because some management policies tend to blame first and think about safety next and partly because people don't like to admit to certain shortcomings.

If we learn from the mistakes of others, then it seems logical to institute, within all air carriers, an incident reporting system that will deliver information, but without stigma. One of the largest international carriers in the world has used this system for years and has nothing but praise for the results. This airline can confidentially track trends with the use of flight data recordings and subsequent analysis. The dissemination of this information along with flight crew reports of incidents and potential incidents can prevent accidents. Lives are being saved at little or no cost to the carrier. This is not just a task for the airline managers. Flight crews need to support this initiative and be given assurance that inappropriate punitive action will not be taken as a result. The various industry associations also need to embrace the idea that shared information will improve safety.

2.3.3 Standard Operating Procedures

There are some airlines that do not currently have good SOPs. This can be resolved in a very short time. While some airlines consider SOPs proprietary, it should be possible to share most of the basic information with those airlines that need to establish SOPs.

2.3.4 Ground Proximity Warning System Installation and Modification Updates

The installation of the Ground Proximity Warning System (GPWS) on all airplanes in a carrier's fleet can reduce CFIT accidents. It is one of the major weapons in the growing arsenal of CFIT prevention methods. Every airplane in every fleet in the world should be equipped with a fully functioning GPWS. Airplanes currently using the original Mark I GPWS should be retrofitted with the newer, updated GPWS equipment to take advantage of technology improvements. Incorporate automatic radio altitude voice callouts to improve terrain awareness. This will give our flight crews and passengers the best chance for survival.

2.3.5 CFIT Accident Prevention Training Program

Airlines that are considered the safest in the industry all have a complete training program that includes CFIT prevention. Most are already teaching their flight crews about the factors and causes of CFIT accidents as well as techniques to avoid getting into these situations in the first place. These airlines make sure that all of their flight crews understand the need for thorough briefings, professional flying, and CRM.

This training aid includes a full training program with both academic and simulator training. An instructor briefing supplement, CFIT safety briefing, and questions are also part of the Example CFIT Training Program section in this training aid. Airlines that currently have a CFIT education and prevention training program in place should review the contents of the Example CFIT Training Program and choose those areas that they deem appropriate for supplementing their current training. Those airlines that do not include CFIT prevention in their training program are encouraged to use the entire Example CFIT Training Program to ensure that their flight crews understand the threat posed by CFIT.

2.3.6 Approach Procedure Design and Specifications

The improved design of the nonprecision approach can be accomplished at little cost. This objective can be met by the simplification of the nonprecision approach, the specification of a stabilized approach, and the provision of a nominal 3-deg glide path.

Specifications for approach criteria are contained in ICAO PANS-OPS and U.S. TERPS. There are many instrument approaches being used by airlines that do not comply with either of these specifications. Organizations, states, regulatory agencies, and others who are responsible for designing instrument approaches should adopt these standardized specifications.

Additionally, significant terrain around airports should be depicted on color contour approach chart products. Flight crew situational awareness would be greatly enhanced.

2.3.7 Barometric Altimetry

The loss of vertical situational awareness is the cause of many CFIT accidents. The contributing factors associated with this cause often have to do with the barometric altimeter. These factors range from misinterpretation of the three-pointer and drum-pointer altimeter to confusion resulting from the use of different altitude and height reference systems, as well as altimeter setting units of measurement. Flight crew training is now used as a means of solving this problem, but consideration should be given to discontinuing the use of some altimeter designs and standardizing the use of altitude and height reference systems and altimeter setting units of measurement.

2.4 Long-Term Solutions

The CFIT Training and Procedures Working Group believes that a long-term solution to CFIT is in communication and training. The management structure must permit a free flow of information in all directions. This would allow the timely passing of information about safety issues that will help prevent CFIT accidents and incidents. Equally important is a comprehensive CFIT prevention training program. All carriers should implement and maintain intensive initial and recurrent ground and simulator training that covers CFIT prevention strategies.

Decision Makers control many of the systemic solutions for preventing CFIT accidents. A detailed analysis that includes the subjects covered in this section should be made, and appropriate action should be taken.

CFIT Operators Guide
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Operators Guide

3.0 Introduction

This Operators Guide is Section 3 of the five-section Controlled Flight Into Terrain (CFIT) Education and Training Aid. Other sections include the Overview for Management, Decision Makers Guide, Example CFIT Training Program, and CFIT Background Material.

For the purposes of the CFIT Education and Training Aid, the term "operators" refers to the people involved in all operations functions required for the flight of commercial airplanes carrying at least 10 passengers, including airplanes involved in cargo operations. "Operators" is a broad term that includes such functions as air traffic systems, flight crew, flight dispatch, flight scheduling, flight training, and other supporting flight operations functions.

The goal of this training aid is to reduce the number of CFIT accidents. This can be accomplished by improving the knowledge and decision making of those who manage and fly within the international aviation system. This Operators Guide targets these people.

The material and recommendations provided in the CFIT Education and Training Aid were developed through an extensive review process to achieve consensus within the international aviation industry.

Portions of the data used in this aid came from the NASA Aviation Safety Reporting System (ASRS). While these are not objective reports, they are an excellent source of CFIT factors that can and have occurred. Even though ASRS reports may contain some unintentional inaccuracy, the CFIT Industry Team has included the information because its value exceeds the risk of editorial comment or inaccurate conclusions.

3.0.1 Operators Guide Objectives

The objective of the Operators Guide is to summarize and communicate key information that is relevant to operators. This Operators Guide:

- Indicates the magnitude of CFIT accidents.
- Identifies the causes of CFIT accidents.
- Identifies factors that contribute to CFIT accidents.
- Provides solutions and recommendations that, when implemented, can prevent CFIT accidents.

3.1 CFIT Accidents

A CFIT accident is defined as an event where a mechanically normally functioning airplane is inadvertently flown into the ground, water, or an obstacle. These accidents have a history as old as flight itself. In the early days of reciprocating engine commercial airplanes, fully half of all accidents were attributable to CFIT. Since the beginning of commercial jet operations, more than 9,000 people have died worldwide because of CFIT.

Figure 1
Hull-Loss Accidents for Worldwide Commercial Jet Fleet

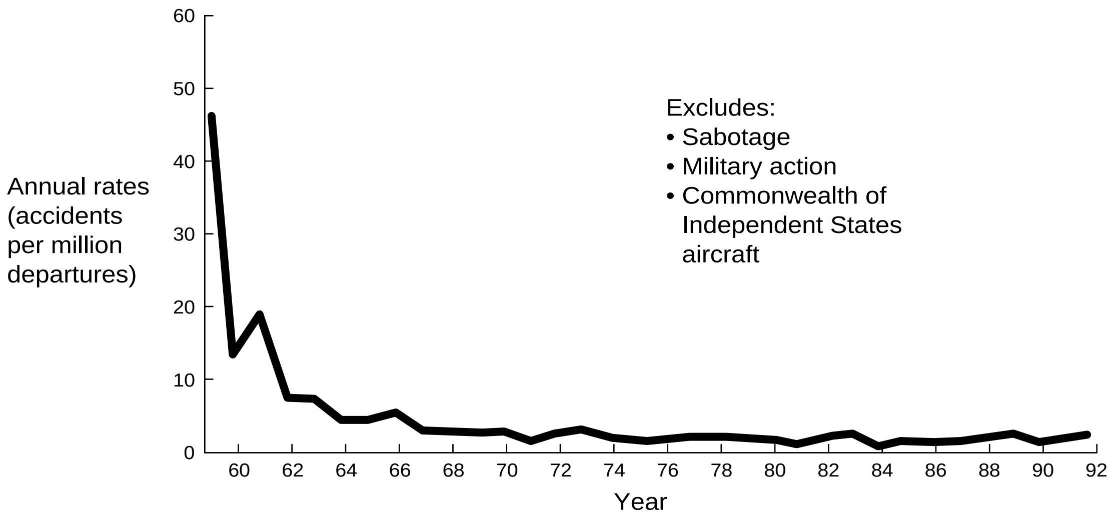
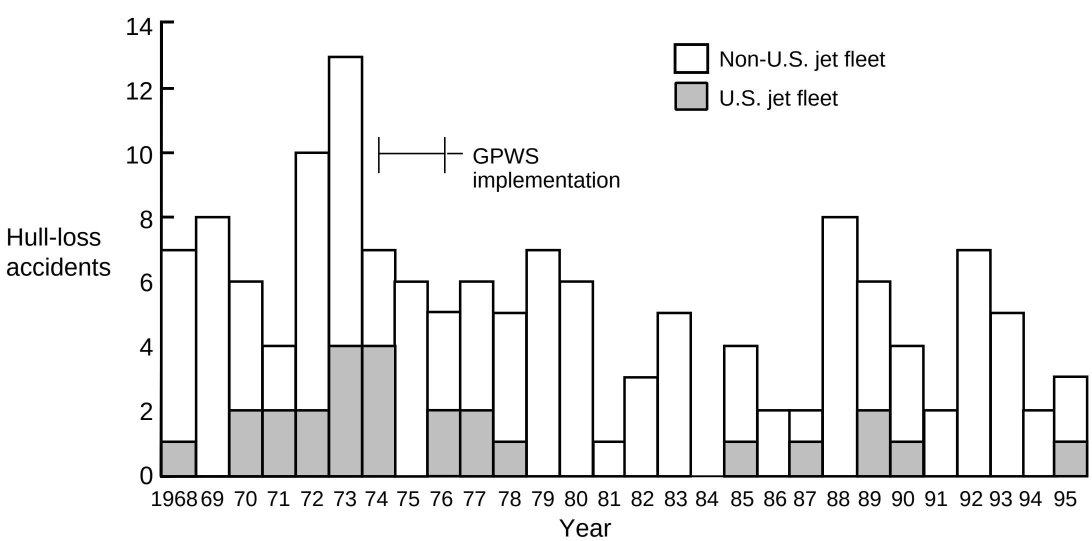


Figure 2
CFIT Hull-Loss Accidents for Worldwide Commercial Jet Fleet



The worldwide accident rate (which includes CFIT) for the commercial jet fleet decreased significantly in the 1960s and 1970s. This rate stabilized at that time and remains fairly stable today (Figure 1). Operators can be very satisfied with this accomplishment, but let's look at the actual number of CFIT accidents that are included in this accident rate. Figure 2 shows hull losses attributed to CFIT for the U.S. fleet as well as the rest of the world's fleet. The reduction in CFIT accidents that started in 1975 will be discussed later. The important thing to understand about these accidents is that they happened with normally functioning airplanes. These are accidents that operators could have prevented! From 1991 through 1995 there were more CFIT accidents than any other type (Figure 3). These accidents led to almost 1,000 fatalities, and in 1995 there were more fatalities attributed to CFIT than to any other type of accident (Figure 4). From November 1994 through December 1995, there were five CFIT accidents and 336 fatalities. CFIT is still happening.

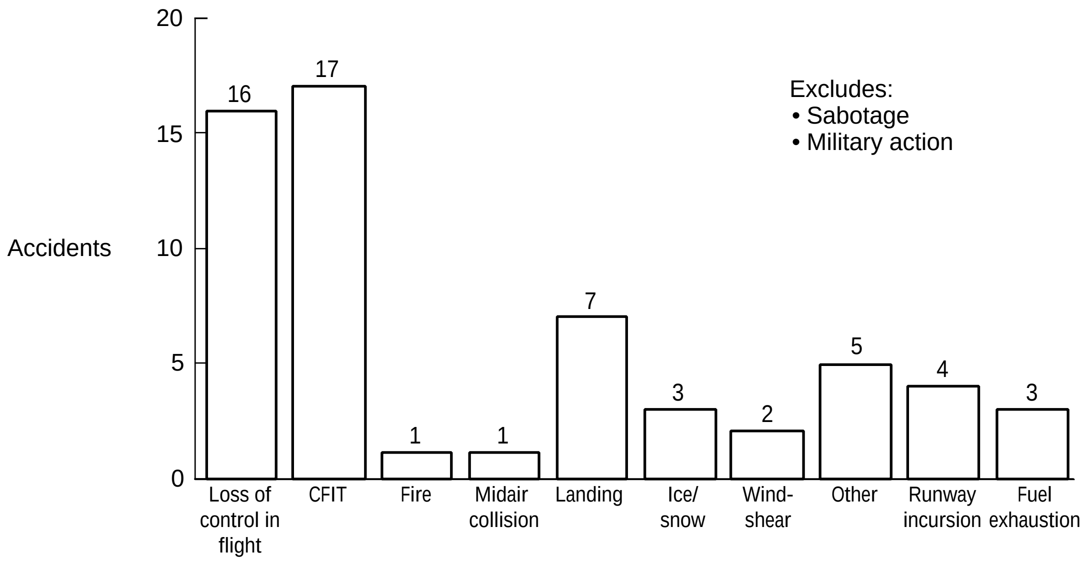


Figure 3
Worldwide Airline Accidents Classified by Type - 1991 Through 1995

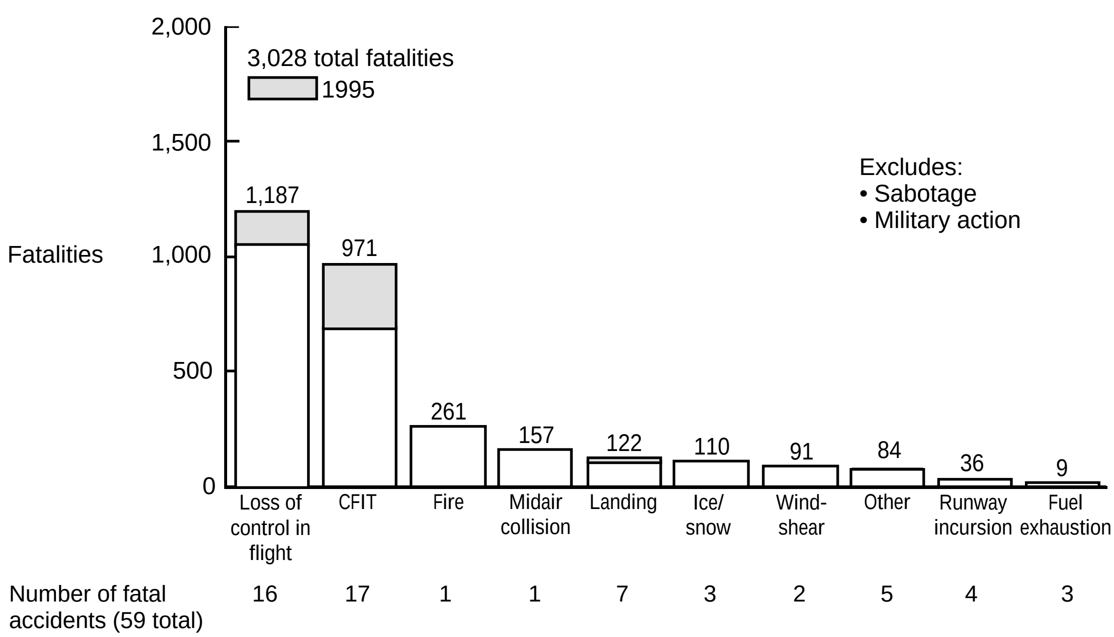


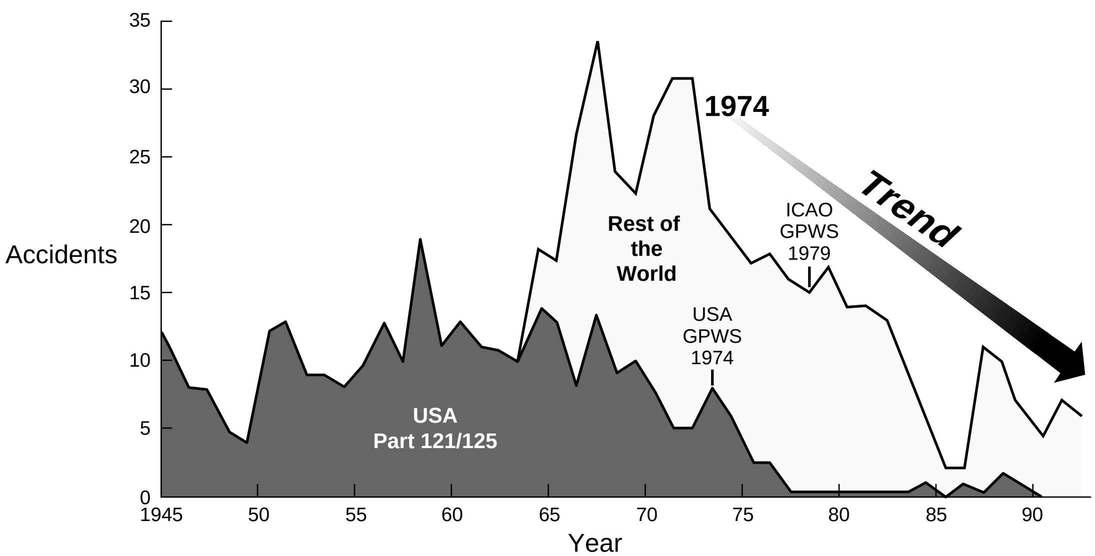
Figure 4
Worldwide Airline Fatalities Classified by Type of Accident - 1991 Through 1995

3.1.1 The Positive Results of the Ground Proximity Warning System (GPWS)

The number of CFIT accidents reached a historical high in 1973 (Figure 2). In the United States, starting in 1975, large jet transport accidents attributable to CFIT fell to an average of only one every 2 years. A major reason for this was the advent of the GPWS. In the early 1970s, Scandinavian Airlines System originated the concept of a warning system that would alert flight crews of imminent flight into terrain. Using the existing radio altimeter and air data computers, AlliedSignal (formerly Sundstrand Data Control) developed this cost-effective and practical device for installation in airplanes. An aural warning tone that was used in the original equipment to warn the flight crew was quickly replaced by a “pull up” command that was triggered by the airplane’s flight path in relation to terrain characteristics.

In 1973, some airplane manufacturers and airlines recommended that GPWS be installed on their airplanes (Figure 5). During the following year, GPWS became standard equipment on most new airplanes. The United States Federal Aviation Administration (FAA) issued a Proposed Rule requiring that GPWS equipment be installed on all airplanes that operated under Part 121 and Part 125 regulations. The FAA still had some doubts concerning the effectiveness of GPWS in preventing CFIT, and it did not want the industry to rely only on GPWS for the prevention of CFIT accidents. In fact, in early 1974, the FAA issued a statement noting that “Present instrumentation and inflight procedures provide for safe and adequate terrain clearance as long as proper flight crew members discipline is maintained and appropriate flight operations procedures are followed.”

Figure 5
CFIT Accidents Per Year—USA and World Carriers



Late in 1974 in the United States, a CFIT accident resulted in more rapid reaction by the FAA. A 727 flying a VOR/DME approach to runway 12 struck a hill 50 ft below the crest 20 mi from Dulles Airport in Washington, D.C. There were more than 90 fatalities. Subsequent to this accident, the FAA enacted FAR 121.360, which required all large jet and turbo-prop airplanes to be equipped with GPWS by the end of 1975. The short response time imposed by this ruling was met with initial reluctance by the airline community. Even with this reluctance and some technical problems that accompanied the regulatory requirement for GPWS, CFIT losses began a very significant and continuous drop. In the United States, accidents that were attributable to CFIT fell from the previous eight per year to only one per 5 years (Figure 2). In addition to GPWS, there were other initiatives that also helped reduce CFIT accidents. Expansion and upgrading of the air traffic control (ATC) radar within the United States, Air Route Traffic System III Minimum Safe Altitude Warning System (MSAWS), approach lighting, Visual Approach Slope Indicator (VASI) and precision approach path indicators (PAPI) systems, and Instrument Landing Systems (ILS) all had a positive effect in reducing the CFIT problem.

The United Kingdom Civil Aviation Authority conducted an evaluation using actual airline flight data. As a result of this, in 1975 it followed the FAA lead and also mandated the installation of GPWS by issuing Specification 14 as the technical standard. The International Civil Aviation Organization (ICAO) established GPWS standards in 1979. All of these actions resulted in the reduction of the number of worldwide CFIT accidents (Figure 2).

Regional carriers in the United States were not required to have the GPWS installed on their airplanes until recently. It is interesting to note that during the time that CFIT accidents for the large carriers decreased to about one hull loss every other year, the regional carriers without GPWS were experiencing CFIT accidents that resulted in an average of three hull losses per year.

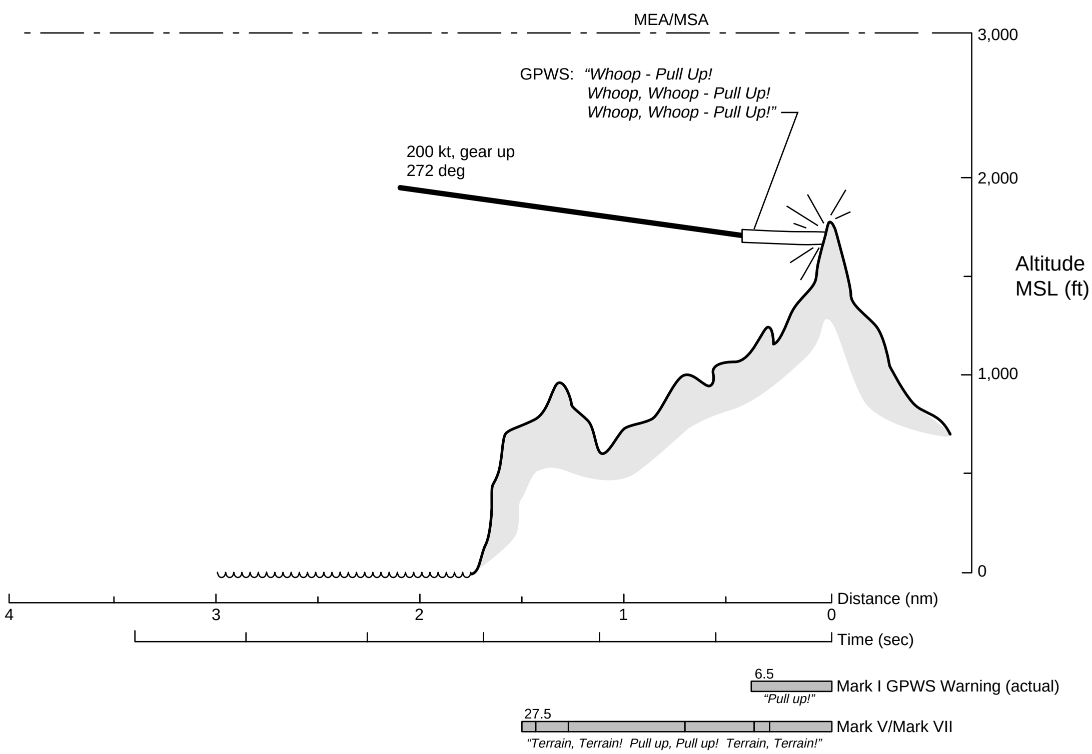
3.1.2 GPWS Initial Reliability and Follow-On Improvements

The first GPWS model, the Mark I, was not as reliable as anticipated, because of the rush to meet regulatory installation time requirements. It was plagued with false and nuisance warnings. This led to these prophetic remarks from the Air Transport Association of America in late 1975: “Pilots will quickly lose confidence in this system if this continues for even a short period of time. Once they lose confidence, it will be practically impossible to regain. Then, the efforts of both the FAA and industry to realize the safety benefits which this system promises will have gone for nothing. We will have spent thousands of man-hours and millions of dollars on a black box that nobody trusts.” In a survey conducted soon after the GPWS installation requirement, 83% of the pilots surveyed expressed concerns about false or nuisance alerts. These concerns included the potential for having a midair collision while performing a mandatory pull-up, losing control of the airplane while distracted, ignoring a valid warning because of system credibility problems, and ignoring a valid warning through a misunderstanding of the cause of the warning.

Now, 20 years later, we still may be living with these concerns. We are still trying to regain flight crew confidence in GPWS. Flight crew recognition and subsequent response is still being influenced by GPWS warning integrity. Many CFIT accidents have been attributable to flightcrews failing to respond properly to valid GPWS warnings even though modifications and improvements were made to the system. (Refer to Sec. 5, AlliedSignal Aerospace Report). The Mark I was improved in 1975, and the Mark II version was on the line in 1976. The Mark II allowed higher sink rates at lower altitudes; provided for better high-speed warnings; and added specific reasons for warnings such as “Too Low-Gear” and “Terrain, Terrain.” The latest versions of the GPWS, the Mark V and VII, are tailored for terrain around specific airports, and they are easily reprogrammed, if needed. Although false alerts still occur and are a cause for concern, there is no evidence that an accident has been caused by these nuisance alerts.

With the early Mark I GPWS, the frequency of pull-up warnings was about one per 750 sectors. (A sector is that portion of an airplane flight that consists of one takeoff and one landing.) Recent data show that pull-up warnings now average about one for each 5,000 sectors for short-haul carriers and once per 7,000 sectors for long-haul carriers. Along with better validity in the GPWS warnings came earlier warnings to the flight crew. With the first versions of GPWS there was as little as 5 sec warning and no warning if the projected impact point was on a relatively steep slope of a mountain. Now, after continual upgrade modifications, the warning time has increased to almost 30 sec, and improvements are still in progress. The significance of this improved warning time can be seen by reviewing the flight path profile of a CFIT accident that happened in Azores, Portugal (Figure 6).

Figure 6
Flight Path Profile: 707-300, Santa Maria, Azores, February 8, 1989



3.1.3 Industry Support Required for GPWS

Installation of GPWS on all airplanes should be the goal of the international aviation industry. It is estimated that over the next 15 years, half of the current unequipped airplanes will be retired from service. However, this still leaves nearly 200 airplanes that do not have GPWS installed. Currently, less than 5% of the world's commercial airplane fleet is not equipped with GPWS; however, these unequipped airplanes are involved in nearly 50% of CFIT accidents (Figures 7 and 8).

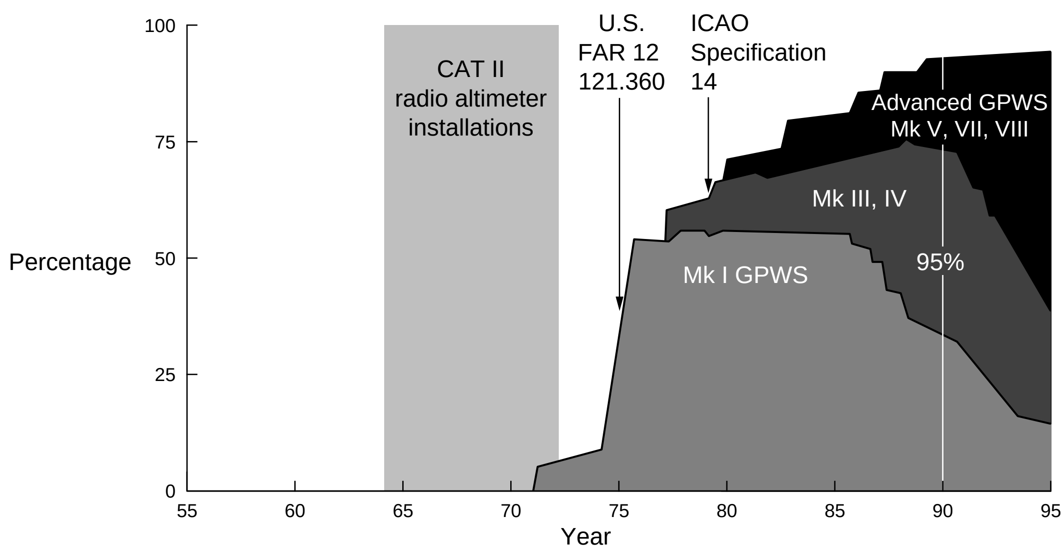


Figure 7
World Airline Jet Fleet Equipped With GPWS

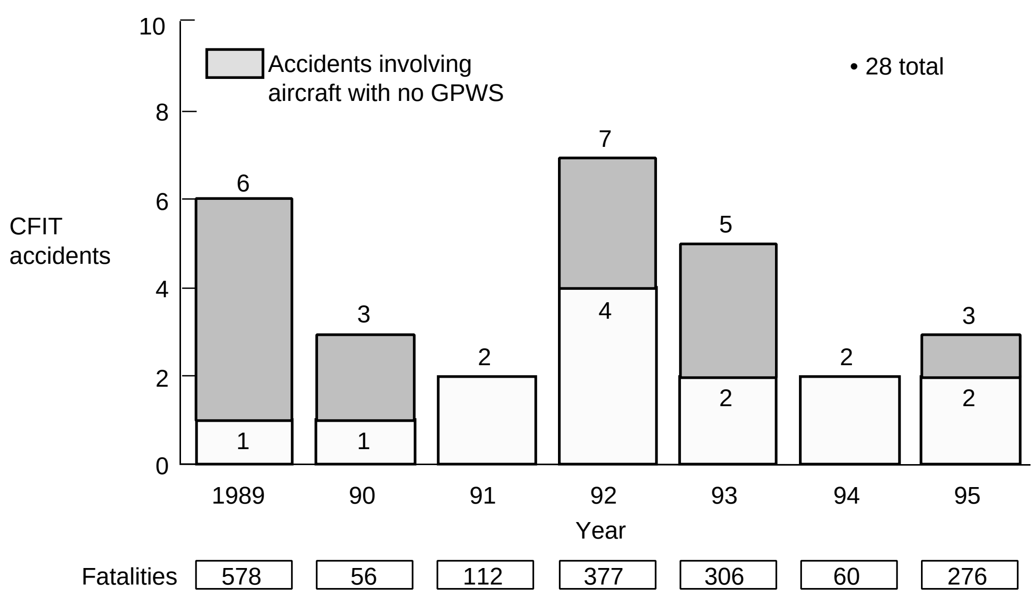


Figure 8
Commercial Jet CFIT Accidents: 7-Year Period - 1989 Through 1995

3.2 CFIT and the Flight Crew

The most prevalent primary factor for hull losses with known causes is the flight crew (Figure 9). For worldwide airlines from 1991 to 1995, there were more CFIT accidents than any other type (Figure 3). What are the causes and contributing factors for these accidents, and why do they occur? The answers lie in two areas. One set of factors is found primarily in the operations area and will be addressed in this section. Of equal importance are the factors that are present in the corporate, management, government, and regulatory area. These factors are covered in Section 2 of this CFIT Education and Training Aid.

3.2.1 Causes for CFIT Accidents

There are two basic causes of CFIT accidents; both involve flight crew situational awareness. One definition of situational awareness is an accurate perception by flight crews of the factors and conditions currently affecting the safe operation of the aircraft and the crew. The causes for CFIT are the flight crews' lack of vertical position awareness or their lack of horizontal position awareness in relation to the ground, water, or obstacles. More than two-thirds of all CFIT accidents are the result of altitude error or lack of vertical situational awareness. Simply stated, flight crews need to know where they are and the safe altitude for flight. The underlying assumption is that a flight crew is not going to knowingly fly into something. It follows then that CFIT accidents occur during reduced visibility associated with instrument meteorological conditions (IMC), darkness, or a combination of both conditions.

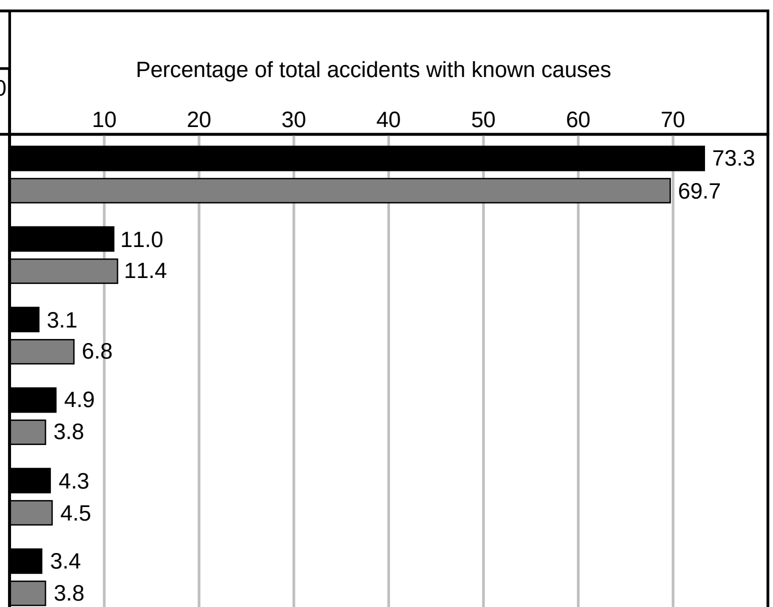
3.2.2 Factors That Contribute to CFIT

There are many factors that lead to CFIT accidents. We all accept that the flight crew has the final responsibility for preventing a CFIT accident, but if many of the factors normally associated with these accidents were eliminated, or at least mitigated, the potential for flight crew errors would be lessened.

- In the following sections, abbreviated solutions to counter CFIT factors and prevent CFIT accidents are indicated by a bullet (solid dot) shown here. More detailed discussion of CFIT prevention strategies can be found in Section 3.3.

Figure 9 Primary Cause Factors for Hull-Loss Accidents for Worldwide Commercial Jet Fleet

Primary factor	Number of accidents: Total	Number of accidents: Last 10 years
Flight crew	327	92
Airplane	49	15
Maintenance	14	9
Weather	22	5
Airport/ATC	19	6
Miscellaneous	15	5
Total with known causes	446	132
Unknown or awaiting reports	90	54
Total	536	186



Excludes:
- Sabotage
- Military action

Legend:
1959 to 1994
Last 10 years (1985 to 1994)

3.2.2.1 Altimeter Setting Units of Measurement Factors

Accidents and numerous incidents have been recorded that involved the aircraft altimeter! Errors associated with the use of the barometric altimeter and its settings remain a problem that is compounded by language, nonstandard phraseology, and the use of different units of measurement. While there is an international standard, it is not adhered to by all states. Altimeter settings may be given in inches of mercury (inHg), hectoPascals (hPa), or millibars (mbars). Note: HectoPascals replaced millibars (metric) as a unit of measurement term for altimeter settings. Some air traffic systems use meters and some use feet for altitude reference. Most airplanes are only equipped with altimeters that use feet as a reference. The unit of measurement used depends on the area of the world in which the flight crew is flying. A problem can arise when a flight crew has been trained and primarily operates in one area of the world and only periodically operates elsewhere.

The following is an example of what can happen. An ATC controller, who speaks English as a second language, hurriedly advises the flight crew to descend and maintain 9,000 ft using an altimeter setting of "992." The flight crew begins the letdown and dutifully sets 29.92, not 992 hectoPascals that the controller was expecting to be set. Throughout the approach the airplane will be approximately 600 ft below the altitude indicated on the altimeters. The airplane will prematurely descend to the next lower altitude on a nonprecision approach and level approximately 600 ft below the MDA. This can make the difference between a normal landing at the destination and a CFIT accident just short of the runway.

- Know what altimeter units of measurement are used for the area in which you are flying.
- Be especially vigilant during radio transmissions of altimeter settings. If in doubt, verify whether the setting was given in inches of mercury or hectoPascals/millibars.
- Be prepared for the conversion of feet and meters.

3.2.2.2 Altimeter Settings Factors

The QNH altimeter setting is obtained by measuring the existing surface pressure and converting it to a pressure that would theoretically exist at sea level at that point. This is accomplished by adding the pressure change for elevation above sea level on a standard day. This QNH altimeter setting is the standard used throughout most of the world. ***Some states, however, report or use QFE.***

The QFE altimeter setting is the actual surface pressure, and it is not corrected to sea level. The QFE altimeter setting results in the altimeter indicating height above field elevation, while the QNH setting results in the altimeter indicating altitude above mean sea level (MSL).

There have been incidents in which a QNH setting has been erroneously used as a QFE setting. This results in the airplane being flown lower than the required altitude (Source: Pilot report from Peoples Republic of China).

The QNE altimeter setting is always 29.92 inHg, or 1013 hPa/mbars. QNE is set when operating at, climbing through, or operating above the transition altitude. Transition altitudes are not standardized throughout the world, which increases the potential for flight crews to make errors.

Extreme atmospheric anomalies, such as low temperatures or low pressures, can affect altimeters and result in reduced altitude margins of safety. This incident was reported by a Jetstream 31 Captain: "The First Officer got the ATIS. Passing FL180, the First Officer called the transition, altimeters 29.82. I questioned that setting, and he recounted, stating the setting of 29.82. We executed the VOR RWY 25 via the arc. Turning onto the inbound course, the minimum alt is 800 feet, to which I started to descend. We had been in and out of clouds with a ragged ceiling and low light conditions. My focus was inside the cockpit. At about 1,400 feet, out of the side of my eye, I noticed that the waves on the water looked awfully close. I looked out the window and got the immediate feeling something was horribly wrong. I told the First Officer to verify altimeter setting, and tower came back with 28.84. We were actually at 400 feet, not 1,400 feet! I added max power and climbed up to 800 feet and we continued to a landing on RWY 36 without further incident. I thank God that conditions were not just a little worse, or there had been less light, because we would have descended into the water at 180 knots." (Source: ASRS report 257947.)

- Know what altimeter setting units of measurements are used for your areas of operation.
- Know the phase of flight in which to apply the

appropriate altimeter settings.
- Establish and use altimeter setting cross-check and readback cockpit procedures.
- Cross-check radio altimeter and barometric altimeter readings.
- Operate at higher than minimum altitudes when atmospheric anomalies exist.

3.2.2.3 Safe Altitudes

Vertical awareness implies that flight crews know the altitude relationship of the airplane to the surrounding terrain or obstacles. Obviously, during IMC and reduced-visibility flight conditions, it is necessary to rely on altitude information provided by other than visual means. To assist flight crews, instrument flight rule enroute charts and approach charts provide Minimum Safe Altitudes (MSA), Minimum Obstruction Clearance Altitudes (MOCA) Minimum Enroute Altitudes (MEA), Emergency Safe Altitudes (EAS), and in most terminal areas, actual heights of the terrain or obstacles. Traditional maps, such as Sectional or Operational Navigation Charts, are available for more detailed study. The potential for CFIT is greatest in the terminal areas. Detailed altitude information is provided to assist the flight crews in maintaining situational awareness.

A flight crew on a flight to Portland, Oregon, USA, made this report: “The area below us was like a ‘black hole’… The city lights were off the right wing—a beautiful night. After being cleared for a visual approach, I began descent so as to arrive... at the recommended 3,000 feet mean sea level. ...at 4,100 feet MSL the GPWS went ‘Whoop, whoop! Pull up! Terrain.’ For a split second we thought it was a false warning, since we were still looking at the airport/city. Then I noticed both radio altimeters go from 2,500 feet to 400 feet in 1-2 seconds. I immediately applied full power and initiated a max climb until over the city’s outskirts (lights). Our whole crew serves this city daily and knows the airport well. Simple fact is that most pilots going into a familiar airport use the approach plate and do not often refer to the area chart. ...We were stupid and very lucky.” (Source: ASRS report 216837.)
- Make sure that adequate charts are available.
- Study the altitude information.
- Know and fly at or above the safe altitudes for your area of operation.

3.2.2.4 Air Traffic Control Factors

The inability of air traffic controllers and pilots to properly communicate has been a factor in many CFIT accidents. There are multiple reasons for this problem. With the growth of the aviation industry throughout the world, the use of English as a common language is more difficult to support. The lack of English language proficiency can make understanding controller instructions to the flight crews and airborne information or requests from the flight crews to the controllers much more prone to errors. Heavy workloads can lead to hurried communications and the use of abbreviated or nonstandard phraseology. The potential for instructions meant for one airplane to be given to another is increased. Unreliable radio equipment still exists in some areas of the world, which compounds the communication problems.

The importance of good communications was pointed out in a report by an air traffic controller and flight crew of an MD-80. The controller reported that he was scanning his radar scope for traffic and noticed that the MD-80 was descending through 6,400 ft and immediately instructed a climb to at least 6,500 ft. The pilot responded that he had been cleared to 5,000 ft and then climbed to... The pilot reported that he had “heard” a clearance to 5,000 ft and read back 5,000 ft to the controller and received no correction from the controller. After almost simultaneous GPWS and controller warnings, the pilot climbed and avoided the terrain. The recording of the radio transmissions confirmed that the airplane was cleared to 7,000 ft and the pilot mistakenly read back 5,000 ft and attempted to descend to 5,000 ft. The pilot stated in the report: “I don’t know how much clearance from the mountains we had, but it certainly makes clear the importance of good communications between the controller and pilot.” (Source: ASRS report 96032.)

ATC is not always responsible for safe terrain clearance for the airplanes under its jurisdiction. Many times ATC will issue enroute clearances for flight crews to proceed off airway direct to a point. When flight crews accept this clearance, they also accept responsibility for maintaining safe terrain clearance.

Airspace constraints that are most prevalent in the terminal areas many times require air traffic controllers to radar vector airplanes at minimum vectoring altitudes that can be lower than the sector MSA. Proper vertical and horizontal situational awareness is vital during this critical phase of flight. Humans make errors. From time to time ATC may issue flawed instructions that do not ensure adequate terrain clearance. While it may be difficult for flight crews to know that an error has been made, it is possible that mistakes can be detected with good flight crew position and altitude awareness.

The following is a report of an incident that took place in El Paso, Texas, USA: “El Paso clearance Delivery: cleared to Salt Lake City Airport, full route clearance, radar vectors TCS, direct GUP, direct HVE, direct SLC, maintain 7,000 feet, expect FL350 10 minutes after departure...After takeoff, fly heading 070 degrees. I read the above clearance back as written above. El Paso clearance delivery responded: readback correct. Runway 08 in use at the time. Winds reported calm. Several minutes later, I requested if runway 04 would be available (while still at the gate) El Paso clearance delivery replied: ‘Affirmative, I'll forward your request for runway 04.’ No amendments or changes to the original clearance were issued until receiving takeoff clearance from tower. Approximately 25 minutes later we departed runway 04 with the following instruction from El Paso tower: ‘After takeoff, turn left heading 330 degrees. Cleared for takeoff.’ While in a left turn to 330 degrees after takeoff, combined tower/departure controller said: ‘radar contact, turn left heading 300 degrees.’ We responded by acknowledging the heading and ‘leaving 6 for 7,000 feet.’ Aircraft was leveled off at 7,000 feet MSL. Captain asked controller the elevation of the terrain below us. Tower replied: ‘5,800 feet.’ After approximately one minute level at 7,000 feet MSL, the radar altimeter light came on, indicating terrain less than 2,500 feet. A climb was immediately initiated when the GPWS warned: ‘Terrain, Terrain.’ ATC was advised we’re climbing. ATC replied: ‘Verify you’re climbing to 17,000.’ Captain replied that were issued 7,000 feet. ATC replied: ‘Climb and maintain 17,000.’...The controller said he was the new shift replacement for the controller who had given us the clearance.” (Source: ASRS 95474.)

- Exercise good radio communication discipline.
- Know the height of the highest terrain or obstacle in the operating area.
- Know your position in relation to the surrounding high terrain.
- Challenge or refuse ATC instructions when they are not clearly understood, when they are questionable, or when they conflict with your assessment of airplane position relative to the terrain.

3.2.2.5 Flight Crew Complacency

Complacency can be defined as self-satisfaction, smugness, or contentment. You can understand why, after years in the same flight deck, on the same route structure to the same destinations, a flight crew could become content, smug, or self-satisfied. Add to this equation a modern flight deck with a well-functioning autopilot, and you have the formula for complacency.

Here is an example of flight crew complacency. The flight crew is flying an arrival. They get a nonstandard clearance to descend to a lower altitude, in an unfamiliar sector. Suddenly, the GPWS warning sounds: “Pull up! Pull up!” The flight crew is not sure what to do, because they have never experienced this before. They may hesitate to pull up, or they may ignore the warning—with disastrous results.

In this scenario, the GPWS warning may not have registered with the flight crew. They have flown into this airport hundreds of times, but because of complacency, their brains may very well have disregarded aural and visual cockpit warnings. At the other extreme, flight crews may also be exposed to continued false GPWS warnings because of a particular terrain feature and a GPWS database that has not been customized for the arrival. The flight crew becomes conditioned to this situation since they have flown the approach many times. This can also lull the flight crew into complacency, and they may fail to react to an actual threat. Note: The newer versions of GPWS can be programmed by the manufacturer for specific airfield approach requirements, so that these nuisance warnings are eliminated.

- Know that familiarity can lead to complacency.
- Do not assume that this flight will be like the last flight.
- Adhere to procedures.

3.2.2.6 Procedural Factors Associated With CFIT

Many studies show that operators with established, well thought out and implemented standard operating procedures (SOP) consistently have safer operations. It is through these procedures that the airline sets the standards that all flight crews are required to follow. CFIT accidents have occurred when flight crews did not know the procedures, did not understand them, and did not comply with them or when there were no procedures established. More than one CFIT accident has occurred when the flight crew delayed its response to a GPWS warning during IMC. If an SOP had addressed this situation and provided the flight crew with specific guidance, maybe an accident could have been avoided. In the absence of SOPs, flight crews will establish their own to fill the void in order to complete the flight. Some crews think the weather is never too bad to initiate an approach! It is the responsibility of management to develop the comprehensive procedures, train the flight crews, and quality control the results. It is the responsibility of the flight crew to learn and follow the procedures and provide feedback to management when the procedures are incorrect, inappropriate, or incomplete.

Figure 10
Percentage of All Accidents by Phase of Flight and the Percentage of Flight Time That the Flight Crew Is Exposed During That Phase

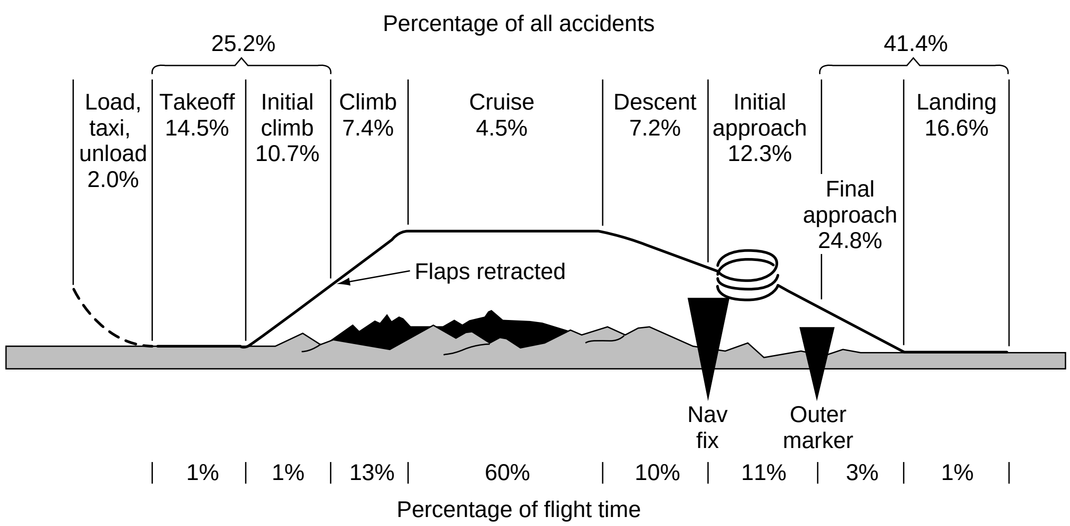
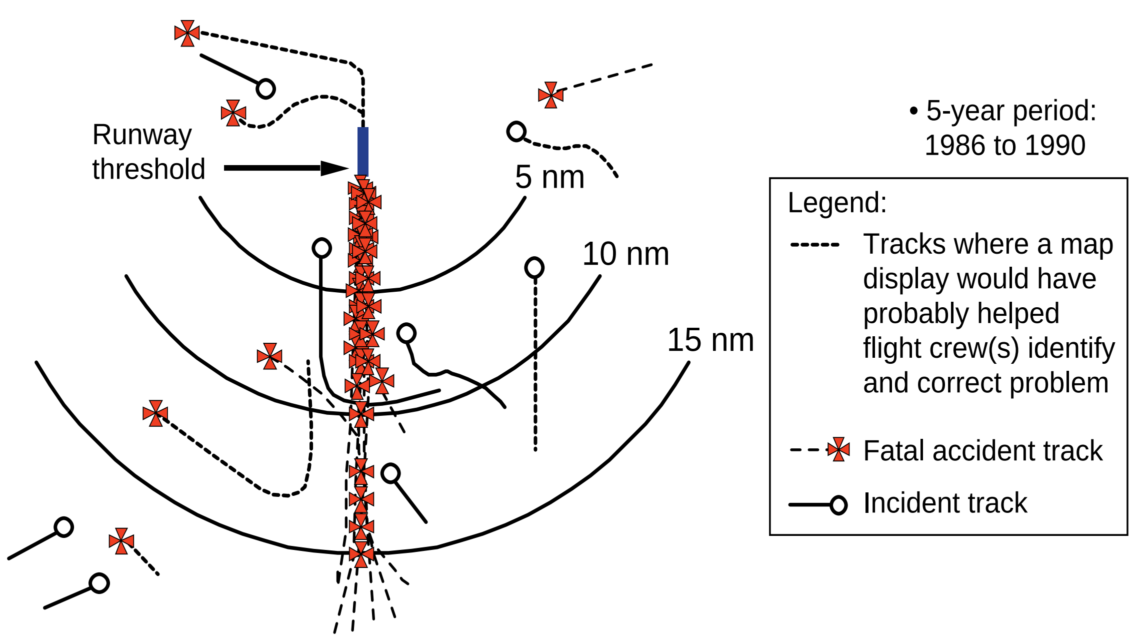


Figure 11
Map Location of CFIT Accidents/ Incidents



- Do not invent your own procedures.
- Management must provide satisfactory SOPs and effective training to the flight crew.
- Comply with these procedures.

3.2.2.7 Descent, Approach, and Landing Factors

CFIT accidents have occurred during departures, but the overwhelming majority of accidents occur during the descent, approach, and landing phases of the flight (Figure 10). CFIT accidents make up the majority of these accidents. An enlightening analysis of 40 CFIT accidents and incidents was accomplished for a 5-year period, 1986 to 1990. The airplanes' lateral position in relation to the airport runway and the vertical profile were plotted. (Figures 11 and 12). One of the interesting things is that almost all the position plots in Figure 11 are on the runway centerline inside of 10 mi from the intended airport. The vertical profiles shown in Figure 12 are also significant. The flight paths are relatively constant 3-deg paths—right into the ground! Most of the impacts are between the outer marker and the runway.

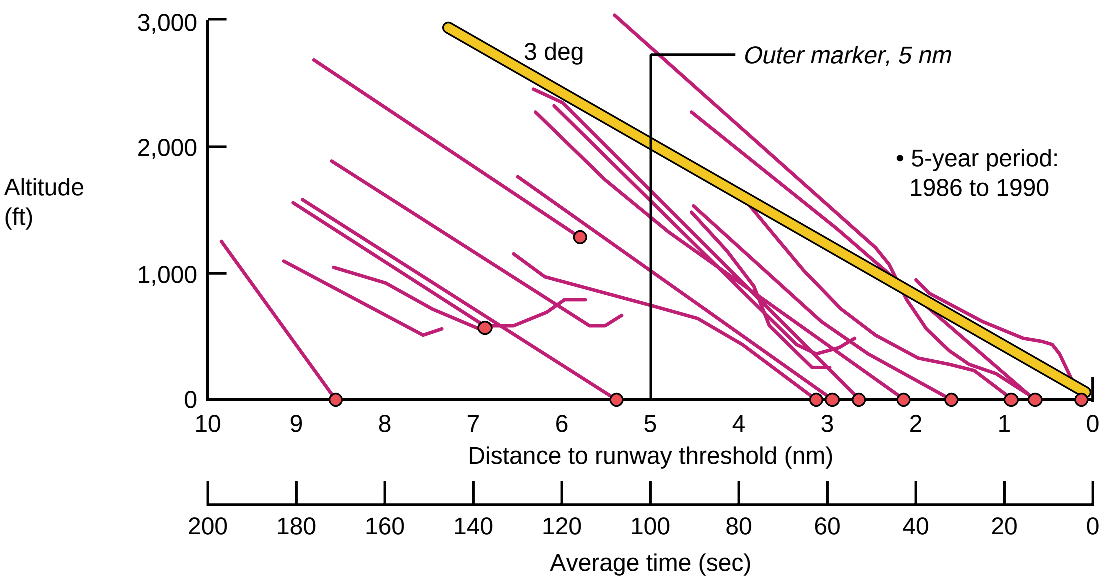


Figure 12
Primary Cause Factors for Hull-Loss Accidents for Worldwide Commercial Jet Fleet

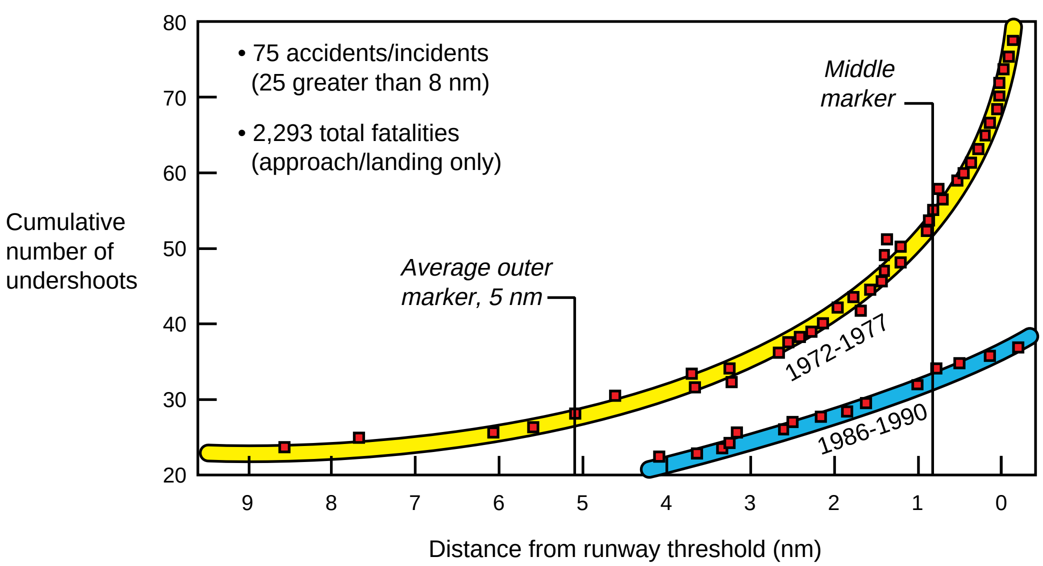


Figure 13
Geographical Location of CFIT Accidents

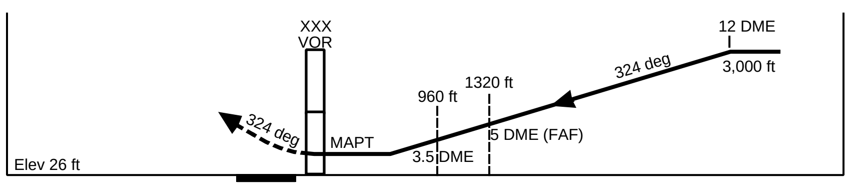
The geographical locations of CFIT accidents during the 1970s show a different pattern than those in the late 1980s and 1990s (Figure 13). During the 5-year period from 1972 through 1977, there were 75 CFIT accidents or incidents. Twenty-five of these accidents/incidents were greater than 8 nm from the runway. The preponderance of the remaining accidents/incidents were inside the middle marker. However, for the period 1986 to 1990, the distribution of accidents/incidents was relatively even. This difference may be the result of improvements made in runway approach aids that took place during this time period. Additional ILS were installed, as well as runway approach lighting systems. Continued capital investment in runway precision approach and lighting systems needs to be made worldwide.

- Know what approach and runway aids are available before initiating an approach.
- Use all available approach and runway aids.
- Use every aid to assist you in knowing your position and the required altitudes at that position.

Most CFIT accidents occur during nonprecision approaches, specifically VOR and VOR/DME approaches. Inaccurate or poorly designed approach procedures coupled with a variety of depictions can be part of the problem. Figure 14 is an example of an approach procedure produced by different sources. There are documented cases that the minimum terrain clearances on some published approach charts have contributed to both accidents and incidents. For more than a decade, a worldwide effort has been under way to both raise and standardize the descent gradient of nonprecision approaches. There are gradients as little as 0.7 deg in some VOR approach procedures. ASRS report 254276 illustrates the hazard of shallow approaches coupled with other confusion associated with the procedure design (Figure 15). In addition to the shallow approach gradients, many approaches use multiple altitude step-down procedures. This increases flight crew workload and the potential for making errors.

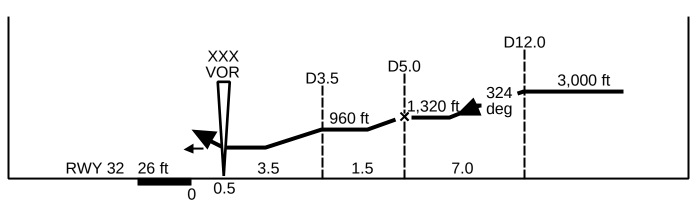
- Study the approach procedure(s) before departure.
- Identify unique gradient and step-down requirements.
- Review approach procedures during the approach briefing.
- Use autoflight systems, when available.

Figure 14
Approach Procedure Design

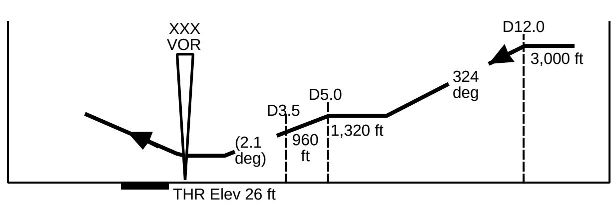


State AIP

- Many ways to present the descent profile
- Comparison of profiles for the same nonprecision approach



Commercial Source A



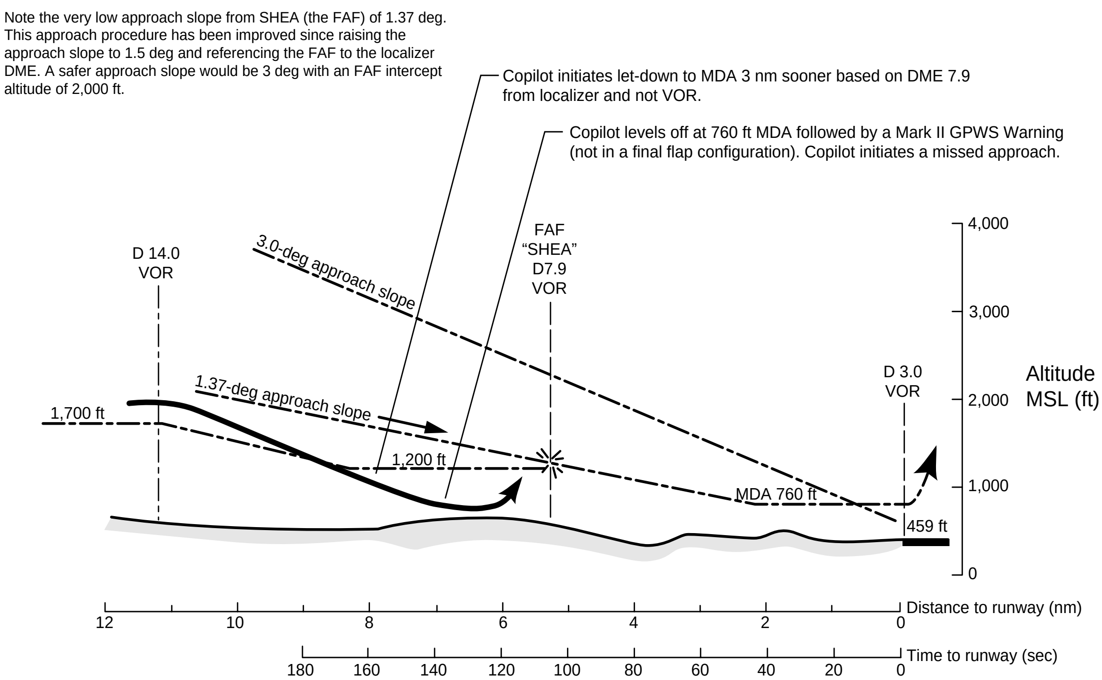
Commercial Source B

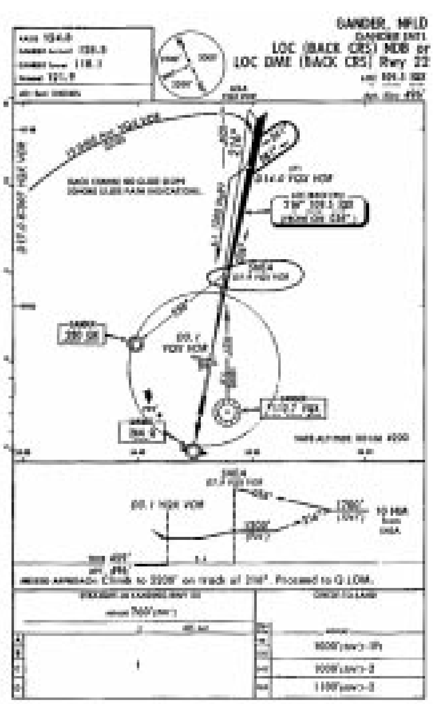
There is more than one standard for approach procedures in the world. The U.S. standard is Terminal Instrument Procedures (TERPS). The ICAO standard is Procedures for Air Navigation Services—Aircraft Operations (PANS-OPS), and the Russian Federation uses still another. Flight crews, therefore, may be exposed to different standards and different margins of terrain clearances.

- Study anticipated approach procedures before departure.
- Know that there are different approach design standards.

Different approach procedure charting requirements and printing can also make it more difficult for flight crews to safely fly an approach. High-elevation obstacles and terrain surrounding airports have been annotated on charts for years, but the actual terrain has not been depicted. Slowly, the publishing and printing organizations for

Figure 15
Flight Path Profile—ASRS Report 254276





aeronautical and approach charts have begun to use color and depict terrain or minimum safe altitude contours. Recently, some of the larger international operators have started printing their own customized charts that include these features. This greatly helps the flight crews to recognize the proximity of high terrain to the approach courses. Hopefully, this will result in fewer accidents.

Unstable approaches contribute to many CFIT accidents or incidents. Unstable approaches increase the possibility of diverting a flight crew's attention to regaining better control of the airplane and away from the approach procedure. A stabilized approach is defined by many operators as a constant rate of descent along an approximate 3-deg flight path with stable airspeed, power setting, and trim, with the airplane configured for landing.

- Fly stabilized approaches.
- Execute a missed approach if not stabilized by 500 ft above ground level or the altitude specified by your airline.

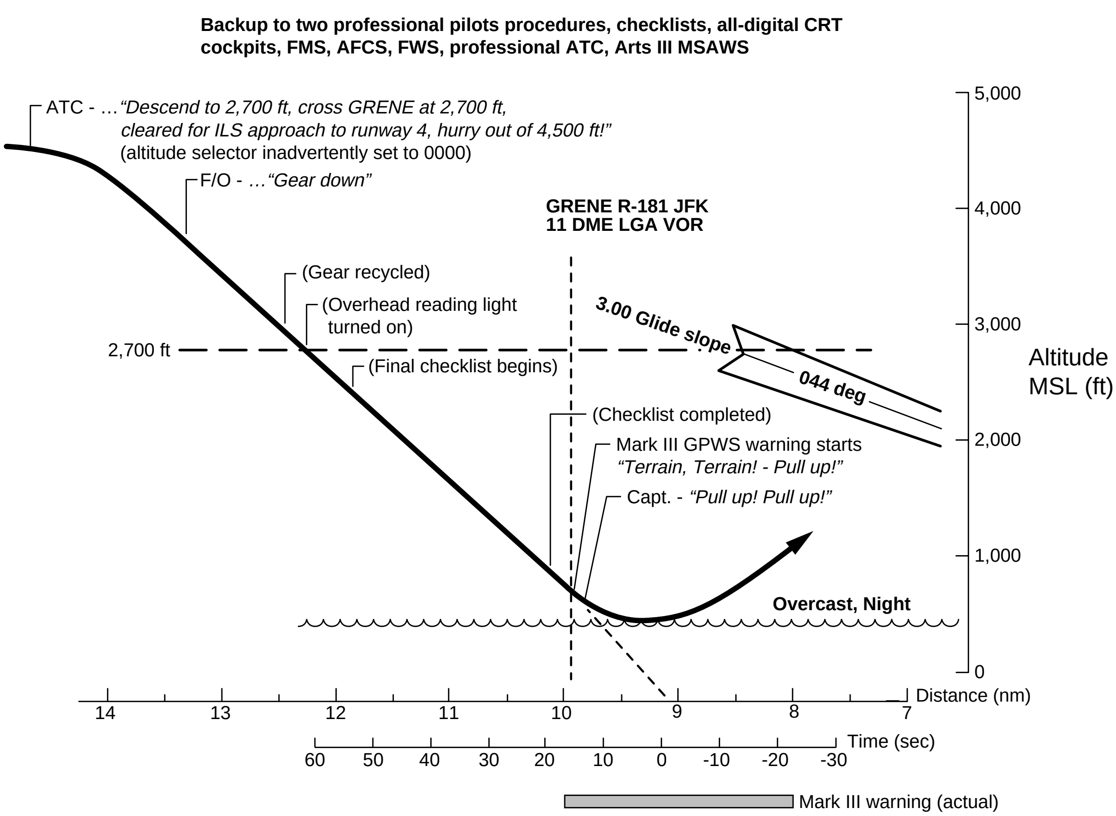
In some modern glass-cockpit aircraft, the flight guidance system has the capability to display flight path vector / flight path angle. Use of this mode enables a stabilized approach to be flown at the required slope during a nonprecision approach, with automatic correction for the effects of wind.

Flight management systems also have the capability to provide a computed profile for a nonprecision approach. Required conditions for the use of lateral and vertical navigation functions for this purpose are that the approach profile is included in the database, that it is verified in accordance with obstacle clearance criteria, and that the FMS accuracy is confirmed to be high.

The use of these techniques, in conjunction with the autoflight system, reduces crew workload and should ensure a higher level of safety. Procedures specific to the airline type are given in the applicable Flight Crew Operating Manual. Crews should be adequately trained, either in the simulator or in flight, to use the procedures associated with these features.

- If a nonprecision approach is necessary, use the recommended flight guidance system function to fly a stabilized profile at the required angle whenever possible.
- Continuously monitor position and track by reference to the basic approach aid(s).

Figure 16
The Last "Safety Net": 767 La Guardia, February 1983



3.2.2.8 Autoflight System Factors

"On final approach into La Guardia Airport, New York, USA, with the weather 400 foot overcast, the descent was made below the minimum maneuvering altitude. I feel that a dangerous situation existed this time, and I will try to give a history of the events (Figure 16).

"Our clearance was 'descend to 2,700 feet, cross GRENE at 2,700 feet, cleared for the ILS approach to runway 4, hurry out of 4,500 feet'. Using the flight level change mode on the mode control panel we descended to 2,700 feet. The first officer was flying and asked for flaps 20, gear down. Acting as copilot and doing the copilot duties, I put the gear handle down and the flaps at 20 degrees. The gear amber light was on, so it was necessary to recycle the landing gear.

"Three green lights appeared after cycling. It was night time, so I turned on the overhead reading light and completed the landing checklist. As I was replacing the checklist to the card holder, the GPWS sounded two pull-up warnings, and I said 'Pull up, pull up.' The autopilot was disengaged and maximum power was added. At about this point, we crossed the LOM. An attempt was then made to get back on the localizer and glide slope, but we were not able to do so. A missed approach was made and another approach and landing was uneventful. On the missed approach, the altitude select on the mode control panel indicated 0000. Neither of us know how it got there.

"The aircraft was descending below the glide slope all the way down and did not capture, but was going to 0000 feet as asked for by the altitude selector.

"I feel that there was some failure in the system as well as in the coordination of the flight crew. I feel that we all must be more cognizant of the fact that the monitoring of... instruments must be absolutely primary by both pilots. We may have been saved by the GPWS and I feel that closer monitoring by both pilots would have prevented this situation. The only reason I write this is to once again alert each of us to the many traps these new concepts and the new instrumentation can lead us into. Heads up is the answer." (Source: ASRS report PAN AM Flight OPS magazine.)

A minimum of three to five autoflight-related near-collision with the terrain incidents occur each year. Not all incidents are reported. The actual number of incidents may be much greater. The advancement of technology in today's modern airplanes has brought us flight directors, autopilots, autothrottles, and flight management systems. All of these devices are designed to reduce flight crew workload. They keep track of altitude, heading, airspeed, and the approach flight path, and they tune navigation aids with unflagging accuracy. When used properly, this technology has made significant contributions to flight safety. But technology can increase complexity, and it can also lead to unwarranted trust or complacency. ***Autoflight systems can be misused, may contain database errors, or may be provided with faulty inputs by the flight crew. These systems will sometimes do things that the flight crew did not intend for them to do.***

Imagine this situation. You are descending, and the autoflight system is engaged and coupled to fly the FMC course. It is nighttime, and you are flying an instrument arrival procedure in mountainous terrain. The FMC has been properly programmed, and the airplane is on course when ATC amends the routing. In the process of programming the FMC, an erroneous active waypoint is inserted. While you and the first officer are reconciling the error, the airplane begins a turn to the incorrect waypoint! It does not take very long to stray from the terrain altitude protected routing corridor.

- Monitor the autoflight system for desired operation.
- Avoid complacency.
- Follow procedures.
- Cross-check raw navigation information.

3.2.2.9 Training Factors

Most of the factors that have been identified are the result of deficiencies in flight crew training programs. Therefore, training becomes a significant factor that contributes to CFIT. Well-designed equipment, comprehensive operating procedures, extensive runway approach aids, and standardized charting or altimeter setting procedures and units of measurement will not prevent CFIT unless flight crews are properly trained and disciplined.

- Develop and implement effective initial and recurrent flight crew training programs that include CFIT avoidance.
- Implement Flight Operations Quality Assurance Programs.

3.3 CFIT Prevention

In Section 2 of this document (the Decision Makers Guide) we point out that CFIT prevention encompasses more than operator-related actions. There are system-related problems that, when solved, will help operators avoid situations that may lead to CFIT. Some progress has been made in solving the systemic problems, but much more needs to be done. ***In the meantime, operators can also do much more to prevent CFIT accidents.***

3.3.1 Minimum Safe Altitude Warning System (MSAWS)

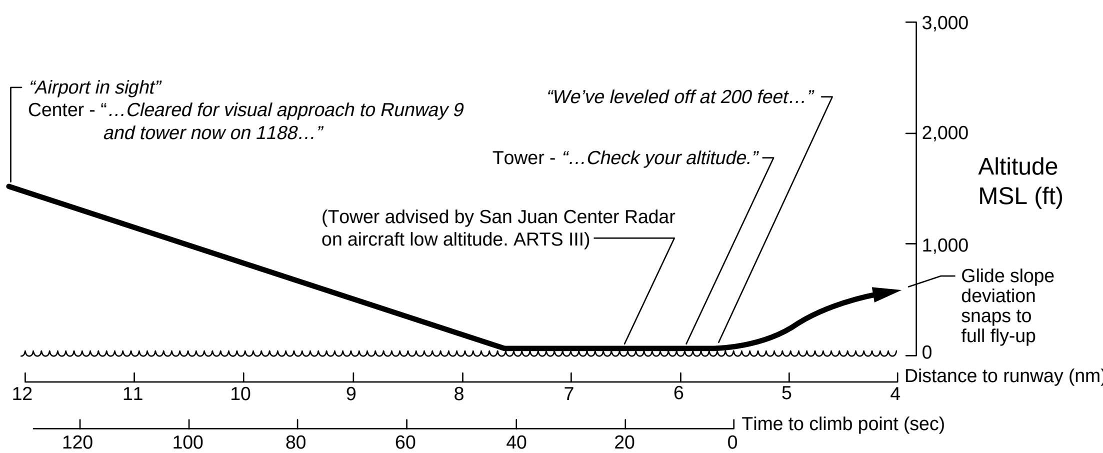
The Minimum Safe Altitude Warning System became operational in the United States in 1976. MSAWS alerts the air traffic controller with both visual and aural alarms when an airplane penetrates, or is predicted to penetrate, a predetermined MSA in the protected terminal area. It operates in two modes: surveillance in all sectors of the terminal area and a mode tailored to monitor airplane altitude versus position on the final approach course. This capability is especially valuable when airplanes are being radar vectored and it is more difficult for the pilots to maintain situational awareness. While MSAWS is an excellent aid in preventing CFIT, it is not widely available outside the United States.

This report was extracted from a 1986 Pan American Flight Operations magazine. The airplane was on a very short flight and never got above 5,000 ft. The time was 0145 local. Approaching destination, the airplane was cleared for a visual approach and was handed off to the tower for landing. The flight crew then descended below a cloud deck in order to keep the airfield in sight. The approach briefing was short, and there was a mention of the short runway during the briefing. The crew continued to descend by flying on the ILS glide slope to an altitude of 200 ft. The Captain later reported that the airplane seemed unusually low in spite of an on-glide-path indication. During this time, the radar at the ATC center noticed the airplane getting unusually low; in fact, the radar reported the airplane below 50 ft at times! The center contacted the destination tower operator and reported its observations. The tower operator immediately contacted the inbound flight and warned the flight crew of the situation.

When asked about their altitude, the flight crew reported "level at 200 ft." Actually, they were 50 ft above the water and had been for almost a minute! Just after the query the airplane climbed to 600 ft. The ILS glide slope, that was previously centered, snapped to the full fly-up position. The airplane completed a normal landing.

Figure 17
Flight Path Profile

Circumstances:	During visual night approach to Runway 9, the aircraft inadvertently descended well short (7 nm) of the runway before error was detected. Aircraft was well right of localizer in possible false lobes. No ILS flags. No GPWS below "Glide slope alert."
Configuration:	Landing
Weather:	17? 11?, visibility: 30 mi



The GPWS never alerted the crew to the low glide slope because the ILS had locked on to a false lobe, and it had never alerted the flight crew to the altitude deviation because the gear was down and the flaps were in the landing position. The GPWS was operating normally, because it used inputs from the Captain's instruments that reflected an on-glide-slope condition. The GPWS never reached a limit that was considered out of tolerance.

The flight crew noticed the low altitude, but paid little attention; the tower operator could not see the airplane, but the MSAWS on the ATC center radar noticed and saved the flight! (Figure 17)

3.3.2 Crew Briefings

Many of the CFIT accidents show a lack of flight crew communication. For example, while one pilot flew the approach, the other did not know or understand the intentions of the flying pilot. This lack of communication can lead to breakdowns in flight crew coordination and cross-checking. ***One of the best ways to let the nonflying pilot know what to expect is to conduct a briefing before each takeoff and each approach.*** While this seems elementary, many flight crews simply ignore the obvious safety implications of the briefings.

Accident statistics show that the vast majority of accidents occur during the approach at the destination airport. Is it not logical then to prepare carefully and properly for the arrival, approach, and landing? ***The approach briefing sets the professional tone for your safe arrival at the destination.*** The flying pilot should discuss how he or she expects to navigate and fly the procedure. This will not only solidify the plan for the approach, but it will inform the nonflying pilot of the flying pilot's intentions, which provides a basis for monitoring the approach. Deviations from the plan now can be more readily identified by the nonflying pilot. The approach briefing should be completed before arriving in the terminal area so that both pilots can devote their total attention to executing the plan.

Operators should require briefings by the flight crew. As operations vary from country to country, some briefing items may be more important than others and some unique items may be added, but there are some items that should always be covered. ***Use the following briefing guidelines if other guidance is not provided by standard operating procedures or the airplane manufacturer.***

Takeoff briefing:

- ♦ Weather at the time of departure.
- ♦ Runway in use, usable length (full length or intersection takeoff).
- ♦ Flap setting to be used for takeoff.
- ♦ V speeds for takeoff.
- ♦ Expected departure routing.
- ♦ Airplane navigation aids setup.
- ♦ Minimum sector altitudes and significant terrain or obstacles relative to the departure routing.
- ♦ Rejected takeoff procedures.
- ♦ Engine failure after V1 procedures.
- ♦ Emergency return plan.

Approach briefing:

- ♦ Expected arrival procedure to include altitude and airspeed restrictions.
- ♦ Weather at destination and alternative airports.
- ♦ Anticipated approach procedure to include:
  - Minimum sector altitudes.
  - Airplane navigation aids setup.
  - Terrain in the terminal area relative to approach routing.
  - Altitude changes required for the procedure.
  - Minimums for the approach DA/H or MDA/H.
  - Missed approach procedure and intentions.
- ♦ Communication radio setup.
- ♦ Standard callouts to be made by the nonflying pilot.

3.3.3 Autoflight Systems

Proper use of modern autoflight systems reduces workloads and significantly improves flight safety. These systems keep track of altitude, heading, airspeed, and flight paths with unflagging accuracy. Unfortunately, there are a great number of first-generation airplanes that are still operating that do not have the advantages associated with well-designed, integrated systems. There are also some flight crews whose airplanes do have modern autoflight systems, that do not take full advantage of these systems to manage the progress of the flight and reduce workload. ***To assist in preventing CFIT, the proper use of autoflight systems is encouraged during all approaches and missed approaches, in IMC, when suitable equipment is installed.*** It is incumbent upon operators to develop specific procedures for the use of autopilots and autothrottles during precision approaches, nonprecision approaches, and missed approaches and to provide simulator-based training in the use of these procedures for all flight crews.

3.3.4 Route and Destination Familiarization

Flight crews must be adequately prepared for CFIT critical conditions, both enroute and at the destination. ***Flight crews must be provided with adequate means to become familiar with enroute and destination conditions for routes deemed CFIT critical.*** One or more of the following methods are considered acceptable for this purpose:

- When making first flights along routes, or to destinations, deemed CFIT critical, Captains should be accompanied by another pilot familiar with the conditions.
- Suitable simulators can be used to familiarize flight crews with airport critical conditions when those simulators can realistically depict the procedural requirements expected of crew members.
- Written guidance, dispatch briefing material, and video familiarization using actual or simulated representations of the destination and alternatives should be provided.

3.3.5 Altitude Awareness

It is essential that flight crews always appreciate the altitude of their airplane relative to terrain and obstacles and the assigned or desired flight path. Flight crews need to receive and use procedures by which they will monitor and cross-check assigned altitudes as well as verify and confirm altitude changes. As a minimum, in the absence of SOPs or airplane manufacturer guidance, use the following procedures:

- Ascertain the applicable MSA reference point. Note: The MSA reference point for an airport may vary considerably according to the specific approach procedure in use.
- Know the applicable transition altitude or transition level.
- Use a checklist item to ensure that all altimeters are correctly set in relation to the transition altitude/level. Confirm altimeter setting units by repeating all digits and altimeter units in clearance readbacks and intracockpit communications.
- Call out any significant deviation or trend away from assigned clearances.
- Include radio height in the pilot instrument scan for all approaches.
- Upon crossing the final approach fix, outer marker, or equivalent position, the pilot not flying will cross-check actual crossing altitude/height against altitude/height as depicted on the approach chart.
- Follow callout procedures (refer to The Use of Callouts, Section 3.3.6).

3.3.6 The Use of Callouts

Callouts are defined as aural announcements by either flight crew members or airplane equipment of significant information that could affect flight safety. These callouts are normally included in an airline's SOP. In the absence of other guidance, use these callouts to help prevent CFIT accidents. A callout should be made at the following times:

- Upon initial indication of radio altimeter height, at which point altitude versus height above terrain should be assessed and confirmed to be reasonable.

- When the airplane is approaching from above or below the assigned altitude (adjusted as required to reflect specific airplane performance).
- When the airplane is approaching relevant approach procedure altitude restrictions and minimums.
- When the airplane is passing transition altitude/level.

3.3.7 GPWS Warning Escape Maneuver

The GPWS warning is normally the flight crew's last opportunity to avoid CFIT. Incidents and accidents have occurred because flight crews have failed to make timely and correct responses to the GPWS warnings. The available time has increased between initial warning and airplane impact since the first version of the GPWS; however, this time should not be used to analyze the situation. React immediately. With the early versions, there was as little as 5 sec warning, and none at all if the impact point was on a relatively steep slope of a mountain. There may be as much as 30 sec for newer and future versions.

In the absence of standard operating procedures or airplane manufacturer guidance, execute the following maneuver in response to a GPWS warning, except in clear daylight VMC when the flight crew can immediately and unequivocally confirm that an impact with the ground, water, or an obstacle will not take place:

- React immediately to a GPWS warning.
- Positively apply maximum thrust and rotate to the appropriate pitch attitude for your airplane.
- Pull up with wings level to ensure maximum airplane performance.
- Always respect stick shaker.

Continue the escape maneuver until climbing to the sector emergency safe altitude or until visual verification can be made that the airplane will clear the terrain or obstacle, even if the GPWS warning stops.

3.3.8 Charts

Flight crews must be provided with and trained to use adequate navigation and approach charts that accurately depict hazardous terrain and obstacles. These depictions of the hazards must be easily recognizable and understood. On modern-technology airplanes, the electronic displays should resemble printed chart displays to the maximum extent feasible.

3.3.9 Training

Flight crew training can be a contributing factor to CFIT. It is also the key to CFIT accident prevention. Modern airplane equipment, extensive standard operation procedures, accurate charts, improved approach procedures, detailed checklists, or recommended avoidance techniques will not prevent CFIT if flight crews are not adequately trained. The cause of CFIT is the flight crew's lack of vertical and/or horizontal situational awareness. We know the solutions to these causes: a proper support infrastructure and a trained and disciplined flight crew. An example CFIT training program is provided in Section 4 of this training aid.

3.4 CFIT Traps

In the previous sections, the causes of CFIT and contributing factors are identified, along with recommendations and strategies that may be used to avoid CFIT accidents and incidents. It could be misleading to the reader when causes and factors are discussed separately. Accidents and incidents do not normally happen because of one decision, or one error. They rarely happen because the flight crew knowingly disregarded a good safety practice. Accidents and incidents happen insidiously. Flight crews fall into traps—some of their own making and some that are systemic. Let's look at some examples of traps that could happen when a flight crew employs one recommendation, but disregards another.

We have identified that nonprecision VOR instrument approaches are especially hazardous when they include shallow approach paths and several altitude step-down points. We recommend that the autoflight system be used, if available, to reduce the workload. While this technique may mitigate the problem with the approach procedure, it can create another trap if the flight crew becomes complacent and does not properly program the computer, monitor the autoflight system, make the proper cockpit callouts, etc.

In another situation, flight crews are encouraged to use the displays that modern cockpits provide to assist them in maintaining situational awareness. However, if they disregard the raw navigational information that is also available, they can fall into a trap if any position inaccuracies creep into the various electronic displays.

The importance of takeoff and arrival briefings is stressed as a means to overcome some of the factors associated with departures and arrivals. However, if the briefings do not stress applicable unique information or become rote or are done at the expense of normal outside-the-cockpit vigilance, their value is lost and the flight crew can fall into another trap.

It should be evident that there is no single solution to avoiding CFIT accidents and incidents. All the factors are interrelated, with their level of importance changing with the scenario. Be aware, the traps are there! Section 5, CFIT Background Material, provides many more examples of traps that can happen to you.

Example CFIT Training Program
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4

Example CFIT Training Program

4.0 Introduction

The overall goal of this CFIT Education and Training Aid is to reduce CFIT accidents and incidents through appropriate education and training. The Example CFIT Training Program is an example of the type of training that should be conducted to meet that goal. The program is primarily directed toward two aspects of the CFIT problem: avoidance and escape.

The most important goal for any flight crew is maintain vertical and horizontal situational awareness in relation to the ground, water, and obstacles. When this is not accomplished and the potential for impact with the ground, water, or obstacles is imminent, the proper escape maneuver must be used to improve the chance of surviving.

This CFIT training program is structured to stand alone, but it may be integrated into existing initial, transition, and recurrent training and check programs. The Academic Training Program is designed to improve awareness by increasing the flight crew's ability to recognize and avoid impending CFIT situations. The Simulator Training Program is designed to apply this knowledge as well as develop proficiency in an escape maneuver that must be used as a last resort for survival.

The Academic Training Program consists of a description and a suggested method for applying the academic training portions of this CFIT Education and Training Aid. For pilots who do not receive simulator training, it provides a comprehensive review of the factors and causes of CFIT accidents and incidents and ways to avoid CFIT traps. For pilots who undergo simulator training, this program prepares them for the decision making needed and critical performance required to avoid a CFIT accident.

The Simulator Training Program includes a simulator briefing outline and two simulator exercises. These exercises are designed for flight crews to practice the escape maneuver and demonstrate airplane performance in critical situations. The second simulator scenario requires flight crews to recognize CFIT traps and make critical decisions in order to avoid an accident.

The simulator implementation information assists simulator technical personnel in incorporating a potential CFIT scenario into the simulator database and lesson plans. It also provides data that may be used in developing a simulator that accurately reflects airplane performance characteristics.

4.1 Academic Training Program

The Academic Training Program contains several instruction modules. These modules may be used as a stand-alone program or in combination with existing training programs and the Simulator Training Program.

4.1.1 Academic Training Objectives

The objectives of the Academic Training Program are to provide the pilot with the ability to:

- Recognize the factors that may lead to CFIT accidents and incidents.
- Know the prevention strategies that will ensure a safe flight.
- Improve situational awareness in order to avoid CFIT.
- Learn an escape maneuver and techniques designed to enhance the possibility of survival.

A suggested syllabus is provided. All of the individual training materials are designed to stand alone or be used as a part of a larger program. No single training format is best for all training situations. Therefore, a modification should be made to meet specific training requirements. There is some redundancy in subject material in order to provide flexibility. It is recommended that the training materials be used in sequence when used as a stand-alone program.

4.1.2 Academic Training Program Modules

The following academic training modules are available to prepare an academic training program:

- Operators Guide (CFIT Education and Training Aid, Section 3) is a comprehensive study of CFIT, its causes, contributing factors, and solutions to counter the factors and prevent CFIT accidents. This is a source document that may be reviewed at any time by the flight crew and others in the operations spectrum of the aviation industry. Pilots should read this before formal CFIT academic or simulator training.

- The Operators Guide to CFIT Questions (Appendix 4-B) is a set of questions designed to test the flight crew's knowledge of each section of the Operators Guide. In a CFIT training curriculum, these questions may be used as a part of the review of the Operators Guide or as an evaluation to determine the effectiveness of self-study before academic or simulator training.
- The CFIT Safety Briefing (Appendix 4-C) is a paper copy of overhead viewfoils, with the descriptive words for each foil. This briefing may be used as a classroom or one-on-one presentation, and it supports a discussion of the Operators Guide.
- The video "CFIT: An Encounter Avoided" addresses the CFIT problem in its entirety. It shows the causes and contributing factors of CFIT accidents and incidents and emphasizes how to avoid CFIT. The video also presents the CFIT prevention safety philosophy of some leaders in the aviation industry. Finally, the video points out future capabilities of the GPWS. A copy of the video script is provided in Appendix 4-E.

4.1.3 Academic Training Syllabus

Combining all of the academic training modules results in the following suggested Academic Training Syllabus (Figure 1).

4.1.4 Additional Academic Training Resources

Section 5, CFIT Background Material, is an excellent source of information for an instructor who seeks more information or detailed explanations of material contained in the Operators and Decision Makers Guides. The video script "CFIT: An Encounter Avoided" is also an excellent source of information. Throughout the Operators Guide are figures and charts that may be used individually to stress certain teaching points. The Instructor Pilot Syllabus Briefing Supplement, Appendix 4-A, provides detailed information about the GPWS operating modes.

4.2 CFIT Simulator Training Program

The Simulator Training Program provides the opportunity for pilots to practice CFIT prevention strategies, but it primarily addresses the second aspect of avoiding CFIT accidents: the escape maneuver. ***Note: The term "maneuver" is associated with the sequence of steps the pilot is required to accomplish in order to avoid impact with the terrain. It is recognized that some airplane manufacturers have established procedural steps that the pilot is required to accomplish for that particular airplane. For simplicity, the term "maneuver" will be used for both situations.*** Training and practice are provided for the pilot to experience realistic situations that require timely decisions and correct responses. During the training, the escape maneuver should be practiced to proficiency by both pilots. This training can be inserted into existing simulator profiles during less intensive workload periods. Initial training

Figure 1
Academic Training Syllabus

Training Module	Presentation Method
Operators Guide	Self-study/classroom
Operators Guide to CFIT Questions	Self-study/classroom
Video, "CFIT: An Encounter Avoided"	Classroom
CFIT Safety Briefing	Classroom

should occur in VMC and should emphasize the need to react to all GPWS warnings.

To be fully effective, the simulator training requires the student to be knowledgeable of the materials in the academic training portion of this aid.

Effective flight crew coordination should be emphasized, especially when operating in the high-potential-CFIT phases of flight: takeoff, approach, and landing. Each operator should consider incorporating unique airports and conditions from its route structure into its individual CFIT simulator training program. Some suggestions for CFIT scenarios include:

- A low-altitude level-off just after takeoff, with a radar vector turn toward high terrain, and no subsequent vectoring.
- An early enroute descent into a mountainous/hilly terminal area in an intensive communications environment.
- A missed approach with a low-altitude level-off and a turn toward high terrain.

4.2.1 Simulator Training Objectives

The objective of the Simulator Training Program is to provide the flight crew with the ability to:

- Recognize the contributing factors that can lead to a CFIT incident.
- Maintain proper horizontal and vertical situational awareness.
- Communicate and coordinate on the flight deck during critical phases of flight.
- Recognize a potential CFIT situation and take appropriate action to avoid it.
- Gain confidence in the GPWS.
- Perform a successful CFIT escape maneuver.

4.2.2 Simulator Training Syllabus

CFIT simulator training should be given during initial, transition, and recurrent training. This training should follow a building block approach to learning. It is recognized that there are many contributing factors that may lead to the loss of vertical and horizontal situational awareness by the flight crew. Because of this, the flight crew cannot be exposed to all of the situations in the simulator that they may confront during their normal flight operations. However, a well-structured training program will include exposure to a sufficient number of contributing factors in each exercise to make the training as realistic as possible. The simulator training should include:

- A briefing.
- A minimum of two exercises. Refer to Figure 2.
- A critique.

4.2.3 Pilot Simulator Briefing

Before the first CFIT exercise:

- Review contributing factors and causes of CFIT accidents.
- Explain the need for good flight crew coordination throughout the flight, but especially during critical phases, such as takeoff, approach, and landing.
- Discuss the GPWS operating modes.
- Review the airplane escape maneuver/procedure and pilot techniques.
- Discuss common flight crew errors.

Figure 2
Summary of Simulator Training

Exercise	Description	Training Objectives
1	Insert a simulator "mountain*" in VFR conditions during flight on the downwind leg of the traffic pattern.	Demonstrate GPWS warnings and proper response times and procedures for the escape maneuver.
2	Insert a simulator "mountain*" in IMC during an appropriate phase of flight.	Demonstrate flight crew awareness and coordination in CFIT situations. Practice correct escape maneuver procedures.

* Invisible, rapidly rising terrain simulator feature.

Before the second CFIT exercise:

- Review the need for crew awareness and coordination.
- Discuss the importance of knowing GPWS warnings and the requirement for rapid flight crew response to these warnings.
- Review CFIT traps.
- Review the escape maneuver/procedure and pilot techniques.

4.2.3.1 Generic GPWS Warning Escape Maneuver

It is understood that each airplane type is different. Airplanes produced by one manufacturer may have different technologies that could dictate separate maneuvers. Appendix 4-D shows the escape maneuver for the airplanes of several manufacturers. If your airplane is not included in the appendix, contact the manufacturer and request the information. ***If your airplane manufacturer or operations policy or operations manual does not provide a GPWS warning escape maneuver or procedure, use the following maneuver.***

These steps must be taken immediately in response to a GPWS warning, except in clear daylight VMC when the flight crew can immediately and unequivocally confirm that an impact with the ground, water, or an obstacle will not take place:

- React immediately to a GPWS warning.
- Positively apply maximum thrust and rotate to the appropriate pitch attitude for your airplane.
- Pull up with wings level to ensure maximum airplane performance.
- Always respect stick shaker.

Continue the escape maneuver until climbing to the sector emergency safe altitude can be completed or until visual verification can be made that the airplane will clear the terrain or obstacle, even if the GPWS warning stops.

4.2.4 Simulator Exercises

These are detailed descriptions of sample simulator training exercises. They illustrate the type of information that training departments should pass on to the flight crews. To optimize learning, these exercises may be modified by individual training departments to better fit their particular syllabus, operating area, and requirements. The scenarios are designed to introduce CFIT into the overall training environment without requiring that a large amount of time be devoted to the subject. These scenarios will give the student the basic knowledge of CFIT, its causes, and how to escape from a potential CFIT encounter.

4.2.4.1 Exercise 1: VMC Initial Introduction of Potential CFIT

The initial conditions for this exercise should be typical for the airfield and airplane model of the operator. These should represent “average” conditions, so as not to detract from the primary purpose of developing proficiency in the mechanics of the CFIT escape maneuver. The CFIT encounter should be prompted by a clear indication of the problem when the electronic “mountain” appears in front of the airplane. The duration of the escape maneuver should be long enough that the airplane is flown to its maximum performance and continues at maximum performance, so that the pilot demonstrates proficiency at maintaining airplane maximum performance and a safe altitude. This should take several thousand feet of altitude gain. The instructor may then remove the “mountain.”

The airplane weight should be appropriate for the visual pattern, but heavy enough to make the escape maneuver realistic. After the “mountain” appears, the instructor should ensure that the flight crew is aware of the GPWS warnings and fully understands their meanings. The escape maneuver should be accomplished using the appropriate airplane maneuver. Repeat the exercise, as needed, so that the flight crew understands the requirement for rapid response to the warning and it has attained proficiency in maintaining maximum airplane performance and executing the escape maneuver.

Initial conditions:

Airplane: appropriate for the operators fleet.
Airplane gross weight: near maximum landing weight.
Flaps: approach setting for the airplane.
Center of gravity: appropriate for the airplane.
Ceiling and visibility: clear.
Wind: calm.
Temperature: 80°F/24°C.
Airport elevation: appropriate for operators airfields.
Altimeter QNH: 29.92/1013.

Pilot requirements:
Upon receiving a GPWS warning, the pilot will practice the CFIT escape maneuver. ***If your airplane manufacturer or operations policy or operations manual does not provide a GPWS warning escape maneuver or procedure, use the following maneuver:***

- React immediately to a GPWS warning.
- Positively apply maximum thrust and rotate to the appropriate pitch attitude for your airplane.
- Pull up with wings level to ensure maximum airplane performance.
- Always respect stick shaker.

Continue the escape maneuver until climbing to the sector emergency safe altitude or until visual verification can be made that the airplane will clear the terrain or obstacle, even if the GPWS warning stops.

Demonstrate proper flight crew coordination. Monitor the radio altimeter during the maneuver. The pilot not flying should call out the radio altitudes and trend, e.g., “500 feet, decreasing”; “300 feet, decreasing”; “600 feet, increasing.” The maneuver should be continued until the maximum performance of the airplane is reached and a safe altitude is attained.

4.2.4.2 Exercise 2: IMC Potential CFIT Encounter

The airplane should be nearly at maximum allowable weight for takeoff or landing. Ensure that the weights do not exceed the airplane limits. The exercise may include takeoff, followed by a low altitude level-off or a maximum weight landing. Either scenario should be in IMC to ensure that the flight crew does not see the “mountain” as they approach it. With the correct “mountain” in the simulator database, the pilot must perform the escape maneuver properly in order to avoid impact with the terrain. This “mountain” is actually a given angle that will require the pilot to attain the maximum airplane performance. The duration of the escape maneuver should be long enough that the airplane is flown to its maximum performance. It should continue at maximum performance so that the pilot demonstrates proficiency at maintaining airplane maximum performance and a safe altitude. This should take several thousand feet of altitude gain. The instructor may then remove the “mountain.” Repeat this exercise as necessary for the flight crew to become proficient in recognizing CFIT traps and executing the escape maneuver.

Initial conditions:
Airplane: appropriate for the operators fleet.
Flaps: appropriate for the phase of flight.
Center of gravity: appropriate for the airplane.
Ceiling and visibility: 200-ft ceiling/0.5 mi visibility.
Wind: calm.
Temperature: 80°F/24°C.
Airport elevation: appropriate for operators airfields.
Altimeter QNH: 29.92/1013

4.2.5 Pilot Requirements

Particular attention must be paid to situational awareness throughout this lesson. Good flight crew coordination is essential to the success of the exercise. Flight crews should be aware of the controls and indicators associated with the GPWS. Accidents have happened because the system has been deactivated or inhibited. Flight crews should not inhibit the GPWS unless they can immediately and unequivocally confirm that an impact with the ground, water, or an obstacle will not take place. Upon receiving a GPWS warning, the pilot will execute the CFIT escape maneuver. In the absence of an airplane manufacturer’s established maneuver, use the following maneuver:

- React immediately to a GPWS warning.
- Positively apply maximum thrust and rotate to the appropriate pitch attitude for your airplane.
- Pull up with wings level to ensure maximum airplane performance.
- Always respect stick shaker.

Continue the escape maneuver until climbing to the sector emergency safe altitude or until visual verification can be made that the airplane will clear the terrain or obstacle, even if the GPWS warning stops.

Demonstrate proper flight crew coordination. Monitor the radio altimeter during the maneuver. The pilot not flying should call out the radio altitudes and trend, e.g., “500 feet, decreasing”; “300 feet, decreasing”; “600 feet, increasing.” The maneuver should be continued until the maximum performance of the airplane is reached and a safe altitude is attained.

4.3 Simulator Implementation

This is designed to assist the simulator programming and checkout departments. If not previously accomplished, the addition of a pop-up “mountain” will be required in the simulator models. Ideally, the “mountain” feature should include an adjustable slope of up to a minimum of 17 deg, and it should be controllable by the simulator instructor. As a minimum, the “mountain” must be capable of triggering the GPWS warning, and it must meet the requirements of the exercises described in Sections 4.2.4.1 and 4.2.4.2. The biggest challenge, once this “mountain” is installed, is to ensure that the simulator accurately reflects the handling characteristics of the particular airplane. This is especially true at very heavy airplane weights.

4.3.1 Simulator Fidelity Check

Operators that use this training aid should ensure that the simulator scenarios accurately reflect airplane characteristics and performance to the extent necessary to achieve the training objectives. In order to prevent negative learning experiences, it is important that unrealistic simulator characteristics be removed and the proper simulation of the “mountain” be provided.

Certified full-flight simulators generally contain testing programs that enable engineers to confirm the accuracy of the simulation. When purchasing new simulators, ensure that the data from the manufacturer are up to date in order to accurately simulate maximum performance climbs necessary for the CFIT escape maneuver. The concept is to meet the training objectives by taking full advantage of simulator quality. In older simulators, always strive to improve simulator fidelity.

The simulator manufacturer should be consulted, if necessary, in order to provide the capability to support this CFIT prevention training.

4.3.2 Computer Analysis/Simulator Study Data Requirements

The analyses are shown in Appendix 4-D. These analyses and simulator studies are divided into different subsections for each manufacturer. Whenever possible, the data shown are for identical parameters. When different parameters are used, they will be noted in the analysis. Each scenario will be studied for time versus distance and time versus altitude gained. For commonality, the data were derived using the following parameters:

- Weight: maximum takeoff.
  Flaps: takeoff position.
  Landing gear: up.
  Speed: V2.
  Thrust: maximum applied at GPWS warning.

- Weight: maximum landing.
  Flaps: up.
  Landing gear: up.
  Speed: maneuvering.
  Thrust: maximum applied at GPWS warning.

- Weight: maximum landing.
  Flaps: approach position.
  Landing gear: down.
  Speed: minimum flap speed.
  Thrust: maximum applied at GPWS warning.

- Weight: maximum landing.
  Flaps: landing position.
  Landing gear: down.
  Speed: VRef plus 5 kt.
  Thrust: maximum applied at GPWS warning.

Time versus distance and time versus altitude gained plots will be taken for each pull-up. These plots will also be recorded to the stick shaker using the following parameters:

- 3-deg/s pull-up to 15 deg and continue to stick shaker.
- 3-deg/s pull-up to 20 deg and continue to stick shaker.
- 4-deg/s pull-up to 15 deg and continue to stick shaker.
- 4-deg/s pull-up to 20 deg and continue to stick shaker.

Instructor Pilot Syllabus Briefing Supplement

A potential CFIT situation is clearly an unanticipated event on the part of the flight crew. The warnings come unexpectedly, and they often require the flight crew to make decisions based on only one stimulus, instead of the many confirming stimuli associated with routine flight events. Since the Captain is responsible for the safety of the passengers, flight crew, and airplane, he or she should exercise appropriate emergency authority to respond to the situation.

If airplane-unique GPWS information is not available, the following information may be used during the simulator briefings. Emphasis should be placed on the capability and credibility of the GPWS. The GPWS is an important piece of safety equipment, and recent versions can be programmed to accommodate an operator's particular needs.

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4-A.1 GPWS Warning Modes (Mark VI)

GPWS Mode 1

Mode 1 provides alerts and warnings for excessive rates of descent with respect to the airplane's possible collision with the ground. Radio Altitude and Barometric Decent Rate (FMP) are monitored to determine Mode 1 warning conditions (Figure 1A).

Two distinct audio warnings, "Sinkrate" and "Pull up" are generated by Mode 1. During these alerts the red "GPWS Warn" lamp is illuminated. When the outer warning curve is penetrated, the "Sinkrate" alert is repeated every 3 sec. If the airplane descent continues into the inner warning curve, the emphatic "Pull up!" alert is given. Both alerts stop when the airplane exits the warning curve.

Mode 1 is automatically desensitized when repositioning the airplane down onto a glide slope beam (Figure 1B). This allows pilots more room to maneuver the airplane without triggering an alert.

When the airplane is below a glide slope centerline, the Mode 1 sensitivity is increased. This provides additional warning time for excessive descents when below the glide slope.

Figure 1A
Mark VI GPWS
Mode 1

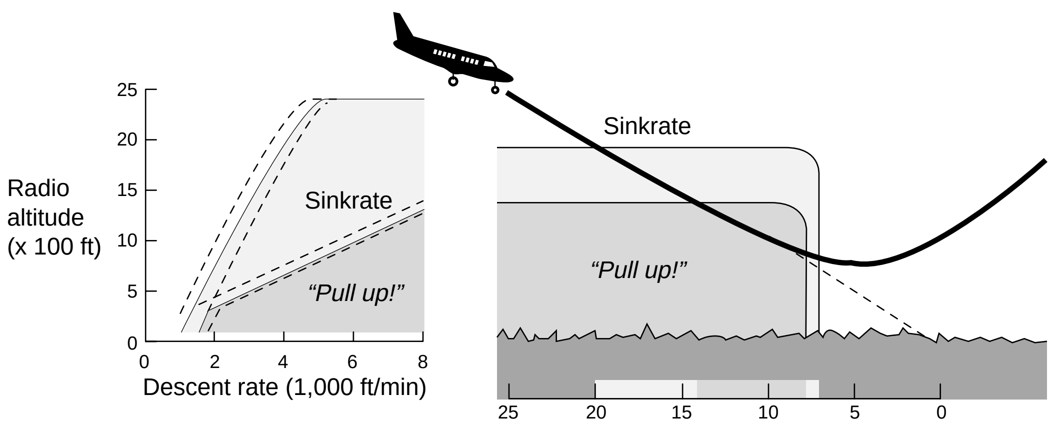
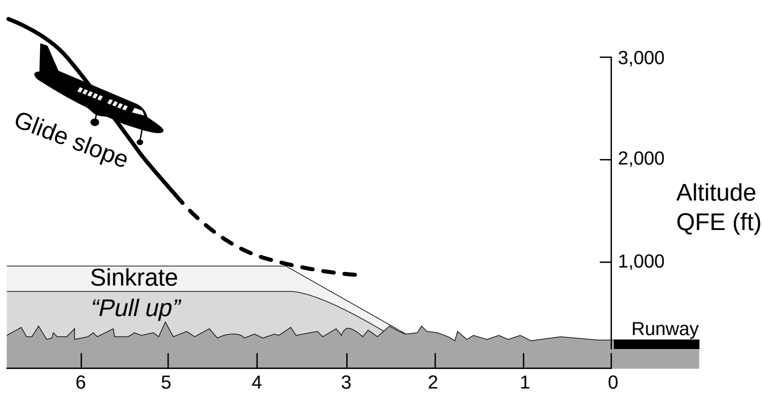


Figure 1B
Mark VI GPWS
Mode 1



GPWS Mode 2

Mode 2 supplies warning protection when terrain below the airplane is rising dangerously fast. These warnings are given well ahead of the airplane's projected collision with terrain. Radio Altitude (AGL) and Terrain Closure Rate is monitored to determine Mode 2 alerts (Figure 2A). Mode 2 also expands as a function of airplane speed. The faster the airplane is traveling, the sooner the excessive closure rate alerts are given.

"Terrain, Terrain!" and "Pull Up!" audio warnings are produced by Mode 2. During Mode 2 alerts, the red "GPWS Warn" lamp is illuminated. When the outer Mode 2 curve is penetrated, the "Terrain, Terrain!" call is given once, and it is followed immediately by the "Pull Up!" warning message until the closure rate is no longer present and the curve is exited. The visual "GPWS Warn" lamp will remain illuminated until safe terrain clearance has been restored (Figure 2A).

Manual activation of the "GPWS Flap Override" switch by the pilot will change the Mode 2 curve, as is automatically done when landing configuration is detected by the GPWS. In either case, Mode 2 warnings are desensitized to allow the airplane maneuverability in closer proximity to terrain, when approaching airports, while still providing appropriate terrain warning protection (Figure 2B).

The ability to effect the Mode 2 change with the use of the "GPWS Flap Override" is especially valuable to airplane maneuvering to land in visual conditions at airports in mountainous areas.

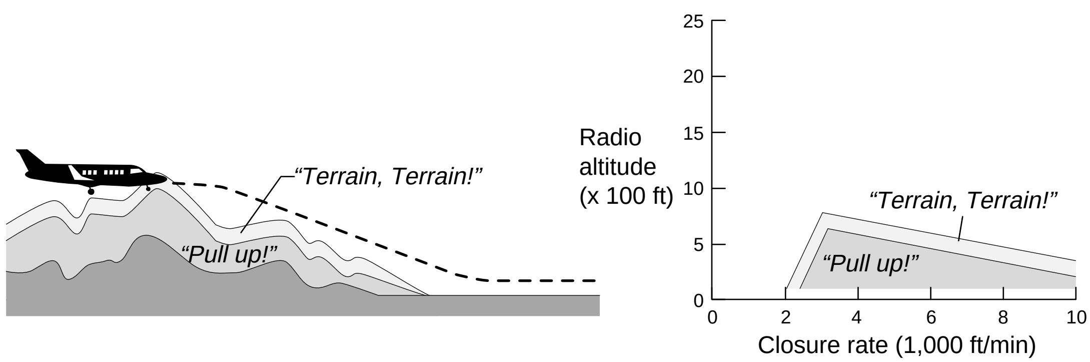


Figure 2A
Mark VI GPWS Mode 2

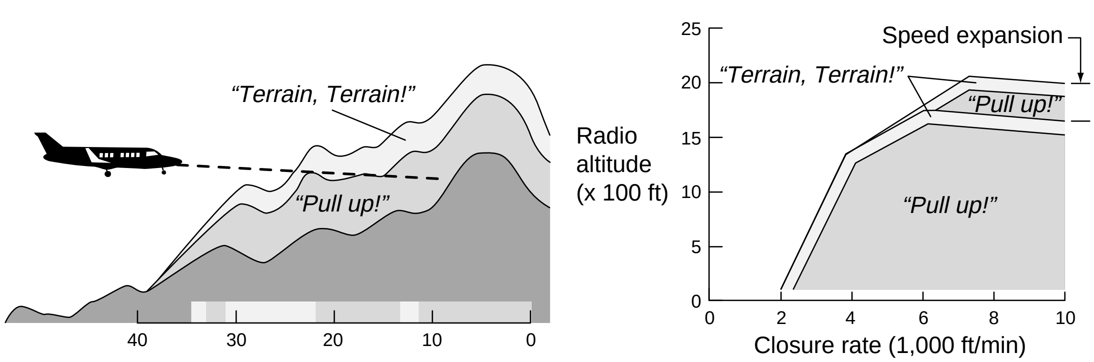


Figure 2B
Mark VI GPWS Mode 2 Desensitized for Landing Configuration

GPWS Mode 3

Mode 3 warns the flight crew of an excessive altitude loss after takeoff or after a missed approach (Figure 3B). Mode 3 monitors the amount of Radio Altitude gained. If Barometric Altitude loss equals approximately 10% of Radio Altitude gained, the "Don't Sink" audio message is given and the "GPWS Warn" lamp is illuminated (Figure 3A). The "Don't Sink" warning will stop and the "GPWS Warn" lamp will extinguish when a positive rate of climb is reestablished.

A "Takeoff" or "Missed Approach" is detected when the GPWS computer sees an increase in Airspeed, Radio and Barometric Altitude, gear retraction, etc. Once the airplane reaches 50 ft AGL, Mode 3 is active. Once above 925 feet AGL for 15 to 20 sec, Mode 3 becomes inactive until the GPWS again detects a "Takeoff" or "Go Around." When Mode 3 becomes inactive, it is replaced by a warning floor below the airplane based on airplane speed and configuration (Figure 4C). This floor protects the airplane for the remainder of the climbout to enroute altitudes.

During training or special pattern work, the "GPWS Flap Override" switch may be activated above 50 ft. This will desensitize the Mode 3 alert envelope to the right, thereby allowing approximately 20% loss of Barometric Altitude before the alert is given (Figure 3A).

Figure 3A
Mark VI GPWS
Mode 3

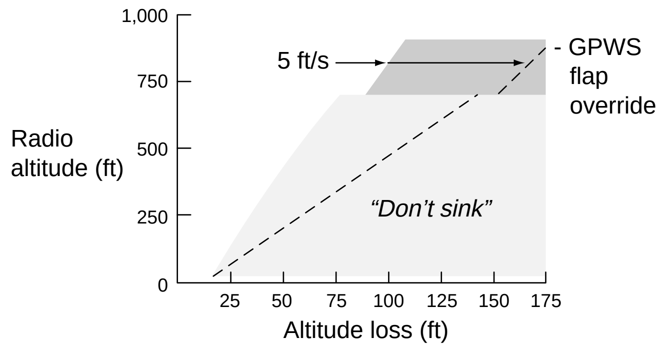


Figure 3B
Mark VI GPWS
Mode 3

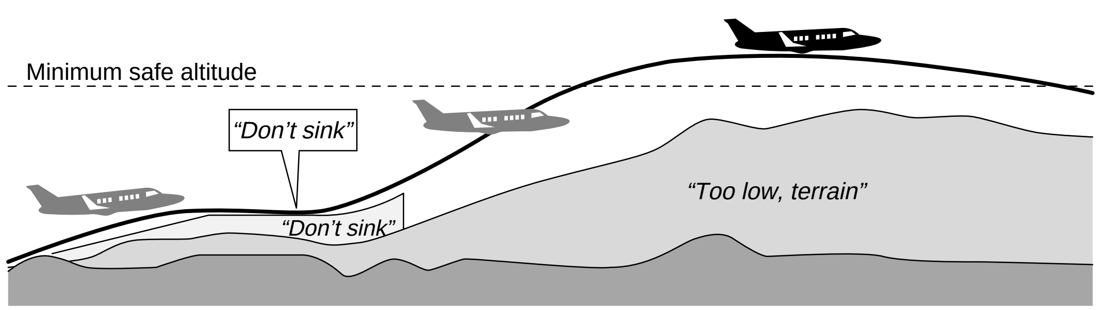
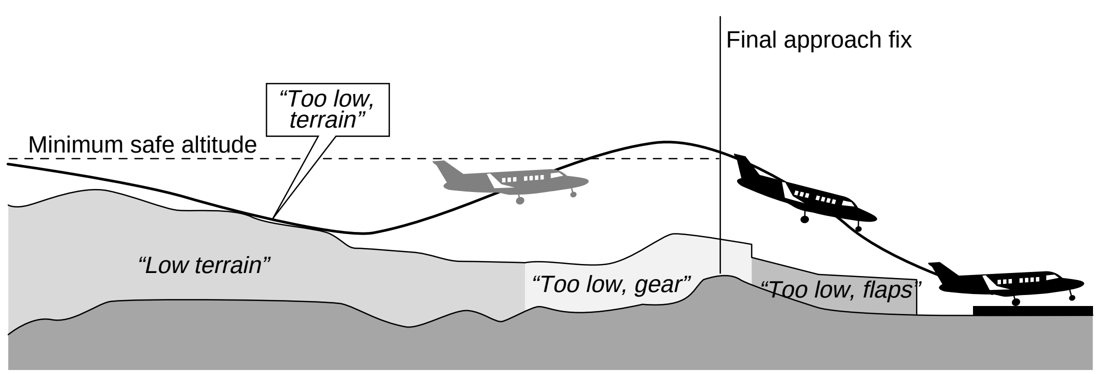


Figure 4
Mark VI GPWS
Mode 4



GPWS Mode 4

Mode 4 warns the flight crew of insufficient terrain clearance during the climbout, cruise, descent, and approach phases of flight. This protection is especially valuable when the airplane's flight path is too shallow to develop excessive closure rates with terrain (Mode 2) or excessive descent rates (Mode 1). Mode 4 has three different alerts, depending on the phase of flight and configuration of the airplane (Figure 3B).

For climbout, cruise, and initial descent during normal flight, the airplane is generally in a clean configuration with gear and flaps up. During these flight phases, the Mark VI provides a "floor" below the airplane to warn of insufficient terrain clearance. At speeds above 200 kt, a "Too Low, Terrain" alert will be given and the red "GPWS Warn" lamp will illuminate if the airplane flies within 750 ft of terrain. At speed from 178 to 200 kt, this same alert will occur, but at lower altitudes AGL corresponding to the slower speed (Figure 4A).

For the initial approach, at speed below 178 kt, the Mark VI monitors airplane configuration. If the airplane descends below 500 ft AGL with landing gear up, the alert "Too Low, Gear" will be given and the red GPWS Warn lamp will illuminate.

On final approach, if the airplane descends below 170 ft AGL with the flaps not in landing configuration, the alert "Too Low, Flaps" will be given and the red "GPWS Warn" lamp will illuminate. This alert may be precluded for landings with partial flaps by pilot activation of the guarded "GPWS Flap Override" switch (Figure 4B).

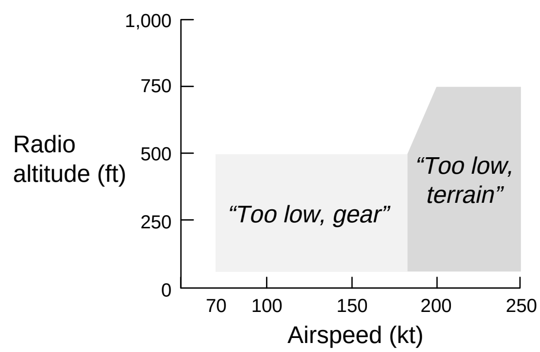


Figure 4A
Mark VI GPWS
Mode 4

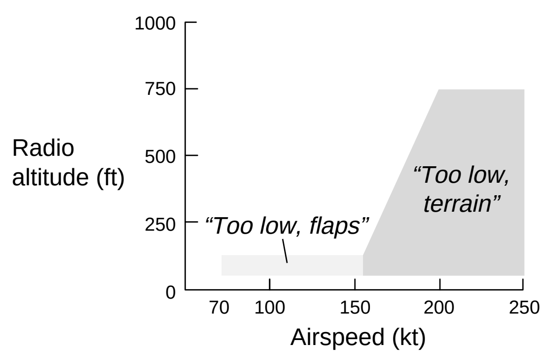


Figure 4B
Mark VI GPWS
Mode 4
Flap Override

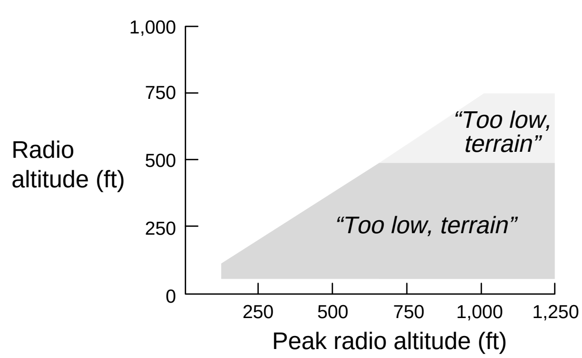


Figure 4C
Mark VI GPWS
Mode 4
Warning Floor

GPWS Mode 5

Mode 5 warns pilots that the airplane is descending below an ILS glide slope. It is automatically armed when the pilot selects an ILS frequency, gear is down, and the airplane is below 925 ft AGL.

The warning envelope contains two boundaries, "Soft" and "Hard," determined by glide slope deviation (Figure 5). When the airplane penetrates the "Soft" alerting region, the audio "Glide slope" warning is given and the yellow "Below Glide slope" lamp illuminates. The initial "Glide slope" message is 6 dB quieter than the system's other audio messages. The audio repetition rate increases as AGL altitude decreases (Figure 5A). If the airplane subsequently enters the "Hard" alerting region, the audio level increases to that of the other audio messages.

Below 150 ft of Radio Altitude, the amount of glide slope deviation required to produce an audio warning is increased to reduce nuisance warnings that could be caused by close proximity to the glide slope transmitter. Mode 5 can be inhibited by pressing the "Below Glide slope" lamp to permit deliberate descent below the glide slope in order to use the full runway under certain landing conditions.

All other warnings, except the excessive bank angle advisory, always have priority over a "Glide slope" alert. With the Mark VI GPWS computer, possible nuisances from erratic glide slope signals are automatically eliminated.

Figure 5
GPWS Mode 5

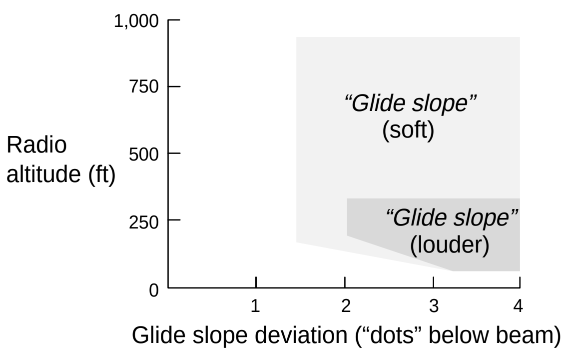
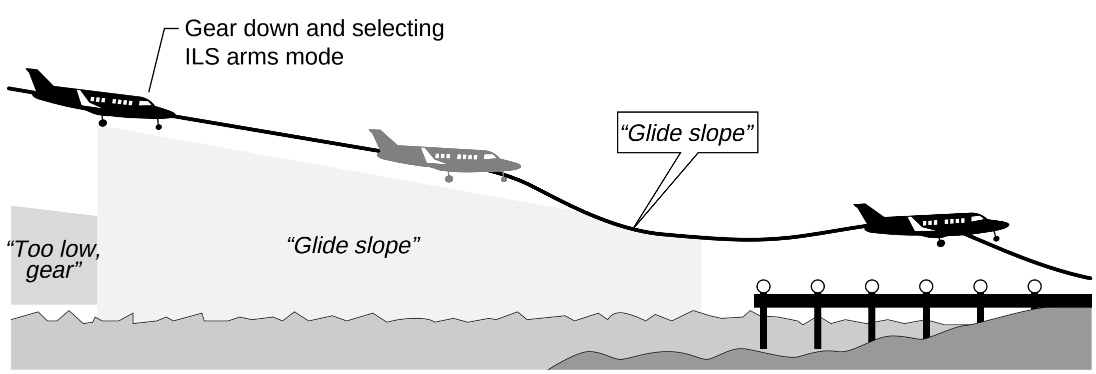


Figure 5A
GPWS Mode 5
Warning Emphasis



GPWS Mode 6

Mode 6 alerts increase situational awareness on final approach and for excessively steep bank angles.

Two audio messages are available to increase altitude awareness on final approach: “Five Hundred” and “Two Hundred” (Figure 7). The “Smart” 500 ft callout occurs once per approach whenever a precision glide slope is not being flown, or if the airplane is well below a glide slope being flown. The 200-ft callout occurs once per approach at 200 ft AGL. The 200-ft callout is always annunciated for altitude awareness.

When the decision height discrete from the radio altimeter indicator is connected to the GPWS, “Minimums, Minimums” is annunciated once per approach as the airplane descends through the “bug” or “DH” setting.

An aural “Bank Angle” warning alerts the flight crew of steep bank angles (Figure 8). The warning limit tightens from 50 deg at 190 ft AGL to 15 deg at ground level (Figure 8). This mode protects flight crews who might be unaware of a potentially dangerous bank angle while maneuvering close to the runway in marginal visibility or at night.

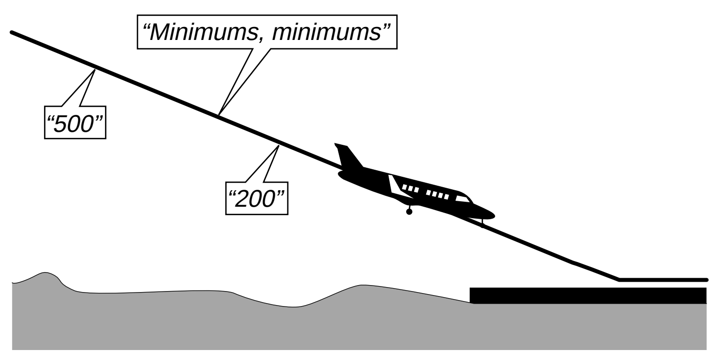


Figure 7
GPWS Mode 6
Smart Callouts

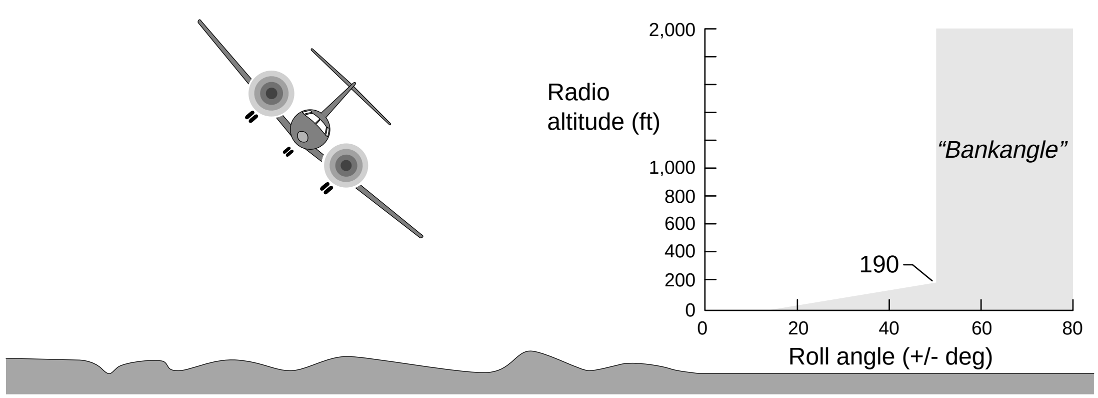


Figure 8
GPWS Mode 6
Steep Bank Angle
Callout

Operators Guide to CFIT Questions

This appendix to the Example CFIT Training Program contains an examination covering important areas in Section 3.

The first part of Appendix 4-B contains the Student Examination. Instructions for answering the questions are provided.

The second part of this appendix is the Instructors Examination Guide. This part contains the questions in the Student Examination, the correct answers to each question, and the section in the Operators Guide where the correct answer may be found.

Table of Contents

Student Examination

Instructions

These questions are based on the material in the Operators Guide to the CFIT Education and Training Aid. The questions are all multiple choice, fill in the blank, or true/false questions. There is one answer to each question which is most correct. Circle the correct answer.

Questions

1. The definition of a CFIT accident is an event in which:
   a. An airplane impacts the ground, water, or an obstacle during the descent, approach, or arrival phase of flight.
   b. A mechanically normally functioning airplane is inadvertently flown into the ground, water, or an obstacle.
   c. An airplane is inadvertently flown into the ground, water, or an obstacle because of malfunctioning navigational aids.
   d. An airplane is inadvertently flown into the ground, water, or an obstacle during an inflight emergency.

2. The basic causes of CFIT accidents are:
   a. An insufficient number of instrument approach aids and runway visual aids.
   b. Flight crew complacency and visual illusions.
   c. Altimeter anomalies and complex instrument procedures.
   d. The lack of flight crew vertical and horizontal situational awareness.

3. There are __________ factors that lead to CFIT accidents.
   a. Only a few.
   b. Two.
   c. Only pilot.
   d. Many.

4. Is there an international standard for the altimeter setting unit of measurement?
   a. Yes, and it is inches of mercury.
   b. Yes, but it is not adhered to by all states.
   c. Yes, but it is only adhered to by the United States.
   d. No.

5. If you set an inches of mercury altimeter setting of 29.92 instead of a hectoPascal setting of 992, the airplane will be flying at an altitude that is in error of about:
   a. Plus 600 ft.
   b. Plus 1,000 ft.
   c. Minus 600 ft.
   d. Minus 1,000 ft.

6. If you incorrectly use a QNH altimeter setting instead of a QNE altimeter setting, the airplane's altitude above the ground will be:
   a. Higher than required.
   b. Lower than required.
   c. Higher or lower, depending on the QNH setting.
   d. Insignificant.

7. When pilots accept an ATC enroute clearance to proceed off airway direct to a point:
   a. The clearance ensures safe terrain clearance.
   b. ATC must also include an altitude that ensures safe terrain clearance.
   c. The pilot is responsible for determining a safe altitude and flying at or above it.
   d. None of the above.

8. The best way(s) for flight crews to overcome communication errors with ATC that contribute to CFIT is to:
   a. Exercise good radio communication discipline.
   b. Know the height of the highest terrain or obstacle in the operating area.
   c. Know their position in relation to the surrounding high terrain.
   d. Challenge or refuse ATC instructions when they are not clearly understood, are questionable, or conflict with their assessment of airplane position relative to the terrain.
   e. All of the above.

9. A good way(s) for flight crews to overcome complacency is to:
   a. Know that familiarity can lead to complacency.
   b. Not assume that this flight will be like the last flight.
   c. Adhere to procedures.
   d. None of the above.
   e. All of the above.

10. Many studies show that airlines with established, well thought out and implemented standard operating procedures consistently have safer operations.
   a. True.
   b. False.

11. The majority of CFIT accidents occur during which phase(s) of flight?
   a. Departure.
   b. Enroute and descent.
   c. Landing.
   d. Descent, approach, and landing.

12. In the approach phase of flight, most CFIT accidents occur during:
   a. Visual approaches.
   b. ILS approaches.
   c. ADF approaches.
   d. VOR and VOR/DME approaches.

13. Which of the following recommendations will mitigate the hazards associated with flying a nonprecision instrument approach?
   a. Study the anticipated approach procedure(s) before departure.
   b. Identify unique gradient and step-down requirements.
   c. Review approach procedures during the approach briefing.
   d. All of the above.

14. The autoflight system will sometimes do things that the flight crew did not intend for it to do.
   a. True.
   b. False.

15. When using an autoflight system, flight crews should:
    a. Monitor the system for desired operation.
    b. Avoid complacency.
    c. Follow procedures.
    d. Cross-check raw navigation information.
    e. None of the above.
    f. All of the above.

16. One of the best ways to let the nonflying pilot know what to expect is to conduct a briefing before each takeoff and each approach.
    a. True.
    b. False.

17. To assist in preventing CFIT, the proper use of autoflight systems is encouraged during all approaches and missed approaches, in IMC, when suitable equipment is installed.
    a. True.
    b. False.

18. Route and destination familiarization training programs for flight crews will assist in preventing CFIT accidents and incidents. Written guidance, dispatch briefing material, and video familiarization using actual or simulated representations of destination and alternates is adequate for this training.
    a. True.
    b. False.

19. Flight crews should confirm altimeter setting units by repeating all digits and altimeter units in:
    a. ATC clearance readbacks and intracockpit communications.
    b. Only ATC clearance readbacks
    c. Only initial contact with approach control.
    d. None of the above.

20. It is essential that flight crews always appreciate the altitude of their airplane relative to terrain and obstacles and the assigned or desired flight path.
    a. Always true.
    b. Only during instrument approaches.
    c. Only during darkness or reduced visibility.
    d. Only if the airplane is not equipped with a GPWS.

21. In lieu of any guidance from your standard operating procedures, a callout (aural announcements by either crew member or airplane equipment of significant information that could affect flight safety) should be made:
    a. Upon initial indication of radio altimeter height.
    b. When the airplane is approaching from above or below the assigned altitude.
    c. When the airplane is approaching relevant approach procedure altitude restrictions and minimums.
    d. When the airplane is passing transition altitude/level.
    e. All of the above.
    f. Only c above.

22. Which is the most appropriate flight crew response to a GPWS warning during IMC?
    a. Quickly verify that the warning is valid and execute the escape maneuver, if the warning is valid.
    b. Recheck the barometric altimeter setting and execute the escape maneuver, if the setting is in error.
    c. Immediately execute the escape maneuver.
    d. None of the above.

23. The GPWS escape maneuver should be continued:
    a. Only until the GPWS warning ceases.
    b. Until the airplane has reached the sector emergency safe altitude.
    c. Until visual verification can be made that the airplane will clear the terrain or obstacle.
    d. Answers b or c above.

24. Flight crews should be provided with and be trained to use adequate navigation and approach charts that accurately depict hazardous terrain and obstacles.
    a. True.
    b. False.

25. CFIT accidents and incidents happen insidiously; flight crews fall into traps.
    a. True.
    b. False.

Instructors Examination Guide

Instructions

This guide contains questions that are based on the material in the CFIT Education and Training Aid. The answers to each question can be found in Section 3, Operators Guide of that document. The questions are all multiple choice, fill in the blank, or true/false questions.

There is one answer to each question that is most correct. The correct answer is listed after each question, along with the section where the correct answer may be found.

Questions

1. The definition of a CFIT accident is an event in which:
   a. An airplane impacts the ground, water, or an obstacle during the descent, approach, or arrival phase of flight.
   b. A mechanically normally functioning airplane is inadvertently flown into the ground, water, or an obstacle.
   c. An airplane is inadvertently flown into the ground, water, or an obstacle because of malfunctioning navigational aids.
   d. An airplane is inadvertently flown into the ground, water, or an obstacle during an inflight emergency.

   Answer: b. (Section 3.1)

2. The basic causes of CFIT accidents are:
   a. An insufficient number of instrument approach aids and runway visual aids.
   b. Flight crew complacency and visual illusions.
   c. Altimeter anomalies and complex instrument procedures.
   d. The lack of flight crew vertical and horizontal situational awareness.

   Answer: d. (Section 3.2.1)

3. There are _________ factors that lead to CFIT accidents.
   a. Only a few.
   b. Two.
   c. Only pilot.
   d. Many.

   Answer: d. (Section 3.2.2)

4. Is there an international standard for the altimeter setting unit of measurement?
   a. Yes, and it is inches of mercury.
   b. Yes, but it is not adhered to by all states.
   c. Yes, but it is only adhered to by the United States.
   d. No.

   Answer: b. (Section 3.2.2.1)

5. If you set an inches of mercury altimeter setting of 29.92 instead of a hectoPascal setting of 992, the airplane will be flying at an altitude that is in error of about:
   a. Plus 600 ft.
   b. Plus 1,000 ft.
   c. Minus 600 ft.
   d. Minus 1,000 ft.

   Answer: c. (Section 3.2.2.1)

6. If you incorrectly use a QNH altimeter setting instead of a QNE altimeter setting, the airplane's altitude above the ground will be:
   a. Higher than required.
   b. Lower than required.
   c. Higher or lower, depending on the QNH setting.
   d. Insignificant.

   Answer: c. (Section 3.2.2.2)

7. When pilots accept an ATC enroute clearance to proceed off airway direct to a point:
   a. The clearance ensures safe terrain clearance.
   b. ATC must also include an altitude that ensures safe terrain clearance.
   c. The pilot is responsible for determining a safe altitude and flying at or above it.
   d. None of the above.

   Answer: c. (Section 3.2.2.4)

8. The best way(s) for flight crews to overcome communication errors with ATC that contribute to CFIT is to:
   a. Exercise good radio communication discipline.
   b. Know the height of the highest terrain or obstacle in the operating area.
   c. Know your position in relation to the surrounding high terrain.
   d. Challenge or refuse ATC instructions when they are not clearly understood, are questionable, or conflict with their assessment of airplane position relative to the terrain.
   e. All of the above.

   Answer: e. (Section 3.2.2.4)

9. A good way(s) for flight crews to overcome complacency is to:
   a. Know that familiarity can lead to complacency.
   b. Not assume that this flight will be like the last flight.
   c. Adhere to procedures.
   d. None of the above.
   e. All of the above.

   Answer: e. (Section 3.2.2.5)

10. Many studies show that airlines with established, well thought out and implemented standard operating procedures consistently have safer operations.
    a. True.
    b. False.

    Answer: a. (Section 3.2.2.6)

11. The majority of CFIT accidents occur during which phase(s) of flight?
    a. Departure.
    b. Enroute and descent.
    c. Landing.
    d. Descent, approach, and landing.

    Answer: d. (Section 3.2.2.7)

12. In the approach phase of flight, most CFIT accidents occur during:
    a. Visual approaches.
    b. ILS approaches.
    c. ADF approaches.
    d. VOR and VOR/DME approaches.

    Answer: d. (Section 3.2.2.7)

13. Which of the following recommendations will mitigate the hazards associated with flying a nonprecision instrument approach?
    a. Study the anticipated approach procedure(s) before departure.
    b. Identify unique gradient and step-down requirements.
    c. Review approach procedures during the approach briefing.
    d. All of the above.

    Answer: d. (Section 3.2.2.7)

14. The autoflight system will sometimes do things that the flight crew did not intend for it to do.
    a. True.
    b. False.

    Answer: a. (Section 3.2.2.8)

15. When using an autoflight system, flight crews should:
    a. Monitor the system for desired operation.
    b. Avoid complacency.
    c. Follow procedures.
    d. Cross-check raw navigation information.
    e. None of the above.
    f. All of the above.

    Answer: f. (Section 3.2.2.7)

16. One of the best ways to let the nonflying pilot know what to expect is to conduct a briefing before each takeoff and each approach.
    a. True.
    b. False.

    Answer: a. (Section 3.3.2)

17. To assist in preventing CFIT, the proper use of autoflight systems is encouraged during all approaches and missed approaches, in IMC, when suitable equipment is installed.
    a. True.
    b. False.

    Answer: a. (Section 3.3.3)

18. Route and destination familiarization training programs for flight crews will assist in preventing CFIT accidents and incidents. Written guidance, dispatch briefing material, and video familiarization using actual or simulated representations of destination and alternates is adequate for this training.
    a. True.
    b. False.

    Answer: a. (Section 3.3.4)

19. Flight crews should confirm altimeter setting units by repeating all digits and altimeter units in:
    a. ATC clearance readbacks and intracockpit communications.
    b. Only ATC clearance readbacks.
    c. Only initial contact with approach control.
    d. None of the above.

    Answer: a. (Section 3.3.5)

20. It is essential that flight crews always appreciate the altitude of their airplane relative to terrain and obstacles and the assigned or desired flight path.
    a. Always true.
    b. Only during instrument approaches.
    c. Only during darkness or reduced visibility.
    d. Only if the airplane is not equipped with a GPWS.

    Answer: a. (Section 3.3.5)

21. In lieu of any guidance from your standard operating procedures, a callout (aural announcements by either crew member or airplane equipment of significant information that could affect flight safety) should be made:
    a. Upon initial indication of radio altimeter height.
    b. When the airplane is approaching from above or below the assigned altitude.
    c. When the airplane is approaching relevant approach procedure altitude restrictions and minimums.
    d. When the airplane is passing transition altitude/level.
    e. All of the above.
    f. Only c above.

    Answer: e. (Section 3.3.6)

22. Which is the most appropriate flight crew response to a GPWS warning during IMC?
    a. Quickly verify that the warning is valid and execute the escape maneuver, if the warning is valid.
    b. Recheck the barometric altimeter setting and execute the escape maneuver, if the setting is in error.
    c. Immediately execute the escape maneuver.
    d. None of the above.

    Answer: c. (Section 3.3.7)

23. The GPWS escape maneuver should be continued:
    a. Only until the GPWS warning ceases.
    b. Until the airplane has reached the sector emergency safe altitude.
    c. Until visual verification can be made that the airplane will clear the terrain, or obstacle.
    d. Answers b or c above.

    Answer: d. (Section 3.3.7)

24. Flight crews should be provided with and be trained to use adequate navigation and approach charts that accurately depict hazardous terrain and obstacles.
    a. True.
    b. False.

    Answer: a. (Section 3.3.8)

25. CFIT accidents and incidents happen insidiously; flight crews fall into traps.
    a. True.
    b. False.

Answer: a. (Section 3.4)

Summary of Answers

1. b
2. d
3. d
4. b
5. c
6. c
7. c
8. e
9. e
10. a
11. d
12. d
13. d
14. a
15. f
16. a
17. a
18. a
19. a
20. a
21. e
22. c
23. d
24. a
25. a

APPENDIX

4-C

CFIT Safety Briefing

CFIT: How Do We Terrain-Proof Our Pilots?

Controlled Flight Into Terrain (CFIT) is defined as an event in which a mechanically normally functioning airplane is inadvertently flown into the ground, water, or an obstacle. Since the beginning of commercial jet operations, more than 9,000 people have died worldwide because of CFIT.

The Flight Safety Foundation organized a CFIT Task Force to study the causes and make recommendations to reduce CFIT accidents by 50% by the year 1998. The Task Force was composed of representatives from aircraft manufacturers, airline operators, government regulators, industry associations, pilots groups, and others.

A consensus was achieved within the industry Task Force, and those recommendations and solutions are included in this briefing.

CFIT:
How Do We Terrain-Proof
Our Pilots?

Figure 4-C.1

Hull-Loss Accidents for Worldwide Commercial Jet Fleet

The worldwide accident rate (which includes CFIT) for the commercial jet fleet decreased significantly in the 1960s and in the 1970s. The rate stabilized and remains fairly stable today.

Hull-Loss Accidents for Worldwide Commercial Jet Fleet

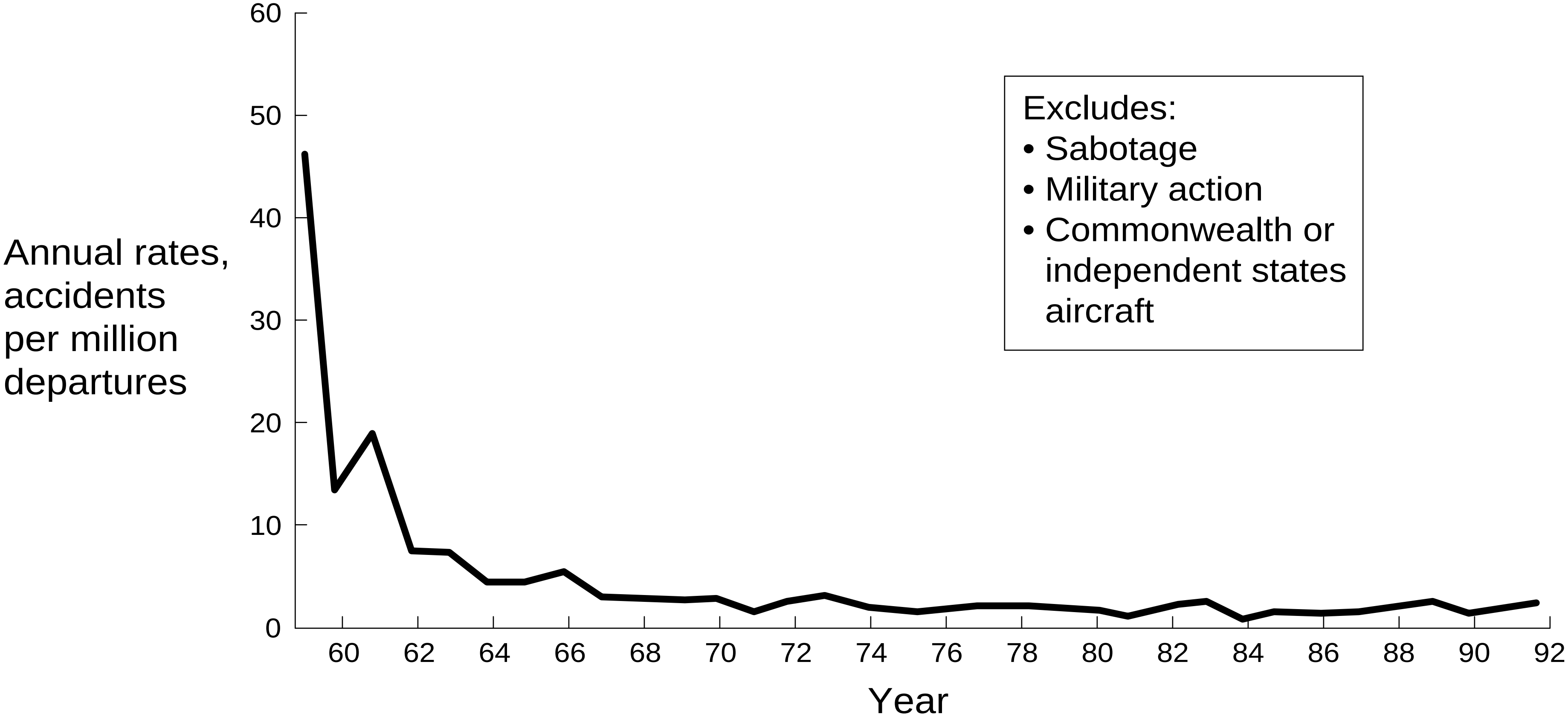


Figure 4-C.2

Controlled Flight Into Terrain

We can be very satisfied with this accomplishment, but let's look at the actual number of CFIT accidents that are included in this accident rate.

Controlled Flight Into Terrain

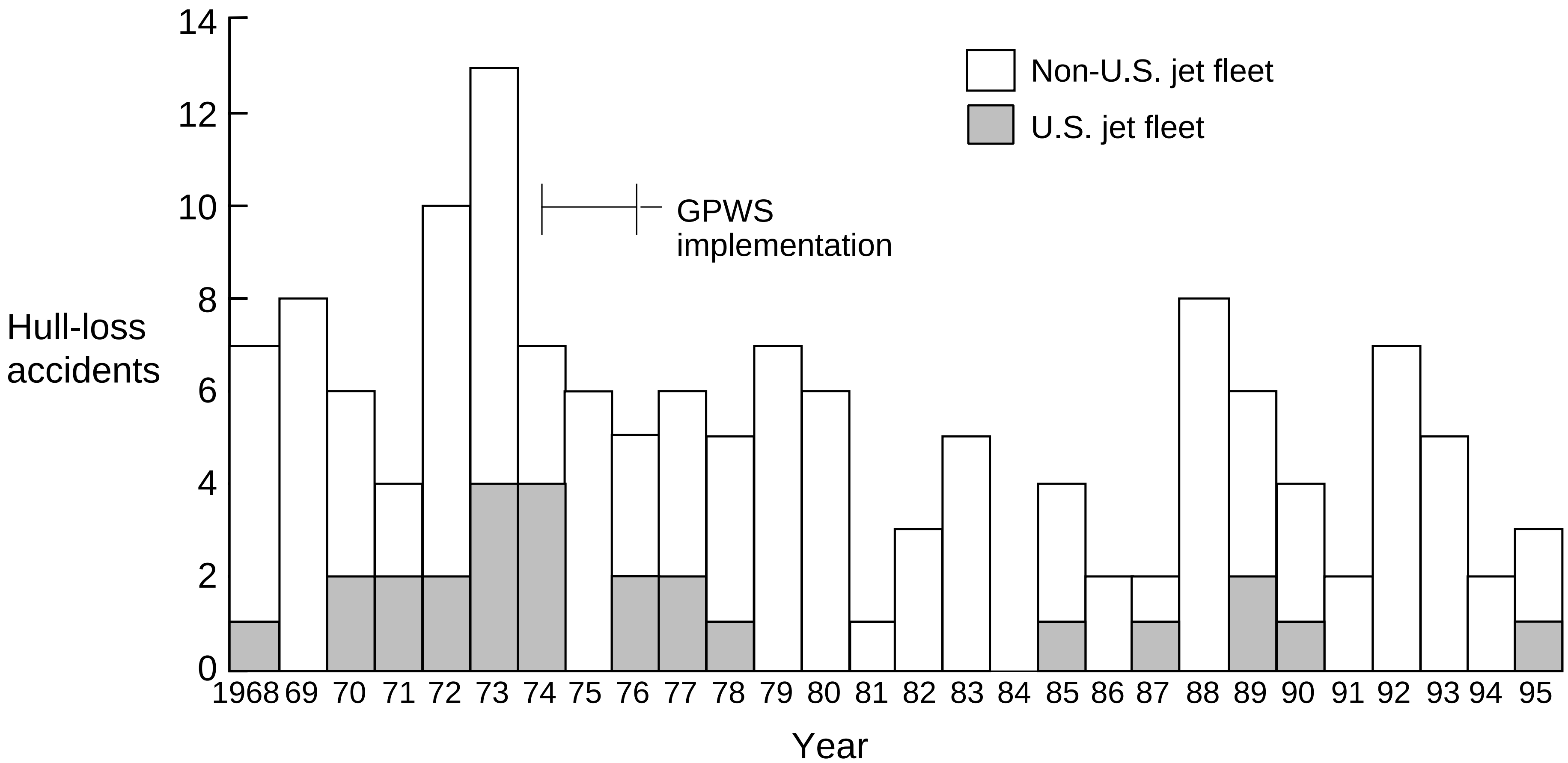


Figure 4-C.3

CFIT Accidents Per Year
USA and World Carriers

This chart shows hull losses attributed to CFIT for the United States fleet as well as the rest of the world's fleet. The reduction in CFIT accidents that started in 1975 will be discussed later. The important thing to understand about these accidents is that they happened with normally functioning airplanes.

These are accidents that operators could have prevented!

CFIT Accidents Per Year

USA and World Carriers

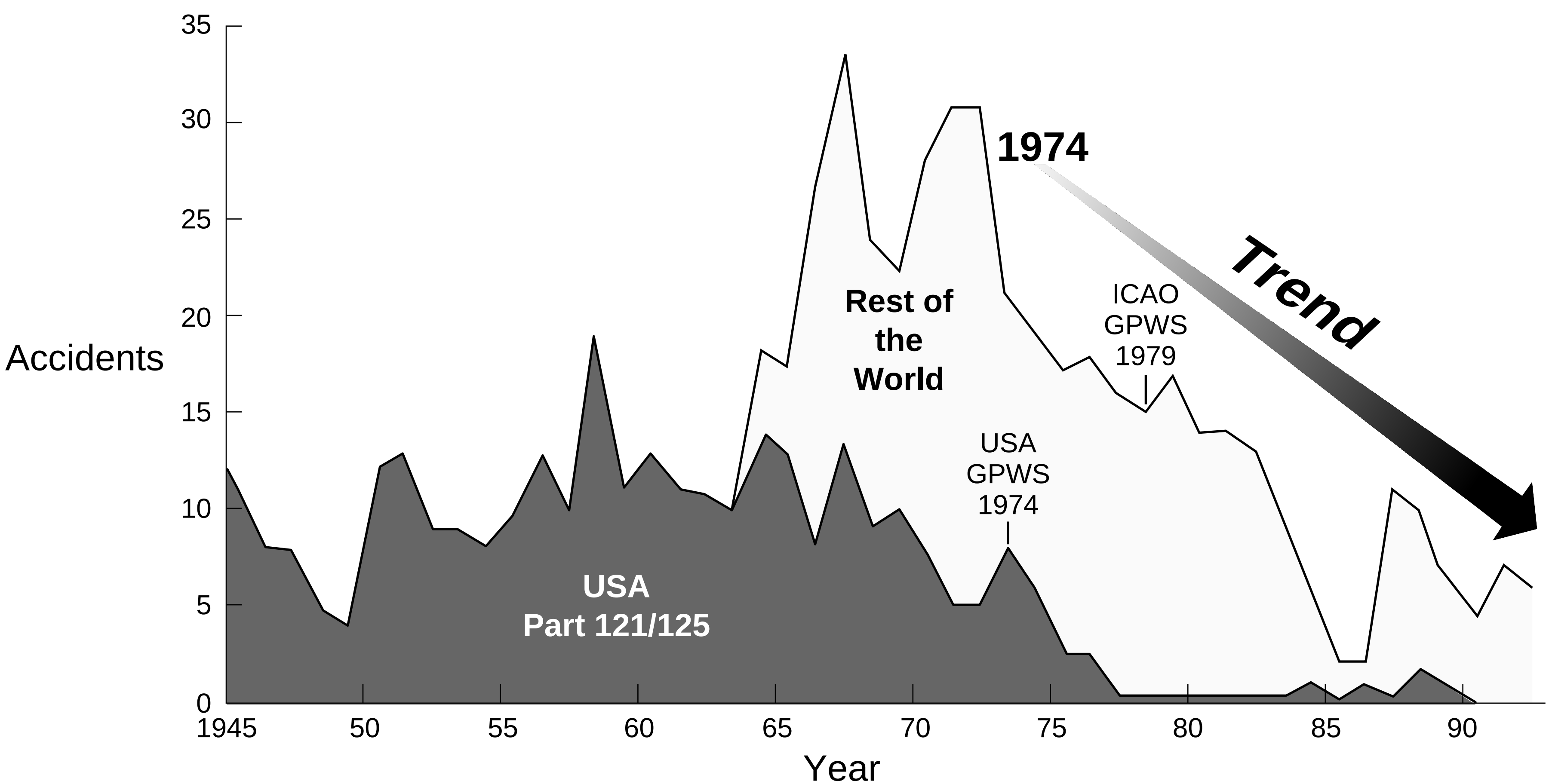
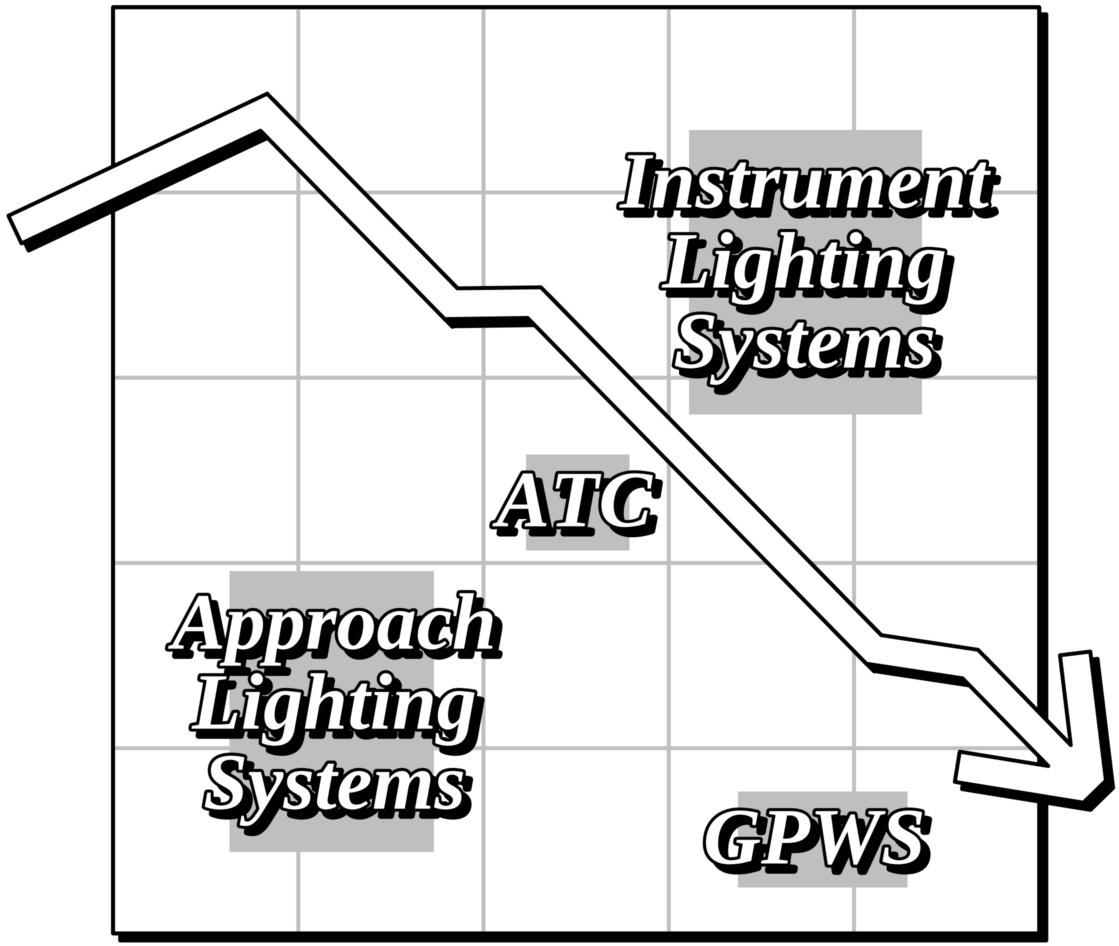


Figure 4-C.4

Worldwide CFIT accident data was not available until the mid-1960s. In the United States starting in 1975, large jet transport accidents attributed to CFIT fell to an average of only one every two years. A comparable reduction took place worldwide. A major reason for this was the advent of the Ground Proximity Warning System (GPWS). There were also other reasons for the reduction of accidents. Expansion and upgrading of Air Traffic Control (ATC) radar within the United States and installation of Approach Lighting Systems and Instrument Lighting Systems were some of the reasons for better flight safety. However, GPWS is generally accepted as making the biggest impact in reducing the number of CFIT accidents.

The most prevalent factor for hull losses with known causes is the flight crew. There are normally more CFIT accidents than any other type. The GPWS is the flight crew's last chance to avoid an impact with the ground, water, or an obstacle. While this briefing will include information on the use of GPWS, it is logical to emphasize the causes and contributing factors of CFIT so that appropriate accident prevention strategies are developed. Hopefully, this will assist the flight crew in avoiding situations that force them to react to a GPWS escape warning.



Reasons for the Fall Of CFIT Accidents

Figure 4-C.5

There are two basic causes for CFIT accidents; both involve flight crew situational awareness. (One definition of situational awareness is an accurate perception by pilots of the factors and conditions currently affecting the safe operation of the aircraft and the crew).

The causes of CFIT are the flight crews' lack of vertical position awareness or their lack of horizontal position awareness in relation to the ground, water, or an obstacle. More than two-thirds of all CFIT accidents are the result of altitude error or lack of vertical situational awareness.

Simply stated, flight crews need to know where they are and the safe altitude to fly. It follows then that CFIT accidents occur during reduced visibility associated with instrument meteorological conditions (IMC), darkness, or a combination of both conditions.

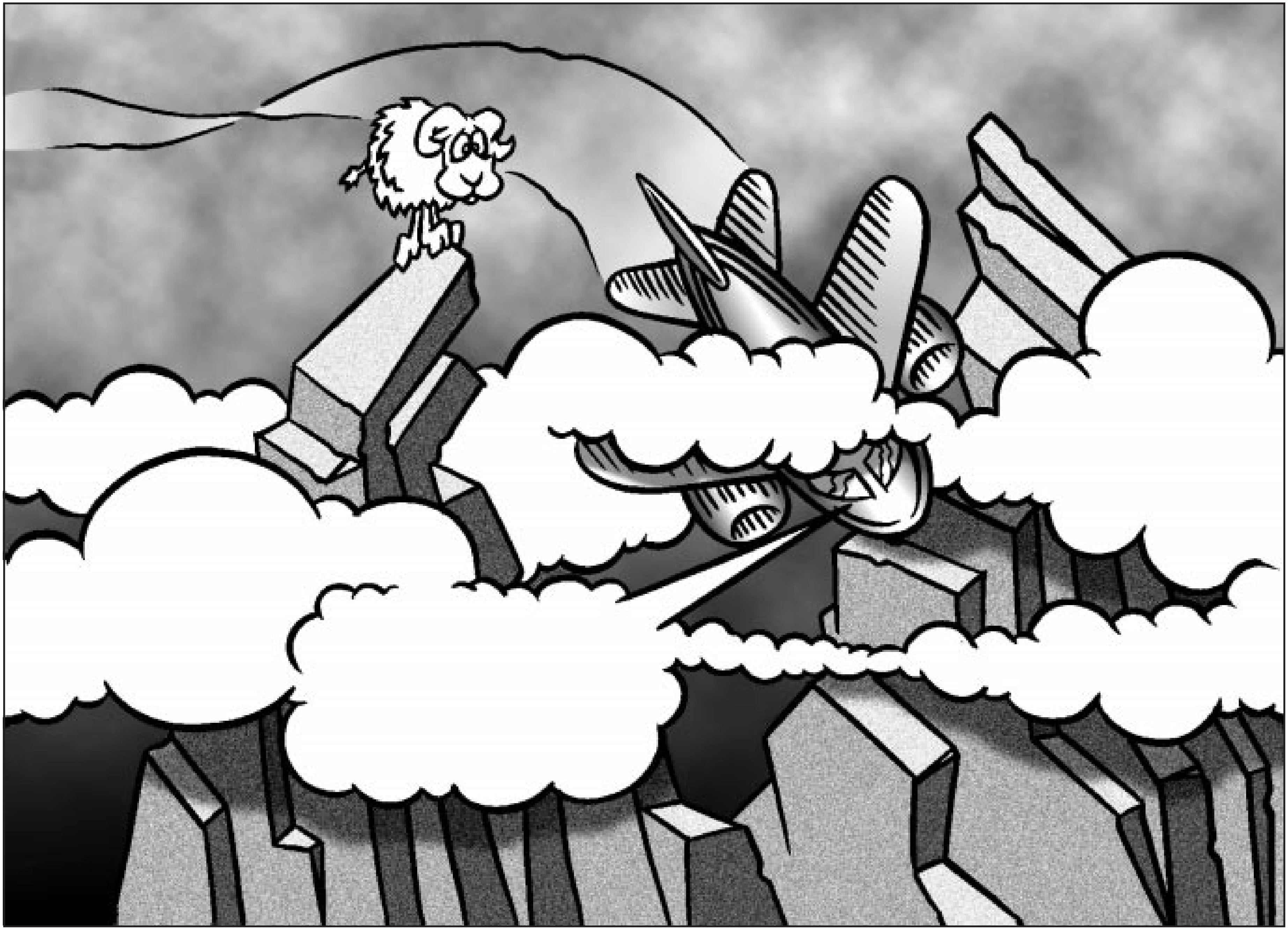


Figure 4-C.6

Factors That Contribute to CFIT

There are many factors that lead to CFIT accidents. We all accept that the pilot has the final responsibility for preventing a CFIT accident, but if many of the factors normally associated with these accidents were eliminated or at least mitigated, the potential for pilot errors would be lessened.

Each of these contributing factors will be discussed. Solutions to counter these factors will be included in the discussion.

Factors That Contribute to CFIT

- Altimeters
- Safe Altitude
- ATC
- Flight Crew Complacency
- Procedural
- Descent, Approach, and Landing
- Autoflight System
- Training

Figure 4-C.7

Accidents and numerous incidents have happened because of problems associated with the aircraft altimeter. These factors associated with altimeters can be grouped into two areas: altimeter units of measurement and altimeter settings.

While there is an international standard for units of measurement, it not adhered to by all countries. Settings may be given in inches of mercury, hectoPascals, or millibars. Additionally, some air traffic systems use meters and some use feet for altitude reference. The unit of measurement used depends on the area of the world in which the flight crew is flying. A problem can arise when the flight crew is trained and primarily operates in one area of the world and only periodically operates elsewhere.

Here is what can happen. An ATC controller, who speaks English as a second language, hurriedly advises the crew to descend and maintain 9,000 feet using an altimeter setting of “992”. The crew sets 29.92 inHg, not 992 hPa that the controller was expecting to be set. Throughout the approach the airplane will be approximately 600 feet below the altitude indicated on the altimeter. This can make the difference between a normal landing at the destination and an accident.

Prevention:

- Know what altimeter units of measurement are used for the area.
- Be vigilant during radio transmissions. Verify if in doubt.
- Be prepared to convert feet and meters.

Inches of Mercury

HectoPascals

Millibars

- Know what altimeter units of measurement are used for the area.
- Be vigilant during radio transmission. Verify if in doubt.
- Be prepared to convert feet and meters.

Figure 4-C.8

The QNH altimeter setting is obtained by measuring the existing surface pressure and converting it to a pressure that would theoretically exist at sea level at that point. This is accomplished by adding the pressure change for elevation above sea level on a standard day. This QNH altimeter setting is the standard used throughout most of the world. *Some states, however, report or use QFE.*

The QFE altimeter setting is the actual surface pressure and is not corrected to sea level. The QFE altimeter setting results in the altimeter indicating height above field elevation while the QNH setting results in the altimeter indicating height above mean sea level.

There have been incidents in which a QNH setting has been erroneously used as a QFE setting. This results in the airplane being flown at a lower than required altitude.

The QNE altimeter setting is always 29.92 inches of mercury, or 1013 hectopascals/millibars. QNE is set when operating at, climbing through, or operating above the transition altitude. Transition altitudes are not standardized throughout the world, which increases the potential for pilots to make errors.

Extreme atmospheric anomalies, such as low temperatures or low pressures, can affect altimeters and result in reduced altitude margins of safety.

It is easy to make mistakes with altimeters. For example, 28.82 inches of mercury is an unusually low setting. Pilots have erroneously set 29 instead of 28 because of the rare occurrences of such a low setting. They have formed a habit of using the “normal” 29. *This mistake will make you fly 1,000 feet lower than required!*

- Know what altimeter units of measurement are used for the area.
- Know the phase of flight to apply the appropriate altimeter setting.
- Use altimeter setting cross-check and readback cockpit procedure.
- Cross-check radio altimeter and barometric altimeter readings.
- Operate at higher than minimum altitudes during atmospheric anomalies.

Figure 4-C.9

Vertical awareness implies that pilots know the altitude relationship of the airplane to the surrounding terrain or obstacles. Obviously, during IMC and reduced visibility flight conditions, it is necessary to rely on altitude information provided by other than visual means. To assist pilots, instrument flight rule enroute charts and approach charts provide Minimum Safe Altitudes (MSA), Minimum Obstruction Clearance Altitudes (MOCA), Minimum Enroute Altitudes (MEA), Emergency Safe Altitudes (EAS), and in most terminal areas, actual heights of the terrain or obstacles. Traditional maps, such as Sectional or Operational Navigation Charts, are available for more detailed study. The potential for CFIT is greatest in the terminal areas. Detailed altitude information is provided to assist the pilot in maintaining situational awareness.

- Make sure adequate charts are available.
- Study the altitude information.
- Know and fly at or above the safe altitudes for your area of operation.

[Optional supporting information]

A pilot on a flight to Portland, Oregon, USA, made this report. “The area below us was like a ‘black hole’ because of forest and it was unpopulated. The city lights were off the right wing—a beautiful night. After being cleared for a visual approach, I began descent so as to arrive... at the recommended 3,000 feet mean sea level. ...At 4,100 feet MSL, the GPWS went‘Whoop, whoop! Pull up! Terrain.’ For a split second we thought it was a false warning, since we were still looking at the airport/city. Then I noticed both radio altimeters go from 2,500 feet to 400 feet in 1-2 seconds. I immediately applied full power and initiated a max climb until over the city’s outskirts (lights). Our whole crew serves this city daily and knows the airport well. Simple fact is that most pilots going into a familiar airport use the approach plate and do not often refer to the area chart. ...We were stupid and very lucky.” (Source: ASRS report 216837.)

- **Make sure adequate charts are available.**
- **Study the altitude information.**
- **Know and fly at or above the safe altitudes for your area of operation.**

Figure 4-C.10

The inability of air traffic controllers and pilots to properly communicate has been a factor in many CFIT accidents. There are multiple reasons for this problem. With the growth of the aviation industry taking place throughout the world, the use of English as a common language is more difficult to support. The lack of English language proficiency can make understanding controller instructions to the pilots and airborne information or requests from the pilots to the controllers much more prone to error. Heavy workloads can lead to hurried communications and the use of abbreviated or non-standard phraseology. The potential for instructions meant for one airplane and given to another is increased. Unreliable radio equipment still exists in some areas of the world, which compounds the communication problems.

- Make sure adequate charts are available.
- Study the altitude information.
- Know and fly at or above the safe altitudes for your area of operation.

[Optional supporting information]

The importance of good communications was pointed out in a report by an air traffic controller and flight crew of an MD-80. The controller reported that he was scanning his radar scope for traffic and noticed that the MD-80 was descending through 6,400 ft and immediately instructed a climb to at least 6,500 ft. The pilot responded that he had been cleared to 5,000 ft and then climbed to…The pilot reported that he had “heard” a clearance to 5,000 ft and read back 5,000 ft to the controller and received no correction from the controller. After almost simultaneous GPWS and controller warnings, the pilot climbed and avoided the terrain. The recording of the radio transmissions confirmed that the airplane was cleared to 7,000 ft and the pilot mistakenly read back 5,000 ft and attempted to descend to 5,000 ft. The pilot stated in the report: “I don’t know how much clearance from the mountains we had, but it certainly makes clear the importance of good communications between the controller and pilot.” (Source: ASRS report 96032)

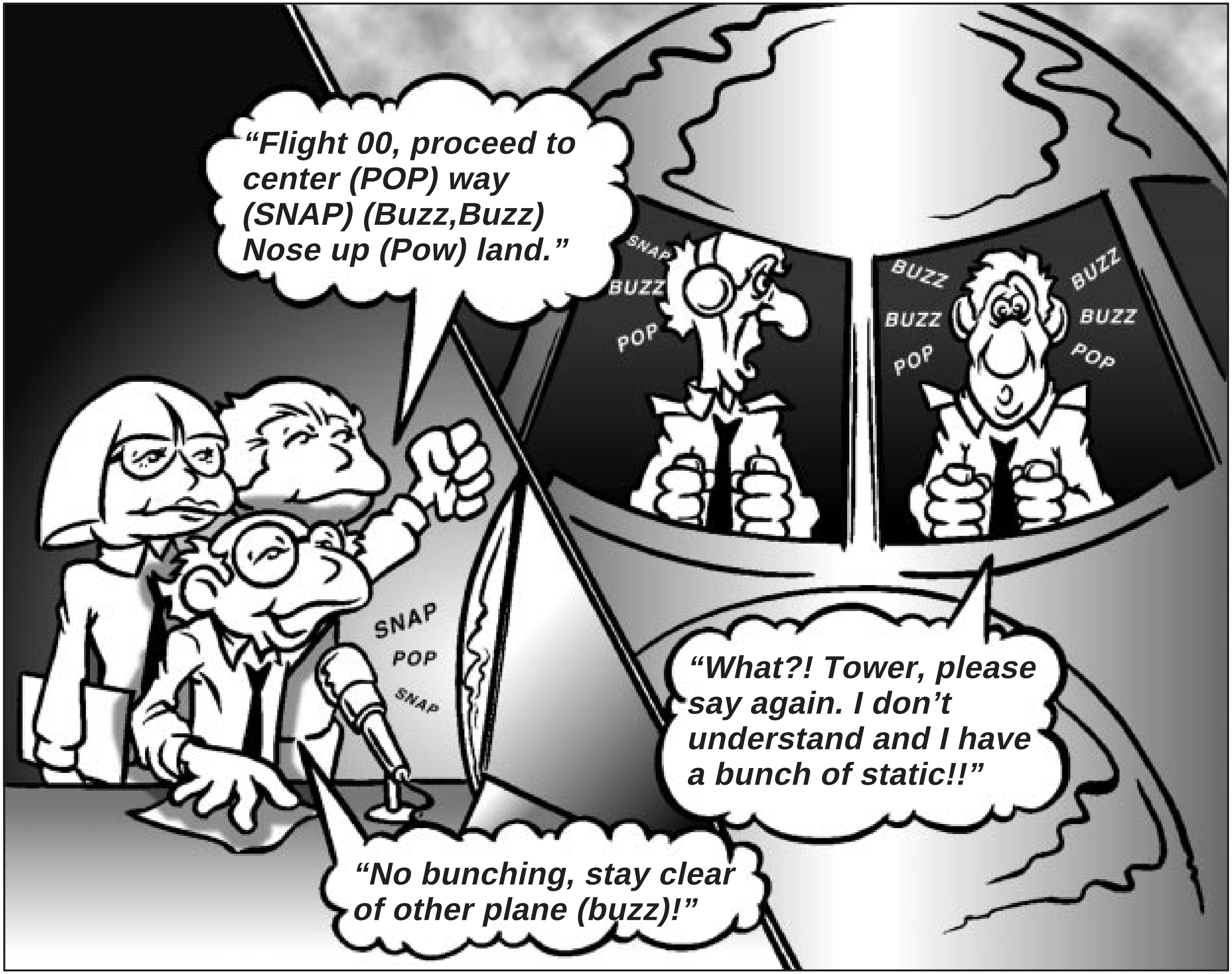
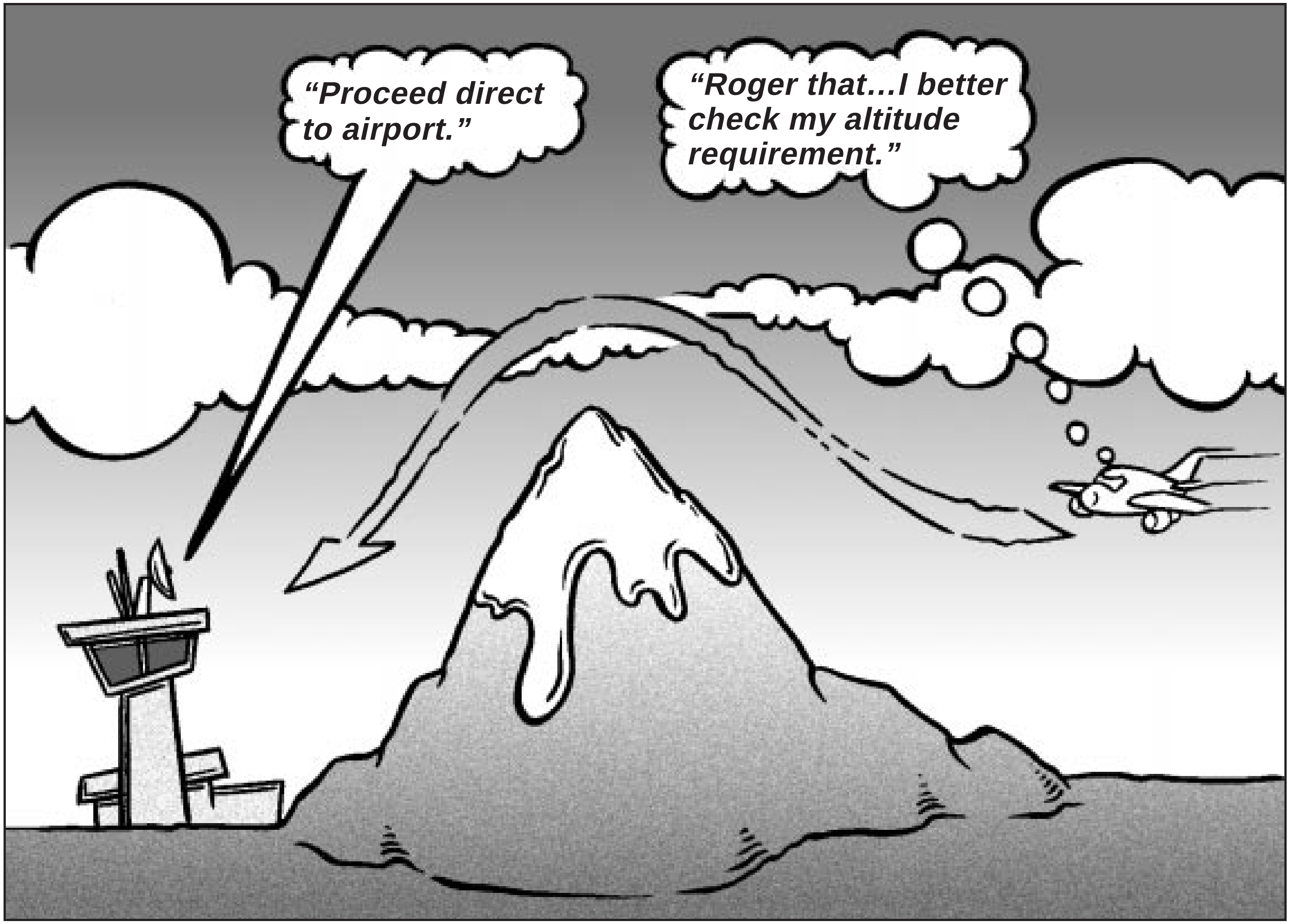

"Flight 00, proceed to center (POP) way (SNAP) (Buzz,Buzz) Nose up (Pow) land."
SNAP
BUZZ
POP
BUZZ
BUZZ
POP
BUZZ
BUZZ
POP
SNAP
POP
SNAP
"What?! Tower, please say again. I don't understand and I have a bunch of static!!"
"No bunching, stay clear of other plane (buzz)!"

Figure 4-C.11

ATC is not always responsible for safe terrain clearance for the airplanes under its jurisdiction. *Many times ATC will issue enroute clearances for pilots to proceed off airway direct to a point. When pilots accept this clearance, they also accept responsibility for maintaining safe terrain clearance.*

- Exercise good radio communication discipline.
- Know the height of the highest terrain or obstacle in the operating area.
- Know your position in relation to the surrounding high terrain.

Airspace constraints that are most prevalent in the terminal areas many times require air traffic controllers to radar vector airplanes at minimum vectoring altitudes that can be lower than the sector Minimum Safe Altitude. Proper vertical and horizontal situational awareness is vital during this critical phase of flight. Humans make errors. From time to time, ATC may issue flawed instructions that do not ensure adequate terrain clearance. While it may be difficult for flight crews to know that an error has been made, it is possible that the mistake can be detected with good pilot position and altitude awareness.



- **Exercise good radio communication discipline.**
- **Know the height of the highest terrain or obstacle in the operating area.**
- **Know your position in relation to the surrounding high terrain.**

Figure 4-C.12

- Challenge or refuse ATC instructions when they are not clearly understood, are questionable, or conflict with your assessment of airplane position relative to the terrain.
- Know the height of the highest terrain or obstacle in the operating area.
- Know your position in relation to the surrounding high terrain.

[Optional supporting information]

"While in a left turn to 330 degrees after takeoff, combined tower/departure controller said: 'Radar contact, turn left heading 300 degrees.' We responded by acknowledging the heading and 'leaving 6 for 7,000 feet. Aircraft was leveled off at 7,000 feet MSL. Captain asked controller the elevation of the terrain below us. Tower replied: '5,800 feet'. After approximately one minute level at 7,000 feet MSL, the radar altimeter light came on indicating terrain less than 2,500 feet. A climb was immediately initiated when the GPWS warned: 'Terrain, Terrain.' ATC was advised we're climbing. ATC replied: 'Verify you're climbing to 17,000.' Captain replied that we're issued 7,000 feet. ATC replied: 'climb and maintain 17,000.'...The controller said he was the new shift replacement for the controller who had given us the clearance." (Source: ASRS 95474.)

Complacency can be defined as self-satisfaction, smugness, or contentment. You can understand why after years in the same flight deck, on the same route structure to the same destinations, a pilot could become content, smug, or self-satisfied. Add to this equation a modern flight deck with a well functioning autopilot, and you have the formula for potential complacency.

Flight crews may also be exposed to continued false GPWS warnings because of a particular terrain feature and a GPWS

- **Challenge or refuse ATC instructions when they are not clearly understood, are questionable, or conflict with your assessment of airplane position relative to the terrain.**
- **Know the height of the highest terrain or obstacle in the operating area.**
- **Know your position in relation to the surrounding high terrain.**

Figure 4-C.13

database that has not been customized for the arrival. The flight crew becomes conditioned to this situation, since they have flown the approach many times. This can also lull the flight crew into complacency, and they may fail to react to an actual threat. Note: The newer versions of GPWS can be programmed by the manufacturer for specific airfield approach requirements so that these nuisance warnings are eliminated.

- Know that familiarity can lead to complacency.
- Do not assume that this flight will be like the last flight.
- Adhere to procedures.

Many studies show that operators with established, well thought out and implemented standard operating procedures (SOP) consistently have safer operations. It is through these procedures that the operator sets the standards that all flight crews are expected to follow.

CFIT accidents have happened when flight crews did not know the procedures, did not understand them, or did not

- **Know that familiarity can lead to complacency.**
- **Do not assume that this flight will be like the last flight.**
- **Adhere to procedures.**

Figure 4-C.14

comply with them, or when there were no procedures established. In the absence of standard operating procedures, flight crews will establish their own to fill the void in order to complete the flight. Some flight crews think the weather is never too bad to initiate an approach! It is the responsibility of management to develop the comprehensive procedures, train the flight crews, and quality control the results.

It is the responsibility of the flight crew to learn and follow the procedures and provide feedback to management when the procedures are incorrect, inappropriate, or incomplete.

- Do not invent your own procedures.
- Management must provide satisfactory standard operating procedures and provide effective training to the flight crew.
- Comply with these procedures.

CFIT accidents have occurred during departures, but the overwhelming majority of accidents occur during the descent, approach, and landing phases of the flight. CFIT accidents make up the majority of these accidents.

An analysis of 40 CFIT accidents was accomplished for a 5-year period, 1986 to 1990. The airplanes' lateral and vertical

- Do not invent your own procedures.
- Management must provide satisfactory standard operating procedures and provide effective training to the flight crew.
- Comply with these procedures.

Figure 4-C.15

positions were plotted in relation to the airport runway. Almost all the position plots are on the runway centerline inside of 10 miles from the intended airport. The vertical profiles showed flight paths at a relatively constant 3 degrees, but right into the ground!

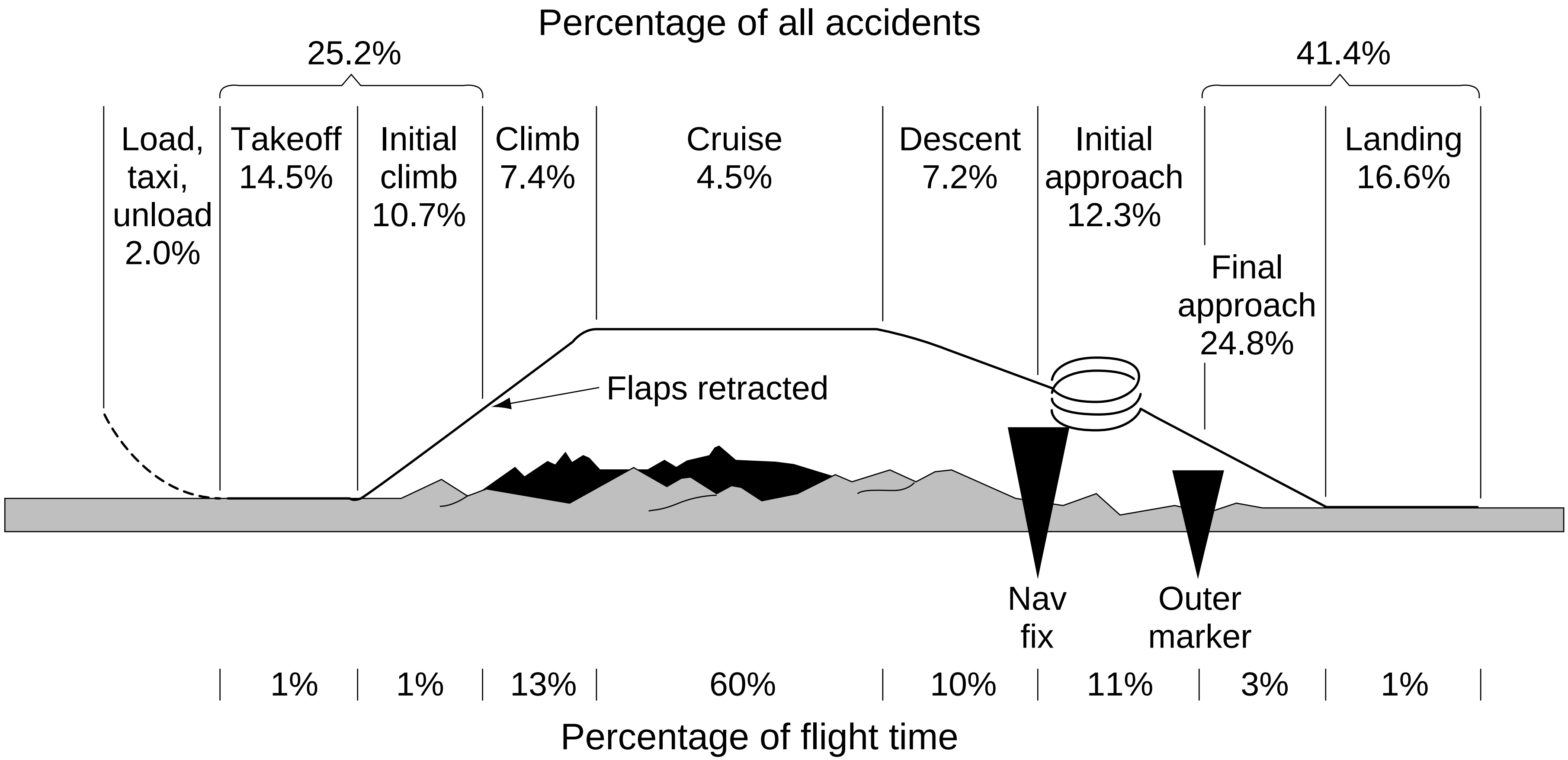
The geographical location of CFIT accidents during the 1970s show a different pattern than those in the late 1980s and 1990s. During the five-year period from 1972 through 1977, there were 75 CFIT accidents or incidents. Twenty-five of these accidents/incidents were greater than 8 nautical miles from the runway. The preponderance of the remaining accidents/incidents were inside the middle marker. However, for the period 1986 to 1990, the distribution of accidents/incidents was relatively even. This difference may be the result of improvements made in runway approach aids that took place during this time period. Additional Instrument Landing Systems were installed, as well as runway approach lighting systems.

- Know what approach and runway aids are available before initiating an approach.

- Use all available approach and runway aids.

- Use every aid to assist you in knowing your position and knowing the required altitudes at that position.

Most CFIT accidents occur during nonprecision approaches, specifically VOR/DME approaches. Inaccurate or poorly designed approach procedures, coupled with a variety of depictions, can be part of the problem.



- **Know what approach and runway aids are available before initiating an approach.**
- **Use all available approach and runway aids.**
- **Use every aid to assist you in knowing your position and knowing the required altitudes at that position.**

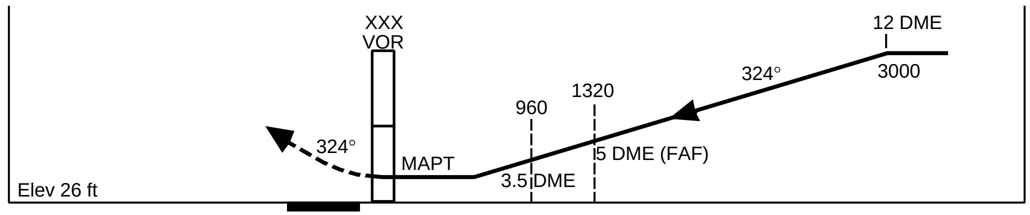
Figure 4-C.16

This is an example of an approach procedure produced by different sources. There are documented cases that the minimum terrain clearances on some published approach charts have contributed to both accidents and incidents. For more than a decade, a worldwide effort has been underway to both raise and standardize the descent gradient of non-precision approaches. There are gradients as little as 0.7 degrees in some VOR approach procedures.

In addition to the shallow approach gradients, many approaches use multiple altitude step-down procedures. This increases the pilot workload and the potential for making errors.

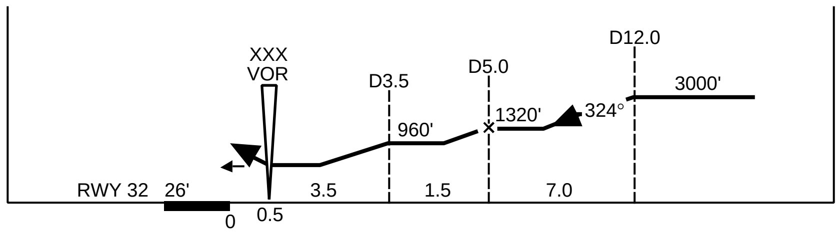
- Study the approach procedure(s) before departure.
- Identify unique gradient and step-down requirements.
- Review approach procedures during approach briefing.
- Use autoflight systems, when available.

There is more than one standard for approach procedures in the world. The United States standard is Terminal Instrument Procedures (TERPS). The ICAO standard is Procedures for Air Navigation Services-Aircraft Operations (PANS-OPS),

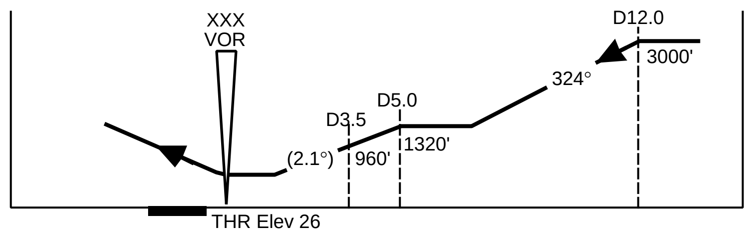


State AIP

- Many ways to present the descent profile
- Comparison of profiles for the same



Commercial Source A



Commercial Source B

- **Study the approach procedure(s) before departure.**
- **Identify unique gradient and step-down requirements.**
- **Review approach procedures during approach briefing.**
- **Use autoflight systems, when available.**

Figure 4-C.17

and the Russian Federation uses still another. Flight crews, therefore, may be exposed to different standards and different margins of safety.

- Study anticipated approach procedures before departure.
- Know that there are different approach design standards.

Unstable approaches contribute to many CFIT accidents or incidents. Unstable approaches increase the possibility of

- **Study anticipated approach procedures before departure.**
- **Know that there are different approach design standards.**

Figure 4-C.18

diverting a pilot's attention away from the approach procedure to regain better control of the airplane. A stabilized approach is defined by many operators as a constant rate of descent along an approximate 3 degree flight path with stable airspeed, power setting, and trim, with the airplane configured for landing.

Use the display and control modes recommended for the type of approach being flown, and as specified in the standard operating procedures applicable to the airplanes type. Be aware of the limitations associated with the specified procedures.

- Fly stabilized approaches.
- Execute a missed approach if not stabilized by 500 feet above ground level or an altitude specified by your SOP.

A minimum of three to five near collision with the terrain autoflight-related incidents occur each year. Not all incidents

- **Fly stabilized approaches.**
- **Execute a missed approach if not stabilized by 500 feet above ground level or an altitude specified by your SOP.**

Figure 4-C.19

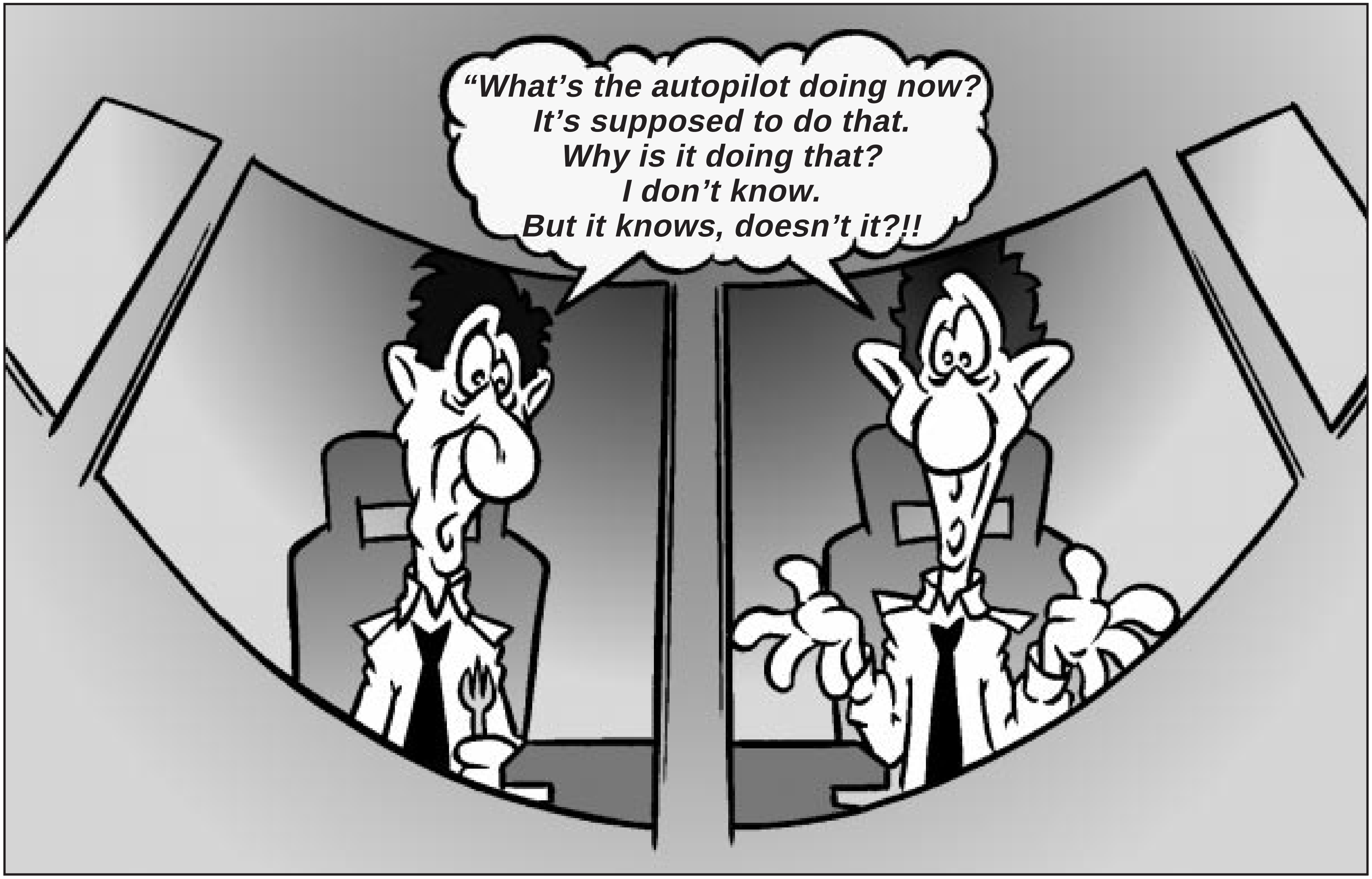
are reported. The actual number of incidents may be much greater. The advancement of technology in today's modern airplanes has brought us flight directors, autopilots, autothrottles and flight management systems. All of these devices are designed to reduce pilot workload. They keep track of altitude, heading, airspeed, and the approach flight path, and they tune navigation aids with unflagging accuracy. When used properly, this technology has made significant contributions to flight safety. But technology can increase complexity and also lead to unwarranted trust or complacency.

Autoflight systems can be misused, contain database errors, or be provided with faulty inputs by the flight crew. They will sometimes do things that the flight crew did not intend for them to do.

- Monitor the autoflight system for desired operation.
- Avoid complacency.
- Follow procedures.
- Cross-check raw navigation information.

[Optional supporting information]

Imagine this situation. You are descending, and the autoflight system is engaged and coupled to fly the FMC course. It is night time, and you are flying an instrument arrival procedure in mountainous terrain. The FMC has been properly programmed, and the airplane is on course when ATC amends the routing. In the process of programming the FMC, an erroneous active waypoint is inserted. While you and the first officer are reconciling the error, the airplane begins a turn to the incorrect waypoint! It does not take very long to stray from the terrain-altitude-protected routing corridor.

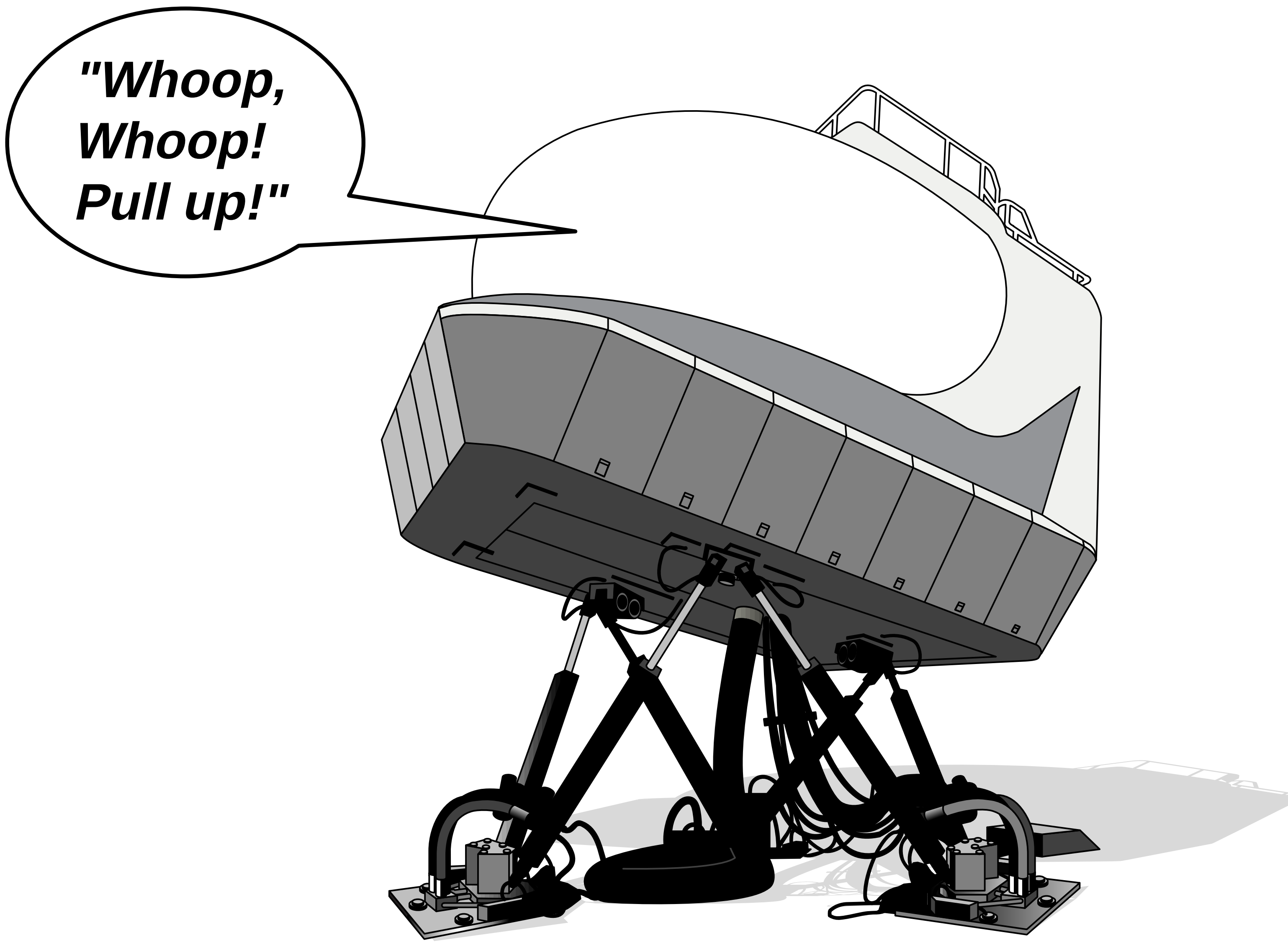


- **Monitor the autoflight system for desired operation.**
- **Avoid complacency.**
- **Follow procedures.**
- **Cross-check raw navigation information.**

Figure 4-C.20

Most of the factors that have been identified are the result of deficiencies in flight crew training programs. Therefore, training becomes a significant factor that contributes to CFIT. Well-designed equipment, comprehensive operating procedures, extensive runway approach aids, and standardized charting or altimeter setting procedures and units of measurement will not prevent CFIT unless flight crews are properly trained and disciplined.

- Develop and implement effective initial and recurrent flight crew training programs that consider CFIT.
- Implement Flight Operations Quality Assurance Programs.



- **Develop and implement effective initial and recurrent flight crew training programs that consider CFIT.**
- **Implement Flight Operations Quality Assurance Programs.**

Figure 4-C.21

In Section 2 of the CFIT Education and Training Aid (the Decision Makers Guide), we pointed out that CFIT prevention encompasses more than operator-related actions. There are system-related problems that, when solved, will help operators avoid situations that may lead to CFIT. Some progress has been made in solving the systemic problems, but much more needs to be done. In the meantime, operators can also do much more to prevent CFIT accidents.

- **Crew briefings**
- **Autoflight systems**
- **Route and destination familiarization programs**
- **Altitude awareness techniques and procedures**
- **Callouts**
- **GPWS escape maneuvers**
- **Better charts**
- **Better training**

Figure 4-C.22

Many of the CFIT accidents show a lack of flight crew communication. For example, while one pilot flew the approach, the other did not know or understand the intentions of the flying pilot. This lack of communication can lead to breakdowns in flight crew coordination and cross-checking. *One of the best ways to let the nonflying pilot know what to expect is to conduct a briefing before each takeoff and each approach.* While this seems elementary, many pilots simply ignore the obvious safety implications of the briefing.

Operators should require briefings by the flight crew. As operations vary from country to country, some briefing items may be more important than others and some unique items may be added, but there are some items that should always be covered.


"Don't forget your briefing before you take off and before you land.

Figure 4-C.23

Use the following takeoff briefing guidelines if other guidance is not provided by standard operating procedures or the airplane manufacturer.

- Weather at the time of departure.
- Runway in use, usable length (full length or intersection takeoff).
- Flap setting to be used for takeoff.
- V speeds for takeoff.
- Expected departure routing.
- Airplane navigation aids setup.
- Minimum sector altitudes and significant terrain or obstacles relative to the departure routing.
- Rejected takeoff procedures.
- Engine failure after V1 procedures.
- Emergency return plan.

Takeoff Briefing

- Weather at the time of departure.
- Runway in use, usable length (full length or intersection takeoff).
- Flap setting to be used for takeoff.
- V speeds for takeoff.
- Expected departure routing.
- Airplane navigation aids setup.
- Minimum sector altitudes and significant terrain or obstacles relative to the departure routing.
- Rejected takeoff procedures.
- Engine failure after V1 procedures.
- Emergency return plan.

Figure 4-C.24

The accident statistics show that the vast majority of accidents occur during the approach at the destination airport. Is it not logical then to prepare carefully and properly for the arrival, approach, and landing? *The approach briefing sets the professional tone for your safe arrival at the destination.* The flying pilot should discuss how he or she expects to navigate and fly the procedure. This will not only solidify the plan for the approach, but it will inform the nonflying pilot of intentions, which provides a basis for monitoring the approach. Deviations from the plan now can be more readily identified by the nonflying pilot. The approach briefing should be completed before arriving in the terminal area, so that both pilots can devote their total attention to executing the plan.

Use the following approach briefing guidelines if other guidance is not provided by standard operating procedures or the airplane manufacturer.

Approach Briefing

- Expected arrival procedure to include altitude and airspeed restrictions.
- Weather at destination and alternate airports.
- Anticipated approach procedure to include:
  - Minimum sector altitudes.
  - Airplane navigation aids setup.
  - Terrain in the terminal area relative to approach routing.
  - Altitude changes required for the procedure.
  - Minimums for the approach DA/H or MDA/H.
  - Missed approach procedure and intentions.
- Communication radio setup
- Standard callouts to be made by the nonflying pilot.

Figure 4-C.25

Proper use of the modern autoflight systems reduces workloads and significantly improves flight safety. These systems keep track of altitude, heading, airspeed, and flight paths with unflagging accuracy. Unfortunately, there are a great number of first-generation airplanes that are still operating that do not have the advantages associated with well-designed integrated systems. There are also some flight crews whose airplanes do have modern systems, but who do not take full advantage of the autoflight system to manage the progress of the flight and reduce workload.

To assist in preventing CFIT, the proper use of autoflight systems is encouraged during all approaches and missed approaches, in IMC, when suitable equipment is installed.

It is incumbent on operators to develop specific procedures for the use of autopilots and autothrottles during precision approaches, nonprecision approaches and missed approaches, and to provide simulator-based training in the use of these procedures for all flight crews.

Figure 4-C.26

Flight crews must be adequately prepared for CFIT critical conditions, both enroute and at the destination. *Flight crews must be provided with adequate means to become familiar with enroute and destination conditions for routes deemed CFIT critical*. One or more of the following methods are considered acceptable for this purpose:

- When making first flights along routes, or to destinations, deemed CFIT critical, Captains should be accompanied by another pilot familiar with the conditions; or,

- Suitable simulators can be used to familiarize flight crews with airport critical conditions when those simulators can realistically depict the procedural requirements expected of flight crew members; or,

- Written guidance, dispatch briefing material, and video familiarization using actual or simulated representations of destination and alternatives should be provided.

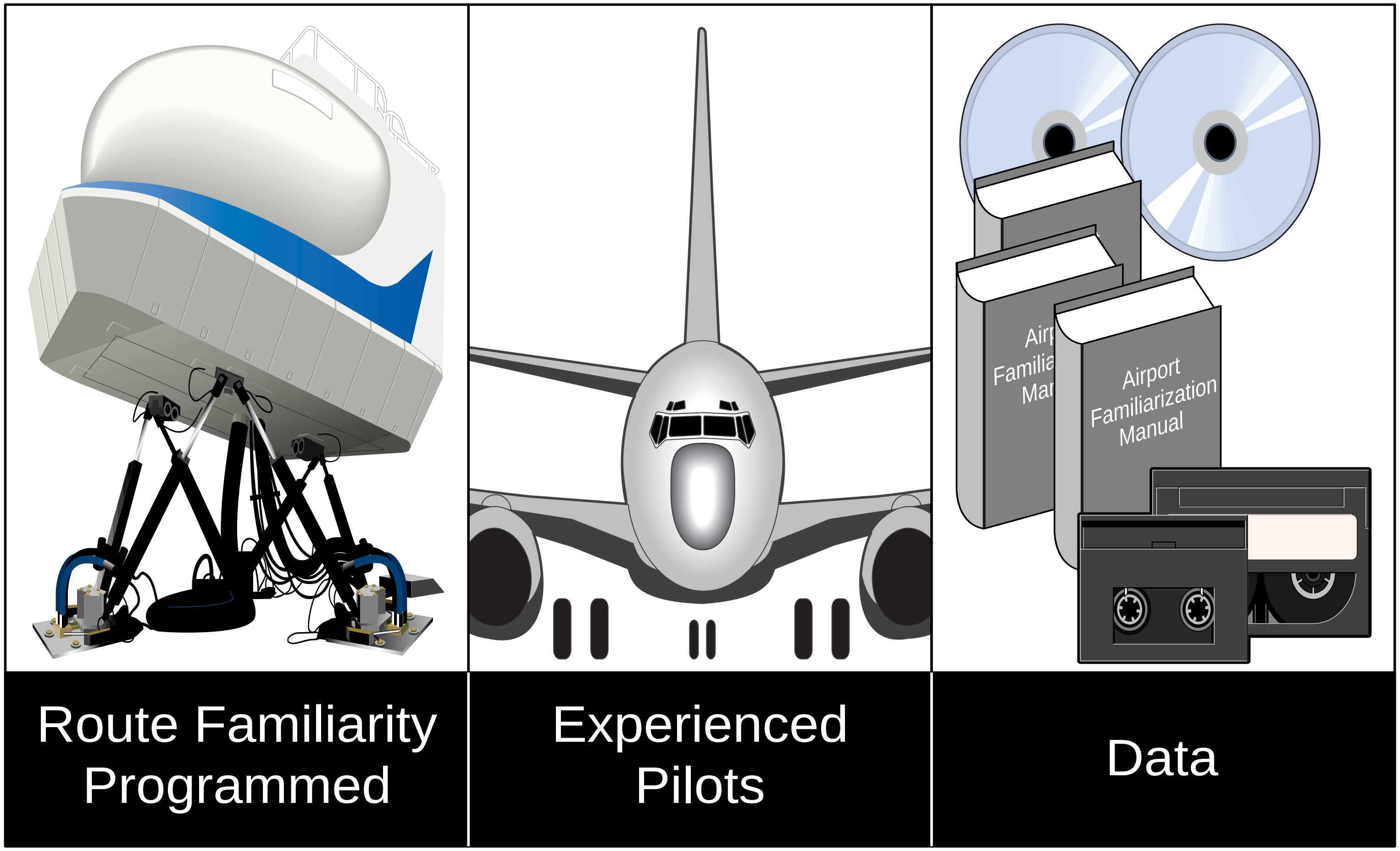

Airport
Familiarization
Manual
Route Familiarity
Programmed
Experienced
Pilots
Data

Figure 4-C.27

It is essential that flight crews always appreciate the altitude of their airplane relative to terrain, and the assigned or desired flight path. Flight crews need to be provided with and need to use procedures with which they will monitor and cross-check assigned altitudes, as well as verify and confirm altitude changes. As a minimum, in the absence of standard operating procedures or airplane manufacturer's guidance, use the following procedures:

- Ascertain the applicable MSA reference point. Note: The MSA reference point for an airport may vary considerably according to the specific approach procedure in use.
- Know the applicable transition altitude or transition level.
- Use a checklist item to ensure that all altimeters are correctly set in relation to the transition altitude/level. Confirm altimeter setting units by repeating all digits and altimeter units in clearance readbacks and intracockpit communications.
- Call out any significant deviation or trend away from assigned clearances.
- Include radio height in the pilot instrument scan.
- Upon crossing the final approach fix, outer marker, or equivalent position, the pilot not flying will cross-check actual crossing altitude/height against altitude/height as depicted on the approach chart.
- Follow callout procedures.

Altitude Awareness

- **Ascertain the applicable MSA reference point. Note: The MSA reference point for an airport may vary considerably according to the specific approach procedure in use.**
- **Know the applicable transition altitude or transition level.**
- **Use a checklist item to ensure that all altimeters are correctly set in relation to the transition altitude/level. Confirm altimeter setting units by repeating all digits and altimeter units in clearance readbacks and intracockpit communications.**
- **Call out any significant deviation or trend away from assigned clearances.**
- **Include radio height in the pilot instrument scan.**
- **Upon crossing the final approach fix, outer marker, or equivalent position, the pilot not flying will cross-check actual crossing altitude/height against altitude/height as depicted on the approach chart.**
- **Follow callout procedures.**

Figure 4-C.28

Callouts are defined as aural announcements, by either flight crew members or airplane equipment, of significant information that could affect flight safety. A callout should be made at the following times:

- Upon initial indication of radio altimeter height, at which point altitude versus height above terrain should be assessed and confirmed to be reasonable.
- When the airplane is approaching from above or below the assigned altitude (adjusted as required to reflect specific airplane performance).
- When the airplane is approaching relevant approach procedure altitude restrictions and minimums.
- When the airplane is passing transition altitude/level.

Callouts

- Upon initial indication of radio altimeter height, at which point altitude versus height above terrain should be assessed and confirmed to be reasonable.
- When the airplane is approaching from above or below the assigned altitude (adjusted as required to reflect specific airplane performance).
- When the airplane is approaching relevant approach procedure altitude restrictions and minimums.
- When the airplane is passing transition altitude/level.

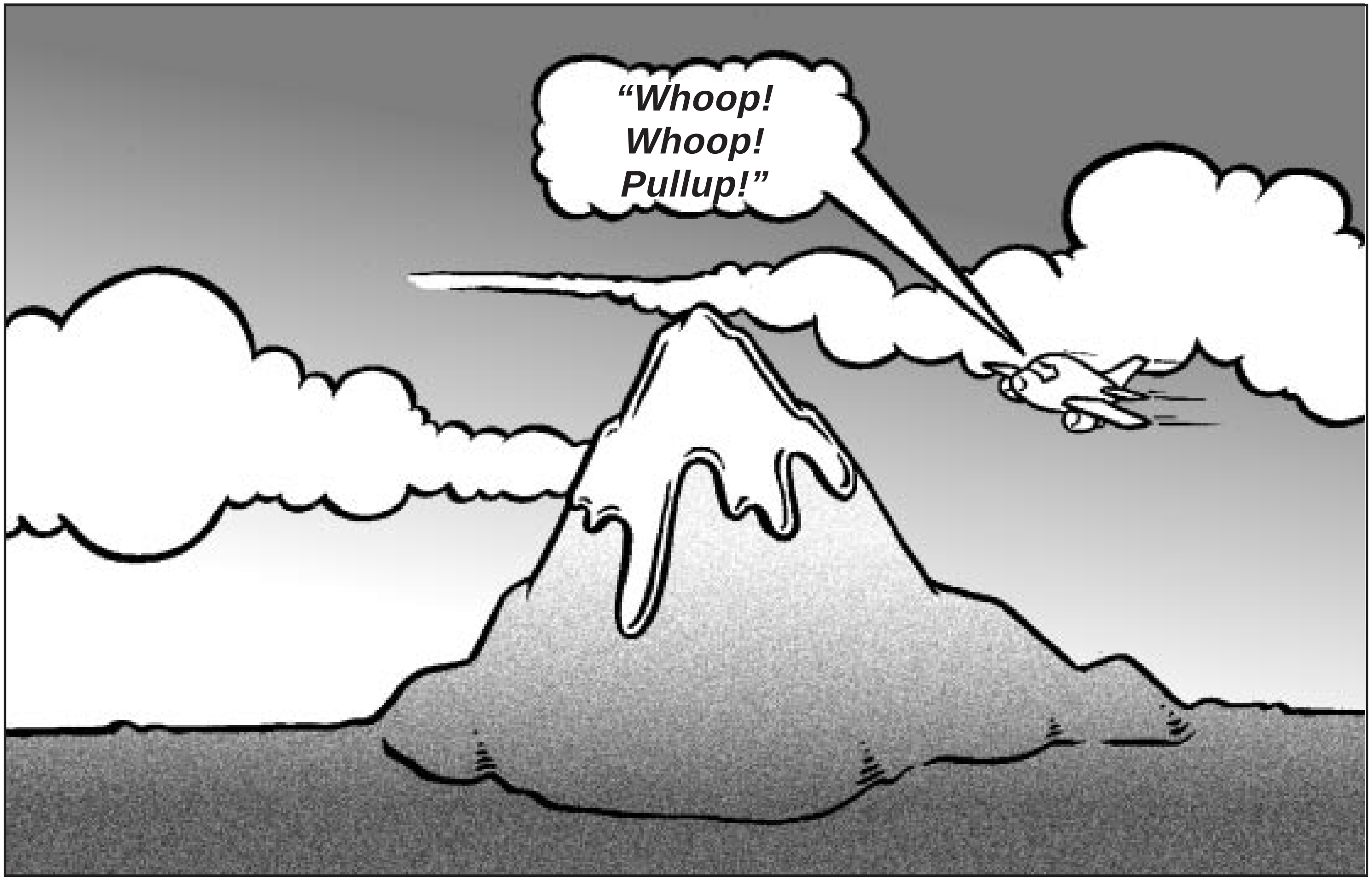
Figure 4-C.29

The GPWS warning is normally the flight crew's last opportunity to avoid CFIT. Incidents and accidents have occurred because flight crews have failed to make timely and correct responses to the GPWS warnings. The available time has increased between initial warning and airplane impact since the first version of the GPWS; however, this time should not be used to analyze the situation. React immediately. With the early versions, there was as little as 5 seconds warning, and none at all if the impact point was on a relatively steep slope of a mountain. There may be as much as 30 seconds for newer and future versions.

In the absence of standard operating procedures or airplane manufacturer guidance, execute the following maneuver in response to a GPWS warning, except in all but clear daylight VMC, when the flight crew can immediately and unequivocally confirm that an impact with the terrain, water, or obstacle will not take place:

- React immediately to a GPWS warning.
- Positively apply maximum thrust, and rotate to the appropriate pitch attitude for your airplane.
- Pull up with wings level to ensure maximum airplane performance.
- Always respect stick shaker.

Continue the escape maneuver until climbing to the sector emergency safe altitude or until visual verification can be made that the airplane will clear the terrain or obstacle, even if the GPWS warning stops.



- React immediately to a GPWS warning.
- Positively apply maximum thrust, and rotate to the appropriate pitch attitude for your airplane.
- Pull up with wings level to ensure maximum airplane performance.
- Always respect stick shaker.

Figure 4-C.30

Flight crews must be provided with and must be trained to use adequate navigation and approach charts that accurately depict hazardous terrain and obstacles. These depictions of the hazards must be easily recognizable and understood. On modern technology airplanes, the electronic displays should resemble printed chart displays to the maximum extent feasible.

Flight crew training can be a contributing factor to CFIT. It is also the key to CFIT accident prevention. Modern airplane equipment, extensive standard operation procedures, accurate charts, improved approach procedures, detailed checklists, or recommended avoidance techniques will not prevent CFIT if flight crews are not adequately trained. The cause of CFIT is the flight crew's lack of vertical and/or horizontal situational awareness. We know the solutions to these causes: a proper support infrastructure and a trained and disciplined flight crew.

Figure 4-C.31

In the previous discussion, the causes of CFIT and contributing factors were identified, along with recommendations and strategies that may be used to avoid CFIT accidents and incidents. It could be misleading to the reader when causes and factors are discussed separately.

Accidents and incidents do not normally happen because of one decision or one error. They rarely happen because the flight crew knowingly disregarded a good safety practice. Accidents and incidents happen insidiously. Flight crews fall into traps: some of their own making and some that are systemic.

Let’s look at some examples that could happen when a flight crew employs one recommendation, but disregards another.

Figure 4-C.32

We have identified that nonprecision VOR instrument approaches are especially hazardous when they include shallow approach paths and several altitude step-down points. We recommend that the autoflight system be used, if available, to reduce the workload. While this technique may mitigate the problem with the approach procedure, it can create another trap if the flight crew becomes complacent and does not properly program the computer, monitor the autoflight system, make the proper cockpit callouts, etc.

In another situation, flight crews are encouraged to use the displays that modern cockpits provide to assist them in maintaining situational awareness. However, if they disregard the raw navigational information that is also available, they can fall into a trap if any position inaccuracies creep into the various electronic displays.

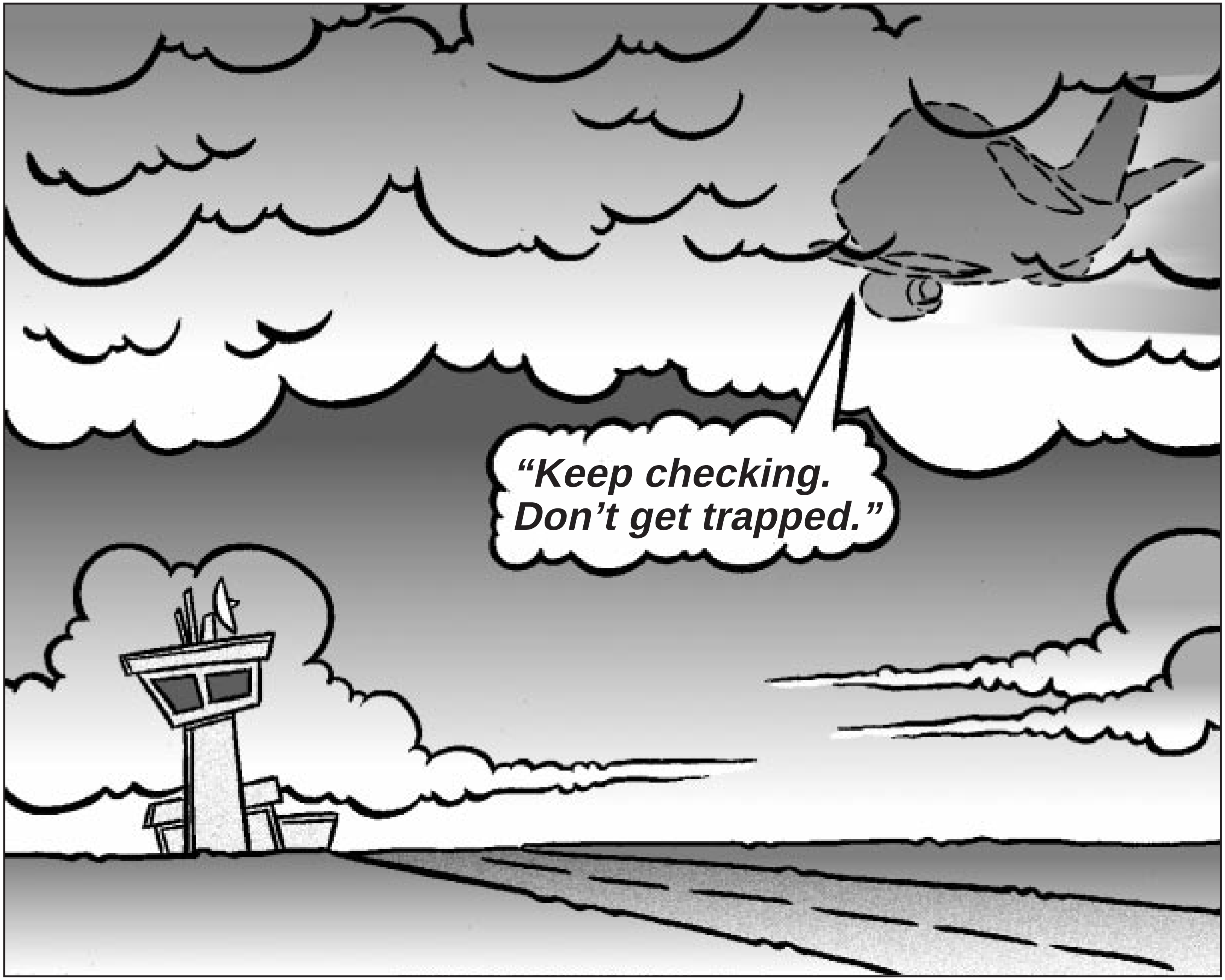


Figure 4-C.33

The importance of takeoff and arrival briefings is stressed as a means to overcome some of the factors associated with the departures and arrivals. However, if the briefings do not stress applicable unique information or become rote or done at the expense of normal outside-the-cockpit vigilance, their value is lost and the flight crew can fall into another trap.


"For this approach, we've got got some special considerations."

Figure 4-C.34

It should be evident that there is no single solution to avoiding CFIT accidents and incidents. All the factors are interrelated, with their level of importance changing with the scenario. *Be aware, the traps are there!*

The last link in the chain of events that lead to CFIT accidents is the flight crew. Be ready!

[Optional supporting information]

The CFIT Training and Education Aid, Section 5, CFIT Background Material, provides many more examples of traps.

Are you terrain-proof?

Figure 4-C.35

Escape Maneuvers

Appendix 4-D provides a single-source reference for GPWS warning escape maneuvers. ***Note: The term "maneuver" is associated with the sequence of steps the pilot is required to accomplish in order to avoid impact with the terrain. It is recognized that some airplane manufacturers have established procedural steps that the pilot is required to accomplish for that particular airplane. For simplicity, the term "maneuver" will be used for both situations.*** The generic escape maneuver developed by the CFIT Task Force is included, along with supporting information. This maneuver should be used if your standard operating procedures or airplane manufacturer does not provide other model-specific guidance for reacting to a GPWS warning. Space has also been provided for the insertion of model-specific escape maneuvers and data from airplane manufacturers. Several manufacturers have included their specific escape maneuver and supporting information. Operators who desire additional information, or the escape maneuver for airplanes not included in this appendix, should contact the appropriate manufacturer.

Table of Contents

4-D.1 Generic GPWS Warning Escape Maneuver

In the absence of standard operating procedures or airplane manufacturer guidance, execute the following maneuver in response to a GPWS warning, except in clear daylight visual meteorological conditions when the flight crew can immediately and unequivocally confirm that an impact with the ground, water, or an obstacle will not take place.

- React immediately to a GPWS warning.
- Positively apply maximum thrust and rotate to the appropriate pitch attitude for your airplane.
- Pull up with wings level to ensure maximum airplane performance.
- Always respect stick shaker.

Continue the escape maneuver until climbing to the sector emergency safe altitude can be completed or until visual verification can be made that the airplane will clear the terrain or obstacle, even if the GPWS warning stops.

4-D.1.1 GPWS Warning Escape Maneuver Analysis

Airplane performance data, through computer analysis and simulator studies, were compiled to determine the feasibility of an industrywide, common CFIT escape maneuver. Performance characteristics for specific airplanes were supplied by the various airplane manufacturers.

Preliminary information indicates that performance data for different airplanes are remarkably similar. Using an initial pitch of 20 deg shows a better altitude gain than a 15-deg pitch for the same horizontal distance traveled during the initial pull-up and during low-altitude recoveries. During extended climbs and for recoveries initiated at higher altitudes, the 20-deg pitch will eventually fall below the 15-deg pull-up pitch.

Maximum altitude will be gained in the shortest horizontal distance by using a pull-up directly to stick shaker. However, this technique results in very low airspeeds and varying pitch attitudes, depending on airplane configuration and elevator effectiveness.

Studies show that there is little difference in performance between a pull-up rate of 3 deg/s and 4 deg/s. Because of this, it is recommended that the standard pull-up rate is 3 deg/s. The studies revealed that airplanes in the takeoff configuration had the worst performance characteristics. Data were collected using V2 speed instead of the more nominal V2 + 15 to 25 kt.

Currently, it appears that a 3 deg/s pull-up, similar to a normal takeoff rotation, to a pitch attitude of 20 deg will result in the most altitude gained for horizontal distance used without exposing the flight crew to excessively high pitch attitudes while flying at low airspeeds.

TERRAIN AVOIDANCE PROCEDURE FOR AIRCRAFT WITH FBW AND WITH CONVENTIONAL FLIGHT CONTROLS

TERRAIN AVOIDANCE PROCEDURES FOR AIRCRAFT WITH FBW AND WITH CONVENTIONAL FLIGHT CONTROLS

1. During daylight VMC when positive visual verification is made that no hazard exists,a GPWS terrain warning may be considered as cautionary. If a GPWS warning occurs and the crew cannot make this visual verification, as in IMC or at night, the crew should immediately and aggressively execute the terrain avoidance procedure applicable to the aircraft type. There should be no attempt to evaluate the warning.

2.1. **For Airbus fly-by-wire aircraft** having full low speed protection, the procedure is as specified on page 2. Push thrust-levers immediately to TOGA and simultaneously pitch nose-up, wings level, disconnecting autopilot. Immediate full aft side-stick will produce maximum performance climb, trading speed for altitude, in the minimum distance. The speed-brakes should be retracted without delay if they are extended. In any case, they will retract automatically when the angle of attack reaches α prot. Maintain gear and flaps position, maintain full back stick until adequate terrain clearance is assured, as indicated by cessation of the GPWS warning and increasing radio altitude. In normal law, the high angle of attack protection will ensure α max is not exceeded, and stall margin is maintained.

2.2. For fly-by-wire aircraft in degraded flight control law, the side-stick should be pulled back, wings level, disconnecting auto-pilot, increasing pitch attitude, if necessary until IAS reaches V_{SW}. Stall warning must be respected to ensure the maintenance of stall margin.

3.1. **For the A300 and A310 families,** with conventional flight control systems, the procedure is as specified on page 3. Apply full rated thrust, disconnect the autothrottle system, and simultaneously pitch up to at least 20°, wings level. Check speed brakes are retracted. Maintain gear and flaps position, monitor the radio altimeter and if necessary, continue to increase pitch attitude smoothly until V_{SS} and / or operation of the stick shaker. Use stick shaker onset to limit pitch attitude. Stick shaker or buffet must be respected at all times to ensure appropriate maneuver and stall margins are maintained. Maintain this pitch until adequate terrain clearance is assured.

3.2. Also on EFIS equiped aircraft, speed trend and Vsw display can help to make a smooth approach to V_{SS}. The FPV may be selected to show climb angle achieved during the maneuver.

4. For both categories of flight control systems, when adequate terrain clearance is assured, smoothly reduce pitch and accelerate, maintaining a positive rate of climb. When adequate IAS is obtained, clean up and reduce thrust as required.

TERRAIN AVOIDANCE PROCEDURE

Applicable to FBW aircraft : A319, A320, A321, A330, A340 in NORMAL LAW

Immediately :

- THRUST LEVERS	TOGA
- { A/P	DISCONNECT
{ SIDE-STICK*	PULL UP, WINGS LEVEL
- SPD BRK	Check retracted

If necessary, use full back stick and maintain α max speed until terrain clearance is assured, (GPWS warning ceased and radio altitude increasing).

• When flight path is safe, decrease pitch and accelerate.

• When speed above V_{LS} and V/S positive, retract flap and gear as required.

* In pitch alternate or direct law, pull up agressively, wings level. If necessary, maintain speed at stall warning until terrain clearance assured.

TERRAIN AVOIDANCE PROCEDURE

Applicable to : A300, A310 and A300-600 aircraft

Immediately :

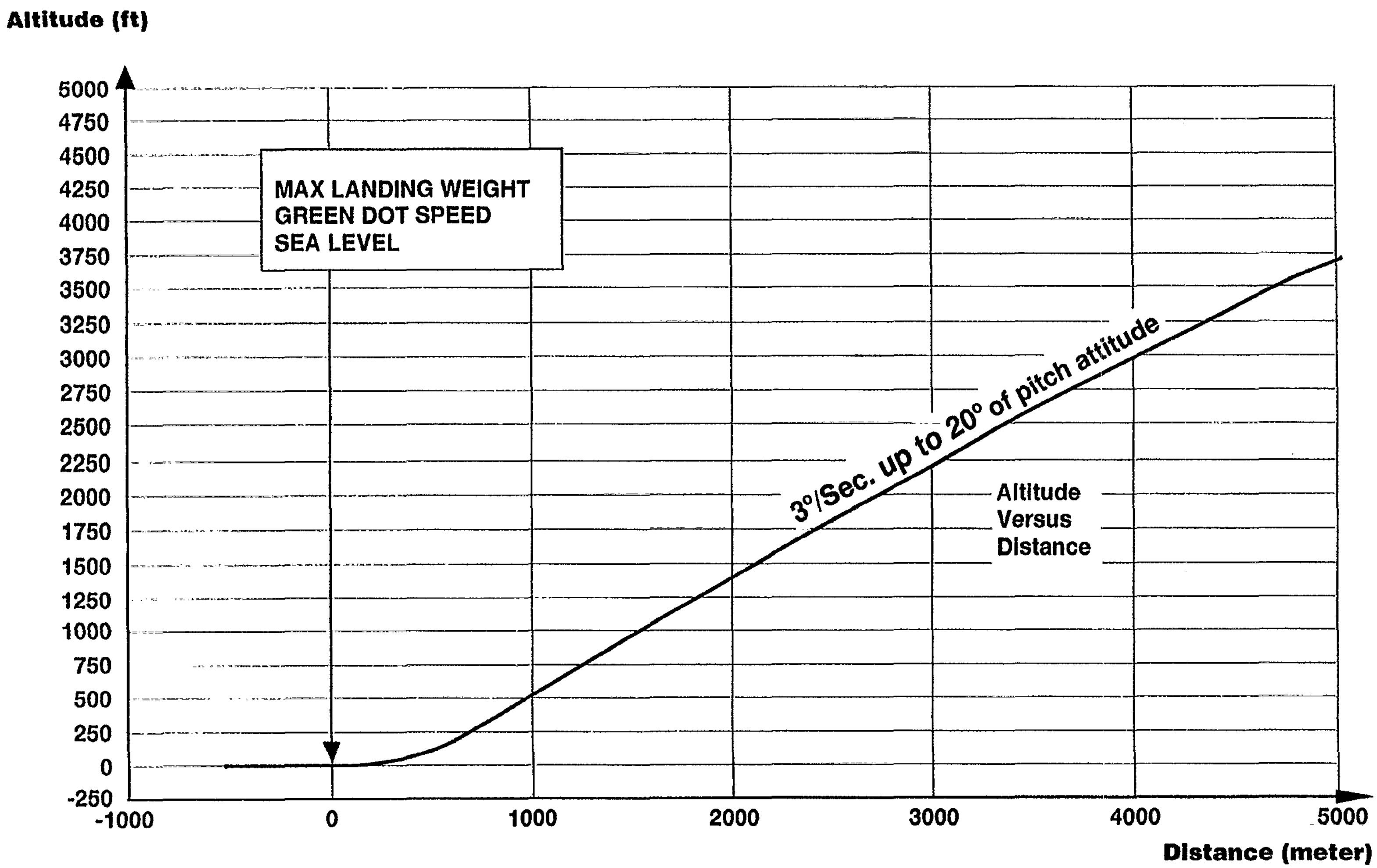
- { THROTTLES	FULL FORWARD
{ A/THR	DISCONNECT
- { A/P	DISCONNECT
{ PITCH	At least 20° UP, WINGS LEVEL
- SPD BRK	Check retracted

If necessary, pitch up to V_{SS} on speed scale, maintain until terrain clearance assured (GPWS ceased and radio altitude increasing).

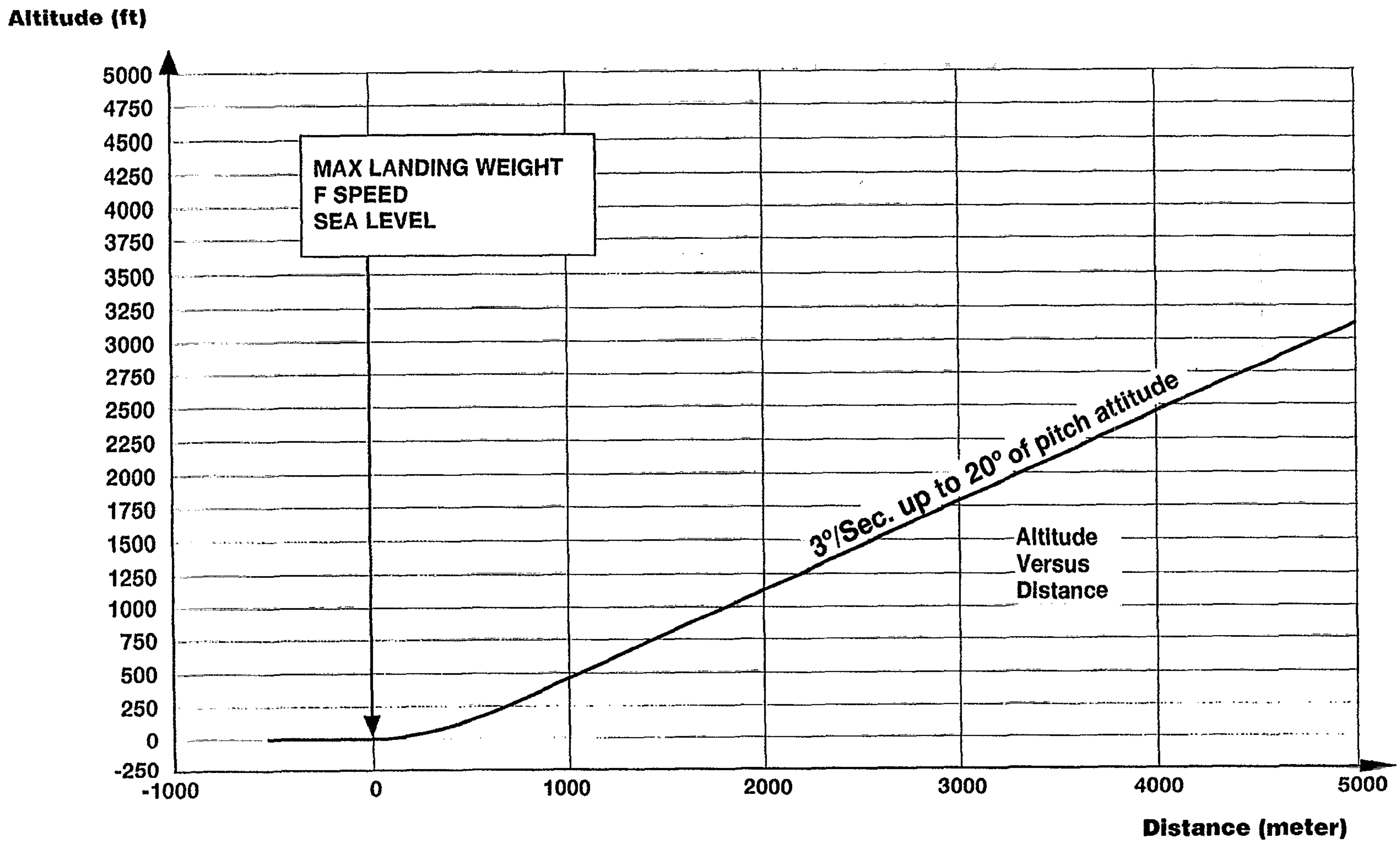
• When flight path is safe, decrease pitch and accelerate.

• When speed above V_{LS} and V/S positive, retract flap and gear as required.

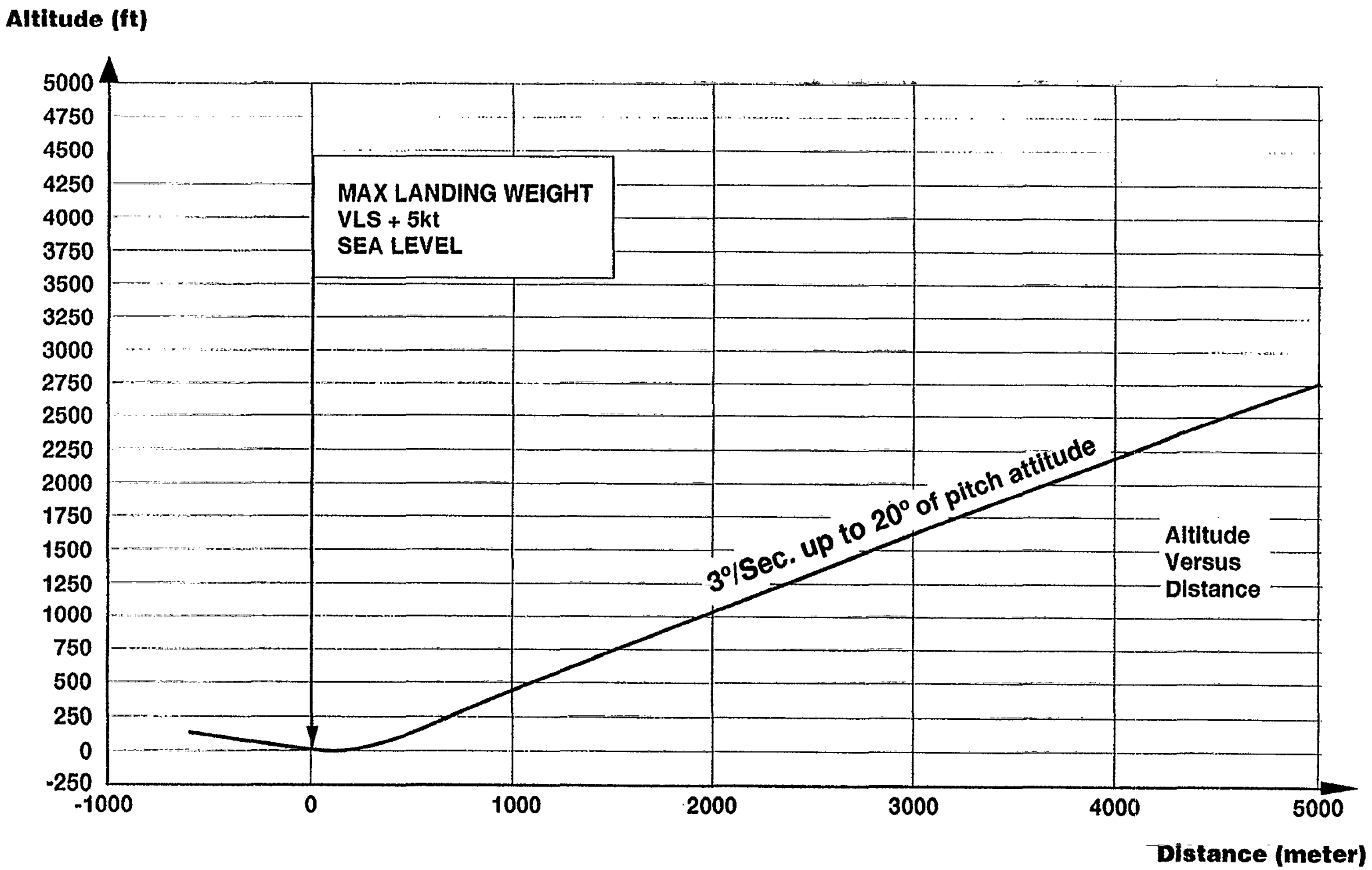
CFIT ESCAPE MANEUVER
A300 B2/B4 FROM LEVEL FLIGHT.
CLEAN CONFIGURATION - GEAR UP



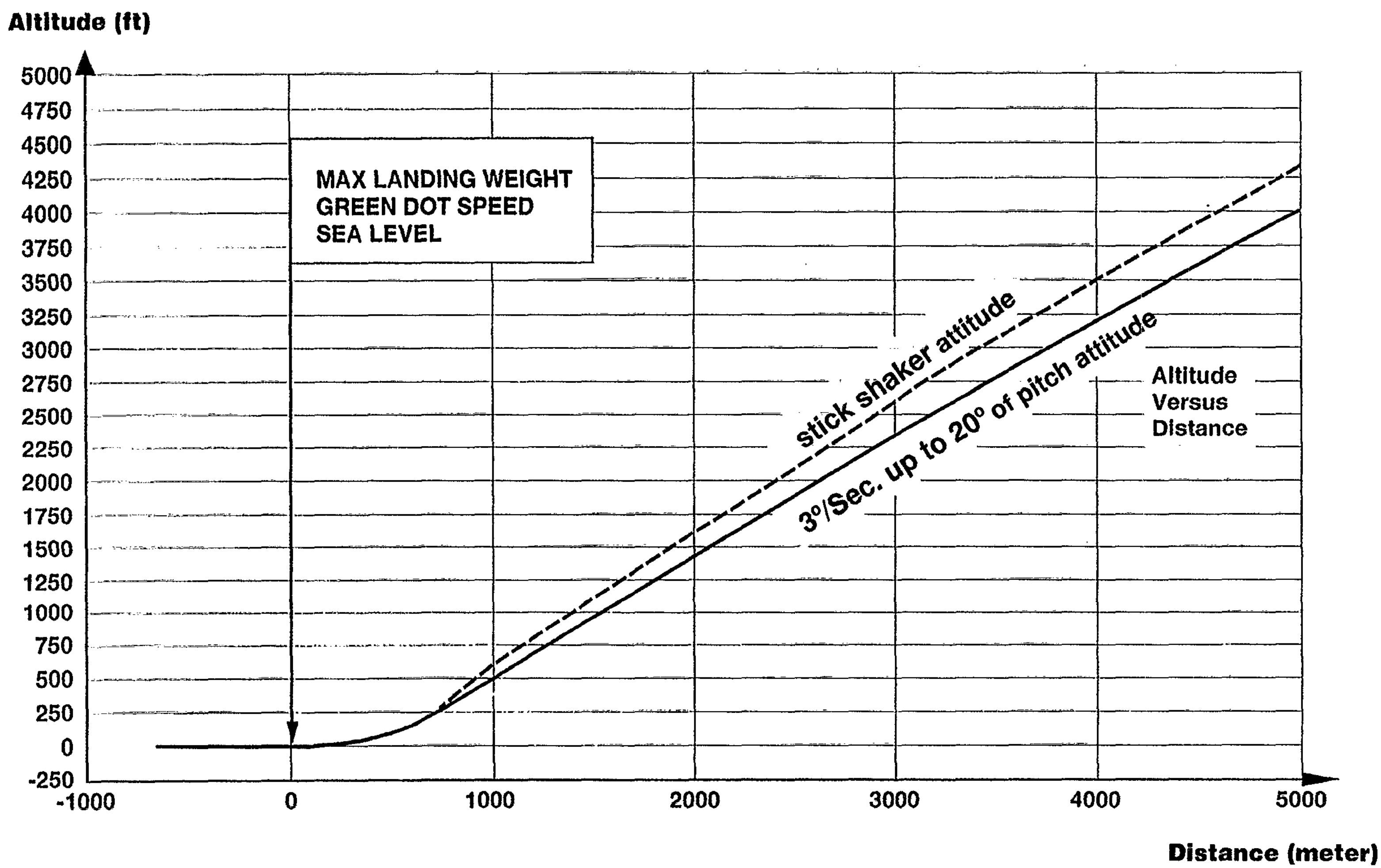
CFIT ESCAPE MANEUVER
A300 B2/B4 FROM LEVEL FLIGHT.
CONFIGURATION 16°/8° - GEAR UP



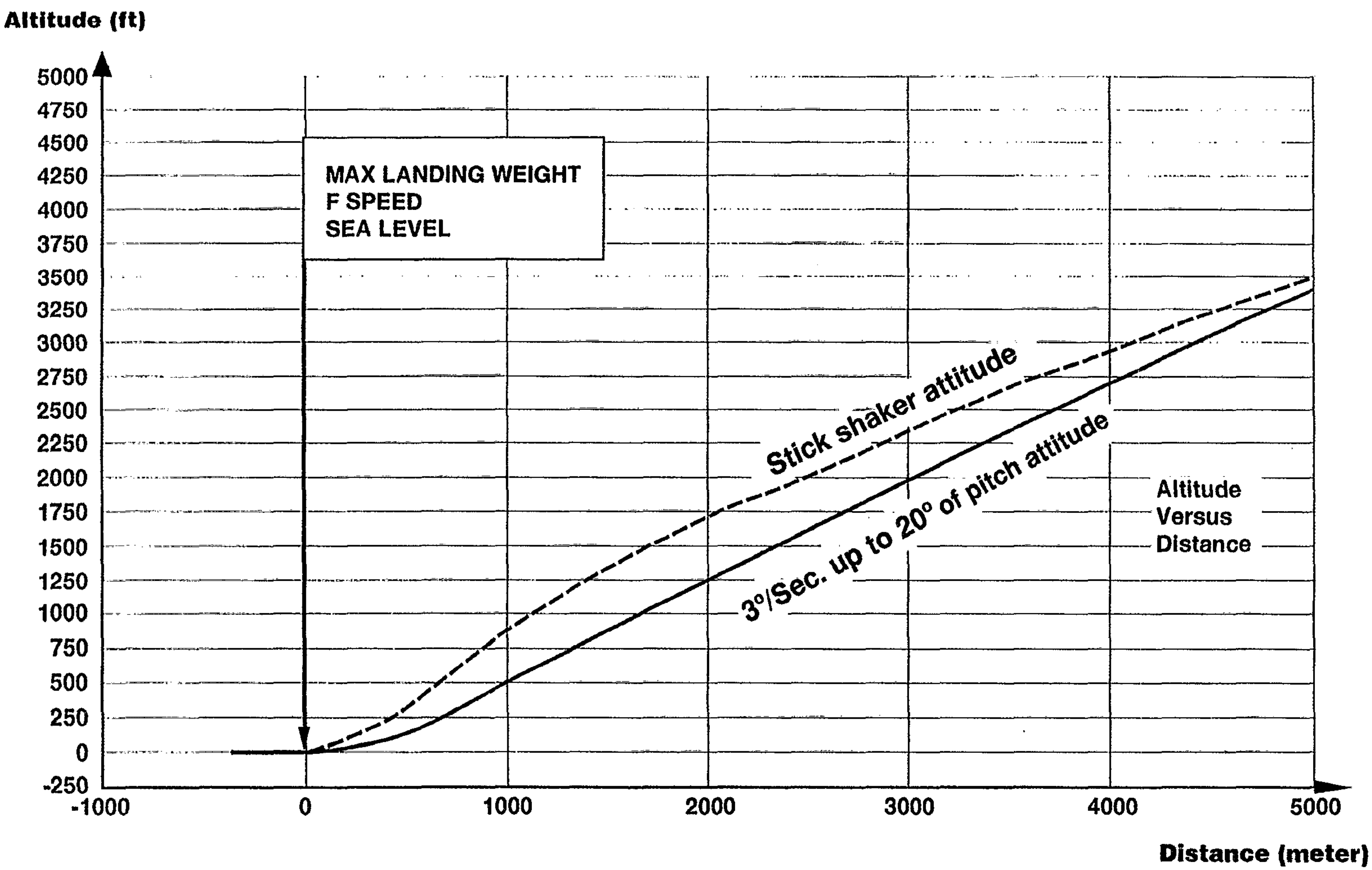
CFIT ESCAPE MANEUVER
A300 B2/B4 FROM 3° GLIDE SLOPE.
CONFIGURATION 25°/25° - GEAR DOWN



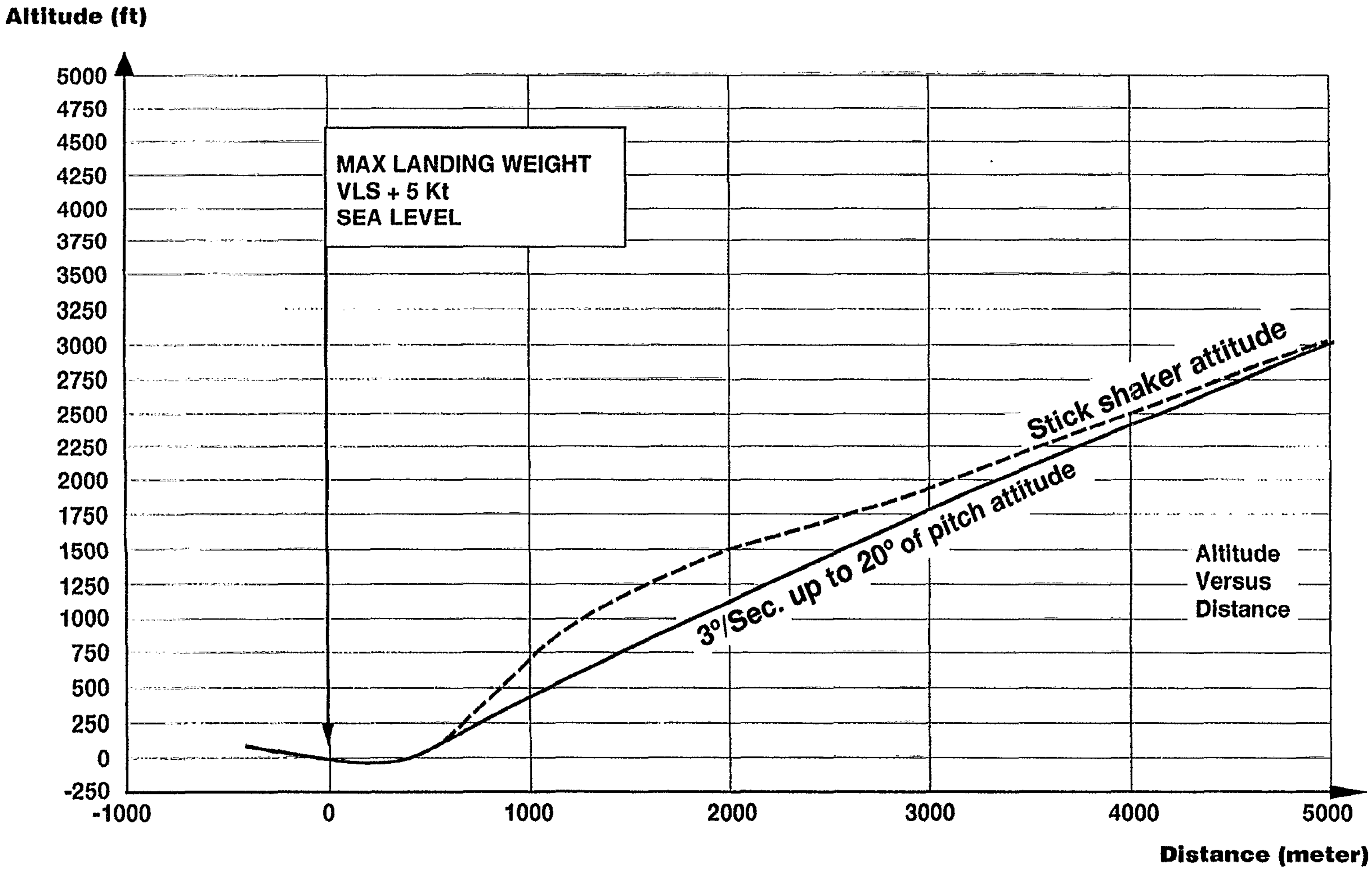
CFIT ESCAPE MANEUVER
A300-600 FROM LEVEL FLIGHT.
CLEAN CONFIGURATION - GEAR UP



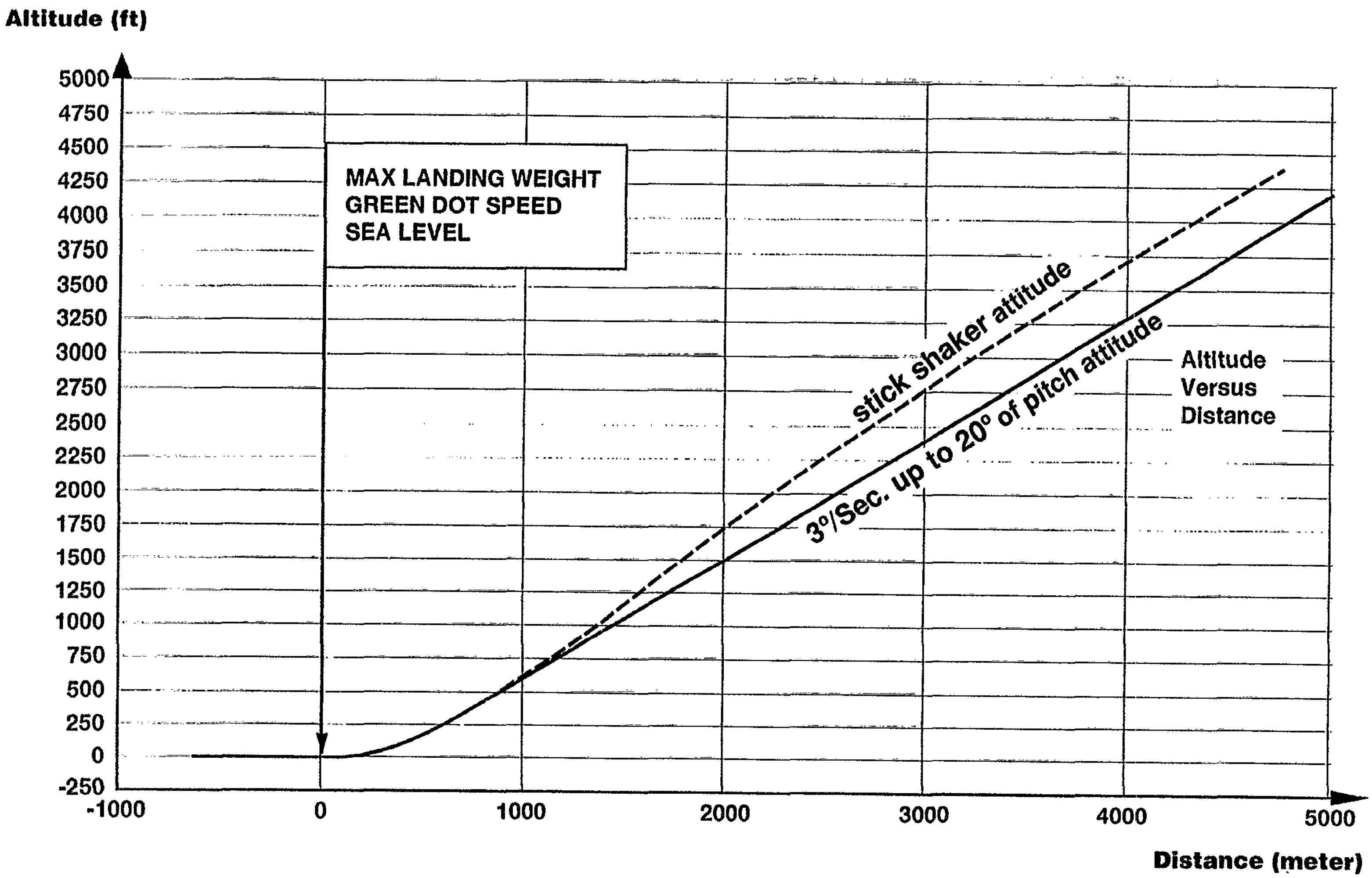
CFIT ESCAPE MANEUVER
A300-600 FROM LEVEL FLIGHT.
CONFIGURATION 15°/15° - GEAR UP



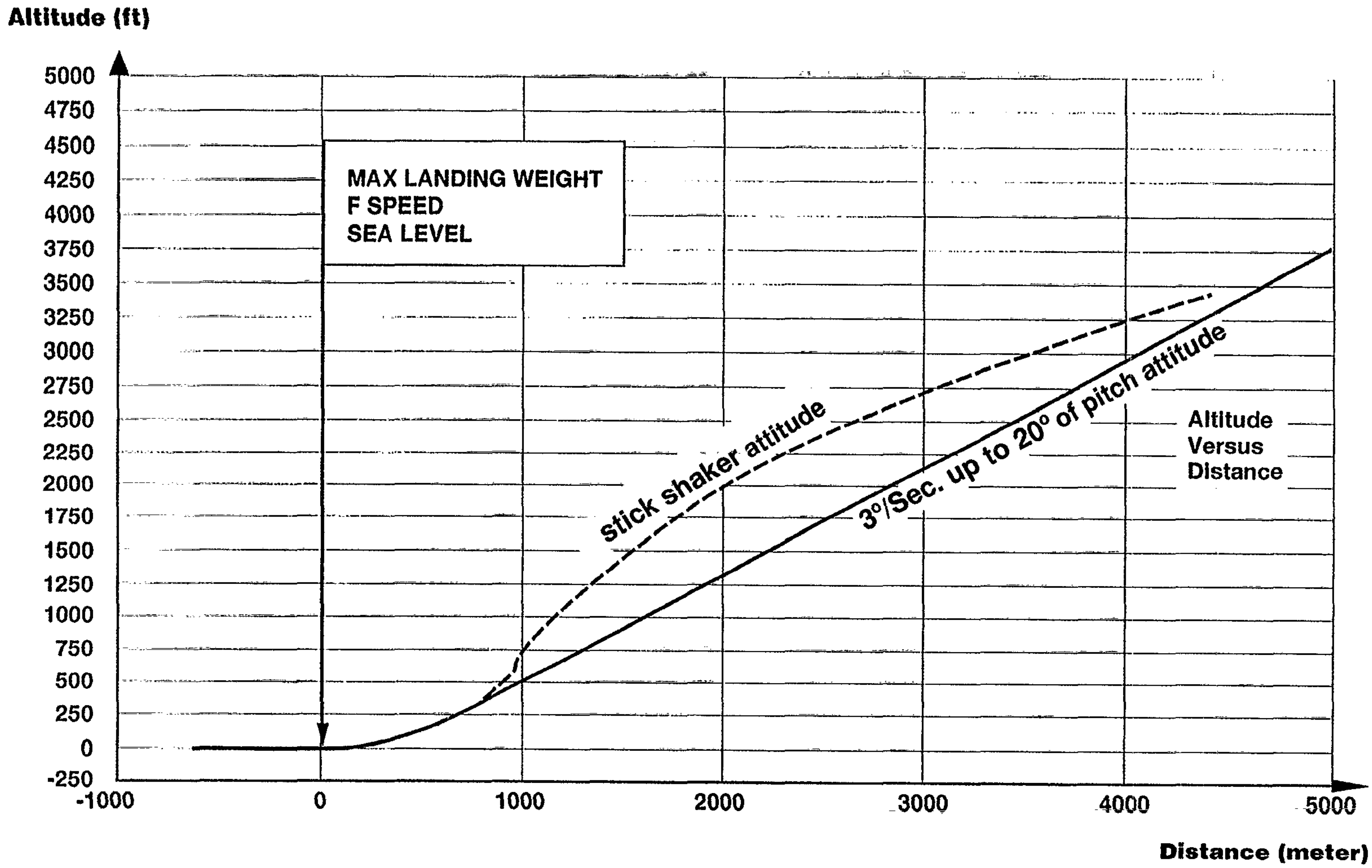
CFIT ESCAPE MANEUVER
A300-600 FROM 3° GLIDE SLOPE.
CONFIGURATION 30°/40° - GEAR DOWN



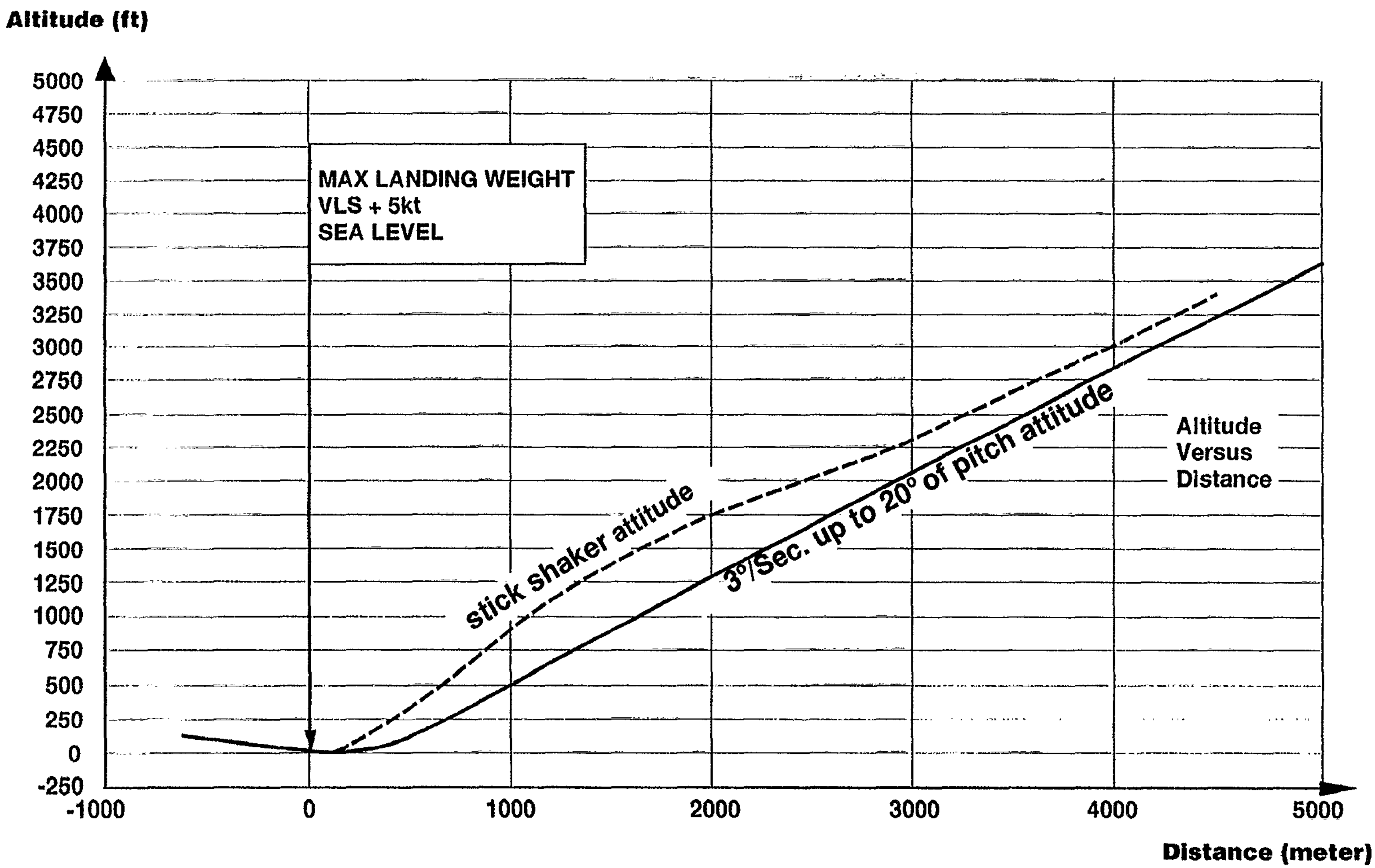
CFIT ESCAPE MANEUVER
A310 FROM LEVEL FLIGHT.
CLEAN CONFIGURATION - GEAR UP



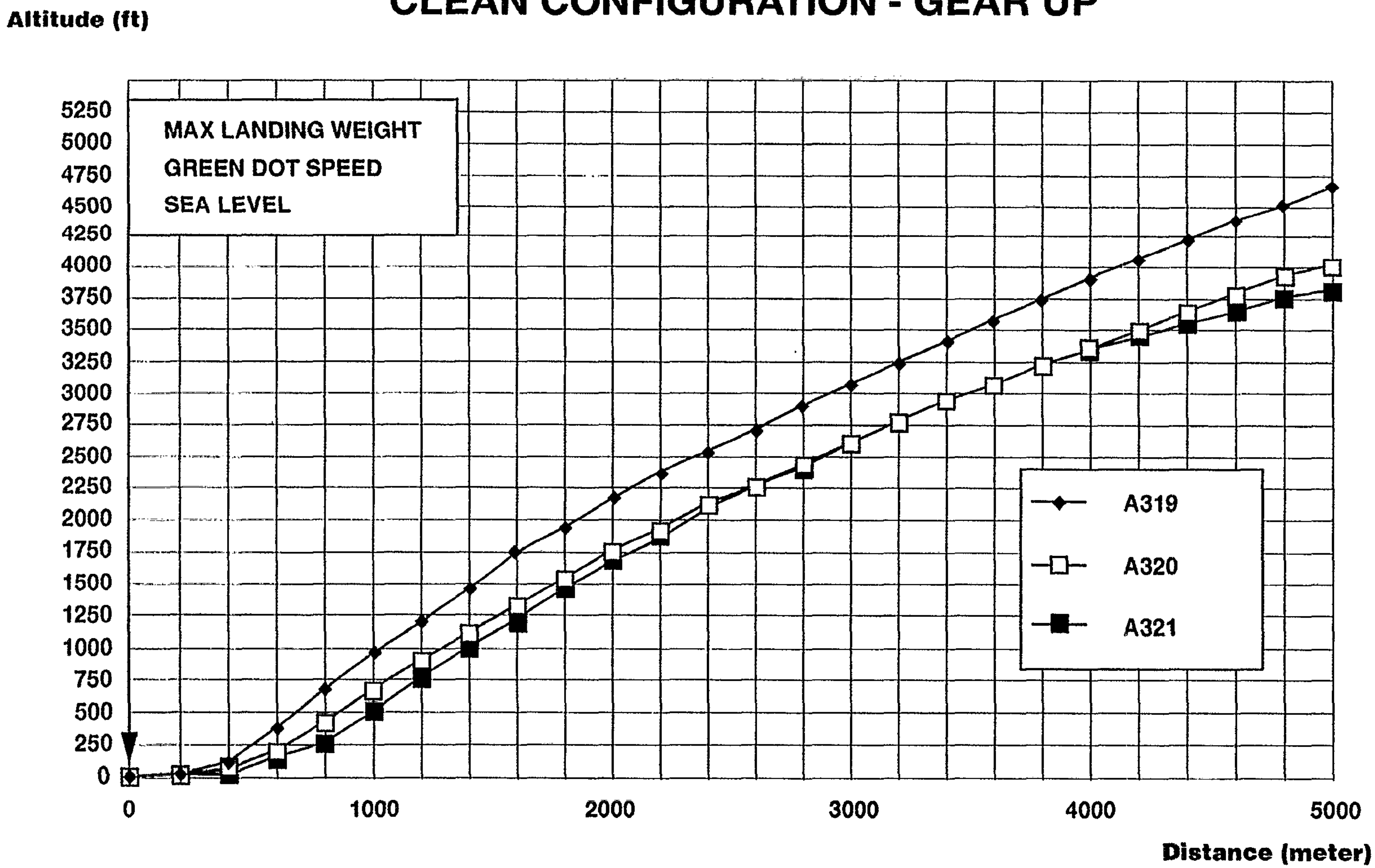
CFIT ESCAPE MANEUVER
A310 FROM LEVEL FLIGHT.
CONFIGURATION 15°/15° - GEAR UP



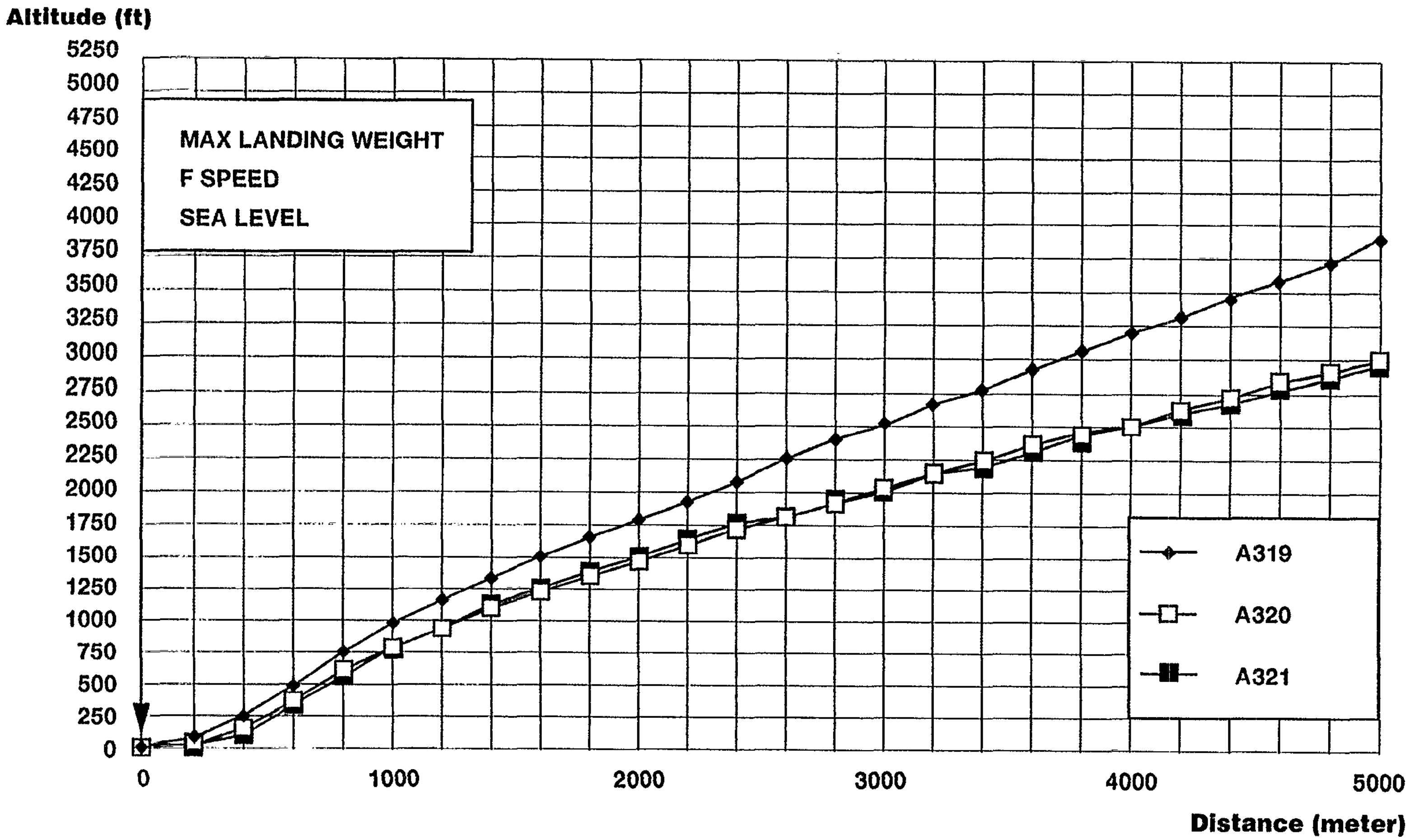
CFIT ESCAPE MANEUVER
A310 FROM 3° GLIDE SLOPE.
CONFIGURATION 30°/40° - GEAR DOWN



CFIT ESCAPE MANEUVER
A319/A320/A321 FROM LEVEL FLIGHT.
FULL BACK STICK
CLEAN CONFIGURATION - GEAR UP



CFIT ESCAPE MANEUVER
A319/A320/A321 FROM LEVEL FLIGHT.
FULL BACK STICK
CONFIGURATION 2 - GEAR UP



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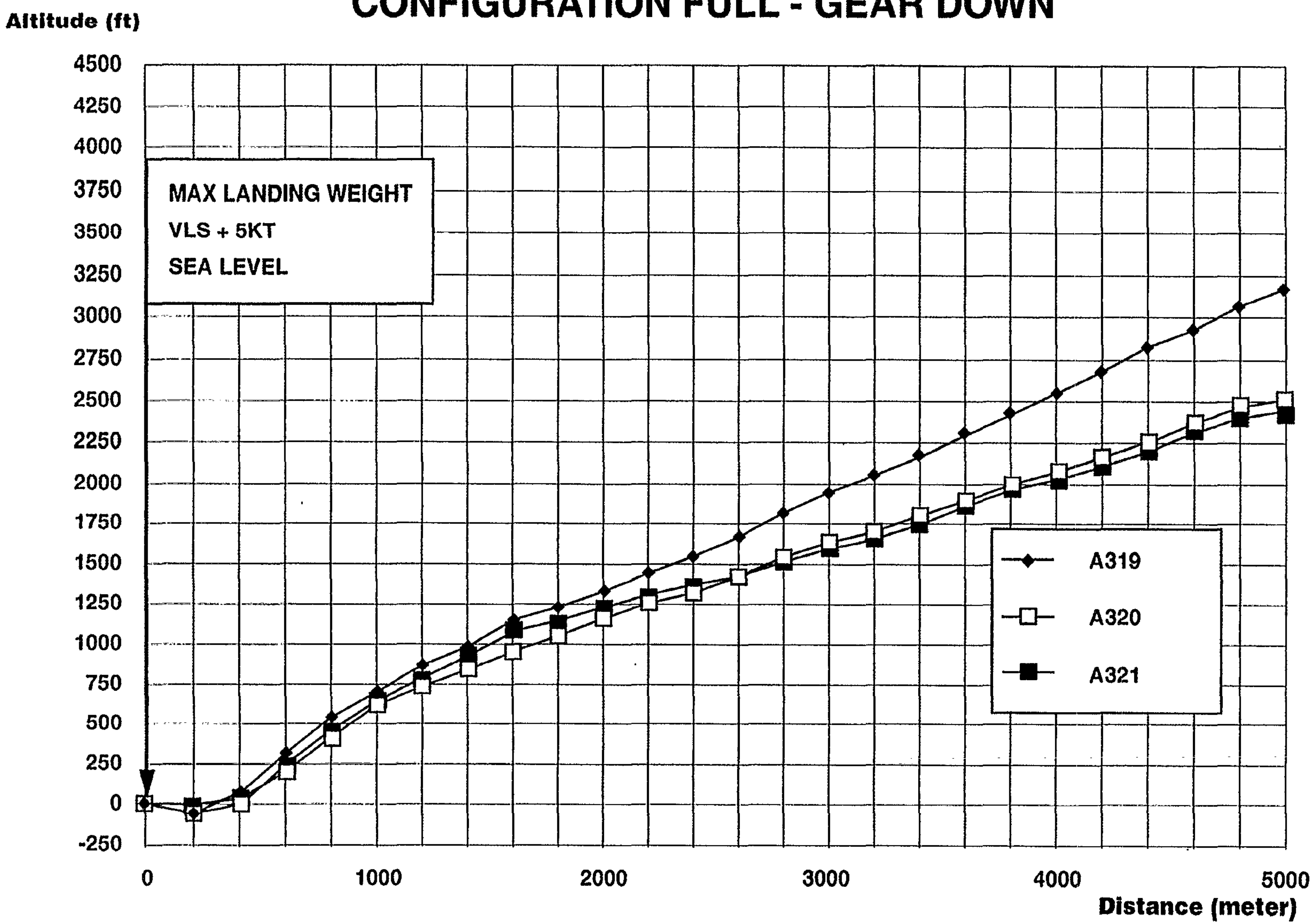
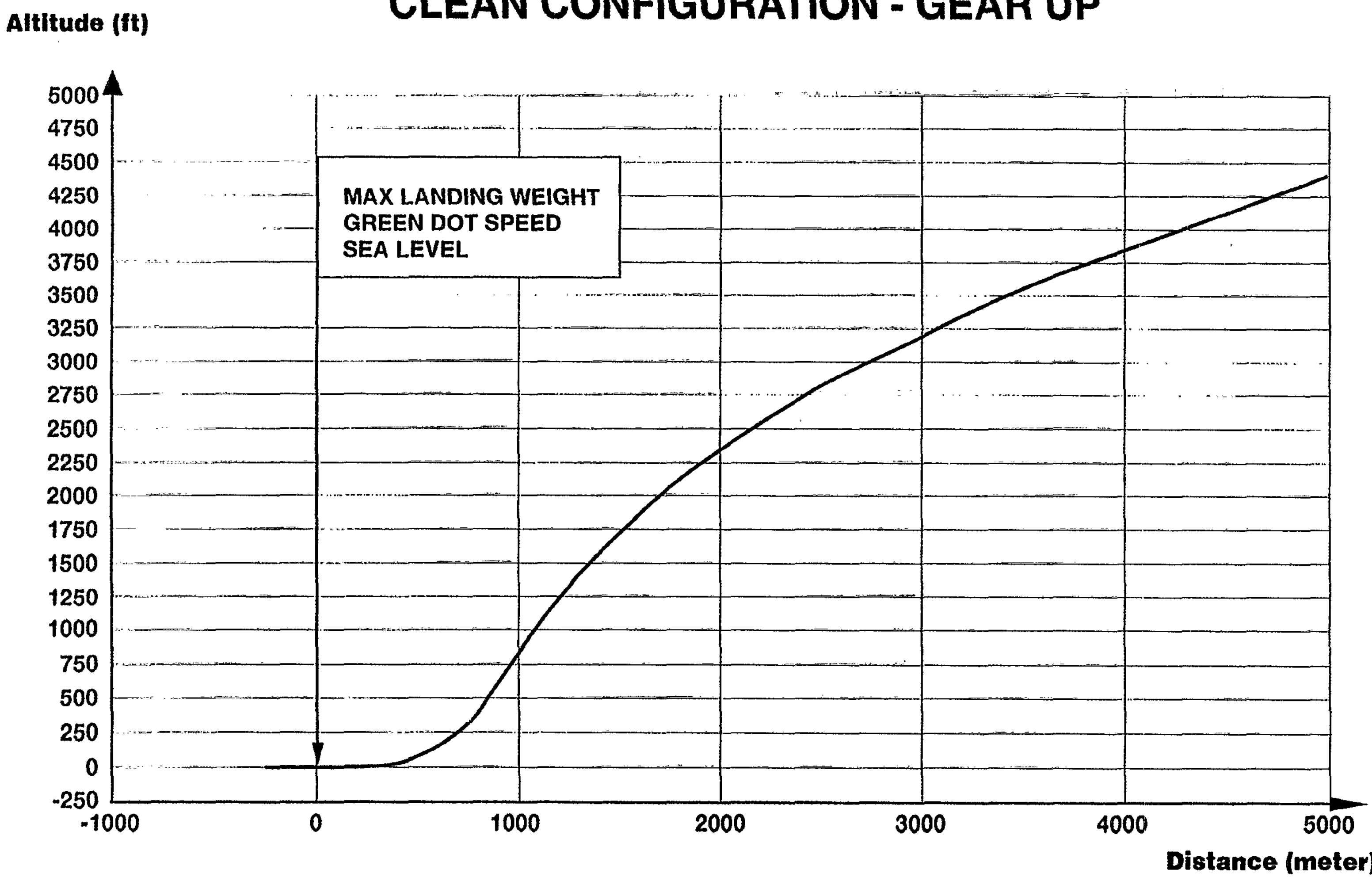
APPENDIX
4-D

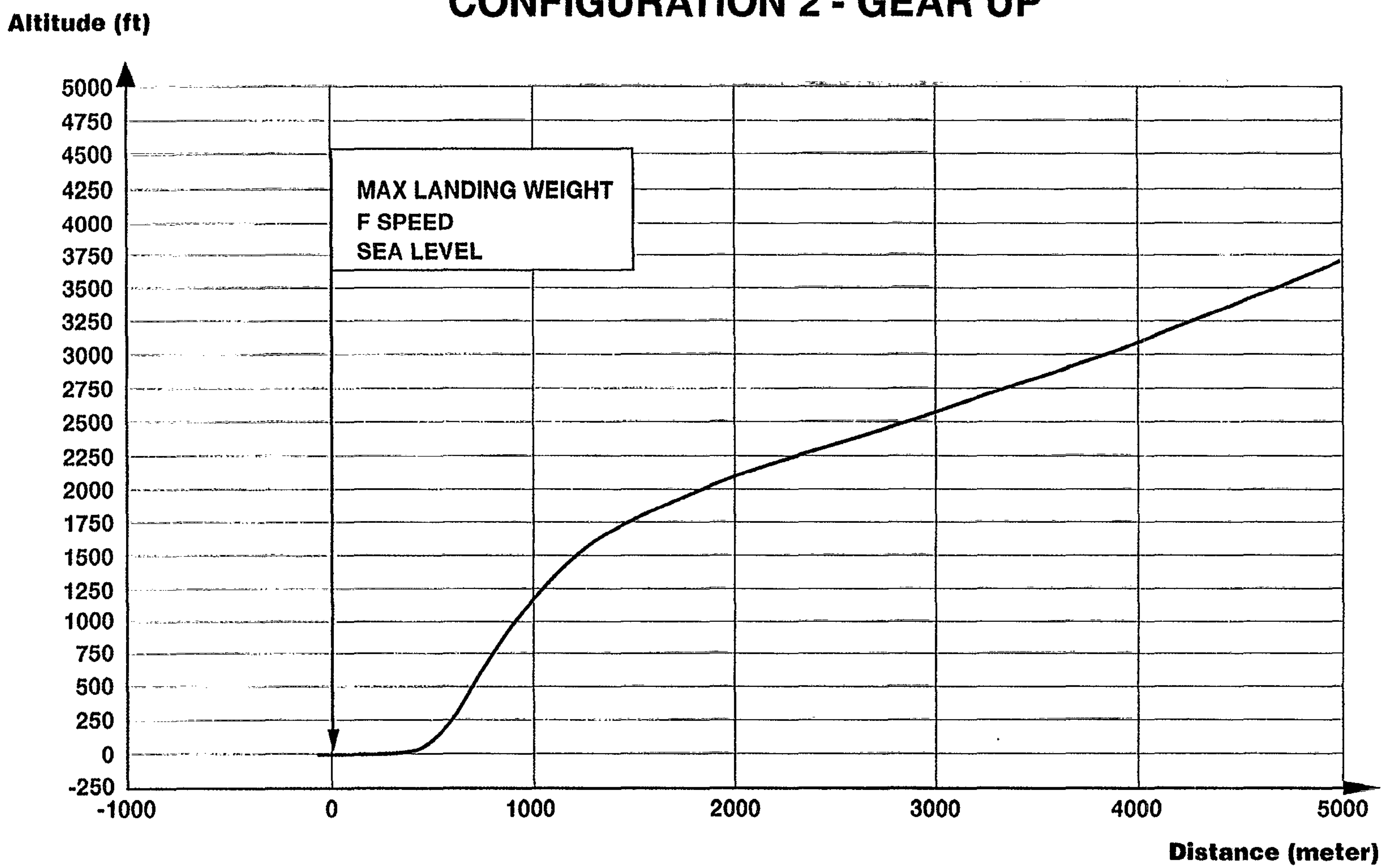
CFIT ESCAPE MANEUVER
A319/A320/A321 FROM 3° GLIDE SLOPE
FULL BACK STICK
CONFIGURATION FULL - GEAR DOWN



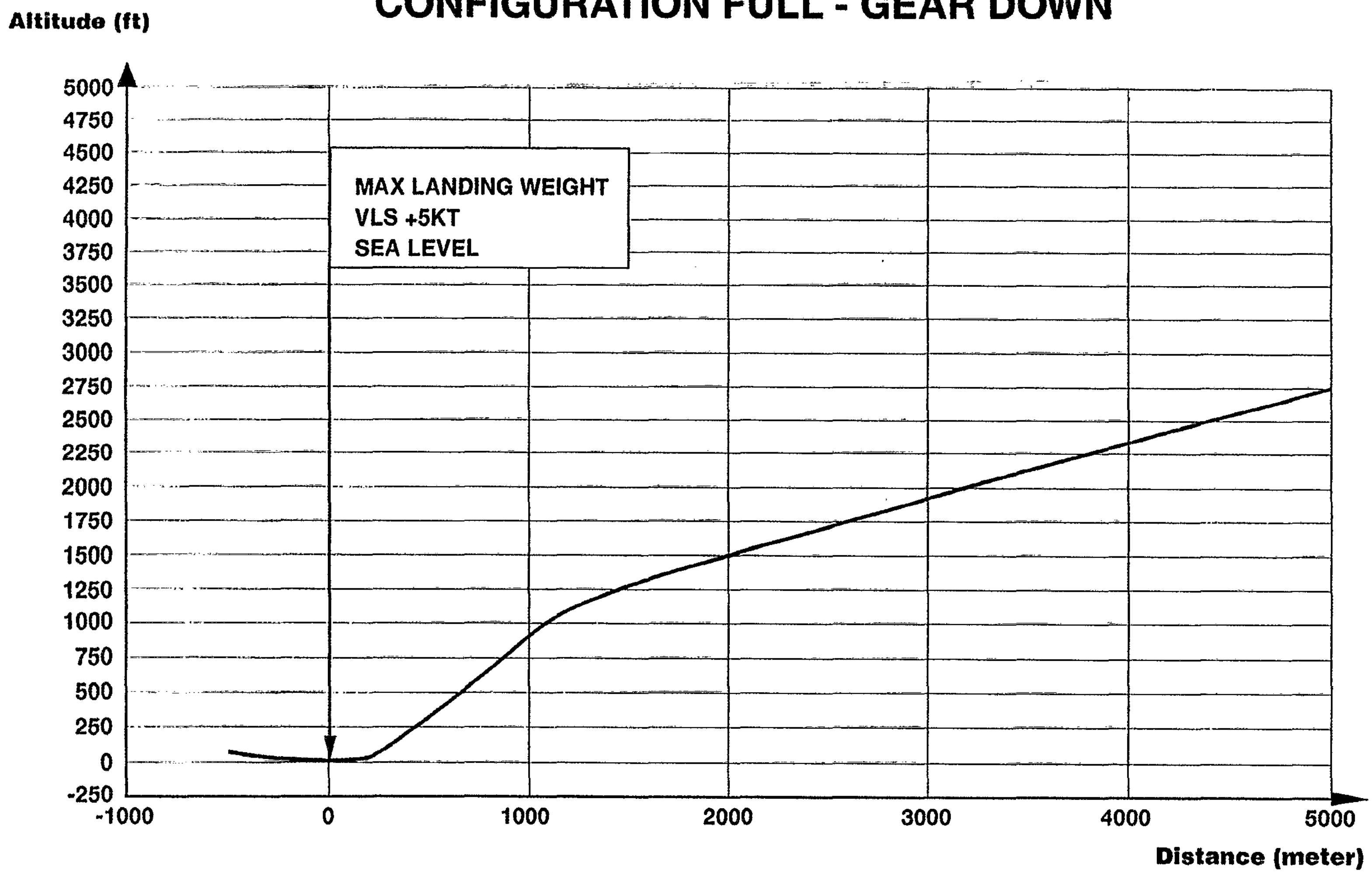
CFIT ESCAPE MANEUVER
A330 FROM LEVEL FLIGHT.
FULL BACK STICK
CLEAN CONFIGURATION - GEAR UP



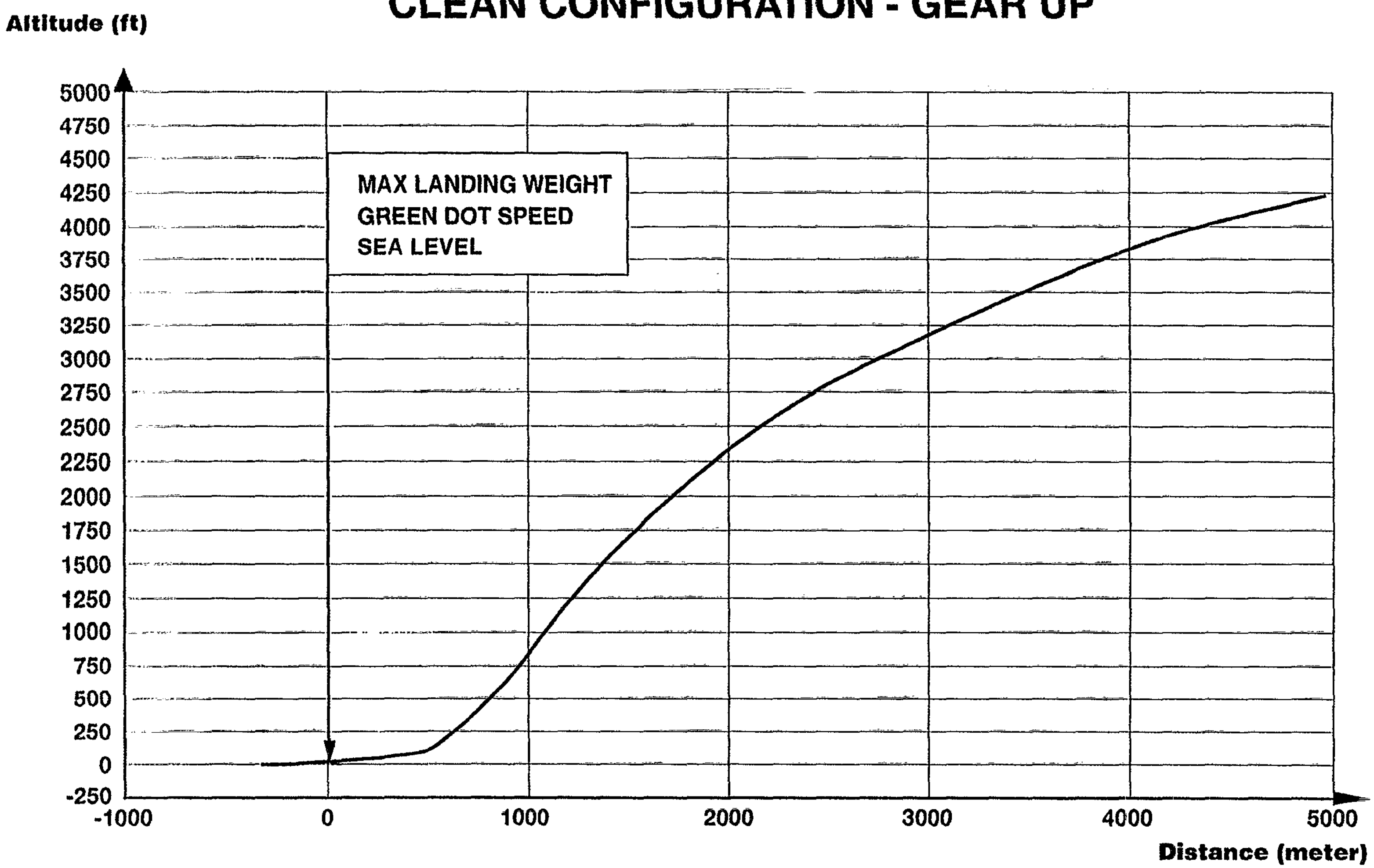
CFIT ESCAPE MANEUVER
A330 FROM LEVEL FLIGHT.
FULL BACK STICK
CONFIGURATION 2 - GEAR UP



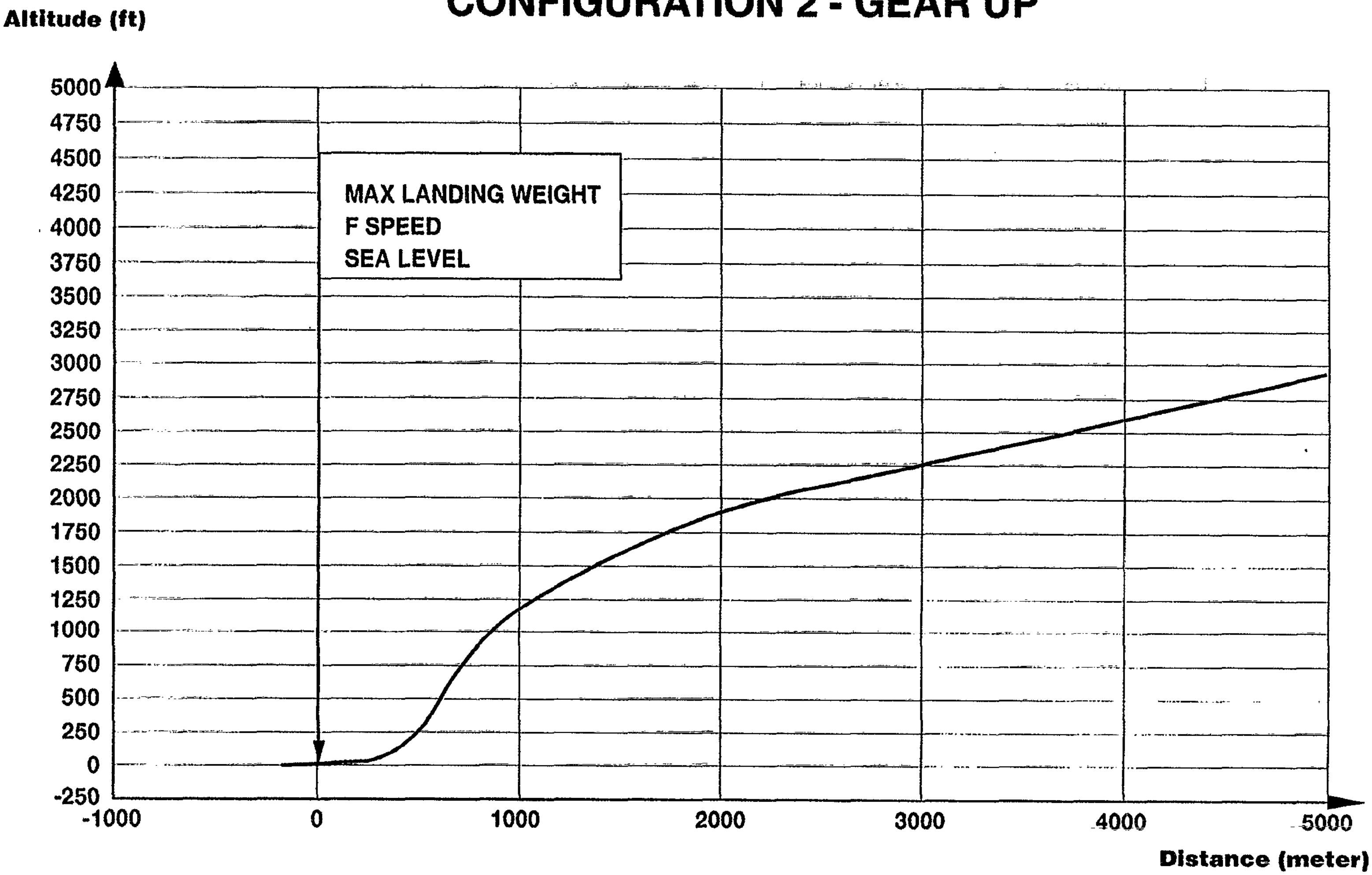
CFIT ESCAPE MANEUVER
A330 FROM 3° GLIDE SLOPE.
FULL BACK STICK
CONFIGURATION FULL - GEAR DOWN



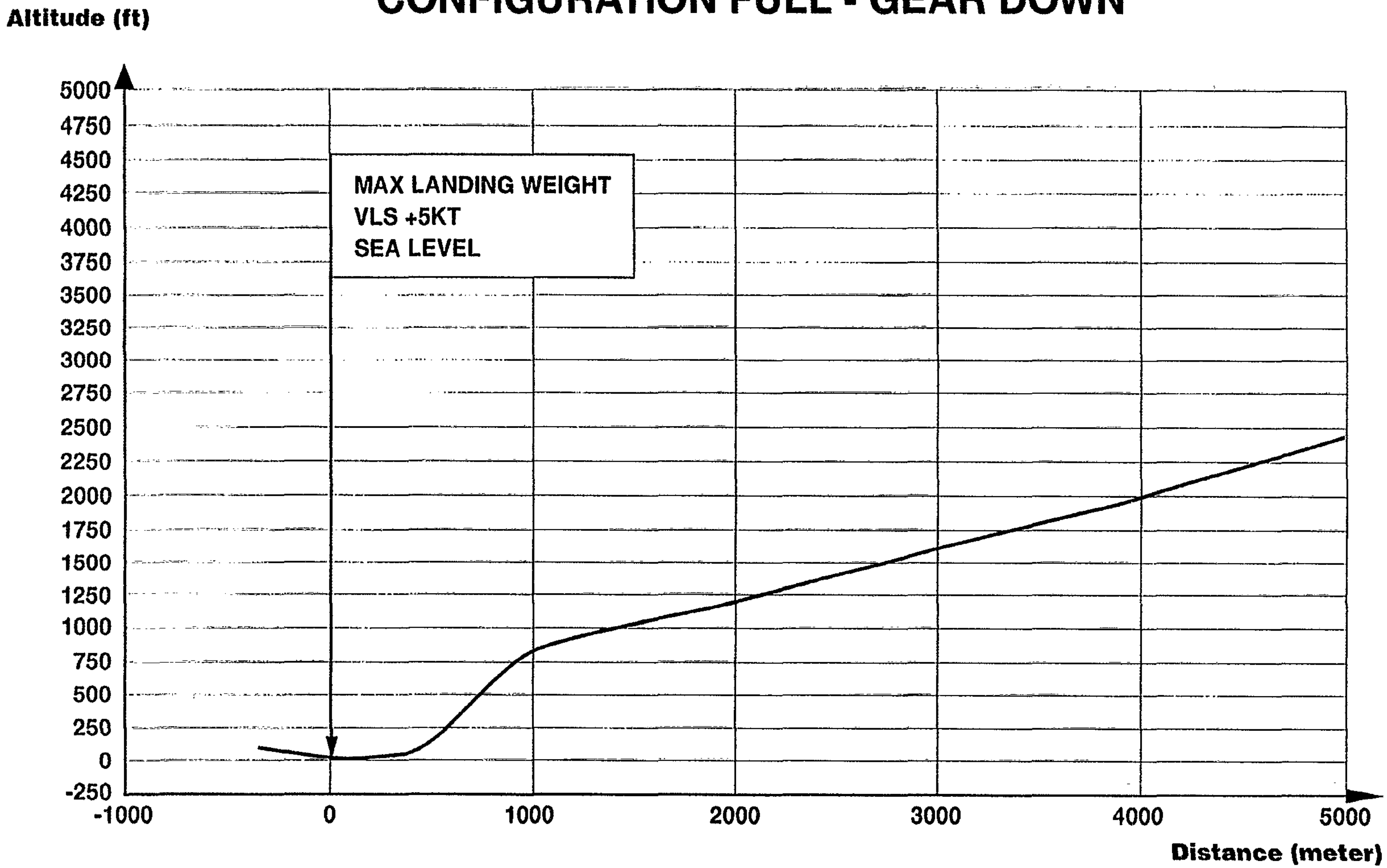
CFIT ESCAPE MANEUVER
A340 FROM LEVEL FLIGHT.
FULL BACK STICK
CLEAN CONFIGURATION - GEAR UP



CFIT ESCAPE MANEUVER
A340 FROM LEVEL FLIGHT.
FULL BACK STICK
CONFIGURATION 2 - GEAR UP



CFIT ESCAPE MANEUVER
A340 FROM 3° GLIDE SLOPE.
FULL BACK STICK
CONFIGURATION FULL - GEAR DOWN



The Boeing Company

Terrain Avoidance

The Boeing Company conducted an escape maneuver aerodynamic study and a flight simulator pilot human factors study. These studies and other information formed the basis for the terrain avoidance procedure.

Contents:

The material contained in this Boeing appendix is considered correct and accurate; however, since it is intended to be informative only, it should not be consulted in lieu of official operations manuals.

TERRAIN AVOIDANCE

The following is immediately accomplished by recall whenever the threat of inadvertent contact with the terrain exists. Any of the following conditions is regarded as presenting a potential for terrain contact:

• Activation of the "PULL UP" warning.
• Other situations resulting in unacceptable flight toward terrain.

PILOT FLYING	PILOT NOT FLYING
• Disconnect autopilot • Disconnect autothrottle(s) • Aggressively apply maximum* thrust • Roll wings level and rotate at a rate of 3° per second to an initial pitch attitude of 20° • Retract speedbrakes • If terrain remains a threat, continue rotation up to the pitch limit indicator (if available) or stick shaker or initial buffet	• Assure maximum* thrust • Verify all required actions have been completed and call out any omissions
• Do not change gear or flap configuration until terrain separation is assured • Monitor radio altimeter for sustained or increasing terrain separation • When clear of the terrain, slowly decrease pitch attitude and accelerate	• Monitor vertical speed and altitude • Call out any trend toward terrain contact

NOTE: Aft control column force increases as the airspeed decreases. In all cases, the pitch attitude that results in intermittent stick shaker or initial buffet is the upper pitch attitude limit. Flight at intermittent stick shaker may be required to obtain positive terrain separation. Smooth, steady control will avoid a pitch attitude overshoot and stall.

NOTE: Do not use Flight Director commands.

* Maximum thrust means "maximum certified thrust". On engines without electronic thrust limiting capability, overboost or "firewalling the thrust lever" should only be considered during emergency situations when all other available actions have been taken and terrain contact is imminent.

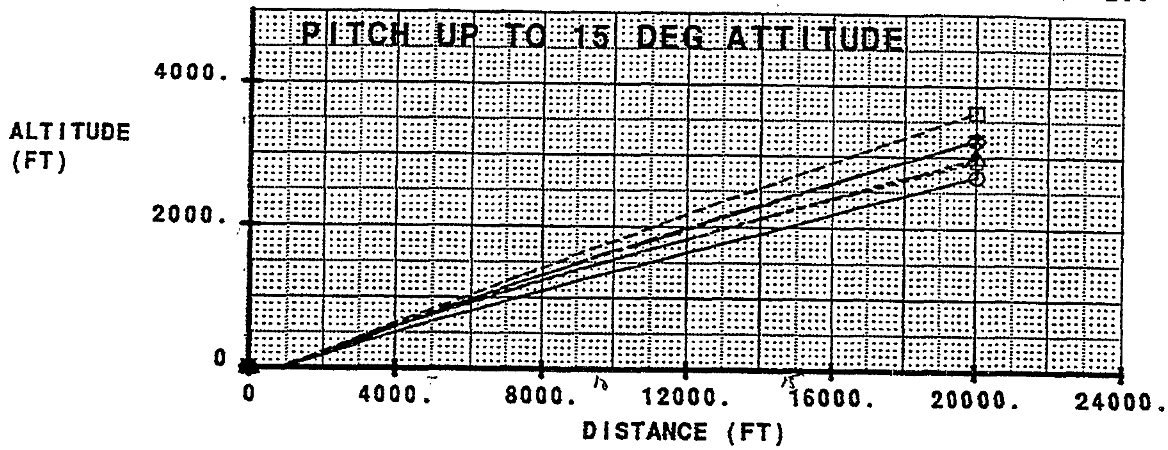
Boeing Aerodynamic Study Results

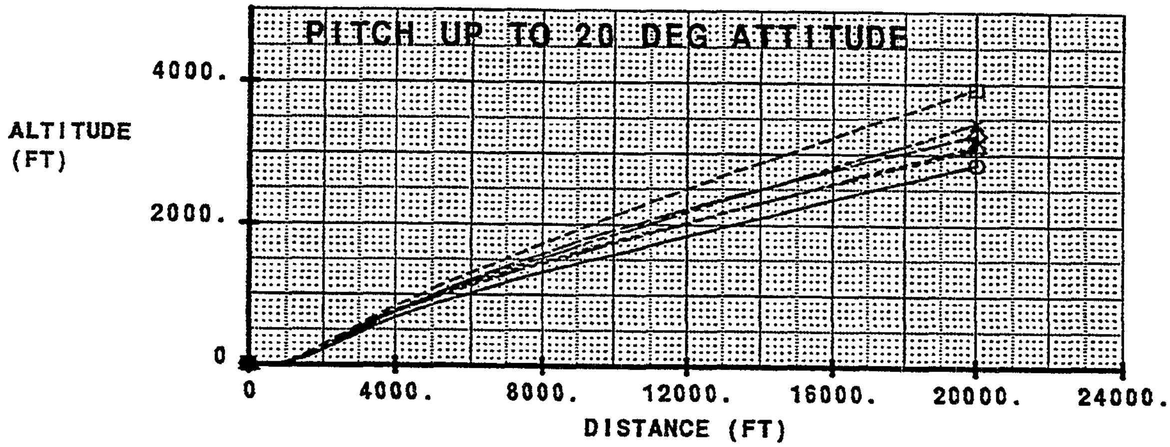
The aerodynamic study evaluated a set of pull-up maneuvers to avoid terrain after receiving a ground proximity warning. The parameters used for the study were three pitch attitudes or angle of attack, two pitch rates, two initial altitudes, and four flap configurations. Figures 1-12 show each plot in various configurations for various Boeing models. Altitude (ft) is graphed on the vertical axis and distance traveled (ft) is graphed on the horizontal axis.

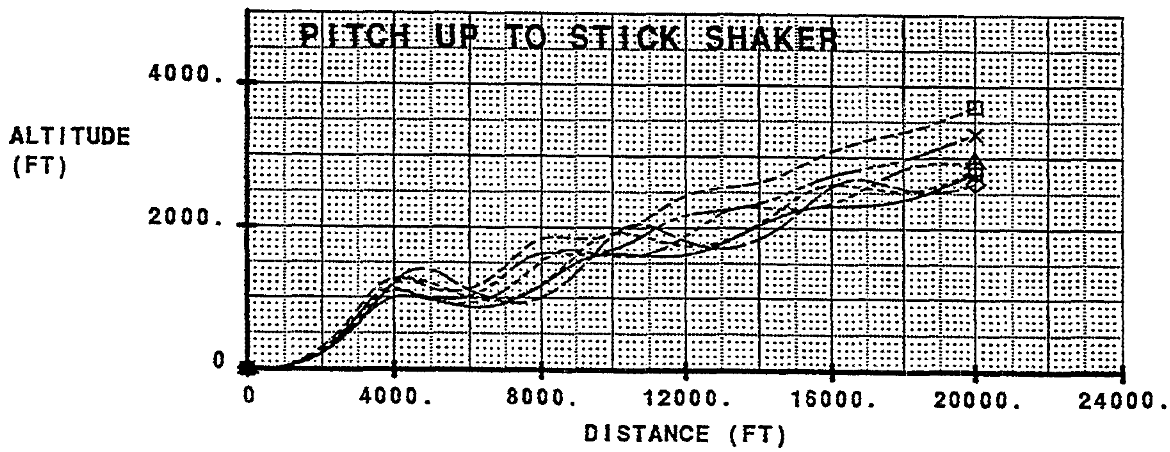
LANDING FLAPS, SEA LEVEL

MAXIMUM LANDING WEIGHT, LANDING GEAR DOWN, VREF +5 KNOTS, MAXIMUM THRUST APPLIED .5 SEC AFTER MANEUVER START, SPEED TRIM OPERATIVE WHERE APPLICABLE

- ○ ——— 727-200
- □ - - - - 737-300
- ◇ ——— 747-400
- × ——— 757-200
- ⬠ - - - - 767-300ER
- △ - - - - 777-200



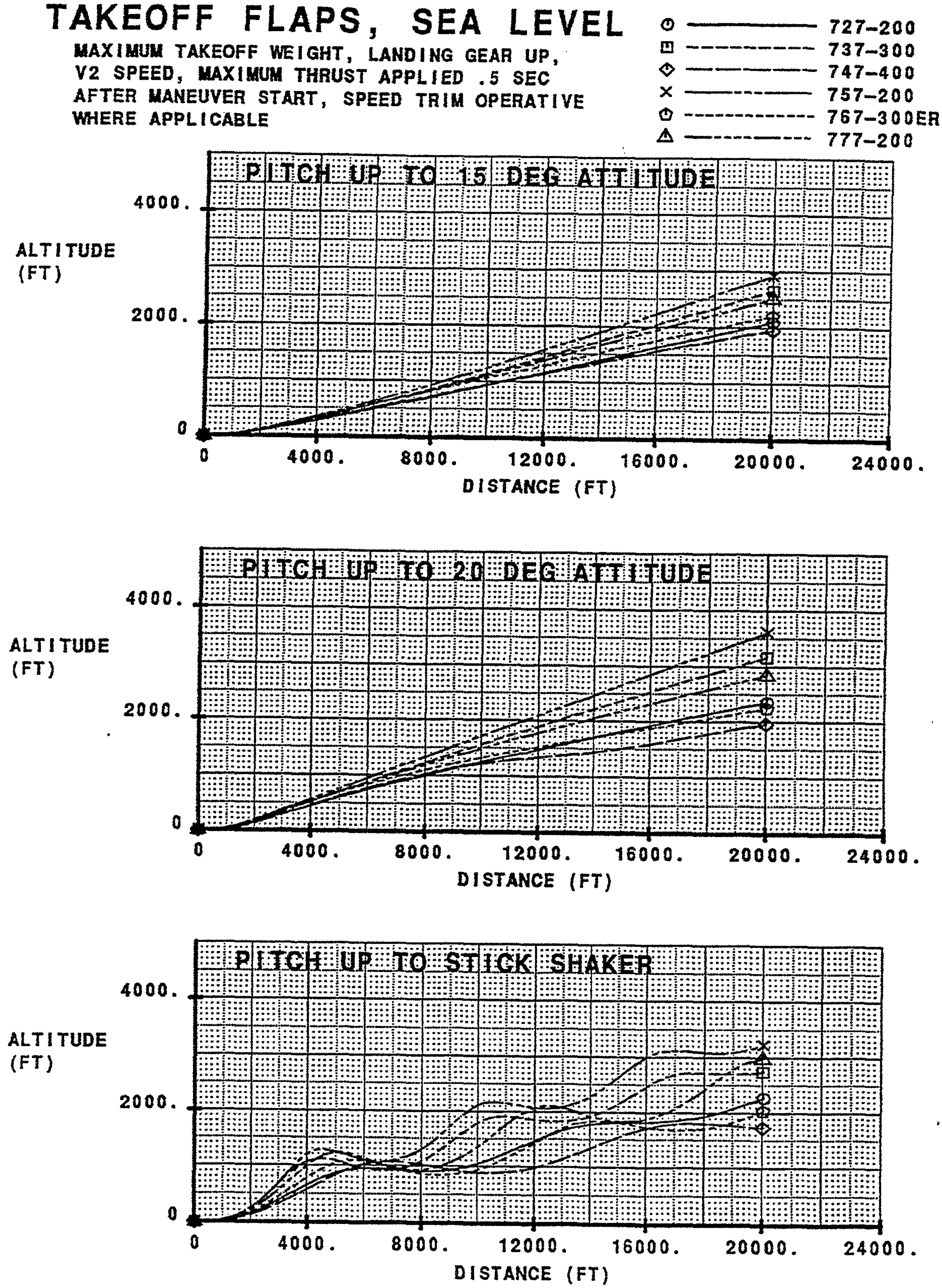




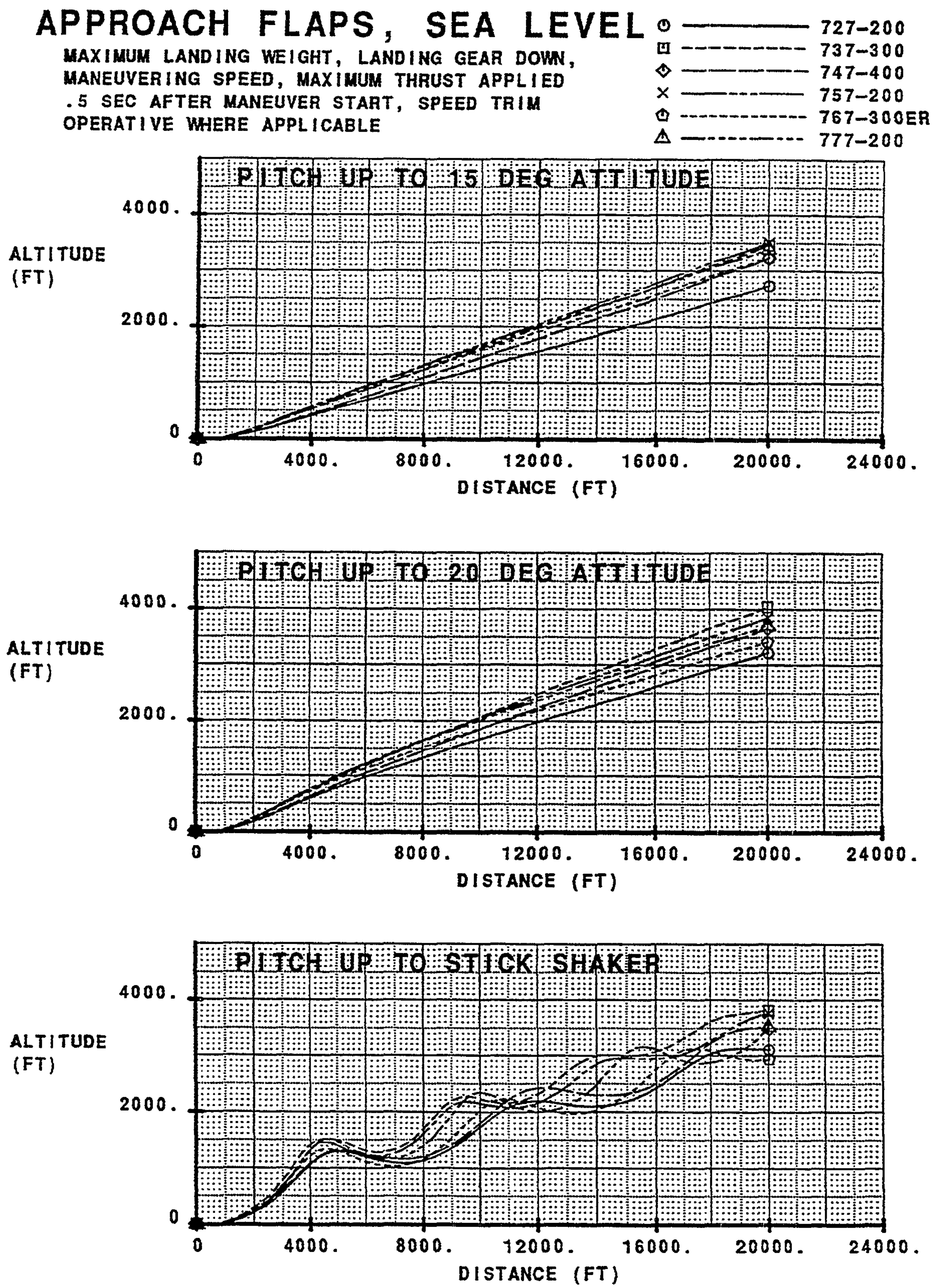
CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Landing Flaps at Sea Level 3 Deg/Sec Pitch Rate	VARIOUS MODELS
CHECK						Figure 1
APR						
APR					THE BOEING COMPANY	PAGE

TAKEOFF FLAPS, SEA LEVEL

MAXIMUM TAKEOFF WEIGHT, LANDING GEAR UP, V2 SPEED, MAXIMUM THRUST APPLIED .5 SEC AFTER MANEUVER START, SPEED TRIM OPERATIVE WHERE APPLICABLE



CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Takeoff Flaps at Sea Level 3 Deg/Sec Pitch Rate	VARIOUS MODELS
CHECK						Figure 2
APR					THE BOEING COMPANY	PAGE
APR						

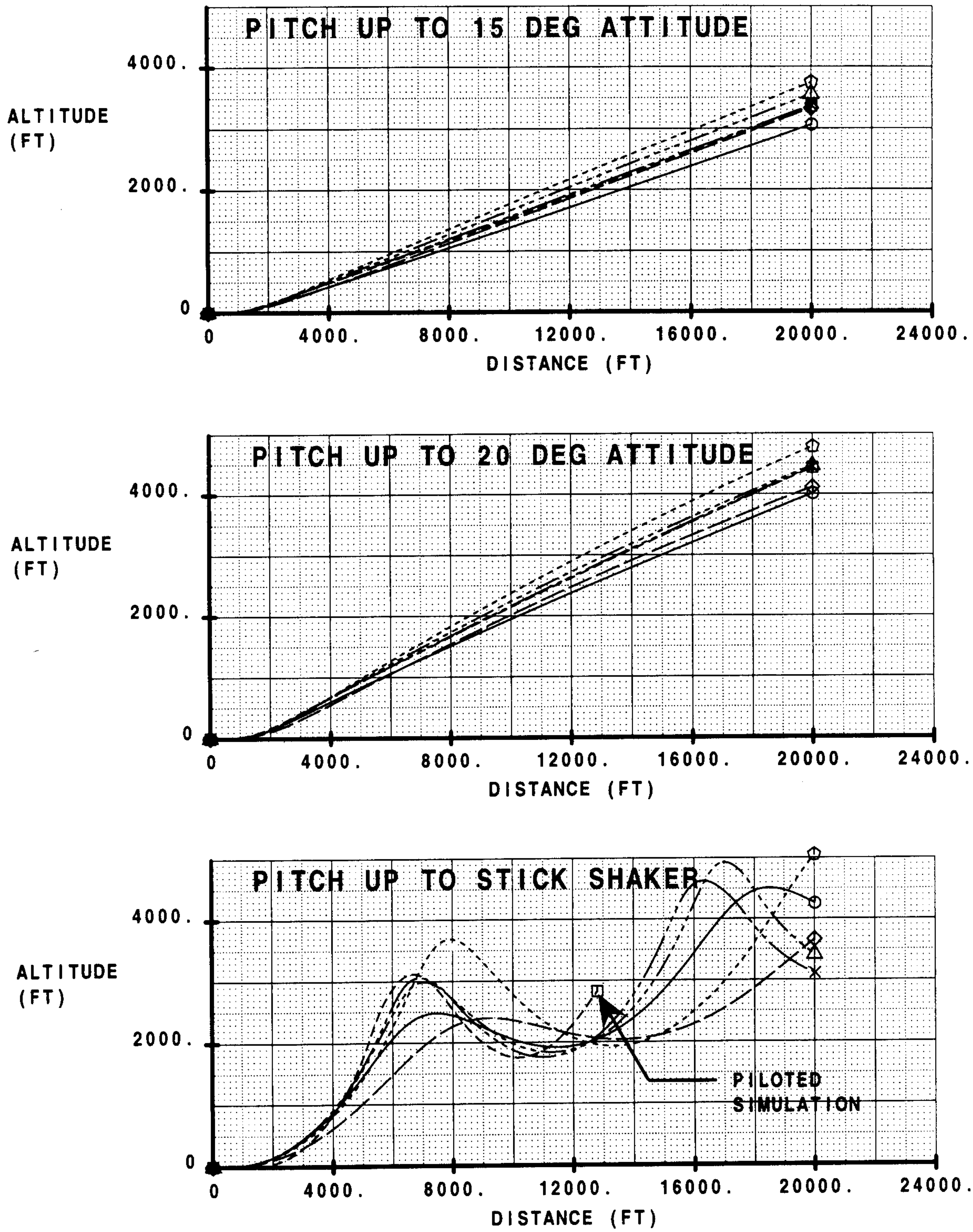


CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Approach Flaps at Sea Level 3 Deg/Sec Pitch Rate	VARIOUS MODELS
CHECK						Figure 3
APR					THE BOEING COMPANY	PAGE
APR						

FLAPS UP, SEA LEVEL

MAXIMUM LANDING WEIGHT, LANDING GEAR UP, MANEUVERING SPEED, MAXIMUM THRUST APPLIED .5 SEC AFTER MANEUVER START, SPEED TRIM OPERATIVE WHERE APPLICABLE

- 727-200
- 737-300
- 747-400
- 757-200
- 767-300ER
- 777-200



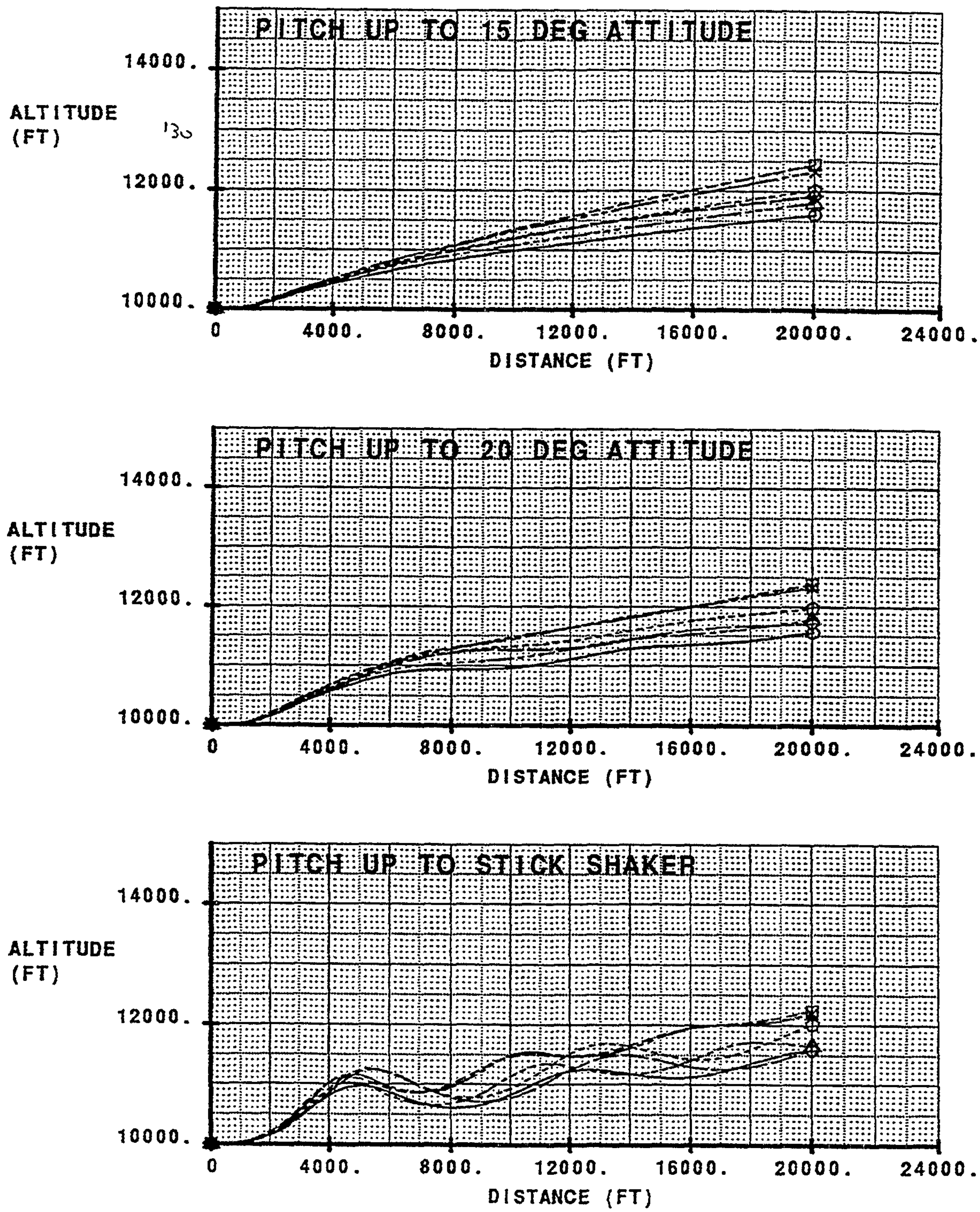
NOTE: MATH PILOT SIMULATION EXCEPT AS NOTED

			REVISED	DATE		
CALC		21APR97			CFIT Escape Maneuver Study Flaps Up at Sea Level 3 Deg/Sec Pitch Rate	VARIOUS MODELS
CHECK						Figure 4
APR					THE BOEING COMPANY	PAGE
APR						

LANDING FLAPS, 10000 FT

MAXIMUM LANDING WEIGHT, LANDING GEAR DOWN, VREF +5 KNOTS, MAXIMUM THRUST APPLIED .5 SEC AFTER MANEUVER START, SPEED TRIM OPERATIVE WHERE APPLICABLE

- ⊙ ———— 727-200
- ⊡ - - - - 737-300
- ◇ — — — 747-400
- × —-—-— 757-200
- ⬠ - - - - - 767-300ER
- △ —-—-— 777-200

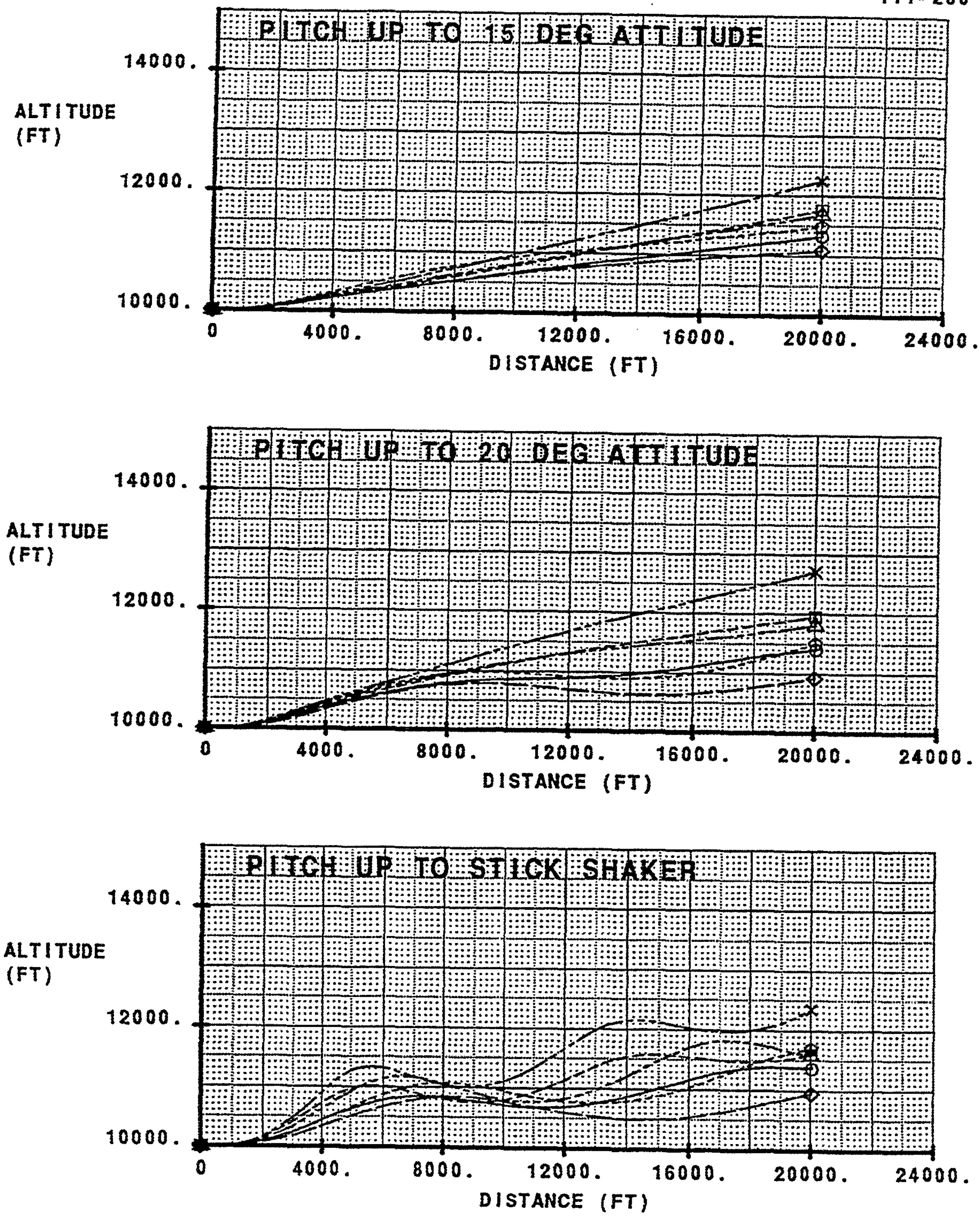


CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Landing Flaps at 10000 ft 3 Deg/Sec Pitch Rate	VARIOUS MODELS
CHECK						
APR						Figure 5
APR					THE BOEING COMPANY	PAGE

TAKEOFF FLAPS, 10000 FT

MAXIMUM TAKEOFF WEIGHT, LANDING GEAR UP, V2 SPEED, MAXIMUM THRUST APPLIED .5 SEC AFTER MANEUVER START, SPEED TRIM OPERATIVE WHERE APPLICABLE

○ ————————	727-200
⊞ ----------	737-300
◇ ————————	747-400
× ————————	757-200
⬠ -------------	767-300ER
△ -----------	777-200

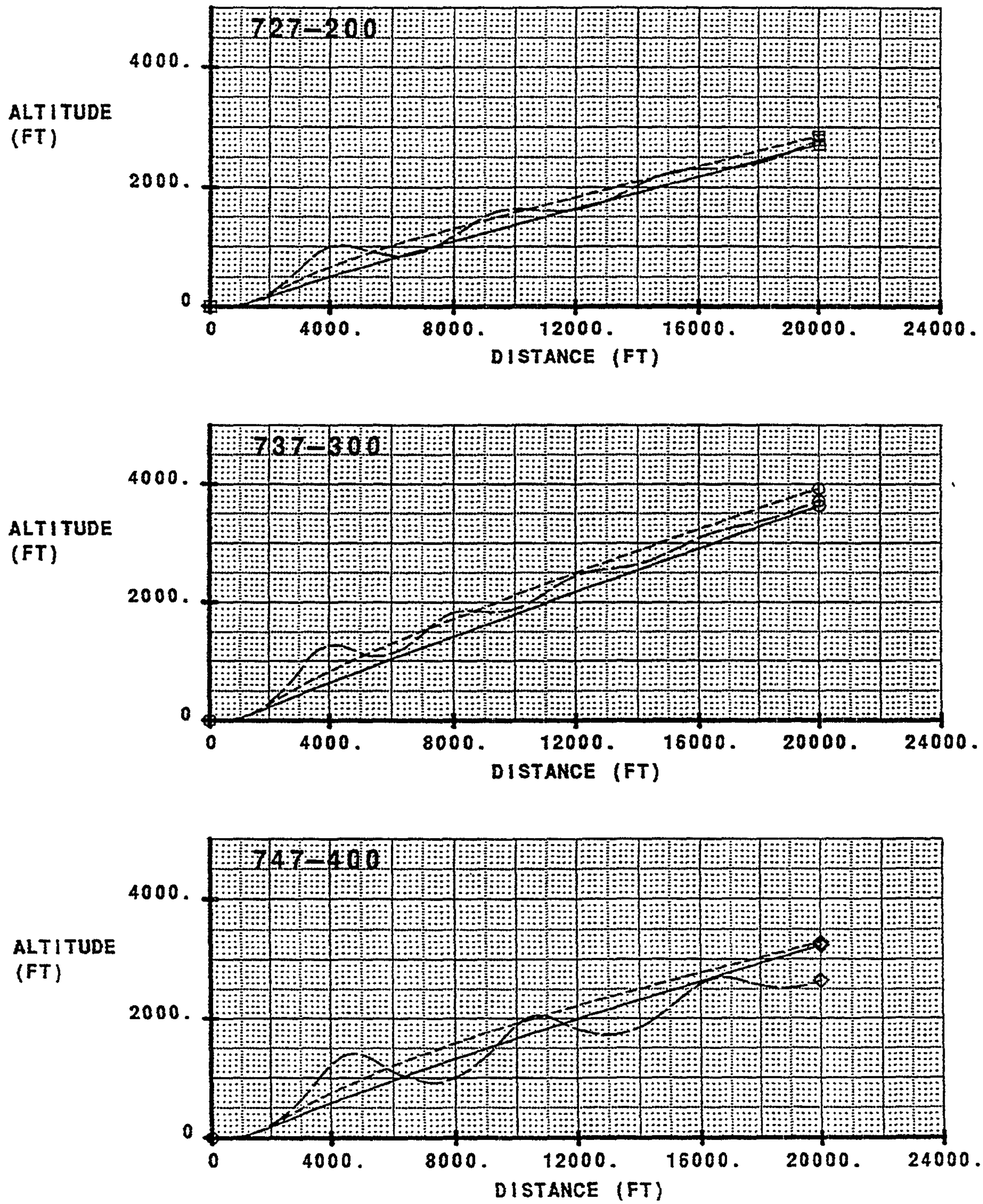


CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Takeoff Flaps at 10000 ft 3 Deg/Sec Pitch Rate	VARIOUS MODELS
CHECK						
APR						Figure 6
APR					THE BOEING COMPANY	PAGE

LANDING FLAPS, SEA LEVEL

PITCH UP TO 15 DEG VS 20 VS SHAKER
3 DEG/SEC PITCH RATE

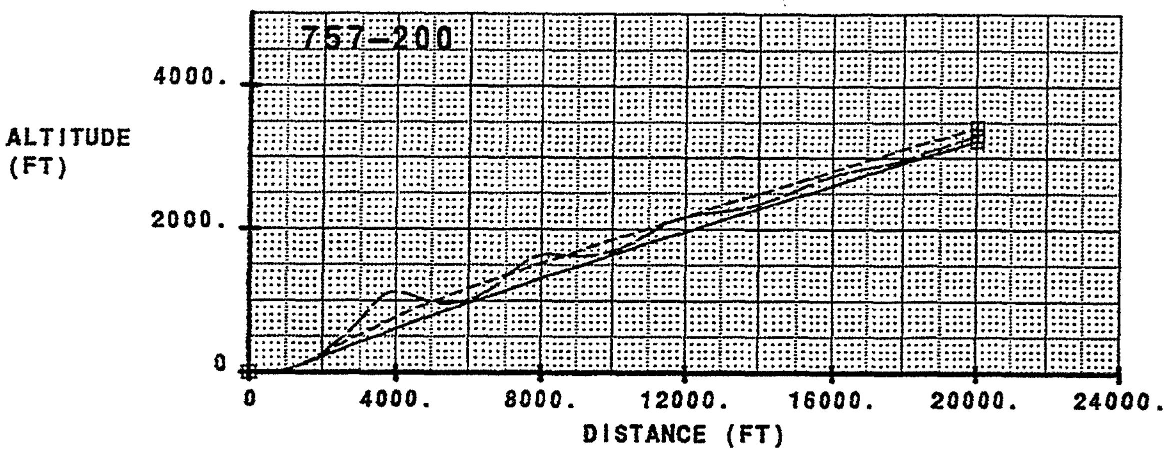
PITCH UP TO:
——— 15 DEG
- - - - 20 DEG
— — — STICK SHAKER

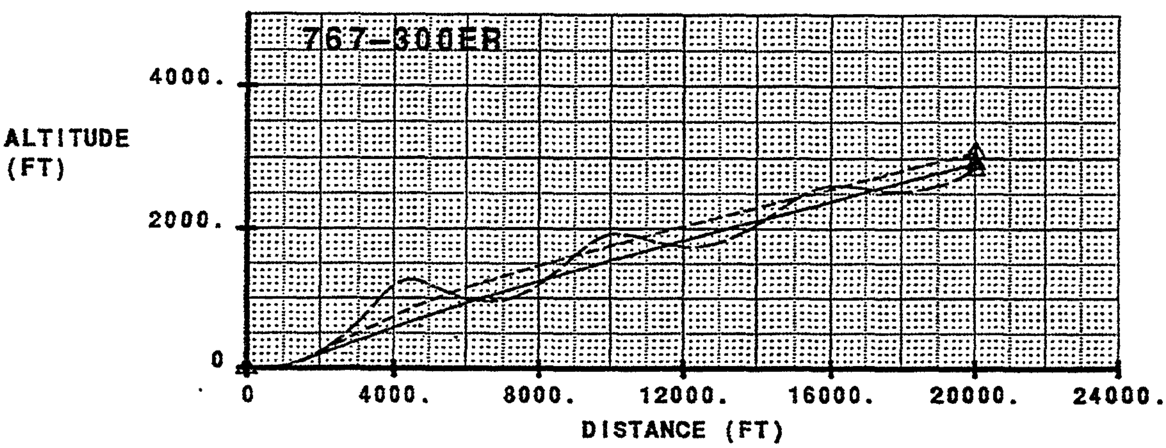


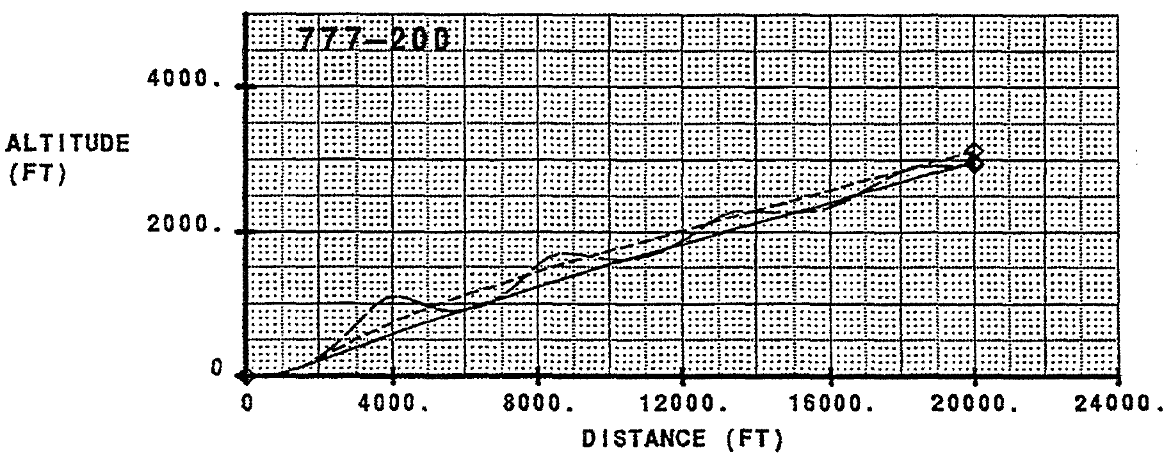
CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Landing Flaps at Sea Level Pitch Up to 15 Deg, 20 Deg & Shaker	727,737,747
CHECK						
APR						Figure 7A
APR					THE BOEING COMPANY	PAGE

LANDING FLAPS, SEA LEVEL
PITCH UP TO 15 DEG VS 20 VS SHAKER
3 DEG/SEC PITCH RATE

PITCH UP TO:
15 DEG
20 DEG
STICK SHAKER





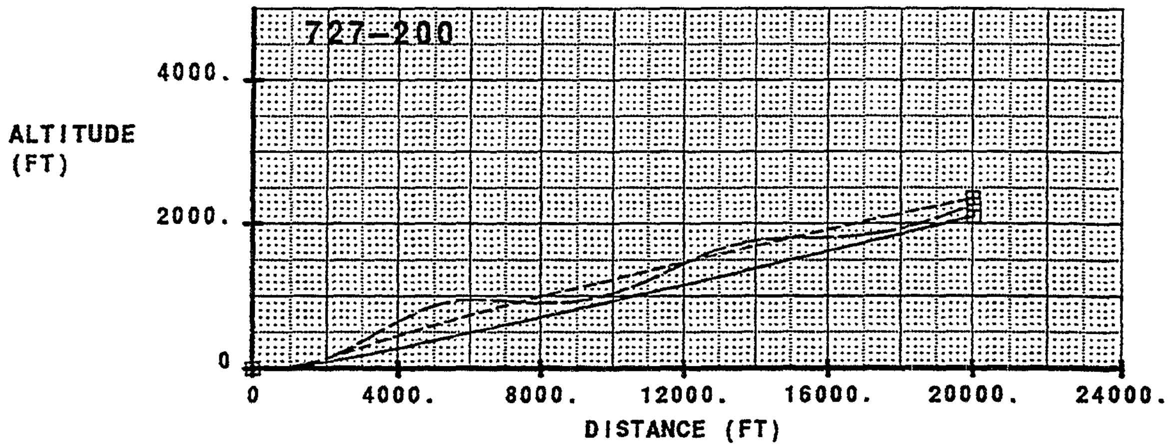


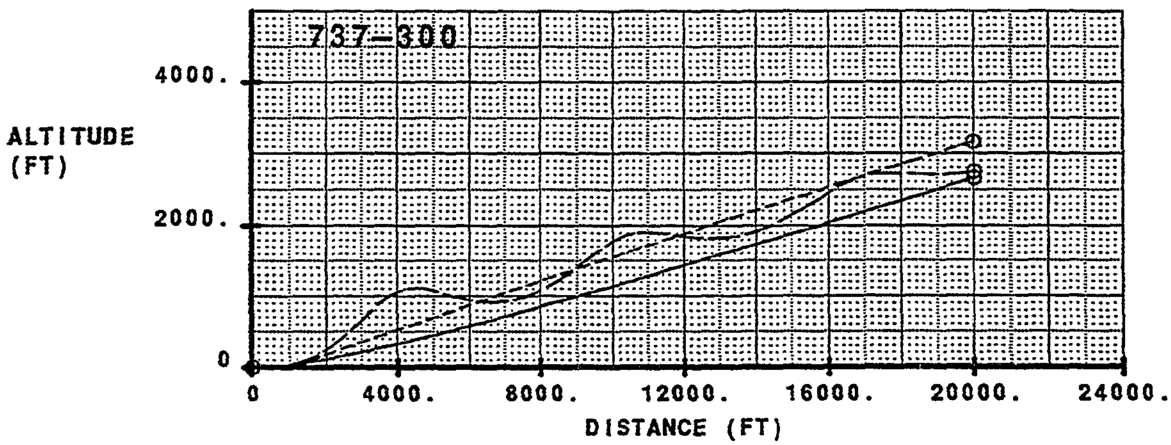
CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Landing Flaps at Sea Level Pitch Up to 15 Deg, 20 Deg & Shaker	757,767,777
CHECK						
APR						Figure 7B
APR					THE BOEING COMPANY	PAGE

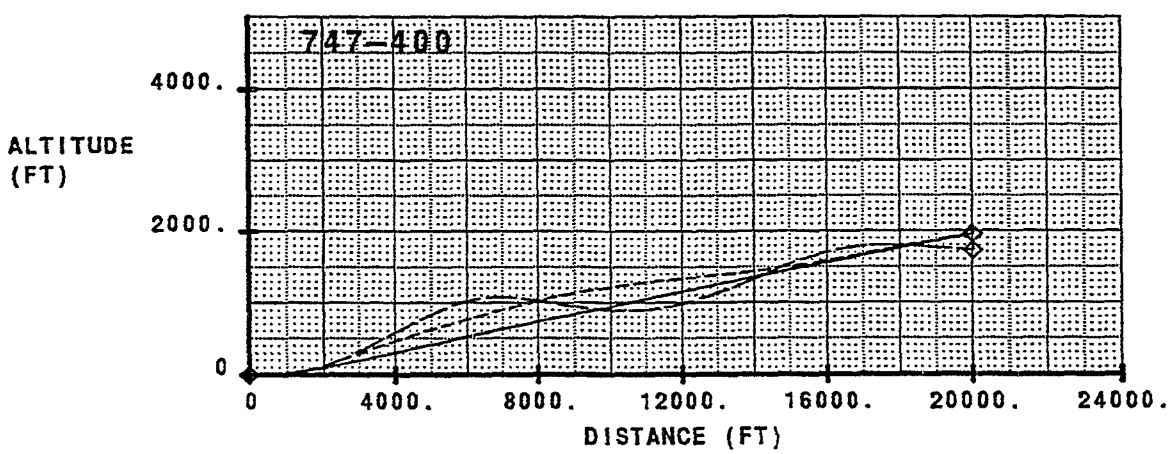
TAKEOFF FLAPS, SEA LEVEL

PITCH UP TO 15 DEG VS 20 VS SHAKER
3 DEG/SEC PITCH RATE

PITCH UP TO:
———— 15 DEG
- - - - 20 DEG
— — — STICK SHAKER

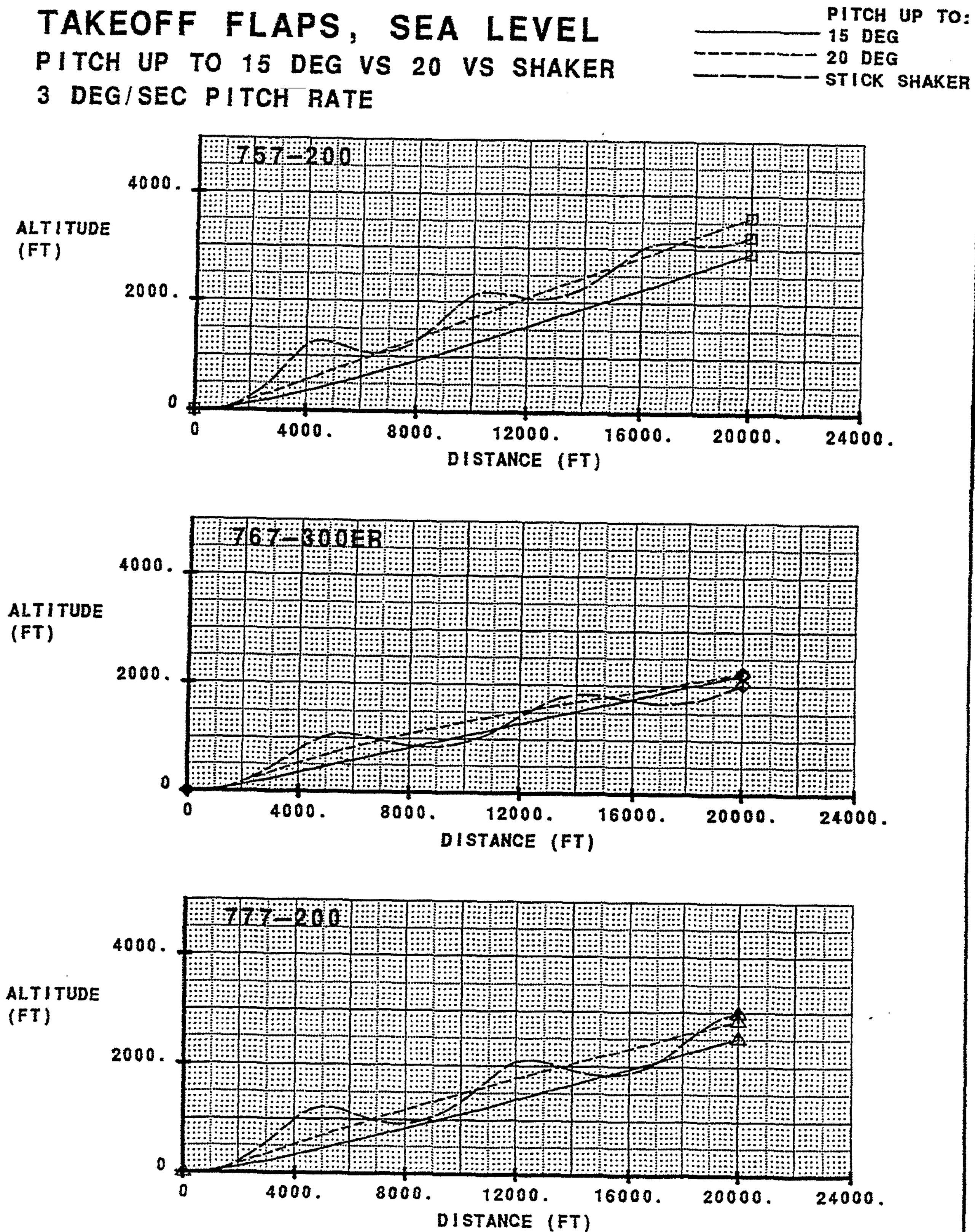






CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Takeoff Flaps at Sea Level Pitch Up to 15 Deg, 20 Deg & Shaker	727,737,747
CHECK						
APR						Figure 8A
APR					THE BOEING COMPANY	PAGE

TAKEOFF FLAPS, SEA LEVEL
PITCH UP TO 15 DEG VS 20 VS SHAKER
3 DEG/SEC PITCH RATE

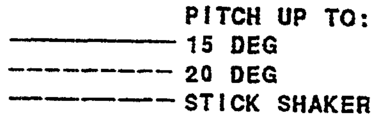


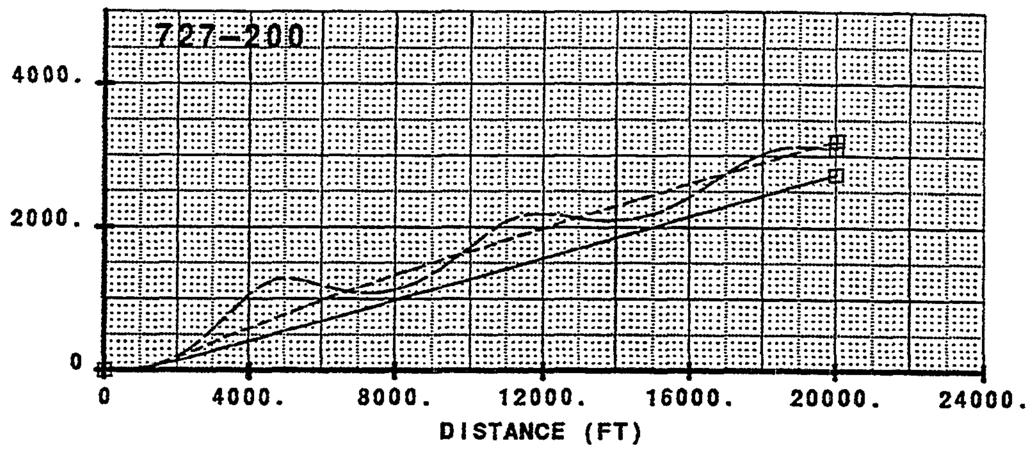
CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Takeoff Flaps at Sea Level Pitch Up to 15 Deg, 20 Deg & Shaker	757,767,777
CHECK						
APR						Figure 8B
APR					THE BOEING COMPANY	PAGE

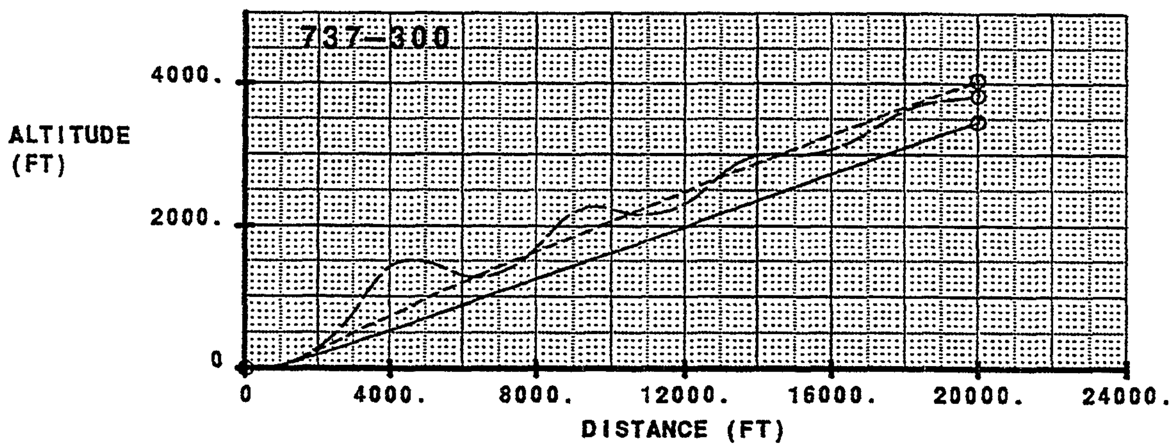
APPROACH FLAPS, SEA LEVEL

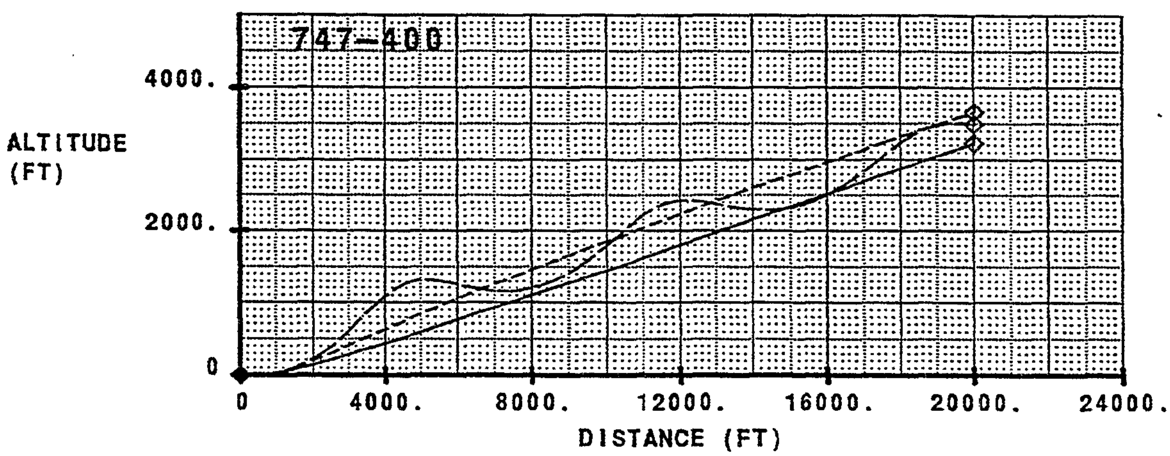
PITCH UP TO 15 DEG VS 20 VS SHAKER

3 DEG/SEC PITCH RATE





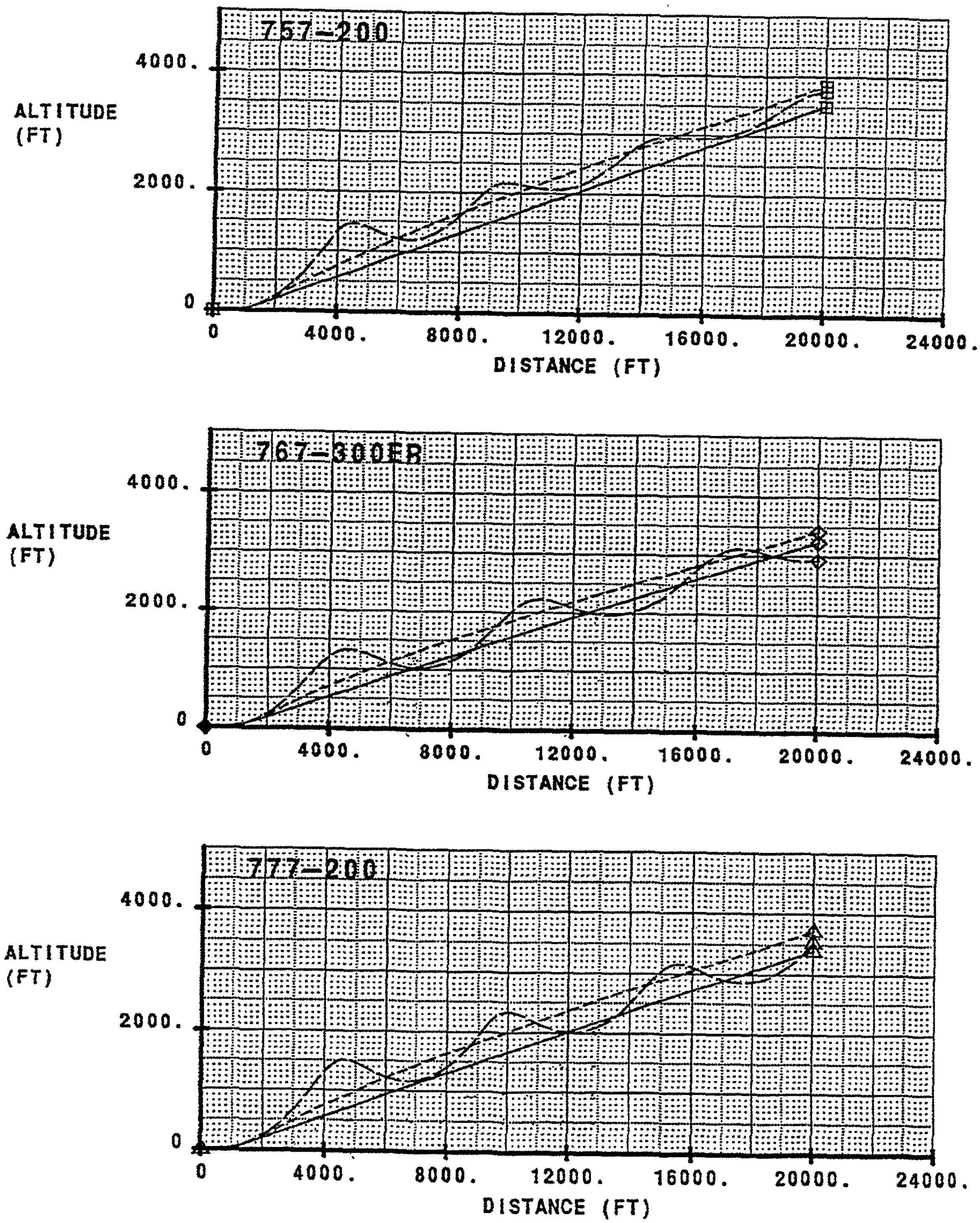




CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Approach Flaps at Sea Level Pitch Up to 15 Deg, 20 Deg & Shaker	727,737,747
CHECK						Figure 9A
APR					THE BOEING COMPANY	PAGE
APR						

APPROACH FLAPS, SEA LEVEL
PITCH UP TO 15 DEG VS 20 VS SHAKER
3 DEG/SEC PITCH RATE

PITCH UP TO:
15 DEG
20 DEG
STICK SHAKER



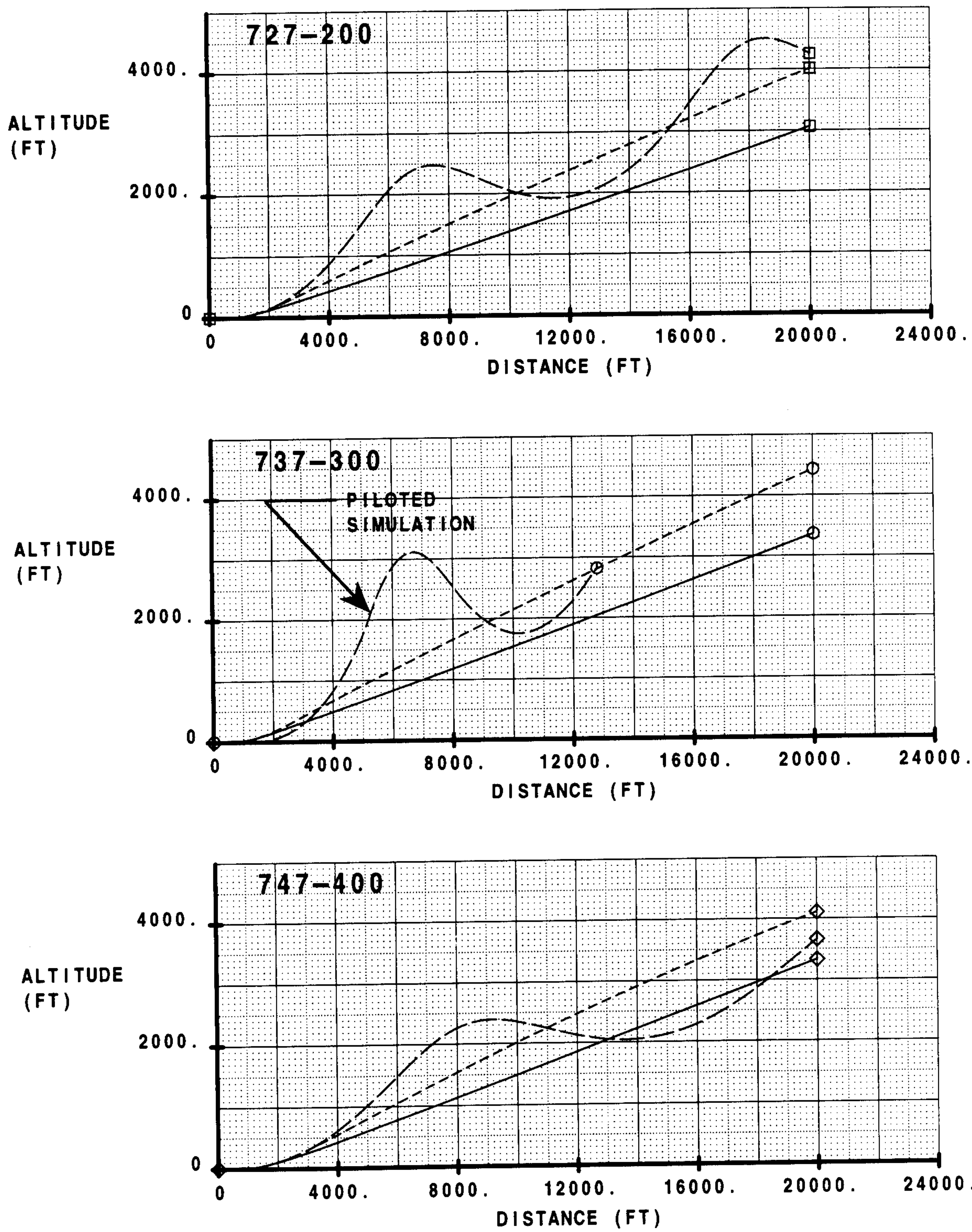
CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Approach Flaps at Sea Level Pitch Up to 15 Deg, 20 Deg & Shaker	757,767,777
CHECK						Figure 9B
APR					THE BOEING COMPANY	PAGE
APR						

FLAPS UP, SEA LEVEL

PITCH UP TO 15 DEG VS 20 VS SHAKER

3 DEG/SEC PITCH RATE

PITCH UP TO:
15 DEG
20 DEG
STICK SHAKER



NOTE: MATH PILOT SIMULATION EXCEPT AS NOTED

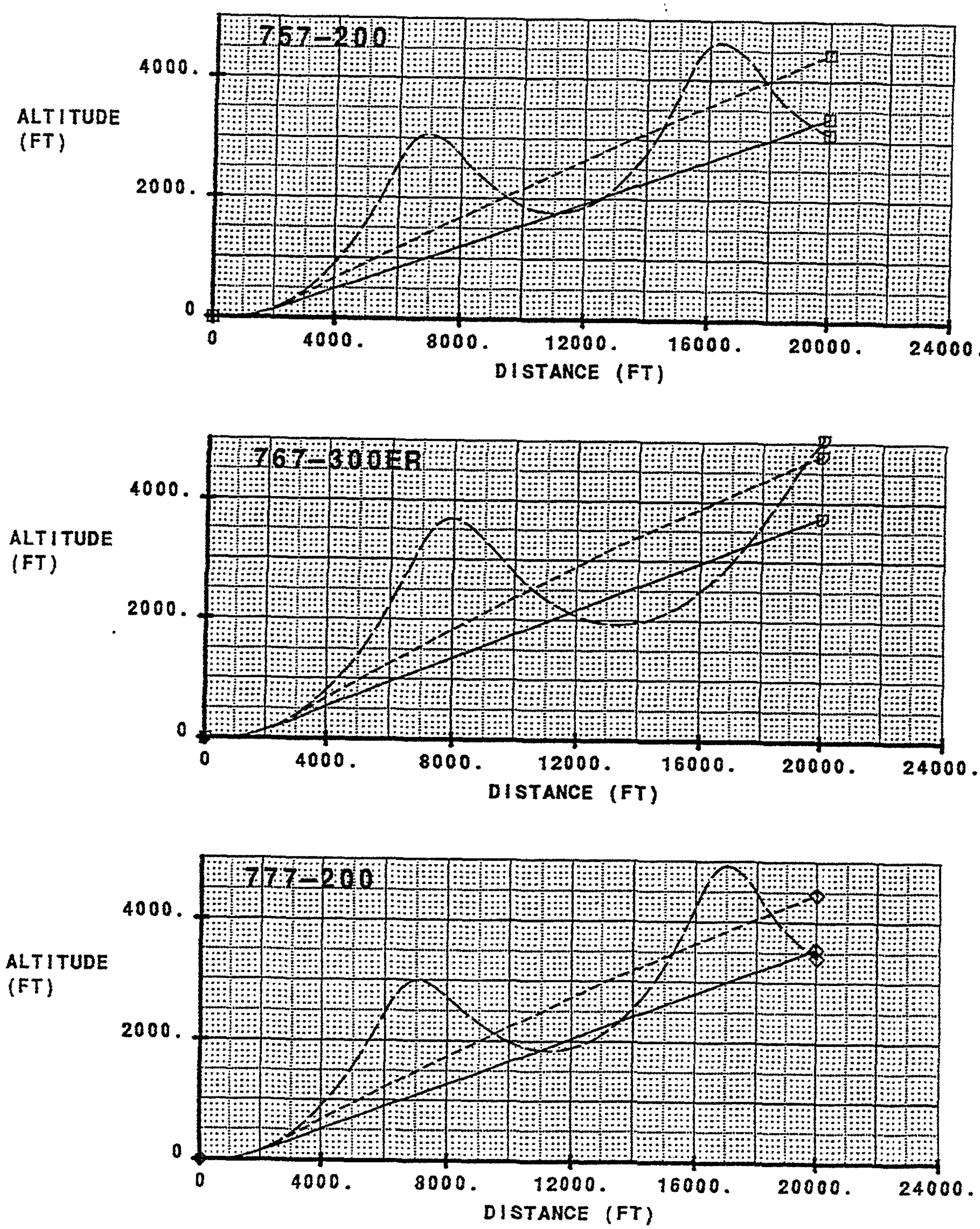
CALC		21APR97	REVISED	DATE	CFIT Escape Maneuver Study Flaps Up at Sea Level Pitch Up to 15 Deg, 20 Deg & Shaker	727,737,747
CHECK						Figure 10A
APR					THE BOEING COMPANY	PAGE
APR						

FLAPS UP, SEA LEVEL

PITCH UP TO 15 DEG VS 20 VS SHAKER

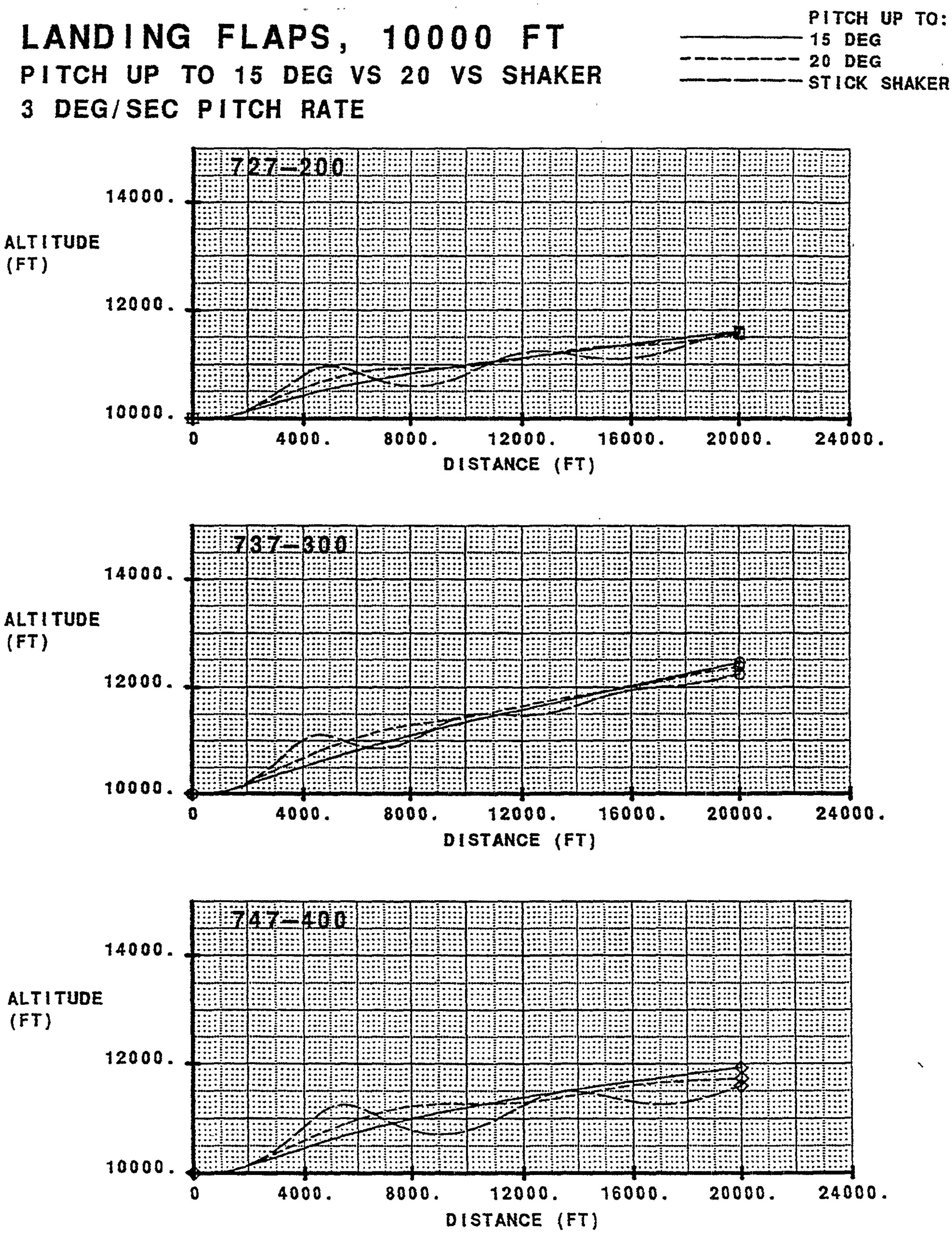
3 DEG/SEC PITCH RATE

PITCH UP TO:
15 DEG
20 DEG
STICK SHAKER



CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Flaps Up at Sea Level Pitch Up to 15 Deg, 20 Deg & Shaker	757,767,777
CHECK						Figure 10B
APR					THE BOEING COMPANY	PAGE
APR						

LANDING FLAPS, 10000 FT
PITCH UP TO 15 DEG VS 20 VS SHAKER
3 DEG/SEC PITCH RATE

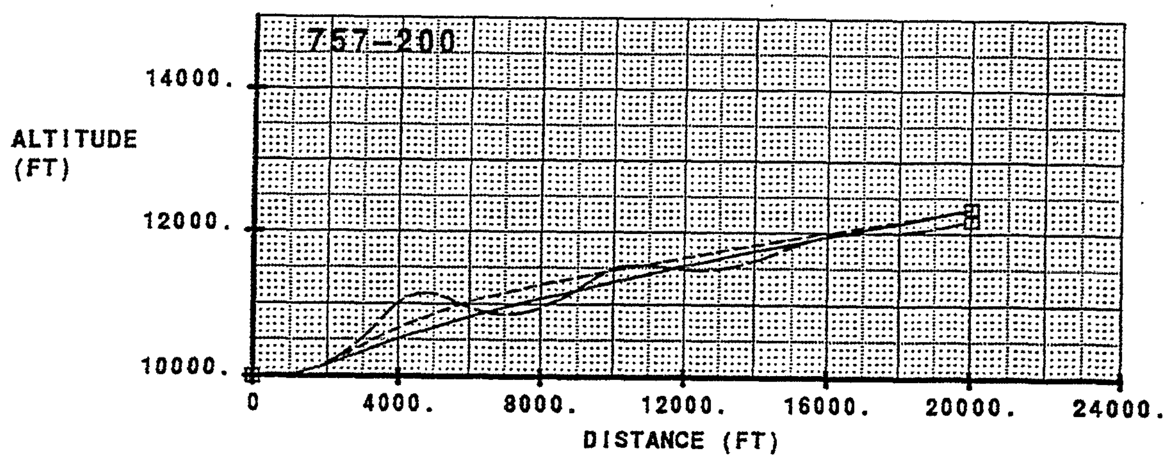


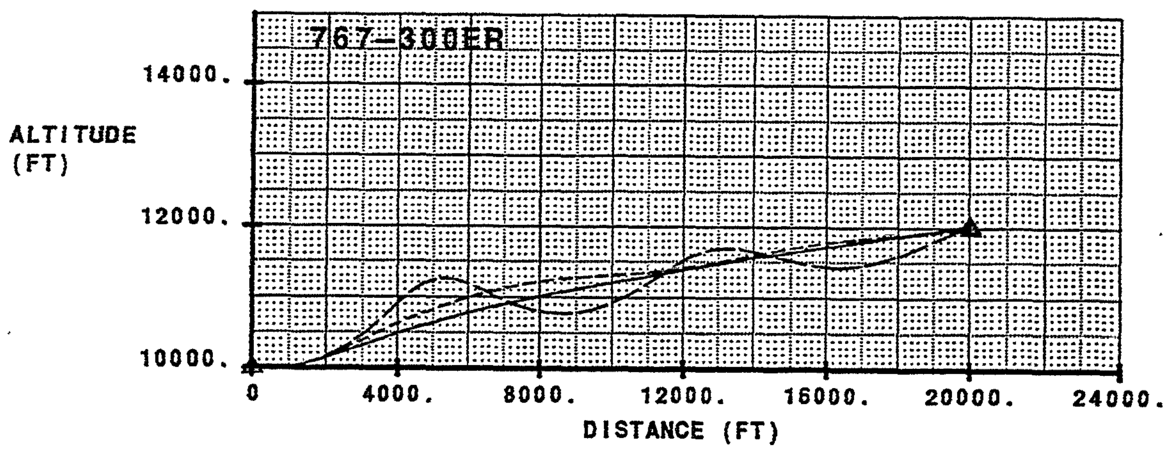
CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Landing Flaps at 10000 ft Pitch Up to 15 Deg, 20 Deg & Shaker	727,737,747
CHECK						
APR						Figure 11A
APR					THE BOEING COMPANY	PAGE

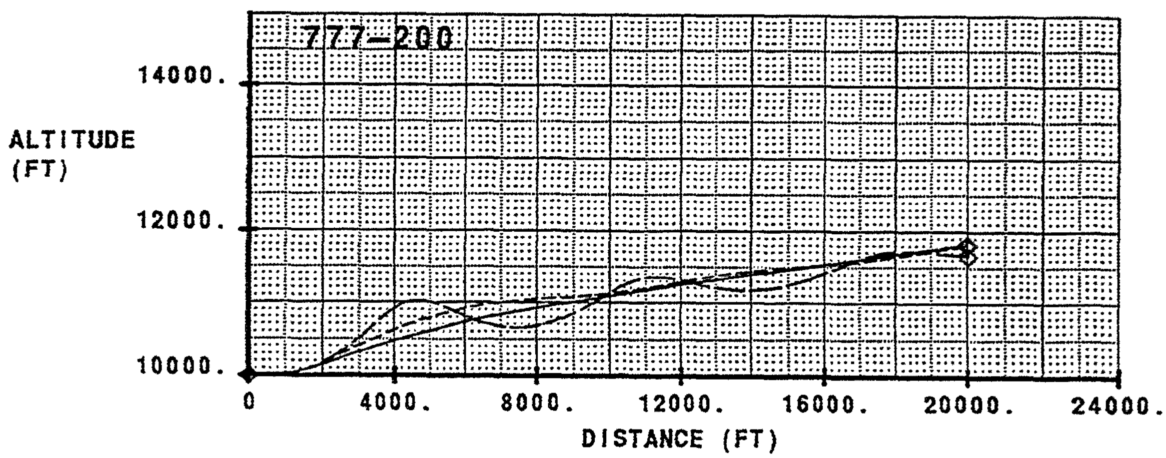
LANDING FLAPS, 10000 FT

PITCH UP TO 15 DEG VS 20 VS SHAKER
3 DEG/SEC PITCH RATE

PITCH UP TO:
15 DEG
20 DEG
STICK SHAKER



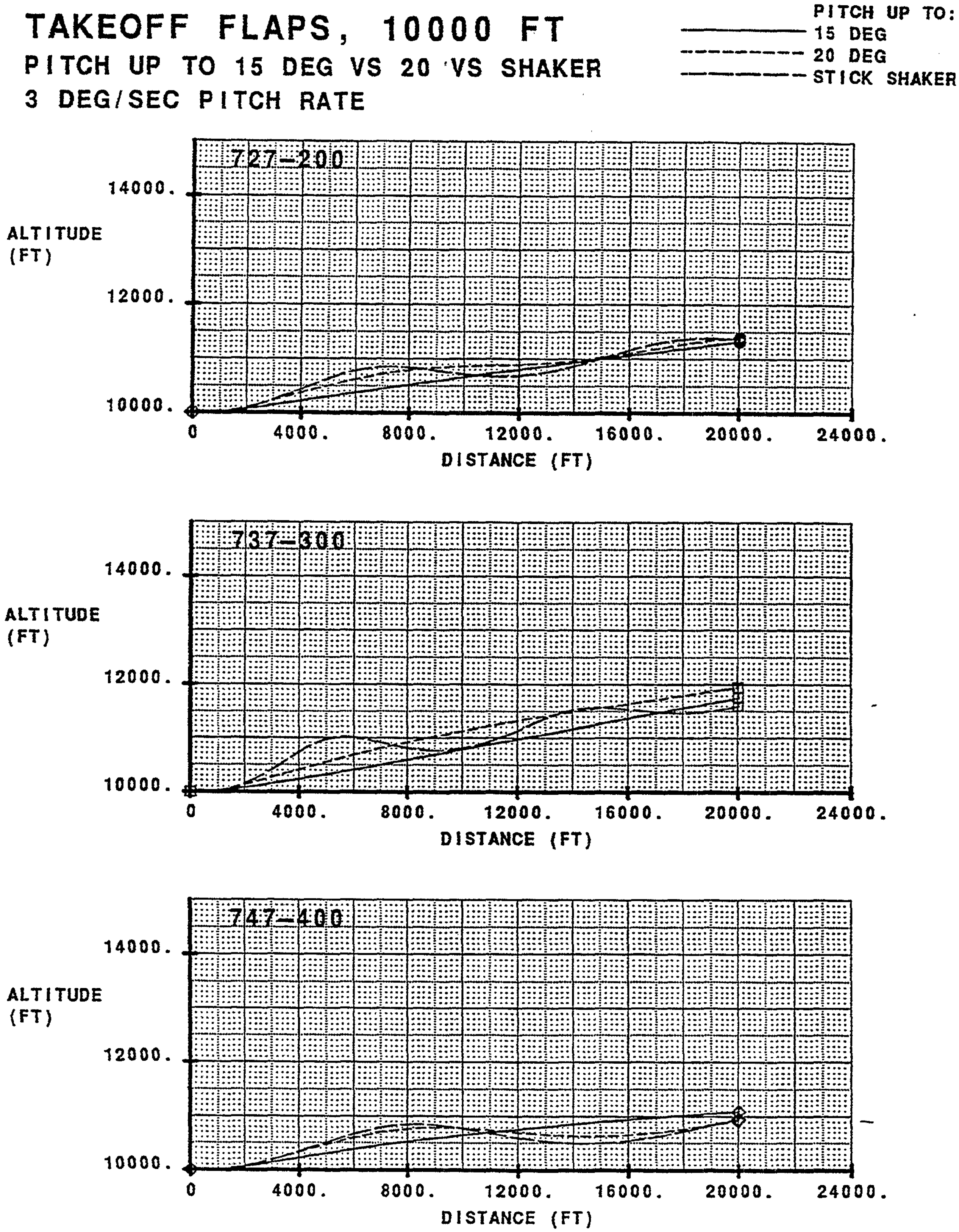




CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Landing Flaps at 10000 ft Pitch Up to 15 Deg, 20 Deg & Shaker	757,767,777
CHECK						Figure 11B
APR					THE BOEING COMPANY	PAGE
APR						

TAKEOFF FLAPS, 10000 FT

PITCH UP TO 15 DEG VS 20 VS SHAKER
3 DEG/SEC PITCH RATE



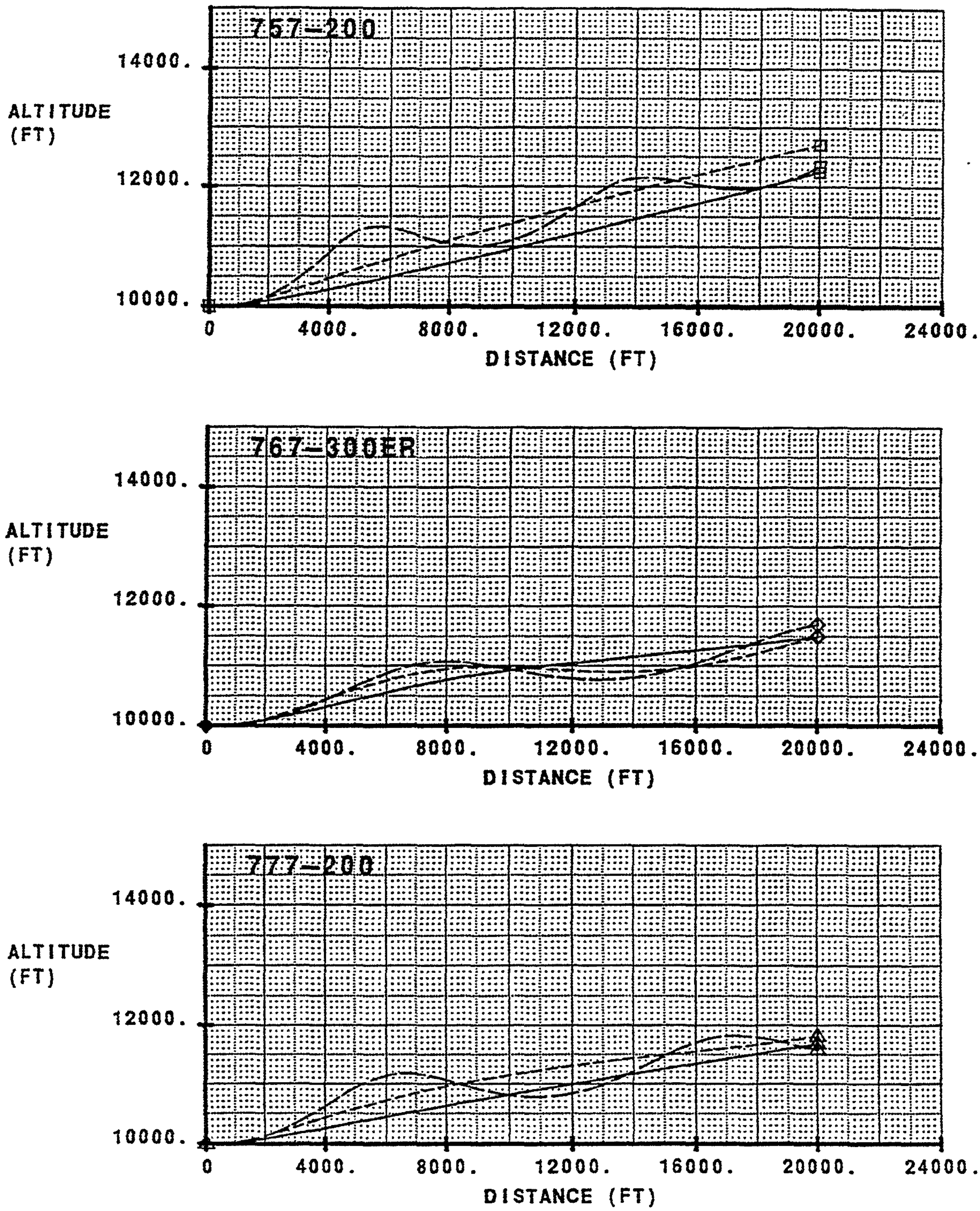
CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Takeoff Flaps at 10000 ft Pitch Up to 15 Deg, 20 Deg & Shaker	727,737,747
CHECK						
APR						Figure 12A
APR					THE BOEING COMPANY	PAGE

TAKEOFF FLAPS, 10000 FT

PITCH UP TO 15 DEG VS 20 VS SHAKER

3 DEG/SEC PITCH RATE

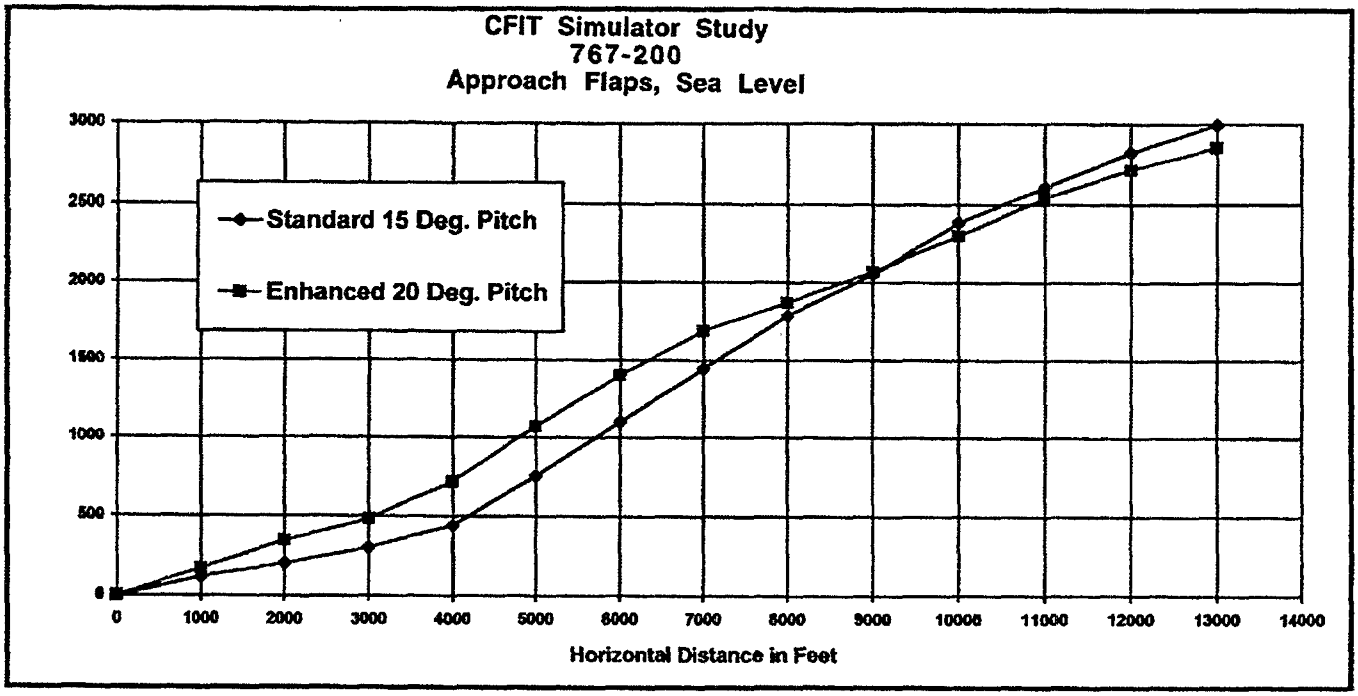
PITCH UP TO:
15 DEG
20 DEG
STICK SHAKER

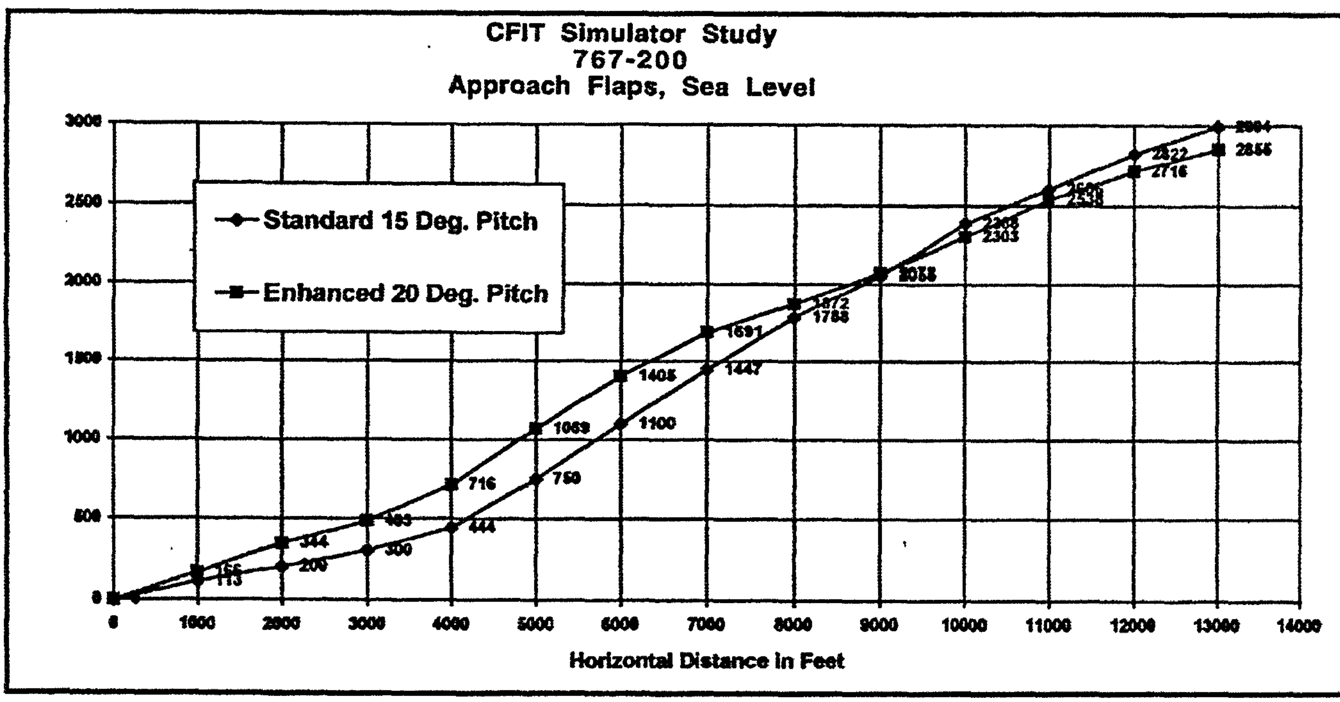


CALC		19MAY95	REVISED	DATE	CFIT Escape Maneuver Study Takeoff Flaps at 10000 ft Pitch Up to 15 Deg, 20 Deg & Shaker	757,767,777
CHECK						
APR						Figure 12B
APR					THE BOEING COMPANY	PAGE

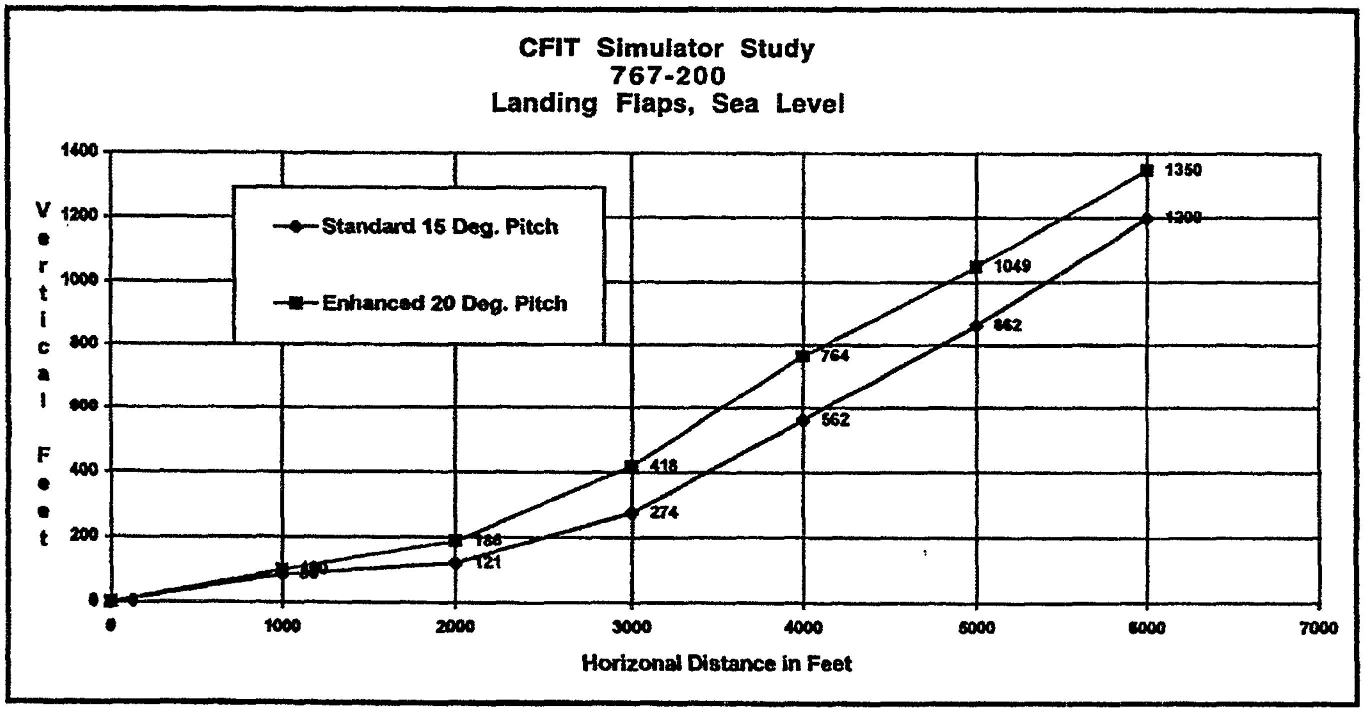
Boeing Flight Simulator Pilot Study

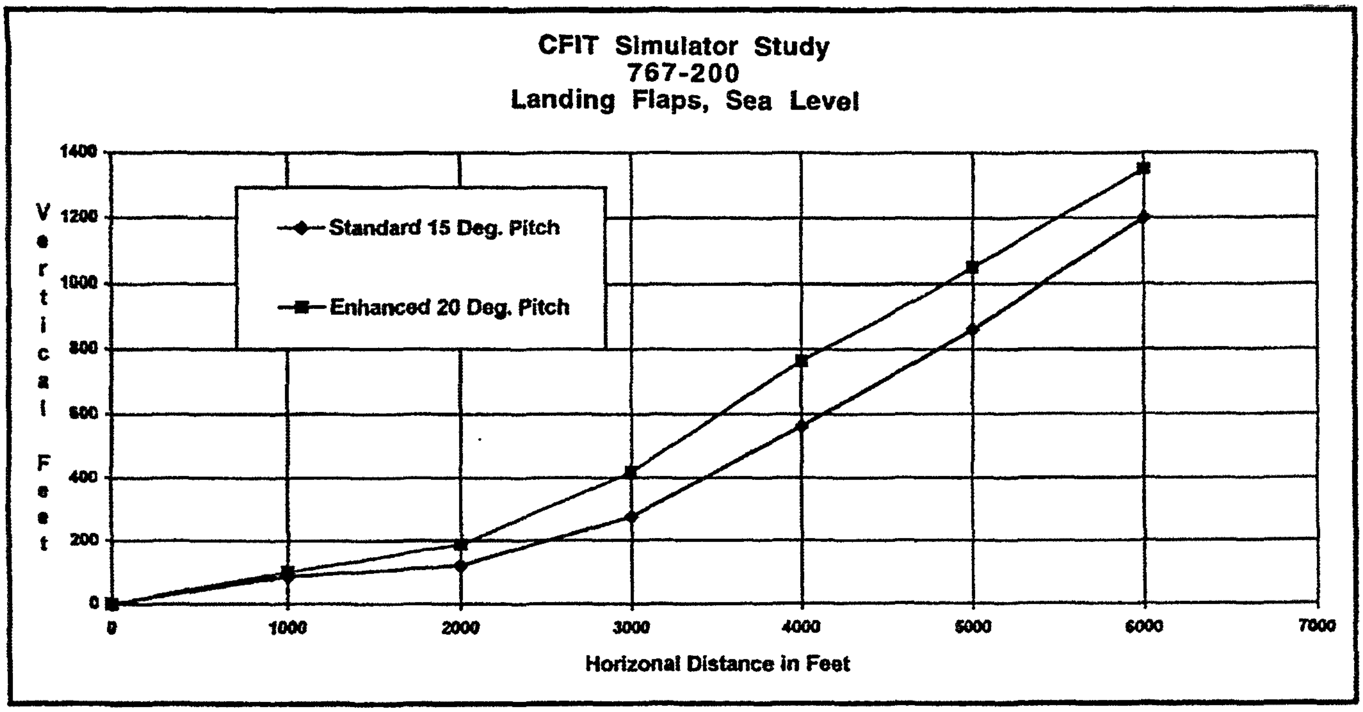
The flight simulator pilot study was conducted in a Boeing 767-200 airplane simulator to evaluate ground proximity warning escape maneuvers. This simulator is indicative of the general performance of the Boeing airplanes, and data will vary little from other Boeing models. The initial conditions for the study are typical of an airplane encountering rapidly rising terrain. Altitude (ft) is graphed on the vertical axis and distance traveled (ft) is graphed on the horizontal axis.

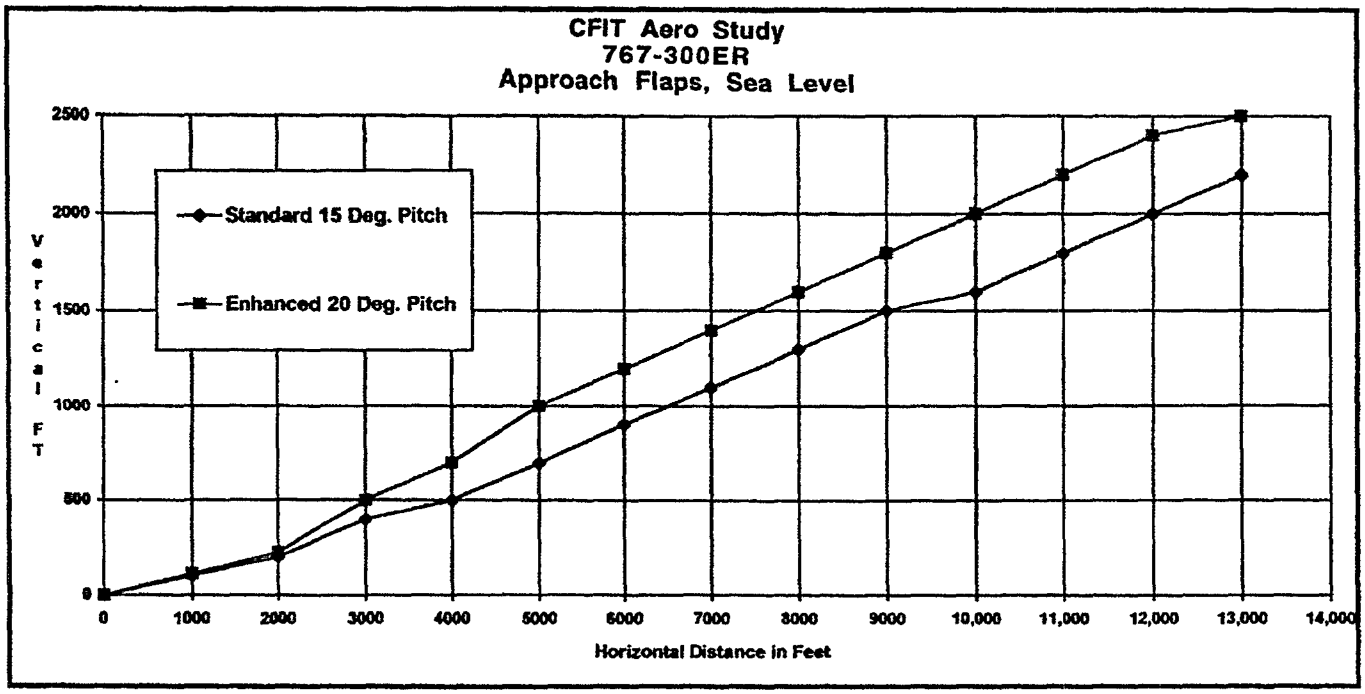

CFIT Simulator Study
767-200
Approach Flaps, Sea Level
Standard 15 Deg. Pitch
Enhanced 20 Deg. Pitch
3000
2500
2000
1500
1000
500
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
Horizontal Distance in Feet

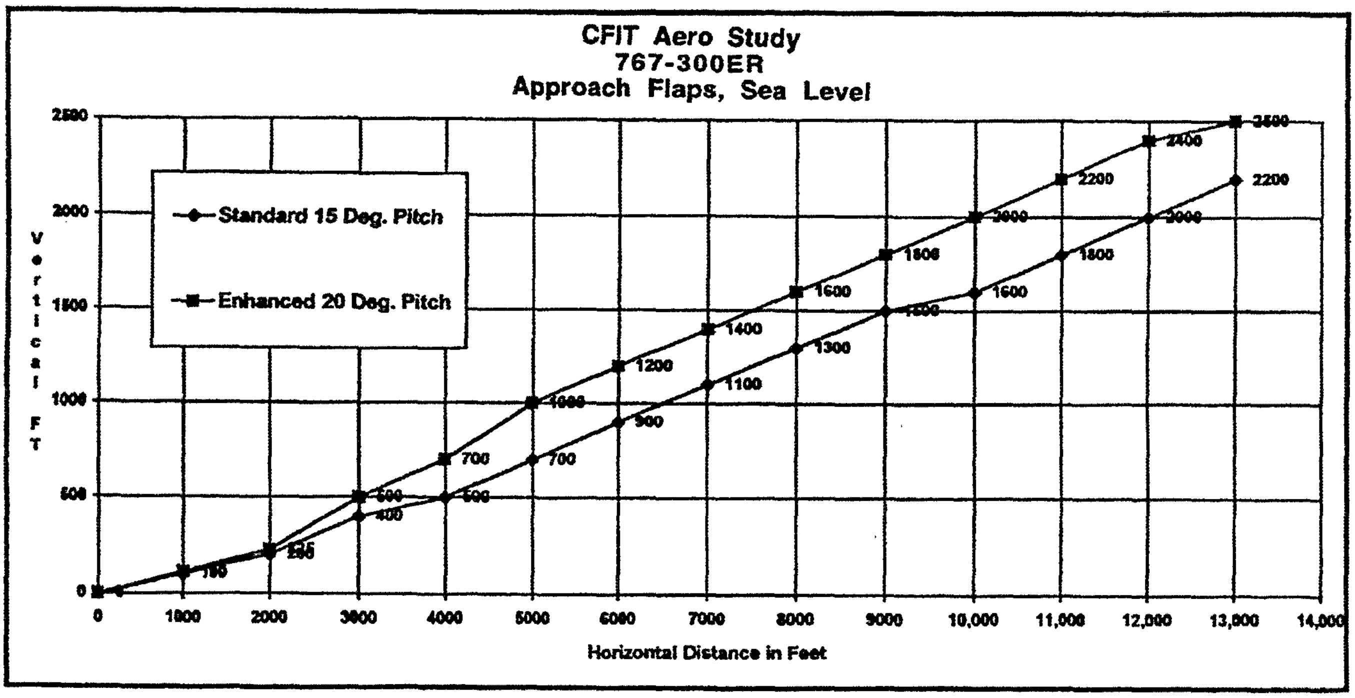


CFIT Simulator Study
767-200
Approach Flaps, Sea Level
Standard 15 Deg. Pitch
Enhanced 20 Deg. Pitch
Horizontal Distance in Feet
0
500
1000
1500
2000
2500
3000
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
113
200
300
444
750
1100
1447
1788
2358
2822
344
483
716
1059
1405
1691
1872
2303
2538
2716
2855

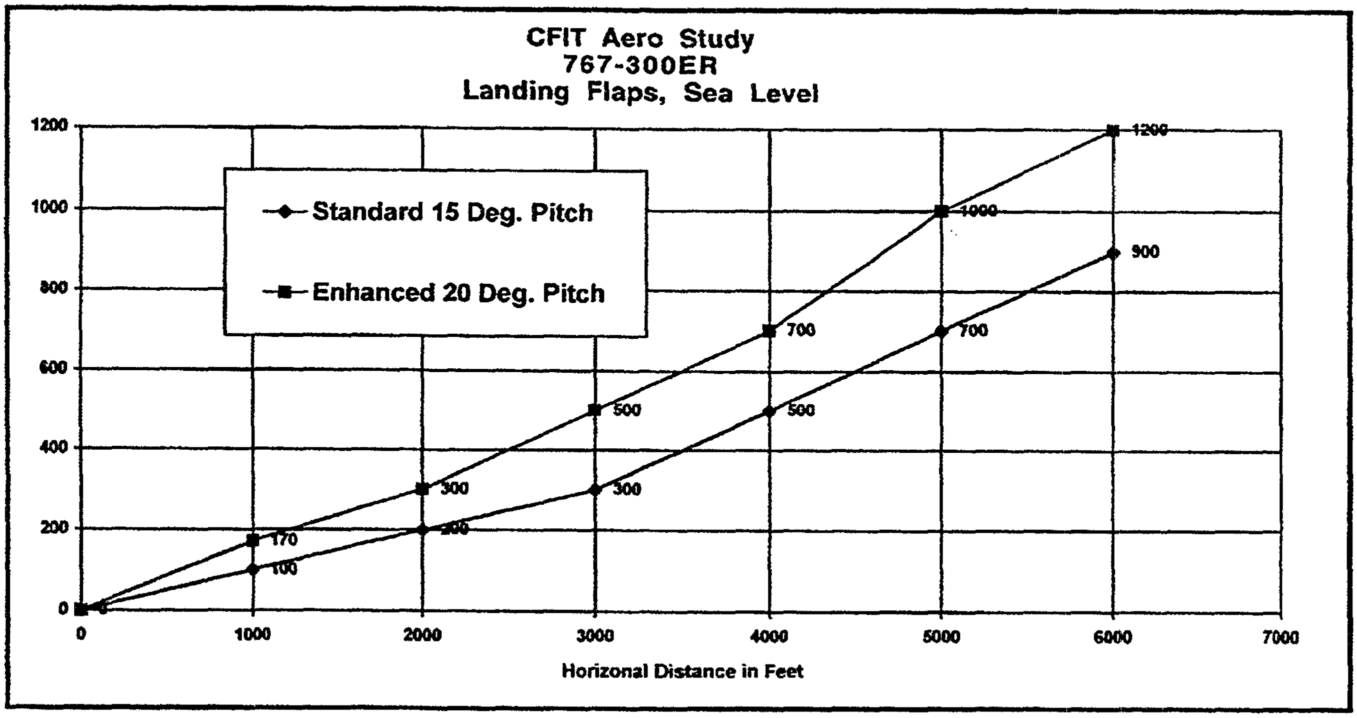

CFIT Simulator Study
767-200
Landing Flaps, Sea Level
Standard 15 Deg. Pitch
Enhanced 20 Deg. Pitch
Vertical Feet
Horizonal Distance in Feet
1350
1049
862
764
562
418
274
188
121
0
1000
2000
3000
4000
5000
6000
7000
200
400
800
1000
1200
1400


CFIT Simulator Study
767-200
Landing Flaps, Sea Level
Standard 15 Deg. Pitch
Enhanced 20 Deg. Pitch
Vertical Feet
0
200
400
600
800
1000
1200
1400
0
1000
2000
3000
4000
5000
6000
7000
Horizonal Distance in Feet

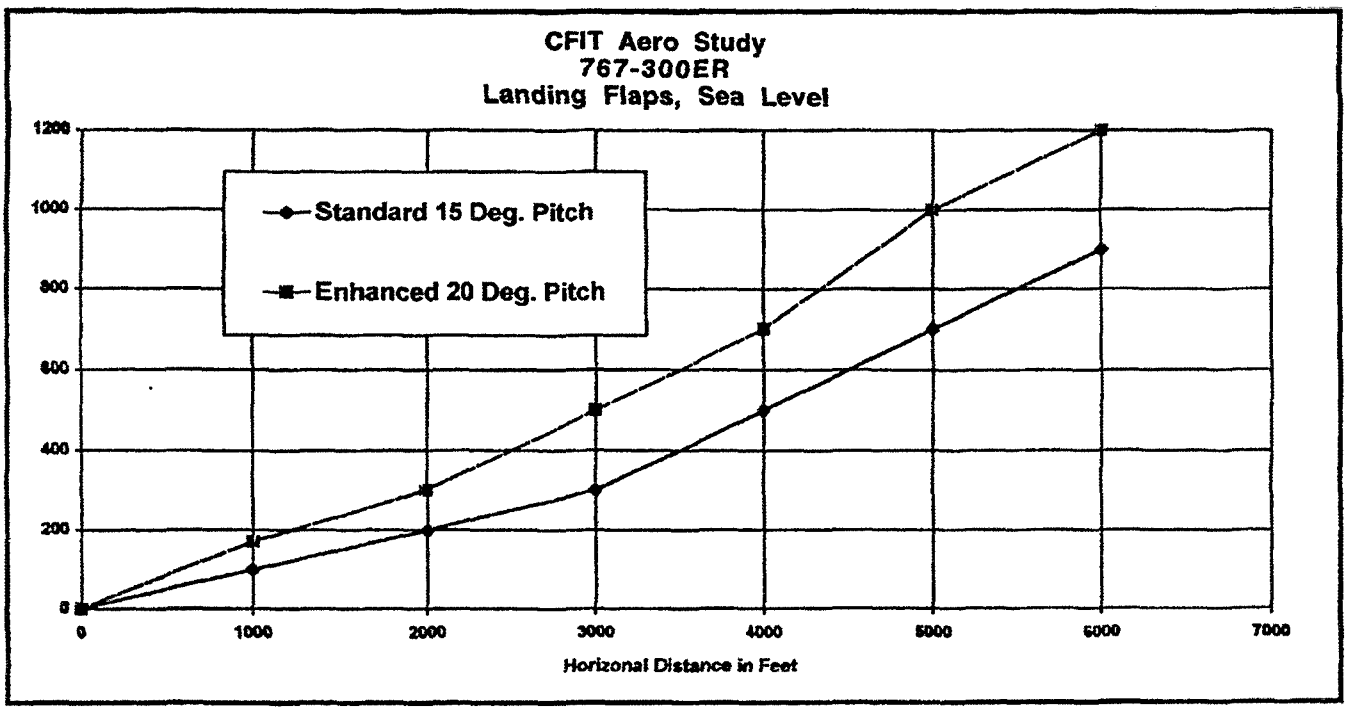

CFIT Aero Study
767-300ER
Approach Flaps, Sea Level
Standard 15 Deg. Pitch
Enhanced 20 Deg. Pitch
Vertical FT
2500
2000
1500
1000
500
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000
11,000
12,000
13,000
14,000
Horizontal Distance in Feet



CFIT Aero Study
767-300ER
Approach Flaps, Sea Level
Standard 15 Deg. Pitch
Enhanced 20 Deg. Pitch
Vertical FT
Horizontal Distance in Feet



CFIT Aero Study
767-300ER
Landing Flaps, Sea Level
Standard 15 Deg. Pitch
Enhanced 20 Deg. Pitch
0
200
400
600
800
1000
1200
0
1000
2000
3000
4000
5000
6000
7000
100
200
300
500
700
900
170
300
500
700
1000
1200
Horizonal Distance in Feet



CFIT Aero Study
767-300ER
Landing Flaps, Sea Level
Standard 15 Deg. Pitch
Enhanced 20 Deg. Pitch
0
200
400
600
800
1000
1200
0
1000
2000
3000
4000
5000
6000
7000
Horizonal Distance in Feet

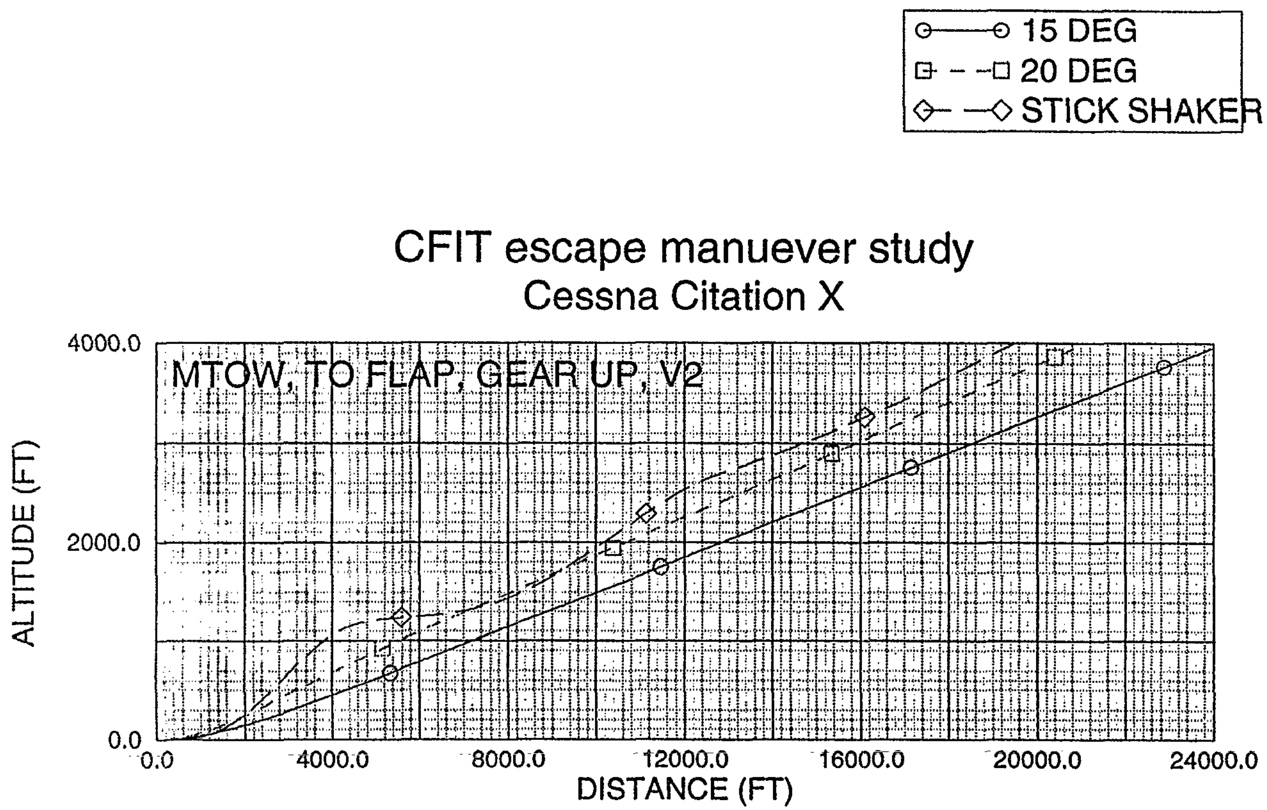
Cessna
A Textron Company

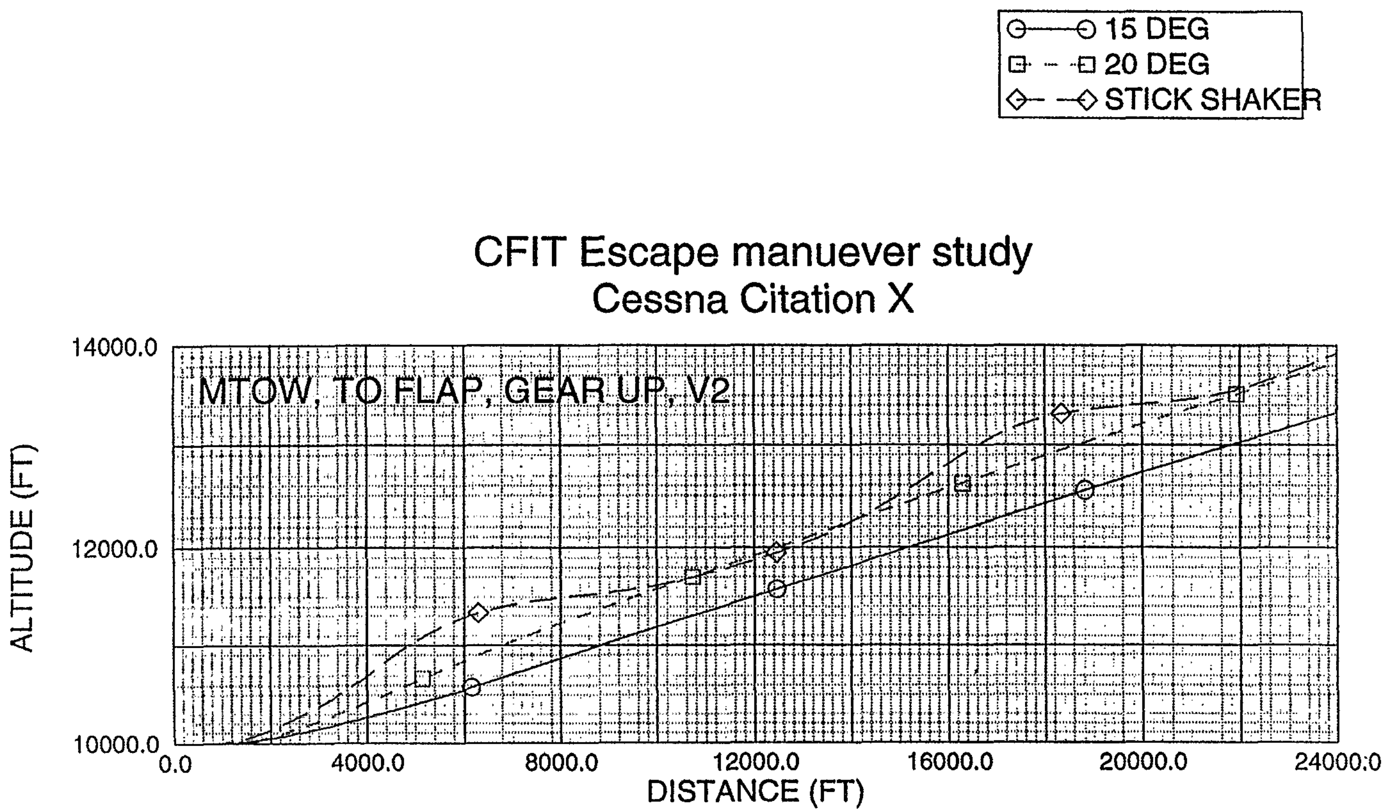
Cessna used an engineering simulation of the Citation X to examine three different escape strategies for four flight conditions. The flight conditions were:

1. takeoff, sea level, max. take off weight, 15 deg flap, gear up, V2
2. takeoff, 10000 ft
3. landing, sea level, max. landing weight, 35 deg flap, gear down, Vref + 5 kt
4. maneuvering, sea level, flap and gear up, Va

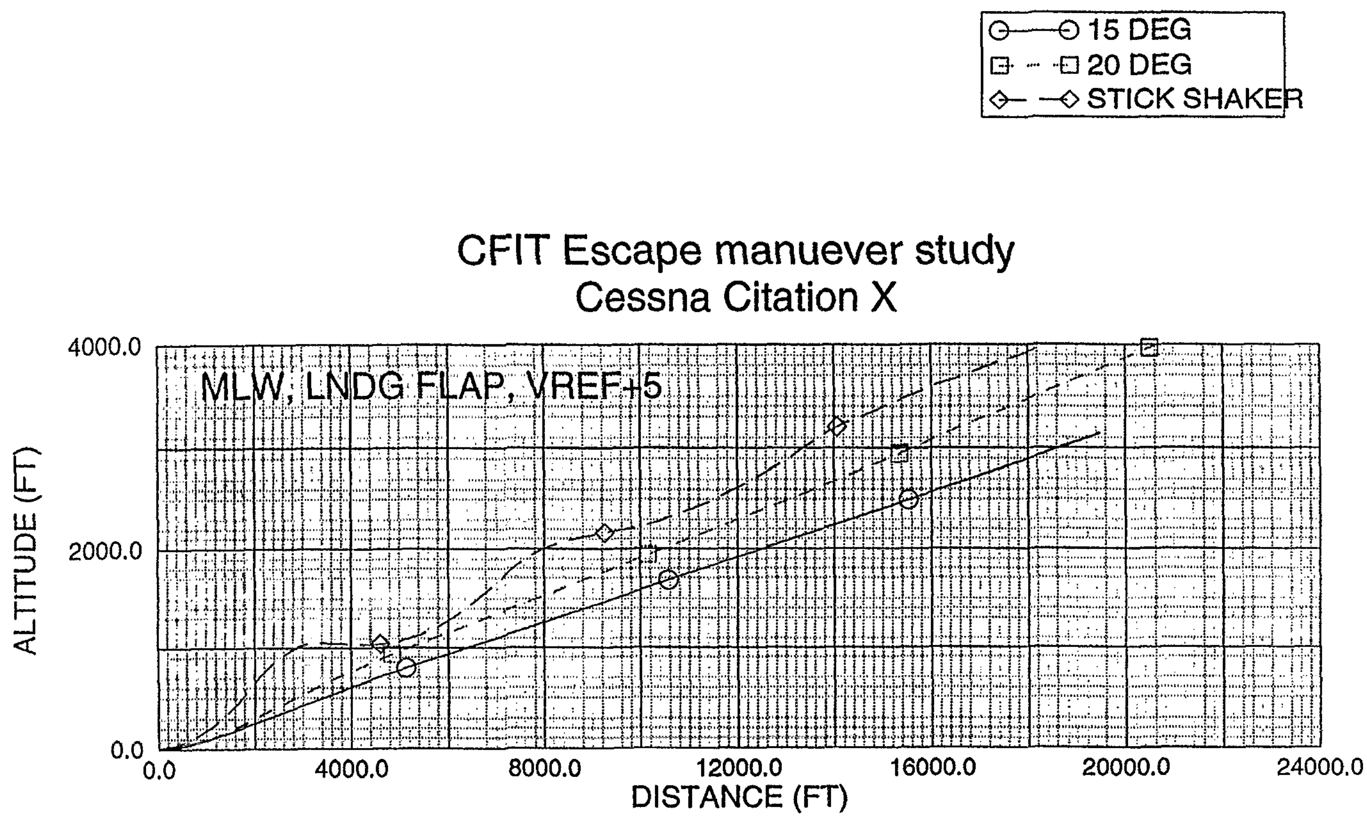
The three escape maneuvers used the same pitch rotation rate of about 3 deg/sec, with the throttles set to takeoff thrust 0.5 sec after initiating a pullup. Rotation was continued to either 15 deg., 20 deg., or stick shaker onset.

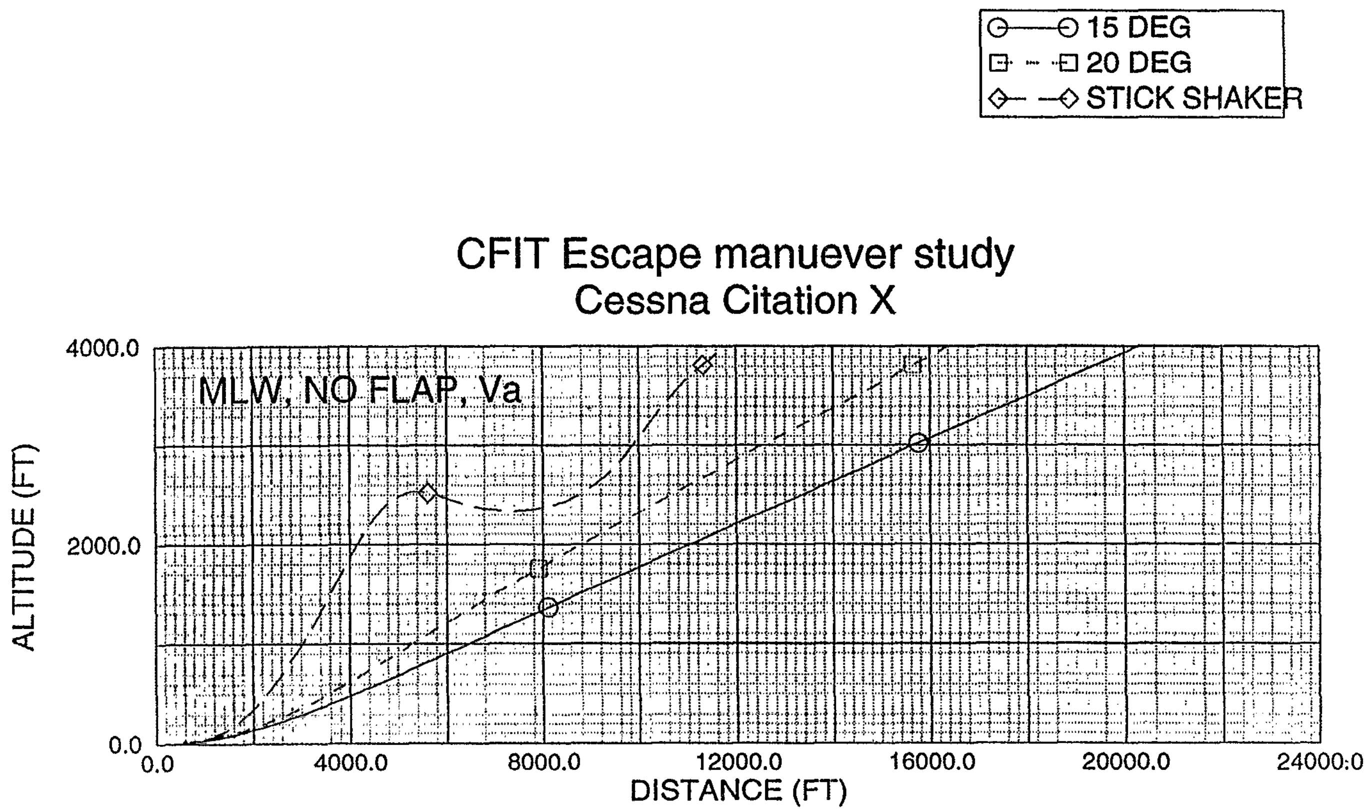
The time histories of altitude gained vs. distance for the Citation X simulation show that rotating to 20 deg. pitch attitude is always better than 15 deg. Rotating to stick shaker onset produces more altitude gain initially in all cases, but altitude falls slightly below the 20 deg. case. at some distance downrange for the takeoff flight conditions. Thus, we would recommend always rotating to 20 deg., and continuing to rotate to stick shaker onset if the GPWS warning continues.


15 DEG
20 DEG
STICK SHAKER
CFIT escape manuever study
Cessna Citation X
MTOW, TO FLAP, GEAR UP, V2
ALTITUDE (FT)
4000.0
2000.0
0.0
0.0
4000.0
8000.0
12000.0
16000.0
20000.0
24000.0
DISTANCE (FT)



CFIT Escape manuever study
Cessna Citation X
MTOW, TO FLAP, GEAR UP, V2
15 DEG
20 DEG
STICK SHAKER
ALTITUDE (FT)
14000.0
12000.0
10000.0
0.0
4000.0
8000.0
12000.0
16000.0
20000.0
24000.0
DISTANCE (FT)


15 DEG
20 DEG
STICK SHAKER
CFIT Escape manuever study
Cessna Citation X
MLW, LNDG FLAP, VREF+5
4000.0
2000.0
0.0
ALTITUDE (FT)
0.0
4000.0
8000.0
12000.0
16000.0
20000.0
24000.0
DISTANCE (FT)



15 DEG
20 DEG
STICK SHAKER
CFIT Escape manuever study
Cessna Citation X
MLW, NO FLAP, Va
ALTITUDE (FT)
4000.0
2000.0
0.0
0.0
4000.0
8000.0
12000.0
16000.0
20000.0
24000.0
DISTANCE (FT)

Introduction

Gulfstream evaluated G-IV airplane performance data with a computer analysis of a 3° - 4° per second pitch rate to a final pitch attitude of 15° nose up and 20° nose up. The computer analysis indicated that additional energy was available with the Gulfstream airplane and could be used for further altitude gain. Subsequently, simulator tests and verification flight tests in the Gulfstream IV were accomplished to verify that greater performance indeed was available.

Four scenarios were evaluated for the Gulfstream IV.

1. Flaps 20, Max Takeoff weight (74,600 lbs), gear up, V_2 (150 KCAS)

2. Flaps 0, max landing weight (66,000 lbs), gear up, maneuvering speed (206 KCAS).

3. Flaps 20, max landing weight, gear down, V_{ref} +10 (163 KCAS)

4. Flaps 39, max landing weight, gear down, V_{ref} +5 (154 KCAS)

Simulator and Airplane Test Procedure

1. Establish flight condition and airplane configuration.

2. At start of maneuver, advance throttles to max continuous thrust and initiate pitch up at 3 to 4 deg/sec rate.

3. When pitch attitude reaches 35 degrees (± 5 degrees), lower nose to achieve and maintain V_{ref} -20.

4. Continue at V_{ref} -20 for at least 30 seconds. (Shaker should not be triggered but if it is, respond appropriately.)

Conclusions

It is concluded based upon the results of both simulation and flight test that the CFIT escape maneuver as shown in Figure 1 is confirmed to be effective over a range of starting flight conditions. Figures show that the pitch angle was quickly increased as specified at the start of each maneuver. Maximum pitch attitudes reached in flight range from 26° to 39°. Simulator results agree closely.

The altitude time histories indicate an initial zoom climb, followed by a sustained climb at a lessor rate. This is a desirable profile, since in a CFIT avoidance situation, one needs to acquire as much altitude as quickly as possible.

The escape maneuver of Figure 1, although derived from GIV flight test and simulation, was determined by computer analysis to also apply to GII and GIII aircraft.

FIGURE 1

CFIT ESCAPE MANEUVER FOR GULFSTREAM AIRCRAFT

APPLICABLE TO GII, GIII, AND GIV

Upon receipt of a GPWS warning, the following procedure must be immediately executed:

A. Disconnect the Autopilot and apply Go-Around Power.

B. Rotate at 3-4 degrees/second to increase pitch attitude to the highest possible value. (A pitch attitude of 25 degrees has been demonstrated on the GIV at maximum landing weight with flaps at 39 degrees)

C. When stick shaker is encountered, or as V_{ref} is approached, reduce pitch rate/angle of attack to intercept V_{ref} -20 KCAS.

D. Check power setting.

E. Monitor Radar altimeter.

NOTE: Analysis and flight simulation have consistently shown that the highest altitude gain results from pitching at the highest rate to the highest angle while decelerating as quickly as possible to the lowest acceptable airspeed. Flight test demonstrated that a pitch attitude of 40 degrees can be reached and 25 degrees can be sustained at light weight on the GIV.

FIGURE 2

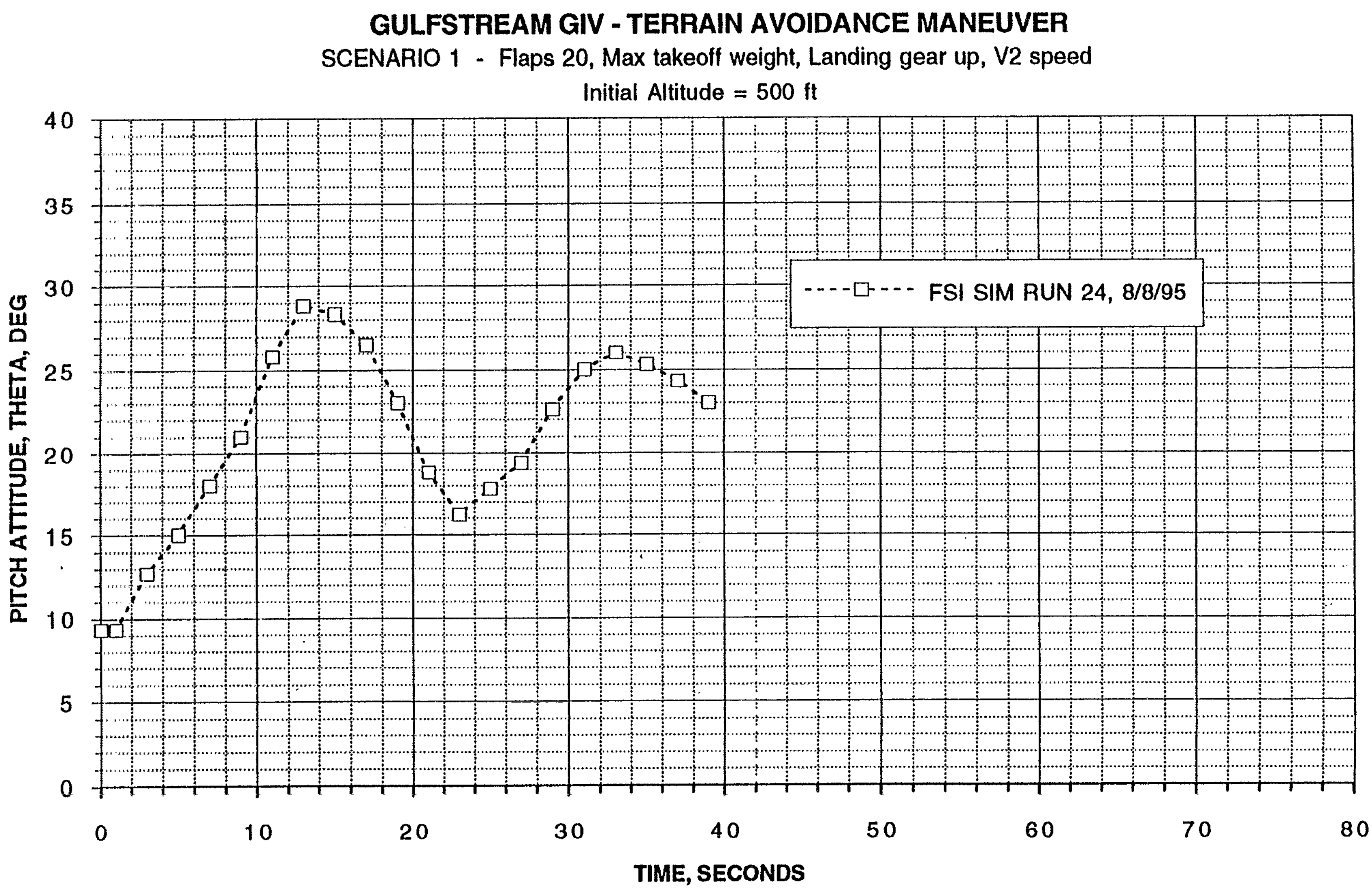

GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 1 - Flaps 20, Max takeoff weight, Landing gear up, V2 speed
Initial Altitude = 500 ft
FSI SIM RUN 24, 8/8/95
PITCH ATTITUDE, THETA, DEG
TIME, SECONDS
0
5
10
15
20
25
30
35
40
50
60
70
80

FIGURE 3

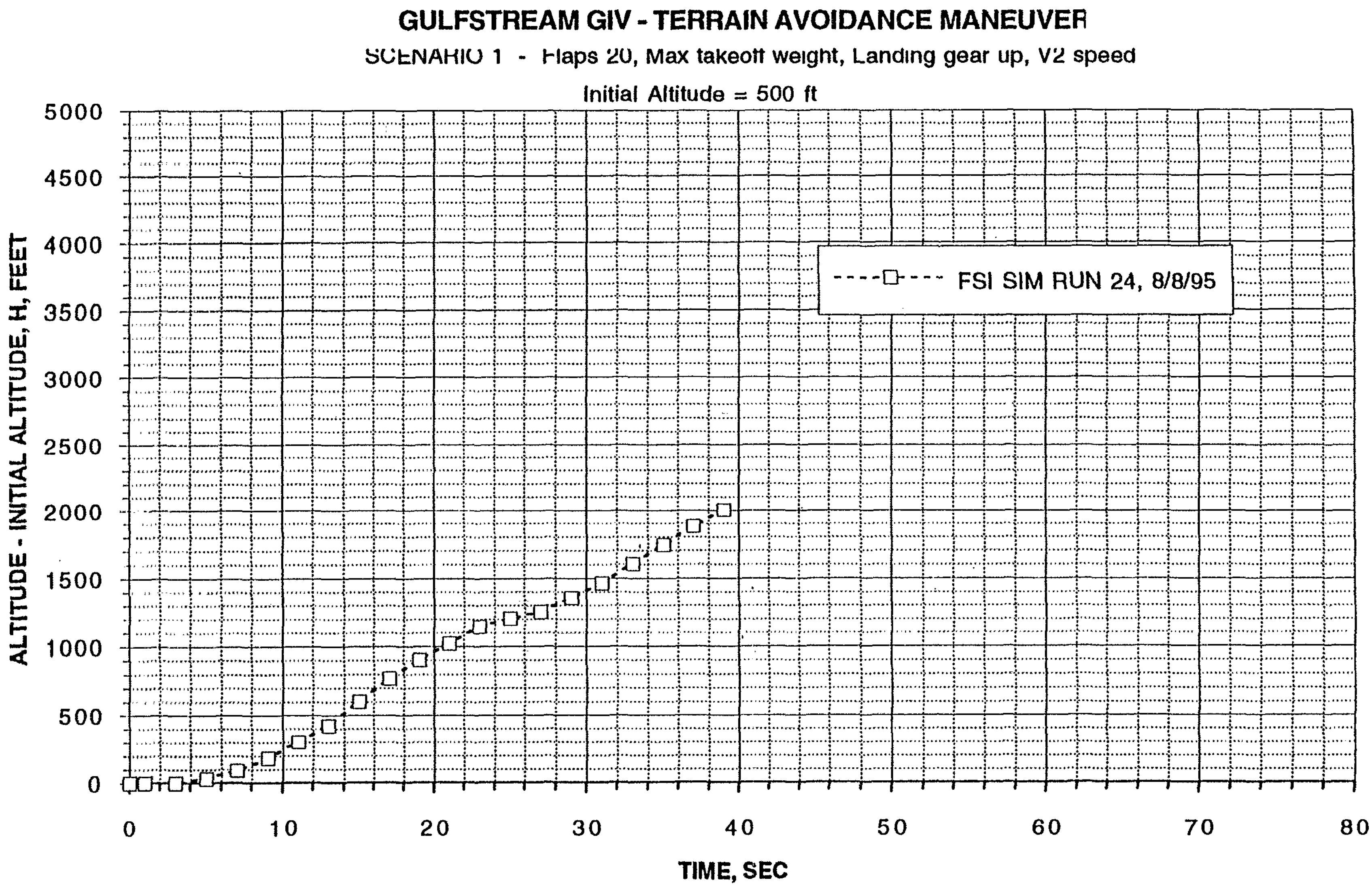
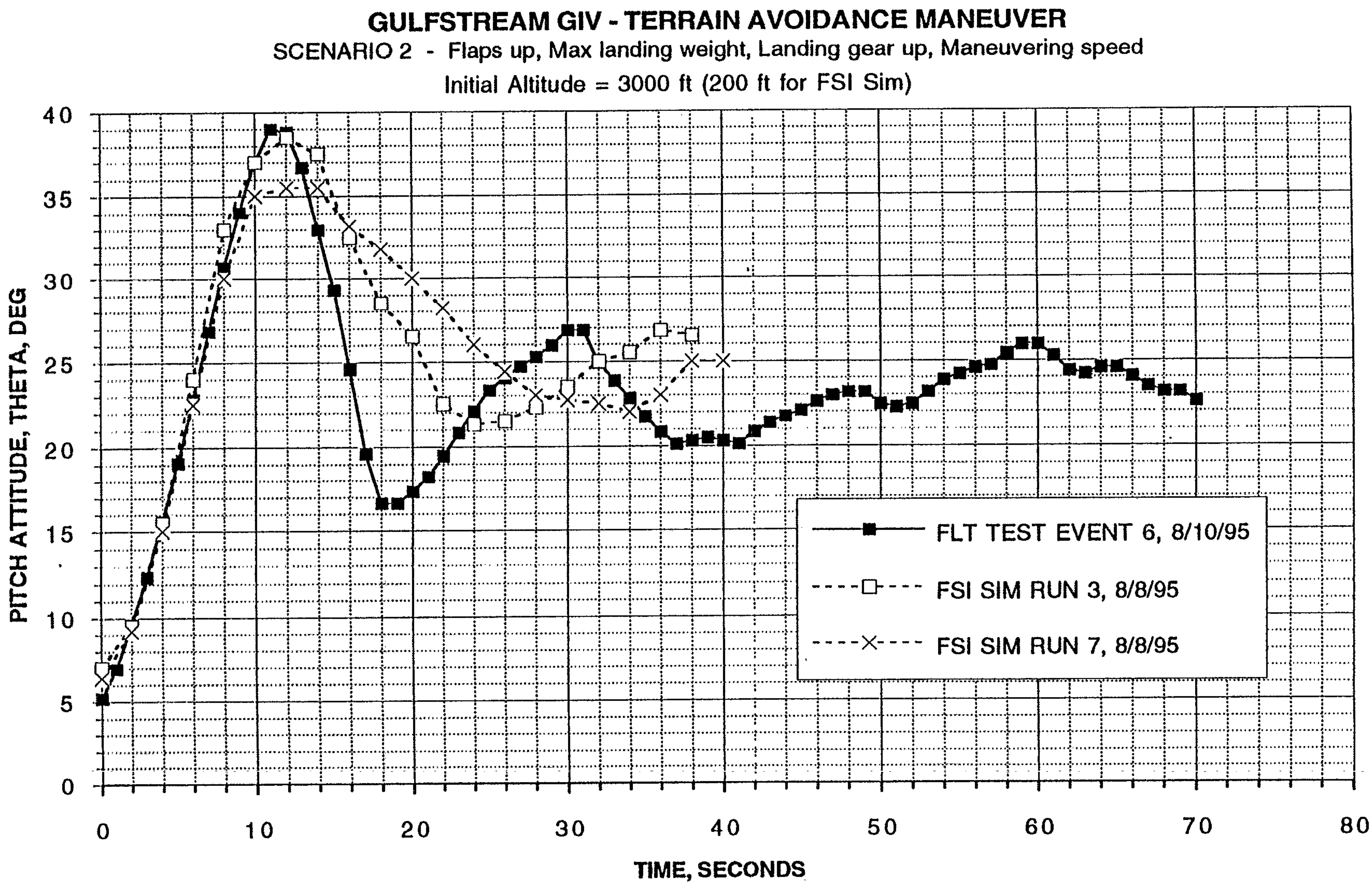

GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 1 - Flaps 20, Max takeoff weight, Landing gear up, V2 speed
Initial Altitude = 500 ft
ALTITUDE - INITIAL ALTITUDE, H, FEET
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
FSI SIM RUN 24, 8/8/95
0
10
20
30
40
50
60
70
80
TIME, SEC

FIGURE 4



GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 2 - Flaps up, Max landing weight, Landing gear up, Maneuvering speed
Initial Altitude = 3000 ft (200 ft for FSI Sim)
PITCH ATTITUDE, THETA, DEG
0
5
10
15
20
25
30
35
40
TIME, SECONDS
0
10
20
30
40
50
60
70
80
FLT TEST EVENT 6, 8/10/95
FSI SIM RUN 3, 8/8/95
FSI SIM RUN 7, 8/8/95

FIGURE 5

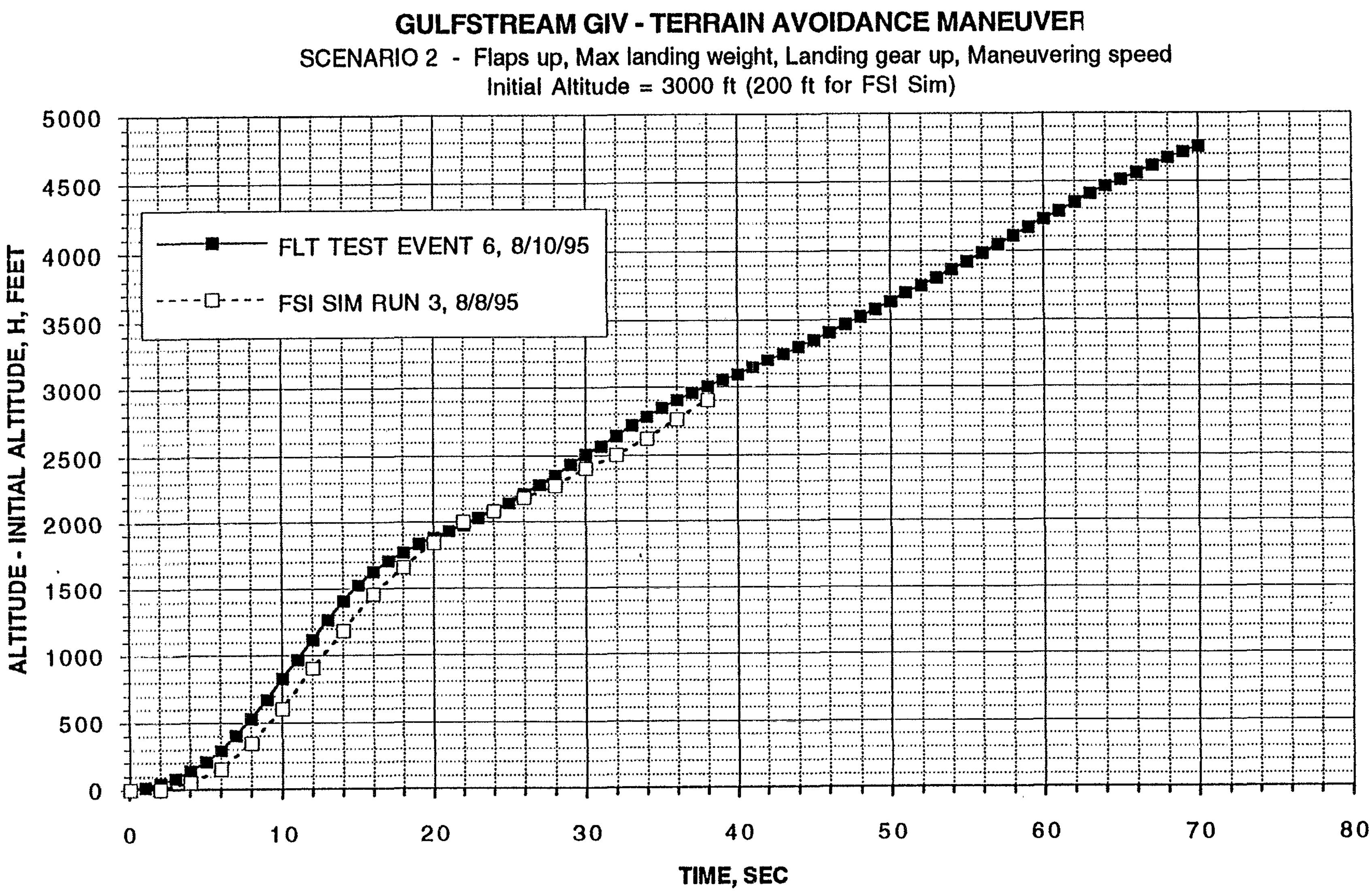
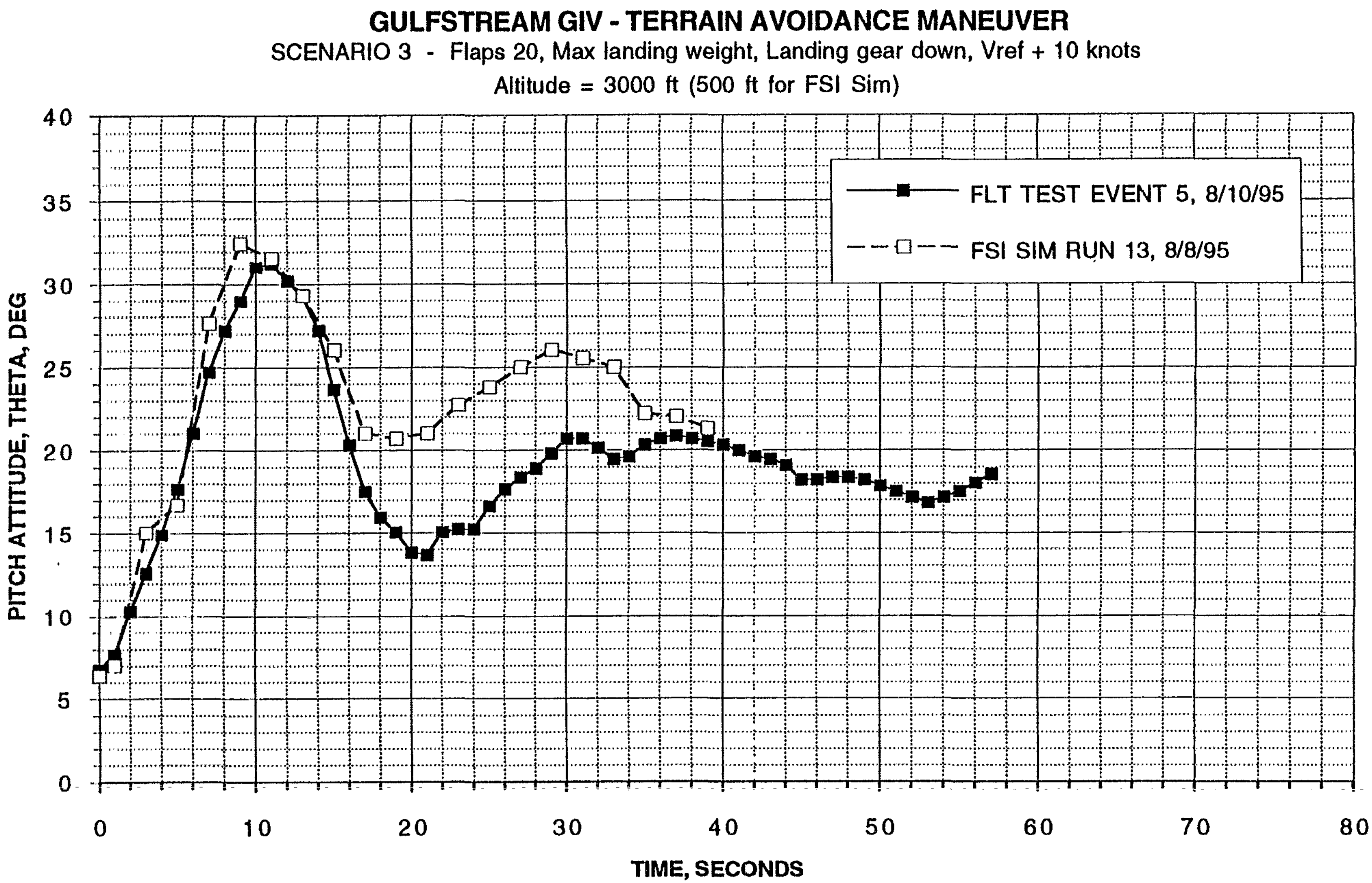

GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 2 - Flaps up, Max landing weight, Landing gear up, Maneuvering speed
Initial Altitude = 3000 ft (200 ft for FSI Sim)
FLT TEST EVENT 6, 8/10/95
FSI SIM RUN 3, 8/8/95
ALTITUDE - INITIAL ALTITUDE, H, FEET
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
TIME, SEC

FIGURE 6



GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 3 - Flaps 20, Max landing weight, Landing gear down, Vref + 10 knots
Altitude = 3000 ft (500 ft for FSI Sim)
PITCH ATTITUDE, THETA, DEG
TIME, SECONDS
FLT TEST EVENT 5, 8/10/95
FSI SIM RUN 13, 8/8/95
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80

FIGURE 7

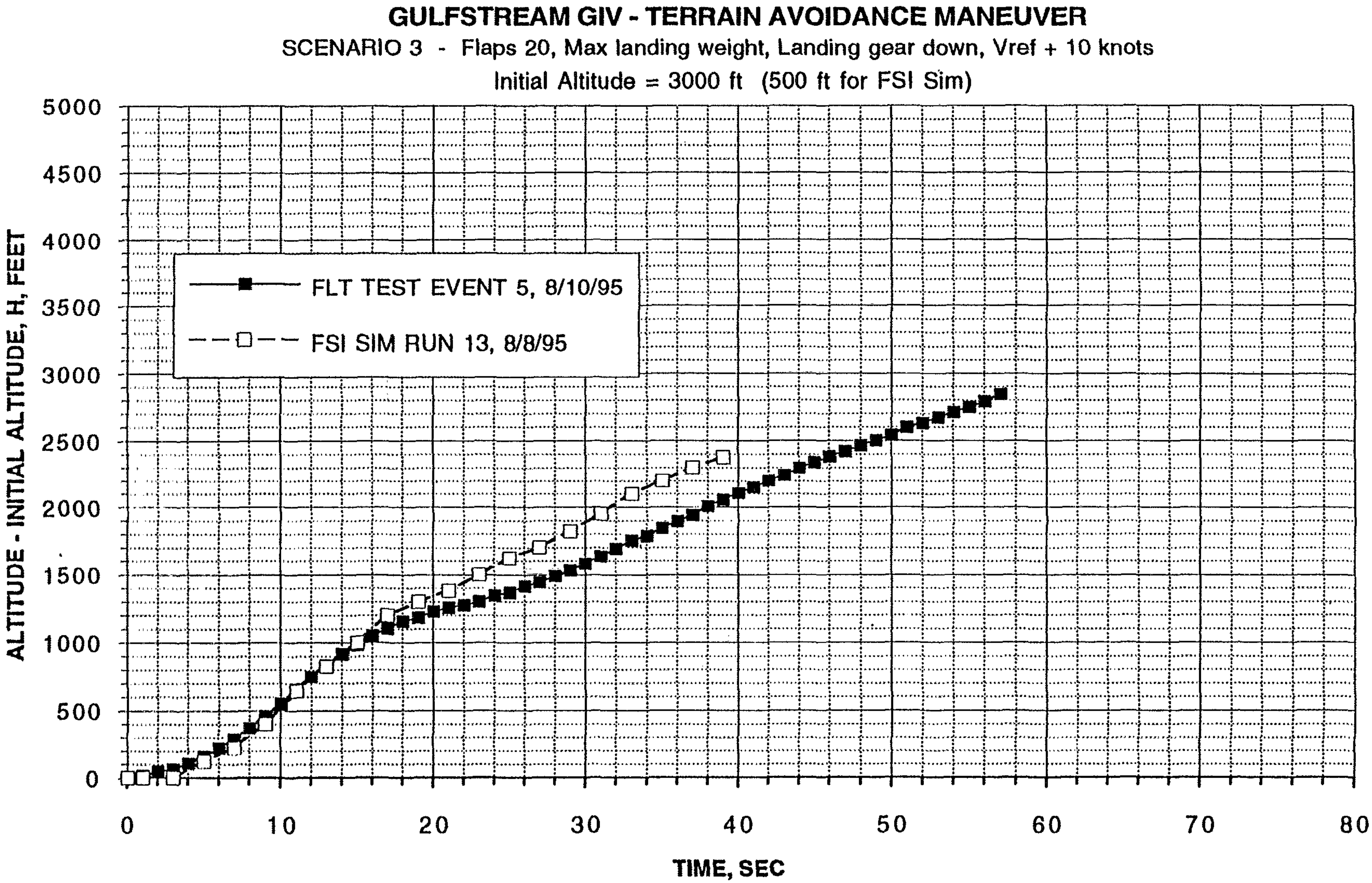

GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 3 - Flaps 20, Max landing weight, Landing gear down, Vref + 10 knots
Initial Altitude = 3000 ft (500 ft for FSI Sim)
FLT TEST EVENT 5, 8/10/95
FSI SIM RUN 13, 8/8/95
ALTITUDE - INITIAL ALTITUDE, H, FEET
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
TIME, SEC

FIGURE 8

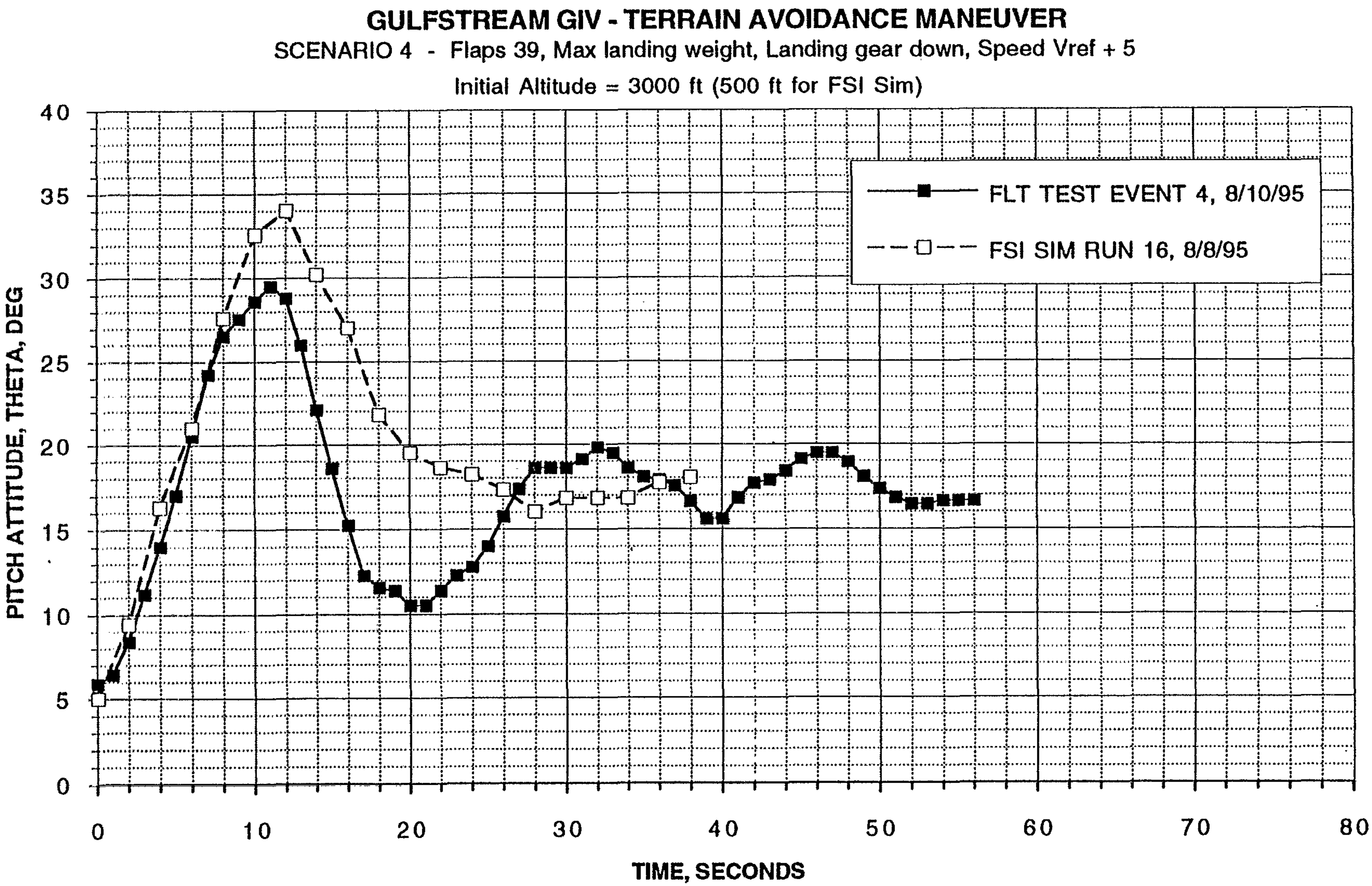
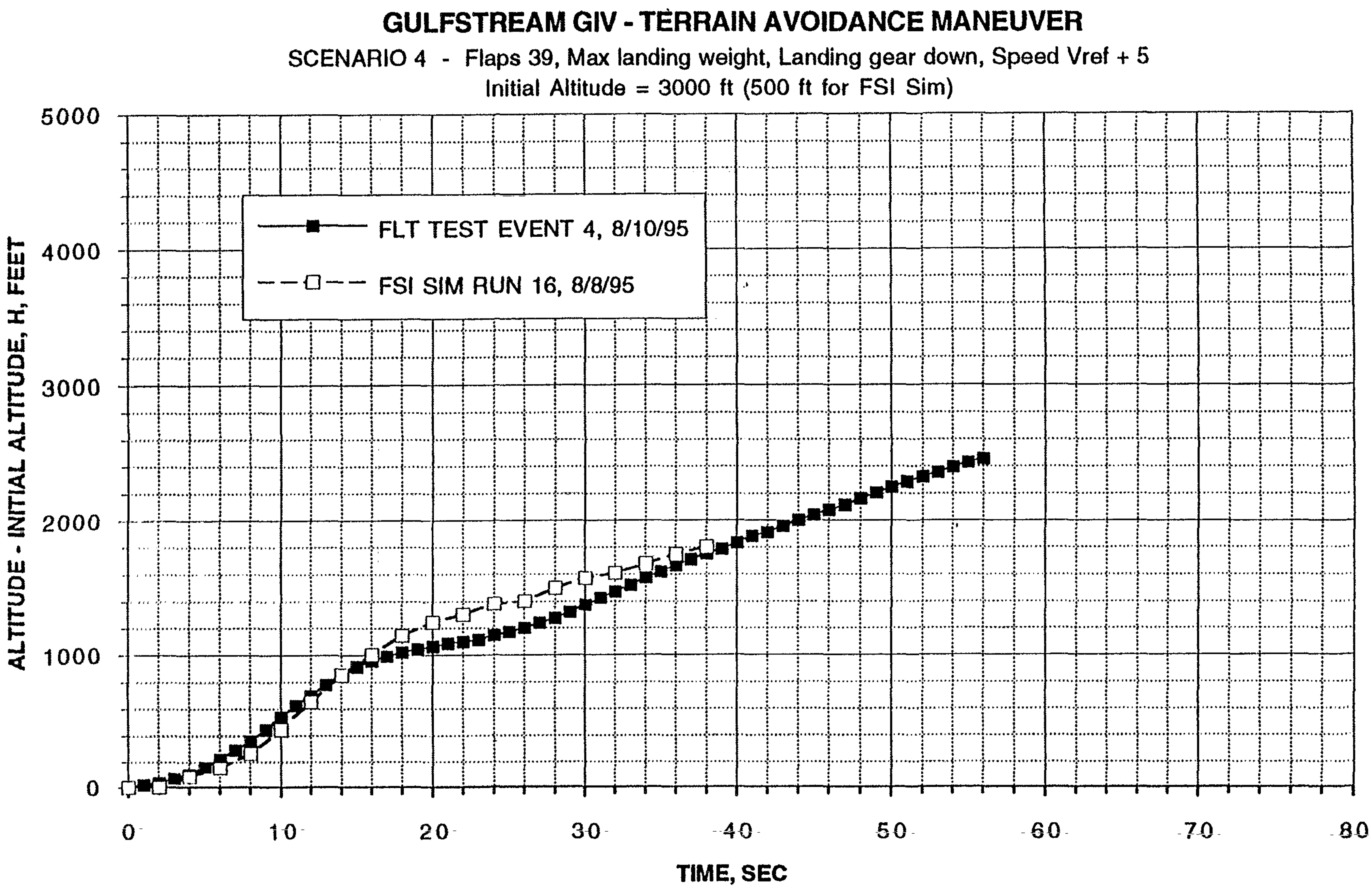

GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 4 - Flaps 39, Max landing weight, Landing gear down, Speed Vref + 5
Initial Altitude = 3000 ft (500 ft for FSI Sim)
FLT TEST EVENT 4, 8/10/95
FSI SIM RUN 16, 8/8/95
PITCH ATTITUDE, THETA, DEG
TIME, SECONDS
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80

FIGURE 9

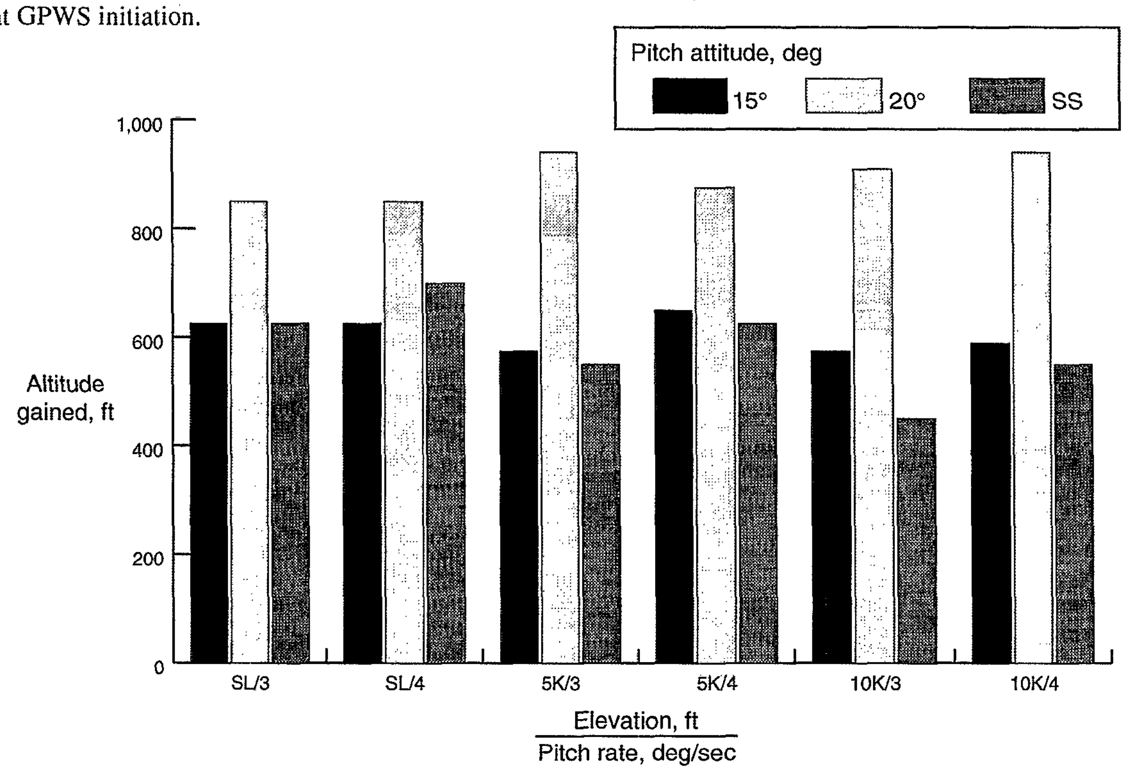

GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 4 - Flaps 39, Max landing weight, Landing gear down, Speed Vref + 5
Initial Altitude = 3000 ft (500 ft for FSI Sim)
FLT TEST EVENT 4, 8/10/95
FSI SIM RUN 16, 8/8/95
ALTITUDE - INITIAL ALTITUDE, H, FEET
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
70
80
TIME, SEC

Introduction

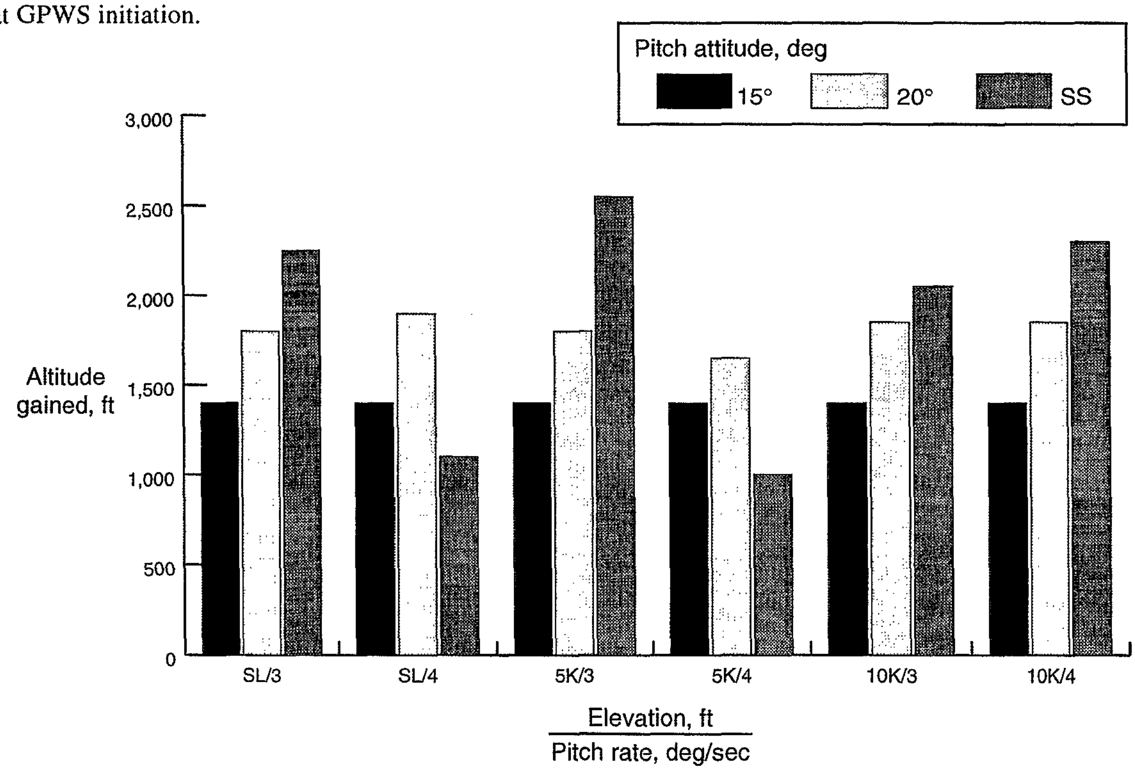
To develop the information provided, seventy two cases were defined from four standard scenarios. Various combinations of altitude, pitch rate, and pitch attitude were run through a simulation program which utilized the MD-11 Aerodynamic Model. Time history plots for each case were generated using the following parameters: velocity, altitude, elevator deflection, pitch attitude, pitch rate, alpha, elevator column force, and normal acceleration.

The four scenarios are:

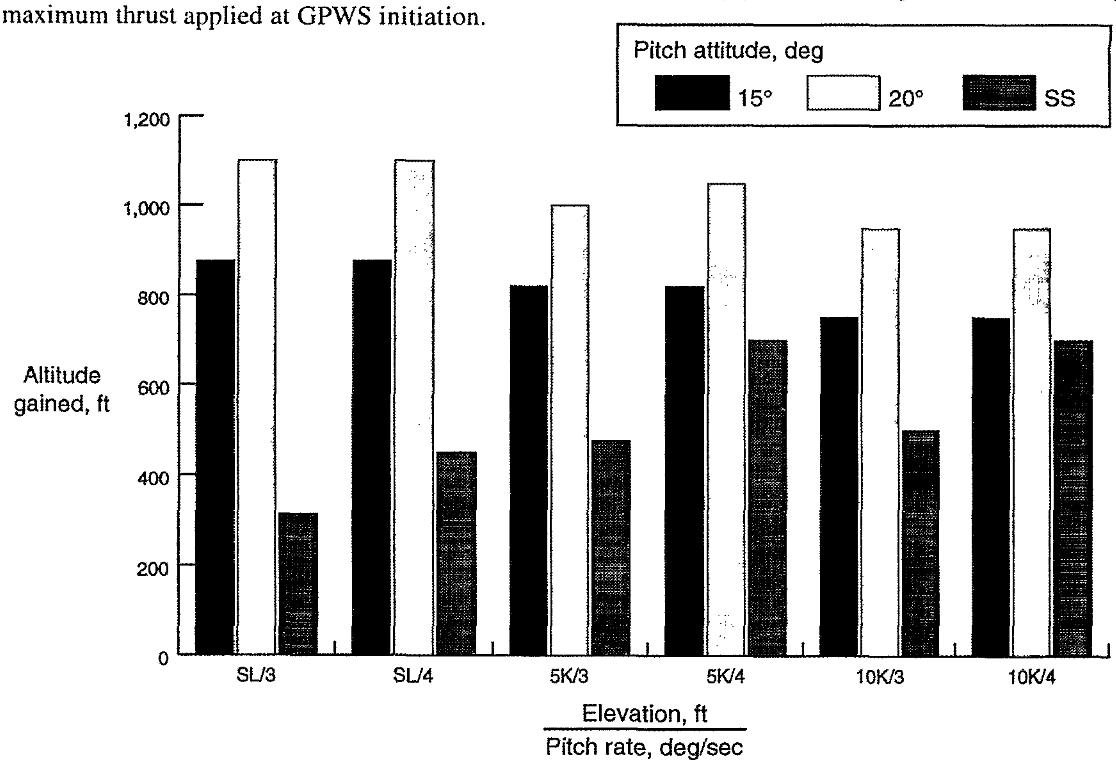
Scenario #1: Maximum takeoff weight; Flaps—takeoff position; Landing gear—up; Speed—V2; Thrust—maximum thrust applied at GPWS initiation.



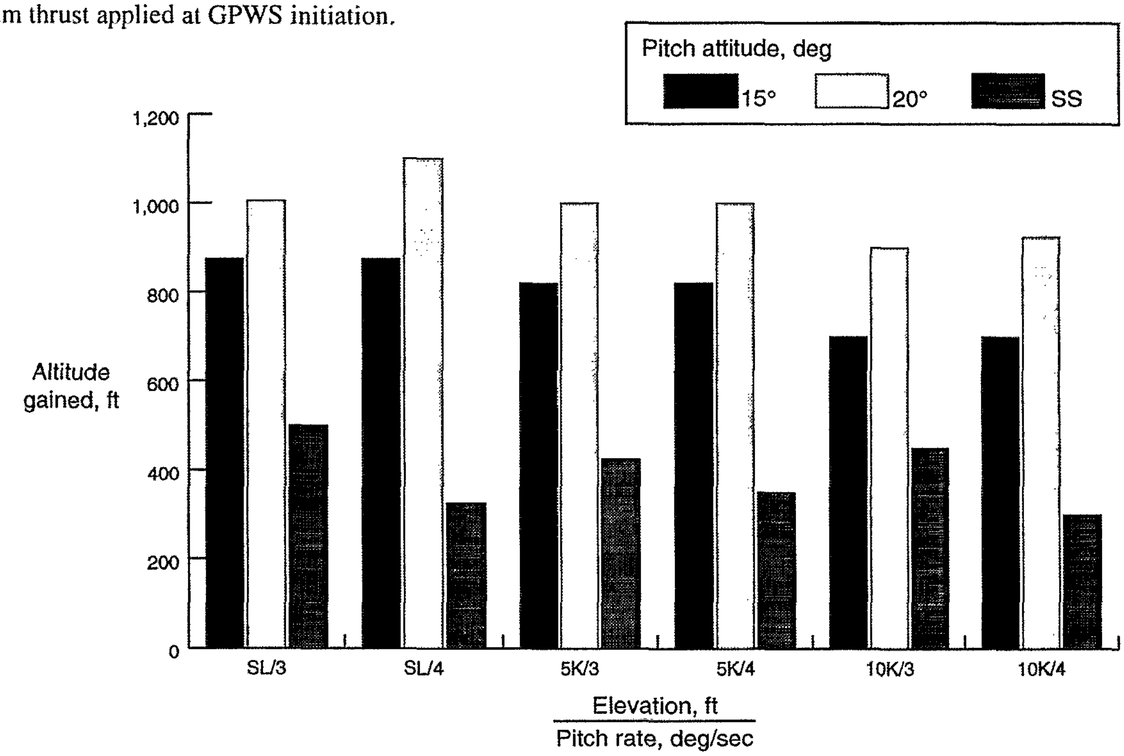
Scenario #2: Maximum landing weight; Flaps—up; Landing gear—up; Speed—maneuvering; Thrust—maximum thrust applied at GPWS initiation.



Scenario #3: Maximum landing weight; Flaps—approach position; Landing gear—down; Speed—minimum flap speed; Thrust – maximum thrust applied at GPWS initiation.



Scenario #4: Maximum landing weight; Flaps—landing position; Landing gear—down; Speed – Vref + 5; Thrust – maximum thrust applied at GPWS initiation.



All scenarios were run with rotation rates of 3° per second and 4° per second with 15°, 20°, and stick shaker (SS) initiation nose up attitudes. All scenarios were run at sea level, 5,000 feet, and 10,000 feet altitudes.

Results

Utilizing a rotation rate of 3° to 4° per second (about the same as a normal takeoff rotation rate) to a pitch attitude of 20° results in the best altitude gain over a given time period in almost all cases.

Although the data was computed with the MD-11 Aerodynamic Model, it is estimated that the trends for all Douglas Commercial Jet aircraft are roughly the same.

Conclusion

Under certain conditions of flight where immediate visual reference to surrounding terrain is not available, prompt and decisive action is required for a GPWS warning.

Caution: Do not ignore short duration warnings. Take immediate and aggressive action.

Flight crews should become familiar with the following sequence of actions and use them immediately and aggressively upon activation of an aural or visual GPWS warning.

Thrust – Disengage the autothrottles and aggressively apply necessary thrust to ensure adequate airplane performance. Avoid engine overboost unless necessary to avoid ground contact. When airplane safety has been ensured, adjust thrust to maintain engine parameters within normal limits.

Autopilot – Disengage the autopilot.

Pitch – Immediately rotate the airplane at a rate of 3° per second (similar to a normal takeoff rotation rate) to 20° pitch attitude. Trade airspeed for climb performance. If necessary (to prevent ground contact), continue to increase pitch attitude until stick shaker actuates. In this situation, consider use of engine overboost by moving throttles to their mechanical limits. Although there are no pitch limitations in emergency conditions, caution must be exercised to keep from maintaining pitch attitudes that result in continuous actuation of stick shaker.

Speed Brakes – Retract speed brakes.

Flight Director – Turn flight director off or disregard commands.

Level the wings to assure maximum airplane performance.

At positive climb rate (when radio altimeter shows an increasing altitude), retract landing gear (if extended).

After GPWS warning ceases, continue climb to published minimum safe altitude.

Revisions

The material in this section is considered accurate; however, since it is intended to be informative only, it should not be consulted in lieu of official operating manuals.

Video Script: “CFIT: An Encounter Avoided”

This video is part of an international industrywide effort to reduce Controlled Flight Into Terrain (CFIT). The Flight Safety Foundation formed a Task Force to produce a CFIT Education and Training Aid. This video is part of that training aid, and it was produced by The Boeing Company.

	(Narrator)
1. Fade up to still graphics (TBD) of a map of Malaysia. CG: weather plate over map: Wind calm Visibility 6000 meters/misty Sky conditions: 3 Octas surface 6 Octas/4267 meters Temperatur: 23°C/73°F Dew point: 22°C/72°F Altimeter: 1011 hectoPascals 229.86 inHg	**Flight Sixty-Six was a Boeing Seven Forty-Seven cargo flight enroute to Kuala Lumpur, Malaysia.The first officer was flying the approach to runway Three-Three during the pre-dawn darkness. The I-L-S to runway Three-Three was out of service as reported in both the current NOTAMS and arrival ATIS. The crew, after being cleared by ATC to fly a N-D-B approach, misread the descent clearance and is descending to four hundred feet instead of two thousand, four hundred feet.**
2. Scroll list of most recent accidents listing month, day, year, place, and number of fatalities/injured. (overseas/domestic mix)	**In the first half of the nineteen nineties (1990s), almost two thousand people died in accidents attributed to Controlled Flight Into Terrain! As you can tell, C-F-I-T accidents and incidents can happen anywhere, at any time.**
3. ADO Build Short shots of GPWS warning, ATC on radar, and flight deck briefing.	**The difference with an incident is that the last link in the chain held. The crew was trained and responded to a GPWS warning...the ATC controller noticed the airplane descending towards terrain... or standard operating procedures were effective. Remember, everyone must be involved!**
4. C-F-I-T Incident CG over red question mark. Scroll future accidents.	**Because of the international increase in air traffic, C-F-I-T projections for the next twenty years show that if trends continue, we can expect to lose one large airplane, worldwide, to a C-F-I-T accident EVERY OTHER WEEK!!**

21 Dec. 1999 Molokai, HI 117
8 Jan. 2000 Ackh, Inur, Malaysia 52
26 Jan. 2000 Hualien, Taiwan 148
5 Feb. 2000 Everett, WA 79
19 Feb. 2000 Kinshasa, Zaire 129
1 March 2000 Koyuk, AK 56
13 March 2000 Oucalpa, Peru 112
26 March 2000 Paris, France 267
7 April 2000, Portland, OR 146
25 April 2000, Bhartpur, Nepal 86
9 May 2000, Bandung, Indonesia 55
21 May 2000, Tripoli, Libya 245
4 June 2000, Attenrhein, Switzerland 23
17 June 2000, Istanbul, Turkey 152
31 June 2000, Posadas, Argentina 113
16 July, 2000, Juneau, AK 38
22 July, 2000, Cozumel, Mexico 15
3 Aug, 2000, Medan, Indonesia 111
20 Aug 2000 Denver, CO 77
6 Sept 2000 Cucuta, Columbia 245
24 Sept 2000, Rio de Janeiro, Brazil 120

That's twenty-eight airplanes and the hundreds and hundreds of people on them, lost, every year!! These statistics conceal the human sadness, as well as the commercially devastating effects on an air carrier's business.

5. National news broadcast of the small airplane crash on approach to Auburn-Lewiston airport in Maine, 1985, carrying Samantha Smith.

(Network broadcast of plane crash)

6. Location is C-F-I-T site, Hurricane Ridge. Talent starts talking off-screen, then walks into frame.

(On-camera talent)
An accident occurred just at this point. It happened at night.The weather was clear. It was the end of a long duty day. The crew could actually see the landing runway. They died less than five hundred feet from the top of the ridge! Why would pilots fly perfectly good airplanes into the ground?

This question is at the heart of our investigation into the causes of controlled flight into terrain accidents.

7. CG over Talent: as a build; **Causes and Contributing Factors**

   Avoiding C-F-I-T Traps
   System Solutions
   Training Solutions

We're going to show you how pilots can get into a C-F-I-T situation, AND ways to avoid these traps. You'll see how changes to the way the aviation industry does business can improve the way we all think and act about safety.

8. Talent walks into frame at Boeing simulator bay.

Finally, we'll talk about effective approaches to C-F-I-T training. To see what the industry has been doing to reduce C-F-I-T accidents, let's look at some history.

(Narrator)

9. Old footage of flight decks with early versions of radio altimeter.

In the late (1960s), as part of the Category Three All Weather Landing System, radio altimeters were installed on many airplanes. For the first time, pilots had a comparatively reliable indication of their height above terrain.

10. On a modern flight deck, 737, we see and hear the Ground Proximity Warning System.

The next major improvement was the Ground Proximity Warning System. Agencies around the world began mandating G-P-W-S for all large airplanes beginning in nineteen-seventy-five (1975).

11. Earth shot with calendars and number of fatalities CG over globe.

In one area of the world, before GPWS was mandated, hull losses for large airplanes were averaging eight a year. With the requirement for GPWS, the C-F-I-T hull loss rate is currently about one every two years. C-F-I-T accidents can be reduced. This is significant because the decline has occurred while the airplane fleet has almost

doubled, and the number of flights have tripled!

12. Graphic comes out of globe; "Incidents are still occcuring daily throughtout the world."

    Yellow dots depict incidents as they build on.

Don't be misled however by these low accident rates. Incidents that could have resulted in accidents are still occurring daily throughout the world. According to some experts a C-F-I-T incident occurs at least every two weeks even in those areas considered the "safest". GPWS still forms the last safety net. We still have room for improvement.

13. In flight, crew giving "One Thousand" foot callout.

Remember, high technology solutions are no substitute for good airline philosophy and flight deck management.

14. Graphics.

The International Civil Aviation Organization, I-K-O, mandated the installation of G-P-W-S in the late nineteen-seventies (1970s). However, about three hundred of the world's jet transports still do not have Ground Proximity Warning Systems. This about three percent. This three percent generates <u>fifty percent</u> of C-F-I-T accidents! Not surprisingly, it's also the oldest generations of aircraft that have the highest accident rates.

15. Approach Control for Seattle-Tacoma International Airport (Auburn) console/screen showing M-S-A-W-S alert. Set up demo of aircraft penetrating minimum safe altitude.

It's not just G-P-W-S, and the upgrades to it that have reduced C-F-I-T accidents. The installation of altitude reporting systems alerts Air Traffic Controllers by using visual alarms when aircraft penetrates, or is predicted to penetrate, a minimum safe altitude in the terminal area.

16. ATC personnel at scopes.
Interior flight deck during landing.

While the installation of these systems is limited, the continual investment by air traffic services in expanding and up-grading ATC radar, the minimum safe altitude warning system, along with runway navigational aids and procedures, have all helped reduce the C-F-I-T risk.

(On-camera testimony)

17. **Jan Stenberg, President/Chief Operating Officer**
Akira Kondo, President, JAL
Dr. Assad Kotaite, President, Council of ICAO

Jan Stenberg (SAS)
To solve CFIT problems, we require commitment from all people throughout the aviation industry. We must advocate the safety culture because it is the right thing to do, and besides, it's just good business. In our company, we constantly talk about how to improve safety. It's an obsession with us, and it should be with you. There are no excuses not to provide our customers with the safest air travel possible.

Akira Kondo (JAL)
Solid investment in training is of the greatest significance. Nothing stands still where safety is concerned, and although operational circumstances are constantly changing, safety will always be the key element in our planning. All of Japan Airlines people are dedicated to safety. That is our mission.

	Dr. Assad Kotaite (ICAO) **Full implementation of the GPWS requirements and of the Controlled Flight Into Terrain prevention program are essential in order to meet the objective of fifty percent reduction in the global Controlled Flight Into Terrain accident rate by the year 1998.**
18. Video clip from Windshear and TCAS CG titles: **"Windshear Avoided, What the Crew Can Do."** **"Traffic Alert and Collision Avoidance System" (TCAS)**	**The commitment that aviation industry showed in the effort against the problems of windshear and mid-air collisions shows our efforts can make a difference"**
19. Graphic.	**Accident fatalities used to be divided between C-F-I-T, midair collisions, windshear, and "other." Of these, Controlled Flight Into Terrain accounted for less than one half of the total.**
20. Graphic build from scene 19.	**Here's what we can do when we work together. By the end of the 1980's, increased awareness and improvements in training, along with new technology such as TCAS and windshear detection have reduced midair collision and windshear accidents, and they almost disappear from the charts.**
21. Graphic continues from scene 20. Builds to reflect C-F-I-T.	**But look what happened to C-F-I-T! It grew to eighty-one percent (81%)!**
22. On-camera narrator.	***(On-camera talent)*** **Why are C-F-I-T accidents so difficult to prevent?? One factor is just human nature.**

	(On-camera sound bites)
23. DVE of talking faces sliding along and through frame. Each quote is from a different pilot.	***"I'll see it coming and know what to do".*** ***"I'd never make that kind of mistake"*** ***"I've never flown in weather that's too bad."*** ***"I've always found the runway."*** ***"Did I ever NOT know my position? Well, I'd never admit that!"*** ***"I've been flying that route for years. And I know my airplane. It's the most modern one in the fleet. It'll never happen to me!"***
	(Narrator)
24. Nightime view of aircraft on approach coming out of clouds. Cut to Astro of 757 at dusk.	**Well, it does happen. Given the right chain of events, C-F-I-T could happen to any of us. One constant in all of these accidents is that outside visibility was limited, or the accident occurred at night. The terrain could not be seen easily...until just before**
25. In fog/out fog.	**impact!**
26. MS of airplane on approach.	**C-F-I-T accidents have occurred on departures as well as on missed approaches. However, most of the recent C-F-I-T accidents and incidents occurred during nonprecision approaches and landings. Let's look at the position and vertical profile of these accidents in relationship to the landing runway.**
27. Graphic (chart build finishes from scene 26).	**This chart shows the vertical path of these events. Notice how stable many of these vertical paths are... right into the ground!**

28. Graphic.	**Almost all are on the runway center line inside of fifteen miles.**
29. On-camera testimony of pilot from inside flight deck.	***(On-camera testimony)*** **Each C-F-I-T accident has ultimately been held to be the pilot's responsibility. The pilot had the last chance to save the aircraft.**
30. Interview with decision maker. **Sir Colin Marshall, British Airways** **Gordon Bethune, President/Chief Operating Officer, Continental Airlines** **David Hinson, FAA Administrator**	***(On-camera testimony)*** **Sir Colin Marshall (British Airways)** **We believe that the danger of Controlled Flight Into Terrain will be reduced only through much greater awareness of contributory factors and commitement to taking necessary action to eliminate them. This involves investment in the right technology, with strict adherence to optimum operating procedures; comprehensive, effective pilot training; and acceptance of the vital need for an open, incident-reporting culture.** **Gordon Bethune (Continental Airlines)** **Hello, I'm Gordon Bethune, President and Chief Executive of Continental Airlines, and also a Boeing-trained 757-767 pilot, so I think I know something about Controlled Flight Into Terrain and the value of technology and safety and how all that runs into a company's bottom line. I gotta tell you that here at Continental, safety is an important investment. You can't pay enough attention to putting the right investment in the right place, and Controlled Flight Into Terrain is an issue that I think every airline needs to address. I hope yours does too.**

	David Hinson (FAA) **I urge everyone, airlines, operators, pilots, and crewmembers, to become aware of the dangers of C-F-I-T and to make sure that they've had the training, and they have the equipment, to help avoid this dangerous situation. Safe flying to you all.**
31. Still photo of CFIT accident (van).	**Let's look at some of the major factors affecting C-F-I-T accident rates and the traps they can present. Then you'll see some of the solutions the international aviation community recommends.**
32. Graphic turns red and title up: **CFIT Contributing Factors**	**Accidents have many contributing factors. Investigators always reveal a chain of events that may even reach back to support organizations.**
33. Graphic from above with CG: **Lack of Vertical Awareness**	***(Narrator)*** **Two-thirds of all C-F-I-T are a direct result of altitude error or lack of vertical situational awareness.**
34. Citation climbing in clouds; lay in TRACON audio for radar vectors: **Lack of Vertical Awareness**	**Pilots must remain aware of terrain when accepting radar vectors. Some believe that A-T-C will provide obstacle clearance while enroute off airways. This is not true! Remember, the pilot is ultimately responsible for obstacle clearance.**
35. Graphic of Azores accident of 707.	**For example, in one accident, if the crew had known where they were and understood that the clearance they received would take them below the Minimum Enroute Altitude, the aircraft would not have struck the mountain just ten feet below the crest.**

36. Return to Graphic build: **Pilot-ATC (Communication errors)** Video of pilot on headset. CG: Language differences: **Lack of Standarized Phraseology** **Readback errors** **Heavy workloads**	**Some communication errors and misunderstandings are due to language differences, lack of standardized phraseology, readback errors, or heavy workloads.**
37. Graphic build (continued): **Approach and Departure Procedures** Video of aircraft flying, audio of ATC giving vectors.	**Radar vectors force pilots to rely on A-T-C controllers for terrain avoidance. However, the pilots must retain vertical situational awareness while under radar vectors.**
38. Graphic build (continued): **Altimeter (setting)**	**Barometric altimeter settings errors remain a problem. There have been cases where pilots use the wrong standard for the area.**
Record audio of British ATC giving altimeter setting.	***(Weather forecast in foreign accent)*** **"CURRENT WEATHER IS TWO OCTAS AT TWELVE HUNDRED, FIVE OCTAS AT THREE THOUSAND, WIND TWO NINER ZERO AT TWELVE, GUST TWENTY, ALTIMETER NINER NINER EIGHT."**
39. CU of setting altimeter in inches and hectoPascals.	**For example, if pilots set inches of mercury instead of hectoPascals, it can eventually result in large errors in the altitude indicated on altimeters.**
40. Graphic build (continued): **Navigational (errors)** CG: **Disorientation** **Improper Transition** **Selecting Wrong Nav Aid** **Lack of Horizontal Situational Awareness**	**Cases of navigational errors involve disorientation with respect to the nav aid, improper transition on approach, selecting the wrong nav aid, or just plain lack of horizontal situational awareness.**

41. Graphic build (continued):
Autoflight (misuse)
WS of 777 FFS. Slow push to CU of EADI-EHSI.

Today's modern airplanes have sophisticated flight directors, autopilots, autothrottles, and flight management systems. These devices make significant contributions to the overall safety of flight.

42. CU of FMC in sim.

But remember, these are only machines that follow instructions. They're smart, but they don't think! They do whatever is asked of them... even if it's wrong.

43. MS of MCU, finger pushing. LNAV engaged.

When commanded, they will unerringly follow your instructions straight into the ground! Each crew member must ensure that both vertical and horizontal modes are correct and engaged. Treat autopilots like inexperienced crewmembers. Cross-check them constantly!

44. Graphic build (continued):
CG:
Other Misinterpreting display range marks
Procedure Errors
Data Base Errors
Barometric Pressure Anomalies

Other factors include misinterpreting display range marks, procedure errors, database errors, or barometric pressure anomalies.

45. Lack of vertical awareness
Pilot-ATC communication errors
Approach and departure procedures
Altimeter setting
Navigation errors
Autoflight misuse
Other

In the accident you're about to see, many of the factors we just described occurred. As you watch this re-creation, see if you can *identify* these factors.

(Recreation of Flying Tigers accident)

(Last three minutes of Flying Tigers re-creation)

46. CG bullets during Flying Tigers (at "OK, 4.0.0"): 1. **Pilot-ATC communication error** CG at "You got 2-5-5....": 2. **Navigational Errors** CG at "You by there 3-20-9": 3. **Lack of Vertical Awareness** CG at "You're alright, just...": 4. **Lack of Vertical Awareness**	
47. Talent on camera/sim bay.	***(On-camera talent)*** **This crew failed to react to eight G-P-W-S warnings. Why did the crew get into this situation? One of the solutions to the C-F-I-T problem is proper training.** **Let's look at a training situation in the simulator where crews learn to avoid C-F-I-T as well as perform the escape maneuver.**
48. WS inside simulator with crew and instructor pilot doing nonprecision approach.	**Before takeoff the crew completed a departure review and briefing. Here we see them as they are going through the approach briefing.**
49. Scene continues. CG: **Situational Awareness**	**The common thread running through C-F-I-T accidents is situational awareness. This includes not only horizontal awareness, knowing where you are over the ground, but vertical awareness as well.**
50. WS inside simulator,Talent is checking approach charts. CG: **Situational Awareness** • **Study approach charts**	**Approach charts should be studied before leaving cruise altitude. Key fixes and airport elevation must be noted and associated with terrain and obstacles along the approach path. Pilots should have a good understanding of both approach and departure design criteria in order to fully**

understand the obstacle clearance margins built into them.

51. CU of colored chart.

Some Captains have spent hours studying a first-time approach into a terrain critical airport. Terrain and obstructions should be studied using a chart that shows elevation contours, preferably a chart with color.

52. WS of sim (insert RMDI swinging).
 Add audio of Beacon.
 Crew calls out "1000 feet."
 CG:
 Situational Awareness
 - **Know altitude and distance from airport**
 - **Cross-check altitudes with charts**

Know your altitude and distance from the landing airport. Cross-check the altitudes with the approach charts or enroute maps. Understand that you are responsible for knowing this information, not the A-T-C controller.

53. CU of EHSI.

Most modern airplanes use electronic displays that show your position. This information is a great help. But remember, errors can occur.

54. MCU of round dial (steam gage).
 HSI.
 CG:
 Situational Awareness
 - Study approach acharts
 - Know altitude & distance from airport
 - Crosscheck altitudes with charts
 - **Check nav radios**

Make sure that the navigational radios are properly set. Several C-F-I-T accidents have occurred because the pilot was flying an instrument approach while the navigational radios were incorrectly tuned.

55. CU of FMC (sim).

If your airplane has a flight management computer, make sure it is correctly programmed. Each pilot should independently verify the information entered into the computer.

56. Simulator scene continued: MCUs of VOR/DME CUs (out before auto enagage). CG: **Situational Awareness** Study approach charts • Know altitude and distance from airport • Cross-check altitudes with charts • Check nav radios **• Monitor raw data**	**During the approach, the pilots must carefully monitor both raw data from the V-O-R, D-M-E, or N-D-B, and information from the barometric and radio altimeter.**
57. Add CG: **Use all data to assist you**	**Use every available aid to assist you in knowing your position and the recommended altitude at that position.**
58. Graphic of Approach plate with old glide path; then overlay with new glide path.	**Hazards exist using low descent quadrant or step-down ap-proaches. When authorized, a continuous descent angle of approximately three degrees is an effective way to fly a stabilized nonprecision approach.**
59. Simulator scene continued: CU of each pilot talking about approach. CG: **Stabilized Approach**	**Studies show that one of the common factors in C-F-I-T acci-dents is the lack of a stabilized approach. Operators considered the safest in the business all have procedures about when an ap-proach must be stabilized and what the crew should do if it is not.**
60. MS of stack of manuals. CG: **Standard Operating Procedures**	**These same operators also have wel-defined standard operating procedures.**

61. Simulator scene continues: MCUs of pilots talking to each other. We hear some sound bites of conversation. CG: **Situational Awareness** • Study approach acharts • Know altitude and distance from airport • Cross-check altitudes with charts • Check nav radios • Use all data to assist you • Stabilized approach • **Communication**	**Communication is the key. Each pilot must have situational awareness to ensure the final descent path is correct. If any flight deck member is unsure, ...execute a missed approach.**
62. Long shot of sim bay; Talent walking down bay, turns and enters classroom.	**One of the solutions to the C-F-I-T problem is classroom instruction and simulator training for the crews. Training needs to include not only C-F-I-T causes and traps, but recovery as well.**
63. DVE slide to briefing room. Instructor is just completing a neatly printed (TV safe) chart that has key points. As he talks, camera cuts to chart. CG: **CFIT Escape Manuever**	**Based on extensive simulator studies, we've found that unless daylight visual verification is made that no hazard exists, the proper C-F-I-T escape maneuver is:** **...React immediately to a G-P-W-S warning without hesitation.** **...Positively apply max thrust and rotate to the appropriate pitch attitude for your airplane.** **...Pull up with wings level to ensure maximum airplane performance.** **... Always respect stick shaker.**
64. WS sim of Dave/Rob executing escape manuever. Disclaimer bullet: **CONSULT YOUR AIRPLANE MANUAL FOR THE EXACT MANEUVER.**	

65. WS inside full-flight sim as student pilots correctly perform CFIT avoidance.	***(Ambient sound of crew inside simulator performing CFIT avoidance)***
66. Footage of enhanced GPWS use. Ambient audio: “Terrain, terrain! Pull….”	**The near future will see the installation of Enhanced G-P-W-S. This technology uses a database that includes the terrain around all major airports. Incorporating this terrain modeling with the current state-of-the-art G-P-W-S will enable the pilot to receive both aural and visual warnings much sooner than with current equipment.**
67. CG: **SUMMARY** **Standardized Regulations**	**Let’s review the major points of this program. We need to reduce C-F-I-T accidents. All of us can help. Worldwide regulations governing flight should be standardized.**
68. Inside 767 SAS in flight.	**This will allow aircrews to be familiar with procedures and approach charts, no matter where they are in the world.**
69. International footage. CG: **Standard Operating Procedures**	**Operators throughout the world must make sure that their standard operating procedures are correct, up to date, and understood by those that use them.**
70. ATC room. CG: **ATC Improvements**	**Air traffic control systems must continue to be upgraded. A-T-C controllers and aircrews must ensure that clearances are understood.**
71. In flight. CG: **Vertical and Horizontal Situational Awareness**	**Aircrews must be constantly aware of the factors that can lead to a C-F-I-T accident. Some of these factors are: lack of both vertical and horizontal situational awareness.**

72. Inflight. CG: **Improved Communication** CG: **Altimeter Awareness**	**Communication errors between A-T-C and the crew. Ultimately, the pilot is responsible for terrain avoidance. Be aware of barometric altimeter setting errors.**
73. CU of nav setup. CG: **Correct Navigation Radios**	**Always cross-check your position and know the navigational radio setup. Many accidents occur because the wrong nav aid is set in the radios.**
74. Flight deck. CG: **Autoflight Modes Correct and Engaged**	**Even with the state-of-the-art electronics and autopilots, remember, they are only machines. Cross-check them!**
75. **Classroom.** CG: **Training**	**Training is the best way to make the crews aware of the C-F-I-T problem and to give them the knowledge to recognize a problem and get out of the situation.**
76. Flight deck. CG: **Study and Brief Departures and Arrivals**	**Study and brief both the departure and arrival. Make sure everyone involved understands what is planned. Any deviations to the briefing should be immediately questioned.**
77. CU of altimeter on plate. CG: **Cross-check Altitudes and Distances**	**Always cross-check altitudes and positions. Know where you are and what altitude is safe.**
78. Crew. CG: **Timely Communication**	**Good crew communication and callouts are essential.**

79. CU of nav radio. CG: **Monitor Navigation Radios**	**Check the navigational radios.**
80. WS flight deck. CG: **React Immediately to a GPWS Warning**	**Unless daylight visual verification is made that no hazard exists, react immediately to a G-P-W-S warning without hesitiation.**
81. CG: **Apply Maximum Thrust**	**Apply maximum thrust.**
82. CG: **Rotate Airplane to Proper Attitude**	**Rotate the airplane to a pitch attitude recommended by the airplane manufacturer.**
83. CG: **Pull Up Wings Level**	**Pull up with wings level.**
84. CG: **Always Respect Stick Shake**	**Always respect stick shaker. New technological advances are on the horizon, and more will follow.**
85. On-Camera talent at Hurricane Ridge, Olympic Mountains. CFIT accident site in distance.	***(On-camera talent)*** **By now, you should be aware of the C-F-I-T traps and some ways to avoid becoming a victim of a C-F-I-T encounter. All of us in the aviation industry can contribute to solutions.**
86. Same site of CFIT accident as used in opening: Hurricane Ridge, Olympic Mountains.	**Effective C-F-I-T training is essential! Together, the aviation community can eliminate Controlled Flight into Terrain accidents.** ***(Music up)*** ***Credits*** ***(Fade to black)*** ***Credits***

CFIT Background Material
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CFIT Background Material

5.0 Introduction

Controlled flight into terrain is certainly not a new phenomenon, but when an accident does occur, it is guaranteed worldwide newspaper headlines. There are initiatives under way to improve flight crew training and also attack many other systemic problems that lead to CFIT accidents. Many people and organizations have been seeking solutions to prevent CFIT. This section includes information associated with some of this work. This selected information represents only a portion of the extensive literature available within the aviation industry.

5.1 General Goals and Objectives

The material in this section is intended to be a resource for those who are developing policies, procedures, and training standards. It may also be used to help develop classroom material and as a resource for answering questions during the training. Only through knowledge can a true understanding of the problem be realized. This section is intended to improve that understanding. The information in this section supports the overall goal of the CFIT Education and Training Aid, which is to prevent CFIT.

It is recommended that the user of this training aid include other appropriate information in this section so that all the information may be readily available in a single source.

5.2 Overview of Background Information

While all the selected information in this section is valuable, there are some documents that should be very useful in understanding and preventing CFIT. The *Flight Into Terrain* document that is included in this section is an extensive compilation of CFIT accidents and incidents, and it is a particularly valuable resource for instructors. Also included are the reports from the various CFIT Task Force Working Groups that provide the basis for much of the information in the previous sections. The Flight Safety Foundation CFIT Checklist is included, and it can be used to evaluate specific flight operations and enhance flight crew awareness of the CFIT risk. Additionally, the Safety Alert Bulletin is included to highlight the CFIT problem. The table of contents should be used to locate other readings.

PROJECT

SAFETY ANALYSIS

HUMAN FACTORS AND

ORGANIZATIONAL ISSUES

IN CONTROLLED FLIGHT

INTO TERRAIN (CFIT) ACCIDENTS

1984 - 1994

Controlled flight into terrain (CFIT)
Human Factors and Organizational Issues

1. This is an update on the activities of the International Civil Aviation Organization (ICAO) Air Navigation Bureau (ANB) with respect to controlled flight into terrain (CFIT) ocurrences, within the context of its Flight safety and Human factors Programme.

2. Since October 1993, the ANB has reviewed and analyzed data available from official sources in an attempt to identify the Human Factors and organizational issues underlying CFIT occurrences. The review has produced the data which is attached. The attachment also includes a description of the methodology used by the ANB in conducting the analysis of the data.

3. The accidents selected for analysis involved commercial air transport turboprop/ turbojet aircraft accidents investigated by States between 1984 and 1994, independent of aircraft mass or seating capacity. The data gathered reflects factual data extracted from the States' official investigation reports, without inferences or assumptions by the Secretariat. The purpose of the analysis was to determine whether there exists a set of human performance issues involved in CFIT accidents which consistently emerge from official investigation reports. This analysis applied the Reason Model (succinctly discussed in the attachment) in an attempt to define the "anatomy" of a CFIT accident from the perspective of Human Factors.

4. It has been a fundamental premise of the ICAO Flight Safety and Human Factors programme since its inception that operational personnel performance does not take place in a social vacuum, but within operational contexts which either resist or foster inherent human weaknesses and flaws. This became obvious as the analysis of the official accident reports progressed. Lapses in human performance were cited in all CFIT reports analyzed. All the reports also disclosed flaws and deficiencies in the aviation system which adversely affected human performance in the particular circumstances under which accidents occurred.

5. The analysis thus discloses a dual pathway leading to CFIT accidents: an "active" pathway, generated by actions or inactions of front-line operational personnel (i.e., pilots, controllers, mechanics and so forth) ; and a "latent" pathway, generated by deficiencies in various aspects of the aviation system, for which managers and decision-makers are responsible.

6. The data indicates a preponderance of the "latent pathway" (approximately 88%), over the "active pathway", (slightly above 12%), in the genesis of CFIT occurrences. Figure 2 in the attachment provides an integrated picture of the Human Factors and organizational issues underlying CFIT occurrences. Figures 2 through 7 present a breakdown of the data obtained from the analysis.

7. The ANB intends to establish further correlations among this data. Likewise, the Secretariat will distribute this information among selected parties, including the Flight Safety and Human Factors Study Group, in an attempt to obtain feedback to further the analysis in depth. The analysis nevertheless clearly suggests the multi-dimensional aspects of Human Factors in CFIT accidents. This reaffirms the need for a systemic, collective approach to safety and prevention.

1. **Sources of data**

1.1 All accident information examined was extracted from the official investigation reports produced by the States' safety agencies. The list of aviation accidents included in the study comprises the following.

Aircraft Occurrence Report, Nahanni Air Services Ltd. de Havilland of Canada DHC-6-100 C-FPPL, Fort Franklin, Northwest Territories, 9 October 1984. Report Number 84-H40004

Aviation Occurrence Report, Labrador Airways Ltd. de Havilland of Canada DHC-6-100 C-FAUS, Goose Bay, Labrador, Newfoundland, 11 October 1984. Report Number 84-H40005

Aviation Occurrence Report, Simpson Air Ltd., Beechcraft King Air B-90 C-GDOM, Fort Simpson Airport, Northwest Territories, 16 October 1988. Report Number A 88W0234

Aircraft Accident Report, Embraer 110 Bandeirante, OH-EBA, in the vicinity of Ilmajoki Airport, Finland, November 14, 1988. Major Accident Report NO. 2/1988, Helsinki, 1990. Ministry of Justice, Ilmajoki Aircraft Accident Investigation Board

Aviation Occurrence Report, Voyageur Airways Ltd. Beechcraft King Air A-100 C-GJUL, Chapleu, Ontario, 29 November 1988. Report Number 8800491

Aviation Occurrence Report, Air Creebec Inc., Hawker Siddeley HS 748-2A C-GQSV, Waskaganish, Quebec, 3 December 1988. Report Number A88Q0334

Aircraft Accident Report, Fairchild Swearingen Merlin III SA226T, N26RT, Helsinki-Vantaa Airport, Finland, February 23, 1989. Accident report No. 1/1989, Helsinki, 1989. Ministry of Justice, Planning Commission for the Investigation of Major Accidents

Aviation Occurrence Brief, Ptarmigan Airways Ltd., Piper PA-31T Cheyenne C-GAMJ, Hall Beach, Northwest Territories, 17 April 1989. Brief Number A89C0069

Aviation Occurrence Report, Skylink Airlines Ltd., Fairchild Aircraft Corporation SA227 Metro III C-GSLB, Terrace Airport, British Columbia, 26 September 1989. Report Number 89H0007

Aircraft Accident Report, Aloha Islandair, Inc.. Flight 1712, de Havilland Twin Otter, DHC-6-300, N707PV, Halawa Point, Molokai, Hawaii, October 28, 1989

Report on the Accident to Indian Airlines Airbus A-320 Aircraft VT-EPN on 14th February, 1990 at Bangalore. Government of India, Ministry of Civil Aviation.

Aviation Occurrence Report, Frontier Air Ltd., Beechcraft C99 Airliner C-GFAW, Moonsonee, Ontario, 30 April 1990. report Number A90H0002

Accident Investigation Report, Beech King Air E90 VH-LFH, Wondai, Queensland, 26 July 1990. BASI Report B/901/1047

Final report of the Federal Aircraft Accidents Inquiry Board concerning the Accident of the aircraft DC-9-32, ALITALIA. Flight No. AZ404, I-ATJA on the Stadlerberg, Weiach, 14 November 1990

Table 1. Organizational processes

Goal-setting	Communicating
Policy-making	Designing/specifying
Organising	Purchasing
Forecasting	Supporting
Planning	Researching
Scheduling	Marketing
Managing operations	Selling
Managing maintenance	Information-handling
Managing projects	Motivating
Managing safety	Monitoring
Managing change	Checking
Financing	Auditing
Budgeting	Inspecting
Allocating resources	Controlling

2.1.2 Defences, barriers and safeguards

These are measures aimed at removing, mitigating or protecting against operational personnel hazards. They serve different functions and present different modes of application. Table 2 introduces a classification of defences, barriers and safeguards.

2.1.2.1 Corporate culture

A set of beliefs, values, norms and assumptions that the organization makes about itself, the nature of people in general and its environment. A set of unwritten rules that govern acceptable behaviour within and outside the organization ("The way we do business here"). Although not a distinct component of the model employed as analytical tool, corporate culture deserves a special mention, since it has been recognized by recent research undertaken by organizational psychology as one of the most important and effective barriers against hazards and safety breakdowns in high-technology systems.

Table 2. Defences, barriers and safeguards

Modes of application

- Engineered safety devices (automatic detection and shutdown, etc.)
- Policies standards and controls (administrative and managerial measures designed to promote standardised and safe working practices–together they constitute the safety management system and have as their adjuncts techniques (cause-consequence analyses, etc.)
- Procedures, instructions and supervision (measures aimed at providing local task-related know how).
- Training, briefing, drills (the provision and consolidation of safety awareness and safety knowledge).
- Personal protective equipment (anything from safety boots to space suits).

2.1.3 Latent Failures

Decisions taken in the managerial and organizational spheres. These are people separated in time and space from the operational interface. Latent failures are originated in flawed organizational processes which break though systems defences, barriers and safeguards. Latent failures may remain undetected for considerable periods of time, before they combine with active failures and local triggers to generate an accident.

2.1.4 Local working conditions

These are the factors that influence the efficiency and reliability of human performance in a particular work context. Table 3 and 4 present a breakdown of local working conditions and list the principal factors.

Table 3. Situational and task factors

Error factors	Common factors	Violation factors
Change of routine	Time shortage	Violations condoned
Negative transfer	Inadequate tools and equipment	Compliances goes unrewarded
Poor signal-noise ratio	Poor procedures and instructions (ambiguous or inapplicable)	Procedures protect system not person
Poor human-system interface	Poor tasking	Little or no autonomy
Poor feedback from system	Inadequate training	Macho culture
Designer-user mismatch	Hazards not identified	Perceived licence to bend rules
Educational mismatch	Undermanning	Adversarial industrial climate (them and us)
Hostile environment	Inadequate checking	Low pay
Domestic problems	Poor access to job	Low status
Poor communications	Poor housekeeping	Unfair sanctions
Poor mix of hands-on work and written instructions (i.e., too much reliance on knowledge in the head)	Bad supervisor/worker ratio	Blame culture
Poor shift patterns and overtime working	Bad working conditions	Poor supervisory example
	Inadequate mix of experience and inexperienced workers	Tasks affording easy shortcuts

Local working conditions (cont.)

Table 4. Personal factors

Error factors	**Common factors**	**Violation factors**
Attentional capture	Insufficient ability	Age and gender
Preoccupation	Inadequate skill	High risk target
Distraction	Skill overcomes danger	Behavioural beliefs
Memory failures	Unfamiliarity with task	(gains outweigh risks)
Encoding interference	Age-related factors	Subjective norms
Storage loss	Poor judgement	condoning violations
Retrieval failure	Illusion of control	Perceived behavioural
Prospective memory	Lease effort (cognitive	control
Strong motor programs	economics)	Personality
Frequency bias	Overconfidence	Non-compliant
Similarity bias	Performance anxiety	Unstable extravert
Perceptual set	(deadline pressures)	Low morale
False sensations	Arousal state	Bad mood
False perceptions	Monotony & boredom	Job dissatisfaction
Confirmation bias	Emotional stress	Attitudes to system
Situational unawareness		Management
Incomplete knowledge		Supervisors
Inaccurate knowledge		Discipline
Inference & reasoning		Misperception of hazards
Stress & fatigue		Low self-esteem
Disturbed sleep patterns		Learned helplessness
Error proneness		

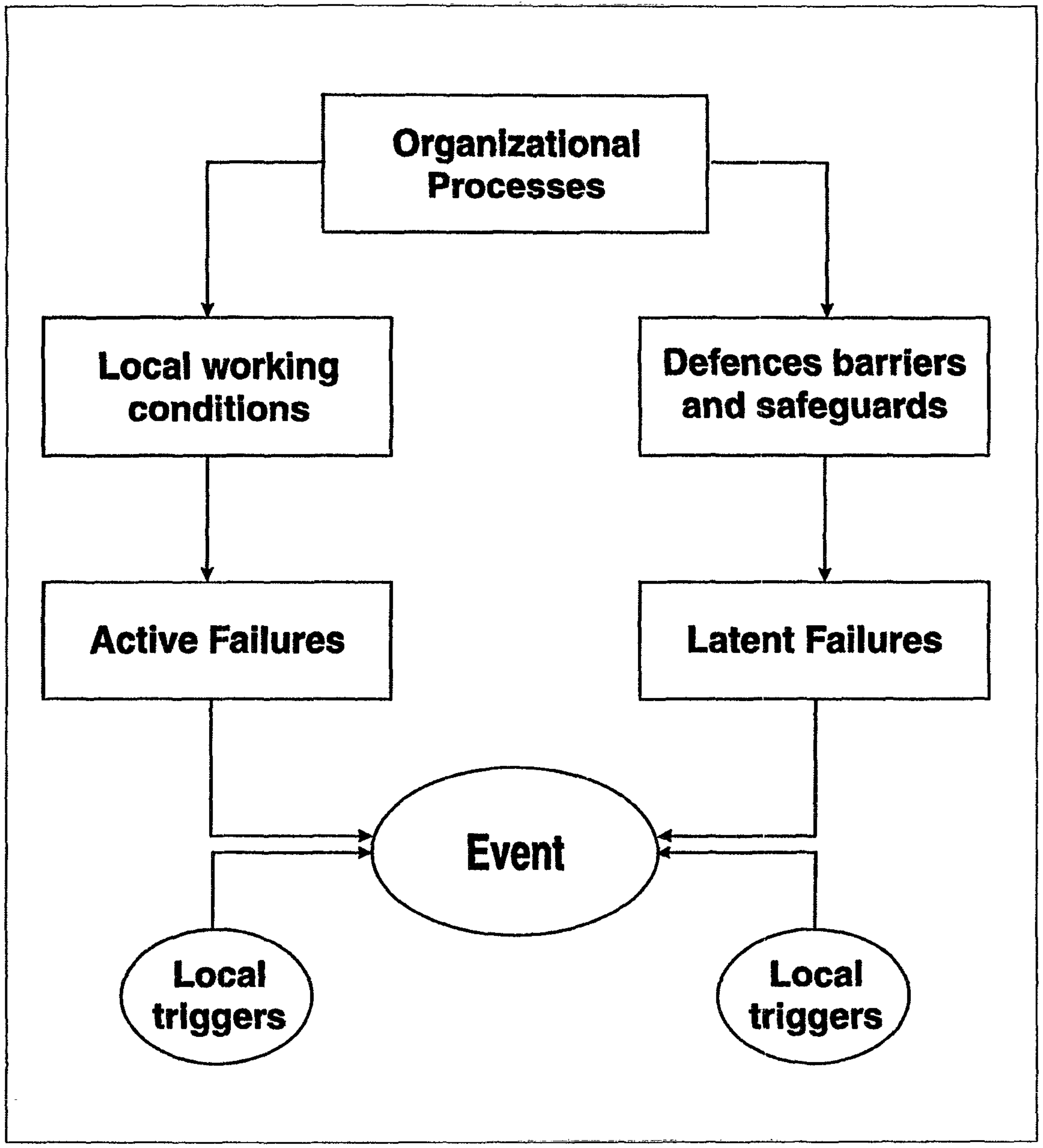
2.1.5 Active Failures

Errors and violations committed by operational personnel, the consequences of which are revealed immediately and have an immediate impact.

2.1.6 Local triggers

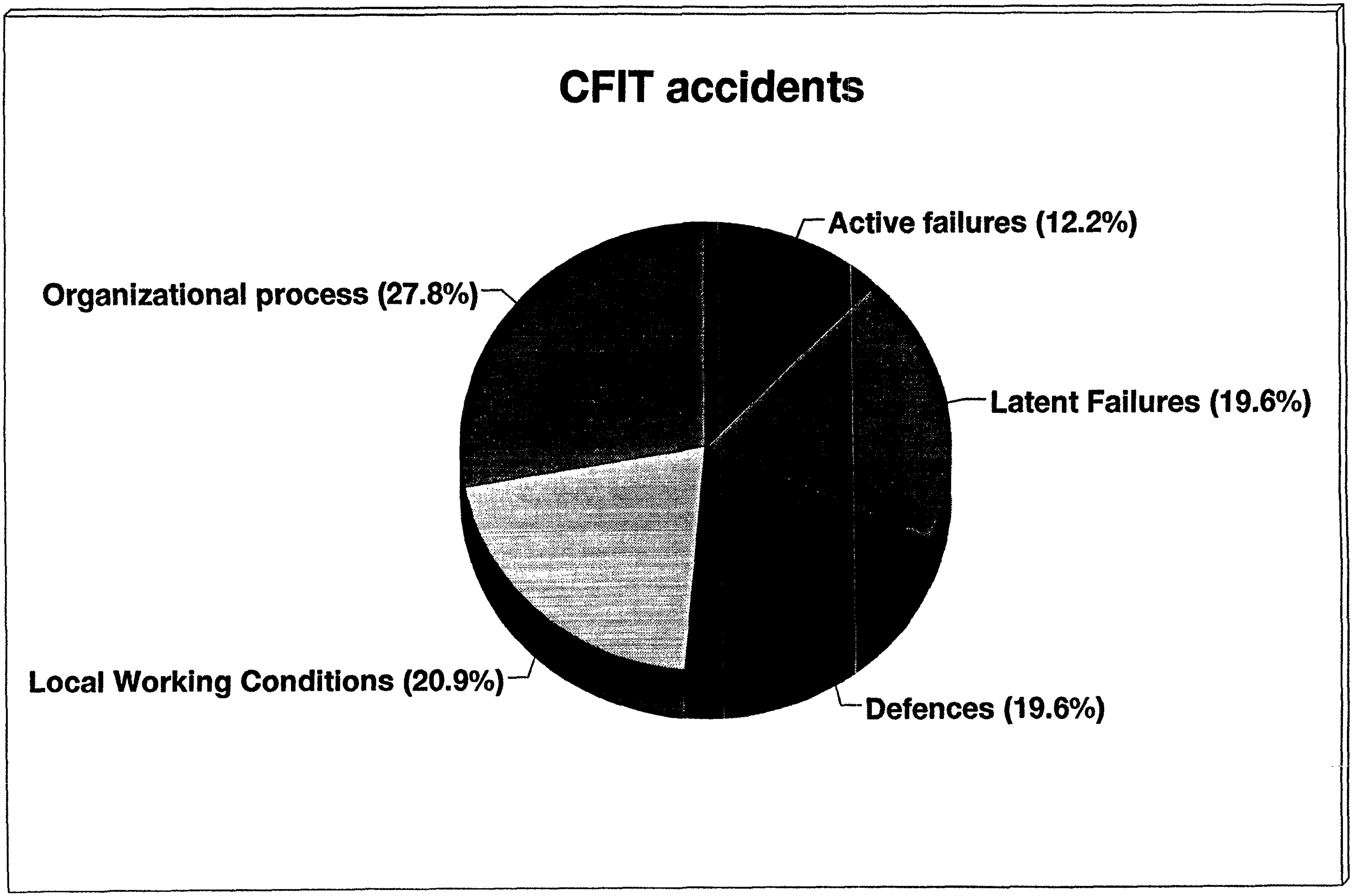
Technical failures, adverse weather conditions or any other particular (i.e., *local*) atypical/abnormal system operating conditions.

FIGURE 1



Organizational Processes
Local working conditions
Defences barriers and safeguards
Active Failures
Latent Failures
Event
Local triggers
Local triggers

FIGURE 2



CFIT accidents
Active failures (12.2%)
Organizational process (27.8%)
Latent Failures (19.6%)
Local Working Conditions (20.9%)
Defences (19.6%)

FIGURE 3

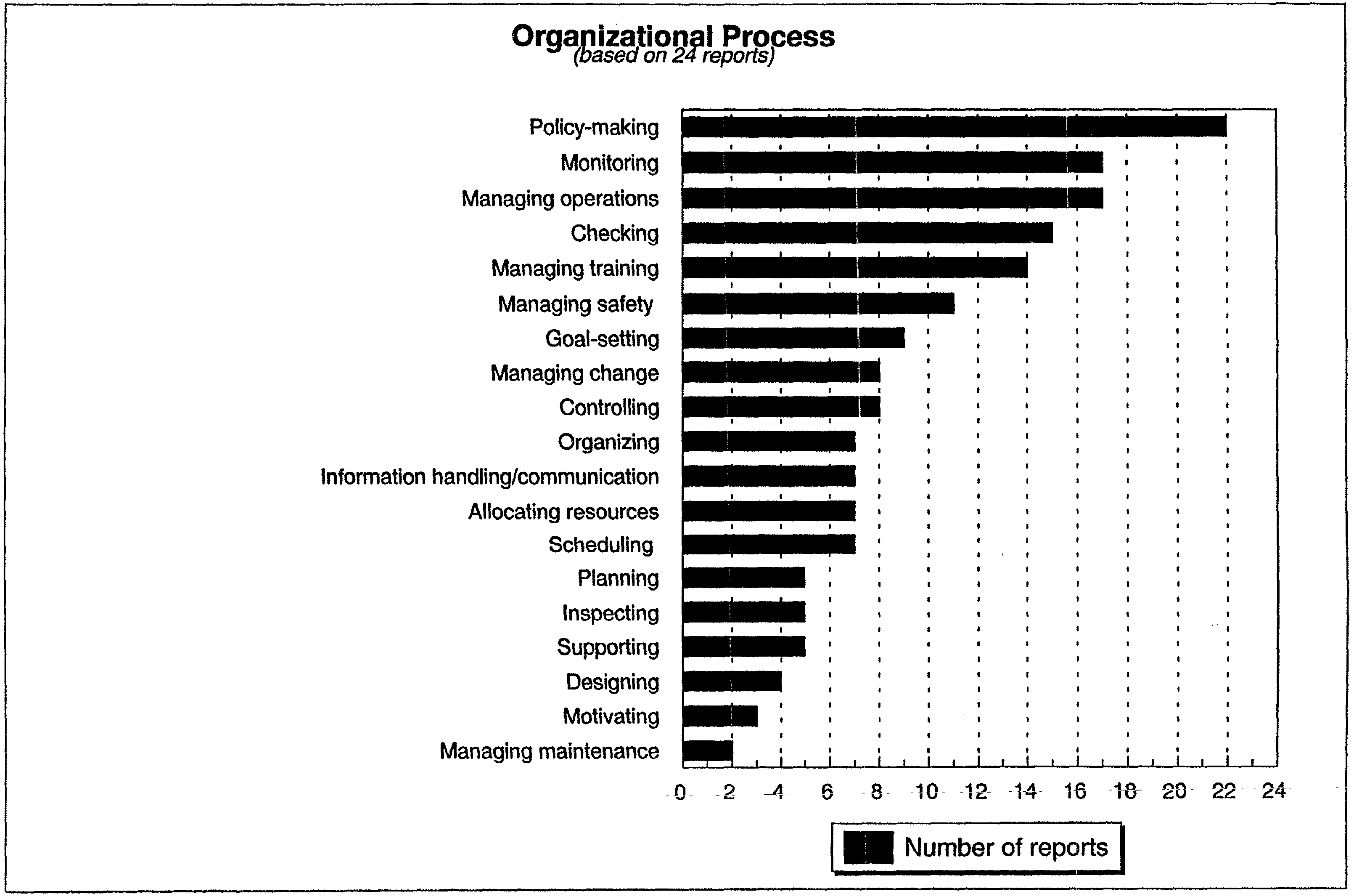
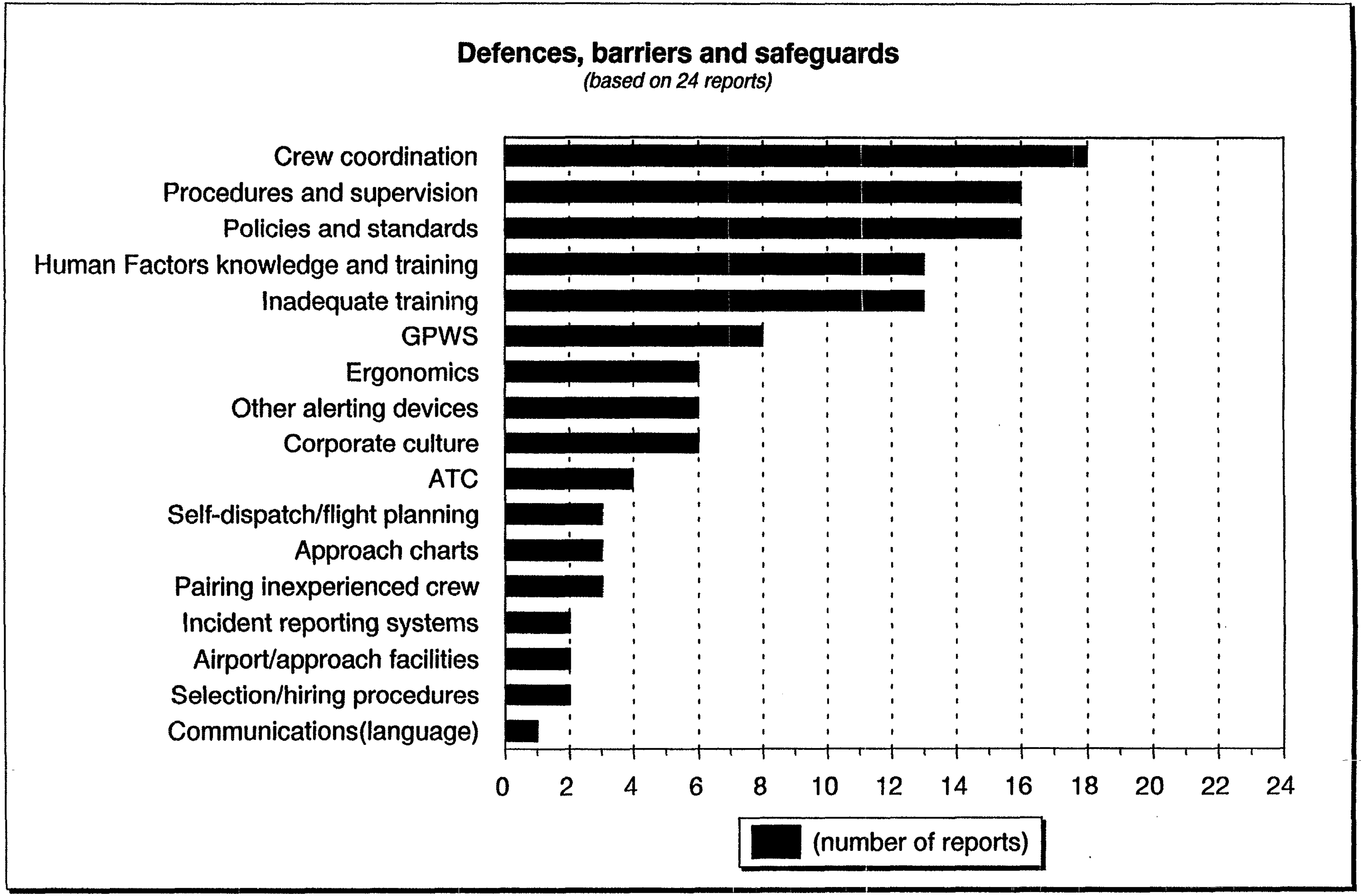
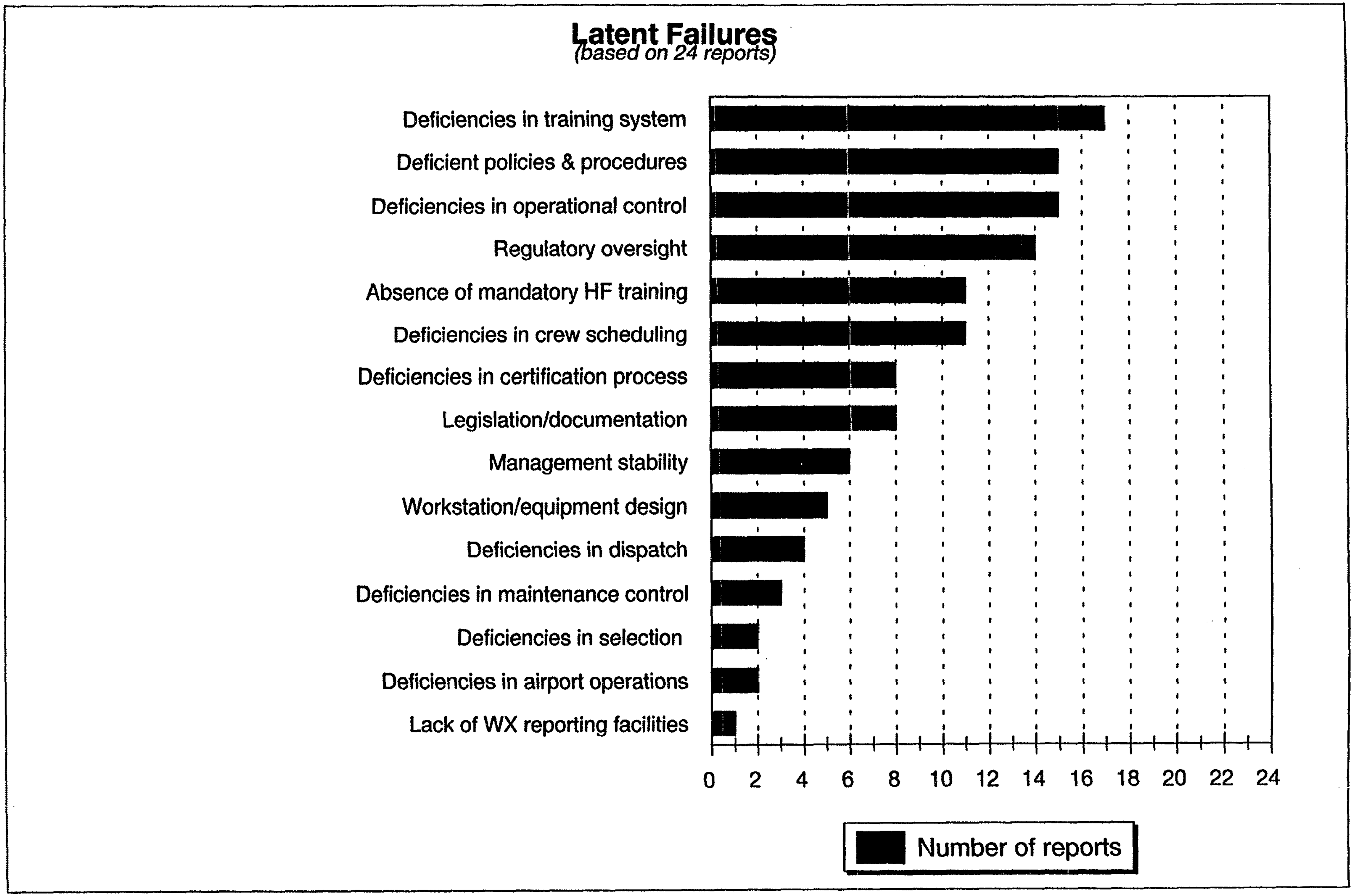

Organizational Process
(based on 24 reports)
Policy-making
Monitoring
Managing operations
Checking
Managing training
Managing safety
Goal-setting
Managing change
Controlling
Organizing
Information handling/communication
Allocating resources
Scheduling
Planning
Inspecting
Supporting
Designing
Motivating
Managing maintenance
0 2 4 6 8 10 12 14 16 18 20 22 24
Number of reports

FIGURE 4



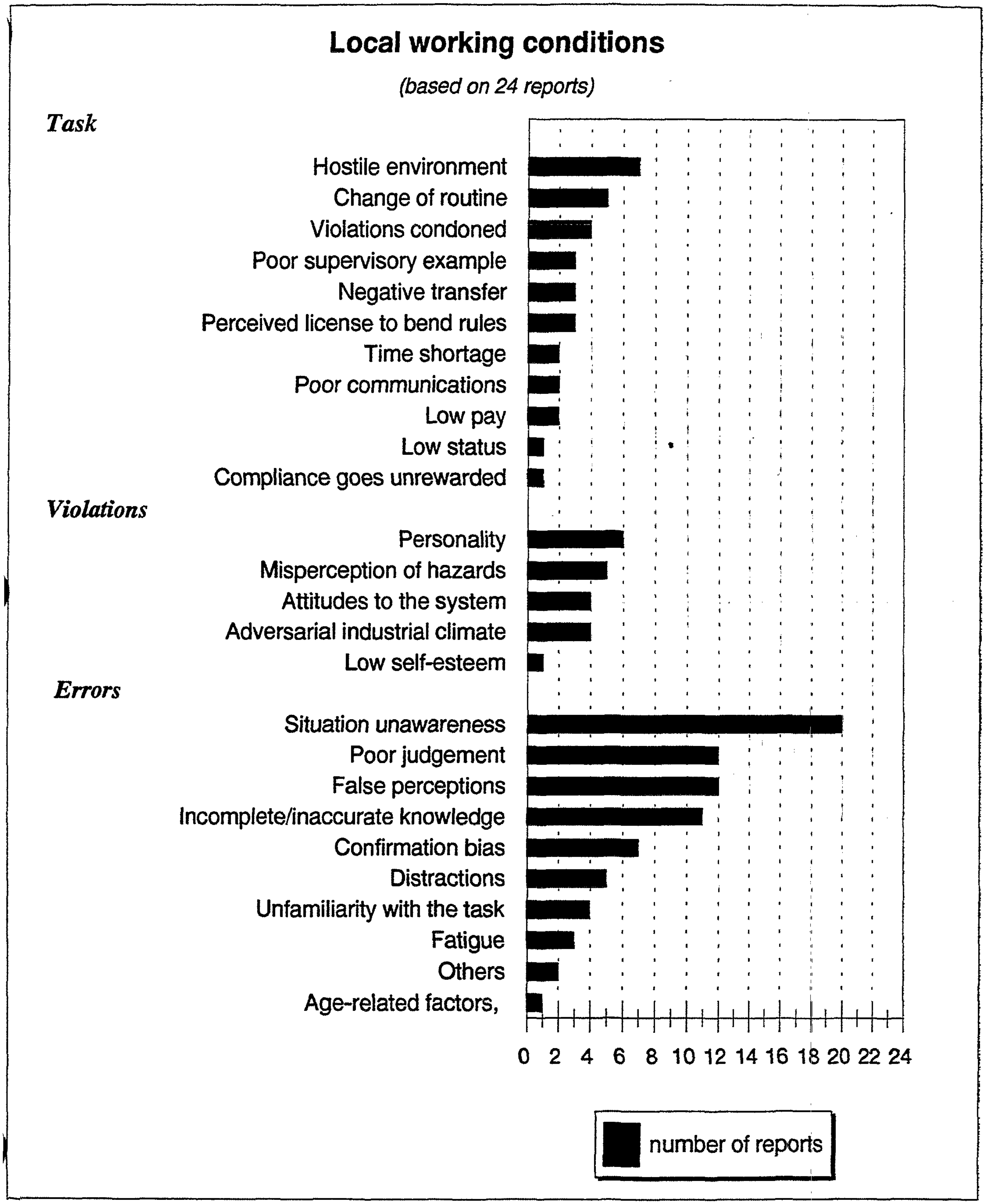
Defences, barriers and safeguards
(based on 24 reports)
Crew coordination
Procedures and supervision
Policies and standards
Human Factors knowledge and training
Inadequate training
GPWS
Ergonomics
Other alerting devices
Corporate culture
ATC
Self-dispatch/flight planning
Approach charts
Pairing inexperienced crew
Incident reporting systems
Airport/approach facilities
Selection/hiring procedures
Communications(language)
0 2 4 6 8 10 12 14 16 18 20 22 24
(number of reports)

FIGURE 5



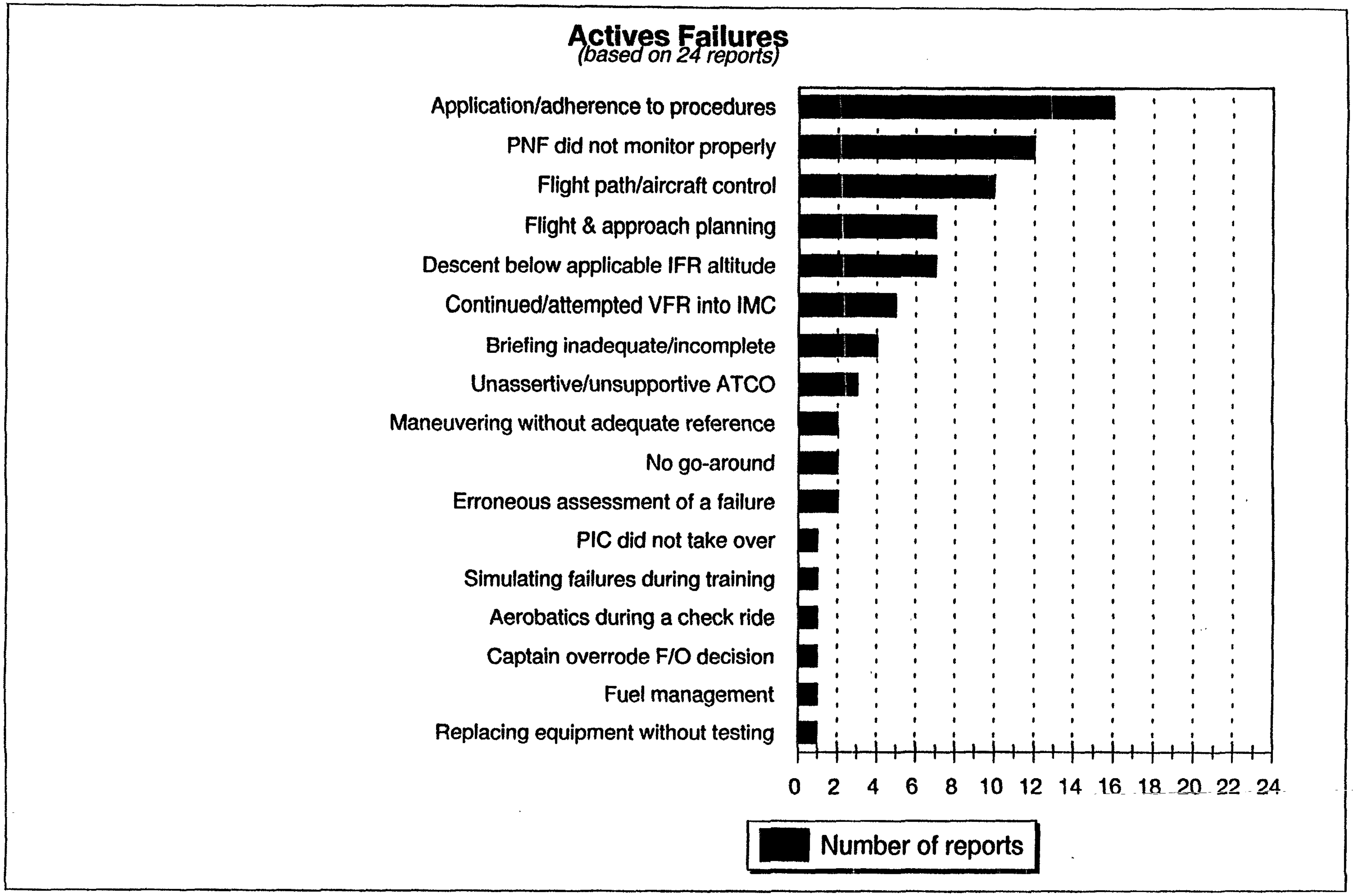
Latent Failures
(based on 24 reports)
Deficiencies in training system
Deficient policies & procedures
Deficiencies in operational control
Regulatory oversight
Absence of mandatory HF training
Deficiencies in crew scheduling
Deficiencies in certification process
Legislation/documentation
Management stability
Workstation/equipment design
Deficiencies in dispatch
Deficiencies in maintenance control
Deficiencies in selection
Deficiencies in airport operations
Lack of WX reporting facilities
0 2 4 6 8 10 12 14 16 18 20 22 24
Number of reports

FIGURE 6



Local working conditions
(based on 24 reports)
Task
Hostile environment
Change of routine
Violations condoned
Poor supervisory example
Negative transfer
Perceived license to bend rules
Time shortage
Poor communications
Low pay
Low status
Compliance goes unrewarded
Violations
Personality
Misperception of hazards
Attitudes to the system
Adversarial industrial climate
Low self-esteem
Errors
Situation unawareness
Poor judgement
False perceptions
Incomplete/inaccurate knowledge
Confirmation bias
Distractions
Unfamiliarity with the task
Fatigue
Others
Age-related factors,
0 2 4 6 8 10 12 14 16 18 20 22 24
number of reports

FIGURE 7



Actives Failures
(based on 24 reports)
Application/adherence to procedures
PNF did not monitor properly
Flight path/aircraft control
Flight & approach planning
Descent below applicable IFR altitude
Continued/attempted VFR into IMC
Briefing inadequate/incomplete
Unassertive/unsupportive ATCO
Maneuvering without adequate reference
No go-around
Erroneous assessment of a failure
PIC did not take over
Simulating failures during training
Aerobatics during a check ride
Captain overrode F/O decision
Fuel management
Replacing equipment without testing
0 2 4 6 8 10 12 14 16 18 20 22 24
Number of reports

- END -

HUMAN FACTORS AND TRAINING ISSUES IN CFIT ACCIDENTS AND INCIDENTS

Capt. Daniel Maurino
Secretary, Flight Safety and Human Factors Study Group, ICAO

INTRODUCTION

Controlled flight into terrain (CFIT) accidents and incidents are those in which an aircraft, under the control of the crew, is flown into terrain (or water) with no prior awareness on the part of the crew of the impending disaster (*Wiener, 1977*). Recent statistics suggest that close to 45% of aircraft losses during the period 1979-1990 can be accounted under this category (*Flight Safety Foundation, 1992*). This has led major international organizations, including the International Civil Aviation Organization (ICAO), the Flight Safety Foundation (FSF) and the International Air Transport Association (IATA), to multiply their endeavours destined to reduce CFIT accidents and incidents.

Concern over CFIT occurrences was first reflected in regulations after a B-727 struck a mountain during a non-precision approach to Dulles, Virginia. A premature descent was attributed to ambiguous pilot-controller communications and unclear information in the approach chart (*NTSB-AAR-75-16*). This was one in a series of accidents in which otherwise airworthy aircraft were flown into the surface by properly certificated flight crews. Implementation of the Ground Proximity Warning System (GPWS) requirement for large, turbine-powered airplanes engaged in international operations (*ICAO Annex 6, 1978*) and its ground counterpart, the Minimum Safe Altitude Warning (MSAW) as a feature of the automated radar terminal system (ARTS-3), were deemed the solution to preclude this type of accidents (*Loomis and Porter, 1981*). Although GPWS has reduced the incidence of CFIT occurrences, on balance it is a fair assessment that it has fallen short of fulfilling the expectations with which it was introduced. *Slatter (1993)* provides an excellent account of the shortcomings in the introduction of the GPWS as well as operational solutions to improve GPWS effectiveness as a safety net.

During the 1980's, enthusiasm regarding Human Factors led industry efforts to try to find solutions to CFIT occurrences through enhanced flight crew performance. The accident in which a DC-8 crashed during approach to Portland, Oregon, after running out of fuel (*NTSB-AAR-79-7*), was one of several approach and landing, CFIT occurrences attributed to breakdowns in flight crew coordination and discipline. It acted as a trigger. Dedicated Human Factors training for flight crews, namely crew resource management (CRM) and Line-Oriented Flight Training (LOFT) (*Cooper, White and Lauber, 1979; Lauber and Foushee, 1981; Orlady and Foushee, 1986, Helmreich, Kanki and Wiener, 1993*), emphasizing the need for improved intra-cockpit communication, exchange of relevant operational information and situational awareness boomed across the airlines. This was accompanied by the inevitable exhortations about cockpit discipline and professional behaviour, elusive terms which escape sound definition and only generate unimaginative solutions with rather dubious results. As with GPWS, although the contribution of CRM and LOFT to aviation safety has been monumental, the pervasiveness of human error in CFIT occurrences suggests that Human Factors training is only a partial solution to CFIT occurrences.

Reducing CFIT occurrences requires recognition that such accidents and incidents are system-induced (*Wiener, 1977*), i.e., they are generated by shortcomings in the aviation system, including deficiencies in the organizations which constitute it. The accident in which a DC-10 crashed into an active volcano in Antarctica (*Aircraft Accident Report No. 79-139*) because of incorrect coordinates in its computer-generated flight plan has been asserted as an example of these shortcomings and the systemic nature of CFIT occurrences (*Mahon, 1981; Vette, 1984; Johnston, 1985; Mcfarlane, 1991*). Deploying people and funds -- always finite resources -- in furthering regulations, design or training will not likely improve CFIT statistics. Remedial and reform actions (*Reason, 1990*) aimed at reducing CFIT should address system failures and organizational deficiencies, since these are the areas where the greatest gains in safety improvement can be realised.

BACKGROUND

In dealing with CFIT occurrences, the industry followed a time-honoured approach. Upon observing one particular safety deficiency (CFIT), remedial action directed to operational personnel, essentially backwards-looking and aimed only at that deficiency led to regulations (Annex 6 and others), design (GPWS and MSAW) and training (CRM and LOFT). Remedial action based on regulations, design and training has worked reasonably well in the past, while the level of technology aviation employed to achieve its production goals (transportation of people and goods safely and efficiently) was relatively low, and the interactions between people and technology simple and predictable. On the other hand, the relatively unsophisticated level of technology utilized up to the 70's imposed considerable limitations on system goals, which in turn denied the system opportunities to foster human error. Examples of these limitations include, among others, simple air traffic control systems, high weather minima, operations restricted to visual conditions, flexible schedules, shorter legs, more layovers which alleviated circadian disrhythmia and simple equipment, transparent in use, demanding basic cognitive skills and responding to simple, well-rehearsed mental models.

Although systemic elements can be found in accidents and incidents since the beginning of aviation, human error in those times of low technology was more a consequence of operational personnel improperly applying their acquired knowledge and skills -- or not applying them at all -- because of shortcomings in equipment design, deficient training or silent regulations rather than induced by stringent system demands. Within this context, strengthening or adding local defenses (*Maurino, 1992*) through regulations, design or training appeared a sensible approach to follow. Such an approach provided considerable yields and elevated aviation to its status as the safest mode of transportation. The pitfall behind this progress is that every single piece of equipment designed and conceived to provide wider berth to human error eventually imposed greater demands over the very humans they were supposed to alleviate, by increasing system production demands. Technical advances are never used to increase the safety of the aviation system as a whole by creating wider safety margins. They are used to stretch system limits, leaving safety margins largely unchanged.

Aviation in the 90's has become an extremely complex system. It is also very sensitive, in the sense that even the smallest interference can lead to catastrophic consequences. In the quest to minimise human error and maximise production, high-technology has been introduced in large scale. Those who watched this introduction with impartial judgement suggest two basic flaws in it: (1) such introduction was technology-driven rather than human-centred (*Billings, 1992*), and (2) it stopped short at the micro rather than at the macro level of system design analysis (*Meshkati, 1992*). The consequence of the first point is that technology, rather than eliminating human error, has merely displaced it (*Wiener, 1988*). The absence of macro analysis in the introduction of technology makes the system complicated and difficult to grasp conceptually rather than simple and easy to understand. New high technology is inherently opaque. The consequences of the interactions among people, technology and other system components in the safety of the system remain largely unknown (*Reason, 1992*).

People and technology interact at each human-machine interface. Both components are highly interdependent, and operate under the principle of joint causation (*Pidgeon, 1991*), i.e., people and machines are affected by the same causal events in the surrounding environment. Furthermore, these interactions do not take place in a vacuum, but within the context of organizations, their goals, policies and procedures (*Bruggink, 1990*). Understanding the principle of joint causation and the influence of the organizational context upon the aviation system operations is central to understanding CFIT occurrences and their prevention. Observing joint causation will avoid the piecemeal approaches based on design, training or regulations which have plagued past safety initiatives. Looking into the organizational context will permit to evaluate whether organizational objectives and goals are consistent or conflicting with the design of the organization, and whether the operational personnel has been provided with the necessary means to achieve such goals.

DISCUSSION

The success of the windshear training aid package (*FAA, 1987*) in reducing windshear-induced accidents has lured the aviation community into adopting similar approaches to other observed safety deficiencies. The recently produced takeoff training aid package (*FAA, 1992*) stands as a good example, and it will undoubtedly contribute in reducing aborted takeoff, overrun accidents. Not surprisingly, many advocate for a training package to reduce CFIT occurrences. It is asserted, however, that neither technical nor Human Factors training are *the* solution to reduce CFIT statistics. Furthermore, any CFIT training package would be redundant with existing training curricula and therefore an unnecessary and unproductive waste of resources.

The success of the windshear -- and hopefully the takeoff -- training aids resides in the fact that both windshear and aborted takeoff occurrences are specific situations, with inherent factors which can be punctually addressed. In both cases specific knowledge must be acquired, specific skills have to be developed and mental models must be revised. Examples of such punctual knowledge include understanding the dynamics of windshear, the consequences in terms of aircraft performance as well as the aerodynamics involved in an encounter, the certification conditions behind demonstrated takeoff distances, the sequence of controls selection or movements, etc. Specific skills must be developed and mental models changed to fly at high body angles, to "fly the stickshaker", to apply maximum braking, etc.; improper application of punctual knowledge or skills specific to these situations may trigger occurrences.

There are no factors inherently specific to CFIT occurrences. All the factors listed as contributing to CFIT occurrences (*Slatter, 1993*) are currently addressed by existing training curricula: navigational errors, non-compliance with approach or departure procedures, altimeter setting errors, misinterpretation of approach procedures, limitations of the flight director/autopilot, etc. All these factors are addressed either during ground school or simulator training. Those factors not covered by technical training are included in CRM training: maintenance/loss of situational awareness, deficient intra-cockpit interaction, flight crew communications etc. A dedicated training package would be a meagre contribution to reduce CFIT occurrences.

The answer to CFIT occurrences lies in looking at them from a systems perspective, and act upon the latent failures which have slipped into the system, ready to combine with operational personnel active failures and, further compounded by adverse environmental conditions, may combine to produce an accident (*Reason, 1990*). Examples of these latent failures include poor strategic planning of operations, absence of clear channels of communication between management and operational personnel (a widely lamented but seldom acted upon, typical system failure), deficient standard operational procedures (a direct consequence of the aforementioned), corporate objectives which are difficult or impossible to achieve with existing resources and corporate goals inconsistent with declared safety goals, among others. It is impossible to act upon a problem unless awareness about it is gained. Therefore, it is advanced that the first answer to reduce CFIT occurrences is education. Education and training are terms loosely used among operational personnel. They are, however, quite distinct and certainly not interchangeable (*ICAO, 1989*). While familiar with training, operational personnel is seldom exposed to education, since it is assumed that it forms part of the basic individual baggage everyone carries before being hired. Given the complex and opaque nature of today's aviation system, it has been suggested that it is time to review the need to further education in aviation (*Kantowitz, 1992*).

Rather than a training package, what is needed to decrease CFIT events is an educational package, directed both to management and operational personnel, to acquaint them with the concepts of high technology system failures, how they manifest through organizational deficiencies, how they may lead to incidents and accidents and the ways to cope with them. The second answer is to take into account Human Factors considerations during system design, both at the micro and macro level. At the micro level, the Human Factors analysis must go beyond knobs and dials in the traditional ergonomic sense, towards the more complex cognitive, information-processing and communication processes between people and between people and technology. At the macro level, the interface between the human-machine sub-system must be considered within the context of the aviation system as a whole, including the declared system goals and the resources allocated to achieve them. If education takes place, this second step is perfectly achievable.

A CASE STUDY

On 15 November 1975, a Fokker F-28 Mk1000 with six crew members and sixty-five passengers on board crashed while attempting to land, following a circling, non-precision night approach in poor weather conditions at Concordia, Argentina (*Exp. No.xx/xx, JIAAC*). In a "textbook" approach and landing, CFIT accident, the aircraft hit the densely forested, sloping terrain less than one mile short of the intended landing runway. The aircraft was completely destroyed, and although there were three injured (one of them the captain) there were no fatalities. The investigating agency took the view that the accident was attributable to pilot error. The pilot was fined by the civil aviation authority and demoted by the airline. Eventually -- and after duly receiving additional training -- he was re-instated to captaincy. Less than appropriate consideration was given to the difficulties of the immediate environment, replete with visual illusion-inducing conditions and with precarious navigation and approach aids. Neither did the investigation addressed the reasons which induced the crew to attempt an approach in such adverse conditions. The safety and prevention lessons which might have been learnt were effectively buried by the honest, but undoubtedly misdirected investigation, limited to the cockpit activities immediately preceding the accident.

When looking at this accident from an organizational perspective, multiple latent failures within the airline become evident. The most obvious organizational deficiencies include lack of strategic planning regarding the F-28 operation and incompatibility between the corporate goals assigned to the F-28 fleet and the resources provided to achieve them. The F-28 had recently been introduced into the airline and the process had been plagued with problems, including the adequacy of the qualifications of the airline training staff as well as the stability of the training organization. Ground school was conducted in-house with inappropriate means and with scant consideration paid to the fact that student captains had no previous jet experience and student first officers were being inducted into the airline. No flight simulator was available at that time, so all training was conducted in the aircraft, with its inherent limitations. Line-indoctrination was hurriedly completed due to the pressing need for crews to meet an ambitious commercial schedule, notwithstanding the mentioned lack of jet experience.

Management's inability to establish clear lines of communication with operational personnel was another serious organizational deficiency. This translated into deficient crew scheduling and pairing, improper consideration to environmental and equipment limitations when scheduling regular commercial services into destinations with doubtful infrastructures and unfriendly environments and, most important, an absolute lack of guidance to flight crews in terms of standard operational procedures as well as the limitations inherent to the operations. Because of these deficient lines of communications, newly qualified flight crews had no clear guidance as to which were the operational behaviours management expected from them. This lack of guidance -- and support -- has been recognized as an organizational failure which contributes to flawed decision-making by operational personnel (*Moshansky, 1992*).

Lack of strategic planning, incompatible goals, failure to communicate goals and to properly train personnel to achieve them are but a few examples of latent failures. They generate working environments replete with conditions which foster human error. Most important, such environments oftentimes make violations inevitable if tasks are to be achieved. An example of violation-producing conditions are those air traffic control procedures which generate nuisance GPWS warnings. Unless revised, they force crews to ignore warnings, thereby generating violations to operational orders to fulfil such procedures. Eventually environment or task conditions which generate errors and violations lead to system-induced accidents. Accident databases are replete with CFIT occurrences which support this contention.

CONCLUSION

When looking for solutions to CFIT occurrences, it is imperative to think in collective rather than individual terms (*Beaty, 1991*). It is naive to brand an entire professional body as being mainly responsible for aviation safety. It is equally impossible to anticipate the many disguises human error may adopt to bypass even the most cleverly designed safety devices. Lastly, it is an unattainable goal to eliminate all system deficiencies leading to accidents.

The solution rests in securing a maximum level of system "safety fitness" (*Reason, 1992*), by working upon latent system failures, such as incompatible goals, poor communication, inadequate control, training and maintenance deficiencies, poor operating procedures, poor planning and other organizational deficiencies which modern accident causation approaches syndicate as responsible for disasters in high technology systems.

Periodic checking of these system "health condition" markers and continuously actioning upon them remain the single most important keys to reduce CFIT occurrences.

The Real World of Human Factors:

Where are we, and where are we going?[1]

John K. Lauber
National Transportation Safety Board
Washington, DC

Good morning—it is a real pleasure to be here with all of you in beautiful Semi-Ah-Moo! I look forward to the next couple of days—based on past experience, this is a meeting well worthwhile.

Let me start by thanking Bob Hilb, Bob Buley, and Will Russell for organizing this morning's panel. And while I'm at it, let me note for the record that all of us owe a great debt of gratitude to Bob Buley and Will Russell for their outstanding efforts to promote the advancement of human factors within the airline community. Their efforts, under the aegis of the ATA Human Factors Task Force, have been instrumental in providing a broad blueprint for needed human factors efforts as embodied in the National Plan for Human Factors, and in securing needed support from both government and industry organizations. They have done an impressive job—thanks Bob and Will, and thanks to all of you for supporting their efforts.

The topic for our panel today is the real world of human factors, a topic that not too many years ago many of your predecessors might have said is an oxymoron. I will never forget a comment made by Hart Langer's predecessor (several times removed), Bill Dunkle, about his views of NASA scientists in general, and human factors specialists in particular. "Human factors scientists," Dunkle said, "always seem to me to be a bunch of people wearing white coats, seated around a big table, holding hands, and trying to establish contact with the living!" And lest you get the wrong impression, let me add quickly that Bill Dunkle was an extremely important, early proponent and supporter of human factors efforts to improve aviation safety—without his early support, the NASA program might well have gone nowhere

But Dunkle's point was a good one, then and fortunately to a much lesser extent, now. All too often, human factors specialists have not been good at establishing effective contact with the living, and for this reason, their work has often had little significant impact upon the real world. Too often, there has been, and continues to be, a genuine disconnect between the profession and those people, like yourselves, who need practical, effective, and timely solutions to problems. The purpose of this panel, as I understand it is to step back and take a look at where human factors stands, including a look at some of the successes, and a look at some of the areas where we need to redouble our efforts. As always, your support for this work is absolutely critical—without you there is no customer, no consumer, and therefore, no market.

I thought it might be useful to start at the beginning—with a definition of "human factors." Unfortunately, the term has come to have many meanings, especially in the popular press. One of my favorite examples of this occurred a couple of years ago in New York City where I accompanied the "go-team" to conduct an investigation of a fatal subway accident. As frequently happens in these situations, one of the local papers, a classic New York tabloid, did a "human interest" story on the investigative team, including Board Member John Lauber. Although I tried carefully during the interview to define what human factors is all about, the headline the next day told the story, "NTSB Team Headed by Doctor of Human Tragedy." When I got started in this business, I didn't realize just what I was getting into!

Let me start with what human factors is NOT. It is not clinical psychology; it is not counseling psychology, it is not hand-holding, let's-be-warm-and-fuzzy-hot tub stuff (although I personally have nothing against hot tubs or warm and fuzzy stuff). Human factors people do a lot of analysis, but they don't "analyze people" if you get my drift.

[1] Remarks presented at Air Transport Association of America Operations Forum, Semi-Ah-Moo, WA. September 19, 1994

Human factor IS an eclectic combination of engineering, experimental psychology, neuroscience, computer science, and ergonomics—literally, "the science of work." It is the application of scientific methodology and principles to the study, design, maintenance, and operation of complex man-machine systems. Human factors focuses upon individuals, teams, and organizations; and upon controls, displays, and tasks. The primary objective of human factors engineering is to optimize the performance of systems by adapting humans to the machines, for example, through training, and by adapting the machines to the humans, for example, through the application of such design principles as "control-display compatibility." Human factors is, in short, a central, critical component of systems engineering.

Let's take a quick look at where we've come in aviation human factors. One of the best examples of how human factors research can contribute to the solution of real-world problems is CRM—Crew Resource Management—the notion that flying a modern aircraft involves considerably more than simple stick-and-rudder skills. Decision-making, communications, and good leadership and followership skills are just as important to the safe and efficient operation of your aircraft as are the highly tuned manual control skills traditionally associated with being a pilot. It is now difficult to go anywhere in the world and find no indication of at least some understanding or appreciation of the importance of good CRM. The concept is being applied in diverse organizations around the globe, although I must say, still with widely varying degrees of efficacy and success. Nevertheless, it is clear that the concept has had a major impact upon the way we train airline pilots everywhere. It's an area that several of us here, including Clay and myself, have had a long association with, and I know that I can speak for both of us when I say that we are very proud of what has been accomplished in this area

Another comparative human factors success story can be found in the NASA fatigue countermeasures program There is an entire panel devoted to this topic later on this program, so I won't dwell on it here, but it is another example of how real-world oriented, scientifically sound human factors research can make a genuine contribution to safety and efficiency in aircraft operations.

While recounting where we have come in this area, let me also note that, compared to a decade or two ago, the operational community is much more highly aware of the importance of human factors problems and solutions. Note, for example, that it is difficult to pick up any trade publication, aviation safety journal, or other aviation-oriented publication without finding frequent reference to human factors issues in the aviation world. I take it as a special tribute to the human factors community that this panel comes first in your busy program, and that two other scheduled panels are also focused on human factors issues Again, it is difficult to go anywhere in the operational world and not find some example illustrating the fact that as a community, the aviation industry is now much more knowledgeable about human factors problems, and solutions, than previously. ICAO has implemented requirements for pilot licensing that include a human factors educational component. Accident investigation authorities now nearly universally apply some form of human factors inquiry in their conduct of official accident investigations, including examination of individual, team, and corporate cultural factors as they might be related to individual accidents. All the major airframe manufacturers employ human factors practitioners in various stages of the design process, again with varying degrees of success. Government regulatory authorities likewise now display significant appreciation for the role of human factors in the aviation system. In short, I think we can safely say to Bill Dunkle that the human factors community has, in fact, been successful in establishing contact with the living. The challenge now is to keep that line of communication open.

That's the good news But, can we just pack it up and go home? I think not, and here are a couple of thoughts about what else we as a community must do in the human factors arena—and I know each of the other panelists also intend to offer their views on this question of where do we go from here. Between the several of us, we ought to generate a fairly comprehensive set of concerns

Let me start by talking about the role of human factors in design, although I know that Curt and Kathy also will address this area. It is clear, based on a history of recent incidents and accidents that we have not yet hit upon an optimal approach to the design of the interface between flight crew and highly automated aircraft The accident at Nagoya, the incident at Hong Kong, and previous accidents involving highly automated aircraft all raise some unsettling questions. And although these events have largely involved aircraft from one manufacturer, it is not wise to assume that the underlying problems don't exist

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elsewhere—I doubt that any manufacturers' aircraft are completely free of potential for human error incidents and/or accidents; i.e., they have, inherent in their design, what Professor James Reason calls, latent failures: pathogenic bugs that will only become manifest under the "right" set of conditions, sometimes with only embarrassing consequences, and sometimes with tragic ones. What this says to me is that human factors considerations are still not sufficiently integrated into the design process; it's not that manufacturers are producing *bad* designs, but they are not optimal designs, and they can, on occasion, trap the unwary (and sometimes even the wary). I think what is required is a more systematic, formal approach that incorporates human factors expertise not only in the preliminary and initial design stages of a product cycle, but throughout that product's service life, making use of information learned from in-service experience for appropriate design modifications, when appropriate, but probably more importantly, using such feedback from line service to other elements of the system, most importantly, procedure development, and training and educational programs. In short, ultimate solution of human factors related design issues is dependent upon the application of a true systems approach. Clearly, one implication of this is that a formal, open line of communications between you, the maintainers and operators, and the manufacturers is of vital importance.

Another area of concern that I have is, unfortunately, and unintentionally, implicit in the discussion just completed: at this stage in the development and application of real-world human factors programs, the focus has been largely on the cockpit. It is a fact that many of our pressing problems have their origin well beyond the cockpit door. For example, there is increasing recognition of and attention to the problem of achieving effective integration of cockpit and cabin crews. There are some laudable efforts underway that apply CRM training and operating principles to cabin crew; similar comments can be made for dispatchers and maintenance personnel. I am a proponent of such efforts to extend the concept of *crew* resource management to the other legitimate members of the crew; I think the record clearly indicates that such efforts are worthwhile.

But in addition to the application of CRM principles to maintenance crew as well, I think one of the areas of highest potential payoff to you, both in terms of safety and economic benefits, is in attending to the fundamental human factors of aircraft and systems maintenance. David Marx, under Curt Graeber's direction at Boeing, has done some outstanding work in this area, and has some good quantitative data illustrating the magnitude of the problem (and thereby, the magnitude of the potential rewards). They have shown, for example, that a significant number of in-flight turnbacks are directly attributable to maintenance error. The very same principles of human error management and containment that apply to the cockpit apply to shop and line maintenance operations. And the very same fundamental solution—through the application of a true systems approach to the design, manufacture, and in-service operation of aircraft—apply in this area too.

Very similar comments can be made in one other area that also has direct, bottom-line impact on aviation safety and economics, air traffic control. Again, there are efforts underway to apply such concepts as CRM to the air traffic control suite; these seem to be promising. But also again, fundamental human factors issues ranging from selection and training, to task and equipment design, have not been adequately addressed at this time. Although outside your direct control, it seems clear to me that you have a vital interest in seeing that these issues are effectively treated, and the sooner the better.

Let me close on another point that I want you to consider. I mentioned at the outset of my remarks the National Plan for Human Factors, developed by Clay Foushee during his stay at the FAA using the broad blueprint provided by the ATA Human Factors Task Force. Although Clay did a tremendous job in overseeing the preliminary development and deployment of the plan, his departure left a hole that has never been filled. I can't in good conscience dance around the issue—I believe the National Plan for Human Factors is withering on the vine and has a good chance of dying unless there is a concerted effort to resurrect it by you and others who are the ultimate customers for its products. NASA-Ames, the institutional home of much of the research, and now, apparently, FAA's RE & D effort are undergoing major reorganizations, thus compounding the danger, at least in the short term. The program needs support, and most importantly, leadership, to reverse the entropic dissolution of what once was a highly promising start. This is only likely to happen with your direct support and efforts. The Administrators of both the FAA and NASA need to hear directly from you, the consumer of their primary products, that you support the efforts of both agencies in this vital area. Congressional leaders need to know of this support as well. And I urge you to continue your support for these activities through the committee structure of your trade association; that of course, includes providing adequate resources—people—to make the system work Such activities are vital if we are, as an industry, ever going to greatly diminish the proportion of accidents due to human error. If we don't succeed in this, we are dooming ourselves to repeat the sad experiences of those who have gone before, and stand in danger of loosing the established lines of communication with the living.

Thanks again, and I look forward to hearing your views on this matter

Chart design revision could enhance safety of non-precision approach and landing operations

The design of non-precision approach charts could be improved by providing the pilot with a stabilized, 3-degree approach profile.

R. T. SLATTER
ICAO SECRETARIAT

THE PROBLEM posed by shallow final approach slopes in non-precision instrument approaches is being considered by a number of operators. One international operator has identified many non-precision approaches where the procedure appears to produce a shallow approach. State aviation authorities and operators have for many years supported the use of a standard approach slope of 3 degrees for all types of approach — visual and instrument, precision and non-precision. This is a part of the doctrine of the stabilized approach, which is considered vital to the safety of approach and landing operations. A 3-degree approach slope gives a rate of descent of 300 feet per nautical mile, or a 5 per cent descent gradient. Pilots are taught to approach a runway on a 3-degree slope and this, in general, is the approach provided by precision approach and visual approach slope indicator systems. As an extension of this concept, it follows that level flight should not be entered at the minimum descent altitude (MDA): instead, if visual contact is established, the descent is continued to land and, should no visual contact occur, a missed approach is initiated.

When designing a precision approach, the procedure designer considers the approach slope as an integral part of the design. Since glide slope guidance is provided on the profile shown on a precision approach chart, it is expected that the pilot will fly the procedure.

In the case of the non-precision approach, however, there is no consideration of the approach slope other than not exceeding the maximum descent rate of 400 feet per nautical mile. The profile shown on a non-precision approach chart is not then the profile that the pilot should fly but the one that provides the minimum prescribed obstacle clearance. The result is that a profile on a non-precision approach chart may show an apparent approach slope well below the desired 3 degrees. The profile shows, in effect, an obstacle clearance surface.

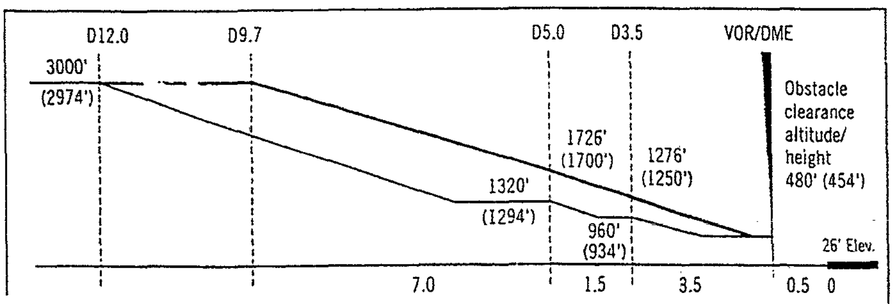
In the same way that pilots are trained and conditioned to fly 3-degree approaches, they are trained to fly the procedures given on an instrument approach chart. When a pilot accurately flies the profile for a non-precision approach, the approach is conducted with the minimum allowed obstacle clearance. It must also be remembered that the altitudes given are for international standard atmosphere (ISA) temperatures and the allowances have to be made, particularly in very cold conditions, to maintain the required clearance.

There are two problems. There is a difference in the type of information provided on a non-precision approach chart from that provided on a precision approach chart. There is also a difference between the outlook of the procedure designer and that of the pilot. The procedure designer provides obstacle clearance information for a non-precision approach. As a result of training and conditioning, however, the pilot will probably treat the non-precision profile as the procedure to be flown.

The ability to approximate a 3-degree approach slope has been available, where distance measuring equipment (DME) is provided, for many years. Many instructors have been teaching that non-precision approaches should be flown with a steady rate of descent of about 300 feet per nautical mile, even when no distance information is available. We now have increasing numbers of aeroplanes which are capable of internally generating an angle of descent. We also have navigation systems that can provide distance information.

It is apparent, therefore, that we should change the philosophy applicable to non-precision approach charts and provide on the profiles of those charts the desired, or 3-degree, approach which the pilot can fly while maintaining the normal stabilized approach procedures. Such an action would also effectively eliminate many of the stepped non-precision approach procedures since the 3-degree profile would be, in many cases, higher than the profiles currently provided on these charts. This logic cannot of course be applied where obstacles demand a steeper than 3-degree approach. Action to introduce a profile to be flown would materially increase the safety of non-precision approach and landing operations. The accompanying figure illustrates these points.

Discussion is required to finalize how best to include optimum flight path guidance on non-precision approach procedure charts while still showing the obstacle clearance information. It is time that this problem was solved.



Non-precision profile showing a 2.2-degree slope (black) having a descent rate of 234 feet per nautical mile and a descent gradient of 3.66 per cent. Desired 3-degree slope is superimposed (green).

Mr. Slatter was a Technical Officer in the Operations/Airworthiness Section of the Air Navigation Bureau at ICAO Headquarters, Montreal until his retirement in December 1993. He is currently acting as a consultant to ICAO.

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THOUGHTS ON THE SUBJECT OF NON-PRECISION INSTRUMENT APPROACH PROCEDURE DESIGN FROM THE POINT OF VIEW OF THE PILOT. CONCENTRATING UPON:

THE DESCENT GRADIENT PROVIDED IN SUCH APPROACH PROCEDURES;

THE POSSIBILITY THAT MULTIPLE PROCEDURES TO THE SAME RUNWAY, USING THE SAME NAVIGATION AIDS, COULD BE RATIONALIZED; AND

INCLUDING THE WAY IN WHICH THESE PROCEDURES ARE PRESENTED ON COMMERCIALLY AVAILABLE APPROACH PLATES AND IN THE APPROACH INFORMATION PROVIDED IN STATES AIPs.

INTRODUCTION

The problem of shallow final approach descent gradients has been raised of late, particularly by the CFIT Task Force, Aircraft Equipment Group at its recent meeting in Montreal. One major international operator, concerned with this problem, has identified ?? non-precision approaches where the final descent gradient is less than 4.3%, 2.5 degrees, at ?? different aerodromes in ? ICAO Regions. This operator has specified descent schedules for use by its own flight crews which provide a descent gradient of at least 2.5 degrees.

DISCUSSION

Pilot-training staff have been teaching for many years that the only way to conduct a consistently safe approach is to fly a stabilized approach. This means that, even in "visual" conditions, the aeroplane should be set up in the landing configuration with appropriate steady airspeed and power by the time it descends through 500 feet above touchdown. In the case of any instrument approach procedure this means that the approach must be stabilized from the commencement of the final descent. In the case of the non-precision approach, current teaching is that a stabilized approach should not include a change to level flight at the minimum descent altitude (MDA), whilst a visual search for the approach area and runway is made.

Pilots are taught that the correct flight path is a 3 degrees approach, or 5%, which equates to a descent of 300 feet per nautical mile. This is normal practise and most precision approaches approximate to 3 degrees. The standard setting for visual approach slope indicators (VASIS) is 3 degrees. Pilots know the configuration and the power requirements needed to achieve this approach slope (with appropriate adjustments for wind and loading). Pilots also become accustomed to the view of the aerodrome and the runway from a 3 degree approach. A 3 degree approach is the normal visual approach without any aids.

Descent on a non-precision approach should approximate to 3 degrees and, should the runway environment not be in view, when the aeroplane reaches the MDA, a missed approach procedure should be commenced. There should not be a level flight element at the MDA.

The concern here is with approaches at the great majority of aerodromes world-wide and not with special requirements or situations where, for example, a separate access landing system might be developed for the larger jets and commuter traffic.

The development of the 3 degree approach was no mistake, it is suitable for past and current aeroplanes. A steeper approach causes difficulty in airspeed control; there is insufficient drag, power may have to be reduced perhaps below that which provides adequate response to thrust demands. A shallower approach requires increased thrust which results in increased fuel consumption and noise; the view of the approach area deteriorates; most importantly, the aeroplane is closer to the terrain, at all stages of the descent, than is necessary. In either case the view of the runway from the final approach is not that to which most pilots are accustomed. Pilots are accustomed to the view from the 3 degree approach slope. This is not to say that some aeroplanes are not compatible with approach slopes greater than 3 degrees.

Any factor which deviates from normal practise is a potential hazard. The investigation into the problem of controlled flight into terrain (CFIT) accidents has revealed that there may be such a hazard in non-precision instrument approaches where they deviate from the optimum. There are approaches where the descent gradient is well below 5%, 3 degrees; one has been identified where the approach is less than one degree. A one degree approach gives a descent rate of 100 ft/nm. There are also non-precision approaches where the angle of the approach is well above 3 degrees.

Another problem is posed by stepped descents in non-precision approaches. The use of a stepped procedure is contrary to the need to generate a steady descent to the MDA. Also the manner in which the vertical profiles of stepped approaches are shown on approach plates invites early descent to the step altitude. This type of depiction is not shown in the Aeronautical Chart Manual. Stepped approaches have been identified where the use of an optimum descent would eliminate any need for the steps. In these cases the entire approach, down to MDA would, if a 3 degree approach were used, be above the vertical profile of the current, stepped, procedures. It is probable that this would apply in many more cases and many stepped procedures could therefore be eliminated.

It is possible to understand that there may be cogent reasons for a descent gradient that is steeper than the optimum. ICAO PANS OPS (Doc 8168) states that the descent gradient, or slope, for the final descent in non-precision operations, should not exceed 5%, 3.0 degrees (PANS OPS, Vol II, Part III, 26.4.5). This paragraph further states that where a steeper descent gradient is necessary, the maximum permissible is 6.5%, 3.7 degrees. PANS OPS, whilst quoting an optimum final approach descent gradient, and a maximum, does not give a minimum descent gradient. The gradient is calculated from the distance from the final approach fix to the threshold, and the vertical distance between the height over the final approach fix and 15 m (50 ft) over the threshold.

Pilots may find it difficult to understand why it should ever be necessary to design an instrument approach procedure with a slope of less than the optimum. From an examination of the rules of procedure design, which starts with the departure from the approach fix into the procedure, from the altitude of the highest minimum sector altitude (MSA), it appears that approaches may be made to fit into the airspace below this MSA. Many instrument approaches do commence from an altitude above that of the MSA, however, it does appear that procedures are designed paying attention to the wrong priorities. It appears that instrument approach procedures are designed from the top down, whereas logically these procedures should be designed from the ground up, based on a 3 degree approach, unless there were unavoidable reasons for a steeper approach. PANS OPS, Volume II, Part III, 1.4, refers to segment application and that the final approach track should be identified first. This paragraph does not state that the final approach profile should also be a controlling factor.

The current concept of efficient use of airspace may concentrate on the use of airspace in the terminal area. It is time that this concept was reversed and the priority given to the safety of the approach to land operation. This may mean that a particular instrument approach procedure may have to be redesigned to commence at a higher altitude. The overriding requirement must be for the safe approach and landing of the aeroplane. The provision of a safe approach would surely be the most efficient use of airspace.

The Instrument Flight Procedures Construction Manual (Doc 9368) contains more than one example of non-precision approaches which show the final approach descent gradient to be less than 3 degrees. The manual also shows approaches where a change in the descent gradient is indicated, from a figure less than the optimum to the optimum of 3 degrees. As stated above, it is difficult to understand why a descent rate of less than the optimum should ever be necessary. Such problems are illustrated on pages 3-19/3-20, 4-5/4-6, 5-7/5-8, and 10-6/10-7 of Doc 9368. Any of these examples may, in the absence of any definition of a minimum approach gradient, lead an instrument approach procedure designer to design an approach with a below optimum descent gradient. In some of the cases a higher, and optimum, descent gradient would resolve the problem that the designer was trying to solve with a stepped descent or a varied rate descent.

Other problems related to procedure design concern how these procedures are presented on approach plates. The problems examined here are those in the presentation of alternative approaches. The procedure provided for a VOR approach when the DME element of a VOR/DME approach is not available or the procedure provided for a localizer only approach when an ILS glide slope is not available. Annex 4, 11.10.6.2 c), states that the missed approach procedure profile should be shown by an arrowed broken line. Annex 4, 11.10.6.2 d) states that the profile for any additional procedure should be shown by an arrowed dotted line. This usage also applies to tracks. Guidance material in the Aeronautical Chart Manual (Doc 8697), pages 7-11-15, 7-11-17 and Specimen Chart 9, and in Circular 187, Instrument Approach Chart - ICAO, Guidance to Chart Makers provide illustrations of the Annex 14 Standard. Improper, use is made of the broken line in both commercial and State material to indicate the vertical profile for additional approaches.

Profiles for non-precision approaches are also shown in a manner which invites pilots to carry out an early descent to the MDA and then to maintain level flight at the MDA, to the missed approach point. It should also be noted that Annex 4, 11.10.6.2 b), c), d) and e), Doc 8697 and Circular 187 all use the word "track" where "profile" should be used. The heading to Annex 4, 11.10.6 should also be amended to read "Portrayal of procedure tracks and profiles".

Some examples are given below to illustrate the types of problems with the slope of the final descent, stepped descents, and the presentation of the approach procedures, which have been described above. They occur both on commercially available approach plates and on approach procedures contained in States AIPs.

Non-precision approach - shallow final approach descent gradient.

The first example (Fig.1) shows a VOR/DME or a VOR approach where the MDA/H for both approaches is 1960/395 ft.

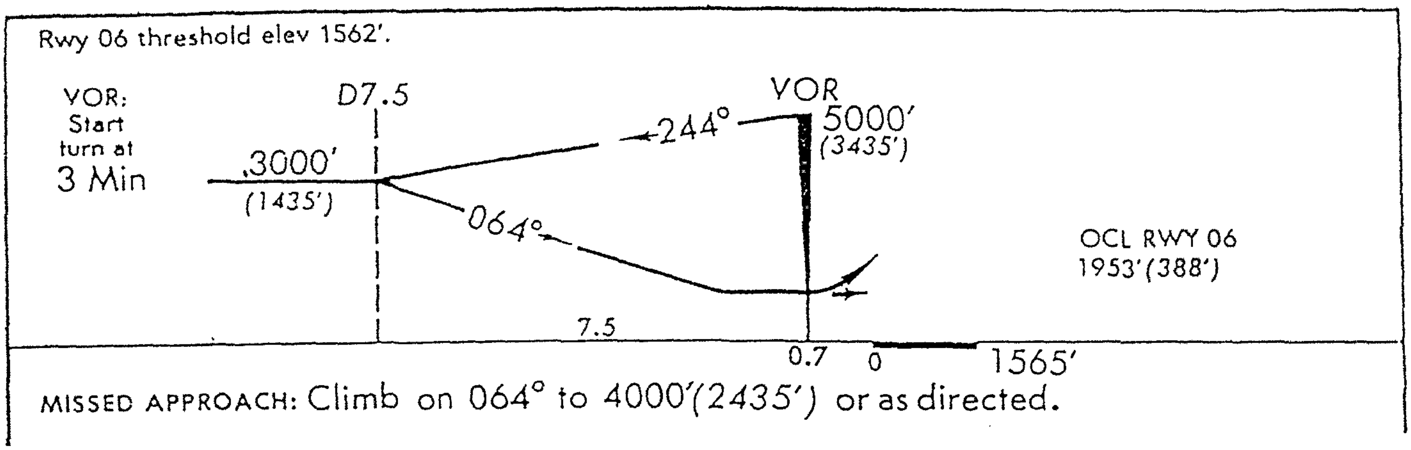

Figure 1. VOR/DME and VOR
(source - commercial approach plate,
the State AIP gives the same information)

The distance provided for the final descent is 8.2 nm. The height through which the aeroplane must descend from the procedure turn to reach a point 50 feet above the threshold is 1385 feet. This gives a required descent rate of 170 ft/nm, an angle of 1.6 degrees. Considering the same distance for the final approach, a 3 degree approach would require that the procedure turn was raised by 1075 feet. To maintain the same final distance the procedure turn should be at an altitude of 4 000 feet (to be exact 4 075 feet).

Two accidents involving hull losses have occurred on this particular non-precision approach. Both aeroplanes, a DC-8 and a B 707, struck the terrain, within 1 nm of each other, at approximately 9 nm on finals, at night. In each case the crash occurred at a greater distance than that at which the final descent should have been commenced. It is not possible to say what difference a 3 degree approach slope for the procedure would have made, other than to say that such a change might have broken the accident chain in one, or both cases. Since we have not received ADREP reports for either of these accidents we do not know whether the navigation aids were even working.

Non-precision approach - shallow stepped approach.

The second example (Fig.2, 3 and 4) shows three shallow stepped VOR/DME approaches, to the same runway, where the MDA/H is 480/454 ft in each case.

The same commercial source provides these three procedures, VOR DME-1, VOR DME-2 and VOR DME-ARC, to the same runway using the same VOR/DME facilities. By comparing the vertical profiles in Figures 2, 3 and 4 it can be seen that all are shown as stepped descents, the average descent gradients are all well below 5%, 3 degrees. The final descents, for the three approaches, commence from two different altitudes and three different DME distances; the check DME points are either different, or if the same, indicate a different check altitude. The only features in which the three procedures agree are in the use of the same VOR/DME facility and the same MDA/H.

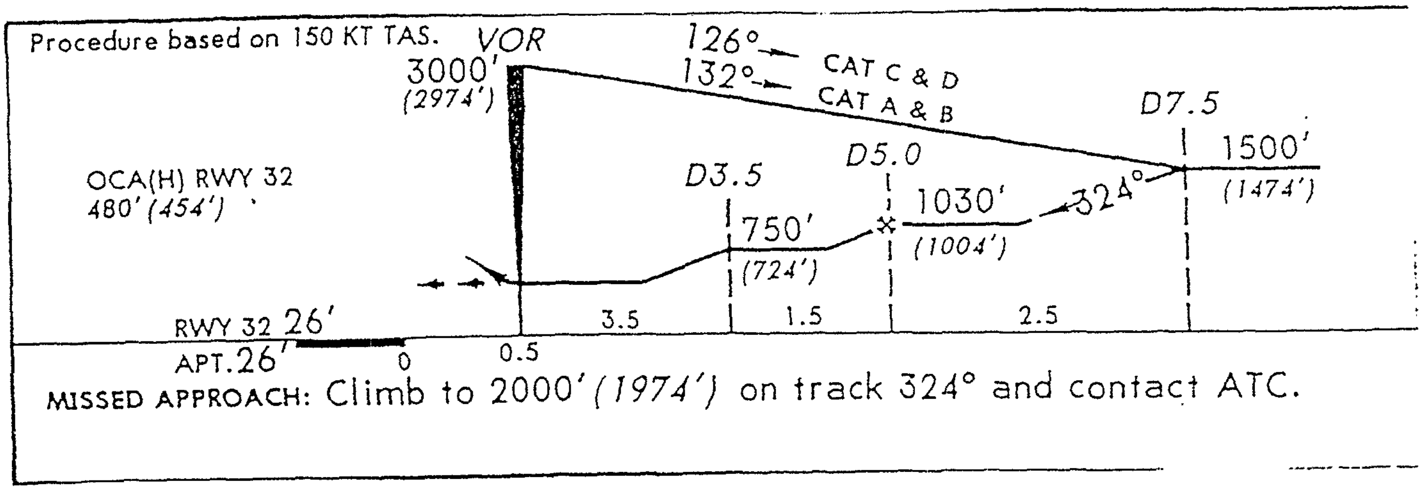

Figure 2. VOR DME-1
(source - commercial approach plate)

The procedure departs the VOR at 3000 ft QNH, commences a level turn at 7.5 DME at 1500 ft QNH. Distance to threshold 8 nm, descent 1424 ft, average 178 ft/nm or 1.67 degrees.

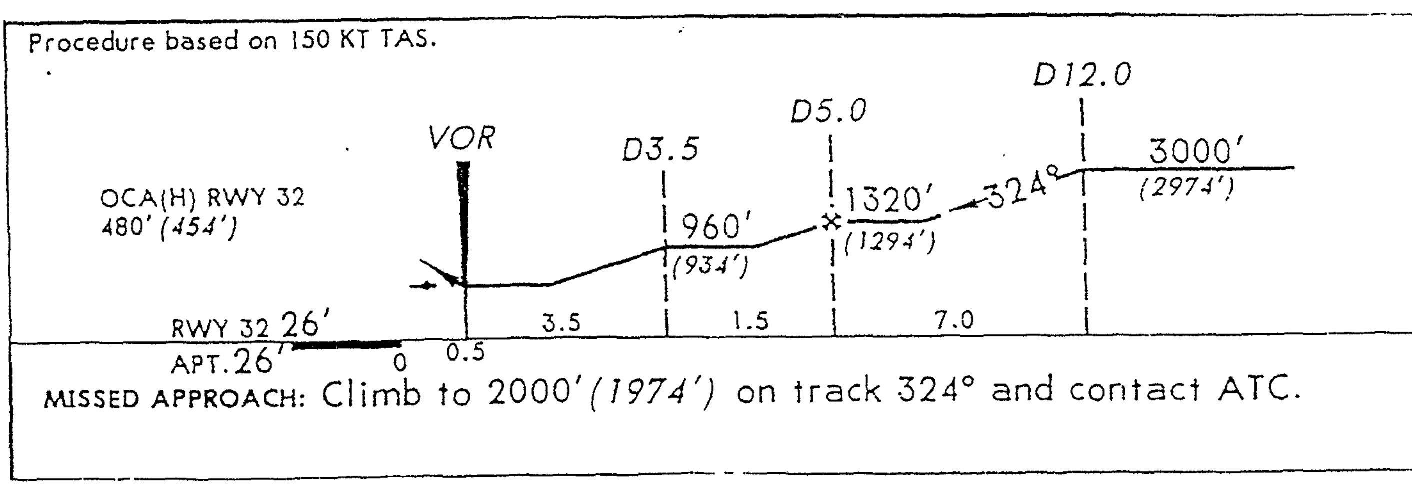

Figure 3. VOR DME-2
(source - commercial approach plate)

The procedure departs a holding fix at 12 DME on the extended approach at 3000 ft QNH commencing immediate descent. Distance to threshold 12.5 nm, descent 2924 ft, average 234 ft/nm, 2.2 degrees.

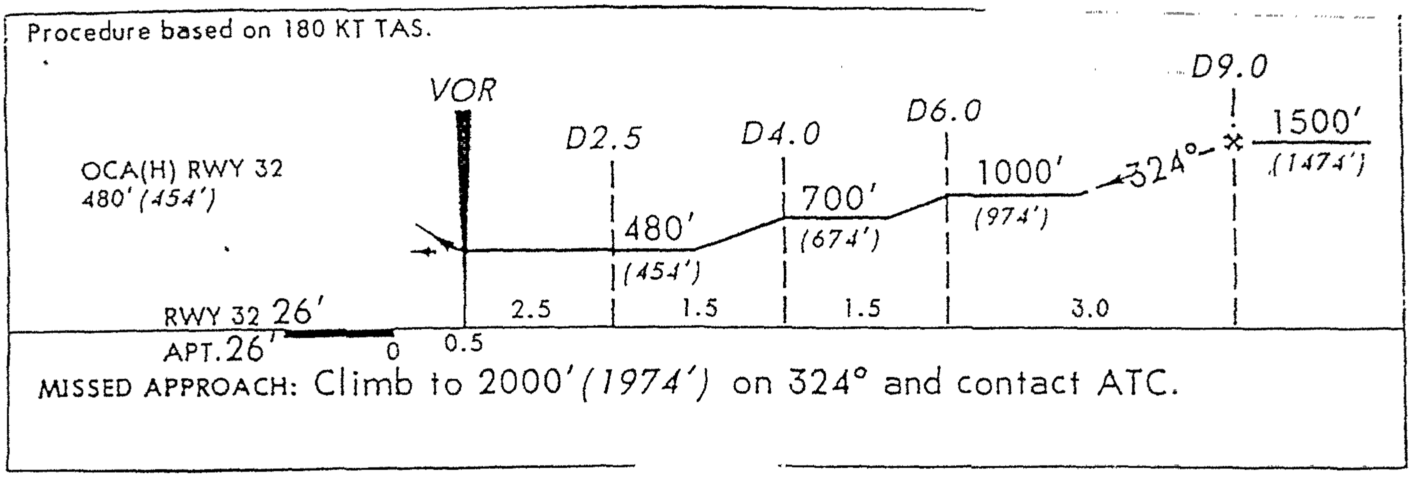

Figure 4. VOR DME-ARC
(source - commercial approach plate)

This procedure is based on a 10 DME arc flown at 3000 ft QNH. The final descent commences from 9 DME at 1500 ft QNH, distance to threshold 9.5 nm, descent 1424 ft, average 150 ft/nm, 1.4 degrees.

Information available from the State AIP, held in ICAO, covers only the VOR DME-ARC procedure. The vertical profile from the AIP is shown in Figure 5.

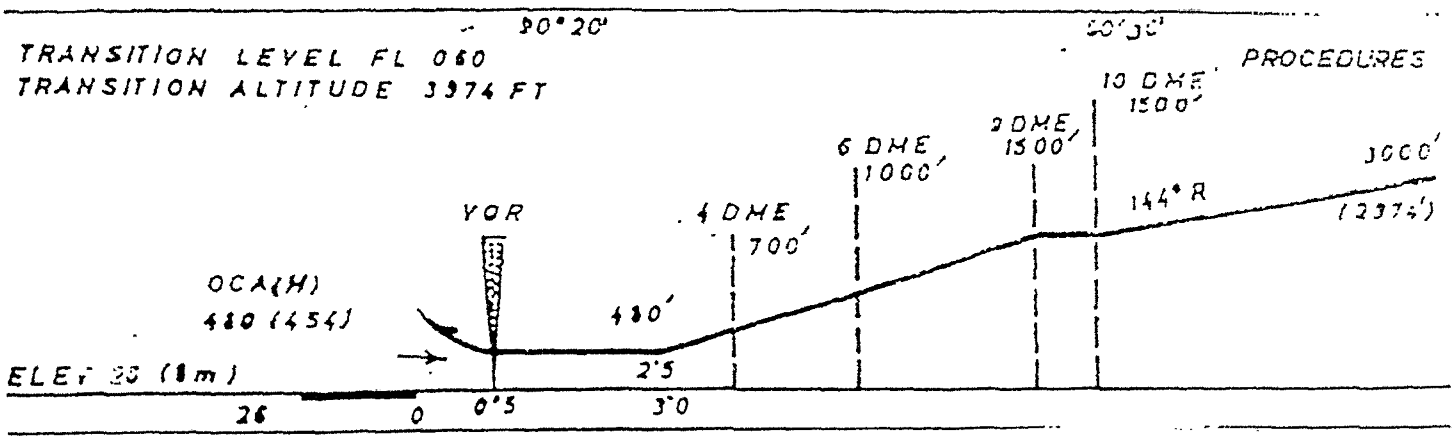

Figure 5. VOR DME-ARC
(source - State AIP)

Whilst Figure 5 does not show a stepped approach, the descent to the threshold is again 150 ft/nm, or 1.4 degrees. Figures 4 and 5 show arrival at the MDA, 480 ft, at a distance of 3 nm or more prior to the threshold. At 3 nm on this approach the altitude, for an optimum descent, should be 1000 ft (in fact 3 x 300 + 50 + 26 = 976 ft).

Approach plates for the VOR DME-1, VOR DME-2 and VOR DME-ARC approaches to the this same runway are provided, for direct comparison, in Figure 6. There would not appear to be any reason why the three stepped final approaches to this runway should not be eliminated, and a 3 degree approach slope instituted. The descents should commence at the same DME and altitude. This would provide standardization for the approaches to the same runway, and the optimum approach slope. The check DME distances and altitudes on the descent for the final approach should be the same for each of these similar approach procedures. Different procedures will be required to bring aeroplanes to the inbound final track and to the point at which the descent should be commenced.

Non-precision approach - misleading depiction of vertical profile.

The third example (Fig.7 and 8) shows an alternative localizer approach for an ILS glide slope out situation. The vertical profiles are taken from a commercial approach plate and from the AIP. The vertical profile shown in Figure 7 is a direct invitation to the pilot to make an early descent to the MDA. The ILS DA/H is 1814/252 ft and the LOC (GP out) MDA/H 1920/358 ft.

Figure 7. ILS and LOC (GS out) approach.
(source - commercial approach plate)

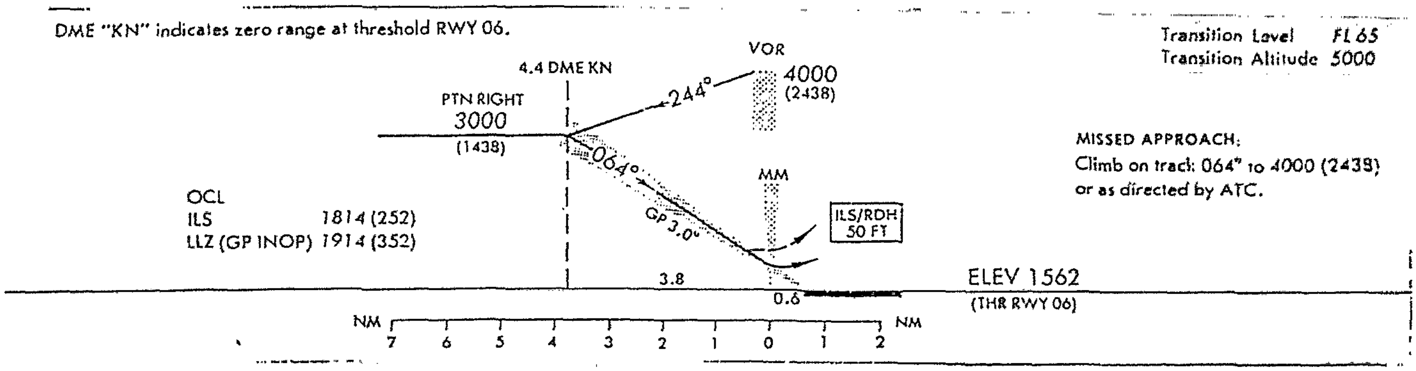

Figure 8. ILS and LLZ (GP INOP) approach.
(source - State AIP)

Figures 7 and 8 show information for the same approaches, with a misleading depiction, an invitation to early descent, with improper use of the broken line, to show the alternative approach, in Figure 7.

INFORMATION ON NON-PRECISION INSTRUMENT APPROACHES WHERE THE FINAL APPROACH IS LESS THAN 2.5 DEGREES. PROVIDED BY A MAJOR INTERNATIONAL OPERATOR
(material yet to be received from British Airways/AERAD)

CONCLUSIONS

1. It must be accepted by all operational personnel that standardization of instrument approaches and the use of the optimum final approach descent gradient is a major flight safety objective which would increase the safety of the approach to landing phase of flight. This is where the majority of accidents occur.

2. Non-precision instrument approaches should be designed with the priority on the optimum, 5%, or 3 degree, final approach descent gradient.

3. ICAO should publish a minimum final approach descent gradient in PANS OPS and apply more emphasis on the use of the optimum of 3 degrees .

4. ICAO instrument approach procedure design guidance material should be revised to ensure that there is no encouragement to design shallow approaches.

5. Immediate efforts should be made to have all non-precision approaches, where the final approach is less than 2.5 degrees, redesigned to a minimum of 2.5 degrees and preferably to 3 degrees.

6. Non-precision approaches that are stepped, and average less than a 3 degrees, should be redesigned with a minimum 3 degree approach which would eliminate many stepped procedures.

7. Efforts should be made to ensure that the depiction of a vertical profile for an alternative non-precision approach does not invite pilots to conduct an early descent to the MDA.

8. Efforts should be made to ensure the usage of arrowed broken and dotted lines, as set out in Annex 4, 11.10.6.1 and 2. Broken lines should not be used to show the vertical profiles, or tracks, of additional approaches, only for showing the missed approach profile and track.

9. Annex 4, 11.10.6 and the Aeronautical Chart Manual (Doc 8697) should be amended to properly reflect the different usage between "track" and "profile".

10. The Aeronautical Chart Manual (Doc 8697) should be expanded to include illustrations of various types of instrument approach procedure.

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Managing Automation in the Cockpit

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Managing Automation in the Cockpit

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Abstract: Automation has been promoted as a way to improve both aviation safety and efficiency. In many ways automation has indeed kept its promise; in many other ways it has been found to be lacking. This study's data were collected using questionnaires, interviews, flight observation, and simulation training observation. While the findings were supportive of the earlier work of Wiener and Nagel, they also identified several new problems. The pilot-computer interfaces are generally non-intuitive for pilots. In addition, several interface problems were due to the inadequate memory of the host computer. These design shortfalls create management challenges for pilots and operators alike.

Key words: human factors, ergonomics, automation, human-computer interface, corporate aviation, regulations, safety, training

INTRODUCTION

Corporate aviation[1] is expanding its use of automation, with some corporate aircraft having greater sophistication than air carrier aircraft. Previous studies (Wiener & Curry, 1980; Wiener, 1989) have identified a number of safety concerns associated with automation in the airline industry. The problems identified were often associated with periods of change (e.g., amendments in flight plan, vectors for traffic). Because the *raison d'être* of corporate aviation is flexibility and change, it would appear to follow that the corporate aviation industry may be more susceptible to some of the negative effects of automation. As a matter of fact, NASA's Aviation Safety Reporting System[2] identified 84 self-reported incidents between 1986 and 1991 (Aviation Safety Reporting System, 1992) that involved advanced automated corporate aircraft.

Corporate aviation by its nature describes a very wide range of activities and sophistication. Operations vary from a small business where the owner personally flies herself to meetings, to dispersed fleets of large aircraft. As a result, the levels of automation vary from a simple two axis autopilot to sophisticated computer based flight management systems capable of flying the aircraft from lift-off to touch down while maintaining optimum performance throughout. It was therefore necessary to limit the scope of this study to only a those aircraft with both cathode ray tube based displays and computer-based flight management systems. The study included observations of flight departments that varied from dispersed multiple location operations to an operation where one person acted as manager, maintainer, and pilot (the aircraft used was approved for single-pilot operation).

Another area that makes corporate aviation unique is that its pilots are usually type-rated in more than one aircraft. While this was a challenge in the days of conventional controls and displays — where the pilots had to learn basic systems and flight characteristics of the various aircraft — the new world of automation *also* makes it necessary that pilots essentially learn different computer operating systems. This problem is exacerbated by the fact that the interface for

[1] Corporate aviation is the part of general aviation that supports the travel of businesses and corporations, particularity the upper management of those organizations.

[2] It should be noted that since it is a voluntary report, only a fraction of all incidents are reported to the System.

mechanical designs, and it may be some time until familiarity with the systems and creativity mix to allow the creation of a truly superior interface. But, improvements are needed if the real potential of the automation is to be achieved.

One area of the human-computer interface that needs significant work is coding. Much of the coding techniques have become aircraft and/or manufacturer specific. In some ways we have come full circle and now transitioning between automated aircraft is often like transitioning between aircraft in the '30s and '40s, when each manufacturer put the basic flight instruments where they wanted. Every time one changed airplanes (often within the same aircraft model) one had to learn a new cross-check sequence. Basic coding standards need to be developed and followed.

Standards are especially needed for color coding. Color appears to be primarily used as a marketing tool and very seldom is based on the perceptual and cognitive attributes of the color. Basic principle driven criteria need to be established and followed for color coding. The application of color without such guidelines can and often does result in decreased performance (e.g., errors).

Awareness of the mode within which the system is operating is an aspect of automation use which shows a steep learning curve that never asymptotes (even for those who spend over 400 hours per year in automated aircraft). The mode awareness survey showed that unexpected or unexplained FMS events tend to be infrequent, minor in nature, and quickly detected. However, the open ended responses were frequent and describe a variety of surprises experienced by the pilots. Such errors suggest that the feedback should be improved so that pilot awareness of system mode and expected action is more easily accomplished. For example, several inflight experiences demonstrated pilots changing from "Heading" to "FMS" mode and being surprised by the abrupt change in direction of flight. Such actions are technically correct for the automation, but not what the pilot intended. A clearer display of mode and/or the design of the system to more typically match the mental model pilots have of how things operate would reduce such experiences.

The pilot-computer interface problems identified by this study can usually be resolved by altering the human, the computer, or both. In many cases, the errors made by pilots are design-induced errors; that is, if the interface was designed differently, these errors would not occur. Thus, while it often appears easier to alter the human side of the equation (i.e., training), it is usually most efficient in the long run to alter the computer side of the equation. The following recommendations are offered for discussion.

- Human factors criteria for the human-computer interface of civilian aviation equipment should be developed. These criteria should be principle driven rather than "design specifications".

- A minimal set of interface standards needs to be developed that would be required for all automated systems. An aircraft's equipment behavior and the pilot's expectations of that behavior should match and should be system independent.

- The amount and type of feedback from the automated systems to the pilots should be improved in order to decrease mode errors.

- Automated systems should be designed to be as consistent as possible, both within and across aircraft. Consistency is an overriding principle that affects usability of a system.

Flight Safety Foundation

CFIT Checklist

Evaluate the Risk and Take Action

Printing and distribution made possible by a grant from

Flight Safety Foundation (FSF) designed this controlled-flight-into-terrain (CFIT) risk-assessment safety tool as part of its international program to reduce CFIT accidents, which present the greatest risks to aircraft, crews and passengers. The FSF CFIT Checklist is likely to undergo further developments, but the Foundation believes that the checklist is sufficiently developed to warrant distribution to the worldwide aviation community.

Use the checklist to evaluate specific flight operations and to enhance pilot awareness of the CFIT risk. The checklist is divided into three parts. In each part, numerical values are assigned to a variety of factors that the pilot/operator will use to score his/her own situation and to calculate a numerical total.

In *Part I: CFIT Risk Assessment,* the level of CFIT risk is calculated for each flight, sector or leg. In *Part II: CFIT Risk-reduction Factors,* Company Culture, Flight Standards, Hazard Awareness and Training, and Aircraft Equipment are factors, which are calculated in separate sections. In *Part III: Your CFIT Risk*, the totals of the four sections in *Part II* are combined into a single value (a positive number) and compared with the total (a negative number) in *Part I: CFIT Risk Assessment* to determine your CFIT Risk Score. To score the checklist, use a nonpermanent marker (do not use a ballpoint pen or pencil) and erase with a soft cloth.

Part I: CFIT Risk Assessment

Section 1 – Destination CFIT Risk Factors	Value	Score
Airport and Approach Control Capabilities:		
ATC approach radar with MSAWS	0	
ATC minimum radar vectoring charts	0	
ATC radar only	-10	
ATC radar coverage limited by terrain masking	-15	
No radar coverage available (out of service/not installed)	-30	
No ATC service	-30	
Expected Approach:		
Airport located in or near mountainous terrain	-20	
ILS	0	
VOR/DME	-15	
Nonprecision approach with the approach slope from the FAF to the airport TD shallower than 2 3/4 degrees	-20	
NDB	-30	
Visual night "black-hole" approach	-30	
Runway Lighting:		
Complete approach lighting system	0	
Limited lighting system	-30	
Controller/Pilot Language Skills:		
Controllers and pilots speak different primary languages	-20	
Controllers' spoken English or ICAO phraseology poor	-20	
Pilots' spoken English poor	-20	
Departure:		
No published departure procedure	-10	
Destination CFIT Risk Factors Total	(–)	

Section 2 – Risk Multiplier

	Value	Score
Your Company's Type of Operation (select only one value):		
Scheduled	1.0	_____
Nonscheduled	1.2	_____
Corporate	1.3	_____
Charter	1.5	_____
Business owner/pilot	2.0	_____
Regional	2.0	_____
Freight	2.5	_____
Domestic	1.0	_____
International	3.0	_____
Departure/Arrival Airport (select single highest applicable value):		
Australia/New Zealand	1.0	_____
United States/Canada	1.0	_____
Western Europe	1.3	_____
Middle East	1.1	_____
Southeast Asia	3.0	_____
Euro-Asia (Eastern Europe and Commonwealth of Independent States)	3.0	_____
South America/Caribbean	5.0	_____
Africa	8.0	_____
Weather/Night Conditions (select only one value):		
Night — no moon	2.0	_____
IMC	3.0	_____
Night and IMC	5.0	_____
Crew (select only one value):		
Single-pilot flight crew	1.5	_____
Flight crew duty day at maximum and ending with a night nonprecision approach	1.2	_____
Flight crew crosses five or more time zones	1.2	_____
Third day of multiple time-zone crossings	1.2	_____
Add Multiplier Values to Calculate Risk Multiplier Total		_____

Destination CFIT Risk Factors Total ¥ Risk Multiplier Total = CFIT Risk Factors Total (–) _____

Part II: CFIT Risk-reduction Factors

Section 1 – Company Culture

	Value	Score
Corporate/company management:		
Places safety before schedule	20	_____
CEO signs off on flight operations manual	20	_____
Maintains a centralized safety function	20	_____
Fosters reporting of all CFIT incidents without threat of discipline	20	_____
Fosters communication of hazards to others	15	_____
Requires standards for IFR currency and CRM training	15	_____
Places no negative connotation on a diversion or missed approach	20	_____

115-130 points	Tops in company culture
105-115 points	Good, but not the best
80-105 points	Improvement needed
Less than 80 points	High CFIT risk

Company Culture Total (+) _____ *

Section 2 – Flight Standards

	Value	Score
Specific procedures are written for:		
Reviewing approach or departure procedures charts	10	______
Reviewing significant terrain along intended approach or departure course	20	______
Maximizing the use of ATC radar monitoring	10	______
Ensuring pilot(s) understand that ATC is using radar or radar coverage exists	20	______
Altitude changes	10	______
Ensuring checklist is complete before initiation of approach	10	______
Abbreviated checklist for missed approach	10	______
Briefing and observing MSA circles on approach charts as part of plate review	10	______
Checking crossing altitudes at IAF positions	10	______
Checking crossing altitudes at FAF and glideslope centering	10	______
Independent verification by PNF of minimum altitude during stepdown DME (VOR/DME or LOC/DME) approach	20	______
Requiring approach/departure procedure charts with terrain in color, shaded contour formats	20	______
Radio-altitude setting and light-aural (below MDA) for backup on approach	10	______
Independent charts for both pilots, with adequate lighting and holders	10	______
Use of 500-foot altitude call and other enhanced procedures for NPA	10	______
Ensuring a sterile (free from distraction) cockpit, especially during IMC/night approach or departure	10	______
Crew rest, duty times and other considerations especially for multiple-time-zone operation	20	______
Periodic third-party or independent audit of procedures	10	______
Route and familiarization checks for new pilots		
Domestic	10	______
International	20	______
Airport familiarization aids, such as audiovisual aids	10	______
First officer to fly night or IMC approaches and the captain to monitor the approach	20	______
Jump-seat pilot (or engineer or mechanic) to help monitor terrain clearance and the approach in IMC or night conditions	20	______
Insisting that you fly the way that you train	25	______

300-335 points	Tops in CFIT flight standards
270-300 points	Good, but not the best
200-270 points	Improvement needed
Less than 200	High CFIT risk

Flight Standards Total (+) _____ *

Section 3 – Hazard Awareness and Training

	Value	Score
Your company reviews training with the training department or training contractor	10	______
Your company's pilots are reviewed annually about the following:		
Flight standards operating procedures	20	______
Reasons for and examples of how the procedures can detect a CFIT "trap"	30	______
Recent and past CFIT incidents/accidents	50	______
Audiovisual aids to illustrate CFIT traps	50	______
Minimum altitude definitions for MORA, MOCA, MSA, MEA, etc.	15	______
You have a trained flight safety officer who rides the jump seat occasionally	25	______
You have flight safety periodicals that describe and analyze CFIT incidents	10	______
You have an incident/exceedance review and reporting program	20	______
Your organization investigates every instance in which minimum terrain clearance has been compromised	20	______

You annually practice recoveries from terrain with GPWS in the simulator	40	____
You train the way that you fly	25	____

285-315 points	Tops in CFIT training	
250-285 points	Good, but not the best	**Hazard Awareness and Training Total** (+) ____
190-250 points	Improvement needed	
Less than 190	High CFIT risk	

Section 4 – Aircraft Equipment

Aircraft includes:	**Value**	**Score**
Radio altimeter with cockpit display of full 2,500-foot range — captain only	20	____
Radio altimeter with cockpit display of full 2,500-foot range — copilot	10	____
First-generation GPWS	20	____
Second-generation GPWS or better	30	____
GPWS with all approved modifications, data tables and service bulletins to reduce false warnings	10	____
Navigation display and FMS	10	____
Limited number of automated altitude callouts	10	____
Radio-altitude automated callouts for nonprecision approach (not heard on ILS approach) and procedure	10	____
Preselected radio altitudes to provide automated callouts that would not be heard during normal nonprecision approach	10	____
Barometric altitudes and radio altitudes to give automated "decision" or "minimums" callouts	10	____
An automated excessive "bank angle" callout	10	____
Auto flight/vertical speed mode	-10	____
Auto flight/vertical speed mode with no GPWS	-20	____
GPS or other long-range navigation equipment to supplement NDB-only approach	15	____
Terrain-navigation display	20	____
Ground-mapping radar	10	____

175-195 points	Excellent equipment to minimize CFIT risk	
155-175 points	Good, but not the best	**Aircraft Equipment Total** (+) ____
115-155 points	Improvement needed	
Less than 115	High CFIT risk	

Company Culture ______ + Flight Standards ______ + Hazard Awareness and Training ______
+ Aircraft Equipment ______ = CFIT Risk-reduction Factors Total (+) ______

*** If any section in Part II scores less than "Good," a thorough review is warranted of that aspect of the company's operation.**

Part III: Your CFIT Risk

Part I CFIT Risk Factors Total (−) ____ + **Part II CFIT Risk-reduction Factors Total** (+) ____

= CFIT Risk Score (±) ____

A negative CFIT Risk Score indicates a significant threat; review the sections in Part II and determine what changes and improvements can be made to reduce CFIT risk.

 To request more information or to offer comments about the FSF CFIT Checklist, contact Robert H. Vandel, director of technical projects, Flight Safety Foundation, 601 Madison Street, Suite 300, Alexandria, VA 22314 U.S., Phone: 703-739-6700 • Fax: 703-739-6708

FLIGHT SAFETY FOUNDATION

Safety Alert

Flight Safety Foundation recommends immediate implementation of the following ground-proximity warning system (GPWS) procedures by all flight operations:

- **When a GPWS warning occurs, pilots should immediately, and without hesitating to evaluate the warning, execute the pull-up action recommended in the company procedure manual;**
- **In the absence of a company procedure, an immediate maximum performance full-power climb should be initiated and continued until the GPWS warning stops and the crew determines that terrain clearance is assured;**
- **This immediate pull-up procedure should be followed except in clear daylight visual meteorological conditions when the flight crew can immediately and unequivocally confirm a false GPWS warning; and,**
- **Air traffic control (ATC) should be notified as soon as possible after a GPWS warning or pull-up.**

Flight Safety Foundation, drawing on broad support from the worldwide aviation industry, has launched an ambitious international project to reduce by 50 percent the number of controlled-flight-into-terrain (CFIT) accidents and approach/landing accidents during the next five years. This Safety Alert is being distributed to air carriers and other flight operators throughout the world as a result of the Foundation CFIT task force's early findings, which are listed below.

- CFIT represents the single largest risk to aircraft;
- Fifty percent of recent CFIT accidents occurred to aircraft without operational GPWS; many others involved early-generation GPWS known to give false warnings;
- Of those CFIT accidents in which aircraft were equipped with a properly operating GPWS, an alarming number of flight crews did not follow recommended pull-up procedures in response to GPWS warnings; and,
- Flight crews in CFIT accidents often ignored GPWS warnings; delayed recommended pull-up procedures while trying to evaluate the accuracy of the GPWS warning; or failed to respond with sufficient aggressive pull-up action.

FLIGHT SAFETY FOUNDATION

DECEMBER 1994

FLIGHT SAFETY DIGEST

The Dollars and Sense of Risk Management And Airline Safety

ICARUS Committee Report

The Dollars and Sense of Risk Management And Airline Safety

Risk management programs are essential tools for airline management to achieve acceptable safety standards while pursuing production objectives, reports Flight Safety Foundation ICARUS Committee.

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ICARUS Committee

Responsibility for aviation safety begins at the very top of an airline company. History has demonstrated repeatedly that without the complete commitment of the highest management levels within a company, operational safety margins are seriously eroded. This does not suggest that a company *will* have an accident, but it does suggest that the risk of having an accident is high — the laws of probability will prevail.

Management has great leverage in affecting operational safety within a company. Through its attitudes and actions, management influences the attitudes and actions of all others within a company: Management defines the safety culture of an organization. This safety culture extends all the way to the maintenance shop floor, to the ramp, to the cabin and to the cockpit. Furthermore, the public and government authorities are increasingly recognizing management's role in air safety by holding management accountable for a serious incident or accident; this accountability is magnified many-fold if a company suffers several such incidents or accidents during the course of a few years.

The following information is designed to provide insight into the costs, causes and prevention of aviation accidents — to be a practical guide for management, not a theoretical treatise.

Safety Fits into Production Objectives

Accidents and incidents are preventable through effective management; doing so is cost-effective. An airline is formed to achieve practical objectives. Although frequently so stated, safety is not, in fact, the primary objective. The airline's objectives are related to production: transporting passengers or transporting goods and producing profits. Safety fits into the objectives, but in a supporting role: to achieve the production objectives without harm to human life or damage to property.

Management must put safety into perspective, and must make rational decisions about where safety can help meet the objectives of the organization. From an organizational perspective, safety is a method of conserving all forms of resources, including controlling costs. Safety allows the organization to pursue its production objectives without harm to human life or damage to equipment. Safety helps management achieve objectives with the least risk.

Although risk in aviation cannot be eliminated, risk can be controlled successfully through programs to identify and correct safety deficiencies before an accident occurs. Such risk management programs are essential tools for management to achieve acceptable levels of safety while pursuing the production goals of the organization.

The airline has to allocate resources to two distinct but interrelated objectives: the company's primary production goals and safety. In the long term, these are clearly compatible objectives, but because resources are finite, there are on many occasions short-term conflicts of interest. Resources allocated to the pursuit of production objectives could diminish those available for safety and vice versa. When facing this dilemma, it may be tempting to give priority to production management over safety or risk management. Although a perfectly understandable reaction, it is ill-advised and it contributes to further safety deficiencies that, in turn, will have long-term adverse economic consequences.

1. Safety is of major concern to the aviation industry and to the public. When compared with other transportation industries — maritime, rail or road transportation — the aviation industry enjoys a superior safety record. Safety consciousness within the industry and the resources that aviation organizations devote to safety are among the reasons for this record.

Nevertheless, there are continuing concerns about maintaining, and improving, the favorable aviation safety record. The ever-increasing capacity of transport aircraft and the growth of global air traffic justify these concerns. For example, transport aircraft seating 300 to 500 passengers are now common, and plans for larger aircraft are under way; congestion in air traffic at complex hubs is also commonplace.

These are but two examples of what can become a statistician's — and an airline manager's — nightmare considering the potential for economic catastrophe to the industry. Newspaper headlines and extensive television coverage of aircraft accidents will become more sensational and more frequent even if safety levels remain the same. Simply put, as a consequence of growth, accident rates deemed acceptable in the past will be inappropriate in the future.

2. All those involved in aviation operations at every level have some responsibility for the safe outcome of such operations. There are, of course, different levels of human involvement and intervention. The physical proximity of a particular level to operational settings does not have a straight-line relationship with the potential for influencing risk in such operations.

Simply put, as a consequence of growth, accident rates deemed acceptable in the past will be inappropriate in the future.

Conventional wisdom allocates safety responsibilities almost exclusively to those at the operational end: flight crews, air traffic controllers, technicians and others.

Safety responsibilities often have been perceived to diminish as one moves away from the cockpit and toward the executive suite. Nevertheless, this notion does not hold true when viewed through the wider lens of systems safety.

From a top-down perspective, within any aviation organization there are at least four levels of human intervention that can greatly affect the level of risk:

- Senior management;
- Line management;
- Inspectors and quality control personnel; and,
- Operational personnel.

Within any civil aviation system, there are at least four major institutions to which these personnel might report:

- Civil aviation administration;
- Safety/accident investigation agency;
- Operators; and,
- Training, maintenance and other support organizations.

3. Each organizational and institutional level has unique opportunities to contribute to safety within the air transport industry, and overall system safety is determined by the interdependent actions of each. There are decisions that senior management — and only senior management — can take (or refrain from taking) that will directly affect safety. No other level can fully compensate for flaws in these decisions after they are implemented; they can only attempt to minimize the adverse consequences of flawed decisions.

By the same token, there are risky or unsafe decisions by operational personnel over which senior management has little or no direct control. And there are inherent limitations to the effectiveness of safety measures that operators can take when facing, for example, flawed regulations.

These flawed regulations may, in turn, result from the failure of an accident investigation agency to uncover fundamental safety deficiencies underlying accidents. Such deficiencies may be traced to deficient training of the investigators or may be fostered by flawed national legislation.

Actions and decisions within the exclusive domain of each organization can greatly affect the ability of the other organizations to discharge their safety responsibilities. Strong and sometimes complex interactions exist among the decisions and actions taken by various levels within and between air transportation organizations and institutions.

4. Historically, safety activities have focused on the organizational and institutional levels in closest temporal or physical proximity to an accident, i.e., operators and operational personnel. Improving the performance of operational personnel, primarily through high-quality training, has greatly enhanced aviation safety.

The industry, however, has reached a point of diminishing returns from this approach; it has reached the stage where a greater expenditure of resources at the operational end of the system will not result in proportionate safety benefits.

New methods of accident prevention emphasize looking at the total picture and taking into account accident prevention strategies in all industrial activities.

Another objective is to develop a perspective that views safety, or risk management, in the context of the primary production goals of civil aviation organizations. Because risk management activities, and the failure to manage risk, involve the expenditure of resources, it is critical that such a perspective be developed.

How Much Does It Cost To Have an Accident?

5. There are two basic categories of accident costs: (1) insured costs, generally including hull losses, property damage and personal liability; and (2) uninsured costs. Insured costs — those covered by paying premiums to insurance companies — can be recovered to a greater or lesser extent. Uninsured costs cannot be recovered, and they may double or triple the insured costs. Typical uninsured tangible and intangible costs of an accident include:

- Insurance deductibles;
- Increased operating costs on remaining equipment;
- Loss of spares or specialized equipment;
- Fines and citations;
- Legal fees resulting;
- Lost time and overtime;
- Increased insurance premiums;
- Cost of the investigation;
- Liability claims in excess of insurance;
- Morale;
- Corporate manslaughter/criminal liability;
- Cost of hiring and training replacements;
- Reaction by crews leading to disruption of schedules;
- Loss of business and damage to reputation;
- Loss of productivity of injured personnel;
- Cost of corrective action;
- Cost of restoration of order;
- Loss of use of equipment; and,
- Cost of rental or lease of replacement equipment.

6. The costs of accidents vary greatly from country to country, and although such costs may be quantified, the monetary value is not always the most critical factor. Some uninsured costs can acquire greater importance than the direct financial effect measured by accounting methods.

The economic and political context largely determines the relative importance of the monetary costs of an accident, as opposed to other factors. In industrialized nations, monetary costs of an accident may be the overriding consideration. In other countries, avoiding damage to the public's confidence in the nation's air transportation system may be a more important consideration. Where airlines are flag carriers, perceived damage to the national image among the international community may be the central consideration. In some situations, the loss of equipment in an accident might disrupt regular international services, a consideration that also might override the monetary costs. The fundamental message is twofold: first, there are economic consequences of aviation safety; second, the costs and benefits of safety cannot be measured only in economic terms.

7. "Unwanted outcomes" other than accidents also incur significant costs for an airline. Maintenance and ramp incidents, for example, present safety issues that can have significant costs, and must be considered as part of a global strategy for safety management. Ramp and ground-handling operations have the potential to cause a major accident, such as through unreported ground-handling damage to aircraft. Costs in maintenance and ramp operations should be a major concern, because aircraft and other equipment are easy to damage and expensive to repair. Indirect costs also include schedule disruption following damage of aircraft or equipment. The ramp and the hangar are also dangerous environments in which to work, given the risk of accidental death or disabling injury. As with flight accident prevention, responsibility for hangar and ramp safety resides at four levels within an organization:

- Senior management;
- Individual supervisors;
- Quality control personnel; and,
- Operational personnel.

Human Errors Occur at Management Level Too

8. Human error is the primary cause for hull losses, fatal accidents and incidents. To devise the appropriate countermeasures, human error must be put into context. Human error in aviation has been almost always associated with operational personnel (pilots, mechanics, controllers, dispatchers, etc.), and measures aimed at containing such error have usually been directed to them. Nevertheless, during the last decade or so, a significant shift toward a substantially different perspective on human error has developed. It has considerable implications in terms of prevention measures and strategies.

9. The aviation system includes numerous safety defenses. Accidents in such a system are usually the result of an unfortunate combination of several enabling factors, each one necessary, but in itself not sufficient, to breach the multiple

layers of system defenses. Because of constant technological progress, equipment failures rarely cause aviation accidents. Likewise, operational personnel errors — although usually the precipitating factors — are seldom root causes of accidents and incidents.

The analysis of recent major accidents both in aviation and in other high-technology industries suggests that it is necessary to look beyond operational personnel errors, into another level of human error: human decision-making failures that occur primarily in managerial sectors.

10. Depending on how immediate their consequences are, human failures can be viewed either as active failures — errors having an immediate adverse effect and generally associated with operational personnel (pilot, controller, technician, etc.) — or latent failures, which are decisions that may not generate visible consequences for a long time.

Typical latent failures in line management include inadequate operating procedures, poor scheduling and neglect of recognized hazards.

Latent failures become evident when combined with active failures, technical problems or other adverse conditions, resulting in a break-through of system defenses, thus producing accidents. Latent failures are present in the system well before an accident, and are originated most likely by decision makers and other personnel far removed in time and space from the event. Examples of latent failures include poor equipment design, improper allocation of resources to achieve the declared goals of the organization and defective communications between management and operational personnel. Through their actions or inaction, operational personnel unknowingly create the conditions under which these latent failures become apparent, often with tragic and costly consequences.

The implication for accident prevention strategies is clear. Safety management will be more successful and cost less if directed at discovering and correcting latent failures rather than at focusing only on the elimination of active failures. While it is vital to minimize them, active failures are only the proverbial tip of the iceberg.

11. Even in the best-run organizations, some important high-level decisions are less than optimum because they are made subject to normal human limitations. Typical latent failures in line management include inadequate operating procedures, poor scheduling and neglect of recognized hazards. Latent failures like these may lead to inadequate work-force skills, inappropriate rules or poor knowledge; or they may result in poor planning or workmanship.

12. Management's appropriate response to latent failures is vital. Response may consist of denial, by which operational personnel involved in accidents are dismissed or otherwise punished and the existence of the underlying latent failures is denied; repair, by which operational personnel are disciplined and equipment modified to prevent recurrence of a specific observed active failure; or reform, by which the problem is acknowledged and global action taken, leading to an in-depth reappraisal and eventual reform of the system as a whole. Only the last response is fully appropriate.

To Err Is Normal

13. Error must be accepted as a normal component of human behavior. Humans, be they pilots, engineers or managers, will from time to time commit errors. Exhortations to "be professional" or to "be more careful" are generally ineffective, because most errors are committed inadvertently by people who are already trying to do their job professionally and carefully. They did not intend to commit the errors.

The solution is to devise procedures and equipment that resist human error. Because technology or training cannot prevent all errors, an equally vital step is to introduce error tolerance into equipment and procedures, so when an error does occur, it is detected and is corrected before there is a catastrophic outcome. Error resistance and error tolerance are important strategies in accident prevention. Of fundamental importance, however, is the recognition that human error must be treated as a symptom, rather than a cause, of accidents and incidents.

14. Psychological factors underlie human error. Often, personnel assigned to tasks do not possess the basic traits or fundamental skills needed to successfully perform them. While formal personnel selection techniques provide some degree of protection, it is impossible to guarantee that all candidates will be able to perform satisfactorily in line operations. The issue is further complicated because proper performance under unsupervised conditions — such as during line operations — rests essentially on proper motivation, and although most professional aviation personnel are highly motivated, other factors can adversely affect such motivation.

Even with these limitations, proper selection techniques constitute an important line of defense. If an organization uses inadequate personnel screening and selection techniques, a latent failure exists within that organization, and may only become manifest through a serious incident or accident.

15. Training deficiencies frequently underlie human error. Training aims at developing basic knowledge and skills required for on-the-job performance; deficient training will obviously foster deficient performance and pave the way for error. Other potential sources of human error include poor ergonomic design of equipment or deficient procedures for using such equipment. Training deficiencies and flawed operational procedures are

latent failures, and thus usually do not have immediate consequences. But, when combined with active failures in operational settings, these latent failures can lead to accidents.

16. Selection, training and equipment design focus on the performance of individuals in the system. Big dividends are obtained by addressing individual performance, but the biggest dividends require a larger frame of reference. Human performance does not take place in a social vacuum, but it is strongly influenced by the environmental, organizational and institutional context in which it occurs. The socioeconomic and legal environment, the way in which the organization is designed and the institutions to which personnel belong, all influence human performance. These are also the breeding grounds for latent failures. From a monetary viewpoint, it makes sense to address latent failures. Canceling one latent failure (for example, training deficiencies) will eliminate multiple active failures, and thereby have a major effect on risk. By focusing on identifying and correcting latent failures, management leverages its ability to control risk.

With the Proper Tools, Human Error Is Manageable

17. The primary message here is that human error is manageable. Error management requires understanding the individual as well as organizational and institutional factors. Human-error accidents, which most accidents are, can then be controlled cost-effectively.

18. Education is an essential prerequisite for effective management of human error. The concepts of accident causation, human error and error management discussed in this brief are the bedrock of such education. Implementing training systems that develop knowledge and skills among operational personnel consistent with organizational objectives, and operational procedures that are compatible with human capabilities and limitations, is fundamental. A quality control system that is oriented toward quality assurance rather than pointing fingers and allocating blame completes the necessary feedback loops to ensure effectiveness of training and procedure development programs.

19. An active management role in safety promotion involves:

Allocation of resources. Management's most obvious contribution to safety is allocating adequate resources to achieve the production objectives of the organization (transporting people, maintaining aircraft, etc.) at acceptable levels of risk.

Safety programs and safety feedback systems. Such programs should include not only flight safety, but also maintenance safety, ramp safety, etc.

Internal feedback and trend monitoring systems. If the only feedback comes from the company's accident statistics, the information arrives too late to be useful for controlling risk, because the events that safety management seeks to eliminate have already occurred. Identification of latent failures provides a much greater opportunity for proactive enhancement of safety.

Incident reporting programs. It has been estimated that for each major accident (involving fatalities), there are as many as 360 incidents that, properly investigated, might have identified an underlying problem in time to prevent the accident. In the past two decades, there has been much favorable experience with nonpunitive incident and hazard reporting programs. Many countries have such systems, including the Aviation Safety Reporting System (ASRS) in the United States and the Confidential Human Factors Incident Reporting Program (CHIRP) in the United Kingdom. In addition to the early identification and correction of operational risks, such programs provide much valuable information for use in safety awareness and training programs.

Besides the national programs, many airlines have found it useful to add their own internal incident reporting systems. These systems can range in complexity and cost from simple and inexpensive telephone "hot lines" to more complex (and usually more cost-effective) systems involving computer data bases, trend identification and monitoring programs, and other sophisticated safety management tools. Some of these systems have been made available to the airline community at a modest cost by their developers.

One notable system is the British Airways Safety Information System (BASIS), which allows active tracking of many different kinds of safety-related information. A similar system, "Safety Manager's Tool Kit," is available from the International Air Transport Association (IATA). Systems like these have tended to show a positive short-term economic benefit in addition to improved operational safety.

Standardized operating procedures. Standardized operating procedures (SOPs) have been recognized as a major contribution to flight safety. Procedures are specifications for conducting actions; they specify a progression of steps to help operational personnel perform their tasks in a logical, efficient and, most important, error-resistant way. Procedures must be developed with consideration for the operational environment in which they will be used. Incompatibility of the procedures with the operational environment can lead to the informal adoption of unsafe operating practices by operational personnel. Feedback from operational situations, through observed practices or reports from operational personnel, is essential to guarantee that procedures and the operational environment remain compatible.

Risk management. The purpose of internal feedback and trend monitoring programs is to allow managers to assess the risks involved in the operations and to determine logical approaches to counteract them. There will always be risks in aviation operations. Some risks can be accepted; some — but not all — can be eliminated; and others can be reduced to the point where they are acceptable. Decisions on risk are managerial; hence the term "risk management."

Risk management decisions follow a logical pattern. The first step is to accurately assess hazards. The second step is to assess the risk involved in such hazards and determine whether the organization is prepared to accept that risk. The crucial points are the will to use all available information and the accuracy of the information about the hazards, because no decision can be better than the information on which it is based. The third step is to find which hazards can be eliminated and proceed to eliminate them. If none of the identified hazards can be eliminated, then the fourth step is to look for the hazards that can be reduced. The objective is to reduce the probability that a particular hazard will occur, or reduce the severity of the effects if it does occur. In some cases, the risk can be reduced by developing means to cope safely with the hazard.

20. In large organizations, such as airlines, the costs associated with loss of human life and physical resources mean that risk management is essential. To produce recommendations that coincide with the objectives of the organization, a systems approach to risk management must be followed. Such an approach, in which all aspects of the organization's objectives and available resources are analyzed, offers the best option for ensuring that recommendations concerning risk management are realistic.

Resources Are Required

21. The safety monitoring and feedback programs should be administered by an independent company safety officer, reporting directly to the highest level of corporate management. The company safety officer and his or her staff must be quality control managers, looking for ways to correct corporate safety deficiencies, rather than pointing fingers at individuals who commit errors.

To discharge their responsibilities for the company and the industry, they need information that may originate through several sources: internal safety audits that identify potential safety hazards, internal incident reporting systems, internal investigations of critical incidents and performance monitoring programs. Armed with information, the safety officer can implement a program for dissemination of safety critical information to all personnel. The stage is then set for a safety-oriented organizational climate.

22. Management attitudes can be translated into concrete actions by the provision of well-equipped, well-maintained and standardized cockpits and other workstations; the careful development and implementation of, and rigid adherence to, SOPs; and a thorough training and checking program that ensures that operational personnel have the requisite skills to operate the aircraft safely. These actions build the foundation on which everything else rests.

Resources Are Available

23. Honest and forthright self-examination is one of the most powerful, and cost-effective, risk-management tools available, and should be performed regularly by all organizations. To help airline managers identify risks and hazards in their organizations, an "ICARUS Self-audit Checklist" is in final development and will be available from Flight Safety Foundation in mid-1995. Its questions are designed to identify specific areas of vulnerability and potential latent failures within a company so that appropriate corrective and preventive measures may be taken. Various sections should be completed by the appropriate organizational elements within a company.

24. Flight Safety Foundation is a valuable and affordable risk management resource. In addition to sponsoring a variety of safety workshops, seminars and other meetings, the Foundation also has a group of operations and safety experts available to conduct independent aviation safety audits. These audits are comprehensive and confidential, and are conducted by senior personnel who have direct experience in airline operations and management.

25. Aircraft and equipment manufacturers also can be a valuable resource for risk identification and management. Manufacturers can be particularly helpful in providing guidance for the development of operating procedures, operating manuals, maintenance and personnel training. Often, they can provide experienced operational and maintenance personnel to help carriers operate their equipment safely and efficiently.

26. Many valuable safety publications are available from government and research organizations to assist managers and decision makers in their safety objectives. Some of the most prominent of these sources of information are:

- Accident investigation reports from national authorities;
- Flight Safety Foundation reports and publications;
- International Civil Aviation Organization (ICAO);
- International Air Transport Association (IATA) ; and,
- U.S. National Aeronautics and Space Administration (NASA).

No matter what resources are available, they will be of the greatest value in a company that demonstrates that aviation safety begins at the very top of its management. ♦

[Editorial note: The preceding article was adapted from a briefing prepared by the ICARUS Committee and presented in a workshop in Geneva, Switzerland, in October 1994.]

FSF CFIT Task Force
Aircraft Equipment Team

Final Report

Presented by

Capt. D.E. Walker
Chairman

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Introduction

The Controlled-flight-into-terrain (CFIT) Aircraft Equipment Team, formed as part of a Flight Safety Foundation (FSF)-led industrywide CFIT accident reduction effort, has completed its mandate. This report summarizes the objectives achieved and presents proposals for action by the CFIT Steering Committee.

The CFIT Aircraft Equipment Team focused on aircraft equipment as a means of reducing the risk of CFIT accidents. Membership included representatives of industry, regulators, research organizations and the International Civil Aviation Organization (ICAO). Three full meetings of the team were held. Various subgroup meetings were held on an *ad hoc* basis. Meeting reports have been distributed to the members.

The team focused on the assignment of priorities for action. The time frame for completion of the recommendations is five years. A consensus was achieved for all decisions.

CFIT Aircraft Equipment Team

Name	Affliation
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J.F. Desmoulins	Airbus Industrie, France
J.A. Diaz de la Serna	International Civil Aviation Organization, Canada
Capt. D. Flemming	British Airways, United Kingdom
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S. Hall	British Airways AERAD, United Kingdom
J. Hart	Air Canada
Dr. R. Khatwa	National Aerospace Laboratory (NLR), Netherlands
T. Lively	Bombardier Inc., Canada
J.F. Manfroy	Dassault Électronique, France
P. Mayes	Bureau of Air Safety Investigation, Australia
M. Moon	General Electric Co. (GEC) Marconi Avionics, United Kingdom
J. Moore	Smiths Industries, United Kingdom
B.L. Perry	International Federation of Airworthiness (IFA) Technical Committee, United Kingdom
Capt. R.T. Slatter	International Civil Aviation Organization, Canada
B. Spindler	Direction Générale de l'Aviation Civile/Service Technique de la Navigation Aerienne DGAC/STNA, France
H. Thomas	Honeywell Inc., United States
Capt. T. Van Heerden	South African Airways
Capt. D.E. Walker (Chairman)	Aviation Consultant, Canada
K. Wilson	Transport Canada
Capt. P. Woodburn	British Airways, United Kingdom
Capt. T. Young	Air Line Pilots Association, United States

Executive Summary

This report summarizes the work of the FSF CFIT Task Force's Aircraft Equipment Team. The tasks defined fall into the following broad categories:

- CFIT accident data base;
- Standards for procedural design and chart production;
- Recommended practices/systems;
- Ground-collision warning systems;
- Recognition of proximity to terrain;
- Accurate vertical navigation;
- Accurate horizontal navigation;
- Understanding factors involved in CFIT; and,
- Potential systems for future consideration.

A consensus was achieved for the recommendations concerning each item. Our recommendations were weighted within these categories according to the estimated cost/benefit ratio. In addition to our recommendations, and ICAO actions, it is important that individual States review their regulations in concert with ICAO action.

Report Format

The reports on items under specific headings or subheadings are organized in the following manner:

a) Title or subtitle;

b) Problem statement: Brief overview of the problem;

c) Recommendations: FSF CFIT Task Force recommendations;

d) Results: What is being accomplished;

e) Action: Action to be taken by the CFIT Task Force; and,

f) References: Supporting documents, some of which are located in the Appendices.

CFIT Accident Data Base

Problem statement

The team has used the accident data base to focus on those areas showing the greatest need. Much of the existing accident data base provides only partial coverage of CFIT accidents because it concentrates on larger aircraft. The data originally published by ICAO in 1992 covered all turbine-engine aircraft in commercial and general aviation operations.

Recommendations

As a matter of urgency, improve the means of collecting and disseminating CFIT accident data. Accident investigation agencies are urged to forward their findings to ICAO in the proper format and in a timely manner. This is particularly critical for the nonheavy jet category.

Develop a means to measure the success of the CFIT prevention program.

Results

ICAO and others have continued to collect and refine CFIT data for all turbine-engine aircraft. These agencies report that the CFIT accident data are often incomplete and usually very tardy. The data are collected and refined in specific areas of interest.

Action

All concerned should continue to monitor and record CFIT occurrences.

The CFIT Steering Committee will require a means to measure the effect of the implementation of the CFIT prevention program.

References

CFIT Accidents and Risk for U.S. Airlines Large Commercial Jets (Appendix A).

Corporate, Regional and Air Taxi CFIT Accidents 1989 to 1994 (Appendix B).

Report. R. Khatwa, National Aerospace Laboratory (NLR) Flight Division, Netherlands (Appendix D).

Maurino, Capt. D. "Human Factors and Organizational Issues in Controlled Flight into Terrain (CFIT) Accidents." Eighth International Symposium on Aviation Psychology, Ohio State University, U.S. April 1995.

Chart Presentation

Problem statement

Navigation errors are a principal cause of CFIT accidents. Improved charts are seen as a major resource in the reduction of navigation errors.

The transition to and from en route charts to departure/arrival charts was of concern and had not been addressed, nor has the question of applying contours and color tinting to other charts. The problem of scale presentation has to be overcome. These items need to be addressed both within ICAO and by the various panels.

Instrument approach charts, standard instrument departure (SID) and standard terminal arrival (STAR) charts often contain a considerable quantity of vital information essential for the safe conduct of flights, in the vicinity of airports and in close proximity to terrain. These charts are frequently complex, with densely packed information. Presentation can result in chart clutter that may cause the pilot to overlook vital information. Errors of extraction and interpretation are known to have contributed to a number of accidents and many incidents. Chart producers should pay particular attention to the need to eliminate clutter and for the need to display only information essential for the safe and proper execution of required procedures. All other related secondary information should be removed to a separate panel or page.

Recommendations

Colored contours should be used to present either terrain or minimum flight altitudes on instrument approach charts.

It is also recommended that ICAO re-examine the specifications for instrument approach charts in ICAO Annex 4, Chapter 11. The objective of this re-examination should be the inclusion of Standards requiring either a presentation showing terrain contours or a presentation including minimum flight altitudes. Further Standards should require the use of brown hypsometric tinting in terrain contour presentations and green tinting in minimum flight altitude presentations. Both presentations should provide for the use of white for the level of the aerodrome to provide contrast and aid the interpretation of the chart. Significant spot heights should be shown on the terrain contour presentation. The terrain profile below an approach should also be shown.

Results

In March 1995 the ICAO Air Navigation Commission (ANC) tasked the Secretariat to review the adequacy of the Annex 4 *Aeronautical Charts* provisions regarding: the portrayal of terrain contours; the portrayal of minimum flight altitudes; use of color tinting; and the provision of the terrain profile under the final approach segment. Major commercial providers of charts are already using the recommended contour and color tinting systems.

Action

Re-emphasize the importance attached to the recommendation for colored contours and re-examination of instrument approach chart specifications to ICAO and to all providers and users.

Recommend that the Society of Automotive Engineers (SAE) G-10 Committee address the problems raised about the role of navigation errors in CFIT accidents.

Inform all State Civil Aviation Authorities and operators of the advantages and availability of instrument approach procedure charts with contour presentations and of the recommendations to ICAO and SAE.

Reference

KLM fax dated 19 August 1994 (Appendix G).

Ground-proximity Warning System (GPWS)

Updating of GPWS Equipment

Problem statement

The Aircraft Equipment Team is aware that the continued use of older unmodified GPWS equipment results in the persistent experience of false and nuisance GPWS warnings that could be avoided if the earlier standard of equipment was taken out of service and all equipment was modified to the latest standard available. These unnecessary, and now avoidable warnings, contribute adversely to the acceptance of the GPWS and the prompt reaction required to GPWS warnings by the flight crew.

Recommendation

Early GPWS equipment should be taken out of service and replaced by modern equipment or updated, where modifications are available. Such action would decrease the number of unwanted warnings experienced and thus increase the integrity and reliability of the GPWS and the likelihood of timely pilot response.

Results

In March 1995 the ICAO ANC stressed the need for the provision of adequate GPWS equipment.

The minimum requirements in the proposed U.S. Federal Aviation Administration (FAA) Technical Standard Order (TSO)-C92c would add to the existing requirements: a requirement for an aural message to identify the reason for a warning; call for the inclusion of airspeed logic to improve warning time; and a requirement for altitude callout in nonprecision approaches. These features are all available in currently produced equipment. The requirements of the proposed TSO-C92c are considered an example of the minimum adequacy of GPWS equipment.

ICAO has adopted amendments to Annex 6, Parts I and II, that extend the requirement to carry GPWS to all turbine-engine airplanes in international commercial/corporate/private operations where the maximum certificated takeoff mass is in excess of 5,700 kilograms (12, 500 pounds) or which are authorized to carry more than nine passengers. These extended requirements, based on an FSF CFIT Task Force recommendation, are effective from 1 January 1999. The amendments include specification of the minimum functions of the GPWS. These are the original functions dating from the 1970s that have not previously been established as ICAO Standards, and some have been intentionally deactivated in GPWS installations in the past.

Action

Re-emphasize to ICAO the importance of taking out of service or updating early GPWS equipment.

Stress to civil aviation authorities and operators the importance of taking older and less effective GPWS equipment out of service.

References

Annex 6, *Operation of Aircraft*, Part I. *International Commercial Air Transport Aeroplanes*, Sixth Edition, paragraph 6.15. July 1995.

Annex 6,*Operation of Aircraft*, Part II. *International General Aviation Aeroplanes*, Fifth Edition, paragraph 6.9. July 1995.

ICAO letter to States and international organizations, reference AN 11/37-95/64, 11 August 1995.

U.S. Federal Aviation Administration (FAA) proposed TSO-92c, *Airborne Ground Proximity Warning Equipment.*

Use of Terrain Data to Improve GPWS Capability and Performance

Problem statement

The capability now exists to use terrain data to provide predictive ground-proximity warning capabilities and to provide a visual display of the terrain to the flight crew. This is demonstrated in the enhanced GPWS being developed. Although a limited amount of terrain data are currently available to the flight crew from the aircraft charts and maps, the increasing availability of worldwide terrain data, in digital form, has opened opportunities for many new cockpit systems. ICAO has established requirements for use of the World Geodetic System 1984 (WGS-84) from the beginning of 1998.

Recommendation

Such developments should be actively supported.

Results

In March 1995 the ICAO ANC noted the support of the CFIT Task Force for the further development and introduction of terrain data base proximity warning systems; stressed the need for an accurate worldwide terrain data base; and urged States to facilitate the release of terrain data in digital form of suitable accuracy and geodetic reference for use in civil aviation, in accordance with Article 28c of the Convention on Civil Aviation.

There is a need for development of specifications for a format and parameters for a universal digital terrain data base.

Recommendation

Radio Technical Commission for Aeronautics (RTCA) and European Organization for Civil Aviation Engineers (EUROCAE) are asked to establish a joint working group to define an international specification that details a suitable format and other relevant parameters for a universal digital terrain data base.

Reference

Terrain Data Integrity Requirements (Appendix G).

Use of GPWS in Domestic as Well as in International Operations

Problem statement

The Standards of ICAO Annex 6, Part I, apply to international commercial operations. The new Annex 6, Parts I and II Standards, which take effect 1 January 1999, will apply to both international commercial and to international corporate and private operations. Many States have introduced requirements for GPWS in domestic commercial operations as well as in international operations. Other States have not extended requirements to domestic operations.

The CFIT accident record shows that the greater proportion of CFIT accidents have taken place in domestic operations. It is necessary to persuade civil aviation authorities that have not yet extended requirements to domestic commercial operations, to undertake this extension. Such action is essential if the objective of the CFIT prevention program is to be achieved.

Very few States require the carriage of GPWS in corporate or private operations. Thought must be given to this area by the regulatory authorities because the new ICAO Standards for general aviation, corporate and private operations, come into force on 1 January 1999. Some corporate operators have voluntarily equipped their aircraft with GPWS, and the business aviation community is showing a great interest in CFIT prevention.

Recommendation

All aircraft in commercial and corporate use should be equipped with GPWS, even where these airplanes are used only in domestic operations.

Results

In June 1995, the ICAO Council approved a report for the ICAO Assembly (19 September to 4 October 1995) on CFIT prevention activity. In addition to the report, the Council will present a draft resolution for adoption by the Assembly to urge States to implement the CFIT prevention program and the related ICAO provisions, particularly those concerning the carriage of GPWS, in domestic as well as in international operations.

Action

Every opportunity should be taken to stress to civil aviation authorities and operators the importance of CFIT prevention in domestic operations. Maximum use should be made of the ICAO 31st Assembly Resolution if this is adopted.

Reference

ICAO Assembly, 31st Session, A31-WP/43, 6 July 1995.

European Organization for Civil Aviation Engineers (EUROCAE) Working Group WG 44, Ground-collision Avoidance System (GCAS)

Problem statement

This group is preparing minimum operational performance specifications (MOPS) for ground-collision avoidance systems (GCAS). This document defines, *inter alia*, mandatory and nonmandatory warnings, pull-up/reaction times and acceptable failure rates. Lateral guidance is currently not mandatory. It is expected that Joint Aviation Regulations–Operations (JAR-OPS) and the Joint Transport Service Orders (JTSO) for GPWS will reference the GCAS document.

Recommendations

Preparation of MOPS for a ground-collision avoidance system.

That a coordinated effort be made by the appropriate bodies to establish standards for the ground-collision avoidance system. These efforts are to be correlated with ICAO standards.

Approach Procedure Design

Problem statement

The design of the nonprecision approach was seen by the group as an area where much could be accomplished at little cost. This objective can be met by the simplification of the nonprecision approach, the specification of a stabilized approach and the provision of a nominal three-degree glide path.

Recommendations

General

Nonprecision approach procedures should be constructed, whenever possible, in accordance with established stabilized approach criteria.

It is also recommended that ICAO re-examine the specifications for the design and presentation of nonprecision approach procedures in the *Procedures for Air Navigation Services Aircraft Operations* (PANS-OPS, Doc. 8168), Volume II, Annex 4 *Aeronautical Charts* and associated guidance material. The objective of this re-examination is to require consideration of the stabilized approach; the provision of a final approach fix; and to require the provision of a three-degree approach slope, where compatible with the obstacle environment. The need to show the underlying obstacle clearance profile on these instrument approach charts should also be considered.

Specific

One final approach segment per navigation aid/runway combination;

If a stepped nonprecision approach cannot be avoided, then the intermediate profile-angles should be shown; and,

The position of the start of the final descent path is to be published.

Recommendations to operators

Nothing in ICAO PANS-OPS prevents the immediate introduction by operators of specific nonprecision instrument approach procedures that take into account the recommendations of the CFIT Task Force, and some operators have been doing so for many years. The concept will require the definition of a fix at the position at which the intermediate approach altitude/height intersects the nominal glide path. Proposals for the amendment of PANS-OPS, from the tenth meeting of the ICAO Obstacle Clearance Panel (31 October to 10 November 1994), would introduce optimum descent gradients for some types of nonprecision approaches where currently only the maximum and minimum gradients are specified.

Recommendation to ICAO

Amplify the 1994 recommendation to ICAO as follows:

Nonprecision approach procedures should be constructed, whenever possible, in accordance with established stabilized approach criteria. If a stepped nonprecision approach cannot be avoided, then the intermediate profile-angles should be shown;

There should be one final approach segment per navigation aid/runway combination;

The final approach glide path should be a nominal three degrees where terrain permits; where a steeper glide path is necessary, up to the maximum angle permitted. A continuous descent is preferred to a stepped approach;

The final segment should start 2,000 feet to 3,000 feet (610 meters to 915 meters) above airport elevation;

There should be provision and publication of a fix at the intersection of the intermediate approach altitude/height and the nominal glide path; and,

Nonprecision approach charts should show the descent profile to be flown;

There should be provision for and publication of appropriate altitude/height checks on the glide path; and,

The profile of the terrain beneath the final approach segment should be provided.

Recommendation to Civil Aviation Authorities and Operators

Continue to emphasize to civil aviation authorities and operators the need to improve the safety of nonprecision approaches by use of the stabilized approach, a three-degree glide path, a final approach point and a final approach fix and the urgency for action on this matter.

Results

In March 1995, the ICAO ANC tasked the Obstacle Clearance Panel to take account of the need for a stabilized approach, based on a three-degree glide path and a final approach fix, in the design and presentation of nonprecision approaches.

References

Slatter, R.T. "Thoughts on the Subject of Nonprecision Instrument Approach Procedure Design from the Point of View of the Pilot." 8 April 1994 (ICAO Document).

Slatter, R.T. "Chart Design Revision Could Enhance Safety of Nonprecision Approach and Landing Operations." *ICAO Journal* (May 1994).

Slatter, R.T. "Nonprecision Approaches, Shallow Descent Gradients." CFIT-AET/WP-OPS/1, 15 May 1994.

Slatter, R.T. "Nonprecision Approaches, Stepped Approaches." CFIT-AET/WP-OPS/2, 12 May 1994.

Slatter, R.T. "Multiple Approaches to One Runway Using the Same Aids." CFIT-AET/WP-OPS/3, 12 May 1994.

Information provided by KLM, 19 August 1994 (Report to Committee).

FAA letter dated 11 January 1995 (Report to Committee).

Walker, Capt. D.E. "Operational Approval of Stabilized Instrument Approach Procedures for Flight Management/Guidance System Equipped Aircraft" (Report to Committee).

Walker, Capt. D.E. "Taking the 'Non' out of the Nonprecision Approach" (Appendix F).

Vertical Navigation

Loss of vertical positional awareness is a principal factor contributing to CFIT accidents. Improved indications of both altitude and height above terrain are seen as reducing the risk of a CFIT accident.

Barometric Altimetry

Three-pointer and drum-pointer altimeters

Problem statement

There is ample evidence that pilot misinterpretation of three-pointer and drum-pointer altimeters can lead to CFIT accidents. There is a long documented history of these errors.

Recommendations

All States and operators should be informed of the dangers inherent in the use of three-pointer and drum-pointer altimeters and usage of these altimeters should be discontinued.

ICAO should examine the case for discontinuing the usage of three-pointer and drum-pointer altimeters and should take appropriate action to amend Annex 6 in this respect.

Results

In March 1995, the ICAO ANC tasked the Secretariat to consider the need to limit the use of three-pointer and drum-pointer altimeters. This action is in hand through initial consultation with the ICAO Operations Study Group.

ICAO Annex 6, Parts I, II and III, Sections II and III amendments adopted in 1995 include the addition of a note to the requirement for sensitive pressure altimeters: "Note. Due to the long history of misreadings, the use of drum-pointer altimeters is not recommended." While the addition of a note was possible in a short time scale, this action is not sufficiently comprehensive or strong enough to answer the problem posed by both these types of altimeters.

Action

Stress to civil aviation authorities and operators the dangers inherent in the use of three-pointer and drum-pointer altimeters.

References

Marthinsen, H.F. "The Killer Instrument: The Drum Pointer Altimeter." International Federation of Air Line Pilots' Associations (IFALPA)/Spanish Air Line Pilots' Association Joint Air Safety Seminar, Madrid, Spain, June 1990.

Human Factors Digest No. 6 (Circular 238): 19.

IFALPA. Annex 8, Appendix AIR-B 11 (Cockpit Standardization). November 1993.

QNH/QFE

Problem statement

These very different altitude and height reference systems are in widespread use. The Aircraft Equipment Team was unable to recommend a resolution of these differences. During the past few years many operators have changed to the use of QNH [code: "To what should I set my altimeter to read your airfield height?"] for takeoff and landing operations. This was done from the time that radio altimeters provided at least some height information that could be taken to replace the height above touchdown provided by using QFE [code: "To what should I set my altimeter to obtain height above your location?" Also, the barometric pressure reported by a particular station]. The impulse to use only QNH is driven by the resulting reduction in need to adjust the altimeter setting. Reduction in the number of times the altimeter setting is changed materially reduces the possibility of error. But there are problems where operators use QFE in an area where the majority use QNH and more particularly in those international operations where users of one system fly to airports where the other system is in use. Although it should be possible to obtain both QNH and QFE altimeter settings, this is not universally the case.

There may not be a solution to this problem. It is similar to the problem of different units for distance and altitude, in that different aviation traditions have established different systems. Use of QFE does give the pilot a direct statement of height above touchdown, which those using QNH can only obtain through a mental computation or comparison of pointer position to a bezel bug set at the touchdown zone (TDZ) elevation. For these reasons instrument approach charts give both altitudes and heights for relevant points in procedures. Use of QNH reduces the number of altimeter setting changes and eliminates the need to make a change during a missed approach, where this would otherwise be necessary.

Both altitude and height information could readily be provided in flight management system (FMS)-equipped aircraft where currently only altitude is provided on the situation display, in addition to the conventional altimeters. Such provision of a direct height above touchdown readout would only require a software change.

Recommendations

Develop rigorous procedures and training in the use of both systems for all flight crews who operate under both systems; and,

There is no doubt that the ideal solution would be to have one system in universal use and that logically this should be the system that calls for fewer changes to the altimeter settings. At the same time, other means of displaying the height above touchdown should be investigated.

Results

In March 1995, the ICAO ANC was informed that the CFIT Task Force would report at a later date on the use of QNH and QFE. Revised ATC procedures have been recommended to the ATC Team.

Action

Recommend that ICAO consider the specification of the use of the QNH reference system for all operations below the transition level/altitude.

Investigate the provision of a direct "height above touchdown" display on aircraft equipped with FMS.

Altimeter setting units

Problem statement

Although international standards call for the use of the hectopascal as the unit for the reporting of atmospheric pressure, the continued use of inches and millimeters of mercury, as well as hectopascals, for reporting atmospheric pressure in different areas of the world, and thus for altimeter setting units, was recognized as likely to continue for some time.

Because of the above differences, specific procedures are used to identify the units used in meteorological reports, but these procedures do not extend to usage in ground-to-air transmissions where the identification of the units is currently optional.

Recommendation

All States should standardize on the use of hectopascals for altimeter settings in accordance with the established international standards, and thus eliminate the potential hazard of mis-setting of the altimeter.

Results

In March 1995 the ICAO ANC was provided with the above recommendation and informed that the CFIT Task Force would be reporting further on this question.

To avoid some errors in altimeter settings resulting from misinterpretation of which units have been provided in a ground-to-air transmission, it is suggested that the unit of measurement be transmitted with the first mention of altimeter setting at international airports. The unit of measure should also be included in automatic terminal information system (ATIS) broadcasts, either voice or datalink. Rigorous procedures and training are necessary where flight crews may be exposed to the use of barometric units other than those to which they are normally accustomed. The use of the term "hex" instead of hectopascal was seen as improving the communication of the altimeter setting between controller and pilot. These questions are also to be discussed by the CFIT Task Force ATC Team.

It has been established that within areas where a specific pressure unit, particularly "inches" is used (and the atmospheric pressure can at times be very low), there is a tendency to set too high a setting through nonrecognition or nonacceptance of the low value. Settings such as 28.98 inches have been mis-set as 29.98 inches, resulting in an altitude/height error of 1,000 feet (305 meters) low. The suggestion in these circumstances is to interpose the word "low" immediately before the pressure setting in ground-to-air transmissions. This proposal has also been referred to the ATC Team.

Action

Re-emphasize the 1994 recommendation and urge States to comply with the international standard for the reporting of atmospheric pressure;

Propose the statement of the applicable pressure unit in the first ground-to-air transmission of an altimeter setting at an international airport and statement of the units in ATIS broadcasts, either voice or datalink;

Propose consideration of the abbreviated term "hex" for the unit "hectopascal" to refer to this unit, which is simpler for users of languages other than English; and,

Propose the interposition of the word "low" before very low altimeter settings, to assist recognition of low settings by flight crew. Actual values to trigger action would need to be determined.

Radio Altimetry

Altitude callout

Problem statement

The team discussed ways in which existing radio altimeter installations could be used to provide terrain clearance information. It was accepted that the widespread operational experience already available on such callouts could provide better guidance on their use than a new simulation program.

Many aircraft have radio altimeters, primarily to support Category II and III operations. However, many operators also employ radio altitude to enhance terrain awareness through a variable combination of crew callouts, automated callouts and associated procedures. These practices have been confirmed through a survey of international operators, who are members of the IATA Flight Operations Advisory Committee (FLOPAC).

It was concluded that use of radio altimetry could enhance terrain awareness and that the full capability of radio altitude information should be exploited. Automated voice callouts of appropriate radio altitudes and associated flight crew procedures should be provided. Some operators have instituted an automated callout at 500 feet (153 meters). This callout, known as a "smart" callout, is arranged to occur only during a nonprecision approach to alert the pilot to proximity of terrain. Use of crew callout, where automated callout was not provided, was also seen as a valuable and unexploited means of enhancement of terrain awareness. Neither automated callouts nor crew callouts will provide protection unless appropriate crew procedures and training are provided.

Recommendations

The radio altitude callout facility should be employed to enhance situational awareness of proximity to terrain. Operators should ensure that the facility is used and appropriate procedures provided. Where altitude callout is not available, or where GPWS is not fitted, a radio altimeter can be used to provide enhanced situational awareness with the use of appropriate procedures.

Results

The ICAO ANC discussed the question of automated altitude callout when it considered the amendments to the GPWS requirements that have now become part of Annex 6. It was considered that altitude callout was not necessarily a function of the GPWS, but may be provided by other means. In March 1995 the ANC noted that the CFIT Task Force was intending to report further.

Further thinking on the altitude callout has prompted confirmation of this means of enhancement of situational awareness. Since altitude callout can, and is, being provided by some manufacturers by means not associated with the GPWS, a requirement for automated callout should not be associated with the GPWS. It is suggested that automated callout be required as a function to assist in the prevention of CFIT specifically to warn of the proximity of terrain and that the radio altimeter reading should be included in the instrument scan and with the nonprecision instrument approach. The precise detail of the function should be left to the individual operator.

Action

Propose that all aircraft that are required to be equipped with GPWS also be provided with the means to generate automated altitude callouts for initial warning of proximity to terrain and for use during nonprecision instrument approach procedures;

Propose that crew callouts are used in all aircraft not required to be equipped with GPWS, but which are equipped with radio altimeters, for initial warning of proximity to terrain and during the conduct of nonprecision approach procedures; and,

Inform all civil aviation authorities and operators of the necessity for appropriate flight crew procedures and training to support the general introduction of automated and flight crew callouts.

Approach waypoints

Problem statement

With a nominal three-degree slope extending upwards from 50 feet (15 meters) above the runway threshold to at least 2,000 feet (610 meters) above airport elevation, the notion of waypoints along that slope becomes valid.

The first waypoint is located at the intersection of the intermediate segment and the final approach segment where the nominal glide path commences, normally not less than 2,000 feet above airport elevation. Some AIPs now define that point. That point may be above the maximum range of the radio altimeter.

The second and third waypoints are defined exclusively by radio altimeter readout. Because of terrain mapping difficulties, the horizontal position of those waypoints may not be defined. The second point is defined by the radio altimeter indicating 1,000 feet above ground level (AGL). The third is where the radio altimeter indicates 500 feet AGL.

Several major air carriers use radio altimeter heights for an aural alert to the crews with defined crew responses. Examples are 2,500 feet (763 meters, when the radio altimeter comes alive), 1,000 feet and for a nonprecision approach, a so-called "smart call" at 500 feet on the radio altimeter.

Action

Propose that the notion of crew alerting by radio altimeter heights be adopted as standard for use with related cockpit procedures developed by the Operations Group.

Reference

Woodburn, Capt. P. Survey of Radio Altimeter Use for Terrain Awareness by International Air Carriers. FLOPAC, International Air Transport Association (Appendix E).

Use of the Global Navigation Satellite System (GNSS)

Problem statement

Many aircraft are now fitted with GNSS equipment. Although GNSS equipment may not yet be approved as a stand-alone means of navigation, it does provide the flight crew with further data on their location when they have reason to question the availability and/or accuracy of the primary navigation system(s). Such errors or failures may be critical, particularly in the approach-and-landing phase of a flight in difficult terrain.

The use of GNSS should be encouraged to provide back-up navigation information, particularly in the approach-and-landing phase of flight. To achieve this safety benefit, the GNSS output must be displayed in a way that is readily usable by the flight crew and that will alert them to potential navigation errors. Appropriate crew procedures and training will also be required.

Recommendation

The development and availability (of GNSS) should be strongly supported.

Results

In March 1995 the ICAO ANC stressed to States the potential for accuracy and the safety inherent in the GNSS. The ANC also informed three ICAO panels, the Global Navigation Satellite System Panel (GNSSP), the All Weather Operations Panel (AWOP) and the Obstacle Clearance Panel (OCP), of the urgent need for application of GNSS to nonprecision instrument approach procedures.

At the ICAO Special Communications/Operations Divisional Meeting (1995) (SP COM/OPS/95), Montreal, Canada, 27 March to 7 April 1995, the need for the development of GNSS nonprecision instrument approach procedures for the overlay of existing procedures and for new procedures was again stressed. GNSS nonprecision approaches will provide all the detail required to apply the stabilized approach and the three-degree glide path. Implementation of these approach procedures will reduce the dangers in many conventional nonprecision approaches where there is no distance-to-threshold information and those without a final approach fix. Progressive development of the GNSS precision approach capability will enable the elimination of the nonprecision approach in all its forms, except a few circling approaches.

Rapid development and publication of appropriate GNSS nonprecision instrument approach procedures are necessary to reduce the risk of unofficial use of the GNSS navigation capability. There are a large number of GNSS receivers available and in use.

Action

Propose the rapid introduction of specifically designed GNSS nonprecision approach procedures where an appropriate level of accuracy is available that conforms to the use of the stabilized approach and the three-degree glide path with a defined final approach point. Glide path angles steeper than three degrees may be used if necessary, up to the maximum permitted.

References

ICAO Special Communications/Operations Divisional Meeting (1995) Report

Slatter, R.T. "Role of CNSS/ATM in Reducing CFIT in the Terminal Area." IATA GLOBAL NAVCOM 1995, Montreal, Canada, 25 September 1995.

ICAO. *Procedures for Air Navigation Services, Aircraft Operations* (PANS-OPS, Doc 8168), Volumes I and II.

ICAO Obstacle Clearance Panel, 10th Meeting Report.

Excessive-bank-angle Warning

Problem statement

The Aircraft Equipment Team is convinced that excessive-bank-angle warning would help avoid CFIT and loss-of-control accidents. Aircraft have been destroyed in accidents when excessive bank angles developed without detection by the flight crew. High undetected bank angles have resulted in loss of vertical control. The risk of future occurrences remains high. Excessive-bank-angle occurrences have been classed with CFIT occurrences because GPWS models from the MK V have provided an excessive-bank-angle warning facility. Excessive-bank-angle warning is provided by some airframe manufacturers independently of the GPWS.

Results

The ICAO ANC discussed the question of excessive-bank-angle warning when it considered the amendments to the GPWS requirements that have now become part of Annex 6. It was considered that this warning was not necessarily a GPWS function, but may be provided by other means. In March 1995 the ANC noted that the CFIT Task Force was intending to include the excessive-bank-angle warning in its next report.

Many of these incidents occur because of lack of tactile sensory feedback. These sensations are often masked by the inadvertent lowering of the aircraft's nose with subsequent altitude loss. Further analysis of excursions in bank angle indicates that these occurrences have had various causes:

- Undetected and uncommanded roll with autoflight engaged;
- Looking outside the cockpit at inadequate visual reference during low altitude maneuvers;
- Vertigo; and,
- Failed attitude reference display.

It is therefore proposed that means be provided to alert the flight crew to an excessive bank angle, particularly when maneuvering close to terrain. Actual values at which the warning should activate depend on the phase of flight. The function should involve:

- Built-in maximum-bank limiters in fly-by-wire aircraft;
- Enhanced/emphasized high bank angles on the attitude display; and,
- Visual or aural alert of high or unusual roll angles.

Action

Propose that all aircraft required to be equipped with GPWS also be provided with the means to generate an excessive-bank-angle warning.

Reference

Partial List of Excessive-bank-angle CFIT Accidents/Incidents (Appendix C).

Head-up Display (HUD)

Problem statement

The team believed that the head-up display (HUD) may be of benefit in all phases of flight, particularly in the final approach phase of nonprecision instrument approaches and visual approaches. The CFIT Working Group is aware of the increasing use of HUDs for air carrier operations and knows why operators with fully automatic instrument approach systems do not want to fit HUDs.

Recommendations

HUD benefits should be publicized more widely. Their use should be encouraged and development should be continued to eliminate known limitations. Further investigations that could demonstrate whether or not the use of HUDs has the potential to reduce the CFIT risk are recommended.

Results

In March 1995 the ICAO ANC noted the CFIT Task Force's support for HUD and the HUD's potential to contribute to safety in nonprecision approach and visual approach and landings.

Action

Such developments should be strongly supported.

References

Flight Safety Digest (September 1991).

Head-up Guidance System Technology (HGST) — A Powerful Tool for Accident Prevention. Project Report FSF/SP-91/01. July 1991.

Enhanced and Synthetic Vision

Problem statement

The team was aware of developments in sensor and data base technologies in the field of enhanced and synthetic vision systems. Such systems attempt to give the flight crew an enhanced image of the external environment, or a completely synthetic reproduction of the external environment, and may have the potential to reduce the CFIT risk. However, many unresolved issues exist with respect to these systems. The CFIT Equipment Team recommends any activities that could demonstrate and quantify whether such systems are, or would be, able to offer safety benefits.

Recommendation

Such developments should be strongly supported.

Results

In March 1995 the ICAO ANC noted the support for the development and introduction into service of enhanced and synthetic vision systems.

Minimum Safe Altitude Warning System (MSAW)

Problem statement

This system is used to assist in the detection of inadvertent flight towards terrain. It is the understanding of the Team that MSAW can be readily implemented at little cost.

Action

Remind the ATC team of the recommendations for use of MSAW and other means of alerting ATC to the terrain proximity of aircraft under their control; and,

Present proposals to the ICAO Air Navigation Commission and individual administrations to make MSAW a standard for CFIT prevention.

Visual Approach Slope Indicator System (VASIS)

Problem statement

The VASIS display is sometimes disabled during certain weather conditions.

Recommendation

VASIS signals are accepted pilot aids. The use of VASIS should be encouraged under all approach conditions. They should not be turned off at any time.

Action

Recommend to ICAO that VASIS installation and continuous operation be supported.

Communication Blocking

Problem statement

The CFIT Working Group is aware that the inability to communicate because of such factors as "stuck" microphones, failures of flight crew to release the press-to-talk (PTT) switch, PTT switch failures and other disruptions have been present in a number of incidents. This can hamper or prevent the transfer of crucial information between ATC and crew in a timely manner.

Recommendation

The CFIT Working Group encourages the use of any appropriate means (which has the required level of integrity and reliability) that restores normal communications and/or prevents communications blockage.

Conclusions

CFIT Accident Data Base

- Continuous measurement of the incident/accident rate is essential to assess any changes as a result of CFIT prevention activities.

Chart Presentation

- Improved charting should be made available to every pilot on every flight. This may be the only CFIT prevention tool available.

Ground-proximity Warning System (GPWS)

- Improved systems are available.
- The trained pilot is an essential component of any system.

Approach Procedure Design

- Nonprecision approaches show high CFIT risk.
- Simplifying them reduces the risk.

Vertical Navigation

- Errors in vertical navigation have many causes.
- Each of the suggested actions reduces the risk.

Use of GNSS\GPS

- Lateral navigational errors could be reduced by reference to GPS/GNSS

Excessive-bank-angle Warning

- Inappropriate bank angles at low altitudes contribute to CFIT accidents.
- Alerting or prevention systems would reduce the incidence.

ICAO Actions

- Only international standards will reduce the CFIT accident rate to the target level. Application of international standards in domestic operations is seen as a major step towards reduction of CFIT rates.

Other Topics Considered

- There are many systems that could contribute to the reduction of the CFIT rate. Only those that are likely within the next five years were considered.

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APPENDIX A

CFIT ACCIDENTS AND RISKS FOR UNITED STATES AIRLINES
LARGE COMMERCIAL JETS

TYPE OF CFIT LOSS		CFIT ACCIDENTS AND RISK				REDUCTION ( ) OR INCREASE (+) TIMES
		PRE-GPWS 1960 thru 1975		POST-GPWS 1976 thru 1994		
Initial Climb	Accelerating Descent	1	0.03	0	<0.001	>-100
Into mountainous terrain	Climb out Initial approach Missed approach	6	0.17	4	0.03	-5.7
Landing short	Note configured to land	5	0.14	0	<0.01	-140
	Configured to land/no glideslope	5	0.14	6	0.06	-2.3
	Below glideslope	8	0.22	0	0.001	-220
	Excessive descent rate	5	0.14	0	0.001	-140
TOTAL CFIT ACCIDENTS & RISKS		30	0.85 x 10	10**	0.09×10^{-6}*	-9.6
	Flight segments	35 x 10		108 x 10		+3.1
	Aircraft numbers	2 800 in 1976		4 800 in 1994		+1.7

CFIT Risk 1990 thru 1994 (5 years) .... 0.028 x 10- flights with 7-_ x 10 flights per year
CFIT Risk 1985 thru 1994 (10 years) .... 0.074 x 10- flights
In the United States (2) ....0.033 x 10 flights
Outside the United States (3) ....0.44 x 10 flights

If aircraft had been fitted with MK II or better, losses would have been reduced probably to 6 (0.055 x 10-).

If aircraft has been fitted with MK V/VI/VII system with "smart" altitude callouts, the losses would have probably been reduced to 3 (0.03 x 10-) .

10 CFIT Accidents. One accident with NO GPWS installed. One accident with glideslope receiver failure. Nine accidents equipped with MK I GPWS.

APPENDIX B

CORPORATE, REGIONAL AND AIR TAXI CFIT ACCIDENTS

1994

OPERATION	DATE	PLACE, AIRCRAFT TYPE		COMMENTS	FATALITIES
Regional	9 Jan	Athens, Greece	DO-228	Hit ridge-powerlines 7 NM from runway, VOR-DME 18L.	- -
Freight	14 Jan	Sydney, Australia	AC 690	Flew into sea 10 NM short at night, rwy 34.	1
Positioning	18 Jan	Kinshasa, Zaire	LJ-24D	Hit short 10 NM at night, visual 24.	2
Charter	24 Jan	Attenrhein, Switzerland	Ce-425	Flew into lake - 2 NM, final 10.	5
Positioning	27 Jan	Meadow Lake, Sask.	IAI-1124	Hit 2 NM SE - stall?, circling 26.	2
Scheduled	23 Feb	Tingo Maria, Peru	Yak-40	Flew into mountain FL131, NDB departure.	31
Positioning	7 March	Virginia	AC-690	Hit trees on approach	1
Freight	9 March	Australia	SA-226	Hit short on approach	1
Business	23 March	Bogota, Colombia	Ce-VI	Hit hillside, initial approach.	4
Scheduled	6 April	Latacunga, Ecuador	DHC-6	Hit 13,400 mtn 300' below crest, premature descent.	17
Regional	25 April	Nangapinoh, Indonesia	BN-2A	Hit mtn at 5400' level, initial descent.	10
Regional	27 April	Stratford, CT	PA-31T	Hit 3 NM short, final 06.	8
Corporate	7 May	Zaire	Be-200	Hit short of runway	9
Medevac	26 May	Papeete, Tahiti	Mu 2B	Hit short by 4 NM on ILS Rwy 04 approach	5
Ferry	27 May	Germany	Be-90C	Hit in steep turn back to runway	1
Medevac	31 May	Thompson, Manitoba	Merlin II	Hit FAF NB 3.4 short, B/C LOC. rwy 33.	2
Regional	13 June	Uruapan, Mexico	Metro II	Hit terrain while maneuvering for 3rd approach.	9
Scheduled	18 June	Palu, Indonesia	F-27	Hit mtn 3-1/2 NM short, initial approach.	12
Charter	19 June	Washington DC-Dulles	LJ-25D	Hit 1-1/2 NM short, ILS 1R.	12
Charter	26 June	Abidjan, Ivory Coast	F-27	Hit 2-1/4 NM short, VOR/DME 21	17
Government	9 July	Kulu, India	Be-200	Hit mtn 7 NM SW of airport, NDB.	13
Charter	17 July	Fort de France	BN-2B	Hit at 2780' mtn, 15' below crest, 6 NM, VOR/DME.	6
Private	24 July	Portsmouth, OH	PA-32T	Hit trees on rising terrain, departure rwy 18.	5 of 6
Gov t (Drug Enforce)	27 Aug	Pucalpa, Peru	CASA-212	Hit hill, NDB/VOR.	5
Charter	13 Sept	Abuja, Nigeria	DHC-6	Hit 5 NM short, VOR-DME 22.	2 of 5
Corporate	17 Sept	Texas	HS-125	Hit Trees on approach	- -
Private	10 Oct	Missouri	AC 690	Hit into groun in initial climb	1
Freight	29 Oct	Ust-llimsk, Russia	AN-12	Hit short on approach by 1-2 NM at night.	21

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Charter, Freight	4 Nov	Kebu, Nabire, New Guinea	DHC-6	Hit hill, approach.	4
Air Taxi	19 Nov	Saumer, France	Be-C90	Hit ground while circling after successful locater; (NDB) approach.	7
Air Taxi	22 Nov	Bolvovig, New Guinea	BN2A-2D	Hit hillside on initial approach.	7
Scheduled	10 Dec	Koyuk, Alaska	Ce-402	Hit short on approach.	5
Business	16 Dec	Michigan	Ce-501	Hit short into approach lights	- -
Scheduled	17 Dec	Tabubil, Papua N. Guinea	DHC-6	Hit ridge enroute to Selbang (25 miles east) on initial climb.	2

(3) Large Turboprop	(7) 10 Seat Turboprop	No GPWS equipment on any of the above aircraft
(6) 10 to 30 Seat Turboprop	(5) 6 Seat Jet	

APPENDIX B (Continued)

1993

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Regional-Schd	6 Jan	Paris, France	DHC-8	Hit short while repositioning ILS 27 to ILS 28	4
Air Taxi	8 Jan	Hermosillo, Mexico	L-35A	Hit Mountain on approach to VOR 23	9
Private	29 Jan	Marfa, TX	Be-90	Circling to runway 12, IMC after VOR 30	0 of 8
Regional-Schd	30 Jan	Ackh, Inur, Malaysia	SC-7	Hit terrain en route	16
Air Taxi	7 Feb	Iquacu, Brazil	Be-90	Hit 0.6 NM short - IMC; heavy rain	6
Air Taxi	8 Feb	Lima, Peru	PA-42-720	Hit mountain initial descent	6
AT-Non Sched	27 Feb	Rio de Janeiro	L-31	Hit short by 300 feet	- -
Air Taxi	18 Mar	Trijillo, Peru	Be-90E	Hit mountain initial descent 50NM short	4
Air Taxi	19 Mar	Dagali, Norway	Be-200	Hit 3 NM short LOC/DME 26, night	3 of 7
Reg l-NonSchd	23 Mar	Cuiaba, Brazil	EMB 110	Hit terrain on climb out	6
Private-Trng	1 April	Blountiville, Texas	SA-226T	Undershoot outside outer marker	4
Air Taxi-Med.	6 April	Casper, WY	MU-2B-35	Hit terrain on DME Arc ILS 8, night	4
Private	1 May	Mount Ida, AR	Be-90	Hit Mt. Ida (3 NM short). Climb IMC	2
Air Taxi-Trng	25 May	Sante Fe, NM	SA-226T	Hit hill while circling to Rwy 15.5 NM short at night	4
Reg Cargo NS	5 June	El Yo Pal, Colombia	DHC-6	Hit short while circling	2
Regional-Schd	11 June	Young, Australia	PA-31	Hit rising ground while circling after ND approach	7
Reg-Carg-Sch	25 June	Atinues, Namiba	Be-200	Hit terrain on missed approach	3
Government	15 July	Bombay, India	Be-90	Hit hill on approach IMC	4
Regional-Schd	31 July	Bharatpur, Nepal	DO-228	Hit mountain on initial approach	19
Air Taxi-Med.	7 Aug	Augusta, GA	Be-90	Hit 1-1/2 NM short on approach IMC to ILS 17	4
AT-Positioning	17 Aug	Hartford, CT	SA-226T	Hit 1/3 NM short IMC to Rwy 02	2
AT-Positioning	27 Sept	Lansing, MI	Be-300	Hit 2 NM after 7.0 IMC turning	2
Regional-Schd	19 Oct	Orchid Is., Taiwan	DO-228	Undershoot	- -
Regional-NS	25 Oct	Franz Josef Glacier, NZ	Nomad	Hit Glacier VMC into IMC	9
Gov t-FAA	26 Oct	Winchester, VA	Be-300	Hit terrain while awaiting IFR clearance	3
Regional-Schd	27 Oct	Namos, Norway	DHC-6	Hit 3 NM short on NDB approach	12
Regional-Schd	1 Dec	Hibbing, MN	BAe JS-31	Hit 3 NM short on LOC (B/C) Rwy 13	18
Regional-Schd	10 Dec	Sandy Lake, Ontario	HS 748	Climbing turn, back into terrain	7
AT-Positioning	30 Dec	Dijon, France	Be-90	Hit short on approach IMC	1

(2) Large Turboprop (16) 10 Seat Prop. Except for DHC-8, there was no GPWS on any of the above aircraft.
(9) 10 to 30 Seat Turboprop (2) 6 Seat Jet

APPENDIX B (Continued)

1992

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Regional-Schd	3 Jan	Saranac Lake, NY	Be-1900	Hit short at FAF on ILS 23 IMC.	2F/2S
Private	11 Feb	Lakeland, FL	Ce-425	Hit short of runway 05 IMC.	1
Charter	16 Feb	Big Bear, CA	PA-31T	Hit terrain at 6740 7 NM east of airport.	7
Private	5 Mar	New Castle, CO	MU-2B	Hit mtn - LOC/DME "A" Gear Down; Approach flaps 10-1/2 NM short.	6
Private	29 Mar	Taos, NM	AC-390	Hit rising terrain on climb out; IMC night 3940 (visual); radio altimeter installed.	1, 5S
State Aircraft	9 April	St. Augustine, FL	Be-90	Hit short on VOR approach 007: 10 EDT IMC.	2
Regional-Tour	22 April	Maui, Hawaii	Be-18	Hit mtn enroute.	9
Regional-Schd	8 June	Anniston, AL	Be-99	Hit terrain during LOC 5 approach.	3F/2S
Personal	24 June	Alamagordo, NM	MU-2B	Hit mtn VMC during climbout 12:21 MDT - Night.	6
Regional-Schd	24 July	Ambeu, Indonesia	Vickers Viscount	Hit mtn during initial approach ILS/04.	71
Personal	13 Aug	Osway, MO	PA-31	Hit short rwy 32-IMC.	--
Personal	4 Sept	Longton, KS	PA-42	Hit wires on approach.	--
Government	19 Oct	Pesqueria, Mex (Monterey)	AC-680T	Hit terrain during climbout IMC.	6
Comm/Air Taxi	31 Oct	Grand Junction, CO	PA-42	Hit mtn 10 NM north RNAV-Cleared to ILS rwy 11. "Macks" int. eastbound 9400 -7800 cliff; IMC day 0315.	3
National Guard	11 Nov	Juneau, AK	Be-200	Hit mtn LOC/DME 20+ NM from runway.	8
Government	10 Dec	Quito, Ecuador	Sabreliner	Hit 3 NM short during VOR/ILS 35 approach.	12
Regional-Schd	13 Dec	Goma, Zaire	F-27	Hit short into terrain during initial approach VOR/DME 36.	37
Government	22 Dec	Quito, Ecuador	PA-31	Hit 3 NM short during VOR/ILS 35 approach.	5

(2) Large Turboprop (13) 10 Seat Prop No GPWS installed on any of the above aircraft.
(2) 10 to 30 Seat Turboprop (1) 6 Seat Jet

APPENDIX B (Continued)

1991

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Corporate	11 Jan	Belo Horizontes, Brazil	LJ-25	Hit 2 NM short.	5
Air Taxi-Ferry	8 Feb	Stansted, UK	Be-200	Hit 2-1/2 NM short of the runway; possible altimeter error.	2
Corporate	12 Feb	Uganda, Kenya	HS-125	Hit mtn on initial approach.	3
Air Taxi	15 Mar	Brown Fld, CA	HS-125	Hit mtn on departure 8L.	10
Corporate	18 Mar	Brasilia, Brazil	LJ-25	Hit short.	4
Corporate	21 May	Bauchi, Nigeria	Ce-550	Hit short.	3
Corporate	17 June	Caracas, Venezuela	G-II	Hit 5 NM short to rwy 10.	4
Corporate	4 Sept	Kota Kinabalu, Malaysia	G-II	Hit mtn during missed approach.	12
Charter	17 Sept	Djibouti	L-100	Hit mtn VMC during initial approach.	4
Corporate	25 Sept	Holtenou Klel, Germany	DS-20	Missed approach.	1
Regional-Schd	27 Sept	Guadalcanal, Sol.	DHC-6	Hit mtn enroute.	15
Corporate	8 Oct	Hanover, Germany	Ce-425	Hit short on ILS 27R.	7
Air Taxi	22 Nov	Romeo, MI	Be-100	Hit 3 NM short on VOR/DME approach, IMC-fog.	4
Corporate	27 Nov	Paloma, Majorca	Be-400	Hit 1/4 NM short.	- -
Corporate	30 Nov	Kelso, WA	AC 690	Hit mtn 13 NM short.	5/1S
Corporate	11 Dec	Rome, GA	Be-400	Hit mtn on departure.	9

(1) Large Turboprop (5) 10 Seat Prop No GPWS installed on any of the above aircraft.
(2) 10 to 30 Seat Turboprop (8) 6 Seat Jet

APPENDIX B (Continued)

1990

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Regional-Schd	15 Jan	Elko, Nevada	Metro III	Hit mtn at FAF VOR-A.	4-5/16
Regional-Schd	16 Jan	San Jose, Costa Rica	CASA	Hit mtn on departure.	23
Air Taxi-Cargo	17 Jan	Denver to Montrose, CO	Ce-208A	Hit 50 below Mt. Massive (14,221) near Leadville, CO.	1
Corporate	17 Jan	West Point, MS	Be-400	Undershoot.	--
Corporate	19 Jan	Little Rock, AR	G-II	Hit short on ILS.	7
Air Taxi-Cargo	29 Jan	Williston, VT	Ce-208B	Hit trees, power lines on climb out at major IMC.	2
Air Taxi-Cargo	29 Jan	Schuyler Falls, NY	Ce-208B	Hit 1-1/2 NM beyond rwy 19 during climb out IMC, night.	1
Schd-Freight	21 Mar	Tegucigalpa, Honduras	L-188	Hit mtn 6 NM short VOR/DME rwy 1.	3
Business	27 Mar	Uvalde, TX	Be-100	Hit terrain 4 NM south of field on approach in IMC-night.	--
Regional-Schd	20 April	Moosonee, Ontario	Be-99	Hit 7 NM short on VOR rwy 24.	1 of 4
Air Taxi	28 April	Tamanrasset, Algeria	Be-90A	Hit 4 NM short on approach.	6
Regional-Schd	4 May	Wilmington, NC	GN-24	Hit short on B/C Loc 16.	2
Air Taxi	11 May	Cairns, Australia	Ce-500	Hit mtn on initial approach.	11
Air Taxi	13 Aug	Cozuneil, Mexico	AC 1121	Undershoot.	1
Air Taxi	11 Sept	New Mexico	MS-760?	Hit mtn on departure.	2
Business	22 Sept	White Plains, NY	AC 690B	Hit short by 3 NM in IMC.	0 of 6
Air Taxi	24 Sept	San Luis Obispo, CA	Ce-500	Hit short on approach LOC 11.	4
Corporate	21 Nov	Keller Jock, Australia	Be-200	Initial approach.	3
Air Taxi	29 Nov	Sebring, FL	Ce-550	Undershot on approach rwy 11.	--
Business	30 Nov	Kelso, WA	AC-690A	Hit short by 8 NM night on initial approach into mountain.	5 of 6
Air Taxi-Cargo	21 Dec	Cold Bay, AK	Ce-208	Hit mountain enroute.	1

(1) Large Turboprop (12) 10 Seat Prop No GPWS installed on any of the above aircraft.
(3) 10 to 30 Seat Turboprop (5) 6 Seat Jet

APPENDIX B (Continued)

1989

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Private	2 Jan	Mansfield, OH			
Private	7 Jan	Paducah, KY	Be-90	Hit mtn on departure.	3 of 15
Schd Freight	12 Jan	Dayton, OH	M-2B	Hit 8 NM short during an ILS 24 approach circle for 23. Night, IMC.	4
Air Taxi	12 Jan	Caracas, Venezuela	Be-200	Hit terrain while diverting in low cloud.	2
Charter	19 Feb	Orange County, CA	Ce-404	Hit mtn 20 NM short.	10
Air Taxi	23 Feb	Altenshein, Lake Contance, Switzerland	AC-690	Hit short to rwy 10. VMC into IMC.	11
Air Taxi	24 Feb	Helsinki, Finland	SA-226T	Hit short on ILS approach IMC.	6 of 7
Regional-Schd	10 April	Valence, France	FH-27T	Hit mtn, initial approach.	22
Air Taxi-Ferry	10 May	Azusa, CA	Be-200	Hit San Gabriel Mountain at 7300 level (departed Santa Monica).	1
Corporate	29 June	Cartersville, GA	DA-20	Initial climb, shallow into terrain.	2
Regional	31 July	Auckland, New Zealand	CV-580	Hit during initial climb.	34
Regional-Schd	3 Aug	Samos, Greece	SD-330	Hit mtn enroute.	16
Charter	7 Aug	Gambella, Ethiopia	DHC-6	Hit power lines - fog.	3 of 7
Air Taxi-Med	21 Aug	Mayfield, NY	Be-100	Hit 1/4 NM short at night IMC.	6
Business	15 Sept	Terrace, BC	Metro III	Missed approach LDA/DME.	7
Regional-Schd	26 Sept	Hurdle Mills, NC	Ce-550	Hit 2-1/2 NM short on approach.	2
Regional-Schd	28 Oct	Molokai, Hawaii	DHC-6	Hit mtn enroute.	20
Corporate	7 Nov	Ribeiro Das, Nevez	LJ	Hit hill on approach.	5
Private	2 Dec	Ruidoso, NM	Be-90	Hit short in procedure turn NDB approach IMC.	2
Air Taxi-Positioning	22 Dec	Beluga River, Alaska	PA-31T	Hit 8 NM short.	- -
Regional-Schd	26 Dec	Pasco, WA	BAe JS-31	Hit short on ILS 21R.	4

(3) Large Turboprop (10) 10 Seat Prop No GPWS installed on any of the above aircraft.

(6) 10 to 30 Seat Turboprop (2) 6 Seat Jet

APPENDIX C

PARTIAL LIST OF EXCESSIVE-BANK-ANGLE CFIT ACCIDENTS/INCIDENTS

DATE	PLACE	AIRCRAFT TYPE	PHASE OF FLIGHT	CIRCUMSTANCES	FATALITIES
Various 1992 93	World-wide	Glass cockpit	En-route	Slow undetected rolls	--
6 June 92	Panama	B737-200	En-route	Slow undetected roll to 90 degrees believed to be ADI or autopilot	47
15 Feb 92	Toledo, OH	DC8-63	Missed approach	Slow undetected roll; autopilot; night	4
12 Dec 91	NWT Canada	B747-100	En-route	Slow undetected roll; autopilot; FL310 to FL190 recovery	--
1990	Montreal - Paris	B747-200	En-route	Slow undetected roll (71 degrees)	--
30 April 89	Miami - London	B747-200	En-route	Slow undetected roll (52 degrees)	--
12 Jan 89	Dayton OH	HS-748	Take-off climb	Slow roll to 50 degrees for turn during climb out; night	2
28 Oct 88	Paris	B747-100	Final	Visual transition, alignment to runway at night, overbank to 17 degrees at 150 ft.	--*
19 Feb 99	Raleigh-Durham	Metro III	Take-off climb	Expedited departure, overbanked to 45 degrees at 300 ft.	12
Dec 87	Edmonton, Canada	DC8-63F	Final	Visual transition at night to align with runway. Overbanked to 15 deg. at 150 ft.	--*
Nov 86	London	B747-200	Final	Visual transition at night to align with runway	--*
12 Nov 80	Cairo	C-141	Turning base to final	Overbanked at night; visual; no lights on ground	13
1 Jan 87	Bombay	B747	Departure climb	Rolled to 80 degrees at 1400 ft; night ADI failure, no flag	213
Sept 77	Geneva	B747	Departure climb	Roll, slow but detected in time by FO; ADI failure, no flag	--

*Significant change

APPENDIX D
REPORT ON CFIT ACCIDENT DATA

By R. Khatwa, National Aerospace Laboratory (NLR) Flight Division,
Amsterdam, Netherlands

1. CFIT accidents are those in which an otherwise serviceable aircraft, under the control of the crew, is flown into terrain, obstacles or water with no prior awareness on the part of the crew of the impending disaster. Inadvertent flight into ground or water has been a problem since the early days of aviation. Although many of the accidents have occurred in the less developed areas of the world, regions such as Western Europe and North America are not immune from the CFIT threat.

Despite all the anti-CFIT measures taken to date, CFIT accidents continue to occur at an unacceptable rate, and a number of common factors have continued to contribute to CFIT accidents. The list is long and the examples include nonstandard phraseology, noncompliance with procedures, visual illusions, confusing charts, crew fatigue, misreading/mis-setting altimeter, disabling GPWS, nonoptimal approach procedure design and ATC errors.

It is crucial to realize that various elements of the aviation infrastructure outside the flight deck can contribute to the cause of the accidents by virtue of their adverse effects on flight crew performance. Crews have often found themselves in the final link in the chain of events that lead to a CFIT accident. An NLR CFIT taxonomy suggests that the combination of variables that normally contribute to a CFIT accident belong to at least two of the following groups: flight crew, environment, approach, ATC aircraft equipment and organizational and regulatory factors. A reduction in the CFIT risk will therefore require a concentrated effort from all elements of the industry.

2. CFIT accidents are generally associated with a high level of kinetic energy, and the result is usually the complete destruction of the aircraft and the loss of almost all the occupants. ICAO statistics for commercial and general aviation operations indicate that for the period 1978–1991 there were 260 CFIT accidents resulting in 5,500 casualties. Both older-generation and newer glass-cockpit aircraft have been involved in the accidents, although data suggest that the risk appears to be higher for the former category.

Most accidents occurred to aircraft engaged in domestic commercial operations. For one particular State alone, between 1976 and 1990 there were 171 CFIT accidents to aircraft engaged in domestic operations. This averages one CFIT accident approximately every four weeks for 14 years for that State alone. A significant proportion of the accidents occurred within a radius of 25 nautical miles of the threshold and on the runway approach path. Data indicate that although the vertical profile is a major source of error, many accident flight descent paths were approximately parallel to a nominal three degree glide path. The absolute number of accidents involving nonprecision approaches appears to be exceptionally high. A large percentage occur during VOR-DEM/LOC-DME approaches. IMC or night IMC conditions are commonly associated with CFIT accidents. It is also evident that a significant number of crews had received little, if any, training specific to recovery procedures.

APPENDIX E

AIRLINE/IATA INPUT — EXTRACTS FROM THE IATA FLOPAC SURVEY OF MEMBERS INTO THE VALUE AND USE OF RADIO ALTIMETERS TO ENHANCE TERRAIN AWARENESS

This survey was completed by senior management pilot representatives affiliated with most of the world's international airlines.

CONCLUSIONS

- There was unanimous consensus that radio altimeters improve terrain awareness.
- There was very strong support for selected radio altitudes to be properly integrated within flight crew procedures and supported by automatic voice callouts.
- Nearly all airlines were aware of and intended pursuing the provision of superior radio altimeter features, to enhance terrain awareness.

British Airways — Stabilized Approach Criteria

- Fleet-specific criteria for desired speed/configuration at 1,000 feet radio altimeter are promulgated, and consideration should be given to a go-around in the event that the 1,000-foot criteria are not achieved.

- On all approaches, the aircraft must be stabilized at 500 feet radio altitude in the planned landing configuration, the glide slope or correct vertical profile must be established with approach power set and indicated airspeed no more than the target threshold speed plus 20 knots. If these criteria are not achieved, an immediate go-around must be carried out.

ICAO

Amendments to Annex 6, Parts I and II

Allied Signal/D. Bateman

- CFIT Accidents by Type of Instrument Procedure, Commercial Jet Aircraft, Last Six Years, July 1988 to July 1994.
- Map location of 40 CFIT Accidents/Incidents from the Runway Threshold Vertical.

APPENDIX F

TAKING THE "NON" OUT OF THE NONPRECISION APPROACH

By Capt. D.E. Walker

The nonprecision approach is the culprit in most CFIT accidents. The point of impact for most CFIT accidents is in line with the intended runway for landing, but anywhere from one to several miles away from the runway. Several aspects of the nonprecision approach contribute to the risk of a CFIT accident short of the runway. The very idea of a nonprecision approach providing no guidance to the pilot in the vertical plane is an anathema. What steps can we take to reduce the risk of this sort of CFIT? By providing precise guidance to the pilot conducting the nonprecision approach? How can we do that?

The first and most obvious step is to provide the pilot with a standard descent slope. Many, if not most, nonprecision approaches provide crossing altitudes at the final approach fix (FAF) that would require a descent path of less than the standard three degrees. There is no minimum approach slope and some nonprecision approaches show a possible descent profile of less than one degree.

Some nonprecision approach charts show the altitude at which a three-degree slope crosses the FAF. In addition, those charts often display the recommended descent rates required to maintain that profile. The pilot is trained to intercept and descend on that three-degree profile. His nonprecision descent has now been made more precise.

Raising the crossing altitude at the final approach fix to establish a three-degree slope would also reduce the number of steps now common during a nonprecision approach. Pilots descending at the wrong step point is a frequent factor in the aircraft colliding with terrain well short of the runway. This is a major cause of CFIT accidents. These inappropriate descents usually result from some sort of navigation blunder.

The often catastrophic result of a navigation blunder may be averted, provided there is some means of alerting the pilot to that error. GPWSs alert the pilot to a descent that is excessively steep. They provide no warning to a pilot descending towards an airport that is not where he expects it to be. The radio altimeter with its audio height callout is used by many operators to alert the pilot to terrain proximity. Some of these devices are being used with so called "smart callouts," which alert the pilot to 500 feet above terrain whenever a nonprecision approach is under way. That is a very worthwhile feature. Its warning comes late, but better late than never. What additional alert would we wish from such a device?

Usually, a nonprecision approach penetrates 1,000 feet above terrain only after passing the FAF. This penetration of the 1,000 feet above terrain will occur at an easily defined point on the three-degree slope from the FAF to the runway. That point should be marked on all nonprecision approach charts. A tentative name of terrain proximity point or TPP is suggested. It is the first opportunity that the pilot has to confirm that vertical tracking is as desired and that the aircraft is actually on the three-degree slope to the runway. Having the radio altimeter system call out when the 1,000-foot AGL veneer is penetrated (TPP) should be time for the pilot to confirm that the aircraft is at the position defined on his chart for penetrating that 1,000-foot veneer on the desired three degree slope. It is our first opportunity to confirm our vertical navigation with reference to underlying terrain.

Summarizing, we want a standard descent profile of nominally three degrees established for all nonprecision approaches. We need to have that slope published on all nonprecision approach charts. Pilots need to be trained to fly that standard descent profile for all, rather than just precision, approaches. Some means of alerting the pilot to his position relative to the desired profile is required. This alert should occur before the aircraft becomes too close to terrain.

I suggest that this combination will do much to reduce the number of aircraft impacting in the final approach zone. These concepts were presented to the CFIT ATC working group meeting in Washington. I propose that they become the principal focus our next meeting of the aircraft equipment group.

APPENDIX G

1. **TERRAIN DATA INTEGRITY REQUIREMENTS** (from AlliedSignal sources)

The required integrity (accuracy) of terrain data depends on its intended use and purpose. Four levels of integrity are:

• **Level 1** Terrain data that are used for navigation, three axis guidance + display with aircraft performance purposes. Its accuracy is generally ± 10 meters. Usage: typical examples would be military attack aircraft using terrain for tactical advantages and helicopters.

• **Level 2** Terrain data that are used for auto-correlation to update inertial navigation purposes and lateral guidance. Its accuracy is generally ± 30 metres.

• **Level 3** Terrain data that are used for supplemental terrain awareness purposes, indication, and relatively crude prediction purposes. Typical accuracy requirements are ± 1/2 Nautical Mile to ± 8 NM, depending on proximity to an airport.

• **Level 4** (Lowest Integrity) Terrain data that are used for supplemental secondary applications transparent to the pilot or other systems. Its integrity is typically ± 1NM accuracy and elevations ± 300 feet. One application is "Envelope Modulation" features found in GPWS.

2. **FAA Letter, Jan. 11,1995**

"Operational Approval of Stabilized Instrument Approach Procedures for Flight Management/Guidance System Equipped Aircraft."

3. **Extract from KLM FAX, 19 Aug. 1994**

"KLM tries to provide a stabilized nonprecision final approach even if no DME facility is available, e.g., by using an outbound timing from a navaid. ...

"We also took notice of your article in the *ICAO Journal* and as you may have guessed, we fully agree with it. ...

"We think that ICAO should bring pressure to bear on States in order to persuade them to stop publishing DME stepdown nonprecision approaches, for reasons of safety."

4. **Flight Safety Foundation**

Safety Alert. June 1993.
Schwartz, D. *FSF CFIT Task Force Flight Crew Training & Procedures Work Group: Report.* 1995.
CFIT Awareness Video.
FSF CFIT Checklist.
FSF *Head-up Guidance System Technology (HGST) — A Powerful Tool for Accident Prevention.* Project Report FSF/SP-91/01. July 1991.

5. **Transport Canada Video,** "Preventing CFIT Accidents."

—END—

FLIGHT SAFETY FOUNDATION CFIT TASK FORCE
FLIGHT CREW TRAINING & PROCEDURES WORKING GROUP

- A REPORT -

Presented to

Flight Safety Foundation
International Air Safety Seminar
Seattle, Washington, U.S.
Nov. 7, 1995

by
Douglas Schwartz
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OVERVIEW

The Flight Crew Training & Procedures Working Group was established in 1993, as one aspect of the Flight Safety Foundation (FSF) CFIT (Controlled Flight into Terrain) Task Force. The Working Group's mission was to "*develop and present guidelines and recommendations for flight crew operating policies, procedures and associated training and evaluation to reduce the risk of having CFIT encounter*" (London, May 1993).

Composed of a broad spectrum of international experts in aviation safety and training, the Working Group encompasses knowledge and experience pertaining to the CFIT phenomenon. Regional and technical diversity was a specific objective in composing the Working Group team. This is reflected in its broad regional representation, with active participation from Africa, Asia, Europe, North America and South America. Technical diversity of the Working Group is also reflected in the range of companies and organizations represented, including airline companies, aircraft manufacturers, training centers, pilot associations (U.S. Air Line Pilots Association [ALPA], International Federation of Air Line Pilots Associations [IFALPA]) and international organizations (FSF, International Civil Aviation Organization [ICAO], IATA).

The Working Group identified three products to deliver to the industry, through Flight Safety Foundation. Each product was developed by a small task team that reported to the full Working Group. Each of the three products was considered an important element of a coordinated strategy to achieve the Working Group's objectives. The products are:

A CFIT awareness package;

A set of recommended policies and procedures related to CFIT risks encountered by flight crews; and,

A model CFIT training program.

This paper describes the status of each of these products.

CFIT AWARENESS PACKAGE

The objectives of the CFIT awareness package are to:

Increase awareness among decision makers about CFIT risks; and,

Promote support for appropriate CFIT safety and prevention strategies.

The awareness package target audience includes:

Airlines;
Government regulators;
Industry groups and associations;
ATC authorities;
Insurers;
Aircraft operators of all kinds;
Lessors;
Financial institutions; and,
Other related groups.

The Awareness Package Task Team has completed its work. Their accomplishments include several important achievements:

A *Safety Alert* issued worldwide by Flight Safety Foundation in late 1993 (Appendix A). This alert warns of the CFIT accident risk and contains recommendations for flight crew response to ground-proximity warning system (GPWS) warnings:

"*When a GPWS warning occurs, pilots should immediately, and without hesitating to evaluate the warning, execute the pull-up action recommended in the company procedure manual. ... This ... procedure should be followed except in clear daylight visual meteorological conditions when the flight crew can immediately and unequivocally confirm a false GPWS warning*";

A recommendation to outfit all aircraft with state-of-the-art GPWS systems;

[In 1995, the CFIT Task Force's recommendation for broadening the use of GPWS was adopted by ICAO. New standards, effective Dec. 31, 1998, require GPWS in all aircraft used in "international commercial and general aviation operations, where the MCTM (maximum certified takeoff mass) is in excess of 5,700 kilograms (12,500 pounds) ... or (that) are authorized to carry more than nine passengers," the ICAO ruling said. ICAO said that the new standards also "specify the minimum modes in which GPWS is required to operate."]; and,

A CFIT awareness video, specifically targeting regional airlines and corporate flight operations.

[The FSF CFIT checklist, distributed worldwide by Flight Safety Foundation, enables a flight crew to calculate the CFIT risk for any route or destination. The checklist assigns positive or negative values to a series of factors to be encountered in the flight or approach.]

CFIT POLICY & PROCEDURES RECOMMENDATIONS

The team was tasked to provide a set of baseline flight crew operating policies and procedures to support reduction of CFIT accident risk. This work of the Policy & Procedures Task Team is complete.

The recommendations that were produced target:

Airlines;
Government regulators;
Pilot associations; and,
Individual flight crew members.

This spectrum of end-users provides a safety net intended to ensure the benefit of the recommendations. Placing a consistent set of procedures in the hands of multiple levels of decision makers provides the redundancy to do this. Each level of authority has the capacity to embrace and implement the recommended CFIT avoidance strategies and achieve productive advantage independently of the others. When all levels do so in coordination with one another, maximum effect is achieved.

The task team produced 15 policy and procedure recommendations. Two are recommendations to corporate management, which have been referred to the CFIT Task Force Implementation Committee for action. The other 13 recommendations relate to flight operations and training.

The policy recommendations to management are contained in Appendix B. The operations and training recommendations are contained in Appendix C. Each is described in terms of a problem statement and associated policy or procedure recommendations. Recommendations address the following topics:

<u>Policy Recommendations to Management (Appendix B)</u>

A policy statement for establishing a safety-oriented corporate culture; and,
A recommendation to implement systemic safety performance measurements.

Flight Operations & Training Recommendations (Appendix C)

Altitude awareness, adherence to altitude clearances and procedures to confirm adequate terrain clearance;
Use of autopilots during approaches and missed approaches;
Acceptance of ATC clearances;
Approach and departure briefings;
Chart supply for flight crews;
Use of checklists;
Allocation of flight crew duties/use of monitored approach procedures;
GPWS warning response;
Nonprecision approach procedures;
Rate-of-descent policy;
Route and destination familiarization;
Stabilized approaches; and,
Ground briefing materials.

MODEL CFIT TRAINING PROGRAM

The CFIT Training Program Task Team was charged with producing a model CFIT training program curriculum. This model was completed in early 1995 and forms the basis of the CFIT Education & Training Aid. This aid will be the most visible product of the Working Group's activity and is patterned after similar training aids previously produced on topics such as wind shear, rejected takeoffs and takeoff performance. It is intended for use by all providers and users of flight crew training.

Resources for development and production of the CFIT Education & Training Aid, along with associated materials and an instructional video, have been provided by the Boeing Commercial Airplane Group. The development group was headed by Capt. Dave Carbough, assisted by Capt. Skip Cooper and Steve Morman. The Training & Procedures Working Group is grateful to these dedicated professionals for their support, effort and persistence.

The Training Aid is composed of two parts:

An instructional video; and,
A detailed written document.

The instructional video contains a history of CFIT accidents, a review of worldwide CFIT accident statistics and trends, an analysis of the "traps" with CFIT accident potential that flight crews might encounter, and CFIT avoidance and recovery strategies. Interviews with aviation industry leaders from throughout the world highlight the importance of the Task Force initiative and call on industry executives at the highest level of organizations to support this effort. The video also includes sample training situations that illustrate how the aid can be used by an operator.

The written document is composed of five sections:

Management Overview
An executive level briefing package to educate senior level executive management about the CFIT phenomenon and the role of management in CFIT reduction strategies;

Decision Maker Guide

Important considerations to help operations managers implement CFIT training and associated policies and procedures;

Operators Guide
CFIT policy and procedures recommendations;

CFIT Training Program
A flight crew training program containing associated instructor documentation, support materials and participant manuals. The program includes specific ground school and simulator training lessons and recognition, avoidance and recovery strategies. Aircraft-specific CFIT recovery procedures are given for aircraft for which appropriate technical data were available; and,

Background Data
Supporting reference material containing engineering and testing data developed and used to support Training Aid recommendations.

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America West Airlines
Britannia Airways
Don Bateman
Boeing Commercial Airplane Group
British Airways
Delta Air Lines
Flight Safety Foundation
FlightSafety International
Gulfstream Aerospace
International Air Transport Association (IATA)
International Civil Aviation Organization (ICAO)
International Federation of Air Line Pilots' Associations (IFALPA)
Japan Airlines
Lockheed Martin
McDonnell Douglas Corporation
SAS
United Airlines
Varig Brazilian Airlines

- APPENDIX A -

FLIGHT SAFETY FOUNDATION
CFIT SAFETY ALERT

-APPENDIX B -

POLICY RECOMMENDATIONS TO MANAGEMENT TEAM

FLIGHT SAFETY FOUNDATION

CFIT TASK FORCE

PROCEDURES & TRAINING WORKING GROUP

COMMITMENT TO SAFETY

Problem Statement

Consistent levels of safety cannot be achieved without a genuine commitment from management to support reasonable initiatives and the dedication of employees to contribute to a safe operating environment.

Recommendation to Steering Committee

Companies should support and adopt a mission statement along the following lines:

All employees, at all levels, share responsibility for safety and for the enhancement of the overall corporate safety culture. Safety priorities are considered in decision making within all departments. To this end, there should be a structure in place, supported at the highest level, to manage and support safety-related issues, as well as to ensure that safety is measured as an integral part of operational efficiency.

The company shall foster confidence that the decisions of all departments with regard to rational safety decisions will be supported and not subject to adverse reaction.

Scrutiny of safety-related decisions will be dedicated exclusively to developing improvements in the operational integrity of support systems.

Refer to Implementation Committee for action.

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

MEASUREMENT & EVALUATION OF SYSTEM PERFORMANCE

Problem Statement

Companies have insufficient systems and infrastructure for monitoring and evaluating the operational performance of management, crew and equipment.

Recommendation to Steering Committee

All companies should provide systems and infrastructure for monitoring and evaluating the operational performance of management, crew and equipment with the objective of enhancing operational integrity. This can be accomplished by means of some, or preferably all, of the following:

- Flight data recorder analysis;
- Quick access recorder analysis;
- Flight operations quality assurance (FOQA) programs;
- Data bases for safety analysis;
- Defined criteria for safety reporting;
- Establishment and encouragement of a "no blame" reporting culture;
- Management process/culture to apply accumulated data effectively; and,
- An independent quality audit function to achieve operational integrity.

Recommendations & Notes

Operational Integrity describes a set of interrelated performance measures that might be employed to measure safety in relation to other key indicators. It presents a set of indices to measure performance of the infrastructures within a system that support safety. The performance measures described are:

- Safety;
- Cost efficiency;

Schedule performance;
Customer satisfaction;
Regulatory compliance; and,
Adherence to operating policies and procedures.

Refer to Steering Committee for further action.

- APPENDIX C -

POLICY AND PROCEDURE RECOMMENDATIONS FOR FLIGHT OPERATIONS & TRAINING

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

ALTITUDE AWARENESS

Problem Statement

Many incidents/accidents have occurred as a result of crews not having sufficient awareness of altitude and proximity to terrain.

Policy/Procedure Statement

It is essential that flight crews always appreciate the altitude of their aircraft relative to terrain, and assigned or desired flight path. Methods by which flight crews will monitor and cross-check assigned altitudes, as well as verify and confirm altitude changes, should be established and followed.

As a minimum, procedures should encompass the following items:

The crew must be responsible for ascertaining the applicable minimum safe altitude (MSA) reference point. Crews are cautioned that the MSA reference point for an airport may vary considerably according to the specific approach in use;

The crew must be aware of the applicable transition altitude or transition level;

There should be a checklist item to ensure that all altimeters are correctly set in relation to transition altitude/level;

Any crew member(s) should call out any significant deviation or trend away from assigned clearances;

Minimum operating altitudes should be adjusted in conditions of low temperatures, low pressures and/or excessive winds. It is suggested that the following corrections be applied:

For low temperature add 4 percent per 10 degreesC below ISA;
For low pressure (if flying on standard pressure setting of

1013 hPa or 29.92 inches), add 30 feet (9.2 meters) per hPa below standard setting; and,

For winds in excess of 30 knots add 500 feet (153 meters) per 10 knots above 30, up to a maximum correction of 2,000 feet (610 meters).

In all cases, air traffic control will be notified when altitude corrections are applied;

A call-out should be made at the following times:

Upon initial indication of radio height, at which point altitude vs. height above terrain should be assessed and confirmed to be reasonable, and radio height will be added to the standard instrument scan of pilots;

Above or below approaching assigned altitude (adjusted as required to reflect specific aircraft performance);

Approaching relevant approach minimums (specific height to be determined by operator); and,

Passing transition altitude/level;

Consideration should be given to incorporating a 500-foot (153-meter) radio height call-out on final approach (strongly recommended for all nonprecision approaches). At this point, altitude vs. height above terrain should be assessed and confirmed to be reasonable or an immediate missed approach initiated;

The pilot flying should announce, and the pilot not flying confirm, any changes to aircraft altitude or heading (excluding minor corrections);

Flight crew members should confirm altimeter-setting units. It is recommended that this be done by repeating all digits and altimeter units in clearance readbacks and by cockpit call-outs between crew members; and,

On crossing the final approach fix, outer marker or equivalent position, the pilot not flying will cross-check actual crossing altitude/height, against altitude/height as depicted on the approach chart.

Notes

Reference item 7 above: the Working Group feels that automated call-outs are preferable to manual call-outs.

Refer to ATC Working Group to advise item #5.

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

USE OF AUTOPILOTS

Problem Statement

Crews do not take full advantage of automatics as a means to manage the progress of a flight and reduce workload.

Policy/Procedure Statement

The use of autopilots is encouraged during all approaches and missed approaches, in instrument meteorological conditions, when suitable equipment is installed. It is incumbent on operators to develop specific procedures for the use of autopilots and autothrottles during precision approaches, nonprecision approaches and missed approaches, and to provide simulator-based training in the use of said procedures to all flight crews.

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

ACCEPTANCE OF ATC CLEARANCES

Problem Statement

From time to time, air traffic control (ATC) issues flawed instructions that do not ensure adequate terrain clearance. Such clearances are too often accepted by pilots without considering consequences and/or questioning instructions.

Policy/Procedure Recommendation

Flight crews should *not* assume that ATC clearances will ensure terrain clearance. If an ATC clearance is given that conflicts with the pilot's assessment of terrain criteria relative to known position, the clearance should be questioned and, if necessary, refused and suitable action taken.

Refer to ATC Working Group (Bob Vandel) for information purposes and perhaps to include in air traffic controller training/orientation.

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

APPROACH AND DEPARTURE BRIEFINGS

Problem Statement

The failure of flight crews to conduct thorough briefings causes uncertainty about intentions, hazards and other special conditions relevant to terrain clearance during approach and departure.

Policy/Procedure Recommendation

Flight crews will conduct predeparture and preapproach briefings. Flight crew briefings will include discussions of hazardous terrain features and avoidance strategies with appropriate consideration for aircraft performance capabilities. Briefings should include use of applicable charts with specific attention to departure routings, departure procedures, arrival routings, approach procedures, missed-approach procedures and altitude changes that ensure terrain clearance relative to planned approach or departure paths.

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

CHART SUPPLY

Problem Statement
The failure of companies to provide crew members with adequate supplies of current navigation and approach charts is a significant barrier to safety of flight. Furthermore, in some instances, current charting standards do not provide adequate information to flight crew members about terrain hazards, or are so complex as to make clear interpretation difficult.

Recommendation to Airborne Equipment Working Group and Steering Committee
Each pilot will be provided with accurate, current charts with clear depiction of hazardous terrain. Charts provided should depict hazardous terrain in a manner that is easy to recognize and understand. Electronic displays should resemble printed chart displays to the maximum extent feasible.

Refer to Airborne Equipment Working Group (David Walker) for further action.

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

USE OF CHECKLISTS

Problem Statement
Poorly conceived procedures for checklist use can result in task saturation of crew members during critical phases of flight. Incidents/accidents have occurred because of noncompletion of relevant checklist(s).

Policy/Procedure Recommendation
It is recommended that a detailed policy on checklist use be formulated by each operator and a strict discipline regarding their use be maintained. Such policies should require that checklists be completed early in the approach phase so as to minimize distraction while maneuvering close to the ground. In all cases, checklists should be completed no later than 1,000 feet (305 meters) above ground level (AGL).

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

ALLOCATION OF FLIGHT CREW DUTIES
USE OF MONITORED APPROACH PROCEDURES

Problem Statement

The majority of CFIT incidents/accidents are known to occur in instrument meteorological conditions (IMC) and night conditions when the pilot flying the approach also lands the aircraft.

Policy/Procedure Statement

Proper management of crew workload during night and IMC requires that precise and unambiguous procedures be established. It is recommended that operators adopt a monitored approach procedure during approaches and missed approaches conducted in these conditions. In this case, the first officer will fly approaches and missed approaches. The captain will monitor approach progress and subsequently land the aircraft after obtaining sufficient visual reference.

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

GPWS WARNING RESPONSE

Problem Statement

Incidents/accidents have occurred because flight crews have failed to make timely response to ground-proximity warning system (GPWS) alerts.

Policy/Procedure Recommendation

When a GPWS warning occurs, pilots should immediately, and without hesitating to evaluate the warning, execute the pull-up action recommended in the company procedure manual. This procedure should be followed in all but clear daylight visual meteorological conditions when the flight crew can immediately and unequivocally confirm a false GPWS warning.

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

NONPRECISION APPROACH PROCEDURES

Problem Statement

Most CFIT incidents/accidents occur during nonprecision approaches. Nonprecision approach procedures are different from precision approach procedures. Furthermore, stepdown nonprecision approach procedures can increase the risk of unstabilized approaches.

Policy/Procedure Statement

Approaches should be constructed and managed so that nonprecision approaches are as similar to precision approaches as possible, incorporating a stabilized approach concept. From a point prior to the final approach fix, pilots will establish an approximate three-degree approach path to touch down, in a stabilized condition for landing.

At the briefing stage, on nonprecision approaches, particular attention should be made regarding locations at which configuration changes will take place, as well as crossing altitudes. Rates of descent on final approach and relevant timings from the final approach fix that can be expected, as well as criteria for continuing the approach visually, should be confirmed. Special attention should be paid to relevant call-outs and monitoring.

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

RATE-OF-DESCENT POLICY

Problem Statement

High rates of descent in close proximity to terrain are dangerous. They result in increased risk of CFIT, high crew workload and reduced margins for safety.

Policy/Procedure Recommendation

A policy should be established that restricts the rate of descent allowed within a prescribed vertical distance of (1) the applicable minimum safe en route altitude, and (2) the minimum sector altitude as defined by ICAO PANS-OPS/TERPS.

For example, the restriction could be 2,000 feet (610 meters) per minute maximum rate of descent at or below 2,000 feet above either of these altitudes.

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

ROUTE & DESTINATION FAMILIARIZATION

Problem Statement

Crews may be inadequately prepared for CFIT-critical conditions, both en route and at destination.

Policy/Procedure Recommendation

Flight crews shall be provided with adequate means to become familiar with en route and destination conditions for routes deemed CFIT-critical. One or more of the following methods are considered acceptable for this purpose:

When making first flights along routes, or to destinations, deemed CFIT-critical, captains should be accompanied by another pilot familiar with the conditions; or,

Suitable simulators can be used to familiarize crew members with airport critical conditions when those simulators can realistically depict the procedural requirements expected of crew members; or,

Written guidance, dispatch briefing material and video familiarization using actual or simulated representations of destination and alternates can be provided.

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

STABILIZED APPROACHES

Problem Statement

Unstable approaches contribute to many incidents/accidents.

Policy/Procedure Statement

Pilots will establish a stabilized approach profile for all instrument and visual approaches. A stabilized approach has the following characteristics:

A constant rate of descent along an approximate three-degree approach path that intersects the landing runway approximately 1,000 feet (305 meters) beyond the approach end and begins not later than the final approach fix or equivalent position;

Flight from an established height above touchdown should be in a landing configuration with appropriate and stable airspeed, power setting, trim and constant rate of descent; and,

Normally, a stabilized approach configuration should be achieved no later than 1,000 feet above ground level (AGL). However, in all cases if a stabilized approach is not achieved by 500 feet (153 meters) AGL, an immediate missed approach shall be initiated.

FLIGHT SAFETY FOUNDATION
CFIT TASK FORCE
PROCEDURES & TRAINING WORKING GROUP

GROUND BRIEFING MATERIAL

Problem Statement
The absence of information to adequately assess routings, terrain and hazards relevant to destination and possible alternates contributes to poor planning and decision making on the part of flight crews.

Policy/Procedure Recommendation
Crew members will be provided with and review suitable materials to conduct thorough briefings for the route to be flown. This must include departure, en route, destination and potential alternates.

As a minimum this should include these materials:
- Current NOTAMs;
- Current weather conditions and forecasts;
- Seasonal weather analysis; and,
- Specific procedures critical to terrain avoidance.

Desirable materials that might also be used are:
- Video route briefings;
- Video destination and alternate airport briefings; and,
- A data base of materials describing unique features/conditions specific to route, destination and alternate airports.

FLIGHT INTO TERRAIN AND THE GROUND PROXIMITY WARNING SYSTEM (GPWS)

ENGINEERING REPORT 070-4251
16 JANUARY 1990

Revised 31 January 1991
Revised 12 February 1991
Revised 2 October 1991
Revised 5 November 1991
Revised 18 March 1992
Revised 28 May 1992
Revised 3 May 1993
Revised 17 July 1993
Revised 25 January 1994
Revised April 1994
Revised 31 January 1995
Revised 7 May 1995
Revised 29 April 1996

DON BATEMAN
ALLIEDSIGNAL

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CREDIT:

- I thank the few, the individuals and organizations around the world who provided much of the information used in this report. They are the real heros and heroines in flight safety.
- I thank Hans Hugli, Steve Johnson, Christine Stahl, Ev Vermilion, and Al Loos, in Engineering, for their help in the flight path to terrain profile construction and simulation.
- I thank Jon Hegstrom, Lisa Isaksen, Steve Garnels and Bruce Raccine's Art Department.
- I thank Jeanette Mefferd for helping with the text and typing.
- I also thank our test and demo pilot Lyle Flick (now retired) for getting us started in the first place.

Don Bateman

Disclaimer:

The accuracy and completeness of the accident/incident examples in this report are limited by the quality of data publicly available. Corrections are incorporated as official data and reports become available. We encourage participation in providing information that would enhance our understanding of these events. Our goal is a continual improvement in aviation safety.

Engineering Report 070-4251

1 November 1990
Revised 18 March 1992 by Don Bateman

Title: **Flight into Terrain and the Ground Proximity Warning Systems**
150 Plus Accidents and Examples

Purpose: Provide examples of Transport Category Aircraft accidents and events where the aircraft was either inadvertently flown into the ground, or nearly flown into the ground. These examples include aircraft equipped with Ground Proximity Warning Systems (GPWS) and other with no GPWS.

These examples can then be used for:

1. Flight Crew Training

   - To illustrate to the pilots some of the dangers and "traps" that can lead to such incidents in both ATC radar and non radar environments.

   - To illustrate recovery procedures and development of such procedures utilizing Flight Simulation.

   - To illustrate the use and limitations of GPWS and the various models of GPWS.

2. Encouraging aircraft operators to utilize the existing GPWS equipment on their aircraft and to keep it operational and maintained.

3. Encouraging aircraft manufacturers, aircraft owners and operators to install the latest available GPWS equipment and to develop better procedures and other cockpit instrumentation aids.

4. Encourage GPWS designers to improve future GPWS effectiveness.

Don Bateman

CONTROLLED FLIGHT TOWARDS TERRAIN (CFTT) INCIDENTS EXAMPLES WHERE GPWS WAS HELPFUL IN SUCCESSFUL RECOVERIES (40)+

DATE	LOCATION	AIRCRAFT	GPWS TYPE
29 Jan 95	Manaus	DC-8-62	MK II
Jan 95	Atlanta	B727	MK I
June 94	Portland	A320	MK III
May 94	San Jose	B737	MK V
Jan 94	Phoenix	A320	MK III
Jan 94	Ft. St. John	DHC-8	MK I
Dec 93	Dallas-Fort Worth	B737	MK V
Nov 93	Anchorage	B747	MK II
Oct 93	Ganer	DC-8	MK II
Oct 93	Gunnison	B737	MK I
Sept 93	Helena	B727	MK I
July 93	Cape Town	B737	MK I
April 93	Portland	L-1011	MK I
Mar 93	Bogota	MD-80	MK II
Sept 93	Naples	DC-9	MK II
June 92	Margarita	B767	MK III
May 92	Ft. Lauderdale	B737	MK I
May 92	Denver	DHC-7	MK I
April 92	Portland	B727	MK II
Mar 92	Quito	DC-8	MK II
Jan 92	Medford	B737	MK II
Sept 91	Mexico City	A300	MK II
June 90	San Diego	A320	MK III
Jan 90	Spokane	B727	MK I
Dec 89	Pointe de Pitre	B747	MKI
Nov 89	Spokane	B737	MK I
July 89	Copenhagen	DC-10	MK I
Oct 88	Long Beach	MD80	MK I
Oct 88	El Paso	B737	MK I
July 88	London	A320	MK III
Nov 87	Prince George	B737	MK I
Dec 86	Spokane	B727	MK I
Dec 86	Tangiers	B737	MK I
May 86	Denver	B727	MK I
Mar 86	Fallon	C-9	MK II
Nov 85	Genoa	MD-80	MK II
Feb 83	La Guardia	B767	MK III
Aug 79	Chitose	B747	MK II
Oct 78	San Francisco	B747	MK I
Feb 76	Salt Lake City	B727	MK II
Oct 76	Mexico City	DC-9	MK I

DB95034.DOC

Next Page

CIRCUMSTANCES: During initial approach to ILS/NDB 34R, the aircraft was pre-maturely cleared to 2950 feet and struck a mountain. The controller (with no radar) believed the aircraft was established on "PRI Corridor 7" (STAR) but the aircraft had apparently deviated south to save fuel.

TIME: Day

WEATHER: OK at the airport.

CONFIGURATION: Clean

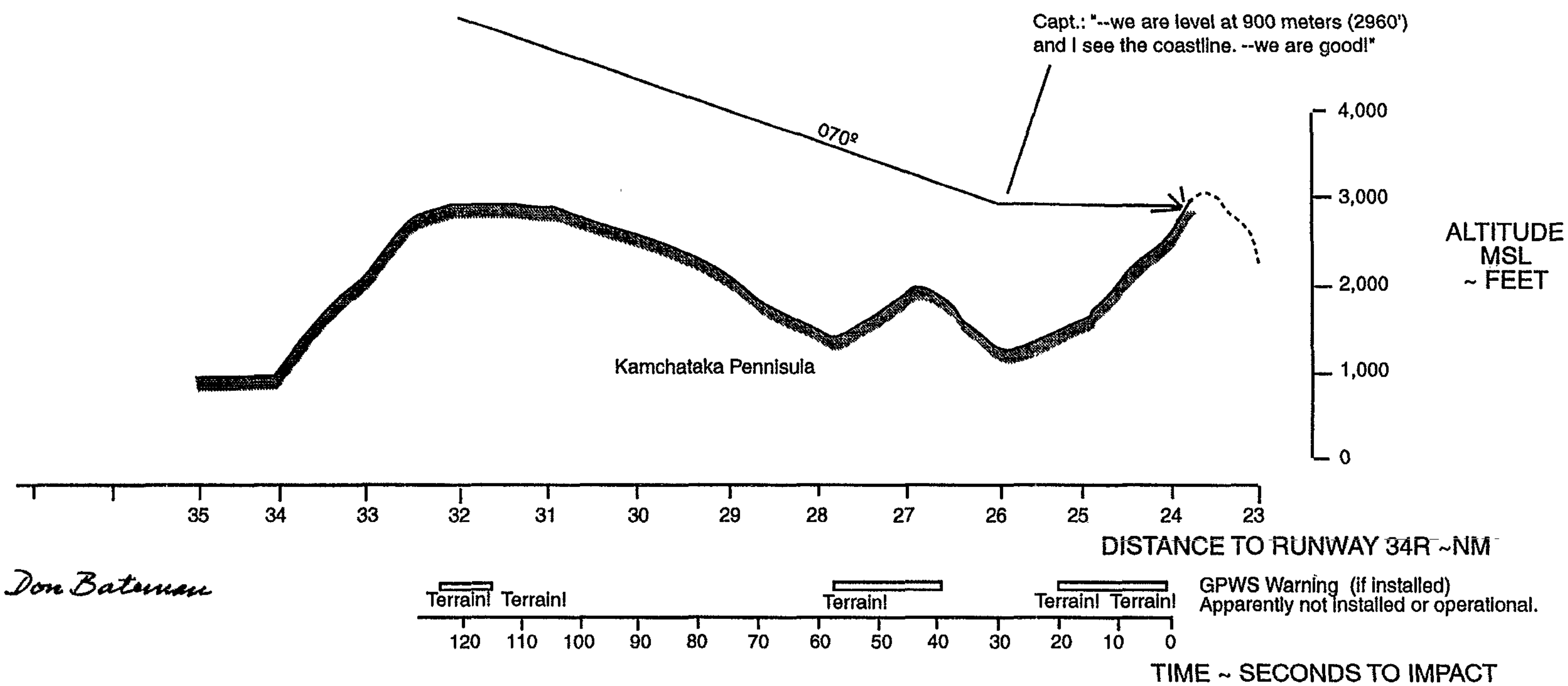
FATALITIES: 21 (7 passengers not registered)

OTHER: Aircraft was carrying 57 tonnes of beef, 17 tonnes in excess of payload limit. To help save fuel, the pilot had counted on an enroute tailwind component that did not happen.

Probable Flight Path Profile IL-76

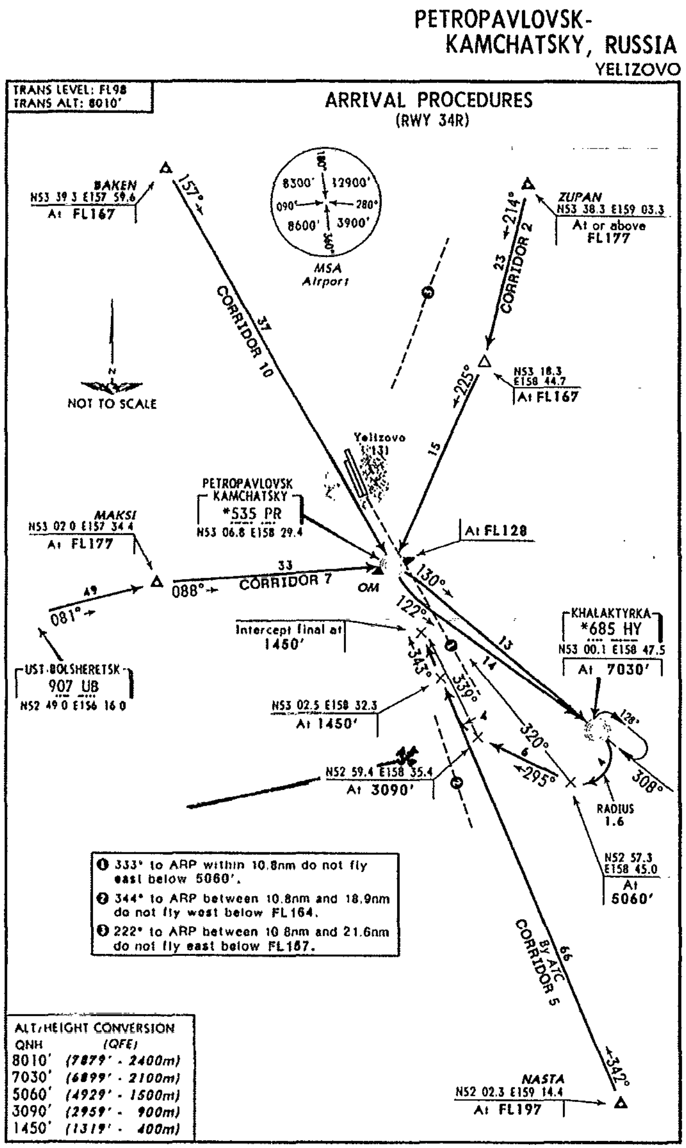
PETROPAVLOYSK - KAMCHATSKY, RUSSIA

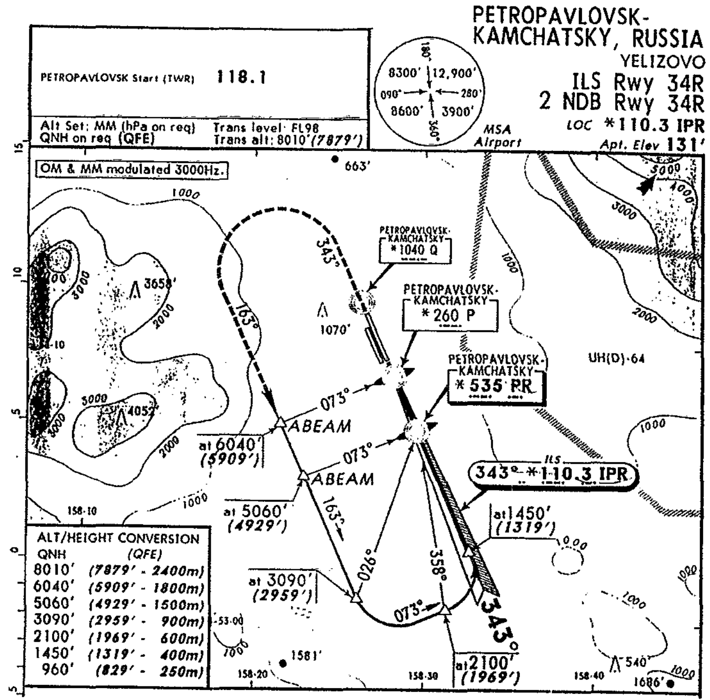
5 APRIL, 1996



Don Bateman

Return to TOC





CIRCUMSTANCES:	While on a NDB approach to runway 12, the aircraft impacted a 2300 foot mountain at the 2290 foot level, 2NM north of the runway. VIP USAF flight.
WEATHER:	Below minimums, 400 broken, 2000 foot overcast, fog, rain, variable visibility 5 to 3 miles, wind 12 kts surface at 120 degrees to probable 25 kts/160 degrees at FAF.
TIME:	14:50 local time
CONFIGURATION:	Landing, flaps 30
GPWS:	Early primitive GPWS installed, but operating status not known. (No CVR) Probably no GPWS warning with landing configuration.
FATALITIES:	35 including U.S. Secretary of Commerce, 10 staff members, 12 U.S.A. corporate company officers, flight crew of 6 and others.
OTHER:	Weather, ceiling and visibility below required instrument procedure minimums. Only one (single) ADF receiver. Pilots may have not been able to tune 'CV' NDB. (operating status of NDB not known).

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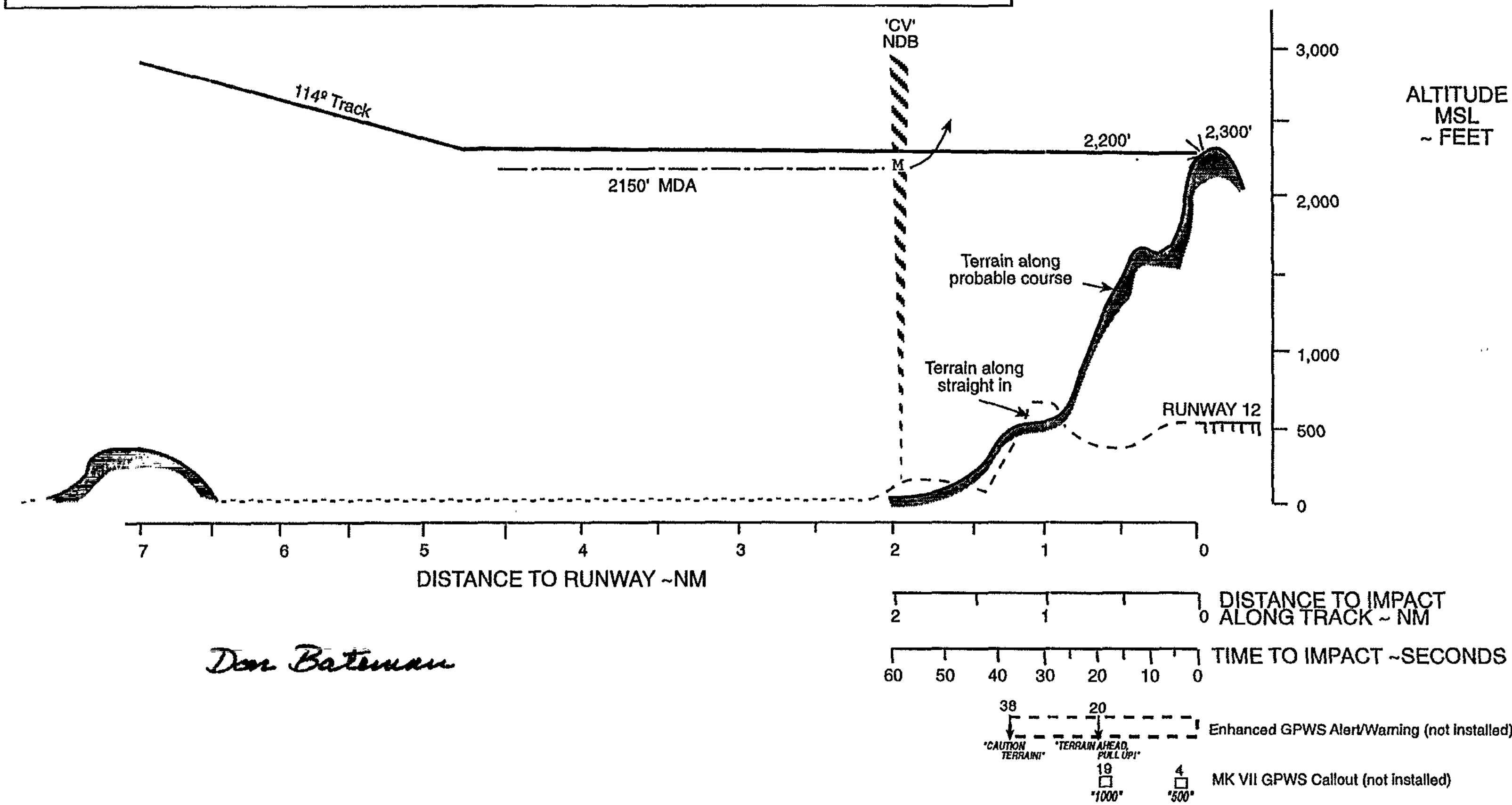
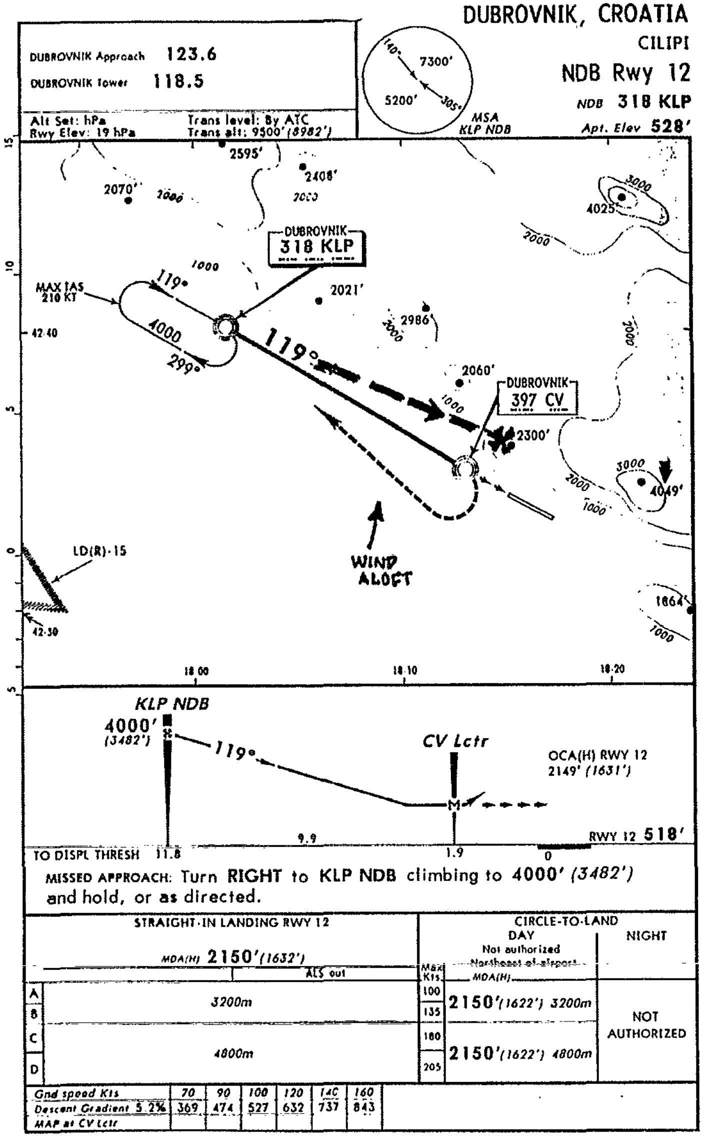
Probable Flight Path Profile
USAF B737-200
DUBROVNIK, CROATIA
3 APRIL, 1996



Don Bateman



Bodies recovered from crash

Brown's body identified; land mines on hillside, strong winds hamper removal of 33 victims

Ron Brown

A peacemaker in the Democratic Party and a champion of American business abroad. A 8

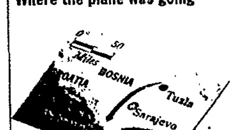
BY TONY SMITH
Associated Press

The body of Ron Brown has been identified following the crash of his plane yesterday near Dubrovnik, Croatia, the White House said today.

White House spokesman Mike McCurry told reporters Clinton called Alma Brown early this morning after being told that Brig. Gen. Michael Canavan, coordinating U.S. search operations at Dubrovnik, had identified the body.

Workers, fighting high winds and sheets of rain, today had recovered all 33 victims of the crash. There were no survivors. A woman was found alive but died aboard a NATO helicopter en route to the hospital.

Where the plane was going



Secretary Ron Brown's plane: The final moments

President Clinton's Commerce secretary and a group of business executives traveling from Tuzla, Bosnia, to Dubrovnik, Croatia, were aboard an Air Force plane that crashed on the Adriatic coast yesterday.

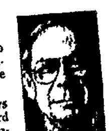
Plane carried many industry leaders drawn by business of rebuilding Bosnia

BY R.C. LONGWORTH
Chicago Tribune

CHICAGO — When John Scoville called his Chicago office from Zagreb on Tuesday night, there was excitement and hope in his voice. After all, he was doing what he did best: traveling the world to make a sale.

"He was very interested in knowing the latest news ... the chances in Bosnia," Refaat Malek, a board member of Harza Engineering Co., said of his conversation with the 64-year-old Scoville, Harza's chairman. "He was very upbeat, he was very optimistic."

So was Walter J. Murphy, an executive of an AT&T subsidiary, and Barry Conrad, a former Chicagoan who



John Scoville

ran his own international hotel and restaurant investment firm, and Robert E. Donovan, the American boss of ABB Asea Brown Boveri Ltd., the giant Swiss engineering firm.

The aftermath of war offers rich opportunities for businesses, particularly for those, like Harza, that are used to operating along the world's political fault lines. There are telecommunications to be restored, roads to

PLEASE SEE *Executives* ON A9

Plane h[...] flight re[...] complic[...] for inve[...]

BY BYRON ACOHIDO
Seattle Times aerospace report[...]

The military Boeing 73[...] Commerce Secretary Ron [...] equipped with flight-data or [...] Force insisted today [...] de[...] flight recorders had been f[...]

Air Force aircraft a[...] exempt from Federal Av[...]tion Administration rul[...] that require data and voi[...] recorders on all commerc[...] aircraft, primarily to provi[...] clues in solving accidents. It [...]t unusual, Air Force Maj[...] Claudia Ziebis said, for mi[...]litary passenger aircraft to [...]

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CIRCUMSTANCES: While on a VOR 'QIT' ILS 35 approach (radar vectored to localizer), the auto-flight inadvertently switched from "LOC" to "HDG" mode and the auto-throttles became uncoupled and not noticed by pilots. The aircraft deviated to the right, full scale of localizer of course into terrain well below glideslope. A Mk V GPWS alert warning "Glideslope!" "Glideslope!" followed by "Sinkrate!" -- Terrain! Terrain! and Pull Up! occured. Pilots were late to respond, but a missed approach was finally made.

WEATHER: IMC until breaking out to visual condition during the missed approach.

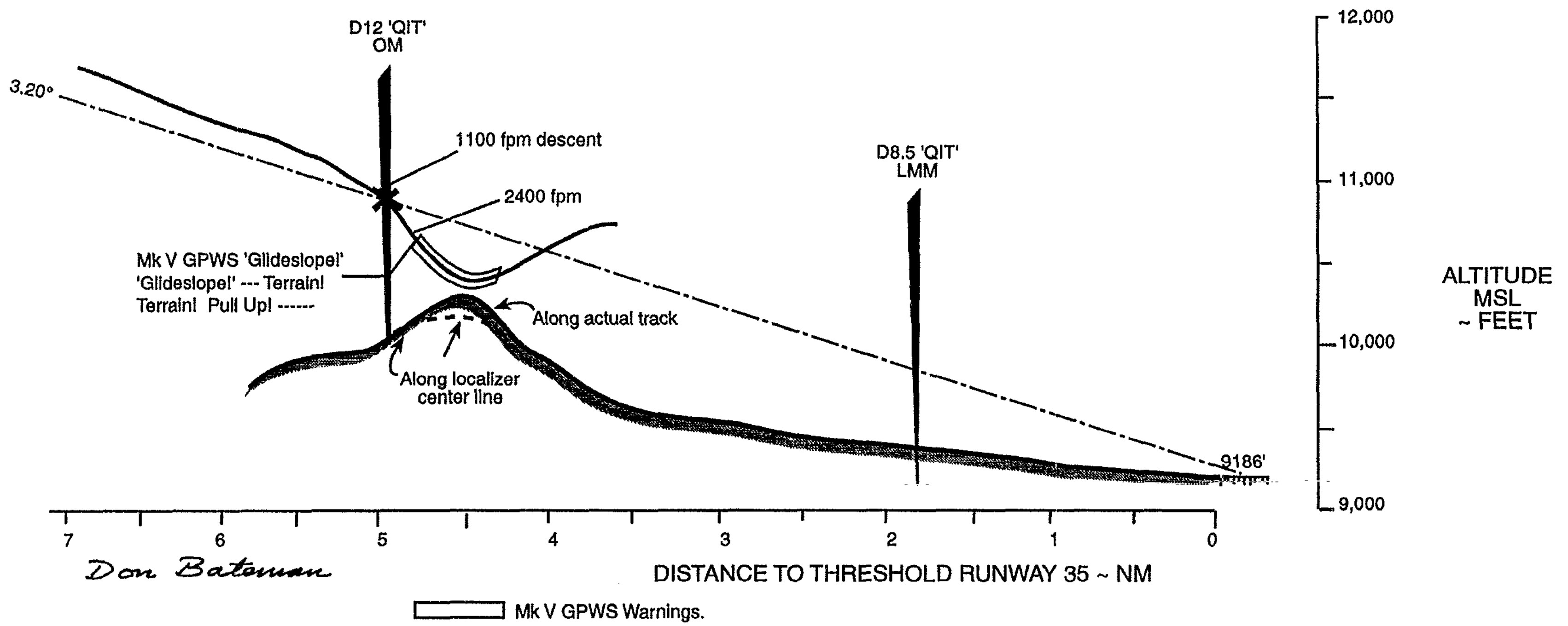
TIME: Day

CONFIGURATION: Probable gear down, flaps in transition from 28 to 50º.

OTHER: Human factors and misleading procedure statements. Pilots flying DC-10 were procedurely told to ignore routine "W-W - Terrain!" because of the early model of GPWS used on DC-10s gave nuisance warnings. There are no nuisance GPWS warnings for Mk V equipmen at Quito. (Envelope Modulation) In this occurence, the Mk V Envelope Modulation performed exactly as designed, giving full warnings soon as the aircraft deviated outside the localizer and glideslope limits. Pilots did not couple to glideslope because of scallops and beam noise. Glideslope used for indication only with Vertical Speed or Flight Path Angle modes of the auto-flight used to track the smoothed glideslope indications.

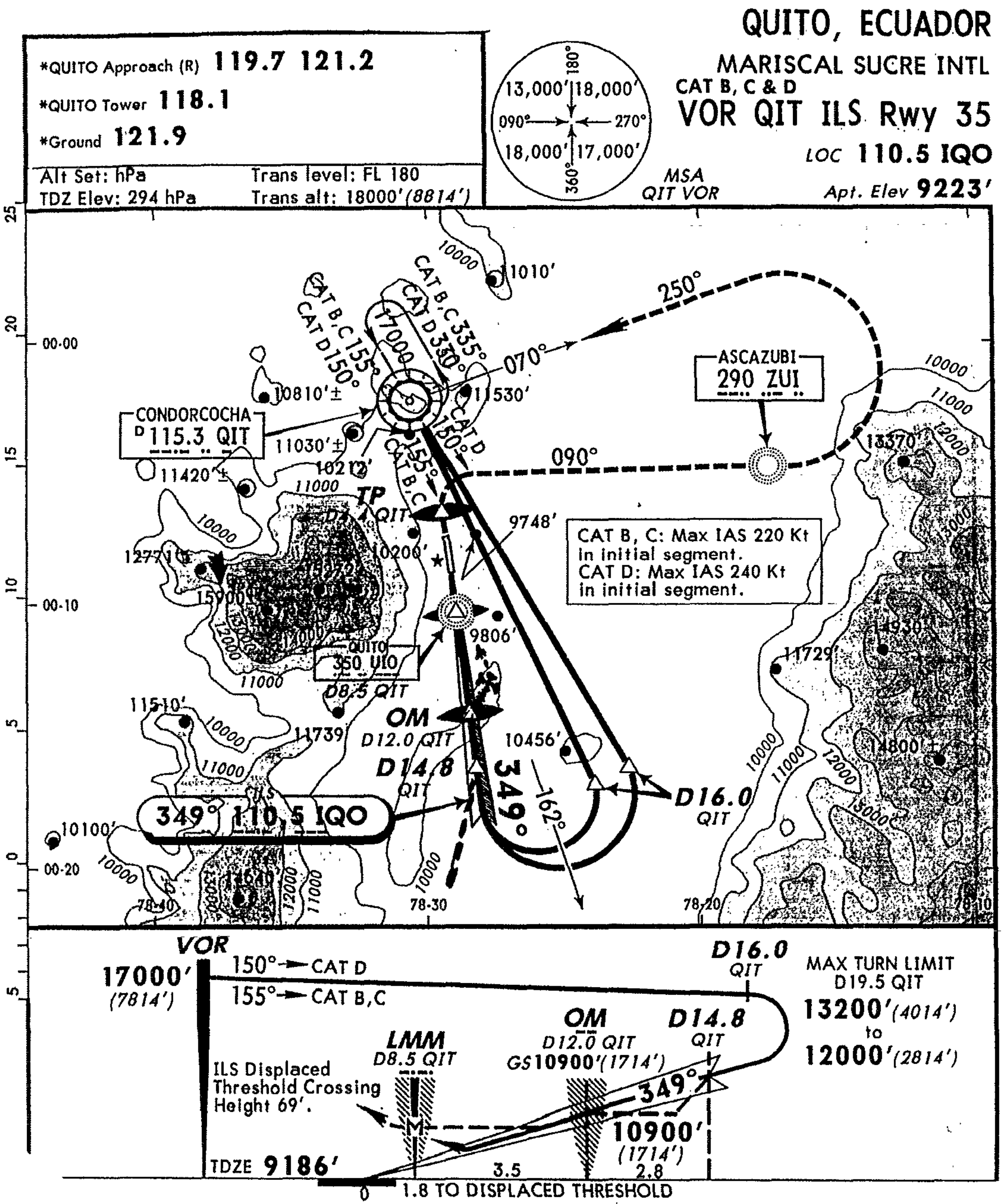
Occurence Flight Path Profile
MD-11
QUITO, ECUADOR
5 MARCH, 1996

See Accidents at Quito: 4 May 1995
22 Dec 1992
10 Dec 1992
Also incident: March 1992



Don Bateman

Return to TOC



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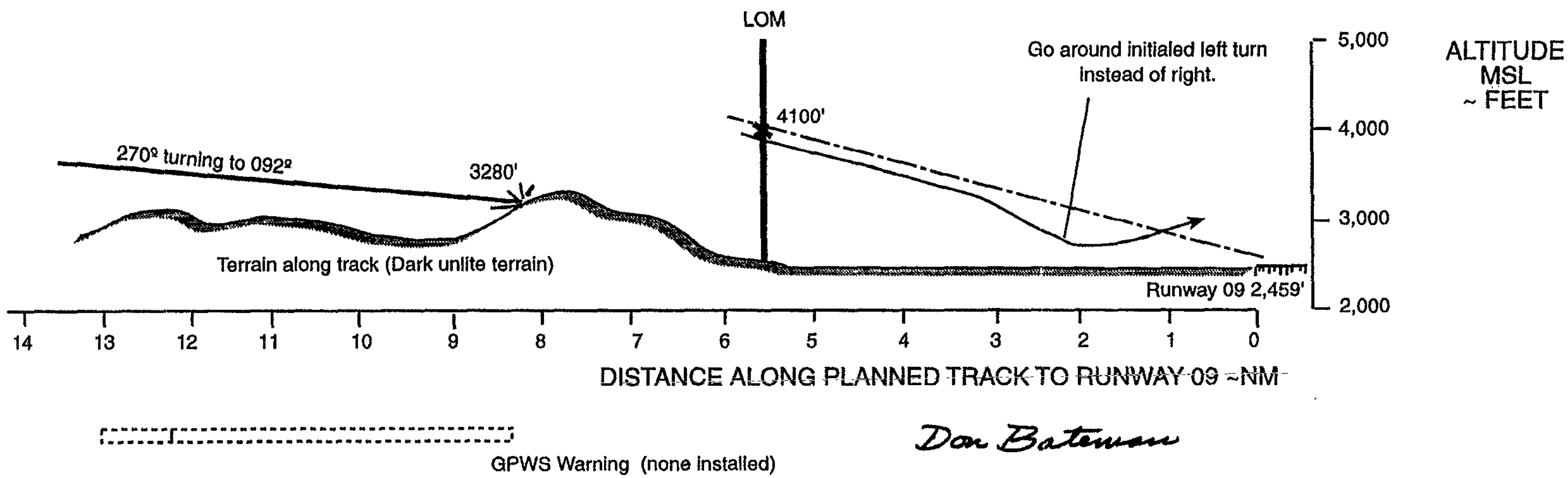
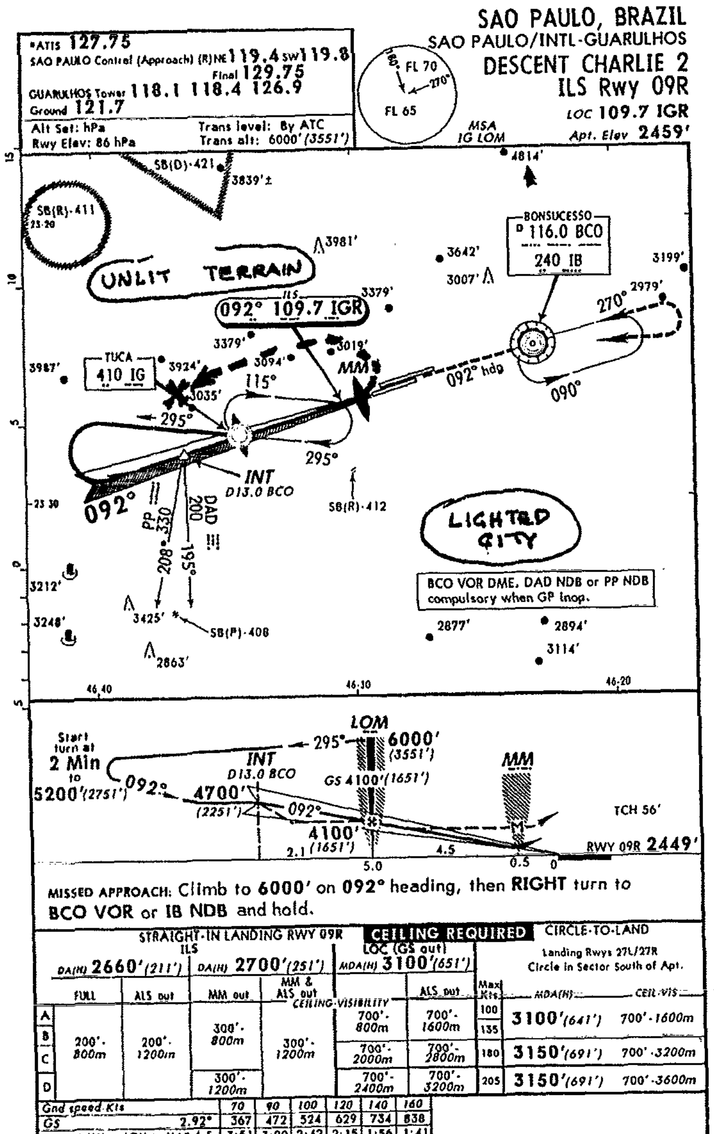
CIRCUMSTANCES:	During a go around after becoming destabilized, the aircraft entered a visual circuit back to ILS runway 09R. While trying to maintain visual contact, the aircraft impacted a mountain while in a beginning turn to base for runway 09.
WEATHER:	Broken 014, FCT 020, BKN 080, wind 120º 3 kts 21/21ºC Q1018
CONFIGURATION:	Believed to be clean
TIME:	02:16 UTC - Night
FATALITIES:	9
OTHER:	The pilots tried to make visual downwind circuit to the north over unlite terrain, instead of to the south over the city. No GPWS was installed.

Probable Flight Path Profile
LJ-25D
SAO PAULO, BRAZIL
2 MARCH, 1996



Don Bateman



Crash kills Brazilian rockers

SAO PAULO, Brazil — Fans lined up 10-deep outside a morgue yesterday to mourn one of Brazil's hottest rock bands, whose members were killed when their private plane crashed into a mountainside.

All five members of the band, Mamonas Assassinas, two assistants, and the pilot and co-pilot were killed Saturday when a chartered Lear jet crashed outside Sao Paulo. There were no survivors.

So many fans gathered outside a roped-off morgue in downtown Sao Paulo, Brazil's largest city, that troops were sent in to keep order. Other fans lined the streets and waved white handkerchiefs from apartment windows as ambulances carrying the bodies drove by. Some wore black armbands.

Appealing mainly to teenagers, Mamonas Assassinas used raunchy lyrics to promote a youthful image. Their first album, "Mamonas Assassinas," sold 1.9 million copies since its release last year.

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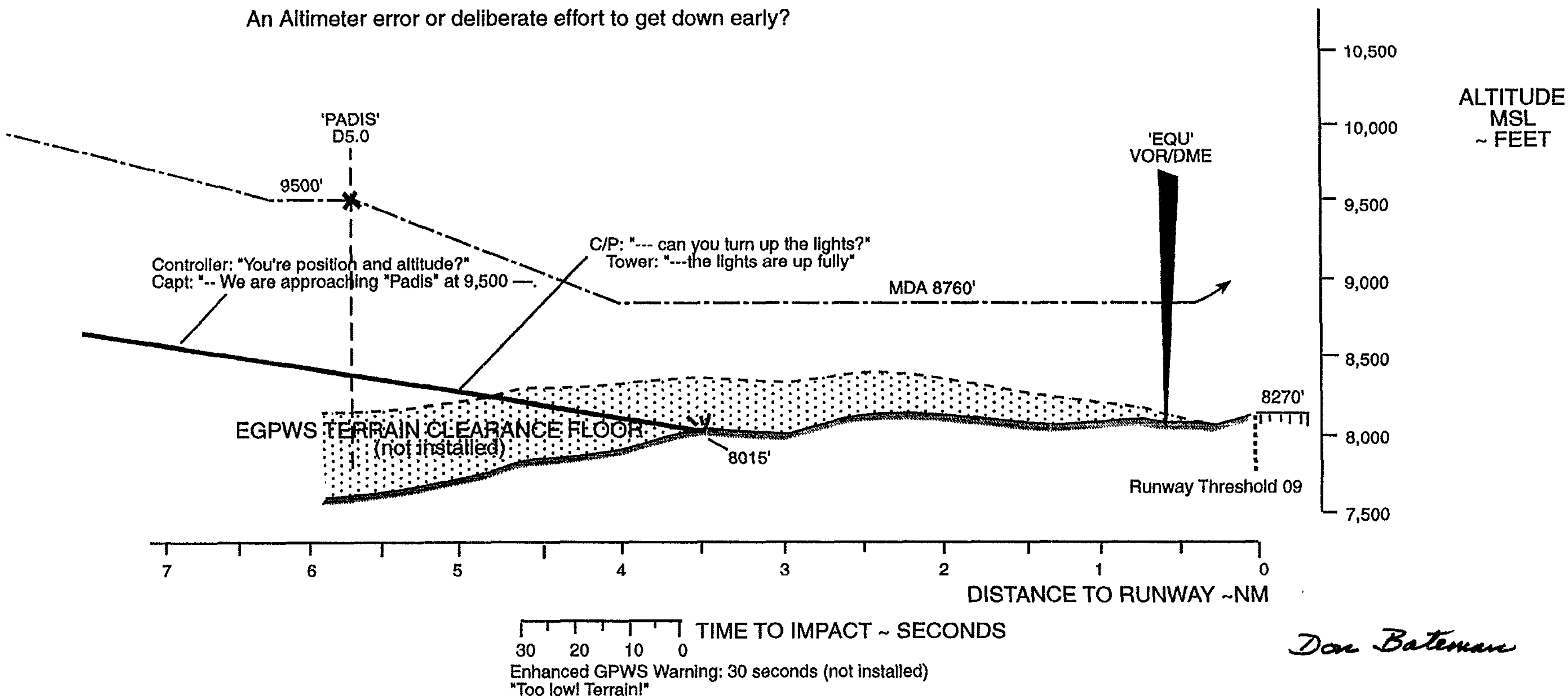
CIRCUMSTANCES:	While on a non-precision VOR DME approach to runway 09, the aircraft impacted short by 3 NM.
WEATHER:	Foggy, drizzle, limiting forward visibility.
TIME:	20:15 local
CONFIGURATION:	Landing
FATALITIES:	123
OTHER:	Mark I GPWS (Collins) installed. No apparent warning. The pilots may have seen the runway lights initially, but lost them as they descended into foggy conditions.

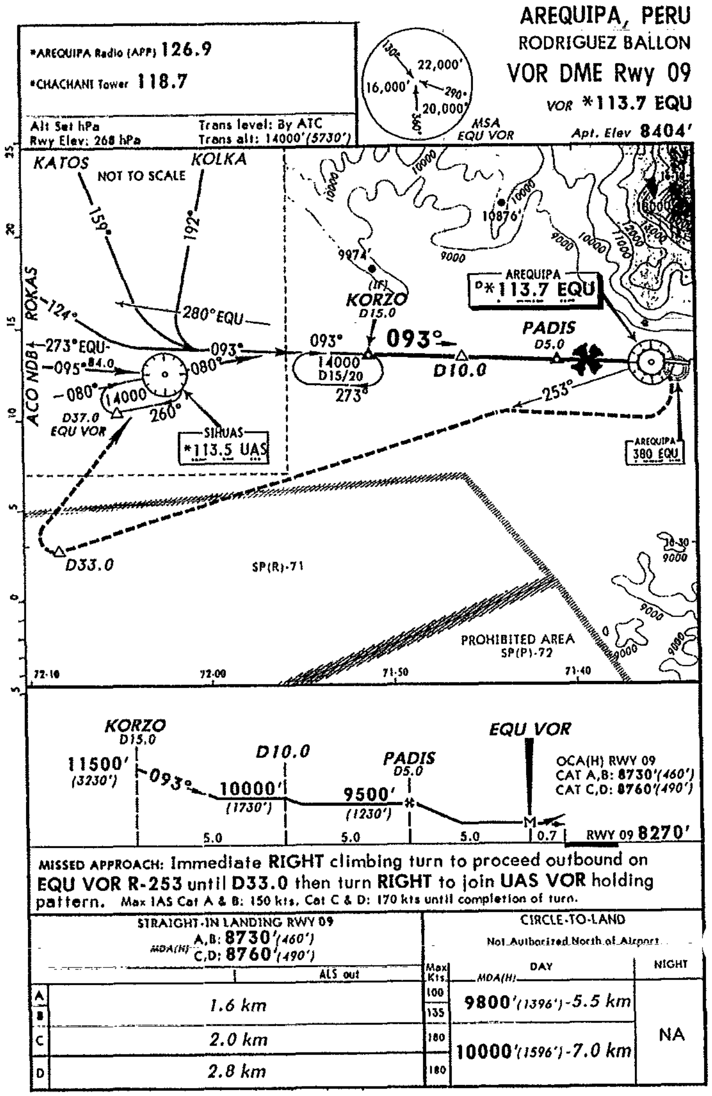
Flight Path Profile
B737-200
AREQUIPA, PERU
29 FEBRUARY, 1996

An Altimeter error or deliberate effort to get down early?

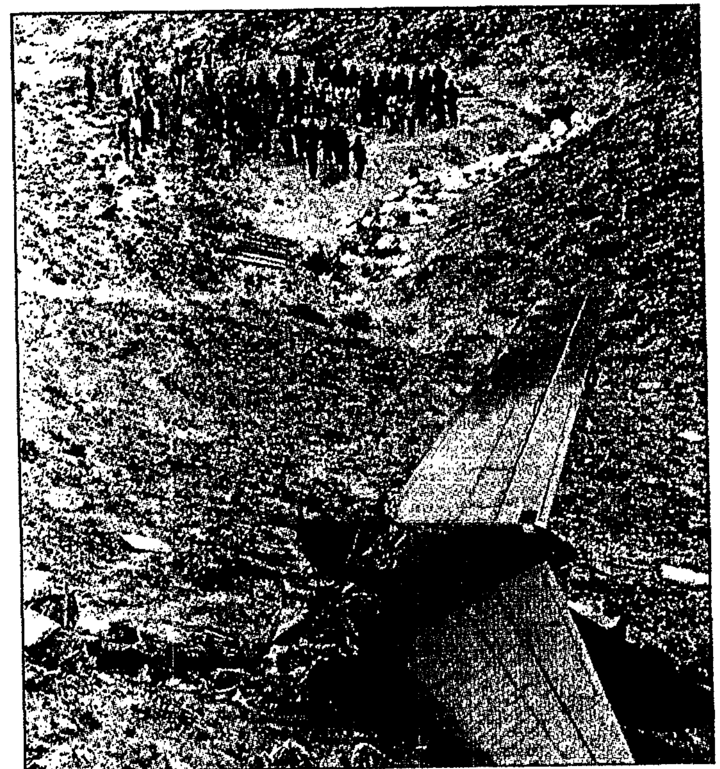


Don Bateman

Return to TOC



Crash memorial



Associated Press

Peruvian rescue workers hold a Mass at the site where Faucett Airlines flight 251 crashed Thursday night. All 123 passengers were killed when the Boeing 737 smashed into a hillside, 5 miles from its destination. See story on **Page A5.**

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CIRCUMSTANCES: While on initial approach VOR DME to runway 19, the aircraft impacted into a mountain.

TIME: 21:41 EST (night)

WEATHER: Visibility greater than 30 NM, Wind calm, Altimeter 30.02 "Hg.

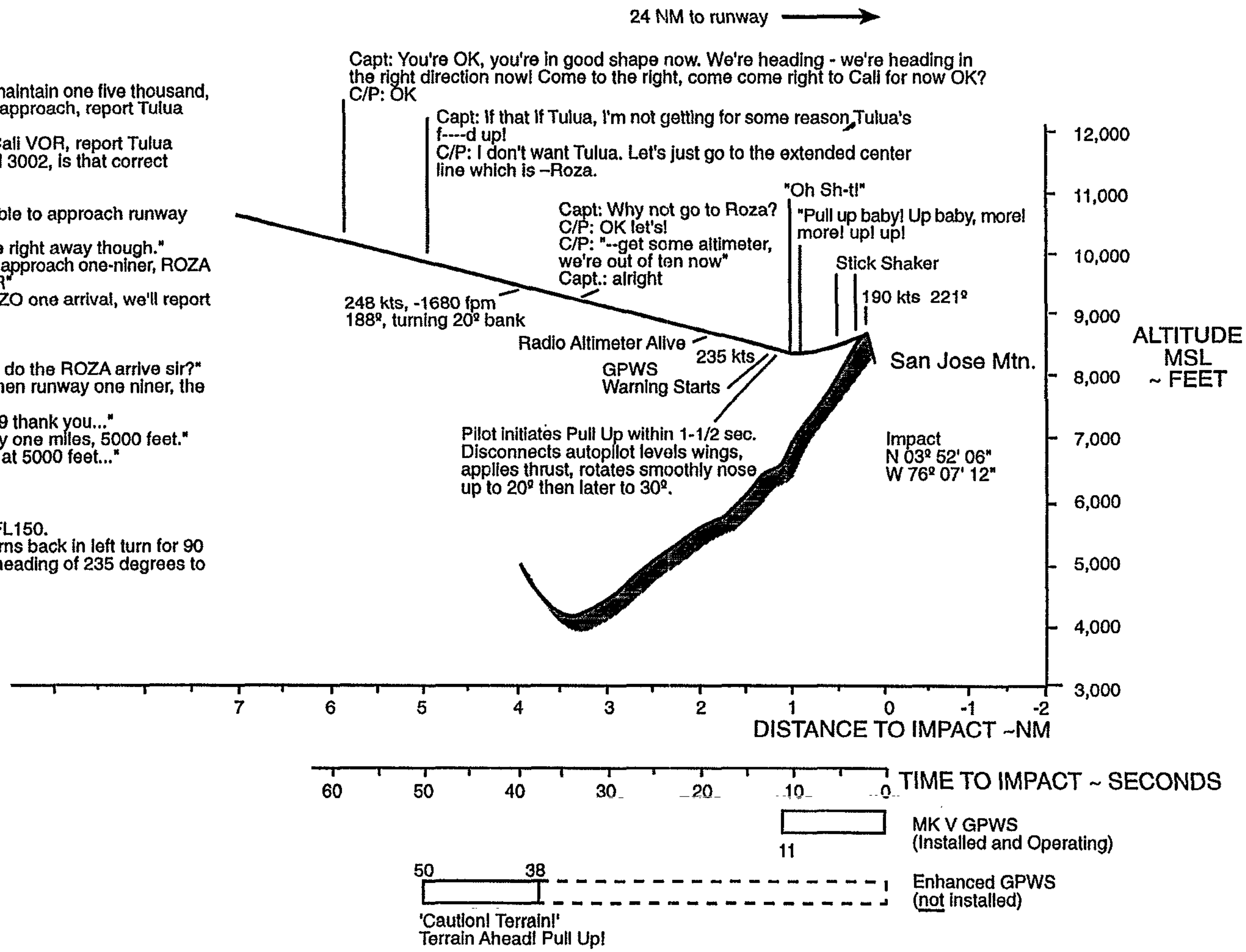
CONFIGURATIONS: Landing gear and flaps up but spoilers deployed.

FATALITIES: 160 of 164. Five rescuers also lost their lives.

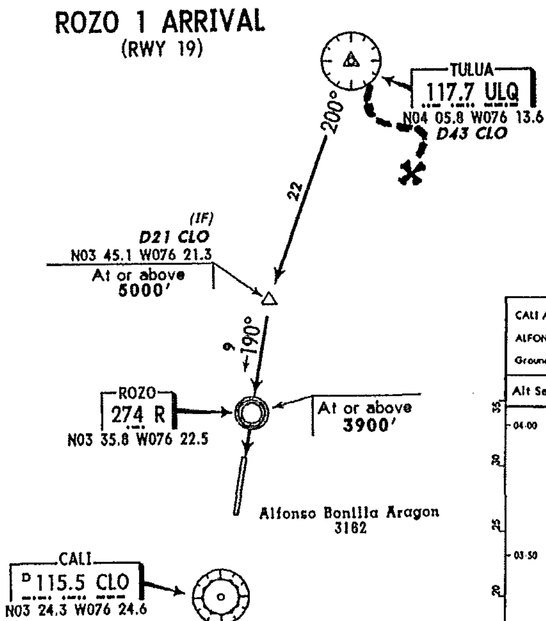
Flight Path Profile
B757
CALI, COLUMBIA
20 DECEMBER, 1995

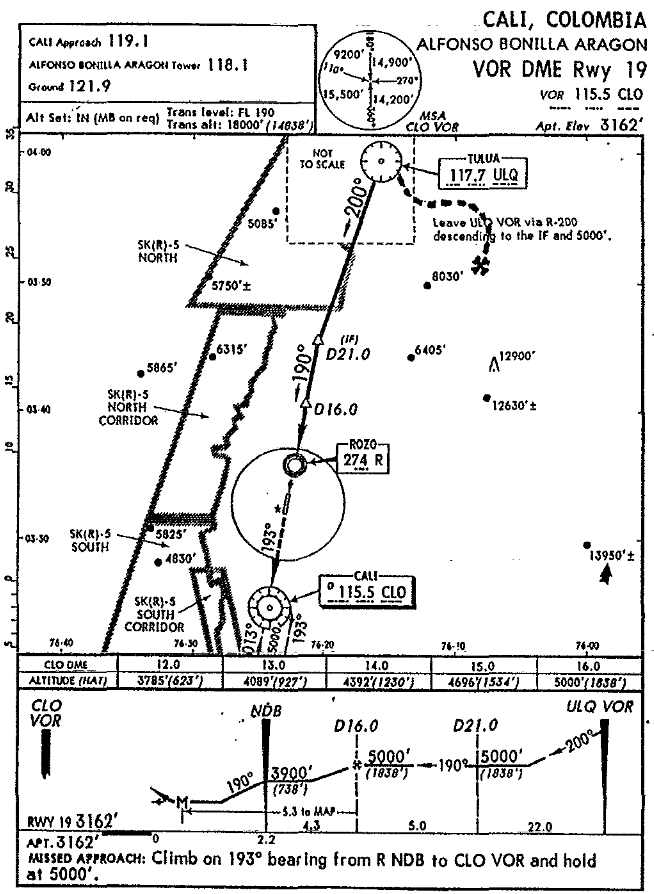
Approach: "...cleared to Cali VOR, descend and maintain one five thousand, altimeter 3002, no delay expected for approach, report Tulua VOR."
Captain: "... OK, understand cleared direct to Cali VOR, report Tulua and altitude 15, that's fifteen thousand 3002, is that correct sir?"
Approach: "Affirmative"
Appraoch: "... OK sir, the wind is calm, are you able to approach runway 19?"
Captain: "Ah, yes sir, we'll need a lower altitude right away though."
Approach: "Roger 965 is cleared to the VOR DME approach one-niner, ROZA Number One arrival, report Tulua VOR"
Captain: "Cleared the VOR DME one niner ROZO one arrival, we'll report the VOR, thank you sir."
Approach: "Report Tulua"
Captain: "Report Tulua"
Captain: "Can 965 go direct to ROZO and then do the ROZA arrive sir?"
Approach: "... Affirmative direct ROZO one and then runway one niner, the winds calm"
Captain: "... all right, ROZO, then ROZO 1 to 19 thank you..."
Approach: "... Affirmative, report Tulua and twenty one miles, 5000 feet."
Captain: "... OK report Tulua, twenty one miles at 5000 feet..."

Aircraft put into descent towards 5000 feet from FL150.
"VLQ" (Tulua) selected in the FMS and aircraft turns back in left turn for 90 seconds, then a right turn was made for a direct heading of 235 degrees to the ROZO radio beacon.



Don Bateman





in Colombia; 159 aboard

By The Associated Press

BOGOTA, Colombia — An American Airlines plane from Miami carrying 159 people crashed last night as it was making its final descent toward the Cali airport in southwestern Colombia, radio reports said.

RCN Radio and Radio Caracol quoted witnesses as saying they saw the plane crash and a large explosion in the Andes mountains outside Cali.

American Airlines officials said 151 passengers and eight crew were aboard the Boeing 757 aircraft.

Flight 965 was flying over Buga, a town about 40 miles north of Cali, when it lost radio contact, officials said.

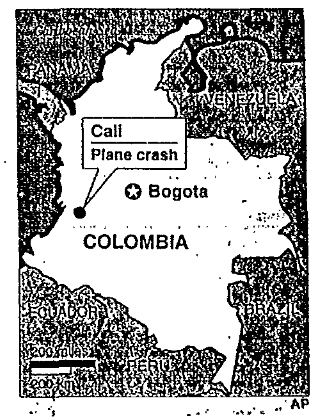
FOR INFORMATION
American Airlines has a "help desk" for people seeking information on family or friends on Flight 965 to Cali. To reach that desk, call reservations at 1-800-433-7300.

Police said they received telephone calls from people in the area reporting an explosion.

"We saw when the plane crashed against a mountain and then a huge fireball erupted," witness Carlos Buitrago told Radio Caracol. He said skies were clear with no rain.

More than three hours after the plane's scheduled 6:45 p.m. arrival, there was still no official word on the aircraft's fate.

Local authorities declared an emergency and launched a search in the area where the plane disappeared, about 185 miles southwest of the capital Bogota. But darkness and the



mountainous terrain were likely to hinder rescue and recovery efforts until dawn. Gen. Jose Serrano, the national police chief, said he would dispatch helicopters at first light.

The Boeing 757-200 is a twin-engine, medium- to long-range jetliner that can carry up to 239 passengers. First flown in 1982, it has a range of 3,200 miles.

In Seattle, Boeing spokesman Bill Curry said this was the first accident involving a 757, which has had an "unblemished record."

Ed Martelle, a corporate communications representative at American Airlines headquarters in Fort Worth, Texas, said that if a crash were confirmed, a "care team" from the airlines would notify the passengers' families.

Next Page

Flight Path Profile
MD-80
WINDSOR LOCKS, CONN.
12 NOVEMBER, 1995

CIRCUMSTANCES: While on a non-precision VOR approach to runway 15, the aircraft inadvertently flew through trees at approximately 760 feet above sea level. (586 feet above the field) A go around was initiated but aborted when engine thrust rapidly diminished and runway lights became visible. The pilots managed to get within 50 feet of the runway threshold taking out the localizer antenna.

WEATHER: C23, visibility 3 miles, wind 192/25 kts & 40 kts, moderate rain, temp 61º F dew point 58º F. Special post accident ceiling 900 overcast.

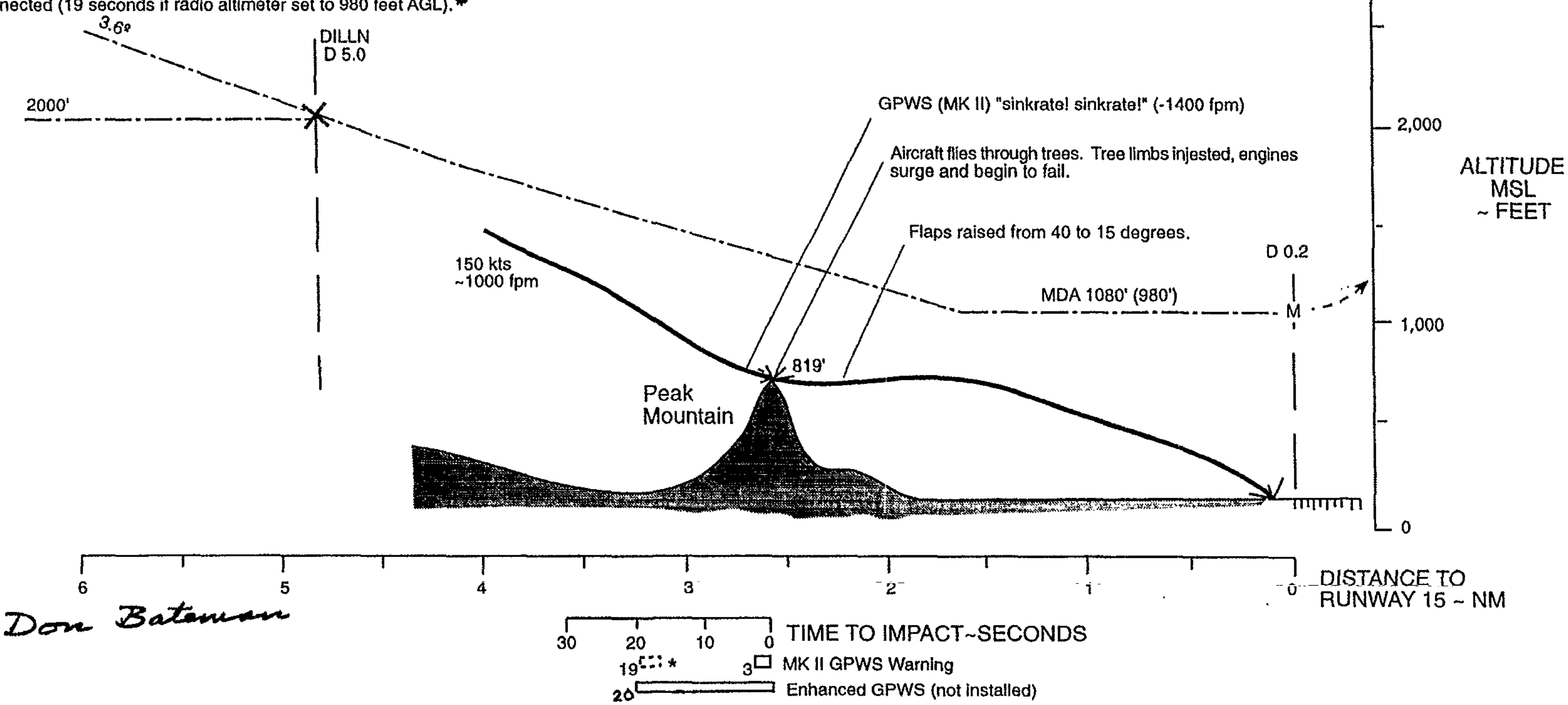
TIME: 00:57 past midnight

INJURIES: one of 72 passengers

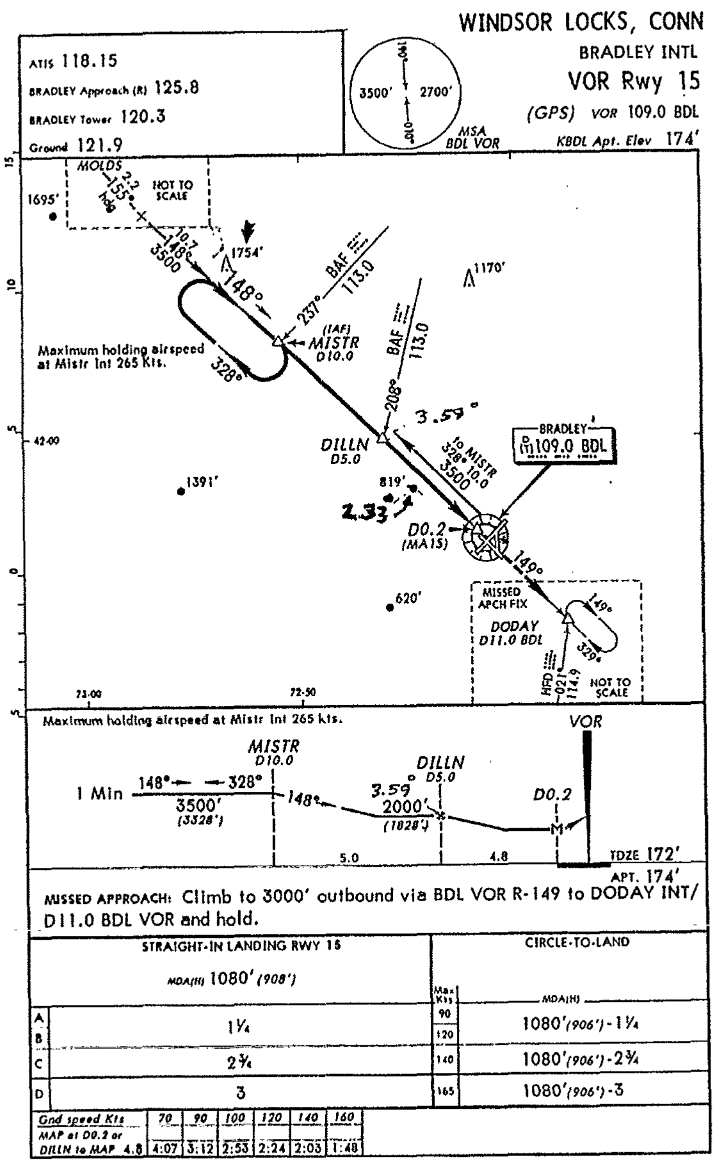
DAMAGE: Destruction of two engines, leading and trailing edge flaps, gear doors, loss of hydraulics, lower rear fuselage and antennas.

POSSIBLE CONTRIBUTING FACTORS:
- Control tower problems, delay in updating altimeter settings to aircraft with fast moving low pressure storm, giving at least 120 feet of error.
- Steep instrument approach procedure with significant terrain (819') on final approach in poor visibility and no approach lights
- Low ground speed because of significant head wind, giving steeper than normal descent angle for standard descent rate of 1000 fpm.

MK II GPWS installed and operational but 'Minimum'!! not connected (19 seconds if radio altimeter set to 980 feet AGL).*



Don Bateman



High winds force jetliner's emergency landing

By The Associated Press

WINDSOR LOCKS, Conn. — An American Airlines jet carrying 78 people encountered dangerous winds and engine problems in stormy weather and clipped a row of trees and an airport antenna during an emergency landing early yesterday.

Some of the 72 passengers said they heard an explosion just before landing and the cabin started to fill with smoke. They slid down chutes to evacuate the plane and only one of the passengers suffered a minor injury.

Everyone remained calm, passengers said, and gave the pilot an ovation after the the MD-80 jet's wheels hit the tarmac.

"The pilot did a magnificent job," said passenger Richard Seymour. "We really thought it was it."

The pilot of Flight 1572 from Chicago declared an emergency one mile before landing at Bradley International Airport at 12:57 a.m., said Mary Culver, a Federal Aviation Administration spokeswoman in New England.

Equipment on board indicated it may have been wind shear, a sudden, powerful gust of wind rushing downward from a thunderstorm. "That's probably the most violent form of weather a pilot can encounter," Culver said.

The pilot used two different maneuvers to counter the weather, but first the right engine, then the left engine failed to respond, said officials.

Robert Benzon of the National Transportation Safety Board confirmed that the plane encountered engine problems but said it was unclear whether they occurred before or after the trees were hit.

CIRCUMSTANCES:	During initial approach, the pilot deviated to the north to avoid heavy weather as indicated on Weather Radar, and tower reports. The aircraft deviated well north along the arc 15 DME, and while intending to proceed direct to the VOR, was cleared to establish an arc of 12 DME to radial 135 for runway 07, and down to 8000 feet and then 5000 feet – A GPWS MKII Warning occurred and the pilot initiated a climb but attained only 400 feet before impact on the north flank of San Vincent volcano.
WEATHER:	30⦶ 37⦶, Altimeter 29.84, temperature 27ºC, visibility 14 miles, wind 070, 5kts, gusting 16, light rain, later thunderstorm.
TIME:	19:50 local
CONFIGURATION:	clean
FATALITIES:	65, including Brazilian and Dutch Ambassadors with staff, business men, two FAA inspectors and tourists.

Flight Path Profile
B737-200
SAN SALVADOR, E.S.
9 AUGUST, 1995

DEVIATION FROM APPROACH PROCEDURE BECAUSE OF HEAVY WEATHER

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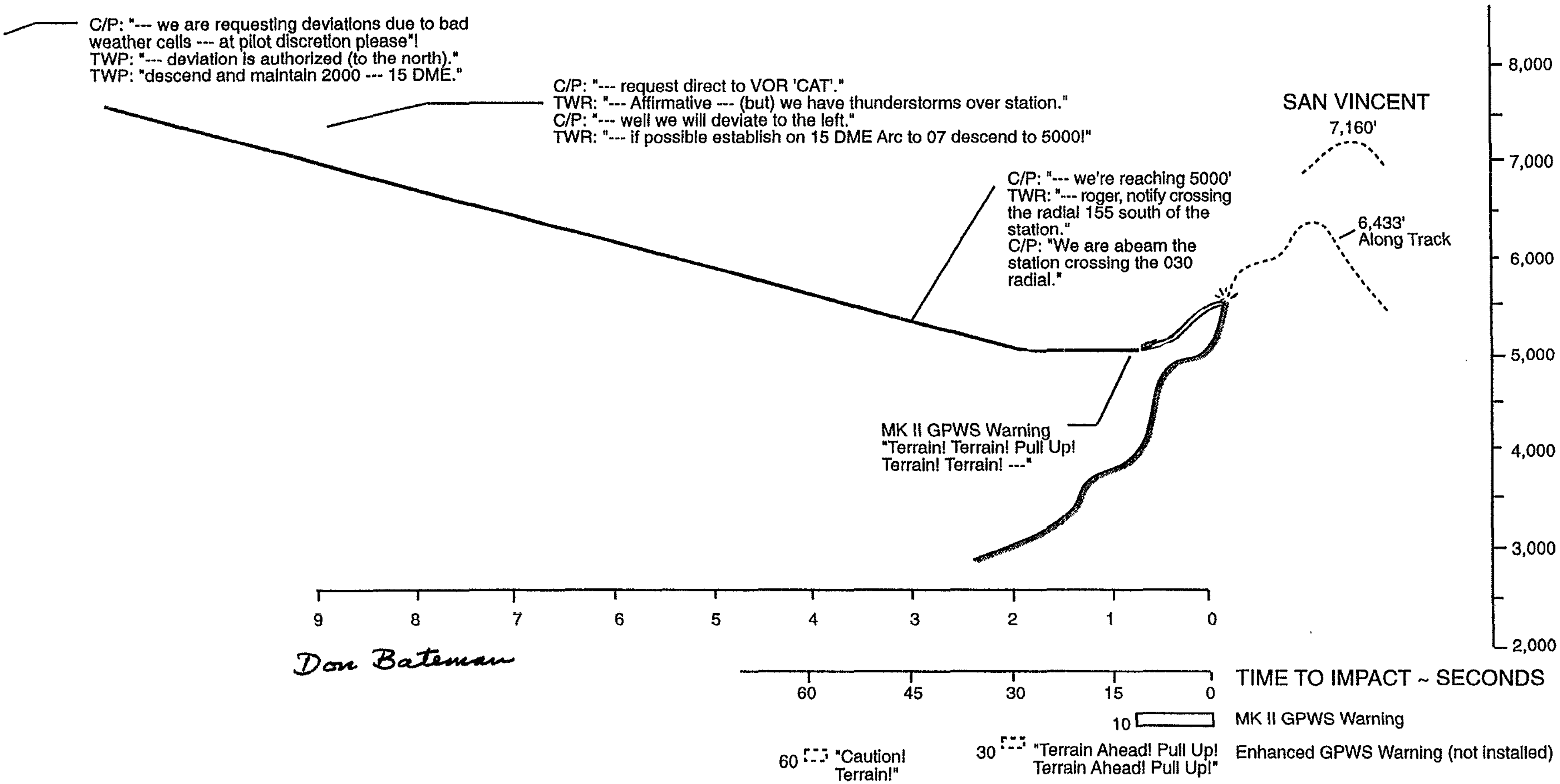
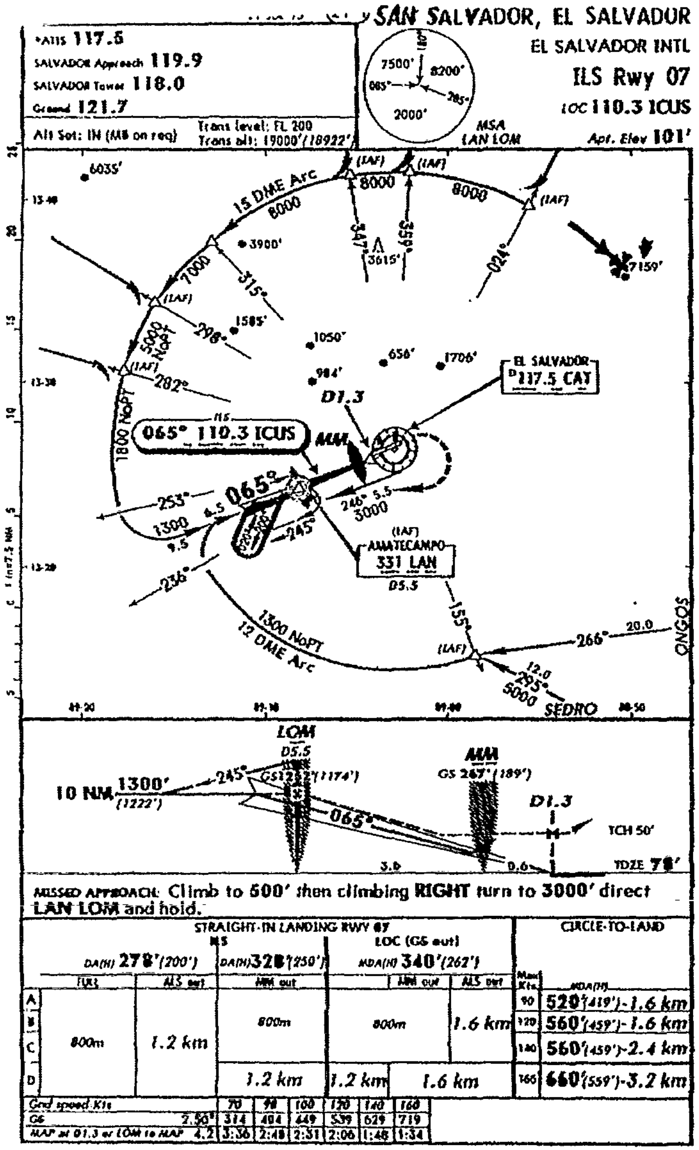


Don Bateman

Return to TOC



10 August '95 The Seattle Times page A3

Jet from Miami crashes in El Salvador, killing 60

Guatemalan plane hits volcano

Associated Press and Reuters

SAN SALVADOR, El Salvador — A Guatemalan jet carrying 65 people on a flight from Miami slammed into a volcano during a storm, and an airline spokesman said today at least 60 of them were killed.

Unconfirmed reports said six Americans were among the passengers.

Aviateca's Flight 901 originated in Miami yesterday and had stopped in Guatemala City.

It was on its approach path to the San Salvador airport last night when it crashed on Chichontepec volcano, also known as San Vicente, 37 miles east of the Salvadoran capital, officials said. The Boeing 737 was to have gone on to Managua, Nicaragua, and San Jose, Costa Rica, the airline said in a statement.

The plane was carrying 58 passengers and seven crew members when it crashed.

Aviateca reservations supervisor Eduardo Marroquin said 60 people have been found dead.

"The plane was on its normal route, but just before landing at San Salvador airport it crashed on the flanks of the Chichontepec volcano," Marroquin said.

Local radio reporters said witnesses heard three big explosions, and that the sky lit up.

"Some people saw a flash and then an explosion, and they thought the volcano was erupting," said Carlos Gomez, an employee of the state telephone company in Tepetitan, a small town near the crash site.

Another Aviateca spokesman, Mauricio Rodriguez, said it was raining heavily at the time of the crash.

Rescue workers who rushed to the crash site in a convoy of ambulances, sifted through the wreckage in inhospitable terrain in central San Vicente province, about 38 miles from the capital.

In the last four years there have been two unexplained 737 crashes. That prompted the U.S. National Transportation Safety Board in February to urge the Federal Aviation Administration to require greater data-handling capabilities in the 737 "black box" before year's end.

ASSOCIATED PRESS

In 1991 a United Airlines Boeing 737-291 crashed in Colorado Springs, Colo., killing all 25 people on board. Last September, a USAir Boeing 737-300 plunged into a hillside outside Pittsburgh, Pa. All 132 people aboard were killed.

Information from Bloomberg Business News is included in this report.

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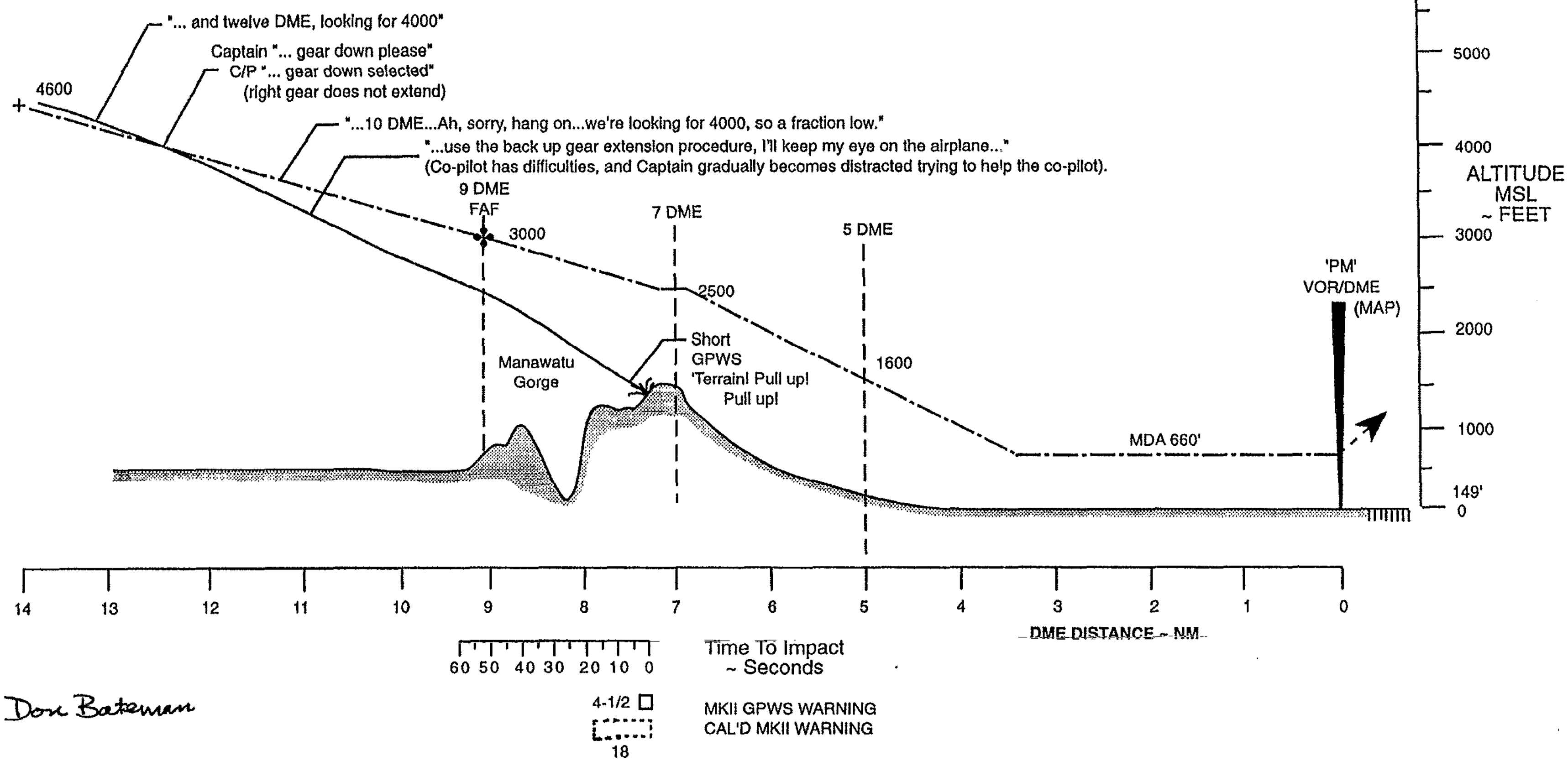
CIRCUMSTANCES:	While on a VOR/DME approach to runway 25, the right landing gear would not extend. Eventually the back up landing gear extension procedure being used by the co-pilot became a distraction to the Captain. The aircraft impacted some 7-1/4 NM short into a hillside.
WEATHER:	Low cloud, limited visibility and rain.
CONFIGURATIONS:	Landing gear and flaps up.
TIME:	09:25 local
FATALITIES:	5 of 21 on board
OTHER:	MKII GPWS installed, but gave very short warning (4.5 seconds versus a calculated warning of 18 seconds). Possible loss of radio altimeter track.

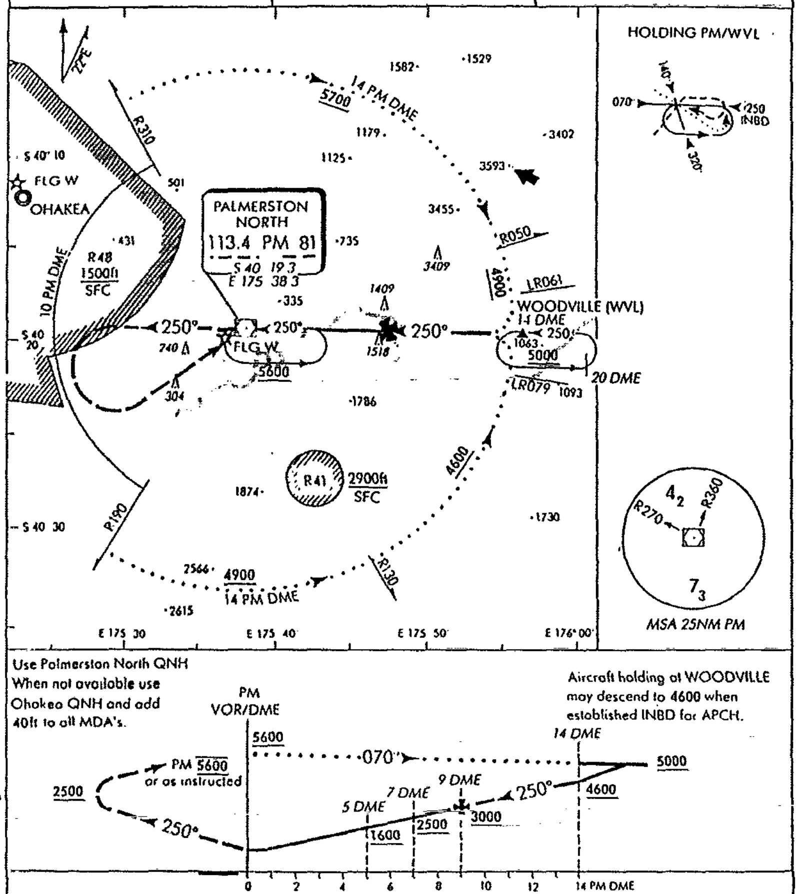
Flight Path Profile
DHC-8
PALMERSTON NORTH, NEW ZEALAND
9 June, 1995



Don Bateman

PALMERSTON NORTH ATIS 129.7 ELEV 149
VOR/DME RWY 25 RWY 25 THR ELEV 148

OHAKEA CONTROL	PALMERSTON TOWER	UNATTENDED
125.1 128.5 263.4	120.6	121.7



DME DIST	MAPt	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Advisory Altitude 5%	MDA	690	990	1300	1600	1900	2210	2510	2820	3120	3420	3730	4030	4330	4640

Category	A	B	C	D
VOR/DME	660 (511) - 2000		660 (511) - 2800	

Crew 'trying to get wheels down'

By SIMON BIRKBECK

THE crew on Ansett flight 703 was trying to get the plane's landing gear down before it crashed into a hillside, killing three people, Transport Accident Investigation Commission chief investigator Ron Chippindale said yesterday.

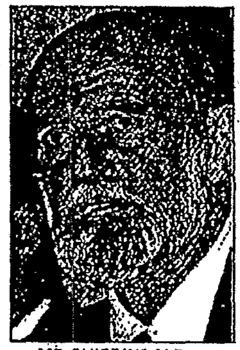
Mr Chippindale said that soon after the aircraft was given clearance to land at Palmerston North airport, its right undercarriage failed to fully extend and the crew started alternative procedures.

What they actually did was one of the investigation's key areas, he said.

Investigations were also centring on the reason why the undercarriage failed and whether the flight path into Palmerston North measured up to international standards.

In Palmerston North yesterday, Mr Chippindale said his main findings so far were that the aircraft was on the correct approach and the only technical hitch was the undercarriage failure.

Alternative procedures for lowering the undercarriage in-



MR CHIPPINDALE. . . 'attention of crew critical'

volved unlocking the wheels and allowing them to free fall or lowering them using a hydraulic hand-pump, he said.

In such situations the crew's duties were split so the flying of the aircraft was maintained.

Mr Chippindale could not say that if whether on this occasion the procedure had forced the crew to avert their attention away from the cockpit's warning systems.

"We are still looking at that question. It's a critical area for the investigation."

The aircraft's ground proximity warning system sounded an alarm "pull up, pull up" in the cockpit moments before impact. Passengers were not warned.

Mr Chippindale said the undercarriage failure "should not in itself cause an off-airfield accident".

Ansett New Zealand spokesman John Cordery said that in the past 18 months there had been three occasions when Dash-8 crew had to use the alternative method of lowering the undercarriage.

He said the aircraft had "well proven" backup systems.

Mr Chippindale said that while modification notices for the changing of the landing gear's components were available, the recommended changes were "very minor" and not mandatory.

Flight attendant Karen Gallagher and passengers Jonathan Keall and David White were killed when the aircraft crashed 13km east of Palmerston North.

Captain Gary Sotheran and co-pilot Barry Brown are still in Palmerston North Hospital's intensive care unit.

They were reported to be in a serious but stable condition yesterday.

The plane crashed at a point about 300 metres lower than it should have been.

William McGrory, the passenger who used his cellphone to guide a rescue helicopter to the crash, was yesterday discharged from Palmerston North Hospital.

Mr Chippindale said that making a final report on the accident could take up to six months.

The cockpit voice and inflight data recorders were both said to be of good quality.

Commission chief executive John Britton said it was not the role of the commission to fix blame, but to identify the causes and improve safety.

Mr Britton said the commission saw a public inquiry into the crash as unnecessary.

THE 'DOMINION' (WELLINGTON)

15 JUN 95

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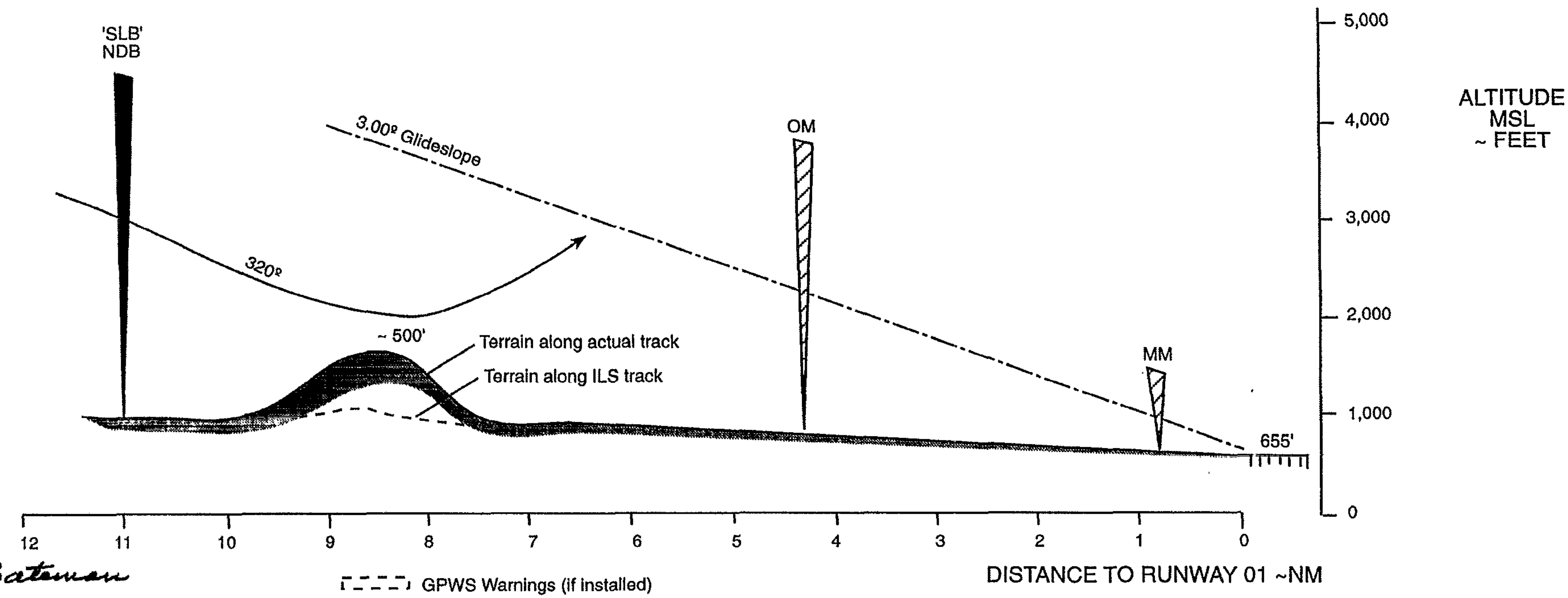
CIRCUMSTANCES: The aircraft cleared for the approach to ILS runway 01, was approximately 2NM west of the localizer and transfered to the tower who was very busy with other aircraft. The aircraft began a premature descent. Fortunately the approach controller continued to monitor the aircraft's altitude and track and noticed the serious deviation and finally advised the tower. The aircraft was instructed to climb to 4000 and for another approach from the north.

WEATHER: 500 foot ceiling. 3 to 4 KM visibility

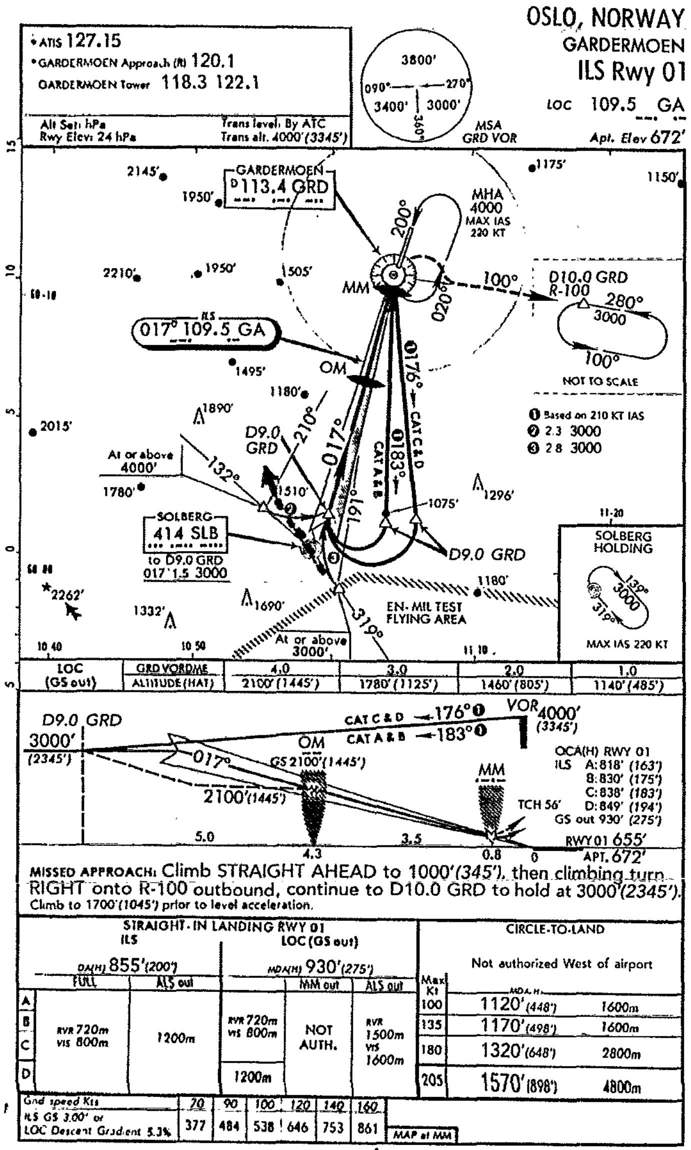
OTHER: Tourist flight with 150 passengers on board

CFTT INCIDENT

Flight Path Profile
TU-204
OSLO, NORWAY
20 MAY, 1995

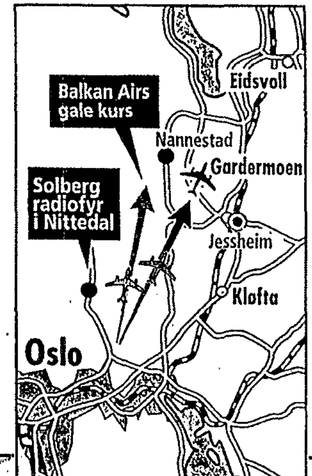


Don Bateman



VG Torsdag 3. august 1995

Balkan Air i SVARTE SKAUEN



Av DAG FONBÆK

Balkan Air holdt på å lande i Nannestad 20. mai – tre-fire kilometer vest for Gardermoen. Havarikommisjonen etterforsker dermed to alvorlige episoder med Balkan Air på Gardermoen.

3–4 kilometer ute av kurs før landing

Det bulgarske flyselskapet er i vinden, for ikke å si i tåka. I hvert fall visste ikke Balkan Air-kapteinen hvor han var da han gikk inn for landing på Gardermoen lordag 20. mai i år:

Fullastet med norske Bulgaria-turister på vei hjem, tok Tupolev-kapteinen peiling på Solberg radiofyr i Nittedal, der han la seg på «retningsstrålen» inn mot sydenden av rullebanen på Gardermoen.

På det tidspunkt hadde flyet ca. fire minutter til landing.

Elendig sikt

På Gardermoen var det elendig sikt med dis, yr og regn. Skydekket var lavt, ca. 500 fot. Sikten var knapt 2–3 kilometer, og Balkan Air-pilotene forberedte en standard instrument-innflyging sydfra.

Flygelederen i tårnet klarerte ham inn, og forsikret seg om at flyet lå i rett høyde og med riktig kurs.

Mens flygelederen i tårnet var opptatt med annet, ble han oppkalt av innflygingskontrollen på Fornebu: «Hva er det Balkan gjør nå?»

Og med en rask klikk på radardataskjermen så flygelederen i tårnet på Gardermoen at Balkan Air-flyet traskt synkende høyde var på helt feil kurs!

Høyden var riktig, men retningskursen gal.

Flyet med 150 passasjerer var i ferd med å lande 3–4 kilometer vest for rullebanen på Gardermoen – i svarteste skauen ett eller annet sted vest for riksvei 174 og boligfeltet Kneppe.

Flyet var nede i 250 meters høyde over bakken (!) altså i full gang med landingen da flygelederen anropte kapteinen og ba ham stige opp igjen – fort. «Du er på feil kurs.»

– Han kunne nok gått klar av og forberede en ny landing på bane 1–9 nordfra, som han gjennomførte greit.

Passasjerene opplevde at flyet steg brått, og at flygerne foretok en ny innflyging, men etter det VG forstår, ble det ikke opplyst noe over høyttaleren om årsaken til den lykkeligvis avbrutte landingen.

Han mente at det slett ikke var noen fare på ferde.

– Episoden er rapportert både til Luftfartsinspeksjonen og Havarikommisjonen, bekrefter Asbjørn Skjervø, avdelingssjef for lufttrafikktjenesten på Gardermoen.

Havarikommisjonen har skrevet til Balkan Air og bedt om fartøysjefens rapport – men de har ingenting hørt, sier havariinspektør Ragnar Hafting:

– Vi blir nødt til å purre på henvendelsen, sier Hafting, som spør seg hvordan Tupolev-flyet kunne bomme så grovt på innflygingen.

FEIL FØLGER FEIL: *To måneder før dette Tupolev-flyet fra Balkan Air slo vingen i bakken under landing på Gardermoen (faksimile), var en maskin fra samme selskap i ferd med å lande i Nannestad, 3–4 kilometer vest for Gardermoen.* Foto: MAGNAR KIRKNES

Stjal fly-klokke

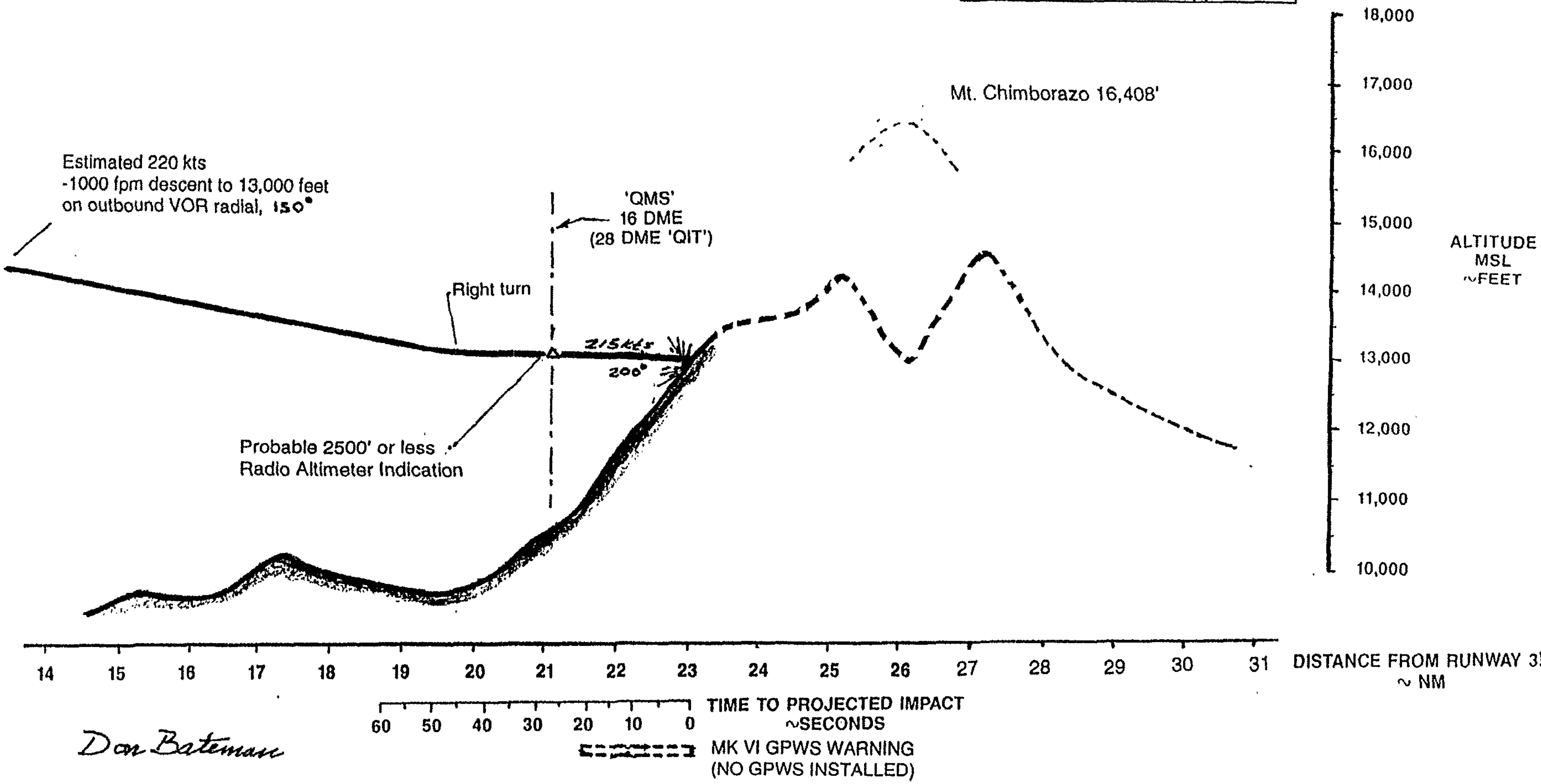
MOSKVA (AP/VG) Politiet arresterte i går en 33 år gammel tankbilsjåfør, etter at han hadde brutt løs en klokke fra instrumentpanelet i cockpiten i en passasjerjet som nettopp var kommet fra Paris og tilbake til Sjeremetjevo-flyplassen i Moskva. Klokken koster over 3000 kroner, og mange er blitt stjålet de siste månedene

Next Page

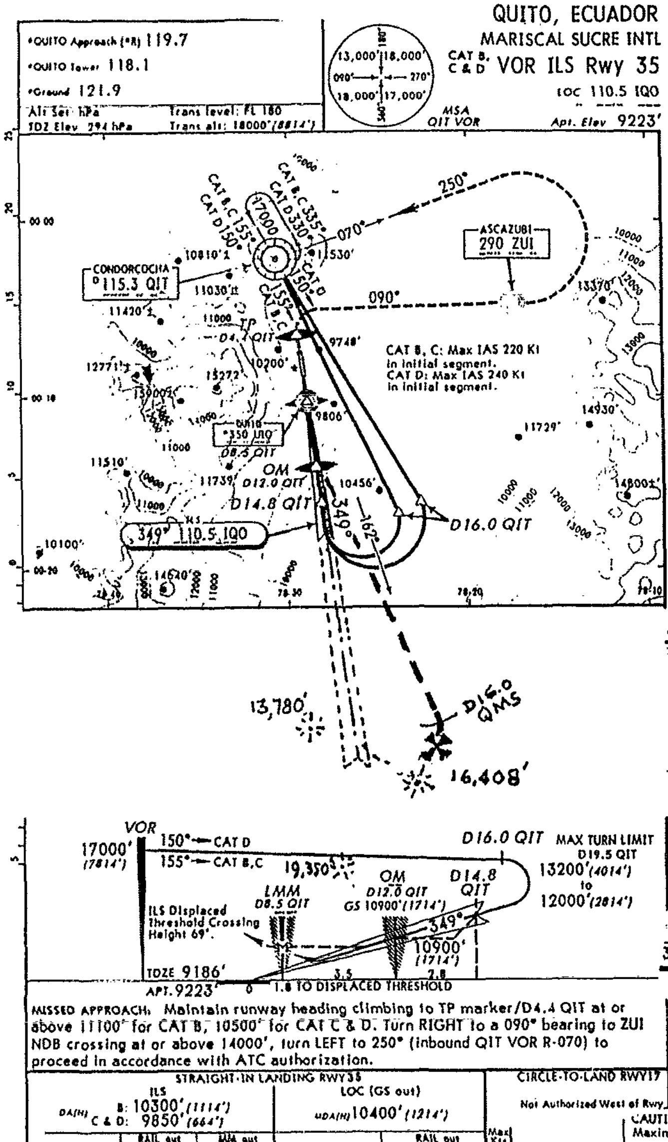
Circumstances:	*During an initial VOR ILS approach to* Runway 35, the aircraft struck the shoulder of a mountain at the 12,350 foot level while turning inbound to the ILS.
Weather:	Not a factor, Quito probably visible throughout approach.
Time:	Midnight.
Configuration:	Clean
Fatalities:	7
Other:	No GPWS installed. This accident appears very similar to a DC-8 March 1992 incident where the wrong VOR was being used for the approach procedure, ("QMS" instead of "QIT"), but a timely GPWS warning allowed a successful escape. There are two VOR ILS runway 35 approach procedures based on different VOR's and with no reference to each (13 NM's apart).

Preliminary Information
Flight Path Profile
G-II
QUITO, ECUADOR
4 MAY, 1995

See March 1992 DC-8 Incident
Quito, Ecuador, same approach.



Return to TOC



An jet en route to Quito from Argentina and carrying seven people, including a top Argentine oil official, crashed Thursday near the Ecuadorean capital, an official said.

All aboard are believed killed in the crash, said Gen. Carlos Puga of the Ecuadoran air force.

The aircraft, carrying Jose Estenssoro, president of Yacimientos Petroliferos Fiscales, and other Argentine and Chilean oil executives, disappeared about midnight local time (0500 GMT).

Puga said the jet was spotted from the air crashed near the Andean mountain town of Machachi, 22 miles (35 kms) south of Quito.

''The plane was found crashed, and because of the mountainous terrain where it went down, we assume there are no survivors,'' said Puga, who was in charge of the search.

The aircraft was said to be a Gulfstream belonging to the American Jet company, and had been chartered by the Yacimientos Petroliferos Fiscales, privatized two years ago. It had left Buenos Aires on Wednesday night.

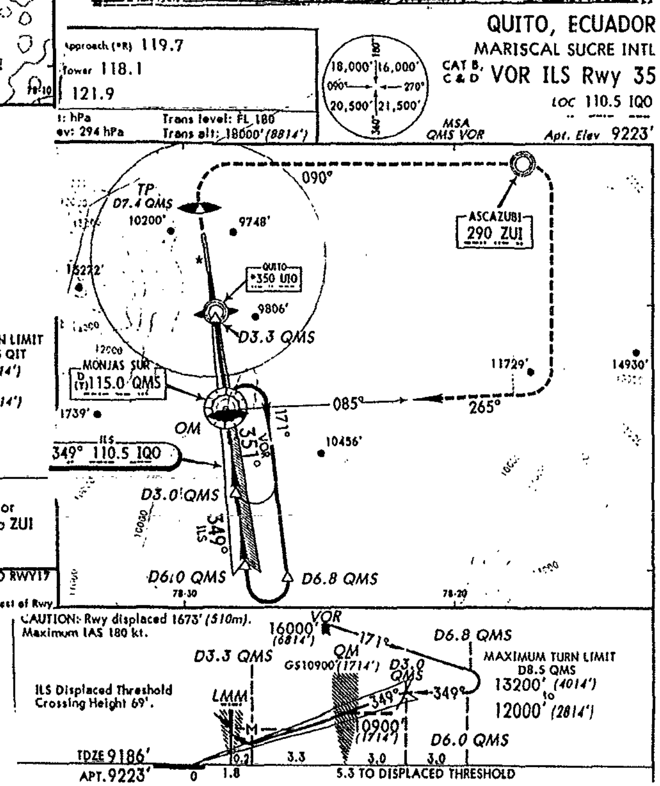
Argentine President Carlos Menem said Thursday morning that Estenssoro and other company executives were on board.

Estenssoro was rumored to be a possible replacement for Argentine Economy Minister Domingo Cavallo if Menem is re-elected this month.

According to a spokesman for the Chilean national oil company, Empresa Nacional de Petroleos, the jet was also carrying executives of that company as well.

Puga said the aircraft was carrying two crew members and five passengers, including Estenssoro and Juan Pedral of the Chilean oil company.

There was no indication yet what caused the crash.

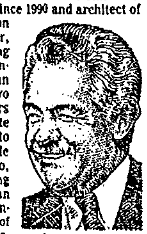


Argentine Oil Chief Dies in Crash, Casting Shadow on YPF's Future

By JONATHAN FRIEDLAND
Staff Reporter of THE WALL STREET JOURNAL

BUENOS AIRES–The death of YPF SA Chairman Jose Estenssoro in a plane crash yesterday leaves Argentina's largest corporation without a charismatic leader just as it embarks on an ambitious international-expansion strategy.

Mr. Estenssoro, chief of the state-controlled oil giant since 1990 and architect of its privatization three years later, was killed along with four Argentine and Chilean executives and two crew members when their private plane crashed into a mountainside near Quito, Ecuador. Among the dead was Juan Pedrals Gill, general manager of the Chilean state-owned oil company, Empresa Nacional de Petroleos de Chile.



Jose Estenssoro

Mr. Estenssoro's death comes a month after YPF completed a $745 million buyout of Dallas-based Maxus Energy Co., a debt-strapped independent oil-and-gas company with properties in the U.S., Indonesia and South America. Mr. Estenssoro hoped the Maxus acquisition would give YPF the necessary technical and managerial talent to branch out throughout Latin America.

The Bolivia-born Mr. Estenssoro, who was often mentioned here as a potential successor to Economy Minister Domingo Cavallo, "will be very badly missed," says Frederick Leuffer, senior energy analyst at Bear Stearns Inc. in New York. "His role went well beyond that of an average oil company chief executive."

Indeed, the 61-year-old Mr. Estenssoro was credited with transforming a badly *managed, money-losing state enterprise* into one of the region's most efficient energy producers and a darling of emerging-market investors. On Tuesday, YPF reported first-quarter earnings of $177 million, more than double its $74 million net income a year earlier.

In trading yesterday on the Buenos Aires stock exchange, YPF shares fell 2.8% to 20.70 pesos ($20.70). Trading was suspended for much of the session, pending news of the crash.

Mr. Estenssoro had been planning to build on his success by bidding for coming oil-and-gas privatizations in Bolivia and Peru and to open up new exploration areas along South America's hydrocarbon-rich Andean spine and offshore in the largely unexplored South Atlantic.

Analysts say they don't expect YPF to change course now. Mr. Estenssoro had brought many of the company's top executives along with him when he left his former job at Hughes Tool Co. "There's a very good team of professionals who have worked together a long time," says Gabriella Romeri, analyst at Barings Securities Argentina.

YPF called a board meeting for today to discuss the implications of Mr. Estenssoro's death, while Argentine President Carlos Menem said he would name a successor shortly. With a stake of 20%, the Argentine government remains YPF's largest shareholder.

The question "is whether they look for a replacement from the outside and whether that threatens the stability of the current management team," says Walter Stoeppelwerth, Argentina director of Smith New Court Inc.

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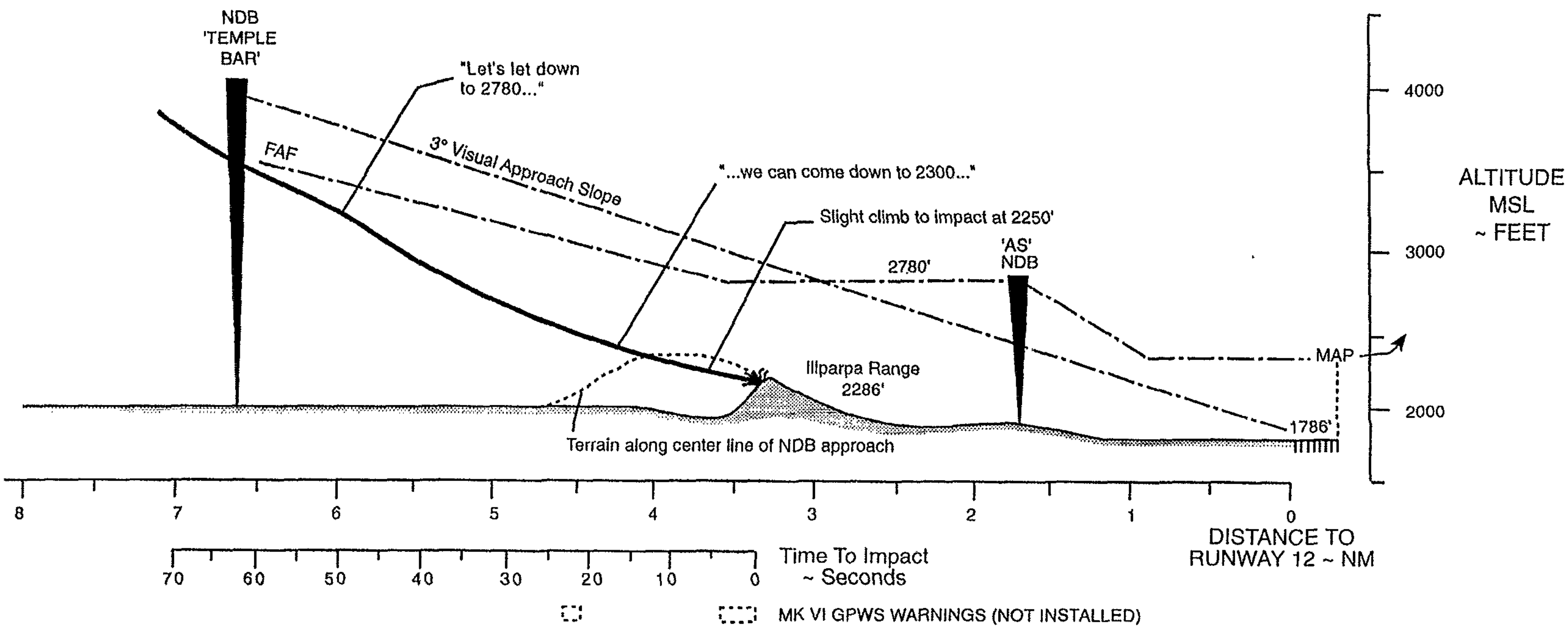
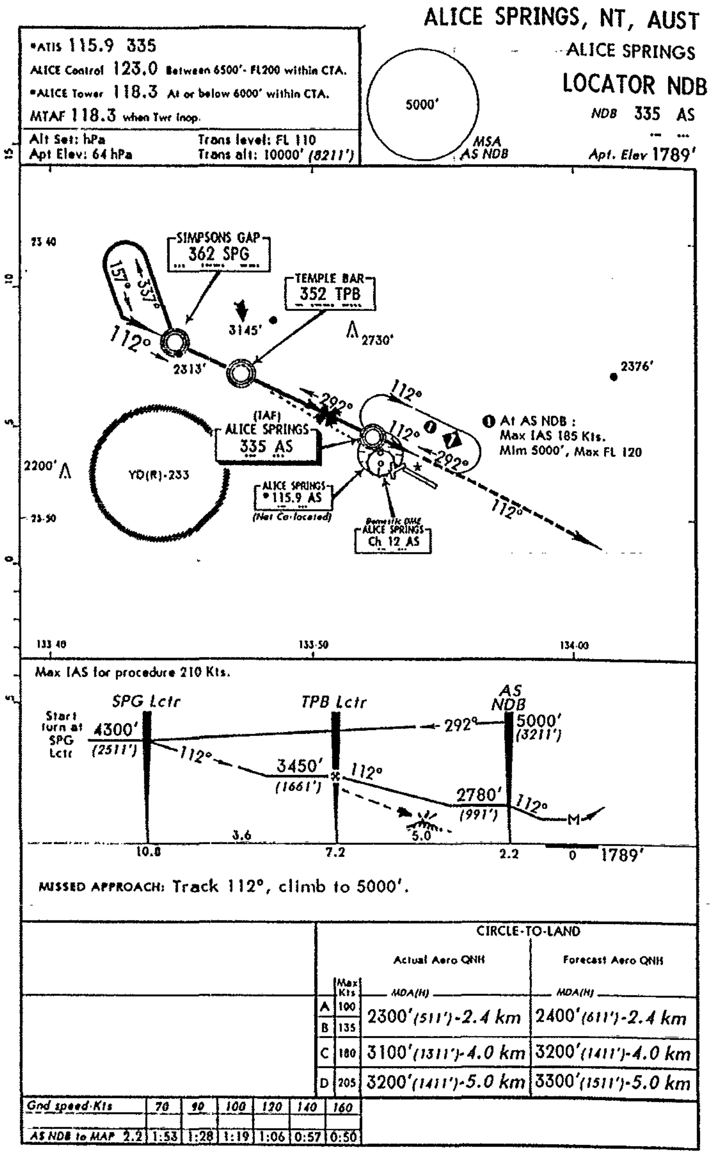
CIRCUMSTANCES:	During a locator/NDB approach to runway 12, this cargo jet clipped the top of a ridge, inbound from the north.
WEATHER:	Clear, no moon .
TIME:	8:10 PM local
CONFIGURATIONS:	Landing gear down, flap position not known
FATALITIES:	3
OTHER:	No apparent aircraft or fuel problem. Runway 12 equipped with G-Slope LOC - DME and NDB, T-VASI, RL, HIALS. Hazardous cargo on board.

No GPWS installed, nor required.

Estimated Flight Path Profile
IAI-1124
ALICE SPRINGS, AUSTRALIA
27 April, 1995



Don Bateman



Northern Territory News, Saturday, April 29, 1995 — NEWS

Darwin man dies in Alice jet crash

By ALASTAIR BETLEY

A Darwin man was among the three people who died in a cargo jet crash at Alice Springs on Thursday night.

Sergeant Nigel McBain of Alice Springs police said yesterday it was unknown how long the man had lived in Darwin.

Sgt McBain said the other two men on board had been employed out of Sydney.

None of their names had been released last night.

Bureau of Air Safety investigators arrived at the scene yesterday and recovered the flight data and cockpit voice recorders from the Pel-Air Westwind twin-engined jet.

A spokesman for TNT Air Couriers at Alice Springs said the plane was on a regular charter from Pel-Air and was en route from Darwin, with its last stop at Tindal near Katherine.

Clipped

Police said it clipped the top of a ridge on the Uparpa range about 8 km from Alice Springs Airport.

The plane then crashed into the side of the mountain range and exploded.

Sgt McBain said witnesses reported the aircraft appeared to be flying unusually low before it crashed.

Bureau of Air Safety Investigation spokesman Hans Tscheppera said yesterday it could take up to a week to analyse [illegible] work out what had happened, and a further week before the bureau would produce a report on the crash.

Mr Tscheppera said: "The aircraft, from what we know initially, obviously wasn't out of [illegible]

At the time of ar[illegible]


The crash site on the Uparpa ranges in which the Darwin man died

'Plane clipped mountain range'

gives a complete fac[illegible] synopsis of the [illegible]

Mr Tscheppera said it was obvious [illegible]

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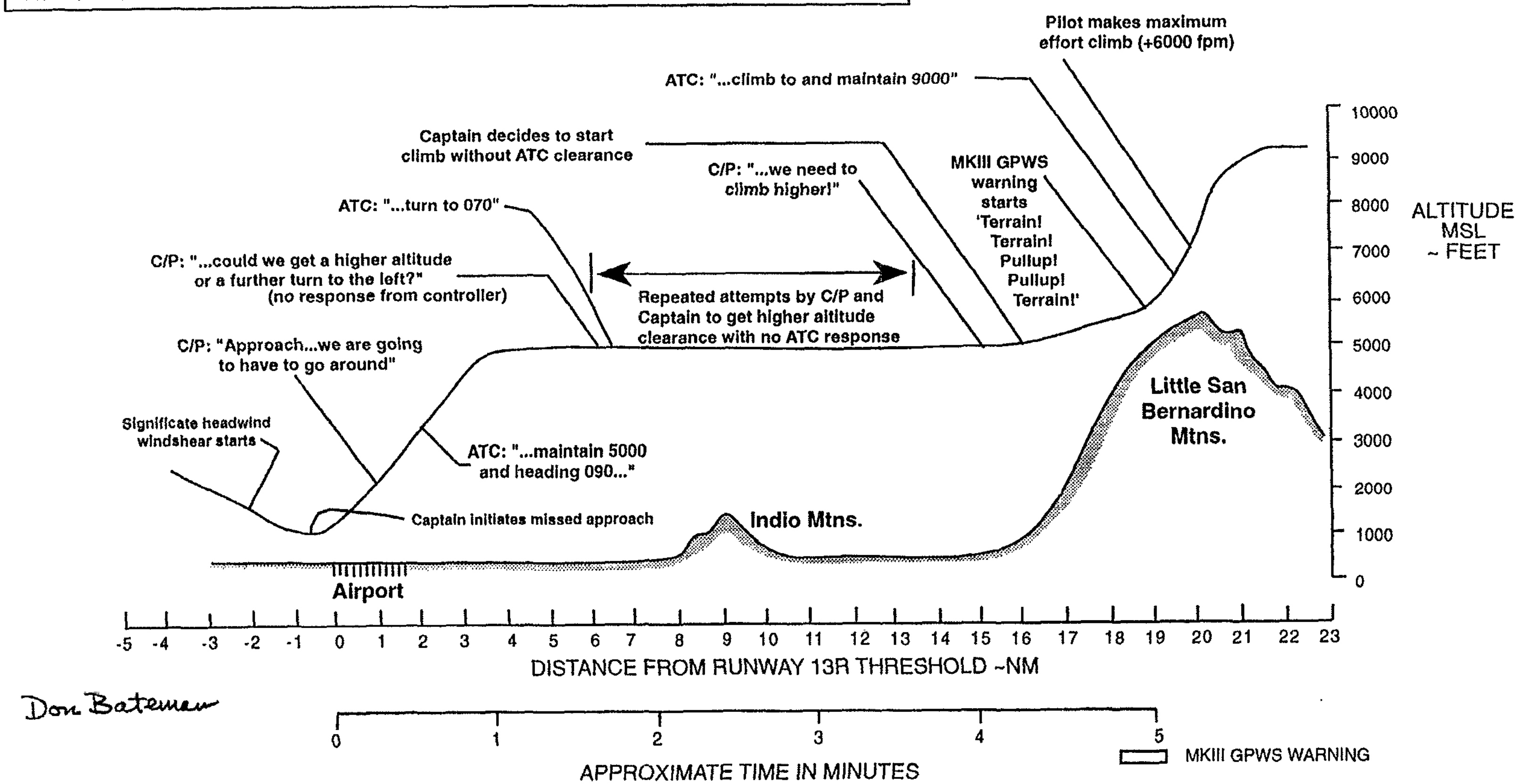
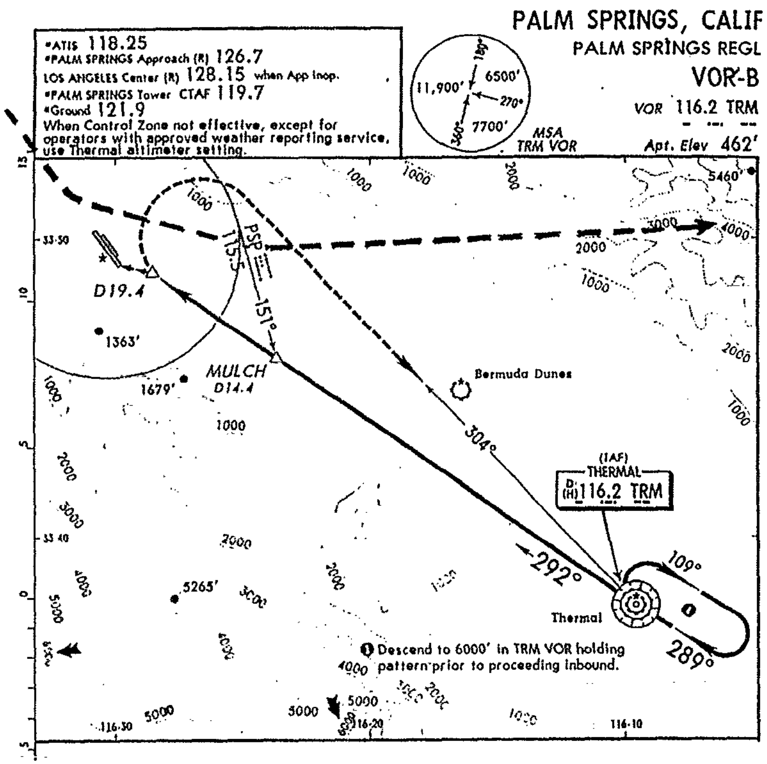
CIRCUMSTANCES:	During a radar approach to runway 13R, the airspeed on final increased to 40kts in windshear conditions. The approach profile became unstabilized and the captain decided to make a missed approach from 500 feet MSL. During the missed approach, the pilots began to receive radar vectors and altitudes inconsistent with the terrian. The pilots became uneasy with the vectors and asked for higher altitudes, that were either ignored or overridden with other radio transmissions, and were finally given a new altitude and heading that further aggravated the flight towards terrain. Finally there was a GPWS warning with the pilots taking immediate recovery action from the terrain.
WEATHER:	Good visibility, but unsettled winds and night
TIME:	21:30 PST
INJURIES:	None of 173 on board

ATC SYSTEM ERROR - Correct clearances to incorrect aircraft? Or loss of communication?

CFTT INCIDENT

Flight Path To Terrain Profile
A320
PALM SPRINGS, CALIFORNIA
13 April, 1995





Rwy 13R has VASI, HIRL lighting

Pilot Report

At 500' AGL on approach to RWY 13 R. We went around due to a windshear condition (increase of I.A.S. of 40 kts) at approximately 2000' MSL on a RWY HDG. Approach control cleared us to turn left to a HDG of 090º and maintain 5000' MSL it was clear to us that we would need to turn much further left and/or climb to a higher altitude. We requested a climb and received a clearance to climb to 7000' and to turn to a HDB o 070º despite now having a higher altitude and a new HDG it was still obvious that we would require another climb and/or HDG change due to the face that the new HDG actually had us pointed to even higher terrain.

Repeated requests for a higher cleared altitude were ignored by ATC. We decided to climb without a clearance, as TOGA power was being applied we disconnected the A/P and applied full AFT sidestick just as this action was taking place. We got the GPWS terrain warning. Since the aircraft was very light only 45.6 tons without seconds we had an indicated V.S.I. of some 6000' F.P.M. and the GPWS warning stopped. As we were climbing we finally received a higher cleared altitude from A.T.C. upon reaching this altitude we asked and received a clearance to our alternate airport.

In summary, I discussed the missed approach Guidance that we received with the Palm Springs A.T.C. Supervisor. He has assured me that at no time was the aircraft below the M.V.A. He also assured me that he would brief all his controllers on what had taken place.

What is of concern, is that regardless of how many times we asked for a higher altitude the controller either ignored us or just give us a new HDG which turned us to even higher terrain.

I suggest that we review our operations into PSP specifically I suggest we create and publish a missed approach procedure for RWY 13R. Also consider to limit or cancel all night operations. Further more, I would like to remind everyone concerned that PSP compared to most all other Airports we operate into offers many different challenges.

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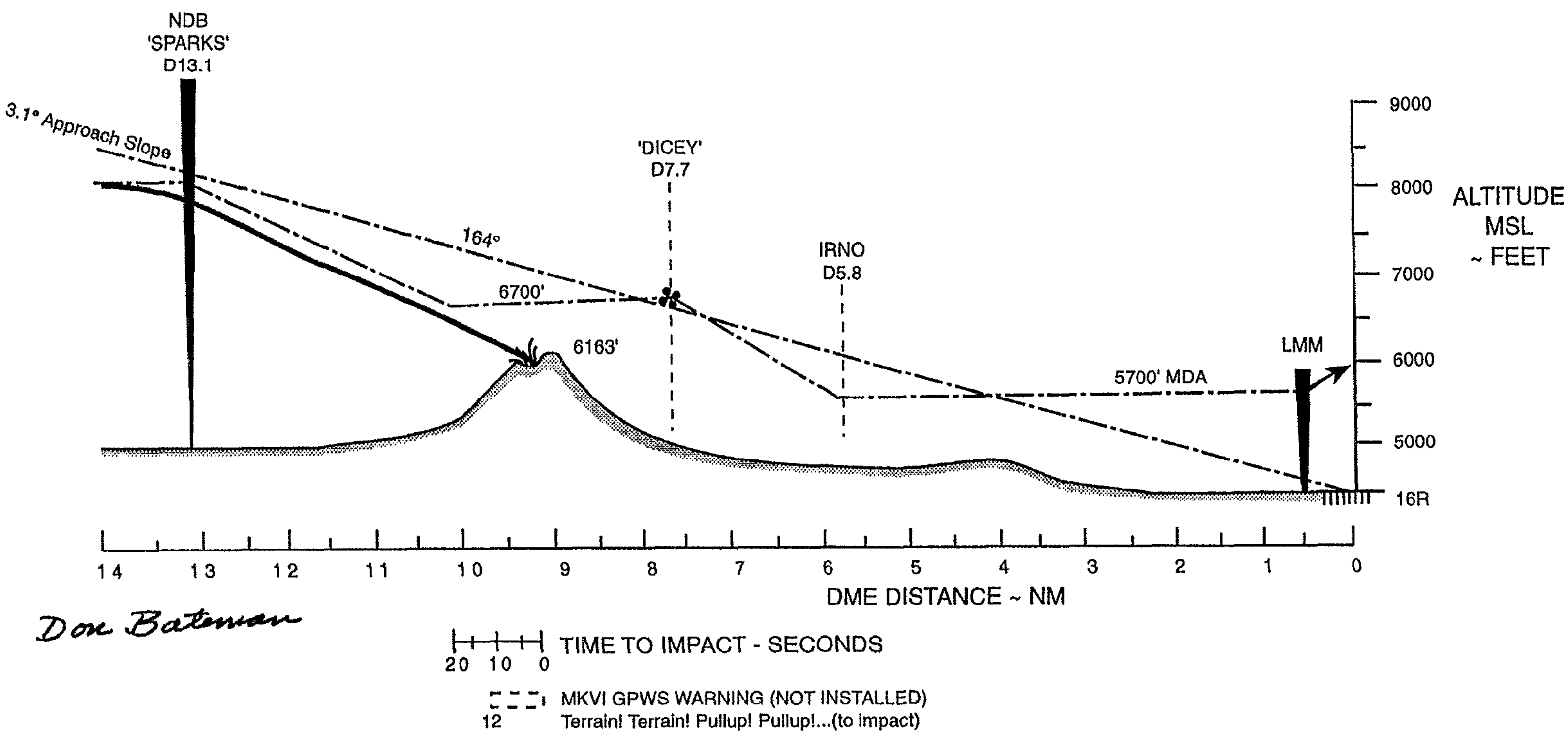
CIRCUMSTANCES:	During a LOC-2 approach to runway 16R, this freight aircraft hit 110 feet below a mountain peak on the localizer center line.
WEATHER:	1900 broken, 3 mile visibility, snow, wind 180/27 gusting 32kts
TIME:	0812L
FATALITIES:	1

Flight Path Profile
RENO, NEVADA
Ce 208B
22 March, 1995

OTHER - The aircraft apparently was not fitted with a glideslope receiver, forcing the pilot to make a localizer approach instead of the ILS 16R



Return to TOC

RENO, NEV

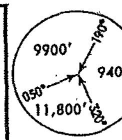
RENO CANNON INTL

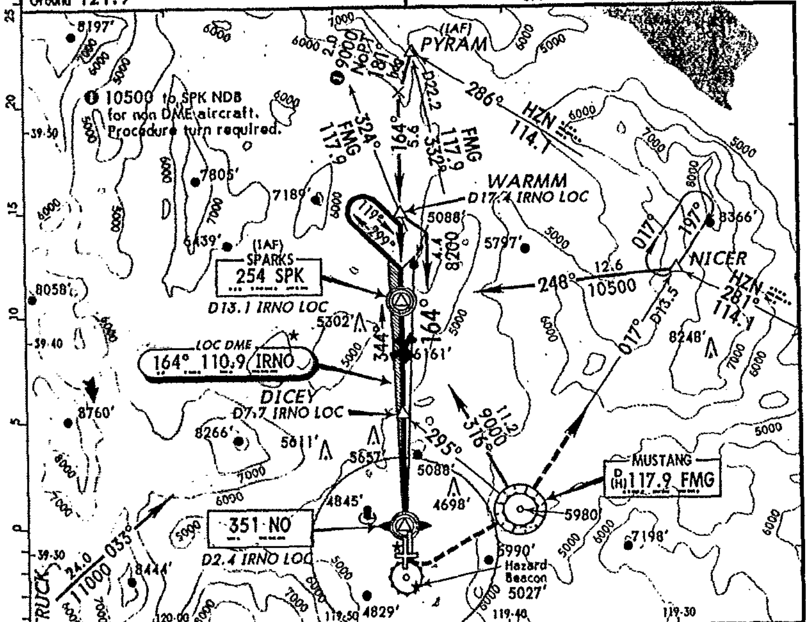
LOC-2 Rwy 16R

LOC 110.9 IRNO

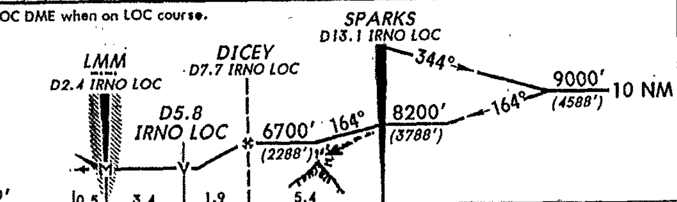
Apt. Elev 4412'

ATIS 124.35
RENO Approach (R) (NW-NE) 126.3
(NE-SW) 119.2
(W) 120.8
RENO Tower 118.7
Ground 121.9





Use IRNO LOC DME when on LOC course.



TDZE 4412'
APT. 4412'

MISSED APPROACH: Climb to 5900' then climbing LEFT turn to 11000' direct FMG VOR, then outbound via FMG VOR R-017 to NICER INT and hold.

STRAIGHT-IN LANDING RWY 16R MDA(H) 5700' (1288')			Max Kts	CIRCLE-TO-LAND MDA(H)
		ALS out		
A	3/4	1 1/4	90	5700' (1288')-1 1/4
B	1	1 1/2	120	5700' (1288')-1 1/2
C	2 1/2	3	140	5700' (1288')-3
D			165	

Gnd speed-Kts	70	90	100	120	140	160
MAP at D2.4 IRNO LOC or DICEY to MAP 5.3	4:33	3:32	3:11	2:39	2:16	1:59

CIRCUMSTANCES:	During an ILS approach to runway 26L, the aircraft descended prematurely well below the glideslope before passing the FAF. A late but important GPWS "Pull Up" allowed a successful recovery from a possible disaster at some 6-1/2 NM short of the runway threshold.
TIME:	Morning
WEATHER:	Instrument Meteorolgical Condition
CONFIGURATION:	Landing
GPWS:	Early obsolete Mark I GPWS

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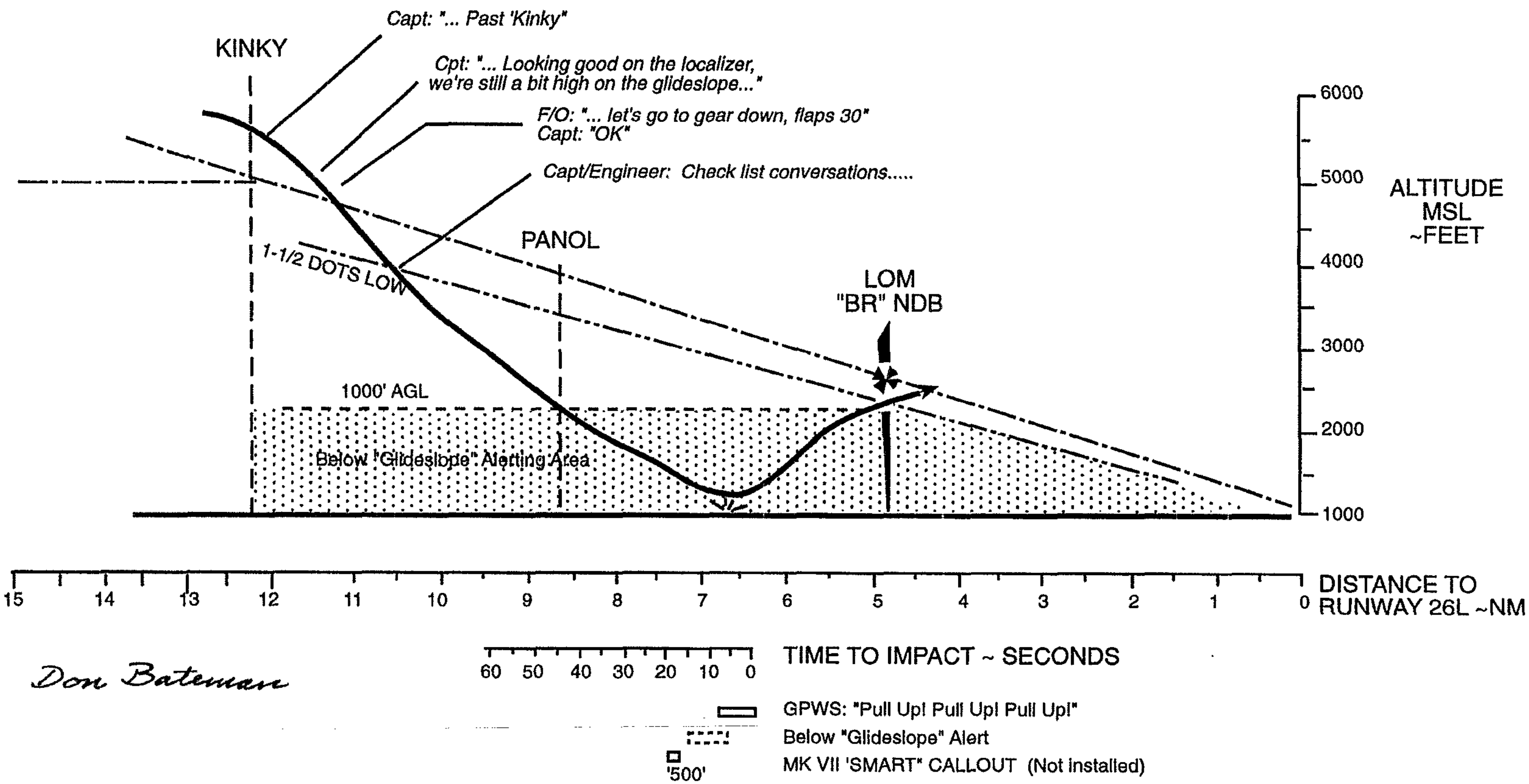
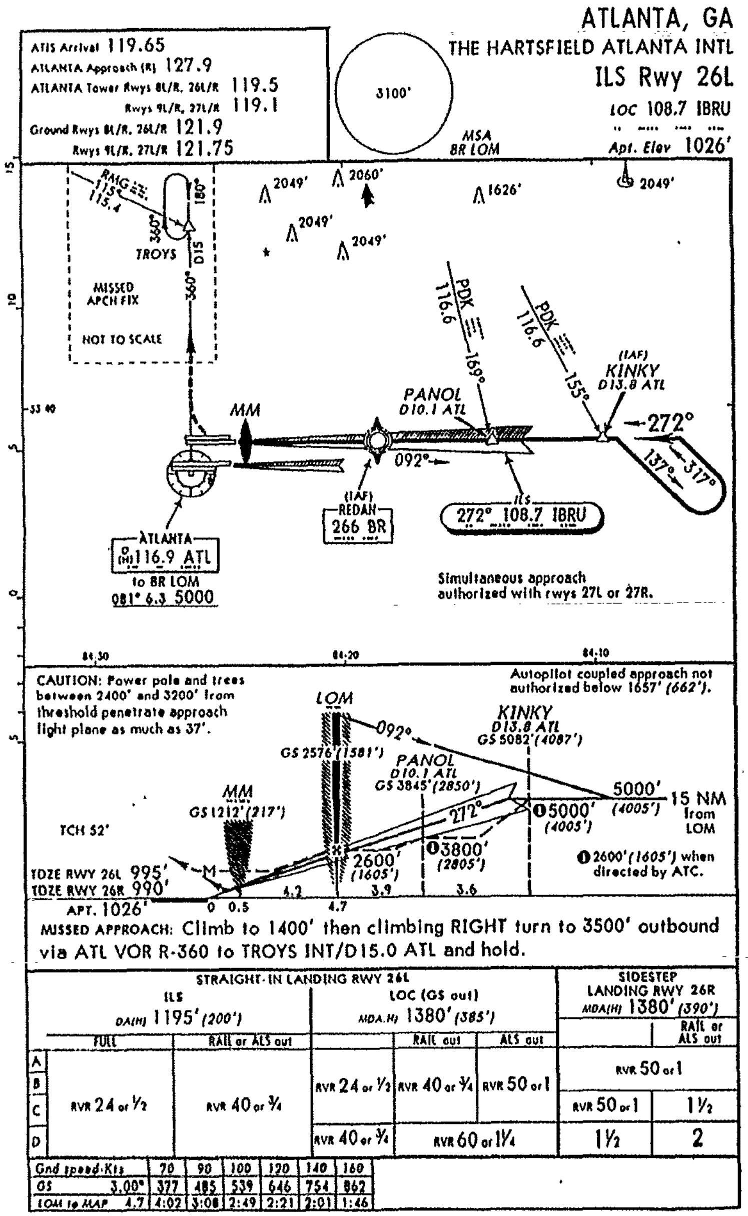
Flight Path Profile
B727-200
ATLANTA, GEORGIA
January, 1995

For other similar incidents see:
January, 1994, Ft. St. John, BC, DHC-8
28 June 1986, Portland, OR DC-10



Don Bateman

Return to TOC



Synopsis:

This early morning flight into Atlanta had been preceded the night before by an evening fight from the west coast to the east coast. Overnight crew rest had been minimum. The approach controller gave radar vectors to ILS 26 L outside "KINKY", but leaving the aircraft well above the glideslope. The first officer was flying and recognizing that the aircraft was high was attempting at the same time to align with the localizer and descend down to the glideslope. The Captain handled the radios and kept his VOR tuned to "PDK" so that the "KINKY" could be determined by passing the 155° radial. After passing "KINKY", the Captain momentarily re-tuned the VOR to the LOC to assess and confirm the aircraft's position on the localizer which it was, but found the aircraft still above the glideslope but correcting. The Captain then re-tuned back to the VOR to help determine "PANOL". The First Officer's RMI needle (slaved to Capt's VOR) swung aft catching the First Officer's eye, convincing him that the aircraft was pass the FAF but still high on the glideslope. He further reduced thrust, called for landing gear down and landing flap to increase the descent rate. The Captain believed the First Officer was merely correcting the aircraft's high position. The Captain and the Second Officer began to complete the approach-landing check list and did not realize the aircraft was slipping well below the glideslope. The check list had become a distraction for the First Officer who reduced the descent rate by adding some thrust but insufficient to prevent the aircraft from descending well below the glideslope.

The MK I GPWS monitors glideslope deviation, but as in most installations, from only the Captain's side. In this incident, the Captain was using the VOR, with no glideslope deviation to the GPWS, and hence there is no below "Glideslope!" alerting function. As the aircraft had been established in landing configuration, there were no GPWS warnings of insufficient terrain clearance. In this early primitive GPWS there are no aural automated "smart" altitude callouts or procedures to help alert the crew of the lost altitude awareness. If the aircraft had been descending at 1200 fpm there would be nothing unusual in the descent rate and no GPWS warning. Fortunately, the descent rate initially 2600 fpm or so had been reduced to about 1600 fpm, and a late but important GPWS "Pull Up!" started at about 300 feet AGL. This allowed the pilots to make a successful recovery and avert what would have been a disaster. (The radio altimeter dipped to about 200 feet AGL). As the aircraft was climbing through 600 feet AGL, the Controller advised the aircraft of a rather late low altitude (MSAW) alert.

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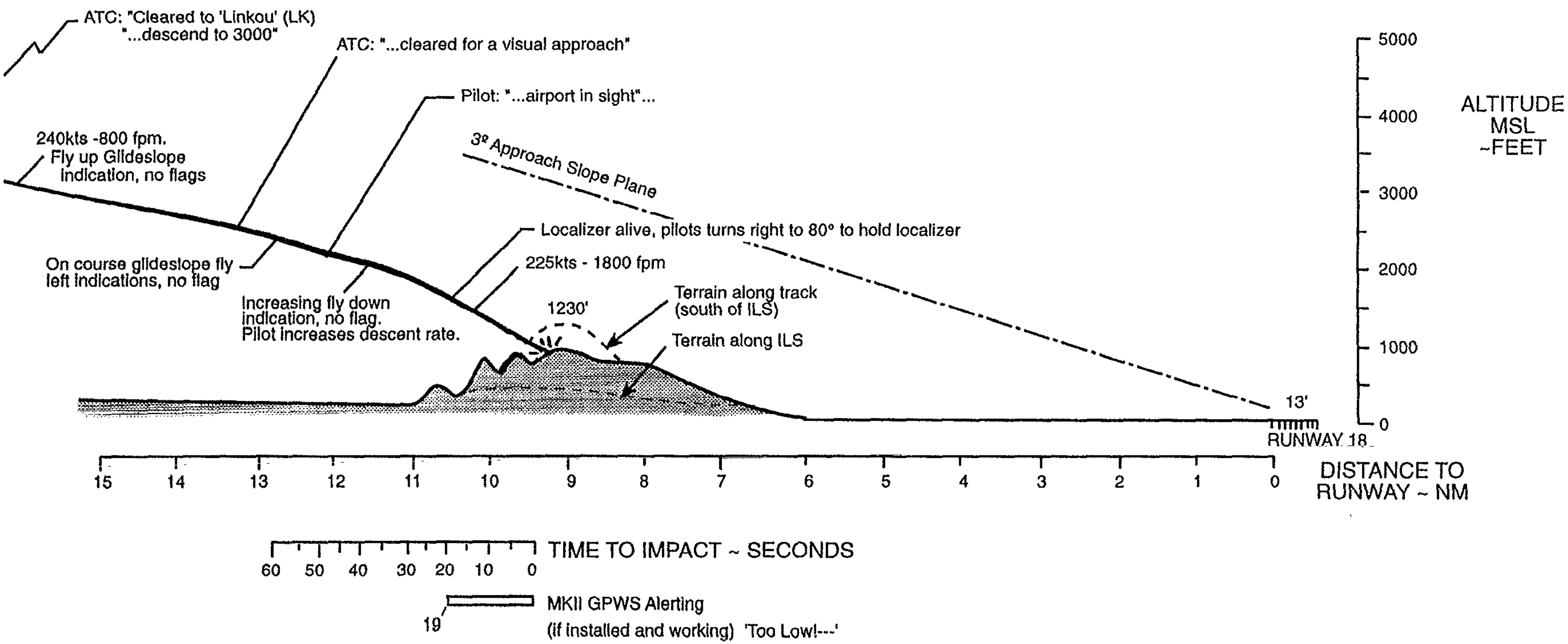
CIRCUMSTANCES:	While positioning back from the Pescadores Island to Taipei, the aircraft was cleared for a visual approach to runway 10 (Sung shau). The aircraft was slightly right of a gap in shallow terrain and impacted at 750 feet MSL of a 1230 foot hill.
TIME:	Night 19:43 L
WEATHER:	Light rain. Visibility at airfield was 9KM
CONFIGURATION:	Gear up, flaps maneuvering
FATALITIES:	4
OTHER:	MKII GPWS installed, but no warning given. GPWS 'Off' switch used or GPWS failure.

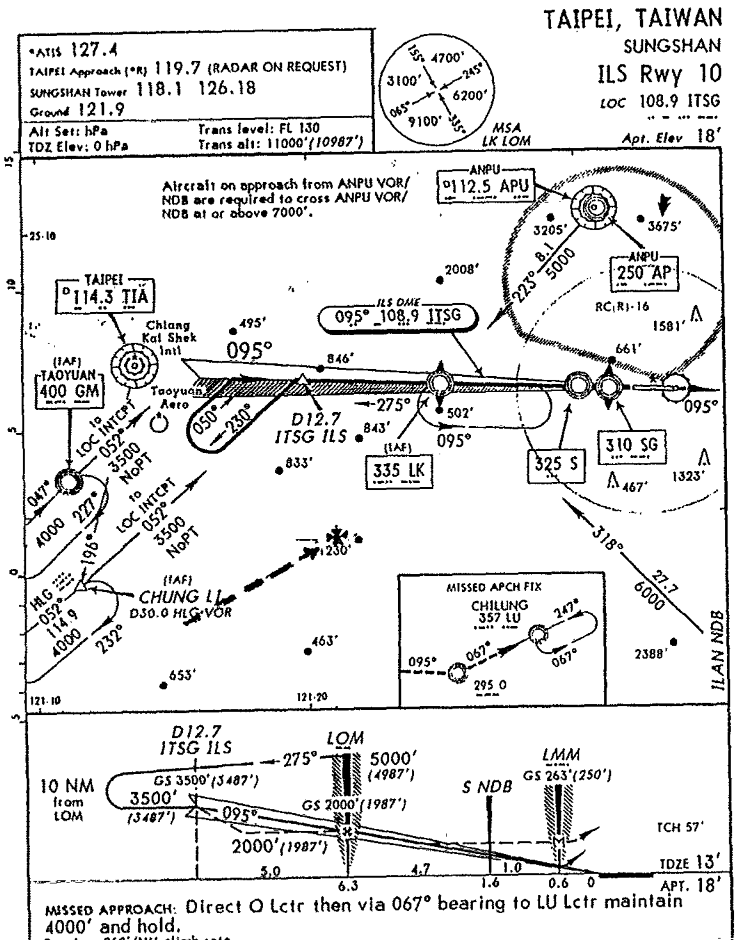
Note: Of the 10,000 aircraft fitted with MKII GPWS, this is the first reported failure of the system to warn of impending impact. A cockpit panel GPWS Three Position guarded switch is used, but with no lock wire. ('Normal', 'Flap Ovrd' and 'Off' positions) There appeared to be no reason for the pilot to disable the GPWS.

Pilots may have been misled, by false on course glideslope and localizer indications, with no flags, similar to 23 December, 1992 F-28 accident in Olso, Norway.

Estimated
Flight Path Profile
ATR-72
TAIPEI, TAIWAN
30 January, 1995



Return to TOC



	STRAIGHT-IN LANDING RWY 10 ILS DA(H) 263'(250') FULL	MM out	ALS out	LOC (GS out) MDA(H) 760'(747') ALS out	L & MM out	Max Kts	CIRCLE-TO-LAND Not Authorized North of Rwy MDA(H)
A	800m	1200m	1600m	3200m	NOT AUTH	90	1300'(1282')-4800m
B						120	
C						140	
D						165	

Gnd speed-Kts	70	90	100	120	140	160
GS 3.00°	373	479	532	639	745	852
MAP at LMM						

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CIRCUMSTANCES: During the final of ILS 10 approach, the aircraft clipped trees approximately 1NM short of the runway but was able to make a successful go-around. The aircraft held for 20 minutes until the heavy rain had passed, and then made an unusual approach and landing.

TIME: Daylight 15:11 local

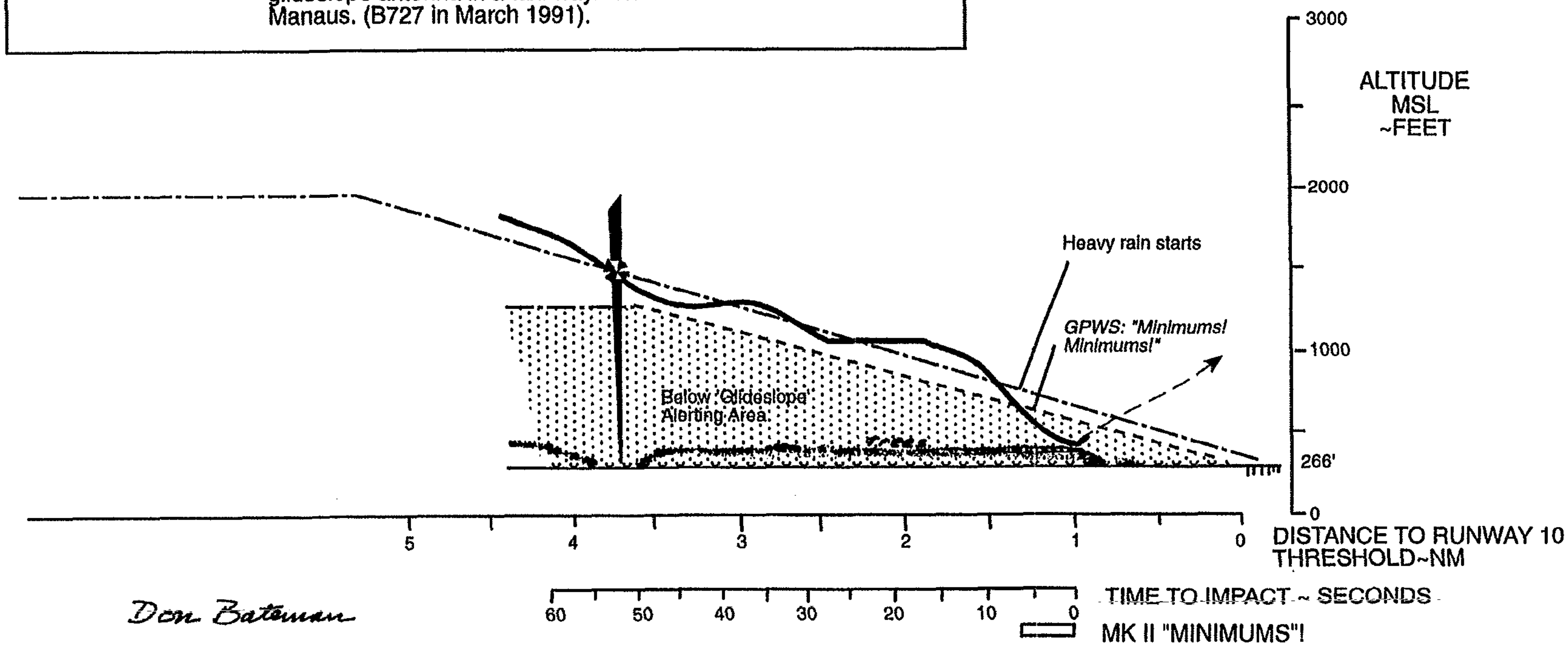
WEATHER: IMC, heavy rain

CONFIGURATION: Landing

DAMAGE: #4 engine cowl ring lost and foliage/tree ingestion

OTHER: Aircraft fitted with MK II GPWS. A timely "Minimums! Minimums!" without the field in sight, prompted the flight crew to initiate a pull up, and a missed approach. There was a possible altimeter error, a possible downdraft and perhaps an ILS glideslope irregularity caused by another aircraft parked in the ground plane of the glideslope antenna in a taxi way. This is a second incident at Manaus. (B727 in March 1991).

Flight Path Profile
DC-8-62
MANAUS, BRAZIL
29, January, 1995



Don Bateman

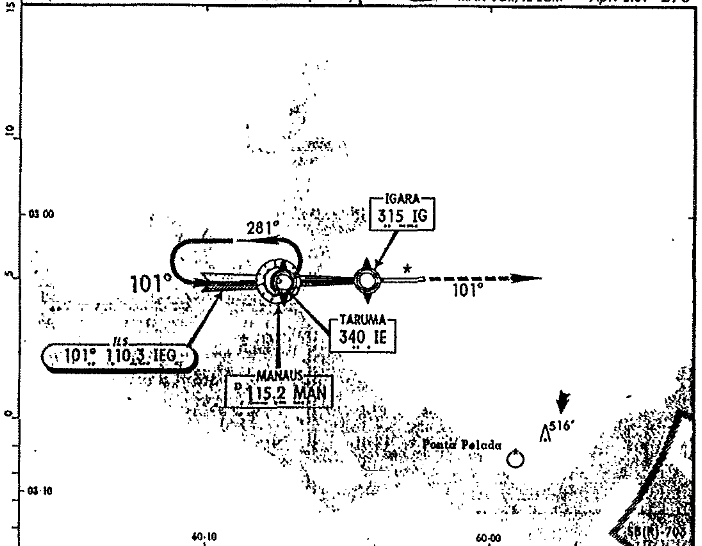
Return to TOC

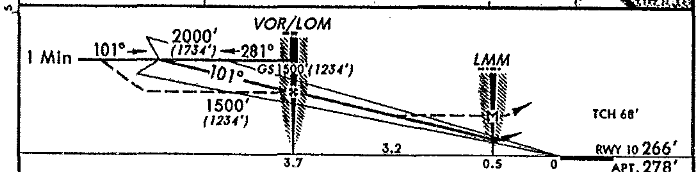
MANAUS Control (Approach) (R) 119.7 *119.1
*120.4 *120.9
EDUARDO GOMES Tower 118.3
Ground 121.9

Alt Set: hPa — Trans level: By ATC
Rwy Elev: 10 hPa — Trans alt: 2000' (1734')

MSA MAN VOR/IE LOM: 2000'

MANAUS, BRAZIL
EDUARDO GOMES INTL
DESCENT CHARLIE 1
ILS Rwy 10
LOC 110.3 IEG
Apt. Elev 278'





MISSED APPROACH: Climb to 2000' outbound on MAN VOR R-101 or 101° bearing from IE LOM.

STRAIGHT-IN LANDING RWY 10 — CEILING REQUIRED — CIRCLE-TO-LAND

	ILS DA(H) 475' (209')		ILS DA(H) 525' (259')		LOC (GS out) MDA(H) 750' (484')				
	FULL	ALS out	MM out	MM & ALS out	CEILING-VISIBILITY	ALS out	Max Kts	MDA(H)	CEIL-VIS
A	200'-800m	200'-1200m	300'-800m	300'-1200m	500'-800m	500'-1600m	100	830' (552')	600'-1600m
B							135		
C					500'-1200m	500'-2000m	180	830' (552')	600'-2400m
D			300'-1200m		500'-1600m	500'-2400m	205	830' (552')	600'-3200m

Gnd speed-Kts		90	110	130	150	170	190
GS	3.04°	484	592	699	807	914	1022
Rate of descent on final (feet/min)		500	600	700	800	1000	1100
MAP at LMM or VOR/LOM to MAP	3.2	2:08	1:44	1:28	1:16	1:07	1:00

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CIRCUMSTANCES: On a back course localizer approach to runway 01, the aircraft descended, aligned on the localizer, past the airport into trees and terrain.

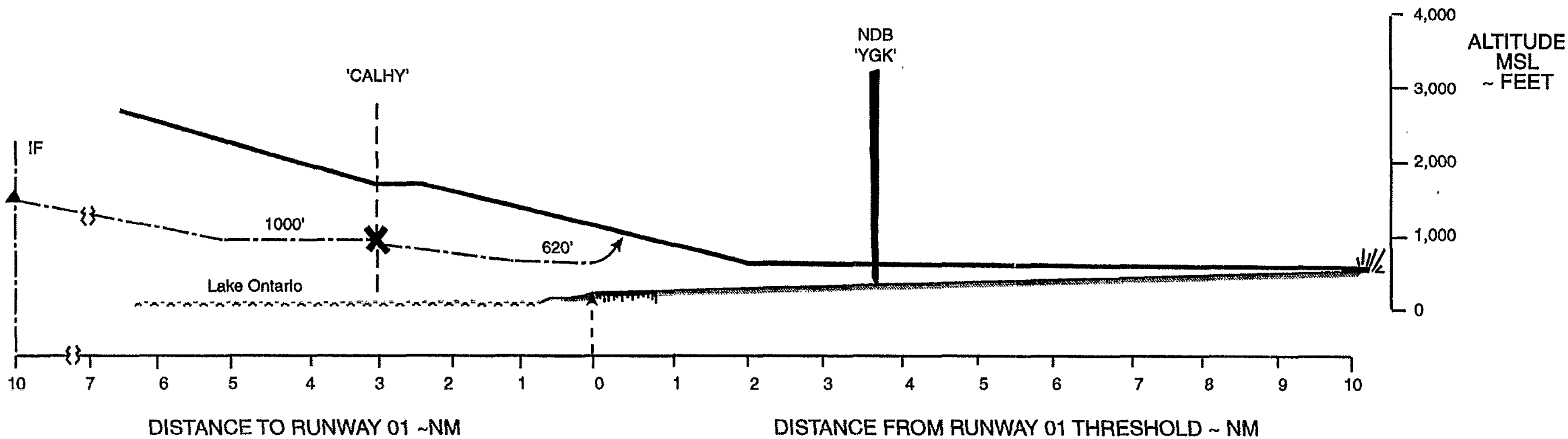
WEATHER: IMC, 700⊕, visibility 1-3/4 to 3 miles, light to moderate rain and fog.

CONFIGURATION: Gear down, flaps up.

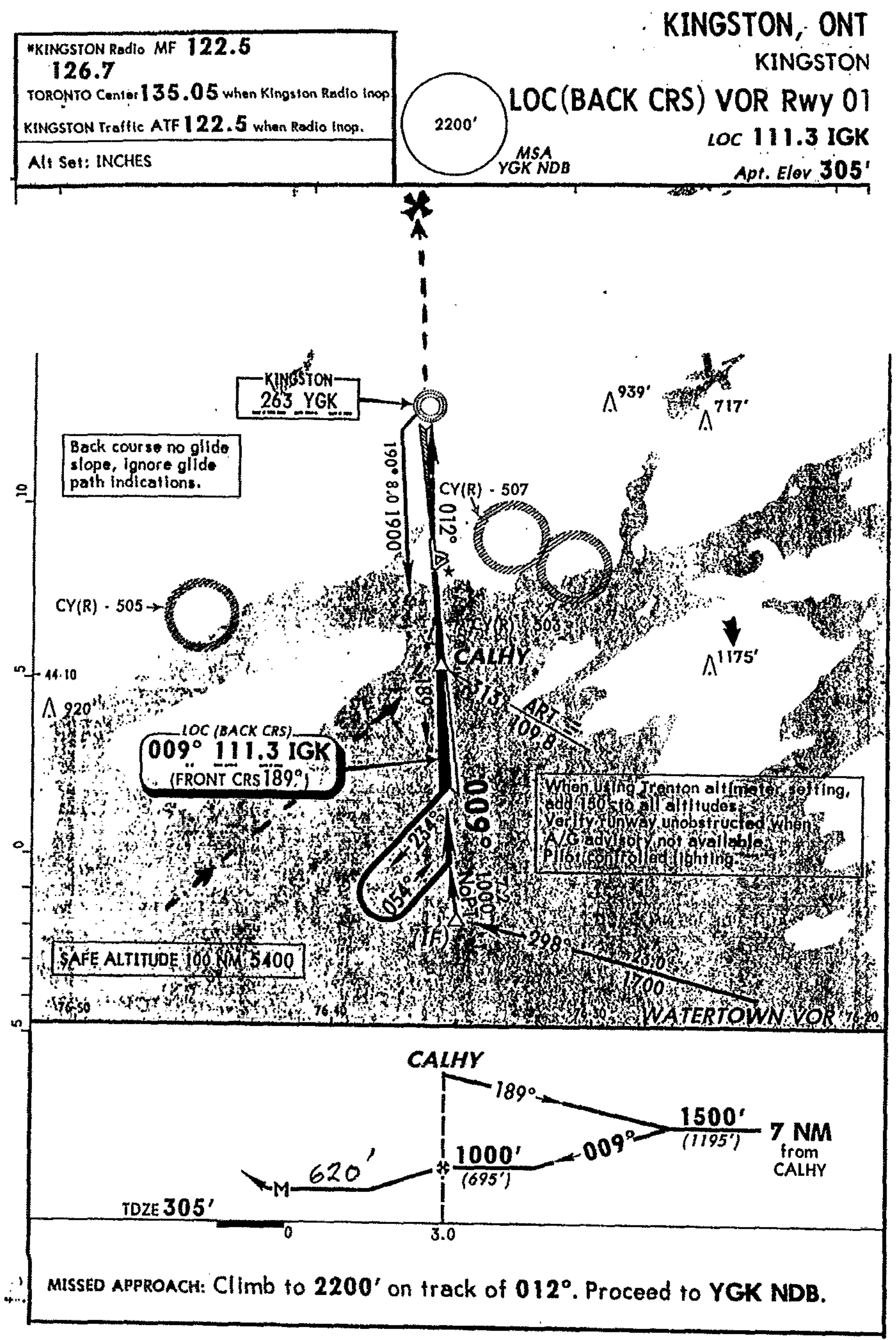
DAMAGE: Aircraft destroyed in fire. Serious injuries to two crew members.

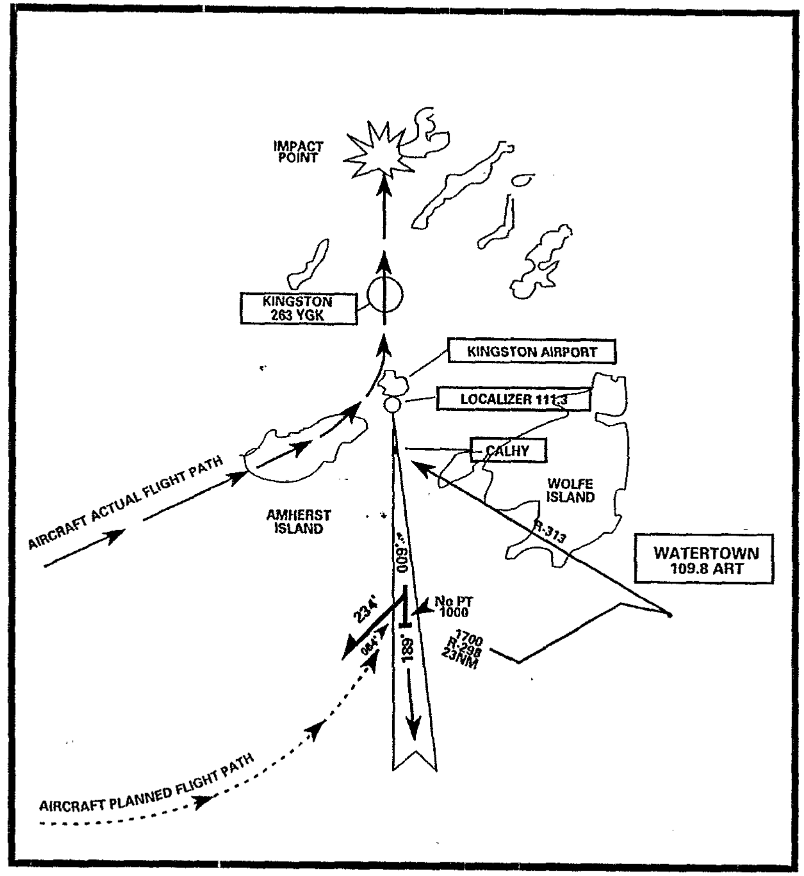
OTHER: Probable error in setting up RNAV radial, shifting the approach 7.2 NM to the north.

Flight Path Profile
Be-E90
KINGSTON, ONTARIO
20 JANUARY, 1995



Don Bateman





Since recorded radar data showed that the aircraft did not proceed to the IF for a straight-in approach, but rather proceeded toward the CALHY FAF with no navigational warnings, the 298-degree radial at 23 nm from the Watertown VORTAC was likely not properly selected as the waypoint for the IF on the aircraft's area navigation (RNAV) computer system. When the aircraft altered course to the left to intercept the on-course centre line it was in a vicinity abeam and west of the CALHY FAF, outside the localizer coverage limits. This indicates that the 313-degree radial, instead of the 298-degree radial at 23 nm, could have been entered in the RNAV as the IF waypoint data, shifting the approach 7.2 nm to the north.

Transport Canada
Report No. A95O0016

CIRCUMSTANCES: During an ILS approach to runway 30, the MK VI GPWS gave a continuous below 'Glideslope' aural alert even when the Captain's glideslope deviation indicator showed the aircraft 1/2 dot high. On attempting to zero the deviation, the GPWS glideslope indicator remained high until the Captain realized the aircraft was truly low.

TIME: Night

WEATHER: IMC

OTHER: NASA ASRS pilot reports show that this type of glideslope indicator failure has happened on other same type BAe JS 31/32 aircraft as well. See: NASA ASRS AN 295131, AN 291011 and AN 276236.

CFTT INCIDENT

Flight Path Profile
BAe JS-31
HUNTINGTON, W. VA.
JANUARY, 1995

FAULTY GLIDESLOPE DEVIATION INDICATOR STUCK DISPLAYING ABOVE GLIDESLOPE

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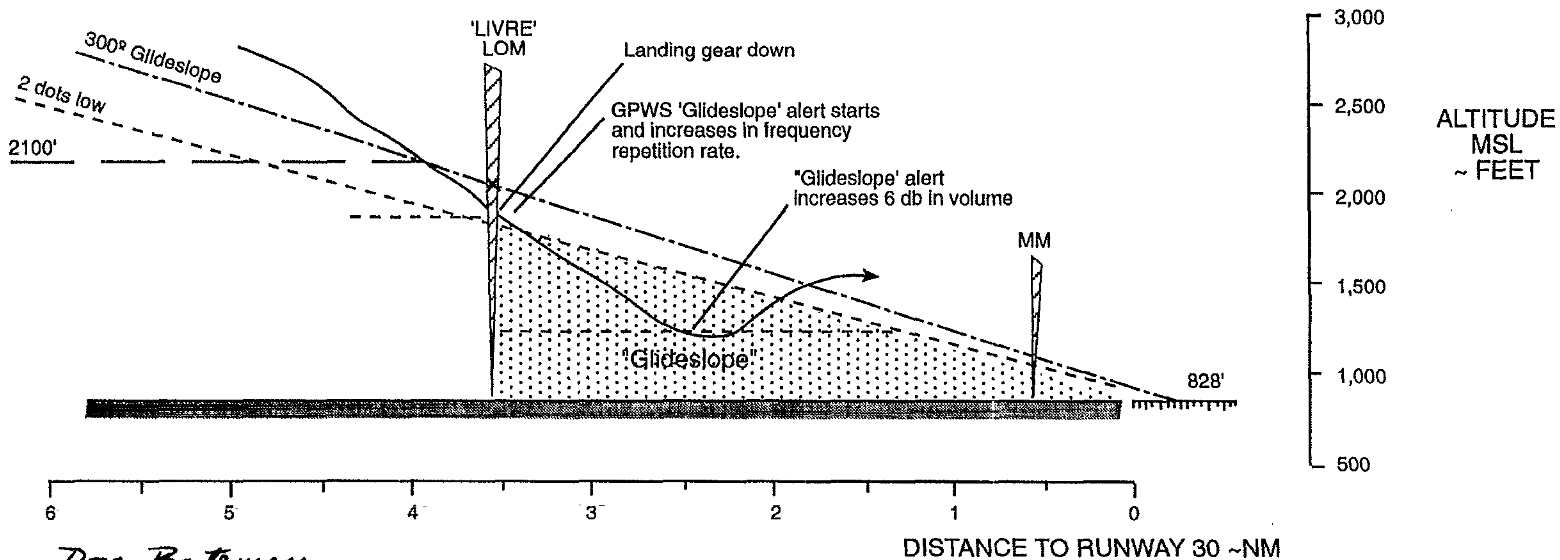
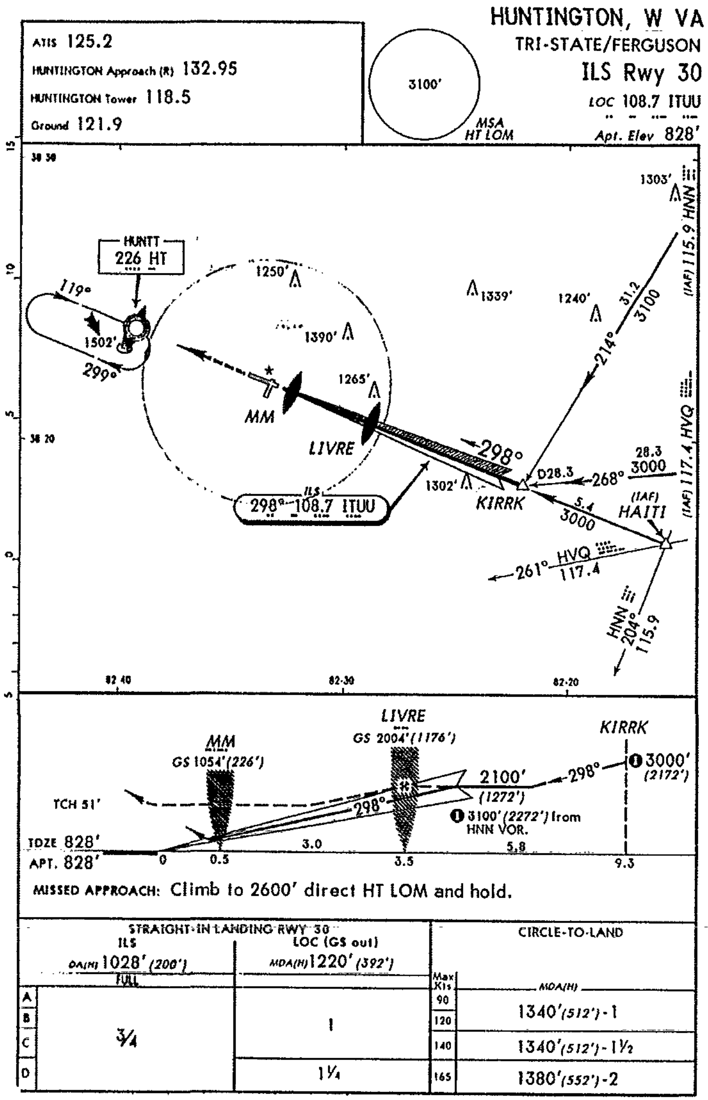
GPWS installed 10 months earlier to comply with FAR 135



Don Bateman



AN 295131

NARRATIVE : WHILE BEING VECTORED FOR THE ILS TO RWY 30 AT HTS, I NOTICED THAT THE GS INDICATOR SHOWED THAT WE WERE ABOVE THE GS, WHICH CORRESPONDED WITH OUR VECTORING ALT OF 3000 FT MSL. APCH CLRED US FOR THE APCH AND WE DSNDED TO 2600 FT MSL AS INSTRUCTED AND IT STILL INDICATED THAT WE WERE ABOVE THE GS. ONCE ESTABLISHED WE COULD DSND TO 2100 FT MSL. ONCE WE BECAME ESTABLISHED ON THE LOC, WE WERE STILL SHOWING 1/2 DOT ABOVE THE GS. I ASSUMED THAT WE HAD RECEIVED A BAD VECTOR FROM ATC, AND BEGAN TO DSND TO CATCH THE GS, BUT WAS NOT AWARE OF THE ALT/RATE OF DSCNT. THE GND PROX WARNING STARTED GOING OFF AND I COULDN'T FIGURE OUT WHY, BECAUSE I WAS STILL INDICATING ABOVE THE GS. WE GET A LOT OF FALSE WARNINGS, SO I ASSUMED THIS WAS ANOTHER ONE, UNTIL I LOOKED AT THE RATE OF DSCNT, AND REALIZED THAT THE GS INDICATOR NEEDLE HAD STUCK IN POS SHOWING US 1/2 DOT HIGH AND I WAS BELOW THE GS. I IMMEDIATELY INITIATED A GAR AND CLBED. MEANWHILE ATC HAD NOTICED THE DEV FROM THE GS AND WAS RECEIVING A LOW ALT ALERT AND CALLED FOR US TO CLB IMMEDIATELY. WHAT THE FO WAS DOING, I DO NOT KNOW. I KNOW THAT HE WAS EXTREMELY TIRED FROM BEING ON DUTY 6 STRAIGHT DAYS (RESERVE FO). HE SAID THAT HE HAD RECEIVED THE SAME INDICATION ON HIS GS INDICATOR, BUT IT WORKED PERFECTLY ON THE NEXT ILS APCH. IF IT HAD NOT BEEN FOR THE GPWS AND ATC, WE WOULD HAVE HAD A CFIT INSTEAD OF A CFTT.

MAKE-MODEL NAME	:	COMMERCIAL FIXED WING
FAR PART NUMBER	:	135
SYNOPSIS	:	CFTT. GS INDICATOR MALFUNCTION.
REFERENCE FACILITY ID	:	HTS
FACILITY STATE	:	WV
DISTANCE & BEARING FROM REF.	:	,118
MSL ALTITUDE	:	1400,3000

CIRCUMSTANCES: During initial descent for a VOR DME approach to runway 36, the aircraft impacted 27 NM short of the runway.

TIME: 19:36 local (night)

CONFIGURATION: Clean

WEATHER: Clear

FATALITIES: 52 (1 survivor)

OTHER: 3 pointer altimeter on c/p's side. It is speculated that the Captain may have been in the right seat, instructing the co-pilot on partial panel flight. CVR inoperative GPWS placarded inoperative GPWS not on MEL, engines idle.

Flight Path Profile
DC-9-15
CARTAGENA, COLOMBIA
11 January, 1995

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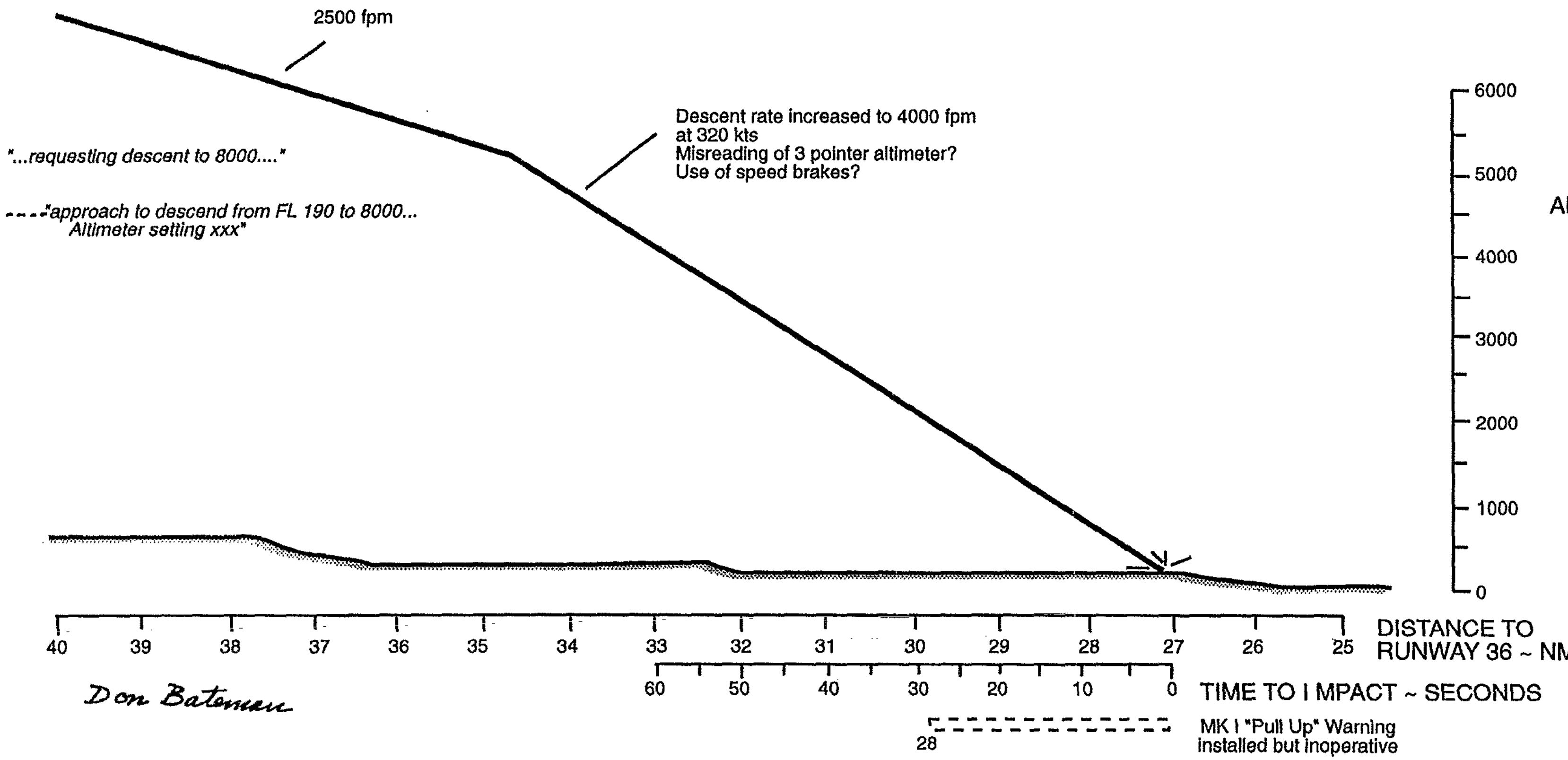
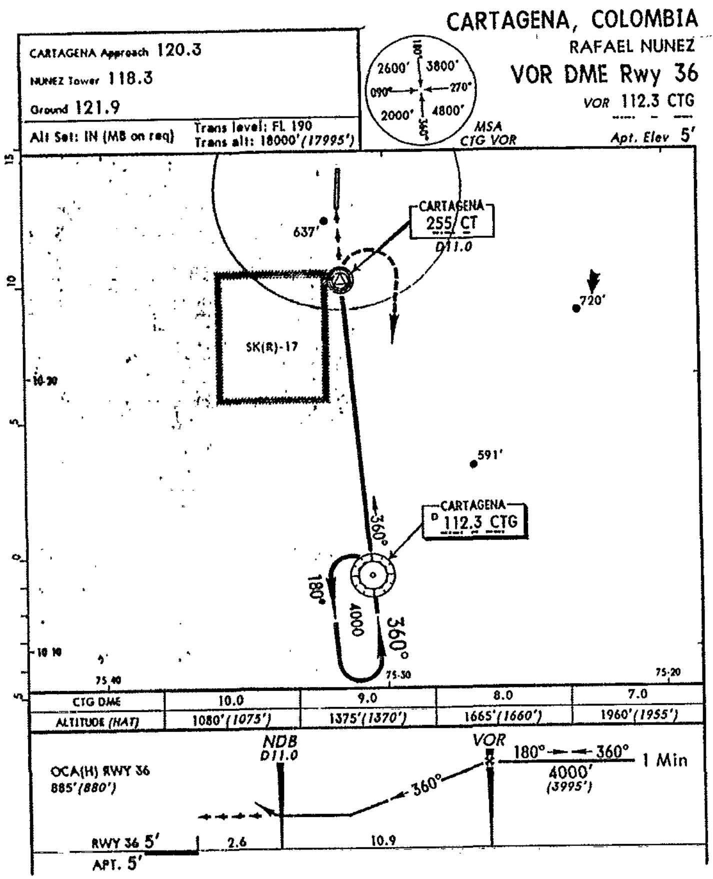
Previous CFIT Accident (same airline):
26 March, 1982, Viscount, Bogata, 22 F, hit mountain



Don Bateman

Return to TOC



Seattle Times Thurs. Jan 12, 1995

All but one are killed in Colombian jet crash

BY ANDREW SELSKY
Associated Press

BOGOTA, Colombia — All around the wreckage of a DC-9 were mutilated bodies — and a 9-year-old girl with just a broken arm. She was the only survivor of a crash that killed 52 people, including her parents and younger brother.

Authorities are hoping Erika Delgado can help them find out what happened in last night's crash of the Intercontinental Aviation plane as it approached the Caribbean resort city of Cartagena.

Although an initial report said the plane exploded in the air — raising memories of the 107 deaths that occurred when drug traffickers blew up a plane five years ago — the report later was in doubt.

Civil Aviation Director Alvaro Ráad Gomez said it would be "premature and irresponsible" to speculate on the cause of the crash.

Police, soldiers, civil defense crews and local farmers recovered all 52 bodies by this morning.

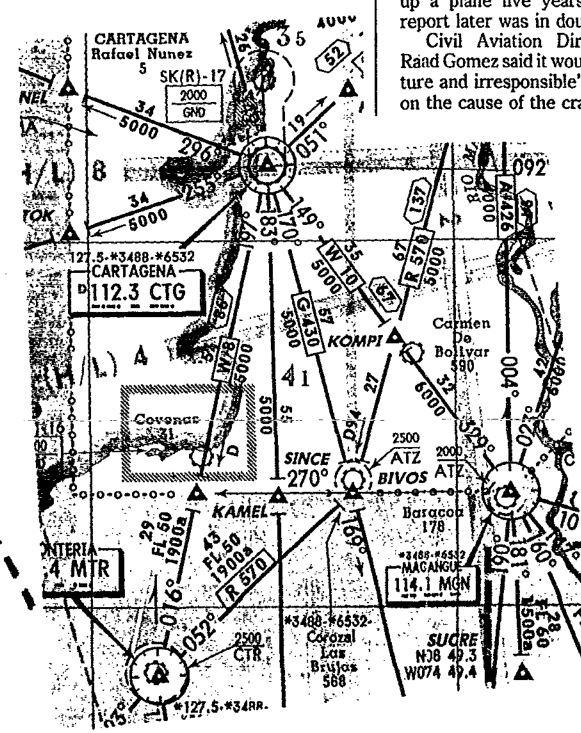
A witness said the plane hit the ground with an explosion. The pilot appeared to be attempting a crash landing, Argemiro Vergara told RCN radio.

The young survivor was reported in good condition today. Her parents and younger brother apparently died in the crash.

Flight 2056 originated in Bogota, 380 miles south of Cartagena. All 53 people aboard were Colombian, authorities said.

The plane had been cleared to descend to 8,000 feet to prepare for landing yesterday when air-traffic controllers lost contact, said Alfonso Ramirez, the airline's president.

In a conversation with the tower minutes before the crash, the pilot gave no indication of an emergency, Ramirez said.



CIRCUMSTANCES:	During final approach (NDB) to runway 12, the aircraft hit short and broke up.
WEATHER:	Obscured, 1000 feet overcast, fog. 4-5 miles visibility
TIME:	01:49 local night
CONFIGURATION:	Believed to be landing
FATALITIES:	5
OTHER:	Medevac Flight: No approach lighting to runway. Probable altimeter setting error of 1000 feet (30.17" was set instead of 29.17" Hg)

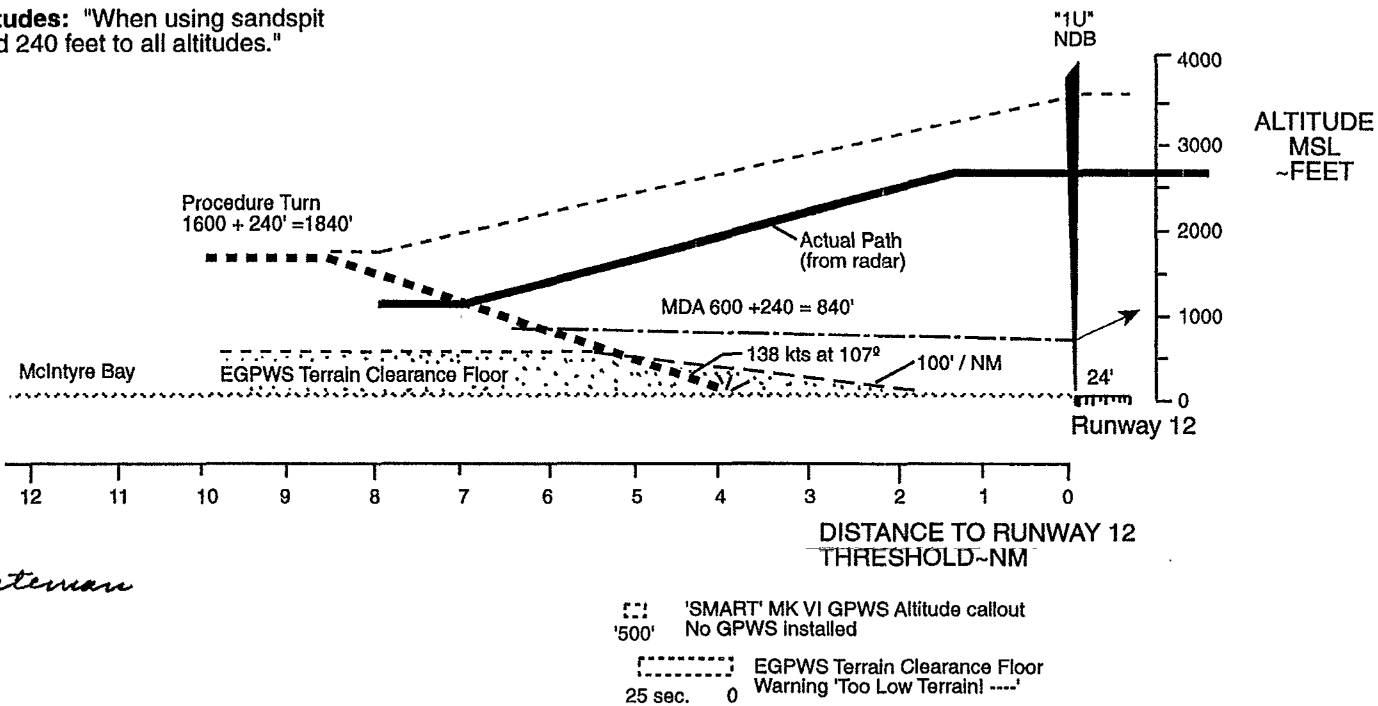
Next Page

Probable
Flight Path Profile
LJ-25
MASSET, B.C.
11, January, 1995

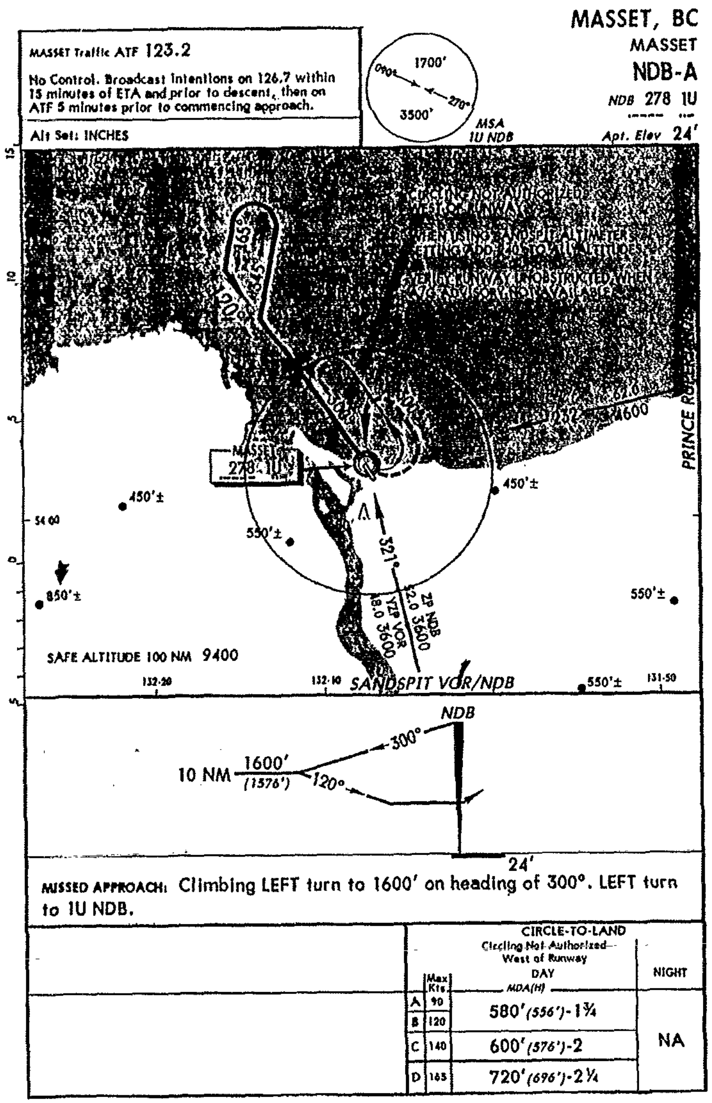
CFIT risks for Medevac aircraft are very high.
See other Medevac CFIT accidents:
* 31 May, 1994 - Thompson, Manitoba (Merlin III)
* 22 August, 1993 - Gold Beach, Oregon (Be-90)
* 22 October, 1985 - Juneau, Alaska (LJ-24D)
* 1985 - Medford, Oregon

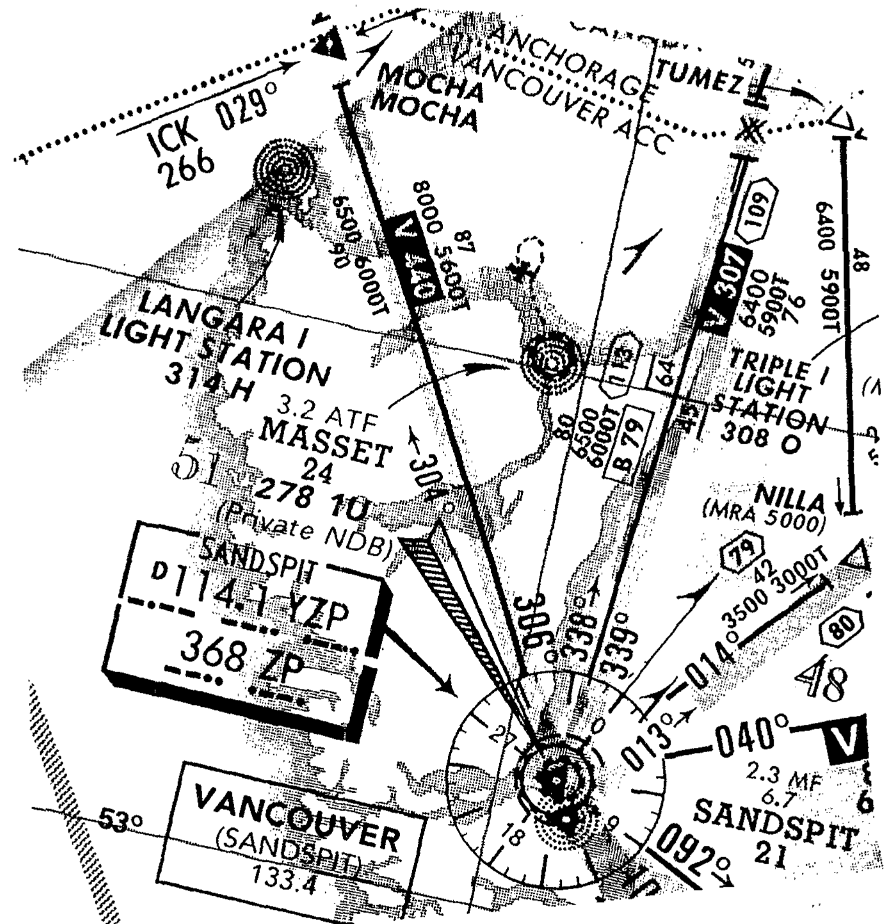
GPWS had been installed, but had been removed by operator.

Procedure for Altitudes: "When using sandspit altimeter setting add 240 feet to all altitudes."



Don Bateman





Body may be linked to missing B.C. jet

VICTORIA, British Columbia (AP) — A body was found Friday near where a Learjet with five people aboard disappeared in the remote Queen Charlotte Islands, Canadian searchers said.

Lt. Cmdr. Louis Garneau of the Rescue Coordination Centre here said the body was spotted by the crew of a Canadian Forces aircraft along the shore of Graham Island west of Masset, about 500 miles northwest of Vancouver.

Garneau said the Royal Canadian Mounted Police detachment in Masset was investigating the discovery.

He said the body was not far from the last known position of the jet, which vanished early Wednesday on a medical flight to Masset to help an expectant mother experiencing labor problems. Garneau said he did not know the sex of the body.

On Thursday, debris from the jet was found near Masset, a remote town of 1,500 at the northern end of the Queen Charlotte chain.

Lt. Denise Laviolette of the Rescue Coordination Centre said the debris made it unlikely there were any survivors.

A first-aid kit was found near Langara Island, 37 miles west of the Masset airstrip. Part of a seat cushion and surgical gloves were found on the island.

The jet is believed to have broken up when it crashed into the sea on its final approach to the Masset runway.

The jet was carrying Dr. Jeffrey Dolph, 27, of Richmond, and paramedics Andreas Goedicke, 40, of Vancouver, and Wendy Thompson, 33, of Whistler. The Vancouver-area flight crew was pilot Dan Jorgenson, 30, and co-pilot Geir Zinke, 29.

The aircraft, owned by Canada Jet Charters, was under charter to the provincial Health Ministry.

The pregnant woman the crew was sent to aid was flown by helicopter to Prince Rupert, where she gave birth to a healthy baby boy.

CIRCUMSTANCES: *Controller* prematurely cleared aircraft for descent into terrain. A timely MK VI GPWS Warning prompted the pilots to inquire about terrain clearance and then climb to a safe altitude.

WEATHER: VMC

TIME: night

OTHER: Aircraft fitted with GPWS 10 months earlier to comply with Part 135.153.

CFTT INCIDENT

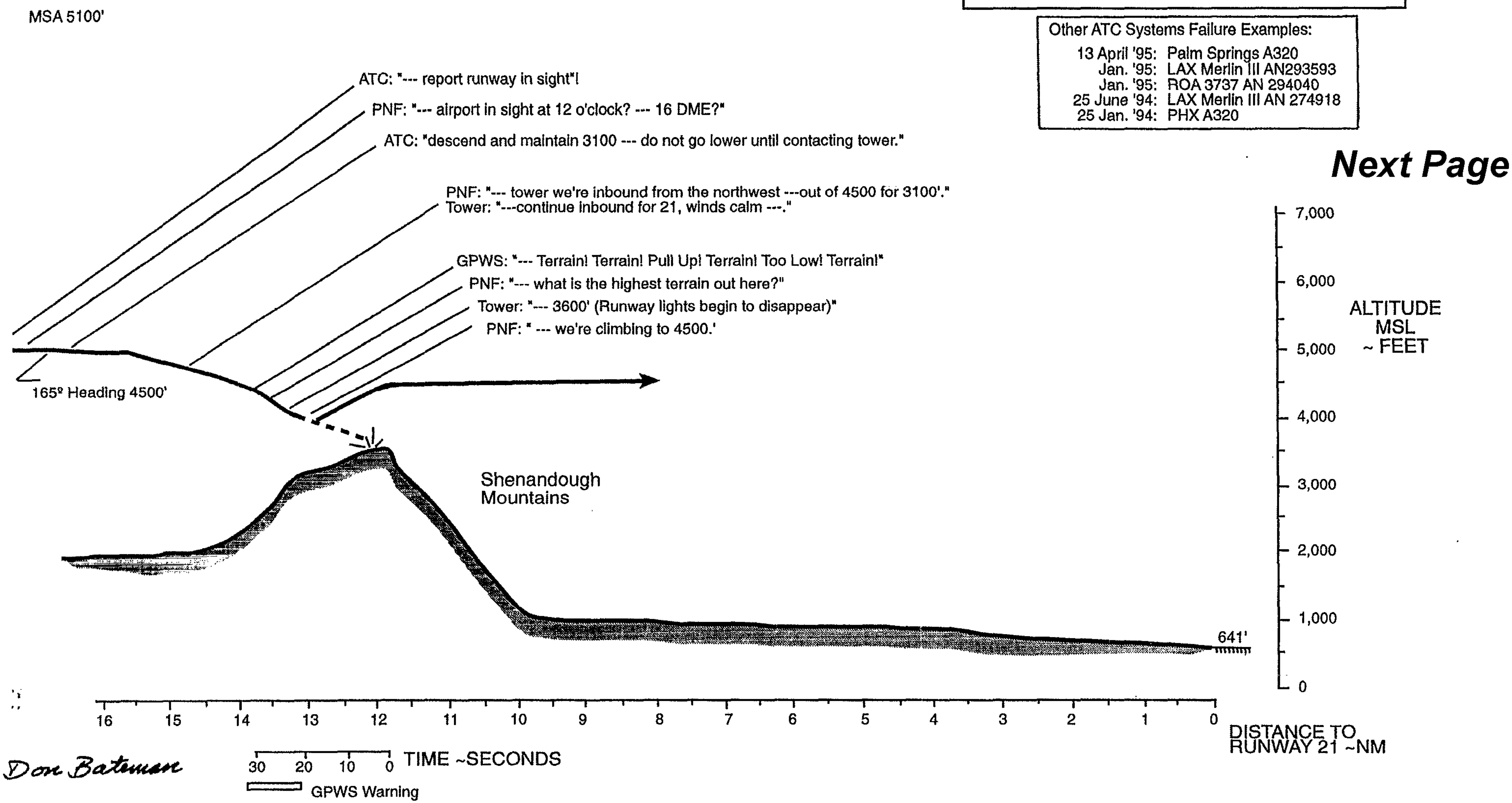
Flight Path Profile BAe JS-31
CHARLOTTESVILLE, VA.
JANUARY, 1995

ATC SYSTEM FAILURE

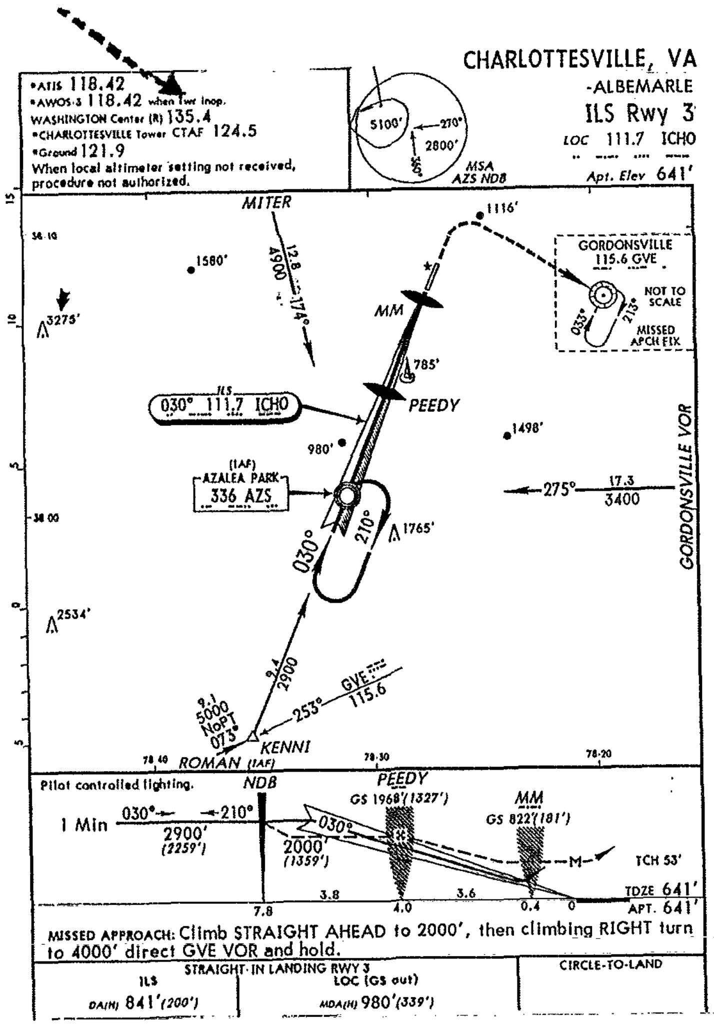
Other ATC Systems Failure Examples:

13 April '95: Palm Springs A320
Jan. '95: LAX Merlin III AN293593
Jan. '95: ROA 3737 AN 294040
25 June '94: LAX Merlin III AN 274918
25 Jan. '94: PHX A320

Next Page



Return to TOC



AN 294917

NARRATIVE : ACR X TRAVELING FROM PIT TO CHO FOR ACR X, I WAS THE PNF OPERATING THE RADIOS. WE WERE WITH ZDC WHO WAS STARTING OUR DSCNT. HE FIRST TOOK US FROM OUR CRUISING ALT TO 8000 FT OR 9000 FT MSL. WE WERE THEN TOLD TO RPT THE ARPT IN SIGHT AND DSND TO 5000 FT MSL. ABOUT 3 OR 4 MINS, I ASKED ZDC IF THE ARPT WAS AT OUR 12 O'CLOCK AND 12 MI. HE TOLD US THAT IT WAS THE ARPT, SO WE CALLED IT IN SIGHT. HE THEN INSTRUCTED US TO DSND AND MAINTAIN 3100 FT MSL, BUT NOT TO GO BELOW THAT ALT UNTIL WE CONTACTED TWR. WE SWITCHED FREQS TO TWR AND STARTED OUR DSCNT TO 3100 FT MSL. WE CALLED TWR AND RPTED OUR POS AT ABOUT 4500 FT MSL. GPWS WENT OFF SAYING 'TOO LOW, PULL UP.' WE STOPPED OUR DSCNT AND LOOKED AT THE RADAR ALT WHICH READ 1200 FT. WE CALLED TWR AND ASKED THE ALT OF THE HIGHEST OBSTACLE. HE TOLD US THE HIGHEST POINT WAS 3600 FT MSL. WE REMAINED AT 4500 FT MSL UNTIL WE GOT CLOSER TO THE ARPT AND THEN LANDED USING THE VISUAL STOP INDICATORS.

MAKE-MODEL NAME : COMMERCIAL FIXED WING
FAR PART NUMBER : 135
SYNOPSIS : ACR X GPWS DSCNT BELOW MVA. SYS ERROR. EVASIVE ACTION TAKEN.
REFERENCE FACILITY ID : CHO
FACILITY STATE : VA
DISTANCE & BEARING FROM REF. : 12,,NW
MSL ALTITUDE : 4500,4500

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CIRCUMSTANCES: It was not until final approach VOR-B to runway 10 (L,R) that an altimeter setting of 1000 foot error was discovered by a GPWS alert and visual contact with terrain. (30.22 instead of 29.22)

WEATHER: 27 ⦶, 12 miles visibility, wind 020º 18 kts (local coastal clouds at low altitudes)

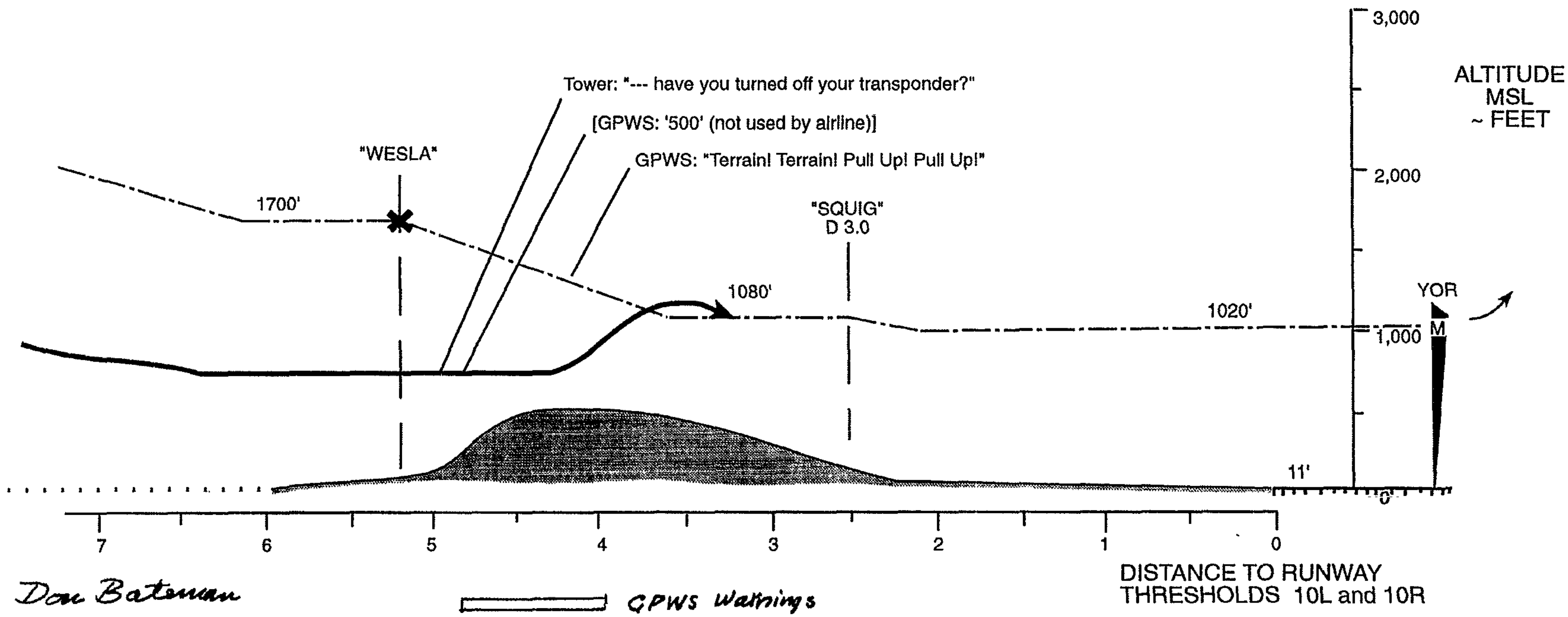
CFTT INCIDENT

Flight Path Profile B737-300

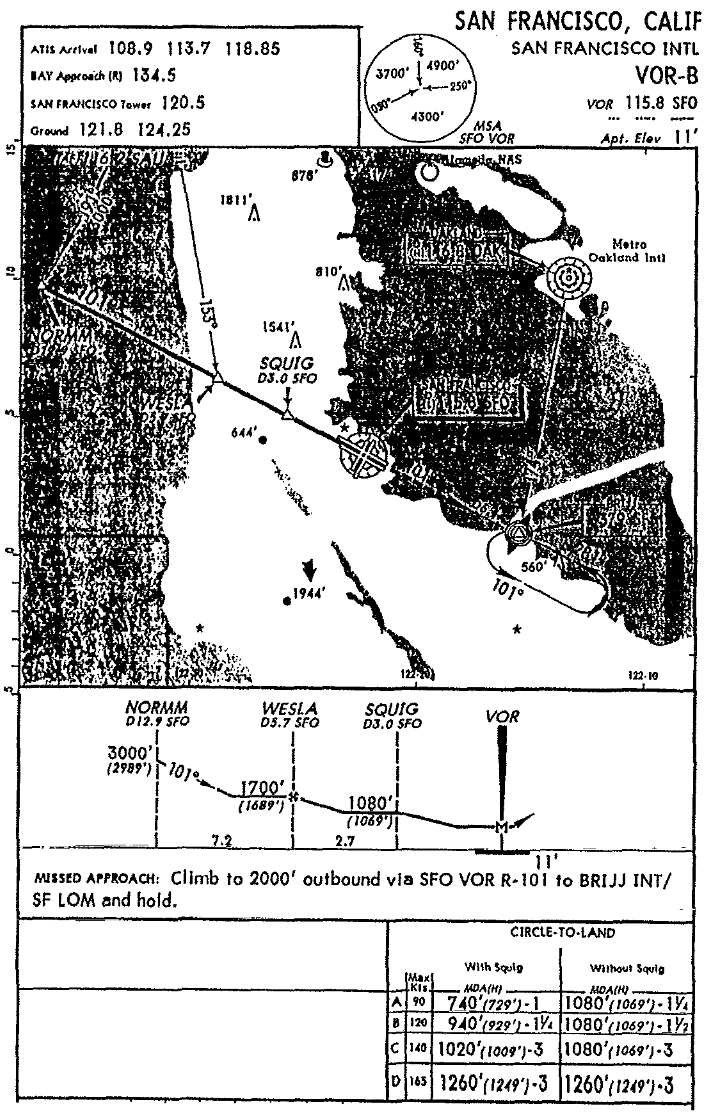
SAN FRANCISCO, CA.

JANUARY, 1995

WRONG ALTIMETER SETTING



Return to TOC



AN #292718

NARRATIVE : THIS WAS THE LAST LEG OF A LONG 3 DAY TRIP WITH ALL NIGHT FLT ON FIRST DAY. I HAD FLOWN WITH THE CAPT BEFORE AND KNEW HIM TO BE HIGHLY COMPETENT. ON THIS TRIP HE WAS A LITTLE OUT OF SORTS AND 'SHORT' WITH THE CREW. WE WERE INBOUND TO SFO FROM PIT, I WAS FLYING THE ACFT. AS IS PROC, CAPT WENT OFF FREQ AT ABOUT 22000 FT TO GET ATIS AND I FLEW AND MONITORED THE OTHER RADIO WITH ATC. CAPT CAME BACK ON FREQ AND WE RAN 'PRELIMINARY CHKLIST,' XCHKING ALTIMETERS AT 30.22. THIS SEEMED A LITTLE ODD TO ME AT THE TIME AS SFO HAD A LOW FRONT MOVING THROUGH, BUT WE WERE BUSY AND I DID NOT PRESS THE ISSUE. WE WERE HANDED OVER TO BAY APCH (I DO NOT REMEMBER HEARING AN ALTIMETER SETTING FROM CTR OR BAY, ALTHOUGH I TRY TO XCHK ALTIMETER WITH THEIR CALL). SFO WAS 2700 FT BROKEN, 12 MI VISIBILITY AND ALTHOUGH THE WIND WAS 020 DEGS, 18 KTS, THEY WERE LNDG ON RWY 10L&R. THE ONLY APCH FOR THESE RWYS IS A VOR-B WITH MINIMUMS OF 1020 FT FOR OUR ACFT. WE WERE GIVEN EXTENSIVE VECTORS AND SLOW-DOWNS. ONCE ON APCH EVERYTHING WAS NORMAL UNTIL JUST BEFORE FAF WHEN WE BROKE OUT OF THE CLOUDS AND A RIDGE WAS LOOKING VERY CLOSE. AT SAME TIME APCH OR TWR ASKED IF WE HAD TURNED OFF OUR XPONDER. ALSO GPWS WENT OFF AS WE PASSED OVER RIDGE. I CHKED OUR ALT AND WE WERE RIGHT ON PROFILE. ADDED PWR AND CLBED 200-300 FT TO ELIMINATE GPWS. RWY WAS IN SIGHT THE WHOLE TIME. I HAD CAPT CHK ALT WITH TWR. ALTIMETER ACTUALLY 29.22 NOT 30.22, PUTTING US APPROX 1000 FT TOO LOW ON APCH. WE RESET ALTIMETER, HELD ALT UNTIL NORMAL DSCNT PATH AND LANDED. CAPT APOLOGIZED FOR GETTING WRONG ALTIMETER SETTING. KNOW OF NO WAY TO PREVENT THIS EXCEPT LISTEN UP WHEN ALTIMETER GIVEN BY ATC OR HAVE BOTH CREWMEMBERS GET ATIS. WHAT SURPRISES ME IS THAT WE WERE LEVEL AT 8000 FT AND 10000 FT FOR LONG PERIODS OF TIME AND APCH DID NOT QUESTION OUR BEING OFF ALT BY ABOUT 1000 FT. I WOULD SUGGEST STRESSING TO FAA THE IMPORTANCE OF SAYING THE ATIS SLOWLY AND DISTINCTLY. I HAVE HEARD MANY ATIS GIVEN IN RAPID FIRE FASHION. ALSO, CREW CONCERNS ABOUT REDUCED FUEL AND FATIGUE COULD HAVE CONTRIBUTED TO THIS.

MAKE-MODEL NAME : B737-300

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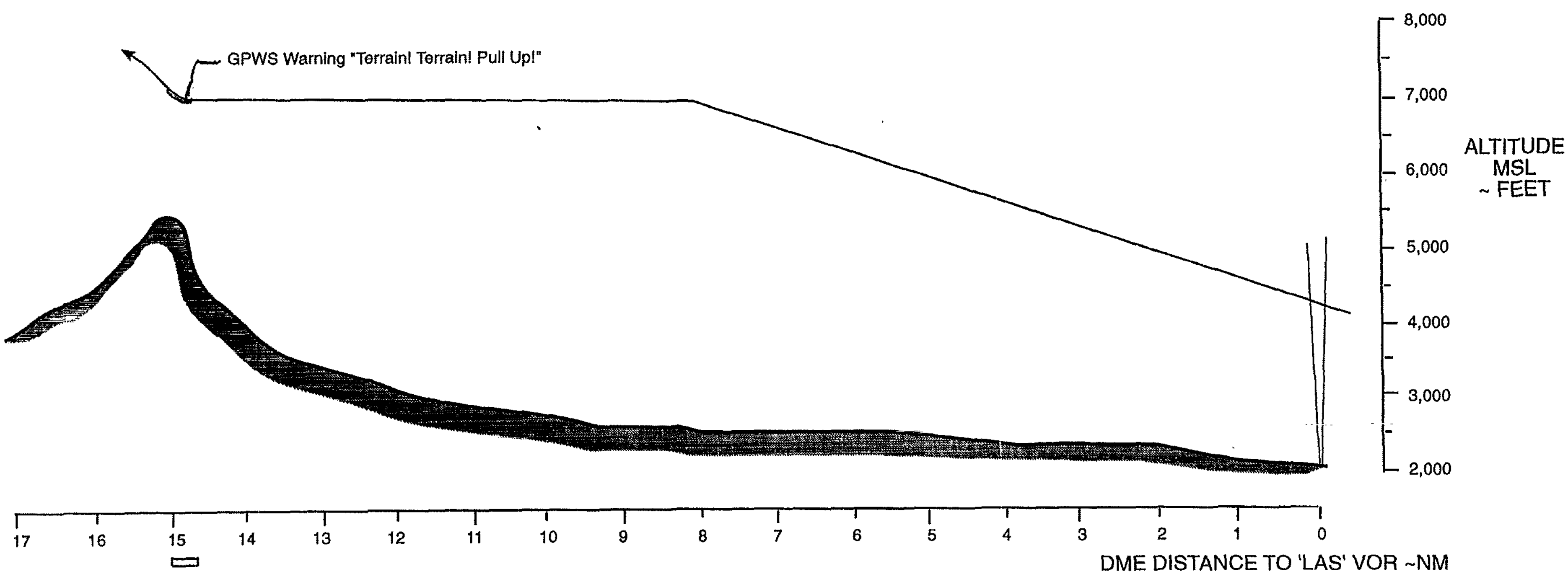
CIRCUMSTANCES:	Because of blocked communications, the aircraft was inadvertently left on an initial altitude of 7000 and not on a climb to 17,000 feet. At some 15 DME from 'LAS', a MK VI GPWS Warning, occurred and the pilot begin an immediate pull up - climb. The controller also received a MSAW Warning and the error was finally detected.
TIME:	Evening
WEATHER:	IMC
OTHER:	GPWS had been installed earlier in the year (FAR 135.153)

Don Bateman

CFTT INCIDENT

Flight Path Profile
EMB 110
LAS VEGAS, NEV.
DECEMBER, 1994

BLOCKED COMMUNICATION



Return to TOC

LAS VEGAS, NEV
McCARRAN INTL

LAS VEGAS Departure (R) North 133.95 South 125.9

OASIS SEVEN DEPARTURE (OASIS7.OASIS) (PILOT NAV)

(RWYS 1L/R, 19L/R, 25L/R)
(DME REQUIRED)
(DAGGETT and HECTOR TRANSITIONS ARE FOR NON-TURBOJET AIRCRAFT. TURBOJET AIRCRAFT ARE TO FILE THE GOFFS TRANSITION)

After D7 LAS, this SID requires minimum climb gradients of:
Beatty Transition: 500' per NM to 9500'.
Daggett Transition: 330' per NM to 8500'.
Goffs Transition: 330' per NM to 8500'.
Hector Transition. 330' per NM to 8500'.
Shado Transition: 500' per NM to 9500'.

Gnd speed-Kts	75	100	150	200	250	300
330' per NM	413	550	825	1100	1375	1650
500' per NM	625	833	1250	1667	2083	2500

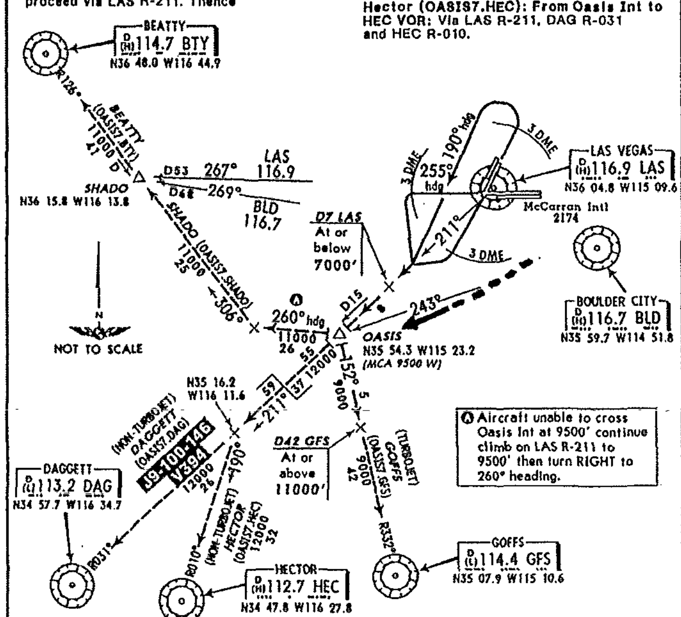
TAKE-OFF
Rwys 1L/R: Climb on runway heading until reaching LAS D3, then turn LEFT to a 190° heading to intercept and proceed via LAS R-211. Thence
Rwys 19L/R: Climb on runway heading until reaching LAS D3, then turn RIGHT to intercept and proceed via LAS R-211. Thence
Rwys 25L/R: Fly a 255° heading until reaching LAS D3, then turn LEFT to intercept and proceed via LAS R-211. Thence

DEPARTURE
Cross LAS R-211/D7 fix at or below 7000', then climb via LAS R-211 to Oasis Int, then via (transition) or (assigned route). Aircraft filing 18000' or above, Expect filed altitude/flight level ten minutes after departure.

TRANSITIONS
Beatty (OASIS7.BTY): From Oasis Int to BTY VOR: Via a 260° heading to intercept and proceed via BTY R-126. Ⓐ
Shado (OASIS7.SHADO): From Oasis Int to Shado Int: Via a 260° heading to intercept and proceed via BTY R-126. Ⓐ

TRANSITION (TURBOJET)
Goffs (OASIS7.GFS): From Oasis Int to GFS VOR: Via GFS R-332. MCA at GFS R-332/D42 at or above 11000'.

TRANSITIONS (NON-TURBOJET)
Daggett (OASIS7.DAG): From Oasis Int to DAG VOR: Via LAS R-211 and DAG R-031.
Hector (OASIS7.HEC): From Oasis Int to HEC VOR: Via LAS R-211, DAG R-031 and HEC R-010.



AN 290825

NARRATIVE : DEP INSTRUCTIONS WERE AMENDED TO FLY RWY HDG TO 7000 FT (ORIGINAL CLRNC WAS THE OASIS DEP). UPON CLBOUT, I ASKED FOR A VFR CLB ON COURSE. THE CTLR SAID HE WAS UNABLE DUE TO TFC AND ASSIGNED A 240 DEG HDG TO INTERCEPT THE LAS 210 DEG RADIAL AND CONTINUE THE OASIS DEP, MAINTAIN 7000 FT. FREQ GOT EXTREMELY BUSY AND CALLS TO OTHER ACFT WERE BEING BLOCKED. A CALL TO US WAS BLOCKED COMPLETELY AND UPON INQUIRY, THE CTLR FAILED TO READ ANY INSTRUCTIONS THAT WERE MISSED. APPROX 1 MIN LATER, THE GND PROX WENT OFF CALLING 'TERRAIN' -- 'PULL-UP.' AT THE SAME TIME THE CTLR ASKED OUR ALT. THE REPLY WAS 7000 FT AND CLBING FOR TERRAIN -- HE REPLIED WE WERE INSTRUCTED TO CLB TO 17000 FT. AT A SAFE ALT, I INFORMED HIM THAT HIS INSTRUCTIONS WERE BLOCKED EARLIER AND WE RECEIVED NO CONFIRMATION AFTER I INFORMED HIM OF THE BLOCKED INSTRUCTIONS. FACTORS LEADING TO THIS SIT WERE CTLR OVERLOAD. THE DEP/ARR CTL AT LAS CLASS B AIRSPACE SHOULD BE DIVIDED INTO SMALLER SECTORS AT BUSY TIMES.

MAKE-MODEL NAME : COMMERCIAL FIXED WING
FAR PART NUMBER : 135
SYNOPSIS : FLC MISTOOK 7000 FT FOR 17000 FT ON CLB INSTRUCTIONS.
REFERENCE FACILITY ID : LAS
FACILITY STATE : NV
DISTANCE & BEARING FROM REF. : 15,,SW
MSL ALTITUDE : 7000,7000

CIRCUMSTANCES: During a second approach, the aircraft impacted terrain 4 NM short of the runway while turning base to runway 03.

TIME: Late Afternoon

WEATHER: Visibility 300 to 900 meters, blowing snow.

CONFIGURATION: Landing

FATALITIES: 58 of 76 on board

OTHER: Adequate fuel on board, no compelling reason to land or make a second approach. Aircraft flown by selected altitude, airspeed and heading inputs to autopilot and autothrottle. Captain probably using map display, as he improvised a procedure to land on runway 03.

Flight Path Profile
B737-400
VAN, TURKEY
29 December, 1994

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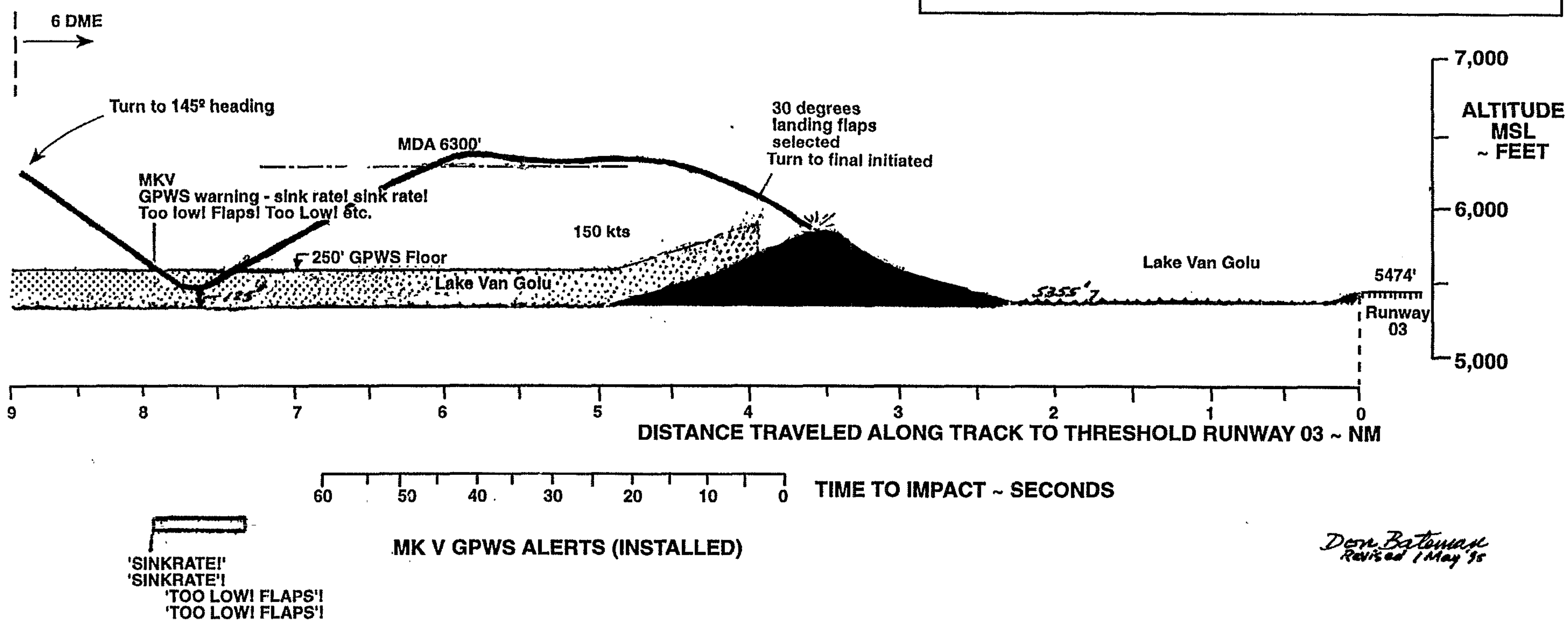
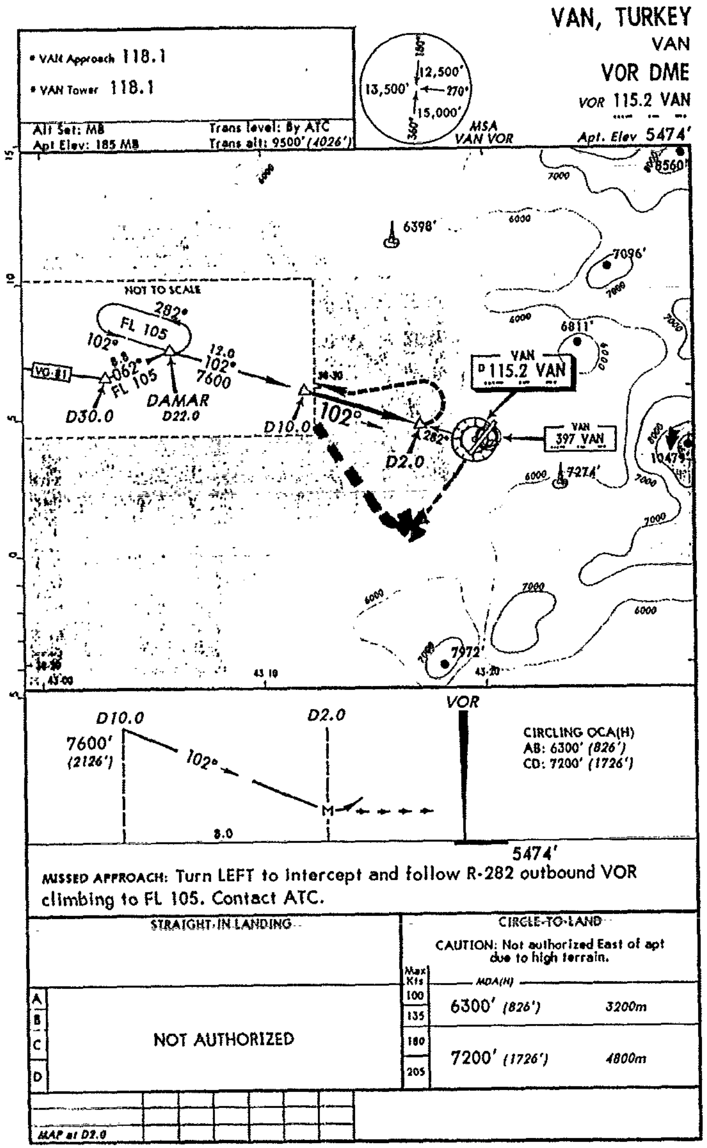
After First Approach:
C/P (to controller): "---on missed approach, returning to Ankara. We could not see anything"
Capt to C/P: "No!... we will try again!"
C/P: "...one more time?"
Capt: "...We are going to try again! Please tell the controller our intentions!"
C/P (to controller): "...we intend to make one more approach"
Controller: "...Are you sure?" "...visibility is low... I could not see you, but I heard you on first approach"
C/P: "...we will make one more"
Cabin attendant: "... shall I tell the passengers we are returning to Ankara?"
Capt: "No! We will try again!"



Don Bateman
Revised 1 May 95

Return to TOC

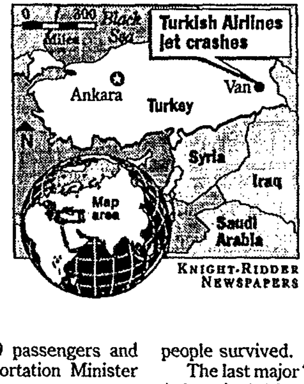


THURSDAY, DECEMBER 29, 1994 Seattle Times A 13

Turkish Airlines jet crashes

Boeing 737 hits peak in Turkey; at least 53 killed

ASSOCIATED PRESS
AND TIMES STAFF



KNIGHT-RIDDER NEWSPAPERS

ANKARA, Turkey – A Turkish Airlines jet with 76 people aboard crashed into a mountain in eastern Turkey in heavy snow today. At least 53 people were killed, an official said.

The plane was carrying 69 passengers and seven crew members, Transportation Minister Mehmet Kostepen said.

Most of the passengers were military personnel.

The Boeing 737-400 took off from the capital, Ankara, and crashed about five miles from its destination, the city of Van. The plane was making its third attempt to land after two previous tries were aborted because of harsh weather, reported Anatolia, the Turkish new agency.

Military personnel are under strict orders to avoid traveling by road in southeastern Turkey because Kurdish separatist guerrillas often target passenger buses in search of security officials.

Army rescue teams went to the scene, but heavy snow hampered rescue efforts, Kostepen said. Murat Ozkan, the deputy governor of Van, told state television that 30 bodies had been recovered. Kostepen said at least 20 people survived.

The last major Turkish Airlines crash was near Ankara in 1983; 46 people died.

The 737-400 in today's crash was delivered in April 1993, said Craig Martin, Boeing Commercial Airplane Group spokesman. But he said he had no details about the crash.

A Boeing team was on standby today waiting a request from Turkish officials to assist in the accident investigation.

Pilot handling an issue in crash that killed 55

ANKARA, Turkey – The crash of a jetliner in eastern Turkey, killing 55 people, stirred controversy because of reports the pilot insisted on landing despite a snowstorm that drastically cut visibility.

The Turkish Airlines Boeing 737 crashed yesterday afternoon just two miles from the airport at Van, about 50 miles from the Iranian border.

The death toll increased to 55 today when one of the injured passengers died in a hospital, the state radio said. The report said 18 survivors remained hospitalized, while the three others were discharged.

The plane was making its third attempt to land after two previous tries were aborted because of the harsh weather, said Faik Akin, a spokesman for the national carrier.

The Anatolia news agency quoted an air-traffic controller telling the pilot that the visibility was only 300 feet at Van airport.

"I will try once more," the pilot said moments before the crash, according to Anatolia.

"Do not land. I cannot even see you. I can only hear the plane's engine. Return to Ankara," the air-traffic controller reportedly said.

The passengers included military personnel on their way to southeastern Turkey, where the army is battling Kurdish rebels.

Next Page

CIRCUMSTANCES: During a Surveillance Radar approach to runway 23, the aircraft hit a 85' electrical power tower at 65' AGL 1.2 NM short of the runway.

WEATHER: Visibility RVR 1100 meters, freezing fog scattered 700 feet, overcast 1200 feet wind 020º/6kts

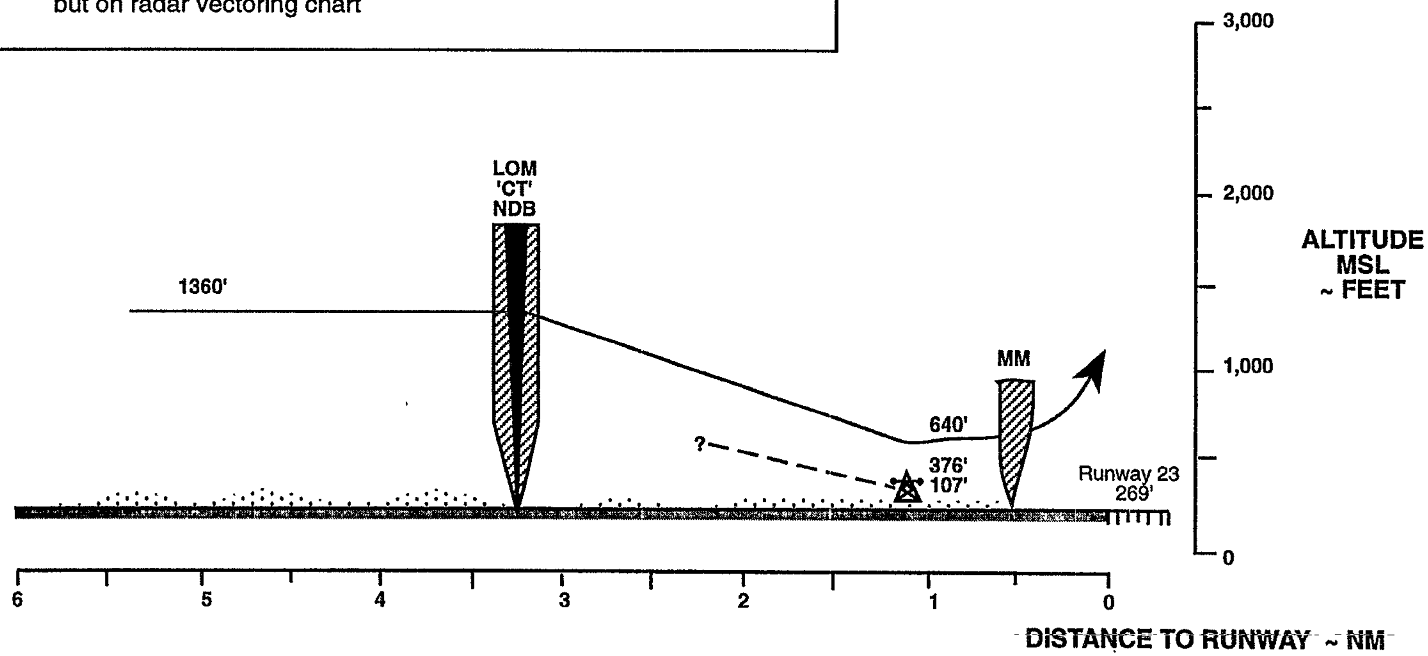
TIME: 09:52

CONFIGURATIONS: Full landing

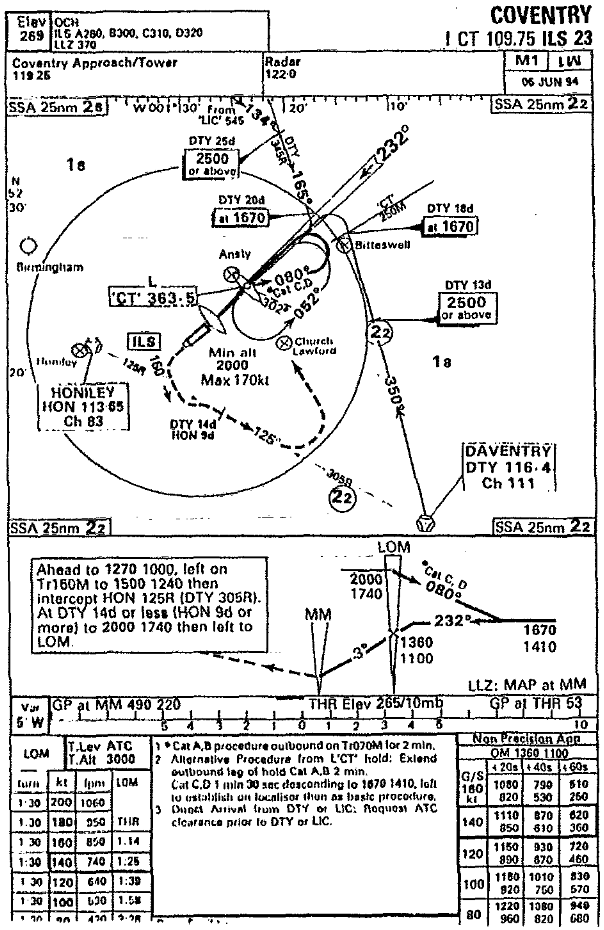
FATALITIES: 5

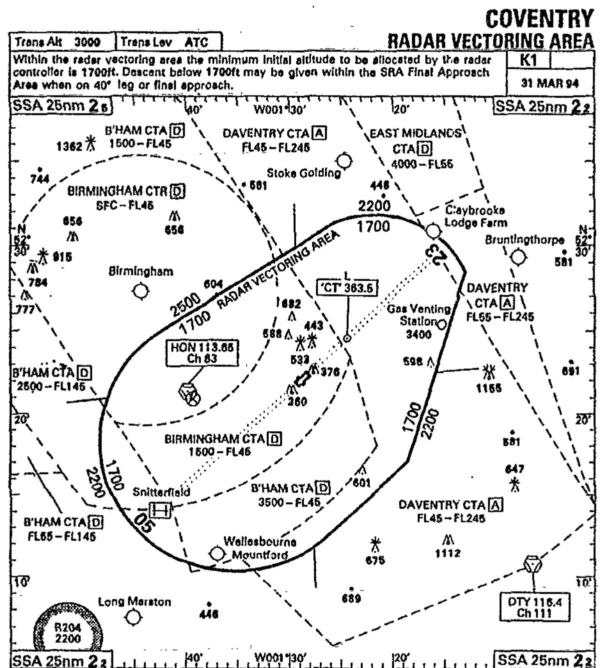
OTHER:
1. Pilots probably very tired (9 hours of night duty)
2. Old ILS receiver could not receive ILS frequencies with .05 Mz spacing and hence could not receive Coventry ILS 109.75 MHz. Surveillance radar approach accepted.
3. Controller gave continuous headings and altitude, but pilots may have had difficulty comprehending and reacting in time.
4. 85 foot tower and power lines not shown on approach procedure, but on radar vectoring chart

Flight Path Profile
B737-200
CONVENTRY, UK
21 December 1994



Don Bateman





LOSS OF COMMUNICATION PROCEDURE

Initial and Intermediate Approach
Continue visually remaining outside Birmingham CTA and CTR or by means of an appropriate final approach aid. If not possible proceed at 2500ft or last assigned level if higher, (but not above 1500ft until clear of Birmingham CTA) to L 'CT'*.

Within Final Approach Area
Continue visually or by means of an appropriate final approach aid. If not possible follow the Missed Approach Procedure to L 'CT'*.

* In all cases where the aircraft returns to the holding facility refer to the Europe and Middle East Supplement for the procedure to be adopted.

Cargo jet crashes in Britain

LONDON — A Boeing 737 cargo jet on approach to Coventry airport hit power lines and crashed Wednesday, killing all five people aboard.

The pilot of the Air Algerie plane veered away from a cluster of houses at the last moment and crashed into a wooded area, witnesses said. No one on the ground was injured, said Phil Spinks of the West Midlands Ambulance Service.

"It is a highly populated area and if it had come down just a bit closer, it would have caused a lot more damage," said witness Stephen Wilson.

Air Algerie said the plane was leased to Phoenix Aviation, based at Coventry airport, 94 miles northwest of London.

The plane, returning empty after delivering 190 calves to Amsterdam earlier in the day, was carrying three Algerian crew members and two British animal handlers, Phoenix Aviation said.

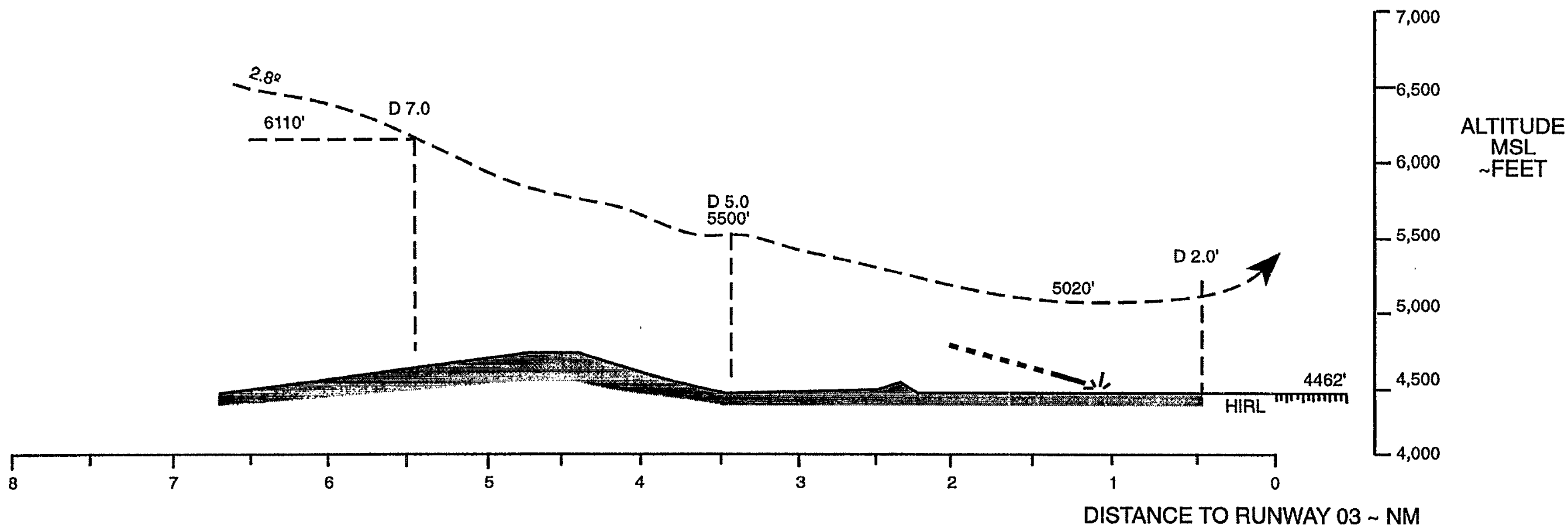
J+A 22 Dec '94 Thursday.

Next Page

CIRCUMSTANCES:	Charter flight carrying Nigerian Football Team, from Tunis to Lagos was to refuel at Tamanrasset. Because of poor visibility, the aircraft held for two hours at the VOR. The aircraft was beginning to run low on fuel and it was decided.to make an approach and land. While conducting a VOR DME runway 03 approach, the aircraft hit short by about 1 1/4 NM.
WEATHER:	800 to 1000 meter visibility
CONFIGURATION:	Landing
FATALITIES:	4 of 39 on board

Flight Path Profile
BAC 1-11-500
TAMANRASSET, ALGERIA
18 September, 1994

GPWS status unknown



Don Bateman

Return to TOC

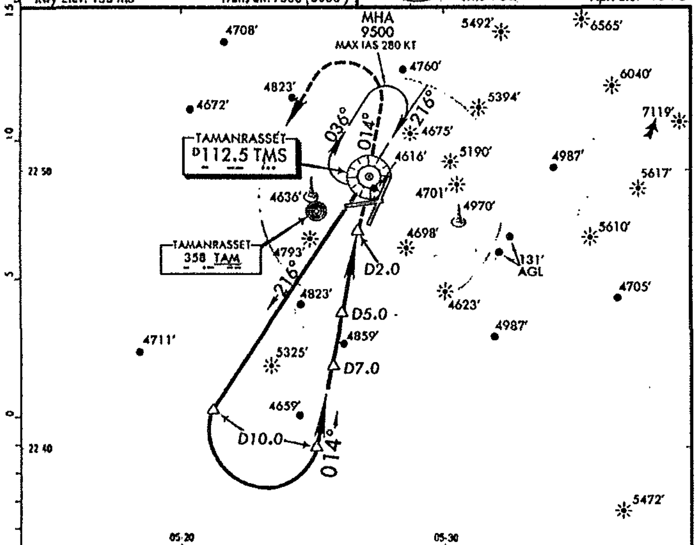
TAMANRASSET, ALGERIA
AGUENAR
VORDME Rwy 03
VOR 112.5 TMS

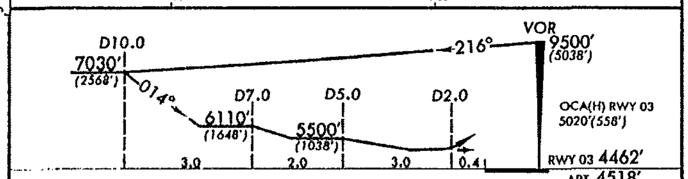
TAMANRASSET Tower 118.1 119.7

Alt Set: MB
Rwy Elev: 153 MB
Trans level: By ATC
Trans alt: 9500′(5038′)

MSA TMS VOR: 11,600′ 090°–270°; 9500′

Apt. Elev 4518′





MISSED APPROACH: Climb on R-014 outbound VOR to 5650′ (1188′), then turn LEFT climbing to 7030′ (2568′).
MAX IAS 220 KT during Missed Apch.

	STRAIGHT-IN LANDING RWY 03		CIRCLE-TO-LAND TO RWY 21 West of Rwy 03-21	
	MDA(H) 5020′(558′)		MDA(H)	
A	1600m	A	5720′(1202′)	2000m
B	2400m	B	5720′(1202′)	2400m
C	2400m	C	5720′(1202′)	4800m
D	2800m	D	5720′(1202′)	4800m

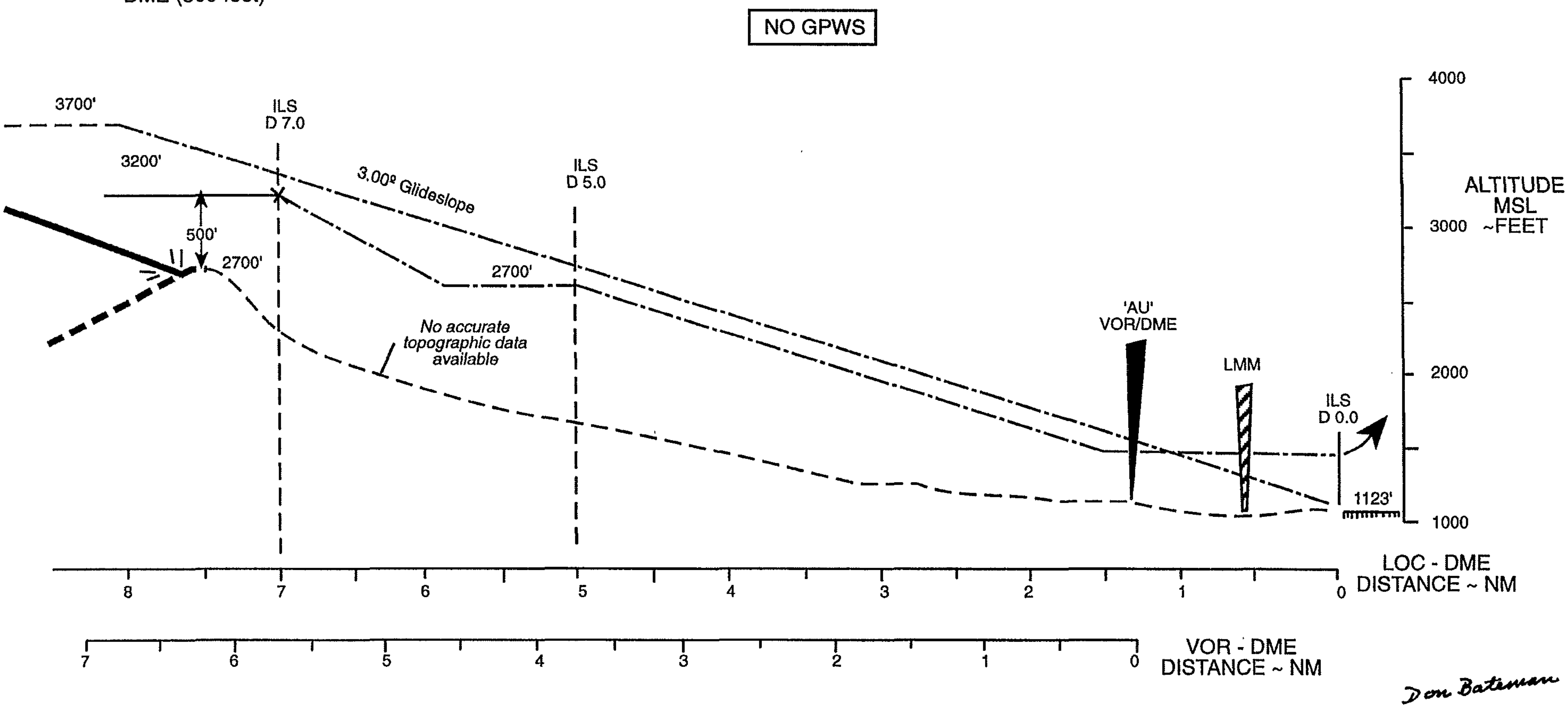
MAP at D2.0

Next Page

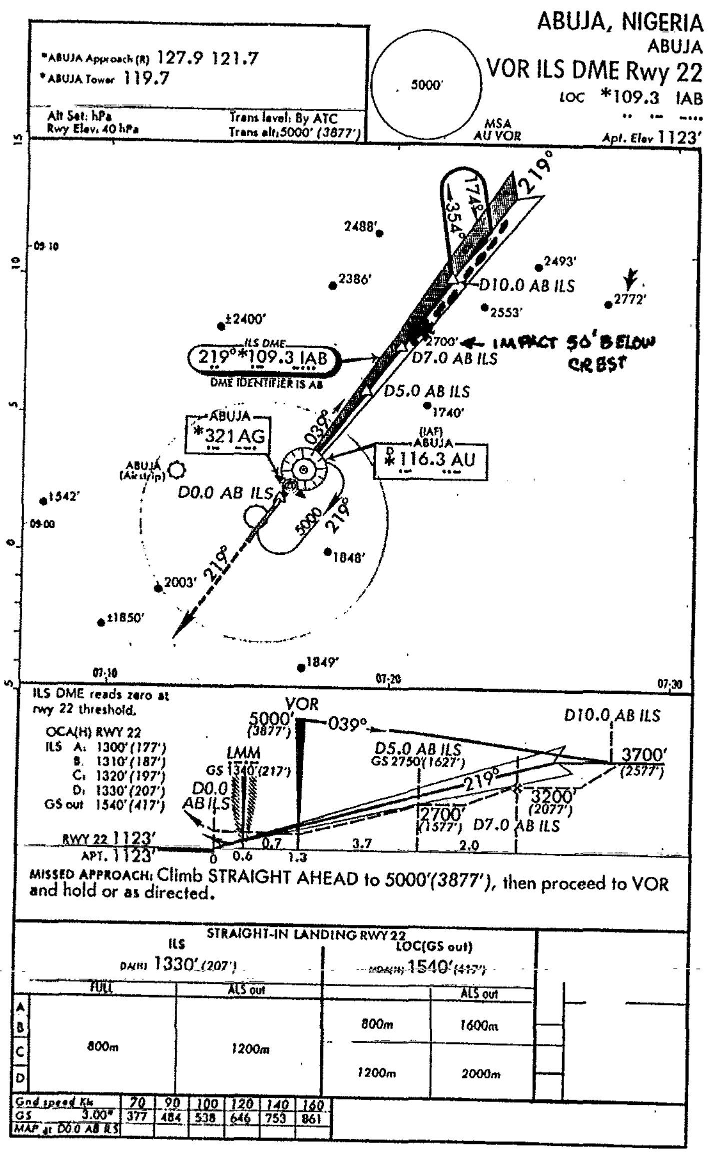
CIRCUMSTANCES:	During a Localizer and VOR/DME approach to runway 22, the aircraft impacted 50 feet below 2700 foot hill seven miles from the runway.
TIME:	12:05 local
WEATHER:	Scattered 500 feet, overcast at 800 feet, rain, wind 190º at 20kts
FATALITIES:	3 of 5 on board charter flight
OTHER:	ILS glideslope inoperative. Pilot may have inadvertently used VOR DME instead of LOC DME and hence descended too soon.

Flight Path Profile
DHC-6
ABUJA, NIGERIA
13 September, 1994

NOTE: Procedure does not offer much terrain clearance at 7-1/2 DME (500 feet)



Return to TOC

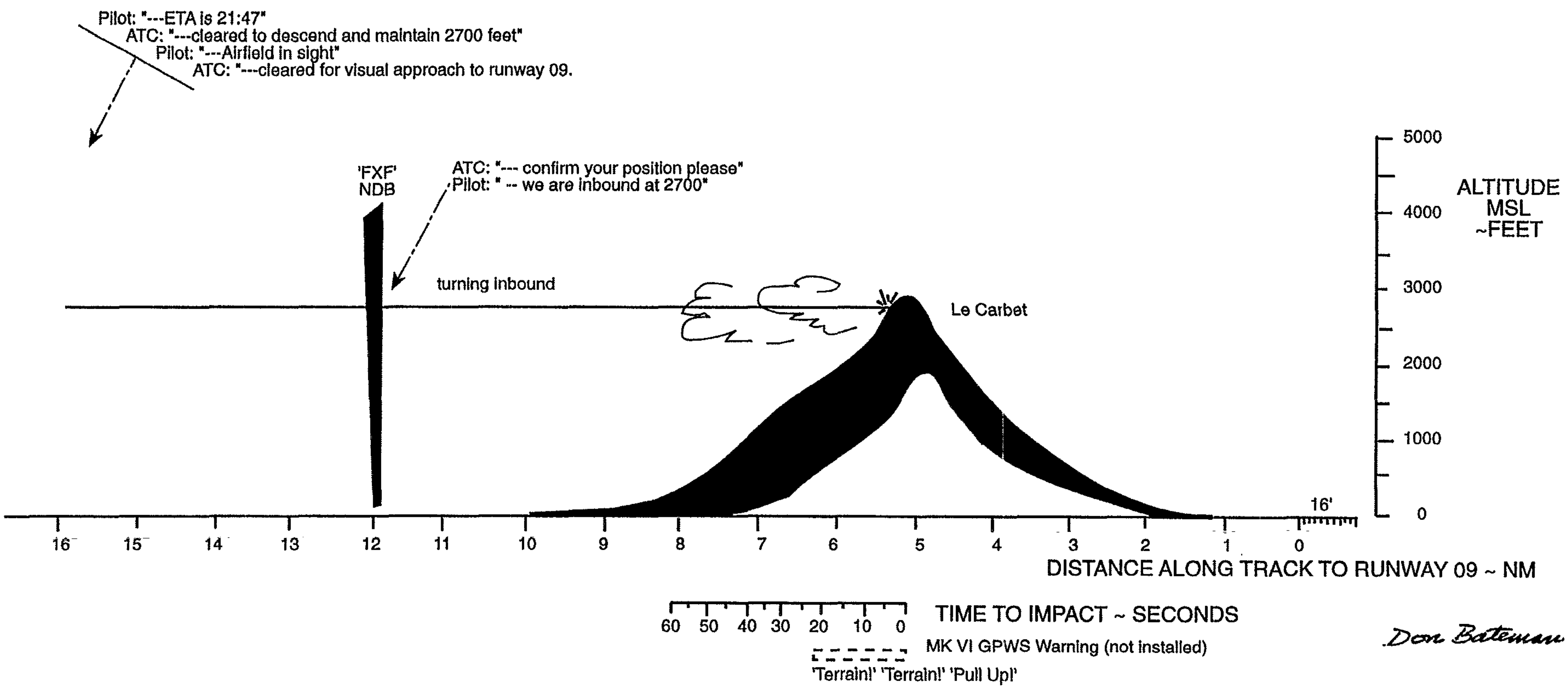


Next Page

CIRCUMSTANCES:	During a night visual approach to runway 09, the aircraft impacted a mountain. The pilot may have lost visual contact in clouds shrouding the mountain. In addition, the pilot may have been handicapped by possible failure of onboard DME readout.
TIME:	21:42 local
WEATHER:	10 plus miles visibility, scattered clouds, wind 090 10-20 kts.
FATALITIES:	6
OTHER:	Aircraft was scheduled in bound flight from Bridgetown (SE 127 NM of Ft. De France)

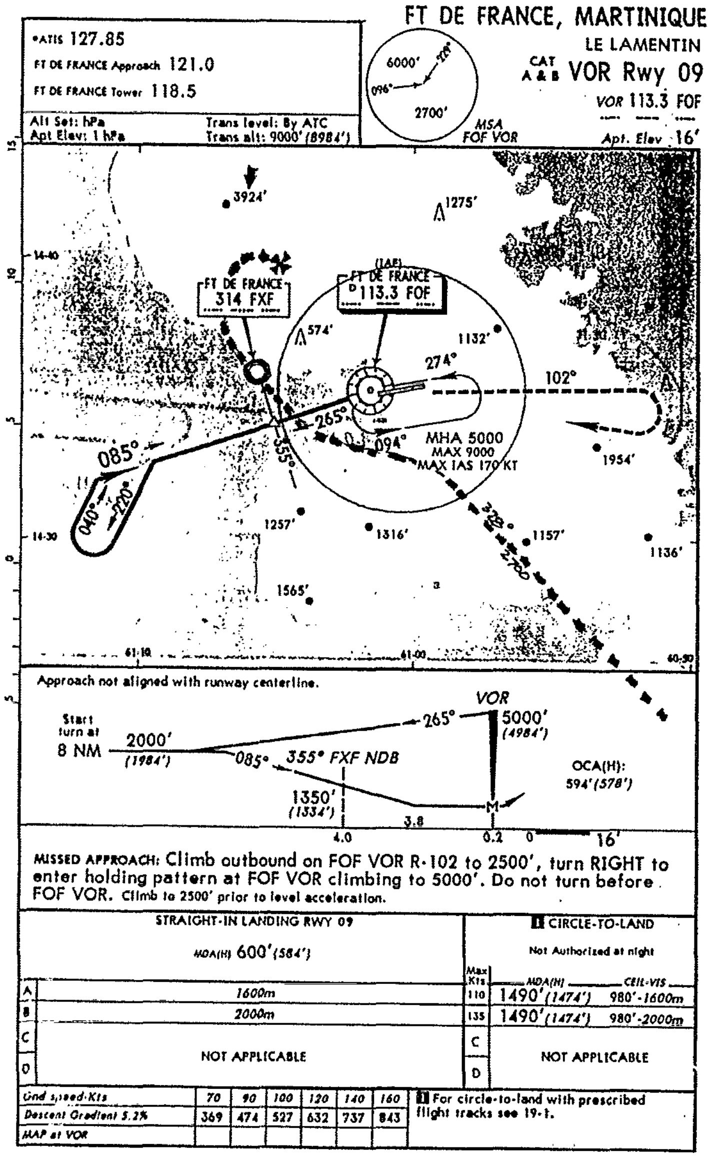
Probable Flight Path Profile
BN2B-21
FORT DE-FRANCE, MARTINIQUE
17 July, 1994

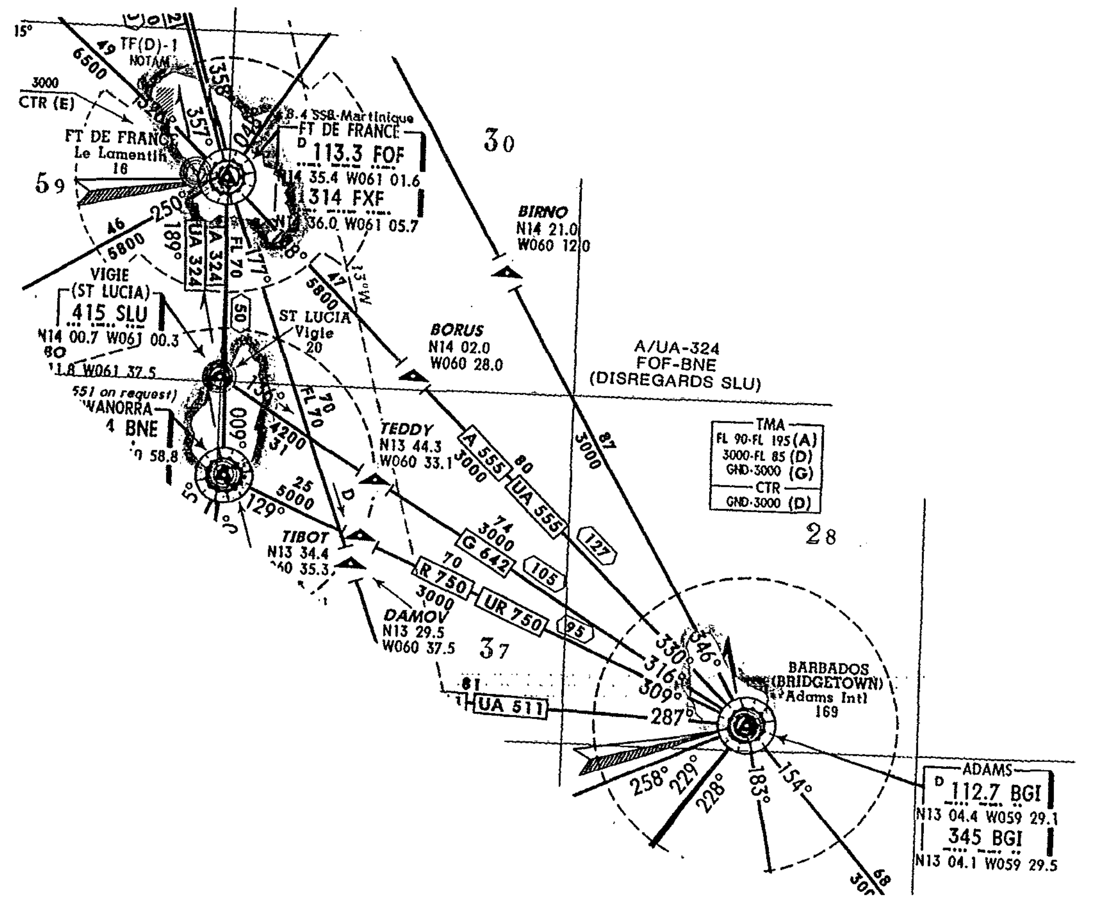
NO GPWS INSTALLED



Don Bateman

Return to TOC





Next Page

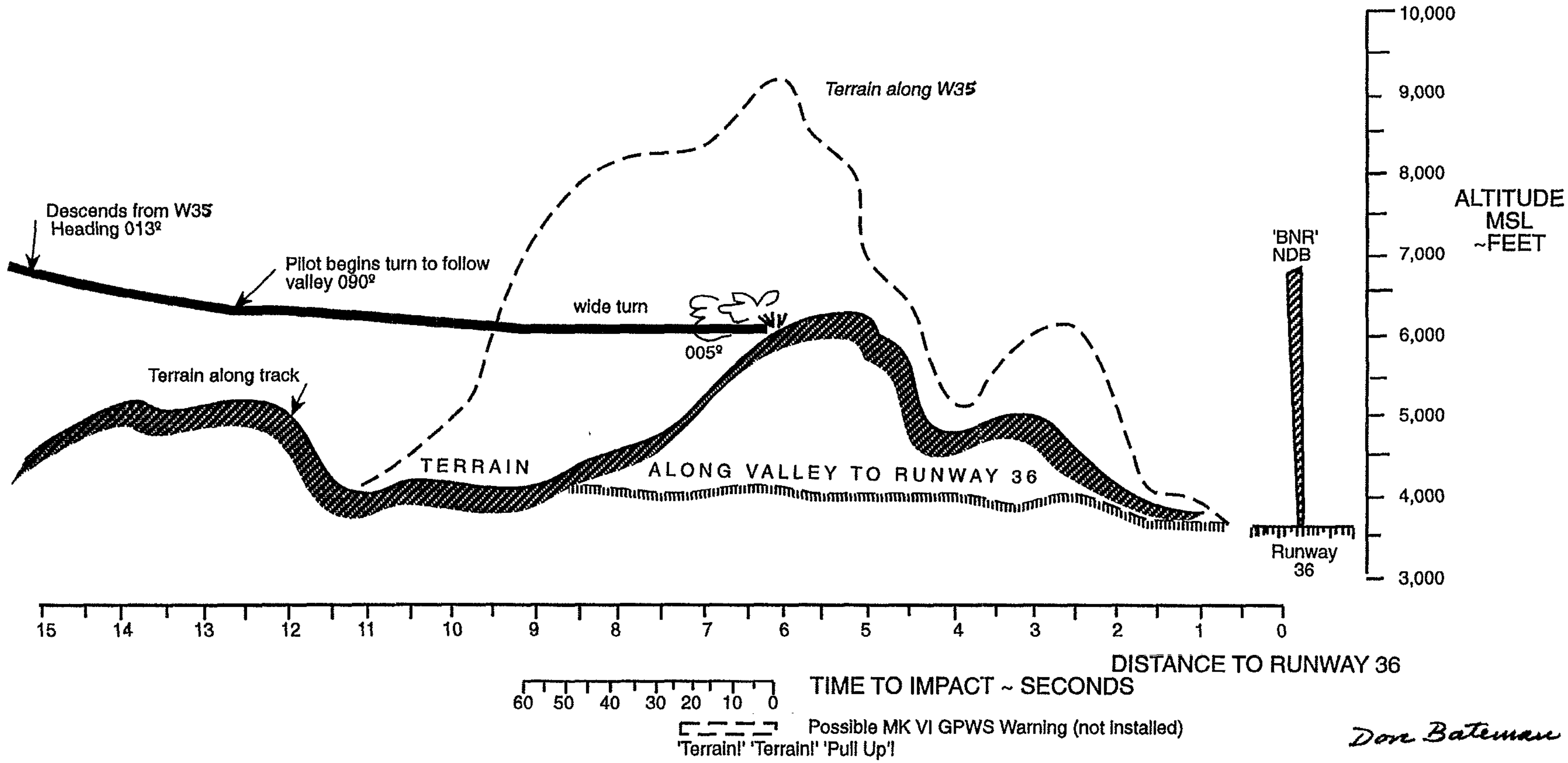
CIRCUMSTANCES: Aircraft left 'W36' airway to fly VFR Contact with valley with scattered clouds and fog. Final turn to runway overshot into east side of valley.

TIME: 09:00L

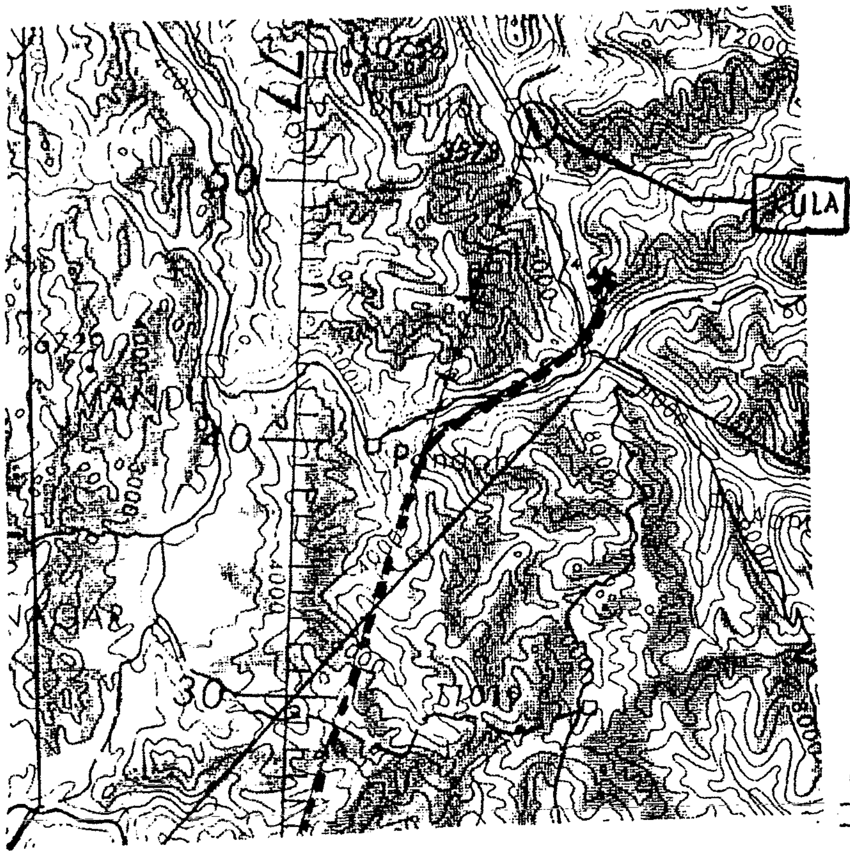
FATALITIES: 13

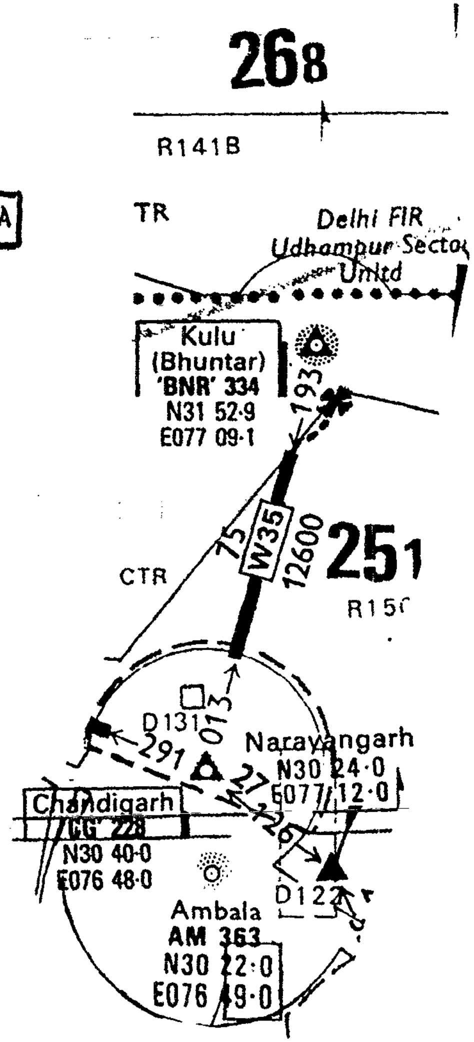
Probable Flight Path Profile
Be-200
BHUNTAR, INDIA
9 July 1994

NO GPWS INSTALLED



IMPACT LOCATION
N31°46.5' E77°13.0'





~~JULY 10 H47~~

Punjab's Governor Dies in Plane Crash

CHANDIGARH, India, July 9 (AP) — The Governor of Punjab state and 12 other people were killed in a plane crash today near the Himalayan resort town of Kulu, the United News of India news agency reported.

The state government aircraft carrying Gov. Surendra Nath, 64 years old, his wife, Gargi Devi, eight other family members and a crew of three took off from Punjab's capital, Chandigarh, for a 40-minute flight to Bhuntar. Air force helicopters located the wreckage about seven miles from Bhuntar airport. The cause of the crash was not known.

Mr. Nath, a former police officer, was appointed Governor in 1991. He supervised elections and the installation of a popular government a year later.

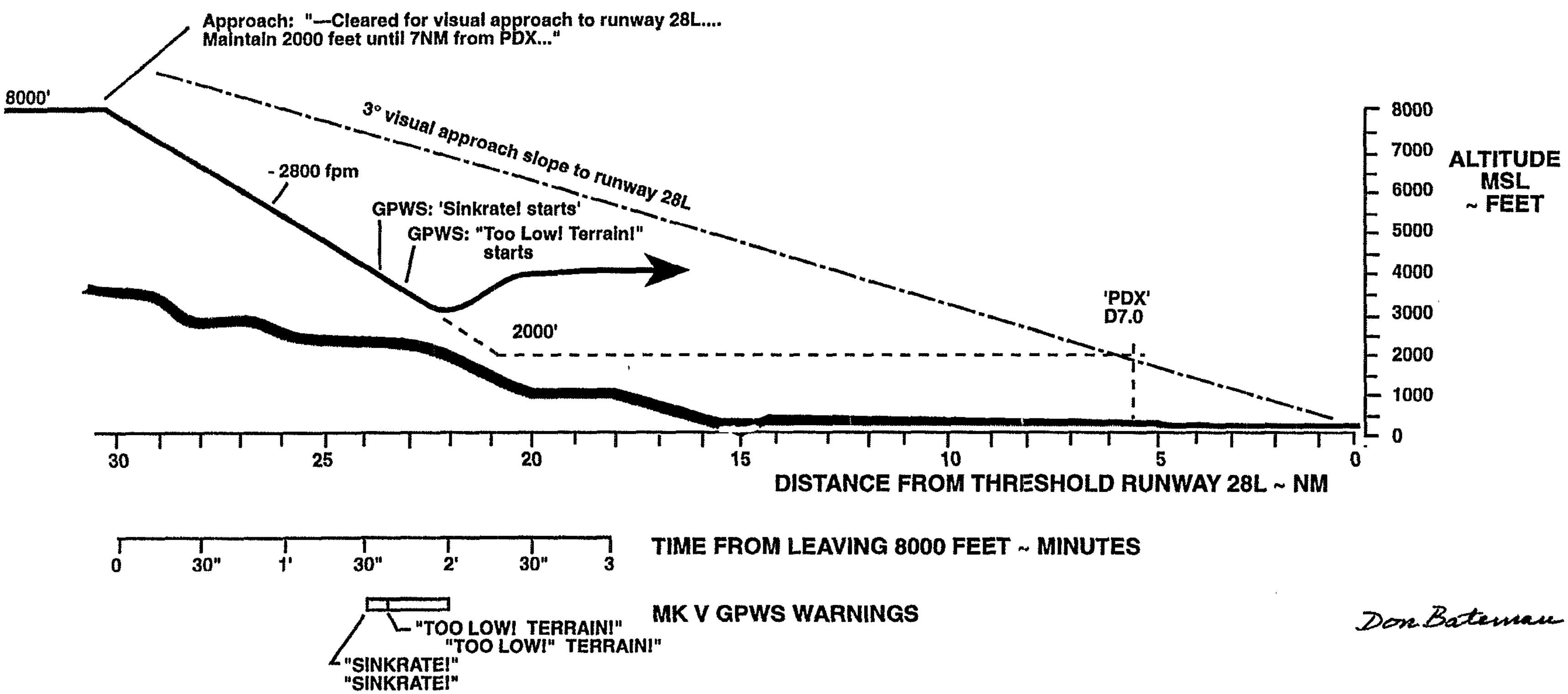
Next Page

CIRCUMSTANCES: During a visual approach to runway 28 left into the setting sun, the aircraft prematurely descended into terrain. The first indication of a possible problem to the pilots were GPWS alerts, at first ignored, because they could see the airport.
Visual approaches, even in daylight, can be full of hazards. For other examples, see:

- •San Jose, California B737 May 1994
- •Memphis, Tennessee DC-10 April 1994
- •Portland, Oregon B727 April, 1992
- •Kelso, Washington AC690 30 Nov. 1990

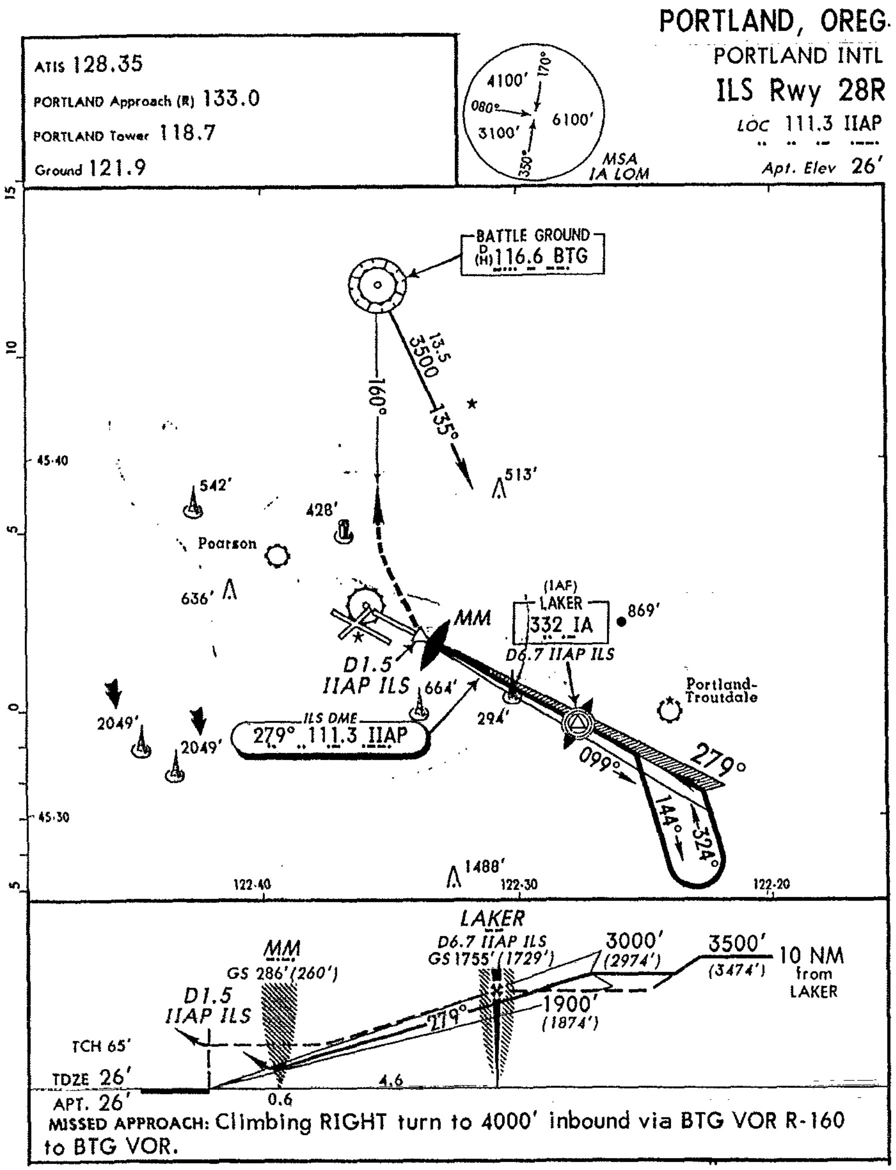
Flight Path Profile
A320
PORTLAND, OREGON
June, 1994

INCIDENT



Don Bateman

Return to TOC

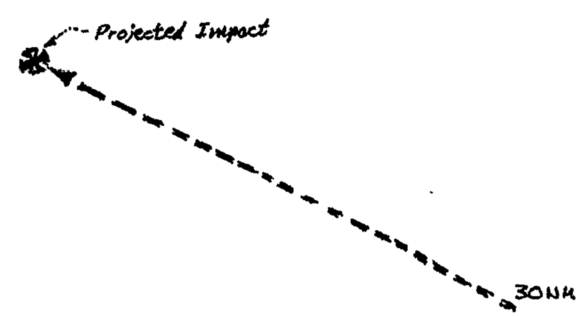


MISSED APPROACH: Climbing RIGHT turn to 4000' inbound via BTG VOR R-160 to BTG VOR.

ASRS # 275426

NARRATIVE : DSNDING INTO LOW SUN SETTING DIRECTLY IN OUR FACE. COULD SEE PDX ALONG SIDE COLUMBIA RIVER ABOUT 30 MI OUT AT 8000 FT. STARTED DSCNT SOON AFTER VISUAL APCH CLRNC ISSUED. APCH CTL STATED, 'CLRED FOR VISUAL APCH TO RWY 28L, MAINTAIN 2000 FT UNTIL 7 NM FROM PDX' WITH THE SUN MAKING IT HARD TO SEE THE RWY AND DISTORTING DISTANCES, I WAS VFR BUT USING MOVING MAP DISPLAY (ND) FOR RWY REF. THE AIRBUS 320, BEING A VERY CLEAN ACFT, IS HARD TO SLOW AND DSND AT THE SAME TIME. ABOUT 22 MI OUT I DECIDED TO 'SCOOT' ON DOWN TO 2000 FT AND 'MOTOR' INTO THE RWY FROM THERE. I WAS DSNDING AT ABOUT 2800 FPM. AT AROUND 4000 FT WE START GETTING 'TOO LOW TERRAIN' GPWS AND 'SINK RATE.' I SLOWED THE DSCNT SLIGHTLY, BUT SINCE THE RWY WAS IN SIGHT AND NO OBVIOUS REAL ESTATE OBSTRUCTION BTWN US AND THE ARPT, WE CONTINUED ON DOWN...THINKING THE WARNING WAS SPURIOUS. THE GPWS STAYED ACTIVE. AT ABOUT 3500 FT, I LOOKED AT THE RADAR ALTIMETER AND IT SHOWED 1800 FT AGL. I DISCONNECTED THE AUTOPLT AND RETURNED TO 4000 FT WHILE THE APCH CTL INQUIRED ABOUT OUR ALT. HE ASSUMED SINCE WE SAW THE RWY THAT WE WOULD CLR ALL TERRAIN, BUT WITH THE SUN REDUCING VISUAL ACUITY, AND NOT LOOKING AT MINIMUM SAFE ALT CHART, WE COULD HAVE DSNDED VERY VERY CLOSE BEFORE WE BECAME AWARE OF THE TERRAIN.

SYNOPSIS : CTLED FLT TOWARD TERRAIN IN A A-320. ALTDEV ALT OVERSHOT IN DSCNT. GPWS WARNING IGNORED. FO, PF, ATTEMPTED TO DSND LOWER THAN CLRED BECAUSE OF 'CLEAN PERFORMANCE' OF ACFT.



Next Page

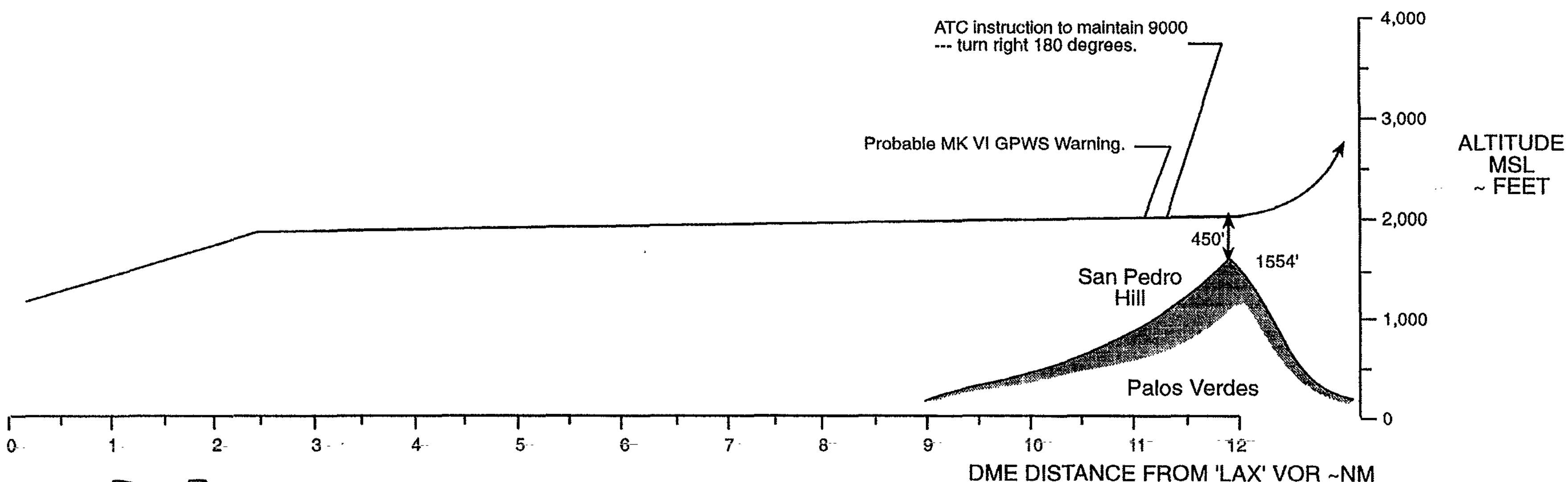
CIRCUMSTANCES:	During heavy traffic ATC communications, aircraft under radar control did not leave initial climb clearance of 2000 feet for an eventual climb to 9000 feet. Aircraft came within 450 feet of San Pedro Hill on the Palos Verdes peninsula at some 12 nm DME from the Los Angeles VOR.
WEATHER:	IMC
OTHER:	Apparently a timely GPWS Warning to the pilot and a MSAW ATC radar alert for the controller made both aware of an ATC system failure. A MK VI GPWS had been installed the month before in the aircraft to comply with the FAR 135.153 GPWS deadline of 31 May.

CFTT INCIDENT

Flight Path Profile
Merlin III
LOS ANGELES, CA.
JUNE, 1994

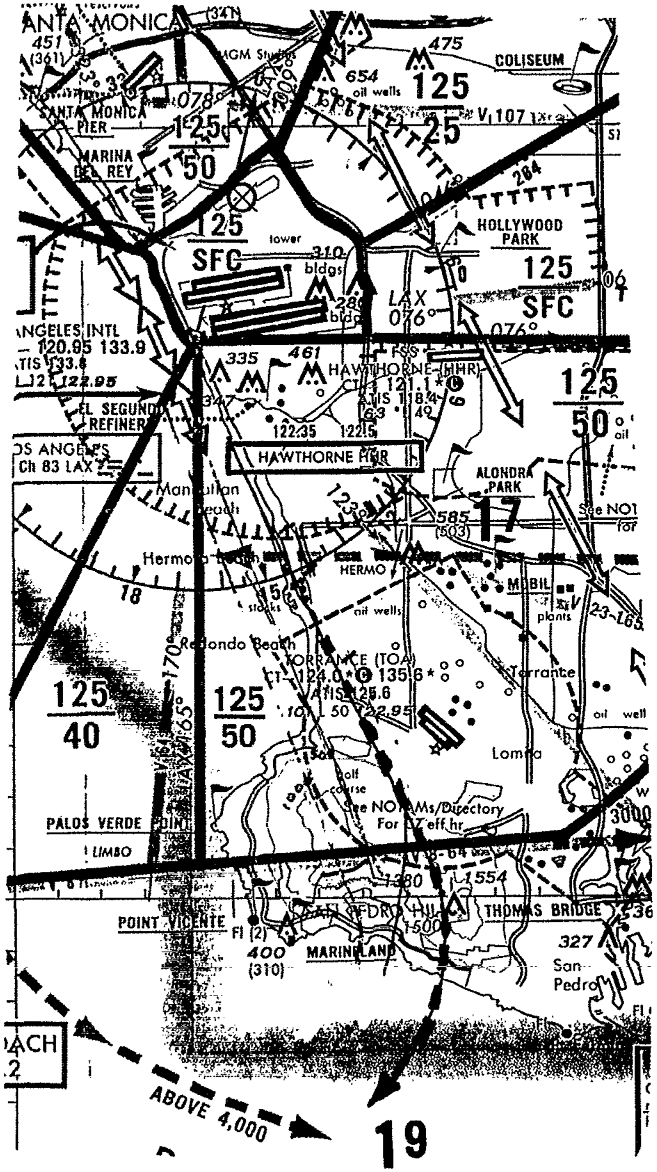
ATC SYSTEM FAILURE

See also another ATC System failure at LAX concerning another Merlin III where the aircraft was inadverdently left on a radar vector into the San Gabriel Wilderness Mountains at 5000 feet 27 DME from 'LAX' VOR and 045º radial. (NASA ASRS AN 293593)



Don Bateman

Return to TOC



AN 274918

NARRATIVE : ACR X, SW 3, DEPARTED LOS ANGELES GOING TO SAN DIEGO. HE WAS VISUAL ON A PRECEDING BA32. X GIVEN CLB TO 9000 FT. BA32 CLBING TO 13000 FT. SECTOR WAS VERY BUSY. X GIVEN A TURN TO 130 DEGS, BA32 TURN TO 110 DEGS. NUMEROUS XMISSIONS TO OTHER ACFT GIVEN. DATA BLOCKS WERE OVERLAPPED, BY THE TIME THEY SPLIT UP X WAS VERY NEAR PALOS VERDES AT 2000 FT (MOA 2600). I TOLD X TO MAINTAIN 9000 FT AND TURN RIGHT HDG 180 DEGS. PLT ANSWERED WITH HE HAD A TERRAIN WARNING AND ASKED ME TO REPEAT. I REPEATED AND HE FOLLOWED INSTRUCTIONS. I TOLD SUPVR ON DUTY ABOUT SIT.

MAKE-MODEL NAME : MERLIN III

FAR PART NUMBER : 121

SYNOPSIS : ACR X RADAR VECTORED BELOW MVA. SYS ERROR.

REFERENCE FACILITY ID : LAX

FACILITY STATE : CA

DISTANCE & BEARING FROM REF. : 5,,E

MSL ALTITUDE : 2000,2000

CIRCUMSTANCES:	During a visual turn to base at night to final approach to runway 21, the aircraft overbanked and rapidly descended impacting some 3NM short of the threshold.
TIME:	19:35L Night
CONFIGURATION:	Flaps up, landing gear up.
WEATHER:	Scattered cloud, visibility 10 km wind 200 deg/7kt
FATALITIES:	17

Flight Path Profile
F-27
ABIDJAN, IVORY COAST
26 June, 1994

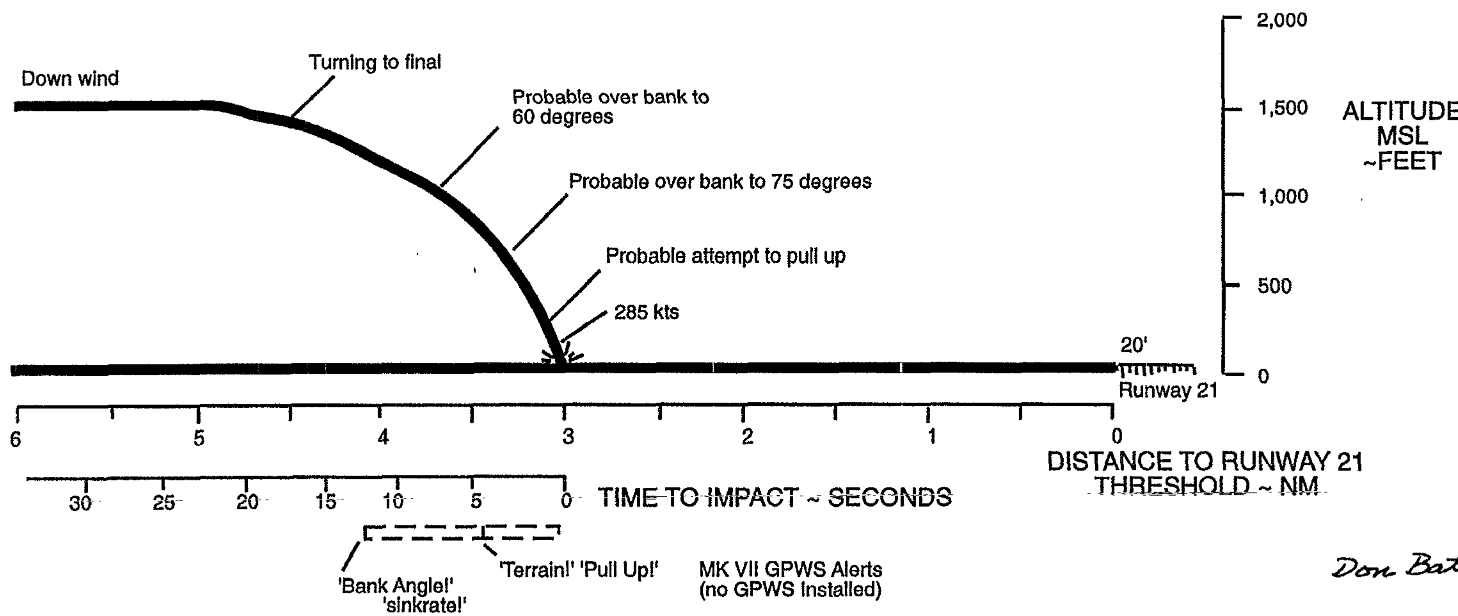
Next Page

Probable distraction, looking outside for visual references to runway or loss of attitude reference leading to overbanked condition.

Other examples:

HS748	Dayton, Ohio	12 Jan '89
Metro III	Raleigh, Durham	19 Feb '88
C-141	Cairo, Egypt	12 Nov '80
B-747	Bombay, India	1 Jan '78

NO GPWS INSTALLED



Don Bateman

Return to TOC

ABIDJAN, IVORY COAST
PORT BOUET
VORDME or VOR Rwy 21
LOCATOR Rwy 21

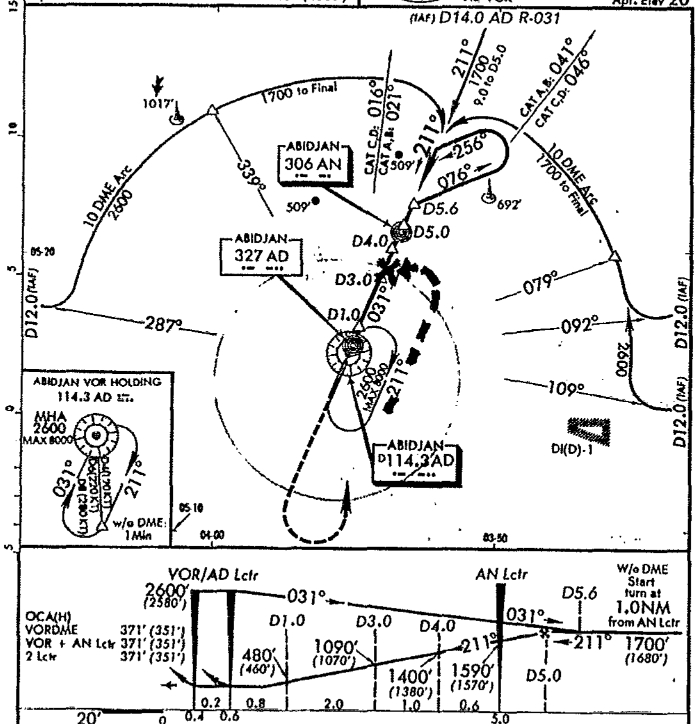
Approach Control through Tower
ABIDJAN Tower 118.1

Alt Set: hPa
Apt Elev: 1 hPa

Trans level: By ATC
Trans alt: 2600' (2580')

MSA AD VOR 2600'

VOR 114.3 AD
Lctr 306 AN
Apt. Elev 20'



MISSED APPROACH: Climb STRAIGHT AHEAD to 1700' (1680'), then turn LEFT to VOR for another approach, or as directed.

	STRAIGHT-IN LANDING RWY 21				CIRCLE-TO-LAND			
	VORDME or VOR + AN Lctr MDA(H) 380' (360')		2 Lctr MDA(H) 380' (360')		Max Kt	DAY		NIGHT
		ALS out		ALS out		MDA(H)	CEIL-VIS	
A	RVR 750m VIS 800m	RVR 1500m VIS 1600m	1200m	RVR 1500m VIS 1600m	100	500' (480')	320'-1600m	NOT AUTH.
B	950m				135	520' (500')	340'-2000m	
C	1050m	1650m		1650m	180	620' (600')	400'-2800m	
D	RVR 1500m VIS 1600m	2000m	RVR 1500m VIS 1600m	2000m	205	760' (740')	500'-3600m	

Gnd speed Kts	70	90	100	120	140	160
Descent Gradient 5.0%	355	456	507	608	709	811
VORDME or VOR MAP at VOR						
Lctr. MAP at AD Lctr						

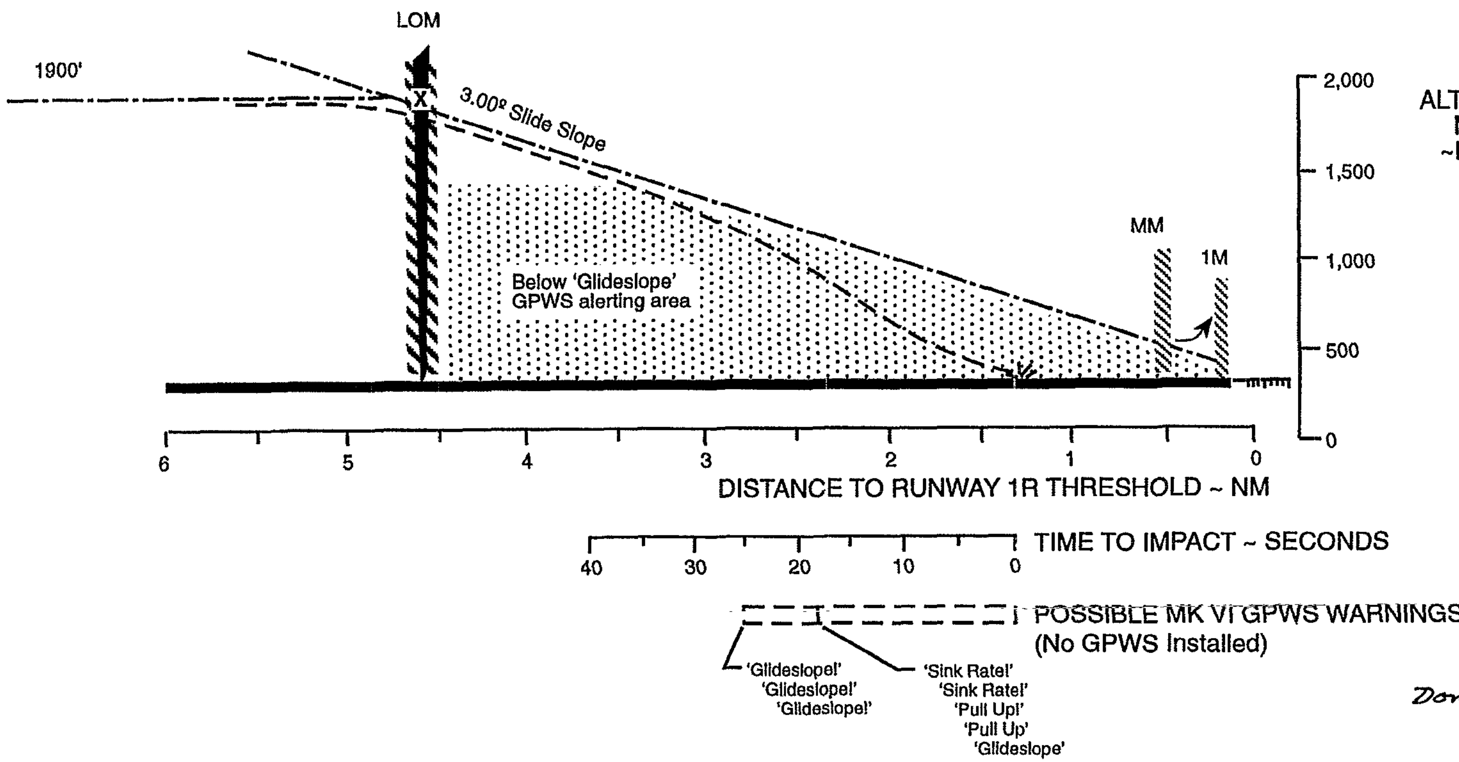
CIRCUMSTANCES:	Aircraft clipped trees 1-1/2 NM short of runway 1R and rolled inverted on second approach. "The first approach was missed and the aircraft went to a "Hold." Meantime, some aircraft had landed and pilot decided to make a second approach. Fuel was not a problem.
WEATHER:	Early morning fog RVR 600 meters.
TIME:	06:25 L
FATALITIES:	12
OTHER:	Charter flight from Mexico with fueling stop at New Orleans.

Flight Path Profile
LJ-25D
WASHINGTON, DULLES (VA)
18 June 1994

Next Page

Note:
Previous LJ-23 landing short (1/2 NM) CFIT accident on runway 1L on 6 October 1968.

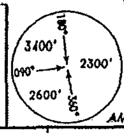
NO GPWS INSTALLED



Don Bateman

Return to TOC

ATIS 134.85
DULLES Approach (R) 120.45
DULLES Tower 120.1
Ground West 132.45 East 121.9



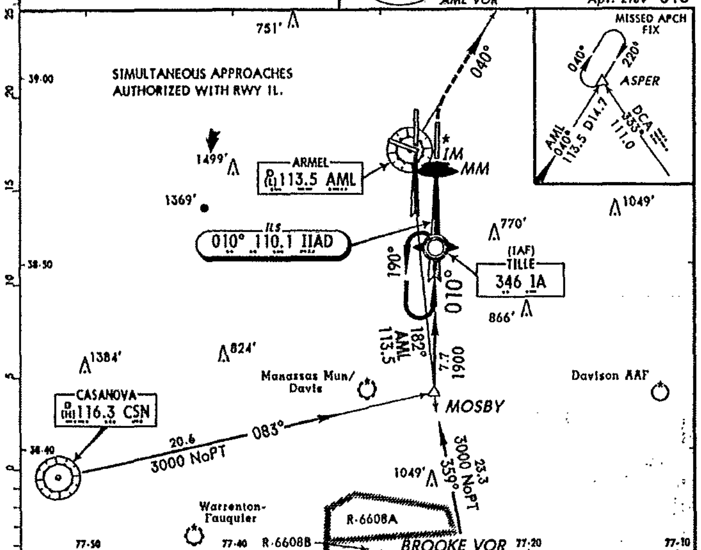
WASHINGTON, DC (VA)

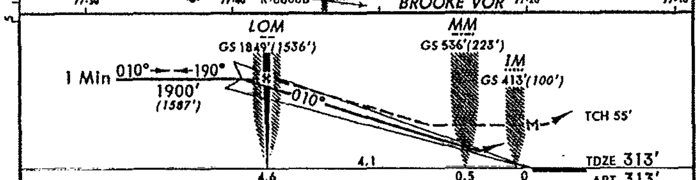
WASHINGTON DULLES INTL

ILS Rwy 1R

LOC 110.1 IIAD

Apt. Elev 313'





MISSED APPROACH: Climb to 800' then climbing RIGHT turn to 3000' outbound via AML VOR R-040 to ASPER INT/AML D14.7 and hold.

	STRAIGHT-IN LANDING RWY 1R: ILS DA(H) 513' (200') FULL	ILS TDZ or CL out	ILS ALS out	LOC (GS out) MDA(H) 680' (367')	LOC ALS out	Max Kts	CIRCLE-TO-LAND MDA(H)
A	RVR 18 or 1/2	RVR 24 or 1/2	RVR 40 or 3/4	RVR 24 or 1/2	RVR 50 or 1	90	840'(527')-1
B	RVR 18 or 1/2	RVR 24 or 1/2	RVR 40 or 3/4	RVR 24 or 1/2	RVR 50 or 1	120	840'(527')-1
C	RVR 18 or 1/2	RVR 24 or 1/2	RVR 40 or 3/4	RVR 24 or 1/2	RVR 50 or 1	140	840'(527')-1 1/2
D	RVR 18 or 1/2	RVR 24 or 1/2	RVR 40 or 3/4	RVR 40 or 3/4	RVR 60 or 1 1/4	165	880'(567')-2

Gnd speed-Kts		70	90	100	120	140	160
GS	3.00°	377	485	538	646	754	861
LOM to MAP	4.6	3:57	3:04	2:46	2:18	1:58	1:44

Don Bateman

CIRCUMSTANCES: To save time and fuel during arrival from the west (Balikpapan), it was usual practice to depart the inbound course (W36) and descend visually up a valley that would take the aircraft to the Teluk Palu Inlet north of the airport. Unfortunately on this particular day, some low cloud shrouded some of the terrain in the valley. The aircraft impacted at approximately 2300 feet MSL, some 100 feet or so from clearing the high ground at the top of the valley pass.

WEATHER: Good visibility at airport but high terrain hidden in haze and some cloud.

TIME: 12:20L (daytime)

FATALITIES: 12

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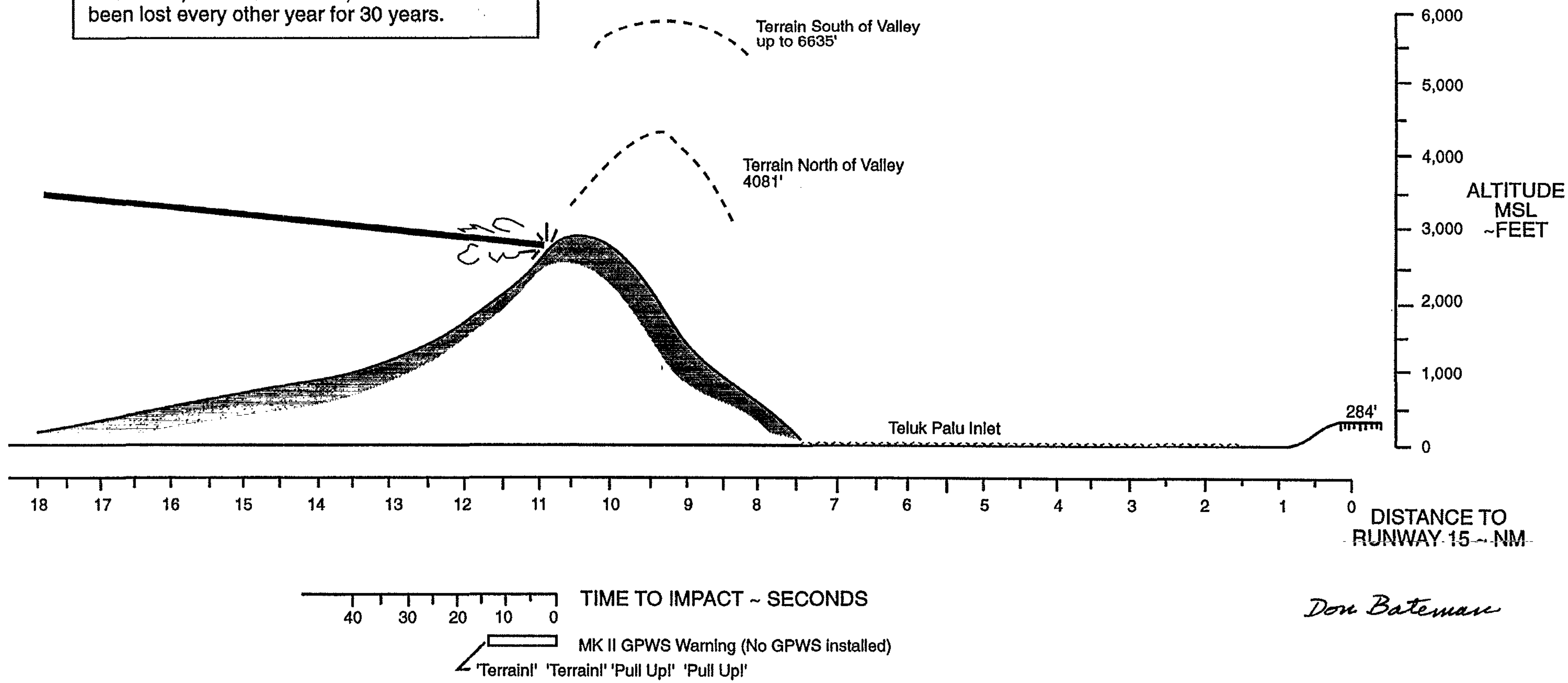
Probable
Flight Path Profile
F-27
PALU, SULAWESI, INDONESIA
18 June, 1994

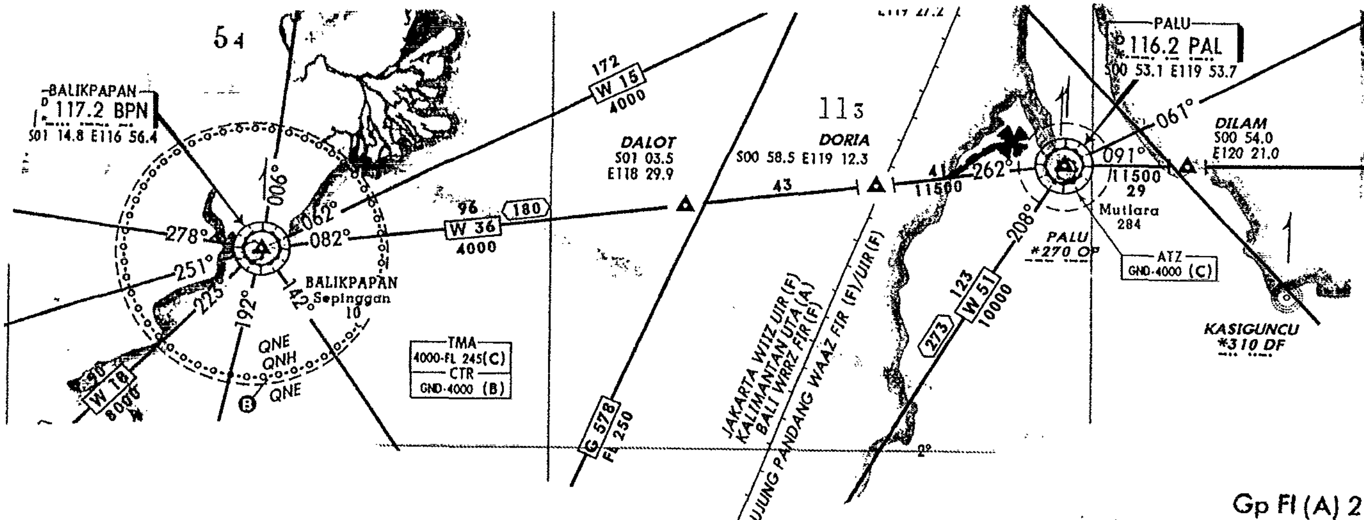
Note: Most Indonesia's regional jet and turbo prop fleet do not have GPWS equipment or even radio altimeters. Consequently with the large CFIT risks, at least one F-28, DC-9 or F-27 has been lost every other year for 30 years.

NO GPWS INSTALLED



Don Bateman

Return to TOC



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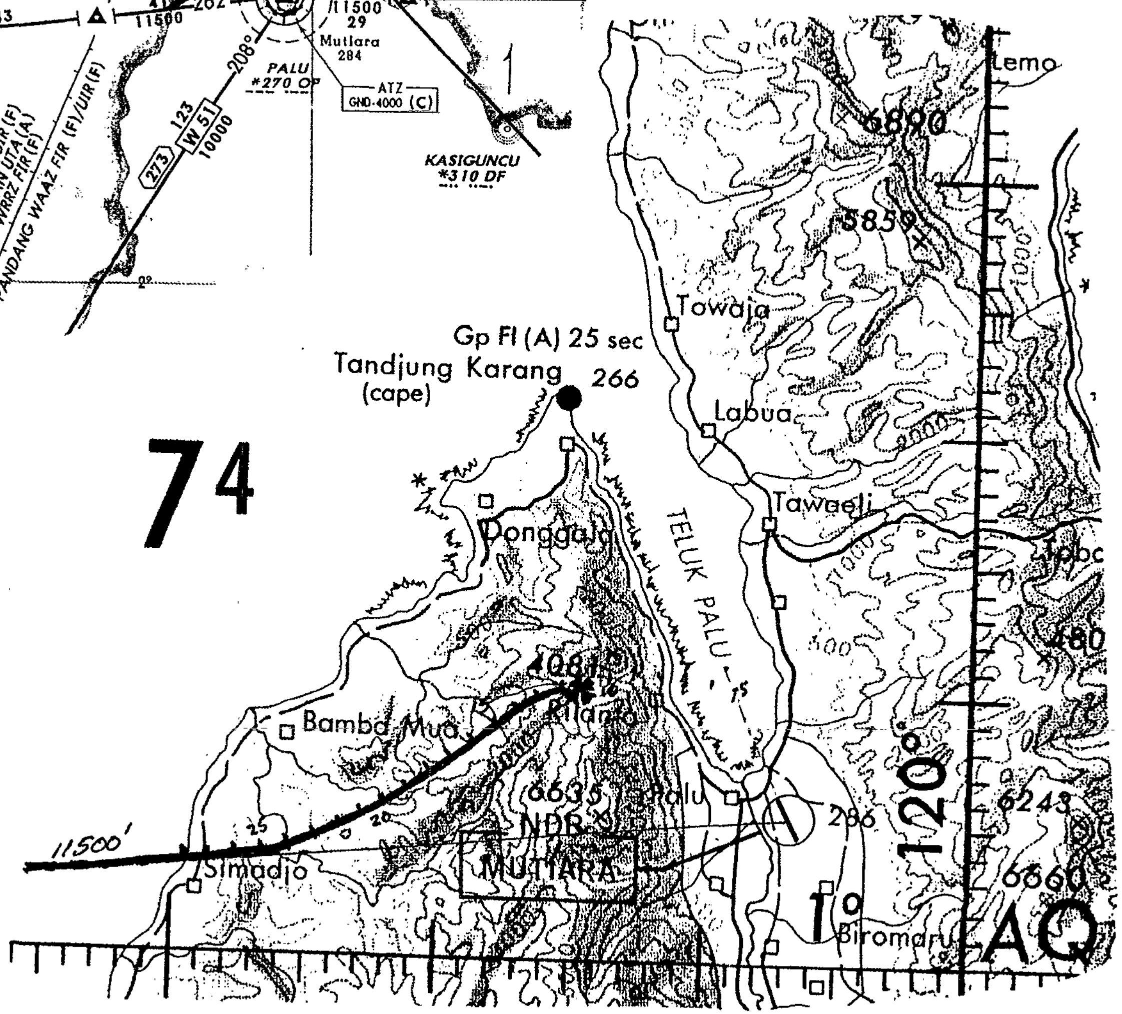

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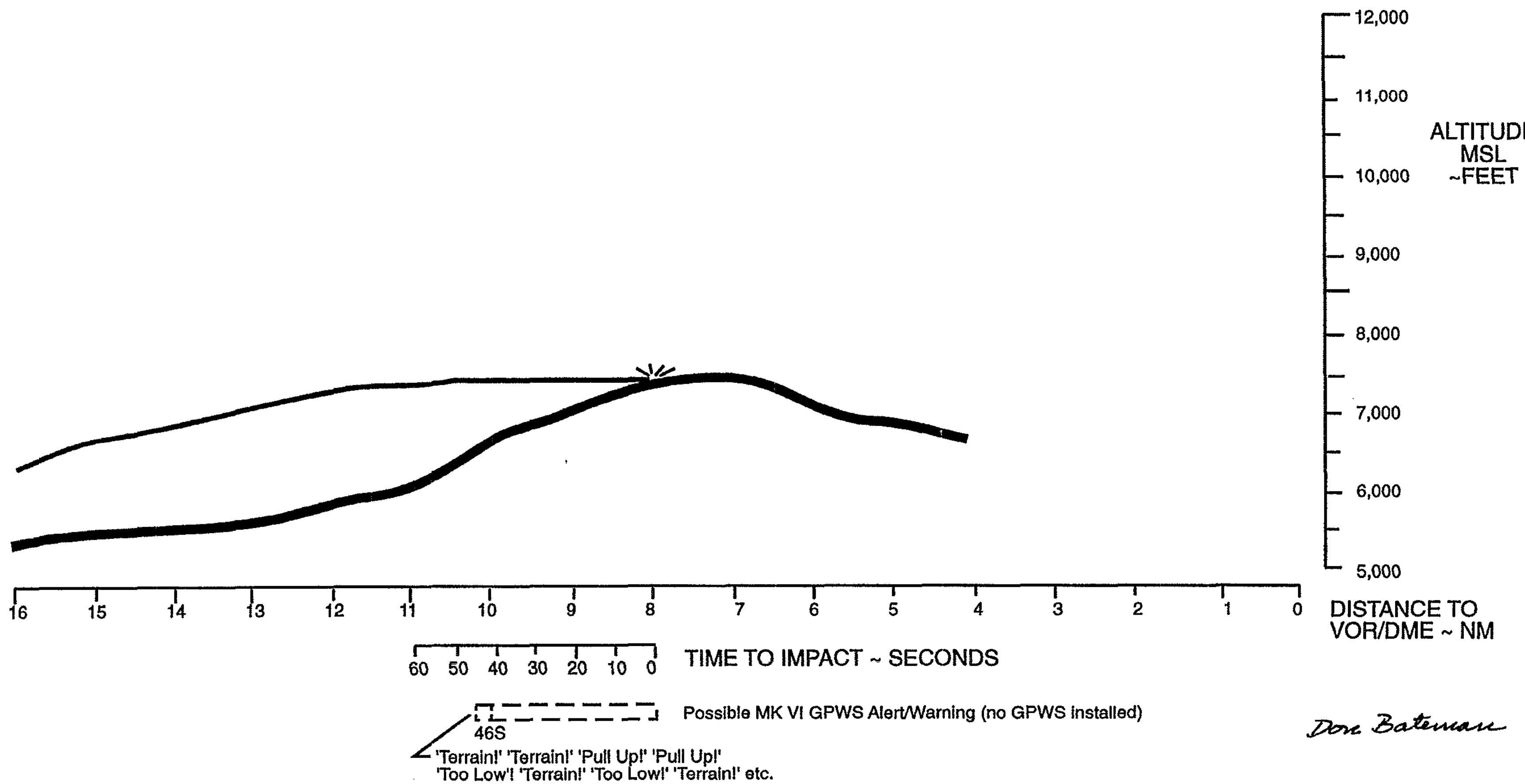
CIRCUMSTANCES: During a second missed approach, the aircraft impacted terrain west of the airport while climbing to the holding altitude of 9000 feet.

WEATHER: Overcast, IMC, limited visibility in rain.

FATALITIES: 9

Probable Flight Path Profile
Metro II
URUAPAN, MEXICO
13 June, 1994

NO GPWS INSTALLED



Don Bateman

Return to TOC

URUAPAN, MEXICO

GEN IGNACIO LOPEZ RAYÓN

CAT A, B & C VOR DME Rwy 02

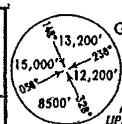
VOR 114.2 UPN

Apt. Elev 5226'

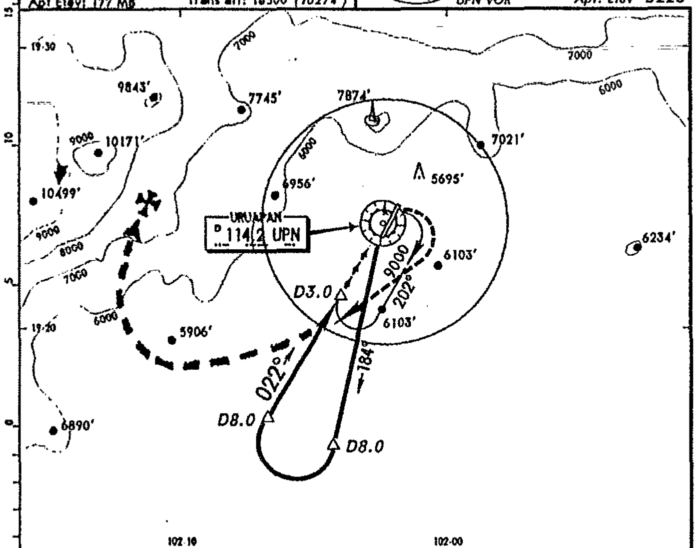
*URUAPAN Tower 118.2

Alt Set: MB (IN on req) Trans level: FL 195

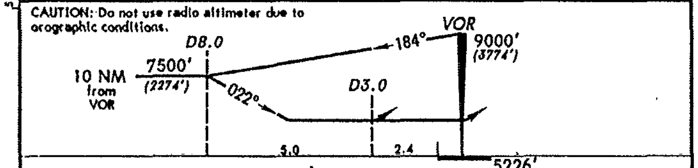
Apt Elev: 177 MB Trans alt: 18500' (13274')



MSA UPN VOR



CAUTION: Do not use radio altimeter due to orographic conditions.



MISSED APPROACH: **Cat A & B aircraft:** Turn RIGHT over UPN VOR to intercept and climb outbound on UPN VOR R-202 to the minimum holding altitude. **Cat C aircraft:** Climb direct to UPN VOR, then turn RIGHT to intercept and climb outbound on UPN VOR R-202 and proceed in climb to the minimum holding altitude.

	STRAIGHT-IN LANDING RWY 02 MDA(H) 6220' (994')	Max Kts	CIRCLE-TO-LAND MDA(H)
A	1½	90	6300' (1074')-3
B	1¾	120	
C	3	140	6500' (1274')-3
D	NOT APPLICABLE	D	NOT APPLICABLE

Cat A & B: MAP at VOR

Cat C: MAP at D3.0

Next Page

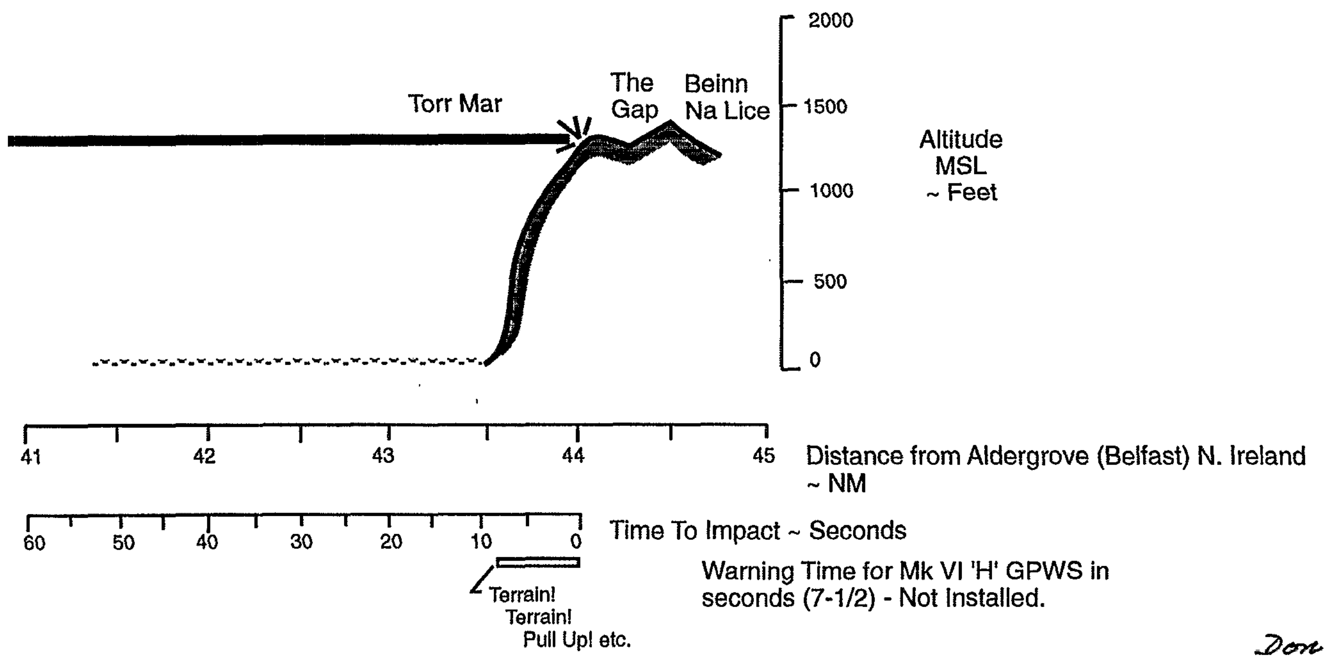
CIRCUMSTANCES:	Enroute from Belfast to Inverness Scotland, the helicopter flew into mountain.
WEATHER:	Fog, terrain shrouded in clouds.
TIME:	18:17 local
FATALITIES:	29

Flight Path Profile

RAF Chinook
Mull of Kintyre, Scotland

2 June, 1994

The Mk VI 'H' GPWS is designed for Transport Helicopters. The possible warning time shown is based on the terrain - flight path-speed profile. There was no GPWS installed.



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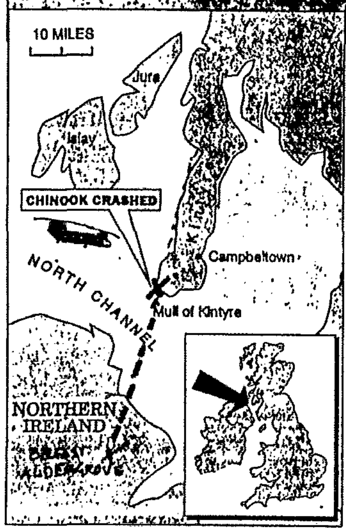
Return to TOC

INVERNESS



MILITARY WORKHORSE: The versatile Chinook helicopter is used for transporting personnel and equipment

CRASH RANKS AMONG WORST EVER

TRAGIC: Three cadets died in Welsh crash

THE Mull of Kintyre crash could rank with the worst helicopter disasters in British history.

The worst-ever crash claimed 45 lives in November 1986.

A Chinook carrying Shell workers crashed into the North Sea during its descent into Sumburgh Airport in the Shetlands.

The next most serious crash was the Scilly Isles disaster in July 1983, in which 20 people died.

A British Airways Sikorsky dived into the water as it flew between Penzance in Cornwall and St Mary's. There were six survivors.

In March 1992, eleven oil workers died when a Bristow Super Puma carrying them on a North Sea shuttle flight plunged into the sea 116 miles east of Lerwick during a two-minute journey from Shell's Cormorant Alpha platform to the accommodation platform.

Last week, two children from Sutton Coldfield in the West Midlands were orphaned when a helicopter carrying their mother and two men, including their pilot father, died in a crash into a mountain in North Wales.

Bomber

Three young air cadets drowned as an RAF Wessex helicopter giving them "air experience" spun and dived into a lake in North Wales last August.

Civilian pilot Robert Reid and a passenger died when their helicopter was struck by a low-flying RAF Tornado bomber in June last year.

RAF flight from Northern Ireland crashes into Mull of Kintyre hillside

Security chiefs among 29 dead in Chinook fireball

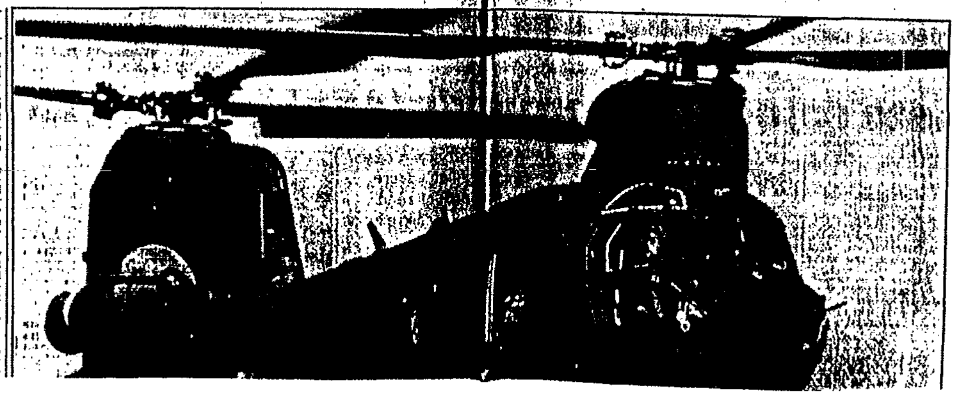
David Sharrock, Sally Weale and Lawrence Donegan

SENIOR Northern Ireland military, police, special branch and government officials, were among 29 people feared dead last night when an RAF Chinook helicopter crashed in foggy conditions on the tip of the Mull of Kintyre in western Scotland.

A massive search and rescue operation was launched, involving helicopters, lifeboats and mountain rescue teams, after the aircraft apparently smashed into a hillside. There were no reports of any survivors.

The helicopter, which flew from Belfast, was carrying RUC officers, army personnel and civil servants to an annual security conference at Fort George, Inverness.

Whitehall sources were giving no details of the precise nature of the Fort George conference last night, but it seems to be one dealing with military and police strategy in the battle



Next Page

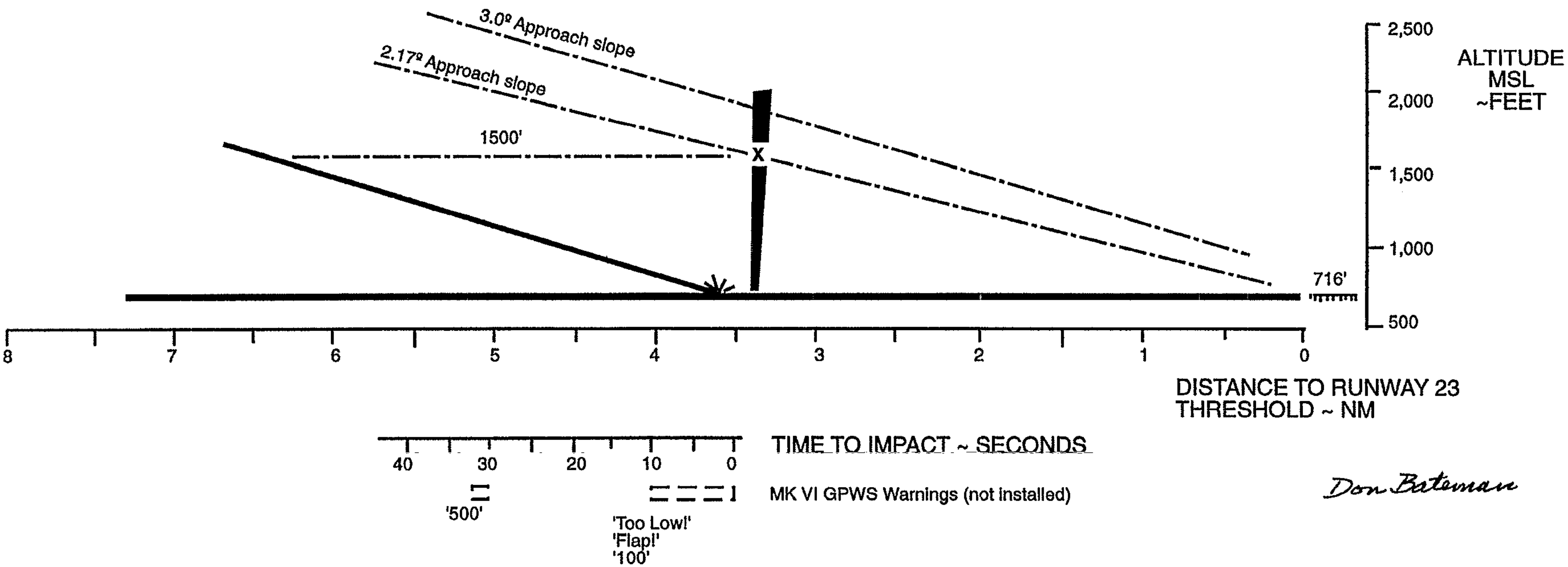
CIRCUMSTANCES:	During a night approach LOC (Back Course) to runway 23, this Medevac aircraft impacted 3-1/2 NM short of the runway at the 'Hotel' NDB beacon. Possible altimeter error or visual illusion.
TIME:	24:00 local night
WEATHER:	VMC
CONFIGURATION:	Landing gear down, approach flaps
FATALITIES:	3 of 5 on board

Probable Flight Path Profile
Merlin II
THOMPSON, MANITOBA
31 May, 1994

Note:
1. Low approach procedure slope of 2.17 degrees
2. CFIT risk with Medevac aircraft very high

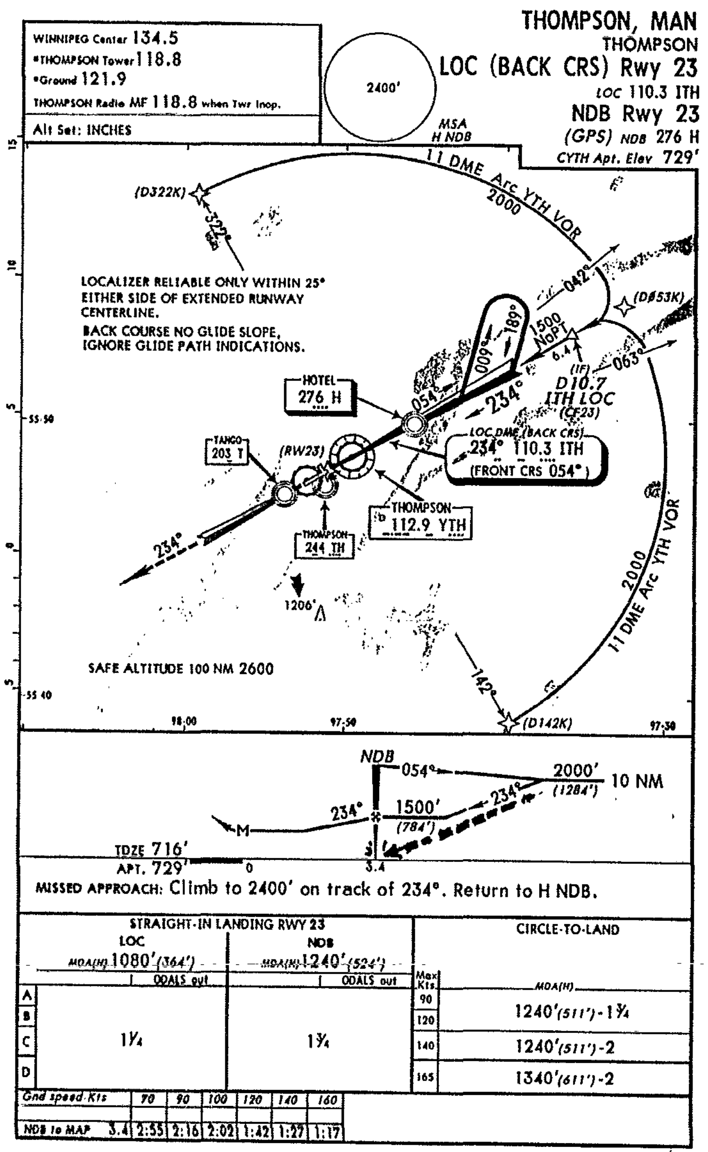
Other examples: 11 January 1995 - Masset, B.C. (LJ-25)
22 August 1989 - Gold Beach, Oregon (Be-90)
22 August 1985 - Juneau, Alaska (LJ-24D)
October 1985 - Medford, Oregon

NO GPWS INSTALLED



Don Bateman

Return to TOC



CIRCUMSTANCES:	During a radar vector for Fairgrounds Visual Runway 30L, the pilots and controller became distracted with radio traffic, and the aircraft was inadvertently delayed in turning, essentially extended the base leg while descending into terrain. Visibility was insidiously degrading, and the terrain shrouded. The pilots received a GPWS Warning and the pilots successfully recovered.
WEATHER AT THE AIRFIELD:	6 mile visibility, 1000 scattered, 3000 overcast 3000
CONFIGURATION:	Landing gear down, flaps 20 degrees

Flight Path Profile
B737-400
SAN JOSE, CALIF.
MAY 1994
INCIDENT

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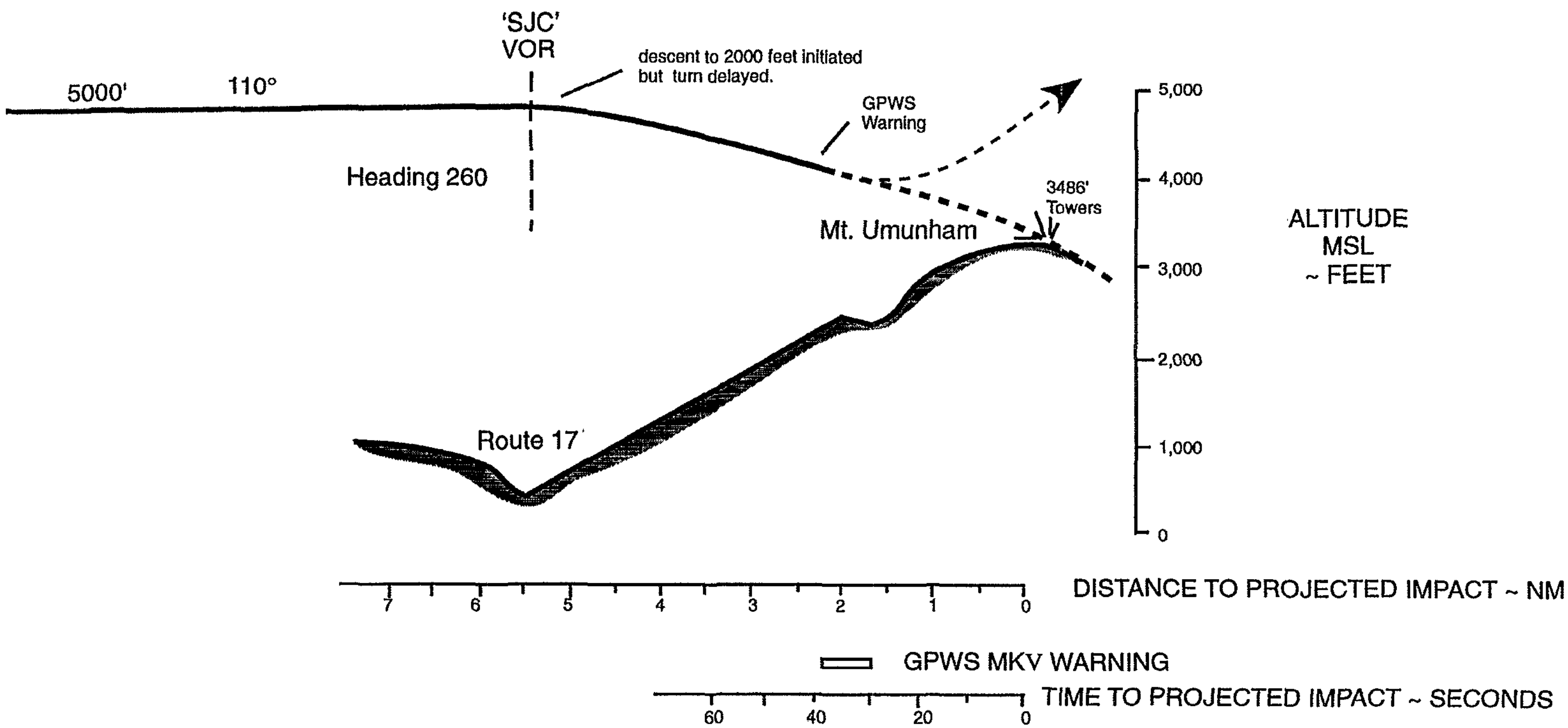


Don Bateman

Return to TOC

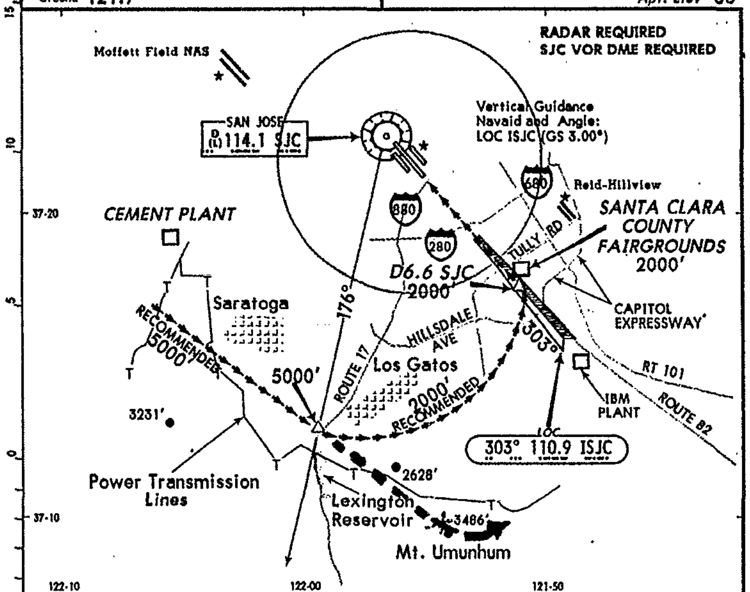
AWOS-3 133.32
*ATIS 126.95
BAY Approach (R) 120.1
*SAN JOSE Tower
SJC VOR R-304-R-122 Rwy 30R-12L 120.7
SJC VOR R-123-R-303 Rwy 30L-12R CTAF 124.0
*Ground 121.7

SAN JOSE, CALIF

SAN JOSE INTL

FAIRGROUNDS VISUAL Rwy 30L

Apt. Elev 56'



FAIRGROUNDS VISUAL APPROACH RWY 30L

Turbo-Jet aircraft from the west-northwest may be vectored in the vicinity of the Cement Plant for a Fairgrounds Visual Approach.

Aircraft should turn final no closer than 6.6 DME SJC at or above 2000' for noise abatement.

WEATHER MINIMUMS

Ceiling 2500' -Vis 5

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CIRCUMSTANCES: During an initial descent and an approach to Grand Junction, the controller apparently believed the aircraft to be arriving from Denver westbound on V134. Aircraft was actually arriving from Farmington on V187. Premature descent clearances were given in error.

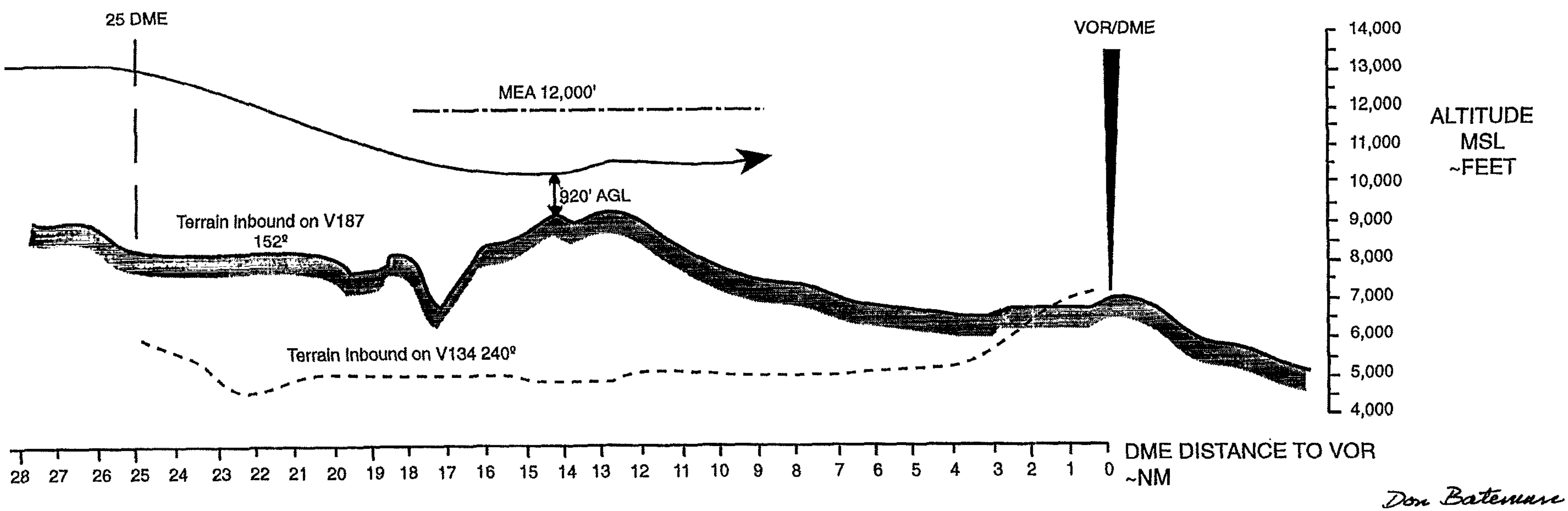
WEATHER: IMC

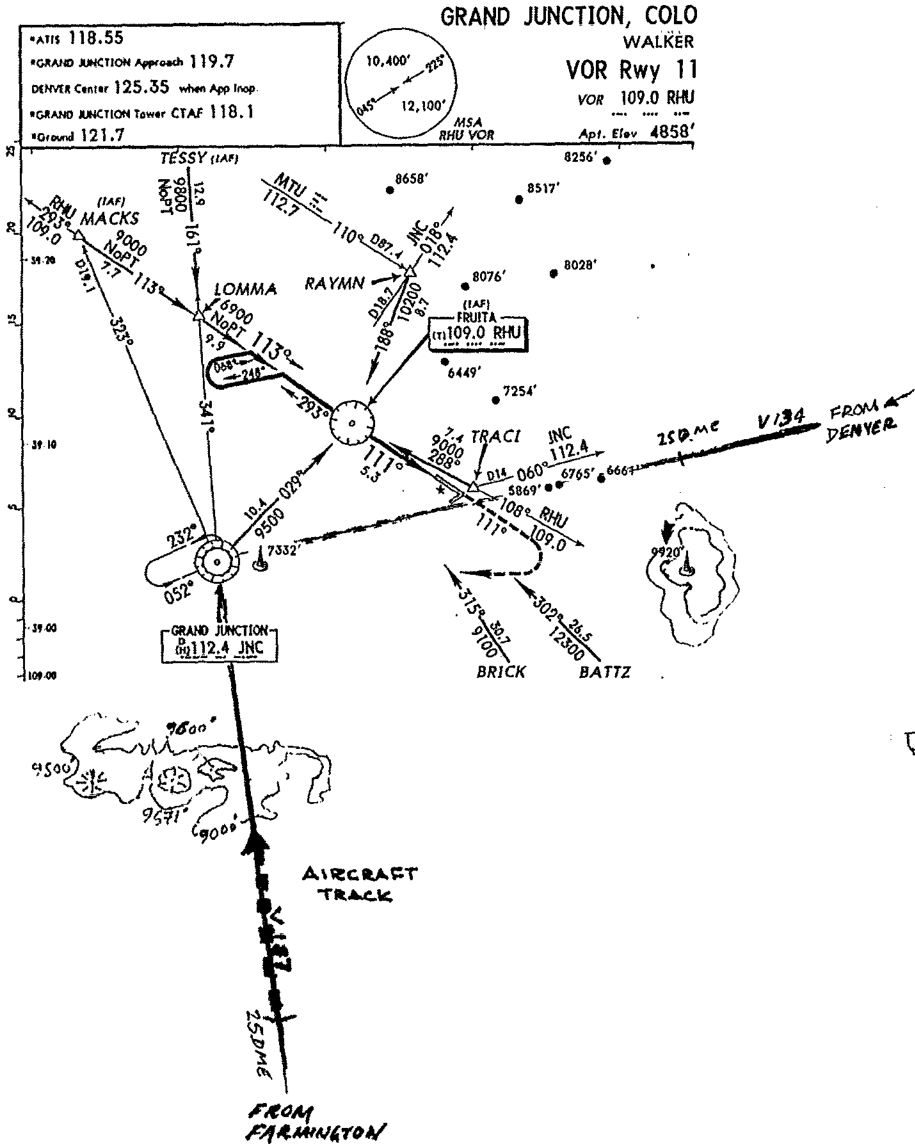
OTHER: Radio altimeter indication helped pilots realize that terrain was close. There was no GPWS installed, but three months later in May, MK VI GPWS was installed.

CONTROLLER - SYSTEM ERROR

Flight Path Profile
BAE JS-31
GRAND JUNCTION, COLORADO
February, 1994

CFIT INCIDENT





ASRS-#263591

NARRATIVE - CAPTAIN : FILED RTE, FMN V187 JNC. THE FLT WAS S OF JNC VOR ON V187. ZDV CLRED US DOWN TO 13000 FT MSL AND CONTACT GJT APCH. GJT APCH WAS CONTACTED AND THEN GAVE A CLRNC TO DSND TO 10100 FT AFTER 25 DME FROM JNC. A COMMENT WAS MADE BY THE CTLR THAT COMPANY HAD BROKEN OUT PRIOR TO REACHING 10100 FT WITH THE ARPT IN SIGHT AND TO EXPECT THE SAME. AS I LEVELED AT 10100 FT MSL, I CAUGHT A GLIMPSE OF THE GND AND SEEMED CLOSER THAN NORMAL. AT APPROX 15 DME FROM JNC, MY RADAR ALTIMETER SIGNALLED 920 FT AGL. I ASKED MY FO FOR THE MEA WHICH WAS 12000 FT MSL. I THEN STARTED A CLB FROM 10100 FT TO A HIGHER ALT OF 10500 FT WHILE MY FO WAS REQUESTING A HIGHER ALT FROM APCH WITH A VERIFICATION OF THE CLRNC. THE CTLR THEN GAVE A CLRNC, 'IF FIELD NOT IN SIGHT AT 14 DME, R TURN DIRECT TO THE FRUITA VOR (RHU) DSND AND MAINTAIN 9500 FT.' I MAINTAINED MY ALT OF 10400-10500 FT. THE CTLR THEN MADE THE COMMENT THAT AT TRACI INTXN, WHICH IS 14 DME, THAT WE WERE GOOD DOWN TO 9000 FT. THIS DID NOT MAKE MUCH SENSE TO MYSELF OR MY FO. ALL OF THIS WAS HAPPENING AT ABOUT 10-12 DME OFF OF JNC. AS WE WERE IN THE R TURN TO RHU, WE BROKE INTO THE CLR WITH THE FIELD IN SIGHT. WE LANDED WITHOUT FURTHER INCIDENT WITH NOTHING ELSE SAID. OVER THE NEXT 3 DAYS, I CONTINUED TO THINK ABOUT THIS AND WHILE TALKING TO MY FELLOW PLTS AND LOOKING OVER THE CHARTS, I BELIEVE NOW I KNOW WHAT HAPPENED. THE CTLR HAD US COMING IN ON V134 FROM DEN VOR AND AT 25 DME, A STEP DOWN TO 10100 FT AND AT 14 DME 9500 FT WOULD APPLY. THE CLRNC AT 14 DME WITH A R TURN TO RHU WOULD STILL APPLY. I SHOULD HAVE NEVER DSNDED BELOW 12000 FT MEA. IT WAS NOT UNTIL AFTER I HAD DSNDED TO 10100 FT AND REVIEWED THE CHART THAT I CAUGHT THE MISTAKE. I HAVE TRAVELED THE RTE DEN- JNC V134 MANY TIMES AND HEARD THE CLRNC AS STATED EARLIER AND THIS IS WHERE THE COMPLACENCY CAME INTO PLAY. THIS WAS MY MISTAKE. THE CTLR'S MISTAKE WAS THAT HE HAD US IN THE WRONG PLACE. THE FACT THAT NEITHER THE CTLR NOR MYSELF CAUGHT IT WAS THE MISTAKE OF BOTH. CORRECTIVE ACTION ACTIONS TO PREVENT THIS FROM HAPPENING AGAIN WOULD BE TO:1). STATE WHICH AIRWAY OR DIRECTION ARRIVING FROM. 2) GJT IS NON-RADAR, INSTALL A RADAR SVC. 3) GET GPWS INSTALLED IN ACFT.

CO-PILOT NARRATIVE -

SUPPLEMENTAL INFO FROM ACN 263751: WE WERE HANDED OFF TO GJT APCH AND WE WERE TOLD TO RPT 25 DME FROM JMC VOR. WE WERE ALSO INFORMED BY GJT APCH THAT THERE WAS A 'BIG HOLE' OVER THE ARPT AND WE SHOULD 'BREAK OUT' AND SEE THE ARPT. AT 25 DME JNC WE WERE CLRED

DOWN TO 10100 FT MSL. THE CAPT QUESTIONED THIS CLRNC AND ASKED ME TO CHK MSA FOR THE AREA WE WERE IN. THE NNW WAS 10400 FT AND FROM NE/SW WAS 11700 FT. THE CAPT STARTED A CLB BACK TO 10500 FT. I QUESTIONED GJT APCH ABOUT THE CLRNC AND REFED THE MSA. I ALSO ASKED FOR DIRECT FRUITA VOR (RHU) FOR THE VOR APCH. GJT APCH SAID THAT IF FIELD NOT IN SIGHT BY 14 DME (JNC) THAT WE WERE CLRED DIRECT RHU VOR AND CLRED TO DSND TO 9000 FT MSL. THE CAPT SAID HE WAS STAYING AT 10500 FT MSL. DURING THE INITIAL DSCNT I COMMENTED ON THE RADAR ALTIMETER BEING ALIVE AND NOTICED IT WAS AS LOW AS 1300 FT AGL. I BELIEVE THE CTLR AT GJT THOUGHT WE WERE INBOUND FROM DEN AND NOT INBOUND FROM THE S.

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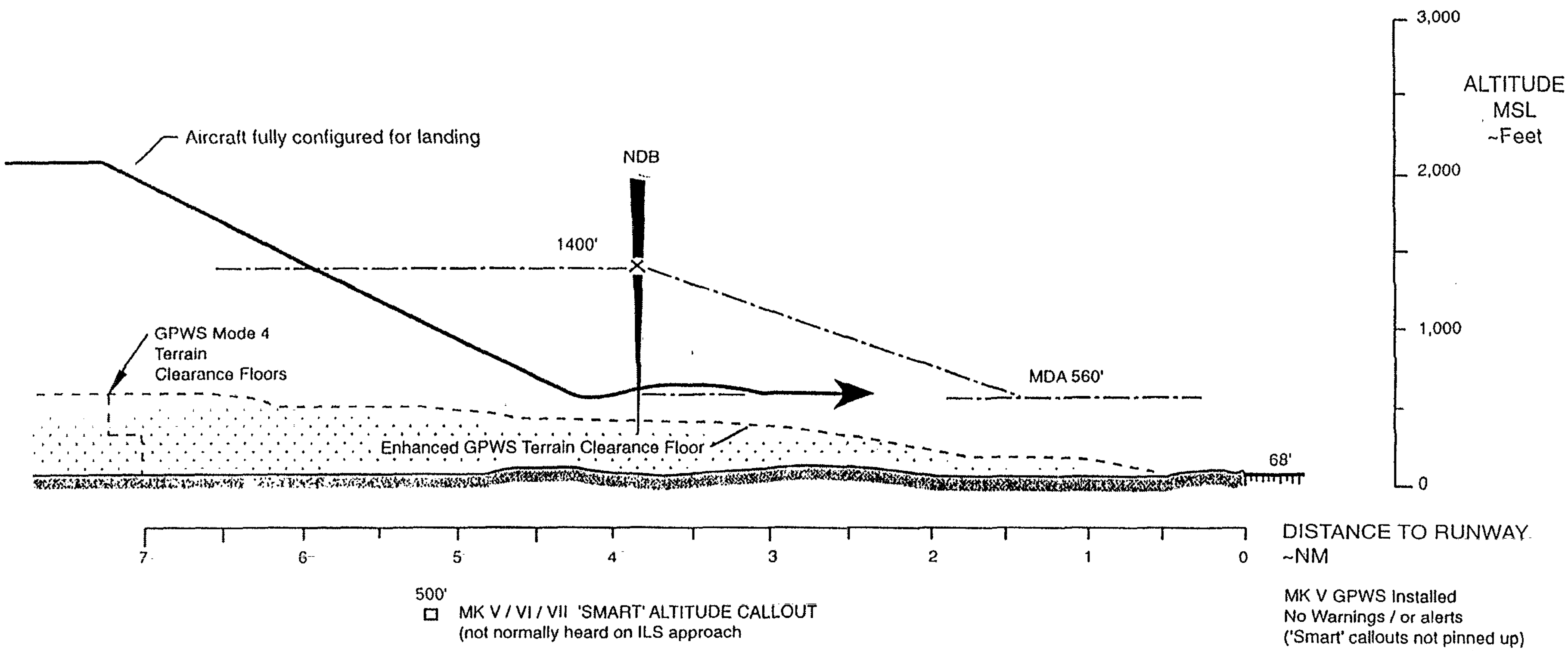
CIRCUMSTANCES:	Switching from radar vectors for LOC B/C runway 4L, to a NDB approach to runway 13, the aircraft descended prematurally to the MDA before the Final Approach Fix. The pilots lost situational awareness. A contributing factor was misinterpretation of the Flight Management System.
WEATHER:	1000 overcast, 5 mile visibility.

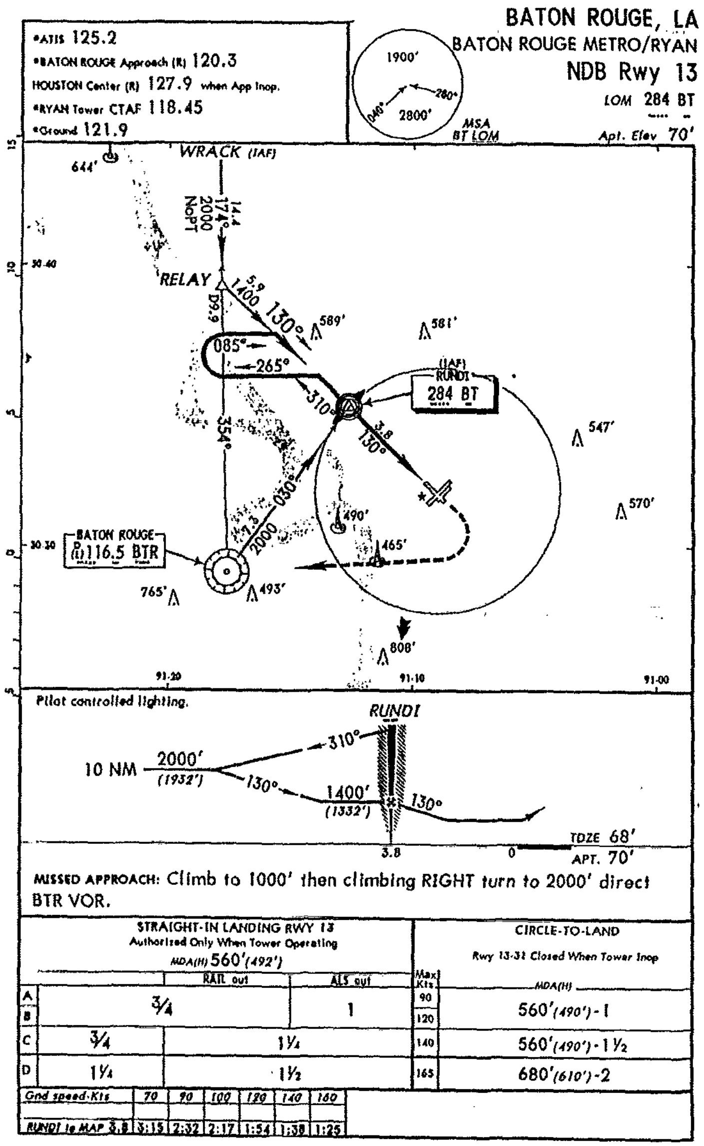
MISINTERPRETATION OF FLIGHT MANAGMENT SYSTEM NAV FIX

Flight Path Profile
B737 - 400
BATON ROUGE, LOUISIANA
February, 1994

Controlled Flight Towards Terrain Incident



Don Bateman



NARRATIVE : WHILE ON VECTORS FOR LOC BACK COURSE TO RWY 4L, CTLR ASKED IF WE WOULD LIKE VECTORS FOR NDB 13 INSTEAD. THINKING WE HAD TIME TO PREPARE FOR THE APCH PROPERLY, WE ACCEPTED. IN REALITY, WE WERE NOT ABLE TO REVIEW AND PREPARE FOR THE APCH. THE CTLR RPTED HE HAD A LOW ALT ALERT AND ASKED OUR ALT. THIS CAUGHT US OFF GUARD. SO HE ASKED AGAIN AND ASKED IF WE KNEW WHERE WE WERE. WE THOUGHT WE WERE INSIDE THE FINAL FIX, WHEN, IN REALITY, WE WERE JUST OUTSIDE AND WERE AT MDA. HE THEN ASKED IF WE SAW THE FIELD. WE DID, SO HE CLRED US FOR THE VISUAL APCH. BY THAT TIME THE COPLT HAD STARTED A CLB BACK TO 1700 FT MSL. THE NDB 13 WAS NOT IN THE FMS DATABASE BUT THE RWY WAS. WHEN PUTTING THE RWY AS THE ACTIVE WAYPOINT YOU ALSO GET 'FF13.' THIS WE BOTH MISTOOK AS THE FINAL APCH FIX, WHEN IT IS REALLY OUTSIDE THE FIX. IN THE FUTURE, I WILL NOT ACCEPT VECTORS FOR ANOTHER APCH UNLESS THERE IS TIME TO FULLY REVIEW THE NEW APCH OR ASK FOR A RADAR FIX.

SOURCE: ASRS # 263826

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SIGNIFICANT INCIDENT

CIRCUMSTANCES: In a one hour period (11:30 local), while trying to fit traffic for flow and spacing, a controller vectored 14 jet aircraft (including the State governor's aircraft) over and into terrain below MSA and below MRVA.

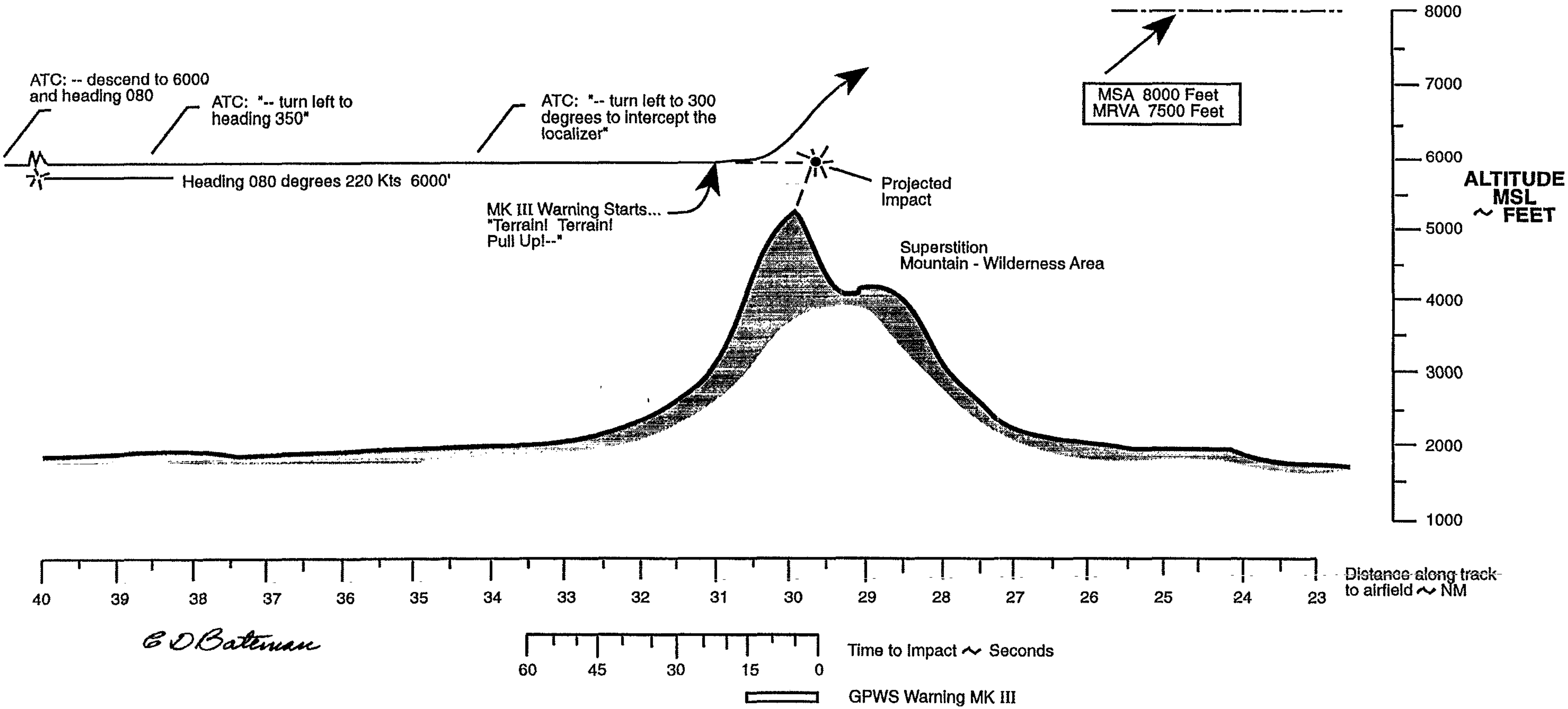
ALTITUDES: Two aircraft pulled up on receiving GPWS warnings taking evasive action from terrain.

WEATHER: Strong winds, mountains shrouded in clouds.

TRAFFIC: High peak flow
Controller was under stress. Later the controller was relieved of duty and given "remedial training."

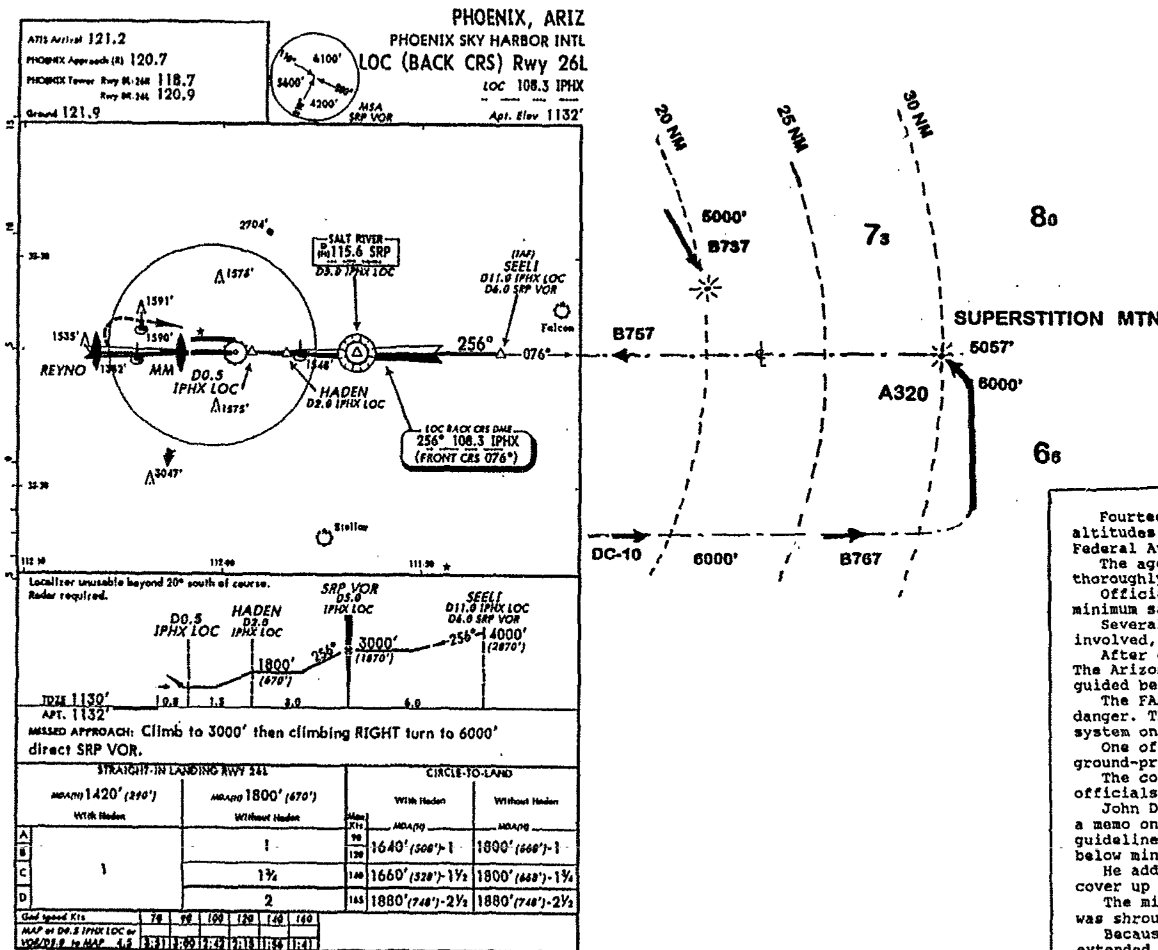
MAJOR QUESTIONS: Where was the MSAW? Where were the backup and supervisory controllers?

Flight Path Profile
A-320
PHOENIX, ARIZONA
25 January, 1994



C D Bateman

Return to TOC



14 JETS NEARED MOUNTAINS, FAA SAYS

Fourteen planes, a dozen more than initially reported, were assigned unsafe altitudes near the Superstition Mountains during bad weather Jan. 25, the Federal Aviation Administration has concluded.

The agency also acknowledged that Phoenix air-traffic managers failed to thoroughly investigate the incident.

Officials had said that only two America West jetliners were guided below minimum safe altitudes by a single controller during an hourlong period.

Several air-traffic controllers complained that a dozen more planes were involved, but those incidents were not immediately investigated.

After one controller contacted an FAA hotline and inquiries were made by The Arizona Republic, the FAA reinvestigated and found that 14 planes had been guided below minimum safe altitudes.

The FAA said that the errors were procedural and that no planes were in danger. The planes had additional protection from a safe-altitude warning system on the ground, the FAA said.

One of the America West jets took corrective action after a ground-proximity alert signaled that the plane was too close to the ground.

The controller involved was given remedial training after the incident, officials said.

John D. Canoles, FAA director of air-traffic-system effectiveness, said in a memo on the incident that Phoenix FAA officials had misinterpreted guidelines and failed to determine whether a number of flights were guided below minimum altitudes.

He added, ''There was no evidence that facility management intended to cover up any part of the incident.''

The mistakes occurred between 11:30 a.m. and 12:30 p.m. Jan. 25. The Valley was shrouded by clouds, and winds made the approach to Sky Harbor difficult.

Because of bad weather and heavy traffic, the landing pattern had been extended about 30 miles from the airport, over the Superstitions, where 6,100 feet is the minimum safe altitude.

The highest elevation in the Superstitions in 5,507 feet.

In the memo, Canoles said the FAA has made several revisions to the Phoenix facility's operating practices.

THE ARIZONA REPUBLIC
DATE: Wednesday, April 20, 1994
EDITION: Final Chaser
SECTION: Valley And State
SOURCE: By Bill Muller, The Arizona Republic

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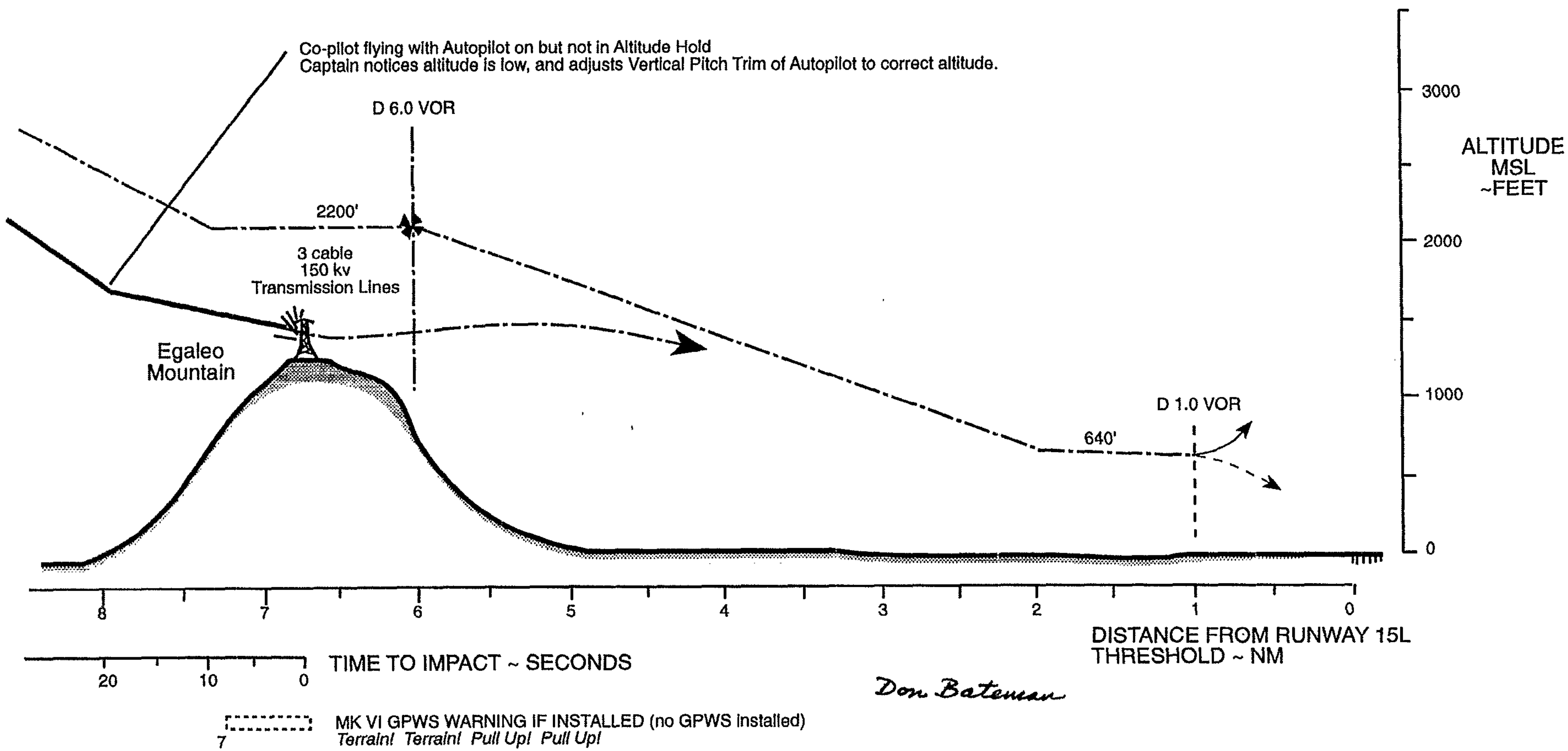
CIRCUMSTANCES:	While on a VOR DME approach to runway 15L, the aircraft impacted a 150 kv transmission line some 7.3 DME from the runway. The aircraft sustained considerable damage, but fortunately, was able to land on one engine.
WEATHER:	IMC, wind 160/14 kts, light rain ...
CONFIGURATION:	Clean
TIME:	09:22 local
OTHER:	No GPWS installed. Autopilot in use but inadvertently not in Altitude-Hold.

Flight Path Profile
Do-228
ATHENS, GREECE
9, January, 1994



Don Bateman

52A

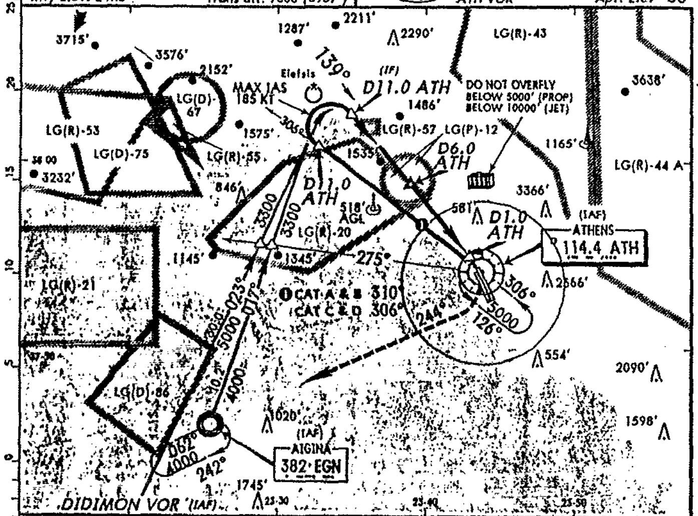
Return to TOC

ATHENS, GREECE
ATHENS
VORDME Rwy 15L
VOR 114.4 ATH

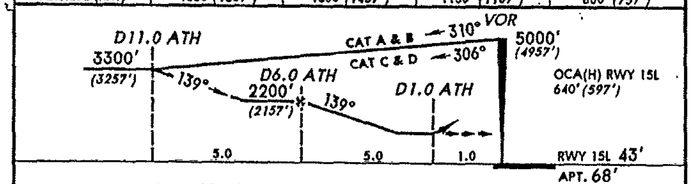
ATIS 123.4
ATHENS Approach (R) 121.4 119.1
ATHENS Tower Civ: 118.1 Mil: 122.1
Ground 121.7
Alt Set: MB
Rwy Elev: 2 MB
Trans level: By ATC
Trans alt: 7000' (6957')

MSA ATH VOR: 6500' (090°–270°), 4500'

Apt. Elev 68'



ATH DME	5.0	4.0	3.0	2.0
ALTITUDE (HAT)	1850' (1807')	1500' (1457')	1150' (1107')	800' (757')



MISSED APPROACH: Turn RIGHT (MAX IAS 185 KT) to intercept 244° climbing to 4000' (3957') to NDB and hold. Climb to 1500' (1457') prior to level acceleration.

	STRAIGHT-IN LANDING RWY 15L MDA(H) 640' (597')	Max Kts	CIRCLE-TO-LAND Not authorized East of runway MDA(H)	
A	1600m	100	890' (822')	1600m
B		135	890' (822')	2000m
C	2400m	180	1000' (932')	4400m
D	2800m	205	1000' (932')	4800m

Gnd speed-Kts	70	90	100	120	140	160
Desc. Grad. 5.8%	411	529	587	705	822	940
MAP at D1.0 ATH						

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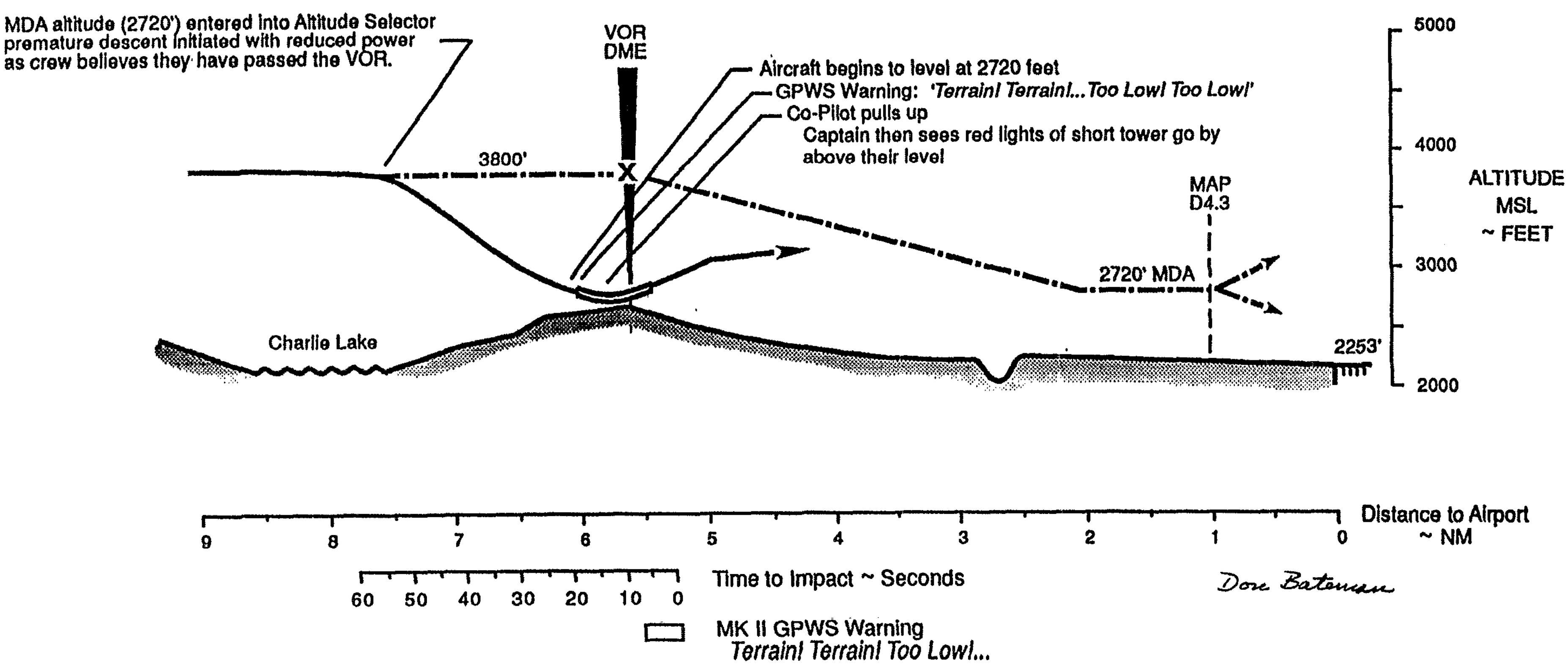
Incident
Flight Path Profile
DHC-8
FT. ST. JOHN B.C., CANADA
January, 1994

CIRCUMSTANCES:	During a VOR/DME approach to runway 11, the aircraft prematurely descended towards the MDA, before reaching the VOR (FAF). A mis-set VOR radial apparently was part of the decision to descend. A MK II GPWS warning alerted the crew in time to climb, just missing a short tower and the ground.
TIME:	Dark.
WEATHER:	1000 feet, scattered clouds, 2.5 miles visibility.
CONFIGURATION:	Landing gear down, flaps 15.
OTHER:	No injury to 23 people on-board. MK II GPWS installed and working.



Return to TOC

FT ST JOHN, BC

FT ST JOHN

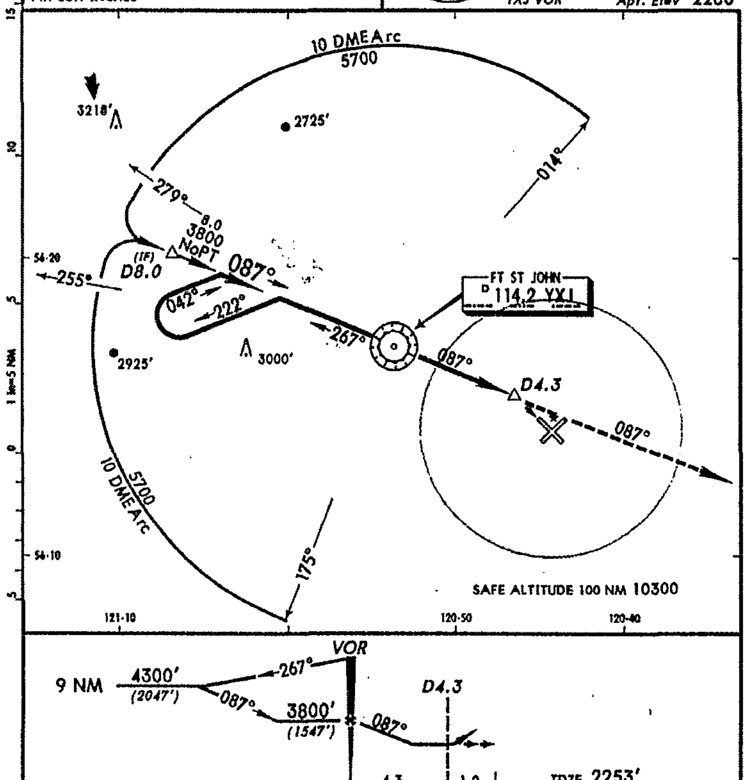
VOR Rwy 11

VOR 114.2 YXJ

Apt. Elev 2280'

EDMONTON Center 132.6
*FT ST JOHN Tower 118.5
*Ground 121.9
*FT ST JOHN Radio MF 118.5 when Twr Inop.
Alt Set: INCHES

MSA YXJ VOR 4300'



MISSED APPROACH: Climb to 4300' outbound on YXJ VOR R-087. Return to YXJ VOR.

	STRAIGHT-IN LANDING RWY 11 MDA(H) 2720' (467')	Max Kts	CIRCLE-TO-LAND MDA(H)
A	1¼	90	2780'(500')-1½
B	1¼	120	2780'(500')-1½
C	1¼	140	2780'(500')-2
D	1¼	165	2880'(600')-2

Gnd speed-Kts		70	90	100	120	140	160
MAP at D4.3 or VOR to MAP	4.3	3:41	2:52	2:35	2:09	1:51	1:37

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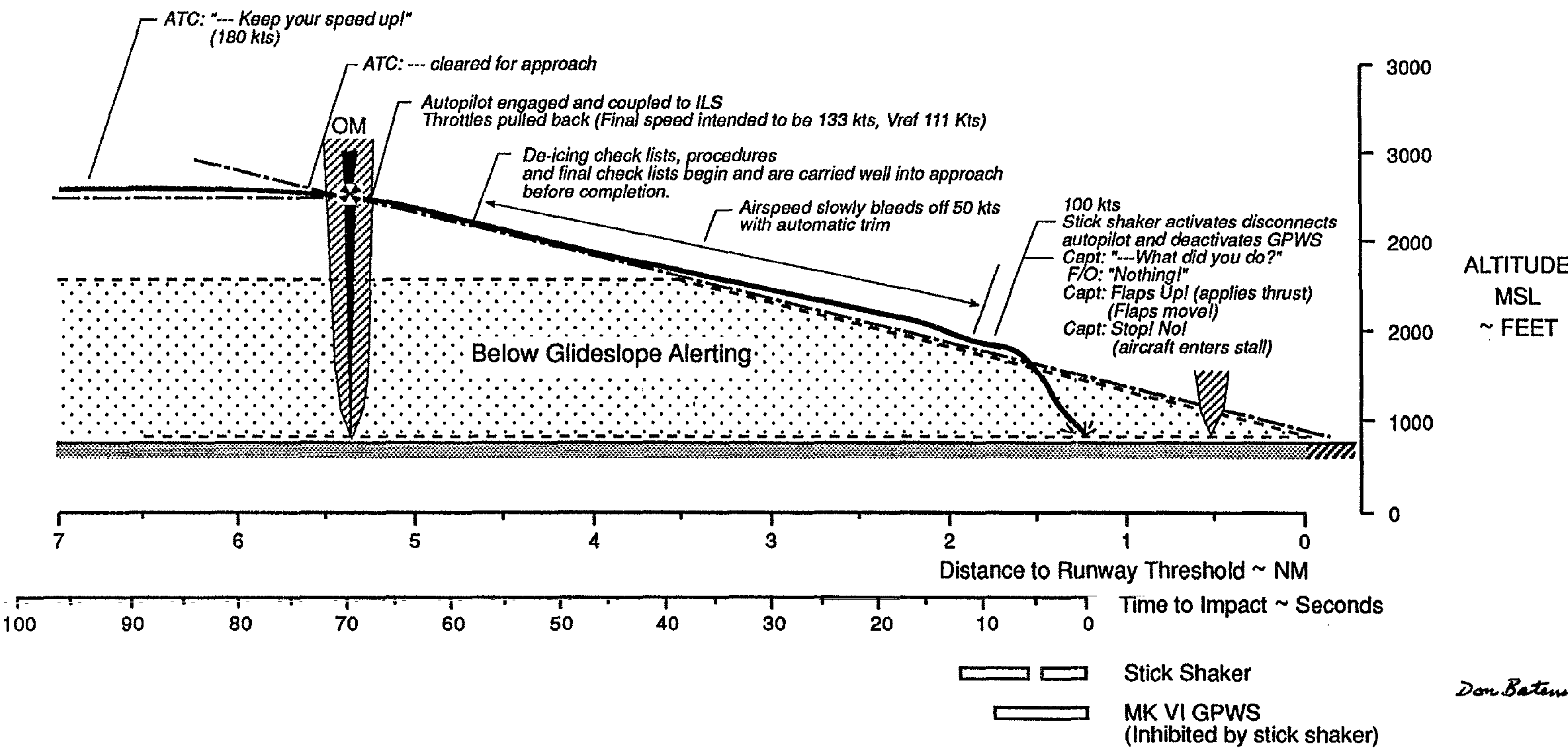
Non-CFIT Accident Flight Path Profile
BAe-JS-41
COLUMBUS, OHIO
7 January, 1994

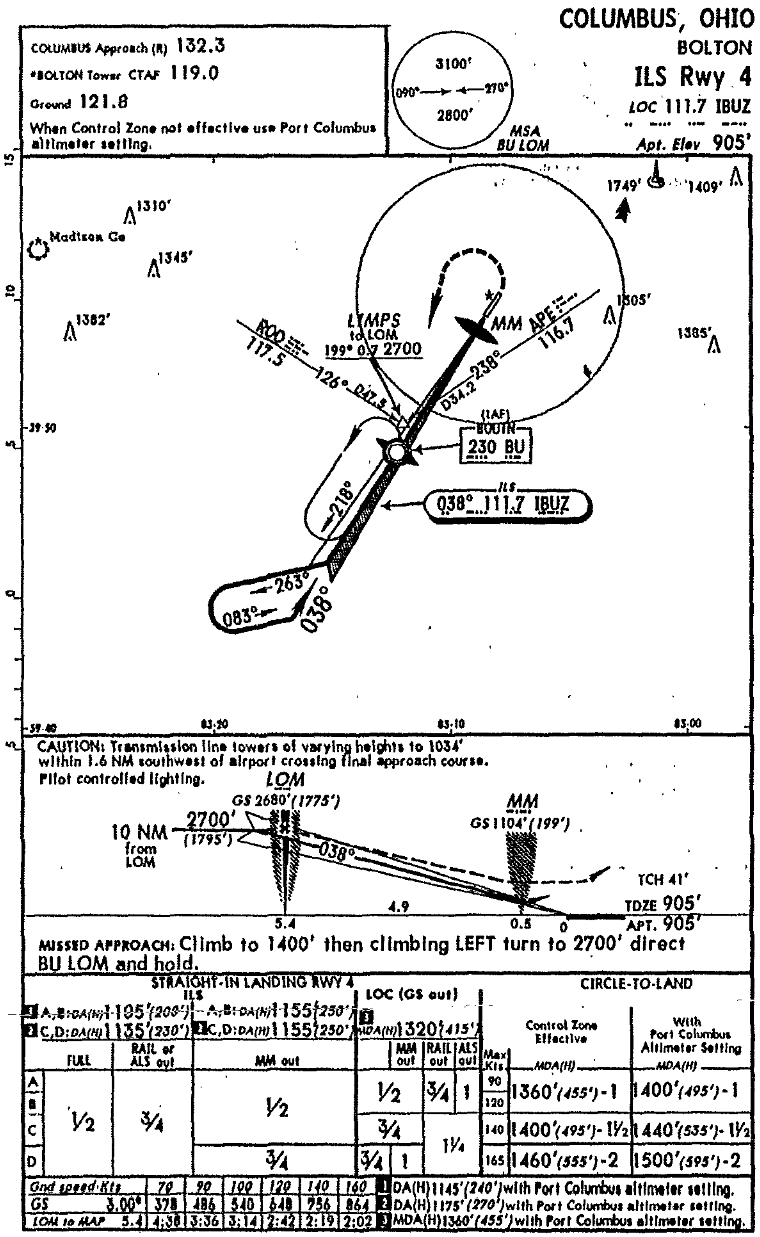
Preliminary - unofficial data

CIRCUMSTANCES:	During an ILS approach to runway 4, the airspeed had bled off by about 50 kts without the knowledge of the pilots and entered stall to impact some 1 1/4 NM short.
TIME:	23:25 EDT
WEATHER:	800 foot ceiling, 2 1/2 mile visibility, fog, light snow, temperature 23, dew point 22, reported light rime ice.
FATALITIES:	5 with 3 survivors.
OTHER:	Glass cockpit with vertical airspeed tape. Captain had 3500 hrs. total time, 150 hrs. in type, F/O had 35 hrs. in type. This accident illustrates stick shaker inhibit of GPWS on some U.K. installations.



Don Bateman

Return to TOC

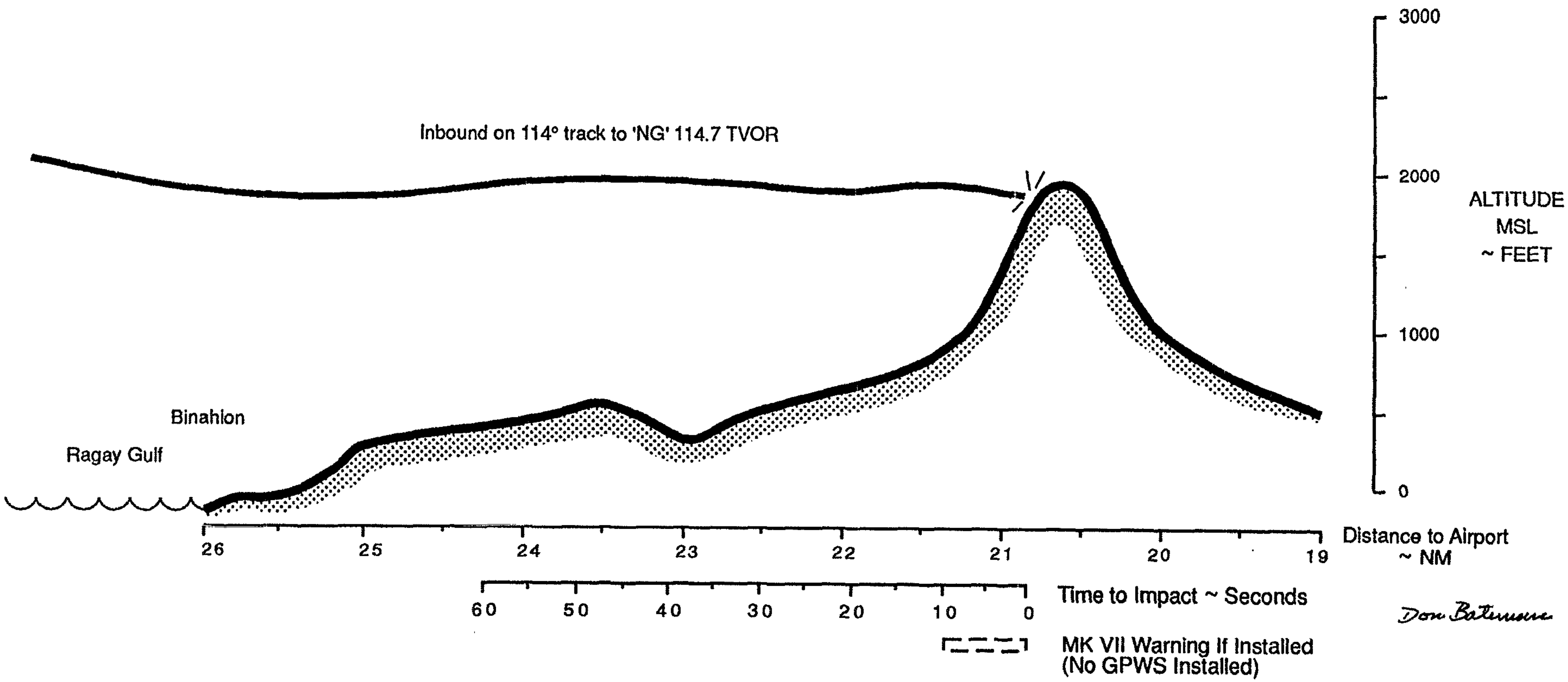


CRASH INVESTIGATION: Federal safety investigators were examining flight data and cockpit voice tapes from United Express Flight 6291, which crashed Friday, killing two passengers and three crew members. The British Aerospace Jetstream 41 commuter plane was preparing to land at Columbus, Ohio, en route from Washington's Dulles Airport. Three members of one family survived.

Next Page

CIRCUMSTANCES:	During a VOR approach to Naga, the aircraft prematurely descended to 2000 feet AGL, and impacted into Mount Manase some 100 feet below the ridge line.
TIME:	14:00 local time.
WEATHER:	IMC, heavy rain, fog.
CONFIGURATION:	Clean.
FATALITIES:	27
OTHER:	Another aircraft a DC-3, impacted within one mile of this accident, inbound to Naga in March 1965 with 10 fatalities.

Estimated Flight Path Profile C-130 NAGA, PHILIPINES 16 December, 1993



Return to TOC

All 27 aboard mercy flight killed in crash

17 Dec '93
'The Citizen'
p.13

LIBMANAN, Philippines. — All 27 people aboard a Philippine transport plane carrying relief supplies were killed when it hit a hill and exploded in flames south of Manila, the head of the air force said yesterday.

"None of the 27 people on board survived, they all died," Brigadier-General Nicasio Rodriguez told reporters after inspecting the site of Wednesday's crash.

Another five people feared to have been on board the air force C-130 Hercules did not take the flight from Manila after it was delayed by bad weather, he said.

Air force officials revised the number of people aboard the plane to 27 from 29 after early confusion on how many people really took the flight.

Rescuers battled in driving rain and bad visibility to sift through the wreckage of the aircraft, which exploded and burned when it plunged into remote Mount Manase about 250 km south-east of Manila.

Witnesses said they found charred bodies scattered through the smoking wreckage of the plane, which just failed to get over the 600m hill as it descended towards Naga Airport in bad weather.

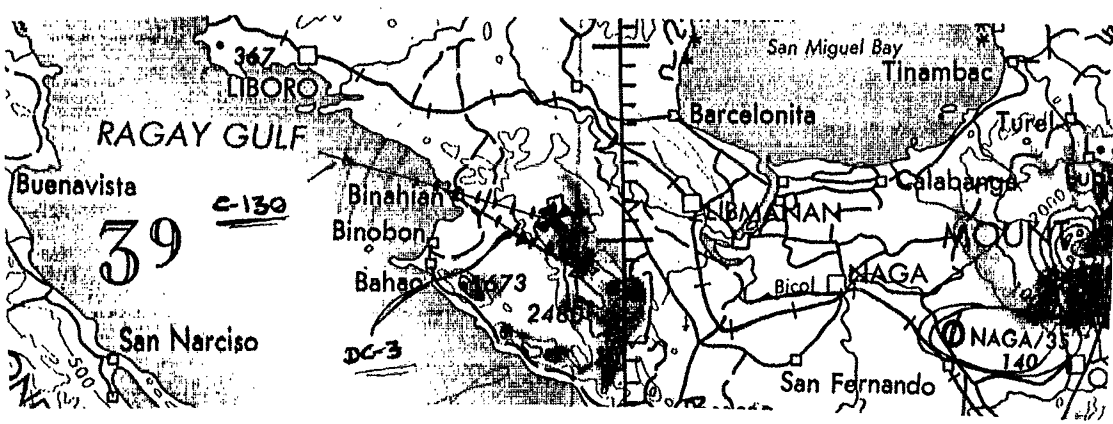
When asked about the cause of the crash, Gen Rodriguez told reporters: "The primary reason was the bad weather although error of judgment on the part of the pilot was part of the crash."

The bodies were airlifted to a temporary helipad about 3 km from the crash site, which is in a forested area known as a stronghold of Communist guerrillas.

The rebels issued a statement saying they would not interfere in the rescue operation.

The aircraft was delivering supplies to the Bicol region, where over 300 people were killed by two typhoons last week.

The flight had been organised by a relief group led by the wives of Cabinet Ministers, but none of them appear to have been on the plane that carried 19 passengers and eight crew. — Sapa-Reuter.



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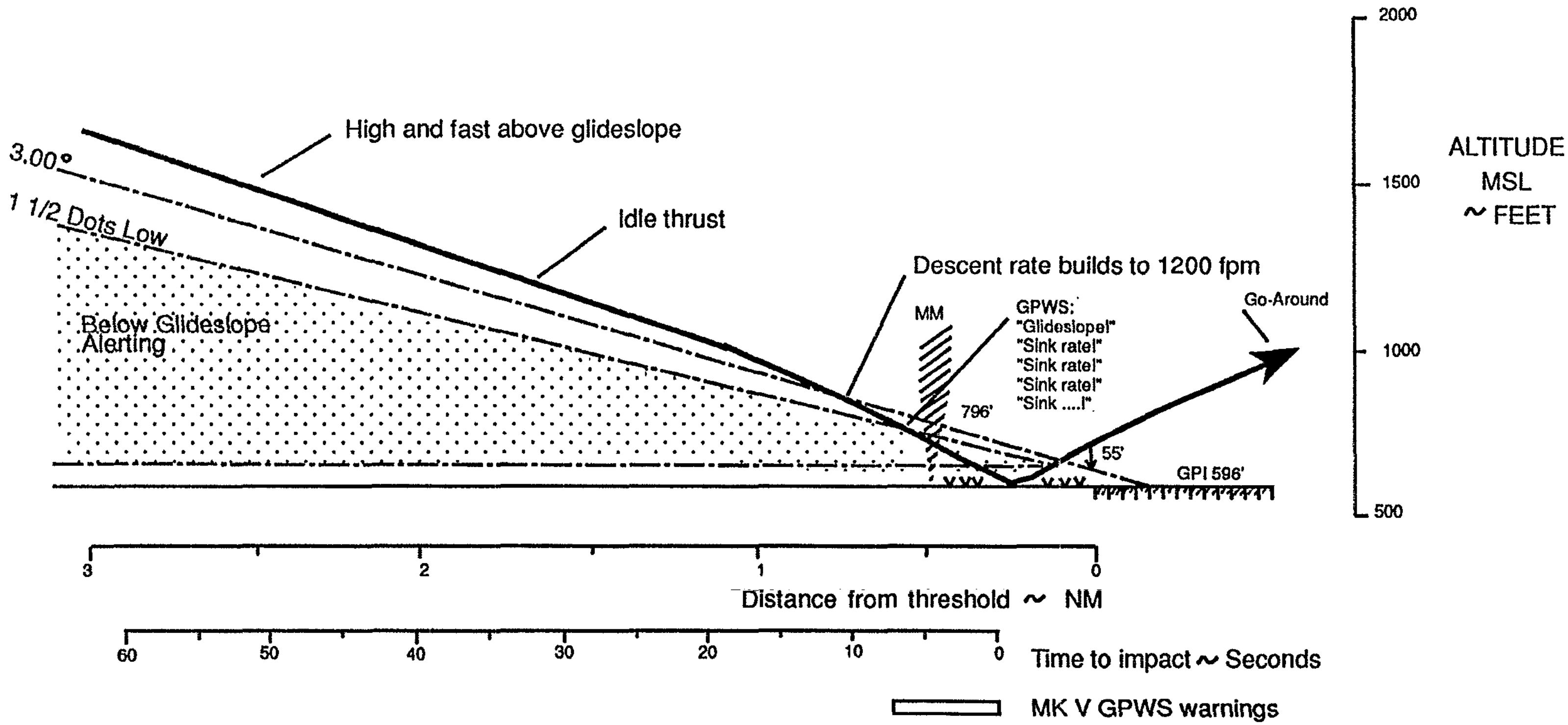
CIRCUMSTANCES:	While on final approach to ILS-2 runway 18L, the aircraft impacted 1800 feet short of the threshold into approach lights. The approach had been accelerated because of reduced visibility which resulted in an unstabilized approach.
WEATHER	RVR 6000 deteriorating.
CONFIGURATION:	Landing configuration. Flaps 40.
TIME:	04:50 Early morning.
DAMAGE:	No one hurt of 69 people on board. Aircraft took out 4 sets of approach lights, damaging the engine nacelles, flaps, and the rear fuselage.
OTHER:	Aircraft equipped with MK V GPWS which provided a timely alert, allowing the captain, with assistance from the first officer, to recover.
	F/O FMS inoperative. F/O tried to re-enter the approach parameters from runway 17R to runway 18L and the Captain's FMS. This kept the F/O's head down and when alerted by GPWS his attention and eyes went to the EADI to help in the recovery.

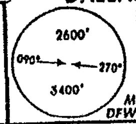
Flight Path Profile
B737-300
DALLAS FT. WORTH, TEXAS
8 December, 1993



Don Bateman

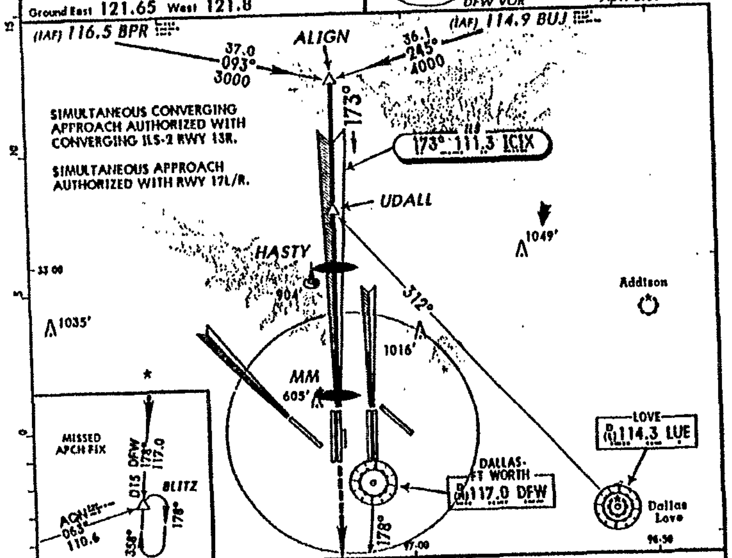
Return to TOC

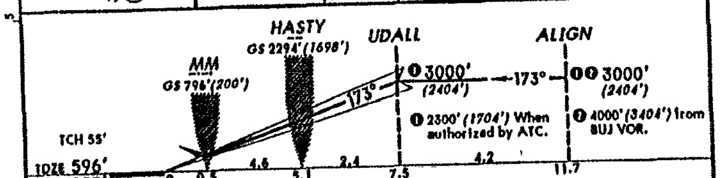
ATIS Arrival 117.0 134.9
REGIONAL Approach (R) East 119.05 West 125.8
REGIONAL Tower East 126.55 West 124.15
Ground East 121.65 West 121.8



DALLAS-FT WORTH, TEXAS
DALLAS/FT WORTH INTL
CONVERGING ILS-2 Rwy 18L

LOC 111.3 ICIX
Apt. Elev 603'





MISSED APPROACH: Climb to 3300' outbound via DFW VOR R-178 to BLITZ INT and hold.

STRAIGHT-IN LANDING RWY 18L

	ILS DA(H) 796' (200') FULL	ILS DA(H) 796' (200') TDZ or CL out	ILS DA(H) 796' (200') RAIL or ALS out	ILS DA(H) 846' (250') MM out	LOC (GS out)
A	RVR 18 or ½	RVR 24 or ½	RVR 40 or ¾	RVR 24 or ½	NA
B	RVR 18 or ½	RVR 24 or ½	RVR 40 or ¾	RVR 24 or ½	NA
C	RVR 18 or ½	RVR 24 or ½	RVR 40 or ¾	RVR 24 or ½	NA
D	RVR 20 or ½	RVR 24 or ½	RVR 40 or ¾	RVR 40 or ¾	NA

Gnd speed-Kts	70	90	100	120	140	160
GS 3.00°	377	485	539	647	755	862

DALLAS-FT WORTH, TEXAS
DALLAS/FT WORTH INTL

GENERAL
During taxi, change Ground Control frequency when crossing the bridges dividing east and west airport sectors.

ADDITIONAL RUNWAY INFORMATION

RWY			USABLE LENGTHS LANDING BEYOND Threshold	USABLE LENGTHS LANDING BEYOND Glide Slope	TAKE-OFF	WIDTH
13L	HIRL CL TDZ VASI(3 bar)-L	grooved				200'
31R	HIRL CL MALSR TDZ	grooved		7945'		
13R	HIRL CL MALSR TDZ	grooved RVR		8220'		150'
31L	HIRL CL TDZ	grooved RVR				
17L	HIRL CL ALSF-II TDZ	grooved RVR		10,338'		150'
35R	HIRL CL MALSR TDZ	grooved RVR				
17R	HIRL CL MALSR TDZ	grooved RVR		10,333'		200'
35L	HIRL CL TDZ ❶ VASI(3 bar)-L	grooved RVR				
18L	HIRL CL MALSR TDZ	grooved RVR		10,302'		200'
36R	HIRL CL TDZ ❷ VASI(3 bar)-L	grooved RVR				
18R	HIRL CL ALSF-II TDZ	grooved RVR		10,298'		150'
36L	HIRL CL MALSR TDZ	grooved RVR		10,373'		
18S						100'
36S						

❶ Upwind angle 3.25°, downwind angle 2.75°.

❷ Upwind angle 3.25°, downwind angle 2.75°.

TAKE-OFF

	Rwys 17L/R, 18L/R, 35L/R, 36L/R CL & RCLM (any RVR out, other two req.)	Rwys 17L/R, 18L/R, 35L/R, 36L/R Adequate Vis Ref	Rwys 17L/R, 18L/R, 35L/R, 36L/R STD	Rwys 13R, 31L CL & RCLM	Rwys 13R, 31L Adequate Vis Ref	Rwys 13R, 31L STD	Rwys 13L, 31R Adequate Vis Ref	Rwys 13L, 31R STD
1 & 2 Eng	TDZ RVR 6, Mid RVR 6, Rollout RVR 6	RVR 16 or ¼	RVR 50 or 1	TDZ RVR 6, Rollout RVR 6	RVR 16 or ¼	RVR 50 or 1	¼	1
3 & 4 Eng	TDZ RVR 6, Mid RVR 6, Rollout RVR 6	RVR 16 or ¼	RVR 24 or ½	TDZ RVR 6, Rollout RVR 6	RVR 16 or ¼	RVR 24 or ½	¼	½

FOR FILING AS ALTERNATE

	ILS-1 Rwy 17L/R, ILS-1 Rwy 13R, ILS-1 Rwy 18L/R, ILS-1 Rwy 31R, ILS-1 Rwy 35R, ILS-1 Rwy 36L, Converging ILS-2 Rwy 17L/R, Converging ILS-2 Rwy 18L/R, Converging ILS-2 Rwy 35R, Converging ILS-2 Rwy 36L	LOC-1 Rwy 17L/R, LOC-1 Rwy 13R, LOC-1 Rwy 18L/R, LOC-1 Rwy 31R, LOC-1 Rwy 35R, LOC-1 Rwy 36L, NDB Rwy 17R, NDB Rwy 35R	Converging ILS-2 Rwy 31R	Converging LOC-2 Rwy 17L/R, Converging LOC-2 Rwy 18L/R, Converging LOC-2 Rwy 35R, Converging LOC-2 Rwy 36L, Converging ILS-2 Rwy 13R, Converging LOC-2 Rwy 13R, Converging LOC-2 Rwy 31R
A	600-2	800-2	900-2½	NA
B	600-2	800-2	900-2½	NA
C	600-2	800-2	900-2½	NA
D	600-2	800-2	NA	NA

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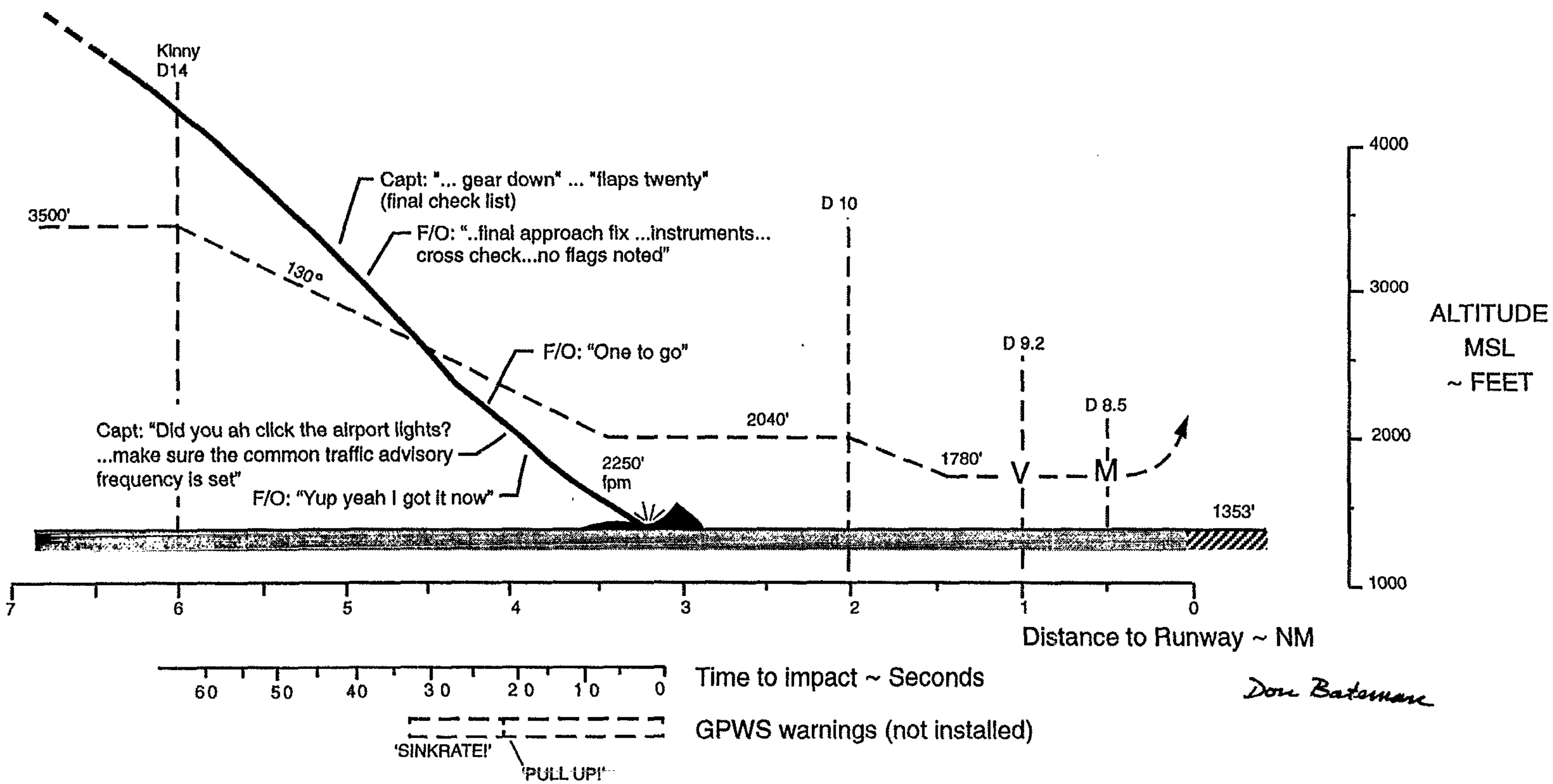
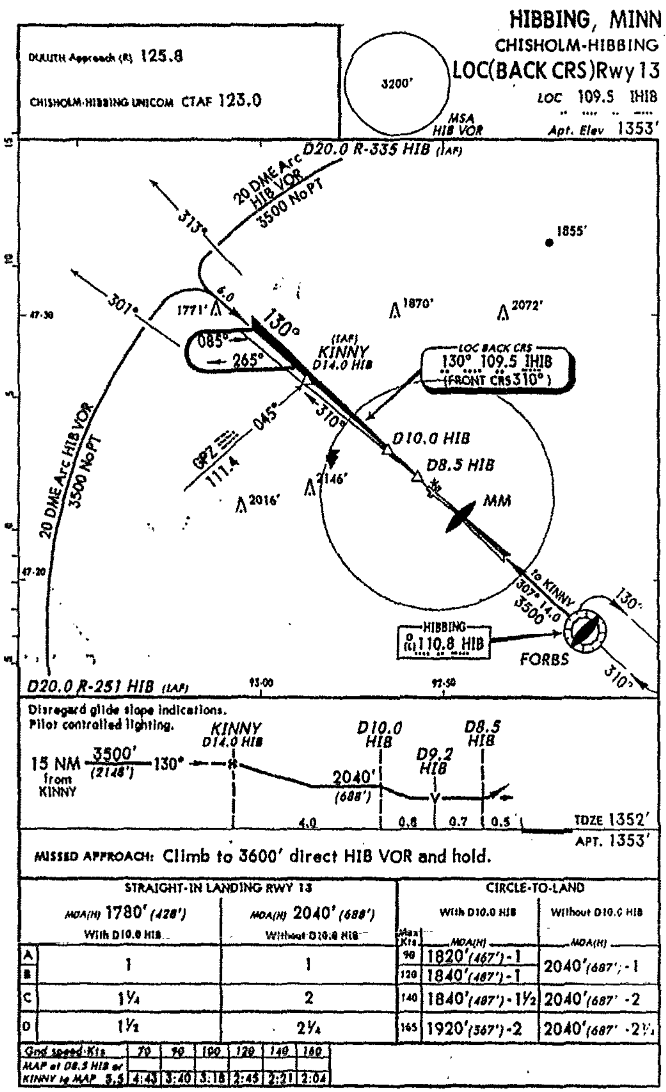
CIRCUMSTANCES:	On final approach to LOC-B/C Runway 13, the aircraft impacted 3.2 NM short of the runway at 19:58 CST. Both captain and co-pilot very experienced in type. (6500/2000 hrs respectively)
WEATHER:	Fog, 1 mile visibility, freezing drizzle, wind 180/10 kts
CONFIGURATION:	Landing gear down, flaps 20.
FATALITIES:	18 including two crew.
OTHER:	No GPWS installed, but GPWS was recently being added to sister ships. No signs of apparent icing. Aircraft kept deliberately high at 8000 feet to minimize risk of icing. Late completion of landing check list. Captain's experience was 7800 hrs., 2260 hrs. in type.

Estimated Flight Path Profile JS-31 HIBBING, MINN. 1 December, 1993





18 killed in Minnesota plane crash

The Associated Press

HIBBING, Minn. — A Northwest Airlink commuter plane crashed last night in foggy, rainy weather near downtown Hibbing, killing all 18 people aboard, authorities said.

The plane, a twin-engine turboprop, crashed into a huge mound of iron-ore waste in a park east of Hibbing, about 200 miles north of Minneapolis, police said.

There were no survivors among the 16 passengers and two crew members, said Mort Edelstein, a spokesman for the Federal Aviation Administration. Airline spokesman Jon Austin confirmed a total of 18 dead.

Austin said the plane, Flight 5719 from Minneapolis to Hibbing, was a Northwest Airlink commuter plane operated by Express Airlines II, Inc.

Express Airlines spokesman Jeff Weherenberg said 11 of the passengers had been expected to get off the plane in Hibbing and five were scheduled to continue on a flight to International Falls on the Canadian border.

Edelstein said the plane was two to three miles from the airport at an altitude of 7,500 feet when it disappeared from radar.

"The last thing the controller saw was a plane dropping off the scope," Edelstein said.

Austin said the plane apparently was on its approach to the airport.

The plane was found upside down, broken in three pieces and resting on a bank of dirt, firefighters said.

Bill Hanegmon, a sheriff's deputy who was the first rescue worker on the scene, said the plane appeared to have skidded across a road and into the side of the hill. There was no sign of an explosion, but debris was scattered over about 50 yards.

The surrounding area was covered with as much as two feet of snow and initially was reachable only on foot or by snowmobile.

The weather at the time of the crash was foggy with freezing drizzle, but it was not immediately known whether those conditions contributed to the crash.

Hibbing is in the heart of the Iron Range, an area in northeastern Minnesota where taconite — used in steel making — is produced.

Brent Bahler, a spokesman for the National Transportation Safety Board in Washington, said an NTSB investigative team was flying from Washington to Hibbing. FAA officials in Chicago said the British Aerospace Jetstream 31 twin-engine jet prop made no distress call before the crash.

■ This report contains material from Reuters news service.

Seattle PI 93/12/02

Federal investigators seek reason for airliner crash

HIBBING, Minn. — Federal investigators yesterday began searching for a way to explain why an Express Airlines II turboprop crashed into a pile of mining waste Wednesday night, leaving at least 18 people dead. It was Minnesota's worst aviation disaster.

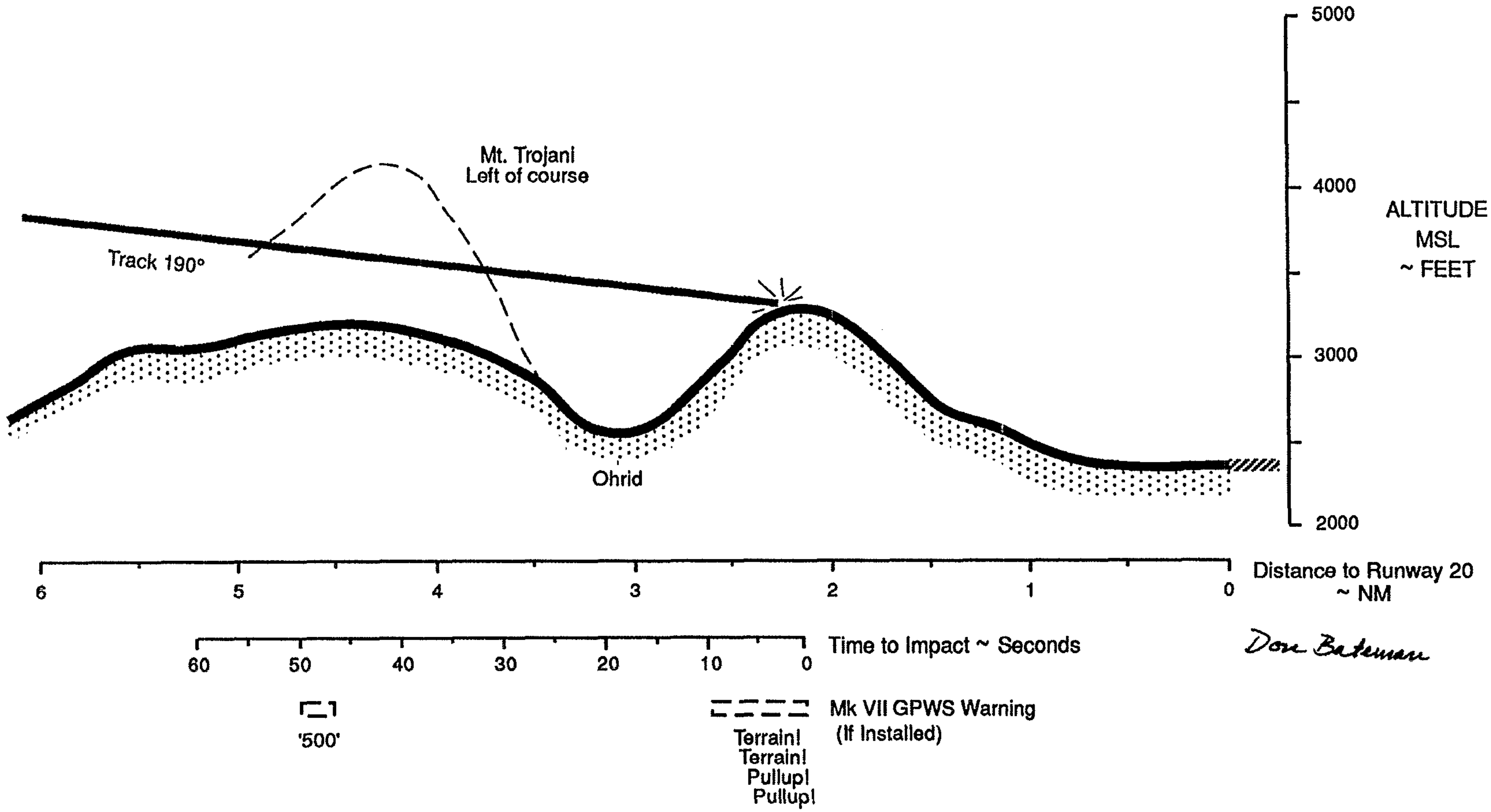
The Twin Cities-to-Hibbing flight was carrying business travelers, including several prominent northern Minnesota residents.

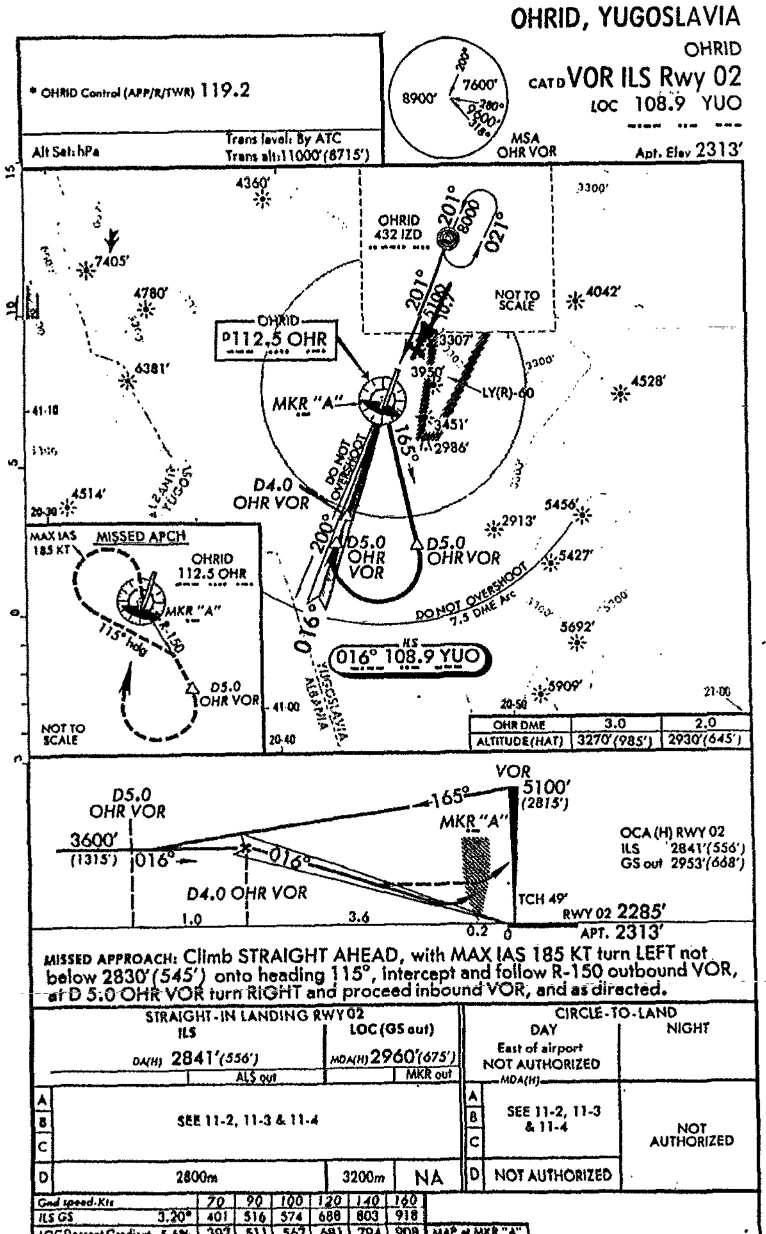
Original reports said the plane carried 16 passengers and two crew members, but there was subsequent uncertainty about possible last-minute boardings at Minneapolis-St. Paul International Airport. The aircraft involved is a British Aerospace Jetstream 31, owned and operated by Atlanta-based Express Airlines II as part of the Northwest Airlink system.

Probable Flight Path Profile YAK-42 OHRID, MACEDONIA 20 November, 1993

CIRCUMSTANCES:	During a probable visual let down in bound from the IZD NDB, after seeing the runway and the town of Ohrid, the aircraft clipped a hill slightly left of course.
WEATHER:	Visibility 9 miles, some clouds shrouding mountain.
TIME:	Approximately midnight
CONFIGURATION:	Approach landing gear down.
FATALITIES:	115 out of 116 on board (8 crew).

A primative GPWS may have been installed (generates a tone).
Status not known.





The Seattle Times Sunday 21 Nov. '93

High death toll is feared in Macedonia plane crash

SKOPJE, Macedonia — A jetliner diverted because of a blizzard crashed in snow-covered mountains in southwest Macedonia with 116 people aboard, state-run radio reported today.

Three people were rescued. The rest were feared dead in last night's crash near Ohrid, 65 miles south of the Macedonian capital of Skopje.

The Soviet-made Yak-42 belonging to the Macedonian carrier Avioimpex was approaching Ohrid for landing when it crashed into a mountain and burst into flames, Macedonia radio said.

The flight originated in Geneva and was headed to Skopje, but was diverted because of the blizzard.

Most of the 108 passengers and eight crew members were thought to be Macedonians and ethnic Albanians, radio said.

The front section of the medium-range 120-passenger jet burned for at least five hours. Heavy snow and rugged terrain were ham[illegible]g rescue attempts.

Plane slams into snowy hill in Macedonia; rescue stalled

SKOPJE, Macedonia — An aircraft with 116 people aboard crashed into a snow-covered hillside in southern Macedonia late yesterday, and police feared many casualties.

The snow, fire and mud hampered rescue attempts, and it was not immediately known how many people had escaped, interior ministry official Ljube Lezkov said. Macedonia radio said the aircraft had come from Geneva before crashing around midnight (6 p.m. EST) at Ohrid airport, 105 miles south of the Macedonian capital of Skopje.

The Soviet-made passenger plane, operated by the Macedonian airline Avioimpex, had been rerouted because of winter weather, the radio said.

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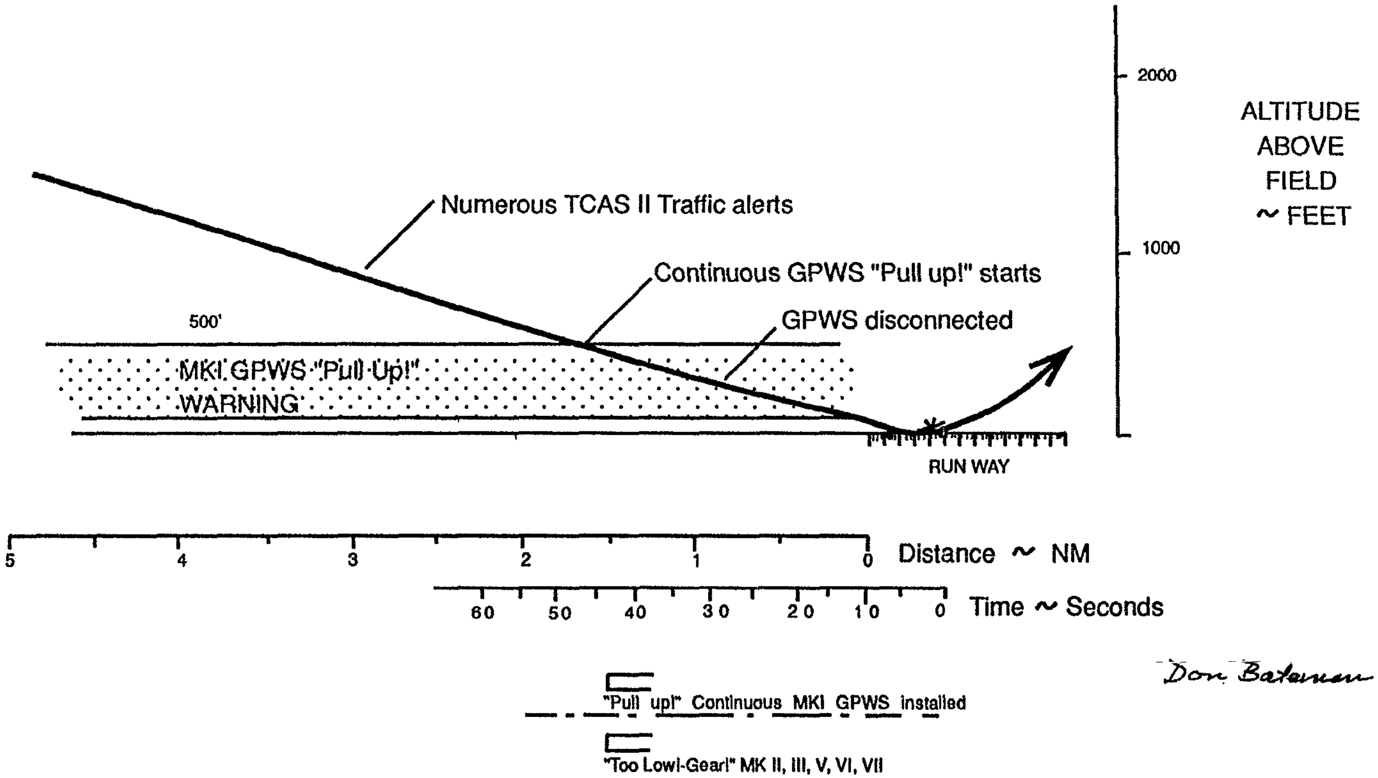
Flight Path Profile
B727-200
CHICAGO O'HARE, ILL
15 November, 1993

CIRCUMSTANCES:	The aircraft was on final approach from 18 NM on long final and configured with 25 degrees flap and landing gear up. The final check list was not completed because of TCAS Traffic alerts and other communications. A Mark I continuous GPWS "Pull up!" began at 500 feet AGL. After reviewing their descent rate, glideslope, and flap position, the F/E silenced the warning by pulling the circuit breaker. The landing gear configuration warning system was not triggered as power had not been reduced. A last moment call from the control tower resulted in a missed approach.
TIME:	Daylight
DAMAGE:	Belly and rear of aircraft damaged. Antennas sheared off.
INJURIES:	None of 88 on board.

NTSB Safety Recommendations AC-92-39 "....require that each warning provided by the GPWS to the flight crew be enhanced with an aural message that identifies the reason for the warning."
This has proved to be a delaying factor in many CFIT situations as pilots attempt to verify need and reason for a "Pull up!"



Don Bateman

Jet down safely, without landing gear

CHICAGO (AP) — An airplane carrying 88 people scraped its belly on the runway aborting its landing after learning from the pilot of another plane that its wheels weren't down.

Federal investigators were trying to determine Wednesday why the plane's landing gear didn't disengage and why alarms that should have alerted the pilot didn't sound.

"It was a potential disaster in the making," said Michael Benson, a spokesman for the National Transportation Safety Board in Washington.

The Continental flight landed safely after its close call Monday. No one was injured, but the rear one-third of the plane's bottom was badly scraped and holes were punctured in the fuselage.

The Boeing 727 was about 4 feet above a runway at O'Hare International Airport when an American Airlines pilot behind the plane radioed the control tower that the plane's landing gear wasn't down.

The tower immediately ordered the Continental jet to abort its landing. The rear third of the plane's underside apparently scraped against the runway as the pilot pulled up.

The plane could have burst into flames if it had made a belly landing, Benson said.

"When a plane has gear problems, they'll foam the runway," he said. "There's an awful lot of heat created and the control factor is minim... sometimes. You can end up, depending on the amount of fuel in the plane, with a very bad fire."

Continental spokesman Ned Walker said Flight 5148 from Houston had a seasoned crew. The seven crew members, who were not identified, were taken off flying status while the mishap was investigated.

The plane was flown without passengers to its base in Houston for inspection and repairs.

Pilot Blames Plane's System For Problem

By Don Phillips
Washington Post Staff Writer

The captain of a Continental Airlines Boeing 727 that almost crash-landed with its wheels retracted in Chicago on Tuesday said heavy traffic and constant collision warnings distracted the crew from its normal duties, the National Transportation Safety Board reported yesterday.

Continental Flight 1543 from Houston was within 50 feet of the runway with 88 people aboard when the three crew members realized that the landing gear was not down, officials said. The tail bumped the runway and was damaged as the plane rose successfully.

The captain's testimony to a safety board investigator is certain to fuel an ongoing dispute over the Tactical Collision Avoidance System (TCAS), designed to warn one plane that another is approaching on a possible collision course.

The system, required by the Federal Aviation Administration, has had software problems and been sharply criticized by pilots and air traffic controllers.

The veteran captain, not named by the safety board, said that the landing approach was longer than normal in heavy traffic and that the crew was distracted by numerous TCAS alerts. At 1,000 feet, an alert sounded, but the crew saw no plane in the area and discounted the warning as a "phantom" indication.

At about 500 feet, the Ground Proximity Warning System sounded a loud "Whoop, whoop, terrain" alert. That system activates if a plane is approaching terrain too fast or descends below 500 feet with gear up.

Seeing no obvious problem outside, the captain continued his approach until, at 50 feet, the crew saw that the green landing-gear lights in the cockpit were not illuminated. That was slightly before a warning call from the tower prompted by another pilot.

The disruptions on descent "caused a disruption in the normal procedures of using the landing checklist," the board said. A spokesman could not clarify whether the crew failed to perform checklist duty or was interrupted during it. Checklists are a required safety item in aviation.

THURSDAY, November 18, 1993

NTSB SAFETY RECOMMENDATION AC-92-39 : "....REQUIRED THAT EACH WARNING PROVIDED BY THE GPWS TO THE FLIGHT CREW BE ENHANCED WITH AN AURAL MESSAGE THAT IDENTIFIES THE REASON FOR THE WARNING."

Pilots forgot landing gear

CHICAGO — Warning alarms for nearby aircraft so flustered the crew of a passenger plane that they failed to lower the wheels as the plane came in for a landing, investigators said Thursday.

The Continental Airlines plane scraped the runway as the pilot aborted the landing Monday on instructions from the control tower at O'Hare International Airport.

Flight 1543 landed safely on a second approach. There were no injuries to the 88 people on board the flight from Houston to Chicago.

A National Transportation Safety Board investigator interviewed the three cockpit crew and determined that in the confusion of warning alarms, they failed to use the landing checklist, which would have indicated the wheels were not down.

Using the checklist is mandatory, said Tanya Christopherson, spokeswoman for the Federal Aviation Administration.

Don Bateman

Some historical incidents and accident that illustrate the need:

DATE	PLACE	AIRCRAFT TYPE	USA PART 121/125	REASON FOR "PULL UP"	CONSIDERED BY PILOT TO BE:	DAMAGE
15 Nov 93	CHICAGO	B-727	YES	GEAR UP	FALSE	FUSELAGE/ANTENNA DAMAGE
13 June 91	TAEGU, KOREA	B-727	NO	GEAR UP	CAPT: FALSE F/E: FLAPS	AIRCRAFT WRITTEN OFF
13 June 90	DALLAS FT. WORTH	DC-10	YES	GEAR UP		TOWER ALERTED CREW
02 Feb 89	HULBERT, FLA	C-141	-	HIGH DESCENT RATE	GEAR UP	DESTROYED - (8) FATALITIES
08 Feb 89	SANTA MARIA	B-707	YES	TERRAIN	TRYING TO DETERMINE CAUSE	DESTROYED - (144) FATALITIES
July 87	LONDON U.K.	B-747	YES	GEAR UP*	FALSE	TOWER ALERTED CREW - GO AROUND
03 July 87	CINCINNATI	B-737	YES	GEAR UP	FALSE	TOWER ALERTED CREW
04 Feb 86	ISLAMABAD	B-747	NO	GEAR UP	FALSE	HEAVILY DAMAGE TO FUSELAGE/ENGINES ~ $15M
07 Nov 85		DHC-5	YES	GEAR UP**	FALSE	HEAVY DAMAGE ~ $0.15M
07 Feb 85	CALCUTTA	B-737	NO	GEAR UP**	FALSE	HEAVY DAMAGE TO FUSELAGE/ENGINES ~ $2M
03 Nov 83	CASPER, WYOMING	B-737	YES	GEAR UP*	FALSE	HEAVY DAMAGE TO FUSELAGE/ENGINES ~ $1.5M
03 Jan 83	BERLIN, GERMANY	B-737	YES	GEAR UP**	FALSE	NACELLE AND E-GEN DAMAGE - GO AROUND LOSS OF POWER ~ $1M
09 Aug 82	MEXICO	B-727	NO	GEAR UP**	FALSE	HEAVY DAMAGE TO FUSELAGE ~ $2M
24 Aug 78	BUENOS AIRES	B-737	NO	GEAR UP*	FALSE	DESTROYED BY FIRE ~ $7M
08 May 78	PENSACOLA	B-727	YES	HIGH DESCENT RATE	CAPT. F/O-HI DESCENT RATE	IMPACTED SHORT INTO SALT WATER (3) FATALITIES *OUT OF 88*
04 April 78	ENGLAND	BAC 1-11	NO	GEAR UP*	F/E: FALSE	HEAVY DAMAGE TO FUSELAGE ~ $3.75M

* Configuration warning system apparently disabled.
** Training, with configuration system disabled.

CIRCUMSTANCES:	While on an ILS approach to runway 25, the aircraft hit short of the runway after hitting high voltage cables.
TIME:	14:56 local time
WEATHER:	Fog, 1000 meter visibility
CONFIGURATIONS:	Landing
FATALITIES:	12 with 30 injuries out of 92 passengers and 10 crew.
OTHER:	Aircraft equipped with MK II GPWS Two altimetry settings procedures used - QNH on captain's altimeter QFE on co-pilot altimeter Apparently crew did not understand english GPWS warnings, nor understood GPWS functions. No training?

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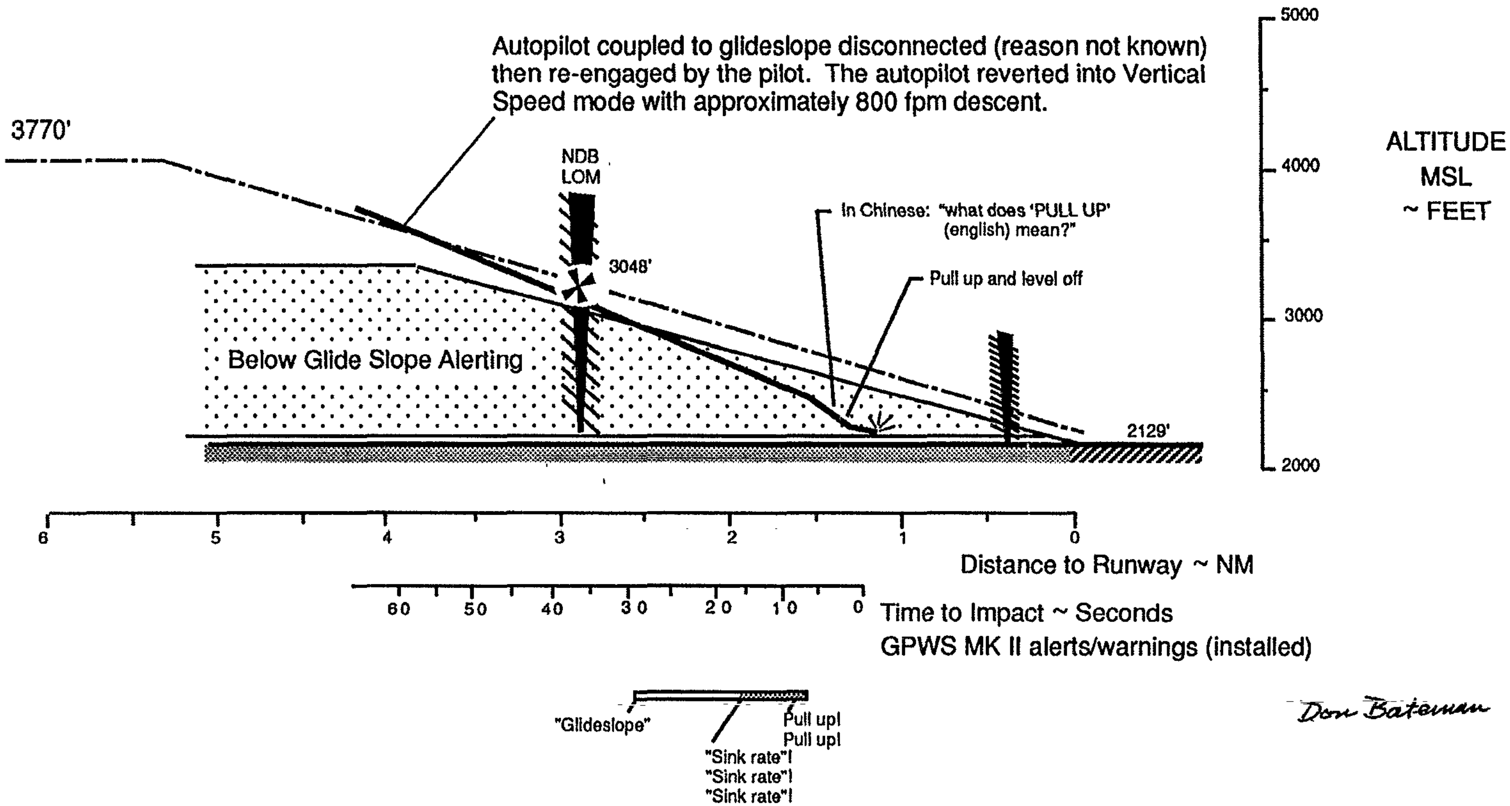
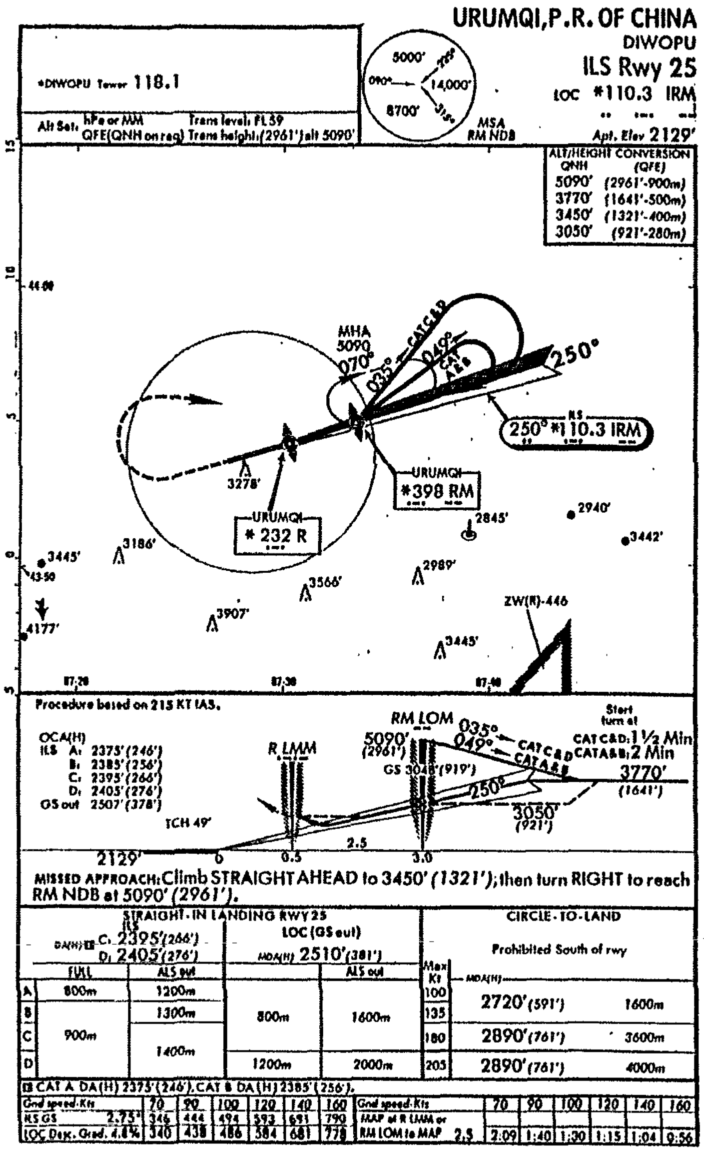
Estimated Flight Path Profile MD-82 URUMQI, CHINA 13 November, 1993



Don Bateman

Return to TOC



BLACK YEAR FOR AVIATION: The burnt out wreckage of the China Northern Airlines plane lies in a rice field near Urumqi airport. Picture. AP

22 passengers still missing after Urumqi disaster

ELEVEN people died and 60 injured when an airliner crashed on its landing approach to an airport in western China, a Chinese news agency reported yesterday.

The China News Service in Hongkong said another 24 people were reported missing after the MD-82 aircraft crashed and burnt on Saturday in a rice paddy about one kilometre from the airport in Urumqi, capital of Xinjiang province.

It said the China Northern Airlines plane crashed at 3.05 pm as it was arriving from Shenyang in the east via Beijing.

It did not mention weather conditions, but the pro-Beijing *Wen Wei Po* newspaper reported earlier that the plane crashed in heavy snow.

The newspaper said 12 people, all Chinese, were killed. The plane was badly burnt and only the cockpit was intact, the agency said.

It said the plane was carrying 92 passengers, nine crew and an aviation official.

The survivors included two Italians, while two Italians and a Japanese were among the injured, the newspaper added but did not give their names.

The crash was China's third aviation accident this year.

In July, a BAe 146 with 108 passengers and five crew crashed on takeoff, killing 58 Chinese and one Briton. In October, an MD-82 overshot a runway, killing two people.

Last year, there were five plane crashes in China, making it the worst year ever in Chinese aviation.

Official Chinese news reports have blamed slack safety procedures and violations of operating regulations. —Agencies

12 feared dead in mainland air crash

UP to 12 people were feared dead and more than 30 injured when a China Northern Airlines plane crashed near the northwestern city of Urumqi, it was reported yesterday.

Two or three passengers died on impact when flight CJ6901 crashed near a small village at 2.56 pm on Saturday as it approached Urumqi airport, an aviation official said in the capital of Xinjiang province.

But he said many more may have died of their injuries in hospital.

The China-funded *Wen Wei Po* in Hong Kong said 12 people were killed and more than 30 injured. Two Italians and a Japanese were among the injured, it said.

The paper said there were 92 passengers and 10 crew aboard the McDonnell Douglas 82 airliner which crashed en route from the northeastern city of Shenyang via Beijing.

Wen Wei Po said the crash occurred in poor visibility and the plane caught fire. But the blaze was soon put out. Initial reports suggested there may have been a fault with the plane's navigational system.

The *Guangming Daily* in Beijing said the plane crashed into the wheat fields of Diwobao village just two kilometres from the airport.

A survivor said as they neared Urumqi the plane had suddenly plunged towards the ground.

An Italian passenger on the flight said the pilot had tried to land in extremely foggy conditions and sent the plane veering into the field.

Stefano Orlandini said the plane later caught fire as passengers were being evacuated.

"I saw some people wounded, one maybe with a broken leg," he said.

Mr Orlandini got out safely with his Italian travelling companion.

Agencies

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CIRCUMSTANCES: During initial climb, the aircraft began a right turn at about 150 feet after retracting gear and flaps. The aircraft turned about 110 degrees without gaining any height and impacted trees in a 50 degree bank about 1.2 NM from the airfield.

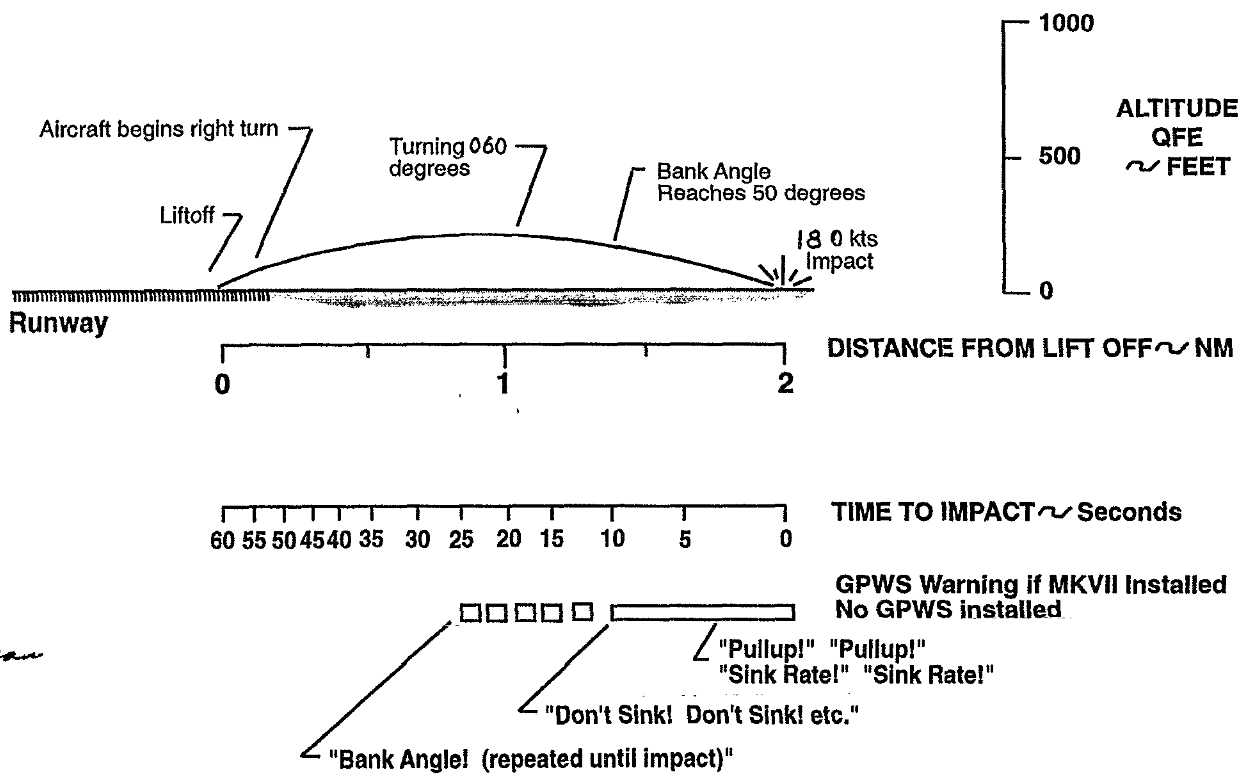
WEATHER: Light snow. Cloud base 700-1200 feet. Visibility 3-5 miles

TIME: 17:30 L Night

FATALITIES: 7

OTHER: This is a Classic Excessive Bank Angle Accident
Other examples are:
12 Jan '89 HS-748 (also a Canadian operated Aircraft)
19 Feb '88 Metro III
12 Nov '80 C-141
1 Jan '78 B-747

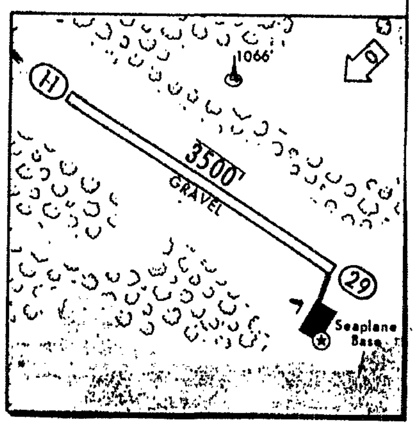
Flight Path Profile
HS 748
SANDY LAKE, ONTARIO
10 November, 1993

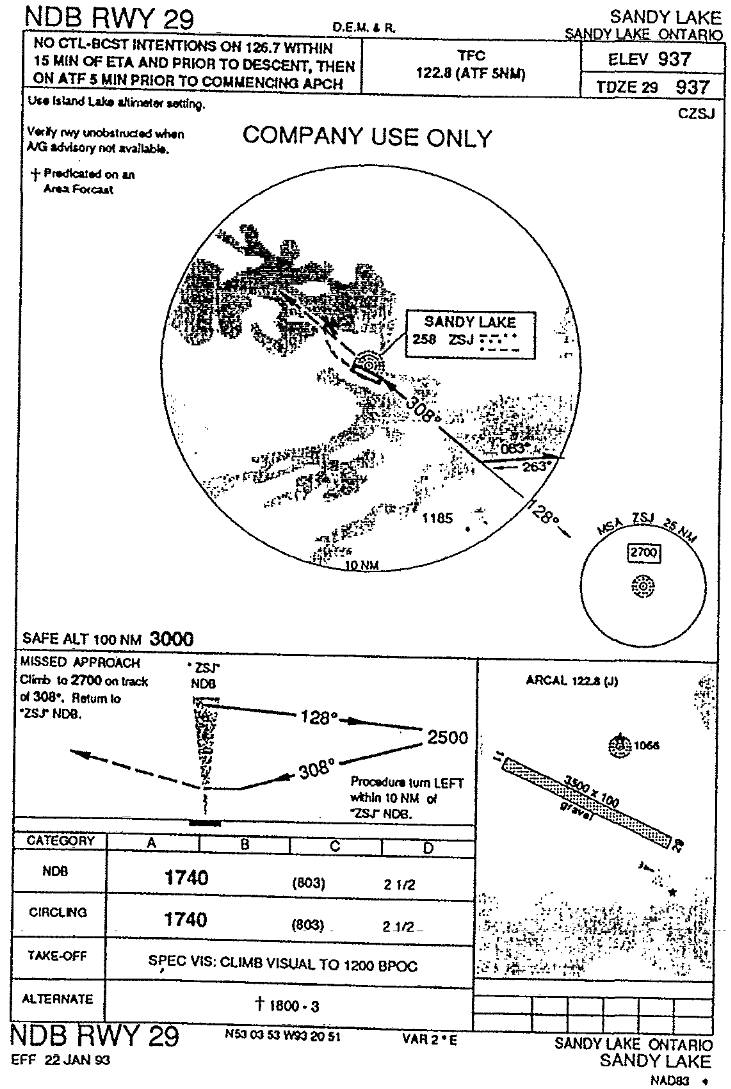


Don Bateman

SANDY LAKE, ONT. CZSJ

937'. Var 02°E. N53 03.9 W093 20.8.
Lights: Activate LIRL-122.8.
Rwy subject to seasonal/climatic variances.
Sandy Lake Traffic ATF 122.8.





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CIRCUMSTANCES: There have been at least three incidents at Anchorage, where 28.xx inches have been interpreted as 29.xx inches for the Barometeric Altimeter setting. This has placed the aircraft 1000 feet below the procedure altitude on approach.

MIS-SET BAROMETRIC ALTIMETER - 1000 FOOT ERROR

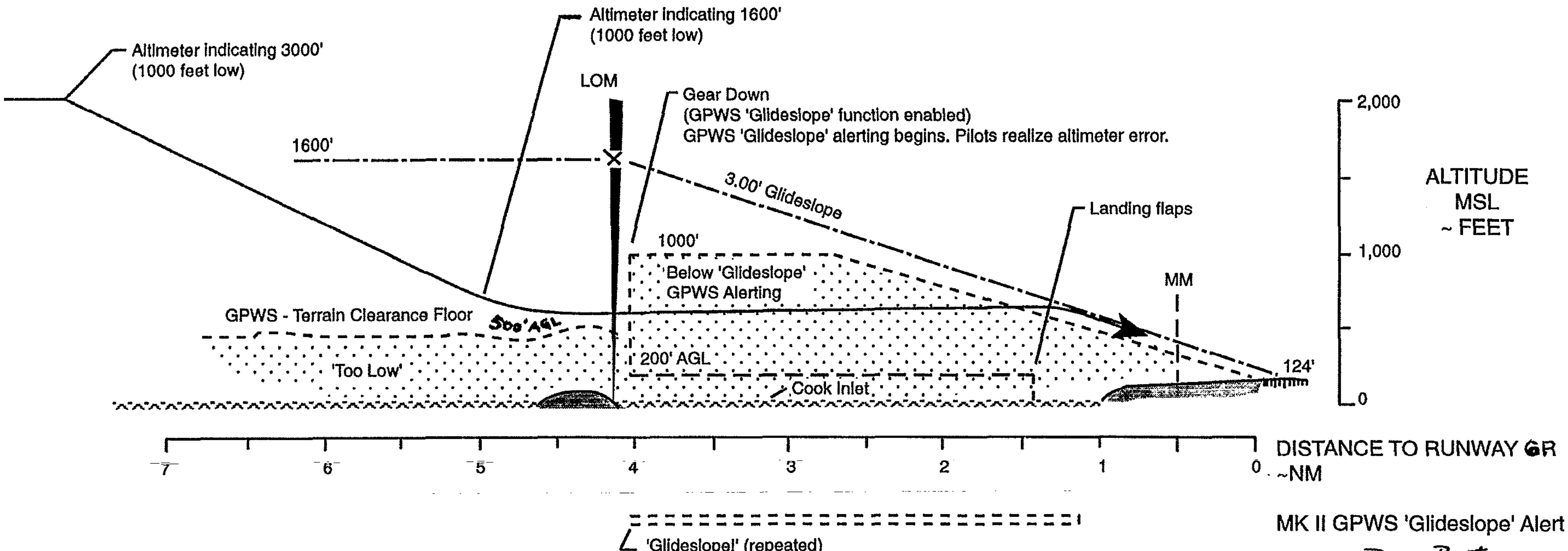
Flight Path Profile
B747 - 200
ANCHORAGE, ALASKA
November, 1993

THREE INCIDENTS

Three Incidents Nov. - Dec. 1993, March 1994

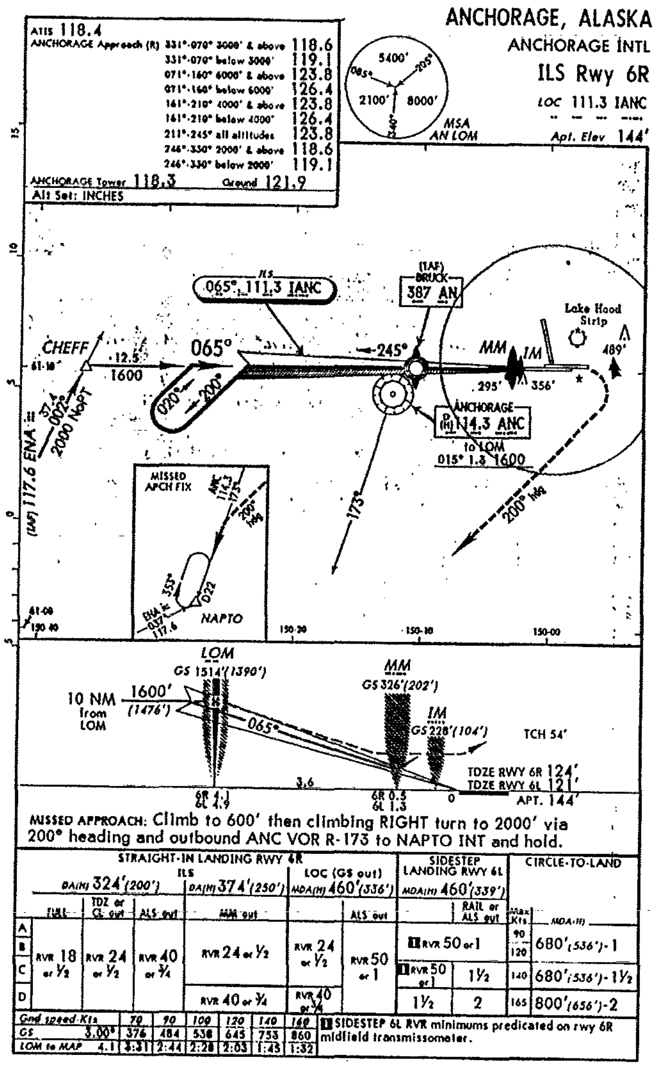
Other similiar Incidents:

Nov. 1991, Jet Stream 31, Kodiak, Alaska
17 Feb 1990 - B737-200, Boise, Idaho



MK II GPWS 'Glideslope' Alert

Don Bateman



MARCH 1994 - B767-300 REF: ASRS #265217

NARRATIVE : DURING VECTORS FOR APCH TO ANC ILS RWY 6R, ATC GAVE ALTIMETER SETTING 29.87 (SOUNDED LIKE AND WAS READ BACK). WE HAD 28.97 SET BUT, THINKING WE HAD COPIED WRONG DATA IN ATIS RPT, WE CHANGED TO 29.87. APCH CTLR ASKED OUR ALT AND WE VERIFIED IT WAS 2000 FT (CLRED TO 1600 FT). HE STATED HIS READOUT WAS MORE THAN 300 FT DIFFERENT THAN OUR RPTED ALT AND ADVISED ALT 'LOW 28.87' AND TO TURN OFF OUR ALT ENCODER AS IT WAS IN ERROR. WE XCHKED THE RADAR ALT AND RESET THE ALTIMETERS TO THIS SETTING AND ADJUSTED OUR ALT. REST OF FLT WAS NORMAL.

DECEMBER 1993 - B747-100F REF: ASRS #259230

NARRATIVE : WHILE DSNDING THROUGH 18000 FT, MISSET ALTIMETERS TO 29.86 INSTEAD OF 28.86, AFTER READING BACK INCORRECT SETTING TO CTR (WITH NO CORRECTION FROM THEM). WE WERE PROGRESSIVELY GIVEN LOWER ALTS (10000 FT, 5000 FT, 3500 FT, 1600 FT) BEFORE LEVELING OFF AT LAST ALT, SO BTWN MISSING THE WRONG SETTINGS ON ALL 3 FRONT INSTS, COMBINED WITH THE SO NOT CATCHING THE MISTAKE AND CTR/APCH NOT HEARING ME CALL BACK 29.86 NO PROB BECAME APPARENT UNTIL TURNING FINAL. WE WERE VECTORED ON BASE INSIDE THE MARKER AND AS WE PICKED UP THE GS WE REALIZED SOMETHING WAS WRONG WITH OUR ALT, SO WE LEVELED OFF AND I TOLD THE FO TO FOLLOW THE VASI. THE LNDG WAS NORMAL. I FIGURE WE WERE DOWN TO 700-800 FT OVER THE COOK INLET WHEN WE INTERCEPTED THE GS. I WAS UNDER THE IMPRESSION THAT ATC WAS SUPPOSED TO ANNOUNCE A LOW 28XXX WHEN ALTIMETER SETTING IS BELOW 29.00 INCHES.

NOVEMBER 1993 - B747-200 REF: ASRS #258851

NARRATIVE : DSCNT CLRNC GIVEN BY ATC WITH ALTIMETER SETTING 28.86. PNF READ BACK 29.86. ATC DID NOT CATCH MISTAKE. ON IN- RANGE CHKLIST, ALL 3 CREW CALLED 29.86 AND SET ALTIMETERS. DURING DSCNT, ATC CLRED US TO 5000 FT, 3000 FT, AND 1600 FT. ACFT WAS ALWAYS WELL ABOVE ALT CLRED TO WHEN NEXT LOWER ALT CLRNC WAS ISSUED. WE WERE CLRED FOR A VISUAL ON DOWNWIND AT 3000 FT INDICATED AND TURNED BASE TO DSND TO 1600 FT INDICATED (FAF ALT). INITIALLY CAPT DID NOT ACCEPT VISUAL TILL APCH GAVE US A TURN ONTO BASE LEG. THIS WAS INSIDE OM TO INTERCEPT FINAL. APCHING FINAL, WE HAD A GS GPWS WARNING. FO REALIZED ALTIMETER SETTING WAS WRONG AND MAINTAINED 1600 FT INDICATED TILL GS INTERCEPT. FO NOTED RADAR ALTIMETER WAS AT 700 FT AT GS WARNING POINT. NOTE: THIS APCH IS OVER WATER (SEA LEVEL). ON ROLLOUT, SO NOTED ALTIMETER WAS SET 29.86 AND SHOULD BE 28.86 SO WE WERE 1000 FT LOWER THAN INDICATED DURING DSCNT AND APCH. SO HAD 28.86 ON THE BUG CARD. CREW MISSED THIS ON 'IN RANGE' AND 'APCH' CHKLIST. ALSO, ATC SHOULD ALWAYS CALL 'LOW' WHEN SETTING IS BELOW 29.00 INCHES. NOW THEY DO SO SOMETIMES.

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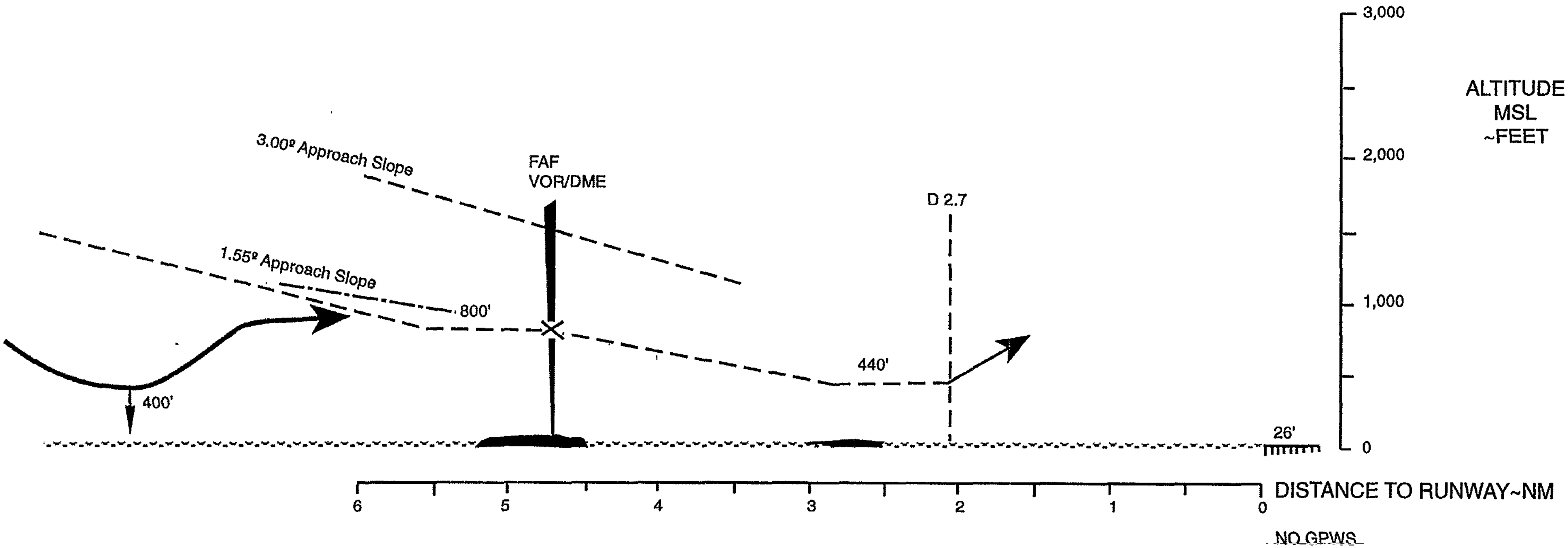
CIRCUMSTANCES:	During a VOR approach to runway 25, the aircraft descended to within 400 feet of the water. An incorrect altimeter setting of 29.82 instead of 28.82 inches of Hg, gave altimeter readings of 1000 ft error.
WEATHER:	Overcast 3000 feet, scattered, fog, visibility 5 miles, winds 010 at 20 kts.
MIS-SET BAROMETRIC ALTIMETER ERROR OF 1000 FEET ERROR	

Flight Path Profile
Jet Stream 31
KODIAK, ALASKA
November, 1993

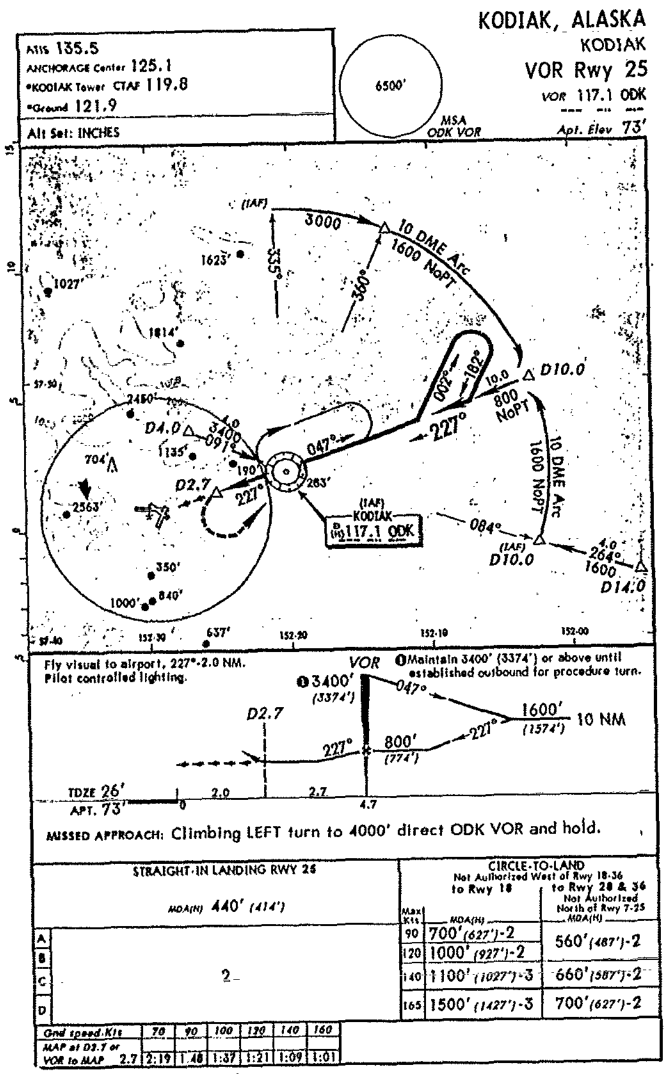
INCIDENT

Note: Abnormal low approach slope of 1.55 degrees further aggrevating altimeter error.



Don Bateman

Return to TOC



NARRATIVE : ENRTE TO ADQ, THE FO GOT WX FROM ENA RADIO AND COPIED AN ALTIMETER SETTING OF 29.82. JUST PRIOR TO DSCNT, HE PICKED UP THE ADQ ATIS. I WAS MONITORING THE #1 RADIO AND DID NOT HEAR THE #2, ON WHICH THE FO GOT THE ATIS. PASSING FL180, THE FO CALLED THE TRANSITION, ALTIMETERS 28.82. I QUESTIONED THAT SETTING, AND HE RECOUNTED, STATING THE SETTING OF 29.82. WE EXECUTED THE VOR RWY 25 VIA THE ARC. TURNING ONTO THE INBOUND COURSE, THE MINIMUM ALT IS 800 FT, TO WHICH I STARTED TO DSND. WE HAD BEEN IN AND OUT OF CLOUDS WITH A RAGGED CEILING AND LOW LIGHT CONDITIONS. MY FOCUS WAS INSIDE THE COCKPIT. AT ABOUT 1400 FT, OUT OF THE SIDE OF MY EYE, I NOTICED THAT THE WAVES ON THE WATER LOOKED AWFULLY CLOSE. I LOOKED OUT THE WINDOW AND GOT THE IMMEDIATE FEELING SOMETHING WAS HORRIBLY WRONG. I TOLD THE FO TO VERIFY ALTIMETER SETTING, AND TWR CAME BACK WITH 28.84. WE WERE ACTUALLY AT 400 FT, NOT 1400 FT! I ADDED MAX PWR AND CLBED UP TO 800 FT AND WE CONTINUED TO A LNDG ON RWY 36 WITHOUT FURTHER INCIDENT. I THANK GOD THAT CONDITIONS WERE NOT JUST A LITTLE WORSE, OR THERE HAD BEEN LESS LIGHT, BECAUSE WE WOULD HAVE DSNDED INTO THE WATER AT 180 KTS. TO HELP WITH THIS PROB, ONLY ALTIMETER SETTING GIVEN WHICH IS LESS THAN 29.00 INCHES, SHOULD BE READ 'ALTIMETER LOW, 28.XX.'

SOURCE: ASRS # 257941

CIRCUMSTANCES:	While on an ILS approach to runway 17, the aircraft descended to 500 AGL at the FAF. The Captain's glideslope receiver failed to zero deviation but with no flags. A MSAW Low Altitude Alert saved the day. There was no GPWS warning or below 'Glideslope' alert. Only the Captain's glideslope receiver is utilized with GPWS in typical installations.
WEATHER:	IMC

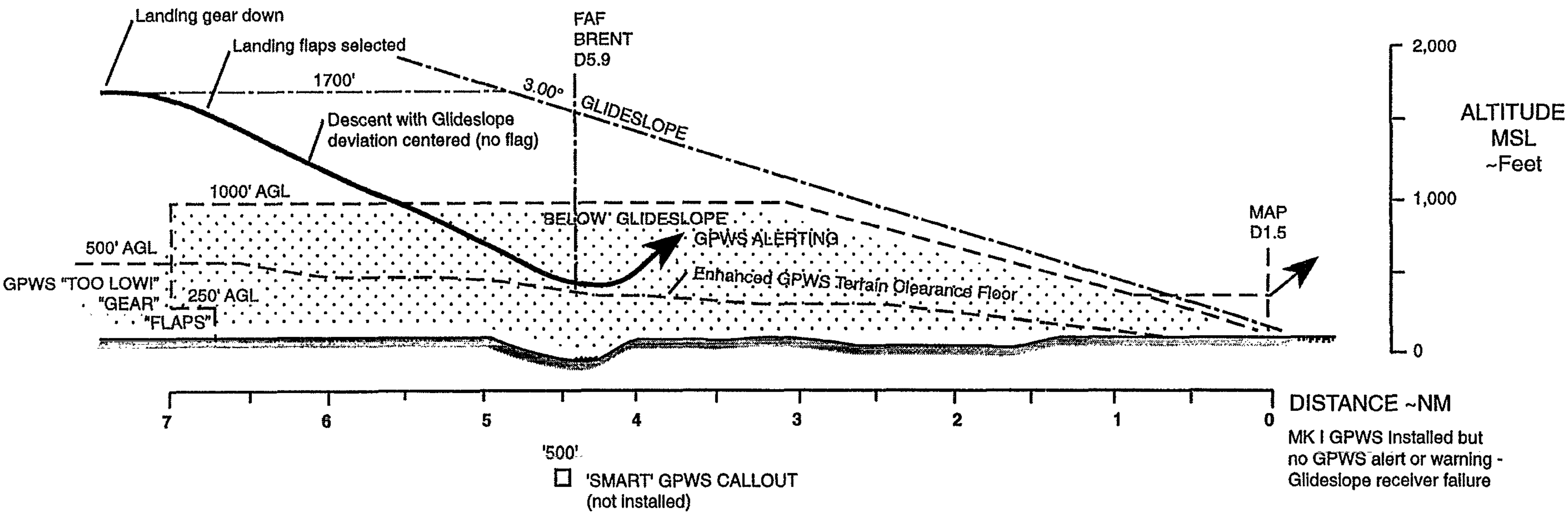
FAULTY GLIDESLOPE RECEIVER (NO GPWS ALERTS)

Flight Path Profile
DC-8-72 F
PENSACOLA, FLORIDA
November, 1993

INCIDENT

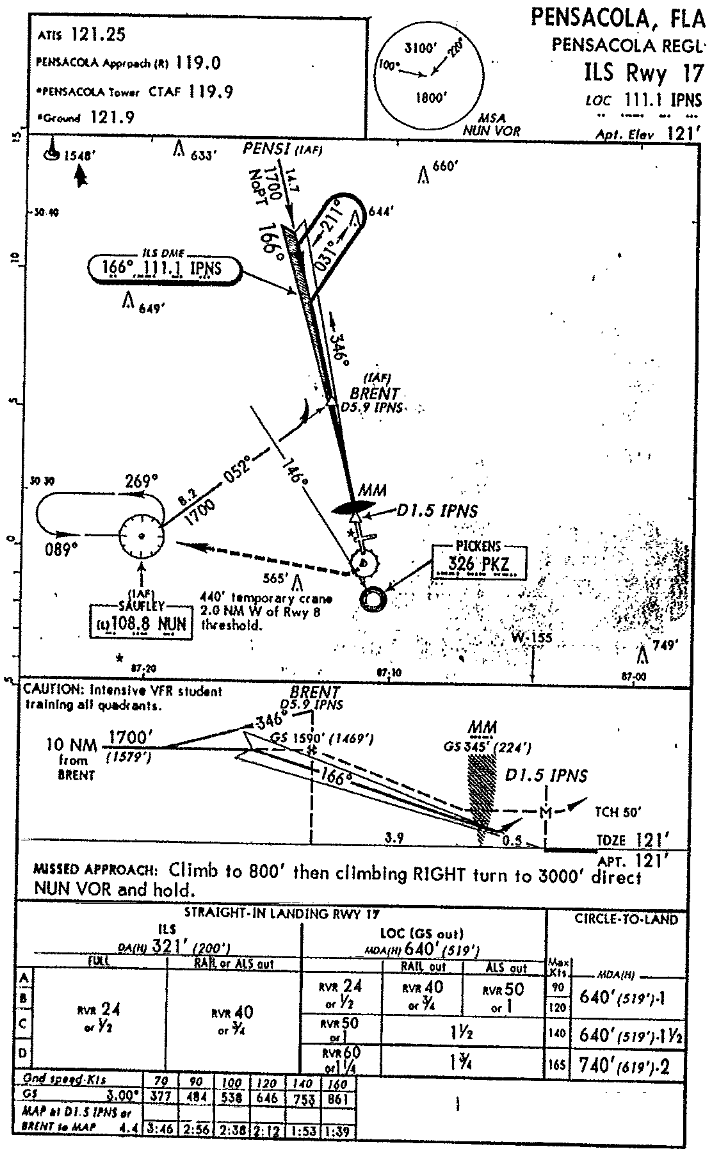
Past Accident examples of suspected glideslope receiver failures are:

- 14 November 1990 — DC-9/30 Zurich — 46 Fatalities
- 13 April 1987 — B707 Kansas City — 4 Fatalities



Don Bateman

Return to TOC



NARRATIVE : WHILE BEING VECTORED FOR THE ILS RWY 17 APCH AT PNS, BOTH NAV RECEIVERS WERE TUNED AND IDENTED BY MYSELF. LOC INTERCEPT OCCURRED NORMALLY WITH A FULL 'FLY UP' GS INDICATION ON BOTH GS INDICATORS. ESTABLISHED ON THE LOC, BOTH GS INDICATORS CAME 'ALIVE' AND THE ACFT WAS SUBSEQUENTLY CONFIGURED AS PER NORMAL PROC. THE GLIDEPATH WAS INTERCEPTED AND FOLLOWED NORMALLY. AT APPROX 500 FT AGL, THE APCH CTLR ANNOUNCED A 'LOW ALT ALERT' AND A MISSED APCH WAS INITIATED IMMEDIATELY. THE CTLR STATED OUR POS AS APPROX 'BRENT' ON THE FINAL APCH COURSE. WE SUBSEQUENTLY CLBED BACK UP TO OUR VECTORING ALT. I ASKED THEM TO CHK THEIR EQUIP AND, AT THE SAME TIME, CYCLED MY NAV RECEIVER AND RETUNED AND IDENTED MY ILS FREQ. MY INDICATOR #2 SUBSEQUENTLY APPEARED NORMAL AND THE #1 GS INDICATED ERRONEOUSLY (I.E, ON GS WITH NON FLAGS) FOR OUR POS (XWIND IN THE RADAR PATTERN). THE FOLLOWING APCH WAS FLOWN AFTER ASSESSING MY INDICATORS AS FUNCTIONAL, WITHOUT INCIDENT. THE #1 NAV REMAINED INCORRECT (ON GS/NO FLAGS) THROUGHOUT THE APCH. AS FOR CONTRIBUTING FACTORS, I CITE MAINLY EQUIP FAILURE, I.E., INCORRECT GS INDICATIONS AND #1 AND #2 NAV INDICATORS.

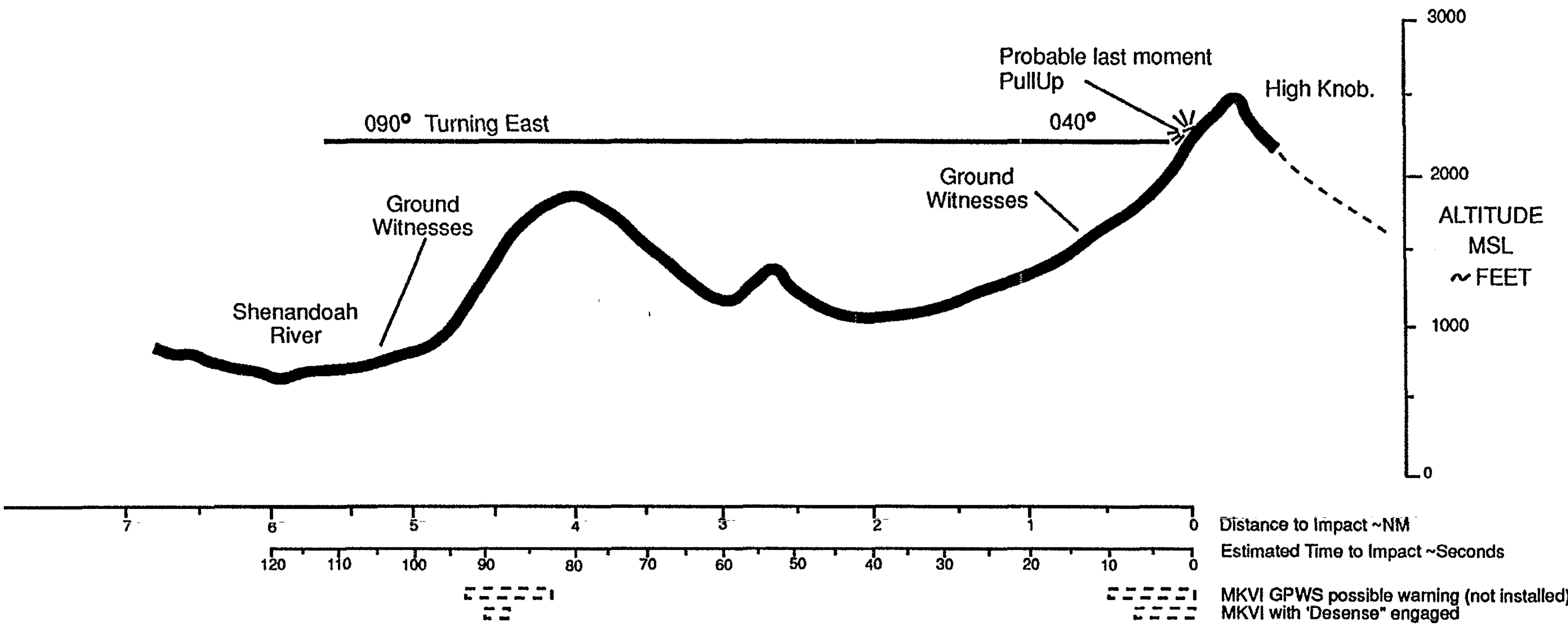
REF: ASRS #257086

Next Page

Probable Flight Path Profile
BE-90
WINCHESTER, VIRGINIA
26 October, 1993

CIRCUMSTANCES:	*While waiting for IFR clearance for Patrick Henry Airport (Norfolk) in local VMC to IMC* weather, the aircraft struck a Blue Ridge mountain. The aircraft had just completed flight inspection of the LOC navigation aids at Winchester airport.
WEATHER:	2200' broken, cloud and fog in the area.
TIME:	Approximately 16:00 EDT
CONFIGURATION:	Clear
FATALITIES:	3
OTHER:	No GPWS, CVR or FDR installed. None required on FAA aircraft.

There are at least two other recent CFIT accidents that illustrate the dangers of awaiting an IFR clearance while trying to maintain VFR, or below the TCA.
11 Dec. '91 - Rome, Ga., BE-400. (Day)
15 March '91 - Brown Field Ca., HS-125 (Night)



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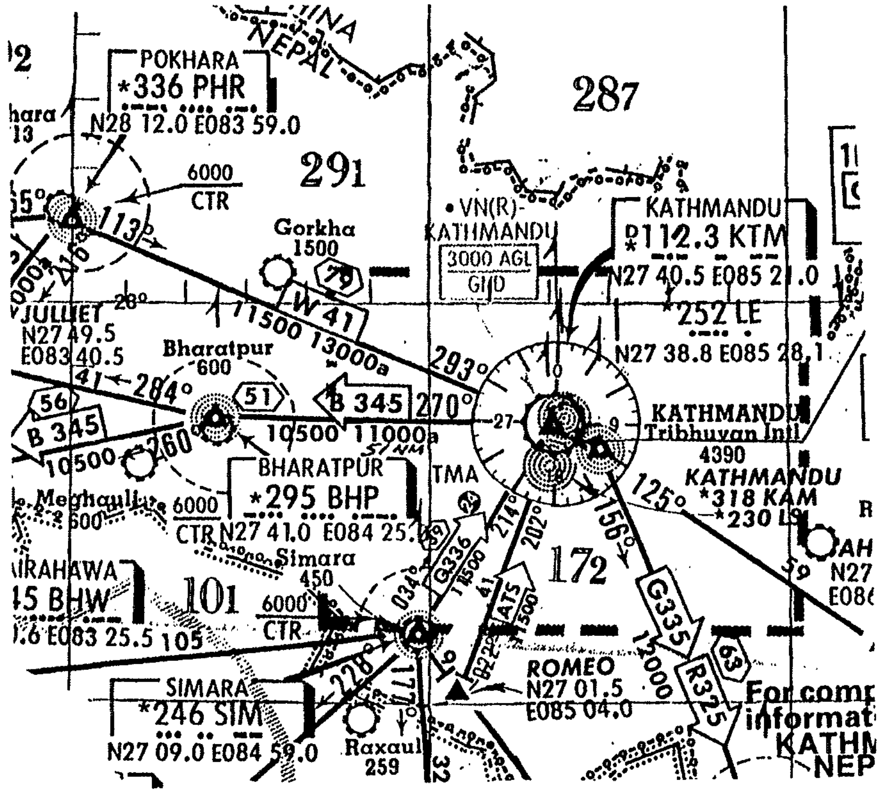
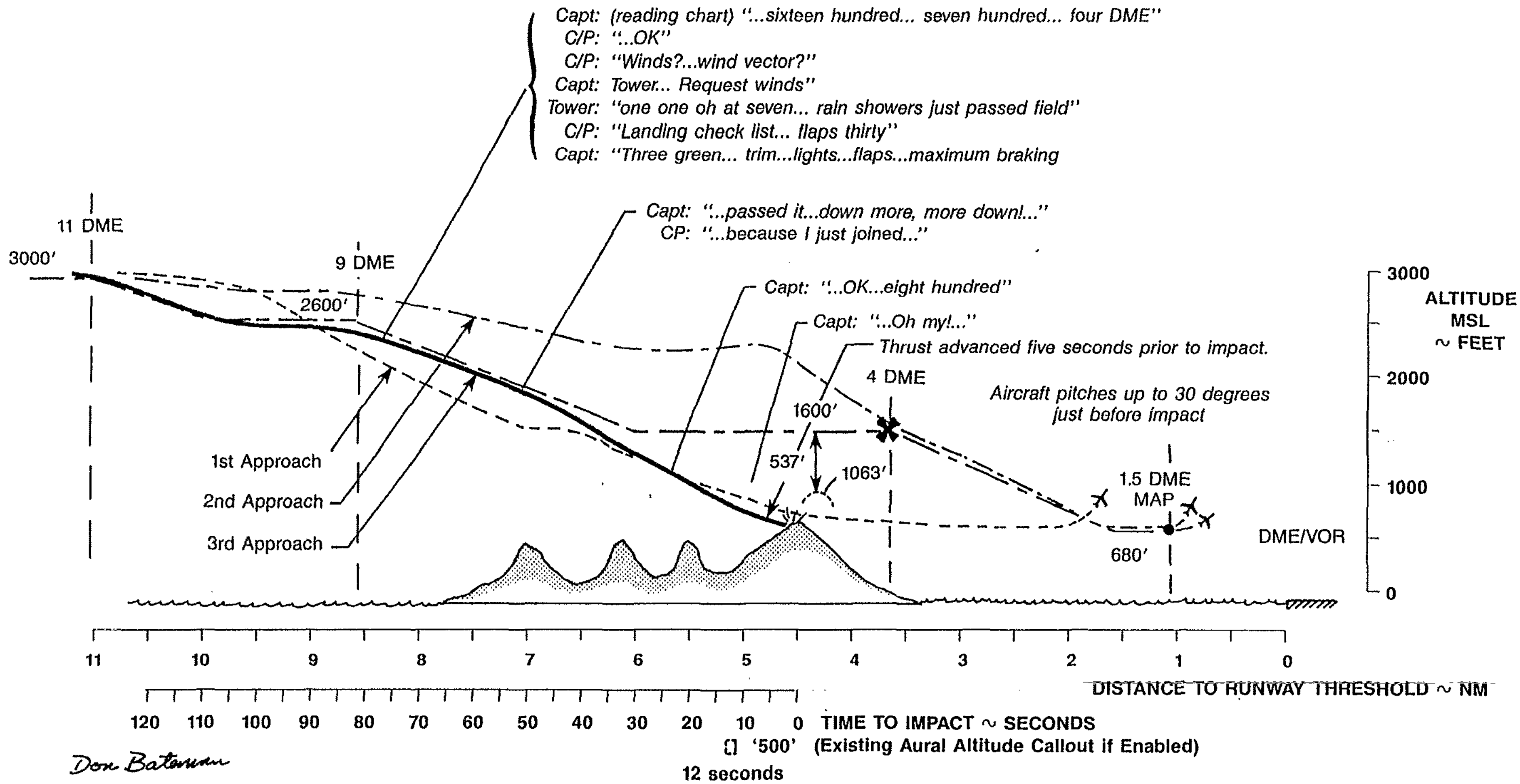

POKHARA
*336 PHR
N28 12.0 E083 59.0
291
287
Gorkha
1500
VN(R)-
KATHMANDU
3000 AGL
GND
KATHMANDU
112.3 KTM
N27 40.5 E085 21.0
*252 LE
N27 38.8 E085 28.1
JULIET
N27 49.5
E083 40.5
Bharatpur
600
W41
11500 13000a
B 345
270°
10500 11000a
KATHMANDU
Tribhuvan Intl
4390
KATHMANDU
*318 KAM
BHARATPUR
*295 BHP
N27 41.0 E084 25.
Simara
450
172
101
ROMEO
N27 01.5
E085 04.0
SIMARA
*246 SIM
N27 09.0 E084 59.0
Raxaul
259
G335
R325
G336
For comp
informat
KATHM
NEP


KATHMANDU
DESTINATION
Nārāyangar
NARAYAN GARH/36
MAGHAULI/38
490
JHAWANI
PĀTAN
4423
BHIMPHEDI

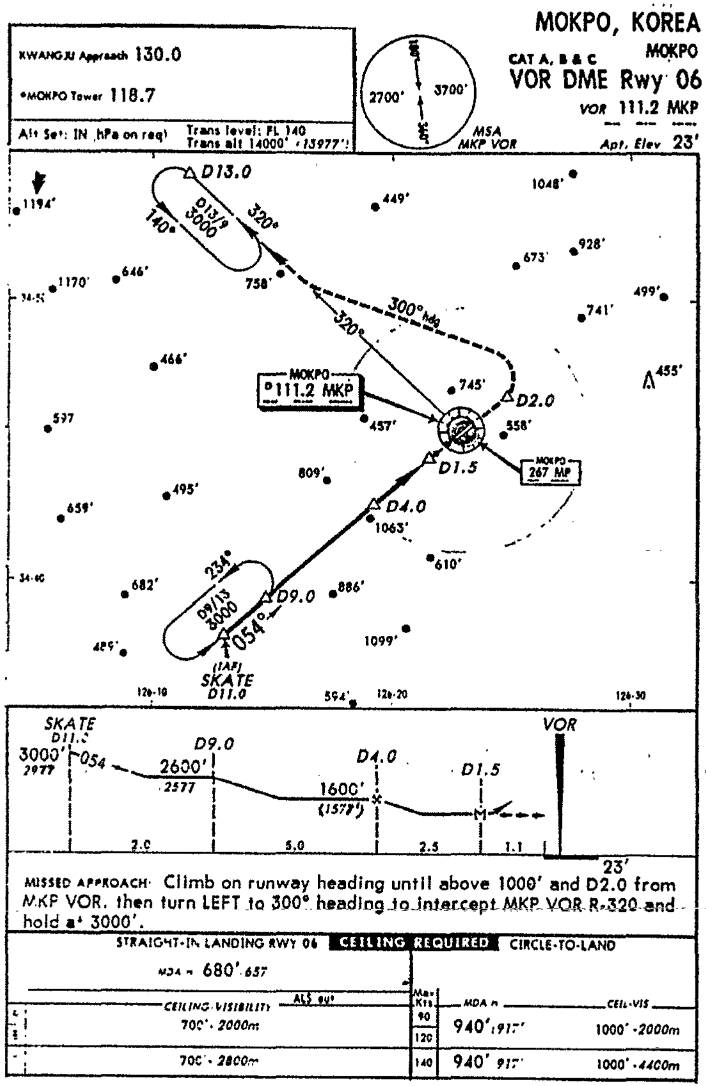
Circumstances:	On a third VOR DME approach to Runway 06, the aircraft impacted a ridge of terrain.
Time:	15:40 Local
Weather:	Overcast, low clouds, wind 1107KTS, rain shower had just passed air field, visibility 1 mile.
Fatalities:	68 out of 110 on board.
Configuration:	Gear down, Flaps 30 (landing).
Other:	MK V GPWS installed, no warning situation. Aural altitude callouts not used, they could have provided timely alert.

Next Page

Flight Path Profile
B737-500
MOKOP, KOREA
26 July, 1993



Return to TOC



Associated Press

A helicopter hovers over the wreckage of an Asiana Airlines Boeing 737-500 early today.

68 killed as South Korean 737 crashes during stormy landing

HAENAM TOWNSHIP, South Korea (AP) — A domestic jet carrying vacationing families crashed into a hill Monday on its third attempt to land in stormy weather, killing 68 of the 110 people aboard, the airline said.

Rescuers searched through the night on a rocky, muddy hillside for bodies and for more possible survivors. They said they refused to give up hope because not all the bodies of those reported dead had been found.

The Asiana Airlines Boeing 737-500 was bound from Seoul to Mokpo, nearly 200 miles southwest of Seoul on the Yellow Sea, when it crashed near Haenam in heavy wind and rain at 3:50 p.m., 20 miles from Mokpo airport, officials said.

The plane was reported missing for almost two hours before two survivors walked out of the remote, rugged crash region and into Haenam Township to seek help.

About 100 villagers rushed to the site — a two-hour walk along 25 miles of muddy paths — with farm implements to help pry survivors from the plane's fuselage, which they said was broken in three pieces. They were joined later by 400 police and rescue workers.

Soldiers blocked access to the crash site Tuesday. Family members of victims waited in a drizzle in a radish field for soldiers to carry bodies wrapped in light blue blankets and plastic from the crash site. Some families were angry that the bodies were being left in the field until they could be transported elsewhere.

"How can you leave my daughter out in the rain like a common dog?" screamed a woman after identifying the body of her daughter, Sung Chun.

The Transportation Ministry listed 51 bodies found, 44 survivors and 15 people missing early today. Some badly hurt survivors were flown by helicopter to nearby hospitals.

Passengers included many families with children on their way to southern villages for summer holidays. One child died en route to the hospital. Two were hospitalized in critical condition.

Flight attendant-survivor Park Jin-ah, 23, said the plane hit on its third attempt to land.

Next Page

Incident
Flight Path Profile
B737-200
CAPE TOWN, S. AFRICA
July 1993

Incident:

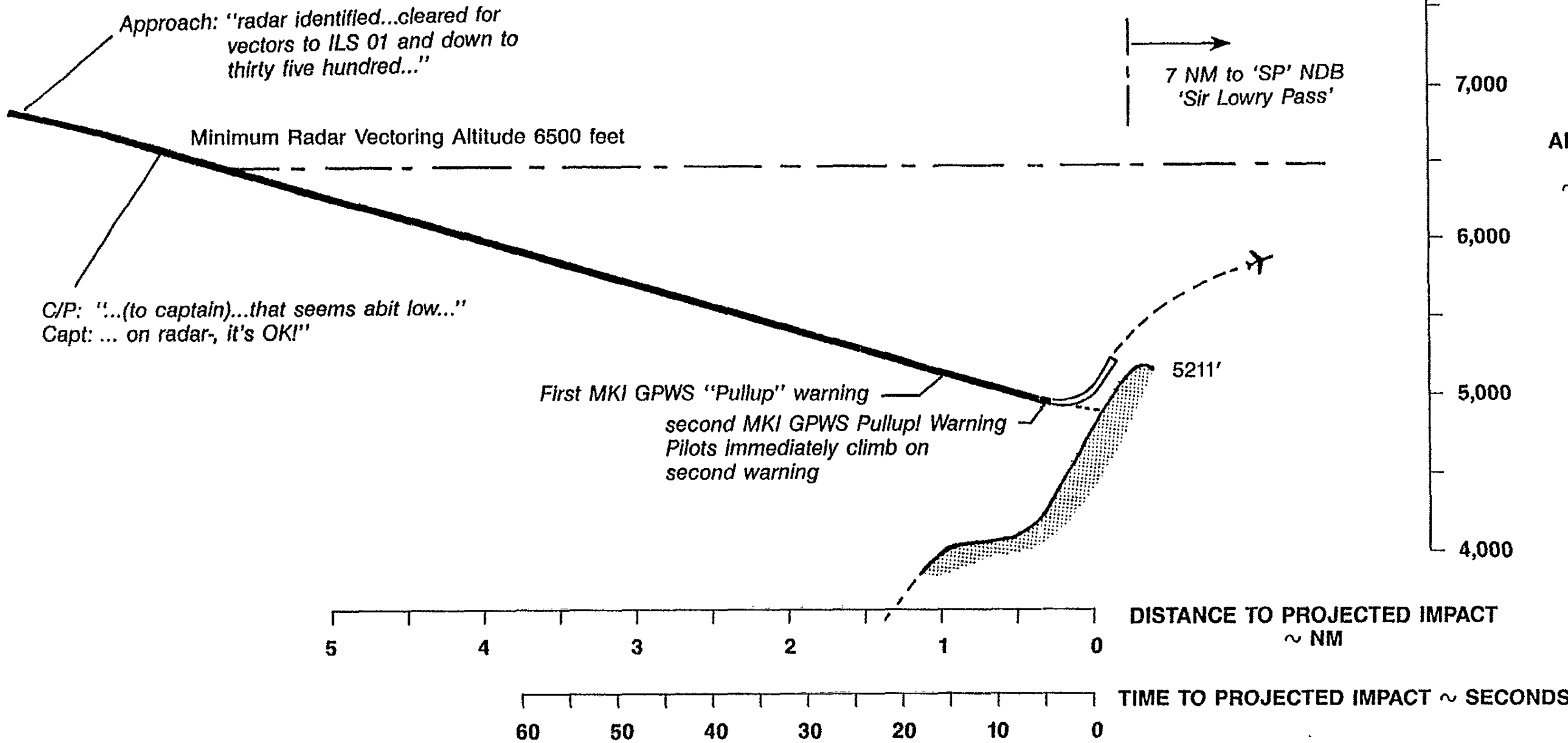
Circumstances: Aircraft was prematurely cleared down to 3500 feet under radar vecotrs to ILS/VOR/DME 01. 4500 feet below MSA. (Minimum should have been 6500 feet) Aircraft was descending, when a MKI GPWS issued a Pullup! warning. The pilots immediately climbed towards 3000 feet"

Time: Night

Weather: IMC

Other: Aircraft equipped with operational MKI GPWS

There has been at least one other incident in Capetown this year - rumored to involve a vector towards Table Top Mountain.

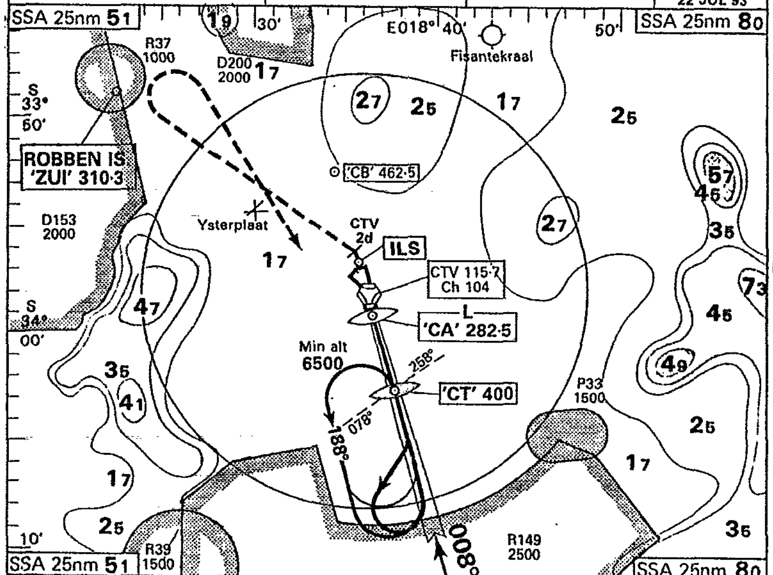


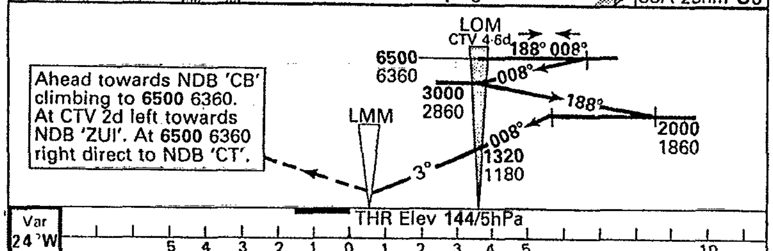
Return to TOC

Elev 151	OCH - ILS Cat 2 - A48, B59, C72, D83 ILS Cat 1-A130, B142, C150, D161

(D.F. MALAN) **CAPE TOWN**
CT 110.3 **ILS/NDB 01**

CAPE TOWN Approach 119·7	MALAN Tower 118·1	ATIS 115·7	M2 ZW EFF 22 JUL 93





LOM turn	kt	fpm	LOM
			T.Lev ATC T.Alt 7500
1:30	200	1060	–
1:40	180	950	THR
1:52	160	850	1:18
2:08	140	740	1:30
2:30	120	640	1:45
3:00	100	530	2:06
3:45	80	420	2:37

1. Initial approach altitude 6500 or higher MSA.
2. Descend in the hold to 3000.
3. Procedure turn approach applicable only within 30° of the outbound heading. Use phraseology 'Request procedure turn approach'.
4. Circling approaches between 010°M & 160°M are not authorised for Cat C & D aircraft.
5. Cat 2 operation and minima must be approved by DCA.

Rev: Restricted areas

Non Precision App
LOM 'CT' 1320 1180

G/S	+20s	+40s	+60s
160 kt	1040 900	750 610	470 330
140	1070 930	830 690	580 440
120	1110 970	890 760	680 540
100	1140 1000	970 830	790 650
80	1180 1040	1040 900	900 760

Next Page

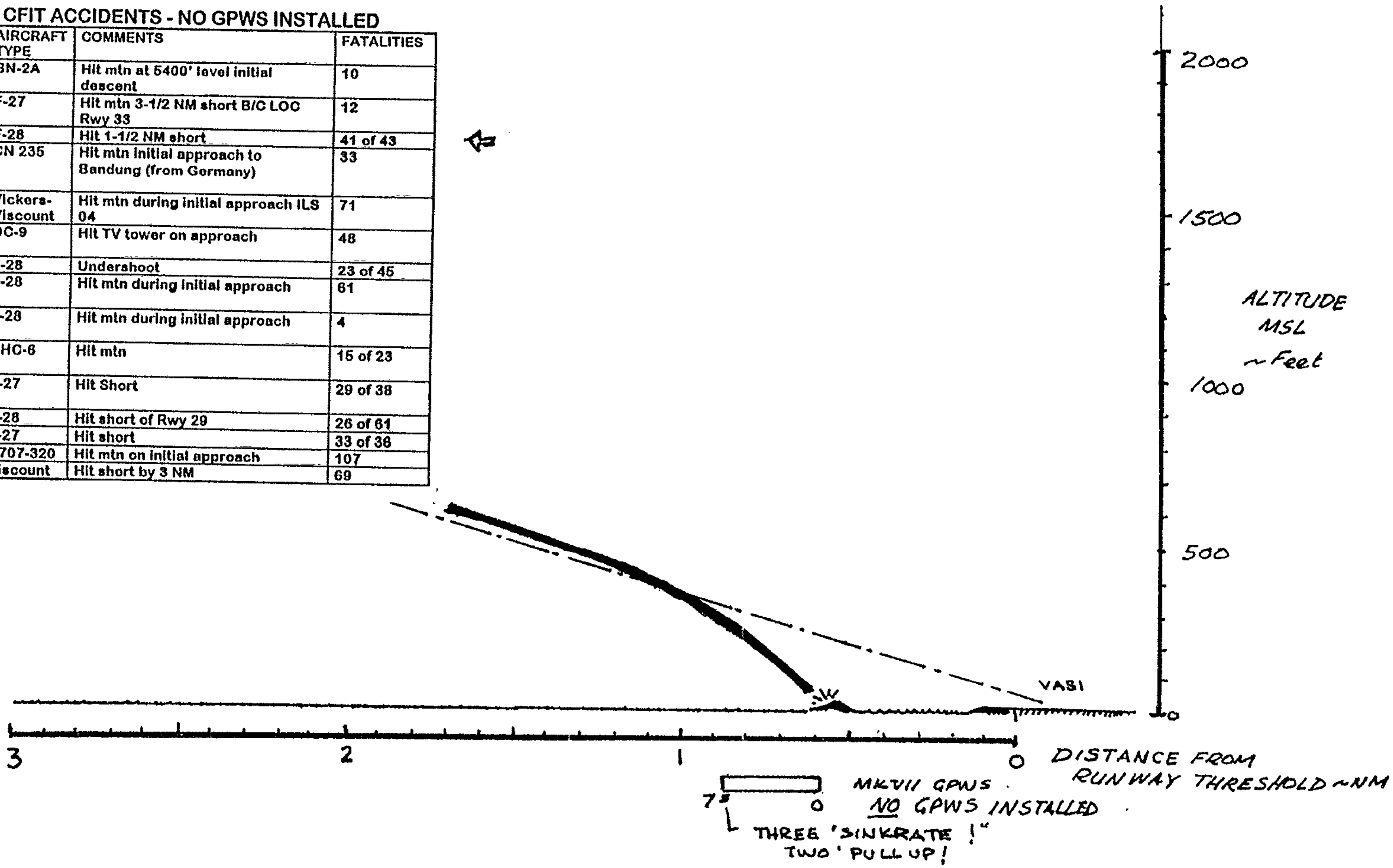
Flight Path Profile
F-28
SORONG, INDONESIA
1 July 1993

CIRCUMSTANCES:	On a final NDB approach to runway 26 the aircraft struck a spit of rocks some 3000 feet short of the threshold and crashed into the water. The pilot had reported the runway in sight.
Weather:	Heavy rain, and poor visibility.
Fatalities:	41 out fo 43 on board.
Other:	No GPWS installed.

PARTIAL LIST OF INDONESIA CFIT ACCIDENTS - NO GPWS INSTALLED

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Regional	25 April 94	Nangapinoh	BN-2A	Hit mtn at 5400' level initial descent	10
Scheduled	18 June 94	Palu	F-27	Hit mtn 3-1/2 NM short B/C LOC Rwy 33	12
Scheduled	1 July 93	Sorong	F-28	Hit 1-1/2 NM short	41 of 43
Scheduled	18 Oct 92	Bandung, Mt. Papandagen, Garut Jawa	CN 235	Hit mtn initial approach to Bandung (from Germany)	33
Scheduled	24 July 92	Ambeu	Vickers-Viscount	Hit mtn during initial approach ILS 04	71
Scheduled	4 April 87	Medan, Sumatra	DC-9	Hit TV tower on approach	48
Scheduled	2 Jan 87	Dumai, Sumatra	F-28	Undershoot	23 of 45
Scheduled	11 July 79	Mt. Sibayak, Sumatra	F-28	Hit mtn during initial approach	61
Positioning	6 Mar 79	Mt. Bromo, Java	F-28	Hit mtn during initial approach	4
Scheduled	29 Mar 77	Balnaka, Sulawerl	DHC-6	Hit mtn	15 of 23
Scheduled	4 Nov 76	Banjarmusin, Kalimatan	F-27	Hit Short	29 of 38
Scheduled	24 Sept 75	Palembang	F-28	Hit short of Rwy 29	26 of 61
Scheduled	7 Sept 74	Branti, Sumatra	F-27	Hit short	33 of 36
Scheduled	22 April 74	Bali	B707-320	Hit mtn on initial approach	107
Scheduled	10 Nov 71	Sumatra	Viscount	Hit short by 3 NM	69

DB95019.DOC



Don Bateman

At least 40 people killed in Indonesian plane crash

1 July 1993

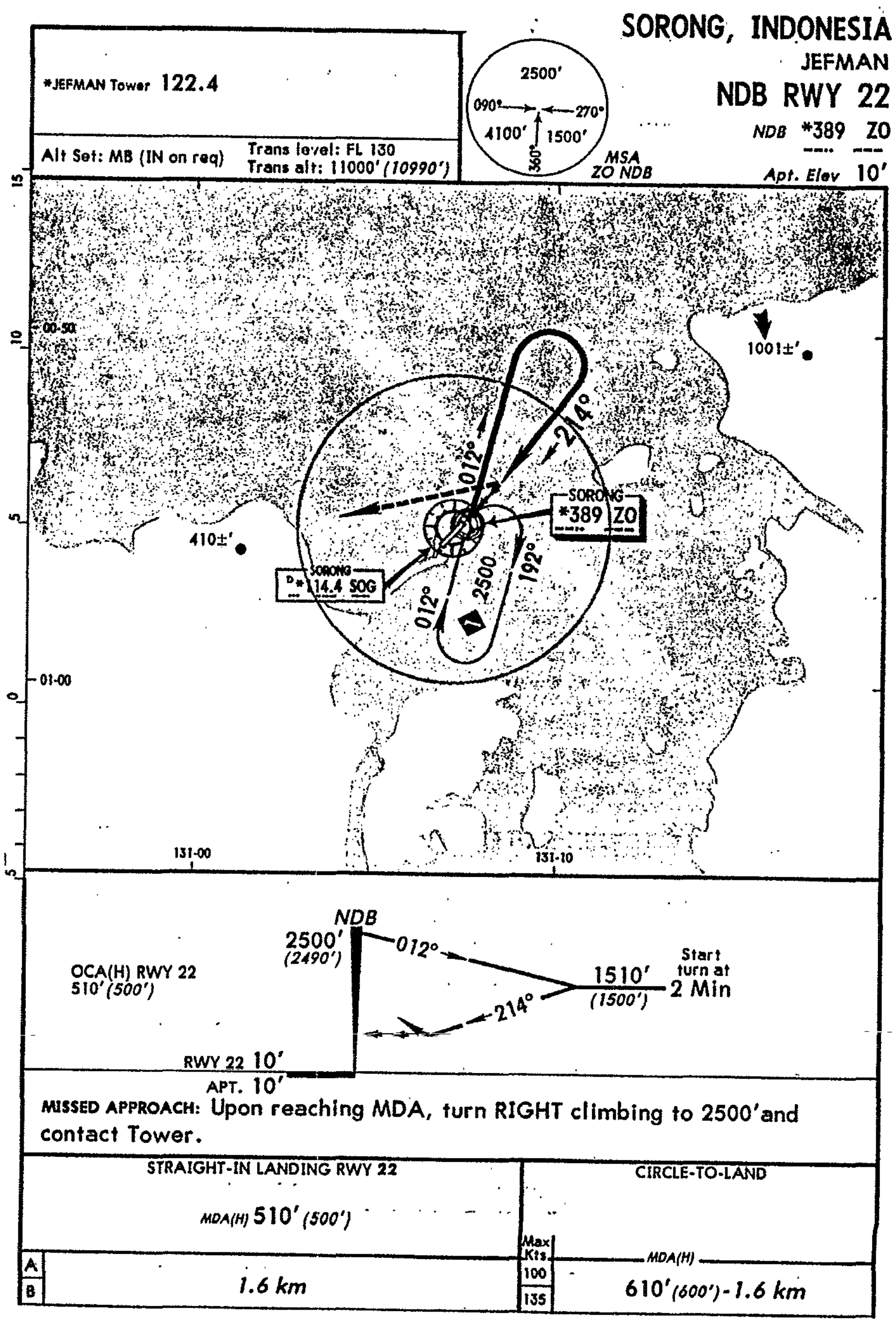
JAKARTA, Indonesia — An Indonesian airliner crashed today in a remote eastern province, killing at least 40 people, an airline spokesman said.

The Fokker-28, which was carrying 43 people, crashed as it was about to land at Jefman Airport in Sorong, about 1,700 miles northeast of Jakarta, said spokesman Agus Sudjono of the private Merpati Nusantara Airlines.

The survivors were unconscious and treated at a hospital, Sudjono said by telephone. The cause of the crash was not immediately known, he added.

Sudjono said it also was not known whether there were any foreigners aboard the flight, which began in Jakarta.

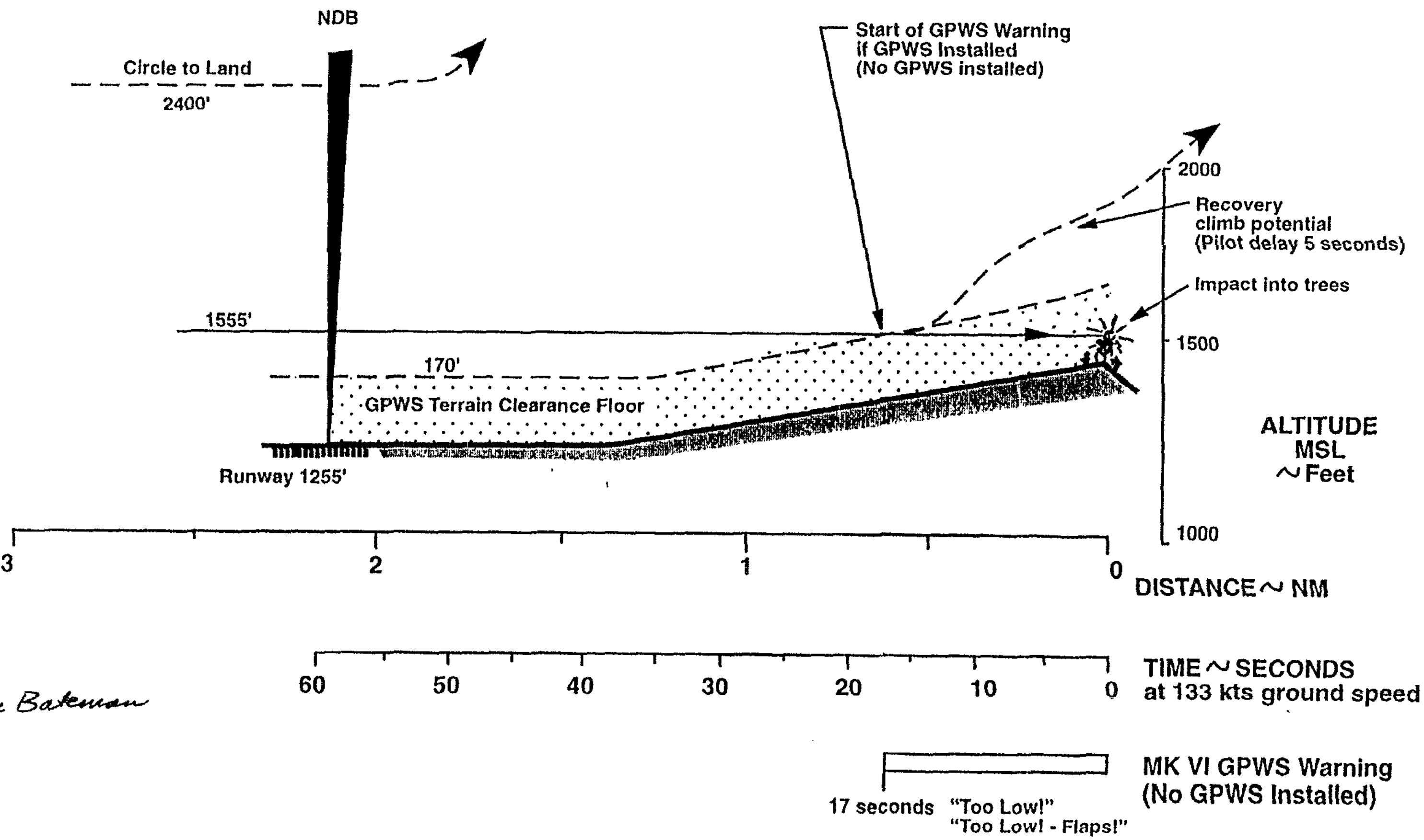
The official Antara news agency said the plane crashed near a beach close to the airport.



Next Page

CIRCUMSTANCES:	During a circle to land circuit after completing an NDB approach, this aircraft struck high ground on the base leg. The aircraft was on a scheduled public flight.
WEATHER:	310/11 kt wind gusting 19kt. 4/8 cloud 800' 6/8 at 1200' 6/8 1500'. Visibility 10 km reduced to 5 km in light rain. Temperature +9° C 1004 hPa.
TIME:	19:20 EST Night
CONFIGURATION:	Landing gear down, partial flaps
FATALITIES:	7
OTHER:	Autopilot, Captain's HSI, ADI inoperative. No GPWS, Radio Altimeter, FDR, CVR

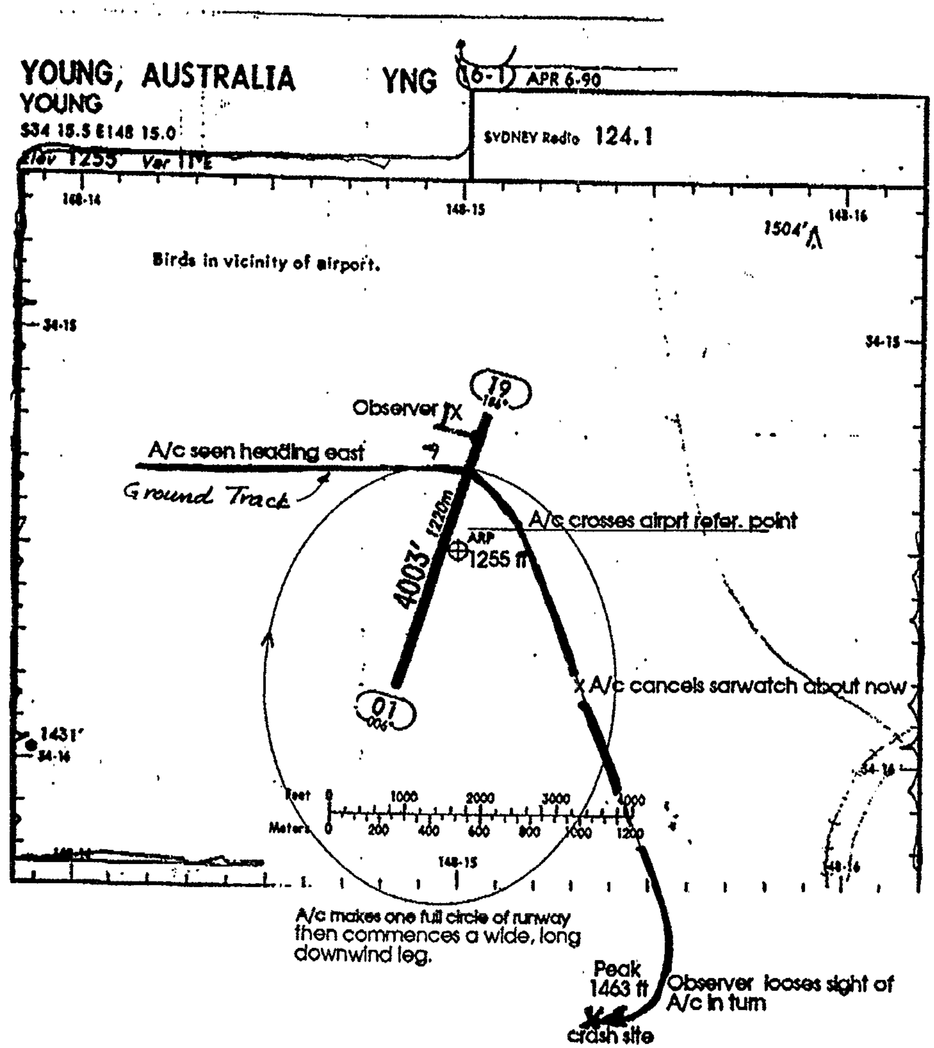
Flight Path Profile
PA-31-350
YOUNG, AUSTRALIA
11 June, 1993



Don Bateman

Return to TOC

Final Approach of VH-NDU
Last 2.5 minutes



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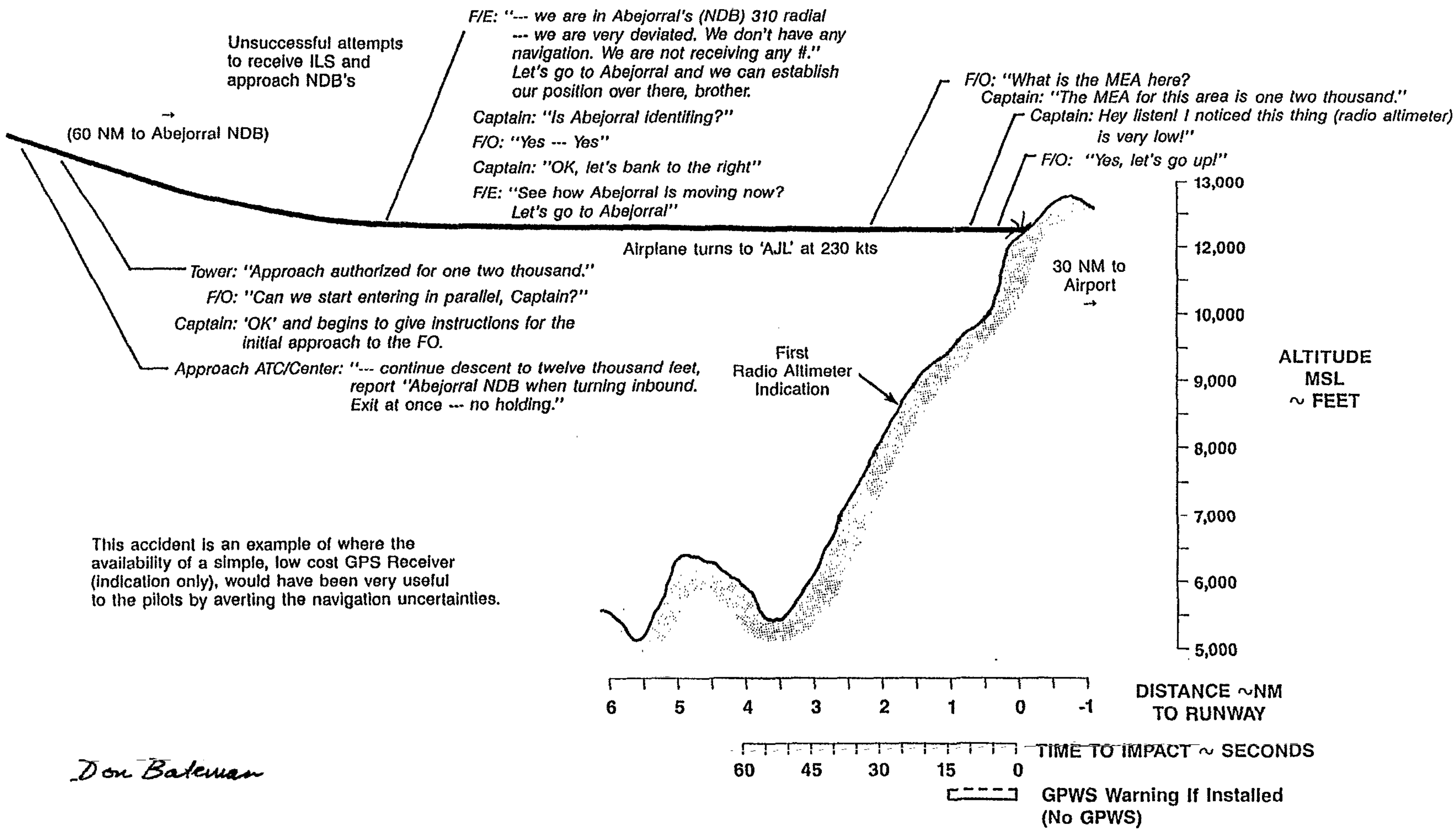
FLIGHT PATH PROFILE
B727-100
Medellin, Columbia
19 May, 1993

Circumstances: On a flight from Panama and the First Officer flying, the aircraft flew into an electrical storm area, and turned to approach Rio Negro after false NDB 'AJL' station passage (approx 60 NM away). A key VOR-DME (Rio Negro) used for the transition , was inoperative. While cleared for the approach by ATC (no radar), the aircraft could not secure ILS or NDB navigation for the approach. The electrical storm subsided, the crew realized their situation, but failed to climb, and struck a mountain 9 NM NE of the 'Kolin' intersection (also determined by another NDB ('UIB').

Weather: IMC. Calm wind at the airport. Heavy rain.

Fatalities: 132 including 7 crew.



This accident is an example of where the availability of a simple, low cost GPS Receiver (indication only), would have been very useful to the pilots by averting the navigation uncertainties.

Don Bateman

Return to TOC

World

NEWS IN BRIEF

Colombian 727 with 132 aboard hits mountain

BOGOTA, Colombia – The wreckage of a Colombian airliner was found today on a remote Andes mountainside. All 132 people aboard were killed, including seven North Americans, airline officials said.

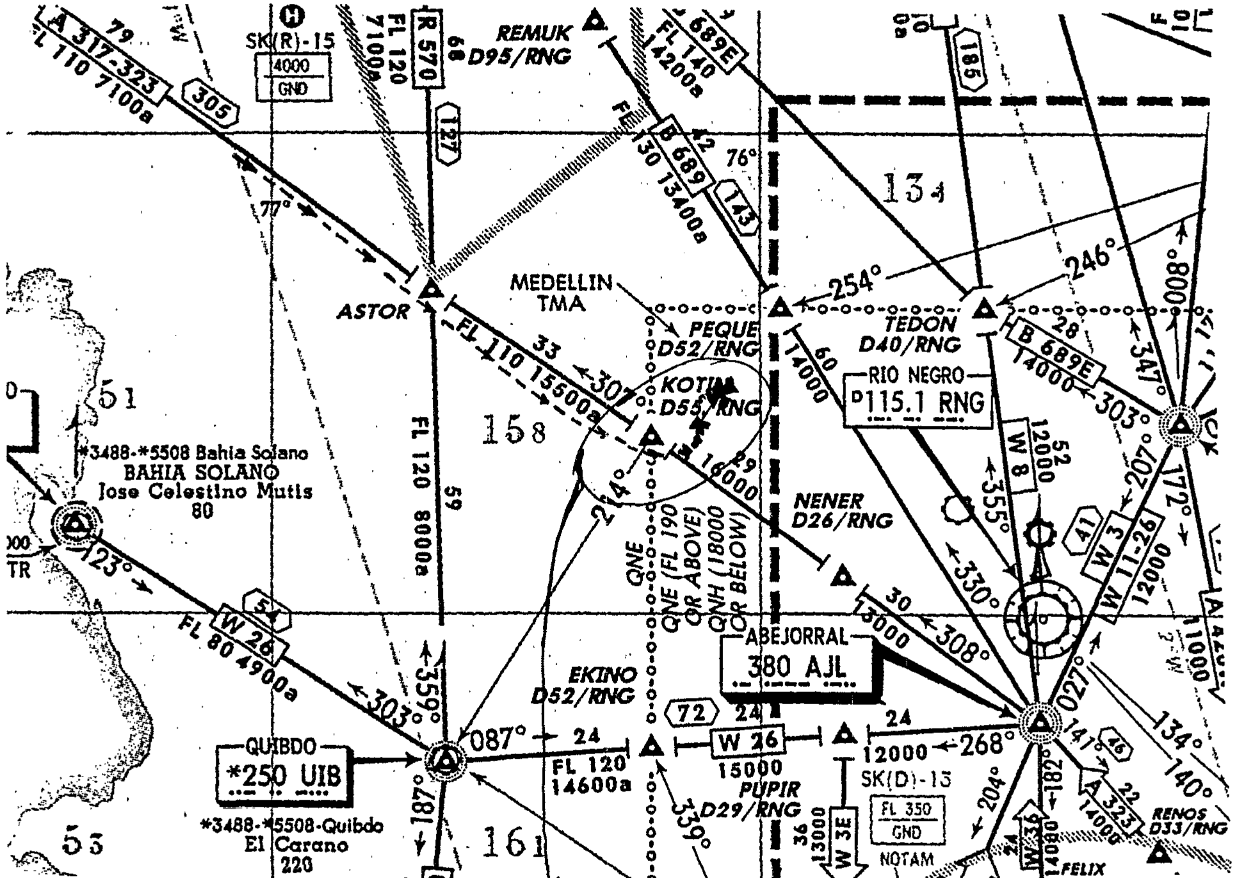
The SAM airline Boeing 727 was found 50 miles northwest of Medellin on the slope of a 12,300-foot peak, a search-plane pilot said. The jetliner, bound from Panama, went down yesterday as it prepared for landing in Medellin.

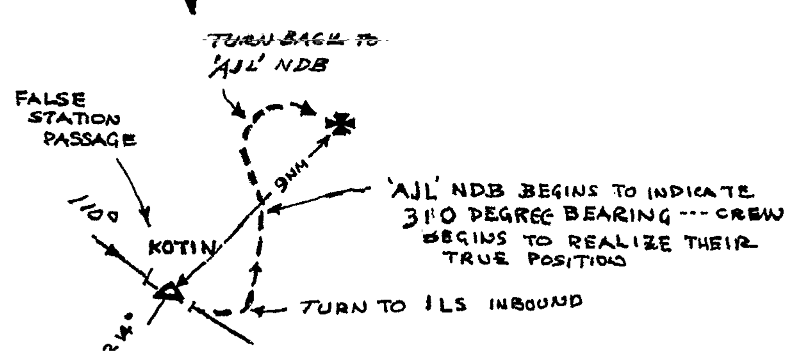
The plane was carrying 125 passengers and seven crew members, the airline said.

It hit the side of a heavily forested mountain in an area of deep canyons. Pilots said the rough terrain created problems for air-rescue crews.

Two pilots speculated in radio interviews that the crash resulted from the loss of radio-navigation beacons blown up by leftist guerrillas last year.

RIO NEGRO 'RNG' VOR/DME





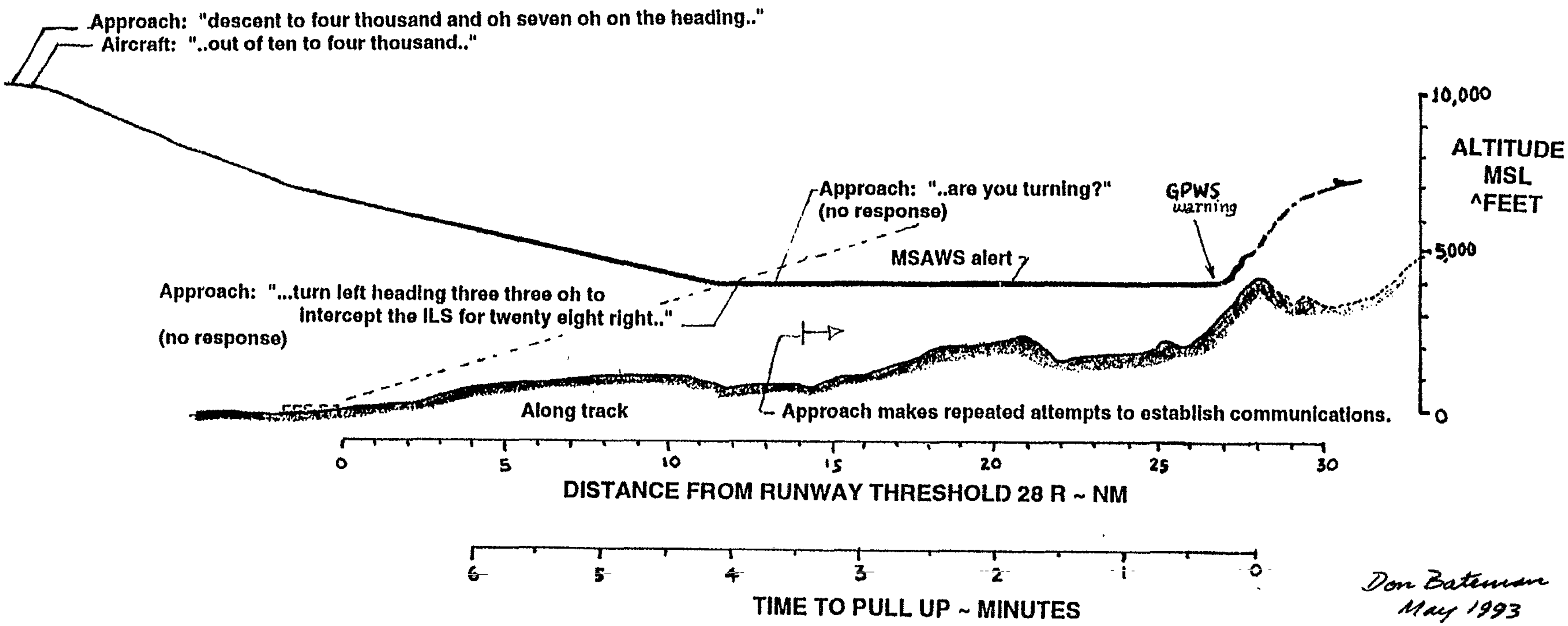
Next Page

Circumstances:
During radar vectors at night for left downwind to ILS runway 28R, radio communication was lost unknown to the flight crew. The aircraft continued its descent and heading clearance. The approach controller became frantic after unsuccessfully re-establishing communication and the MSAWS alert started and continued for some 2½ minutes. Apparently an aircraft microphone switch was stuck on. Then the controller "figurably died" when suddenly on the VHF channel was heard a GPWS "Whoop-whoop! Pull Up!"--continuing for some seconds and then stopped. Secondary radar contact remained as the altitude readout rapidly increased. A pilot passenger recalls the Portland city lights disappearing behind the aircraft some minutes before the aircraft suddenly pitched up in a ratcheting fashion to ever higher climb attitudes. Eventually, communication was re-established and an uneventful landing was made.

Time:	Late evening (a quiet night with little ATC traffic)
Weather:	5000 scattered

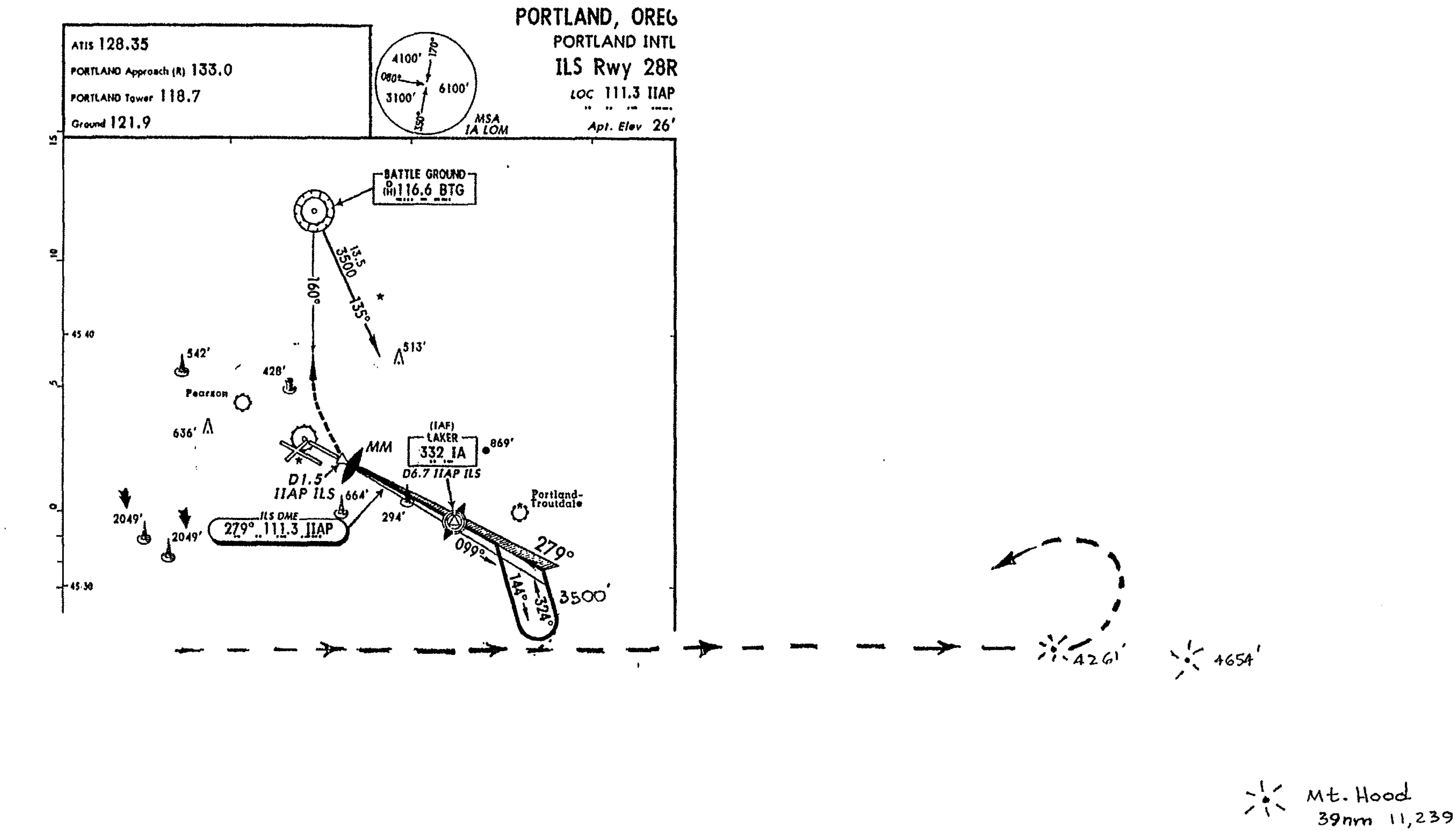
Flight Path Profile
L-1011
PORTLAND, OREGON
April, 1993
INCIDENT

Profile and dialog based on unofficial reports. Loss communication procedures apparently not followed?



Don Bateman
May 1993

Return to TOC



Next Page

Flight Path Profile
A320
EDMONTON, ALBERTA
2 April 1993

INCIDENT

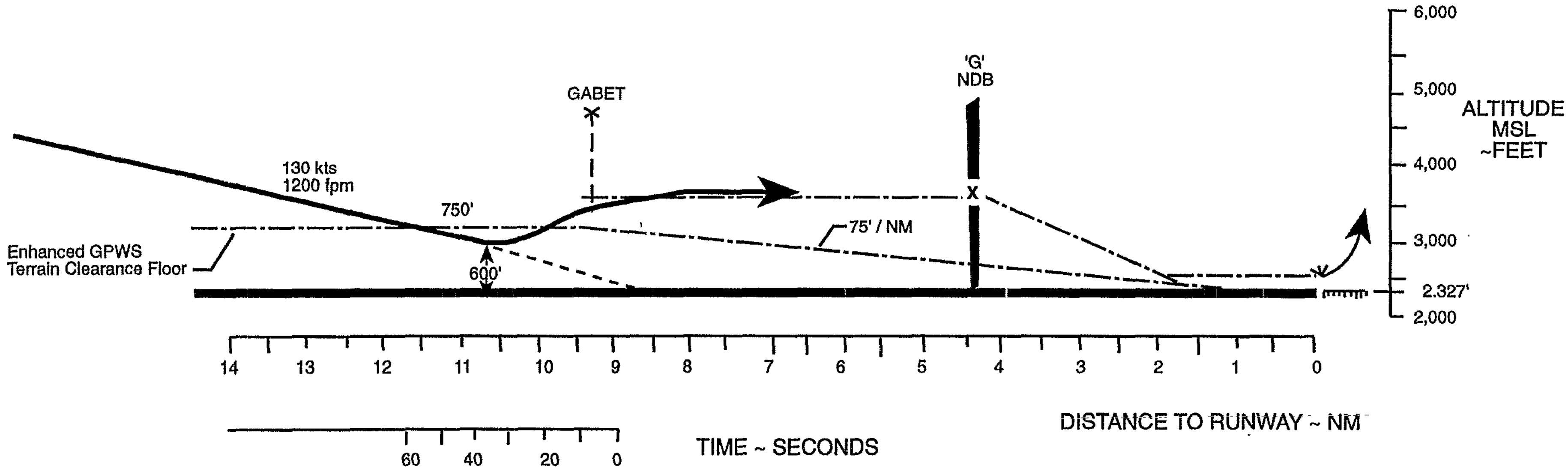
CIRCUMSTANCES: During a back course localizer approach to runway 20, the aircraft descended to within 600 feet AGL at 10-1/2 NM from the runway. The co-pilot finally recognized the problem and called for a climb. Auto Thrust System (ATS) on throughout the incident - FCU and Flight Directors disengaged as Captain flew manually. No barometric altitude alert as landing gear was down.

CONFIGURATION: Landing

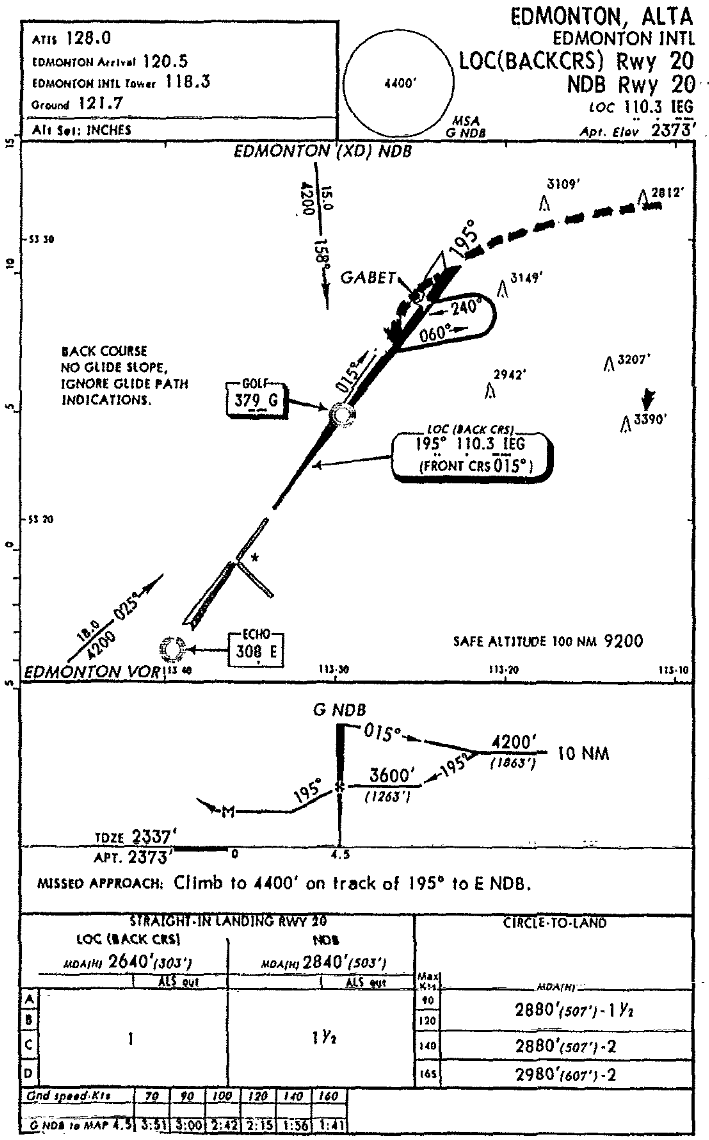
WEATHER: 600+, 5 mile visibility, fog, 2ºC / 1º dew point, wind 150/3 kts

OTHER: 49 on board / Time 13:20 local

Note:
MK III GPWS installed but *NO* alert or warning as aircraft in landing configuration, no glideslope, stable descent and no altitude alerts pinned up.



Don Bateman



Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Occurrence Report

Altitude Related Event

Air Canada
Airbus Industrie A320-211 C-FKAJ
Edmonton International Airport,
Alberta 10 mi N
02 April 1993

Report Number A93W0039

Synopsis

Air Canada Flight 183, an Airbus A320, was on radar vectors for a straight-in back course approach to runway 20 at the Edmonton International Airport, Alberta. Approximately six miles north of the final approach fix (FAF), the pilot unintentionally descended to approximately 2,900 feet above sea level (asl). The minimum authorized crossing altitude over the FAF is 3,600 feet asl. The altitude deviation was recognized, a climb established back to 3,600 feet, and the landing was carried out without further incident.

The Board determined that the crew did not properly monitor the altitude during the approach and allowed the aircraft to descend to a non-safe altitude before initiating a recovery.

Ce rapport est également disponible en français.

Next Page

CIRCUMSTANCES: During a LOC DME approach to runway 26 this airtaxi aircraft impacted 3 NM short of the runway threshold. The pilots apparently began to see ground lights, perhaps an electrical power station and prematurely departed the instrument procedure for visual flight. The airfield was probably never ever seen.

TIME: 20:02 Local night

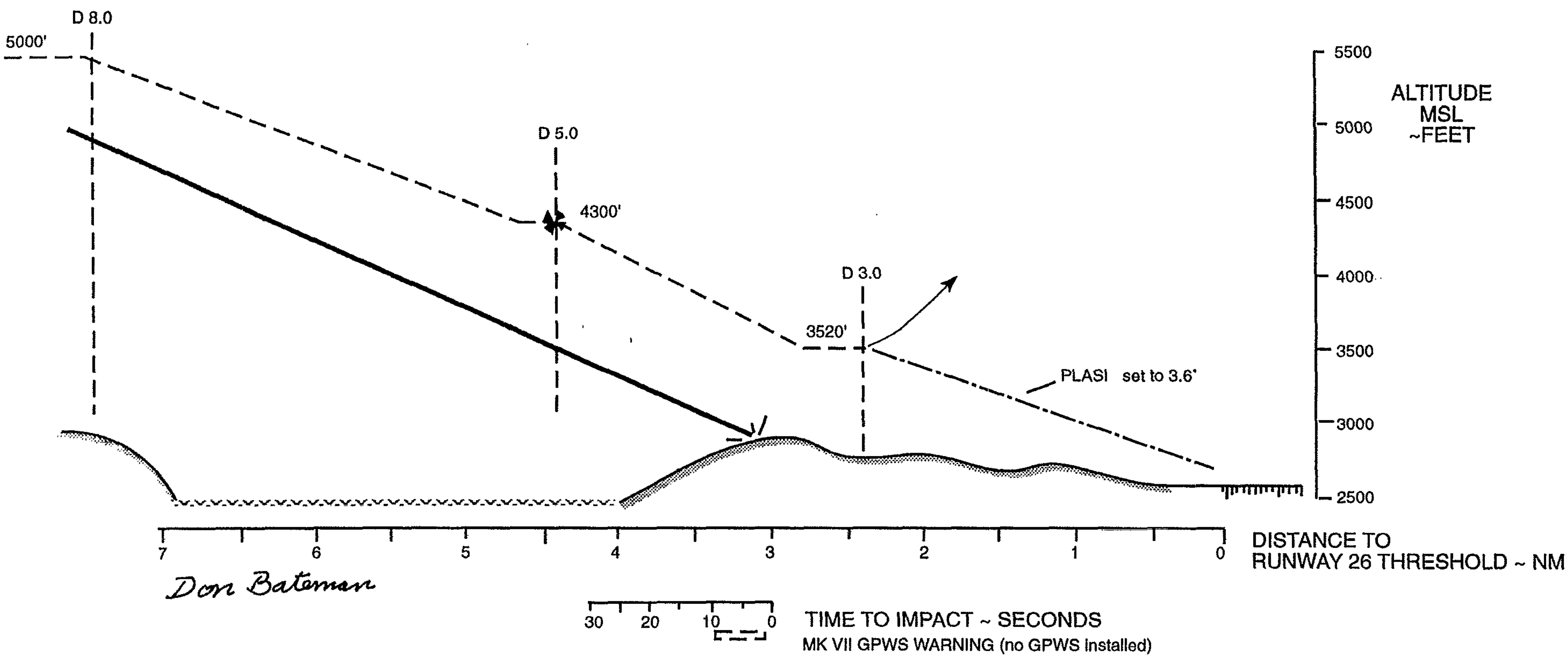
WEATHER: Visibility 4 KM, snow, ceiling 1200 feet -2º C

CONFIGURATION: Gear down, flaps approach

FATALITIES: 3 of 10 on board

Flight Path Profile
Be-200
DAGALI, NORWAY
19 March, 1993

Radio Altimeter installed. No GPWS. Runway 26 had HIRL/HIALS/PLASI set to 3.6º



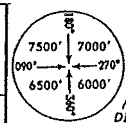
Return to TOC

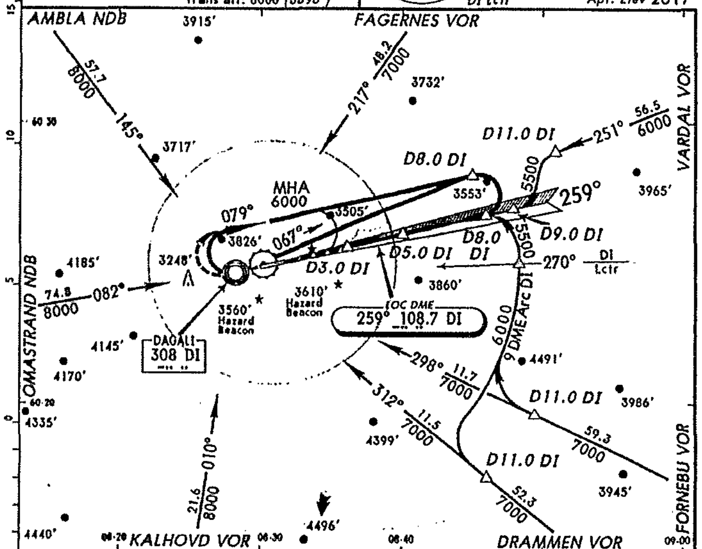
DAGALI, NORWAY
DAGALI
LOC DME Rwy 26
LOC 108.7 DI
Apt. Elev 2617'

*DAGALI Information 121.3

Alt Set: hPa

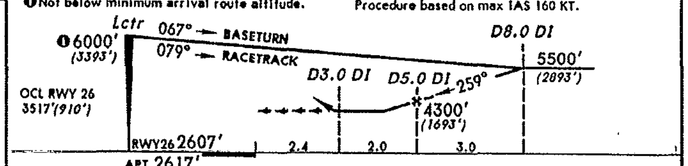
Trans level: By ATC
Trans alt: 6000'(3393')





❶ Not below minimum arrival route altitude.

Procedure based on max IAS 160 KT.



MISSED APPROACH: Climb on 259° to Lctr, then climbing turn RIGHT and continue climbing to 6000'(3393') in holding

	STRAIGHT-IN LANDING RWY 26 MDA(H) 3520'(913')	ALS out
A, B	3200m	
C	4400m	
D	4800m	

Gnd speed-Kts	70	90	100	120	140	160
Descent Gradient 6.5%	461	592	658	790	922	1053
MAP at D3.0 DI						

Next Page

Incident:

Circumstances: Aircraft was prematurely cleared down to 10,000′ in holding pattern. (Minimum descent altitude in hold is 13,200′) A MKII GPWS "Terrain/Pullup" warning was given because of 11,000 terrain S.W. of the Bogota VOR as the aircraft passed through 11,700′. An immediate pullup by the pilot (2 seconds response) towards 13,200 feet, maximum thrust was made, but later arrested at 12,600′ as the aircraft intercepted the localizer, and the radio altimeter shouwed the aircraft clear of terrain.

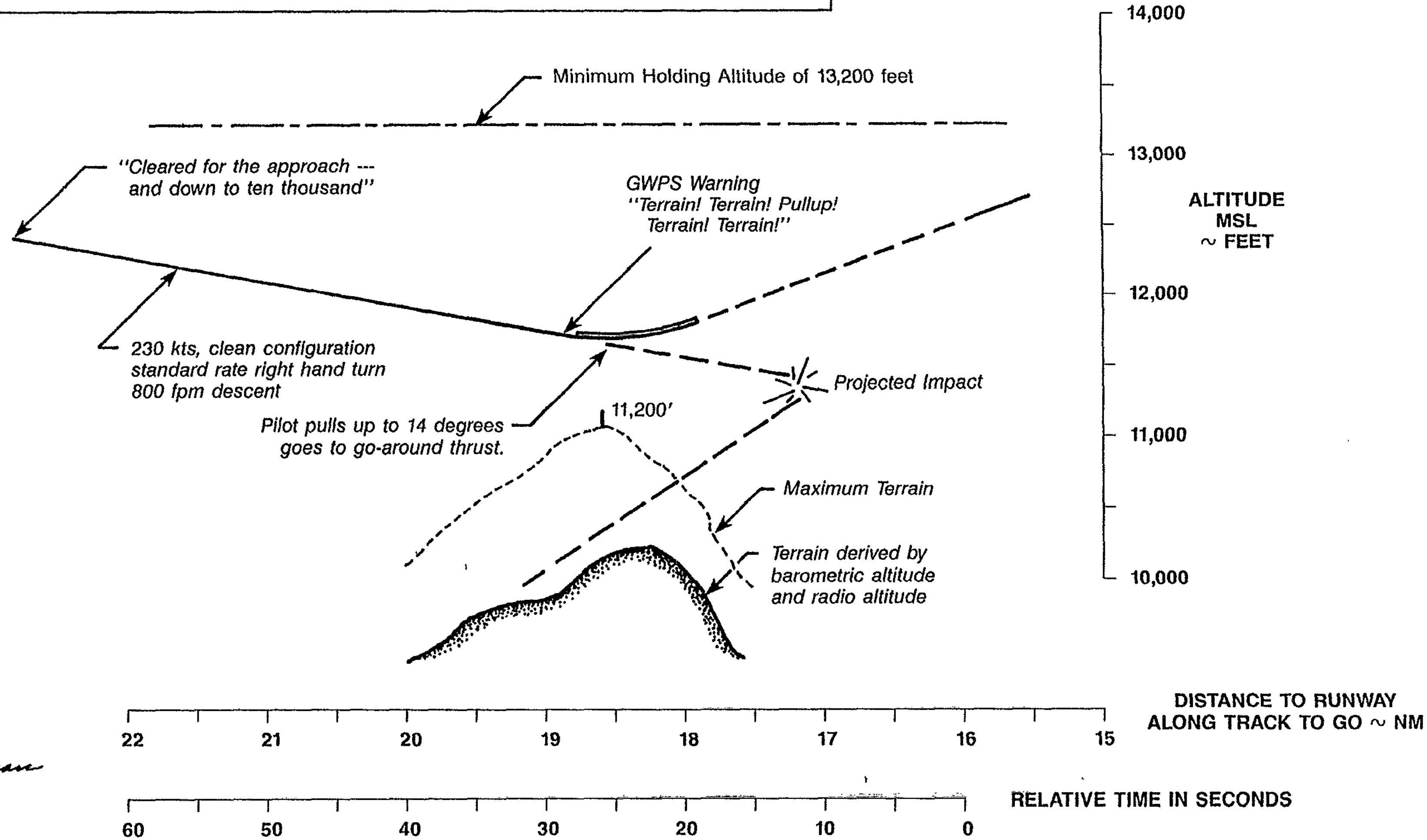
Time: Night

Weather: IMC

Other: MK II installed and working.

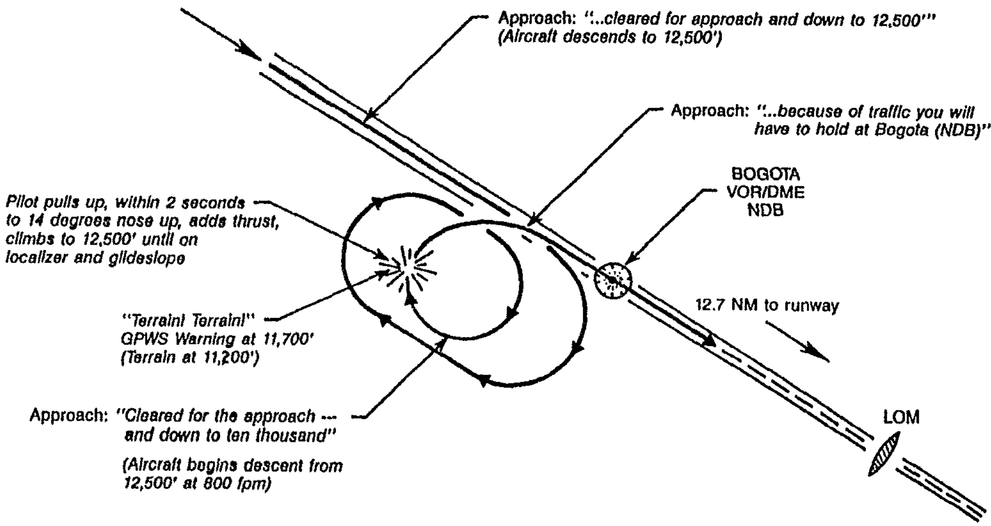
Incident Flight Path Profile

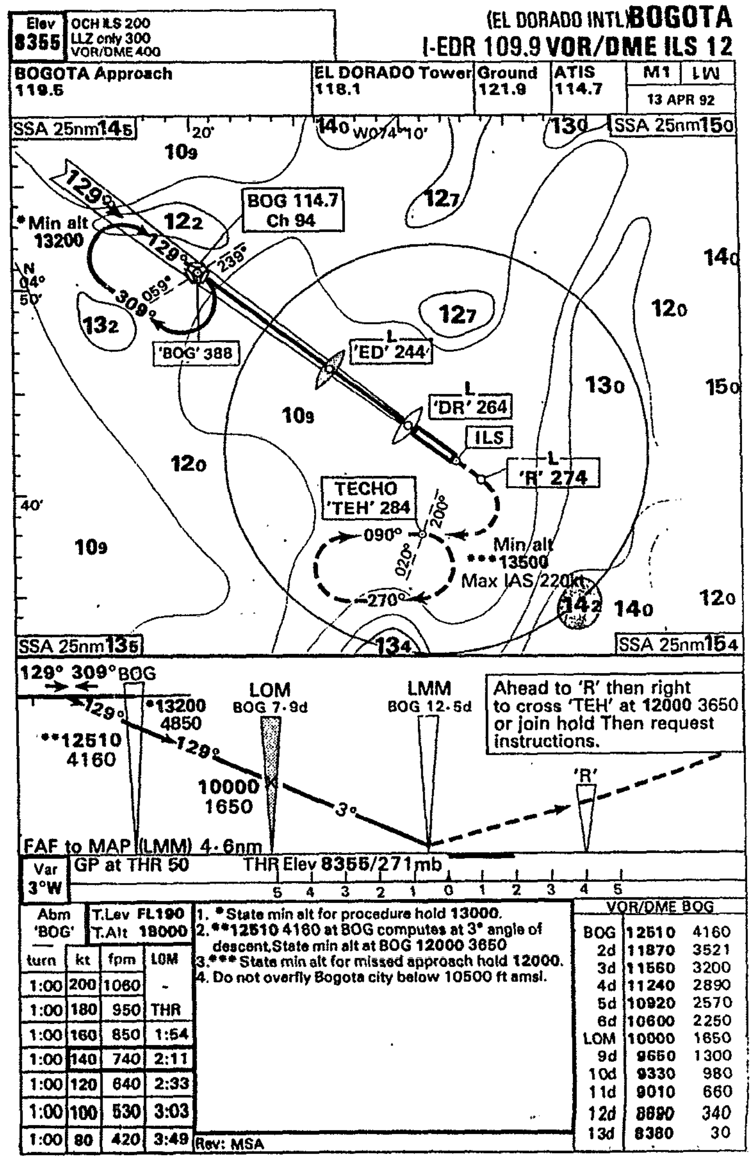
MD-80
BOGOTA, COLUMBIA
10 March, 1993



Don Bateman

Return to TOC





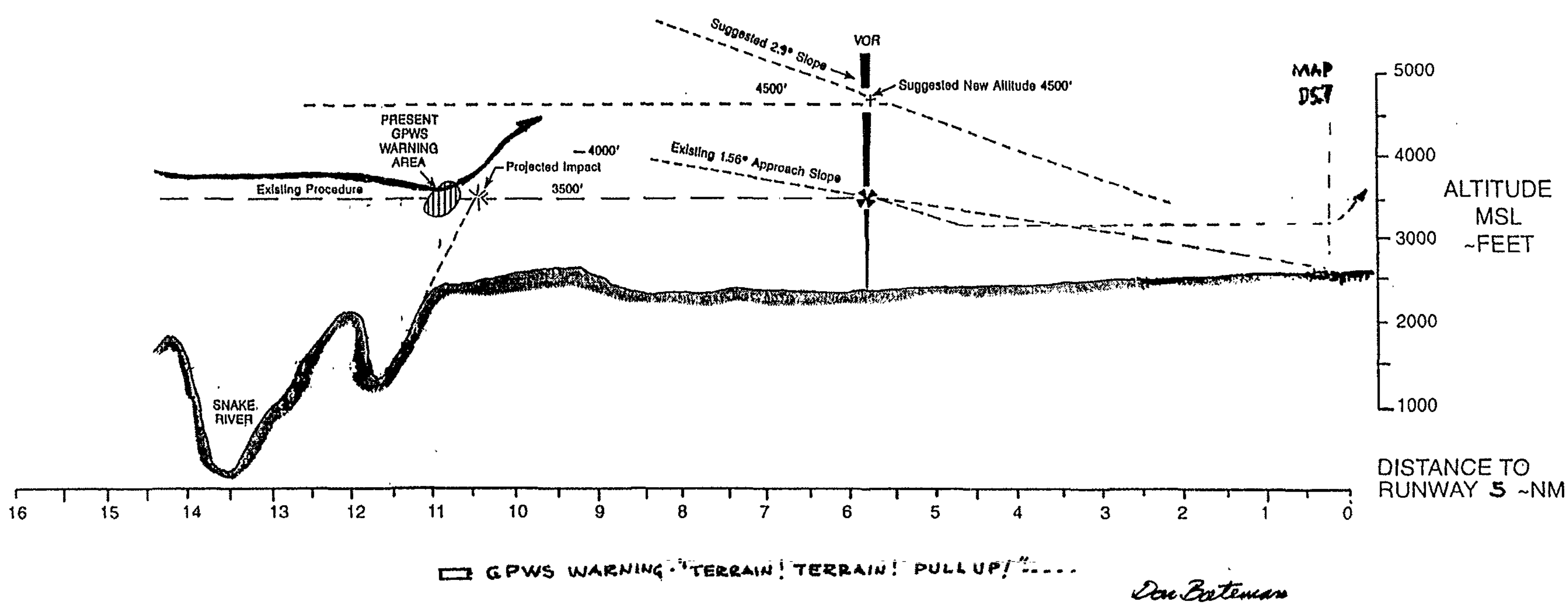
Circumstances:	While on a VOR instrument approach to runway 5, the flight crew received a GPWS warning and pulled up. The flight crew were following their procedures The next approach was kept high at 4000 feet until the VOR and an uneventful landing was made with no GPWS warning.
Weather:	IMC
Configuration:	Landing gear up, maneuvering flap.
Other:	This incident illustrates that low approach slope procedures (in this case 1.5°) can cause nuisance GPWS warning and especially make the aircraft vulnerable to altimetry errors, to visual illusions and greater exposure to a possible landing short into terrain or water. Raising this approach to 2.9° would eliminate all GPWS warnings and improve terrain clearance on the approach.

Flight Path Profile
DHC-8
PULLMAN, WASHINGTON
January, 1993
Incident

Next Page

THE LOW APPROACH SLOPE INSTRUMENT PROCEDURE 'TRAP'

INSTRUMENT PROCEDURE WITH
LOW APPROACH SLOPE OF 1-1/2°!

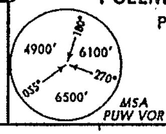


Return to TOC

WALLA WALLA Radio 122.6 122.1G

PULLMAN/MOSCOW REGL UNICOM CTAF 122.8

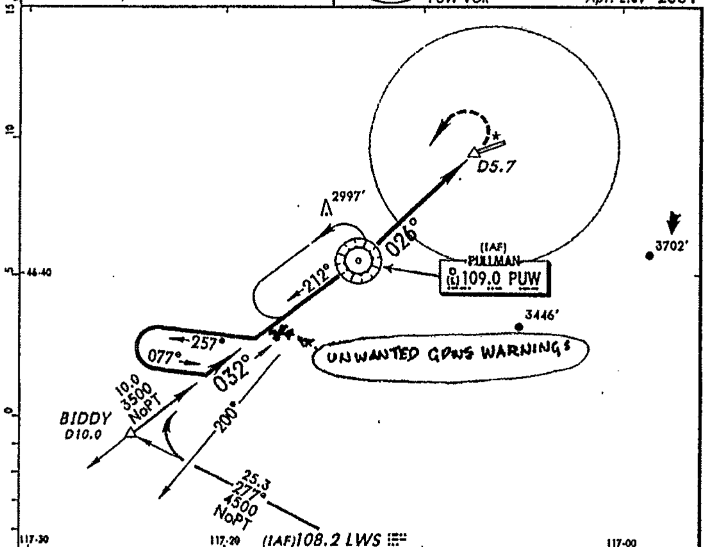
Obtain local altimeter setting on CTAF; if not received, use Walla Walla.

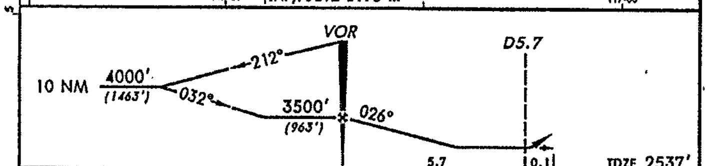


PULLMAN/MOSCOW, WASH
PULLMAN/MOSCOW REGL
VOR Rwy 5

VOR 109.0 PUW

Apt. Elev 2551'





APT. 2551'

MISSED APPROACH: Climbing LEFT turn to 4000' direct to PUW VOR and hold.

	STRAIGHT-IN LANDING RWY 5	
	MDA(H) 3140' (605') With Local Altimeter Setting	MDA(H) 3420' (883') With Walla Walla Altimeter Setting
A, B	1	1¼
C	1¾	2¾
D	2	3

CIRCLE-TO-LAND Max Kts	With Local Altimeter Setting MDA(H)	With Walla Walla Altimeter Setting MDA(H)
90, 120	3140' (589') - 1	3420' (869') - 1¼
140	3140' (589') - 1¾	3420' (869') - 2¾
165	3180' (629') - 2	3480' (929') - 3

Gnd speed-Kts		70	90	100	120	140	160
MAP at D5.7 or VOR to MAP	5.7	4:53	3:48	3:25	2:51	2:27	2:08

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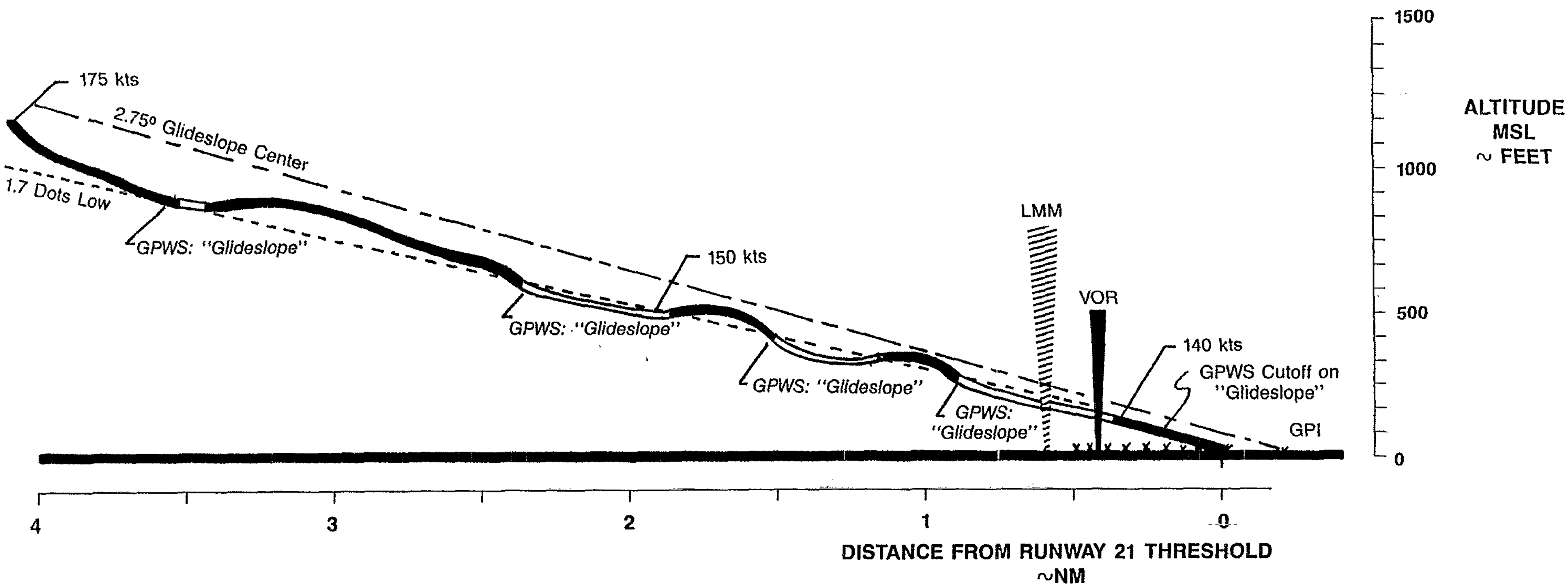
FLIGHT PATH PROFILE
B707-321
Abidjan, Ivory Coast
15 January, 1993

Circumstances:	During early morning ILS approach to runway 21, aircraft slipped under the glideslope and hit short of threshold by 10 feet, breaking off main landing gear, skidding to a stop on engine necelles and nose gear.
Time:	04:18 local time
Weather:	Fog, visibility 900 meters
Injuries:	None for six on board. Aircraft written off.
Other:	Aircraft equipped with GPWS, and crew apparently corrected for each 'glideslope' alert. PAPI-L set for 2.75°



ABIDJAN, IVORY COAST

PORT BOUET

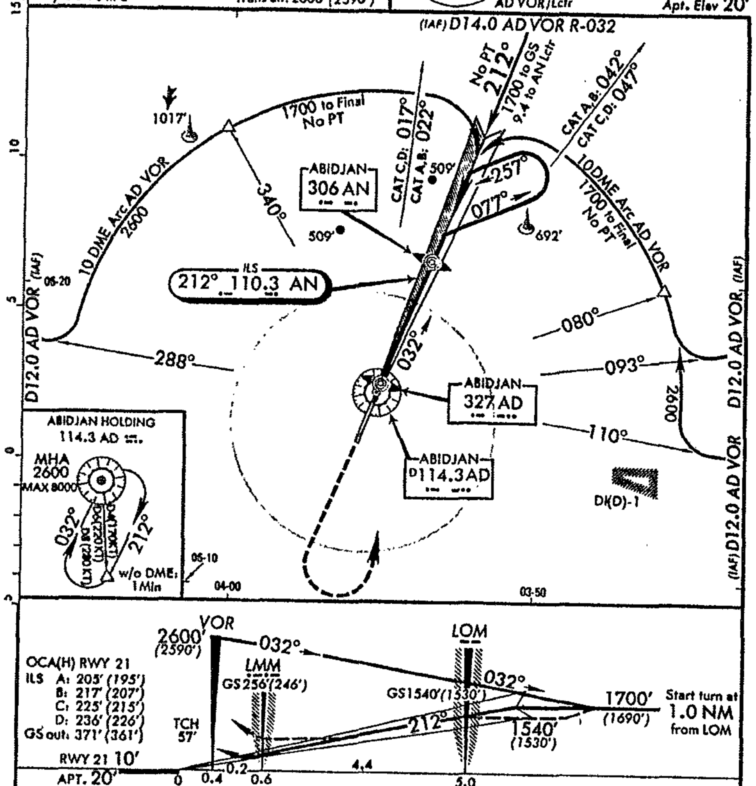
ILS Rwy 21

LOC 110.3 AN

Apt. Elev 20'

VHF/DF
Approach Control through Tower
ABIDJAN Tower 118.1
Alt Set: hPa / Rwy Elev: 0 hPa — Trans level: By ATC / Trans alt: 2600' (2590')

MSA AD VOR/Lctr 2600'



MISSED APPROACH: Climb STRAIGHT AHEAD to 1700' (1690'), then turn LEFT to AN Lctr for another approach, or as directed.

	STRAIGHT-IN LANDING RWY 21 ILS DA(H) A: 210' (200') B: 220' (210') C: 230' (220') D: 240' (230') FULL	ALS out	LOC (GS out) MDA(H) 380' (370')	LMM out	ALS out	Max Kt	CIRCLE-TO-LAND DAY MDA(H) — CEIL-VIS	NIGHT
A	RVR 720m VIS 800m	1200m	RVR 750m VIS 800m	NOT AUTH.	RVR 1500m VIS 1600m	100	470' (450') 300'-1600m	NOT AUTH.
B			950m			135	520' (500') 340'-2000m	
C	800m	1250m	1050m		1650m	180	620' (600') 400'-2800m	
D	900m	1350m	1300m		2000m	205	760' (740') 500'-3600m	

Gnd speed-Kts	70	90	100	120	140	160
GS 2.75°	346	444	494	593	691	790

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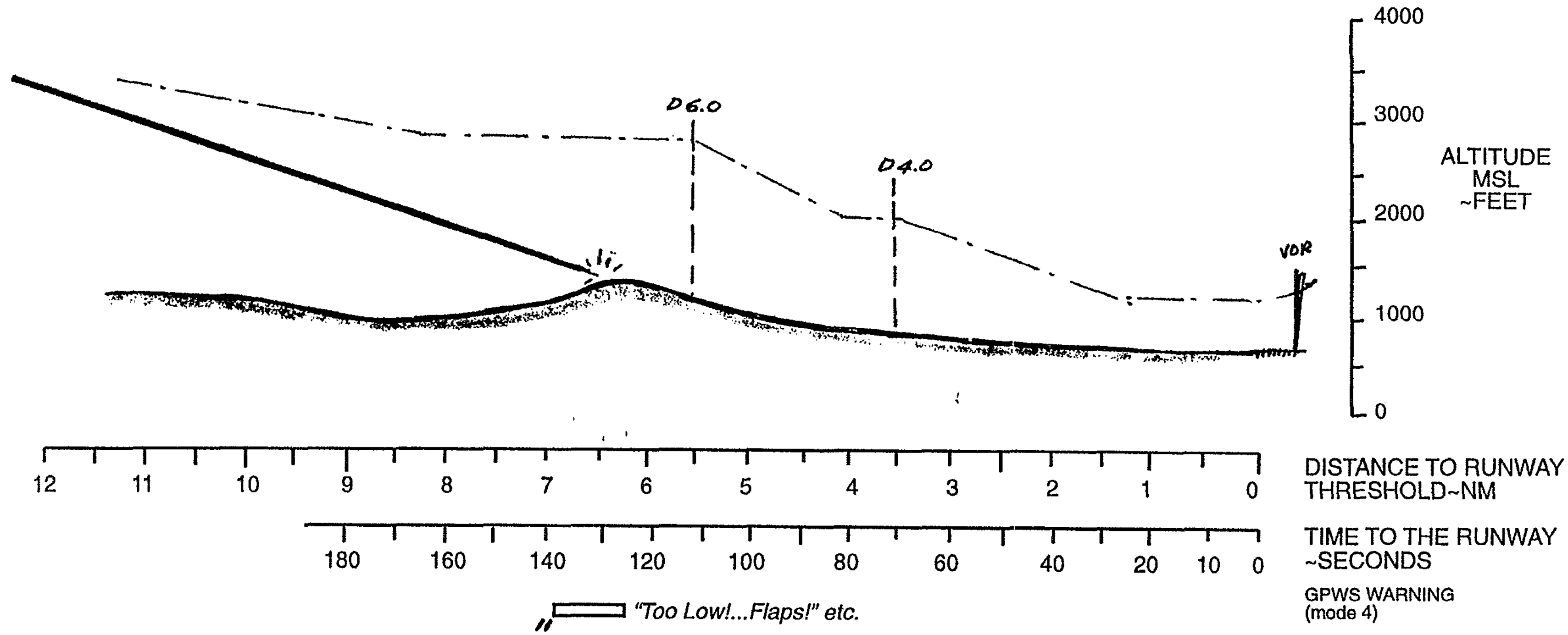
Flight Path Profile
L-35A
HERMOSILLO, MEXICO
8 January, 1993

Circumstances:	During a VOR DME final approach to runway 23 the aircraft hit short into a hill at 6-1/2 NM from the runway.
Weather:	500 foot overcast, rain, poor visibility
Time:	08:10 local
Configuration:	Gear down, approach flaps
Fatalities:	9 (Air Taxi)



Return to TOC

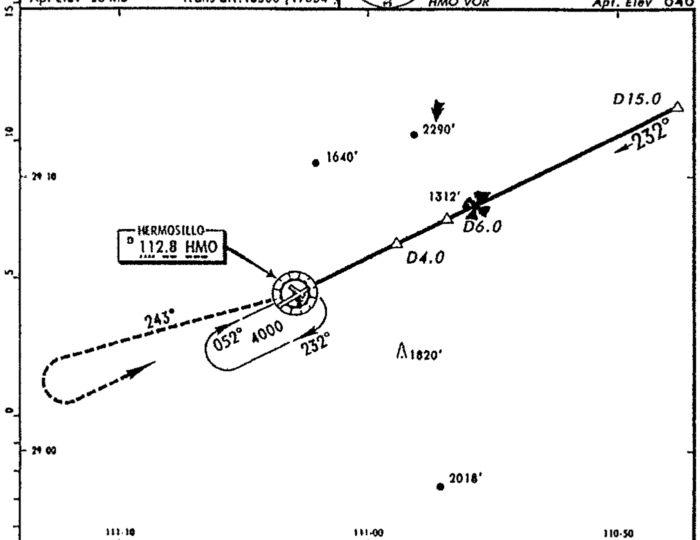
HERMOSILLO, MEXICO
GEN IGNACIO PESQUEIRA GARCIA INTL
VOR DME-1 Rwy 23

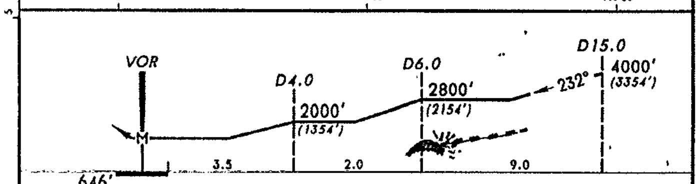
VOR 112.8 HMO

Apt. Elev 646'

*ATIS 127.7
*HERMOSILLO Approach 121.4
*HERMOSILLO Tower 118.7
Alt Set: MB (IN on req) Trans level: FL 195
Apt Elev: 23 MB Trans alt: 18500' (17854')

080° 5000' 3000' 350°
MSA HMO VOR





MISSED APPROACH: Climb outbound on HMO VOR R-243. Make a teardrop turn to the LEFT within 10 NM to HMO VOR to the minimum holding altitude.

	STRAIGHT-IN LANDING RWY 23 MDA(H) 1140' (494')	Max Kts	CIRCLE-TO-LAND MDA(H)
A	1	90	1340' (694')-1
B		120	
C	1½	140	1340' (694')-2
D		165	1640' (994')-3

FLIGHT PATH PROFILE

DHC-8/300
Charles De Gaulle, Paris
6 January, 1993

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Circumstances: While repositioning from ILS runway 27 to ILS runway 28, aircraft impacted short by 0.4 NM and 0.25 NM to the right of localizer 28. Insufficient time to reposition, re-stabilize, and change NAV and COM frequencies. Co-pilot flying.

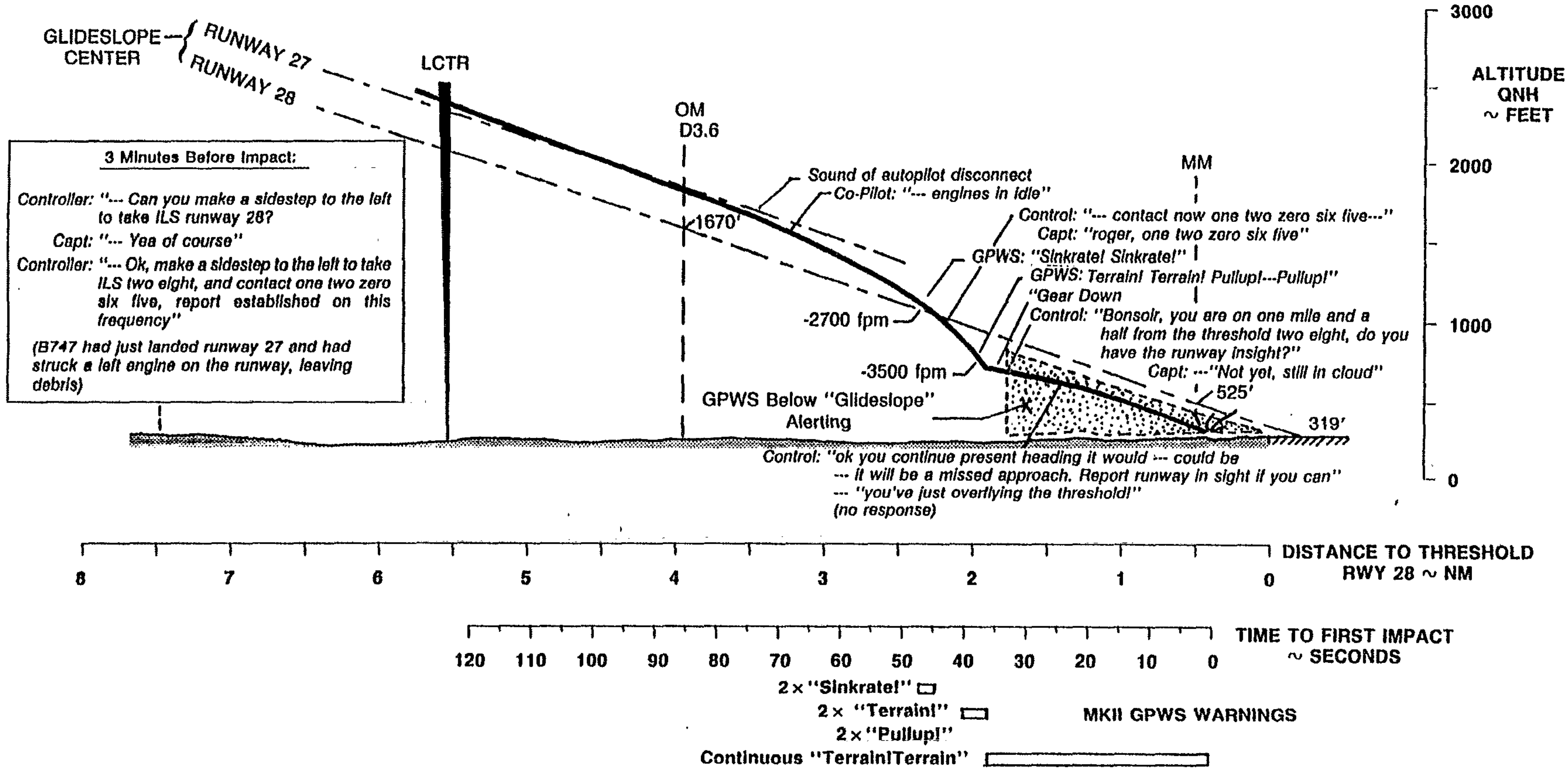
Time: 18:19 UTC Night

Weather: Wind 190-200°/10 to 14 kts
Visibility 1500M - 800M RVR 700 to 1400M
8/8 stratus, base 200 to 600 feet QNN 1029 hPa
Temperature 8.4/9°C

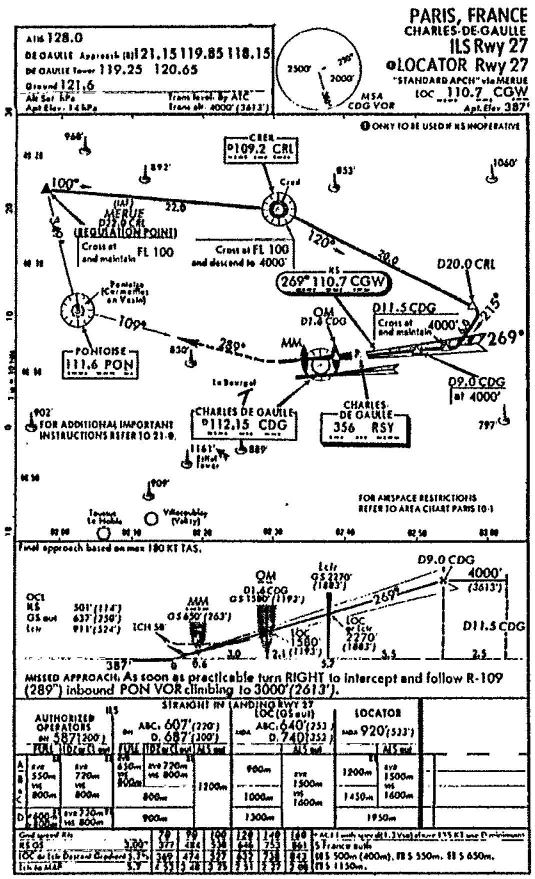
Configuration: Landing gear down, flaps retracted 0°.

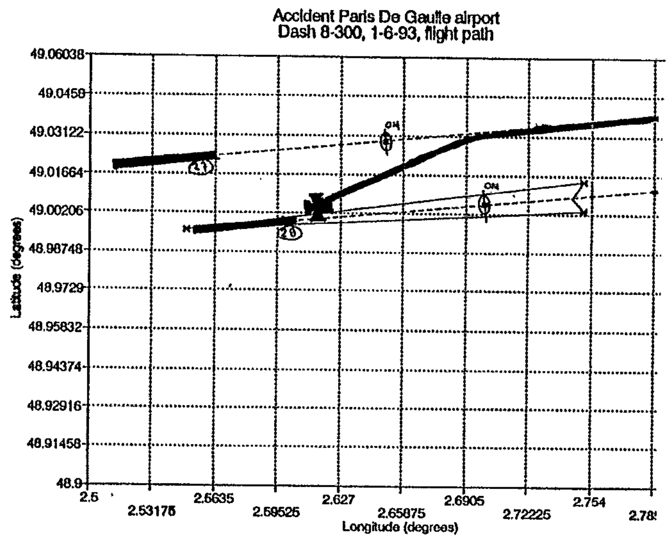
Fatalities: 4 including one child. 9 seriously hurt, 11 injured.

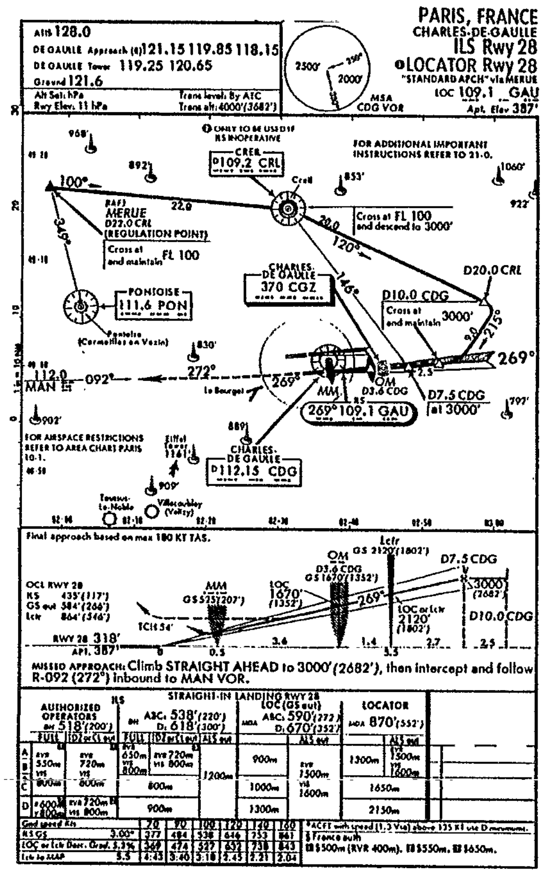
Other: Aircraft fitted with operational GPWS MkII.



Return to TOC



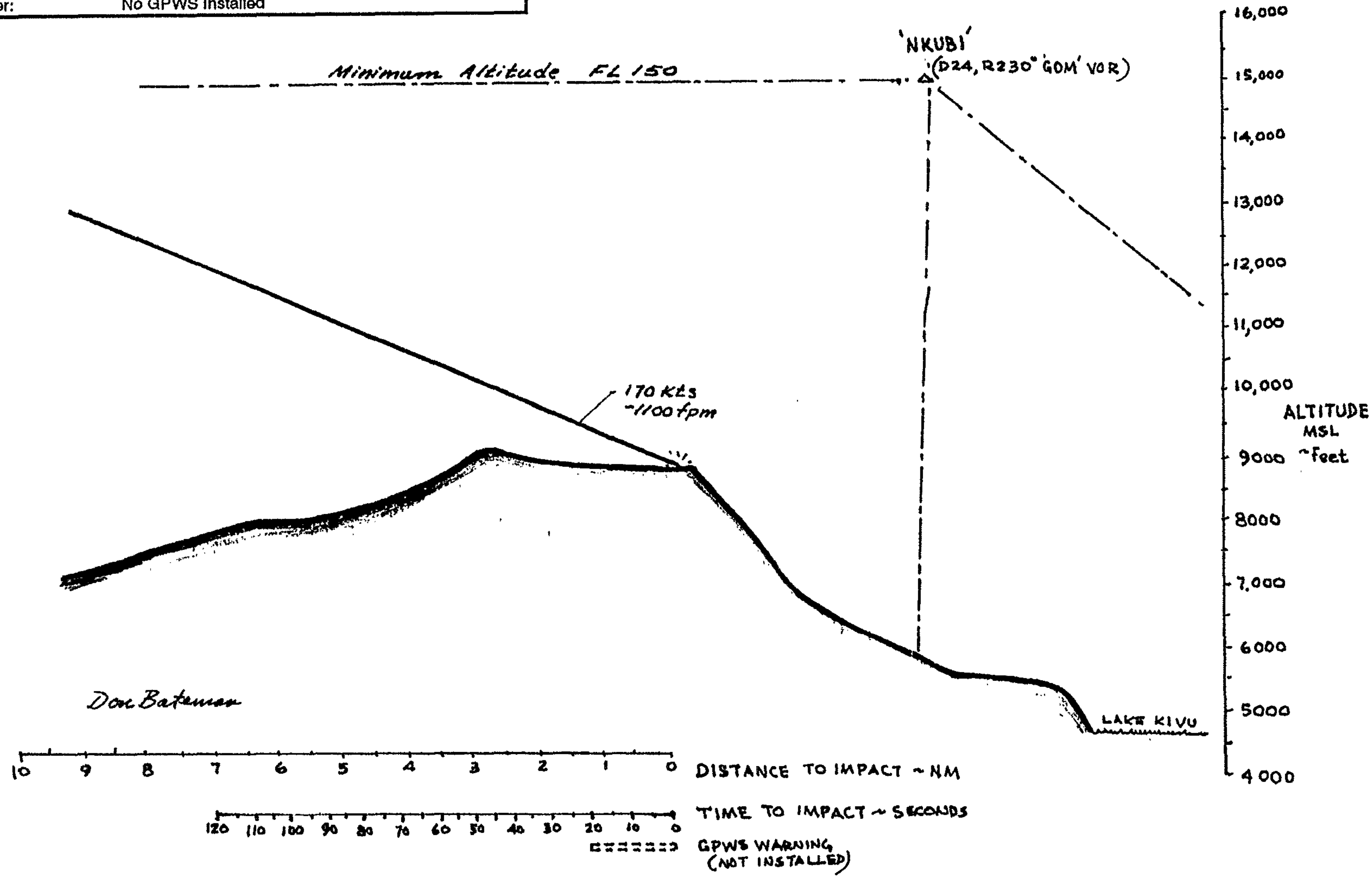




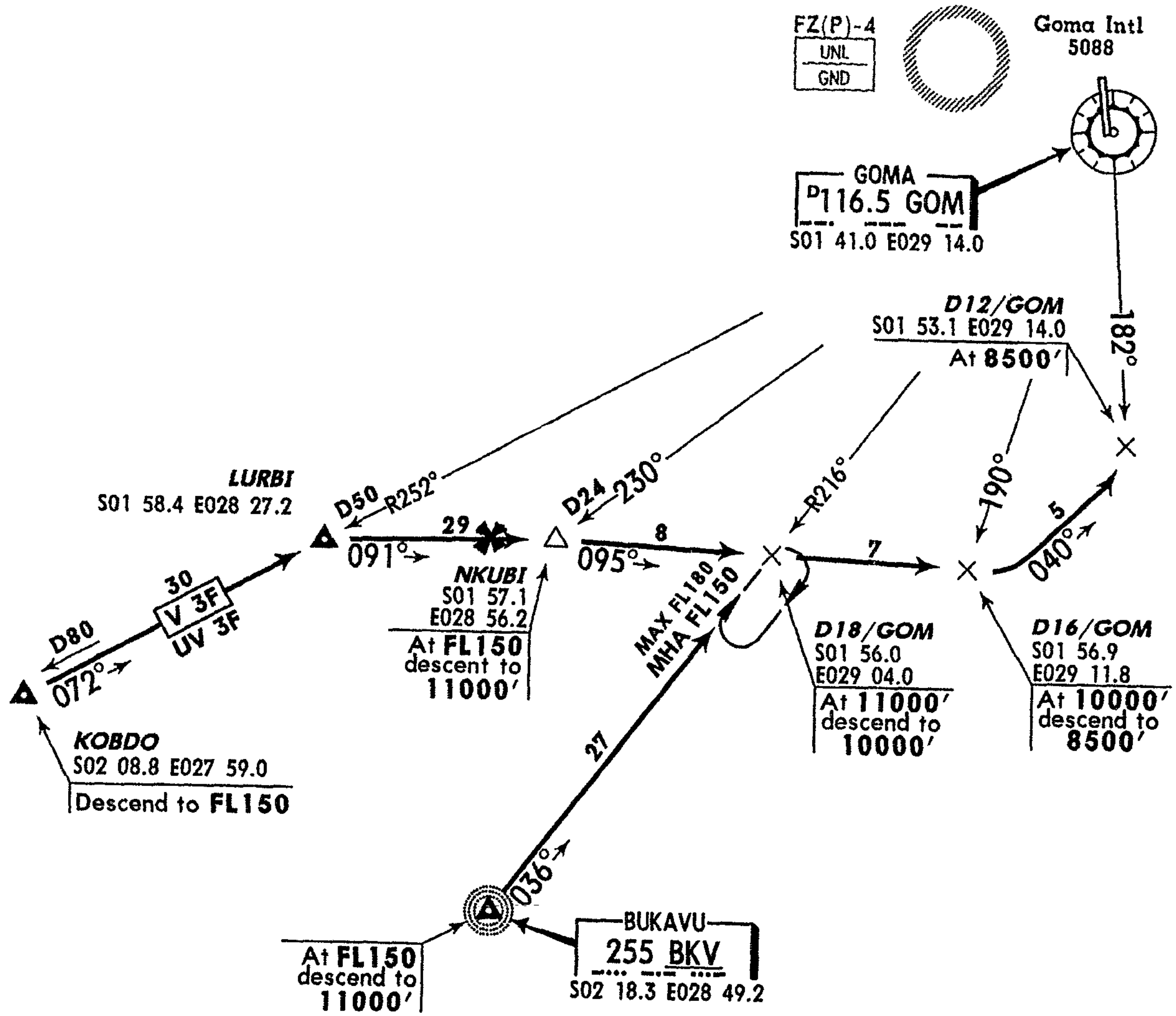
Next Page

Circumstances:	While on initial approach (VOR-DME) to runway 36, the aircraft was cleared to descend prematurely to 8,500 feet. The aircraft impacted approximately 65 feet below the last ridge between the aircraft and the airport. Non-standard phraseology led to a misunderstanding between the pilots and controller of the aircraft's position (non-radar environment).
Time:	Night
Fatalities:	37
Other:	No GPWS Installed

Flight Path Profile
F-27
GOMA, ZAIRE
13 December, 1992



Return to TOC



FLIGHT PATH PROFILE
Sabre Liner/Twin Piper
Quito, Ecuador
10/22 December, 1992

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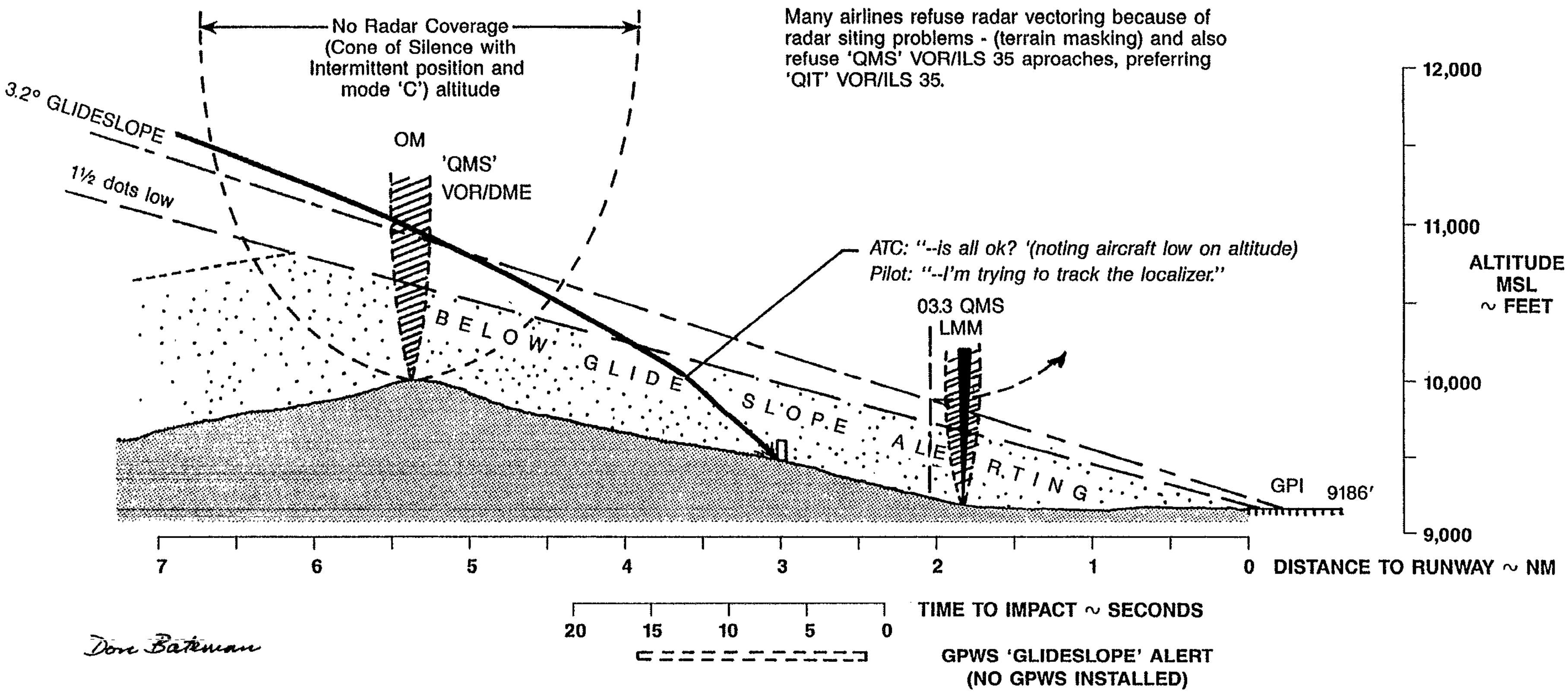
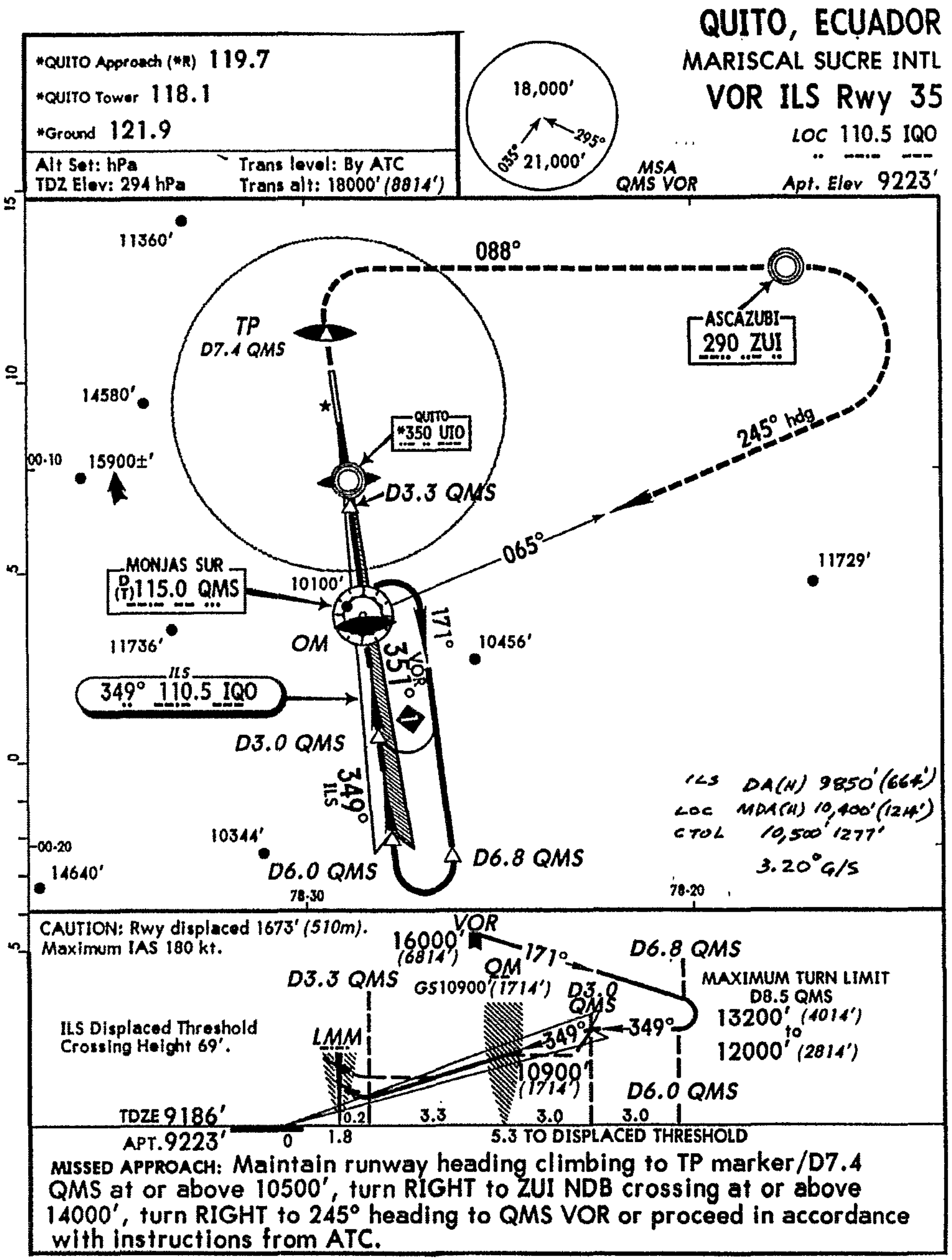
Circumstances:	*Both aircraft on approach hit 3.0NM short into two building 300 meters apart. Both aircraft had accepted radar vectors to 'QMS' VOR/ILS 35*	
10 Dec '92 Sabreliner:	Impacted 1st floor of building	
	Time:	19:40 local Night
	Weather:	6 KM visibility at airport, but fog low clouds at building #1.
	Fatalities:	12 including Ecuadorian Chief of Army, his son, 1 Major, 2 Captains (pilots), 4 Lieutenants, 3 Seargents. Pilot in command had less than 50 hours time in type.
22 Dec '92 Twin Piper:	Impacted 3rd floor of building #2.	
	Time:	11:20 local morning
	Weather:	4 KM visibility at airport, but fog, low clouds near building.
	Fatalities:	5 including Government Minister of Tourism and Information.

It has been reported that the localizer can suddenly 'scallop' between the OM and LMM to runway 35, and pilots tend to overconcentrate on maintaining localizer track and slip through the glideslope.



Return to TOC



Ecuador general killed

QUITO, Ecuador — The army's top general, his son and eight military officers were killed Thursday when their private jet clipped a 10-story building under construction and crashed in a residential area, officials said.

There were no survivors aboard plane and at least one worker in the building was killed, officials said. Radio reports, which could not be immediately confirmed, said there were at least three dead on the ground.

Gen. Carlomagno Andrade and the others were returning from a military ceremony in Machala, about 220 miles southeast of Quito, when the wing of the 16-seat Saberline executive jet hit the fifth floor of the building.

Journal American 11 Dec '92

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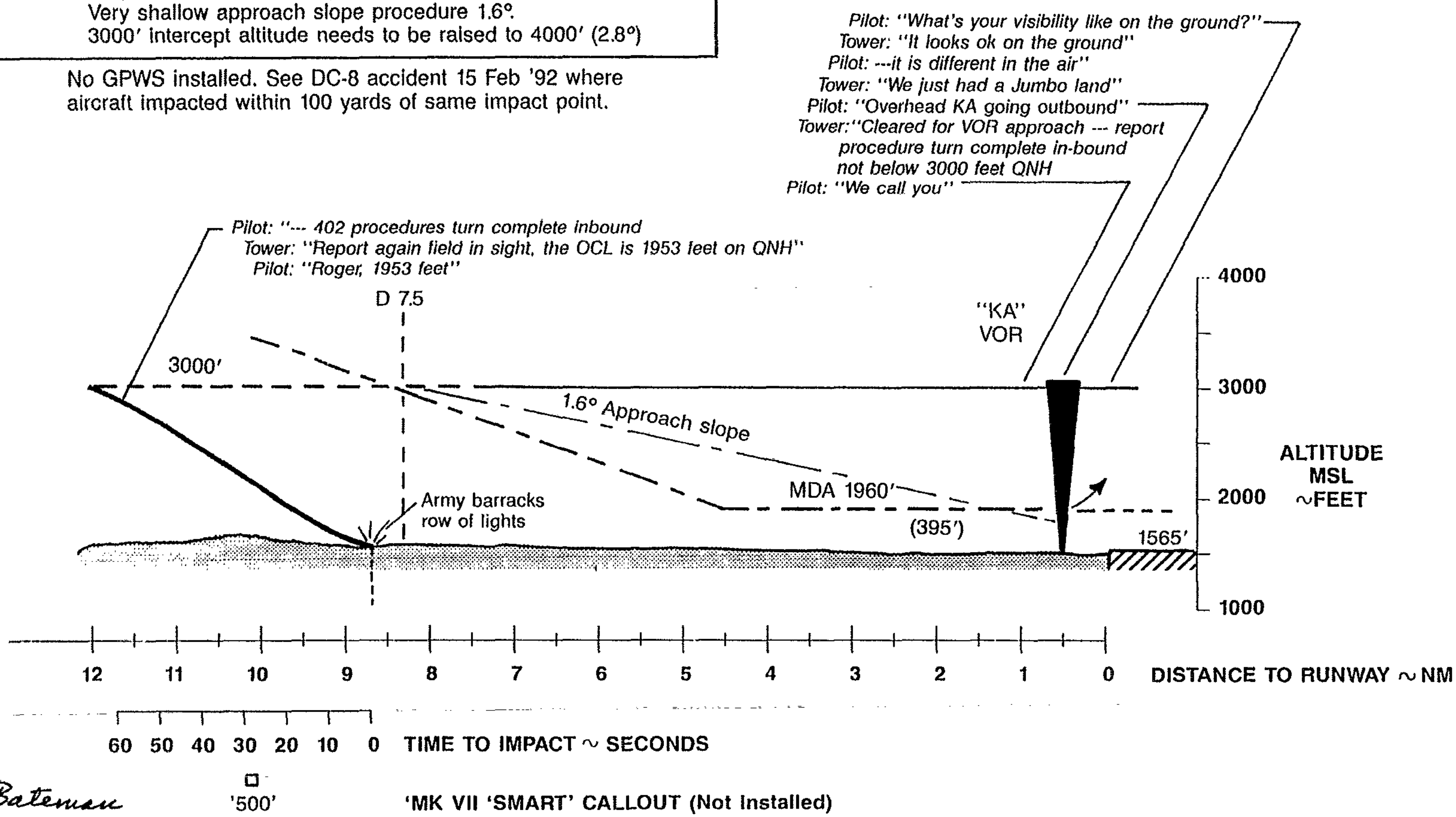
FLIGHT PATH PROFILE
B707-320C
Kano, Nigeria
25 November, 1992

Conditions:	While on VOR approach to runway 06, aircraft hit 9 NM short of runway threshold. Unofficial report is that crew prematurely descended after seeing red lights which turned out to be an army barracks.
Time:	(night) 01:43
Weather:	At 01:00 --- Wind 070/12, visibility 4000M, slight dust haze, cloud 5 CS 9000M, Altimeter 1018, temperature 20°C
Configuration:	Landing
Damage:	After clipping trees, aircraft destroyed in fire. 4 on board walked away with no injuries.
Other:	Example of Procedural 'Trap' --- Very shallow approach slope procedure 1.6°. 3000′ intercept altitude needs to be raised to 4000′ (2.8°)

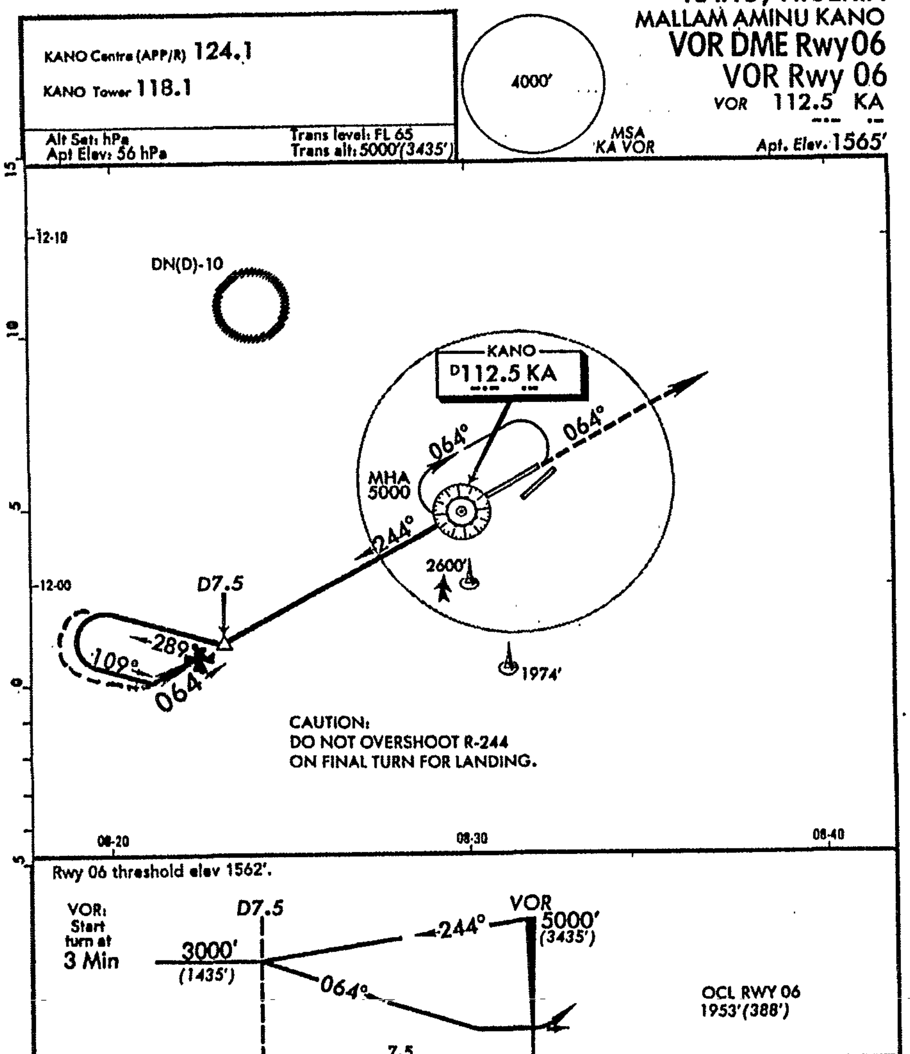
No GPWS installed. See DC-8 accident 15 Feb '92 where aircraft impacted within 100 yards of same impact point.



Don Bateman

Return to TOC

KANO, NIGERIA
MALLAM AMINU KANO
VOR DME Rwy06
VOR Rwy 06
VOR 112.5 KA
Apt. Elev. 1565'



MISSED APPROACH: Climb on 064° to 4000'(2435') or as directed.

STRAIGHT-IN LANDING RWY 06

MDA(H) 1960'(395')

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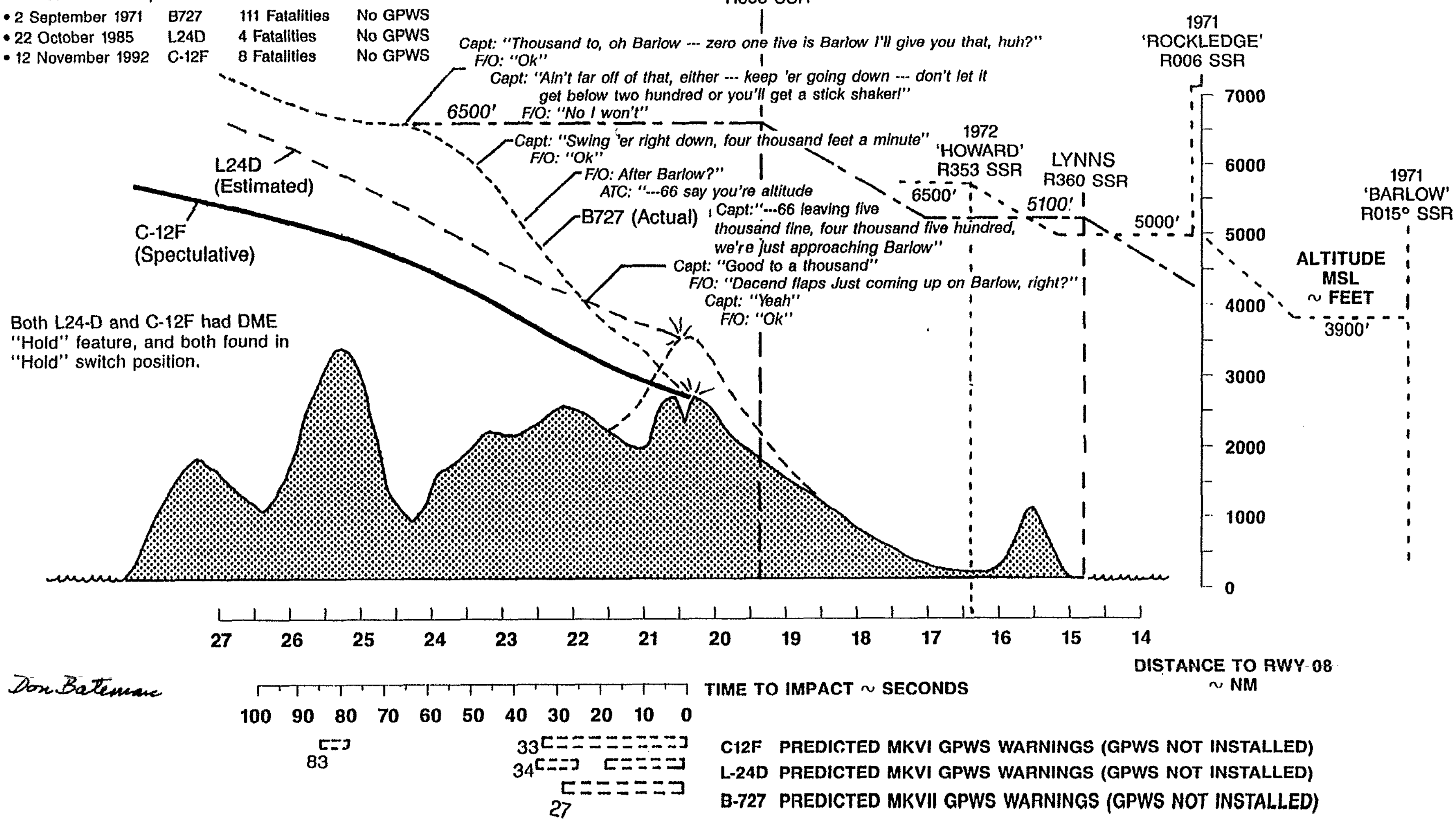
Circumstances:	During a localizer instrument approach (LDA-1) to runway 8, the aircraft impacted a ridge on Mt. Chilkat
Weather:	Probably IMC. At the airport weather reported as low clouds, rain mixed with snow, winds gusting 35 mph.
Time:	09:02 local
Fatalities:	8. Included 3 Generals, 2 Colonels, 1 Warrant Officer and 2 Sergeants
Other:	Aircraft reportedly fitted with "Talking Altimeter", Global Positions Receiver and MOCA/MSA data base.
	No GPWS installed. Army had previously rejected GPWS (TSO-C92b) 2 years prior to accident. Juneau accident of 2 Sept 1971 had been used as example to Army of GPWS safety merits!

FLIGHT PATH PROFILE
U.S. Army C-12F
Juneau, Alaska
12 November, 1992

Note: Three aircraft have impacted Mt. Chilkat. All were prematurally low in altitude. Sisters VOR has been held with suspicion by some investigators but errors not proven

- 2 September 1971 B727 111 Fatalities No GPWS
- 22 October 1985 L24D 4 Fatalities No GPWS
- 12 November 1992 C-12F 8 Fatalities No GPWS



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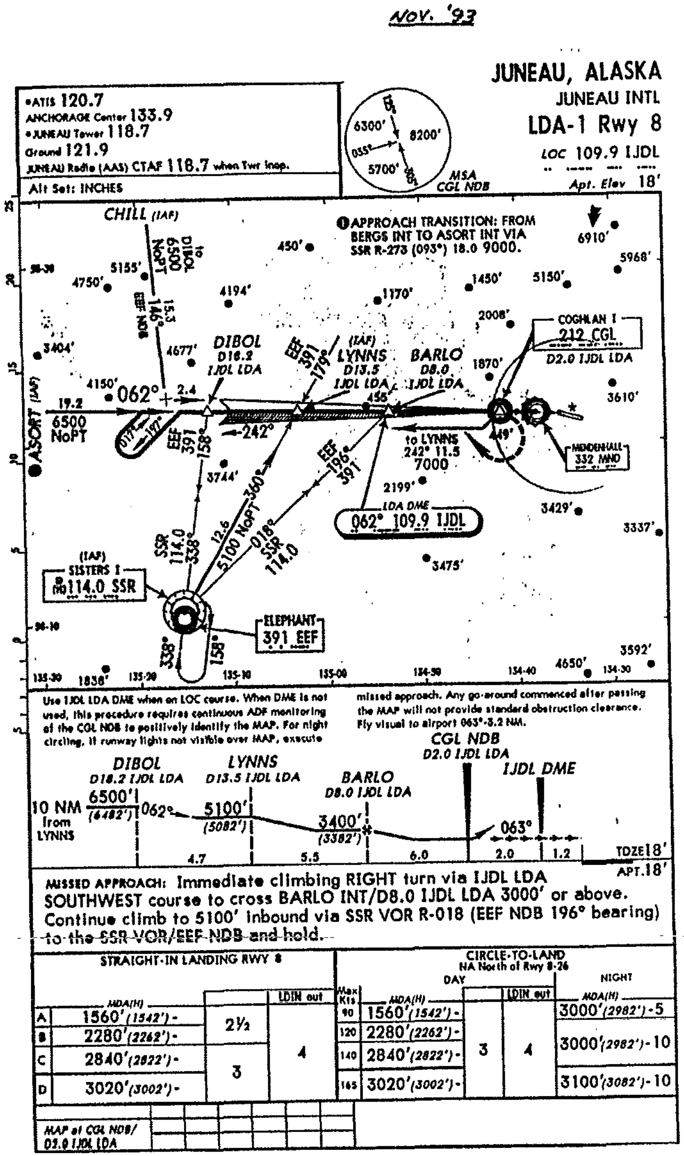
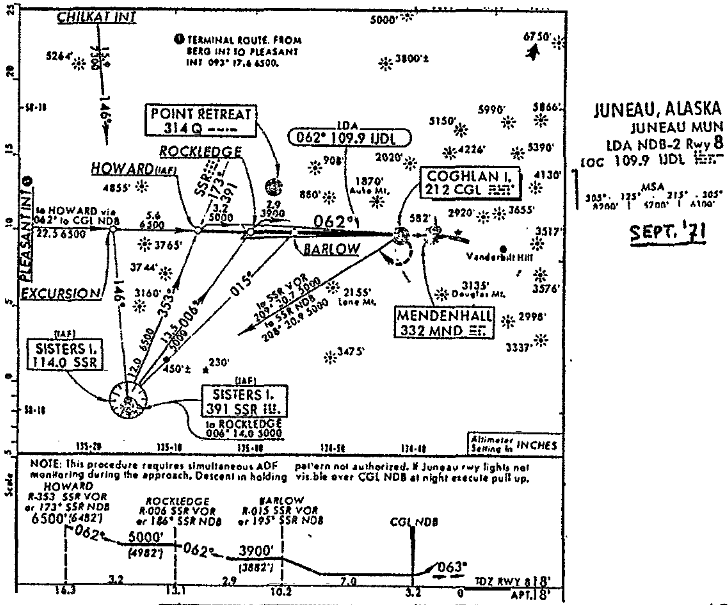




A-10 THE SEATTLE TIMES SATURDAY, NOVEMBER 14, 1992

Weather at crash site prevents recovery of 8 dead Guardsmen

by Brian S. Akre
Associated Press

JUNEAU, Alaska – Snow and low clouds grounded initial efforts yesterday to retrieve the bodies of eight men from the wreckage of an Alaska National Guard plane that crashed on a remote mountainside.

The Coast Guard was trying to get a helicopter to the site about 30 miles west of Juneau. "They're sitting out there waiting for the weather to change," Lt. Ray Massey Jr. said.

The C-12F twin-engine plane crashed at the 2,600-foot elevation on the Chilkat Peninsula on Thursday. The site is in the Chilkat Range between Juneau and Glacier Bay National Park.

Photos of the site show the plane's tail and wings broke off on impact, but the main fuselage remained intact. There were no survivors.

In Anchorage, the loss of the men was deeply felt in the close-knit National Guard unit where most of them were based.

"Up and down the hallway there's a lot of red, wet eyes," said Capt. Mike Haller. "We're pretty shook up."

Among those killed was the commander of the Alaska Army National Guard, Brig. Gen. Thomas C. Carroll. Carroll, 44, also served as deputy commissioner and chief of staff of the state Department of Military and Veterans Affairs.

Alaska flags were being flown at half-staff yesterday in Carroll's honor.

Maj. Gen. Kenneth W. Himsel, an Indiana national guardsman on a brief assignment in Alaska, also was killed in the crash. Himsel was deputy commanding general for reserve components for the Forces Command at Fort McPherson in Atlanta.

Himsel, 55, was planning to retire in February after 33 years of combined active duty and National Guard service.

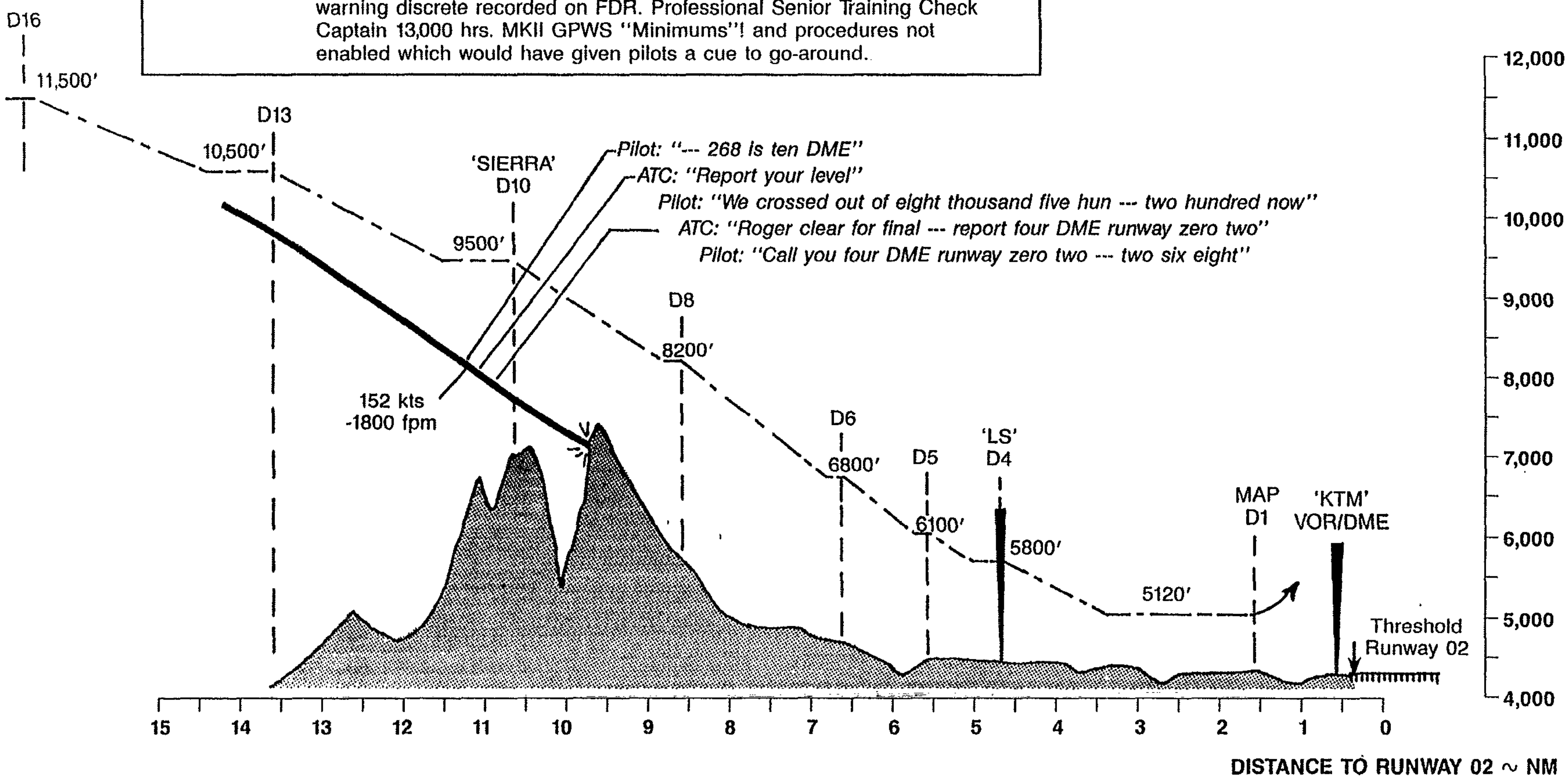
Maj. Gen. Hugh L. Cox III, adjutant general of the Alaska National Guard, said the men will be sorely missed.

An Army investigation team from Fort Rucker in Alabama was scheduled to arrive in Juneau late yesterday or today, Massey said.

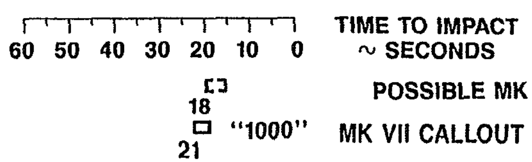
The plane crashed while on an instrument-aided approach to the Juneau airport. It was en route from Elmendorf Air Force Base in Anchorage. The pilot gave no indication that the plane was in trouble, officials said.

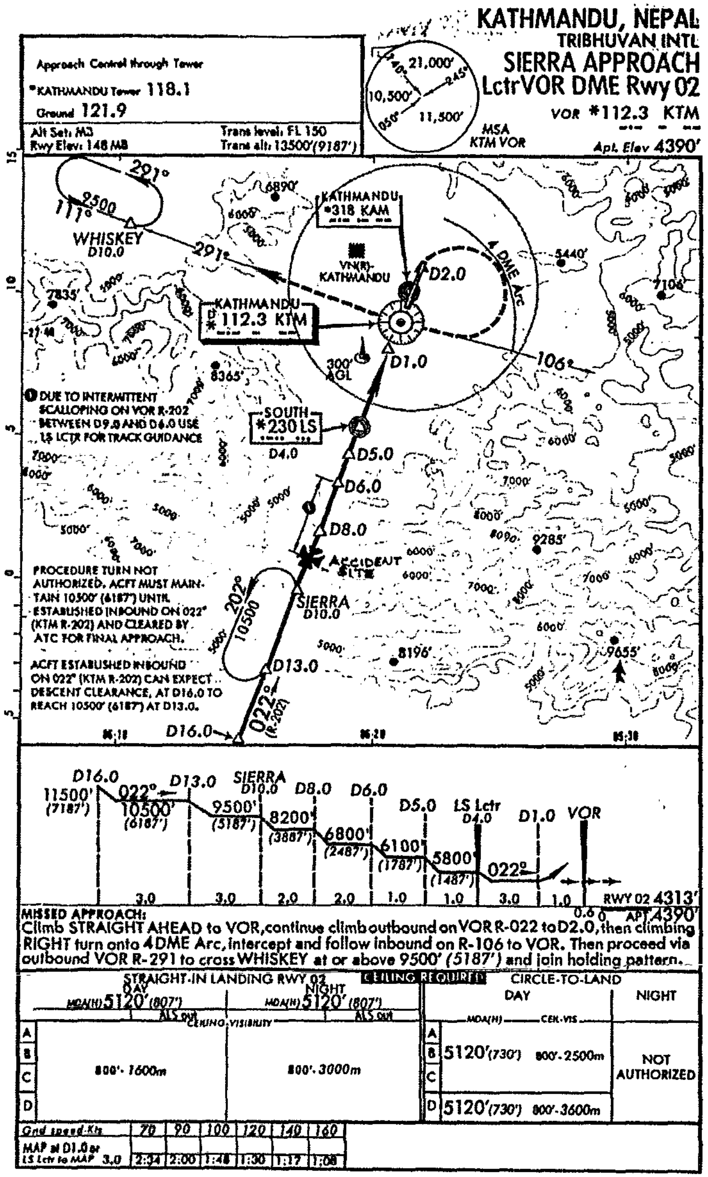
FLIGHT PATH PROFILE
A300-B4
Kathmandu, Nepal
28 September, 1992

Circumstances:	Aircraft, while tracking NDB-VOR-DME runway 02, hit last ridge between aircraft and airport, 260 feet below top at 9NM. Captain may have misread the approach plate on altitude versus DME. This accident very similar to B737 Unalakleet 2 June 1990, where the error was not detected by the co-pilot.
Time:	14:00 local
Weather:	VMC at airport, but clouds covering mountain tops.
Configuration:	Landing, 25 flaps
Fatalities:	167
Other:	Very steep approach, approximately 6½ degrees, requires landing configuration. Autopilot #2 and autothrottle engaged. MK II GPWS installed, but operation not known. CVR area microphone inoperative. No GPWS warning discrete recorded on FDR. Professional Senior Training Check Captain 13,000 hrs. MKII GPWS "Minimums"! and procedures not enabled which would have given pilots a cue to go-around.



Don Bateman





" . . . *Mountains should be abolished. At least that'd stop all these aeroplanes bumping into every other peak . . . It's just happened . . . in Nepal . . . Kathmandu . . . I was reading the story in the paper. Here . . . look."*

"The Adventures of Tin Tin in Tibet"

by Hergé, 1960

167 die as Pakistani plane rams hill near Katmandu

KATMANDU, Nepal (AP) — A Pakistani jet filled with Europeans — including mountain climbers and missionaries — plowed into a pine-covered hillside Monday, and rescuers searching the burning wreckage reported no survivors among the 167 aboard.

Officials said one American also was on board the Pakistani International Airlines Airbus A300 when it crashed on a landing approach, the second air disaster near the capital in as many months.

The pilot had given no indication anything was wrong before contact was lost with the plane, and the weather was normal, officials said.

Airline sources in Pakistan said the plane may have been flying too low as it approached this city ringed by Himalayan mountains thousands of feet high. The sources, speaking on condition of anonymity, said the plane was flying at 7,500 feet when it should have been at 9,000.

The airline has had a poor safety and service record in recent years. A Thai Airbus crashed into a snowy peak near the capital in July, killing all 113 people aboard.

The Pakistani jet, on a flight from Karachi, Pakistan, crashed 14 miles south of Katmandu's airport, said Nagendra Prasad Ghimire, deputy chief of Katmandu airport.

Except for a few chunks of scattered wreckage, the fuselage was mainly in one piece, according to Associated Press reporter Binod Joshi, who drove to the site. The plane's tail was in the air and its nose buried in the ground.

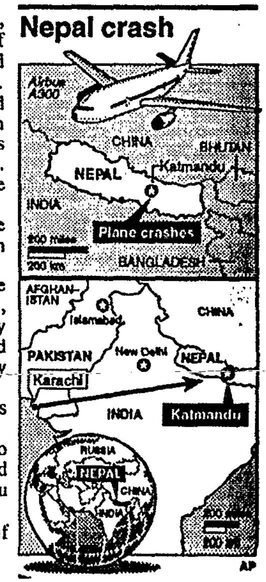
Rescue crews that reached the site earlier by helicopter said the plane was on fire.

Kedar Prasad Bagjai, a villager whose home is a 30-minute walk from the site, said he heard a loud noise followed by explosions that lasted 15 minutes. He and other villagers said they later saw "many bodies" at the crash site.

They said there were scattered clouds but no rain at the time of the crash.

The state-owned Nepal Radio announced that bodies of victims would be handed over to relatives at Katmandu airport today.

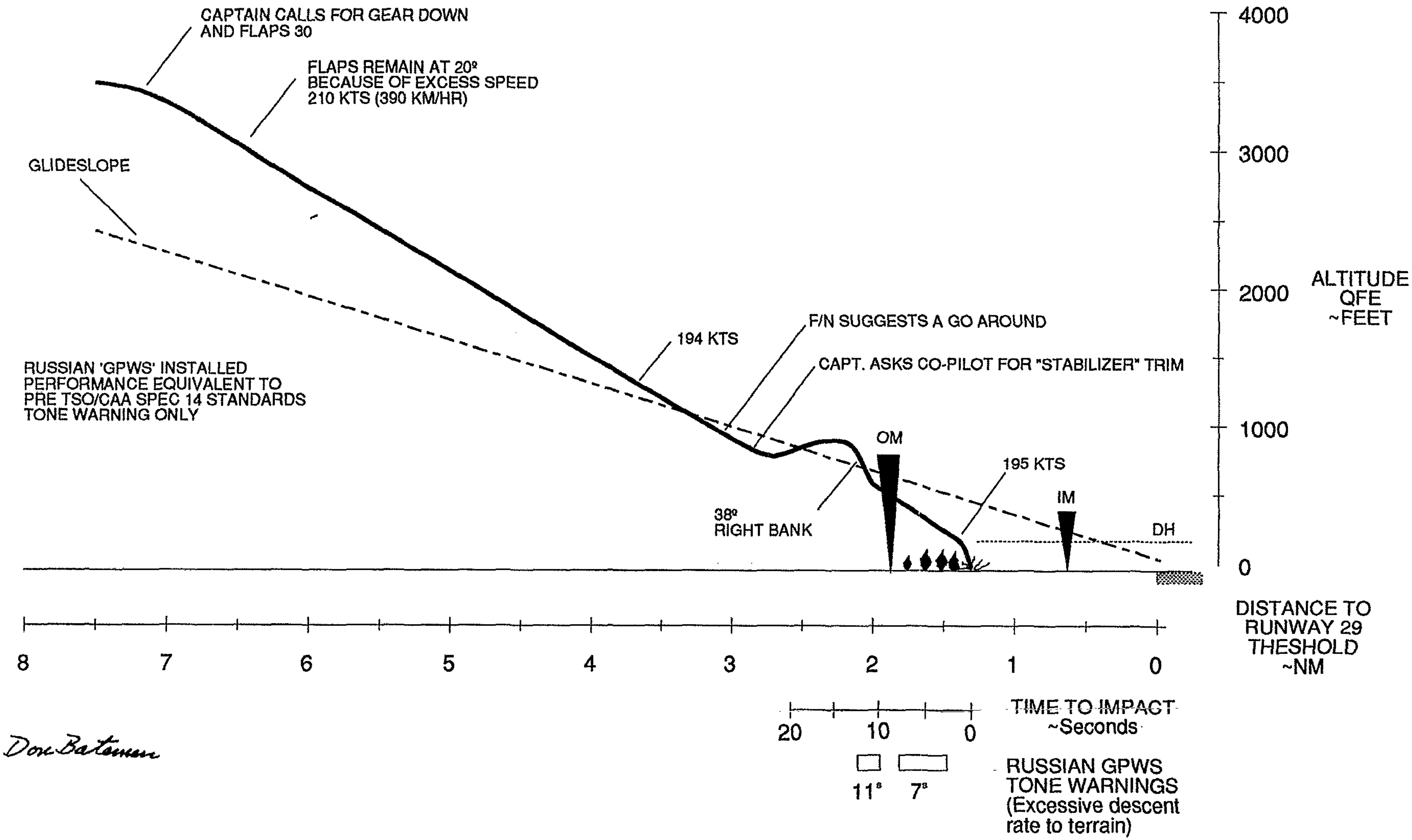
The accident occurred at the start of Nepal's tourist season.



Next Page

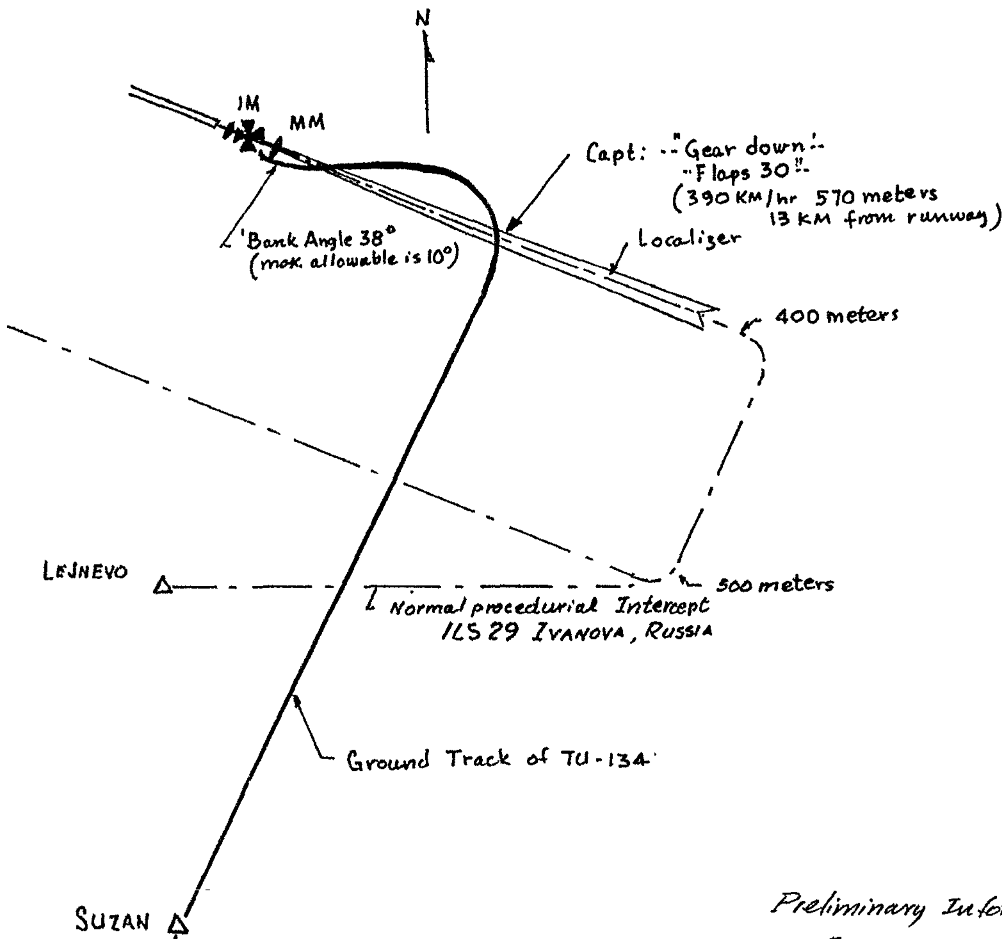
Circumstances: During an expedited approach to ILS runway 29, aircraft became unstablized, with 'S' turns through the localizer at 60 Kts excess speed, overbanked, out of trim and in limited visibility. Aircraft's right wing clipped trees and tore off, aircraft hit inverted.
Time: Night
Weather: Ceiling 360 feet, visibility 4,000 feet
Fatalities: 84 (21 children) 7 crew

FLIGHT PATH PROFILE
TU-134
IVANOVO, RUSSIA
27 August, 1992



Don Bateman

Return to TOC



On Board: (7) Crew
Captain, Co-pilot, Navigator,
Flight Engineer, Engineering Instructor
(2) Hostesses
(77) Passengers of which (21) were children, many in parent's arms, returning from vacations.

Other Factors: Reserve crew up for 20 hrs.
8 hr rest. 4h 53' in aircraft
Captain 53 yrs old, 14,500 hrs
2-1/2 years in type.
Co-pilot 5,000 hrs, 100 hrs in type; F/N-F/E 8000 hrs, 5-1/2 yrs in type. All familiar with route and professional.

At First Impact: aircraft clipped trees 3-4 meters below tops, loosing skin from right wing. Bank angle increased to 55 , right wing broke off, aircraft inverted with Pilot pulling back at 360 km/hr.

Flaps, although set for 30 , remained to 20 because of excessive speed. (100 km/hr above normal final approach speed.

Preliminary Information -

- Expedited, unstabilized approach by Captain probably very tired, fatigued, frustrasted and determined to complete approach.

Don Bateman
8th October 1992

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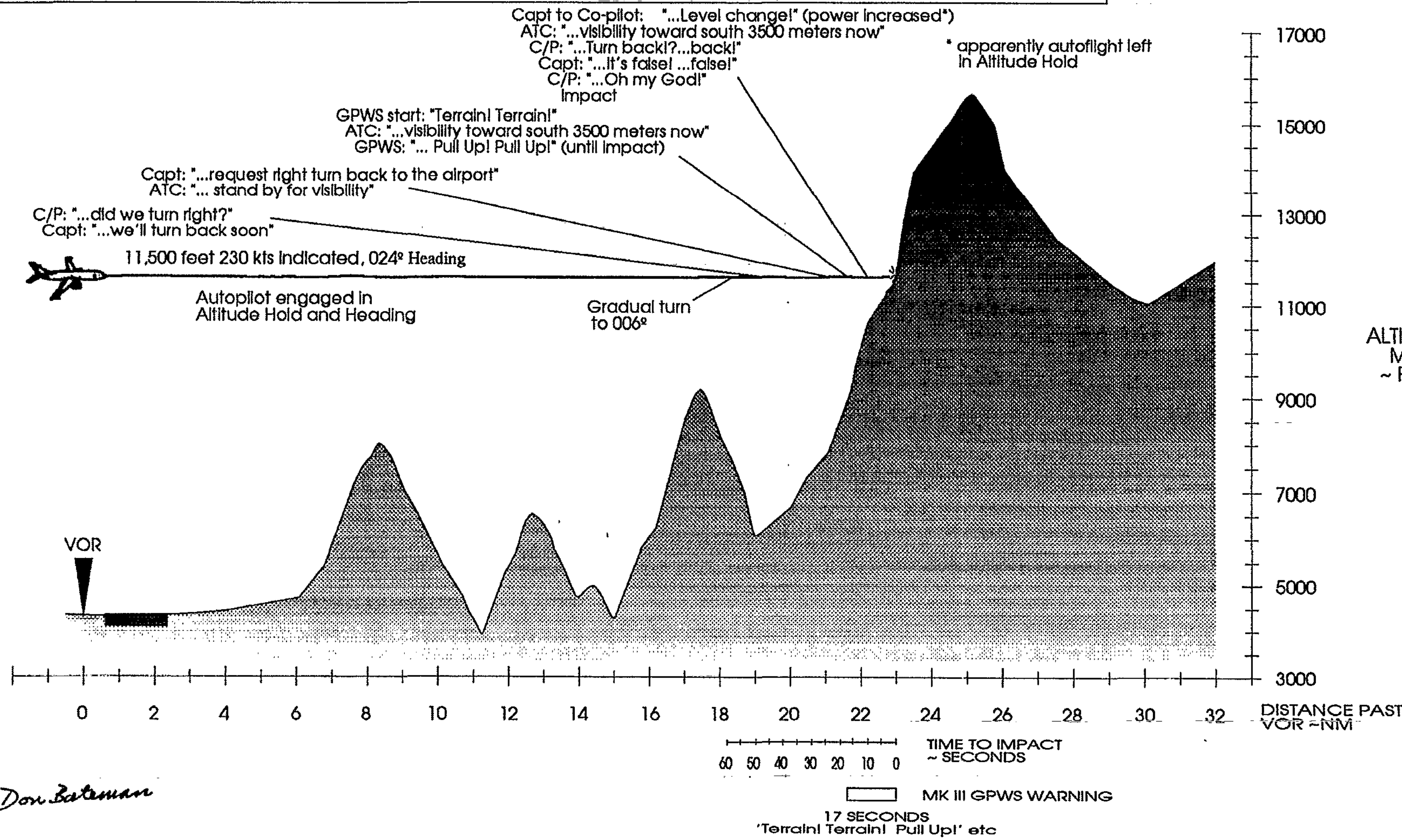
Circumstances:	The aircraft impacted terrain during a missed approach. The flight crew, while at an initial approach altitude of 11,500 feet, had difficulty selecting and obtaining a landing flap position. This delayed the initiation of the descent for NDB-VOR/DME approach to runway 02. The crew then decided to request a clearance back for a second attempt at the same altitude. ATC granted this clearance back to "Sierra". However, both crew members left the flying to the auto pilot and became fatally distracted in locating the paper area navigation chart, determining co-ordinates for "Romeo" and other Initial Approach Fixes (IAF) missing from the FMS data base. These co-ordinates were then entered by hand into both FMS using the keyboards. Valuable time was then lost trying to show these IAF's on the Navigation Display in Map mode (behind the aircraft). A critical 3-plus minutes were lost in this process. Instead of an immediate pull-up recovery, after a GPWS (MK III) warning occurred some 17 seconds before impact, the crew delayed, waiting for ATC permission to turn back.
Time:	13:00 Local approximately.
Weather:	IMC, rain, heavy at times.
Configuration:	Clean
Fatalities:	113

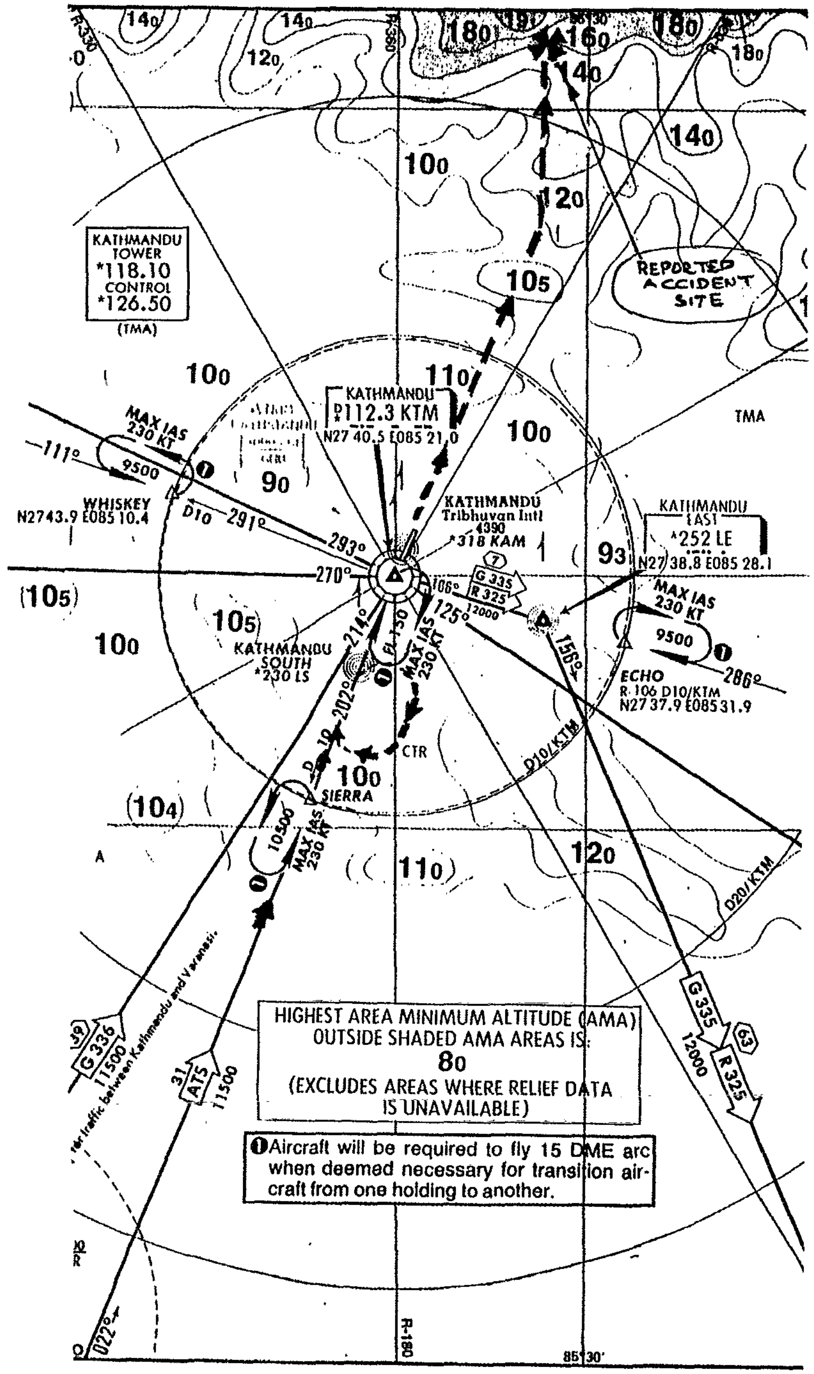
FLIGHT PATH PROFILE
A310-300
KATHMANDU, NEPAL
31 JULY 1992



Don Bateman

3/30/94

Return to TOC



Lessons:

1) This accident highlights how the FMS and Map displays found in the modern glass cockpit can be addictive and compelling, can contribute to a lack of terrain awareness, and in this accident...a fatal distraction.

2) There is need in CRM training to illustrate why immediate terrain recoveries are necessary, and how to recognize "traps" in the ATC radar/non-radar environment.

3) There is a need for "hands on" terrain recovery training in the simulator. The pilot should be able to practice responsive sustained smooth pitch ups to nominal recovery attitudes.

4) In most glass cockpits there is typically only a simple digital readout of radio altitude immersed in the clutter of the ADI. The lack of a prominent radio altitude indicator that gives terrain "unwinding" trend handicaps the pilot in recognizing any possible terrain problem in the first place, and then later as a tool for terrain recovery. This is a step backwards in terrain situational awareness when compared to present radio altimeter indicators (tape and dial) available in the older non-glass cockpits.

The A310 has a "declutter" function on the Primary Flight Display of Attitude Data for unusual pitch or roll attitudes. For abnormal attitudes, attitude, speed/mach and heading are retained, all other indications are erased to help declutter the display. Why not devise a similar scheme for an emergency "Terrain! Pull-up!" GPWS warning...highlighting attitude, radio altitude and trend to help the pilot expedite a safe terrain recovery?

5) Other factors illustrate the use of non-standard phraseology, misunderstandings, lack of aircraft positional awareness for both crew and controller, and other traffic.

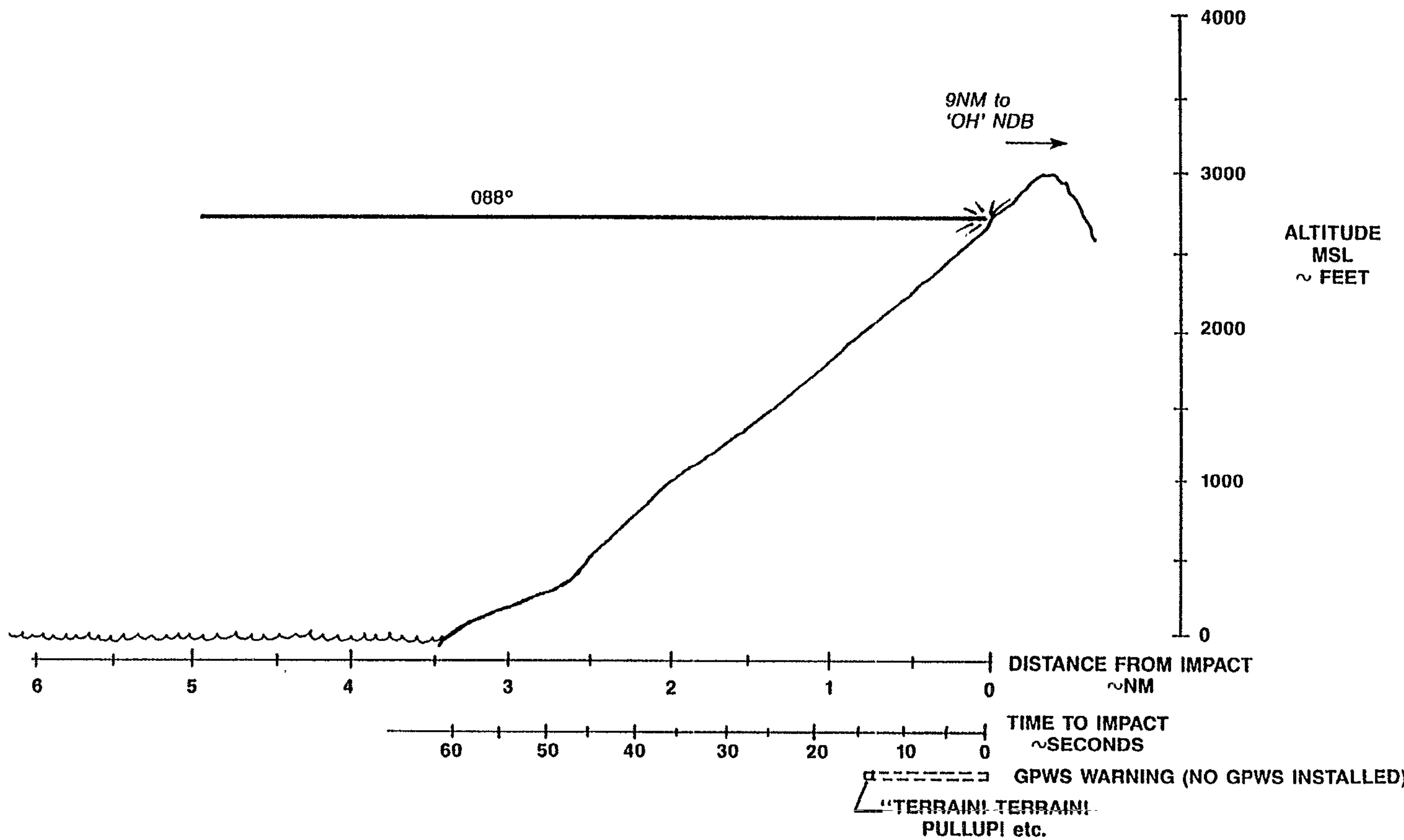
Don Bateman
8th October 1992

Next Page

Circumstances:	On initial approach ILS Runway 04 to Ambon, aircraft struck a mountain 9 NM from the runway. Aircraft had descended prematurely for an unknown reason, such as misunderstanding of clearance transition altitude.
Weather:	IMC
Fatalities:	71 (7 crew)

Preliminary Data

FLIGHT PATH PROFILE
Vickers Viscount
AMBON, INDONESIA
24 July, 1992



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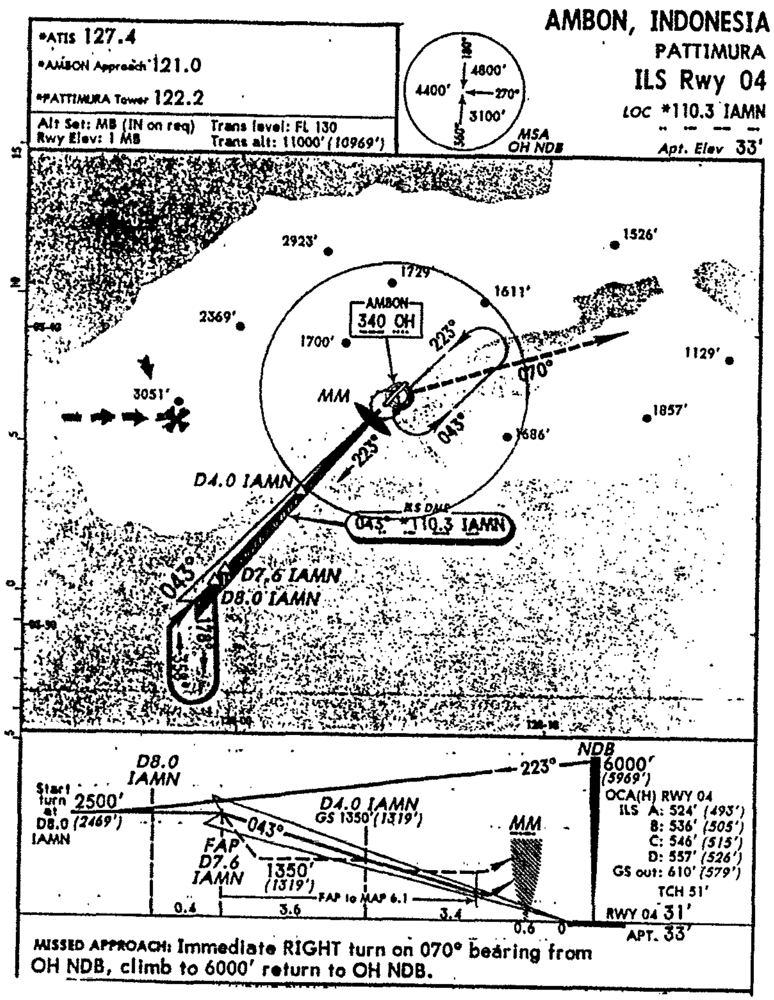


A 4 THE SEATTLE TIMES

Saturday, 25 July 1992

World

NEWS IN BRIEF

Plane carrying 71 people is missing in Indonesia

JAKARTA, Indonesia – A plane with 71 people on board was missing today, a day after it failed to make a landing due to bad weather in Indonesia's eastern province of Ambon, officials said.

The domestic Mandala Airlines flight lost contact with the ground after failing to make a landing in the fog on the island of Ambon, 1,500 miles east of Jakarta.

Circumstances: The aircraft clipped the top of a T.V. tower located on the top of a 3000 foot mountain during a night time departure. A misunderstood clearance with non-standard phraseology and improper read back led to a flight into terrain situation. "Perry" intersection, located 032 degrees and 150 nm from the airport, had been entered into the FMS as a waypoint direct from liftoff. The aircraft tuned at 750 feet after liftoff to follow the magenta line to "Perry" on the Navigation Display in MAP mode.

A MK V GPWS issued a "Terrain! Terrain! Pull Up! some six seconds from impact. The F/O immediately responded with a gentle Pull Up that was not sustained, but which saved the aircraft, crew and passengers from certain destruction and loss of life.

Time: 22:05 local

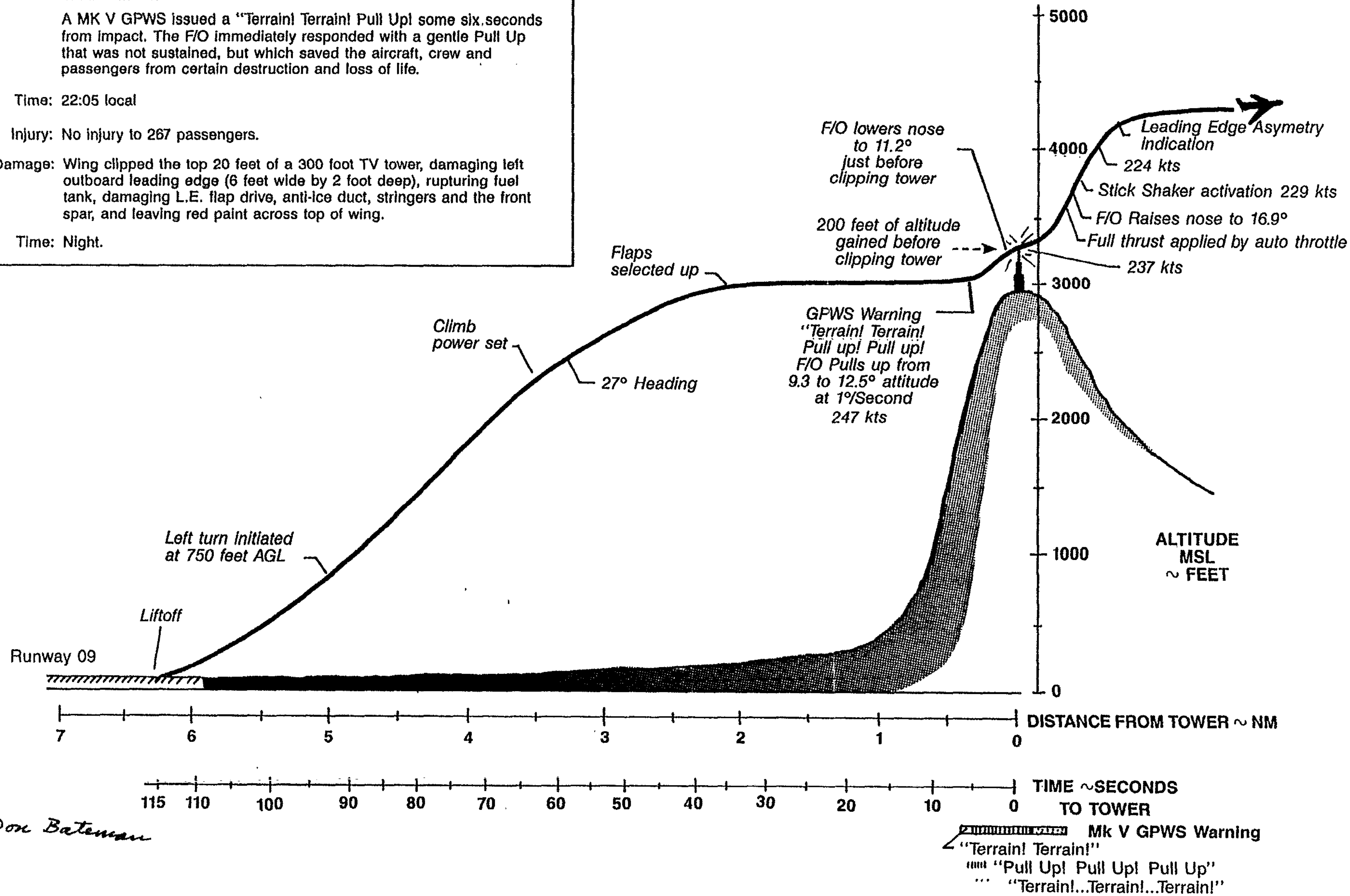
Injury: No injury to 267 passengers.

Damage: Wing clipped the top 20 feet of a 300 foot TV tower, damaging left outboard leading edge (6 feet wide by 2 foot deep), rupturing fuel tank, damaging L.E. flap drive, anti-ice duct, stringers and the front spar, and leaving red paint across top of wing.

Time: Night.

FLIGHT PATH PROFILE
B767-300 ER
MARGARITA, VENEZUELA
23 June, 1992

Next Page



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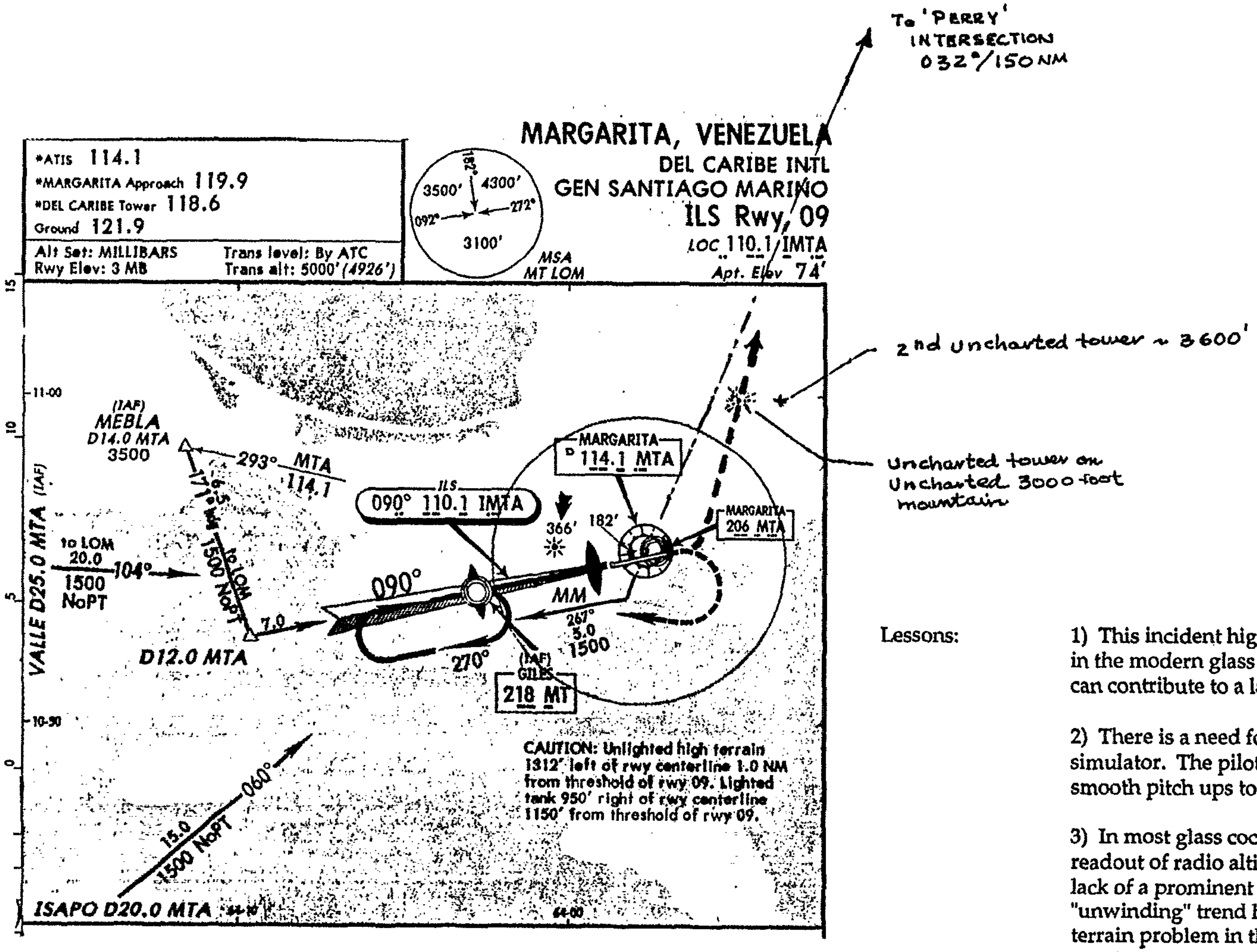

Lessons:

1) This incident highlights how the FMS and Map displays found in the modern glass cockpit can be addictive and compelling, and can contribute to a lack of terrain awareness.

2) There is a need for "hands on" terrain recovery training in the simulator. The pilot would be able to practice responsive sustained smooth pitch ups to nominal recovery attitudes.

3) In most glass cockpits there is typically only a simple digital readout of radio altitude immersed in the clutter of the ADI. The lack of a prominent radio altitude indicator that gives terrain "unwinding" trend handicaps the pilot in recognizing any possible terrain problem in the first place, and then as a tool for possible terrain recovery. This is a step backwards in terrain situational awareness when compared to present radio altimeter indicators (tape and dial) available in the older non-glass cockpits.

4) Significant terrain or man made obstacles may not be shown on instrument procedure charts. There appears to be no legal responsibility for completeness or accuracy of depicting significant terrain, terrain contours or obstacles. Potential legal and liability concerns may delete or deny this valuable information for the pilot. (Margarita has two major towers located on the same 3000 foot mountain, but neither are shown), and the mountain itself is shown only on one of the charts, and not on the others.

Don Bateman

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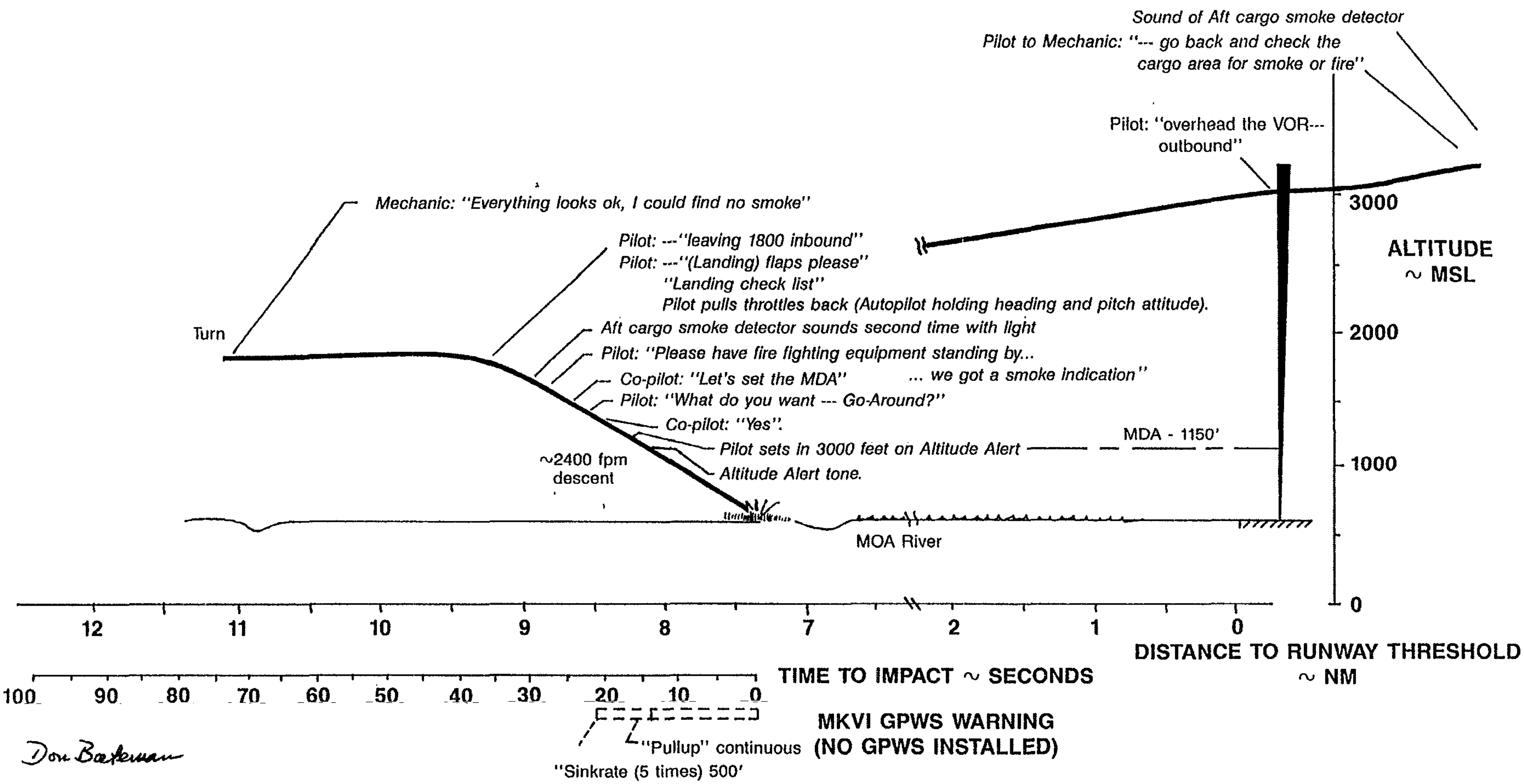
FLIGHT PATH PROFILE
B737-200C
CRUZEIRO DO SUL, BRAZIL
22 June, 1992

Circumstances:	Aircraft freighter while on approach to VOR runway 10, hit short of the runway by 7½ NM. Co-pilot flying. Captain distracted by intermittent aft cargo smoke alarm and light during approach.
Time:	01:05 local
Weather:	Clear, unlimited visibility
Fatalities:	3
Other:	General freight, food, chickens etc. Autopilot on heading hold.

Aircraft wired for GPWS, but no GPWS computer installed.



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Return to TOC

JEPPESEN JUN 28-91 (13-1)

CRUZEIRO DO SUL, BRAZIL

CRUZEIRO DO SUL INTL

DESCENT DELTA 1
VOR Rwy 10

VOR 112.0 CZS

*CRUZEIRO Radio 125.7

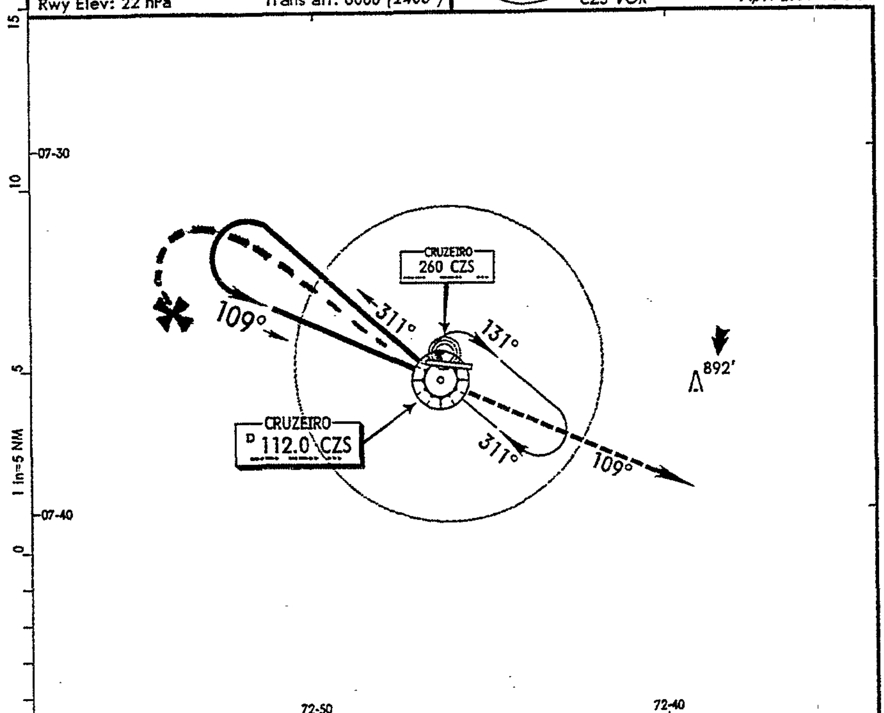
Alt Set: hPa
Rwy Elev: 22 hPa

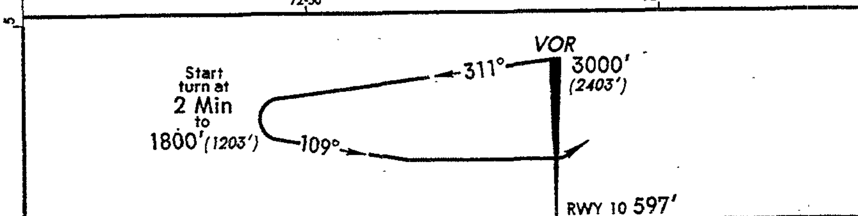
Trans level: By ATC
Trans alt: 3000'(2403')

3000'

MSA CZS VOR

Apt. Elev 600'





MISSED APPROACH: Climb to 3000' outbound on CZS VOR R-109.

	STRAIGHT-IN LANDING RWY 10	CEILING REQUIRED	CIRCLE-TO-LAND	
	MDA(H) 1150' (553')	Max Kts	MDA(H)	CEIL-VIS
	CEILING-VISIBILITY			
A	600'-2000m	100	1150'(550')	600'-2000m
B		135		
C	600'-2400m	180	1150'(550')	600'-2400m
D	600'-2800m	205	1150'(550')	600'-3200m

Rate of descent on final (feet/min)	600
MAP at VOR	

PANS OPS 3

CHANGES: Runway number.

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Flight Path Profile
Be-C99
Anniston, Ala.
8 June,1992

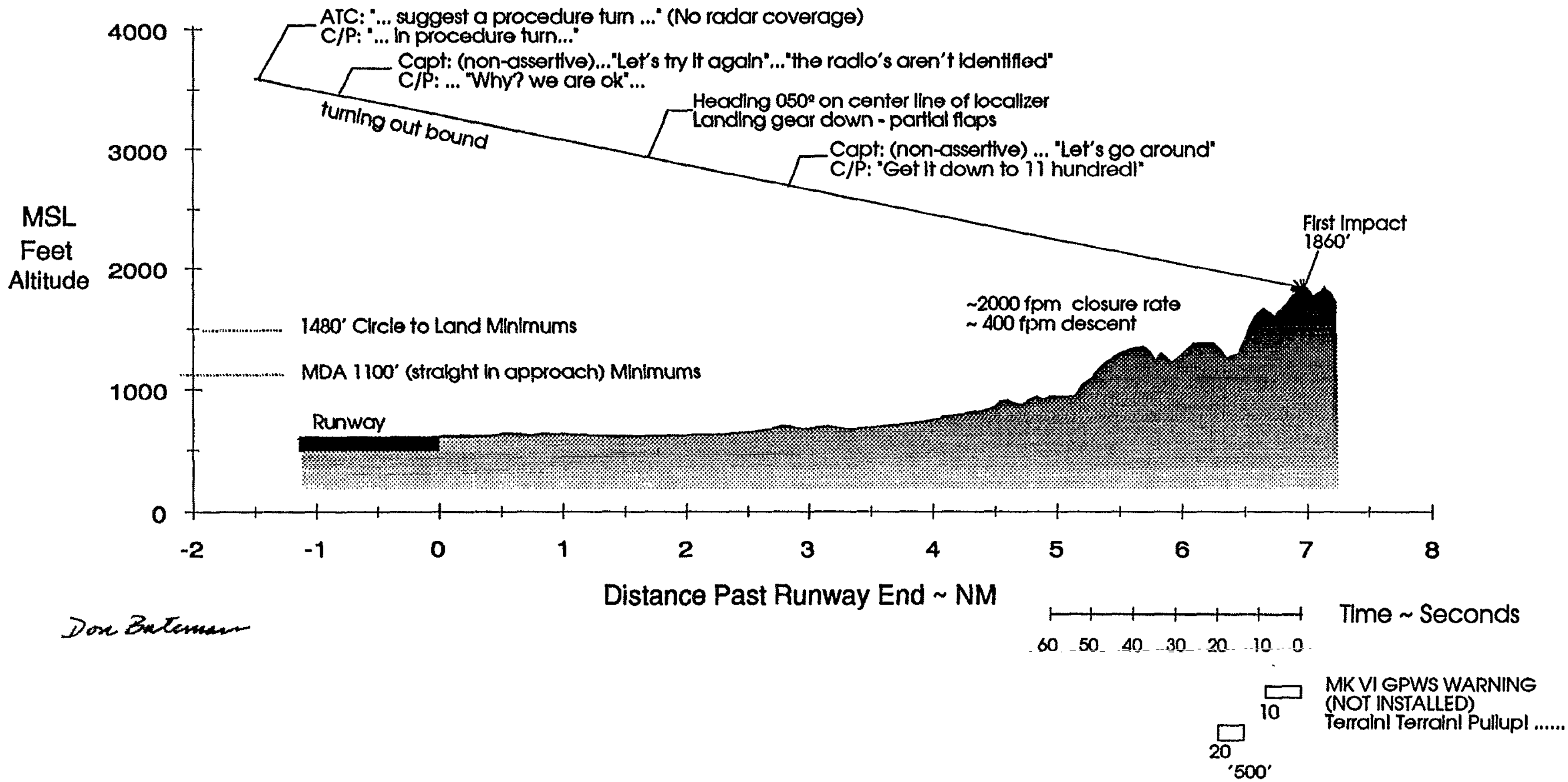
Circumstances: While conducting a ILS localizer approach to runway 5, the aircraft impacted a hillside. The pilot had inadvertently turned the aircraft right directly onto the localizer out bound and in a descent. The aircraft over flew the airport, while centered on the the localizer, by some 6.8 NM before impact.

Weather: 700 foot scattered, 500 foot broken, 4000 foot overcast, 3 miles visibility, foggy, rainy

Time: 09:00 AM local

Fatalities: 3 out of the 6 onboard.

Other: Captain flying his first and last revenue flight, had extensive helicopter experience, but handicapped by minimum instrument flight hours. Company provided only one set of approach plates per crew, co-pilot monitoring approach. No GPWS installed. FAR 135.153 published 20 March, 1992 requires GPWS installation by 20 April, 1994.



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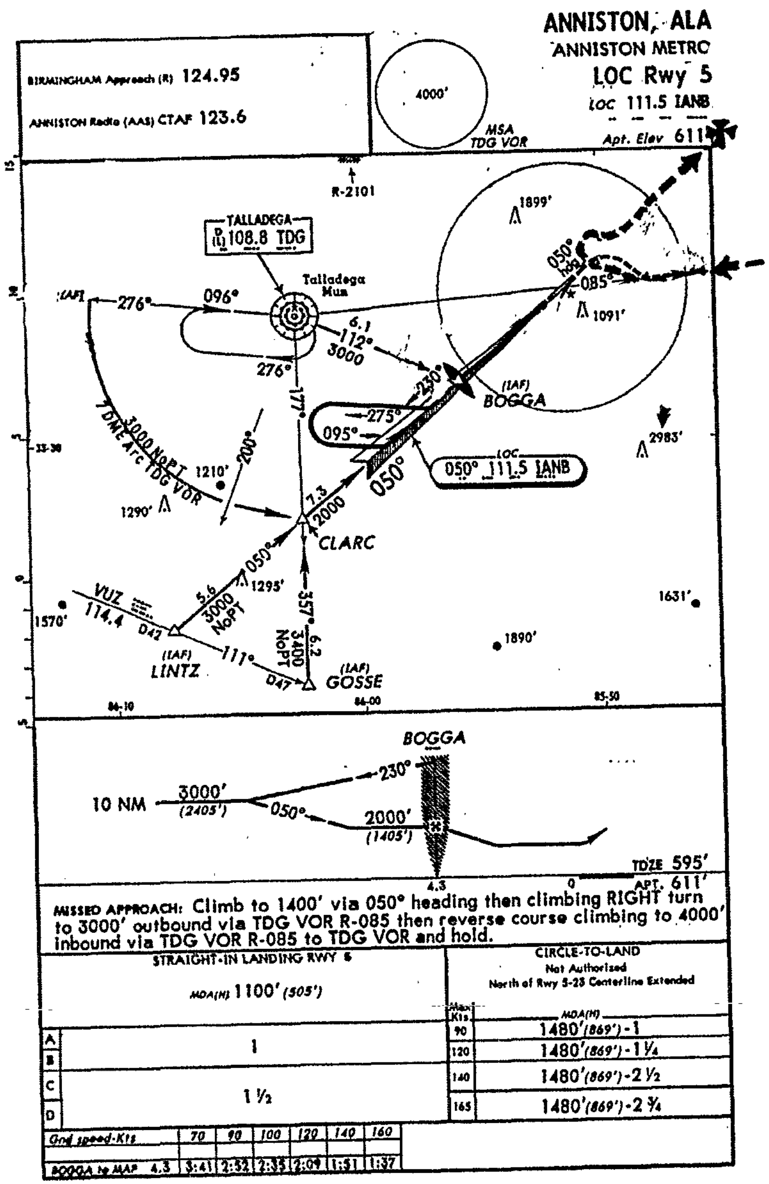
Return to TOC



Journal American 6-9-92

Briefly

Compiled from JA news services

3 die in plane crash

ANNISTON, Ala. – A commuter plane crashed in a remote area of Fort McClellan army base Monday, killing three of the six people aboard, officials said. A survivor who walked out helped rescuers find the wreckage more than five hours later.

GP Express Flight 861 originated in Atlanta and had been cleared to land at Anniston Airport at about 8:50 a.m. There were reports of fog and rain in the area when the plane crashed at the base about 10 miles to the northeast, said Arlene Salac, a Federal Aviation Administration spokeswoman in Atlanta. She wouldn't speculate whether those conditions were to blame.

Passenger Dennis Lachut, 29, of Fort Lewis, walked away from the crash and was in good condition at Northeast Alabama Regional Medical Center.

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CIRCUMSTANCES: Aircraft was inadvertently vectored by controller towards mountainous terrain. Controller was overloaded by vectoring heavy traffic around numerous thunderstorms through other ATC sectors resulting in excessive coordination and heavy communications.

WEATHER: IMC, Thunderstorms

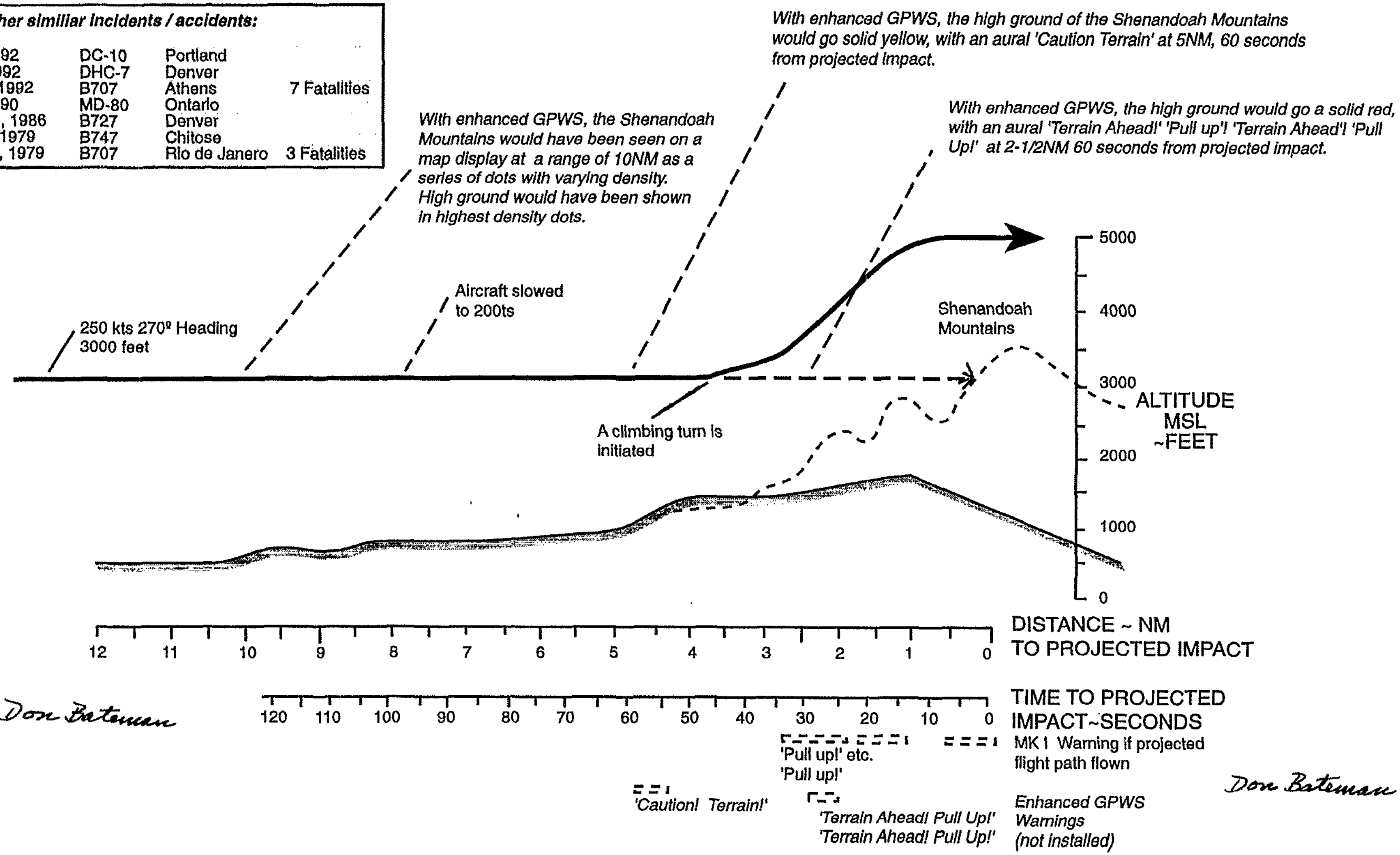
THE ATC RADAR VECTOR 'TRAP'

Flight Path Profile
MD-80
WASHINGTON, DULLES VIRGINIA
May, 1992

Controlled Flight Towards Terrain Incident

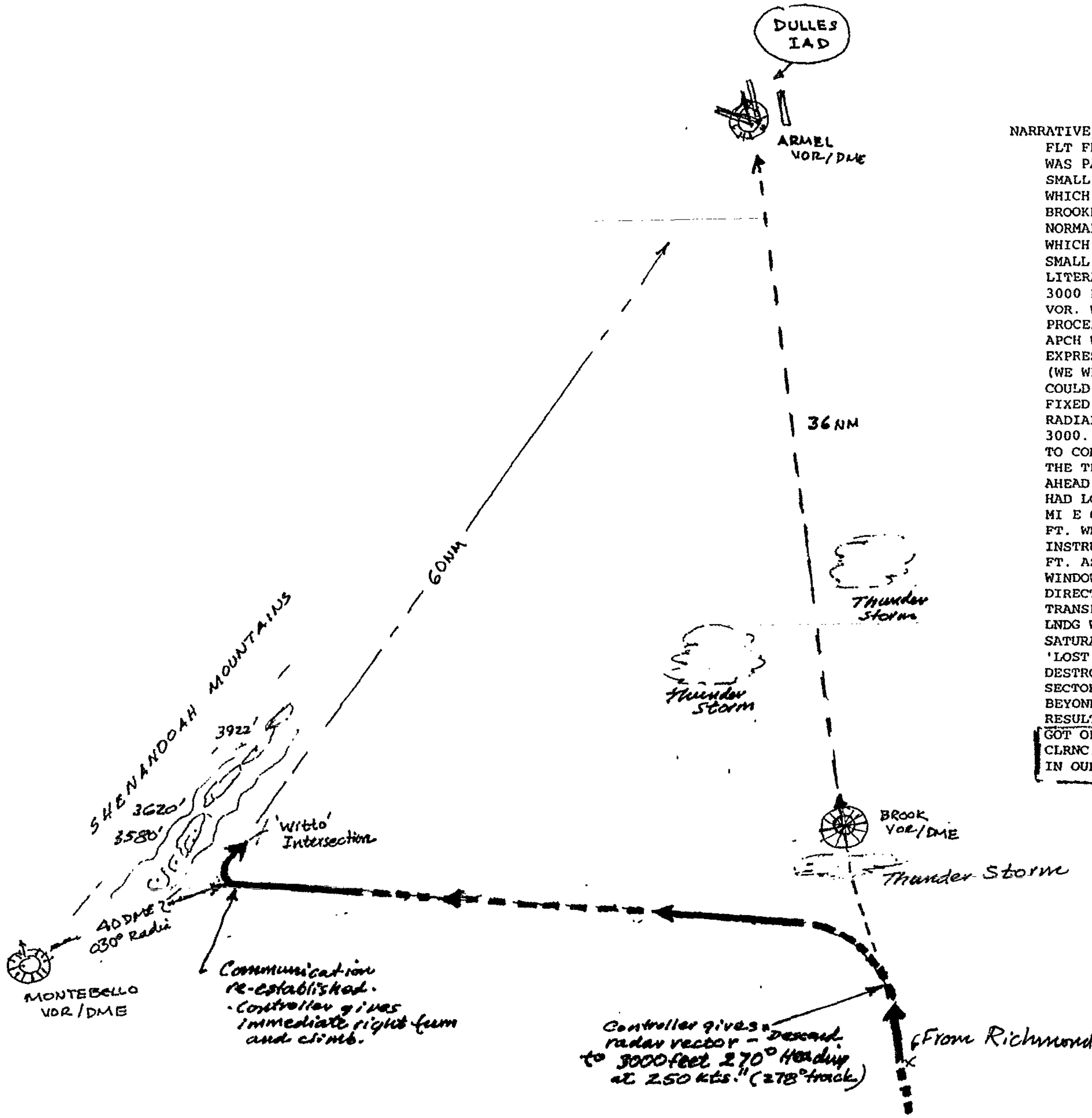
See other similar incidents / accidents:

May 1992	DC-10	Portland	
April 1992	DHC-7	Denver	
March 1992	B707	Athens	7 Fatalities
May 1990	MD-80	Ontario	
May 16, 1986	B727	Denver	
Aug 1, 1979	B747	Chitose	
July 26, 1979	B707	Rio de Janero	3 Fatalities



Don Bateman

Don Bateman



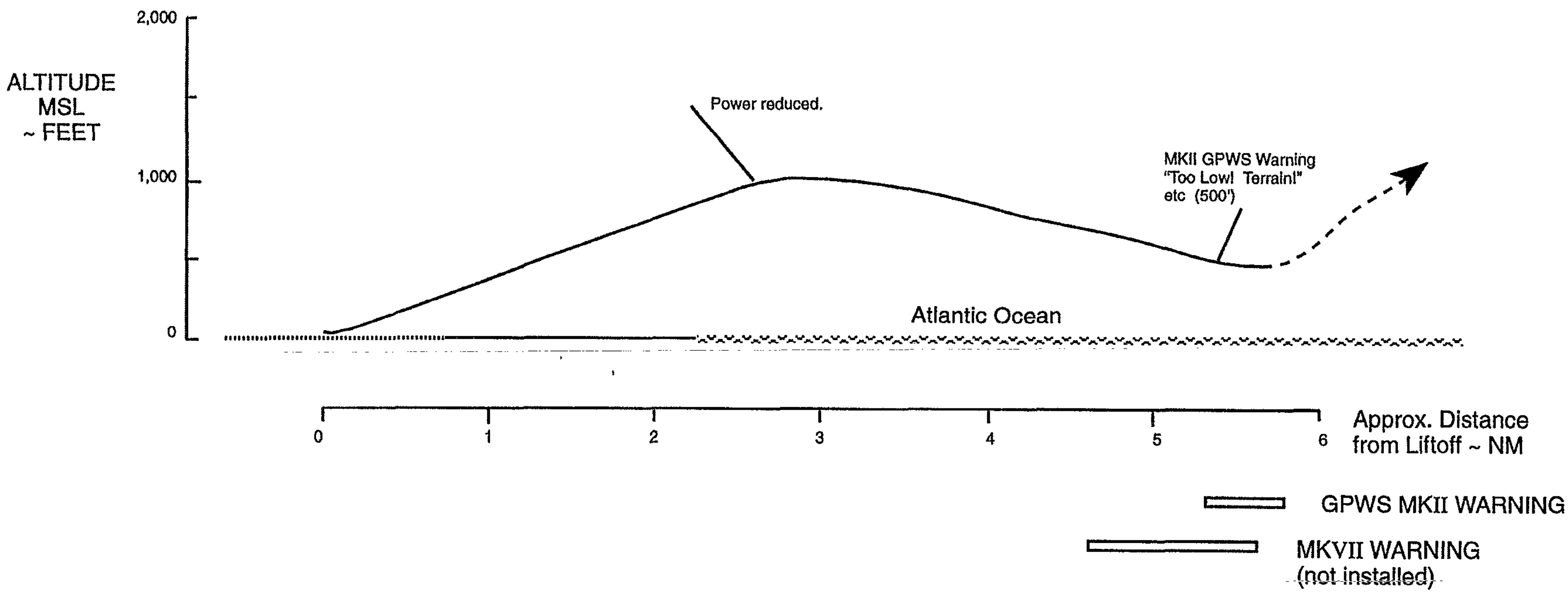
NARRATIVE : ACR X WAS CONDUCTING A SCHEDULED ACR FLT FROM RICHMOND, VA (RIC) TO WASHINGTON DULLES (IAD). A FRONT WAS PASSING THROUGH THE AREA, CAUSING NUMEROUS RAIN STORMS AND SMALL TSTMS. WE WERE PROCEEDING N FROM RIC TO THE BROOKE VOR, WHICH IS THE S ARR FIX TO IAD. A TSTM DEVELOPED DIRECTLY OVER BROOKE, WHICH CAUSED ALL THE INBOUND ACFT TO DEVIATE FROM THE NORMAL ARR CORRIDOR. THE CTLR ISSUED NUMEROUS VECTORS, MANY OF WHICH WERE REFUSED BY THE ACFT RECEIVING THEM, DUE TO THE MANY SMALL TSTMS IN THE AREA. THE FREQ WAS EXTREMELY BUSY. IT WAS OFTEN LITERALLY IMPOSSIBLE TO GET A WORD IN. ACR X WAS TOLD TO DSND TO 3000 FT MSL AND BEGAN DEVIATING AROUND TSTMS JUST S OF THE BROOKE VOR. WE WERE THEN GIVEN A HDG OF 270 DEGS BY IAD APCH. WE PROCEEDED ON THIS HDG AT A SPD OF 250 KTS FOR ABOUT 10 MINS. IAD APCH WAS STILL EXTREMELY BUSY WITH OTHER ACFT. THE CAPT BEGAN TO EXPRESS CONCERN ABOUT THE HEIGHT OF THE TERRAIN WE WERE APCHING. (WE WERE IMC AT THE TIME.) WE ATTEMPTED TO CONTACT IAD APCH, BUT COULD NOT GET THROUGH THE OTHER TFC ON THE RADIO. BY THIS TIME, I FIXED OUR POS AS 40 MI FROM THE MONTEBELLO VOR ON THE 60 DEG RADIAL. THE MEA ON THE AIRWAY AT THIS POINT IS 6000 FT. WE WERE AT 3000. THE CAPT SLOWED THE ACFT TO 200 KTS, WHILE I AGAIN ATTEMPTED TO CONTACT IAD APCH. THE RADIO ALTIMETER BEGAN TO INDICATE THAT THE TERRAIN WAS RISING, AND WE COULD SEE THE HILLS THROUGH THE FOG AHEAD. I FINALLY GOT THROUGH TO IAD APCH. THEY ADVISED THAT THEY HAD LOST RADAR CONTACT WITH US AND ASKED OUR POS. I GAVE IT AS 40 MI E OF MONTEBELLO. THEY THEN ASKED US TO CONFIRM WE WERE AT 7000 FT. WHEN TOLD THAT NO, WE WERE AT 3000 FT, THEY ISSUED INSTRUCTIONS FOR AN IMMEDIATE R TURN TO 030 DEGS AND A CLB TO 5000 FT. AS WE STARTED THE TURN, WE COULD SEE TERRAIN OUT THE CAPT'S L WINDOW THAT WAS ABOVE THE LEVEL OF THE ACFT. THAT TERRAIN WAS DIRECTLY ON OUR PREVIOUS COURSE. ATC ASKED US TO SWITCH TO ANOTHER TRANSPONDER AND SOON REACQUIRED RADAR CONTACT. A NORMAL APCH AND LNDG WERE THEN MADE AT IAD. SIGNIFICANT FACTORS WERE: 1) THE TOTAL SATURATION OF THE ATC SYS CAUSED BY THE TSTMS. THE CTLR CLRLY 'LOST IT' WHEN THE STORM MOVED OVER HIS INITIAL FIX, THUS DESTROYING HIS PLANS. AS ACFT DEVIATED, THEY WANDERED INTO OTHER SECTORS AND OUR CTLR HAD TO COORDINATE WITH THESE CTLRS. IT WAS BEYOND HIS ABILITY, AND HE COMPLETELY FORGOT ABOUT OUR FLT AS A RESULT. 2) THE TOTAL LACK OF TERRAIN INFO IN OUR COCKPIT. ONCE WE GOT OFF THE AIRWAYS, WE HAD TO DEPEND ON THE ATC SYS FOR TERRAIN CLRNC. WE HAD NO OTHER INFO, EXCEPT TO NOTE THE MEA'S OF AIRWAYS IN OUR APPROX AREA.

SOURCE: ASRS # 211075

Next Page

CIRCUMSTANCES:	During a night time departure over water, pilots became distracted by large lighted outside object, reduced their rate of climb and inadvertently descended towards ocean until GPWS Warning occurred.
WEATHER	5 mile visibility, haze
CONFIGURATION:	Landing Gear up, 15 flaps
OTHER:	Pilot(s) became slightly disoriented

Flight Path Profile
B737-200
FT. LAUDERDALE, FLA.
MAY 1992
INCIDENT



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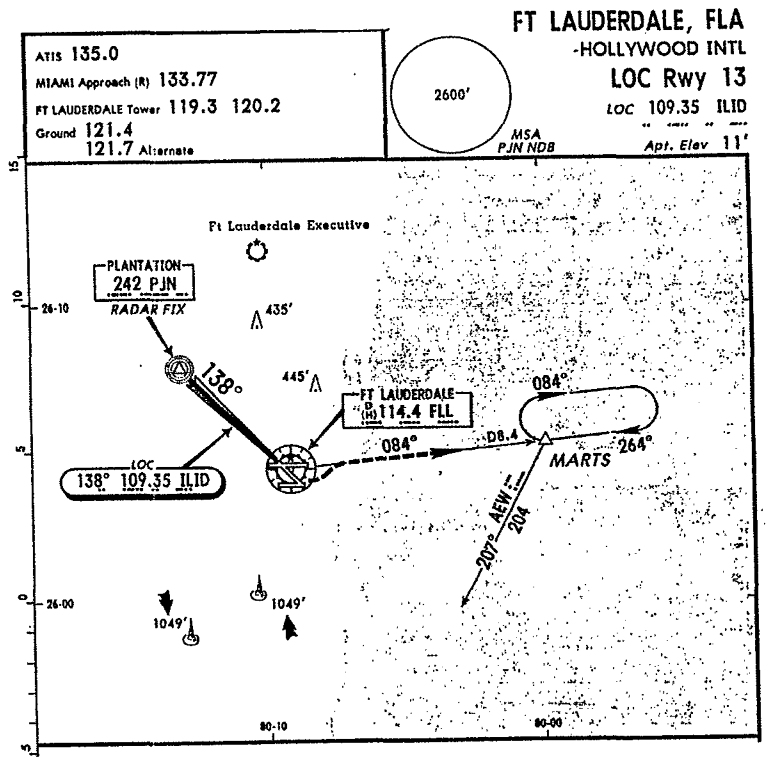
Return to TOC

ANOMALY DESCRIPTIONS : CONFLICT/GROUND LESS SEVERE; OTHER; CONTROLLED FLT TOWARD TERRAIN; ALT DEV/UNDERSHOOT ON CLB OR DES; NON ADHERENCE LEGAL RQMT/CLNC;
ANOMALY DETECTOR : COCKPIT/FLC; COCKPIT/EQUIPMENT; ATC/CTLR;
ANOMALY RESOLUTION : FLC BECAME REORIENTED; FLC RETURNED ACFT TO ORIGINAL CLNC OR INTENDED COURSE;
ANOMALY CONSEQUENCES : NONE;
NARRATIVE : SITUATION OCCURRED AFTER TKOF FROM FLL AT NIGHT. DEP WAS TO THE E OVER WATER AND NO HORIZON WAS VISIBLE. FLT VISIBILITY WAS LIMITED IN THAT DIRECTION DUE TO HAZE. AFTER TKOF THERE WERE NUMEROUS LIGHTS AHEAD INCLUDING 1 LARGE OBJECT WITH MANY LIGHTS, DEFINITION WAS VAGUE AND NO SHADE WAS DISCERNABLE. FLT PROFILE WAS NORMAL THROUGH 1000 FT AND FLAP RETRACTION WAS INITIATED. I BECAME INCREASINGLY CONCERNED ABOUT THE LARGE LIGHTED OBJECT AND REDUCED RATE OF CLB, IT APPEARED TO BE ABOVE US. AT THIS POINT I WAS CONVINCED IT WAS AN INFLT HAZARD BUT HAD NO IDEA WHAT IT WAS, POSSIBLY A BLIMP (?). MY ATTITUDE CHANGE RESULTED IN A DSCNT WHICH CONTINUED TO NEAR 500 FT. A GPWS WARNING WAS RECEIVED AND A CLB WAS INITIATED. AT ABOUT THIS TIME, OUR LIGHTED OBJECT WAS RECOGNIZED, WITH GREAT RELIEF, AS A CRUISE SHIP. DEP ASKED IF WE HAD PROBLEMS AND WE ADVISED THEM THAT WE WERE CLBING AND EXPLAINED BRIEFLY WHAT HAD HAPPENED. FLT PROCEEDED WITHOUT FURTHER COMPLICATIONS. I MADE SOME BAD DECISIONS RESULTING FROM THE CONFUSING AND PUZZLING VISUAL PICTURE. I ALLOWED MYSELF TO BECOME MOMENTARILY DISORIENTED WHILE OVER-CONCENTRATING ON THE VISUAL CONTACT. A BETTER AVOIDANCE TECHNIQUE WOULD HAVE BEEN TO TURN RATHER THAN CHANGE NOSE ATTITUDE. I THINK I DID NOT DO THAT BECAUSE OF THE NUMBER OF OTHER LIGHTS AHEAD, ALSO PROBABLY SURFACE CRAFT, AND NO HAZARD-FREE RTE WAS OBVIOUS TO ME.
SYNOPSIS : AN MLG CREW IN NIGHT OP, OVER WATER, BECAME SLIGHTLY DISORIENTED AND HAD A GPWS WARNING.

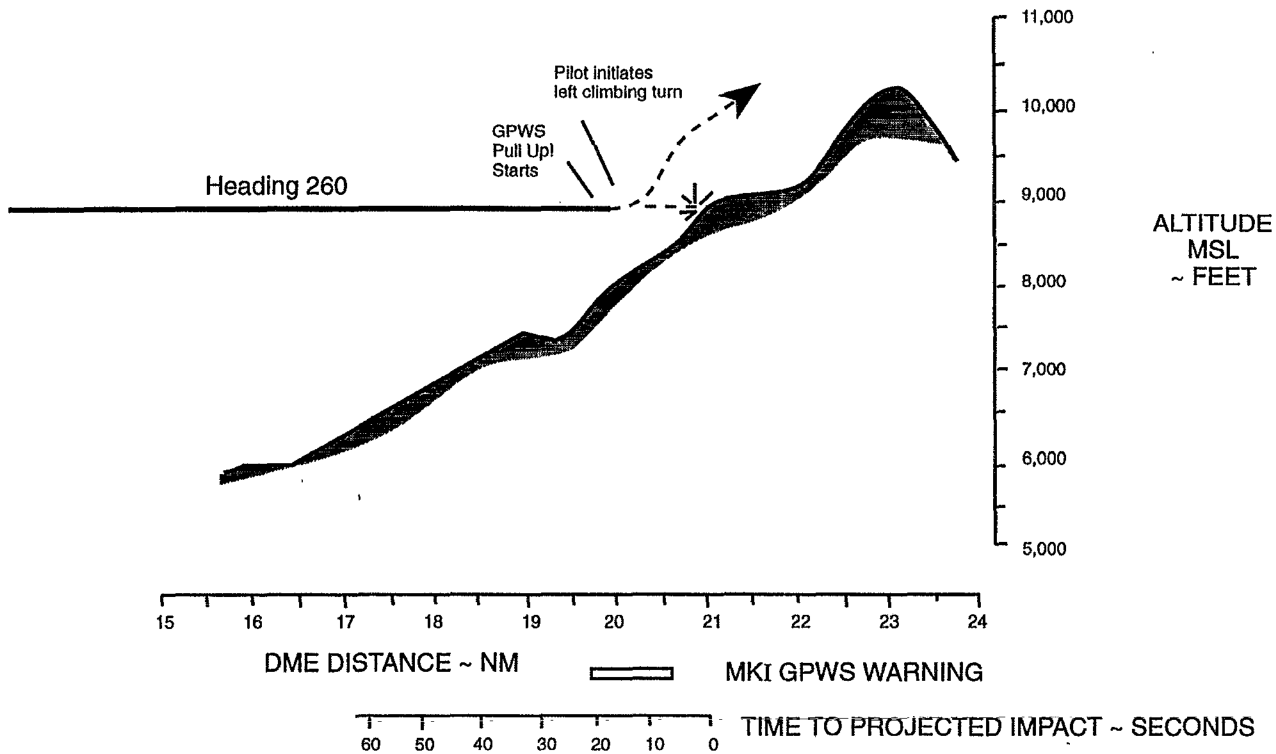


SOURCE: ASRS #210764

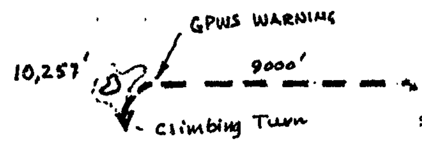
Next Page

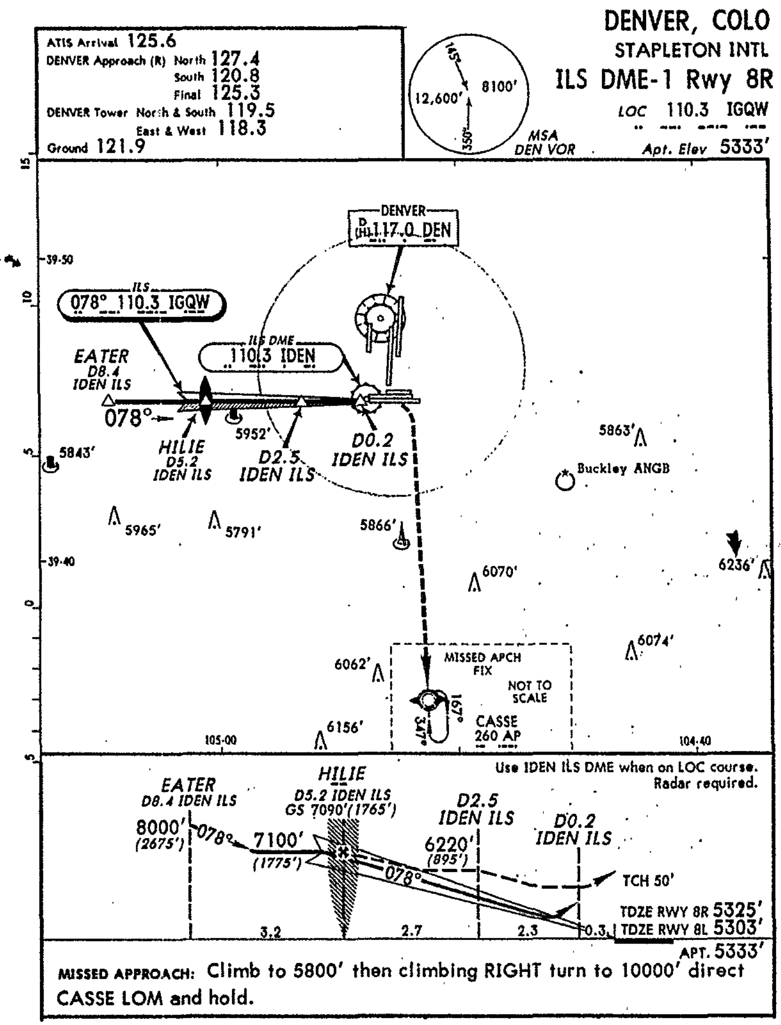
CIRCUMSTANCES:	During radar vectors for ILS-DME runway 8R, ATC communications failure left the aircraft on a flight path to a 10,300 foot mountain. A successful recovery was made by the pilot after receiving a GPWS warning.

Flight Path Profile
DHC-7
DENVER, COLORADO
MAY 1992
INCIDENT



Don Bateman





NARRATIVE : RADAR VECTORED FOR THE ILS-DME-1 8R AT DEN. N OF APCH COURSE ON VECTOR HDG OF 260 AT 9000 MSL. KNOWING OF AND SEEING THE MOUNTAINS W OF DENVER (VMC) WE TRIED CALLING AND REQUESTING A TURN WITH NO ANSWER. AT 20 DME, THE GPWS WENT OFF COMMANDING A PULLUP. INITIATED A CLBING L TURN VISUALLY AVOIDING TERRAIN. CALLED TWR FREQ AND ADVISED THEM. CALLING ATC BY PHONE AFTERWARD, THEY SAID THEY HAD A RADIO PROBLEM AND WERE UNABLE TO CONTACT 3 ACFT. SUPPLEMENTAL INFO FROM ACN 214250: THEY TOLD US THAT THEY TRIED MANY TIMES TO CALL US. ALSO THEY SAID THEY TRIED TO CALL 3 OTHER ACFT WITH NO RESPONSE. HE BLAMED IT ON AN ATC COM FAILURE.

SYNOPSIS : ATC COM FAILURE AT DEN TRACON LEADS TO CFTT FOR COMMUTER FLC.

Pilot Report NASA ASRS
#214254

Next Page

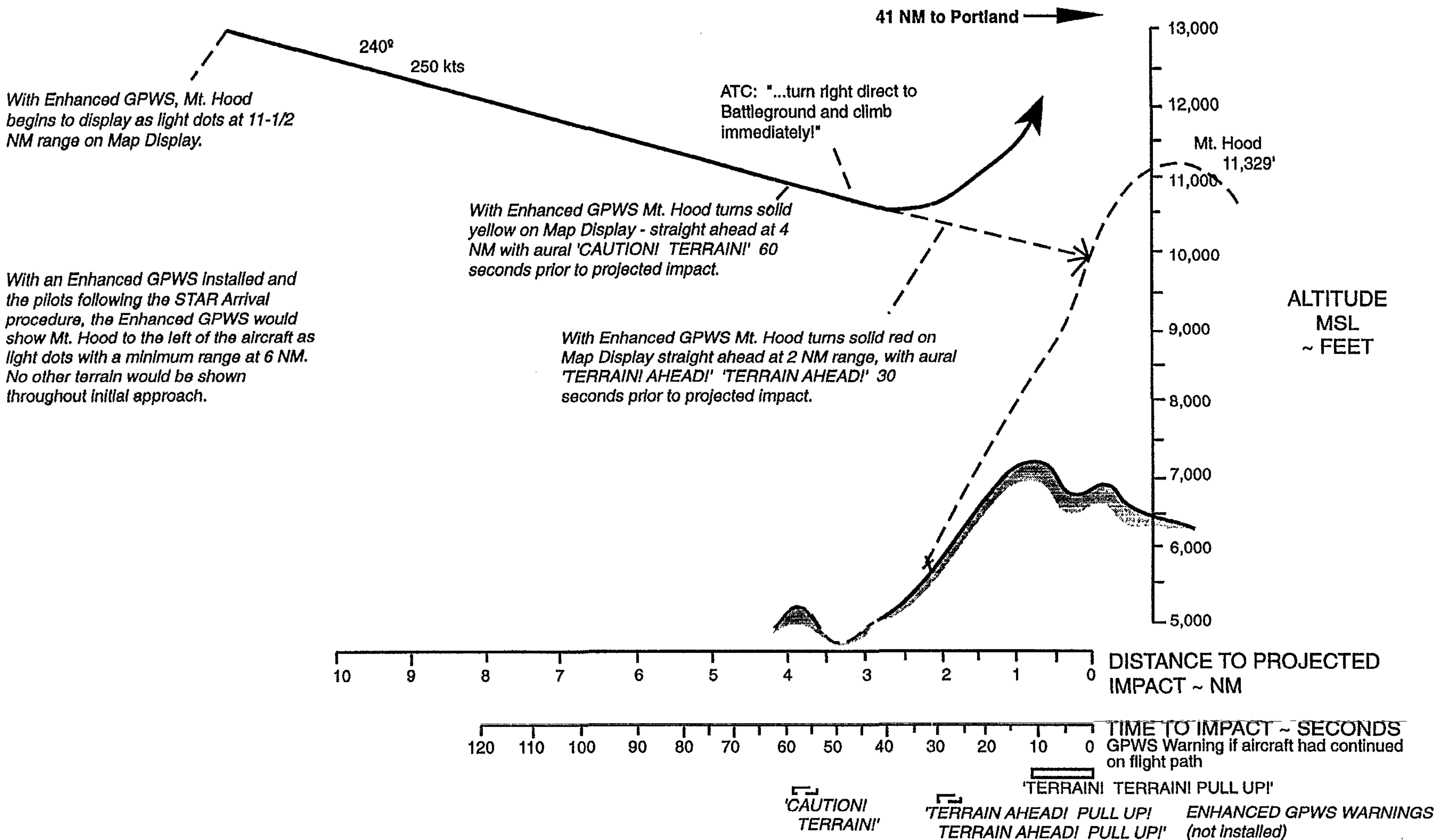
CIRCUMSTANCES: Controller inadvertently cleared aircraft to 10,000 feet altitude below MSA and Minimum Radar Vectoring Altitude. Controller assumptions, confusion and blocking radio traffic delayed corrective clearance, leaving aircraft on trajectory into Mt. Hood.

WEATHER: IMC, Radar controller 'save'... but where was MSAWS?

THE ATC RADAR VECTOR 'TRAP'

Flight Path Profile
DC-10
PORTLAND, OREGON
April, 1992

Controlled Flight Towards Terrain Incident



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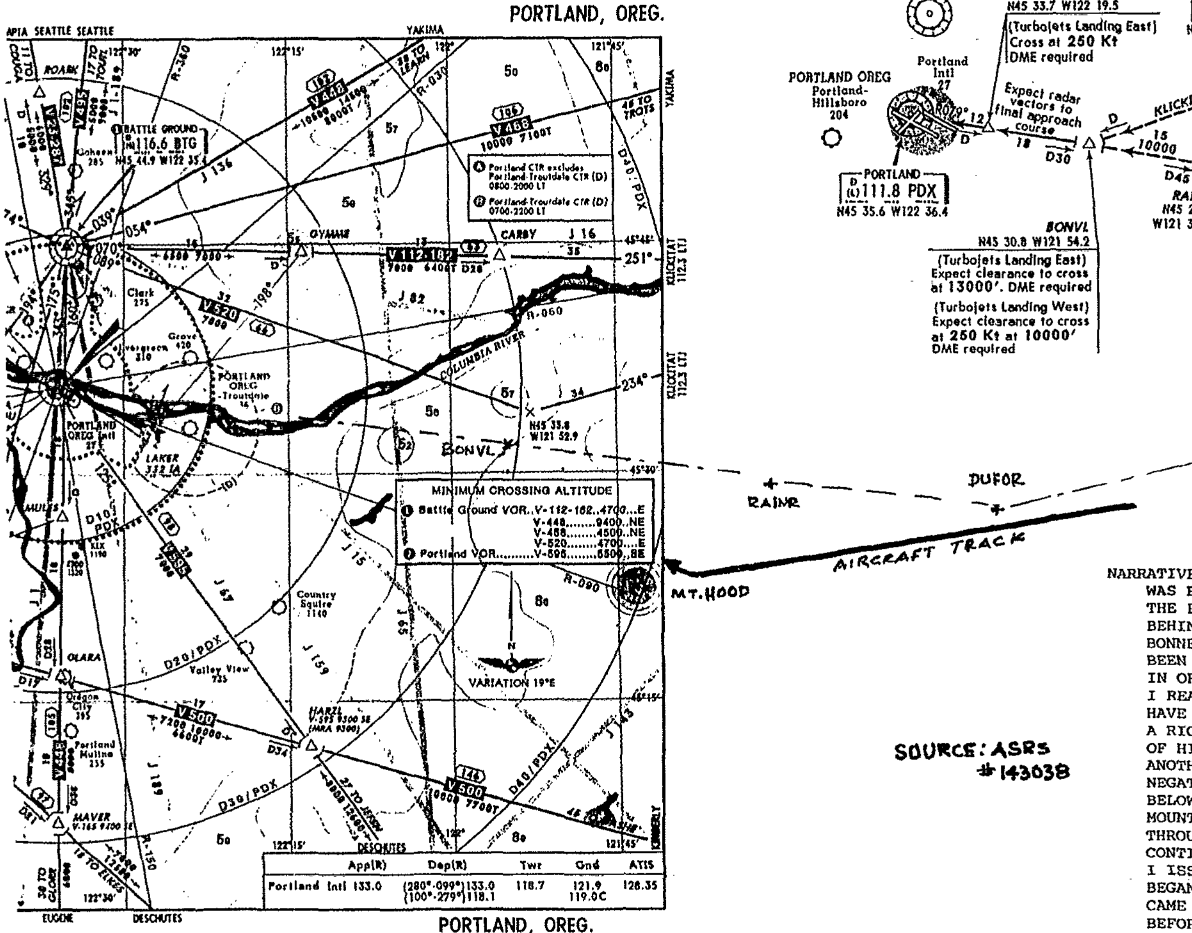

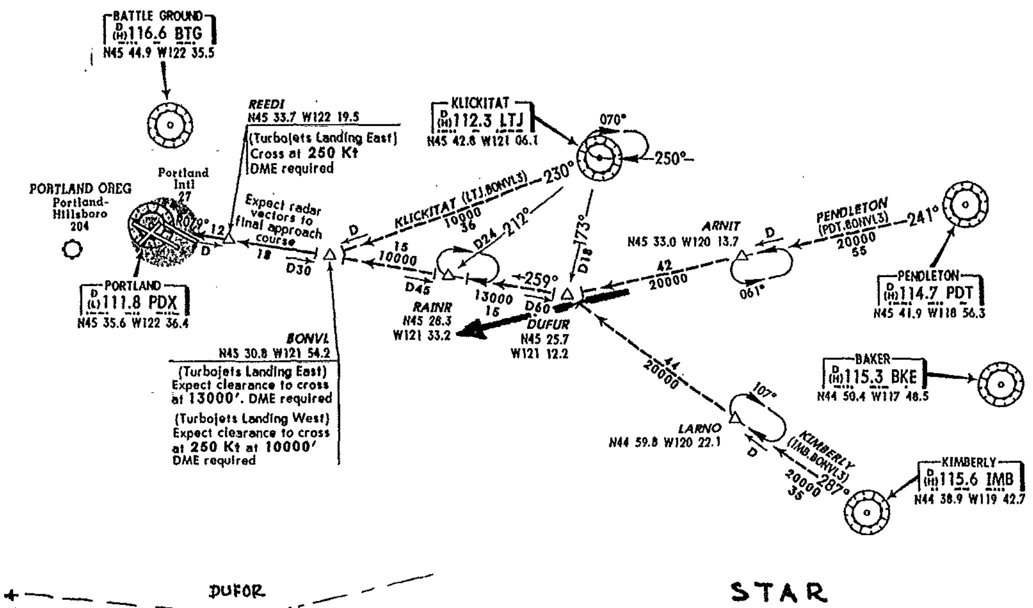

SOURCE: ASRS #143038

NARRATIVE : ALL AREA SECTORS WERE COMBINED AND TFC WAS BEING WORKED ON 2 RADAR SCOPES. DURING THE RELIEF BRIEFING, THE PREVIOUS CTLR STATED THAT HE HAD TURNED ACR X 5 DEG LEFT TO GO BEHIND SOME TFC. THIS PUT THE ACFT ON A TRACK TO JOIN THE BONNEVILLE ONE ARR INTO PDX AND I WAS NOT AWARE THE STAR HAD NOT BEEN ISSUED. ACR X HAD BEEN CLRED TO 140 AND I RECLRED HIM TO 100 IN ORDER TO MEET THE LOA WITH PDX. AS ACR X DESCENDED THROUGH 134 I REALIZED HE HAD FLOWN THROUGH THE PDX 079 RADIAL WHICH HE WOULD HAVE HAD TO INTERCEPT TO FLY THE STAR. I ISSUED A CLRNC TO 130 AND A RIGHT TURN DIRECT BTG VOR AS THE ACFT WAS ABOUT TO ENTER AN AREA OF HIGH TERRAIN AROUND MT HOOD. THE PLT'S REPLY WAS BLOCKED BY ANOTHER ACFT. ACR X THEN STATED HIS CLRNC WAS TO 100. I REPLIED NEGATIVE AND AGAIN ISSUED 130 (WHICH BY NOW HE HAD DESCENDED BELOW) AND A RIGHT TURN IN AN EFFORT TO TURN ACR X AWAY FROM THE MOUNTAIN PEAK. I ALSO INFORMED THE PLT IT APPEARED HE'D FLOWN THROUGH THE ARR AND ASKED IF HE HAD MT HOOD IN SIGHT. THE PLT CONTINUED TO DSND AND STATED THAT HE HAD BEEN ISSUED A HDG. AGAIN, I ISSUED A RIGHT TURN DIRECT BTG AND A CLIMB. THE ACFT FINALLY BEGAN HIS TURN AND CLIMB AND WAS HANDED OFF TO PDX APCH. ACR X CAME WITHIN 3 NM OF THE PEAK (11329 MSL) AND DESCENDED BELOW 110 BEFORE COMPLYING WITH INSTRUCTIONS TO TURN AND CLIMB. A MISCOM BETWEEN 2 CTLRS CONTRIBUTED TO THE INITIAL DEVELOPMENT OF THE SITUATION. ACR X HAD NOT BEEN ISSUED THE STAR AS SHOWN ON THE FLT PLAN. DUE TO COMPUTER PROCESSING OF PREFERENTIAL ARR ROUTES, IN SOME CASES THE FLT PLAN SHOWS THE STAR HAS BEEN ISSUED WHEN IN FACT IT HAS NOT. I ASSUMED THE PLT HAD BEEN TOLD TO REJOIN THE STAR AS WOULD HAVE BEEN STANDARD PROC HAD IT BEEN INITIALLY ISSUED. I BELIEVE THE SITUATION DEVELOPED INTO AN IMMINENT ONE DUE TO LACK OF RESPONSE ON THE PART OF THE PLT. ACR X CONTINUED TO DSND AND WAS SLOW IN TURNING WHILE THE PLT QUESTIONED WHY HIS CLRNC WAS BEING CHANGED. THIS ARR ROUTE NEEDS TO BE CHANGED. ALTHOUGH THE ROUTE IS FLT CHECKED DOWN TO 100, THERE IS NO ROOM FOR ERROR DUE TO THE PROX OF HIGH TERRAIN. THERE HAVE BEEN NUMEROUS INSTANCES OF ACFT FLYING THROUGH THE INTERCEPT RADIAL PLACING THEM HEAD-ON INTO MT HOOD. UNTIL NOW, THE DANGEROUS SITUATIONS HAVE BEEN AVOIDED.

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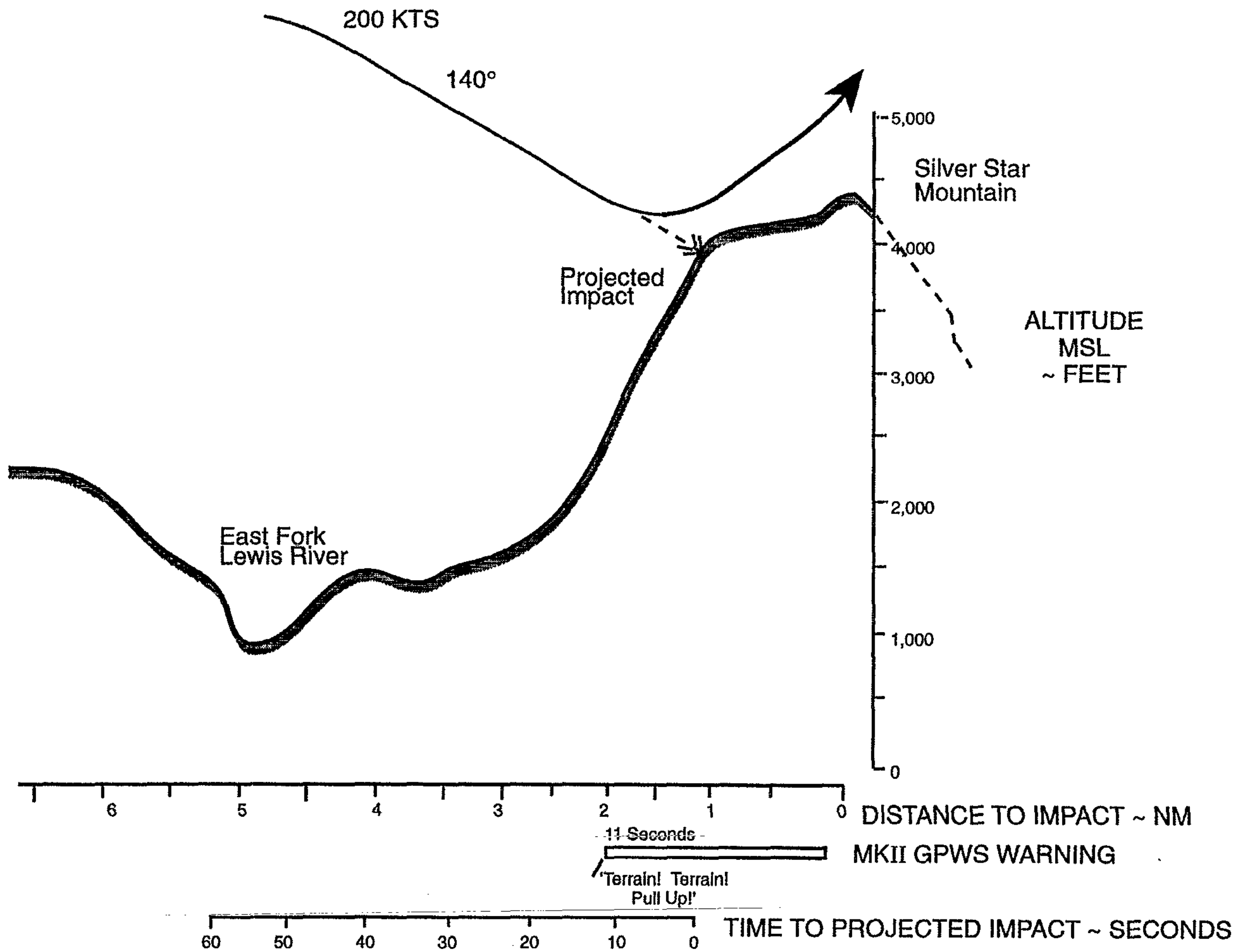
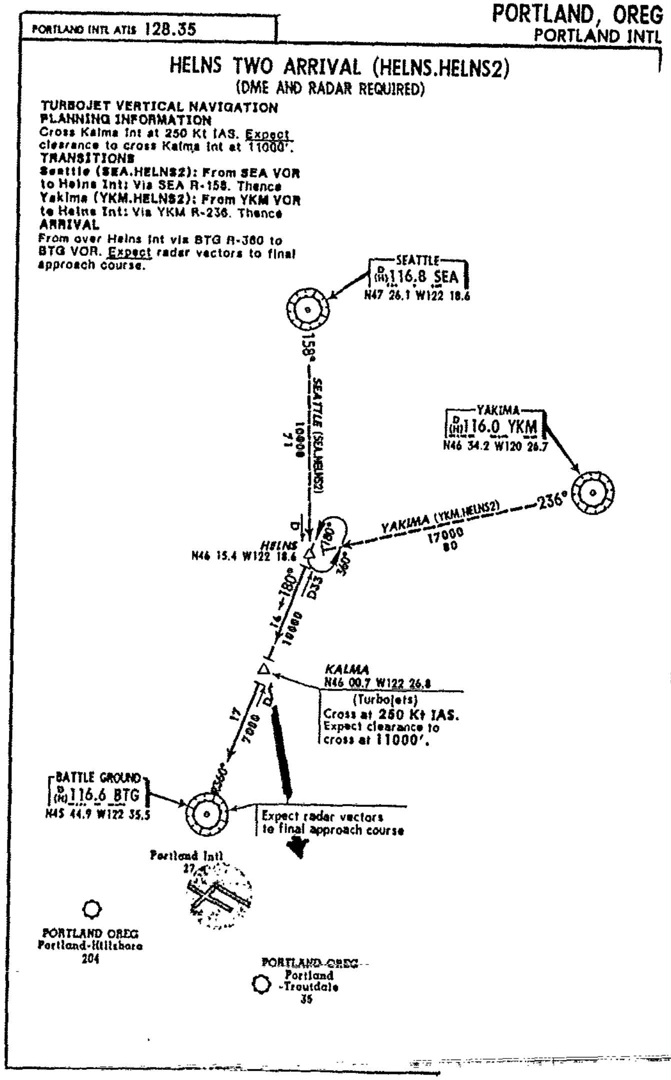
CIRCUMSTANCES:	During a night visual approach to ("Mill Visual") runway 28R, aircraft descended below MSA and almost collided with 4390 feet mountain 20 NM from the airport. A timely GPWS Warning and prompt pilot response led to a successful recovery.
WEATHER:	Clear, unlimited visibility
CONFIGURATION:	5 degrees flap, Gear Up

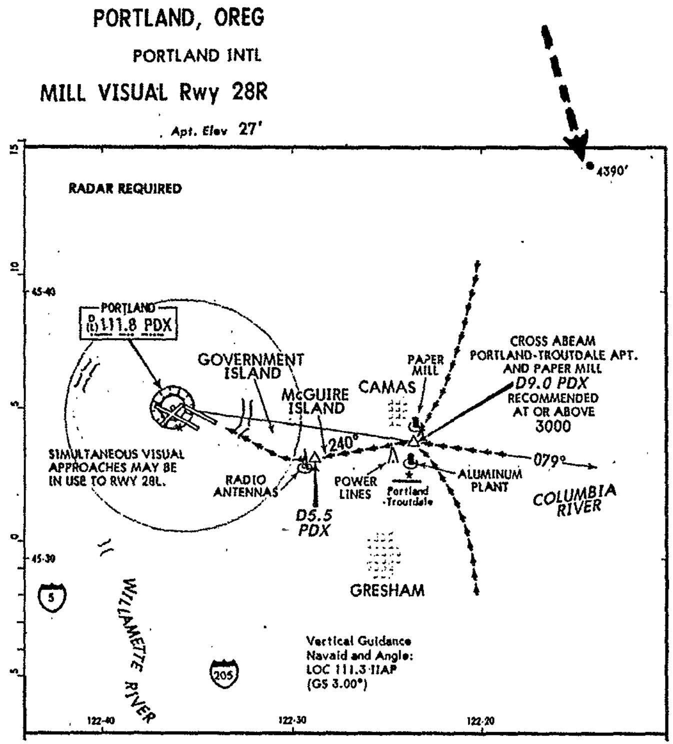
Flight Path Profile
B727-200
PORTLAND, OREGON
APRIL 1992
INCIDENT



Don Bateman

Return to TOC





NARRATIVE : FLT SEA TO PDX ON HELNS 2 ARR TO PDX. AFTER KALMA, PDX APCH VECTORED US APPROX HDG 140 FOR SPACING FOR INBOUND ACFT FROM THE S, AND FOR DOWNWIND/BASE FOR THE MILL VISUAL APCH. WE WERE A LITTLE FURTHER THAN USUAL ABEAM THE ARPT, PROBABLY FOR ANTICIPATED SPACING. IT WAS A CRYSTAL CLR NIGHT AND WE WERE LEVEL AT 6000 FT MSL. APPROX XING V448 WE RPTED ARPT AND MILL IN SIGHT AND WERE CLRED FOR THE MILL VISUAL RWY 28R APCH. THE AREA BELOW US WAS LIKE A 'BLACK HOLE' BECAUSE OF FOREST AND IT BEING UNPOPULATED. THE CITY LIGHTS/ARPT WERE OFF OUR R WING -- A BEAUTIFUL NIGHT. AFTER BEING CLRED FOR THE VISUAL, I BEGAN DSCNT SO AS TO ARRIVE OVER THE MILL AT THE RECOMMENDED 3000 FT MSL. AT APPROX XING OF V112 AT 4100 FT MSL THE GPWS WENT 'WHOOP! WHOOP! PULL UP! TERRAIN!' FOR A SPLIT SECOND WE THOUGHT IT WAS A FALSE WARNING SINCE WE WERE STILL LOOKING AT THE ARPT/CITY. THEN I NOTICED BOTH RADIO ALTIMETERS GO FROM 2500 FT TO 400 FT IN ABOUT 1-2 SECONDS. I IMMEDIATELY APPLIED FULL PWR AND INITIATED A MAX CLB UNTIL OVER THE CITY'S OUTSKIRTS (LIGHTS). THEN I CONTINUED THE DSCNT/VISUAL APCH AND LANDED. OUR WHOLE CREW SERVES PDX DAILY AND KNOWS THE ARPT WELL. SIMPLE FACT IS THAT MOST PLTS GOING INTO A FAMILIAR ARPT USE THE APCH PLATE AND DO NOT OFTEN REFER TO THE AREA CHART. APCH CTL WAS WORKING OTHER ACFT AND DID NOT CALL US ABOUT BEING TOO LOW. HE TURNED US OVER TO TWR AROUND THE MILL. ALTHOUGH WE SCREWED UP AND LEARNED OUR LESSON, IT MAY BE PRUDENT TO PUBLISH WARNINGS FOR NIGHT VISUALS ON THE 19-1 APCH PLATE (MILL VISUAL) AND AT LEAST PUT THE MSA 'PIE' BACK ON THE TOP OF THAT CHART. WE WERE STUPID, AND VERY LUCKY.

SYNOPSIS : ACR LGT, IN A NIGHT OP, WAS SAVED FROM IMPACTING ON DESIGNATED MOUNTAINOUS TERRAIN BY THE GPWS WHILE ON A VISUAL APCH TO 28R MILL VISUAL APCH TO PDX, OR.

Pilot Report
NASA ASRS #216837

Circumstances: "Scenic Air Tours" aircraft operating under Part 135 impacted Mt. Haleakala while enroute VFR into IMC back to Honolulu.

Weather: VFR deteriorating to IMC, Cloud base 1000'

Time: 15:53 Local Standard Time

Fatalities: 9

Other: Probable 30° outbound VOR 'UPP' radial error. Minimum IMC instrumentation on aircraft.

FLIGHT PATH PROFILE

Be-E18S
Maui, Hawaii
22 April, 1992

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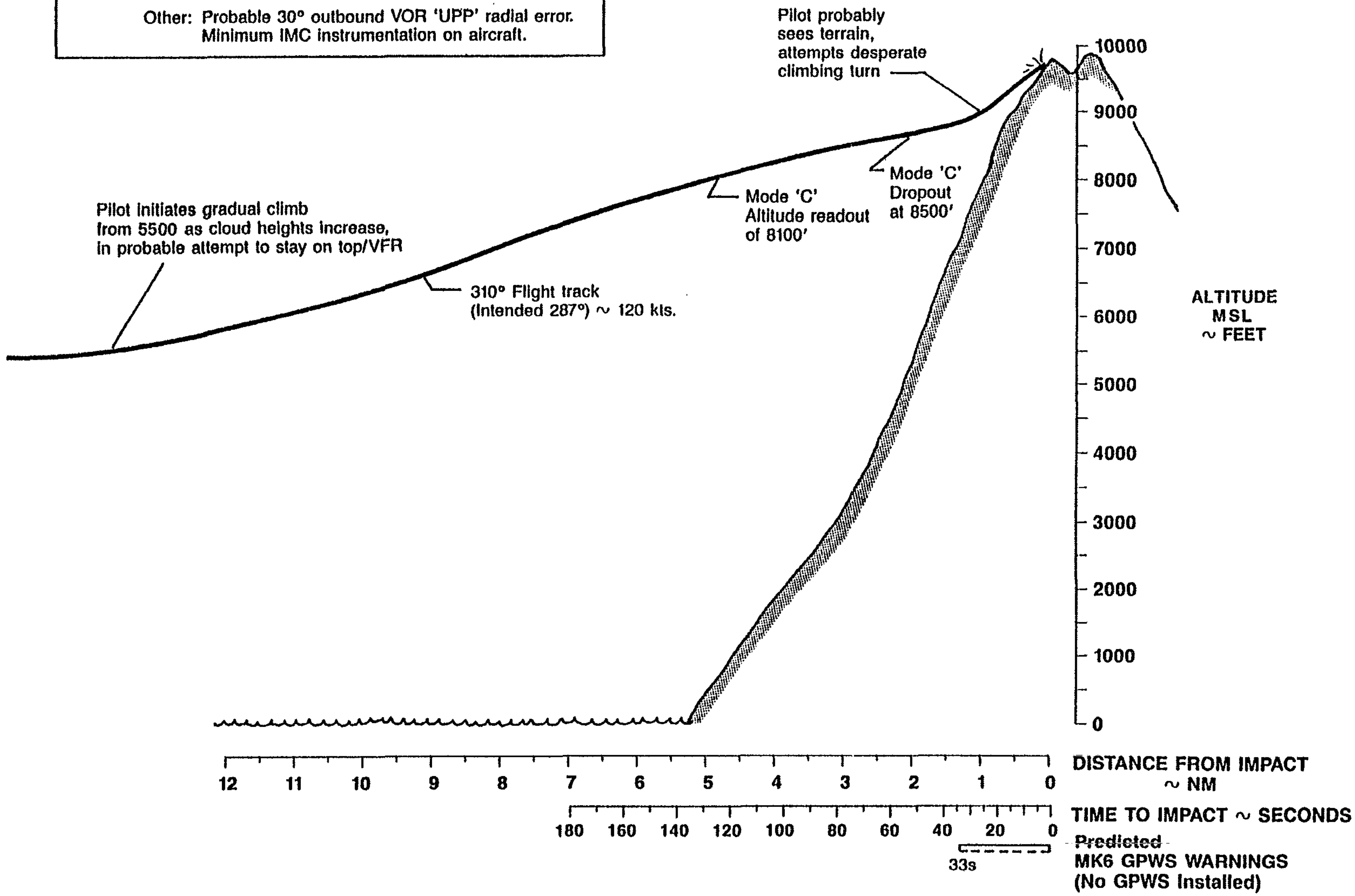


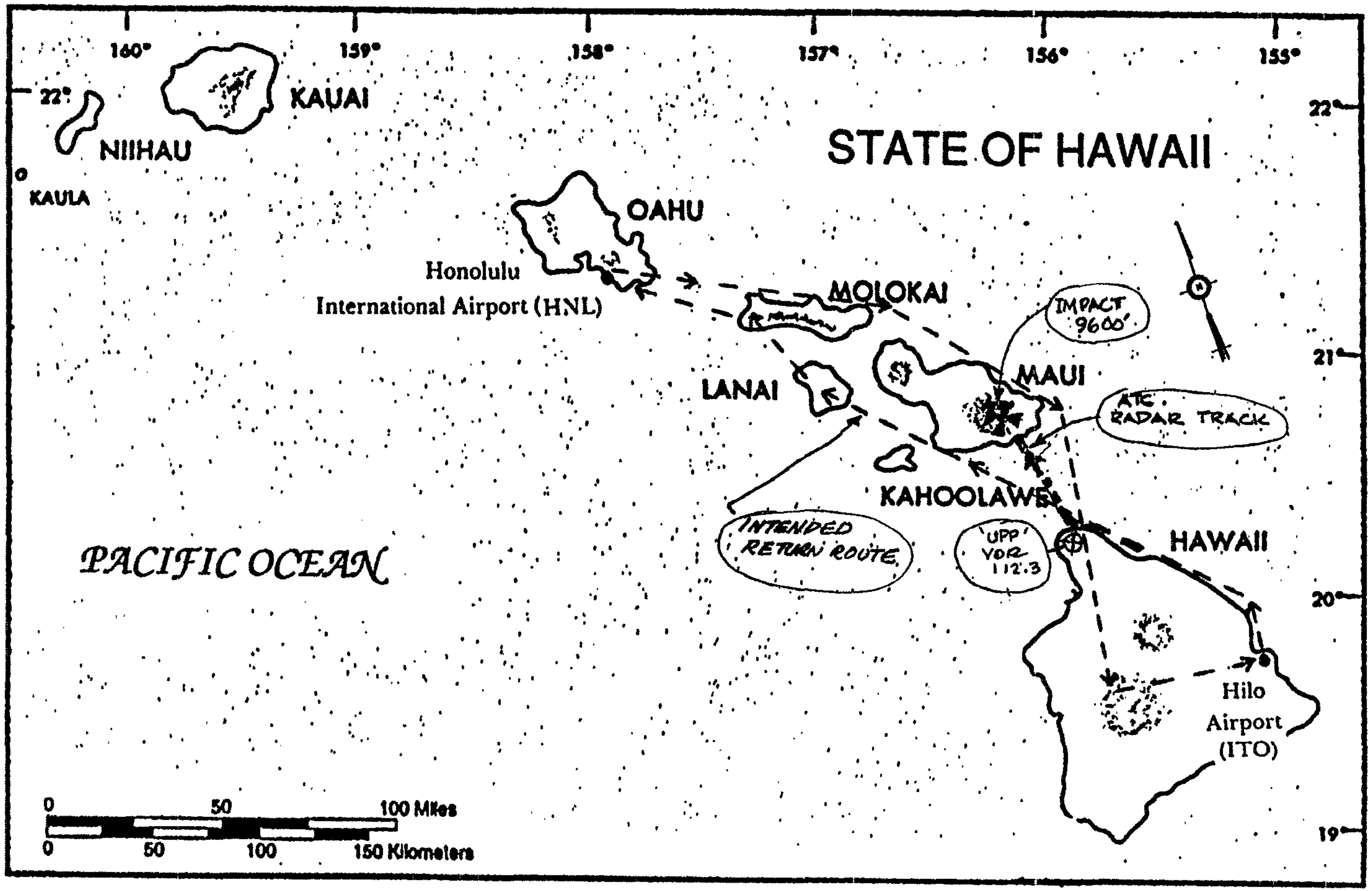
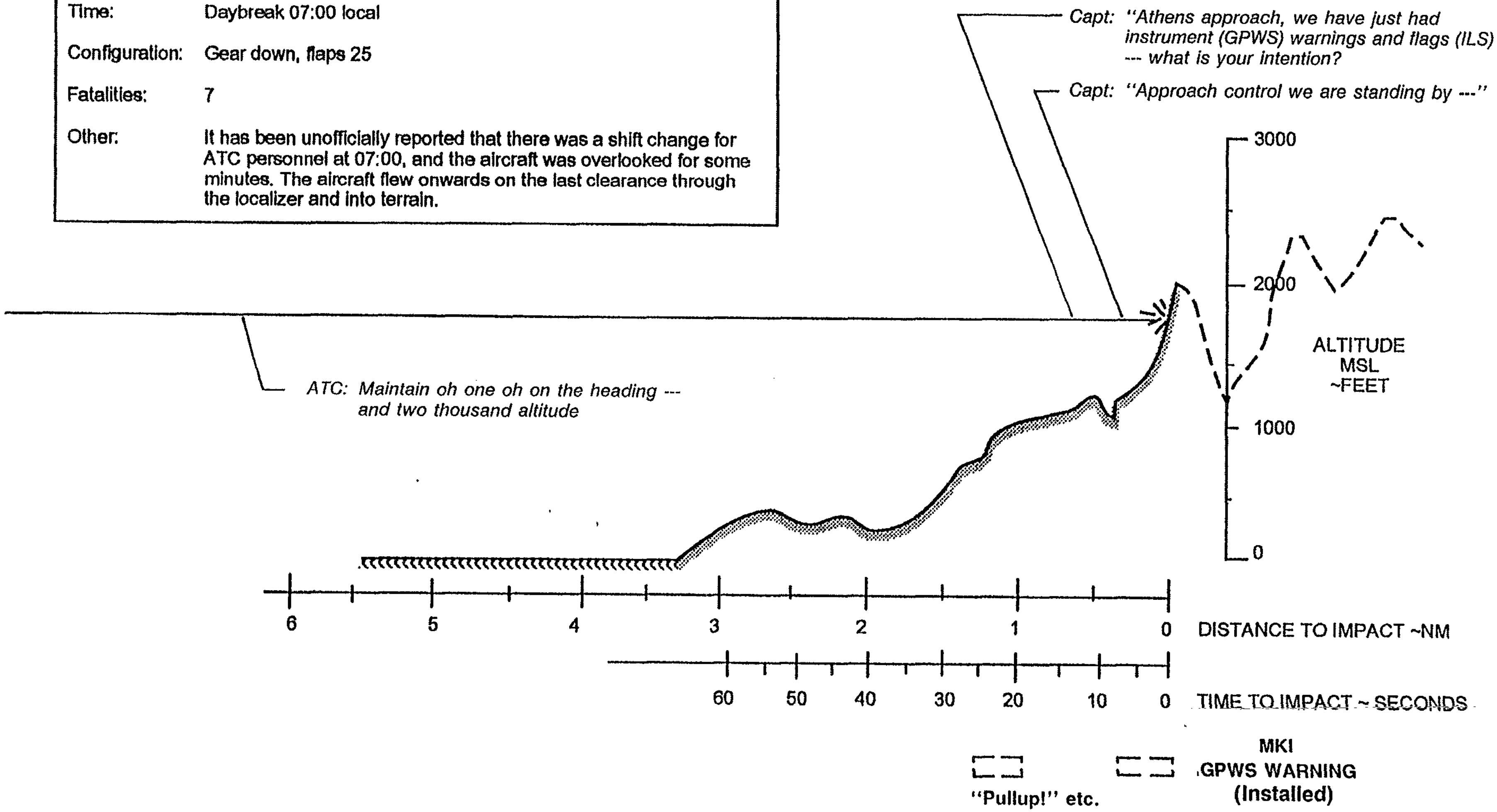


Figure 1.--Tour route.

Next Page

Circumstances:	Aircraft while under radar vectoring, was flown into a mountain 3NM from airport. Aircraft was on a flight from Amsterdam to Khartoum with Athens as re-fueling stop. Aircraft was loaded with medical relief supplies. Aircraft was given a clearance to descend to 2000 feet and to maintain a heading of 010 degrees.
Weather:	Visual in early morning sea haze. Mountains obscured in fog.
Time:	Daybreak 07:00 local
Configuration:	Gear down, flaps 25
Fatalities:	7
Other:	It has been unofficially reported that there was a shift change for ATC personnel at 07:00, and the aircraft was overlooked for some minutes. The aircraft flew onwards on the last clearance through the localizer and into terrain.

FLIGHT PATH PROFILE
B707-320
Athens, Greece
24 March, 1992



Return to TOC

ATHENS, GREECE
ATHENS
RADAR
ASR Rwy 33R

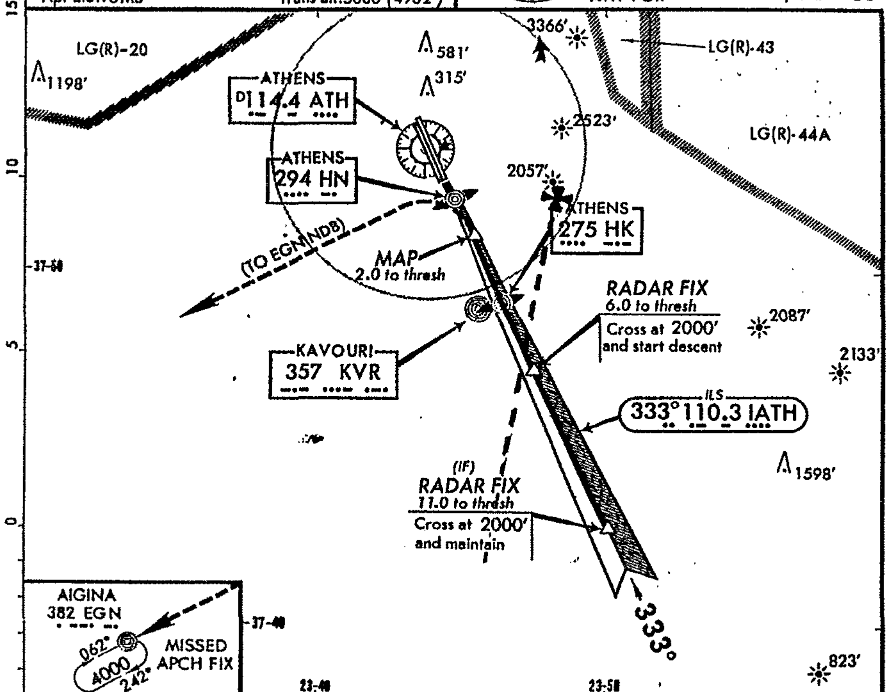
ATIS 123.4
ATHENS Approach (R) 121.4 119.1
ATHENS Radar 121.4
ATHENS Tower CIV: 118.1 MIL: 122.1
Ground 121.7

Alt Set: MB
Apt Elev: 3MB

Trans level: By ATC
Trans alt: 5000' *(4932')*

MSA ATH VOR: 5800' / 090°–270° / 4400'

Apt. Elev 68'



RADAR FIX FROM THR	4.0	5.0
ALTITUDE *(HAA)*	1380' *(1312')*	1690' *(1622')*

Do not overfly Acropolis (5NM north of ATH VORDME) below (prop) 5000', (jet) 10,000'.

OCA (H) RWY	33R
BASED ON ELEV.	68'
ASR	1200' *(1132')*

MISSED APPROACH: Turn LEFT, climb to EGN NDB to 4000' *(3932')* and hold.

STRAIGHT-IN LANDING RWY33R	CIRCLE-TO-LAND
MDA(H) 1200' *(1132')*	West of runway only.

Next Page

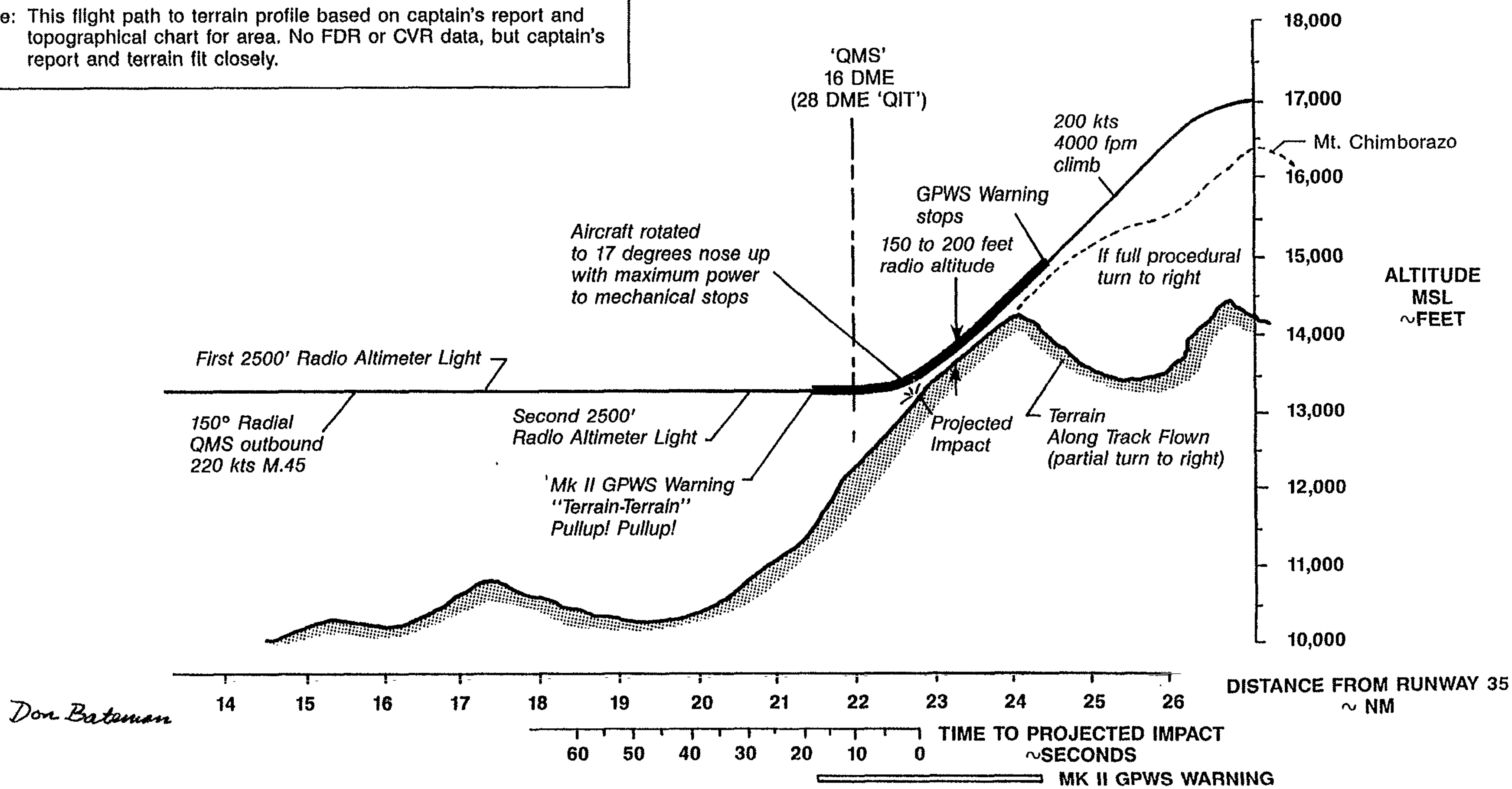
FLIGHT PATH PROFILE
DC-8
Quito, Ecuador
Reported in March, 1992

Circumstances: During a VOR ILS Runway 35 approach, the aicraft almost flew into a 16,408 foot mountain. This professional crew initiated the approach from the enroute inbound VOR instead of the procedure VOR. No "hands on" terrain recovery training, but captain made a superb recovery utilizing available energy of aircraft. Mk II GPWS installed, giving 6 seconds of additional precious warning time over a MK I.

Time: Night

Weather: Rain, IMC, Thunderstorms in area.

Note: This flight path to terrain profile based on captain's report and topographical chart for area. No FDR or CVR data, but captain's report and terrain fit closely.



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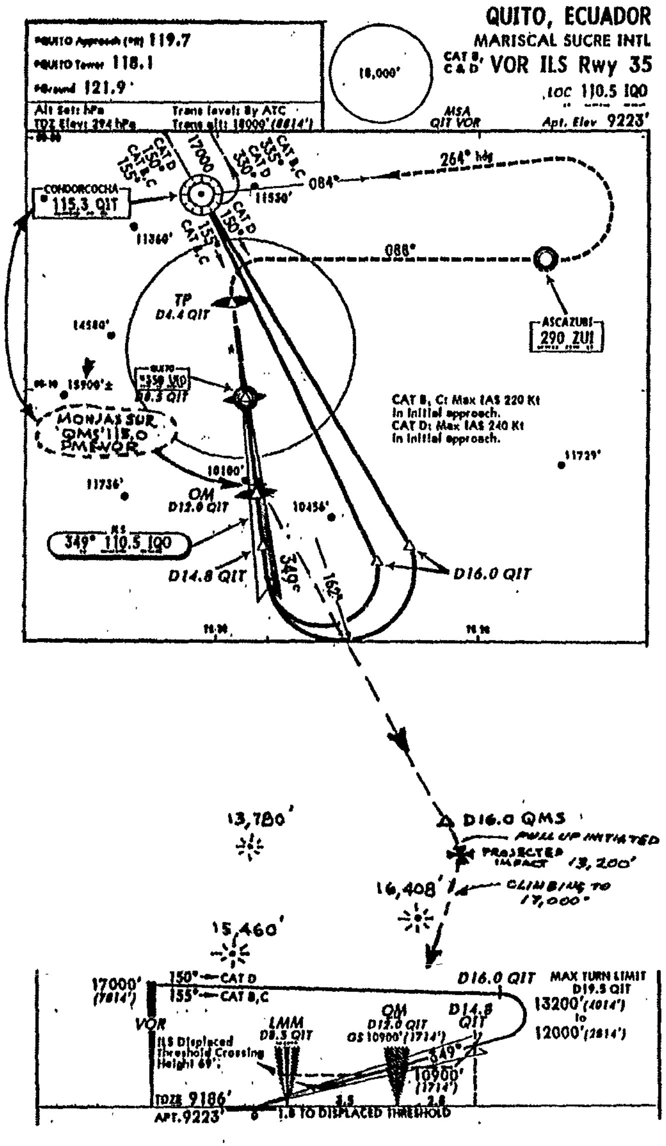

CAPTAIN's REPORT -----

At about 10 D.M.E., I noticed that the radar altimeter warning light came on momentarily. Since I knew we were over very high terrain, I made a note to keep an eye on it. Seconds later, the radar altimeter came alive, and started a rapid descent from 2,500. At about 1,300 feet, I applied MAX power (to the mechanical stops) and rotated the aircraft to a 17 degree nose up pitch. We were at about 14,000 feet MSL at this time. The radar altimeter continued to drop, and finally settled at about 150 feet, with the GPWS yelling "Terrain, Terrain" etc. The aircraft was now on a maximum climb of about 4,000 fpm, but the radar altimeter continued to show between 150 and 200 feet. I knew that the terrain was higher to the left, so I tried to turn right, but each time I banked to the right, the radar alt. would loose about 50 feet. Finally, after what seemed like an eternity, we climbed out of radar altimeter range, and at this time, we had passed 16,000 feet. We climbed back to 17,000 feet, and returned to the VOR. (The weather was lousy, with thunderstorms in all sectors). We advised Quito approach (no radar available) that we had returned to the VOR and would be making a second approach. I then asked the F/O for his opinion, and he stated that it had to be a false warning. He said that he had verified that we were on the correct radial, the correct D.M.E. and the correct altitude. He stated that in the past he had experienced various warnings from the radar altimeter in the same area, and that he was convinced that they were false warnings. We again reviewed the approach procedure, and established on the radial to commence a new approach. I had a gut feeling that something was not right, so I decided to abandon the descent at 16,000 feet, and return to the hold, to take another look at everything.

I asked the F/O to again double check all frequencies, radials, etc. Just then he said "oh oh". We have been tuned to the wrong VOR all along. This frequency belongs to Monjas Sur, and we are supposed to be flying QIT which is 10 miles north of here. We immediately proceeded to the right VOR, and as we were commencing the approach, we were advised by Quito that the field was again below minimums, with a severe thunderstorm. At this point, we had only 8,000 lbs of fuel remaining, and the required to reach Guayaquil would have been about that or more.

Since we were already established on the radial, I chose to continue the approach. We reached minimums with severe rain, and there was nothing in sight. We continued the approach, and at about 100 feet, saw the end of the runway. After completion of the landing, the tower informed us that the airport was closed. They never said a thing about all the time it took us to complete the approach, and we never brought it up. We sat in a darkened cockpit for about 15 minutes, without saying much of anything. Then, after getting to a hotel to spend the night, we started shaking.

We were asked to ferry to Guayaquil the next morning. It was a beautiful, clear day, and the tower authorized us to proceed VFR. ~~I took off on runway 17 and flew right~~ over Monjas Sur VOR, at 15,000 and proceeded on the 150 radial outbound, but had to climb to avoid getting too close to the terrain which was on BOTH sides of the airplane. We were flying between two mountain ranges, the one on the right being Mt. Chimborazo, which rises to nearly 20,000 feet.

As the saying goes: "NEVER AGAIN". I am just glad that I was able to live and tell about it.

Circumstances: Aircraft had made two ILS approaches to runway 07. On the second approach, flown by the F/O, the approach became unstabile and a go around was initiated by the Captain. After levelling at 2000 feet AGL, the aircraft entered a spiral to the left. The captain turned to controls over to the F/O who attempted a late roll out and pull-up recovery.

Weather: M 4 ⊕, visibility 2 miles, light rain and fog. Wind 10kts/100°, 35 kts/180 at 220 feet.

Time: 03:27 local

Fatalities: 4

FLIGHT PATH PROFILE
DC-8-63
TOLEDO, OHIO
15 February, 1992

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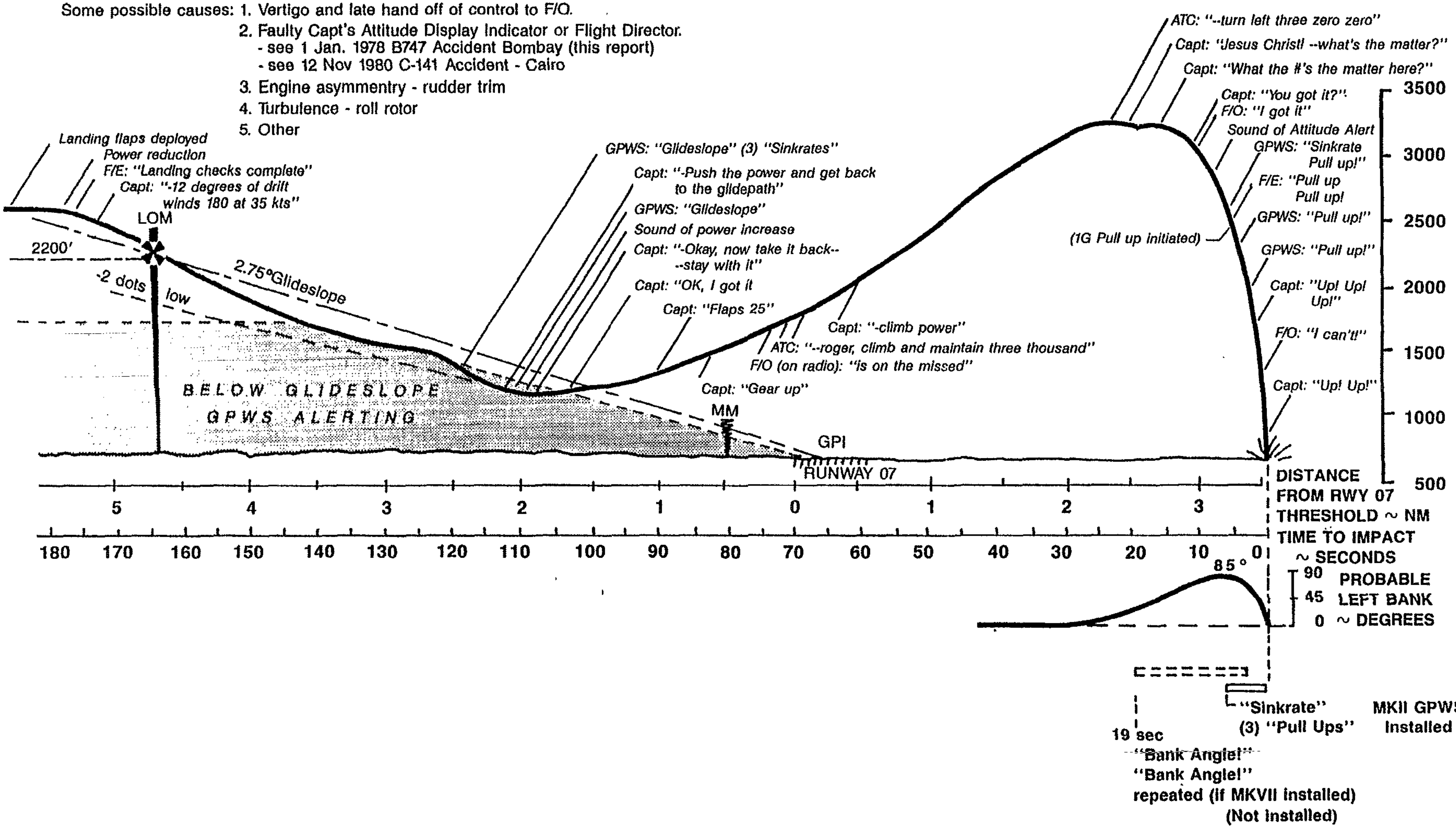
Some possible causes:
1. Vertigo and late hand off of control to F/O.
2. Faulty Capt's Attitude Display Indicator or Flight Director.
   - see 1 Jan. 1978 B747 Accident Bombay (this report)
   - see 12 Nov 1980 C-141 Accident - Cairo
3. Engine asymmentry - rudder trim
4. Turbulence - roll rotor
5. Other



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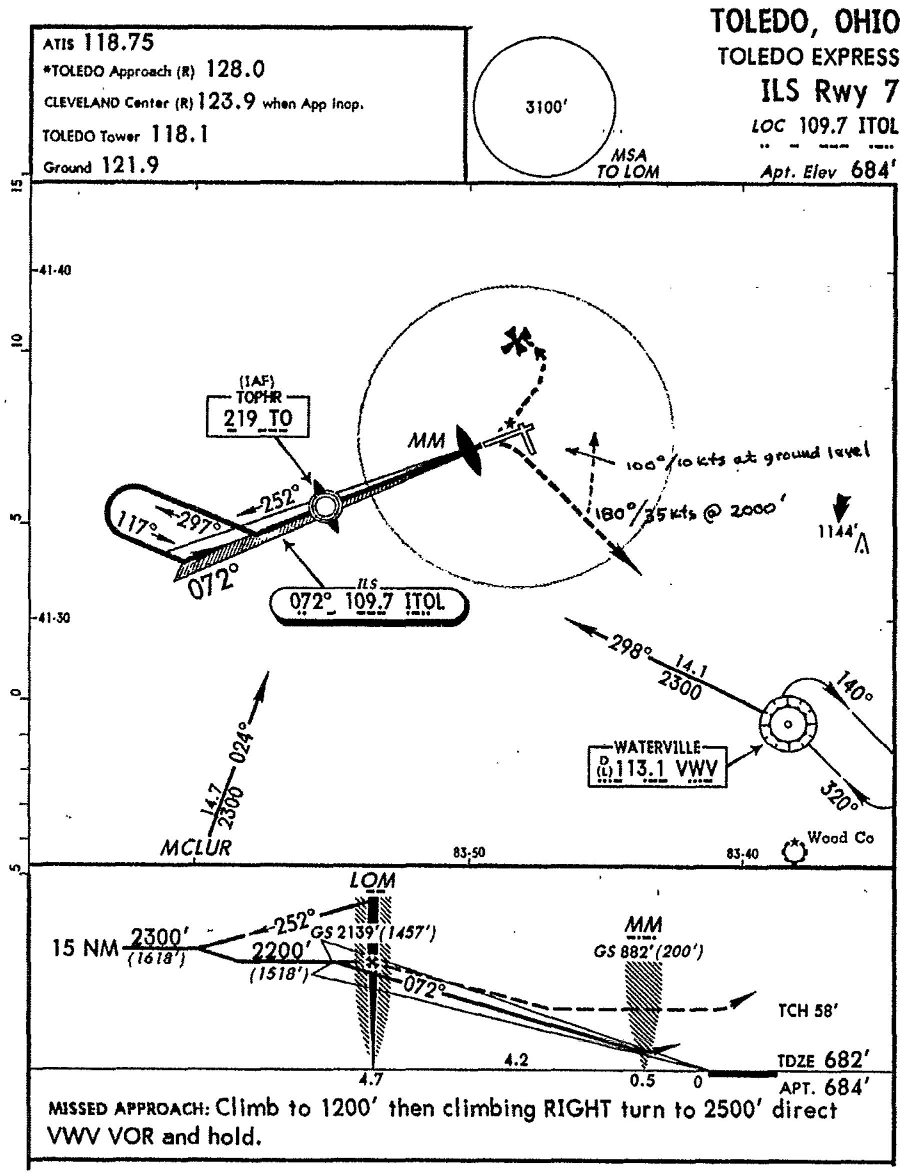

Conditions:	While on VOR approach to runway 06, aircraft hit 9.8 NM short of runway threshold. Captain was anxious to get down to MDA after exiting the procedure turn.
Time:	(night)
Configuration:	Landing gear down-Flaps intransit to 25
Damage:	Aircraft destroyed in fire. 5 on board walked away with no injuries.
Other:	Example of Procedural 'Trap' Very shallow approach slope procedure 1.6°. 3000′ intercept altitude needs to be raised to 4000′ (2.8°).

Drum and pointer altimeter. Aircraft apparently lower by 1000 feet than intended. Clipped tree tops. No GPWS installed.

FLIGHT PATH PROFILE
DC-8
Kano, Nigeria
15 February, 1992

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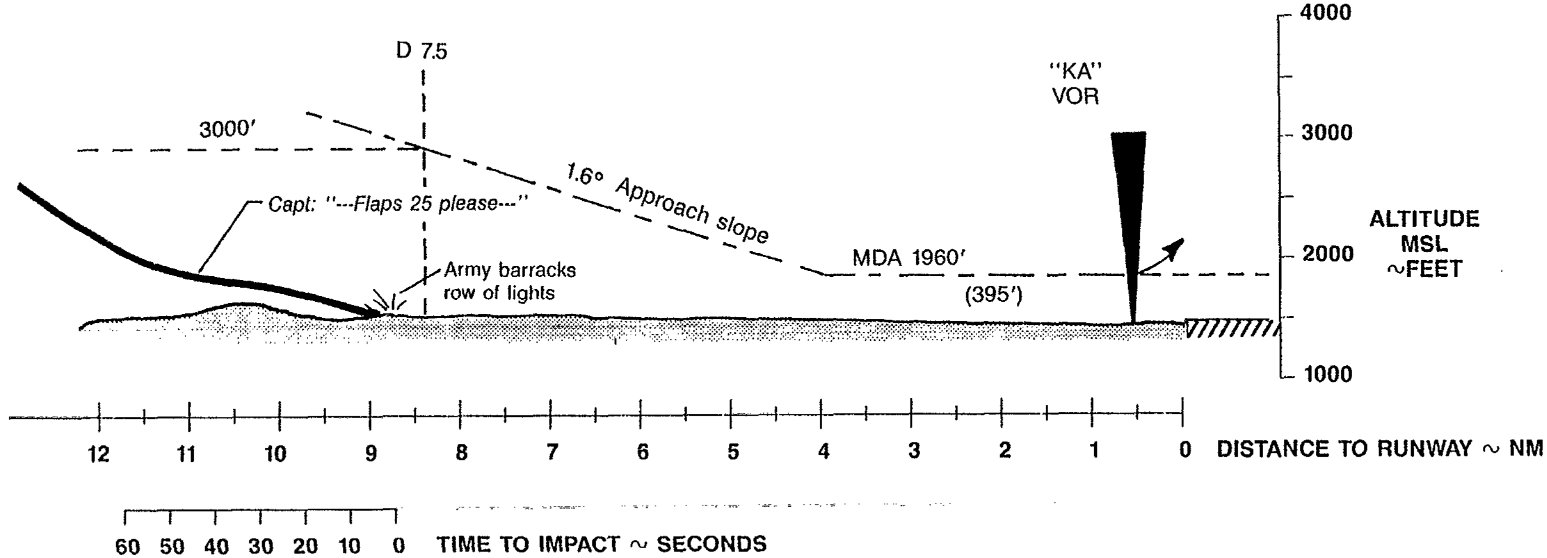
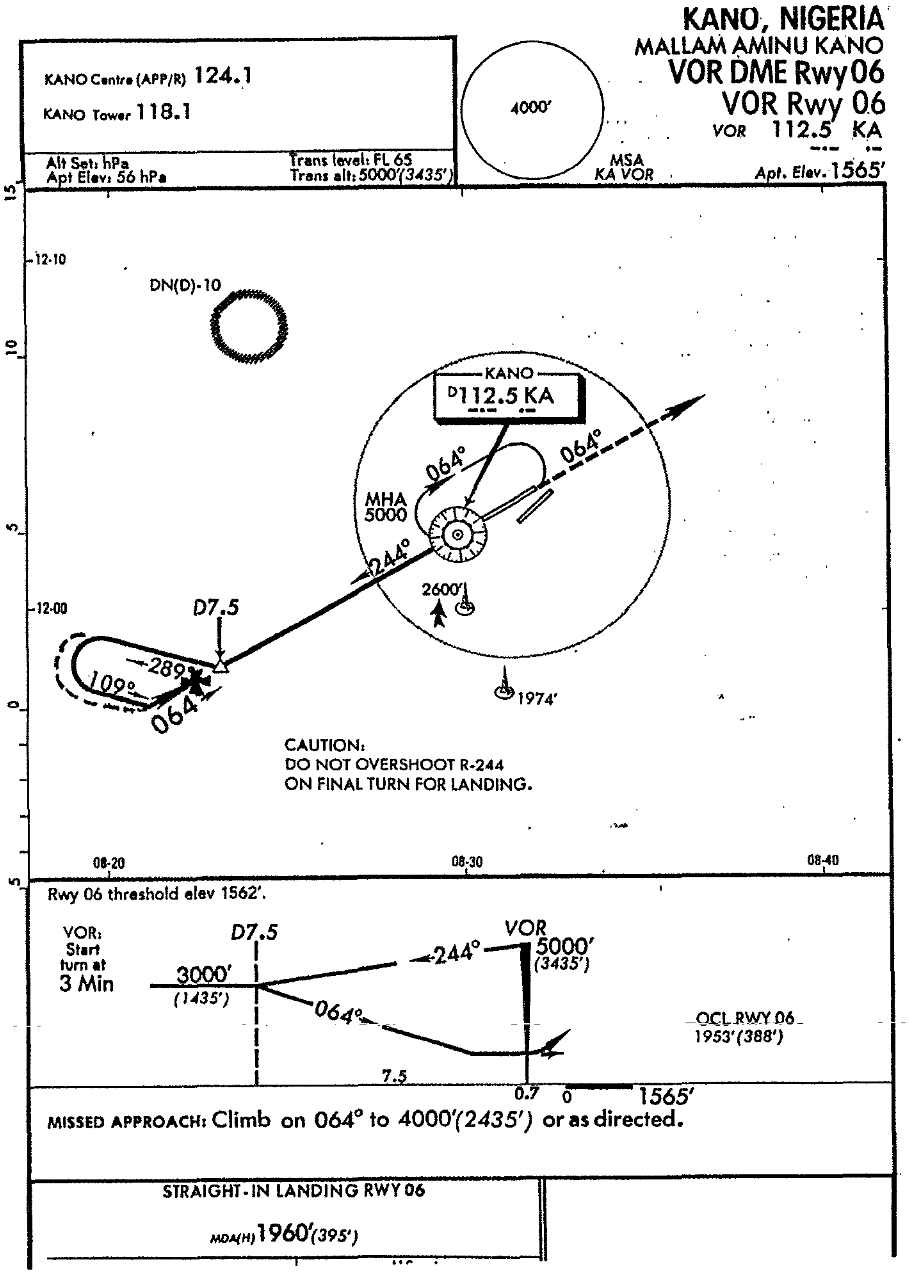


Don Bateman

Return to TOC



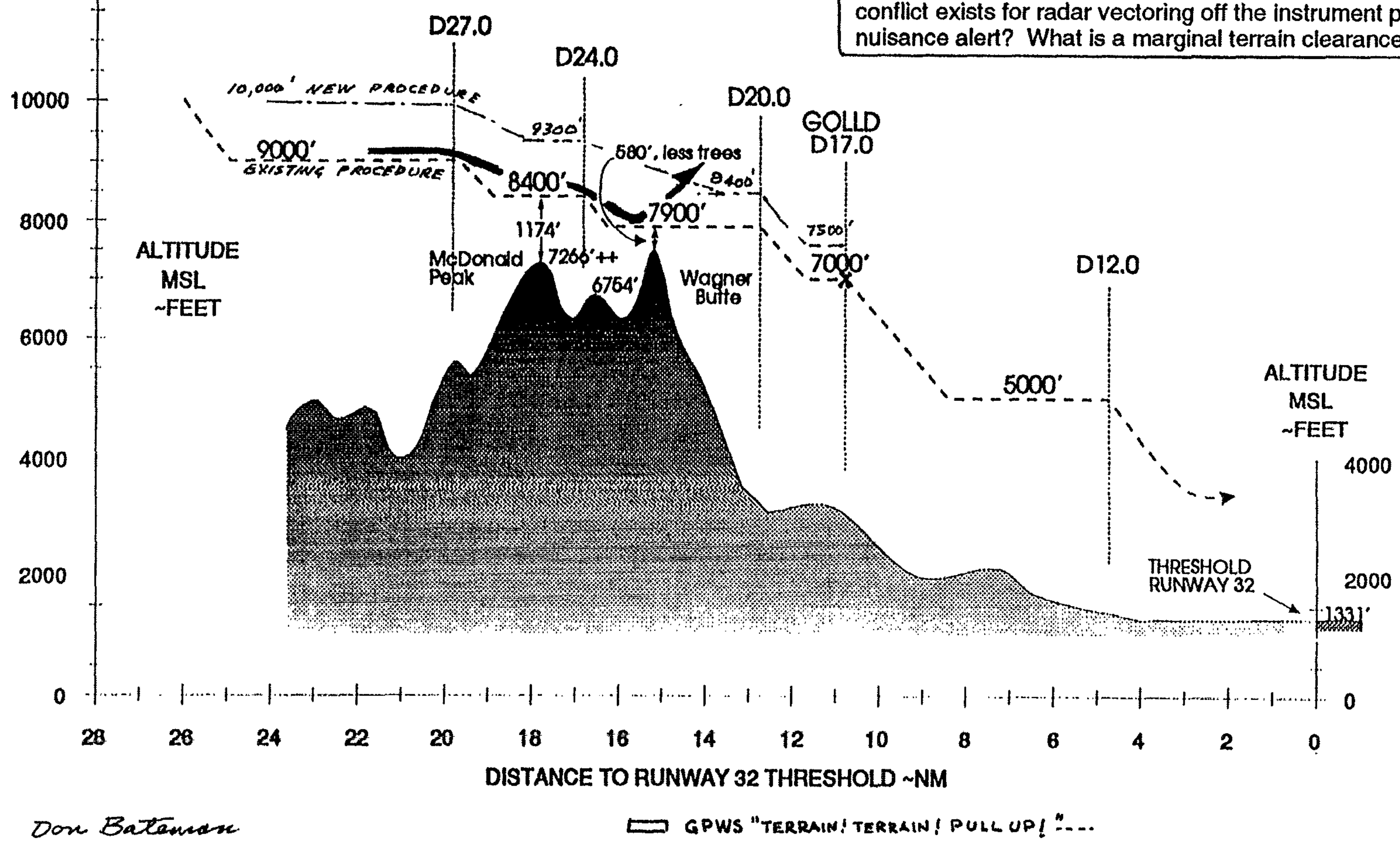
Next Page

Circumstances:	During a VOR DME-C approach to Medford, the flight crew received a GPWS warning at 15 NM or so from the runway and immediately pulled up. It is believed the aircraft's radio altimeter dipped to 400 feet. The flight crew had complied completely with all procedures. They then asked, and received permission, to conduct an ILS DME 14 approach with a circle to land.
Weather:	IMC
Time:	Daylight

Flight Path Profile
B737-200
MEDFORD, OREGON
January 1992

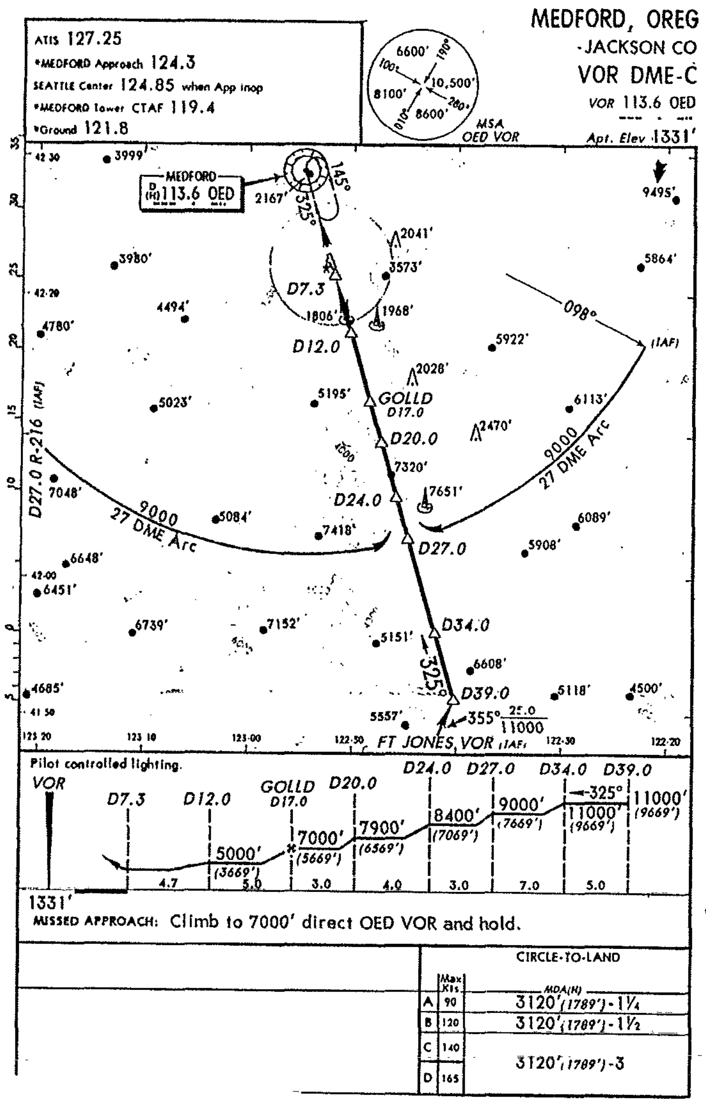
Incident

This incident illustrates the incompatibility between the terrain clearances for some instrument approach procedures and those for GPWS. A similar conflict exists for radar vectoring off the instrument procedures. What is a nuisance alert? What is a marginal terrain clearance?

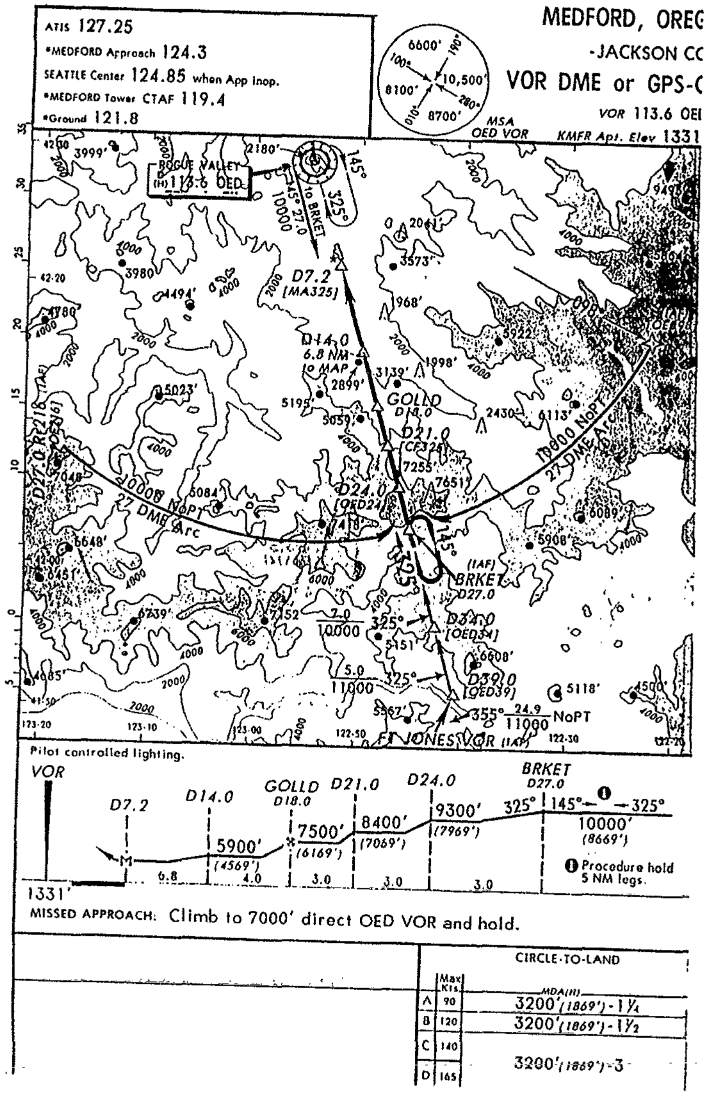


Don Bateman

Return to TOC



Old procedure---------GPWS Warnings



New procedure--------No GPWS Warnings

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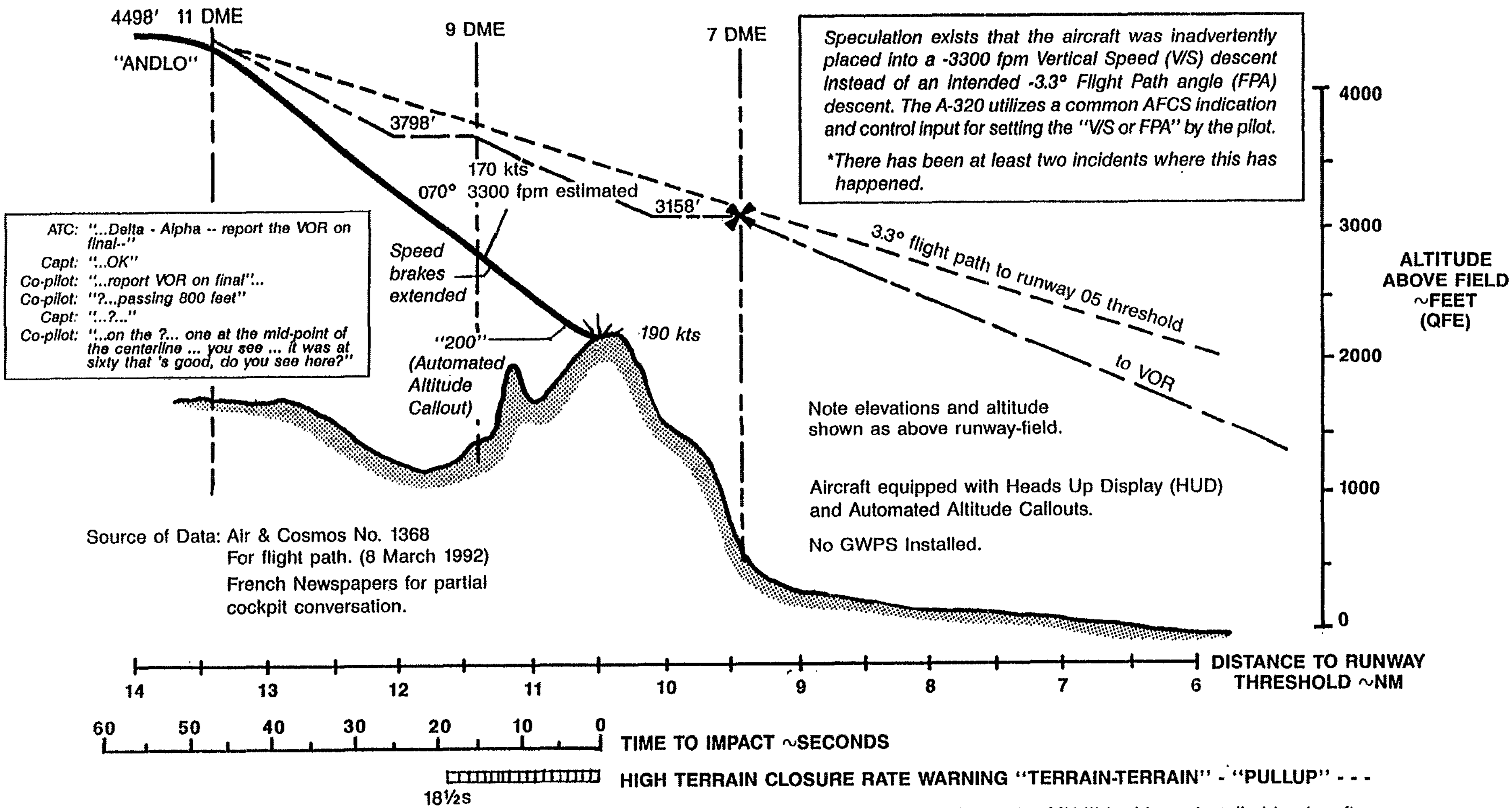
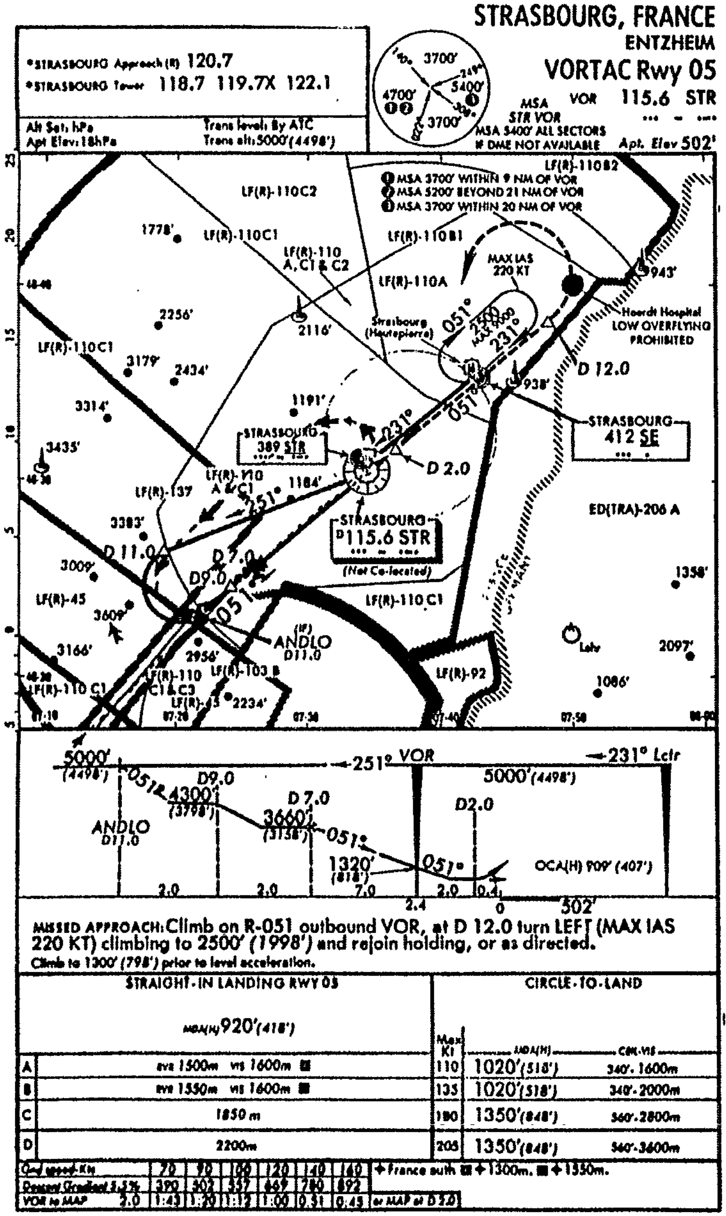
Circumstances:	During a VORTAC approach to runway 05, aircraft inadvertently began a rapid descent rate and hit crest of mountain after turning onto the final approach course.
Time:	19:20 Local
Weather:	IMC. Airport reported winds 20kt/040 Gusts 30, visibility 5 miles 11⊕ 26⊕
Configuration:	Believed to be gear down flap 2.
Fatalities:	87 out of 96 on board.

FLIGHT PATH PROFILE
A-320
Strasbourg, France
20 January, 1992



The above possible MK III warning is shown if a MK III had been installed in aircraft. (MK V not certified at time of accident for use on the A320)



9 Survive as Airbus Carrying 96 Crashes in French Hills

Associated Press

MONT SAINT-ODILE, France, Jan. 21 (Tuesday)—A French Airbus A-320 carrying 96 people crashed in snow and fog on a wooded ridge in eastern France Monday night. At least nine survivors, including a toddler, were found during a four-hour search.

The 20-month-old girl was the only person to emerge unscathed from the wreckage of the state-run Air Inter flight, police said. The smoking debris was strewn about a snowy pine forest.

Two of the survivors were critically injured. Most or all of the survivors were seated in the rear of the plane, rescuers said. Crews worked in 20-degree cold to remove the injured and the dead from the crash site near Mont Sainte-Odile, a 2,500-feet peak in the Vosges Mountains, 30 miles southwest of Strasbourg near the German border.

Rain and snow slowed the search by about 1,000 people. Logging roads provided the only access to much of the fog-shrouded area. The airline set up a center at Lyon's Satolas airport for relatives of those aboard. Few details about the passengers were available, although most reportedly were business travelers.

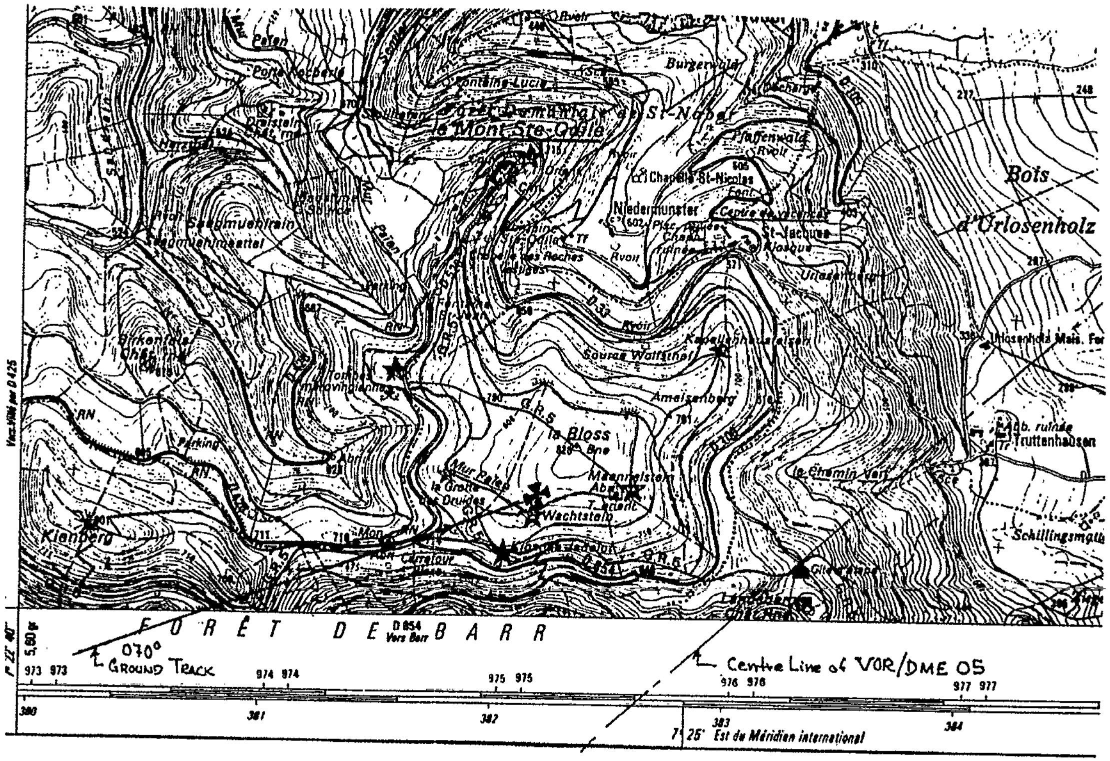
Flight IT-5148 was en route from Lyon to Strasbourg when radio contact was lost shortly before the scheduled landing at 7:25 p.m. (1:25 p.m. EST), officials said. The wreckage was located shortly before midnight. The plane carried 90 passengers and a crew of six, Air Inter said.

An airline communique said there was no indication what had caused the crash. The plane, put into service in December 1988, had no record of mechanical trouble in 6,312 hours of flying time. It was checked earlier Monday, the airline said.

Two A-320s had crashed since the aircraft when into service, one into a forest on June 26, 1988, while executing a low pass during an air show at Habsheim, France. Three passengers were killed.

On Feb. 14, 1990, a three-month-old A-320 crashed while preparing for landing in Bangalore, India, killing 92 people.

Airbus blamed pilot error in both accidents, but some aviation officials suggested a computer malfunction. The A-320 is the only commercial aircraft that uses computers capable of operating all flight controls.



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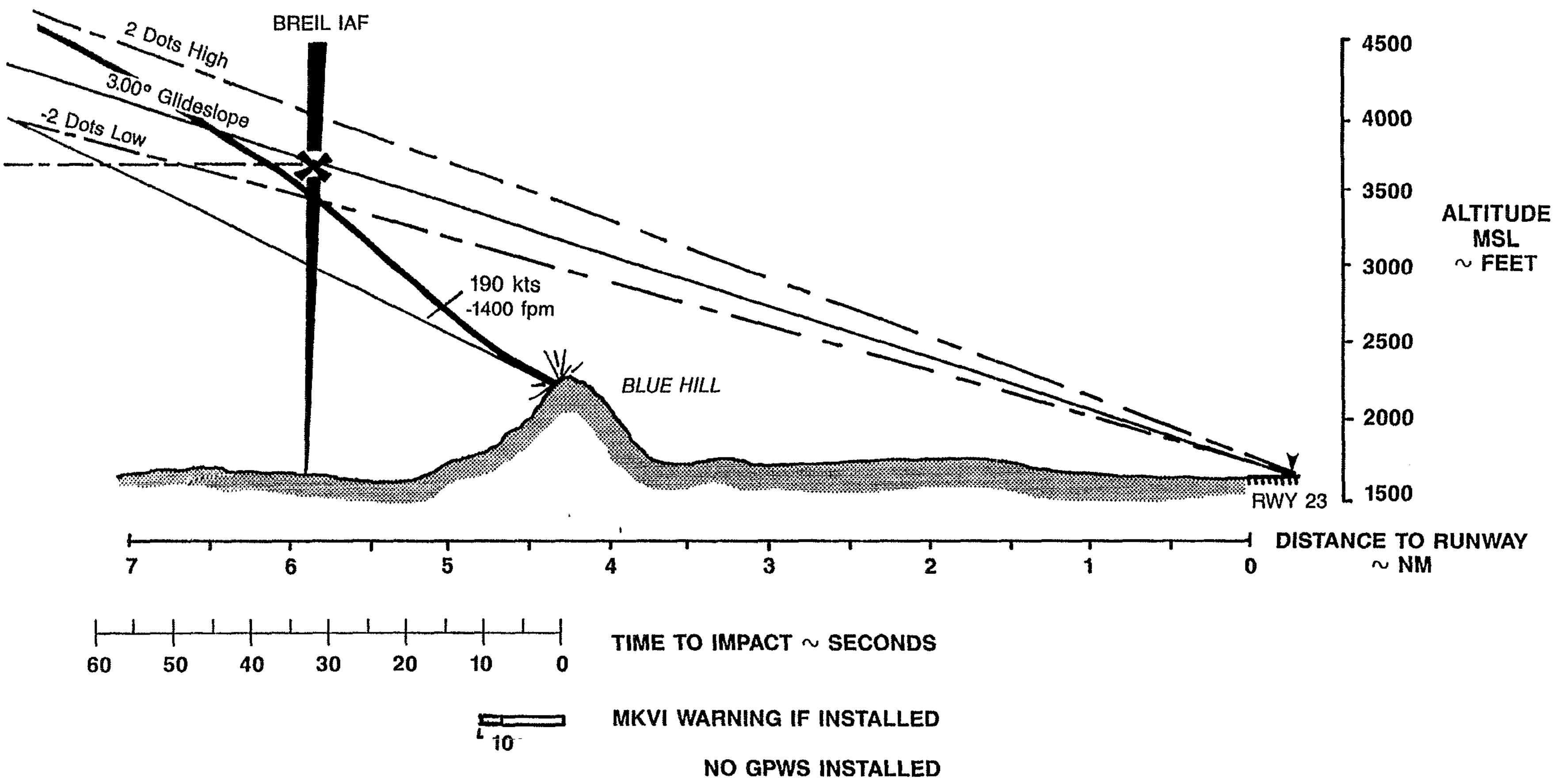
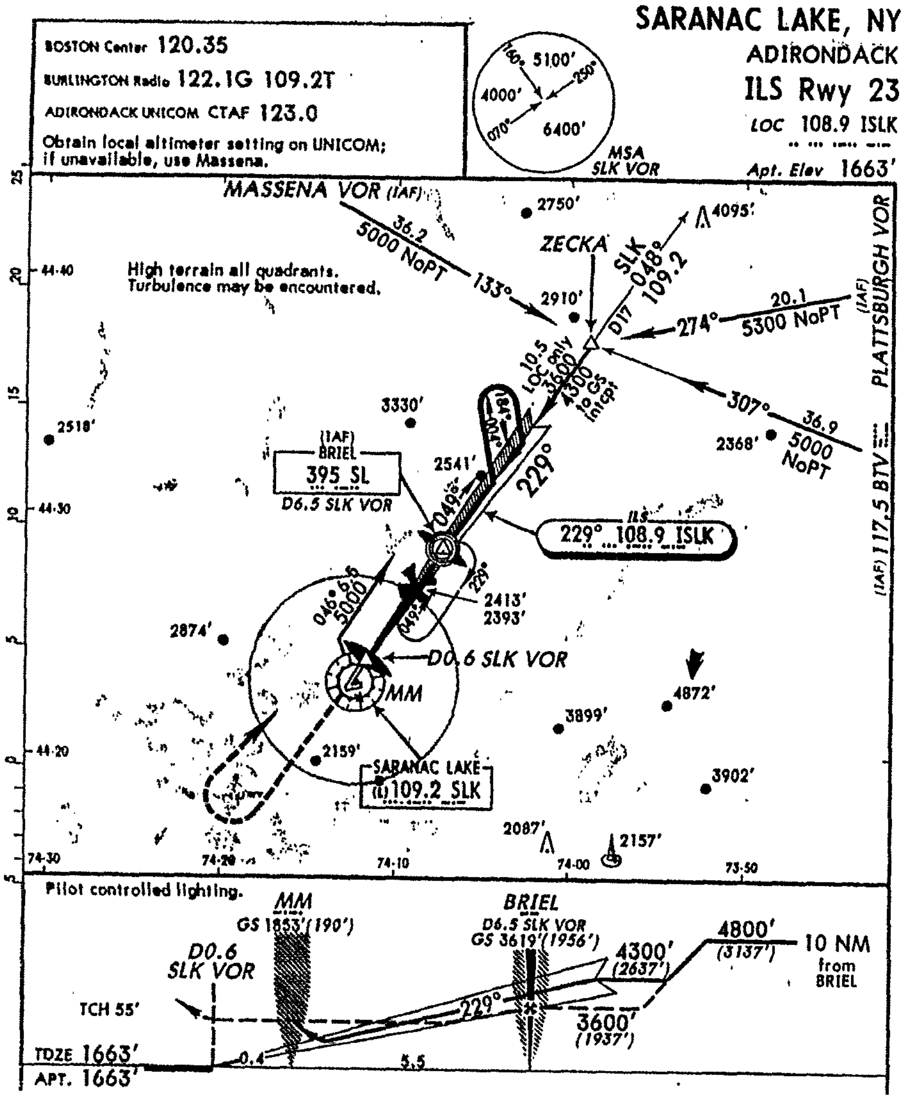
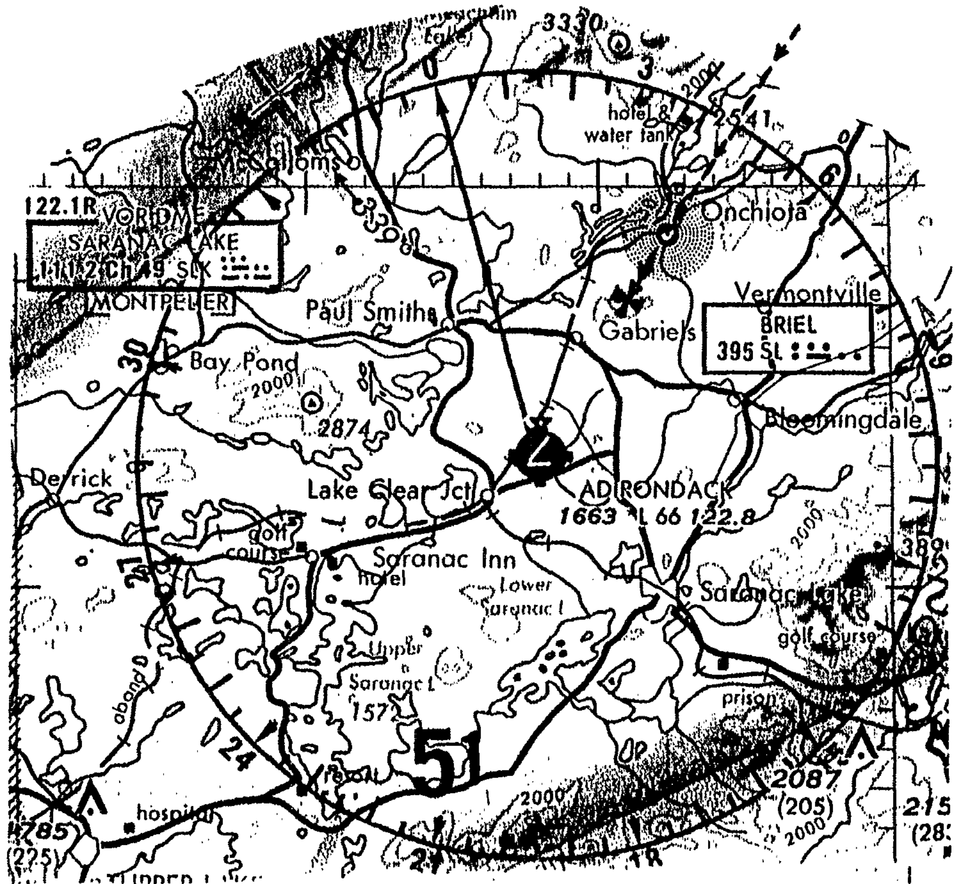
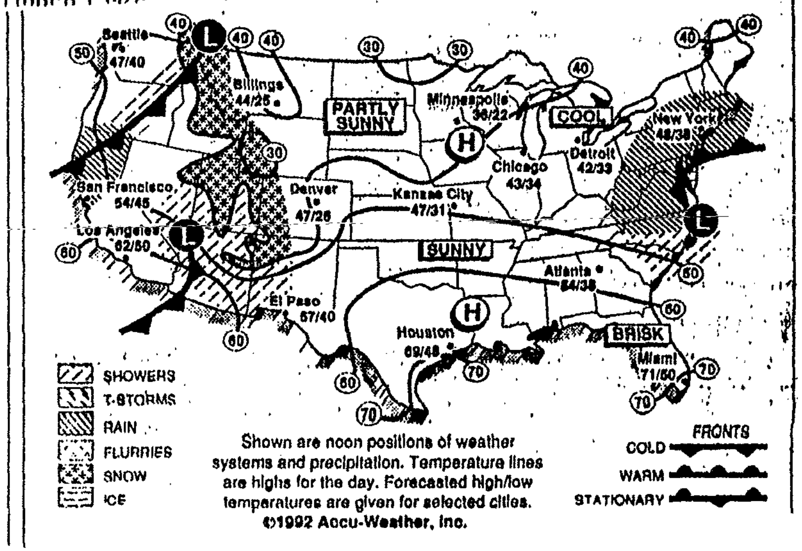
Circumstances:	Commuter flight from Plattsburgh. While on final to ILS runway 23, the aircraft hit short into a ridge just below the crest of a 2390 foot hill.
Weather:	IMC - Morning. 05:30.
Configuration:	Gearup - Flaps up.
Fatalities:	2 out of 4 on board.

FLIGHT PATH PROFILE
Be-1900C
SARNAC LAKE, N.Y.
3 January, 1992









2 dead, 2 hurt in plane crash

SARANAC LAKE, N.Y. — A commuter airplane crashed approaching an Adirondack Mountain airport earlier today, killing two people and injuring the two others on board, authorities said.

The survivors were taken to a hospital about seven miles from the crash site.

Friday, January 3, 1992

Circumstances: After an unstabilized approach to ILS 33, the aircraft landed long (2000') and fast (+30 kts). Under heavy braking in an attempt to stop within 5800 feet of remaining runway, the aircraft departed the runway tearing off the nose gear and left main gear.

Time: 18:53 local (night)

Weather: 100 meter overcast, 1200 meter visibility, some fog with wind at 010 degrees and 7 kts.

Other: Captain flying. F/O called for a missed approach at least 3 times during the approach.

Injuries: None of the 97 on board.

Damage: Aircraft damaged severely and written off.

FLIGHT PATH PROFILE

DC-9/30
Warsaw, Poland
17 December, 1991

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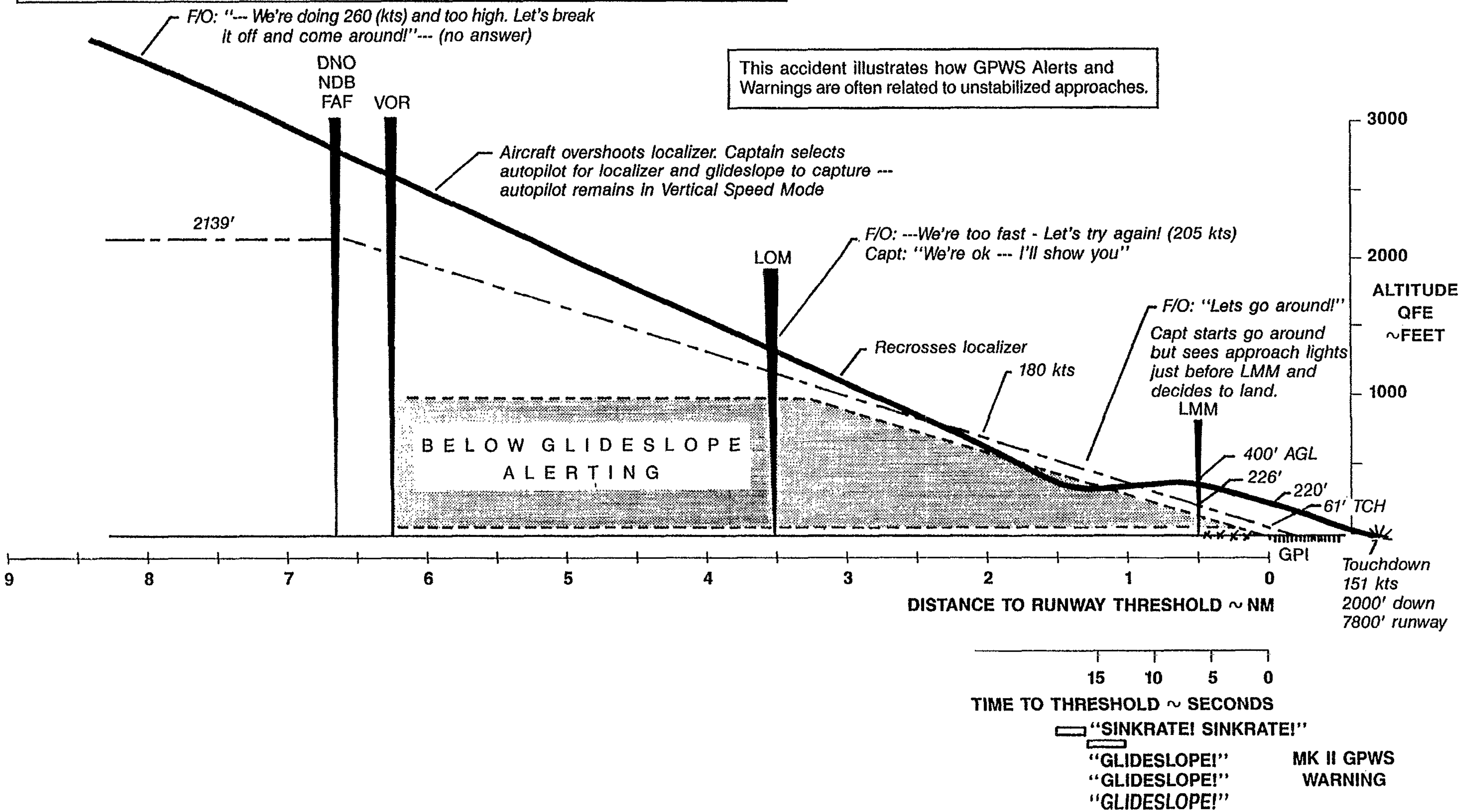
This accident illustrates how GPWS Alerts and Warnings are often related to unstabilized approaches.



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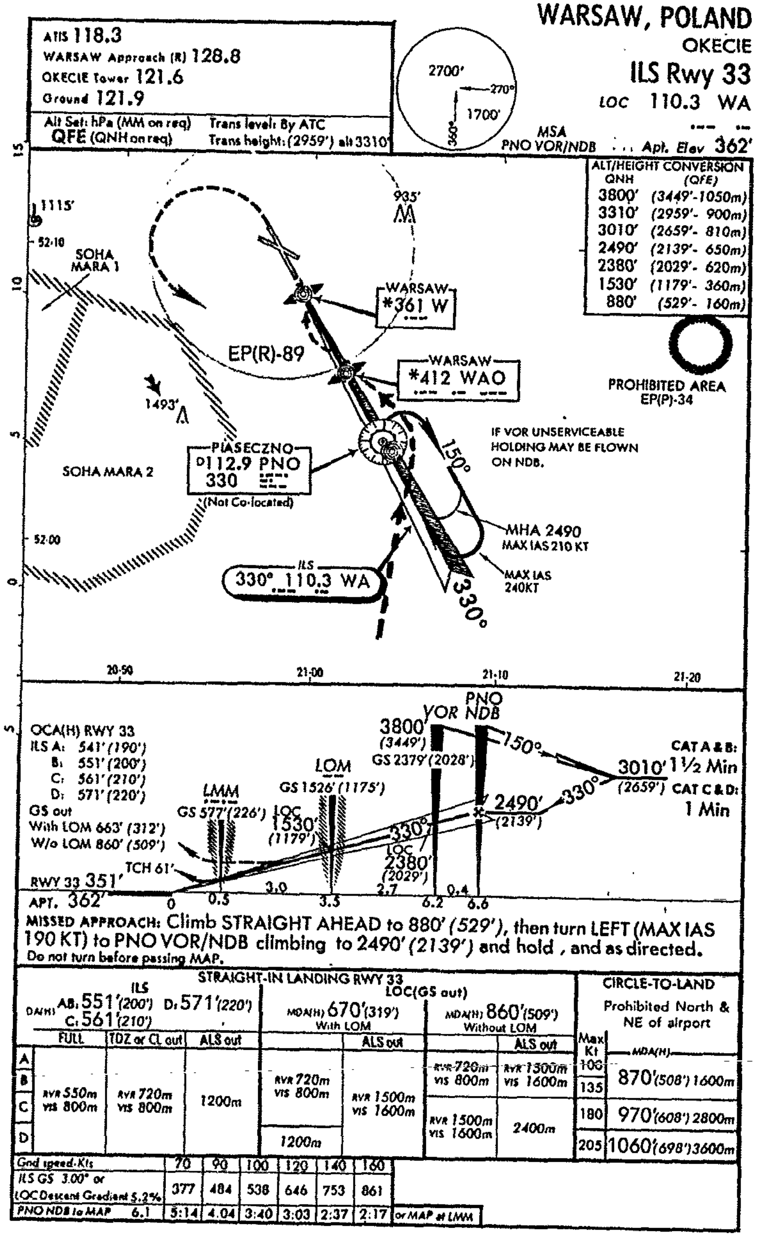

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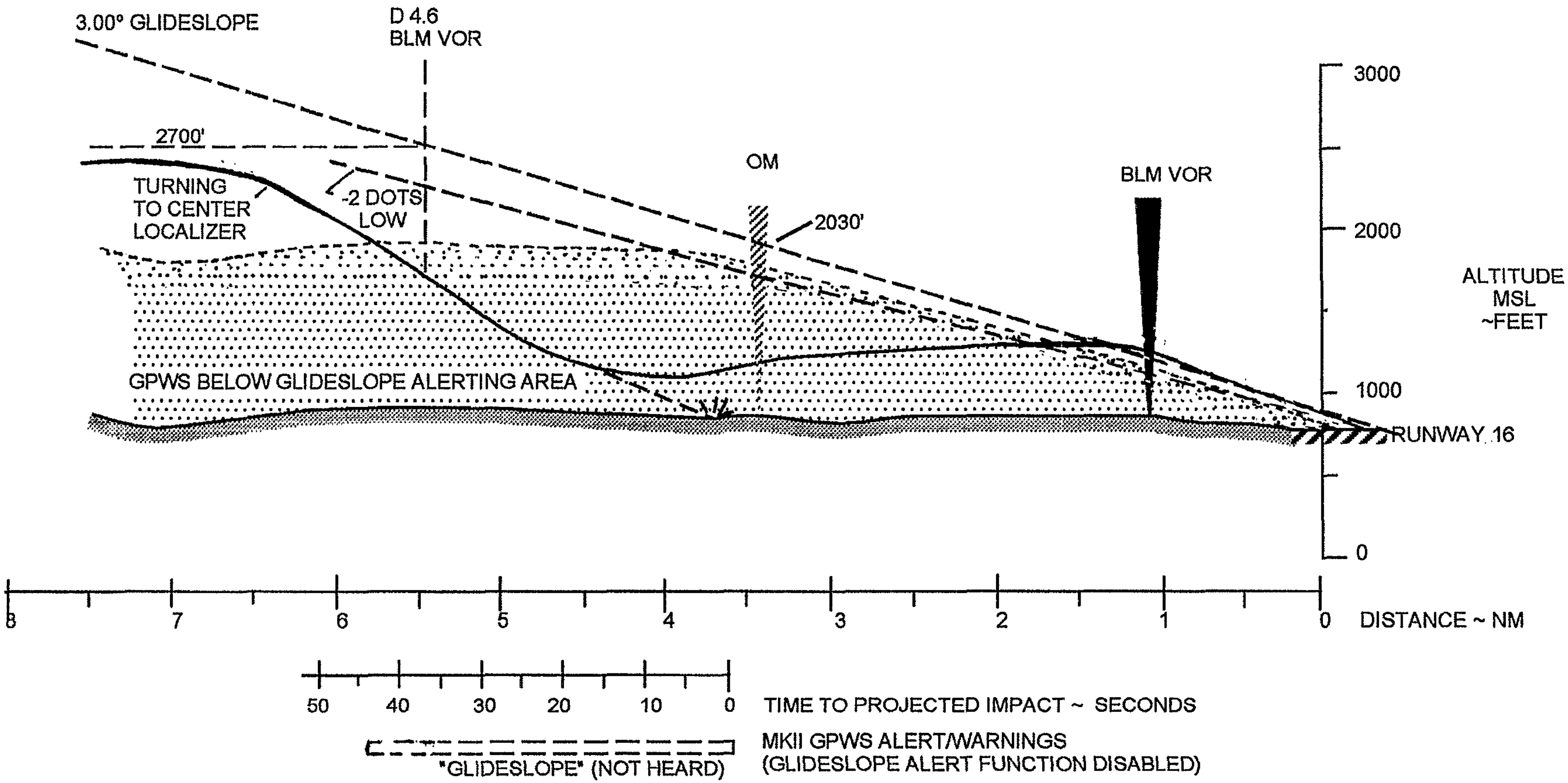
FLIGHT PATH PROFILE
MD-80
Basle-Mulhouse, France
Reported in December, 1991

Conditions:	Co-pilot, flying with autopilot engaged and flight director needles centered for a descent of 1500 fpm, flew low below the glideslope, with localizer captured and vertical speed, well short of the runway ILS 16 threshold.
Weather:	3.3⓪ 7 st 006 01/M00 1024.Icing in clouds. Wind 060/6kts.
Conditions:	Pilots, preoccupied with capturing localizer. Aircraft in landing configuration. GPWS glideslope alert function deliberately disabled by airline policy, hence there was <u>no</u> "Glideslope" aural alert.



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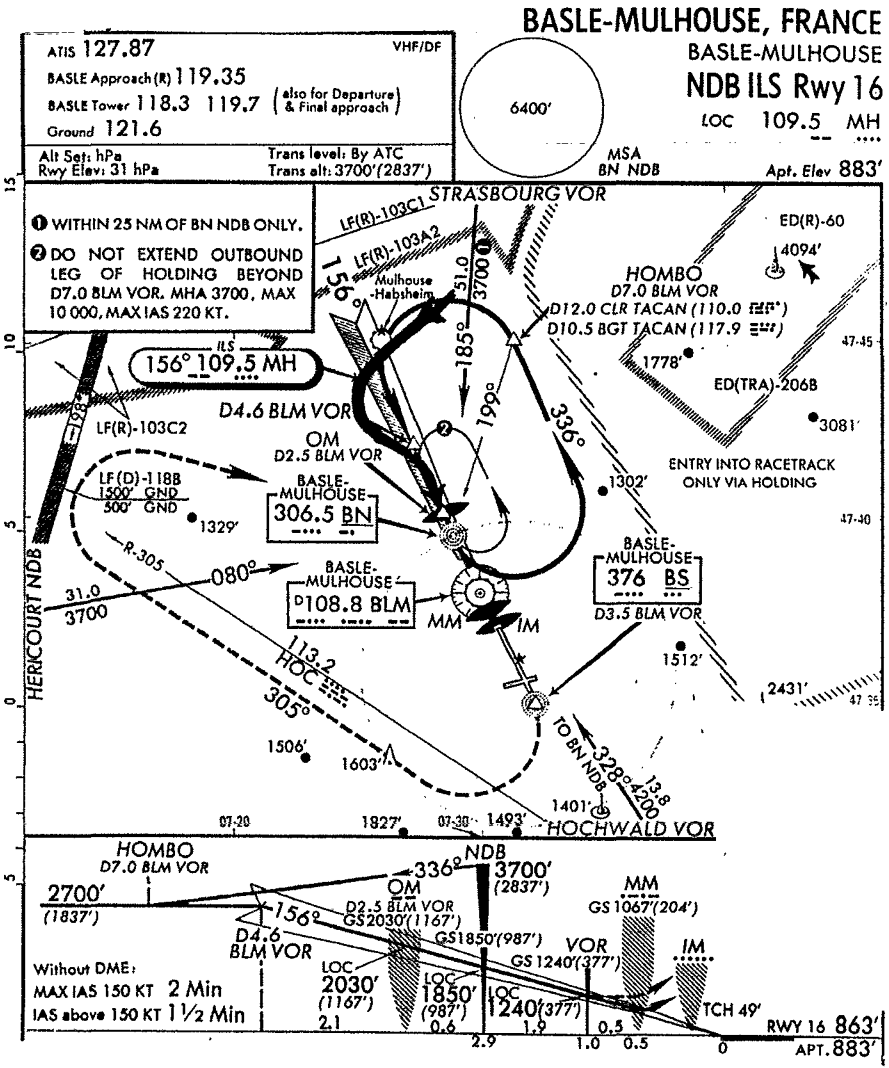
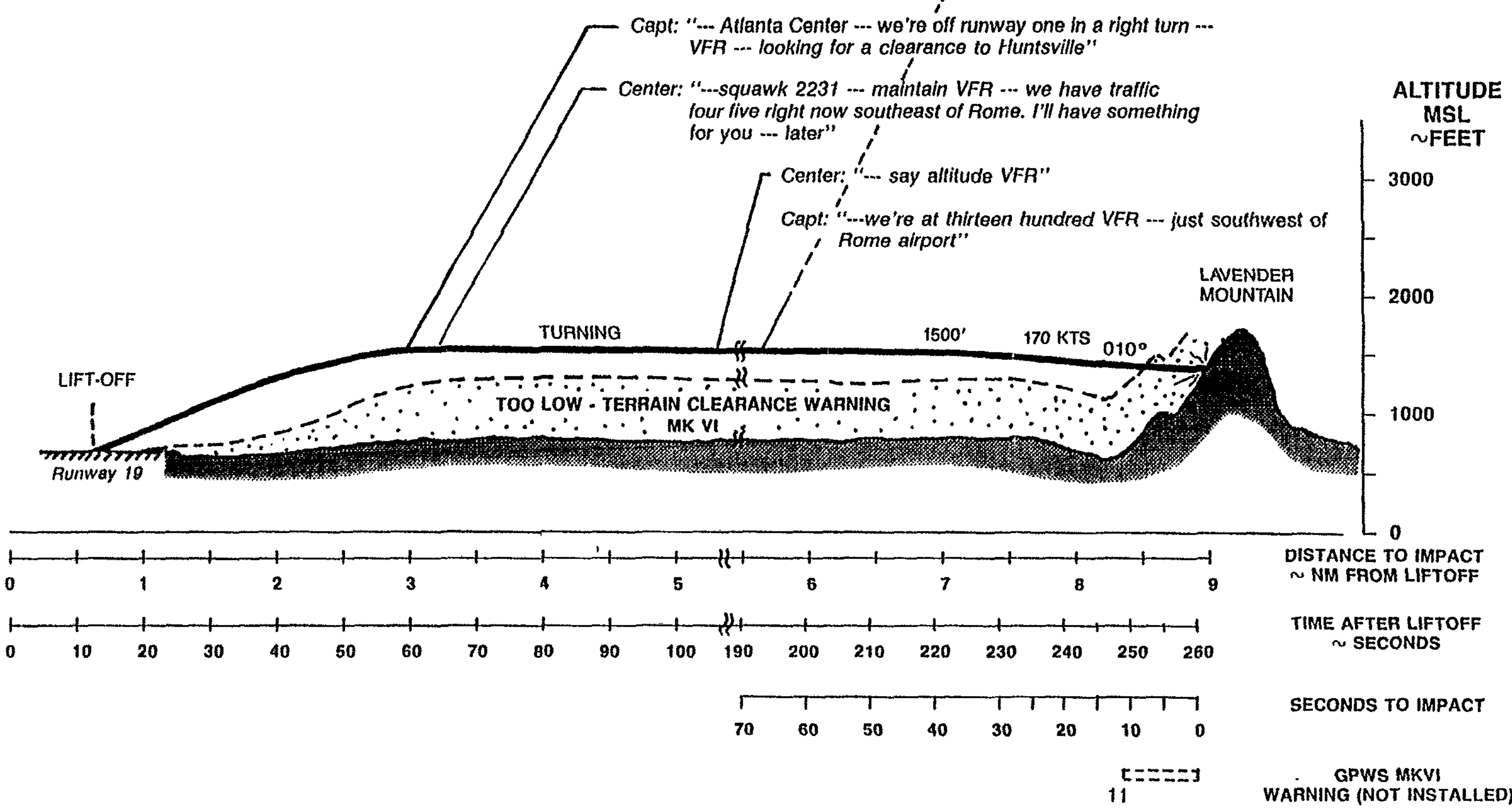


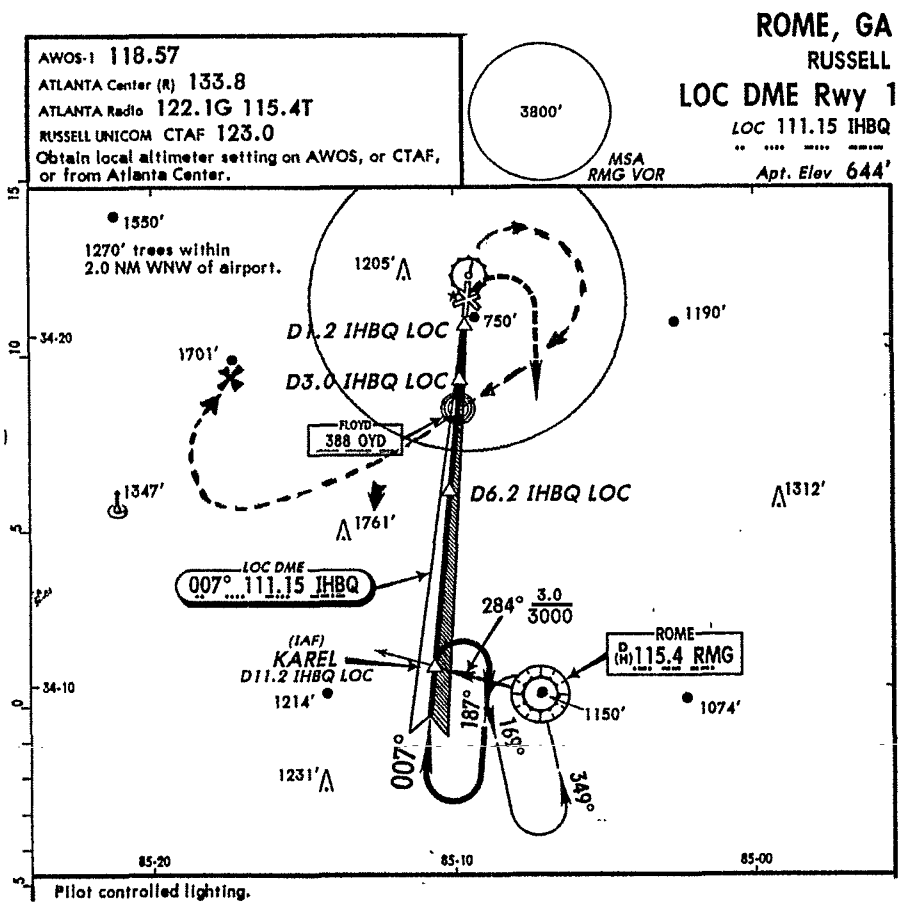
Next Page

Flight Path Profile
Be-400
ROME, GEORGIA
11 DECEMBER, 1991

Circumstances:	Aircraft departed for flight to Huntsville, Alabama. Pilot had pre-filed flight plan, and was attempting to get clearance while remaining VFR and below Chattanooga TCA.
Weather:	Scattered low level clouds, fog but VFR near field.
Time:	9:40 local (morning)
Configurations:	Clean
Fatalities:	9

C/P: "do a one eighty to the left?"
Capt: "--- you're getting close. You're gunna to the right"
C/P: "---Huh?"
Capt: "--- to the right"
C/P: Okay. (but) I can't see over there"
Capt: (if you turn left) you're gunna turn right back into that guy shootin' the approach"
C/P: "Okay"
Capt: "there's a mountain right out there"
C/P: "yeah"
Capt: "and an antenna you won't be able to see in the fog."
C/P: "Should I just punch up?"
Capt: "No --- there's a guy on approach out there"
C/P: "which way do you want to go?"
Capt: "go back to the right"
C/P: "I can't see over here --- that's why I wanted to go the other way"
Capt: don't climb any more--- bring it right on around --- pull it back a little ---"
C/P: "huh?"
Capt: "slow'er down a little"





Crash kills store officials

ROME, Ga. – A corporate jet taking executives on a Christmas tour of their grocery stores slammed into a mountain Wednesday, killing the seven passengers and two crew members on board. A twin-engine Beechcraft jet owned by Birmingham, Ala.-based Bruno's Inc. and bound for Huntsville, Ala., went down on Lavendar Mountain on the Berry College campus just northwest of Rome, 80 miles north of Atlanta. Nobody survived. The cause of the crash was under investigation. Among those killed in the crash were Bruno's Chairman Angelo J. Bruno, his brother, Vice Chairman Lee J. Bruno, and three company vice presidents.

The company operates more than 240 stores in Alabama, Georgia, Florida, Tennessee, Mississippi and South Carolina.

Next Page

Flight Path Profile
CL-601
SEATTLE, WASHINGTON
November, 1991

DME 'HOLD' TRAP INCIDENT

CIRCUMSTANCES: During a localizer back course to Boeing Field runway 31L, the aircraft prematurally descended to the Minimum Descent Altitude of 700 feet before reaching the final approach fix at 'Bense! Apparently the 'SEA' DME was left in 'Hold' position and DME indications were from 'SEA' and not the IBFI localizer DME.

TIME: Night

WEATHER: IMC, 600 broken

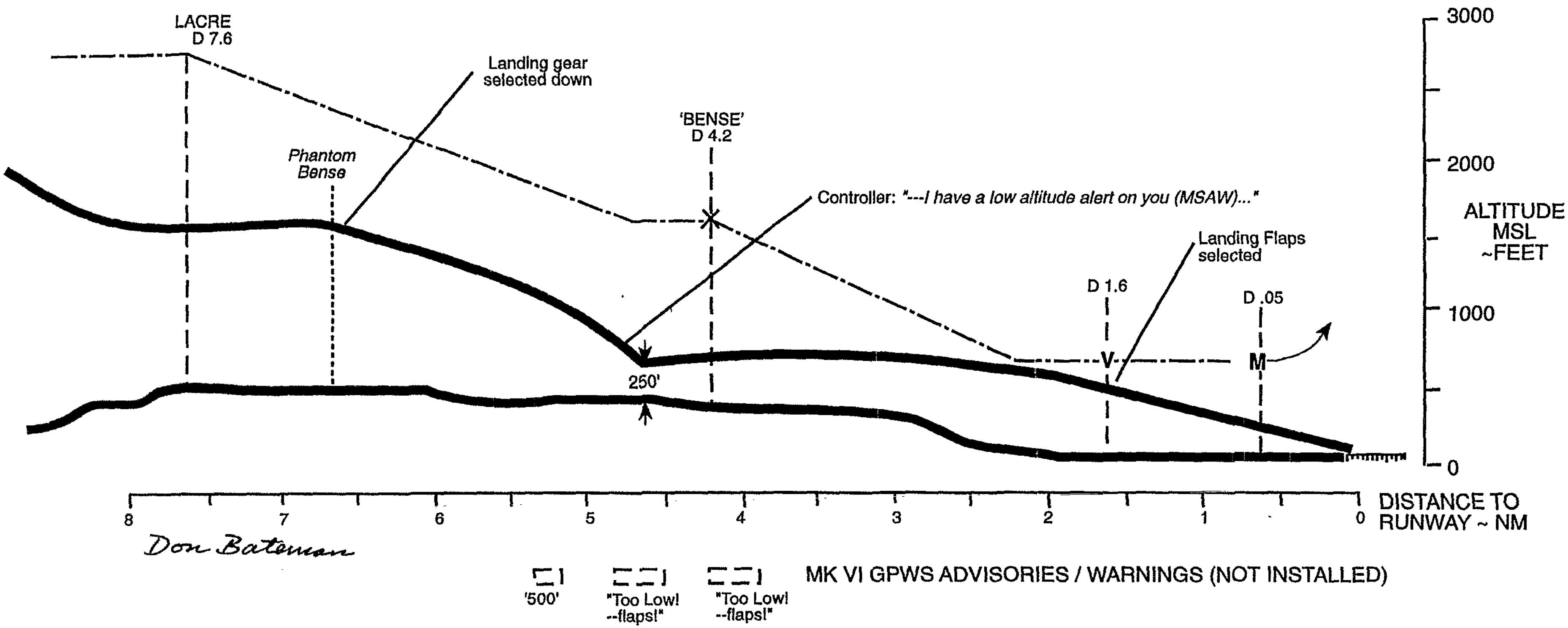
OTHER: Pilots very tired.

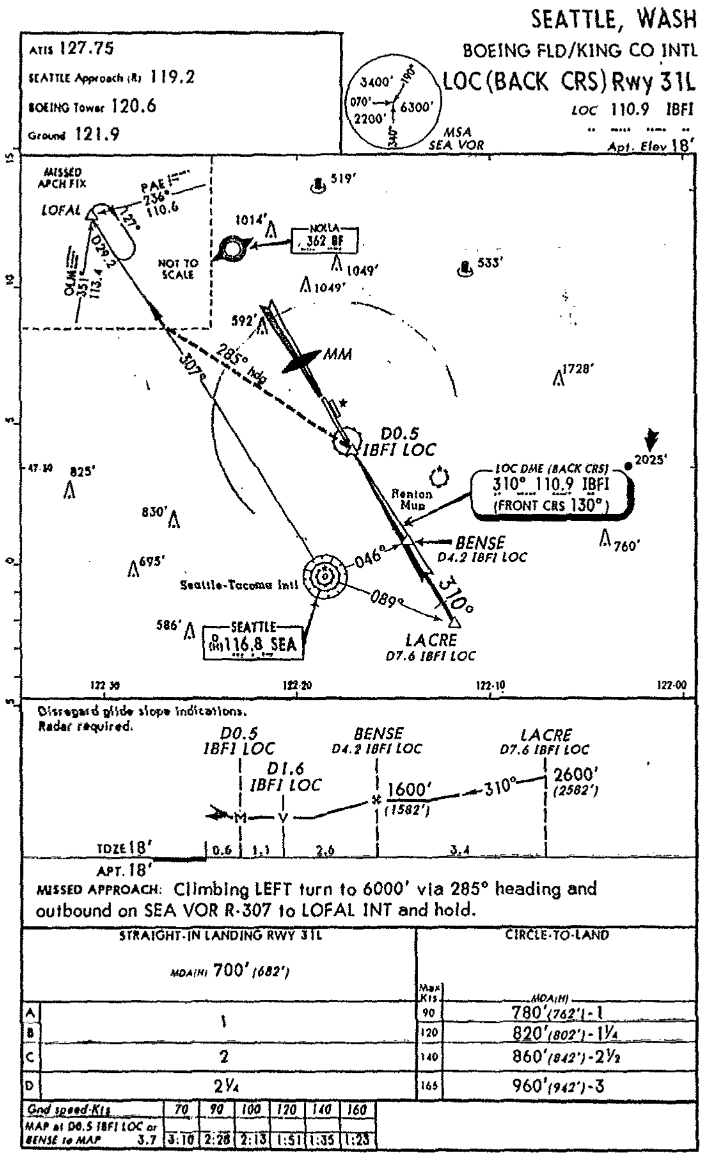
DME 'Hold' features are very useful but can also be very deadly:

Other DME 'Hold' Incidents/Accidents see:

Spokane	20 Jan 81	Be-99	7 Fatalities
Juneau	22 Oct 85	LJ-24	4 Fatalities
Juneau	12 Nov 92	Be-100	8 Fatalities

NO GPWS INSTALLED





SOURCE: ASRS #195342

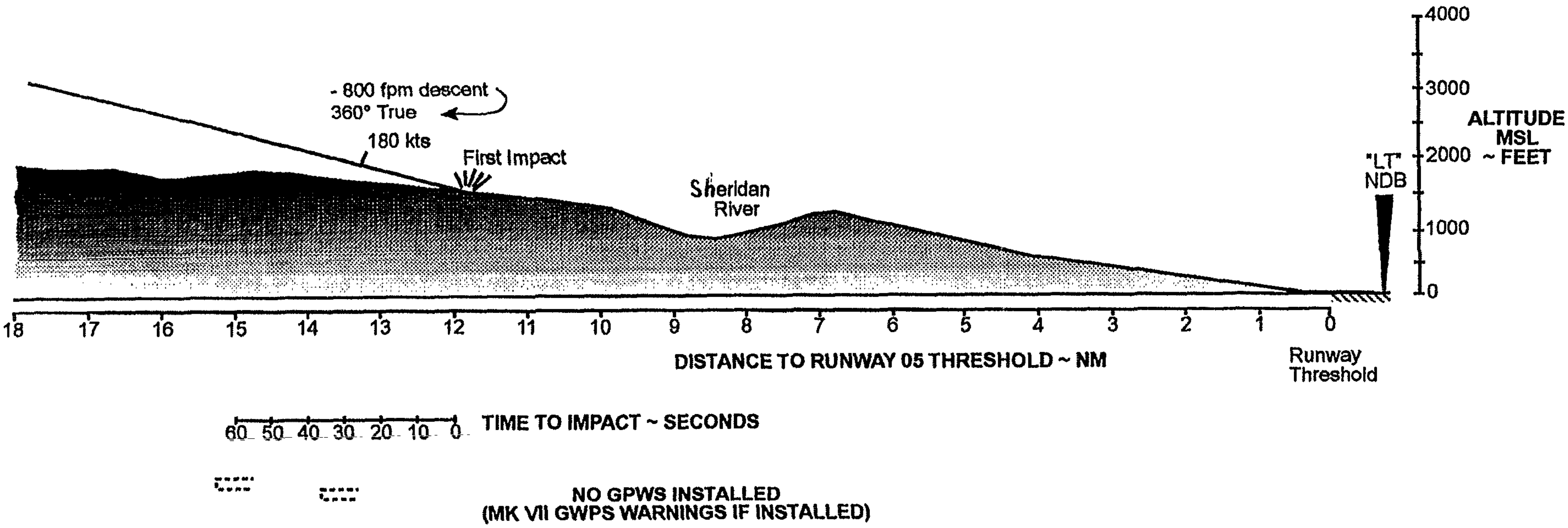
NARRATIVE : WE DSNDED TO VARIOUS STEP DOWN ALTS ON APCH BASED ON DME. DURING THE FINAL STEP DOWN (1600 FT - 700 FT) THE APCH CTLR GOT AN ALT WARNING ON US AND NOTIFIED US WE WERE TOO LOW. OUR DME HAD BEEN IN 'HOLD' OFF THE SEA VOR BY MISTAKE, AND NOT THE BFI LOC AS THEY SHOULD HAVE BEEN. WHEN THE CTLR CALLED WE WERE JUST BREAKING OUT, WE STOPPED DSCNT, GOT THE FIELD IN SIGHT AND LANDED NORMALLY. BOTH PLTS HAD BEEN ON DUTY FOR +12 HRS AND DEALING WITH WX, ICE, ETC. FATIGUE WAS A FACTOR. MY RELIANCE ON THE OTHER PLT TO SET UP THE APCH WAS ALSO A FACTOR. WE FLY TOGETHER OFTEN AND ARE BOTH GOOD INST PLTS (MOST OF THE TIME)! THANK YOU ATC FOR HAVING THIS ALT WARNING CAPABILITY -- WE ARE EMBARRASSED AND WISER -- BUT VERY MUCH ALIVE!

Next Page

Flight Path Profile
C-130
ALERT, NWT
30 OCTOBER, 1991

Circumstances:	During routine supply run from Thule, aircraft struck tundra some 12 nm short of runway 5.
Weather:	Clear, haze, wind 15 kts 010°
Configuration:	Clean
Fatalities:	5 with 6 seriously hurt out of 13 on board.

Other: Aircraft may have been on visual to runway 5? Altimeter setting problem? Transition altitude? WX radar range setting problem? Questions that presently are not answered.



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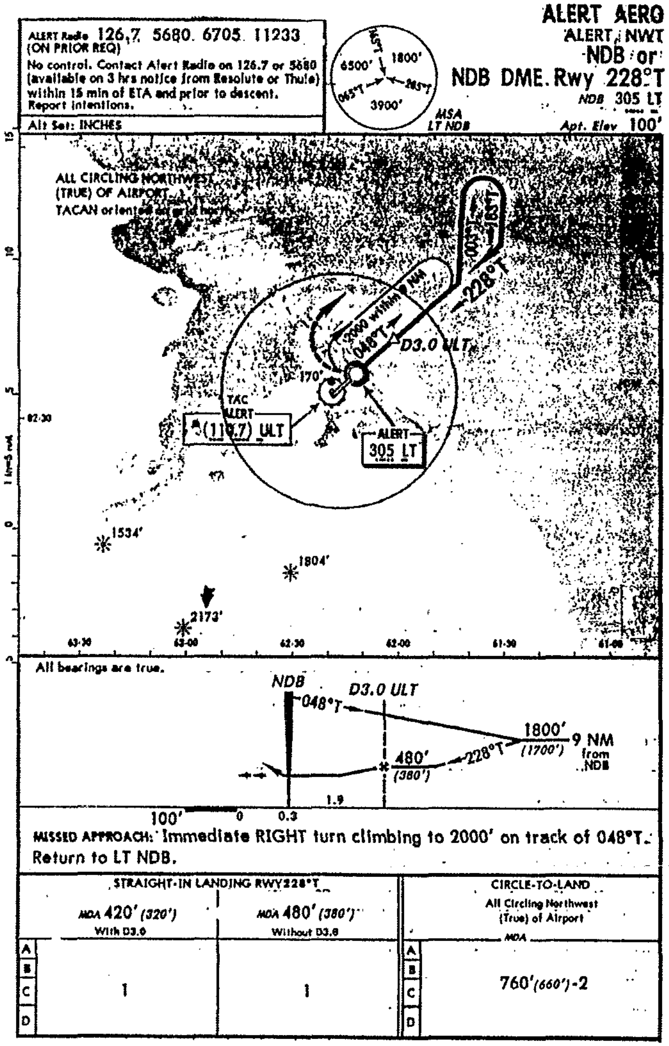

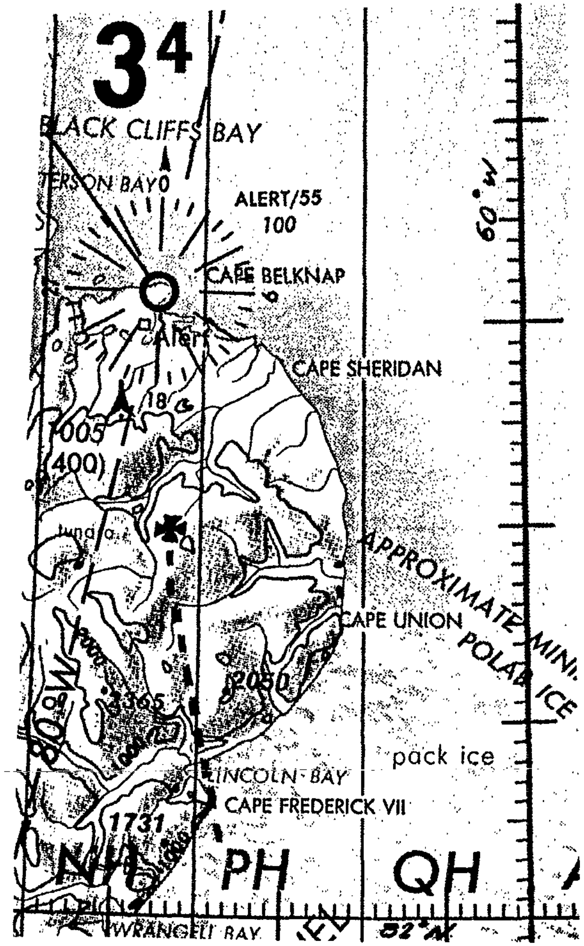


B8 National Saturday, November 2, 1991 Saskatoon, Saskatchewan The Star

Dramatic rescue

Chronology of events surrounding the crash of a Canadian Forces C-130 Hercules transport plane in the high Arctic (all times Mountain):

WEDNESDAY

1 p.m. (approx.)
Hercules sets out from Thule, Greenland, on a supply mission bound for Canadian Forces Station at Alert, N.W.T. Five crew members, 11 military personnel and two civilians on board.

2:30 p.m.
Hercules crashes 20 kilometres south of Alert

3:50 p.m.
Report Hercules is overdue in Alert reaches search and rescue officials in Edmonton. Search crews from CFB Edmonton and across Canada take to the air

THURSDAY

12 a.m.
Search plane spots flares from crash site. Ground crews traveling in tank-like all-terrain vehicles from CFB Alert are forced to turn back because of whiteout conditions. Minus 20 degree blizzard conditions and gusting winds also stymie paratroopers trying to get to the site.

9:30 p.m.
Blizzard finally subsides. Military spokesmen say attempt to reach the crash site is imminent.

11 p.m.
Six military paramedics are dropped to crash site by helicopter. They begin providing first aid and emergency treatment

FRIDAY

1 a.m.
More paramedics parachute in and ground crew arrives at the site, making total of 20 rescuers on the scene.

9 a.m.
Military helicopters begin to airlift survivors from crash site to Alert

12:39 p.m.
Department of National Defence releases names of five military personnel killed in the crash

Alert
Axel Heiberg Island
N.W.T.
Ellesmere Island
GREENLAND
Thule
Airbase

André Lachapelle – (CP)

Five dead, six seriously injured in arctic crash

By Judy Monchuk
The Canadian Press

Military helicopters airlifted survivors from the wreckage of a military transport plane Friday, ending a two-day survival nightmare on the frozen tundra near the top of the world.

Five military personnel on board the CC-130 Hercules died in the crash. Six of its 13 other passengers were seriously injured and were taken to a U.S. military hospital in Thule, Greenland.

Operating under an almost constant shroud of darkness and stymied by freezing blizzard conditions and gusting winds, search-and-rescue crews were not able to reach the crash site until 12 p.m. CST Thursday — more than 30 hours after the plane went down.

It was another 10 hours before the airlift of survivors began.

"We are somewhat relieved that we only have five deaths," Col. Mike Wansink told an Edmonton news conference late Friday. He sounded more relaxed than at an earlier briefing when the fate of those on board was less clear.

After the long wait to get to the crash site, it took less than three hours for military helicopters to pluck out all survivors, said Maj. Don Blair, head of search-and-rescue operations at Canadian Forces Base Edmonton.

Some of the survivors "were in desperate enough state that hypothermia was becoming a problem," said Warsink, base commander at Edmonton, where two of the dead were stationed.

Medical paratroopers reached the crash site about eight hours after the accident Wednesday, but gusting winds and blowing snow made it impossible for them to parachute to the ground.

A Hercules circled the crash site until the weather cleared — a reminder to survivors that help was close at hand as they huddled inside the plane fuselage to avoid temperatures of below minus 20 C.

Military officials had earlier said the crash victims had supplies to help them survive for an extended period of time. But Warsink conceded Friday that time was running out when the airlift finally began.

"It was getting desperate, there's no doubt. The temperatures, the weather."

"We were all very much concerned about that and extremely frustrated that we could do virtually nothing and we were impeded by the elements."

Early reports of flames spotted at the crash site had led military officials to fear the transport plane — which was carrying a load of diesel fuel — had exploded on impact.

Once contact was established and it became clear there were survivors, there were unconfirmed reports of six people unaccounted for. In fact, five died.

They were: the pilot, Capt. John Couch of St. Albert, Alta., Master Cpl. Roland Pitre of Edmonton, Capt. Judy Trepanier Warrant Officer Robert Grimsly, both of Ottawa, and Master Warrant Officer J. T. Jardine of Trenton, Ont.

The crash survivors were suffering a variety of injuries including frostbite, broken bones, cuts and burns.

The most seriously injured were expected to be transferred to hospitals in southern Canada late Friday. Blair said the military hoped to transfer them to communities close to their hometowns.

The bodies of the dead remained in the wreckage Friday night and a coroner was on site.

Little was known about what paramedics discovered at the scene. Until rescue personnel were finally able to reach the site late Thursday, there had been only sporadic contact by radio and Morse code between survivors and the military.

The transport plane crashed while flying to the Canadian Forces radar base at Alert, the northernmost settlement in the world. It is located on the tip of Ellesmere Island just south of the North Pole — a rocky, rugged area where the only break from darkness at this time of year is two hours of twilight.

What began as a story about a plane crash Wednesday quickly turned into a saga of survival in the forbidding frozen darkness of the high Arctic.

Rescue crews ran up against a fierce blizzard. With snow and winds gusting over 50 kilometres an hour, those trying to get to the site by land encountered zero visibility on Wednesday and Thursday.

It took the ground search party three attempts to get to the scene — eventually reaching the area on tank-like all-terrain vehicles two hours after the medical crews parachuted in.

One of the passengers, Capt. Wilma Degroot of CFB Trenton, is a medical doctor, Wansink said. It was not known if Degroot was able to help survivors at the crash site.

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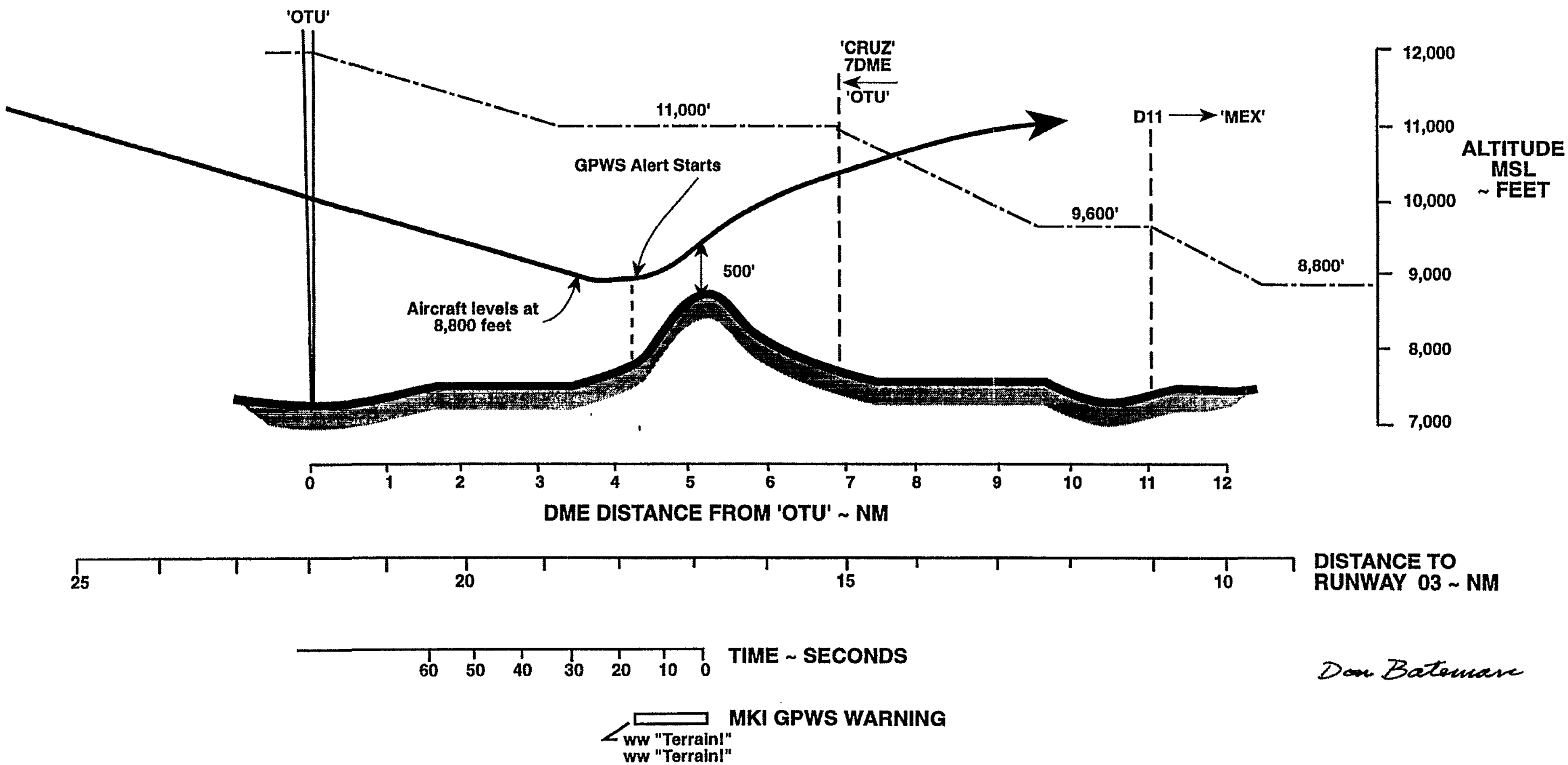
CIRCUMSTANCES: During initial approach, the aircraft was prematurally cleared to descend to 8,800 feet prior to reaching the 'Otumba' VOR. (Minimum Altitude was 11,000 feet) on reading the VOR, a Otumbar Two Arrival clearance was then given. A timely GPWS Warning occurred as the aircraft approached a 8,700 foot mountain . The pilots immediately climbed to 11,000 feet.

WEATHER: Clouds shrouded the high terrain.

OTHER: Possible language and mis-communication between controller and pilots

Flight Path Profile
A300
MEXICO CITY, MEXICO
September, 1991

INCIDENT



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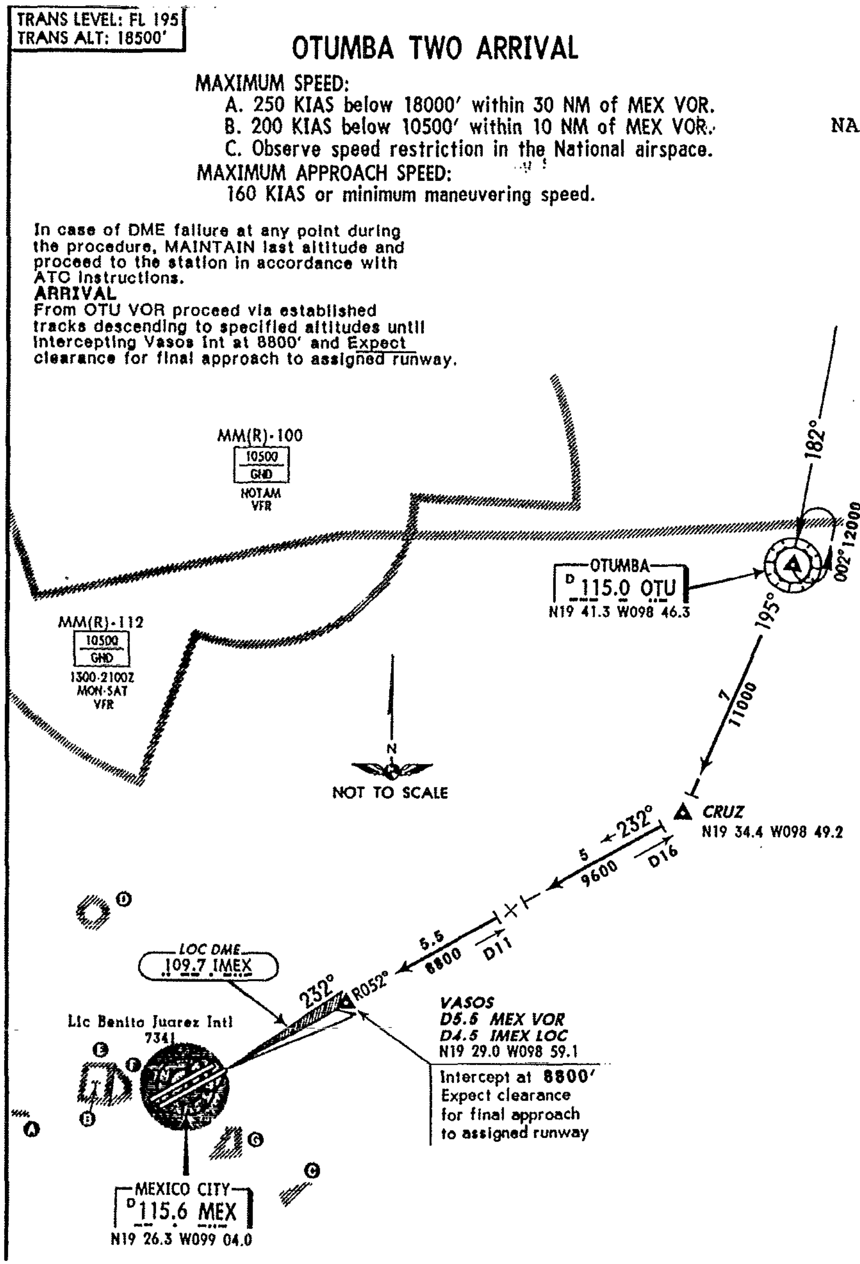


NARRATIVE : CLRED DIRECT OTU VOR. (NO FURTHER CLRNC OR EXPECTED ARR GIVEN.) CLRED TO DSND TO 8800 FT WHILE STILL N OF THE OTU VOR. APPROX OVERHEAD OTU VOR AT APPROX 10000 FT MSL, CLRED FOR THE OTU 1 ARR AFTER SWITCHED FROM MEXICO CENTER (126.6) TO APCH CTL. (I HAD THE ARR OUT IN FRONT OF ME. SINCE WE HAD BEEN CLRED DIRECT OTU VOR PREVIOUSLY, I ANTICIPATED THIS ARR, HAD LOOKED AT IT, AND PLACED IT ON THE YOKE CUPBOARD. I ALSO TOLD THE FO TO TAKE IT OUT.) AS I WAS TURNING OUTBOUND ON THE 195 DEG RADIAL OF OTU VOR, ATC ASKED IF WE WERE FAMILIAR WITH THE ARR. THE FO RESPONDED 'YES'. ATC ASKED, 'WHAT IS YOUR ALT?' FO RESPONDED 9600 FT CLBING UP TO 11000 FT. THE GND PROX WARNING SYS TERRAIN WARNING SOUNDED AND I IMMEDIATELY APPLIED MAX PWR AND EXECUTED A POSITIVE PULL-UP OUT OF THE DANGER ZONE TO ABOVE 10000 FT CLBING TOWARD 11000 FT. BY THIS POINT, WE WERE FLYING THE OTU 1 ARR AND ALREADY ESTABLISHED ON THE OTU VOR 195 DEG RADIAL OUTBOUND AND AT CRUISE (7 DME) TURNING R TO INTERCEPT THE MEX VOR 232 DEG COURSE INBOUND BACKED-UP WITH THE IMEX 232 DEG LOC. I NOW BEGAN DSNDING TOWARD 9600 FT AND CONTINUED THE OTU 1 ARR ON THE HIGH SIDE OF PUBLISHED ALTS UNTIL ESTABLISHED ON THE IMEX LOC/GS INBOUND. WHEN I WAS FIRST CLRED DIRECT TO OTU VOR AND ANTICIPATED/TOOK OUT THE OTU 1 ARR PLATE (ALSO TOLD FO TO TAKE OUT SAME PLATE), I DID NOT BRIEF 'IN-DEPTH' BOTH VERT AND LATERAL NAV PROCS AS I HAVE BEEN TRAINED TO DO OVER AND OVER AGAIN, ESPECIALLY SINCE WE WERE FLYING OUTSIDE UNITED STATES AIRSPACE. THUS, WHEN ATC (126.6) CLRED US TO DSND TO 8800 FT WHILE WE WERE STILL N OF OTU VOR, I SHOULD HAVE NEVER ACCEPTED ANY ALT CLRNC LOWER THAN 12000 FT. WE WERE BEHIND SCHEDULE (STARTED WHEN WE BEGAN DUTY DAY) AND I WAS TRYING TO MAKE UP SOME TIME, I PLANNED AND BEGAN DSCNT CLOSER IN TO MAINTAIN A HIGHER AIRSPD FOR AS LONG AS I COULD. I FOCUSED MORE ON LATERAL NAV AND RELIED ON ATC FOR VERT NAV SINCE I HAD HEARD THE 'MAGIC' WORDS 'RADAR CONTACT.' I ALLOWED MYSELF TO BECOME COMPLACENT AND TRUST ATC FOR VERT NAV. ONE MUST NEVER, EVER DO THIS WHILE FLYING ANYWHERE, ESPECIALLY OUTSIDE UNITED STATES AIRSPACE WHETHER IN RADAR CONTACT OR NOT.

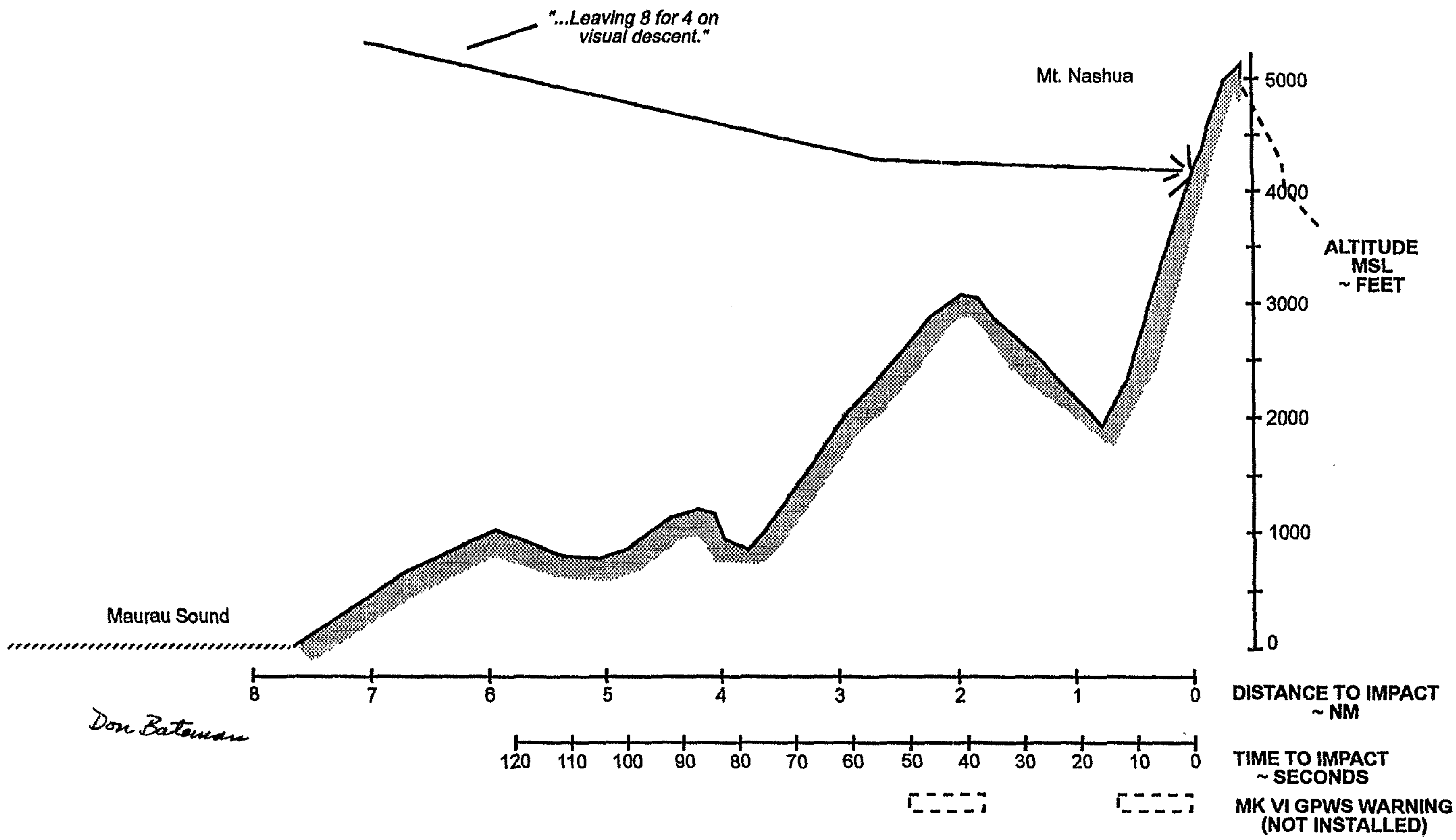
SUPPLEMENTAL INFO FROM ACN 188454: THE CLRNC FOR THE OTU 1 ARR SHOULD HAVE BEEN GIVEN BEFORE WE ARRIVED OVERHEAD OTU. SUPPLEMENTAL INFO FROM ACN 188682: THE PNF USUALLY CHKS ALL ALT AND XING RADIALS. THIS NIGHT IT DID NOT TAKE PLACE. WE MISSED THE MOUNTAIN PEAK ON J39-49 FROM OTU TO MEX BY LESS THAN 500 FT AGL. I FEEL THERE IS A LANGUAGE BARRIER ALSO. IT IS OFTEN HARD TO TELL WHAT AN ATC CTLR WANTS OR IS SAYING. HE MAY HAVE ACTUALLY CLRED US PROPERLY TO THE OTU 1 ARR, BUT THE WAY WE INTERPRETED IT WAS COMPLETELY DIFFERENT. OUR READBACK IN ENGLISH MAY HAVE BEEN MISUNDERSTOOD ALSO.

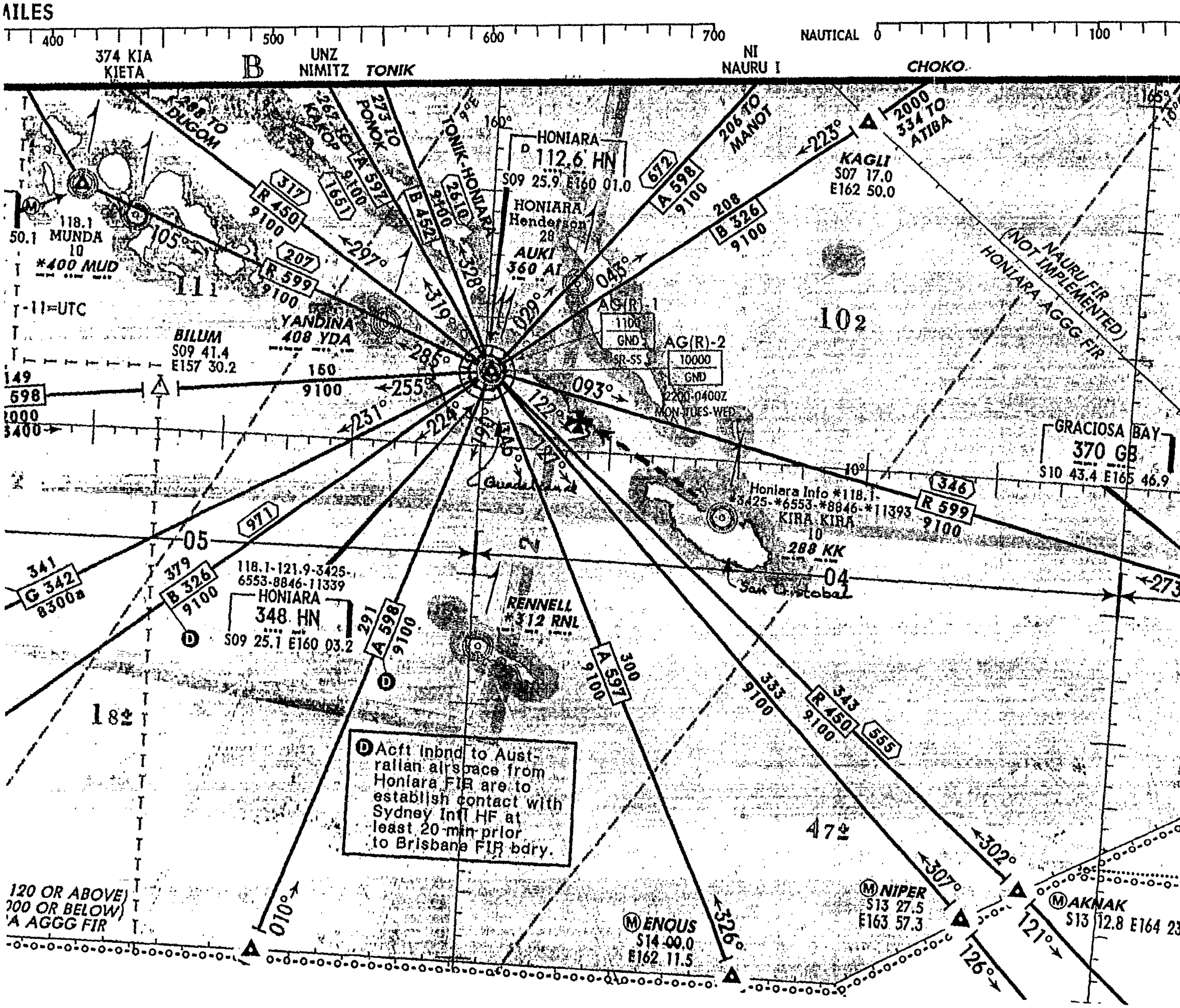
Next Page

Circumstances:	Aircraft flew into mountain 43 mm from Honiara while on visual flight rules in bound from San Cristobal Island.
Weather:	Heavy rain and cloud.
Time:	Day light
Fatalities:	15

No GPWS Installed

Flight Path Profile
DHC-6/310
GUADALCANAL, SOLOMONS
27 SEPTEMBER, 1991





NEWS IN BRIEF

SOLOMONS CRASH

A de Havilland Canada Twin Otter of Solomon Airlines, the Solomon Islands internal carrier, crashed with the loss of 15 lives on the southern tip of Guadalcanal island late last month. The aircraft, on a routine flight from San Cristobal to Guadalcanal, crashed into a jungle-covered mountain in bad weather and was found only after a three-day search.

FLIGHT INTERNATIONAL 9 - 15 October, 1991

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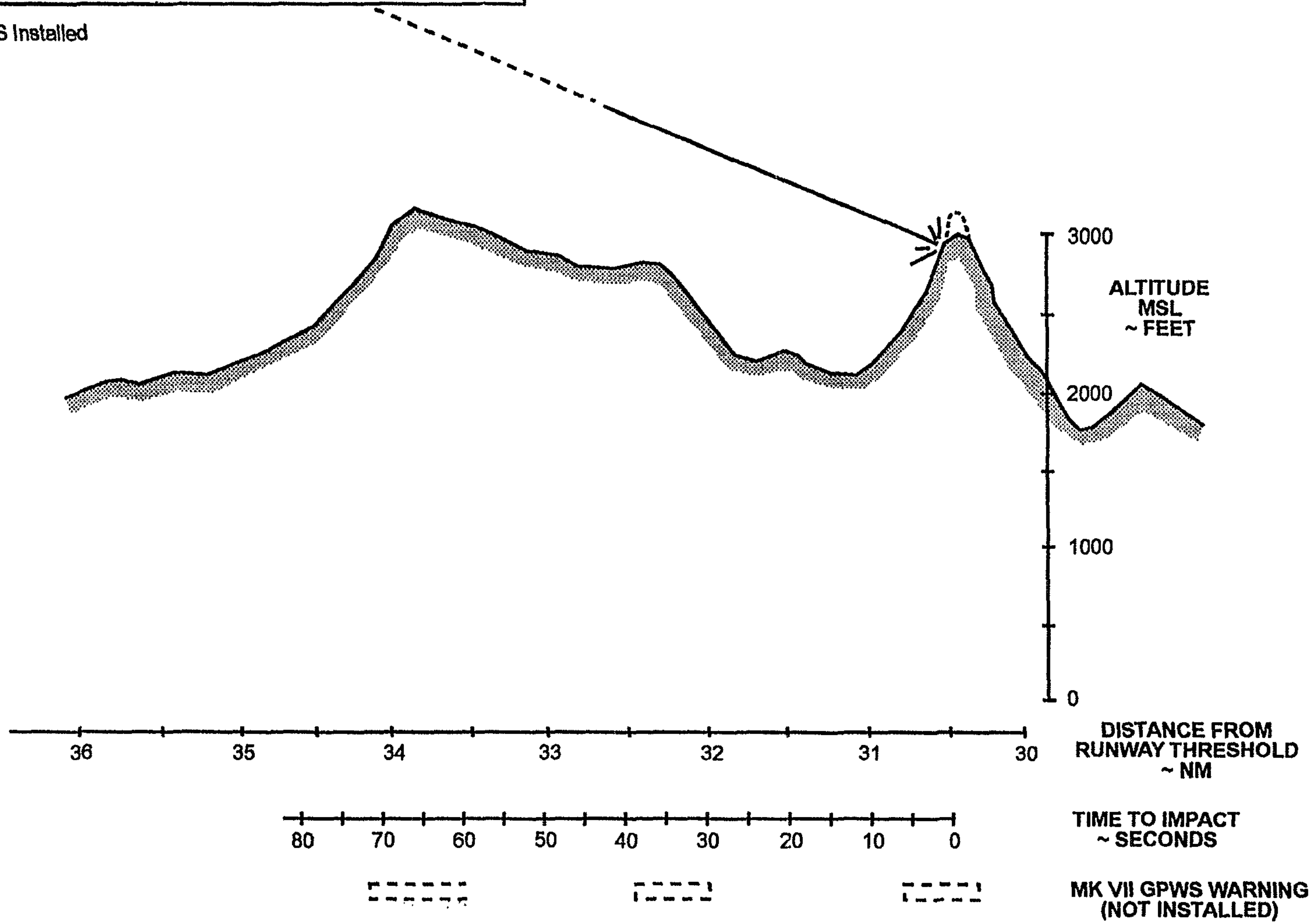
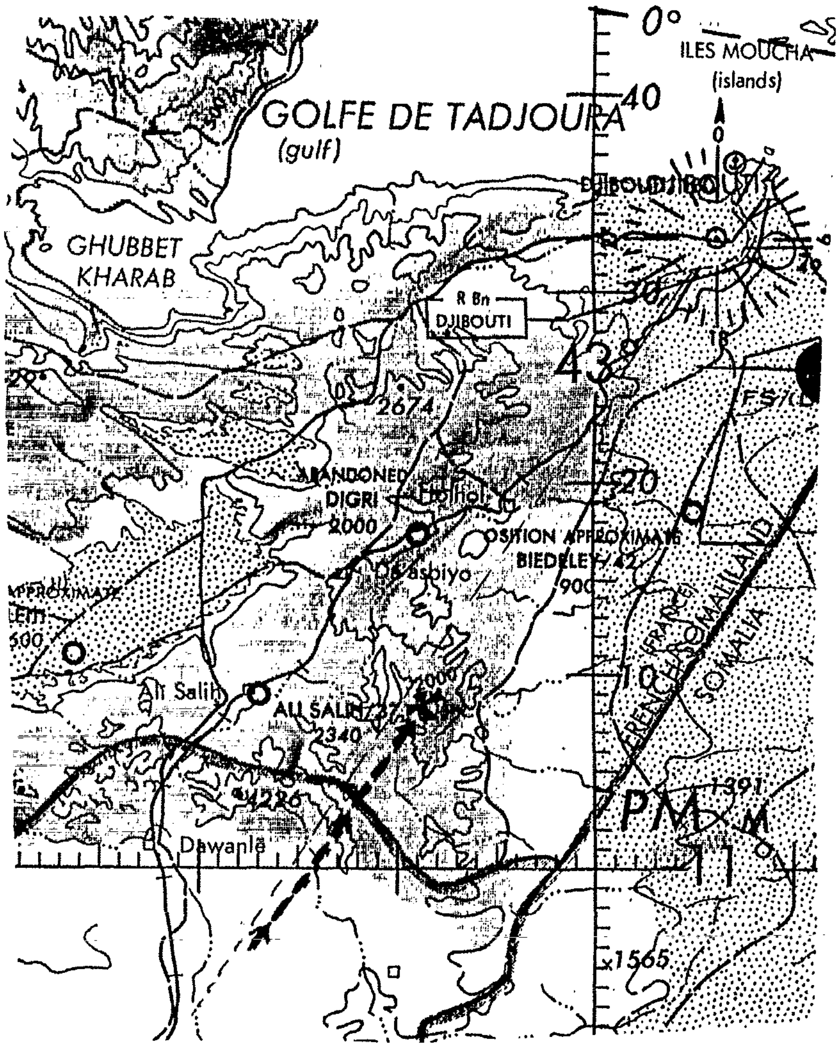
Flight Path Profile
L100-30
DJIBOUTI, AFRICA
17 SEPTEMBER 1991

Circumstances:	Aircraft prematurely descended too early and flew into side of Mt. Arey near the summit on approach to Djibouti.
Weather:	Poor. Mountain shrouded in cloud
Configuration:	Clean
Fatalities:	4
Other:	Aircraft flying food and relief supplies on behalf UN World Food Program Aircraft had diverted from flight to Dire Dawa from Djibouti, back to Djibouti, because of weather.

No GPWS Installed

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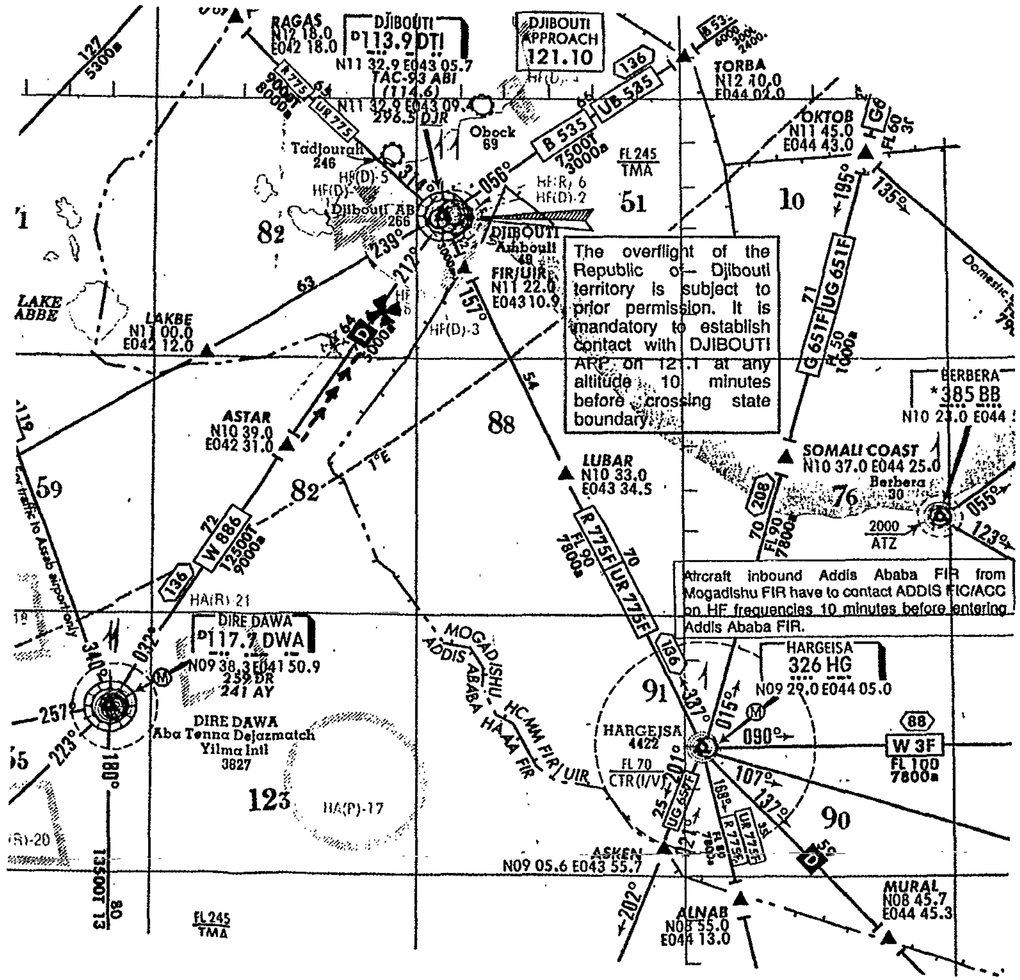
(gulf)
ILES MOUCHA
(islands)
GHUBBET
KHARAB
DJIBOUTI
R Bn
DJIBOUTI
ABANDONED
DIGRI
2000
POSITION APPROXIMATE
BIEDELEY
Ali Salih
ALI SALIH
Dawanlé
FRENCH SOMALILAND
SOMALIA


RAGAS
DJIBOUTI
113.9 DTI
DJIBOUTI
APPROACH
121.10
TORBA
OKTOB
Tadjourah
Obock
LAKBE
ASTAR
LUBAR
SOMALI COAST
BERBERA
385 BB
The overflight of the Republic of Djibouti territory is subject to prior permission. It is mandatory to establish contact with DJIBOUTI ARP on 121.1 at any altitude 10 minutes before crossing state boundary.
Aircraft inbound Addis Ababa FIR from Mogadishu FIR have to contact ADDIS FIC/ACC on HF frequencies 10 minutes before entering Addis Ababa FIR.
DIRE DAWA
117.7 DWA
DIRE DAWA
Aba Tenna Dejazmatch
Yilma Intl
HARGEISA
326 HG
HARGEISA
ASKEN
ALNAB
MURAL
LAKE ABBE

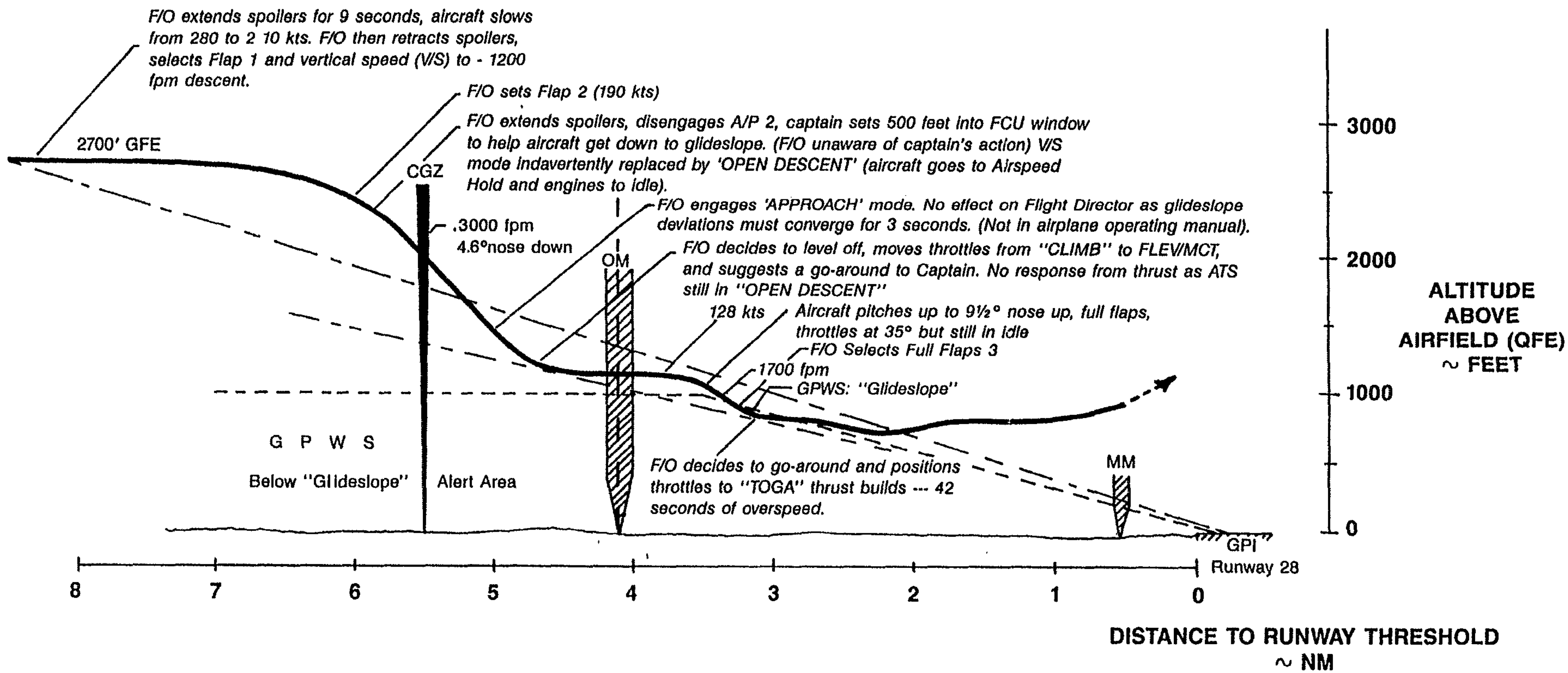
Next Page

Circumstances: Incident . Aircraft inadvertently mishandled on ILS 28 approach to Charles de Gualle airport by use of auto-flight controls. The result was an unstabilized approach, eventual go-around and the maximum flap speeds exceeded by some 38 kts. F/O flying. Crew actions not co-ordinated.

Weather: 8/8 at 500 feet.

Time: Night.

Autoflight Incident
FLIGHT PATH PROFILE
A320
PARIS, FRANCE
15 September 1991



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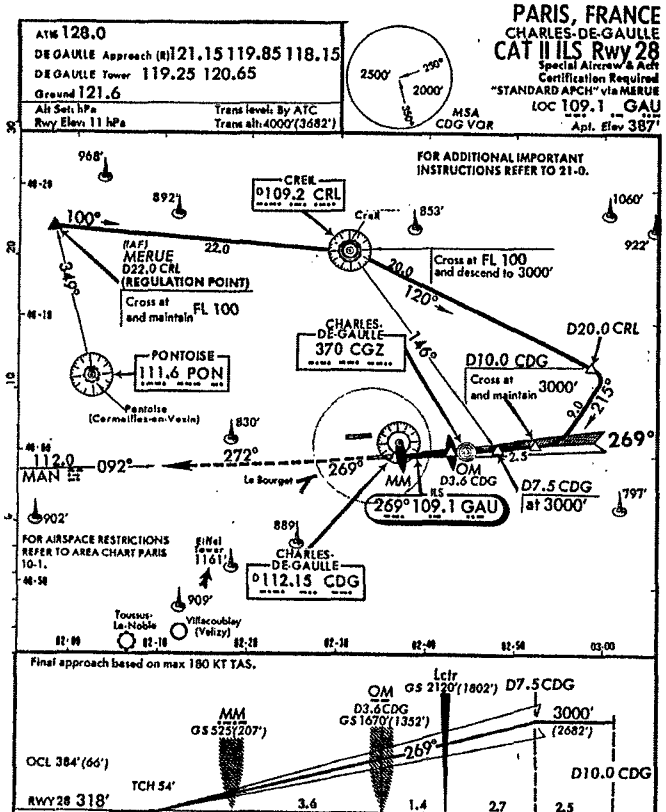

MISSED APPROACH: Climb STRAIGHT AHEAD to 3000'(2682'), then intercept and follow R-092 (272°) inbound to MAN VOR.

STRAIGHT-IN LANDING RWY 28
CAT II ILS

	RA 104' DH 418'(100')	RA 154' DH 468'(150')
A, B, C*	RVR 350m at TDZ, RVR 175m at midpoint	RVR 500m at TDZ, RVR 250m at midpoint
D	RVR 400m at TDZ, RVR 200m at midpoint	

Gnd speed-Kts	70	90	100	120	140	160
GS 3.00°	377	484	538	646	753	861

*ACFT with speed (1.3 Vso) above 135 KT use D minimums.

Circumstances:	Aircraft hit at 4000 feet level of Crocker Range, some 30 mm south of runway 02, during initial approach. Inappropriate descent clearances from ATC. ATC distracted working inbound airliner.
Weather:	Terrain shrouded in layered clouds.
Fatalities:	12

FLIGHT PATH PROFILE

Gulfstream II
Kota Kinabalu, Malaysia
4 Septemper, 1991

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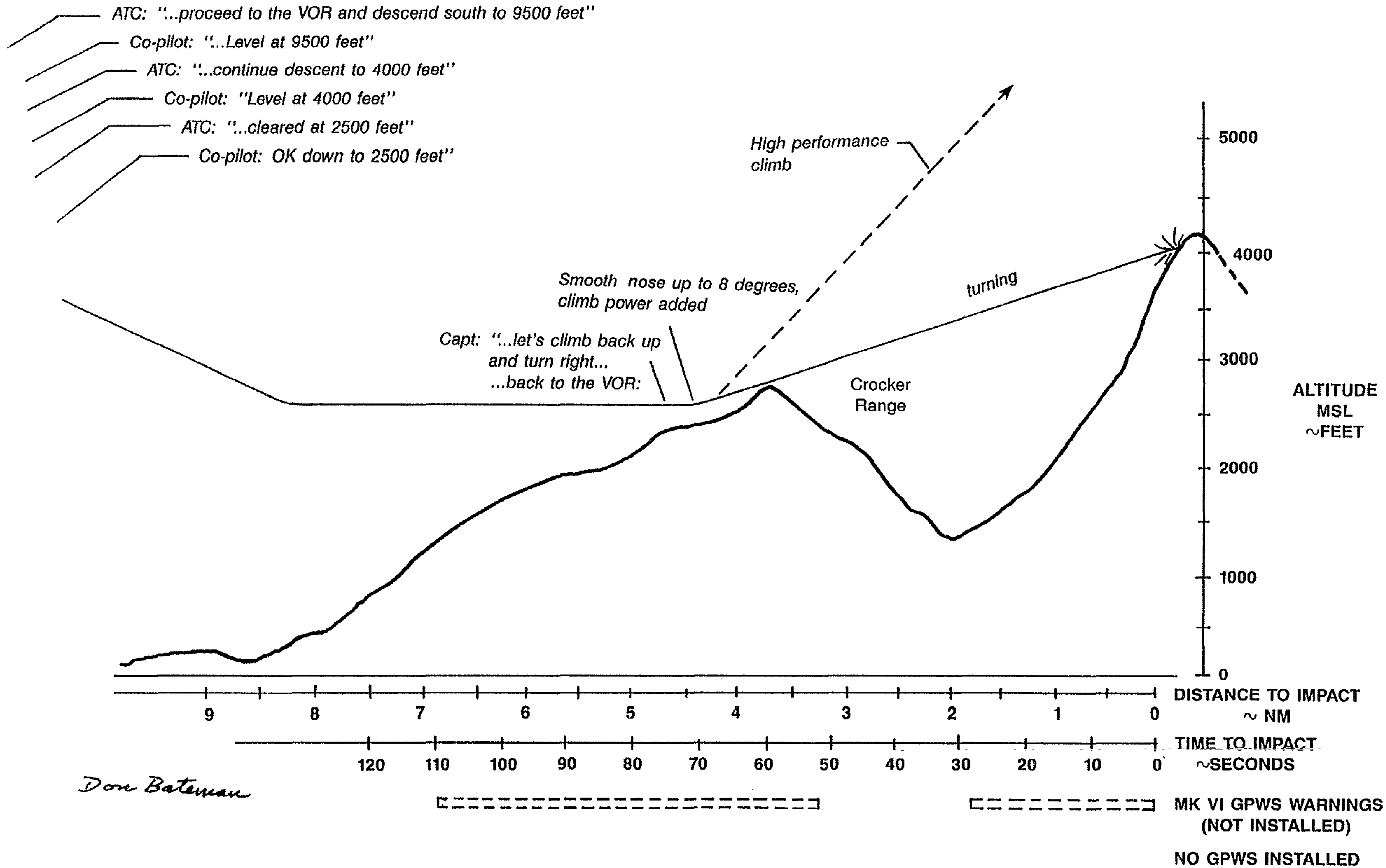
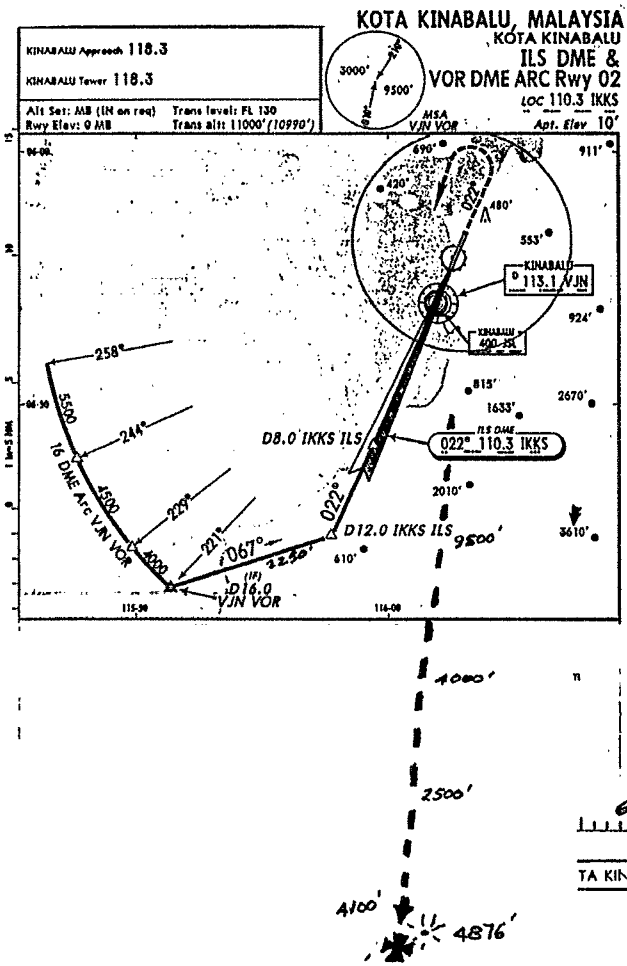
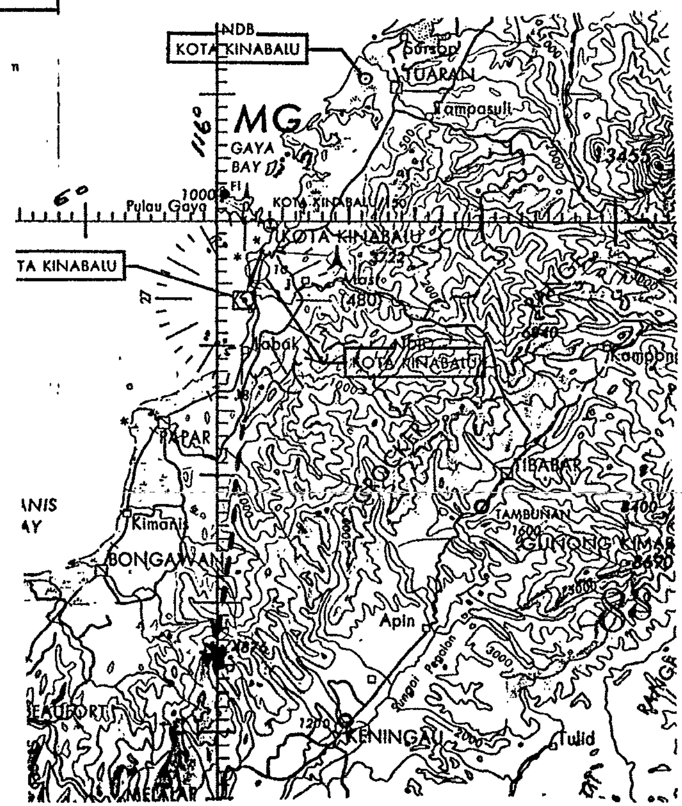


Don Bateman

Return to TOC





A 2 The Seattle Times Friday, September 6, 1991

Crashed jet found in Malaysia

KUALA LUMPUR, Malaysia – Searchers combing thick jungle today found the wreckage of a jet carrying 12 people, including U.S. and British oil executives and their wives. Officials said there appeared to be no survivors. The jet, owned by Conoco Inc. of Houston, Texas, disappeared from radar Wednesday as it prepared to land in Kota Kinabalu on the island of Borneo for refueling on its way from Tokyo to Jakarta, Indonesia. The wreckage of the Grumman Gulf Steam 2 was found 910 miles east of Kuala Lumpur.

Oregonian Sept 7, 1991

SEPT 4, 1991

All believed dead on U.S. jet that crashed in Malaysia

KUALA LUMPUR, Malaysia — Rescuers on Friday found the wreckage of a corporate jet carrying 12 persons — nine of them Texas oil executives and spouses, plus a crew of three. Officials said apparently no one survived.

The jet, owned by Conoco Inc. of Houston, disappeared from radar Wednesday as it prepared to land in Kota Kinabalu on the island of Borneo for refueling en route to Jakarta, Indonesia, from Tokyo.

The wreckage of the Grumman Gulfstream II was found 30 miles south of Kota Kinabalu, said Stanley Harsha, U.S. Embassy spokesman in Kuala Lumpur. He said the plane had crashed into the Crocker mountain range at an altitude of 4,500 feet.

Conoco's president, Constantine Nicandros, said, "The plane turned and ran into the mountain. Why ... we just don't know."

The company identified those on the jet as William K. Dietrich, 53; his wife, Gayle, 54; Colin H. Lee, 55, and his wife, Brooke, 53; H.K. "Kent" Bowden, 57, and his wife, Connie, 56; James Myers, 50, and his wife, Linda, 41; and Ann K. Parsons, 35. The crew was identified as pilots Kenneth R. Fox, 46, and Gary Johnston, 55, and mechanic Steve P. James, 40. All were from Houston.

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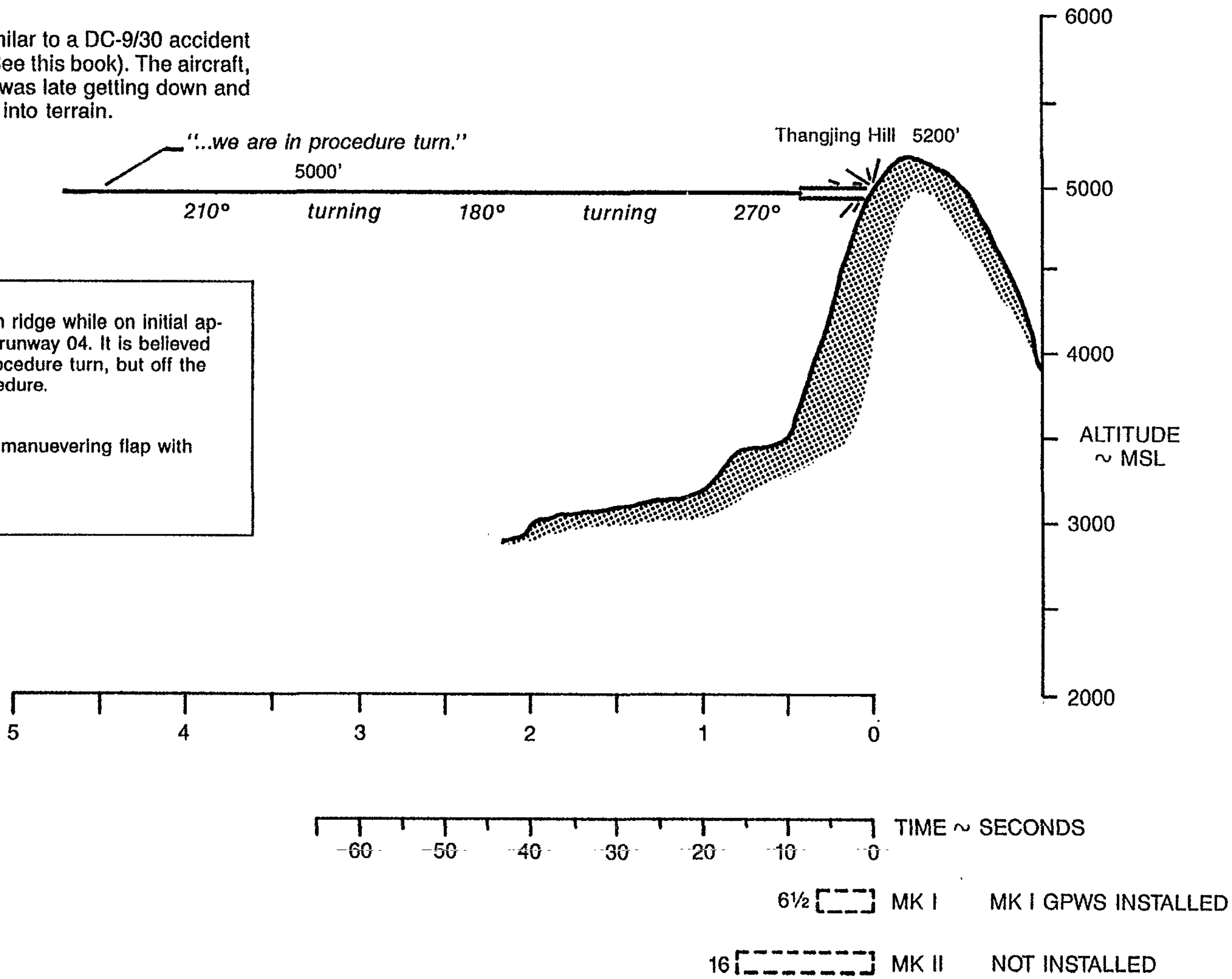
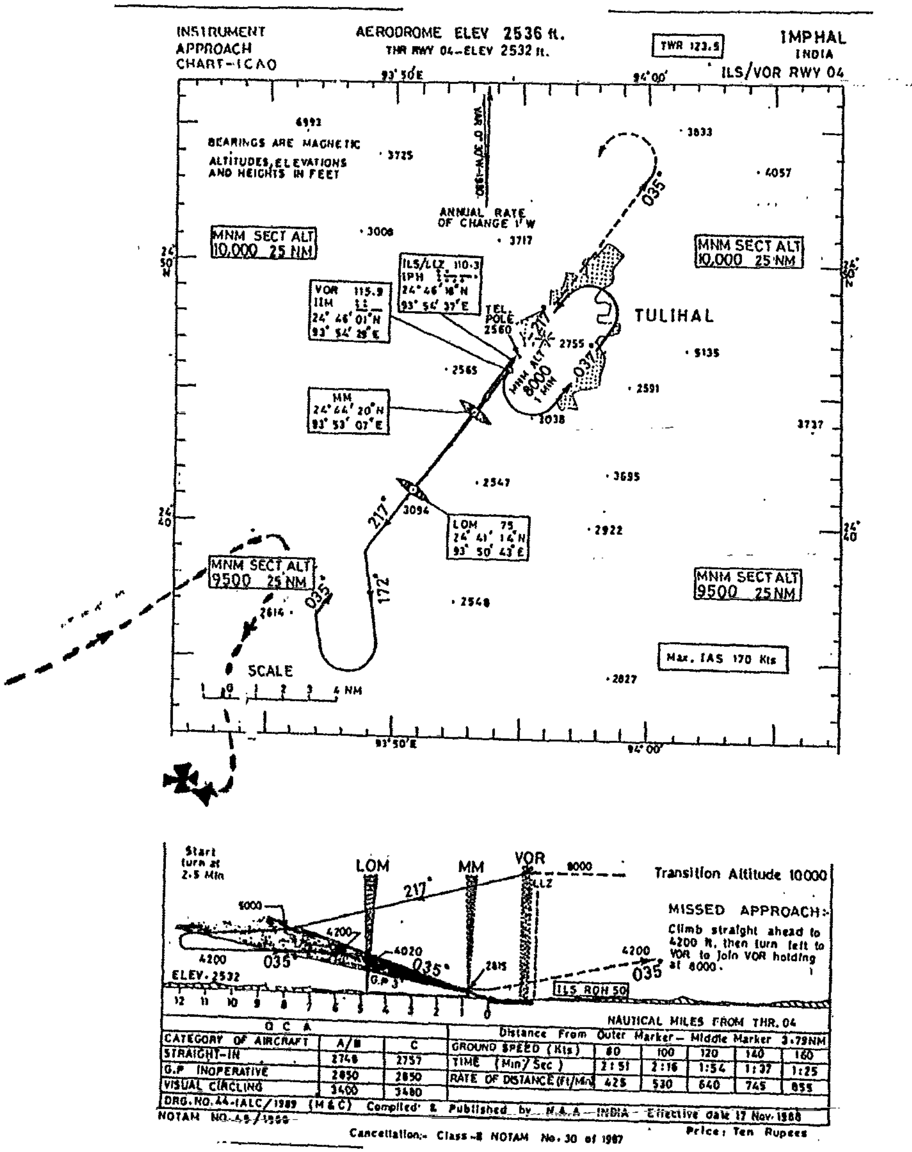
FLIGHT PATH PROFILE
B737-200
Imphal, India
16 August 1991

This accident appears to be very similar to a DC-9/30 accident on 20 June 1973 at Puerto Vallarta (See this book). The aircraft, also with *no* DME or ATC radar aid, was late getting down and fast which took it off the procedure into terrain.

Circumstances:	Aircraft hit mountain ridge while on initial approach to ILS/VOR runway 04. It is believed aircraft was in a procedure turn, but off the bounds of the procedure.
Weather:	IMC
Configuration:	Believed to be in a manuevering flap with landing gear up.
Fatalities:	69



Don Bateman



A2 The Seattle Times	Friday, August 16, 1991

Rescuers find no survivors in Indian plane crash

NEW DELHI, India - Rescue workers struggled through dense jungle and driving rain to a hill in northeast India where an Indian Airlines Boeing 737 crashed, but found no survivors among the 69 people aboard, officials said today.

All 63 passengers and six crew members aboard the plane, on a flight from Calcutta to Imphal, were Indian, airline officials said.

They suspect something was wrong with the instrument landing system guiding the plane through the clouds to the airport, whose control tower lost radio contact with the Boeing just two or three minutes before it was due to land yesterday.

Journal American

Briefly

Compiled from JA news services

Bodies recovered

Associated Press

Workers trek through the jungle across a makeshift bridge on Sunday, bearing the charred bodies of most of the passengers from a jetliner that slammed into a mountain in eastern India. Sixty-three passengers and six crew members were on board the Indian Airlines Boeing 737-200 when it crashed in hilly jungle terrain on Friday, 27 miles short of its destination of Imphal. There were no survivors. There has been no official word on the cause of the accident.

FLIGHT PATH PROFILE
G-II
Caracas, Venezuela
17 June, 1991

CIRCUMSTANCES:	During an improvised instrument approach to runway 10, the aircraft impacted terrain 5 NM short of the runway. The glideslope was inoperative for ILS DME runway 10. There is no approved localizer only approach because of terrain. The appropriate approach was VOR DME runway 10, which would have ensured terrain clearance. The captain however, preferred the 'precision' of a localizer approach over that of a VOR radial. The captain improvised letdown altitude instructions to the flying co-pilot from 'Guare' (10.7 DME) inbound on the localizer.
TIME:	22:00 EDT (night)
WEATHER:	30 ⊕ , light rain IMC, 300/3 miles, wind calm, altimeter 0118
CONFIGURATION:	Gear down, approach flaps
FATALITIES:	4
OTHER:	Aircraft fitted with an operating Voice/Terrain Advisory System ('Talking Altimeter'), but no GPWS. 'Talking Altimeters' are heard repeatedly on every approach. Captain in right seat.

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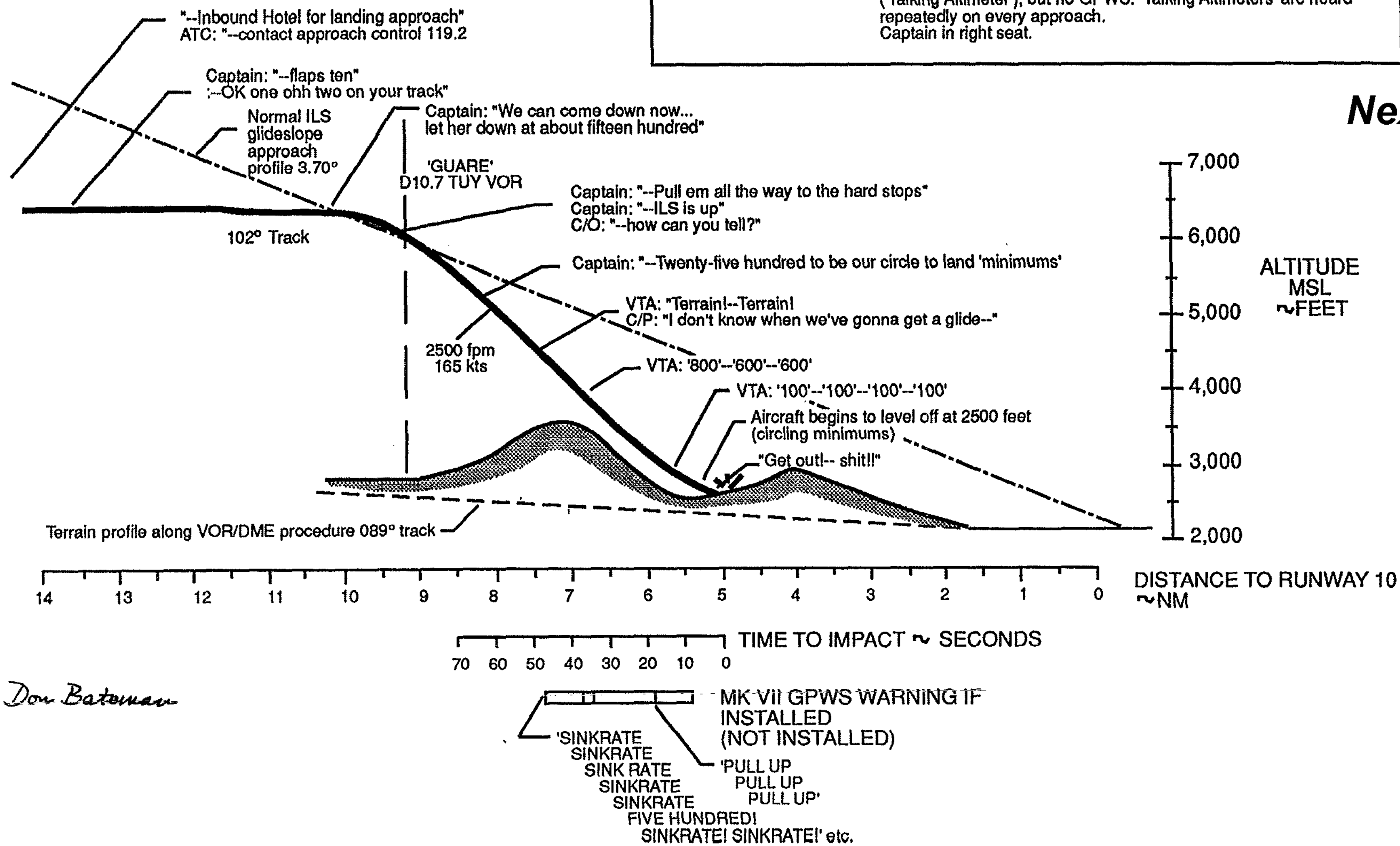
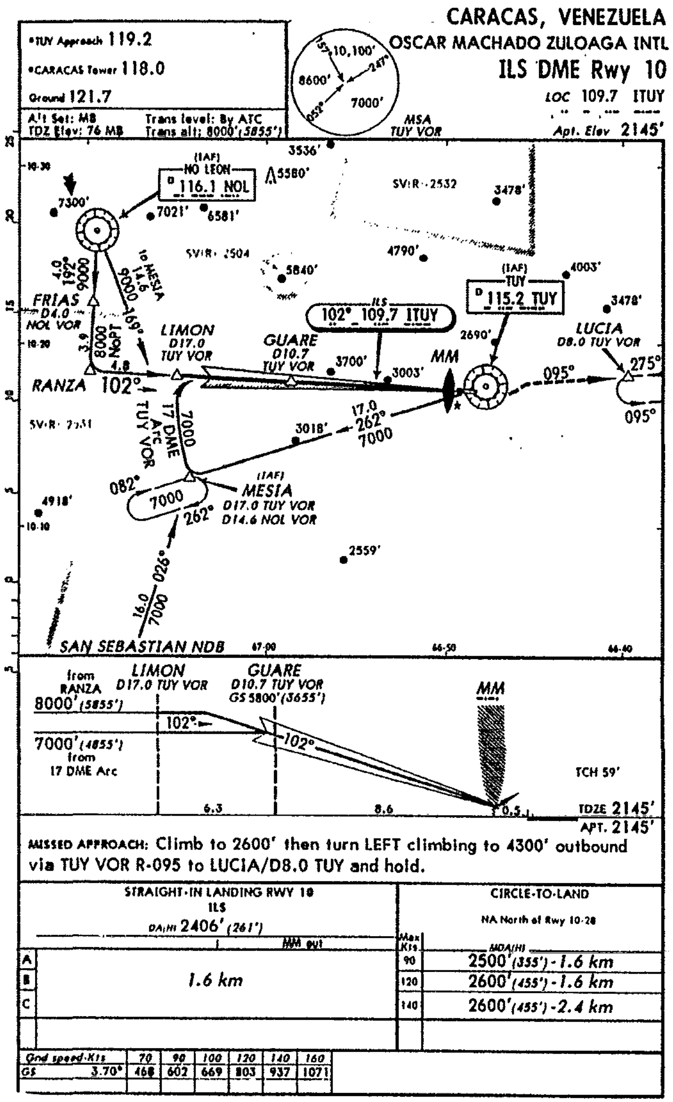
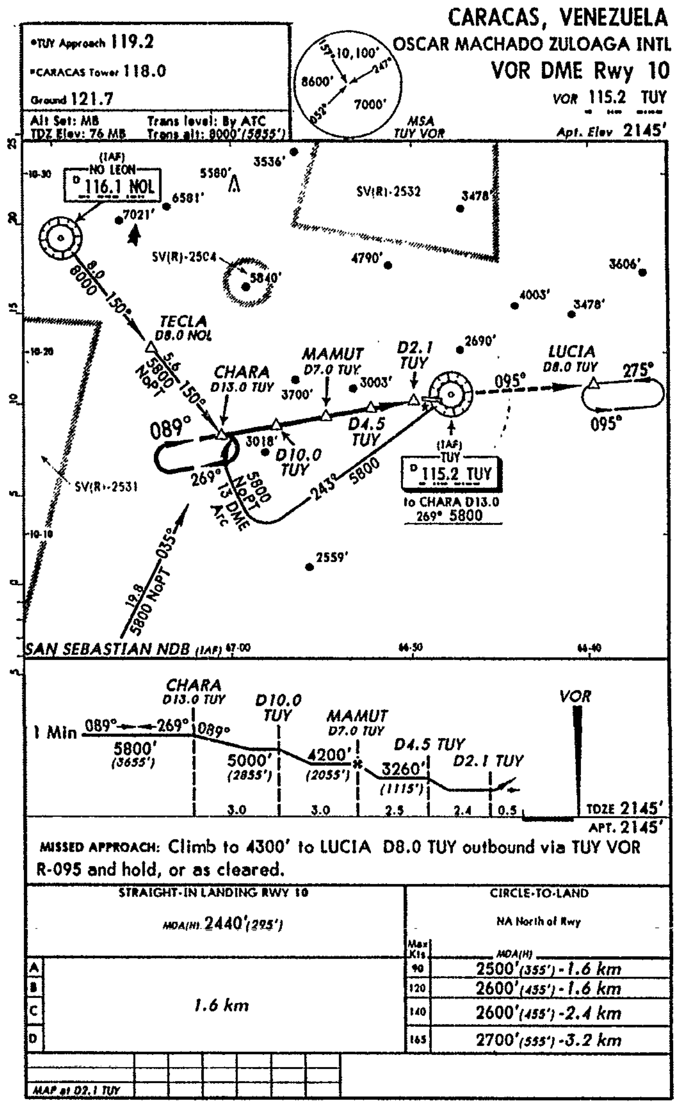


Don Bateman

Return to TOC





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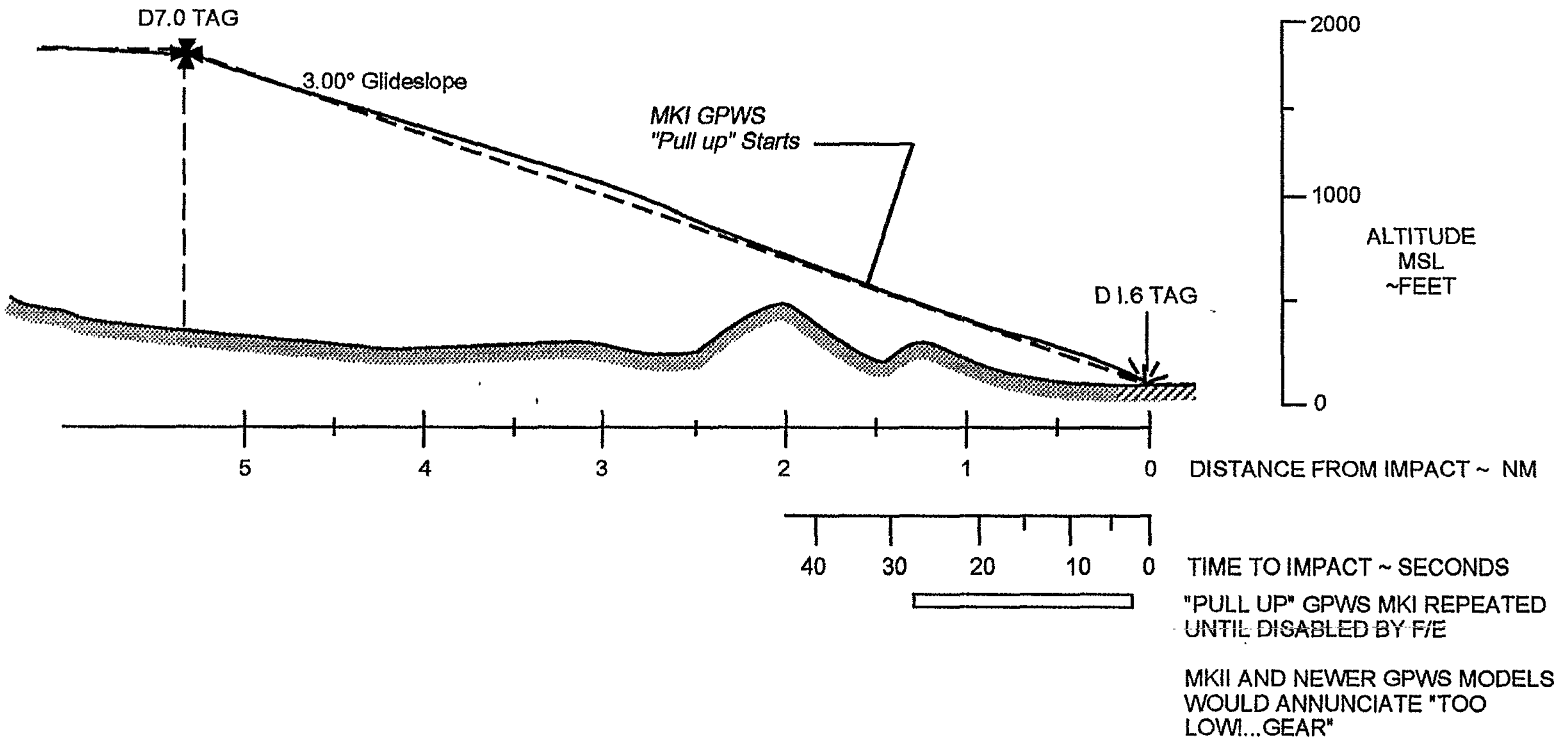
FLIGHT PATH PROFILE
B727-200
Taegu AB, Korea
13 June, 1991

Circumstances:	Aircraft inadvertently landed with all landing gear retracted. F/O, seated in Captain's seat gave order for "Gear down". Captain, seated in F/O's seat and flying aircraft, assumed F/O was stating gear was down. Check list interrupted by communications and never completed. Flaps were left in 25. However, F/E believed GPWS "Pull up" was caused by flaps not in landing position. F/E tried to use the "Flap override" to silence warning to no avail. F/E eventually pulled GPWS circuit breaker. The configuration warning was (routinely) silenced. Tower radioed "Go around" using wrong aircraft call sign.
Time:	18:45 local
Damage:	Substantial - Aircraft later scrapped
Other:	MKI GPWS installed. "Pull up" warning only. MKII and on, identify cause of GPWS warning. See: London B747 incident July 1987



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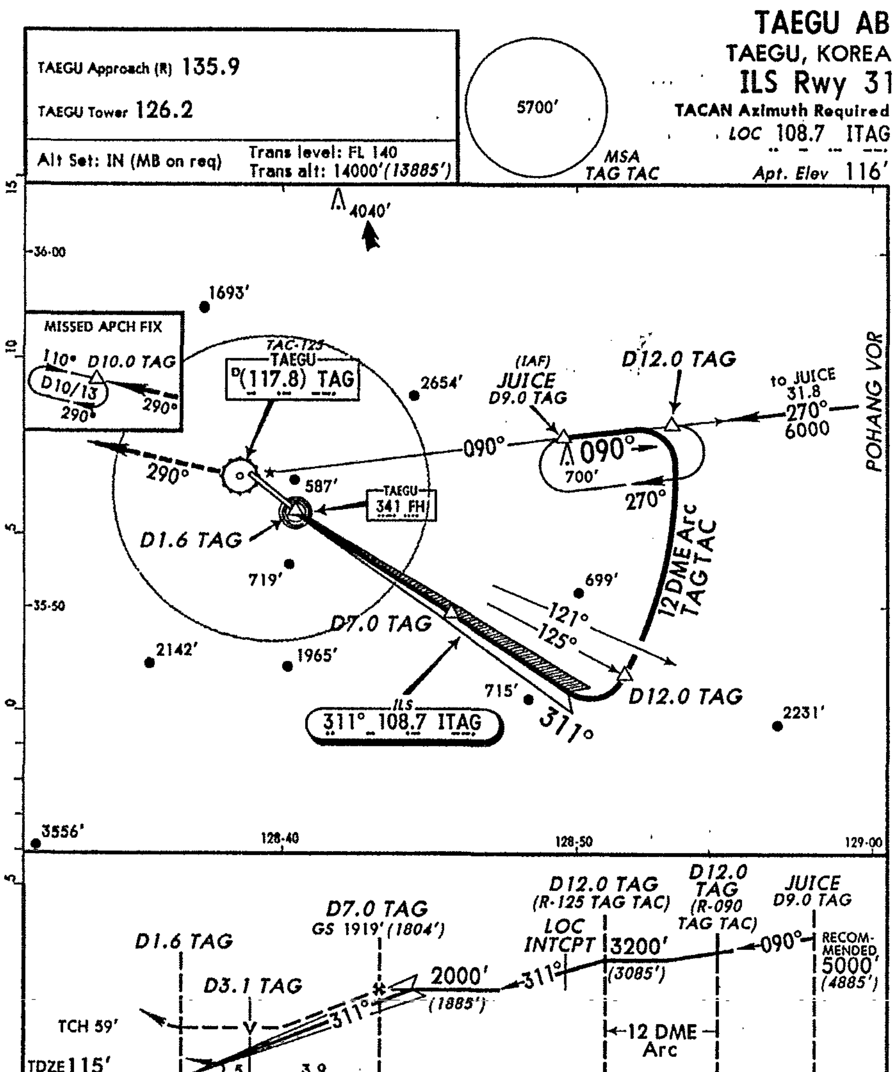


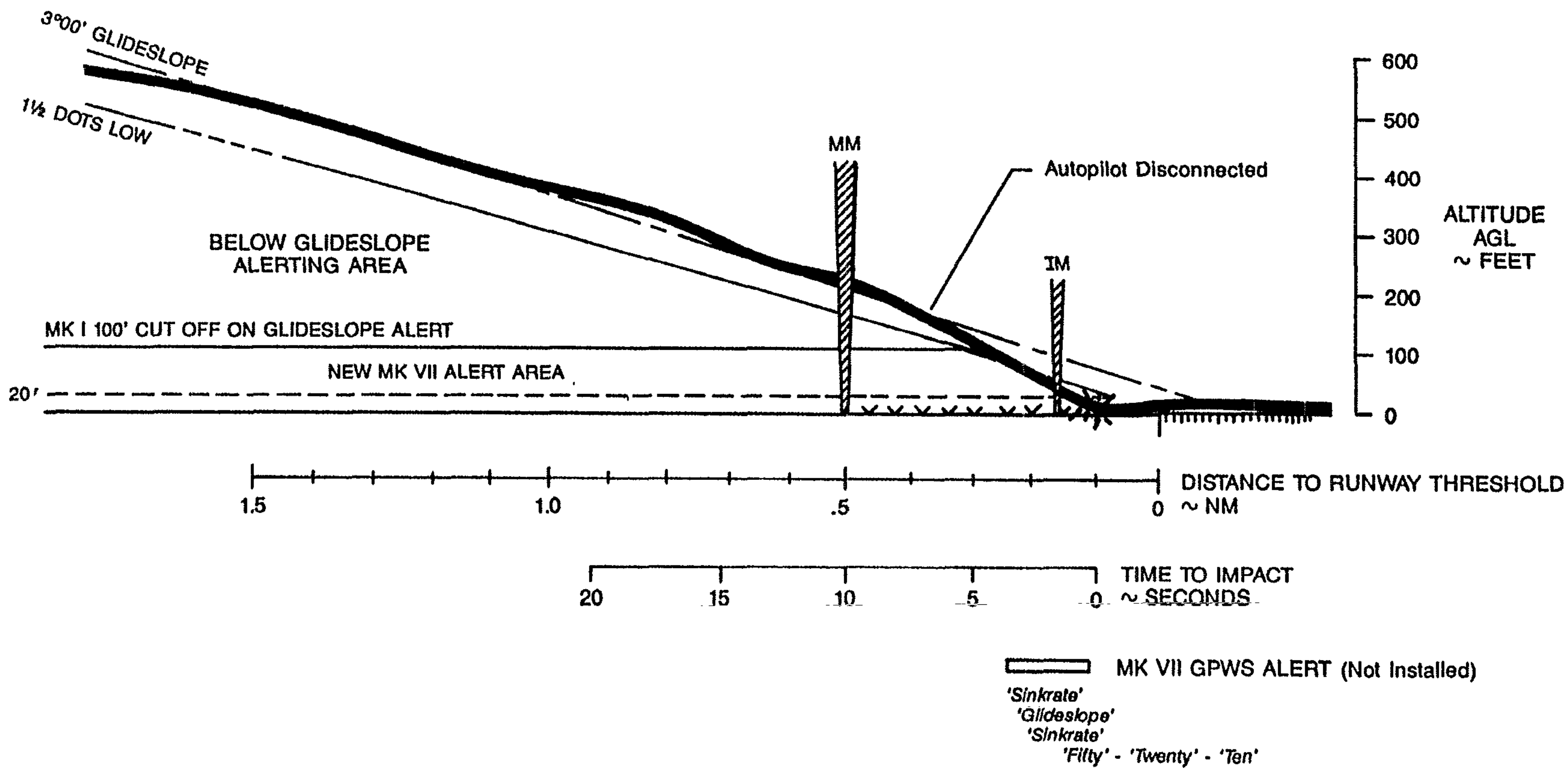
MISSED APPROACH: Climb STRAIGHT AHEAD to TAG TAC, then turn LEFT, climb outbound on TAG TAC R-290 to 5000' and hold at D10.0 TAG.

STRAIGHT-IN LANDING RWY 31		CIRCLE-TO-LAND
ILS	LOC (GS out)	
DA(H) 315' (200')	MDA(H) 640' (525')	NA Northeast of Rwy 13-31

Next Page

Circumstances:	Aircraft undershot the runway 02L threshold by 400 feet, bouncing out of the approach lights onto the runway. Aircraft had been flown on autopilot to 150-200 feet AGL.
Weather:	CAT II, RVR 1200 on start of final but deteriorated to RVR 700. Winds calm.
Configuration:	Landing
Damage/Injuries:	No injuries to 132 passenegers and 6 crew but damage to trailing edge flaps, aft fuslage, engine cowlings and tires.
Other:	Airline recommends that autopilot remain coupled to 80 feet AGL. Captain had flown very few CAT II approaches over previous year. MK I GPWS installed but *No Warning.*

FLIGHT PATH PROFILE
B727-200
Nashville, Tennessee
15 May, 1991



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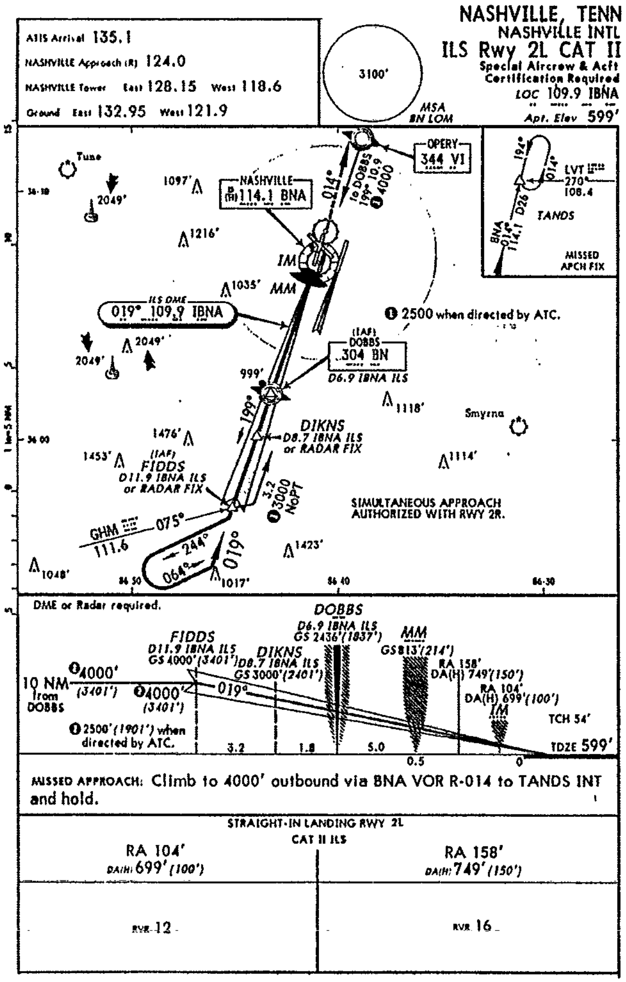

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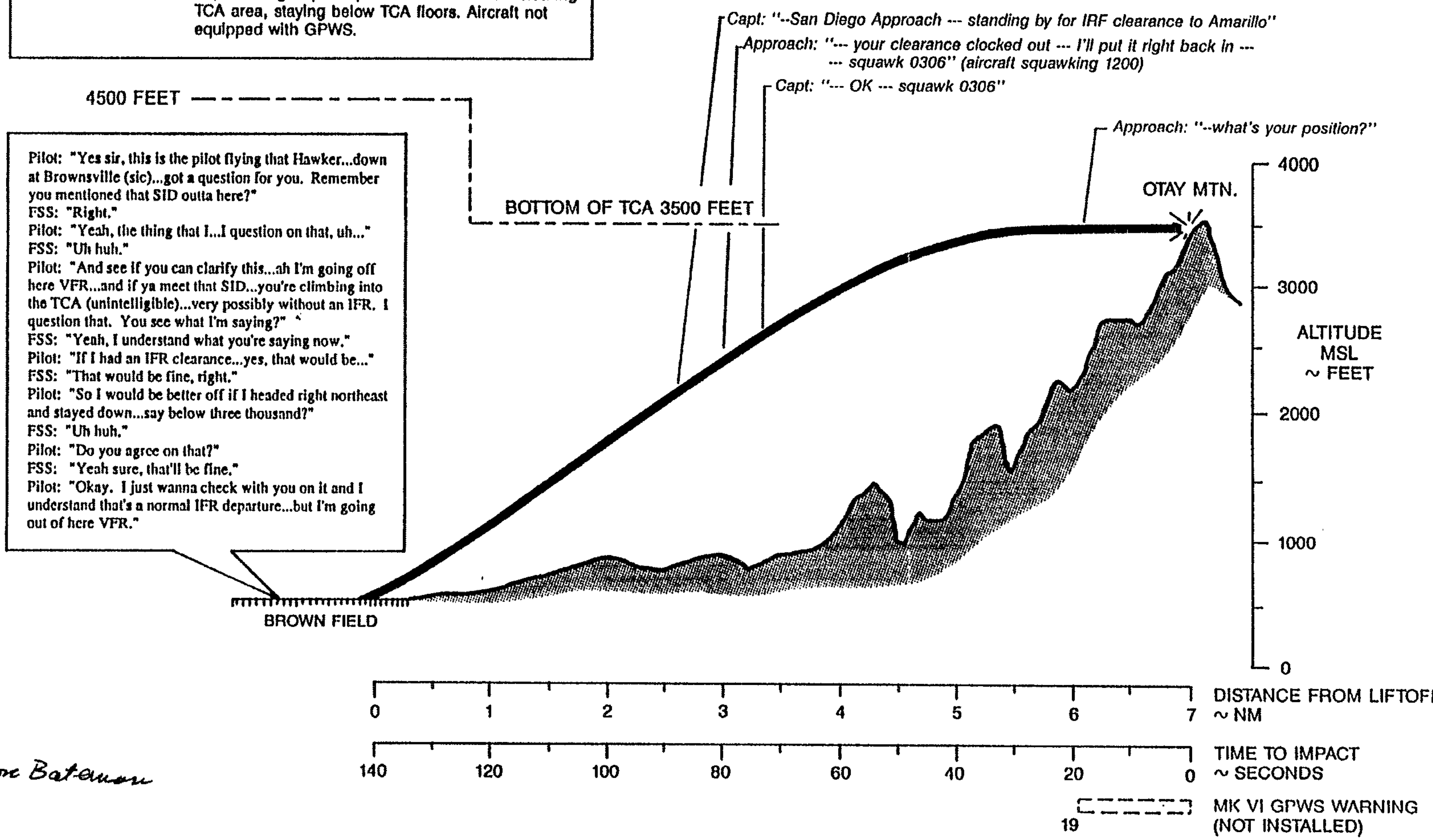
Circumstances:	Charter aircraft took off runway 8L bound for Amarillo, Texas, leveled off at 3500 feet to remain VFR below TCA to avoid San Diego ATC departures, and flew into mountain.
Time:	01:45 a.m., night
Weather:	VMC clear, visibility 10 miles
Configuration:	Clean
Fatalities:	10
Other:	Professional crew, but intimidated by ATC and uncertainties on how to depart IFR with tower closed, deciding to pick-up IFR clearance after clearing TCA area, staying below TCA floors. Aircraft not equipped with GPWS.

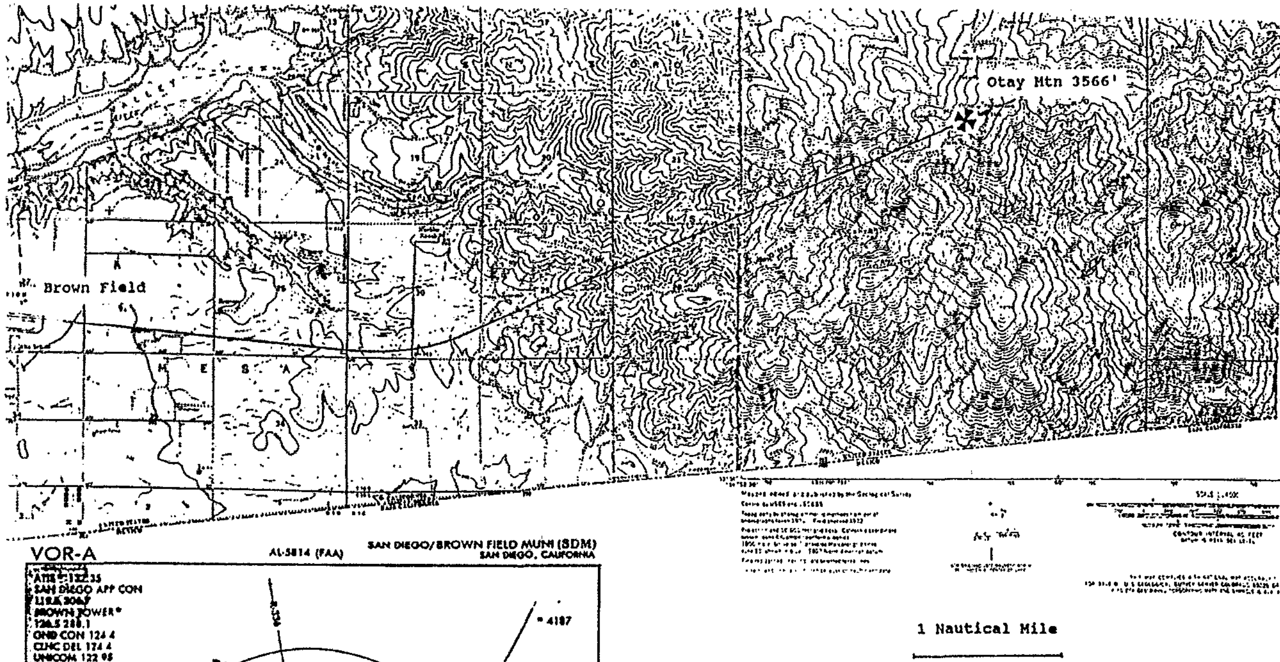
FLIGHT PATH PROFILE
HS-125
Brown Field, California
15 March 1991

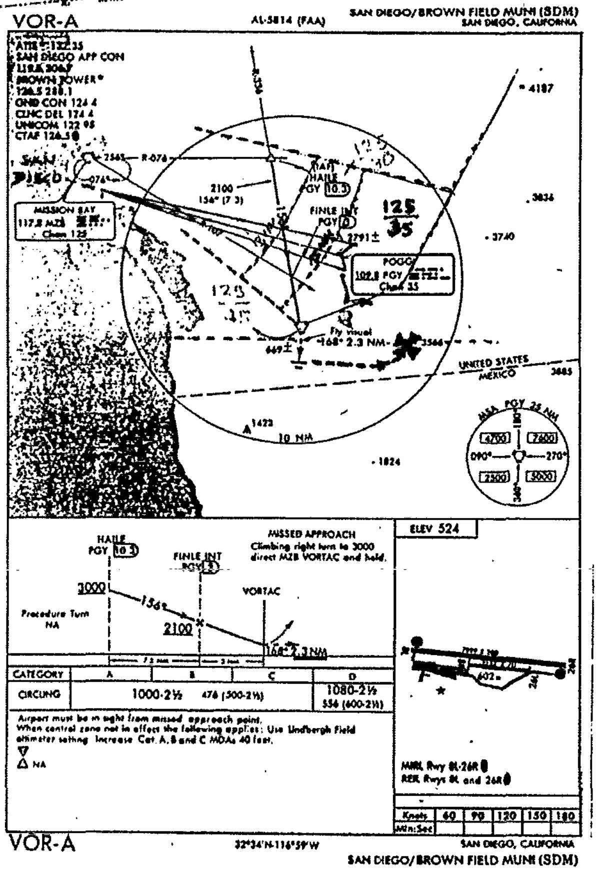


Don Bateman

REV

Return to TOC





Seattle Times 03/16/91

Plane carrying McEntire's band crashes; 10 killed

OTAY, Calif. — Seven members of country-western singer Reba McEntire's band, along with her road manager and two pilots, were killed when a private plane crashed in a mountain area about 25 miles southeast of San Diego about 1:45 a.m. yesterday.

McEntire was not aboard. There were no survivors. Those on the plane included tour manager Jim Hammon, band leader Kirk Cappello, who played keyboard, vocalist Paula Kaye Evans, guitarists Michael Thomas and Terry Jackson, keyboardist Joey Cigainero, drummer Tony Saputo and Chris Austin, a vocalist who played fiddle and guitar.

McEntire, 35, and her band had performed in San Diego Friday night. The singer had stayed behind in San Diego and was going to take another flight yesterday. McEntire's hit records include "Whoever's in New England," "Little Rock," "Walk On" and "Rumor Has It."

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FLIGHT PATH PROFILE
DC-9/30
Santa Barbara, Venezuela
5 March, 1991

Circumstances: Aircraft apparently departed Maracaibo on an incorrect radial or airway for a ~150 nm flight to Santa Barbara. On initial descent, the aircraft was ~80 nm east of Santa Barbara. A GPWS (MKI) "Pullup" warning occured. A pullup escape recovery was initiated within 2 seconds of the GPWS warning. A good rotation rate (2°/second) produced 2 *g*'s and a probable nose up attitude of 25°. Full climb power was applied producing ~6500 fpm climb. After the GPWS warning ceased, the attitude was lowered to ~12° and a right turn initiated. The climb rate dropped the 2000 fpm. The aircraft turning into higher terrain, impacted about 100 feet below the crest of the ridge. Probable contributing factors to the navigation error were complacency, distraction, unintentedness and assumptions.

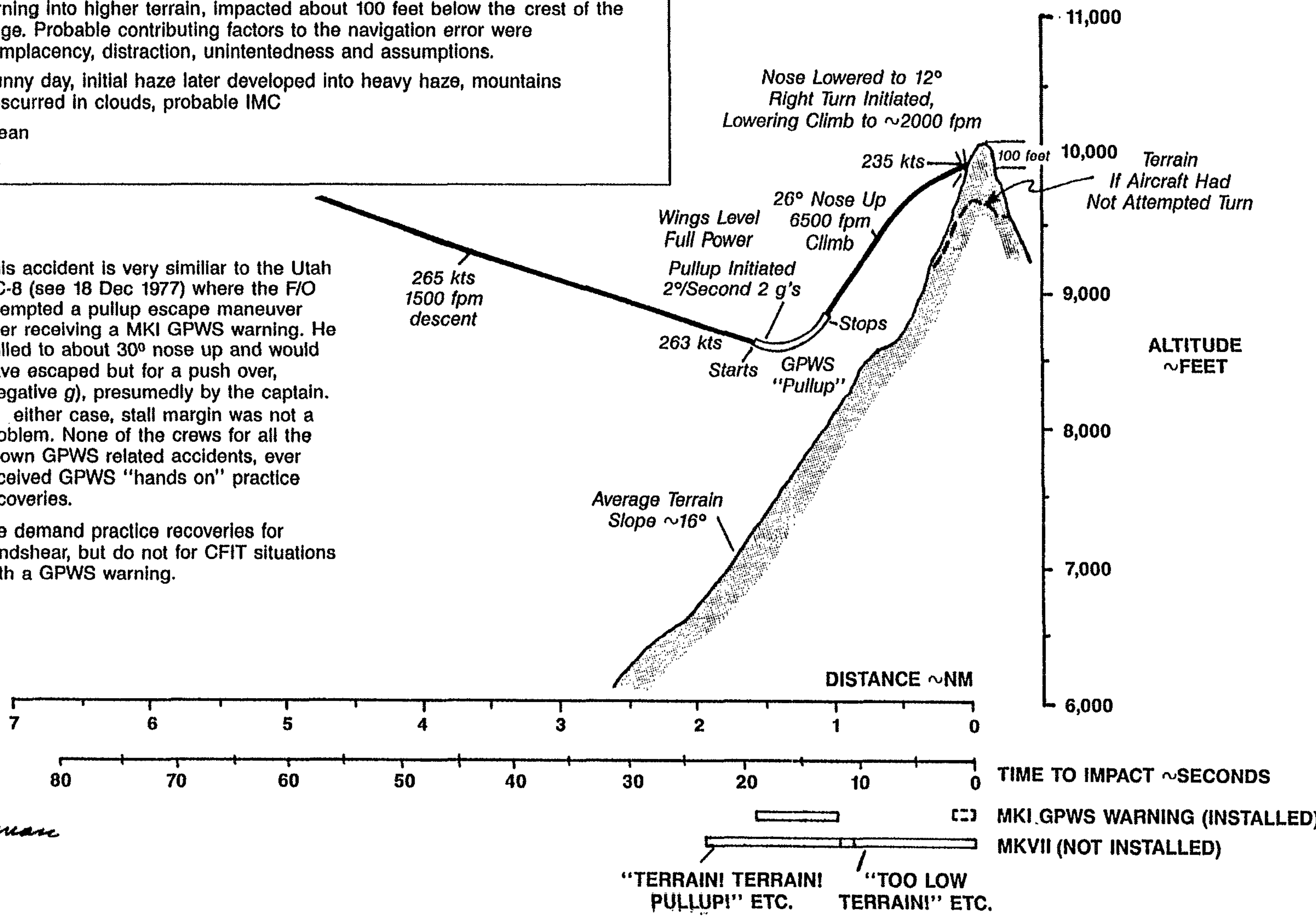
Weather: Sunny day, initial haze later developed into heavy haze, mountains obscurred in clouds, probable IMC

Configuration: Clean

Fatalities: 43

NOTE: This accident is very similiar to the Utah DC-8 (see 18 Dec 1977) where the F/O attempted a pullup escape maneuver after receiving a MKI GPWS warning. He pulled to about 30° nose up and would have escaped but for a push over, (negative *g*), presumedly by the captain. In either case, stall margin was not a problem. None of the crews for all the known GPWS related accidents, ever received GPWS "hands on" practice recoveries.

We demand practice recoveries for windshear, but do not for CFIT situations with a GPWS warning.



Don Bateman

Return to TOC

43 killed in plane crash

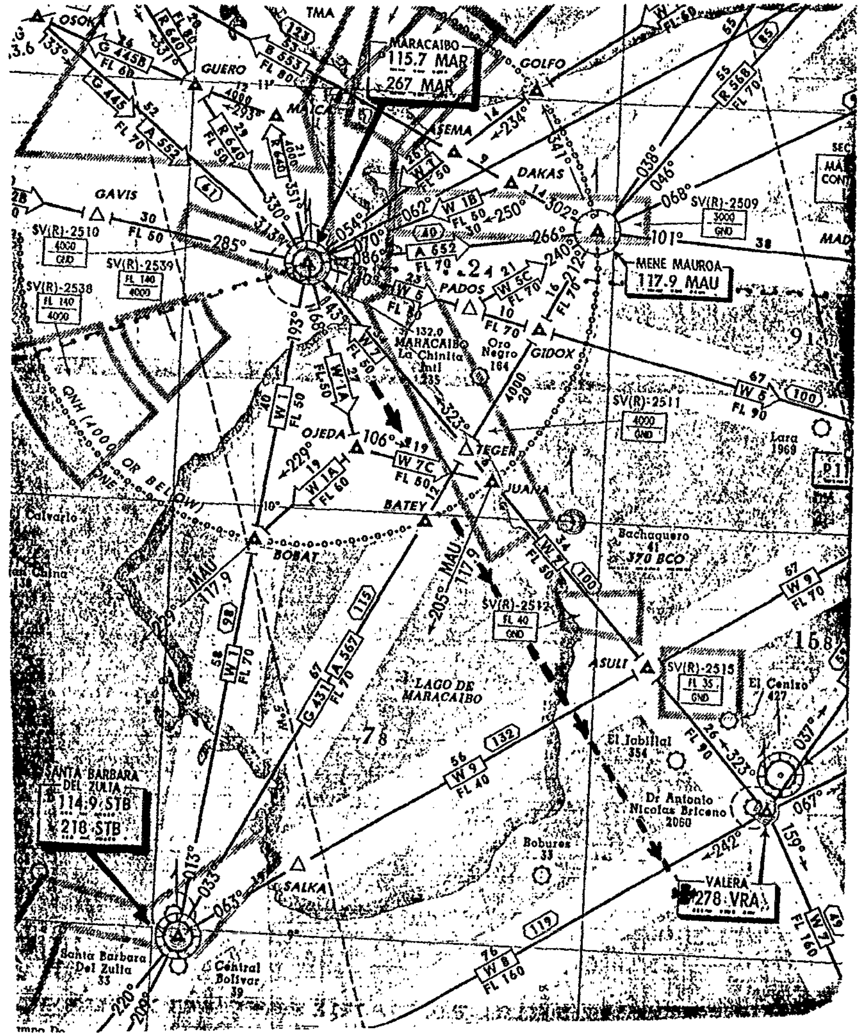
AP/Carl Fox

CARACAS, Venezuela – A Venezuelan jet carrying 43 people crashed into a mountain southwest of Caracas after straying miles from its scheduled course, authorities said Wednesday. There were apparently no survivors.

The DC-9 twin-engine jet disappeared Tuesday afternoon while flying from the oil-rich city of Maracaibo to Santa Barbara, 135 miles to the southeast. But the wreckage was found nearly 100 miles east of Santa Barbara, strewn over a half-mile area on a remote Andean mountain.

"It seems there are no survivors," said Franklin Rodriguez, a manager for the airplane company, Aeropostal. Company officials said all of the victims were Venezuelans.

Speaking to reporters in Maracaibo, Rodriguez said a search team had searched the crash site on the 13,800-foot Paramo Los Torres mountain, which is about 350 miles southwest of Caracas.



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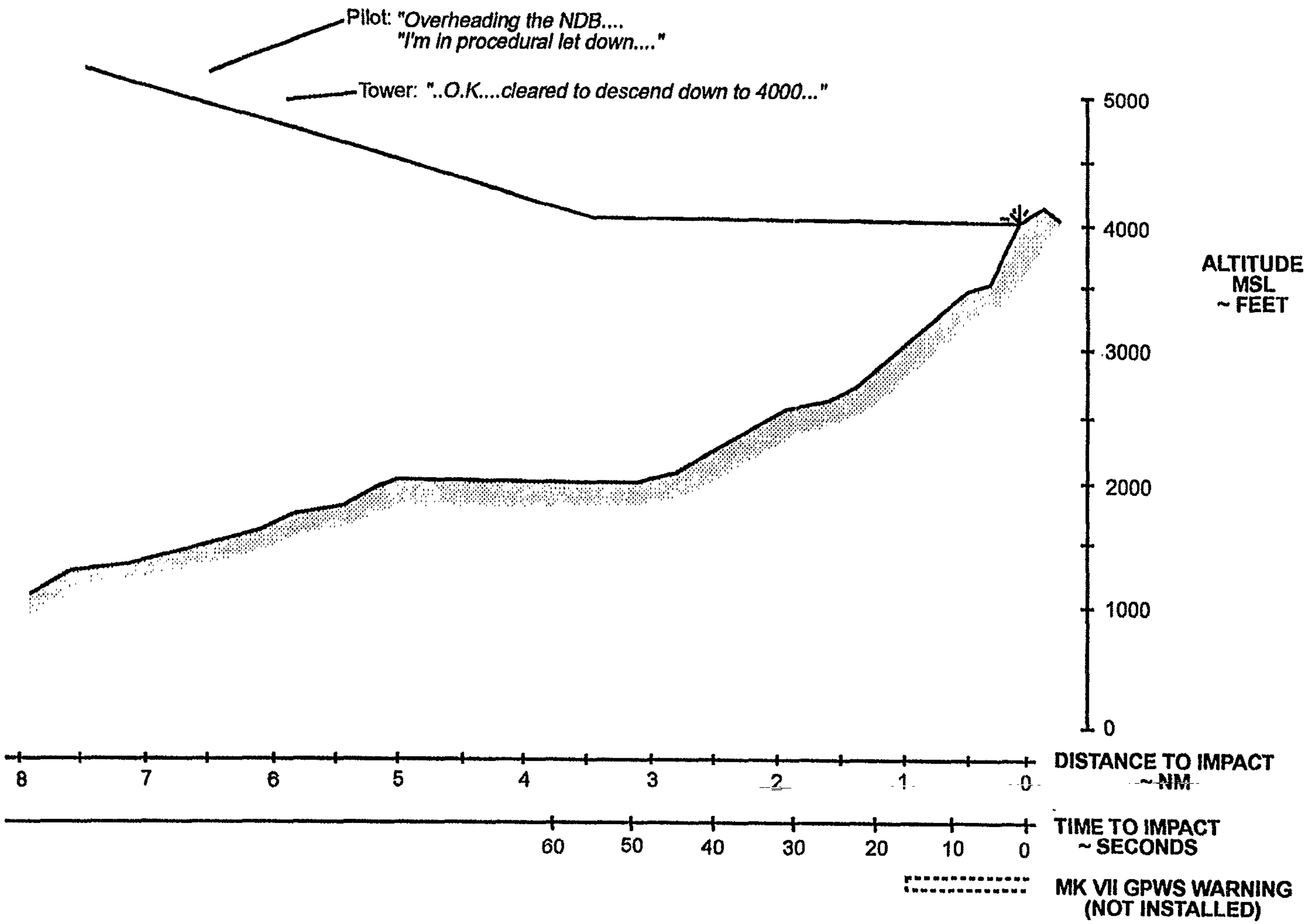
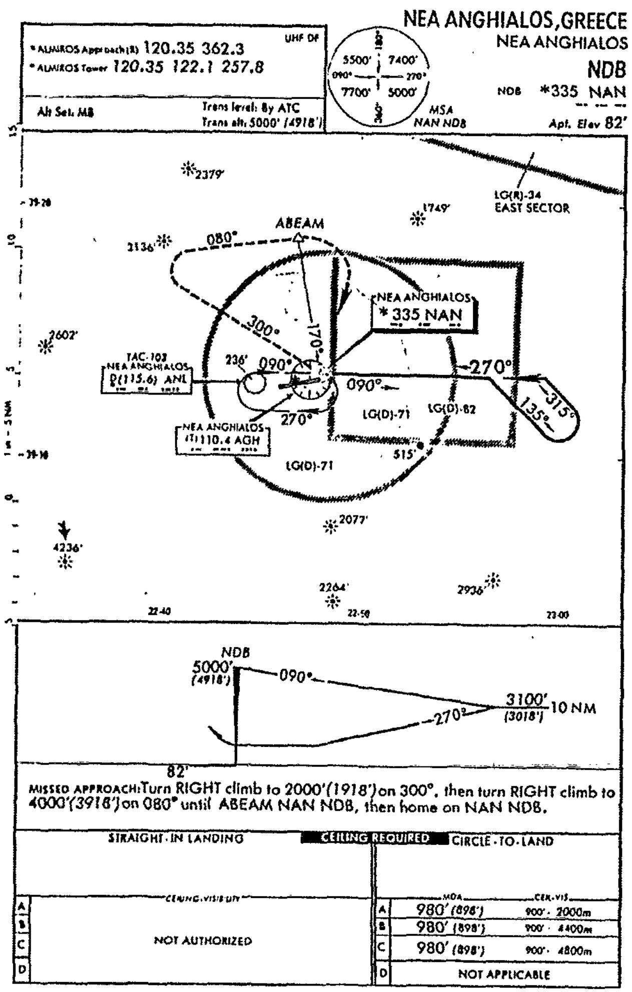
Circumstances:	During a descent and turn over the airport, the aircraft was incorrectly cleared down to 4,000 feet, and hit the top of a mountain.
Weather:	IMC
Configurations:	Clean
Fatalities:	63

No GPWS

Flight Path Profile
C-130
NEA ANGHIALOS, GREECE
5 FEBRUARY, 1991





Casualties

GREECE

An Elliniki Aeroporia (Greek Air Force) Lockheed C-130 Hercules crashed in bad weather on an internal flight between Elefsira and Nea Anhialos military air bases on 5 February. There were 56 on board including four crew. The aircraft had made contact with Nea Anhialos while 32km (20nm) southeast of the airfield before radar contact was lost.

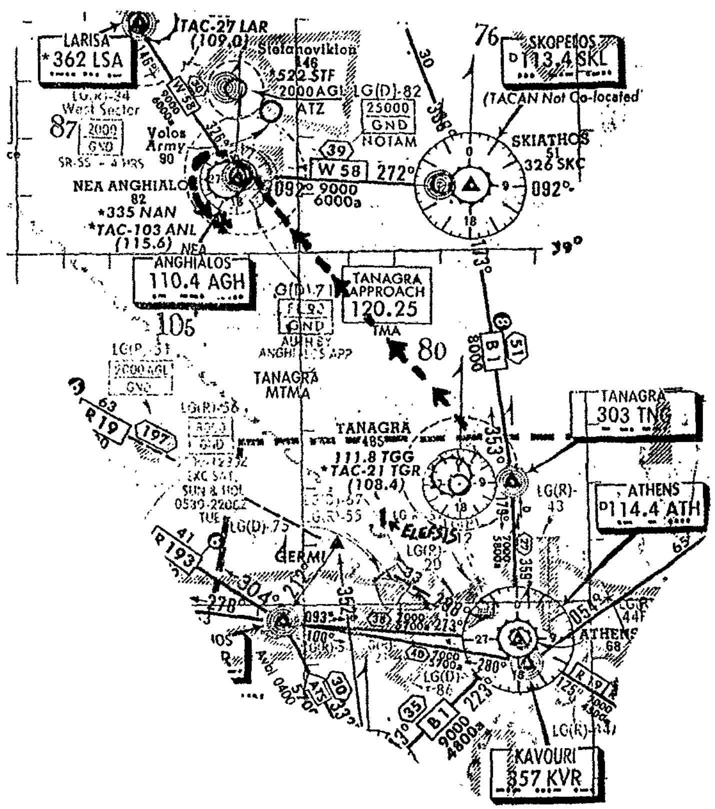
FLIGHT INTERNATIONAL 13 - 19 February, 1991

* * *

The wreckage of a Greek military plane that vanished from radar screens nearly a week ago has been found on the top of a snow covered mountain in central Greece. Authorities said there were no survivors among the 63 airmen aboard. The C-130 Hercules disappeared as it made an approach to land at Volos while on a routine mission from the capital Tuesday. The cause of the crash is under investigation.

* * *

Wall Street Journal - Europe
11 Feb, 1991



Greek Hercules wreck found

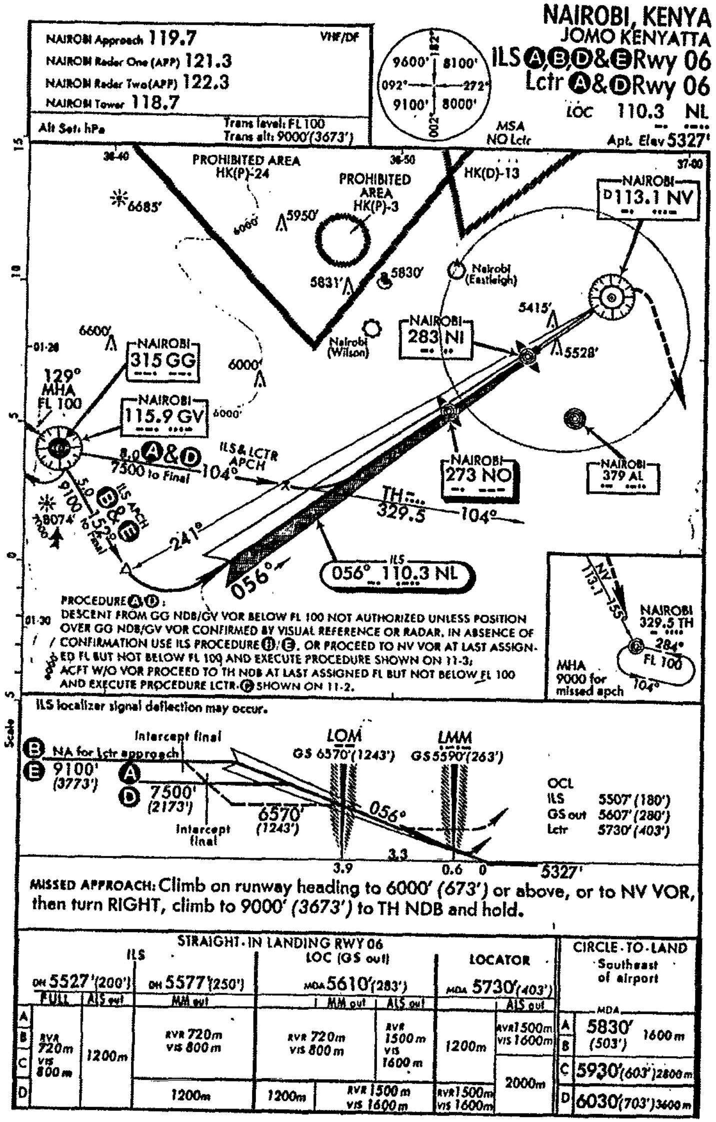
The Greek Air Force Lockheed C-130 Hercules that crashed on 5 February was found on a mountain top near the Nea Ankhialos military airbase on 8 February. All 63 on board had been killed.

The aircraft was on a flight from the Elefsis military airfield near Athens to Nea Ankhialos near the city of Volos. The Hercules flew via the Tanagra non-directional beacon (NDB) north of Athens.

Early reports state that, following the procedural turn for landing, the pilot was apparently given clearance to descend to 4,000ft (1,212m) instead of the 5,000ft that the NDB approach stipulates.

The aircraft crashed in mountainous terrain during bad weather. The pilot appeared to have attempted a crash landing.

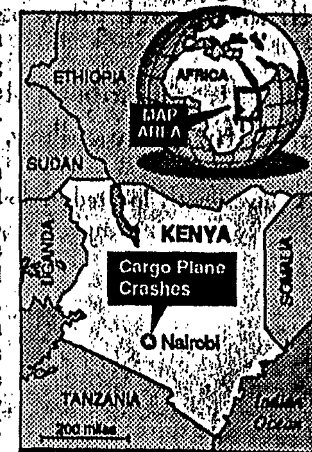
FLIGHT INTERNATIONAL 20 - 26 February, 1991



4 DECEMBER '90

Relief plane crashes

NAIROBI, Kenya — A Sudanese relief plane crashed and burned early today while trying to land at Nairobi's international airport in heavy fog, killing all 10 people aboard, airport authorities said.



The dead, seven crew members and three passengers, were all Sudanese nationals, said Mike Fernandez, an official with Trade Winds Express Ltd., the Kenyan company handling the jetliner's cargo.

The Boeing 707 was arriving from Sudan's capital, Khartoum, to pick up emergency relief supplies destined for famine-threatened southern Sudan when it crashed.

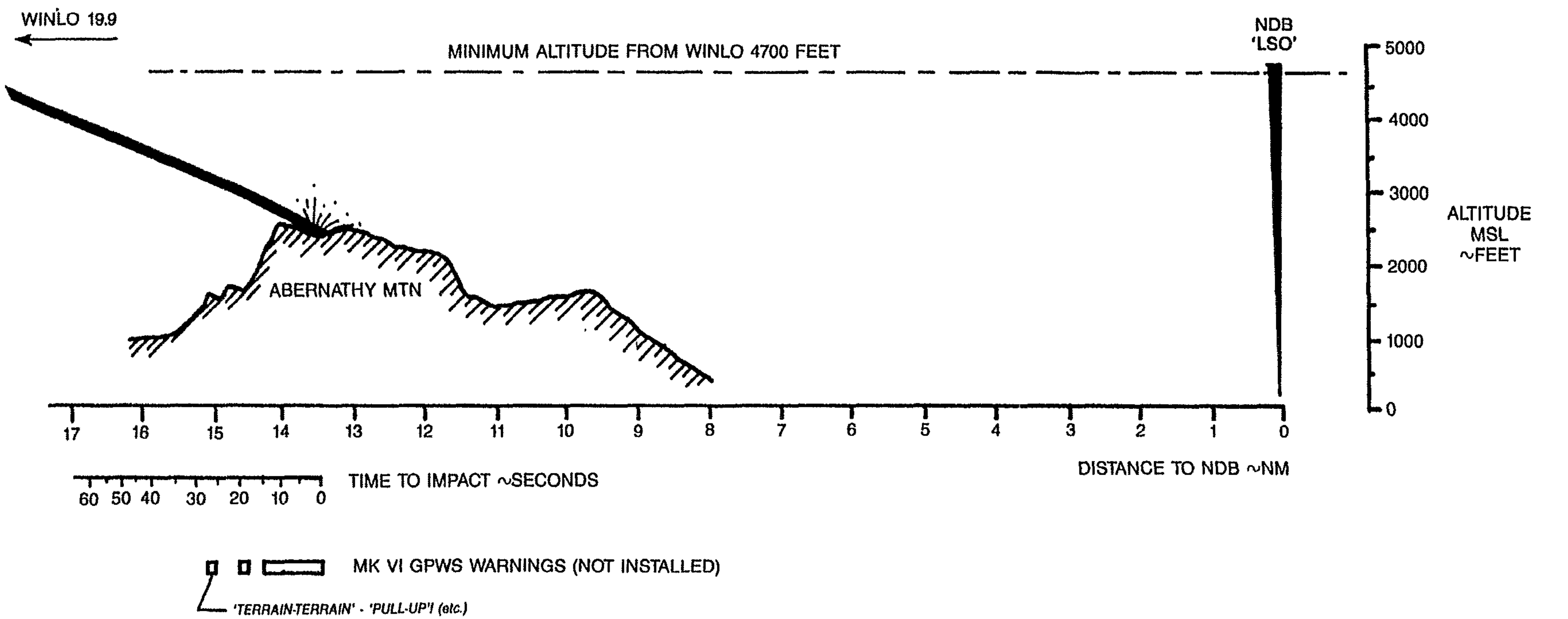
The aircraft overshot the runway at Jomo Kenyatta International Airport once and was making a second attempt at landing when it crashed, said Fernandez.

FLIGHT PATH PROFILE
AC 690
Kelso, Washington
30 November, 1990

Next Page

Circumstances:	During initial approach to Kelso, the aircraft prematurely let down and hit a mountain.
Time:	Night 19:00 PST
Weather:	IMC
Fatalities:	5 out of 6 onboard

Cancelled IFR To VFR to save time. Probably saw Kelso City lights in distance.



Don Bateman

90-307-02

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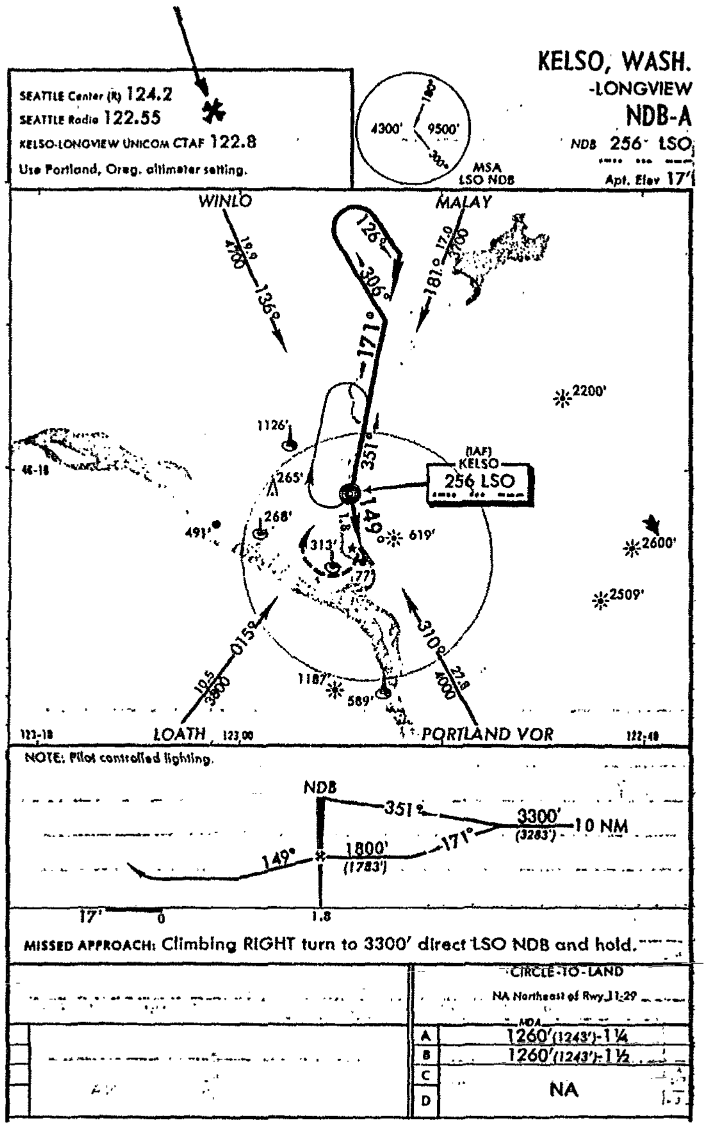

3-DEC-90 PI

5 Canadians die in plane crash

Survivor found walking in woods

P-I Staff and News Services

RYDERWOOD, Wash. — The head of a logging equipment company and four other Canadians died when a light plane crashed into the forest near this southwest Washington town, officials said.

The lone survivor was found walking in the woods by bow hunters early yesterday morning, nearly 38 hours after the accident happened, said Brian Holmes of the Washington state Aeronautics Division.

Kathy Madill, 42, of Nanaimo, British Columbia, was airlifted to Emanuel Hospital in Portland, Ore., where she was listed yesterday in fair condition with a broken collarbone, hypothermia and shock.

The plane was flying from Nanaimo to Kelso, Wash., on a business trip Friday night for S. Madill Co., said company spokesman Steve Shaw.

He described Madill as the world's leading manufacturer of heavy-duty logging equipment.

The firm is headquartered in Canada but has a plant in Kalama, just south of Kelso.

Killed in the crash were Madill's husband, company President Pat Madill, 42, and his stepdaughter, Leanne Johnson, 19; Johnson's boyfriend, Ralph Pomphrey, 20; and company pilot Bill Anderson and his wife, Marlene Anderson, all of the Nanaimo area, Shaw and Holmes said.

The company plane, a 10-seat Aero Commander 690, crashed into a forested ridge — west of Ryderwood and about 60 miles north of Portland — about 7 p.m. Friday, Holmes said.

The group was headed to the Kalama plant, Shaw said.

"It's our plant in the States," he said. "We flew down two or three times a month, at least."

The firm, established in 1911, employs 100 people in Nanaimo and 20 in Kalama, he said.

Shaw said he began notifying airports and search and rescue teams Saturday afternoon when officials at the Kalama plant called to ask the whereabouts of the company visitors.

The cause of the accident was being investigated by the National Transportation Safety Board and the Federal Aviation Administration.

FLIGHT PATH PROFILE
DHC-8
Samil Island, Thailand
21 November 1990

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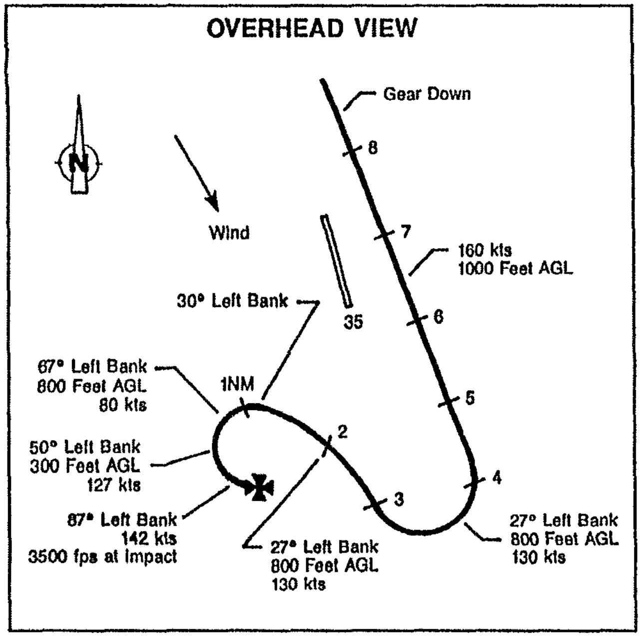
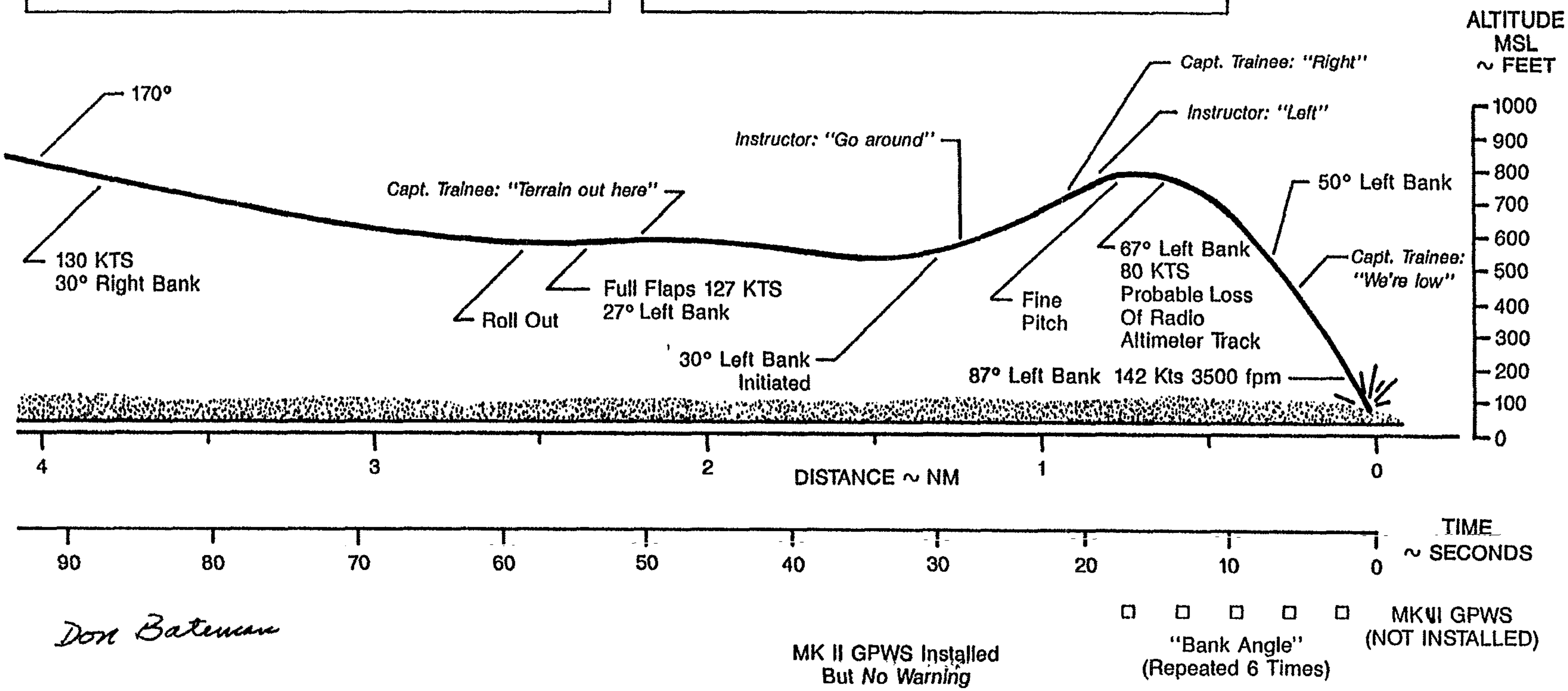


Circumstances:	During NDB approach to runway 17 in heavy weather, and circle to land on runway 35, aircraft lost visual contact with runway. A non-decisive missed approach was initiated, props were put in fine pitch but climb power was not applied. Pilots still trying to find airport. During left turn, spatial disorientation led to overbanking. Flight crew was under pressure to make landing, as returning to Bangkok was only alternative. 'Trainee Captain' and 'F/O' Instructor Captain complicated 'who was flying?'
Weather:	Dark, very poor visibility, rain and wind 32 at 20 kts.
Time:	Dusk 18:15 Local Time
Configuration:	Landing
Fatalities:	36



Don Bateman

A14 Seattle Post-Intelligencer, Friday, November 23, 1990 ★

2 Seattle residents die in Thai crash

Jet from Bangkok hits coconut trees

P-I Staff and News Services

BANGKOK, Thailand — Two Seattle residents were among 38 people who died in the crash of a Thai plane carrying foreign vacationers to a resort island, the U.S. Embassy said yesterday.

Killed in the Bangkok Airways crash were Edward G. Lincoln and Kathleen Lincoln, who live in the Greenwood area.

An embassy official identified the Lincolns as being among passengers in the plane that slammed into coconut trees in heavy rain and gusty wind late Wednesday as it prepared to land on Koh Samui.

Witnesses said the plane exploded and then crashed about six miles from the airport. Everyone aboard the plane, a de Havilland turbo-prop, was killed, including the five crew members and 33 mostly foreign passengers, officials said.

The airport, with no radar or advanced ground control equipment, opened last year to draw more foreign tourists to the pristine island in the Gulf of Thailand, 300 miles south of Bangkok. The plane was on a 50-minute flight from Bangkok when it crashed.

Prime Minister Chatichai Choonhavan ordered an investigation into the crash and an inspection of safety conditions at Koh Samui's airport, his spokesman Suvit Yodmani said.

Embassy officials said they had no additional information on the two Seattle victims.

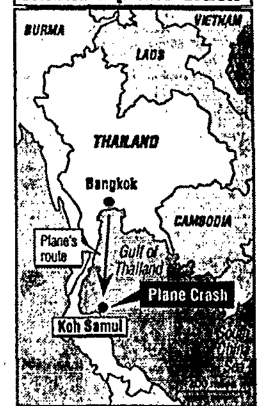
Family members could not be reached yesterday at the Lincolns' home.

A Metro spokesman in Seattle said yesterday that the transit agency had been told one of its employees may have been involved in the accident.

"We have a Kam Lincoln who works for us as a commuter or customer service representative," Jim Lindler, Metro spokesman, said. "We understand there is a possibility she may have been involved in the accident.

"But until we get a chance to talk to the family, we feel it is not appropriate to release any information," Lindler said.

Thailand plane crash



The Associated Press

The passengers also included four or five Japanese, two Australians and one German, said Na[illegible]ika Niyomrerk of the public relations department of Bangkok Airways. There also may have been Swedes and Finns aboard, she said.

Passanee Thongsuk, a hotel receptionist, said she saw the plane crash and explode about 6:20 p.m. She said she was watching for the plane because her hotel was expecting some of the tourists aboard it to check in.

"I saw the plane slowly heading down," she said. "A few seconds later, I saw a big fire and smoke . . . There was a loud explosion. It came down between some houses near the main road. The people living there were very lucky to escape."

Dr. Suvit Nantapanich, the director of Samui Hospital, said the bodies would be flown to Bangkok.

The aircraft was a de Havilland Dash 8 Series 100 plane, one of two delivered to Bangkok Airways last year, said an aviation source in Seattle. The planes are built in Toronto by de Havilland Canada, a Boeing subsidiary.

A de Havilland Dash 8 was involved in an out-of-control emergency landing at Seattle-Tacoma International Airport on April 15, 1988.

Twenty-four of the 40 people on board the Spokane-bound Horizon Airlines plane were injured when the plane landed with a fire in a wheel well area.

37 feared dead in plane crash in Thailand

THIRTY-SEVEN people were killed last night when a plane crashed during a heavy rainstorm on the Thai resort island of Koh Samui.

The Canadian-made de Havilland Dash 8-300 turboprop exploded either before or upon crashing into a coconut grove near the post office at about 6.45 pm and was still burning an hour and a half later, police said.

Bangkok Airways Flight 125 from Bangkok went down about 3.5 kilometres from the runway of the airport, which opened last year turning the island into a major tourist destination.

A police spokesman said the plane was unable to land because of the conditions and was probably trying to head back to Bangkok.

On board were 33 passengers and a crew of four Thai nationals.

"We have recovered all the bodies," he said.

The airline last night issued a list of passenger names, all but three of them foreigners, including four married couples, one child and an infant.

There were seven Japanese, six Germanic, six common Scandinavian and the rest English sounding names.

Although the southern parts of the country have become increasingly popular destinations for Hongkong people and a large number of tour groups are in Thailand at any given time, there were no Chinese names on the manifest.

November marks the beginning of Thailand's high season for tourism.

Miss Passance Thongsuk, a hotel receptionist on the island, said she saw the plane crash and explode.

She said she was looking at the sky for the plane because her hotel was expecting some of the passengers to be guests.

"I saw it slowly heading down," she said.

"A few seconds later, I saw a big fire and smoke. I was shocked and I knew the plane had crashed. There was a loud explosion.

"It came down between some houses near the main road," she said.

"The people living there were very lucky to escape."

Strong winds and stinging rain were buffeting the island, 850 kilometres south of the capital, residents said, and many fishing boats had capsized in the Gulf of Thailand.

Reuter, Associated Press

South China Morning Post 22 November 1990

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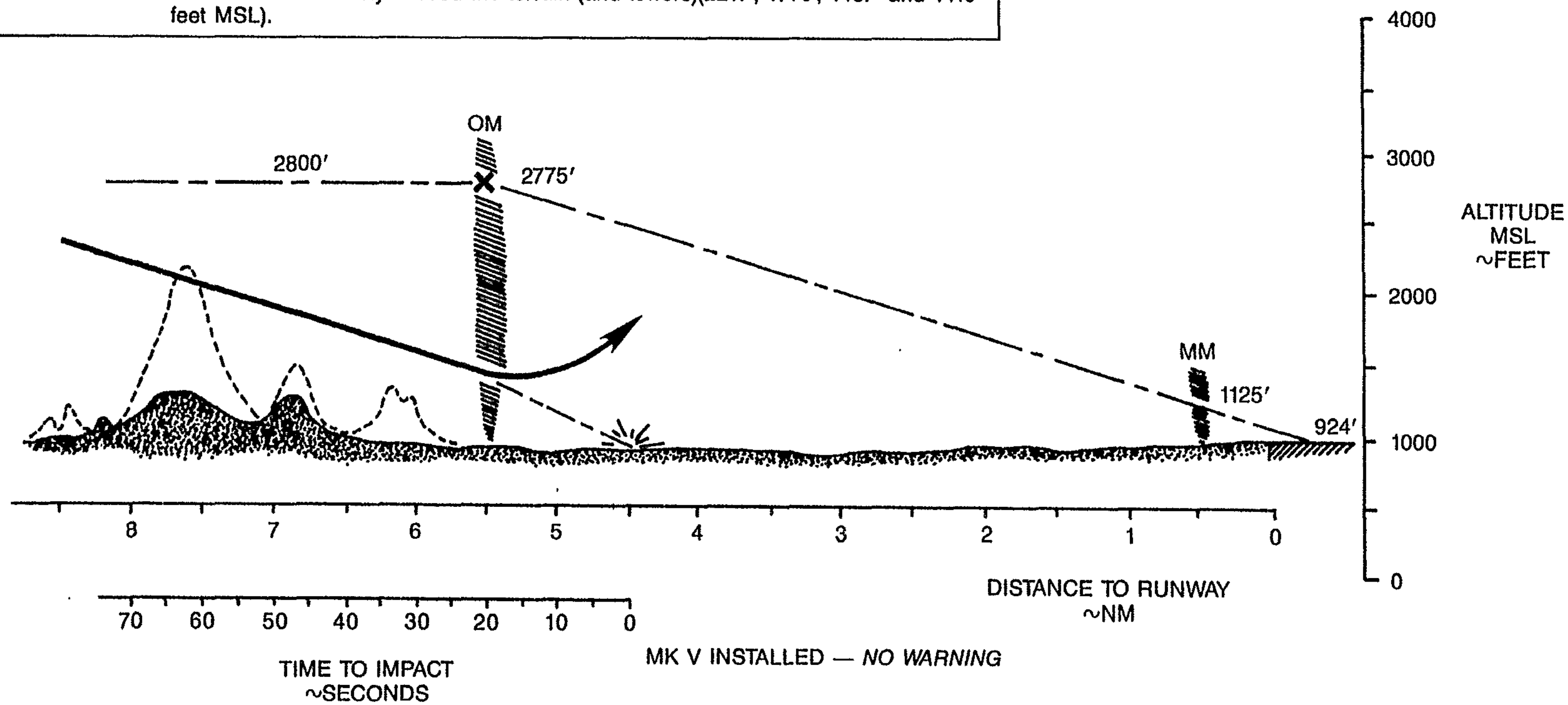
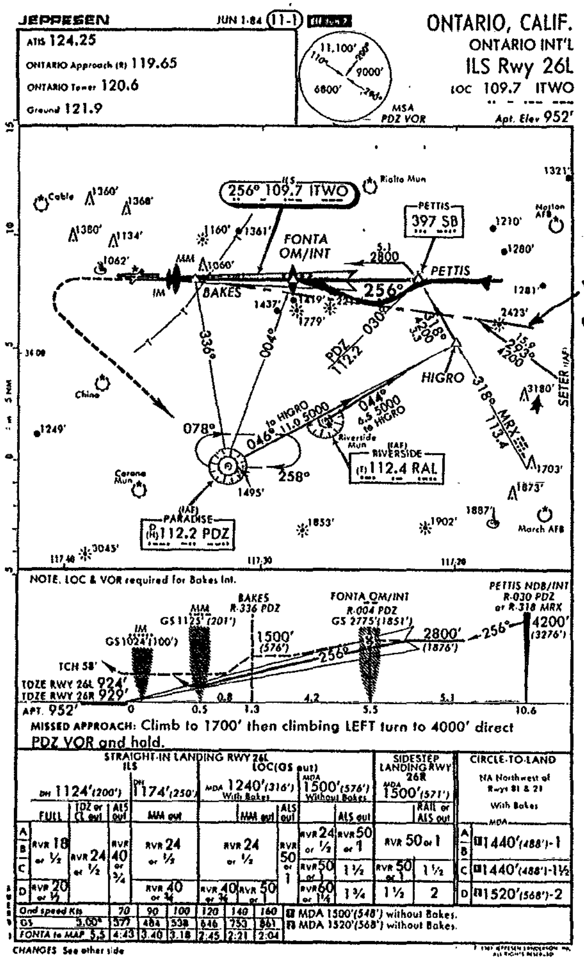
Circumstances:	*Preliminary Incident Data* While on final approach to ILS runway 26L, the aircraft inadvertantly descended to less than 390 feet, some 1400 feet below the outer marker crossing altitude of 2800 feet. A MSAW occured, the aircraft advised, and a missed approach was made. There was <u>no</u> GPWS warning from the MK V.
Configuration:	Landing.
Weather:	Clear but marginal visibility. 2½ miles obscurred, limited contrast to terrain.
Time:	Daylight afternoon.
Other:	It has been reported that the aircraft was cleared for ILS 26L near 'Pettis', then suddenly recleared for VOR runway 26R with AFGS engaged for approach mode. The aircraft was almost established on the VOR approach when it was recleared back to the ILS. The AFDS did not couple to glideslope and reverted to a vertical speed mode. There is significant terrain left of the localizer course, and the aircraft fortunately missed the terrain (and towers)(2217', 1770', 1437' and 1419' feet MSL).

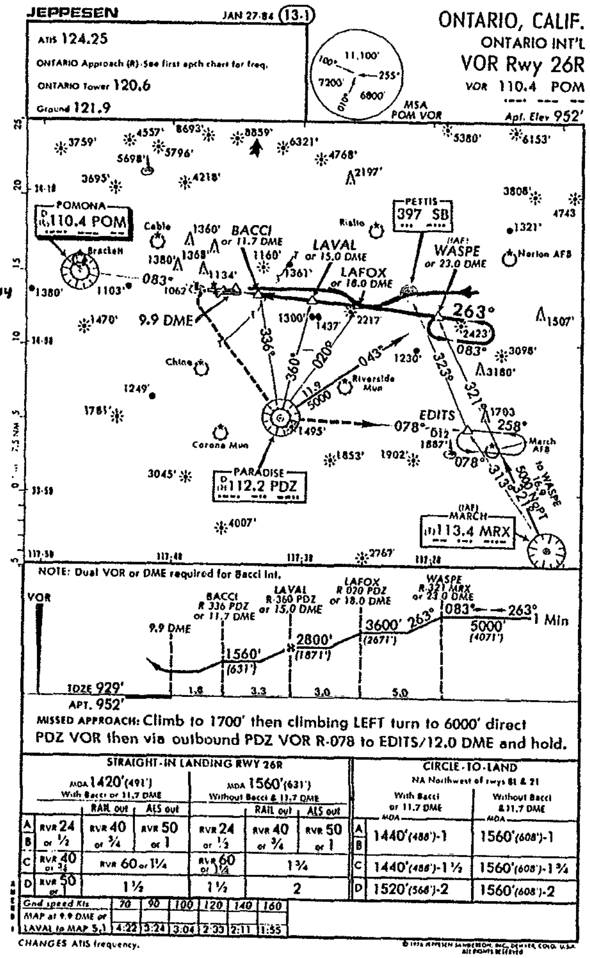
FLIGHT PATH PROFILE

B737-300
Ontario, California
16 November, 1990



Return to TOC





FLIGHT PATH PROFILE
DC-9/30
Zurich, Switzerland
14 November 1990

Cockpit Altimetry procedures in use:
- Flying pilot uses QFE on initial and final approach
- Non-flying pilot uses QNH until Final Approach Fix, then goes to QFE.

F/O believed tto be flying.

Nav frequency selection controlled by a 3-way position switch allowing:
- Individual selection
- Selection of both from Captain's control head.
- Selection of both from F/O's control head.

The GPWS glideslope signal input is directly from Captains's receiver. If the Captain was using Nav receiver to determine 249 & 271 VOR radials, there would have been no glideslope signal to the GPWS (see similar incident 28 June, 1986 DC-10 @ Portland)

Circumstances:	Aircraft hit short during an ILS approach to runway 14.
Weather:	Rain, Fog,The 6 mile visibility
Time:	Night 20:13 Local Time
Other:	Probable landing configuration, stable approach
Fatalities:	46 - all on board

Terrain profile accuracy based on unofficial ground track. Both ground track & cockpit conversations from unnofficial sources. Possibility of glideslope receiver failure and *no* flag.

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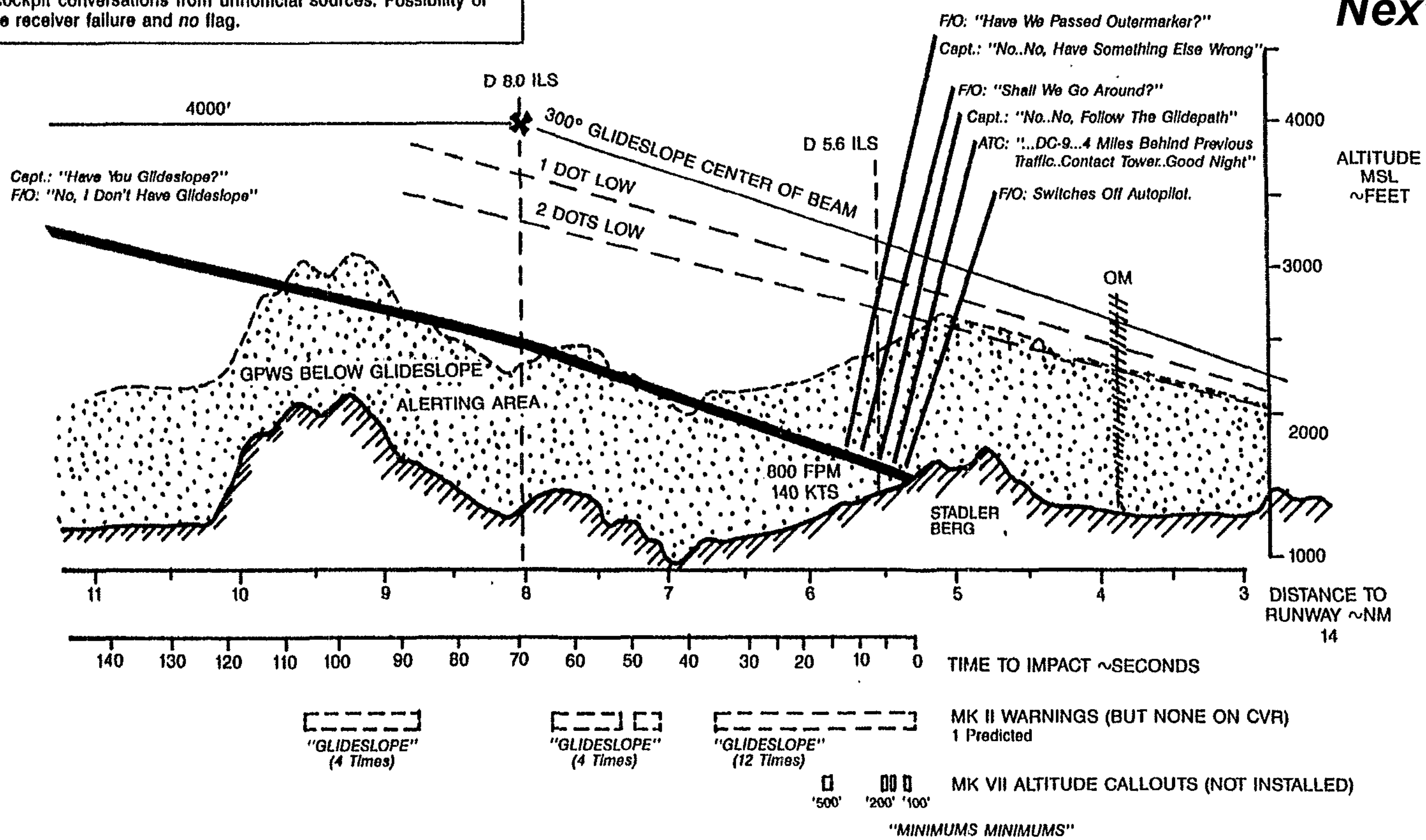

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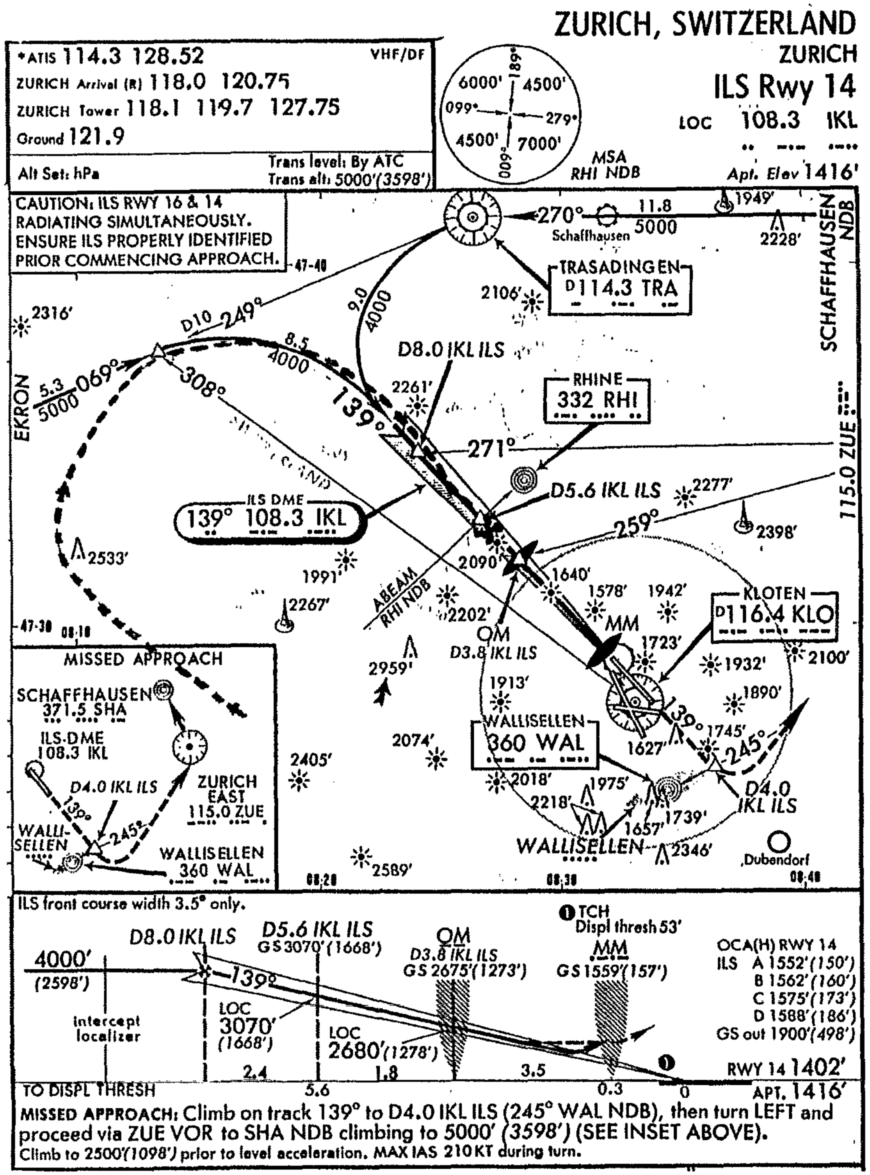


Journal American 15 NOVEMBER, 1990

DC-9 crash kills 46 in Zurich

By Onna Coray
Associated Press Writer

ZURICH, Switzerland – An Alitalia DC-9 jetliner approaching Zurich airport crashed into a wooded hillside and burned Wednesday night, killing all 40 passengers and six crew aboard, police said.

Witnesses reported what appeared to be fire and explosions before the plane hit, Zurich police told a news conference.

Flight AZ404 of the Italian airline, coming from Milan, crashed about 8:20 p.m. (11:20 a.m. PST) five miles north of Kloten international airport outside Zurich, near the village of Weiach, airport spokesman Peter Gutknecht said.

Only a few on board were Italians, an Alitalia spokeswoman said. Italian reports said most of the other passengers were apparently Swiss and Japanese. Alitalia said it did not expect to publish a full passenger list before Thursday.

The Swiss Federal Meteorological Office said visibility at the time of the crash was good — up to 10 miles, with light rain and light winds. Early reports had cited heavy rain.

Fire raged in the wreckage and woodside for at least 1½ hours, police said.

Hanni Steffen, a nearby resident and a medic, said she rushed to the site but all help appeared too late.

"The plane was burning like a volcano," she said.

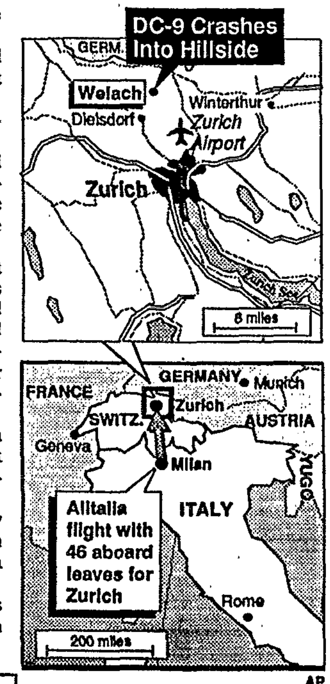
Italy's state-run RAI television said first reports appear to discount the possibility of a terrorist act, but that the crash did not seemed linked to the weather.

The jet cut a swath through the forest and broke apart on impact, witnesses said. Smoking wreckage, covered with firefighting foam, was scattered about the muddy hillside. The tail section had broken off. One landing gear and a section of wing were also discernible.

The plane was on time following a 50-minute flight from Milan when it disappeared from radar screens, Gutknecht said.

Swiss aviation authorities said they had begun an investigation, and Italian authorities said they would dispatch a team of investigators.

The crash site is about 10 miles northeast of central Zurich in northern Switzerland.



Eugen Thomann, the Zurich police official in charge of rescue operations, told reporters about 200 police and firefighters were at the scene early Thursday, preparing to salvage the wreckage and identify the bodies after daybreak. Authorities sealed off the site.

Alitalia said the DC-9 was built in 1974, and as of last year's flight register, had flown 29,000 hours. It said the plane was last inspected Nov. 4.

The last major crash involving an Italian airliner occurred Oct. 15, 1987, when an ATR-42 turboprop of the carrier ATI, an Alitalia subsidiary, crashed near Como on a flight from Milan to Cologne, Germany, killing 37.

FLIGHT PATH PROFILE
A-320
San Diego, CA
June 1990

Next Page

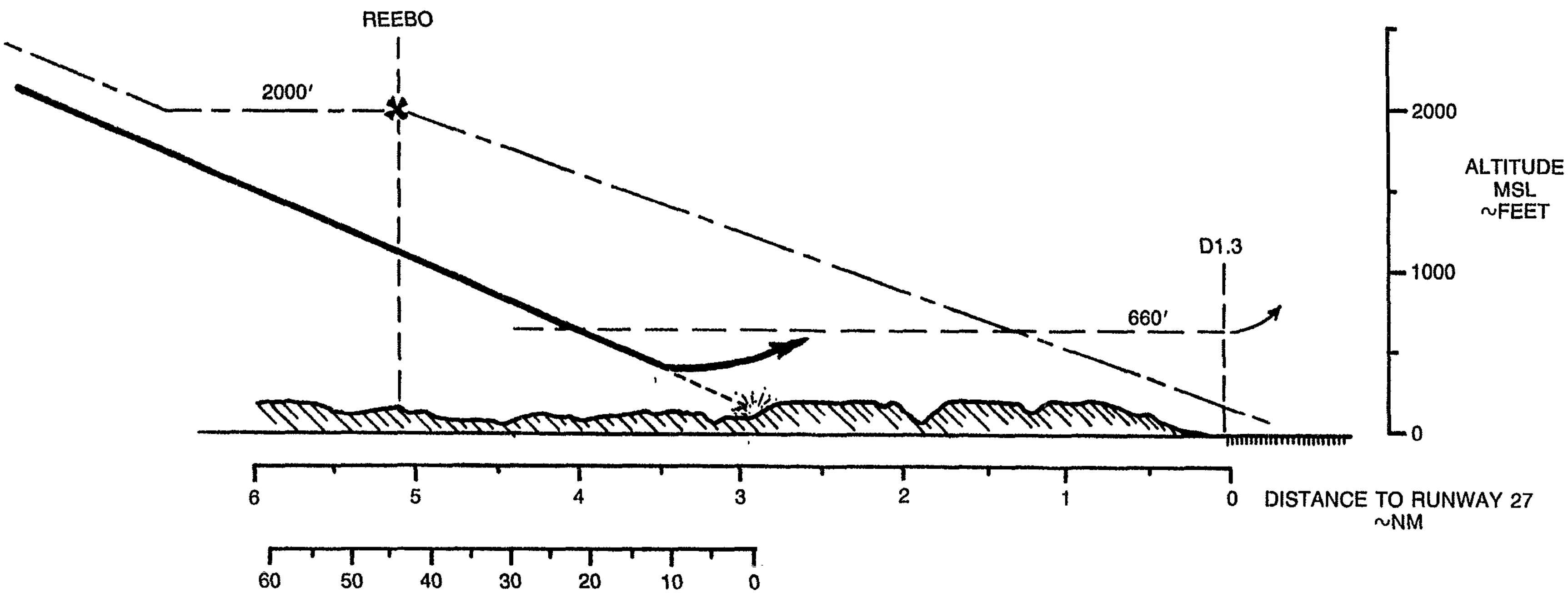
INCIDENT #2

Circumstances: FMGS engaged and tracking Localizer B/C 27 Flight Path Angle selected for 3.0 degrees but was inadvertently in Vertical Speed. Pilots adjusted vertical speed back to 1200 fpm, but became distracted and descended well below REEBO and below MDA. Error was detected by pilots and tower. Aircraft was re-established on visual approach slope.

Weather: Considerable haze

Configuration: Landing

This incident based on "sketchy" data provided by line pilots.

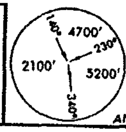


MK III INSTALLED-

NO WARNING- LANDING CONFIGURATION
DESCENT RATE INSUFFICIENT
TO TRIGGER GPWS *"SINKRATE"*

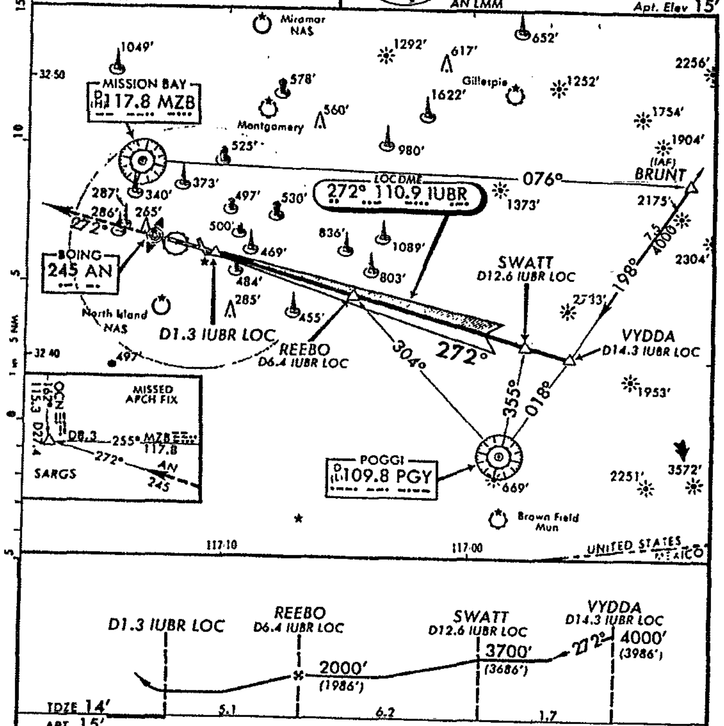
Return to TOC

ATIS 134.8
SAN DIEGO Approach (R) 127.3
LINDBERGH Tower 118.3
Ground 123.9



SAN DIEGO, CALIF.
SAN DIEGO INT'L-LINDBERGH
LOC Rwy 27
LOC 110.9 IUBR

Apt. Elev 15'



MISSED APPROACH: Climb to 2500' via bearing 272° from AN LMM to SARGS INT.

	STRAIGHT-IN LANDING RWY 27 MDA 660'(646')		CIRCLE-TO-LAND MDA
A	RVR 50 or 1	A	800'(785')-1
B		B	800'(785')-1¼
C	1¾	C	800'(785')-2¼
D	2	D	820'(805')-2½

Gnd speed-Kts	70	90	100	120	140	160
MAP at D1.3 IUBR or REEBO to MAP 5.1	4:22	3:24	3:04	2:33	2:11	1:55

NOTE: Air carrier landing visibility reduction for local conditions NA.

FLIGHT PATH PROFILE
A-320
San Diego, CA
June 1990

Next Page

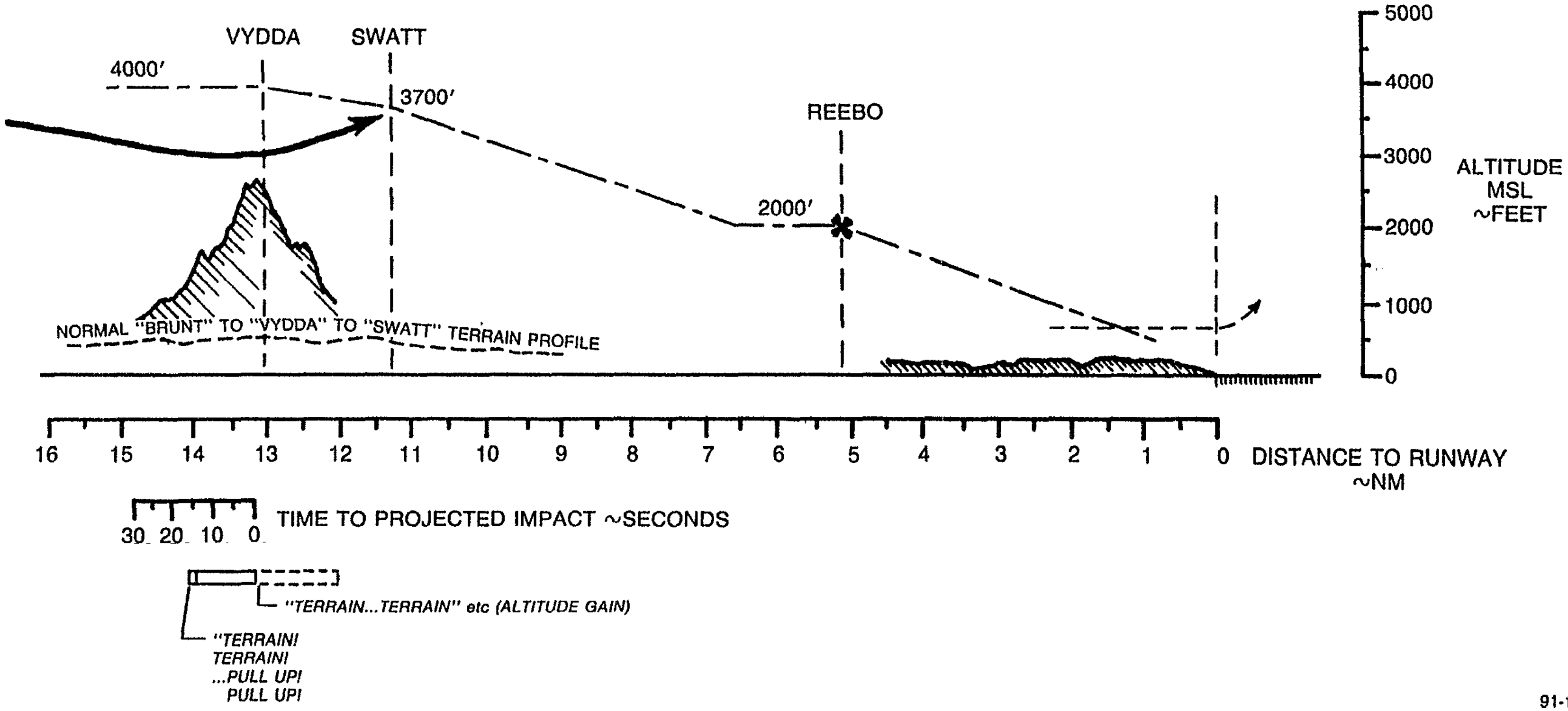
INCIDENT #1

Circumstances: Aircraft was laterally directed by the pilot to fly direct to "SWATT" and not to "VYDDA" by means of the Plan Mode on the ND. The FMGS was engaged in Heading Mode, and an altitude of 2700 had been inadvertently selected. L-V Nav

Weather: Broken clouds. Terrain in clouds.

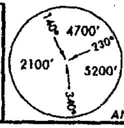
Other: A GPWS warning occured and the pilot climbed to 3700 feet.

This incident based on "sketchy" information provided by line pilots.



Return to TOC

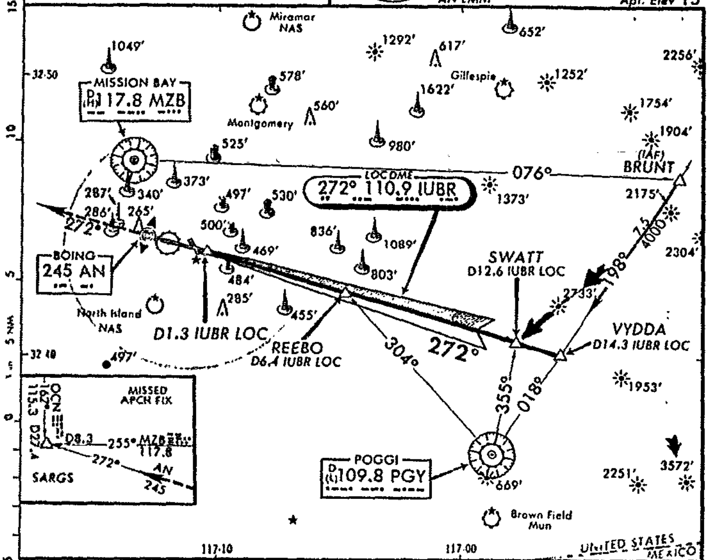
ATIS 134.8
SAN DIEGO Approach (R) 127.3
LINDBERGH Tower 118.3
Ground 123.9

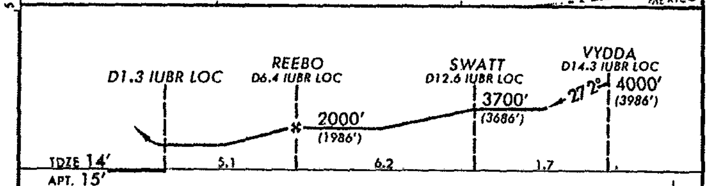


SAN DIEGO, CALIF.
SAN DIEGO INT'L-LINDBERGH
LOC Rwy 27

LOC 110.9 IUBR

Apt. Elev 15'





MISSED APPROACH: Climb to 2500' via bearing 272° from AN LMM to SARGS INT.

	STRAIGHT-IN LANDING RWY 27 MDA 660'(646')		CIRCLE-TO-LAND MDA
A	RVR 50 or 1	A	800'(785')-1
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C	1¾	C	800'(785')-2¼
D	2	D	820'(805')-2½

Gnd speed-Kts	70	90	100	120	140	160
MAP at D1.3 IBUR or REEBO to MAP 5.1	4:22	3:24	3:04	2:33	2:11	1:55

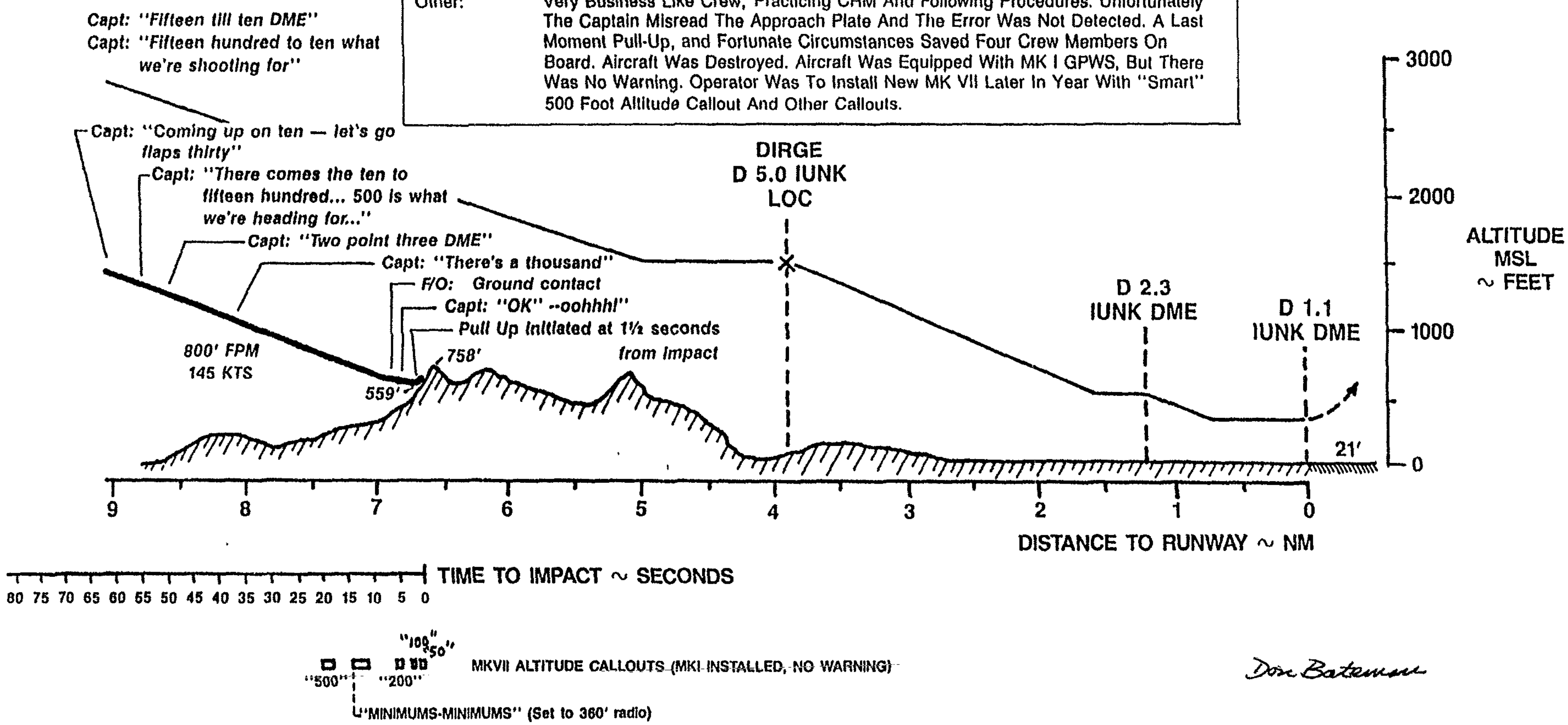
NOTE: Air carrier landing visibility reduction for local conditions NA.

Next Page

Flight Path Profile

B737-200
UNALAKLEET, ALASKA
2 JUNE 1990

Circumstances:	Aircraft Hit Terrain Some 6.7 NM Short During LOC/DME Approach To Runway 14. Aircraft Was Being Re-Positioned For Scheduled Flight.
Time:	09:00 AM
Weather:	Fog 1½ Mile Visibility
Configuration:	Landing
Other:	Very Business Like Crew, Practicing CRM And Following Procedures. Unfortunately The Captain Misread The Approach Plate And The Error Was Not Detected. A Last Moment Pull-Up, and Fortunate Circumstances Saved Four Crew Members On Board. Aircraft Was Destroyed. Aircraft Was Equipped With MK I GPWS, But There Was No Warning. Operator Was To Install New MK VII Later In Year With "Smart" 500 Foot Altitude Callout And Other Callouts.



Journal American
Bellevue Wa

SUNDAY, June 3, 1990 ■ A7

Air crash causes delay, passengers waiting not told

ANCHORAGE (AP) – MarkAir passengers waiting to depart Unalakleet for Anchorage were kept aboard Flight 87 for hours Saturday morning without being told delay was caused by a MarkAir plane crash four miles away.

"Needless to say there was some confusion," said MarkAir vice president Larry Anderson.

Flight 3087 from Anchorage to Unalakleet was added to MarkAir's Saturday morning schedule to accommodate hundreds of fishermen — many of them with family in Seattle — ready to leave town when this week's Norton Sound herring fishery ended on Thursday.

MarkAir said the Boeing 737 crashed around 9 a.m. as it made a final approach at the remote, gravel airstrip.

There were four crew members but no passengers aboard. The crash injured two flight attendants, Michelle St. Amour and Sonya Nelson, both of Anchorage.

St. Amour apparently was the more seriously injured and doctors from Nome who examined her at the crash site determined she should be moved only by stretcher.

The pilot, Capt. Glenn Smith, and copilot, Robert Fell, were uninjured, a MarkAir spokesman said.

The crew was returned to Anchorage on Flight 87 and the injured women were treated at Providence Hospital where they were being examined Saturday night.

Anderson said passengers may have sat as long as four hours, without being allowed to leave the plane, so that the plane could leave for Anchorage as soon as the injured crew members were loaded on.

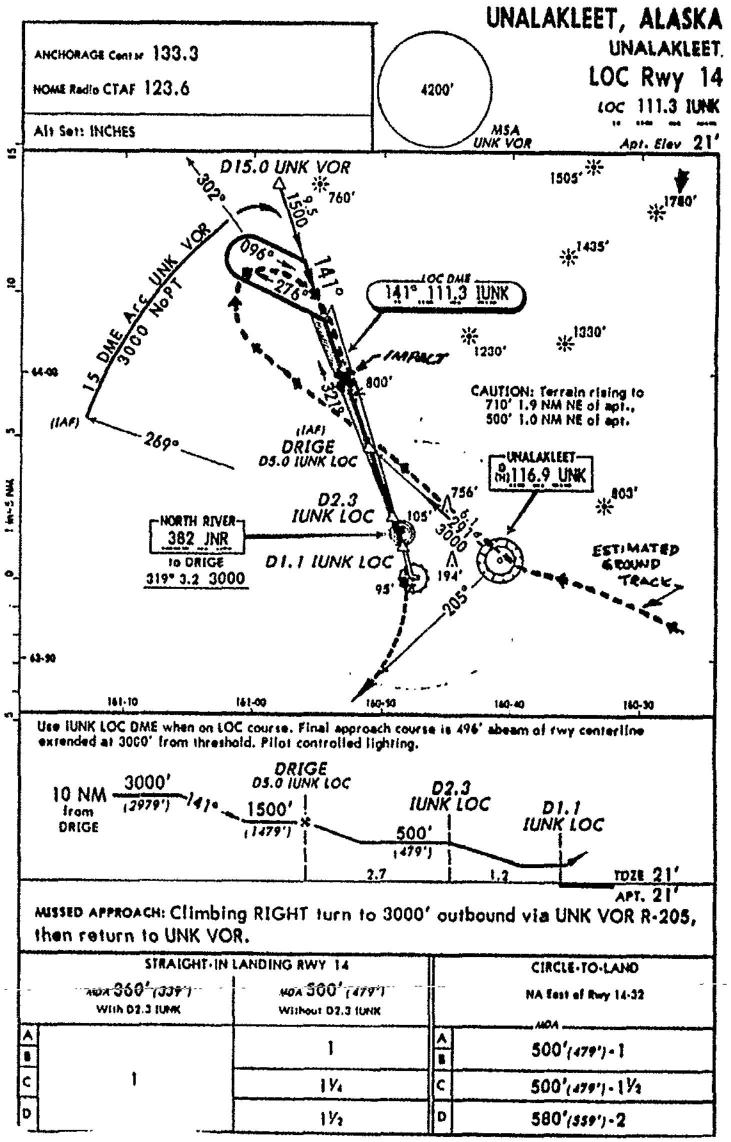
"Because of fog, the helicopter that went out to the crash site wasn't able to just go out and back," Anderson said.

Anderson said the wait could have been as long as four hours.

Passenger Teresa Perry of Anchorage said the plane was boarded around 10 a.m.

MarkAir said the plane left Unalakleet around 2:20 p.m.

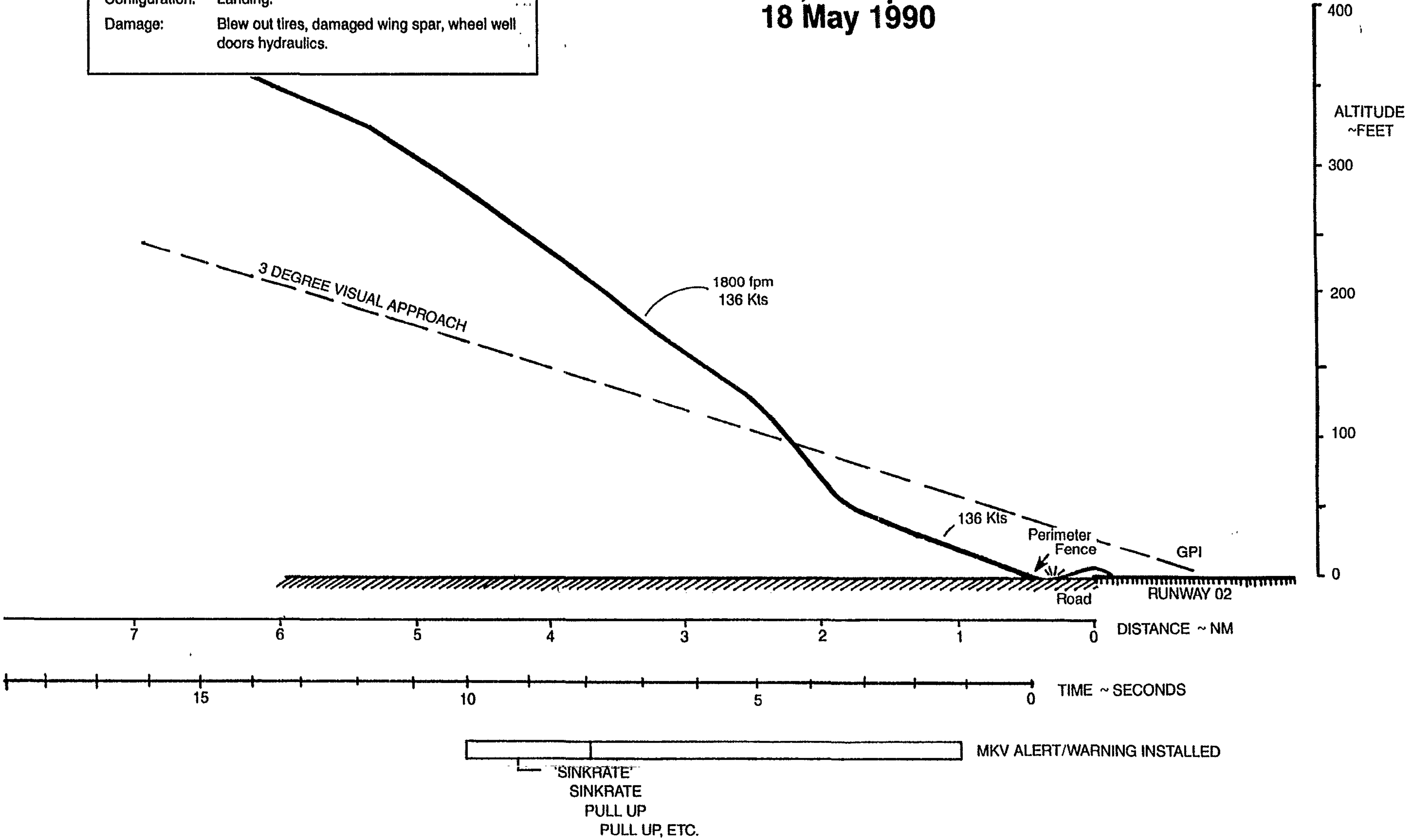
Perry, who was traveling with her 3-year-old daughter, Natalie, said she finally heard from one of the herring fishermen aboard that the delay was linked to a crash. "But that wasn't until we were collecting my baggage in Anchorage," she said.



90-282

Circumstances:	Aircraft hit short by 60 feet of runway perimeter during VOR- Visual Approach to runway 02.
Weather:	4 KM visibility, wind 330/8 kts.
Configuration:	Landing.
Damage:	Blew out tires, damaged wing spar, wheel well doors hydraulics.

FLIGHT PATH PROFILE
B737-300
Iloilo, Phillipines
18 May 1990

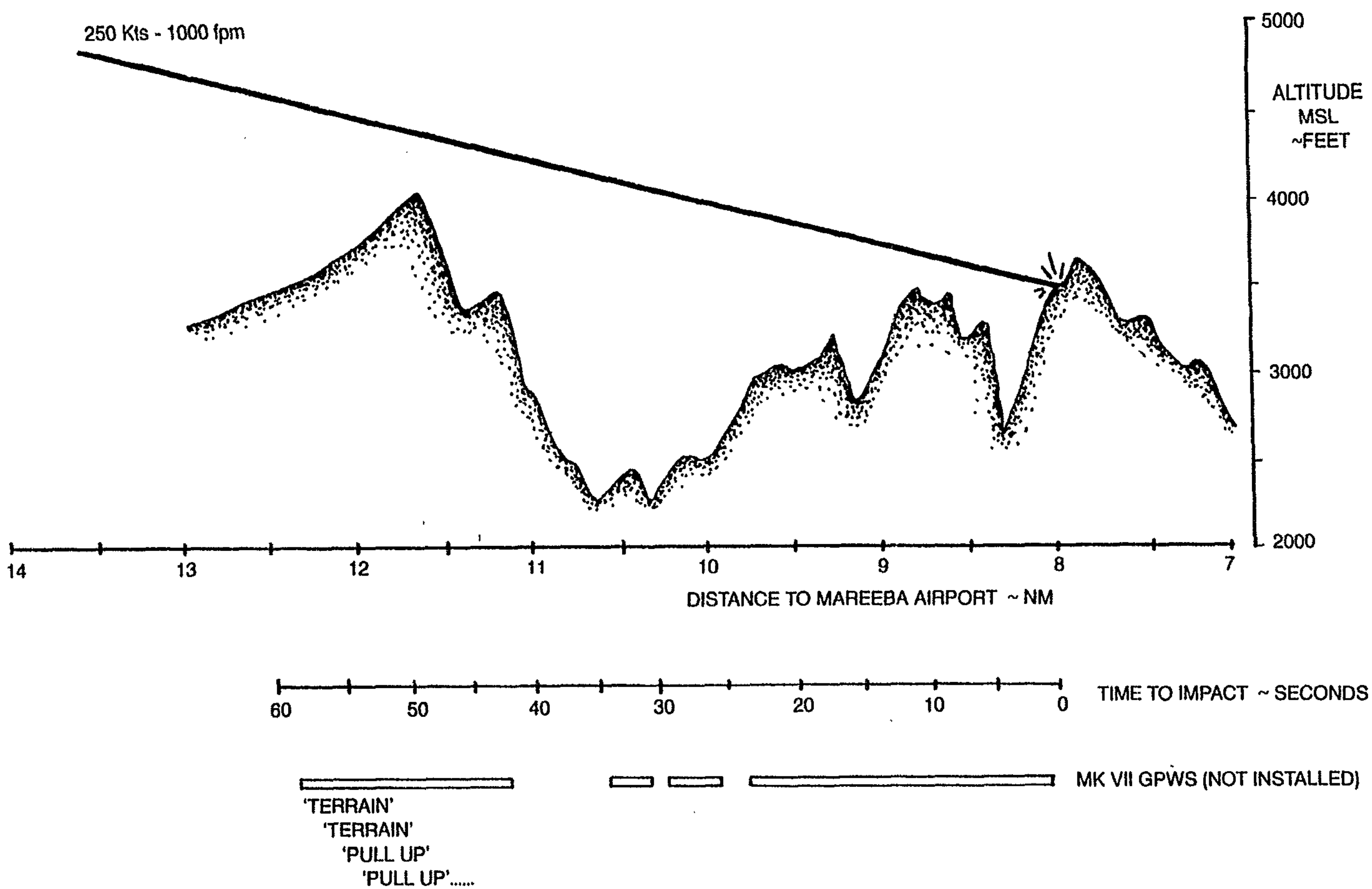


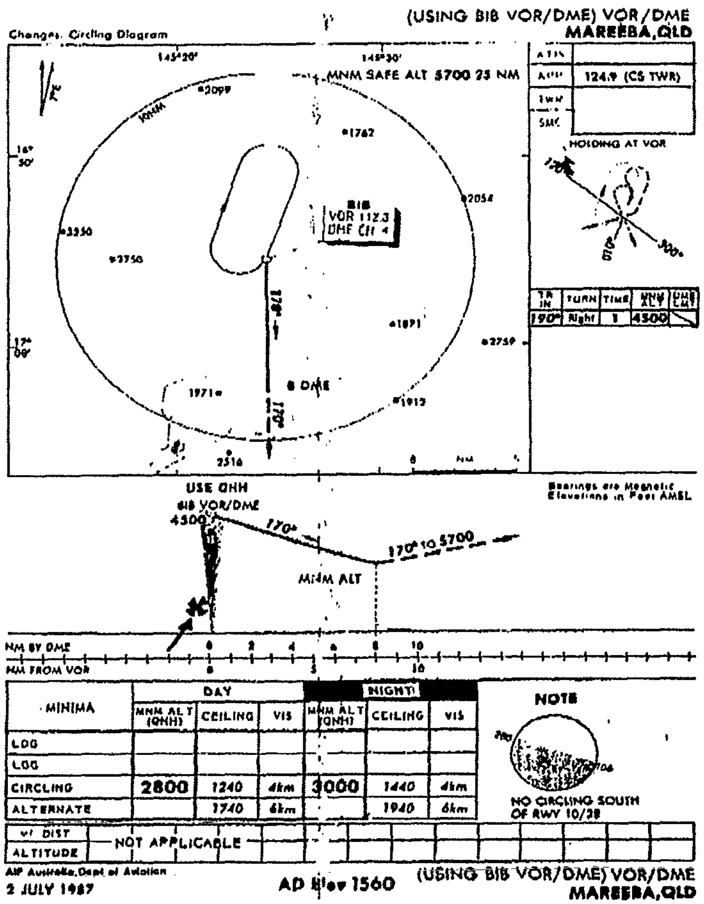
Next Page

90-282

Circumstances:	Charted aircraft hit 80 feet below summit of Mt. Emerald on initial approach to Mareeba 4 nm left of track. Clearance was to hold at 10,000 feet.
Other:	Aircraft fitted with GNS. No ATC Radar
Time:	Night 17:38
Weather:	Raining, clouds.
Fatalities:	11

FLIGHT PATH PROFILE
Ce Citation II
Cairns, Australia
11 May 1990





Eleven missing after jet crashes in Qld rainforest

"The Age" – May 12, 90

By MICHAEL CARRICK and AAP

The mayor of Cairns, Alderman Keith Goodwin, is believed to be one of 11 people on board a Cessna Citation jet that crashed in rainforest during bad weather in far north Queensland last night.

The secretary of the Queensland Local Government Association, Mr Greg Hoffman, said the 10 passengers were councillors from five north Queensland towns.

Civil Aviation Authority officials and army helicopters were last night trying to locate the crash site near the sugar towns of Atherton and Mareeba, 1400 kilometres north of Brisbane and 50 kilometres south-west of Cairns.

"It (the jet) just dropped off the radar screens," a Mareeba police spokesman said.

Emergency signals were picked up by commercial aircraft about 6.30 pm.

Mr Bill Evans, of the authority's Brisbane office, said the missing jet, which could carry up to 11 passengers and the pilot, was on a flight from Proserpine to Cairns via Mareeba when it lost radio contact with Cairns Airport at 5.38 pm.

Mr Evans said the authority's search and rescue satellite had been unable to pick up the weak distress signals, indicating that the Citation's beacon had been damaged or was lying in a valley.

An authority spokesman said the distress signal "could have been set off manually or have been triggered by the impact of a crash".

Police said they had no confirmation of the fate of the passengers, but the Mareeba and Atherton hospitals had been placed on emergency standby to receive crash victims.

Mr Hoffman said he could not release names of those who had been on board. "They had been attending the North Queensland Local Government Association's half-yearly conference yesterday and today," he said.

"It is normal practice for a group of councils to charter a plane between them for these occasions."

The deputy mayor of Cairns, Alderman John Cleland, said: "We think Mr Goodwin was on board."

Alderman Cleland said the mayor was one of a group of councillors returning north from a local government conference at Airlie Beach.

The Atherton deputy shire clerk, Mr Gordon Malcolm, said a local councillor, Mr Ivan Wilkinson, was among those missing.

A weather bureau spokesman said flying conditions in the crash area were terrible: "It has been raining and the cloud is very low."

The missing aircraft was on charter from Air North Queensland, a Cairns-based company.

Plane inquiry could take months

"The Age" – May 14

By GREG ROBERTS, Cairns

An inquiry into the crash of a Cessna Citation in North Queensland could take several months to determine the cause of the disaster, a spokesman for the Civil Aviation Authority said yesterday.

The spokesman said the plane wreckage had been strewn over a wide area, making investigations difficult.

A violent electrical storm is believed to be responsible for the crash on Friday night, which killed all 11 people on board.

It is believed the storm caused the pilot to lose direction and crash into dense forest on the slopes of Mount Emerald, 15 kilometres north-west of Atherton, at an estimated 280 kmh.

Cairns was in a state of shock yesterday following the death in the crash of its mayor, Alderman Keith Goodwin, and a prominent alderman, Mrs Rose Blank.

Seven other senior, local government figures from four towns were also killed, along with the pilot and a Roman Catholic nun.

Contact with the jet was lost after 5.38 pm on Friday, when air traffic controllers at Cairns Airport ordered the pilot, Mr Stan Lindgren, to maintain altitude in a holding pattern at 3000 metres.

The direction was given just before the chartered jet was due to land at Mareeba for a stop on its return from a local government conference at Airlie Beach.

A Cairns pilot, Mr Craig Rose, said yesterday that the area was notoriously unsafe for air traffic.

Despite this, Cairns Airport, the fifth busiest airport in Australia, is not serviced by radar.

A memorial service is expected to be held in Cairns on Friday.

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Flight Path Profile
BE C-99
MOOSONEE, ONTARIO
30 April, 1990

CIRCUMSTANCES: During a night scheduled VOR approach to runway 24 the aircraft crashed short by 7 NM - The Captain had broken out to VMC at 900 feet MSL and decided to complete a visual approach.

WEATHER: 400 Feet AGL broken, 1000 feet AGL, overcast, four miles visibility in light rain, wind 4 mph from 270 degrees, Temperature +8C. dew point +8C degrees.

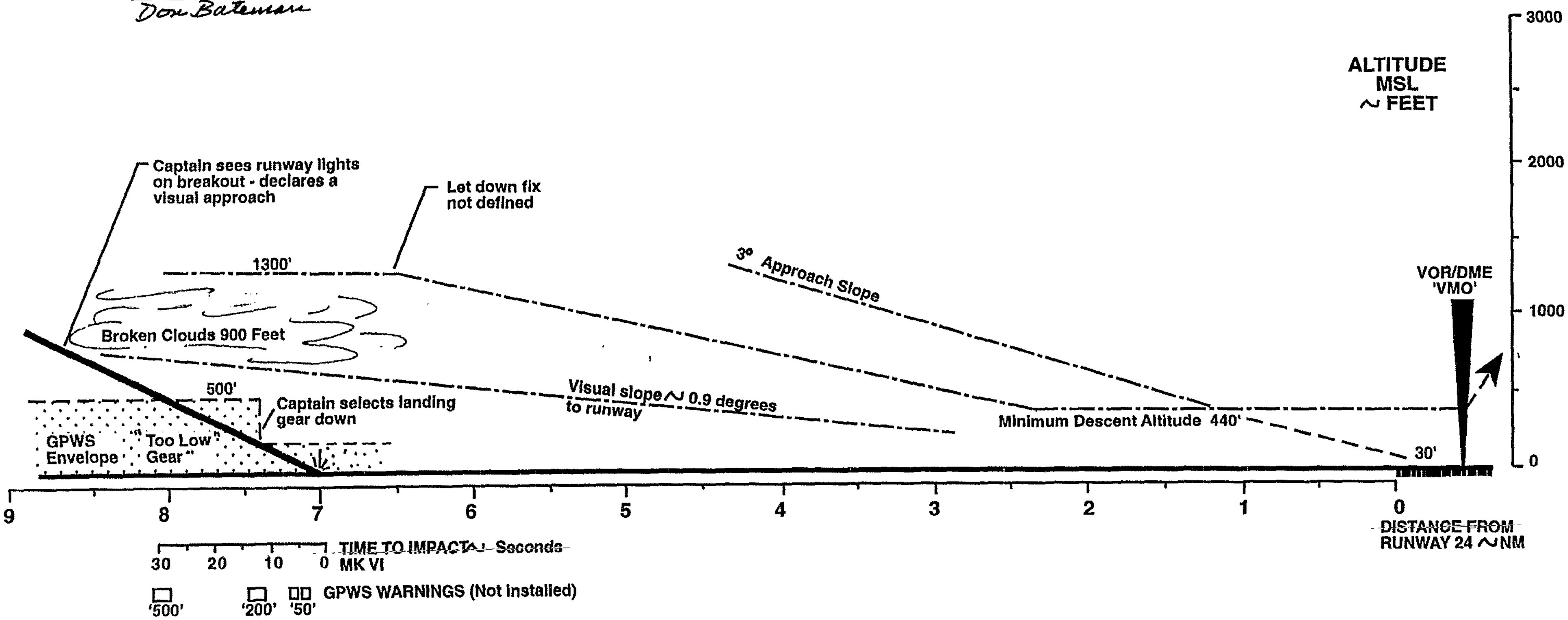
TIME: 21:35 EDT night

CONFIGURATION: Gear down, flaps clean

FATALITIES: 1 of 4 on board

OTHER: No VASI approach slope indication. Possible 'Black hole' visual illusion, poor eye location, minimum night training low time captain. Poorly designed procedure - No DME fix for descent to MDA.

Don Bateman



Return to TOC

VOR RWY 24

D.E M.AR

MOOSONEE
MOOSONEE ONTARIO

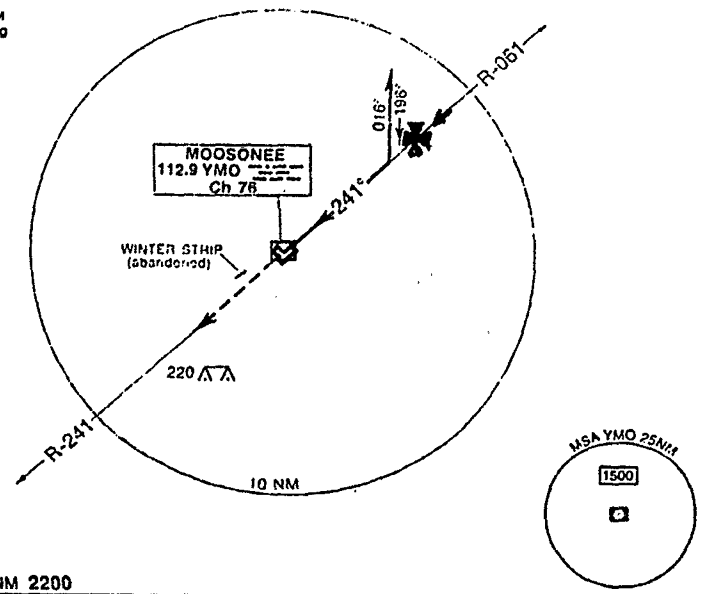
ARR	UNICOM	DEP	
TIMMINS 126.7	122.8 (ATF 5NM) O/T TFC 122.8	TIMMINS 126.7	ELEV 30 TDZE 24 25

CYMO

Winter strip abandoned. Do not use.

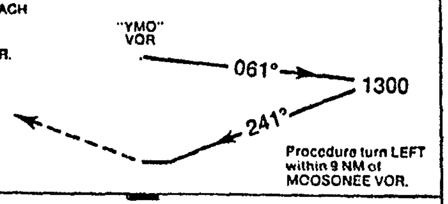
Obtain Moosonee altimeter setting from Timmins radio or Moosonee UNICOM before commencing IFR procedure.

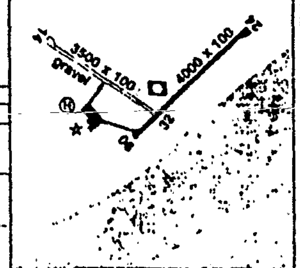
Verify runway unobstructed when A/G advisory not available.



SAFE ALT 100 NM 2200

MISSED APPROACH Climb to 1300 on R-241. Return to MOOSONEE VOR.





CATEGORY	A	B	C	D
VOR	440	(415)	1	
CIRCLING	540 (510) 1½		540 (510) 2	640 (610) 2

Knots	70	90	110	130	150
Min: Sec					

VOR RWY 24

EFF 11 JAN 90 CHANGE: ARR & DEP freqs added

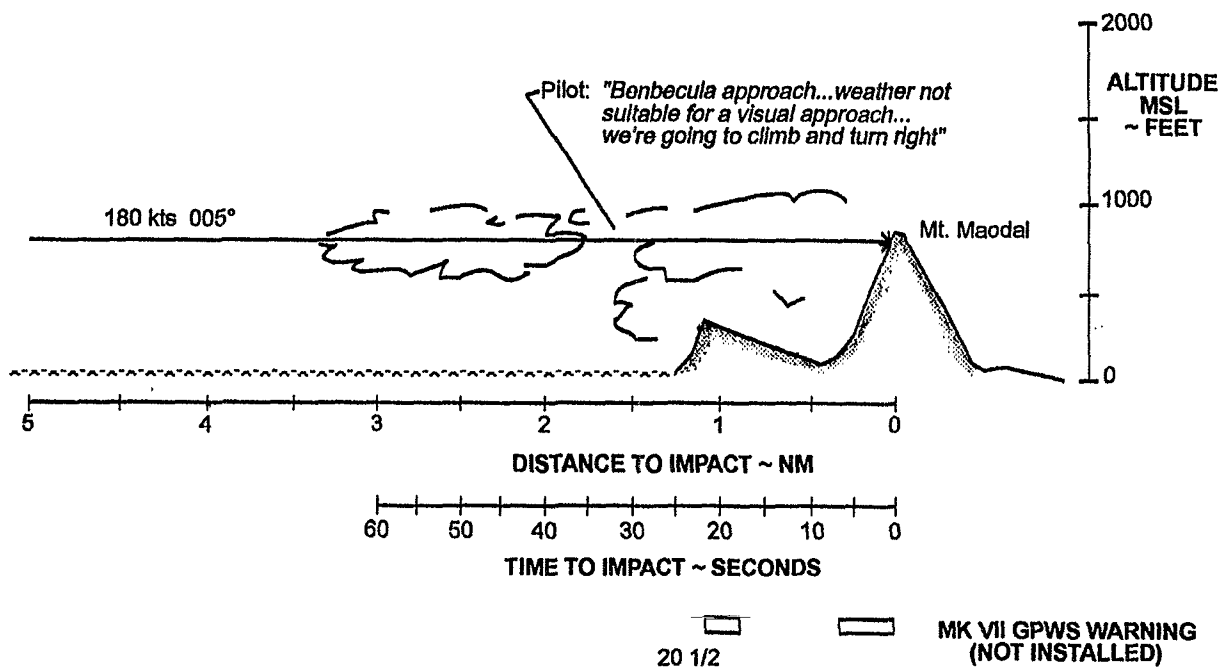
N51 17 20 W80 36 20 VAR 13°W

MOOSONEE ONTARIO
MOOSONEE

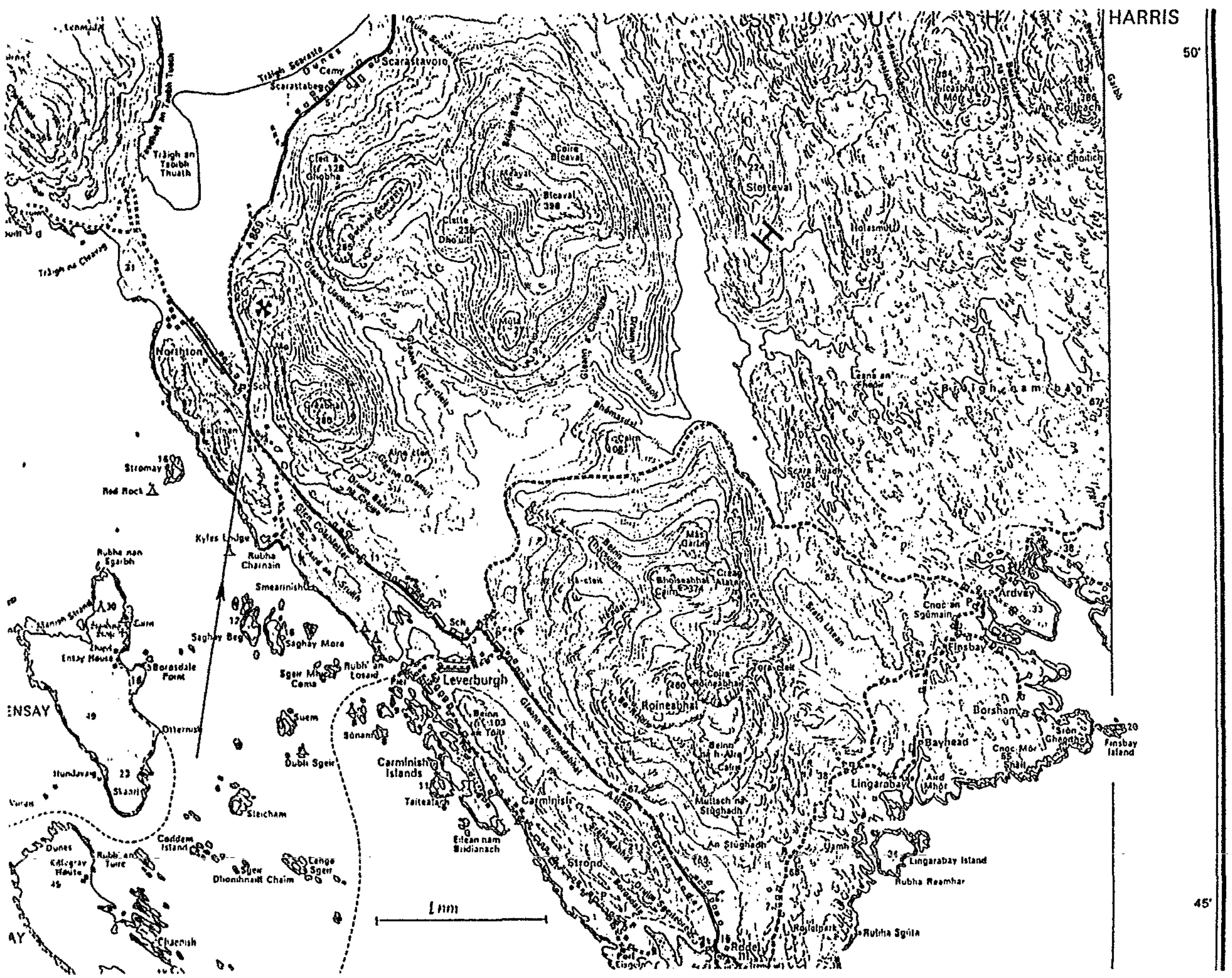
Next Page

Circumstances:	Aircraft flew into a hill in cloud while operating visually 15 NM north of their reported position.
Weather:	Generally clear but with areas of low cloud and poor visibility.
Time:	Day light
Configuration:	Clean
Fatalities:	14

Flight Path Profile
RAF SHACKLETON
ISLE OF HARRIS, SCOTLAND
30 APRIL, 1990



Return to TOC



RAF Shackleton crash due to human error .

London: The crash on a Royal Air Force Shackleton AEW2 on April 30, 1990, was caused by human error, the UK Ministry of Defence has said.

The aircraft was operating off the west of Scotland in generally clear weather but with areas of low cloud and poor visibility over the coast. While operating with a Tornado F3 the Shackleton had turned off its radar and after this decided to conduct a visual approach to Benbecula.

On contacting the tower at Benbecula, the crew gave their position as "about 20 miles west of the airfield," according to the MOD. Investigation after the crash revealed the aircraft was in fact 15 miles north of their reported position.

The crew then contacted Benbecula approach stating that the weather was not suitable for a visual approach and that the aircraft was climbing and turning right. The Shackleton hit a hill in cloud on the Isle of Harris three minutes later. It was determined that the aircraft was in controlled flight and all four engines were developing cruise power.

While the last position shown on the aircraft's ground position indicator was about 20 miles south west of the accident site, navigational inaccuracy was not considered to have been a primary cause of the crash.

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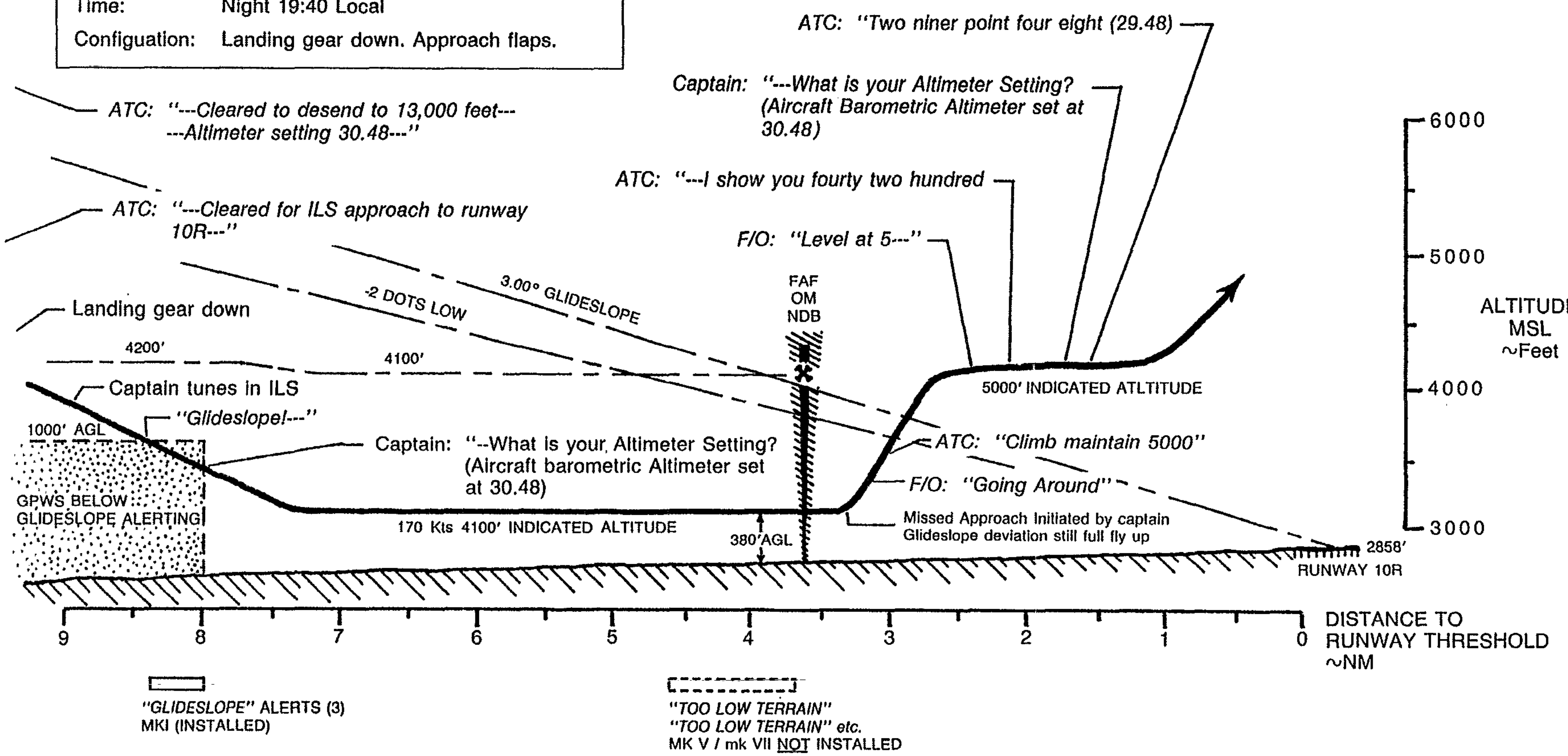
FLIGHT PATH PROFILE

B737-200
Boise, Idaho
17 February, 1990

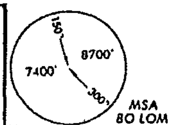
Circumstances:	While on an ILS approach to runway 10R, the aircraft inadvertantly was 1000 feet below the Final Approach Fix, with both altimeters indicating 4100 feet. On the missed approach, it was discovered that the altimeter settings were incorrect!
Weather:	Ceiling 300 feet, visibility 2 miles with fog.
Time:	Night 19:40 Local
Configuation:	Landing gear down. Approach flaps.



Return to TOC

- ATIS 123.9
- BOISE Approach (R) 119.6
- BOISE Tower Rwy 10R/28L 118.1
  Rwy 10L/28R 119.0
- Ground 121.7

BOISE Radio (AAS) CTAF 118.1 when Twr inop.



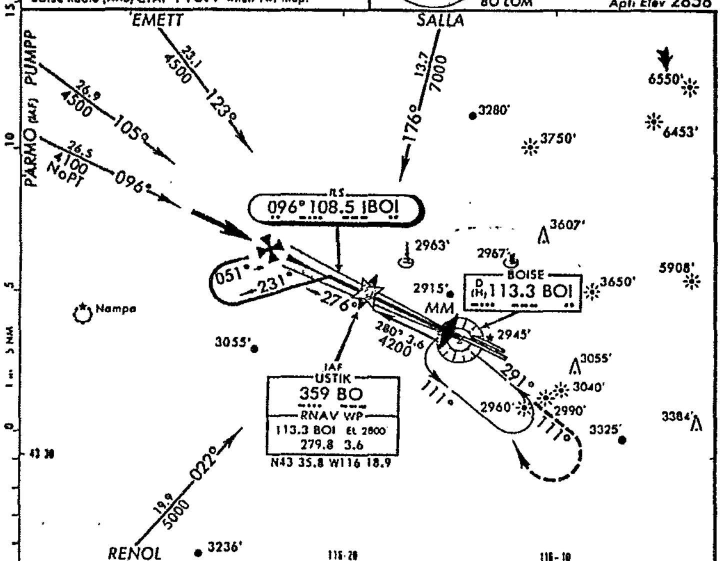
BOISE, IDAHO

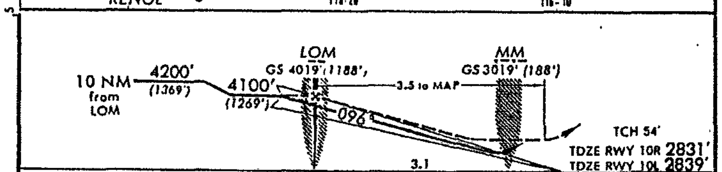
BOISE AIR TERM.

ILS Rwy 10R

LOC 108.5 IBOI

Apt Elev 2858'





MISSED APPROACH: Climb to 3900' via outbound BOI VOR R-111 within 6 NM then climbing RIGHT turn to 6000' direct BOI VOR and hold.

	STRAIGHT-IN LANDING RWY 10R — ILS DH 3031' (200')		DH 3081' (250')	LOC (GS out) MDA 3120' (289')				SIDESTEP LANDING RWY 10L MDA 3120' (281')	CIRCLE-TO-LAND NA North of Rwy 10L-28R MDA
	FULL	RAIL or ALS out	MM out		MM out	RAIL out	ALS out		
A	RVR 24 or ½	RVR 40 or ¾	RVR 24 or ½	RVR 24 or ½		RVR 40 or ¾	RVR 50 or 1	1	3260' (402')-1
B									3320' (462')-1
C								1½	3320' (462')-1½
D			RVR 40 or ¾	RVR 40 or ¾	RVR 50 or 1			2	3420' (562')-2

Gnd speed-Kts		70	90	100	120	140	160
GS	3.00°	377	484	538	646	753	861
LOM to MAP	3.5	3:00	2:20	2:06	1:45	1:30	1:19

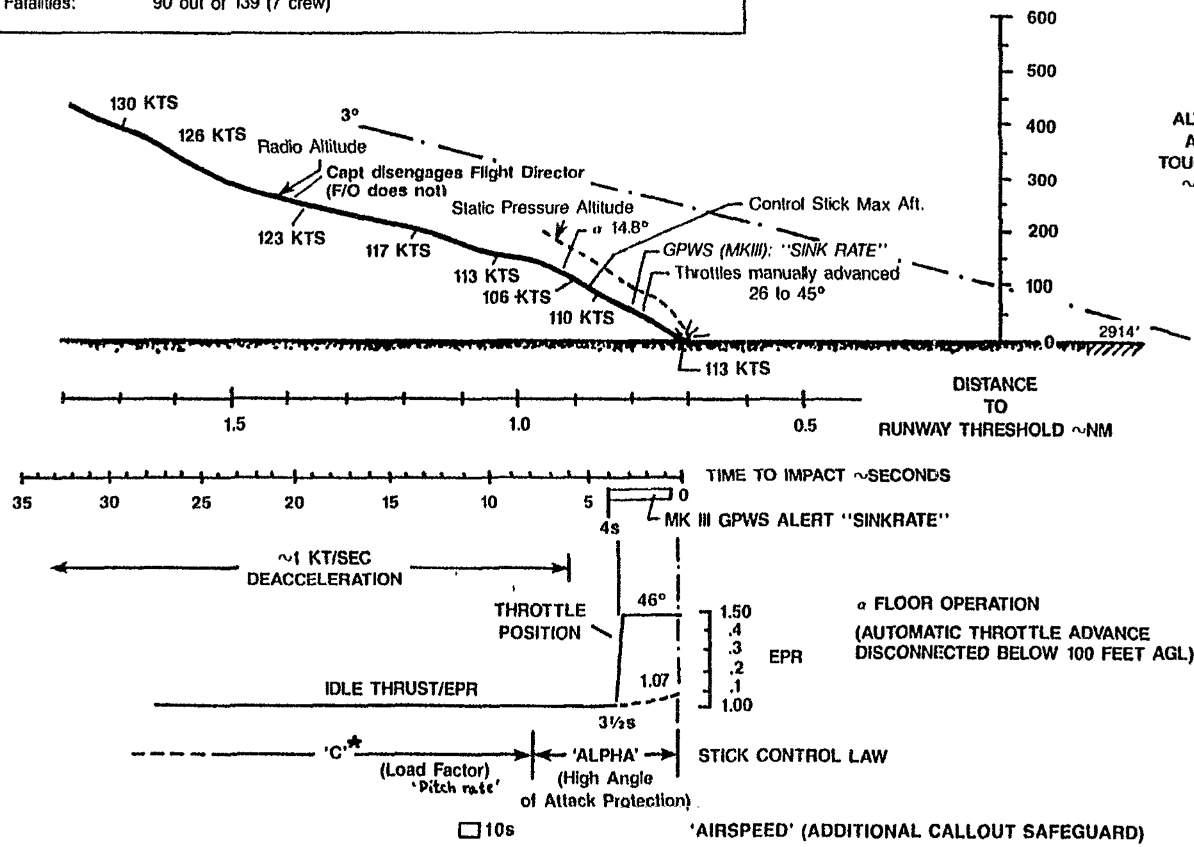
Return to TOC

Flight Path Profile

A-320
BANGALORE, INDIA
14 FEBRUARY, 1990

Circumstances:	While on a visual approach, the aircraft ran out of flying speed and hit short into a golf course, bounced, hit some trees and an embankment, possible distraction by F/O (more experienced A320 captain).
Weather:	Not a factor.
Configuration:	Landing gear down, flaps 30
Engines:	V2500
Fatalities:	90 out of 139 (7 crew)

NOTE: The AFS Altitude Acquisition Mode was inadvertantly activated for "700". (The airfield elevation was 2,914 feet). The pilot had meant instead, to activate the Vertical Speed Mode for "700" feet per minute descent. The pilot also inadvertantly set the vertical mode to "Open Descent" instead of a Speed Select Mode. The Auto Thrust (FMGS) went from Speed Mode to Thrust Idle Mode.

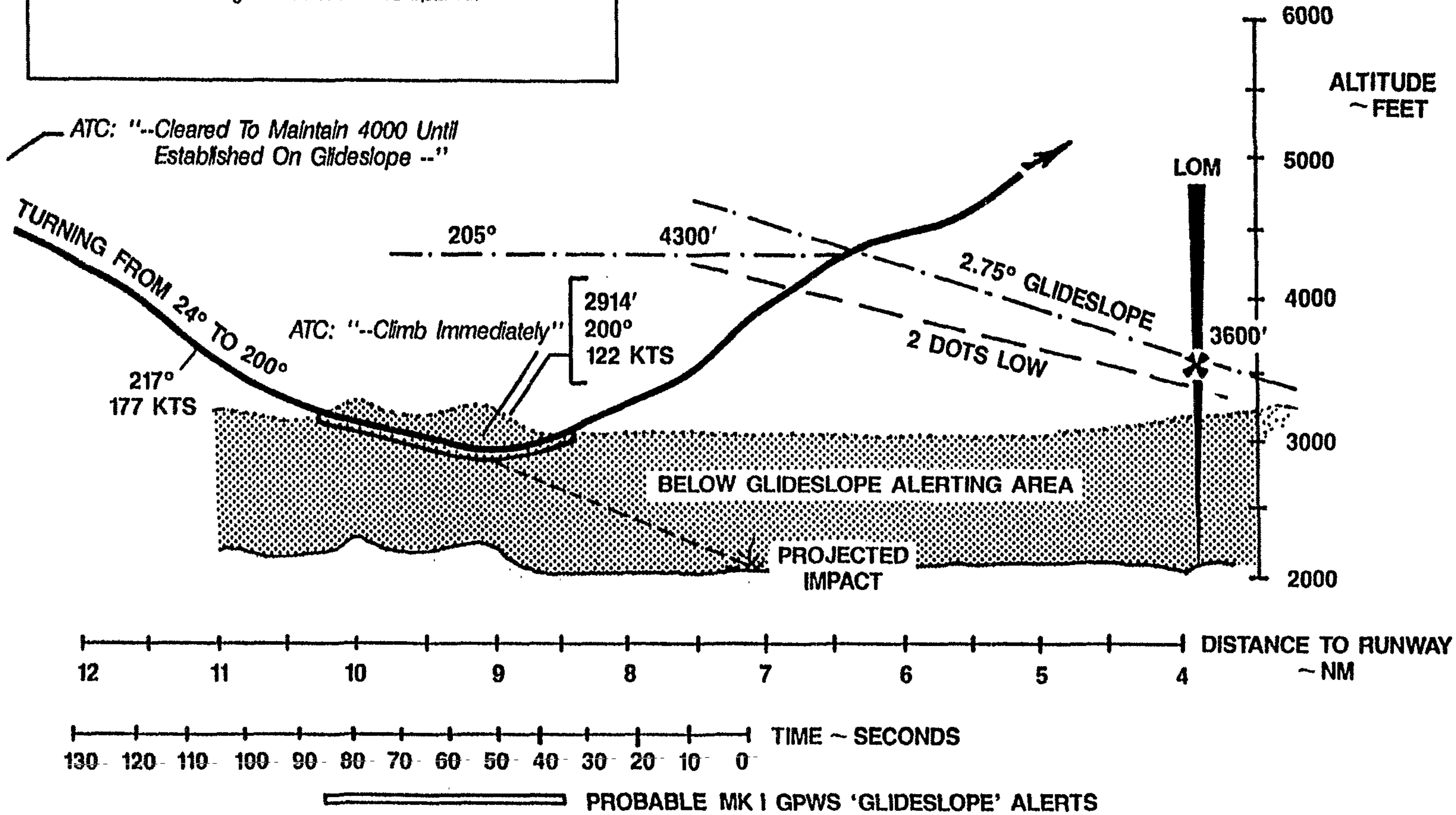


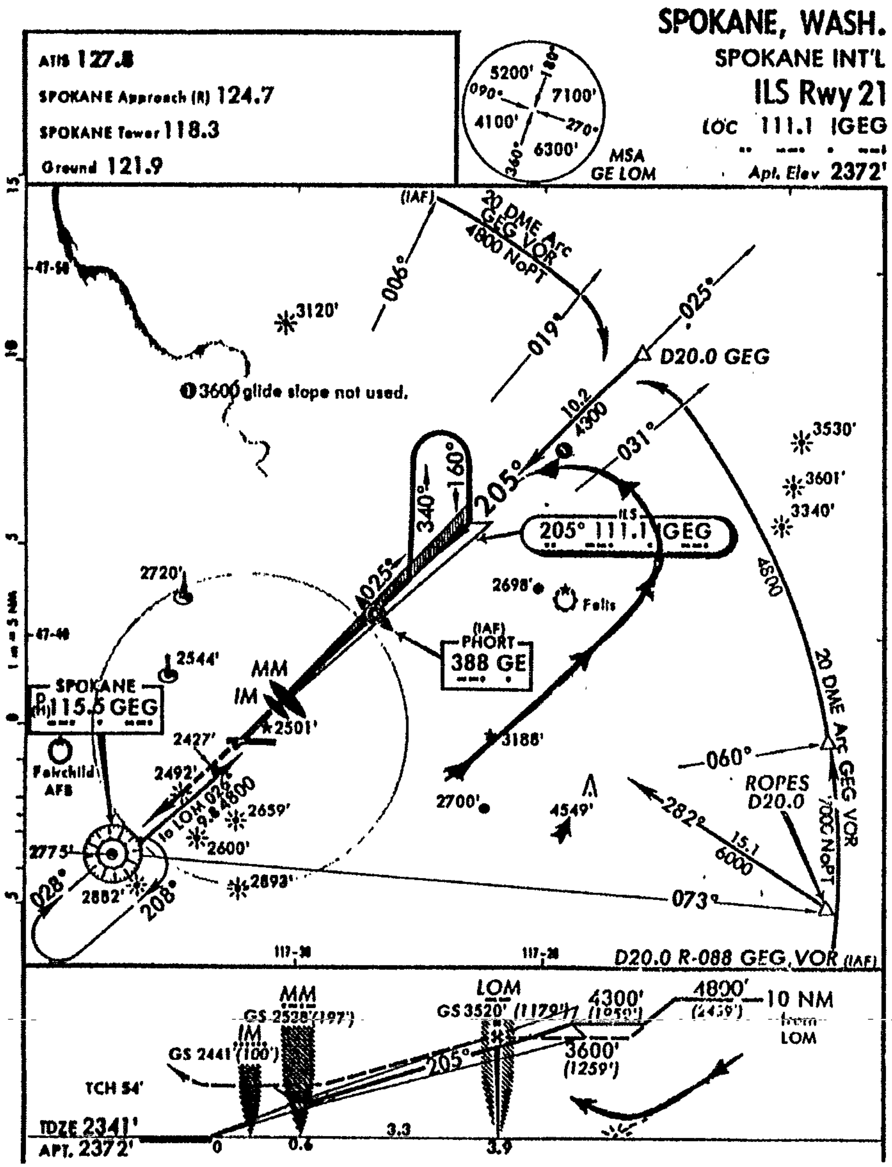
Next Page

Flight Path Profile

APPROACH INCIDENT
SPOKANE, WASHINGTON
B727-200
27 JANUARY, 1990

Notes: Radar Vectors To ILS 21. Night. 2400 RVR Blowing Snow. MK I GPWS Installed.





Aircraft descended below the glideslope in IMC weather. There was a possible subtle incapacation of the Captain at first not recognized by himself or the other cockpit crew members. Suggestions and limited corrective actions by both F/O and F/E initially rejected by Captain until the GPWS below 'glideslope' alert and ATC action.

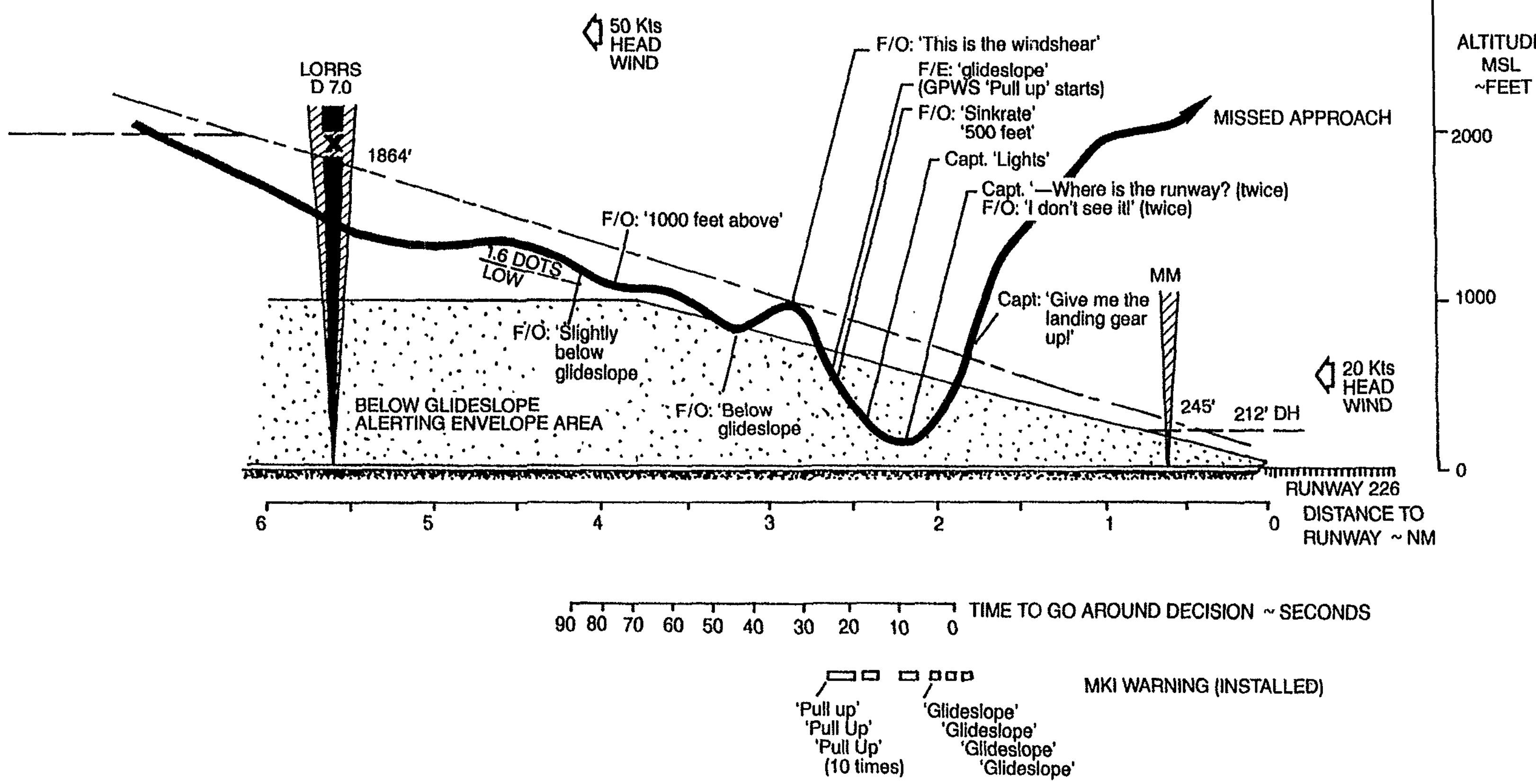
Next Page

90-282

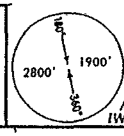
Circumstances:	Weather, ATC delays, fuel concerns, all added pressure to the crew to make a successful approach and landing to runway ILS 226. The approach was manual and unassisted by Flight Director or Autopilot, and became instabilized during the last 3 NM resulting in considerable GPWS warnings and a fateful missed approach which resulted minutes later in fuel exhaustion. The argument is for "specific GPWS training and updated GPWS equipment, where if the crew had properly responded to the GPWS alerts and re-established a normal ILS glideslope profile, they would have arrived at the decision height where the runway environment would have been in view to complete a successful landing."
Fatalities:	73

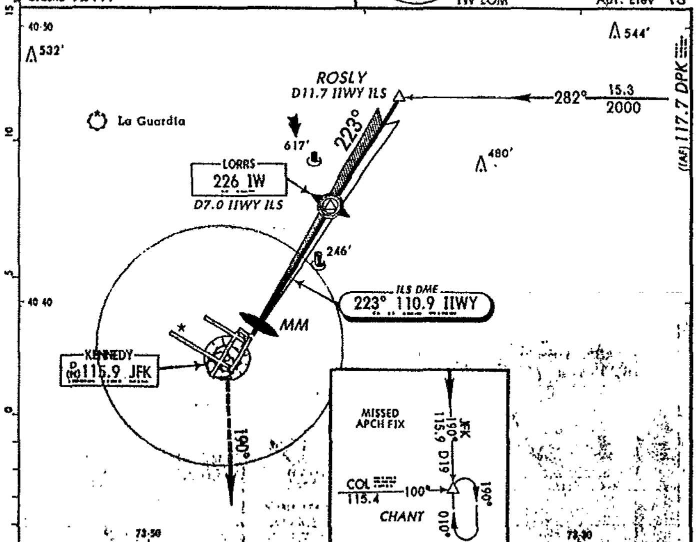
FLIGHT PATH PROFILE

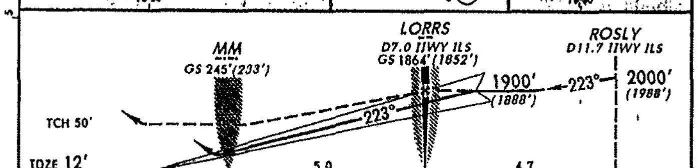
B707-320
JFK, New York
25 January 1990



ATIS Arrival (NE) 117.7 (SW) 115.4	NEW YORK, NY
NEW YORK Approach (R) 127.4	KENNEDY INTL
KENNEDY Tower 119.1	ILS, Rwy 22L
Ground 121.9	LOC 110.9 IIWY
	Apt. Elev 13'







MISSED APPROACH: Climb to 500' then climbing LEFT turn to 3000' outbound via JFK VOR R-190 to CHANT INT/D19.0 and hold.

	STRAIGHT-IN LANDING RWY 22L ILS DH 212'(200') FULL	TDZ or CL out	RAIL or ALS out	DH 262'(250') MM out	LOC (GS out) MDA 440'(428')	RAIL out	ALS out		CIRCLE-TO-LAND MDA
A	RVR 18 or 1/2	RVR 24 or 1/2	RVR 40 or 3/4	RVR 24 or 1/2	RVR 24 or 1/2	RVR 40 or 3/4	RVR 50 or 1	A	580'(567')-1
B	RVR 18 or 1/2	RVR 24 or 1/2	RVR 40 or 3/4	RVR 24 or 1/2	RVR 24 or 1/2	RVR 40 or 3/4	RVR 50 or 1	B	580'(567')-1
C	RVR 18 or 1/2	RVR 24 or 1/2	RVR 40 or 3/4	RVR 24 or 1/2	RVR 40 or 3/4	RVR 60 or 1 1/4		C	580'(567')-1 1/2
D	RVR 20 or 1/2	RVR 24 or 1/2	RVR 40 or 3/4	RVR 40 or 3/4	RVR 50 or 1	1 1/2		D	620'(607')-2

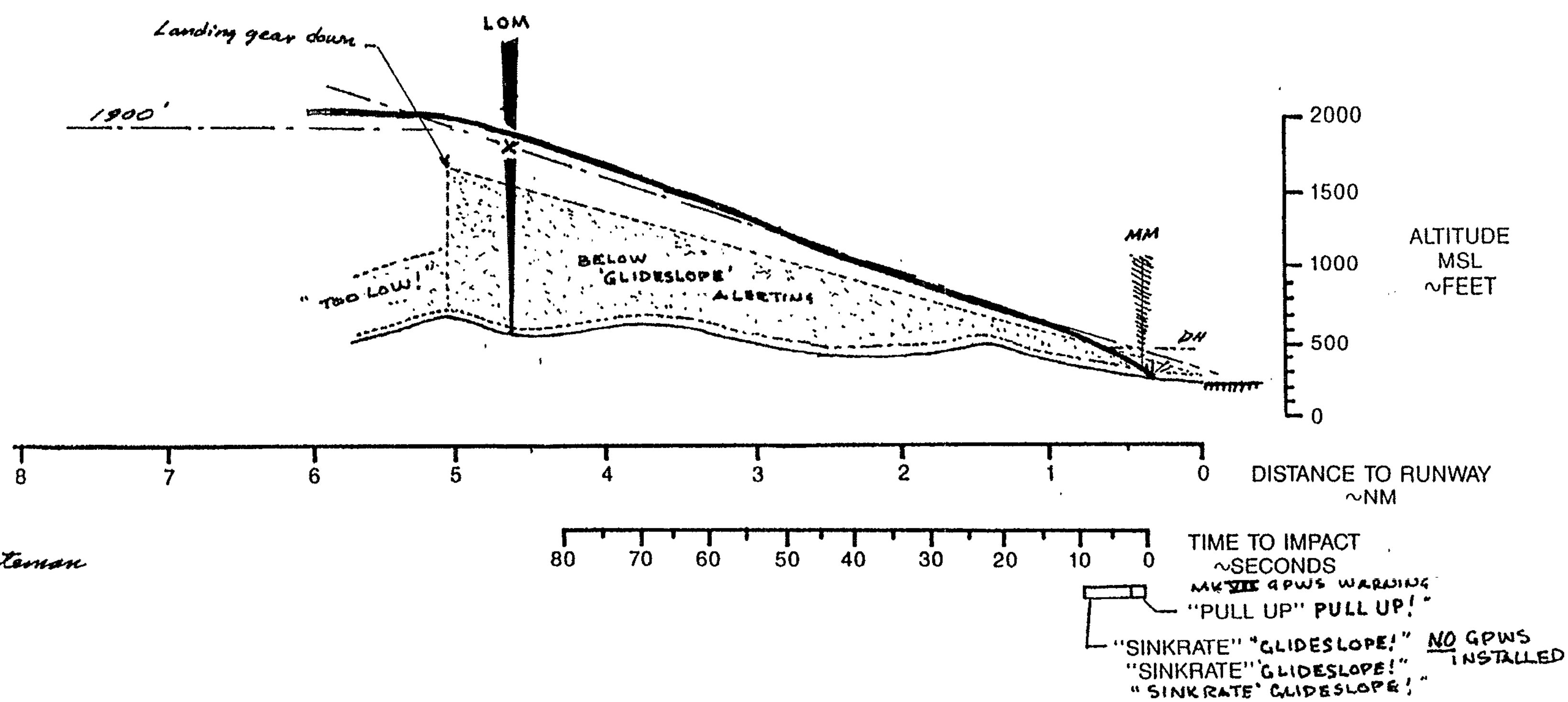
Gnd speed-Kts	70	90	100	120	140	160
GS 3.00°	378	486	540	648	756	864
LORRS to MAP 5.6	4:48	3:44	3:22	2:48	2:24	2:06

Circumstances:	While on an ILS appraoch to runway 04, the aircraft impacted 9.5 NM short of the runway threshold.
Weather:	IMC - x200, visibility 1/4 mile, wind 180/06 46F, dewpoint 45 F.
Time:	17:10 local
Configuration:	Landing
Fatalities:	7
Other:	Both pilots had very high time prop aircraft experience, but only 160 hours in type and their first jet.

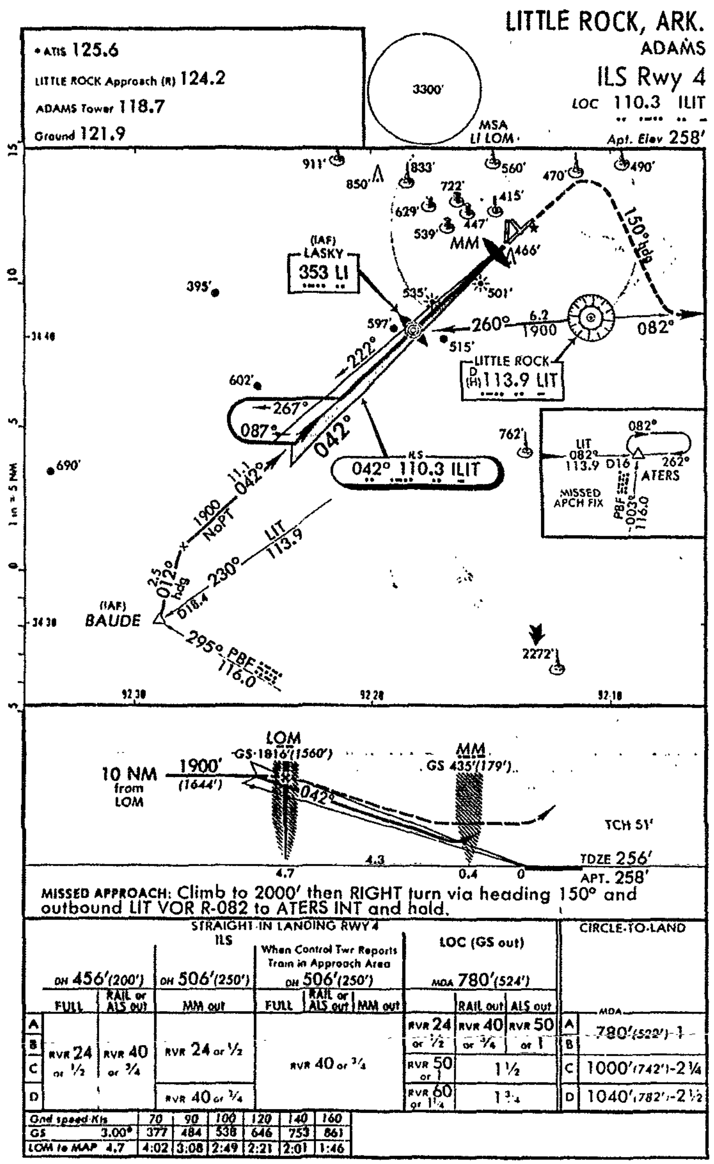
NO GPWS Installed.

Flight Path Profile
G-II
LITTLE ROCK, ARKANSAS
19 January, 1990

Next Page



Don Bateman



Seattle Times 20 Jan 1990

Seven are killed when jet crashes at Ark. airport

■ LITTLE ROCK, Ark.

A twin-engine corporate jet crashed short of a Little Rock municipal airport runway in a storm late yesterday, killing all seven people aboard, authorities said.

The 21-seat Gulfstream II jet, carrying employees of an Eastman Kodak Co. subsidiary, apparently was attempting a landing, witnesses said.

Seven bodies were recovered from the wreckage, said Coroner Steve Nawojczyk. He said there were no survivors.

The plane hit guidance lights short of the airport, hit a street near an airport intersection, struck railroad tracks and a fence, losing a wing and wheel, and plowed 200 feet into airport property without reaching the runway, said Bill Booker, who was at the scene.

Heavy rain and lightning swept through the area about the time of the crash.

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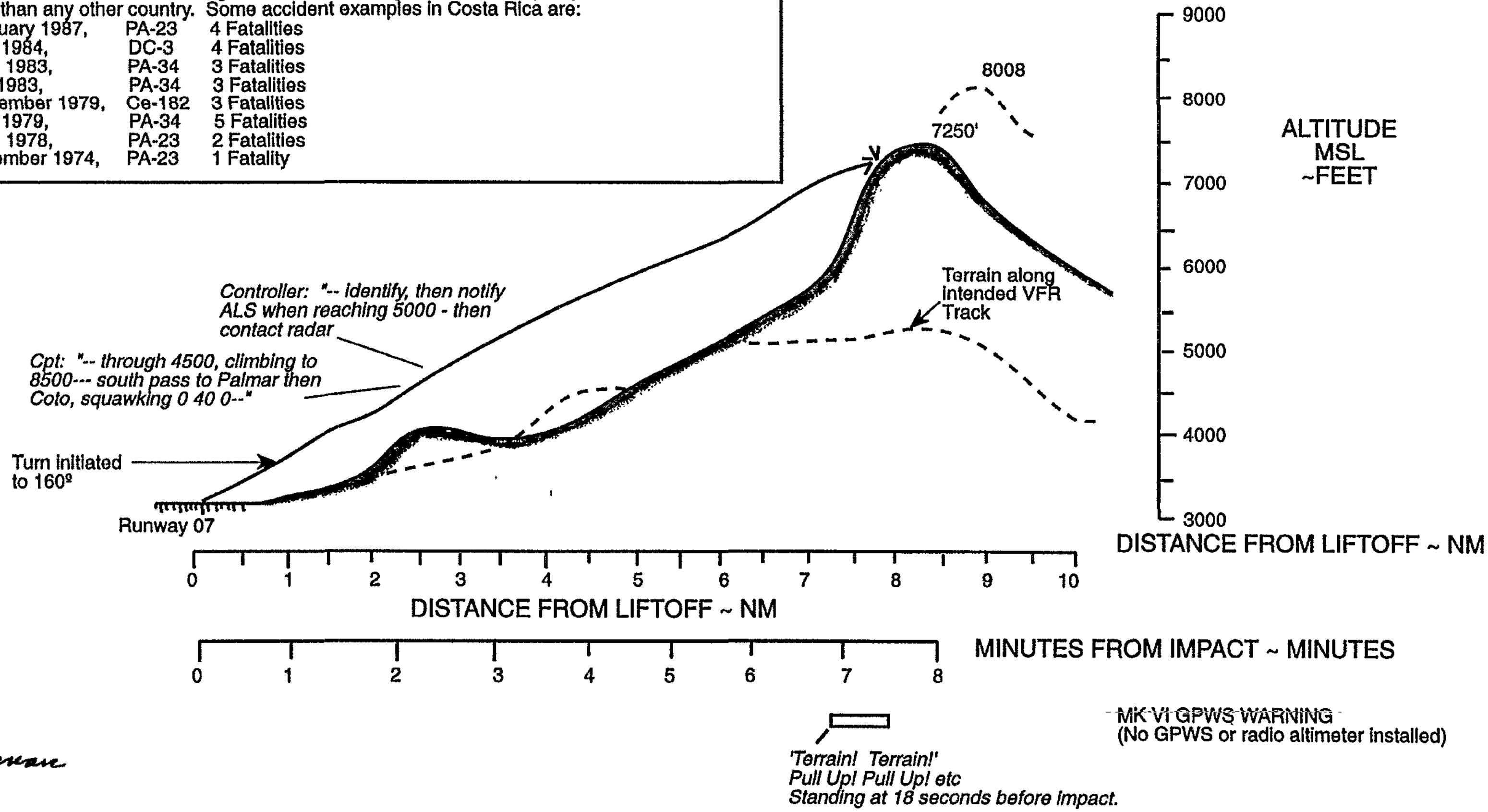
Flight Path Profile
C-212
SAN JOSE, COSTA RICA
15 January, 1990

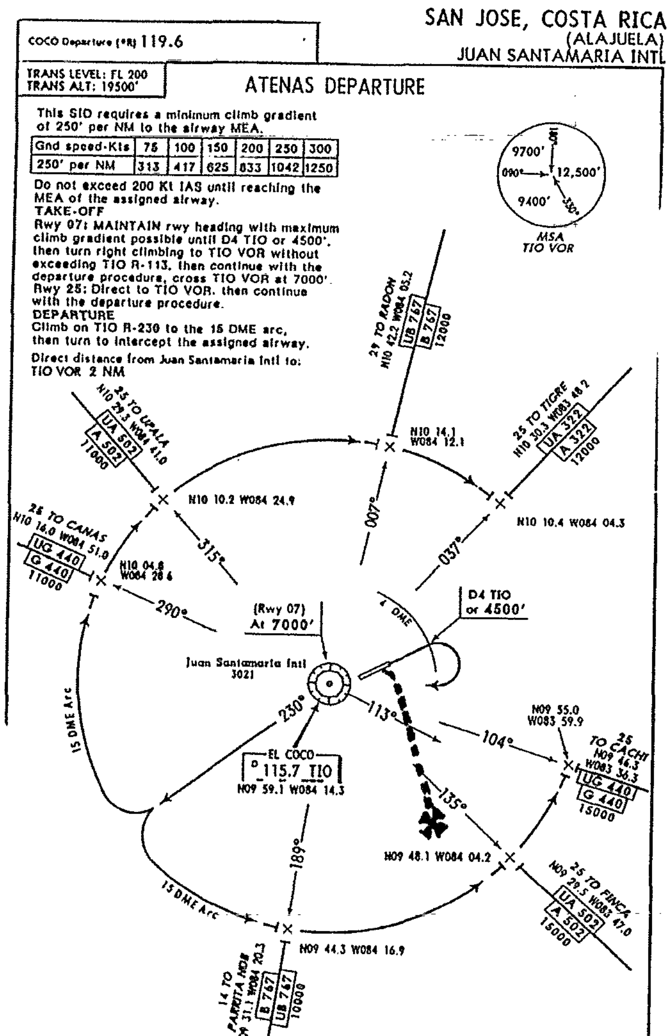
CIRCUMSTANCES:	This was a scheduled flight to Palmar Sur and Coto 47 to the south. The flight departed on a VFR flight plan. But after departing runway 07 and while climbing to 8500 feet, the aircraft entered IMC weather. Unfortunately the aircraft was slightly east of the intended track, and the aircraft impacted the westerly flank of Cerro Cedral at 7,250 feet...
TIME:	08:30 local
FATALITIES:	23
OTHER:	No radio altimeter or GPWS installed

NOTE: Every year, world wide, there are many accidents where the aircraft in VFR flight rules is flown into terrain after encountering instrument metrological conditions (IMC). Costa Rica is no different than any other country. Some accident examples in Costa Rica are:

27 February 1987,	PA-23	4 Fatalities
19 April 1984,	DC-3	4 Fatalities
12 June 1983,	PA-34	3 Fatalities
12 April 1983,	PA-34	3 Fatalities
24 September 1979,	Ce-182	3 Fatalities
8 April 1979,	PA-34	5 Fatalities
21 June 1978,	PA-23	2 Fatalities
24 December 1974,	PA-23	1 Fatality



Don Bateman



WORLD

Seattle Times 16 Jan 1990

Airliner crash kills 23 in Costa Rica

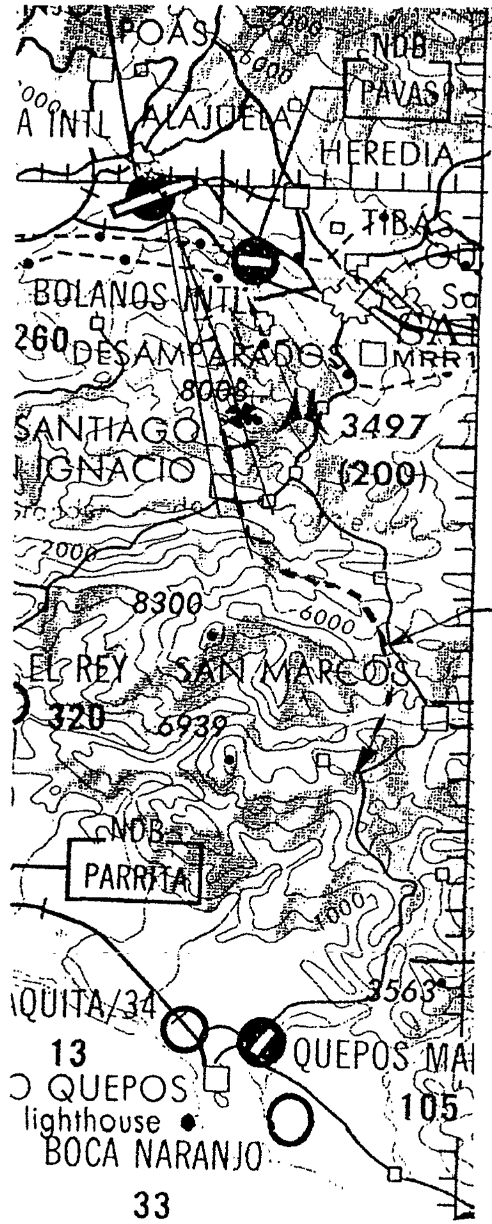
■ SAN JOSE, Costa Rica

A twin-engine propeller-driven airliner carrying 23 people crashed into a mountain in stormy weather shortly after takeoff and everyone on board was killed, officials said.

Carlos Jimenez, a spokesman for the Public Security Ministry, said the plane crashed into 1,500-foot Pico Blanco, about 10 miles southwest of the San Jose airport. He said 10 passengers were foreigners.

A rescue patrol that reached the crash site at 9 p.m. yesterday, about 12 hours after the crash, recovered all 23 bodies, said Juan Felix Barrantes, head of the Civil Guard.

The Spanish-built twin-engine commuter plane belonged to Servicios Aereos Nacionales. It had a Costa Rican crew of three.



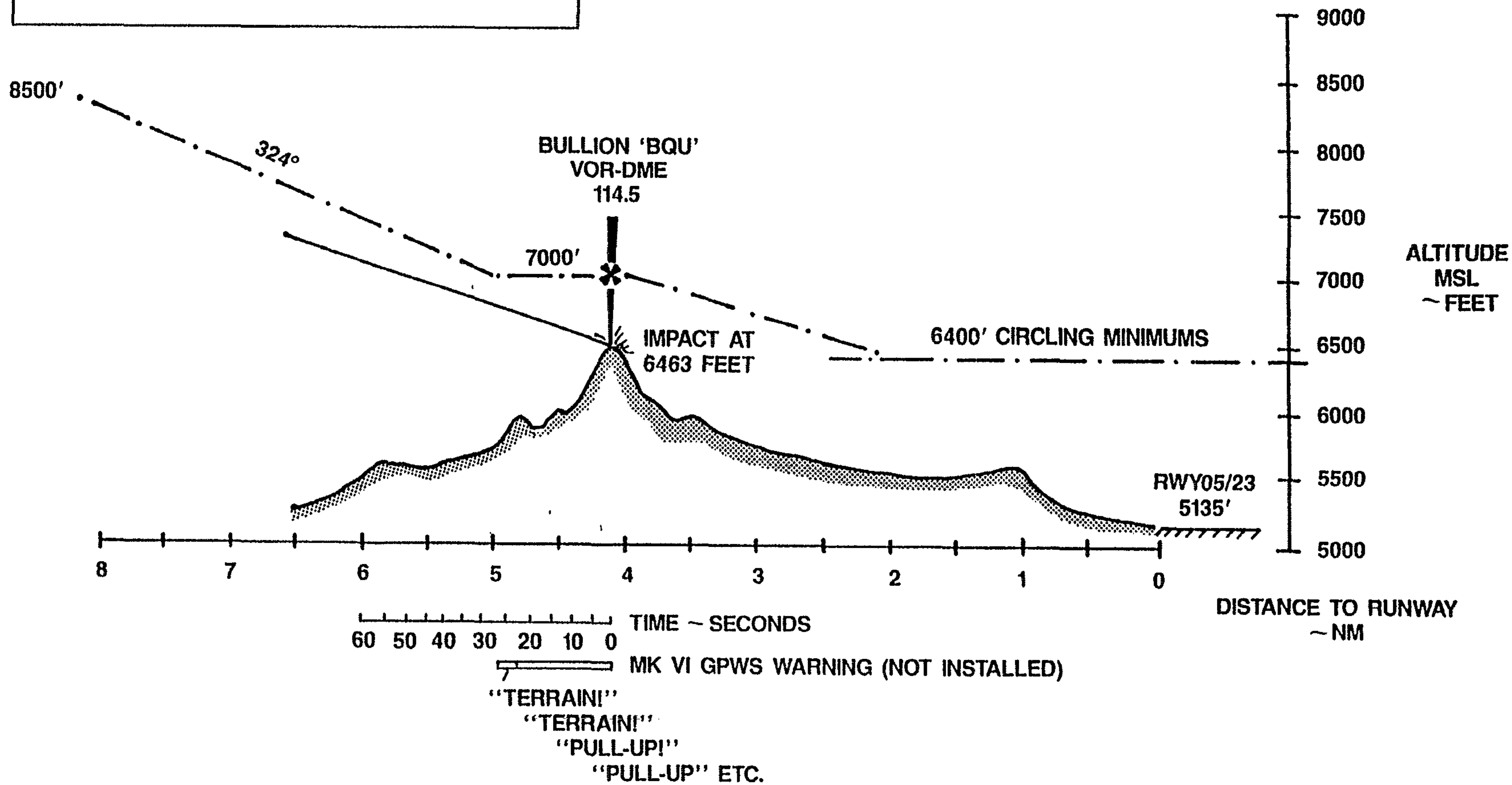
Intended VFR Route

Flight Path Profile

Next Page

METRO III
ELKO, NEVADA
15 JANUARY, 1990

Notes:	Aircraft Clipped Top Of Mountain And Crashed During Instrument VOR-A Approach
Weather:	IMC In A Snowstorm
Fatalities:	16 On Board, But No Fatalities!



'Miracle': All aboard survive air crash

Commuter plane hit mountaintop, then slid

Associated Press
and Times staff

ELKO, Nev. – All 16 people aboard a commuter plane survived after it hit a mountaintop yesterday during a snowstorm and plunged down a hillside in a crash landing some passengers called a miracle

"We started bumping up and down, and I didn't know where we were or what was happening," said Nicole Blohm, a 20-year-old passenger. "Apparently we were sliding down the mountain at that time. I knew we had crashed. I was thinking, 'This is it.' "

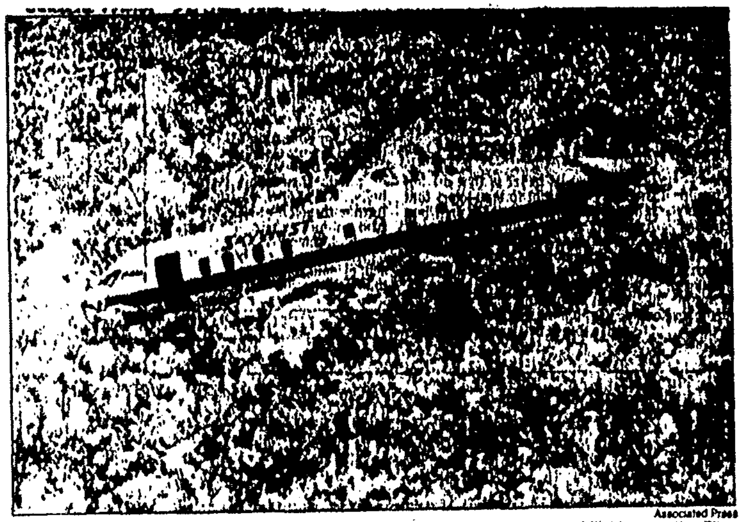
Most of the passengers walked away from the crash after the plane, Flight 5855, went down four miles west of the airport in Elko. The plane was bound for Reno from Salt Lake City via Elko.

Four people were admitted to Elko General Hospital in fair condition, and 12 others were treated and released, according to a nursing supervisor.

The captain, who suffered a broken leg and at least two broken ribs, was the most seriously injured, the hospital said.

"I think it is a miracle none of us died," said 18-year-old Kristina Blohm, Nicole's sister.

The year-old Metro III twin-engine plane, carrying 14 passengers and two crew members, crashed when the pilot was attempting an instrument landing during the snowstorm.



Associated Press

The wingless, tailless wreckage of a SkyWest commuter plane lies on a snowy hillside near the Elko, Nev., airport after clipping a mountaintop.

Helicopter pilot Ted McBride, who sighted the wreckage, said the plane appears to have clipped the top of a 6,463-foot mountain.

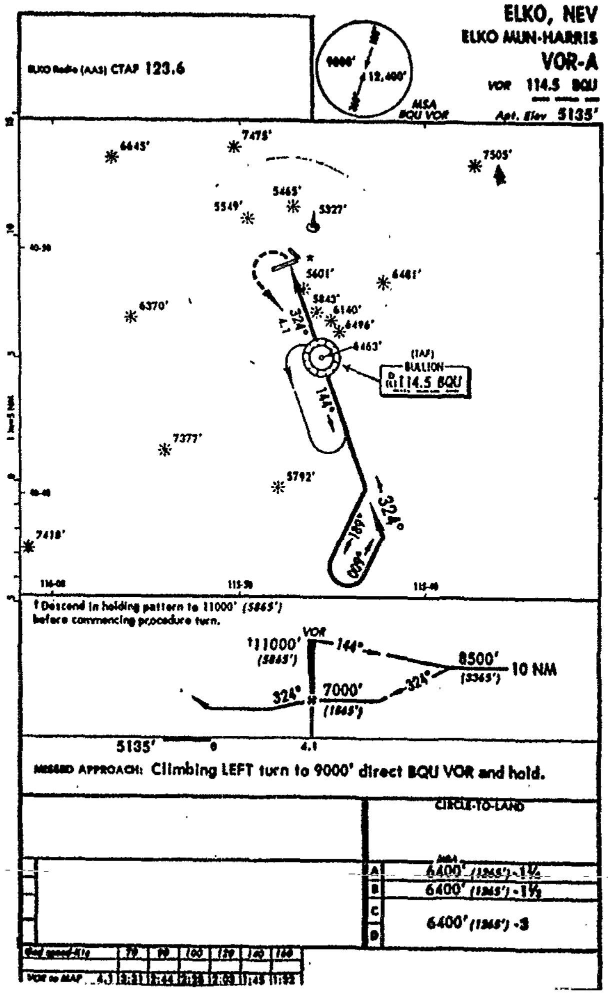
The plane then became airborne briefly before skidding about a quarter of a mile down the steep slope.

No one aboard was thrown from the plane, and its fuselage was intact on the mountain.

There was no immediate indication of what caused the crash, SkyWest President Jerry Atkin said in St. George, Utah, where the airline is based. But he said the plane was 500 feet lower than the pilot believed.

SkyWest serves 44 cities in Nevada, Wyoming, Montana, Idaho, Colorado, Utah, Arizona and California.

In Colorado yesterday, a fire broke out in an engine of an Aspen Airways plane shortly after takeoff. The Convair 580 propjet returned safely to the Grand Junction airport for an emergency landing, officials said. None of the 26 passengers was injured.



FLIGHT PATH PROFILE
BAe Jetstream 31
Pasco, Washington
26 December, 1989

Next Page

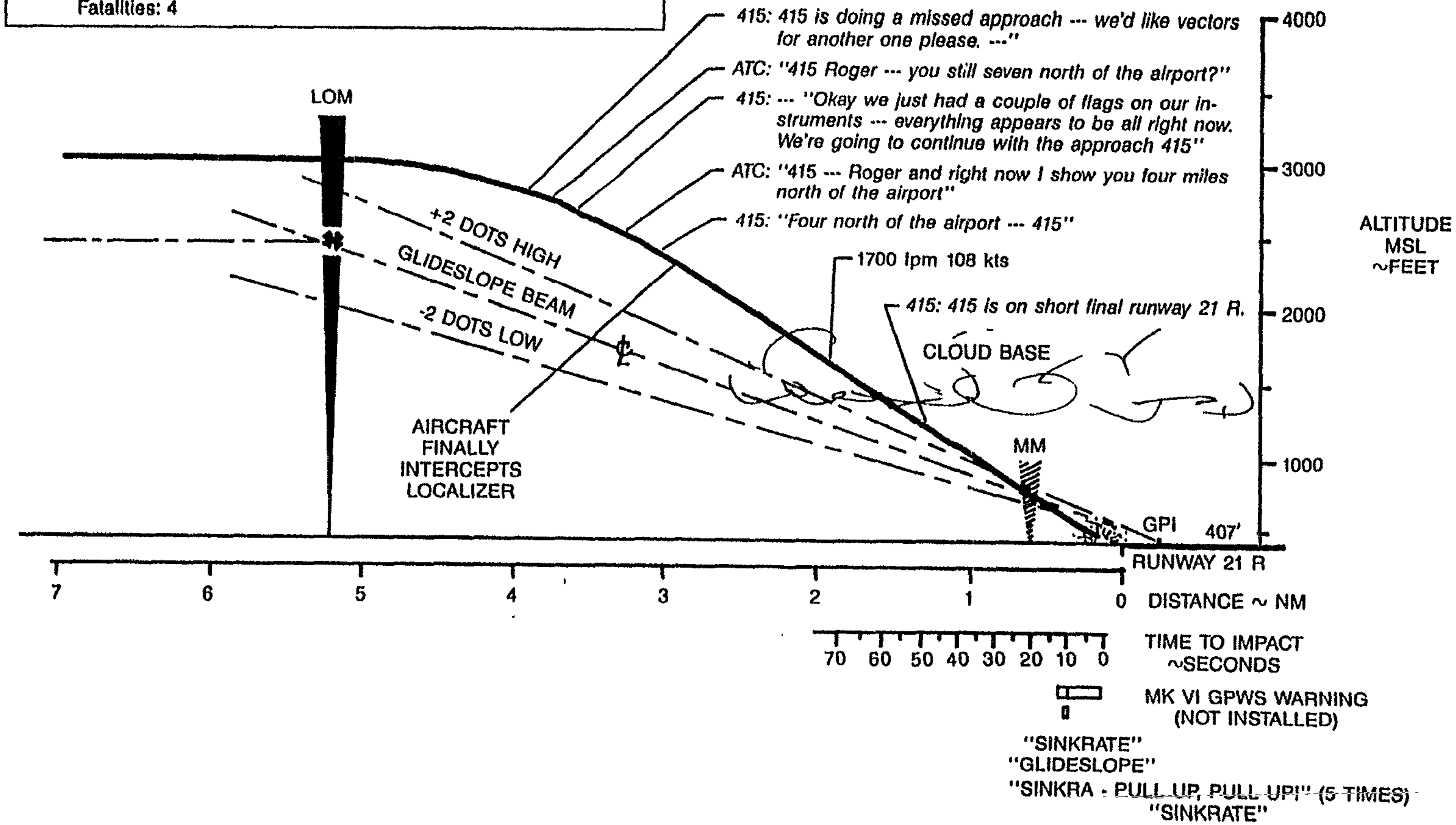
Circumstances: Aircraft hit 600 feet short on an instrument approach to runway 21 R. Aircraft intercepted Localizer 2 NM inside outer marker.

Time: 22:30 PST

Weather: 14 ⊕

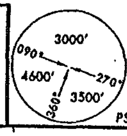
Configuration: Landing

Fatalities: 4

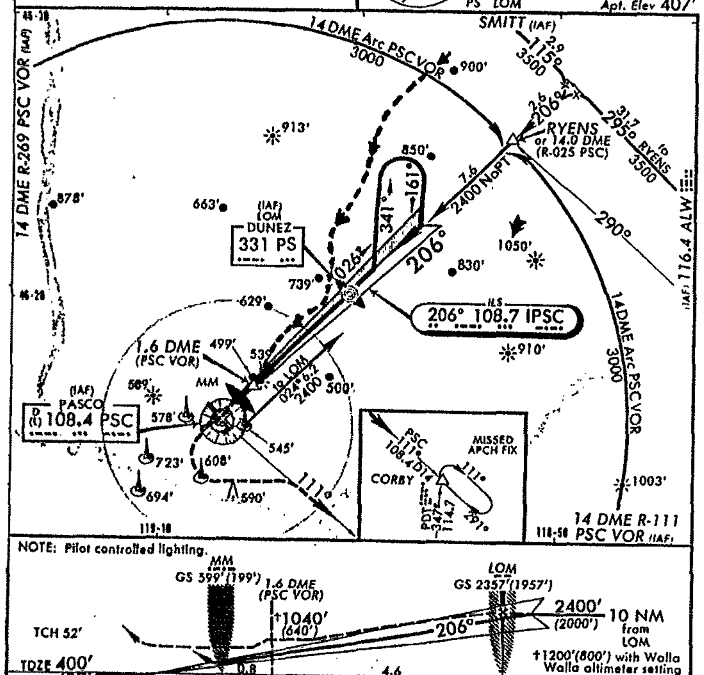


91-18

•ATIS 125.65
SEATTLE Center(R) 125.0
•PASCO Tower CTAF 118.2
•Ground 121.8
When Control Zone not effective & without approved weather service, use Walla Walla altimeter setting.



PASCO, WASH.
TRI-CITIES
ILS Rwy 21R
LOC 108.7 IPSC
Apt. Elev 407'



MISSED APPROACH: Climb to 800' then climbing LEFT turn to 3100' via outbound PSC VOR R-111 to CORBY INT and hold.

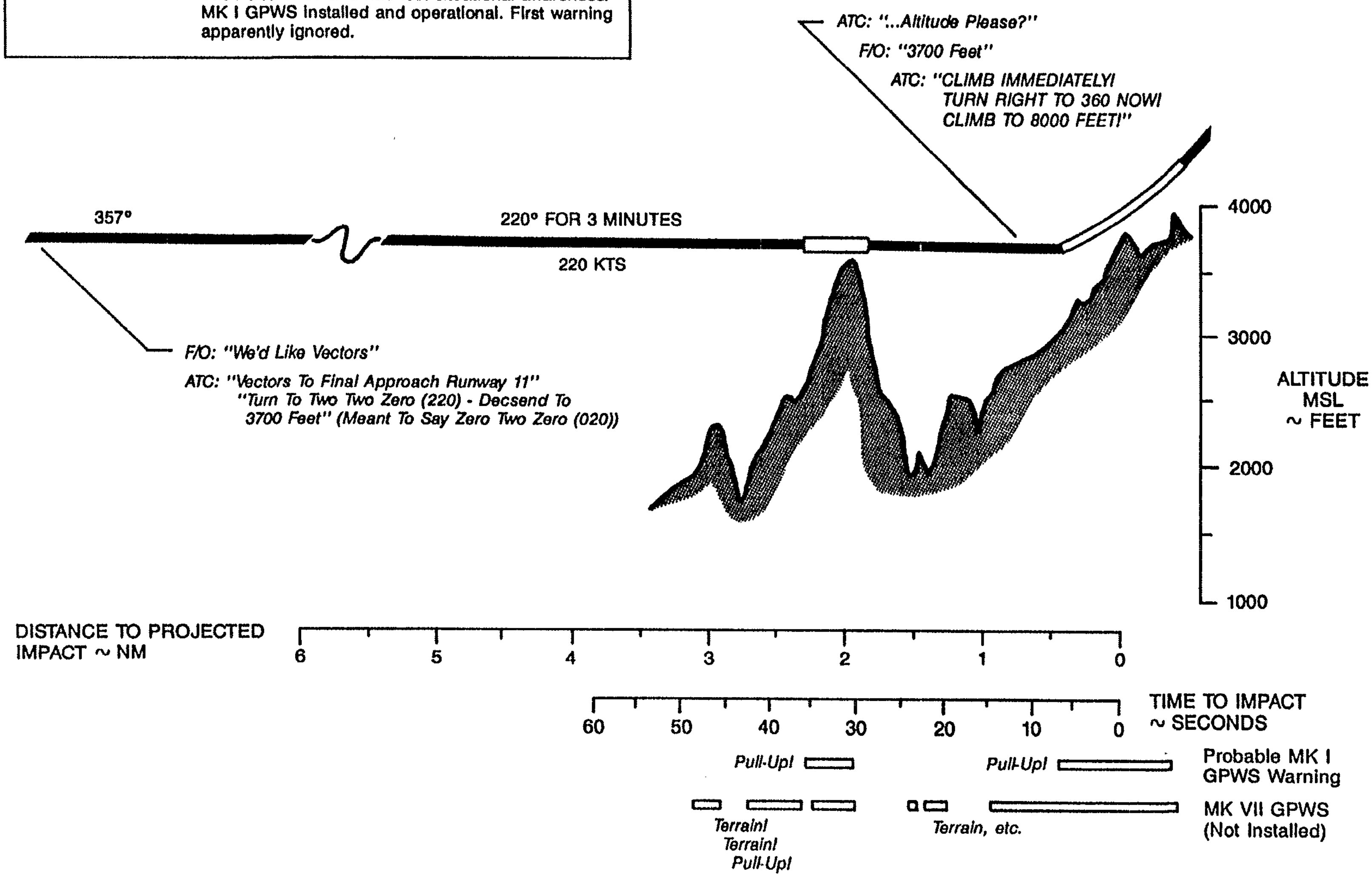
<table>
<tr><th colspan="11">STRAIGHT-IN LANDING RWY 21R</th></tr>
<tr><th rowspan="2"></th><th colspan="3" rowspan="2">ILS</th><th colspan="7">LOC (GS out)</th></tr>
<tr><th colspan="4">With 1.6 DME</th><th colspan="3">Without 1.6 DME</th></tr>
<tr><td></td><td colspan="10">Control Zone Effective or With Approved Weather Service</td></tr>
<tr><td></td><td colspan="2">DH 600'(200')</td><td>DH 650'(250')</td><td colspan="4">MDA 800'(400')</td><td colspan="3">MDA 1040'(640')</td></tr>
<tr><td></td><td colspan="10">With Walla Walla Altimeter Setting</td></tr>
<tr><td></td><td colspan="2">DH 760'(360')</td><td>DH 760'(360')</td><td colspan="4">MDA 960'(560')</td><td colspan="3">MDA 1200'(800')</td></tr>
<tr><td></td><td>FULL</td><td>RAIL or ALS out</td><td>MM out</td><td></td><td>MM out</td><td>RAIL out</td><td>ALS out</td><td></td><td>RAIL out</td><td>ALS out</td></tr>
<tr><td>A</td><td rowspan="4">½</td><td rowspan="4">¾</td><td rowspan="3">½</td><td colspan="2" rowspan="3">½</td><td rowspan="3">¾</td><td rowspan="3">1</td><td rowspan="2">½</td><td rowspan="2">¾</td><td rowspan="2">1</td></tr>
<tr><td>B</td></tr>
<tr><td>C</td><td>1¼</td><td colspan="2">1¾</td></tr>
<tr><td>D</td><td>¾</td><td>¾</td><td>1</td><td colspan="2">1¼</td><td>1½</td><td colspan="2">2</td></tr>
</table>

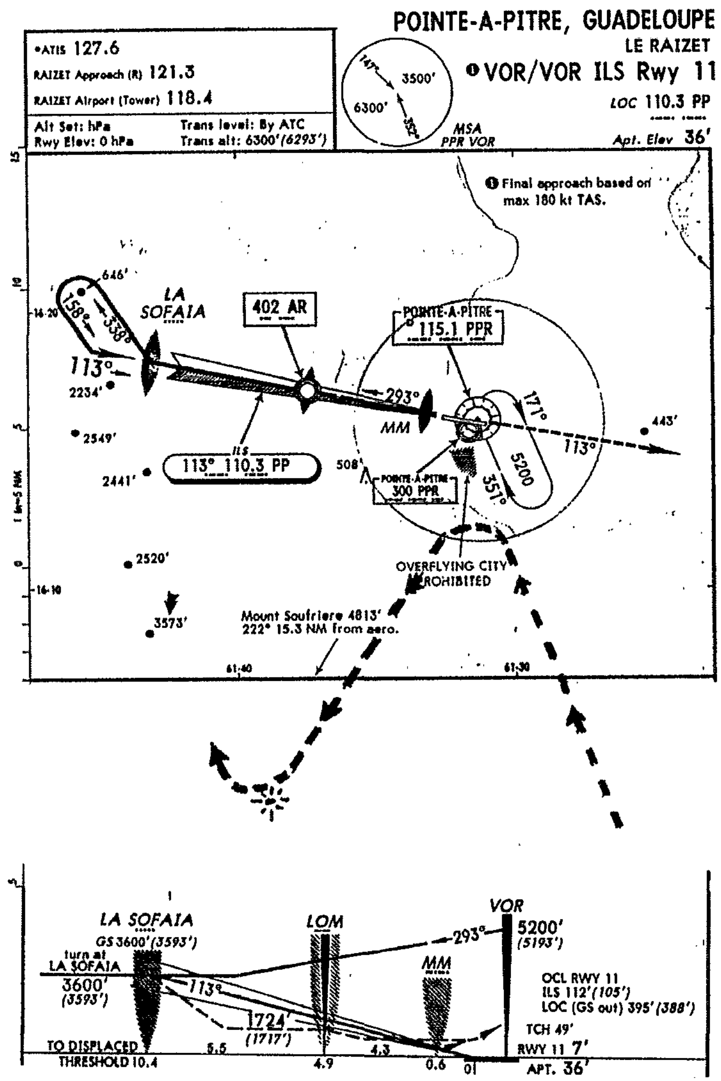
CIRCLE-TO-LAND	With 1.6 DME	Without 1.6 DME
CZ Eff or With Approved Wx Service	MDA	MDA
A, B	880'(473')-1	1040'(633')-1
C	880'(473')-1½	1040'(633')-1¾
D	1040'(633')-2	1040'(633')-2
With Walla Walla Altimeter Setting	MDA	MDA
A, B	1040'(633')-1	1200'(793')-1
C	1040'(633')-1½	1200'(793')-1¾
D	1200'(793')-2	1200'(793')-2

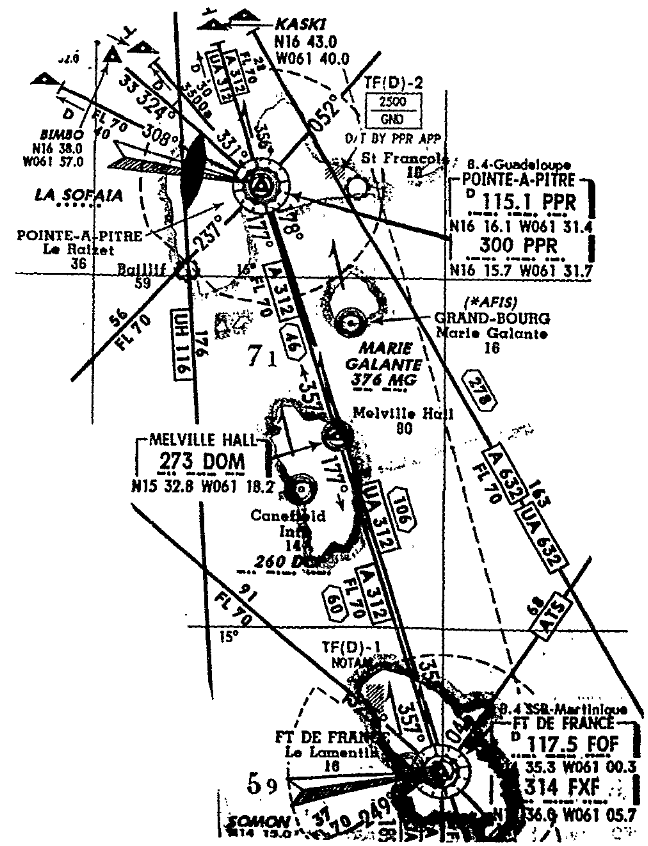
Next Page

FLIGHT PATH PROFILE
B747-200
Pointe-A-Pitre, Guadeloupe
December, 1989

Circumstances:	While under radar vectors for runway 11, aircraft missed the slopes of Mt. Soufriere by an estimated 100 feet. Controller error not detected by flight crew.
Time:	Daylight
Weather:	Cloudy - Base 20, Top 60, Cumulus 90
Configuration:	Clean
Other:	Crew very fatigued and apparently did not read back clearance and had lost situational awareness. MK I GPWS installed and operational. First warning apparently ignored.




POINTE-A-PITRE, GUADELOUPE
LE RAIZET
VOR/VOR ILS Rwy 11
LOC 110.3 PP
Apt. Elev 36'
ATIS 127.6
RAIZET Approach (R) 121.3
RAIZET Airport (Tower) 118.4
Alt Set: hPa
Rwy Elev: 0 hPa
Trans level: By ATC
Trans alt: 6300'(6293')
MSA PPR VOR
3500'
6300'
Final approach based on max 180 kt TAS.
LA SOFAIA
402 AR
POINTE-A-PITRE 115.1 PPR
113° 110.3 PP
POINTE-A-PITRE 300 PPR
OVERFLYING CITY PROHIBITED
Mount Soufriere 4813' 222° 15.3 NM from aero.
LA SOFAIA
LOM
MM
VOR
GS 3600'(3593')
turn at LA SOFAIA
3600' (3593')
5200' (5193')
1724' (1717')
OCL RWY 11
ILS 112'(105')
LOC (GS out) 395'(388')
TCH 49'
RWY 11 7'
APT. 36'
TO DISPLACED THRESHOLD 10.4


KASKI
N16 43.0
W061 40.0
BIMBO
N16 38.0
W061 57.0
LA SOFAIA
TF(D)-2
2500
GND
O/T BY PPR APP
St Francois
POINTE-A-PITRE
115.1 PPR
N16 16.1 W061 31.4
300 PPR
N16 15.7 W061 31.7
POINTE-A-PITRE
Le Raizet
36
(*AFIS)
GRAND-BOURG
Marie Galante
16
MARIE GALANTE
376 MG
Melville Hall
80
MELVILLE HALL
273 DOM
N15 32.8 W061 18.2
Canefield
TF(D)-1
FT DE FRANCE
Le Lamentin
16
FT DE FRANCE
117.5 FOF
314 FXF

CIRCUMSTANCES:	During initial approach to ILS-29, the aircraft struck a mountain. This Medevac aircraft was positioning to Bardufoss from Tromso which is only 32 NM from the north. The aircraft was entering a procedure outbound turn, but overshot the Initial Approach Fix (IAF) NDB by 2-1/2 NM (or 30 seconds). It was too fast, turning outside the approved procedure area and prematurely descended to 5000 feet. It struck the mountain ridge some 35 feet from the top. There was also a probable atmospheric altimetry error.... because of non-standard temperatures, placing the aircraft some 300 feet low.
TIME:	23:02 local
WEATHER:	IMC - wind 270/1 skt. Visibility over 10km at airfield.
CONFIGURATION:	Clean
FATALITIES:	4
OTHER:	Radio altimeter installed. No GPWS. Military radar coverage.

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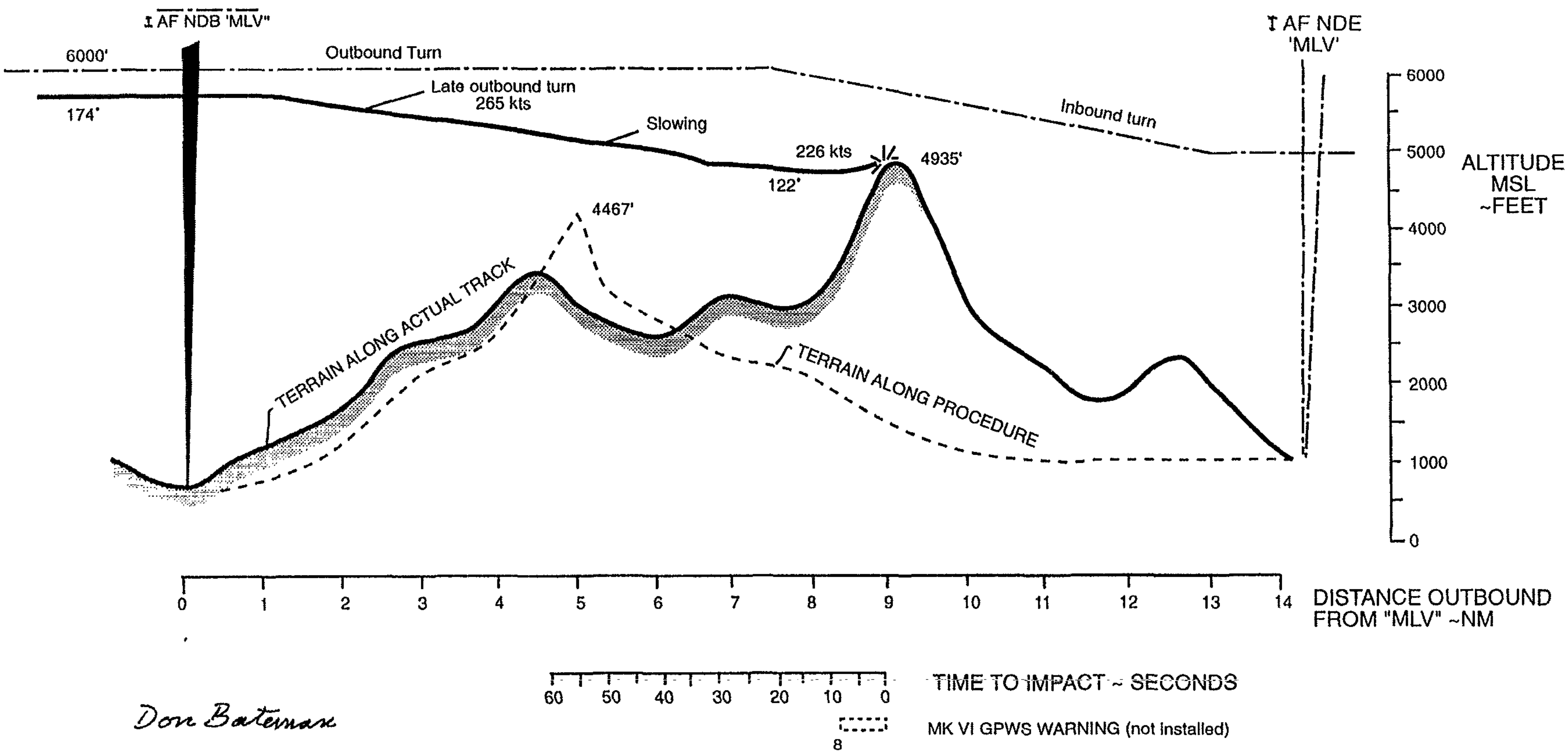
Flight Path Profile
Ce-551
BARDUFOSS, NORWAY
14 November 1989



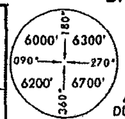
Don Bateman

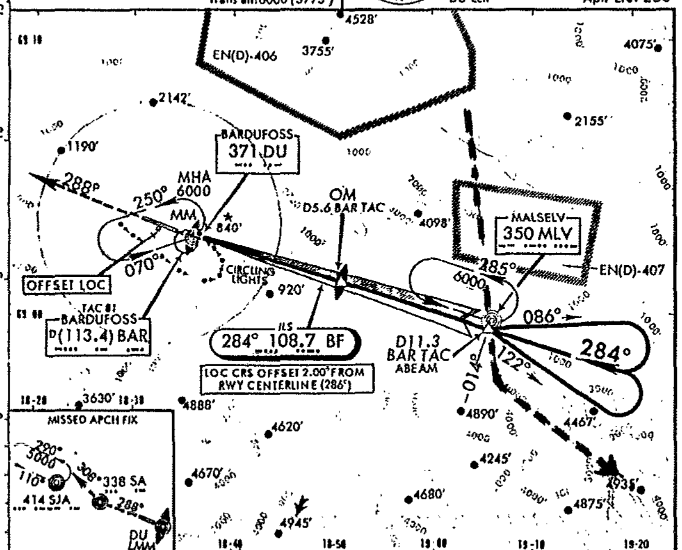
Return to TOC

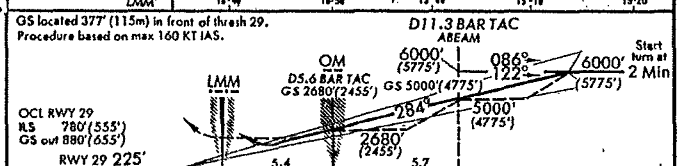
BARDUFOSS, NORWAY

BARDUFOSS
ILS Rwy 29
LOC 108.7 BF
Apt. Elev 260'

VHF/DF	
BARDUFOSS Approach (R)	118.8
BARDUFOSS Tower	118.1 122.1
Alt Set: hPa	Trans level: By ATC Trans alt: 6000' (5775')







MISSED APPROACH: Climb STRAIGHT AHEAD on 288° to SA Lctr, then turn RIGHT continue climb on 308° from SA Lctr to 5000' (4775') and join holding over SJA NDB.

STRAIGHT-IN LANDING RWY 29

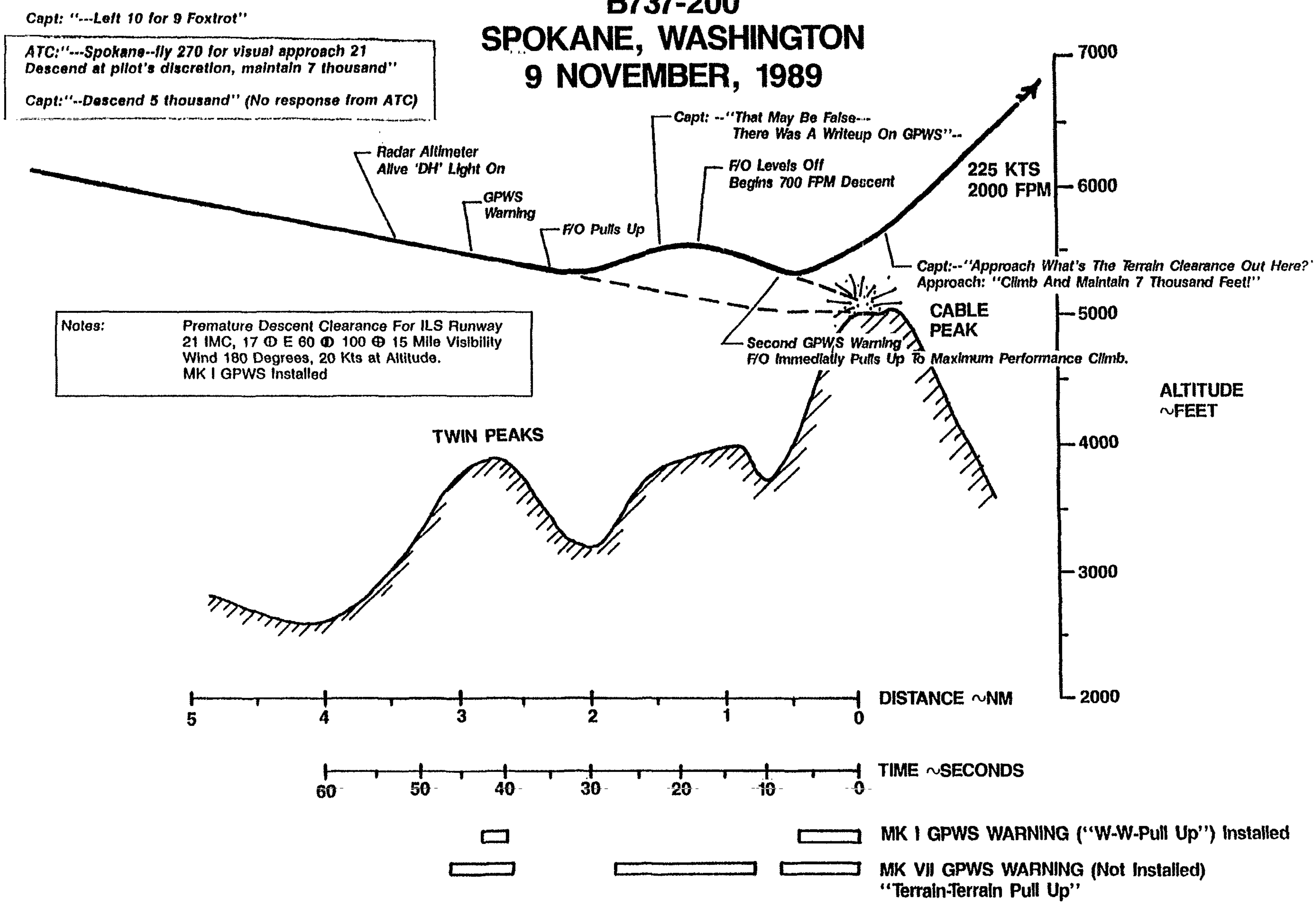
	ILS DA(H) 780' (555')		LOC (GS out) MDA(H) 880' (655')		
	FULL	ALS out		L & MM out	ALS out
A	1900m	2700m	1600m	NOT AUTHORIZED	1600m
B					
C			2000m		2800m
D			2400m		3200m

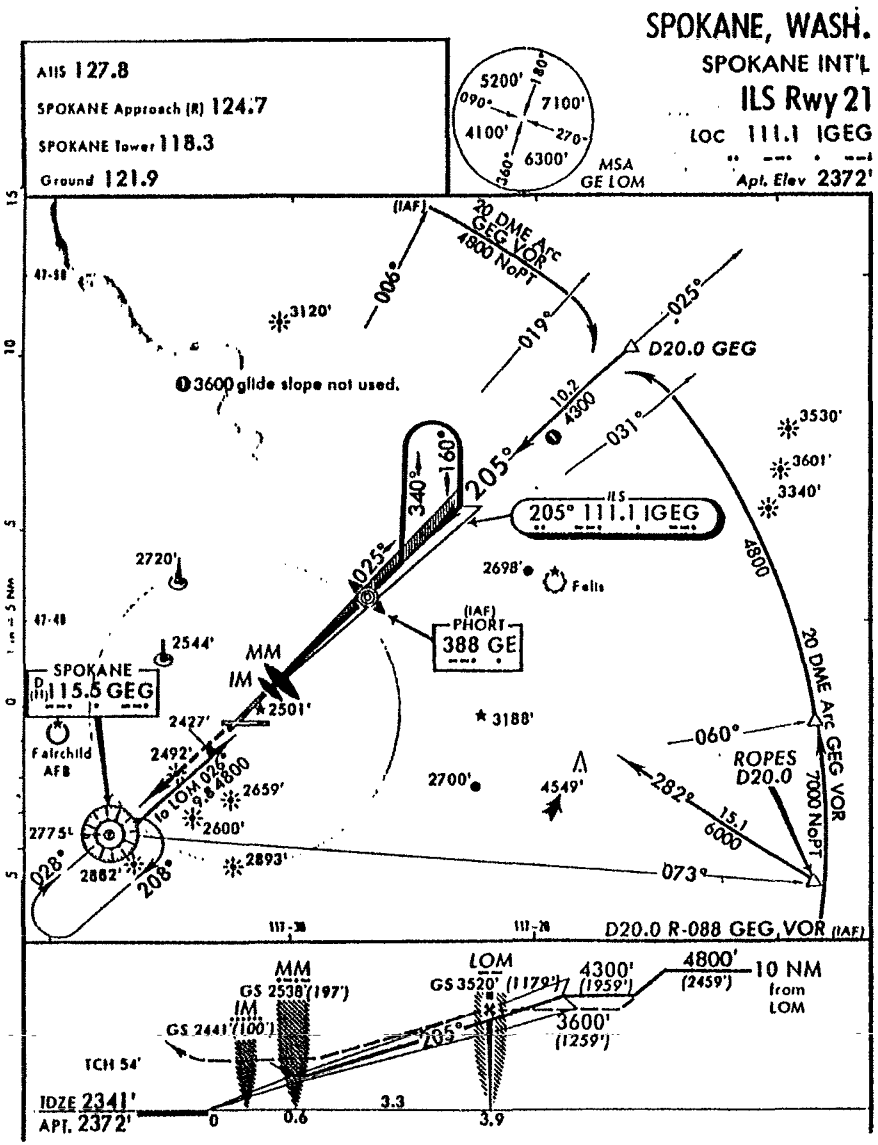
Gnd speed Kts	70	90	100	120	140	160
GS 3.80°	476	612	680	816	952	1088
MAP at LMM						

Next Page

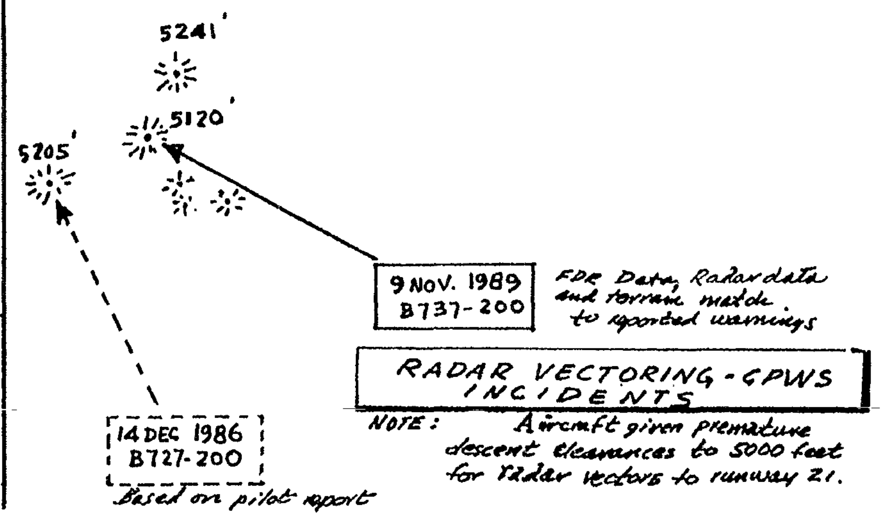
Flight Path Profile

RADAR VECTORING INCIDENT
B737-200
SPOKANE, WASHINGTON
9 NOVEMBER, 1989





This radar vectoring incident, (one of at least three at Spokane), illustrates the danger of miscommunicated ATC/pilot descent altitude clearances. Fortunately in this case (as in the others), the flight crew pulled up on activation of GPWS. Flight crews are particularly vulnerable when radar descent clearances are in areas off the instrument approach procedure. (Interestingly some of the terrain not shown on the adjacent plate is shown on the government procedure. It also appears that Spokane does not have ARTS III Minimum Safe Altitude Warnings (MSAW) for the controller.)



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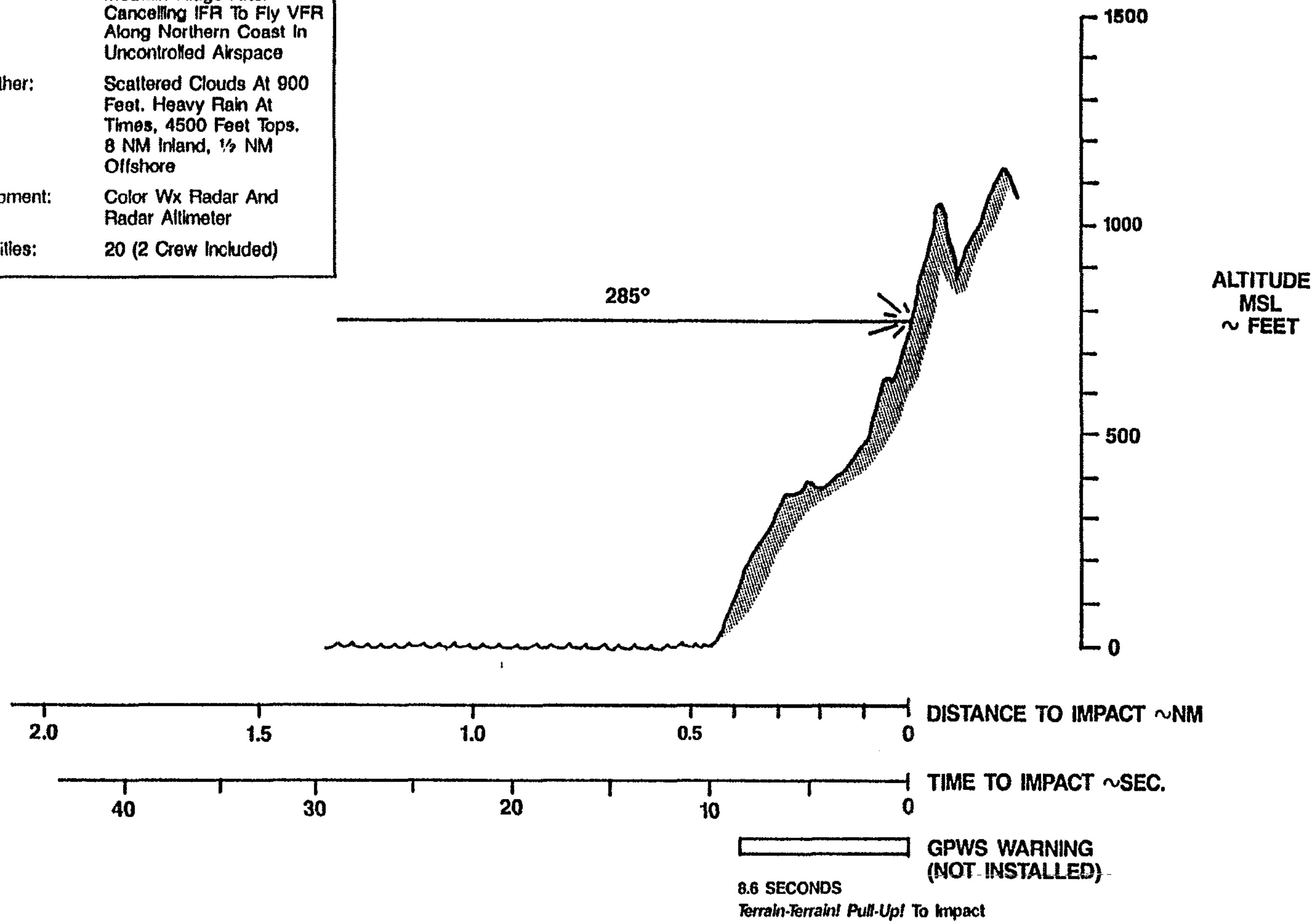
Flight Path Profile

DHC-6
MOLOKAI, HAWAII
28 October, 1989

Summary:	Flight 172 Maui To Molokai Aircraft Flew Into Coastal Moutain Ridge After Cancelling IFR To Fly VFR Along Northern Coast In Uncontrolled Airspace
Weather:	Scattered Clouds At 900 Feet. Heavy Rain At Times, 4500 Feet Tops. 8 NM Inland, ½ NM Offshore
Equipment:	Color Wx Radar And Radar Altimeter
Fatalities:	20 (2 Crew Included)



Return to TOC

The Honolulu Advertiser

Monday, October 30, 1989

TRAGEDY ON MOLOKAI

20 die in worst interisland air crash

8 from high school teams among dead

By David Waite
Advertiser Staff Writer

KAUNAKAKAI — Molokai, the Friendly Isle, became the island of despair yesterday as grieving began for family and friends lost in a Saturday night airplane crash that claimed the lives of 20 people.

Thirteen of the dead were Molokai residents. Eight were members of the Molokai High School boys' and girls' volleyball teams, returning from matches on Maui.

The high school also lost girls' volleyball Coach Odetta Rapanot and athletic Director John Ino in the tragedy.

Other Molokai High School team members had come home safely on earlier flights.

Officials said the Aloha IslandAir Twin Otter commuter flight from Maui smashed "at high velocity" into a cliffside near the remote Molokai valley of Halawa.

It was apparently the worst interisland air crash in history.

There was no immediate cause given for the crash, and officials said there had been no word or sign of trouble from the plane before it disappeared from radar screens Saturday night.

Investigators from the National Transportation Safety Board were expected at the crash site today.

According to the airline, the flight also carried a passenger from Maui, two from Houston and two from Philadelphia in addition to its two man crew.

The crash emotionally devastated Molokai, where the islands's 6,000 residents feel close to each other and to their championship high school volleyball teams.

"That thing was bad. We have a real bad thing over here," said Maui Deputy Fire

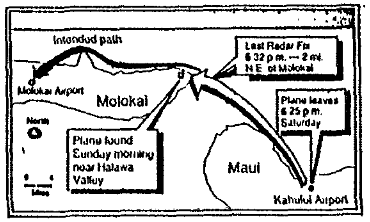
See Commuter, Page A1-A

Advertiser photo by Bruce Asato

Friends and family console each other at Pauole Center in Kaunakakai.

Advertiser photo by David Yamada

Rescue workers examine crash site near Halawa Valley.



'She was my baby'

By Edwin Tanji
Advertiser Maui County Bureau

KAUNAKAKAI, Molokai — "She was my baby," said Larry Helm, tears streaming from his face, as he hugged friends and family sharing his grief.

He had gone to Halawa Valley himself to see what had happened to his youngest daughter, Natalie.

"There's no way (anyone survived). It's all black and burned," he said.

Aunty Mae Helm sat quietly, her face etched with grief, but offering as much solace as she received over the death of her granddaughter, a 10th-grader at Molokai High School.

"Thank you for coming," she said. "There is nothing anyone can do now."

Mae Helm lost her son, George Helm, a decade ago when he disappeared at sea during a protest over the bombing of Kahoolawe. But this was more tragic for the youthfulness and number of the victims, who were known to families throughout Molokai.

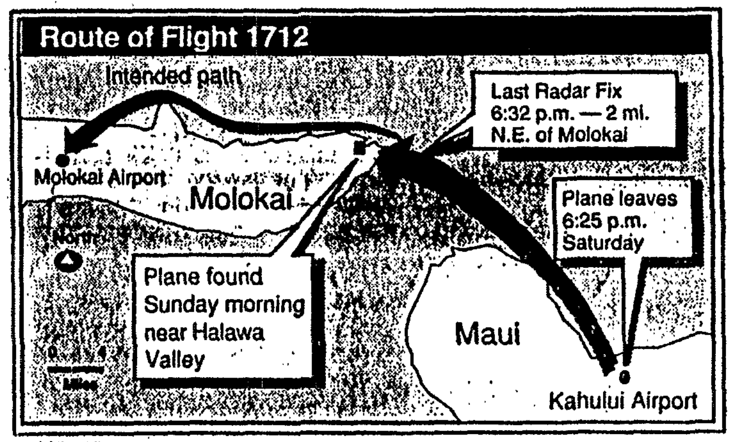
"People don't want to talk about it. It's too painful," a friend of family members warned. "It's terrible. The community feels just terrible."

Molokai families were particularly upset that the remains recovered from

See Community, Page A-1B

Natalie Helm, Molokai High School sophomore from Hoolehua, was a volleyball and softball player.

- A routine flight. A recently checked plane. An experienced pilot. Why? Page A-1A
- Saturday had been a day of celebration for Molokai High's volleyball teams. Page A-1B
- Molokai High plans psychological help for grieving students. Page A-1B



CIRCUMSTANCES: While on an ILS approach to runway 01, to be followed by circling to Runway 19, the aircraft inadvertently descended off the localizer course into terrain. A radar controller at Bandufoss detected the problem and alerted the flight crew in time for a successful recovery.

WEATHER: IMC - aircraft picking up ice

TIME: 13:52 local

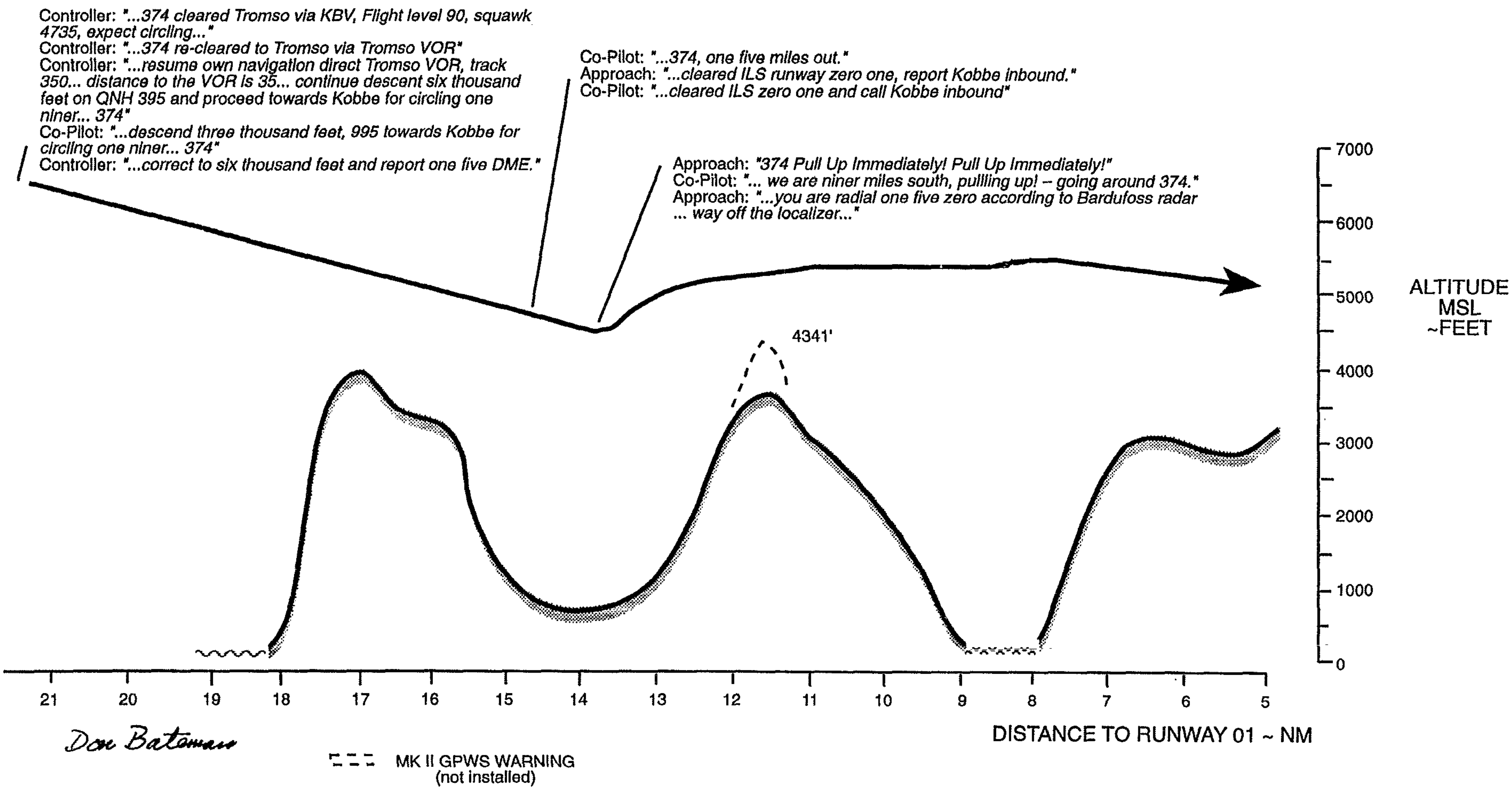
CONFIGURATION: Gear up, flaps 15

OTHER: Short flight from Bardufoss (36 nm) put time pressure on the pilots. Pilots also were busy and distracted with anti-ice procedures and watching engine EPRs. (Ice on windshields and wipers.) No approach briefing. Captain was receiving little help from co-pilot. 120 people on board. Early primitive MK 1/2 GPWS installed and no warning.

Flight Path Profile
DC-9-40
TROMSO, NORWAY
27 October, 1989

INCIDENT

Next Page



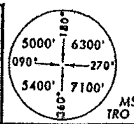
Don Bateman

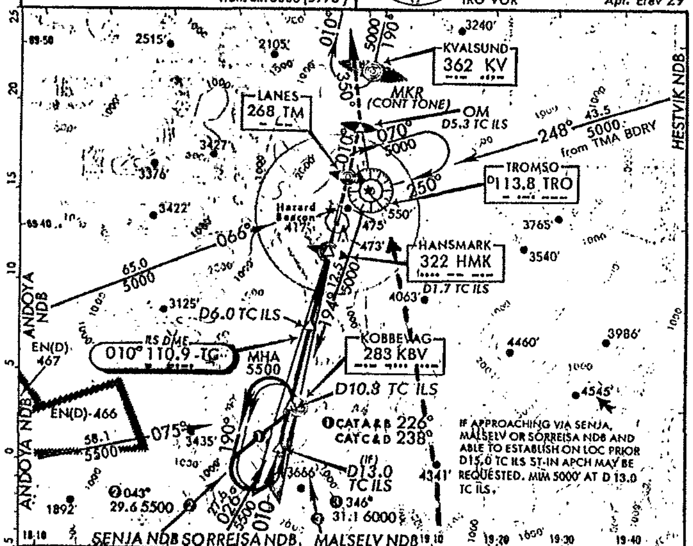
TROMSO, NORWAY
LANGNES
ILS DME Rwy 01
LOC 110.9 TC

Apt. Elev 29'

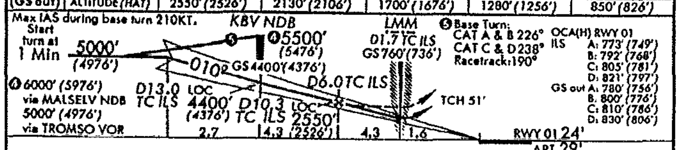
- * ATIS 126.12 — VHF/DF
- * LANGNES Approach 123.75
- LANGNES Tower 118.3 122.1X

Alt Set: hPa — Trans level: By ATC — Trans alt: 6000'(5976')





LOC (GS out) TC DME	6.0	5.0	4.0	3.0	2.0
ALTITUDE (HAT)	2550' (2526')	2130' (2106')	1700' (1676')	1280' (1256')	850' (826')



MISSED APPROACH: Climb STRAIGHT AHEAD on 010° via TM Lctr to OM/D5.3 TC ILS, then turn LEFT climbing on R-350 outbound TRO VOR. At 3500' (3476') proceed to KV Lctr to 5000' (4976') and hold. Climb to 3600' (3576') prior to level acceleration.

STRAIGHT-IN LANDING RWY 01

	ILS DA(H) A: 773' (749') B: 792' (768') C: 805' (781') D: 821' (797') FULL	ILS ALS out	LOC (GS out) MDA(H) A: 780' (756') B: 800' (776') C: 810' (786') D: 830' (806')	LOC L & MM out	LOC ALS out
A	2300m	3000m	3000m	NOT AUTH.	3000m
B	2400m	3100m			
C	3200m		3600m		3600m
D	3200m	3300m	4000m		4000m

CIRCLE-TO-LAND
Not authorized West of airport

Max Kt	MDA(H)	
100	840' (811')	3000m
135	1150' (1121')	[1] 3000m
180	2760' (2731')	4800m
205	2960' (2931')	4800m

Gnd speed-Kts	70	90	100	120	140	160
ILS GS 4.00°	501	644	715	854	1002	1145
LOC Desc. Grad. 7.0%	496	638	709	851	992	1134

MAP at LMM or D1.7 TC ILS

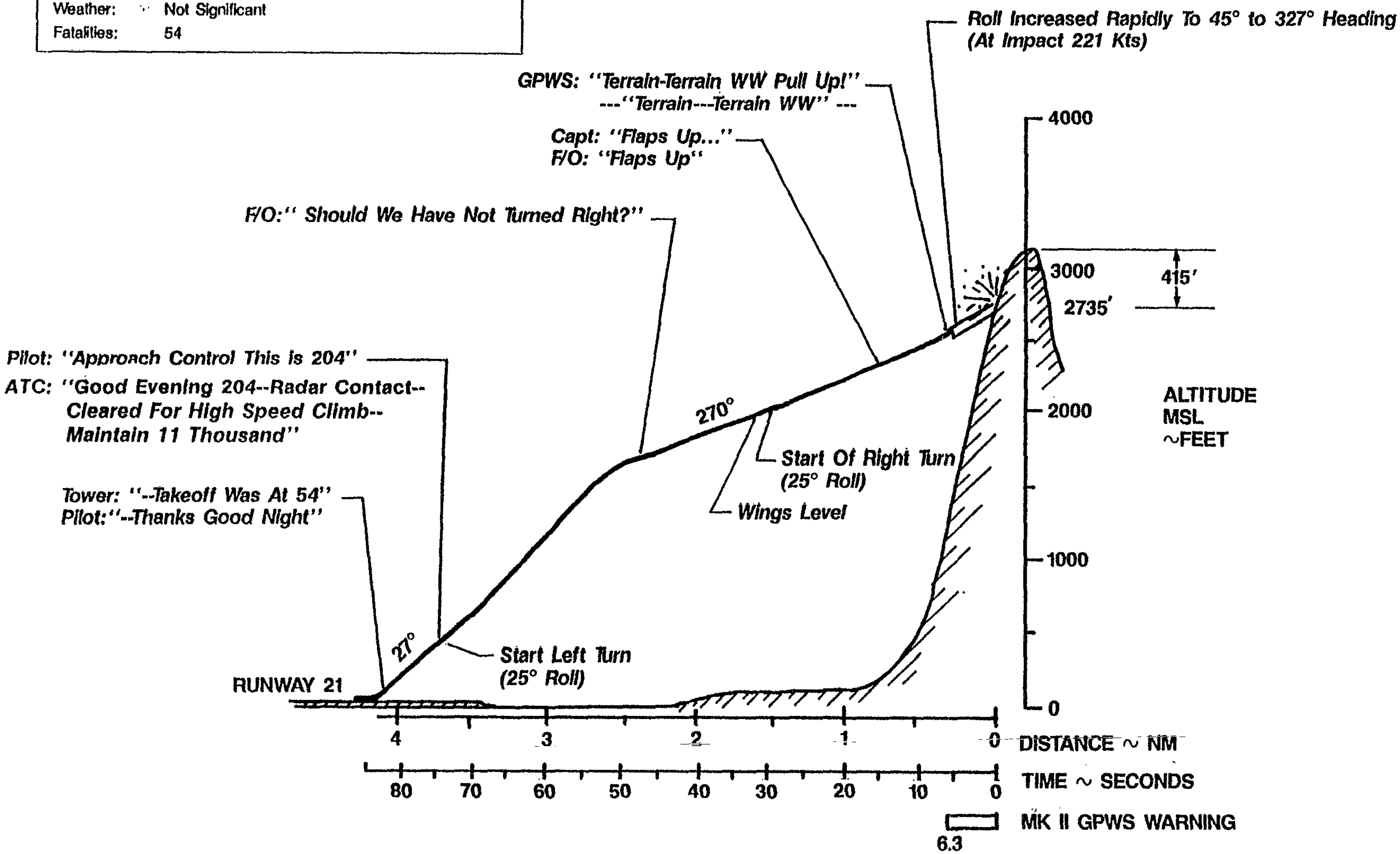
[1] After ILS apch: VIS 3100m.

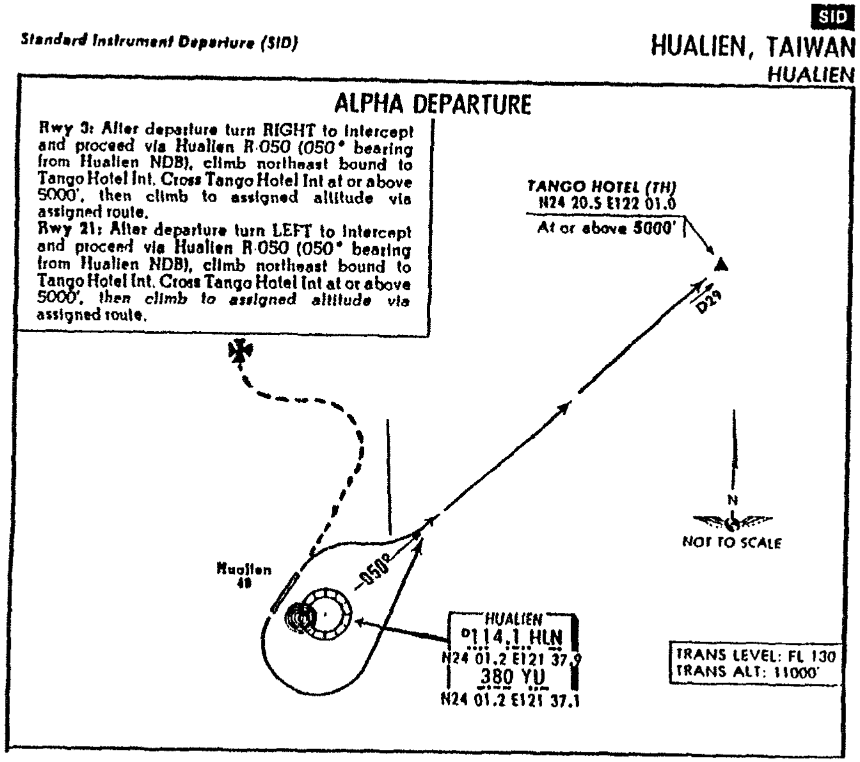
Next Page

Flight Path Profile

B737-200
HUALIEN, TAIWAN
26 OCTOBER, 1989

Summary:	Night Departure Runway 21 Cleared For'Alpha Departure' Aircraft Inadvertently Turned To Left And Later Corrected To Right, But Too Late. Aircraft Hit Mountain. (18:56 Local)
Weather:	Not Significant
Fatalities:	54





Crashed 737 'turned wrong way'

A China Air Lines (CAL) Boeing 737-200 (B-180) crashed into Taiwan's central mountains on 26 October. The crash happened about ten minutes after take-off from the coastal city of Hualien, on a regular 30-minute flight to Taipei

The Deputy director of the Taiwan Civil Aviation Authority, Chang Kuang-uao, says: "The plane should have turned to the right after it was airborne. How come it went left?"

The normal procedure out of Haulien is to make the initial climb to the east over the sea, then turn north and pass over the Chiashan mountains, into which the aircraft crashed. On this occasion the pilot, who has flown 15 years with CAL and had logged 6,500 flying hours, turned left and flew west.

The 737-200 was delivered new to CAL in 1986. Its wreckage is spread widely through several valleys, and no survivors are expected from the 47 passengers and seven crew. □

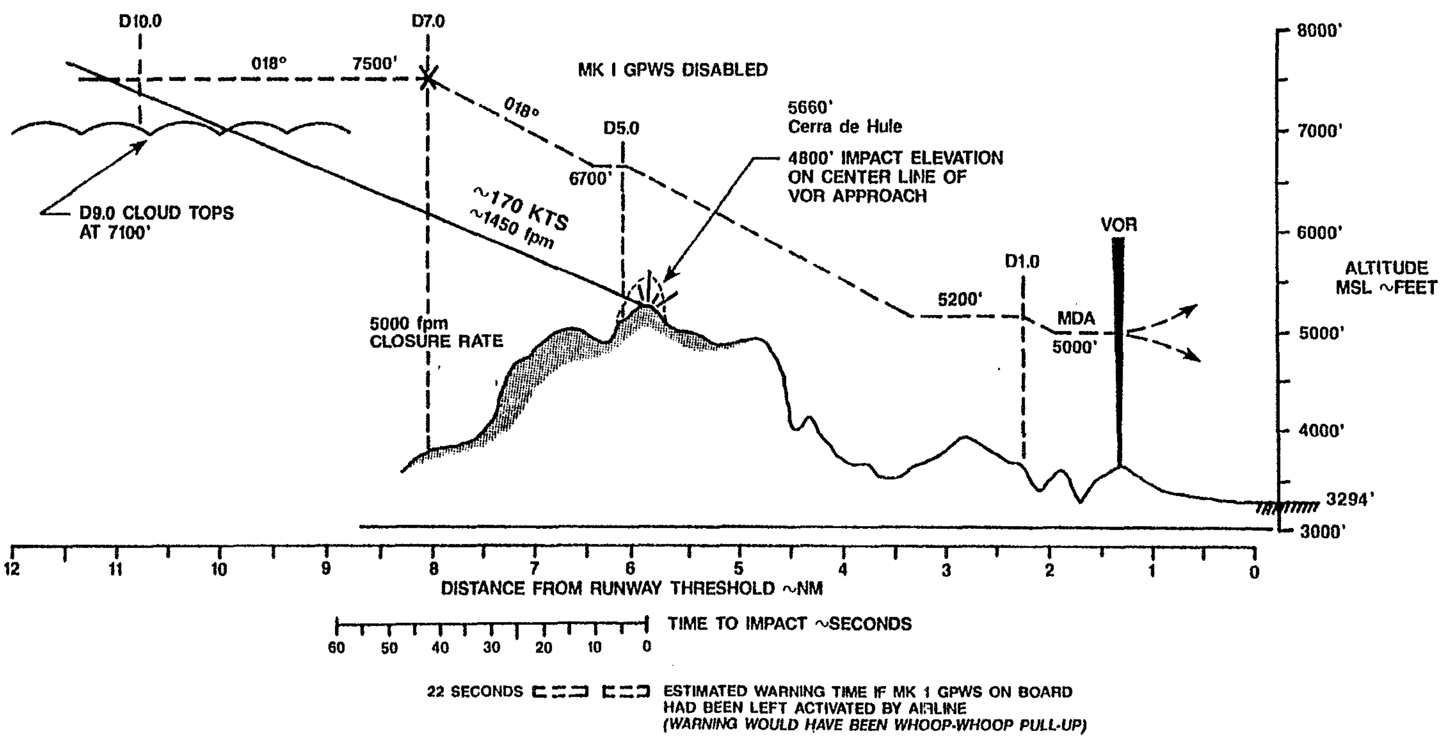
Next Page

Flight Path Profile

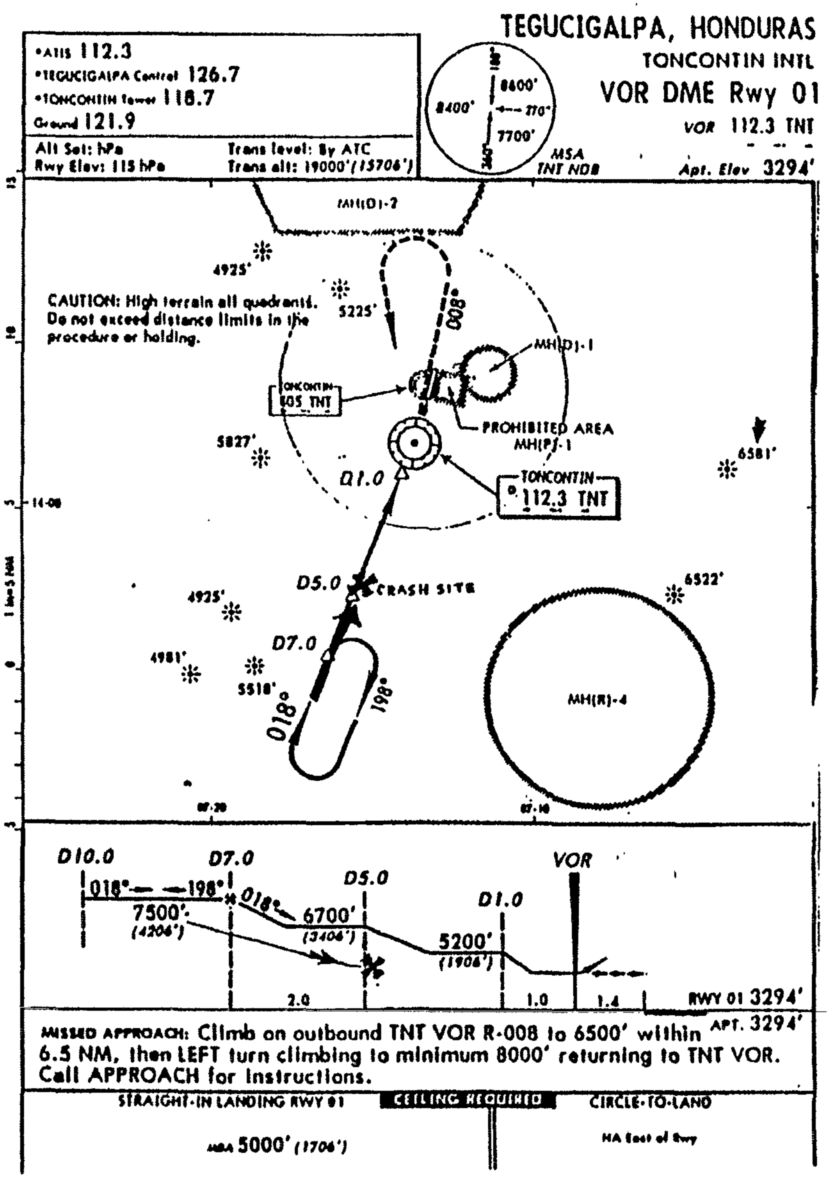
B727-200

TEGUCIGALPA, HONDURAS
21 October, 1989

Circumstances:	While On A VOR DME Rwy 01, Aircraft Prematurely Descended And Impacted Terraced Mountain 6½ NM Short Of Runway
Weather:	Heavy Rain, Wind, Foggy. GPWS Was Leased From Continental Airlines.
Configuration:	Gear Up. 25 Flap
Fatalities:	131 Out Of 146 On Board (Captain & F/O Survived)



Similar Accidents:
- 21 March 1990 L-188 Hit 4500' Level 3 Fatalities
- 25 February 1989 DC-7 Hit Same Mountian 10 Fatalities



727 Strikes Mountain Approaching Tegucigalpa, Honduras

Following is a preliminary report:

On October 21, at 0745 local time, during a VOR DME 01 approach to Tegucigalpa in IMC, Flight 414, a 727-200 operated by the Honduran national airline Tan-Shasa, struck a mountain 4.8 miles from the runway when the captain deviated below approach chart minimum step down altitudes. Of the 141 passengers and crew on board, 131 were fatally injured; the captain and first officer survived.

Weather at the airport was clear but surrounding mountain tops were obscured by clouds with tops around 7000 ft and bases approximately 5000 ft MSL.

The 727 was leased from Continental Airlines. A Mark I GPWS was installed but it was disconnected in accordance with company directives in order to provide commonality with the rest of the company's non-GPWS-equipped 727s.

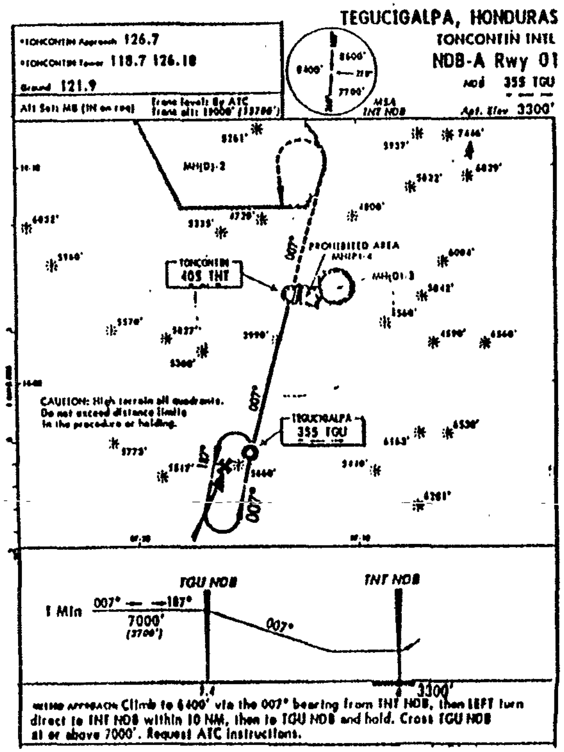
The captain and first officer were recently qualified on the 727, but both had extensive experience at Tegucigalpa; the captain while flying in command of 737s and the first officer while serving as a Honduran Air Force T-37 instructor pilot. The captain had approximately 17,000 hours flight time.

The captain conducted the approach without reference to his approach chart, that is, the chart was not out. The first officer had the approach chart out but made none of the company-required altitude-DME crossing callouts.

Based on communications tapes and flight recorder plots, the crew may have called 14 DME before actually arriving at that position. Another flight was inbound to Tegucigalpa at that time and sequencing priority, based on which flight was closest to the airport, could have been a factor. Flight 414 was cleared for the VOR DME approach to runway 01, a procedure specifying a series of step downs to avoid high terrain beneath the final approach course.

The flight began a continuous descent from 7600 ft about 11 DME (instead of waiting to pass the 7 DME, 7500 ft step down point) and entered the cloud deck about 7000 ft. Initial sink rate was approximately 800 ft/min but after passing 6700 ft, sink increased to about 1800 ft/min, then, at 6300 ft, decreased to approximately 1500 ft/min. All the while, the flight was beneath the step down profile.

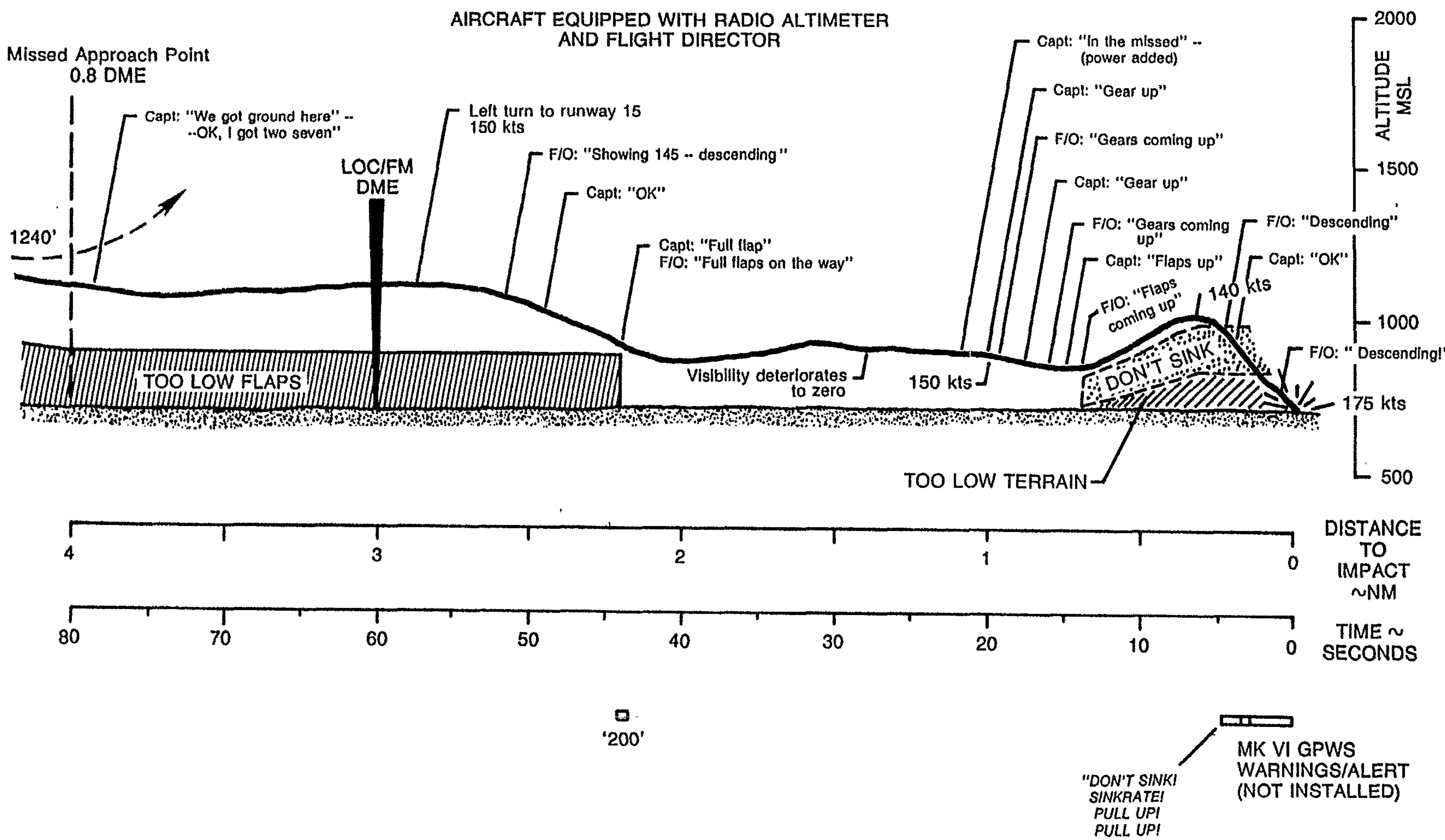
First impact occurred on an agriculturally-terraced mountain saddle, approximately 4800 feet MSL, at 4.8 DME. The right wing and tail separated and fuel from ruptured tanks ignited, consuming a large part of the fuselage. ■



Note: 5660' Terrain Peak and NDB 'TGU' near accident site not shown on VOR DME 01 Approach plate.

Circumstances:	During a missed LDA/DMEC approach, the aircraft accelerated into the ground in IMC.
Time:	08:29 PDT
Configuration:	Clean - Climb Power
Weather:	Visibility to the south ½ mile in fog (fog bank advancing north accross the field) -X6 Ⓘ 35 Ⓘ 120 Ⓘ wind calm visibility 5 miles, fog, smoke
Fatalities:	7

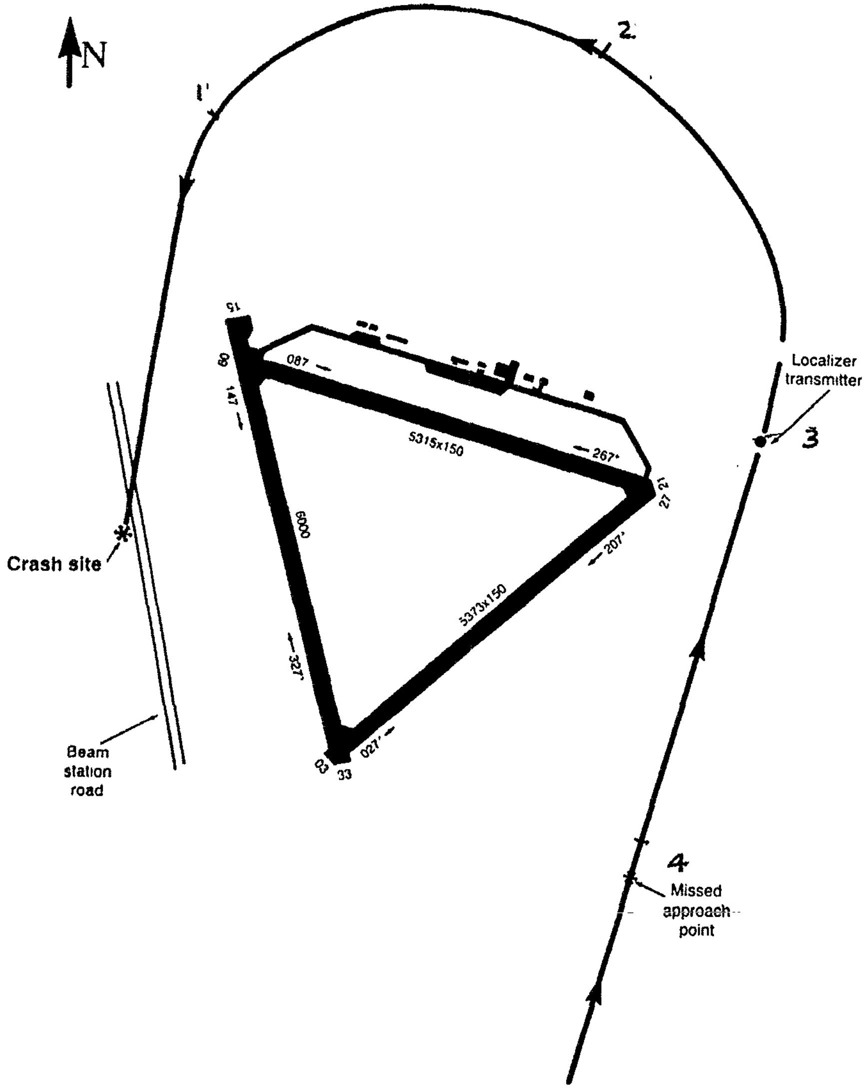
FLIGHT PATH PROFILE
Metro III
Terrace, B.C.
26 September 1989



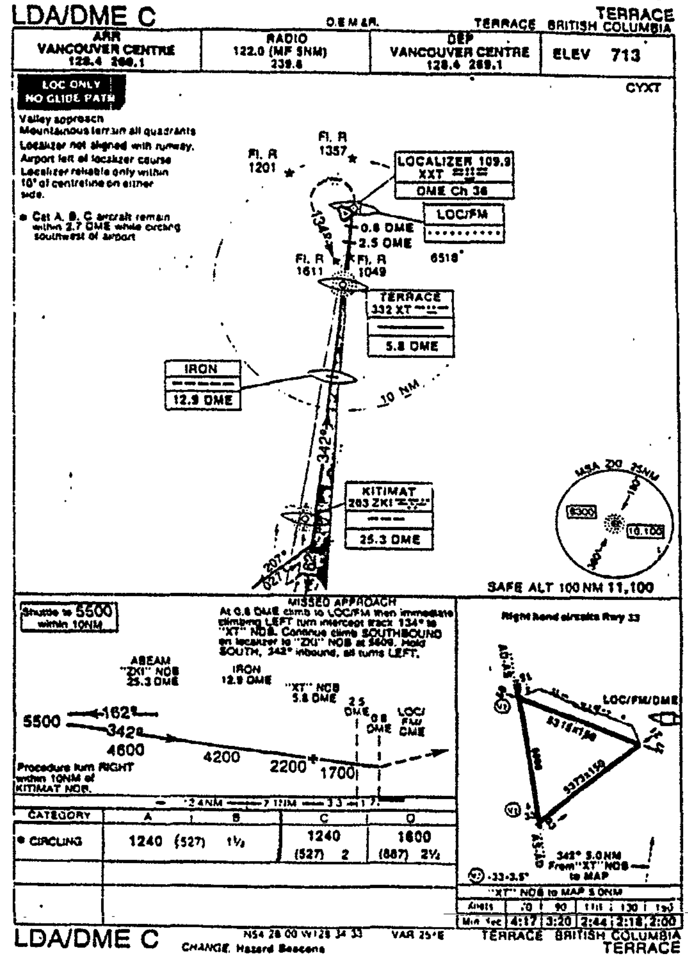
Return to TOC

PLAN VIEW OF FLIGHT PATH

APPENDIX A



APPENDIX B



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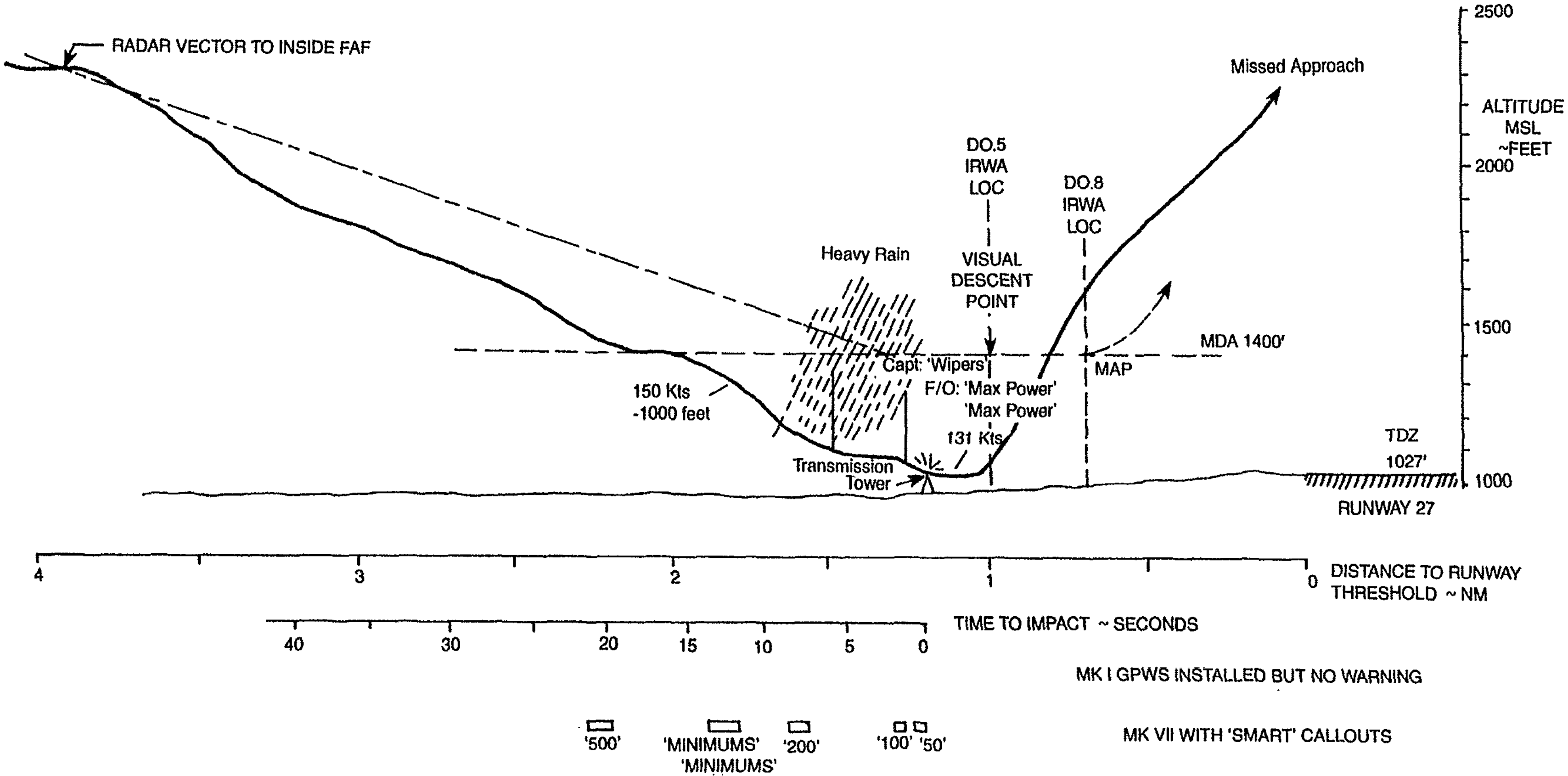
90-282

Circumstances:	During a B/C LOC approach to runway 27, the aircraft inadvertently descended below MDA and severed four electrical transmission lines 75 feet AGL. Because of weather, the aircraft was recovered from a visual approach runway 19 to B/C LOC approach 27 for favourable winds.
Weather:	Wind E 260/24Kts gusts to 39. Visibility restricted by heavy rain. 71 F. 25 Ø C75. SIGMET on convective weather.
Time:	Night 21:33
Other:	MSAW did not provide alert to controller because software inhibited area to minimize nuisance alerts.
Injuries:	None out of 60 on board
Damage:	Main gear & nose gear doors torn off. 12 inch cut into vertical stabilizer to spar. Hydraulic systems A & B lost.

Pilots may have mistaken shopping mall for approach lights.

FLIGHT PATH PROFILE
B737-200
Kansas City, Missouri
8 September 1989



Return to TOC

8 SEPT 1989 NO GPWS WARNING LOC/DME

737 Hits High Tension Wires on Approach to Kansas City

This is a preliminary report:

On September 8, at approximately 2130 local time, a U.S. Air 737-200 descended below MDA before reaching the visual descent point (VDP) on a night IMC back course localizer approach to runway 27 striking two high tension electrical power lines 1.2 miles from the approach end of the runway. The "B" hydraulic system was lost as a result of wire strike damage but the flight was able to make a successful missed approach and divert to Salina, Kansas where it landed uneventfully.

Weather: Special report at 2127 CDT; indefinite ceiling, ½ mile visibility, thunderstorms and heavy rain. This information was not transmitted to the crew. 200°/38 KTS

Half hour old ATIS stated: 2500 ft scattered, 7500 ft overcast, visibility 10 miles.

The flight departed Pittsburgh and was routine in all respects until the incident.

Initially, the crew was given vectors for a runway 19 visual approach but two aircraft missed the approach due to low visibility in heavy rain showers so approach control switched runways, setting the crew up for the back course localizer to runway 27.

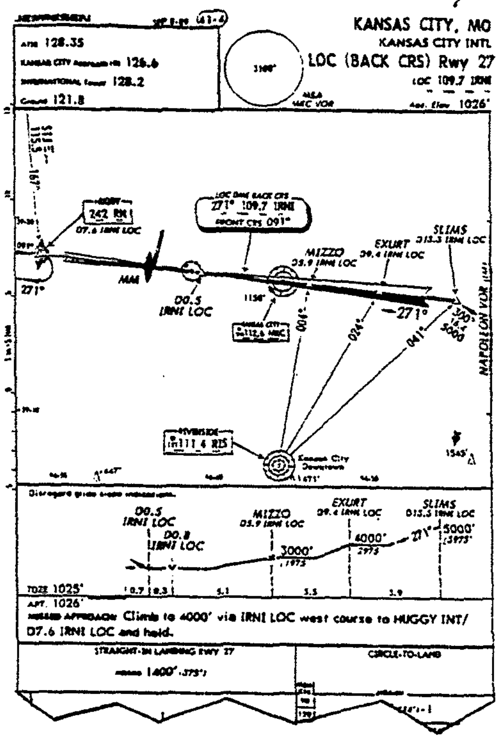
The first officer retuned the navaids for the back course localizer and shortly thereafter the crew was cleared for the approach. Approach control didn't broadcast the 2127 CDT special weather observation until after the flight had been handed off to the tower. No updated weather information was provided by the tower before the incident which occurred at 2134 CDT.

An FAA air carrier inspector, recently rated on the 737, was seated in the cockpit jump seat during the approach. He didn't notice anything irregular and did not alert the crew in any manner before the incident.

After intercepting the final approach course in rain showers with the captain hand flying, the crew reportedly sighted lights which they equated with the approach end of the runway (the runway has no approach lights, but has REILs and VASI). With outside cues in sight, the captain descended below MDA (375 ft above the touchdown zone) before reaching the VDP one mile from the runway.

Rain became heavier, windshield wipers were switched on and the descent continued. Around this time, with very heavy rain beating on the windshield, the first officer (who recently had completed a windshear training package) became aware of flattening of terrain cues and called out "go-around."

The captain immediately responded, rotating the nose upward and pushing the throttles to the forward stops.



Almost simultaneously the aircraft struck and severed three power lines approximately 75 feet above the ground and 1.2 miles from the runway threshold.

The crew felt the airplane lurch and heard a bang but didn't equate these perceptions to an obstacle strike. Then, a short time later, all B system hydraulic fluid was lost. Although the cockpit crew and FAA inspector didn't notice anything indicative of a wire strike outside the cockpit, passengers reported seeing a bright blue flash at about the time the airplane pulled up. The flight then diverted to Salina, Kansas and landed uneventfully.

After landing, an inspection revealed a deep cut in the vertical fin leading edge about 2 ft below the top of the stabilizer. The cut extended back to the front spar which apparently had sufficient rigidity and mass to sever the ¾ inch ground wire which it had struck. The nose gear struck and severed two of four 1¼ inch 160 KVA power lines strung below the ground wire. These impacts separated the nose gear's right door and damaged the left nose gear door. One of the snapped flailing wires damaged the left main gear shimmy damper and anti-skid electrical connections and severed a B hydraulic system line in the wheel well, depleting the system.

The captain had operated in command on the 737 for about one year and the first officer had flown the 737 for about two years.

PAN AM FLT OPS

c Tuesday, August 22, 1989 Journal-American A5

Air ambulance crashes in Oregon; 3 are killed

GOLD BEACH, Ore. (AP) — A twin-engine air ambulance crashed Monday while trying to land at the Gold Beach airport, killing the three volunteer crew members on board.

Curry County Sheriff Chuck Denney said the twin turboprop Beechcraft King-Air operated by Mercy Flights Inc. of Medford hit a power pole at 12:50 p.m.

Mercy Flights identified the dead as the pilot, Richard Mendolia, 40, of Medford; co-pilot Wally Nitowski, 48, of Eagle Point, and the flight nurse Diane Lefler, 40, of Jacksonville.

The crash was the second in Mercy Flights' 40 years of volunteer service.

The plane was engulfed in flames as it tumbled into the front yard of a house next to the end of the runway, Denney said.

The crash temporarily cut off power to part of this city of 1,585 on the southern Oregon coast.

Denney said the plane apparently got off course in fog as it made its approach to the airport.

The plane hit a parked truck and flipped over before coming to rest next to the house. The house and a boat were damaged by the heat from the flames.

There were no reports of anyone hurt or killed on the ground, said sheriff's Deputy Karen Baker.

Mendolia and Nitowski were local commercial pilots and Lefler worked at Ashland Community Hospital, said Mercy Flights operations director Bob Cecil at a press conference in Medford.

Mendolia was called in from the crew rotation list and Nitowski and Lefler were already at Mercy Flights' office at the Medford-Jackson County Airport and volunteered to go when the call came in for a flight, Cecil said.

"They were here because they loved to be here," Cecil said with tears in his eyes. "It is love of man and love of flying that causes us to do what we do."

They were dispatched to pick up an 81-year-old woman who had suffered a stroke and bring her to Medford for treatment, said Rex Strichler, medical director for Mercy Flights.

After the crash, the patient was taken by road to Medford, he said.

The air ambulance service stopped operations for 24 hours to mourn the dead crew, Cecil said.

Mercy Flights was founded in 1949 to carry children suffering from polio from rural areas to hospitals in Portland.

Mercy Flights founder George E. Milligan and three other people were killed in 1965 when a Mercy Flights plane carrying a patient from Gold Beach crashed on approach to Medford-Jackson County Airport.

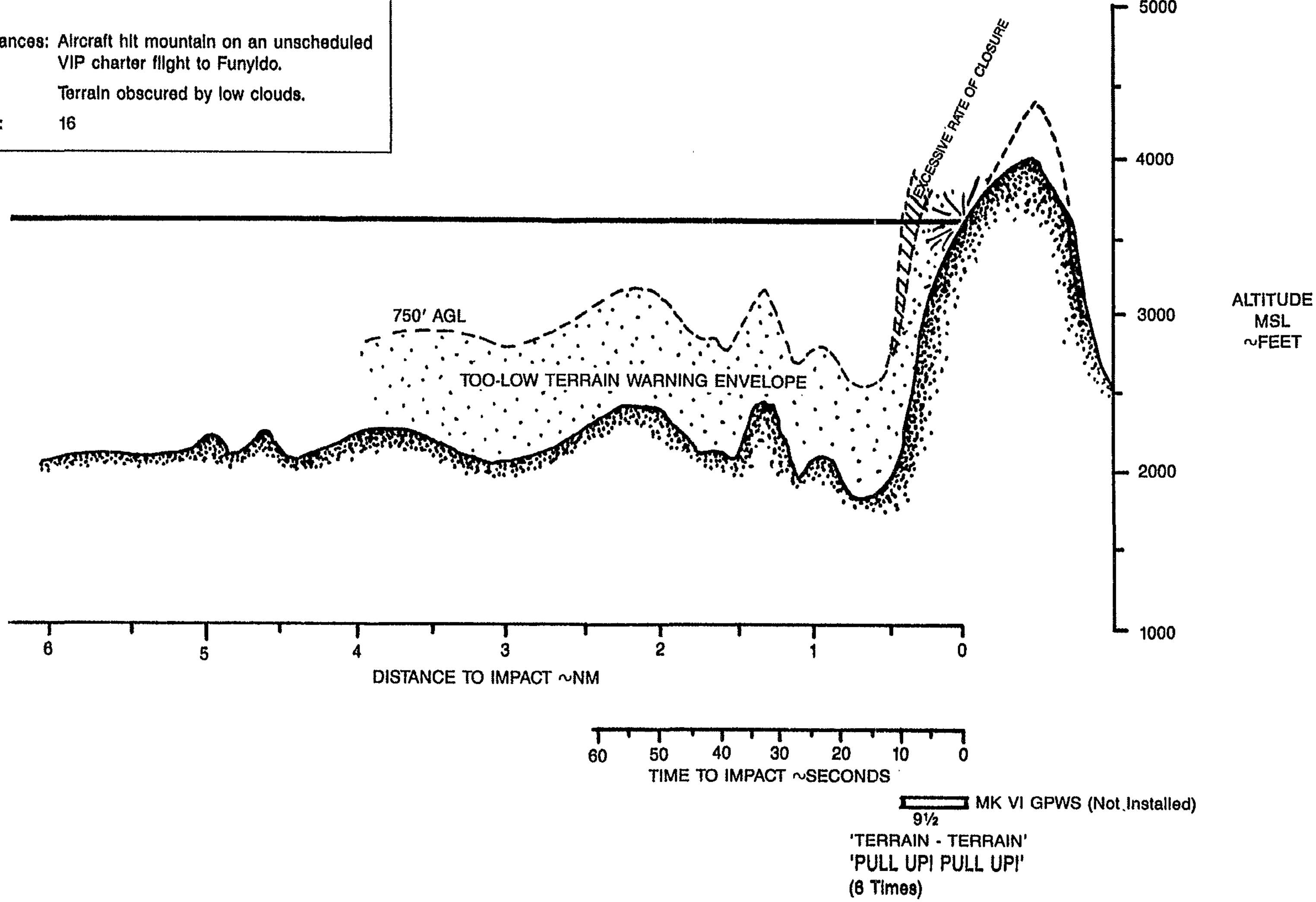
Baker said Federal Aviation Administration officials were on their way to Gold Beach to investigate the crash.

90-282

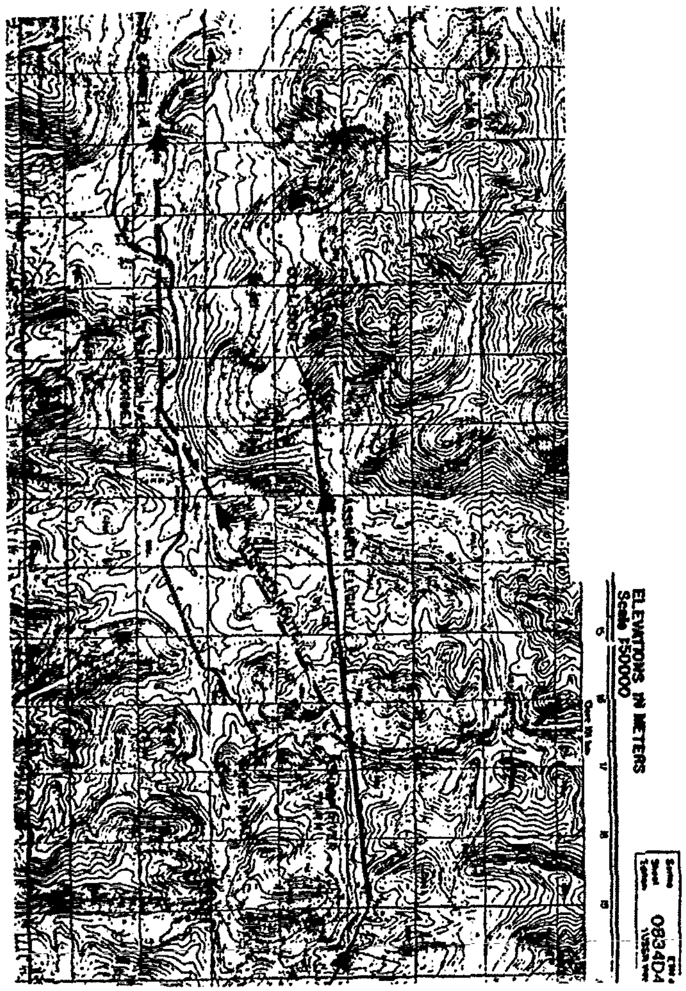
FLIGHT PATH PROFILE
DHC-6
NR. Gambella, Ethiopia
7 August, 1989

NOTES:

Circumstances:	Aircraft hit mountain on an unscheduled VIP charter flight to Funyido.
Weather:	Terrain obscured by low clouds.
Fatalities:	16



Return to TOC



United Press International

Children carry food for the hungry that was to be placed into collection baskets at a memorial in Houston for Rep. Mickey Leland, who died Aug. 7 on a hunger relief mission to Africa.

Leland called martyr in war on hunger

Associated Press

HOUSTON — Rep. Mickey Leland was eulogized yesterday as a martyr for the cause of world hunger, and mourners were urged to honor his memory by carrying on his work.

"Mickey is gone, but his values and his work will live after him in our memory and in our commitment," House Speaker Tom Foley said at a funeral Mass at St. Anne's Catholic Church.

"We can all do something by which to remember Mickey and to honor his life and work," Foley said. "We can commit ourselves to reward and serve those values and commitments that marked Mickey's life and led to Mickey's death."

Leland, 44, a Texas Democrat, was killed with 15 others Aug. 7 when their plane crashed in Ethiopia while carrying them to a camp for Sudanese refugees. A private burial is planned for the six-term congressman when his remains are returned to Houston, probably this week, friends said.

Hundreds of people crowded under the ornately carved arches of the central Houston church yesterday, and hundreds more gathered outside as politicians and clergymen praised Leland's work on behalf of the starving.

Leland's wife, Alison, and other family members attended the service, along with numerous dignitaries. The Mass followed Friday's memorial service, which drew 5,000 people.

Bishop Joseph Fiorenza of the Diocese of Galveston-Houston read a message delivered through the Vatican Embassy in Washington. Pope John Paul II, the message said, "is well aware of Rep. Leland's great humanitarian effort to relieve the starvation of the Sudanese refugees in Ethiopia."

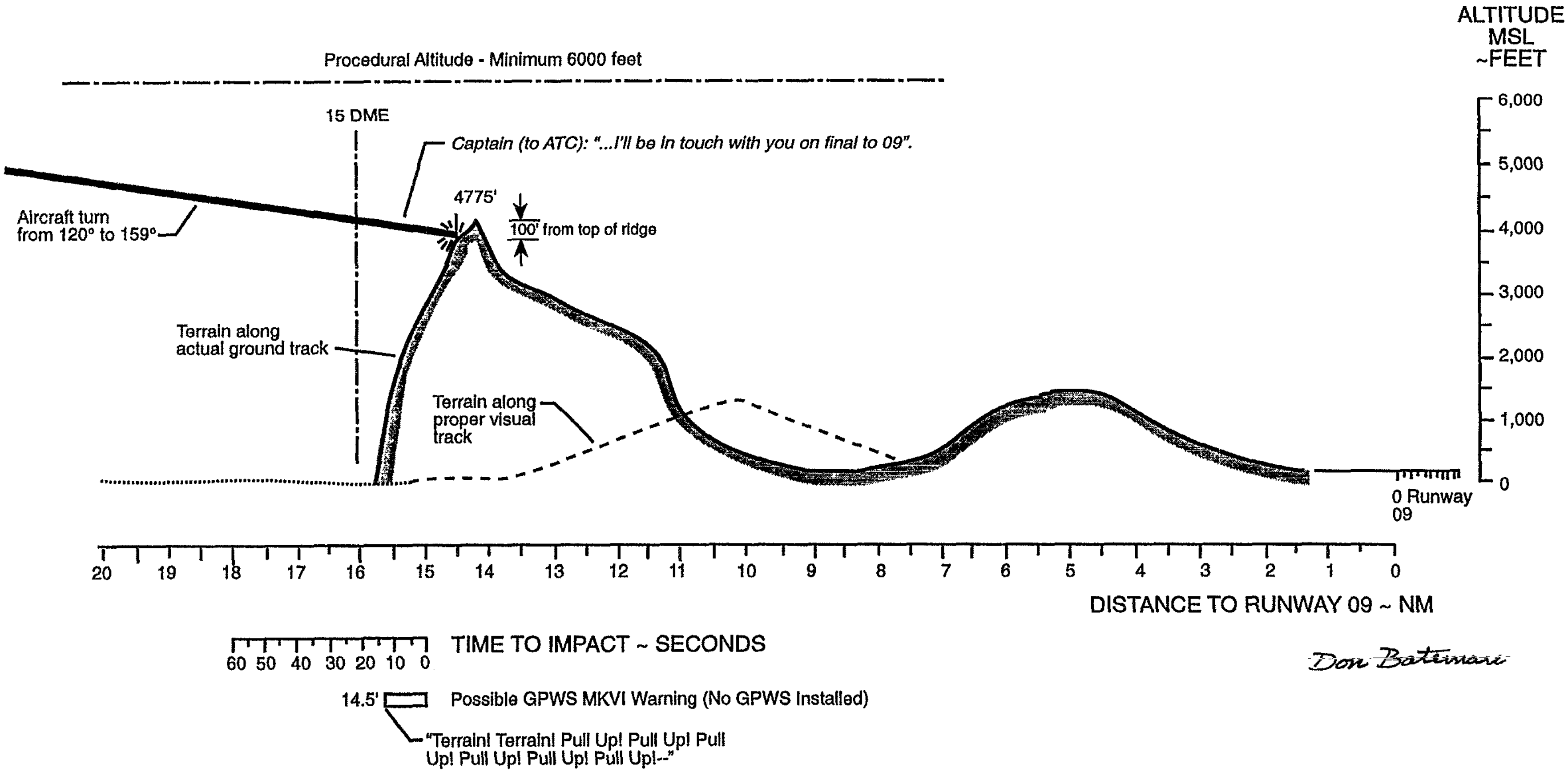
The Rev. Jesse Jackson spoke at a service that mixed a traditional Roman Catholic Mass with gospel singing.

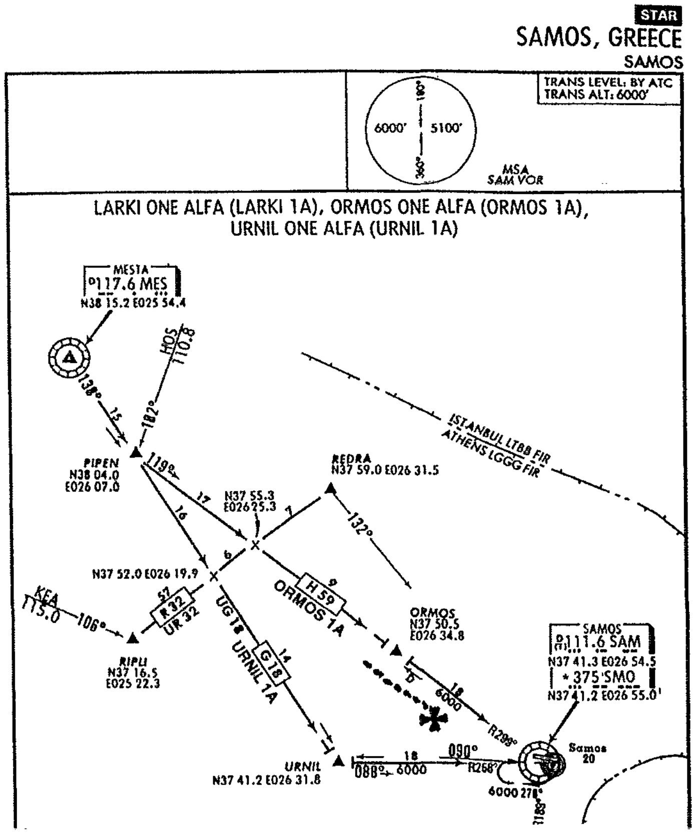
Next Page

CIRCUMSTANCES:	Aircraft hit 4775 foot mountain at the 4000 foot level on initial 'visual' approach. The aircraft was inbound on 'H59' 4NM west of track in VMC conditions at 15 DME, a descending turn to 159° from 120° was made to form a left base to runway 09 visually. Unfortunately the aircraft entered IMC and the pilots did not detect their error in time.
WEATHER:	High terrain shrouded in cloud.
TIME:	15:30 local approx.
FATALITIES:	34

Flight Path Profile
SD-330
SAMOS, GREECE
3 August, 1989

NO GPWS INSTALLED




STAR
SAMOS, GREECE
SAMOS
TRANS LEVEL: BY ATC
TRANS ALT: 6000'
6000'
5100'
MSA
SAM VOR
LARKI ONE ALFA (LARKI 1A), ORMOS ONE ALFA (ORMOS 1A),
URNIL ONE ALFA (URNIL 1A)
MESTA
117.6 MES
N38 15.2 E025 54.4
HOS
110.8
PIPEN
N38 04.0
E026 07.0
REDRA
N37 59.0 E026 31.5
N37 55.3
E026 25.3
ISTANBUL LTBB FIR
ATHENS LGGG FIR
N37 52.0 E026 19.9
KEA
115.0
RIPLI
N37 16.5
E025 22.3
R32
UR 32
UG 18
G 18
URNIL 1A
H 59
ORMOS 1A
ORMOS
N37 50.5
E026 34.8
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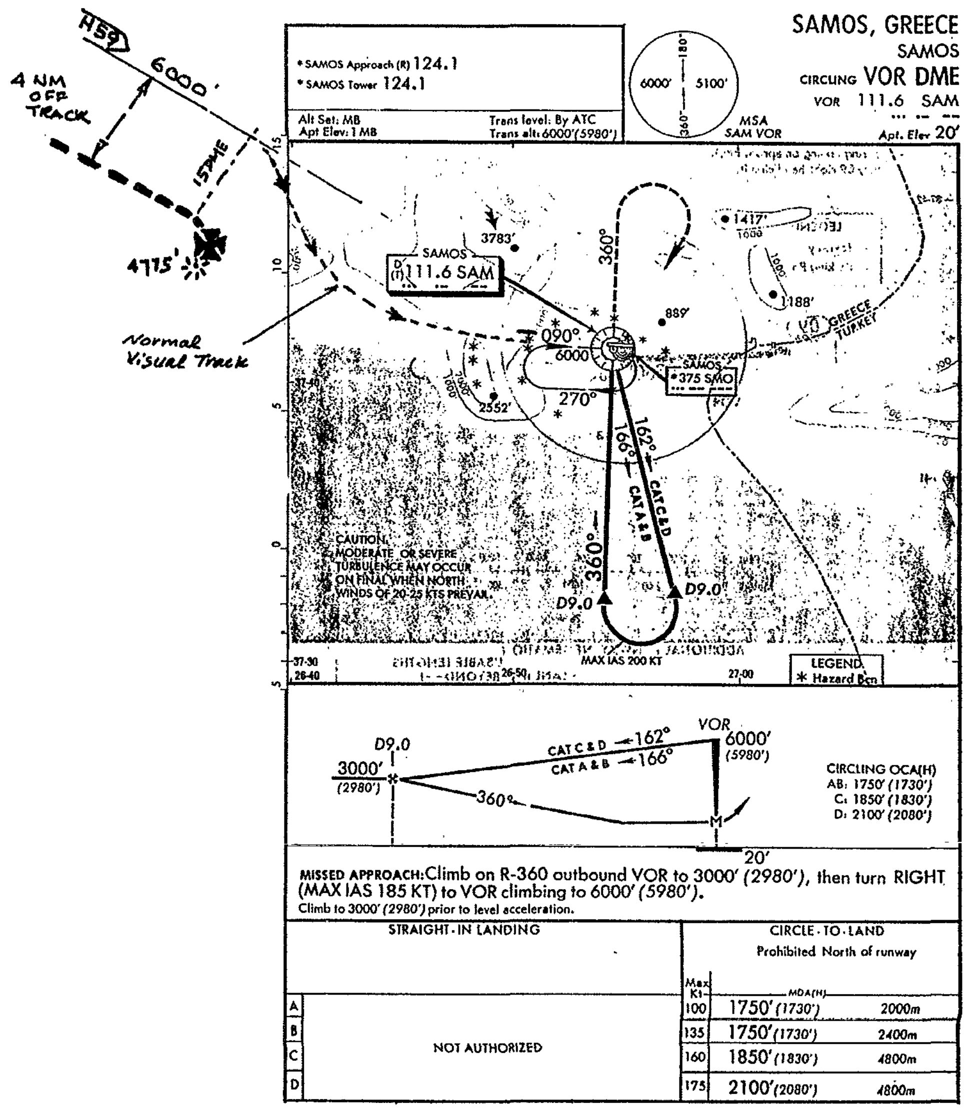
Samos
20


H59
6000'
4 NM
OFF
TRACK
15DME
4775'
Normal
Visual Track
SAMOS Approach (R) 124.1
SAMOS Tower 124.1
Alt Set: MB
Apt Elev: 1 MB
Trans level: By ATC
Trans alt: 6000'(5980')
6000'
5100'
MSA
SAM VOR
SAMOS, GREECE
SAMOS
CIRCLING VOR DME
VOR 111.6 SAM
Apt. Elev 20'
SAMOS
111.6 SAM
3783'
1417'
1188'
889'
2552'
GREECE
TURKEY
090°
6000
270°
SAMOS
375 SMO
360°
166°
162°
CAT A & B
CAT C & D
CAUTION:
MODERATE OR SEVERE
TURBULENCE MAY OCCUR
ON FINAL WHEN NORTH
WINDS OF 20-25 KTS PREVAIL.
D9.0
MAX IAS 200 KT
LEGEND
Hazard Bcn
D9.0
3000'
(2980')
VOR
6000'
(5980')
CAT C & D 162°
CAT A & B 166°
360°
20'
CIRCLING OCA(H)
AB: 1750' (1730')
C: 1850' (1830')
D: 2100' (2080')
MISSED APPROACH: Climb on R-360 outbound VOR to 3000' (2980'), then turn RIGHT (MAX IAS 185 KT) to VOR climbing to 6000' (5980').
Climb to 3000' (2980') prior to level acceleration.
STRAIGHT-IN LANDING
NOT AUTHORIZED
CIRCLE-TO-LAND
Prohibited North of runway
Max Kt
MDA(H)
A 100 1750' (1730') 2000m
B 135 1750' (1730') 2400m
C 160 1850' (1830') 4800m
D 175 2100' (2080') 4800m

CIRCUMSTANCES: While on VOR DME approach to runway 22L, the aircraft prematurely descended down to within 160 feet of the water. GPWS installed and gave timely high descent rate warning. Mis-set barometeric altitude settings (29.91 inches instead of 991 millibars) leading to the aircraft being low in altitude by 640 feet.

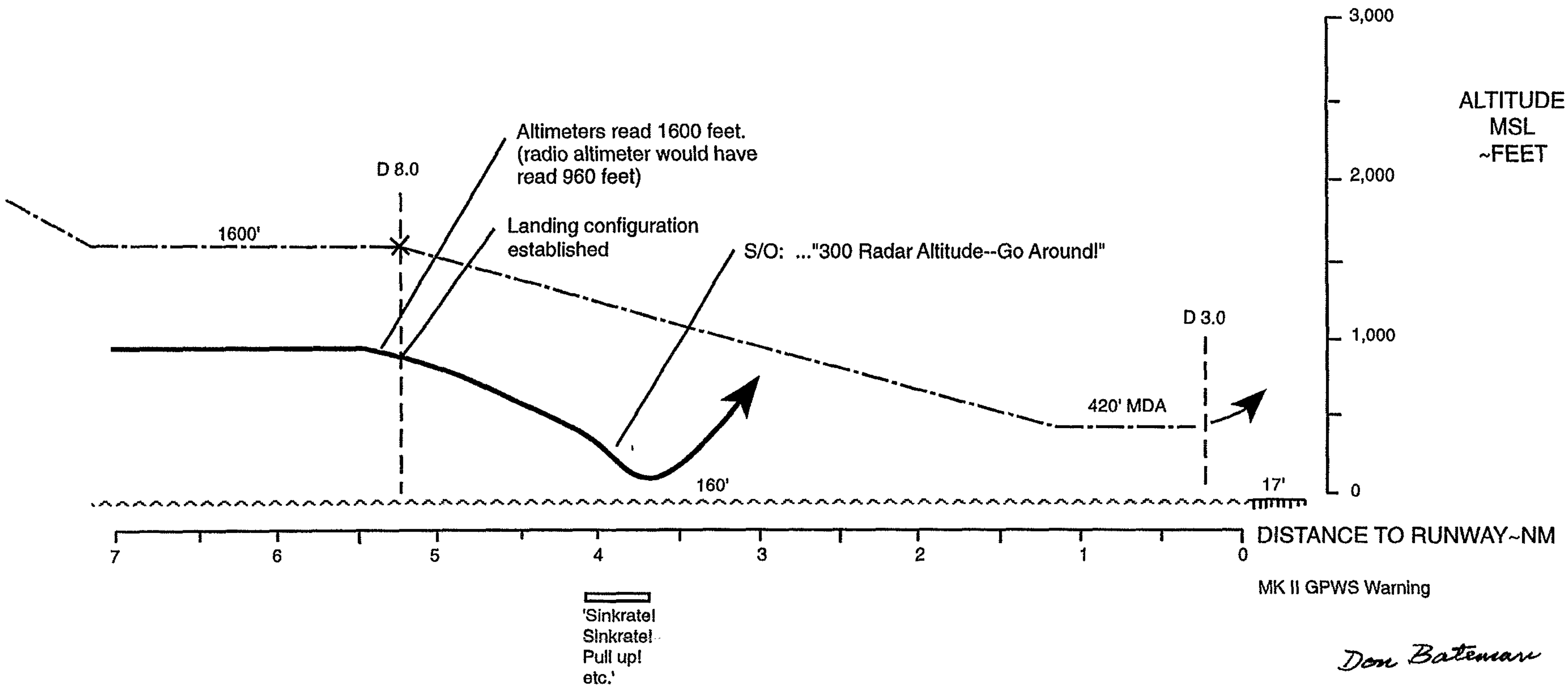
WEATHER: IMC, 70C 5 KM VIS Winds 200 at 25-30 kts

MIS-SET BAROMETERIC ALTITUDE SETTING 640 feet

Flight Path Profile
DC-10/30
COPENHAGEN, DENMARK
July, 1989

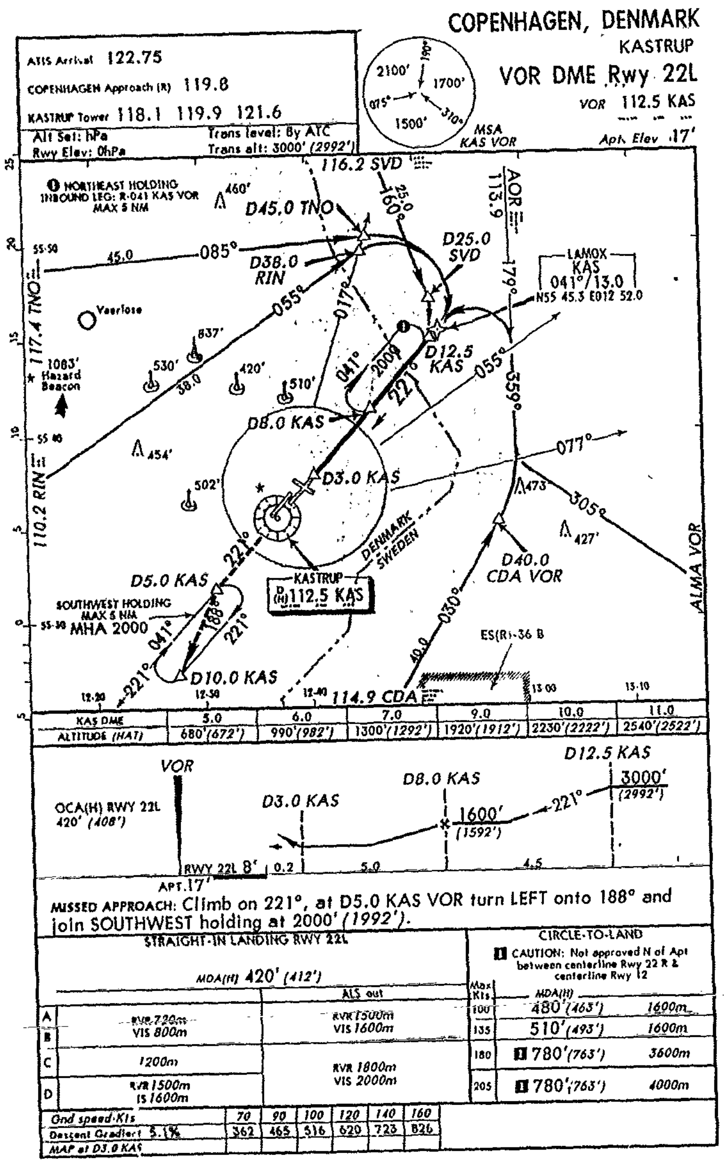
INCIDENT

Next Page



Don Bateman

Return to TOC



KAS DME	5.0	6.0	7.0	9.0	10.0	11.0
ALTITUDE (HAT)	680'(672')	990'(982')	1300'(1292')	1920'(1912')	2230'(2222')	2540'(2522')

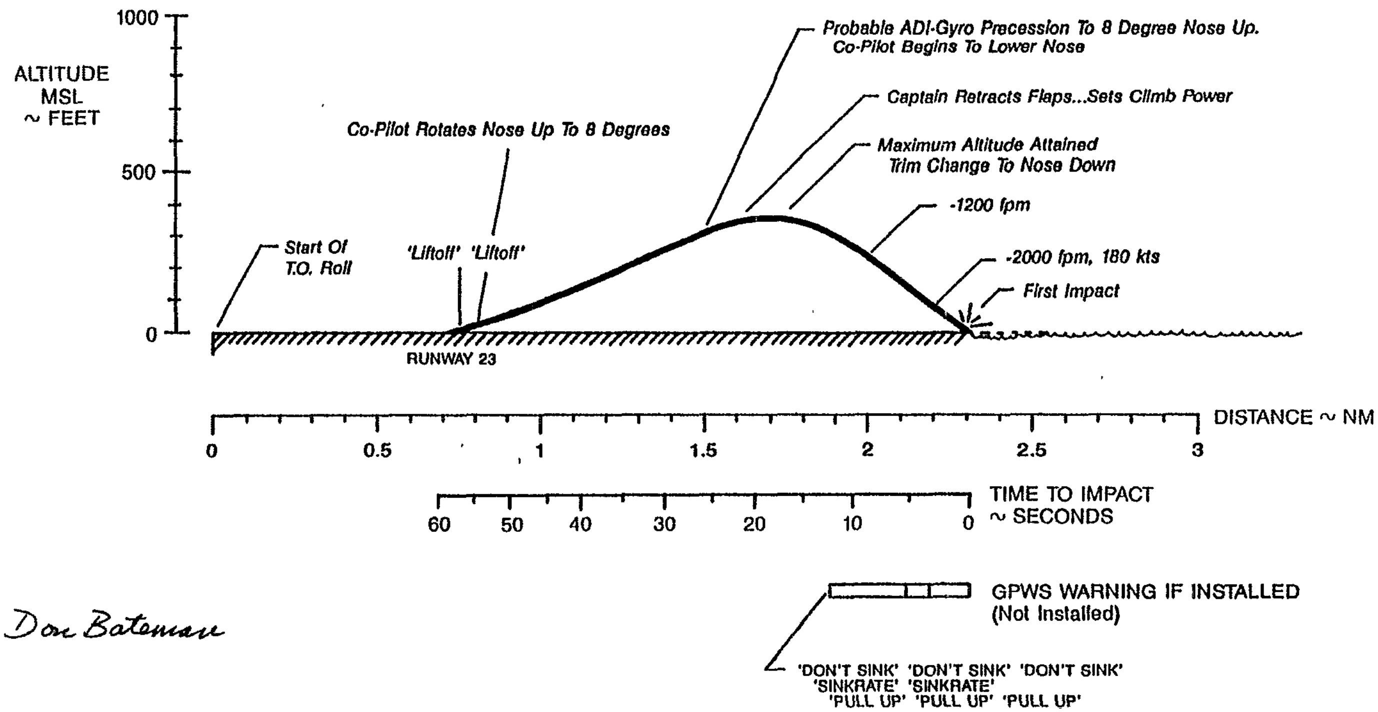
NARRATIVE : 3-MAN WDB CREW EXPERIENCED IN EUROPE OPS REPORTED FOR SCHEDULED DUTY AT XX30 PM EDT TO FLY DTW-BOS, CHANGE ACFT AT BOS AND FLY BOS-CPH. SCHEDULED DUTY TIME WAS 12+25. DEP FROM BOS WAS DELAYED 2+30 FOR ACFT MAINT. CREW DEPARTED BOS WITH PROTECTED COPENHAGEN ARR TIME OF OY55 EDT. CREW HAD BEEN AWAKE FOR 20 HRS INCLUDING THE ENTIRE EASTERN TIME ZONE NIGHT AT TIME OF LNDG AT CPH. APCH IN USE AT CPH WAS 22L VOR DME. S/O (MIS) COPIED ATIS SHOWING ALTIMETER SETTING TO BE 29.91, CEILING AT 700' WITH 5 KM VIS AND WIND AT 25-30 KTS. TRANSITION LEVEL WAS 40 AND "QNH 991" WAS GIVEN BY APCH. F/O WAS FLYING APCH AND WAS CLRED TO INITIAL APCH ALT OF 2500' ON A 270 DEG INTERCEPT HDG, PUBLISHED MDA WAS 420'. INTERCEPT OCCURRED AT 13 DME, AND FINAL APCH FIX WAS AT 10 DME. UPON INITIAL TWR CONTACT CREW WAS ADVISED OF HEAVY RAIN AT FIELD. FLT DIRECTORS WERE SHOWING ACFT ON COURSE BUT CDI'S WERE SHOWING COURSE TO BE RIGHT. FLT DIRECTORS WERE TURNED OFF AND F/O CONTINUED WORKING TO CORRECT TO VOR COURSE. WIND AT 2000' WAS 300/40 DRIFT WAS 9L. AT 1000 ABOVE MDA CAPT CALLED OUT "1000" AND SHORTLY THEREAFTER S/O MONITORING APCH (COMPANY DOES NOT SUPPLY APCH CHARTS TO S/O'S) CALLED OUT "300 RADAR ALT, GO AROUND". MISSED APCH WAS INITIATED IN HEAVY RAIN WITH PRESS ALT READING 800'. F/O FLEW MISSED APCH. AFTER MISSED APCH CAPT QUESTIONED TWR ABOUT ALTIMETER SETTING BEING 29.91 AND RELIEVED CONFIRMATION. S SECOND VOICE HOWEVER CORRECTED THAT STATEMENT TO 991 MILLIBARS. ACFT ALTIMETERS WERE RESET FROM 29.91 TO 991 MILLIBARS, A 640' DIFFERENCE. F/O FLEW ACFT ON SECOND APCH TO SAME RWY LNDG WITHOUT INCIDENTS. ACFT MOST PROBABLY WAS WITHIN 160' OF STRIKING THE WATER IN A 1500 FPM RATE OF DSNT ON THE FIRST APCH. CONTRIBUTING CONDITIONS: MISCOPY OF ATIS. VERY TIRED CREW. "QNH 991" TERMINOLOGY. FL400 TRANS LEVEL DURING BUSY APCH PHASE. NO GLIDE SLOPE AVAILABLE ON APCH. VERY STRONG XWINDS. HEAVY RAIN. VERY LOW ALTIMETER SETTING (29.27"). AS A MINIMUM FIX FOR THIS PROBLEM, TERMINOLOGY SHOULD BE QNH 0991 WHEN QUOTING MILLIBARS OR HECTO PASCALS, "QNH 991" IS NOT ENOUGH! CALLBACK CONVERSATION WITH REPORTER REVEALED THE FOLLOWING: THE S/O WAS MONITORING THE RADIO ALTIMETER ON DESCENT AND NOTED THE DISPARITY BETWEEN IT AND THE BAROMETER ALTIMETER AND CALLED OUT TO GO AROUND JUST AS THE GND PROX WARNING WENT OFF SO WE WERE ALL COORDINATED ON THE GO AROUND. ONE PROBLEM ON ALTIMETER SETTING IS THAT WE DID NOT RECEIVE THE ALTIMETER UNTIL ABOUT 4000' ON DSNT. THIS IS COMMON IN EUROPE 6 - 4T FEET ON DSNT. SO WAS HURRIED AND VERY TIRED AND APPARENTLY MISHEARD THE ALTIMETER AS 29.91 WHEN THEY SAID QNH NINER NINER ONE.

SOURCE: ASRS # 118461

Next Page

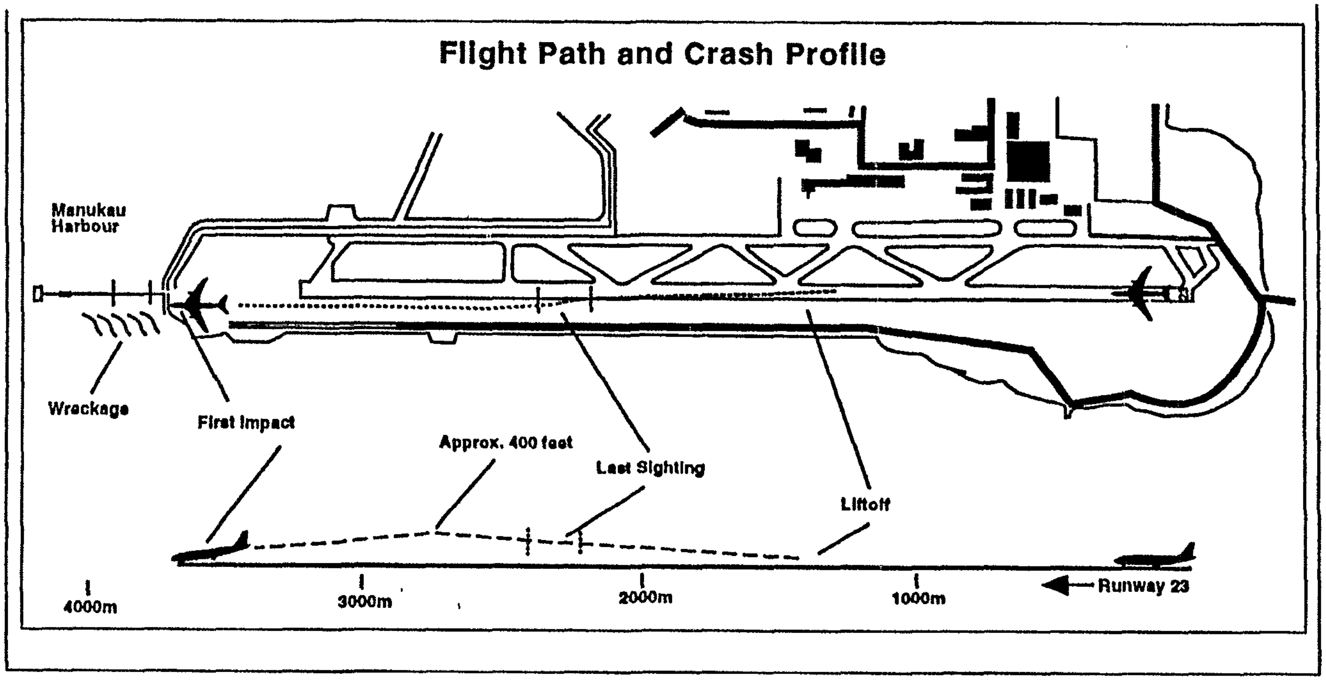
Circumstances:	Aircraft accelerated back into ground during night takeoff. Co-Pilot flying with a faulty ADI. ADI had been previously reported with precession errors 5 to 10 degrees nose up, but was not replaced because of a lack of spares. Normal climb attitude is 6 to 8 degrees nose up.
Time:	Night
Weather:	IMC - light drizzle
Fatalities:	3
Other:	Aircraft had been fitted with GPWS MK I but was later removed after leaving U.S.A. Aircraft still equipped with wiring, lights, etc. for GPWS. N.Z. Report: "GPWS might have helped avoid the crash. Although such equipment was recommended by ICAO for the aircraft class on international operations, it was not required for New Zealand registered turbo-prop aircraft after a trial test period resulted in unacceptable false warning rates."

FLIGHT PATH PROFILE
CV-580
Auckland, New Zealand
31 July, 1989



Don Bateman

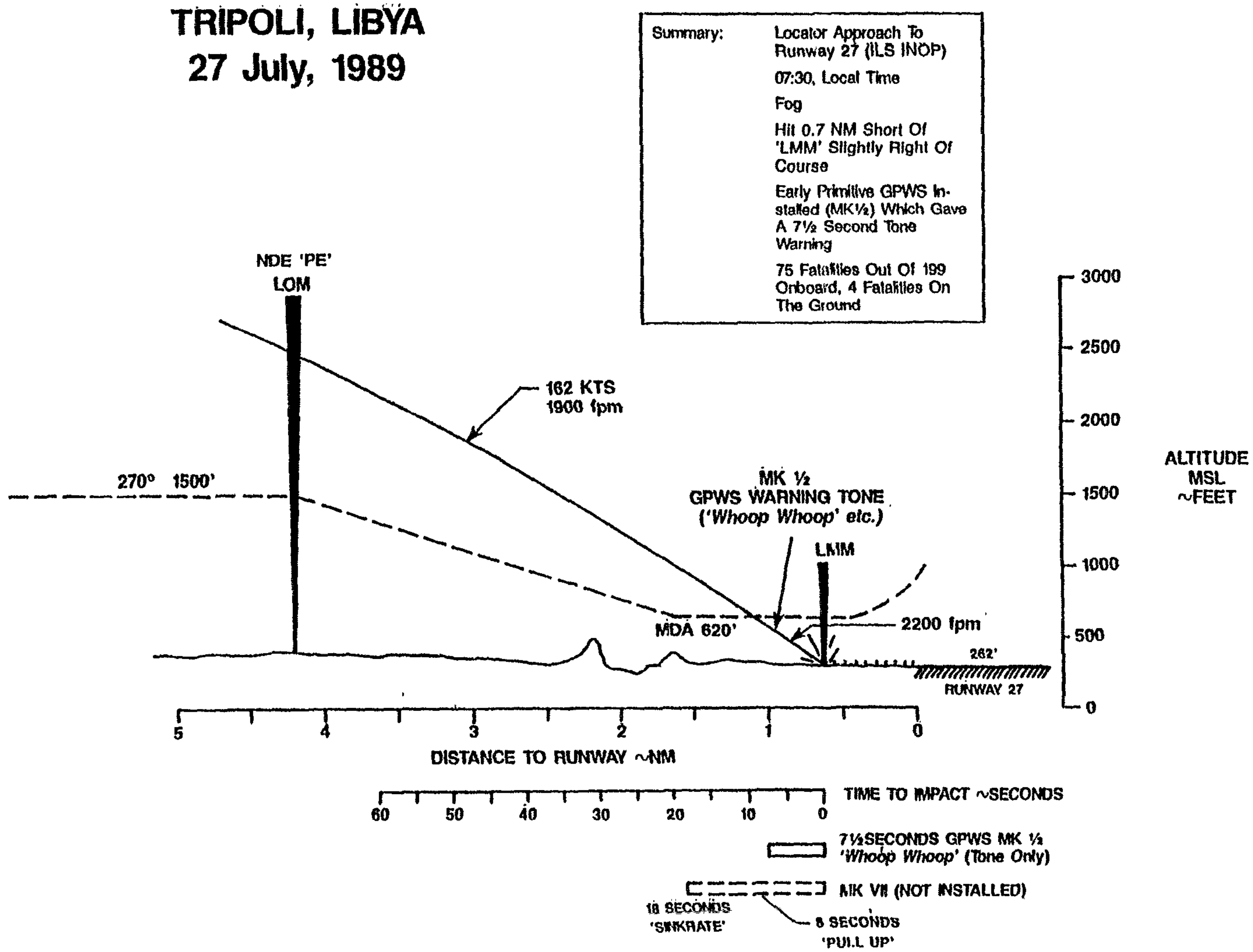
Return to TOC

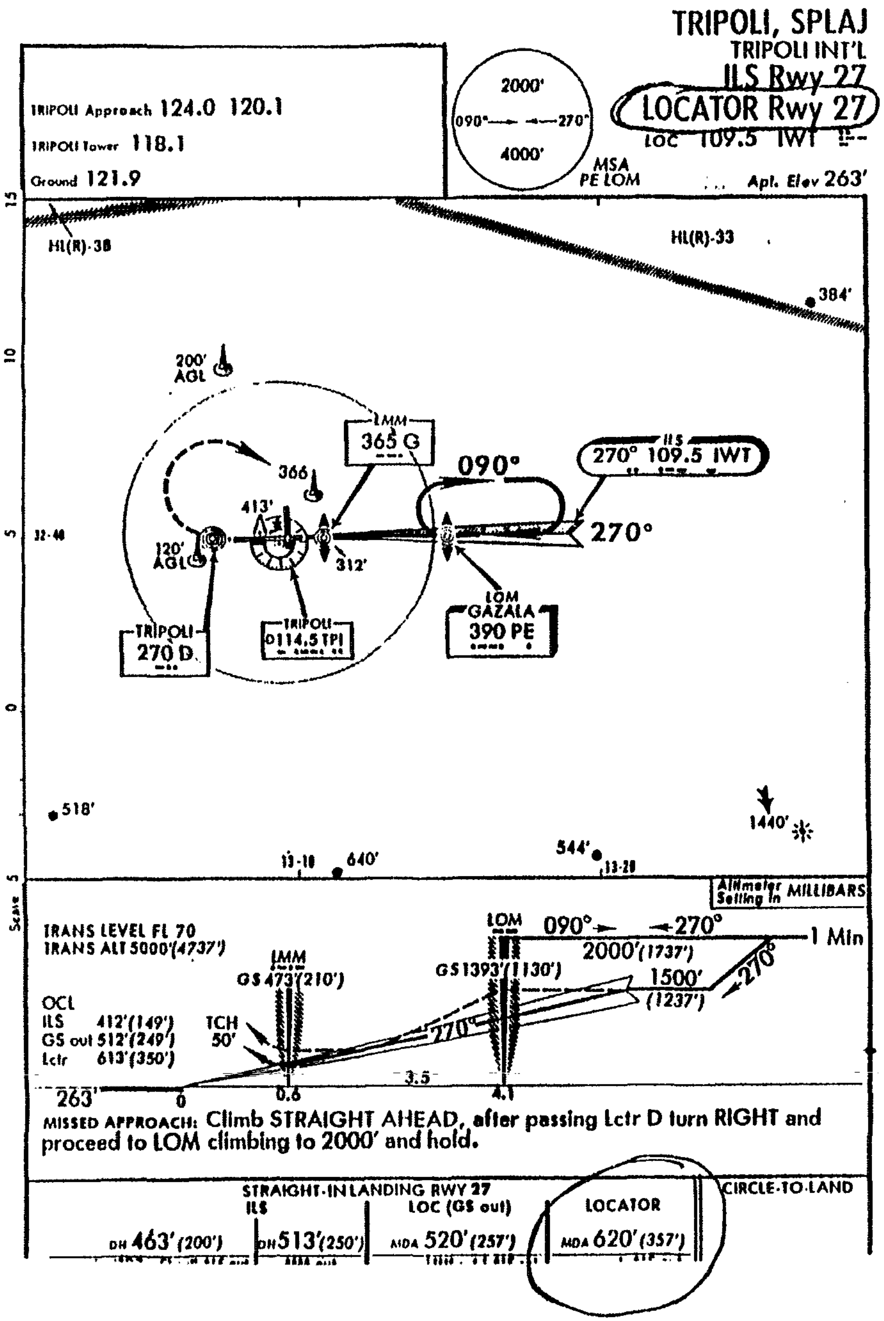


Next Page

Flight Path Profile

DC-10-30
TRIPOLI, LIBYA
27 July, 1989





HEADLINES

NOTAM 'ILS OUT!' III: LOCATOR

Korean DC-10 crashes in Libya

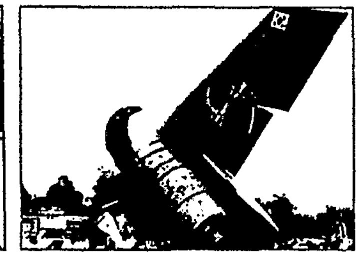
A Korean Air McDonnell Douglas DC-10-30 crashed while attempting to land at Libya's Tripoli Airport on July 27. The DC-10 came down some three miles short of the airport, and destroyed houses and several cars. Four people on the ground, 72 passengers, and three crew were killed.

An Aeroflot aircraft that arrived at Tripoli an hour before the DC-10 had carried out a missed approach and diverted to Malta because of fog. Tripoli's runway 27 is equipped with a Category II instrument landing system, and the DC-10 is equipped for automatic landing, although it is not known if this was used. The captain, Kim Ho-jung, who survived the accident, said he had lost radio contact with Tripoli some 15min before the accident.

Unconfirmed reports say the copilot reported engine trouble on Tripoli approach, and also said that a wheels-up landing might need to be attempted. If confirmed, this could point to a triple flame-out, which dictates a high-speed approach with slats retracted and flaps up, and the need to leave emergency gear extension until as late as possible.

The DC-10 was operating flight KE803, a scheduled service which departs Seoul at 1840h local time and has intermediate stops at Bangkok and Jeddah, with arrival at Tripoli scheduled for 0730h local time. There were 181 passengers and 18 crew on board. The aircraft lost in the accident (HL-7328) was manufactured in 1973, the 125th DC-10 off the line, and was delivered to Thai Airways, which later sold it to Korean Air. It had amassed about 47,500h total time, over some 11,200 flights.

DC-10s are powered by General Electric CF6 turbofans, although the -30's CF6-50s produce more thrust than the -10's CF6-6s. The uncontained failure of a CF6-6 led to the United Airlines DC-10-10 accident at Sioux City, USA, on July 19. □

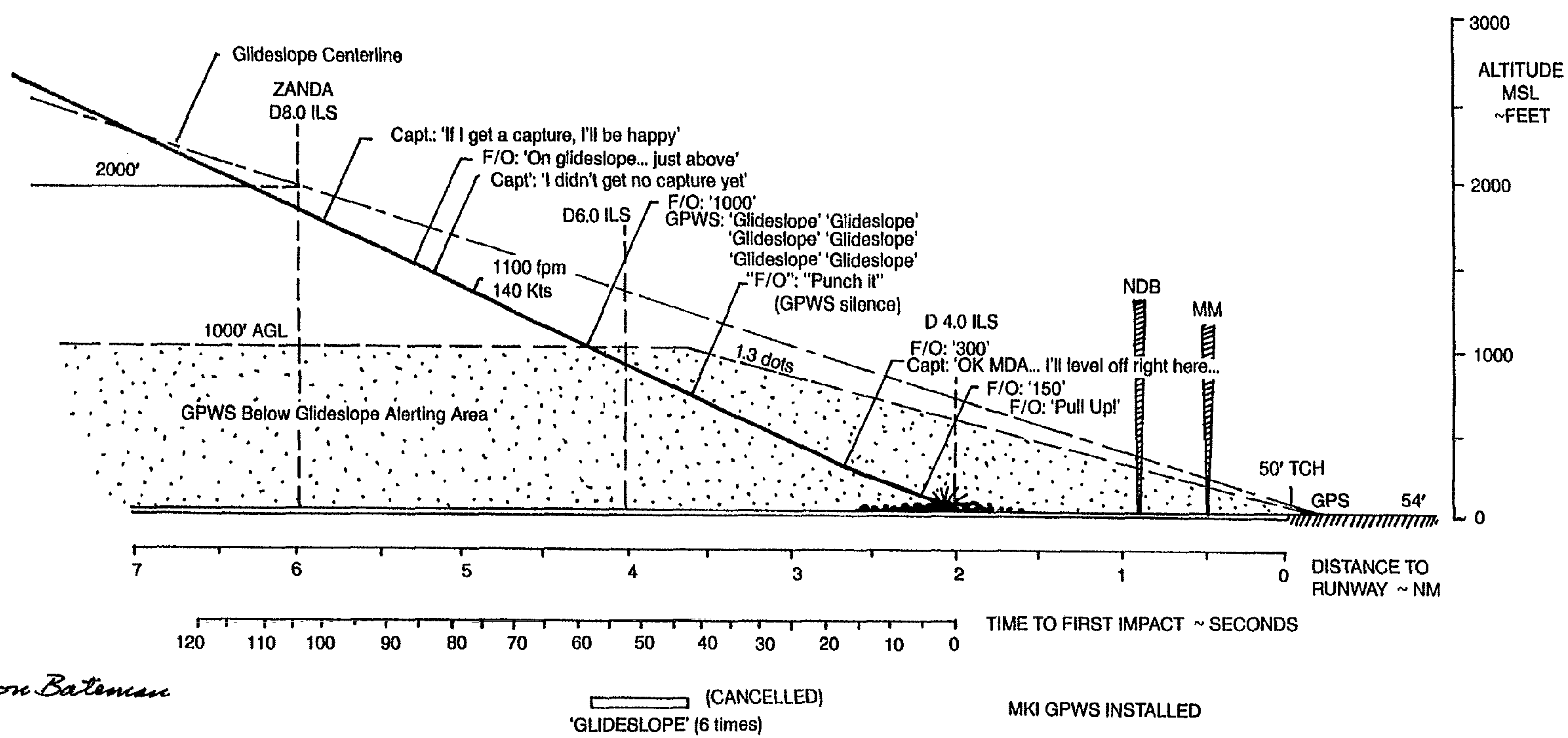


An intact but fire-damaged nacelle suggests that the Korean DC-10 did not suffer catastrophic rear-engine failure

90-282

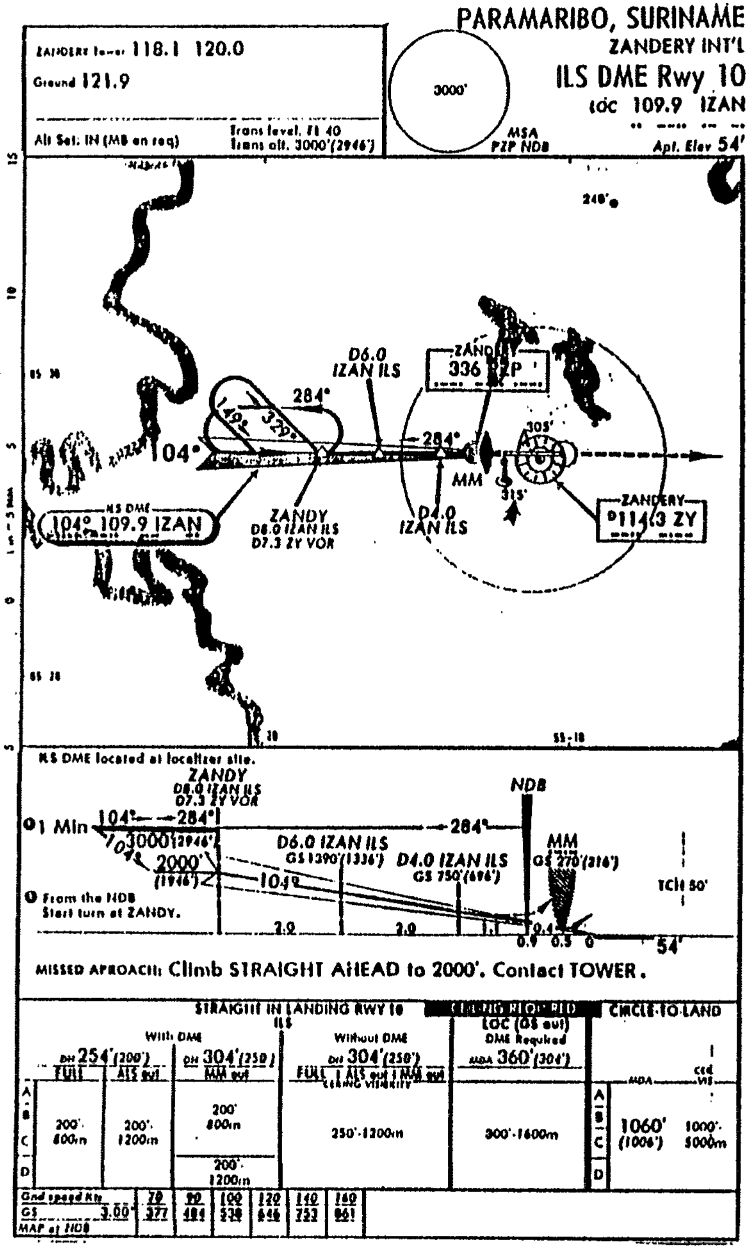
Circumstances:	Aircraft hit short during an ILS approach ro runway 10. The approved clearance was VOR DME Runway 10, but the ILS was on and utilized by the crew. Crew concerned about fuel required to divert to Guyama.
Weather:	900 meters visibility in fog.
Time:	Night
Other:	Possible contributing cause was improper management of Flight Director (No glideslope capture... fixed vertical speed from above the glideslope). Runway visible at times during approach. Aircraft was leased from U.S.A. with crew. (Ex. Braniff)
Fatalities:	170 out of 183 on board

FLIGHT PATH PROFILE
DC-8/62
Paramaribo, Suriname
7 July 1989



Don Bateman

Return to TOC



168 Aboard Airliner Killed in Crash in Suriname

PARAMARIBO, Suriname, June 7 (AP) — A Suriname Airways jetliner en route from the Netherlands with 182 people aboard crashed today in a jungle area near the Paramaribo International airport, killing 168 people, the airline said.

The Suriname News Agency said the jet, a DC-8, went down at about 4:30 A.M. two miles from Zanderij International Airport. Fourteen survivors were taken to University Hospital in Paramaribo, but their identities and condition were not immediately known.

An airline spokesman, Robbi Lachmising, said in Amsterdam that the plane crashed in dense fog. The airport has no radar, Mr. Lachmising said. Suriname, on the northern coast of South America, is a former Dutch colony.

The Suriname News Agency said three of the nation's top military officers were on the flight and identified them as the army Chief of Staff, Maj. Raymond Lieuw Yen Tai, the air force commander, Maj. Eddy Djoe, and the army chief of operations, Capt. Armand Salomons. All were presumed dead, the agency said.

The plane carried 173 passengers and 9 crew members, Mr. Lachmising said.

The airline said the plane was flown by Americans and identified them as Capt. Will Rogers; Glyn Tobias, a pilot, and Rose Warren, the engineer. All were listed as full-time employees of Suriname Airways. Their hometowns and fates were not immediately known.

The 20-year-old DC-8, which was registered in the United States, broke into four pieces but did not explode, and no fire broke out, Mr. Lachmising said.

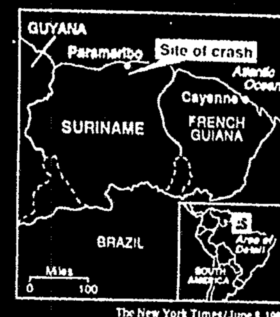
There were no immediate reports on what caused the crash. Mr. Lachmising said it "was not caused by the plane's technical condition."

The airline spokesman said the jetliner, leased by Suriname Airways from an unidentified American company, was extensively overhauled in Luxembourg about 10 days ago.

The plane, which took off late Tuesday from Schiphol Airport in Amsterdam, tried three times to land at Suriname's airport, another airline spokesman said in Amsterdam. The weather was "extremely bad" and on the third attempt the jet hit a treetop, the spokesman said.

At least three passengers were top Dutch soccer players of Surinamese origin, according to Inter Football, a Dutch organization for professional soccer players. They were to take part in a national tournament in Suriname.

A passenger list was not immediately available, but an airline spokesman in Amsterdam, Glenn Jie, said most of those on board were Surinamese people living in the Netherlands.

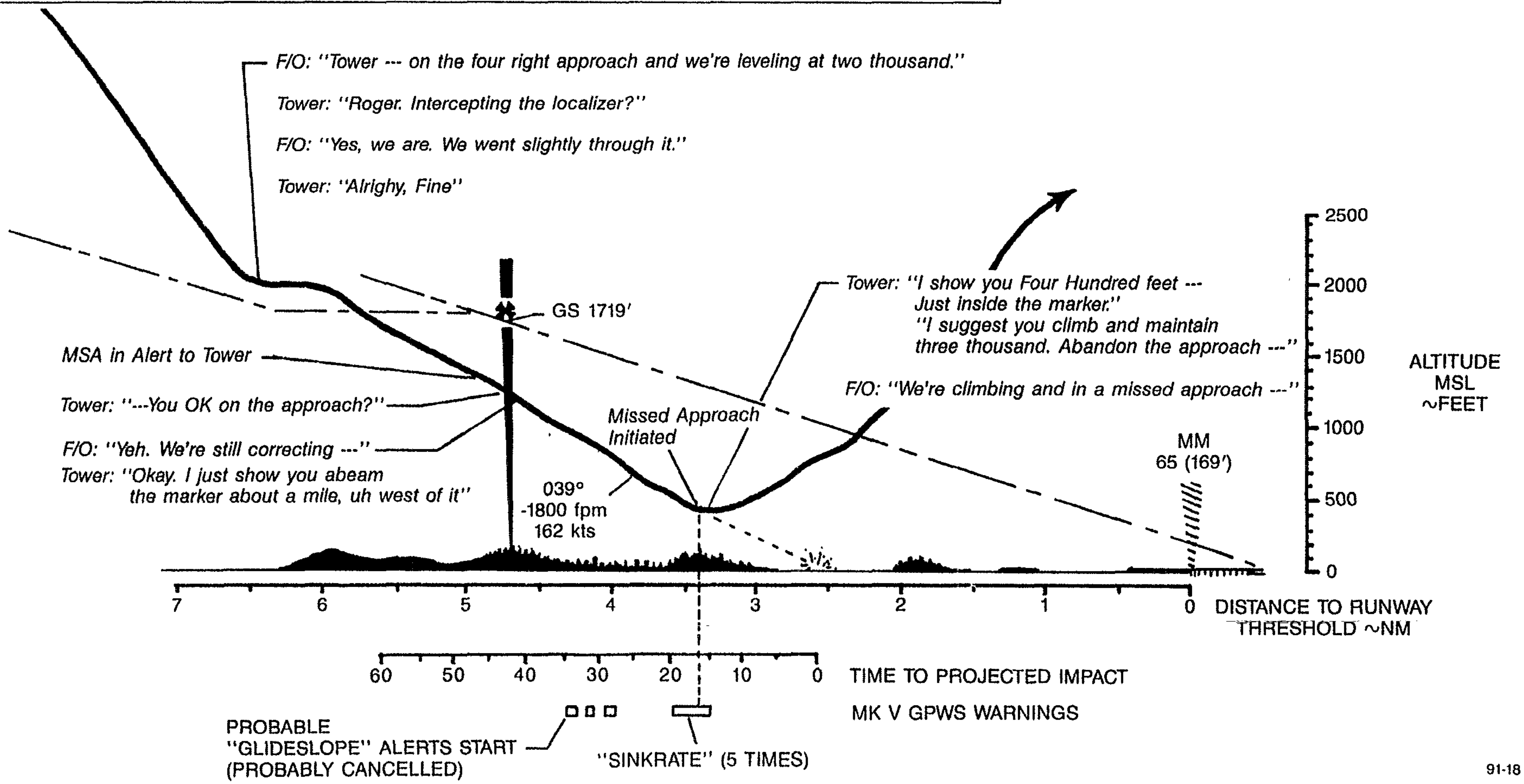


182 people were on board a DC-8 that crashed outside Paramaribo.

Next Page

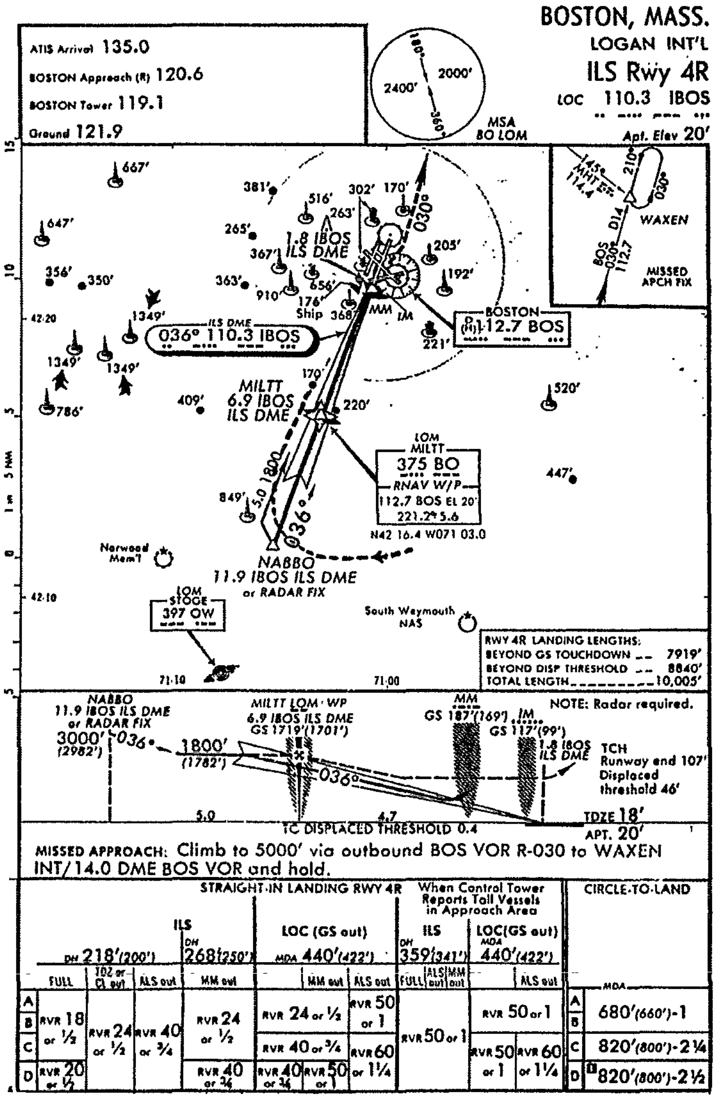
Circumstances:	During an ILS AFGS approach to runway 4 R, the aircraft overshot the localizer, and during an attempt to capture the localizer manually using the AFDS, the aircraft inadvertently descended well below the glideslope and 1 NM left of course, resulting in a missed approach.
Weather:	Partially obscured 300 feet, scattered, measured ceiling 400 feet,¾ mile visibility for and rain.
Time:	Night
Contributing Factors:	1. F/O had left Bank Angle Limit Selector at 10° and had not reset it to AUTO or 25°, which limited the AFGS (and AFDS) bank angle during the intercept to capture the localizer 2 In an attempt to regain the localizer, the Heading Select Mode was engaged while in Approach Mode. The Captain disengaged the autopilot, manually flying with the AFDS, but because the glideslope had not been captured, the AFDS remained locked in Vertical Speed. 3. ATC's very tight turn onto localizer 4. Distraction caused by spurious Left Engine Bleed System, aural, visual, EICAS cautions.

FLIGHT PATH PROFILE
B767
Boston Massachusetts
8 June, 1989



91-18

Return to TOC



Next Page

Circumstances: During initial approach to Valence ILS OI, the aircraft struck a mountainous wall.

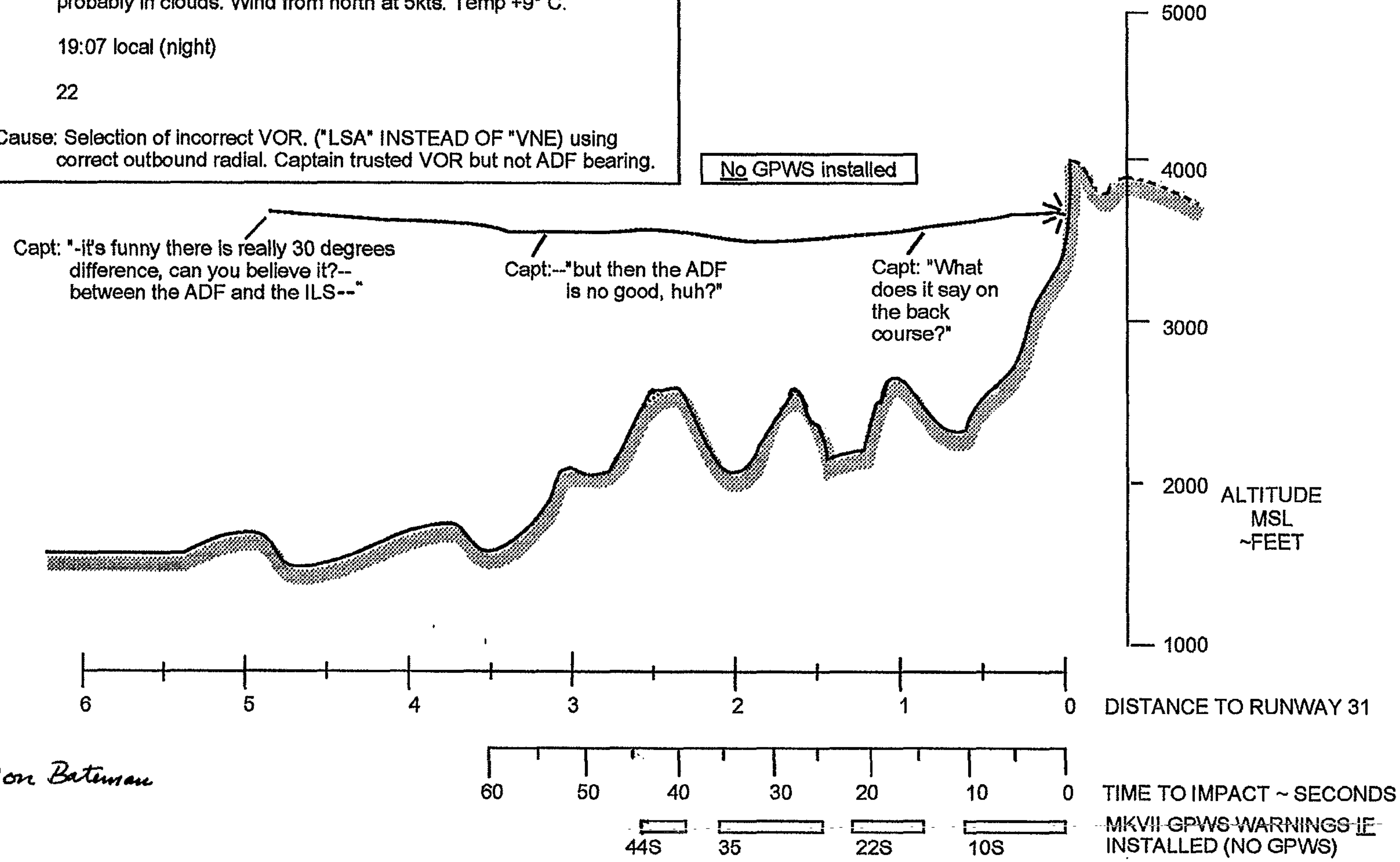
Weather: Lower ceiling 2300 to 2700 meters, tops 3500 to 5000 meters, and a layer of 5 to 7/8 cumulus, and stratocumulus from 600/800 meters to tops 1500/2000 meters. Visibility 5 to 10 km, -R. Aircraft probably in clouds. Wind from north at 5kts. Temp +9° C.

Time: 19:07 local (night)

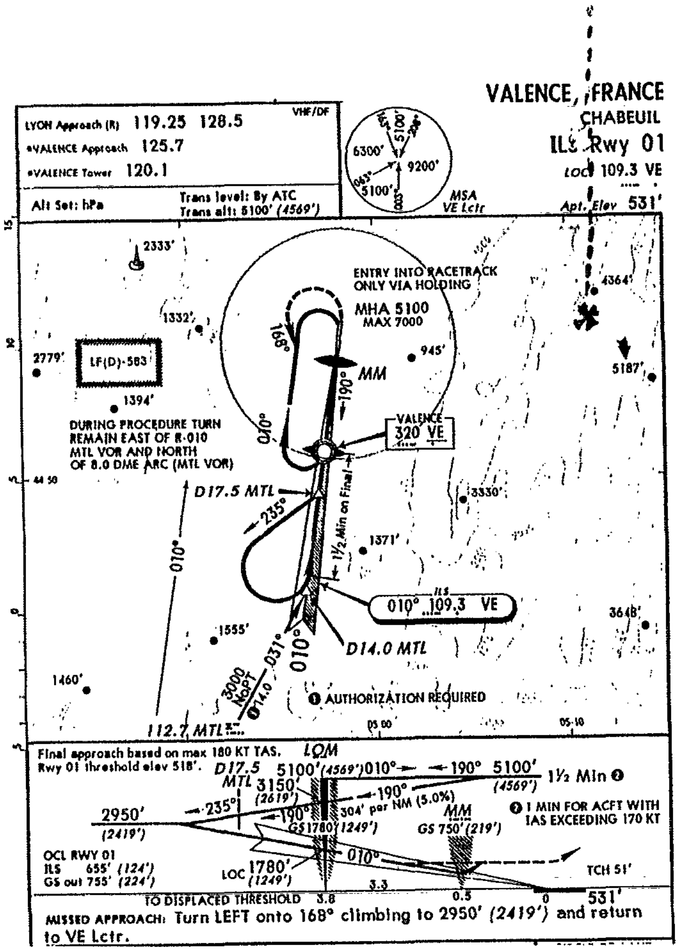
Fatalities: 22

Probable Cause: Selection of incorrect VOR. ("LSA" INSTEAD OF "VNE) using correct outbound radial. Captain trusted VOR but not ADF bearing.

FLIGHT PATH PROFILE
FH-227
Valence, France
10 April, 1989



Don Bateman



22 Reported Dead in a French Plane Crash

VALENCE, France, April 10 (AP) — A passenger plane crashed into a foggy mountainside in southeastern France tonight, killing all 22 people aboard, officials said.

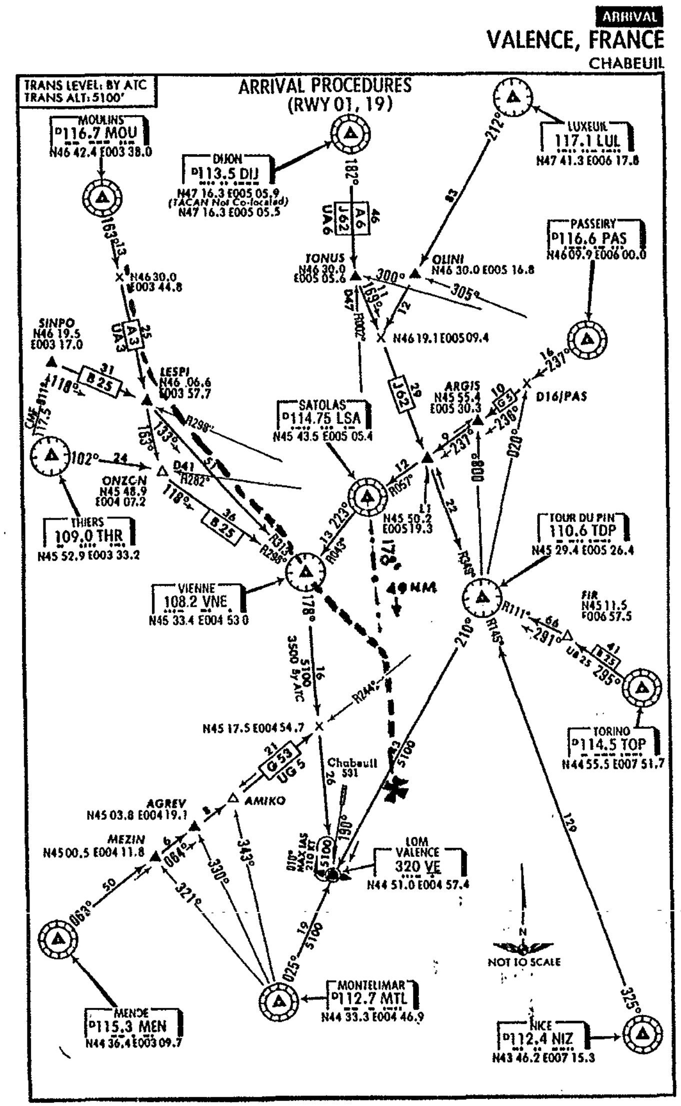
Rescue workers located the wreckage of the Fokker F-27 about three and a half hours after the crash, which occurred shortly after 9 P.M. as the plane was about on its landing approach, local officials said.

They reported finding bodies among the aircraft's scattered debris in a forest near the village of Leoncel, about 15 miles from this city in southeastern France.

The wreckage was on the northern face of the Vercors mountain, at an altitude of 3,900 feet. Officials said the cloud cover was low and the area was foggy.

The twin-engine turboprop, was flying for the private airline Europe Aero-Service. It was making a regular flight from Orly Airport in Paris to Valence.

Officials said there were three crew members and 19 passengers, including three children, aboard the plane.



Next Page

CIRCUMSTANCES: While on final approach to TACAN RWY 18, the aircraft descended rapidly with engines at flight idle, failing to level off at MDA or on the proper approach slope, impacting 21/2 nm short of the runway.

CONFIGURATION: Landing

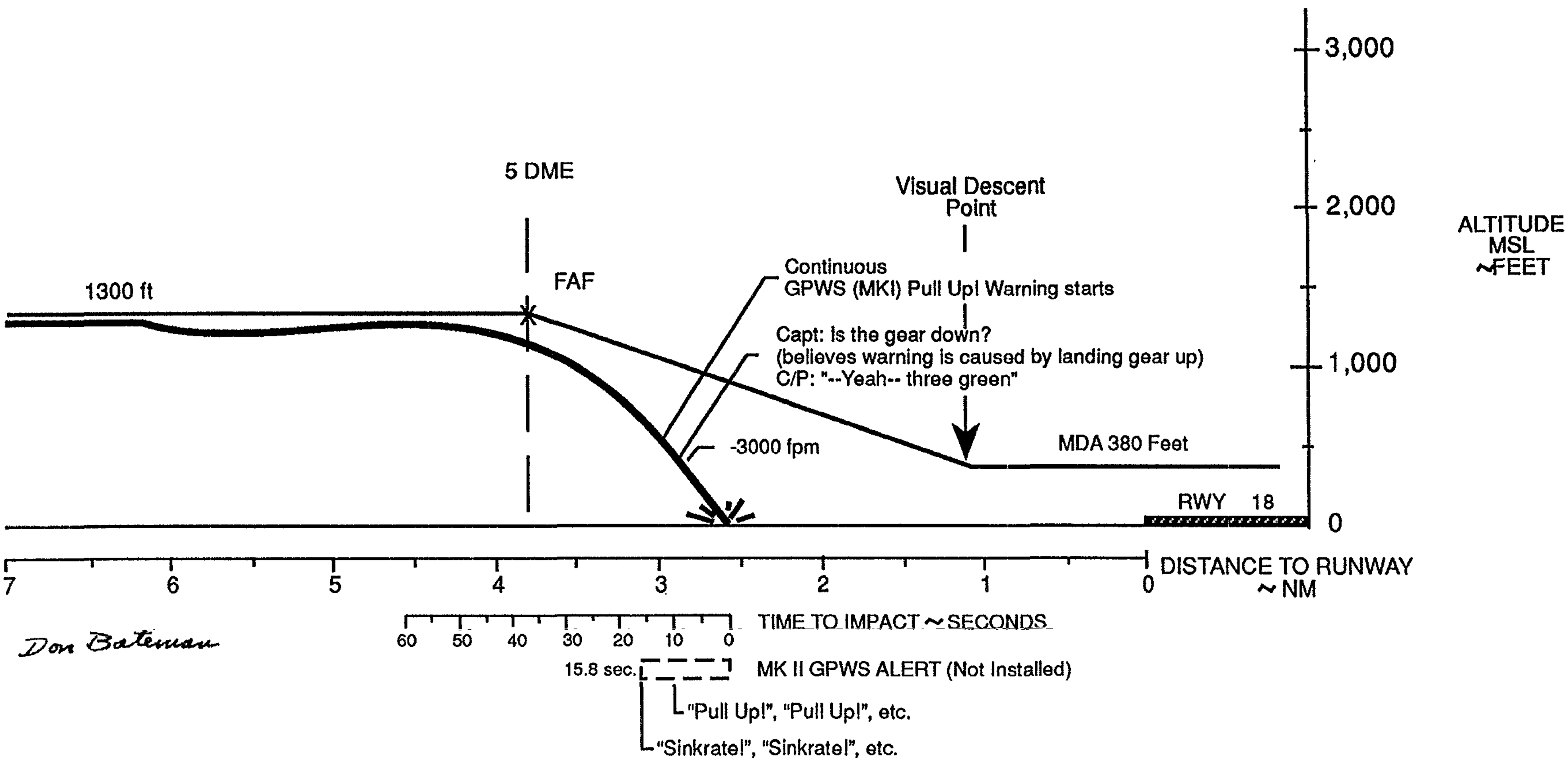
TIME: 19:57 CST, Night

WEATHER: 4 ⊕, 6 mile visibility

FATALITIES: All on board (7 crew and 1 passenger)

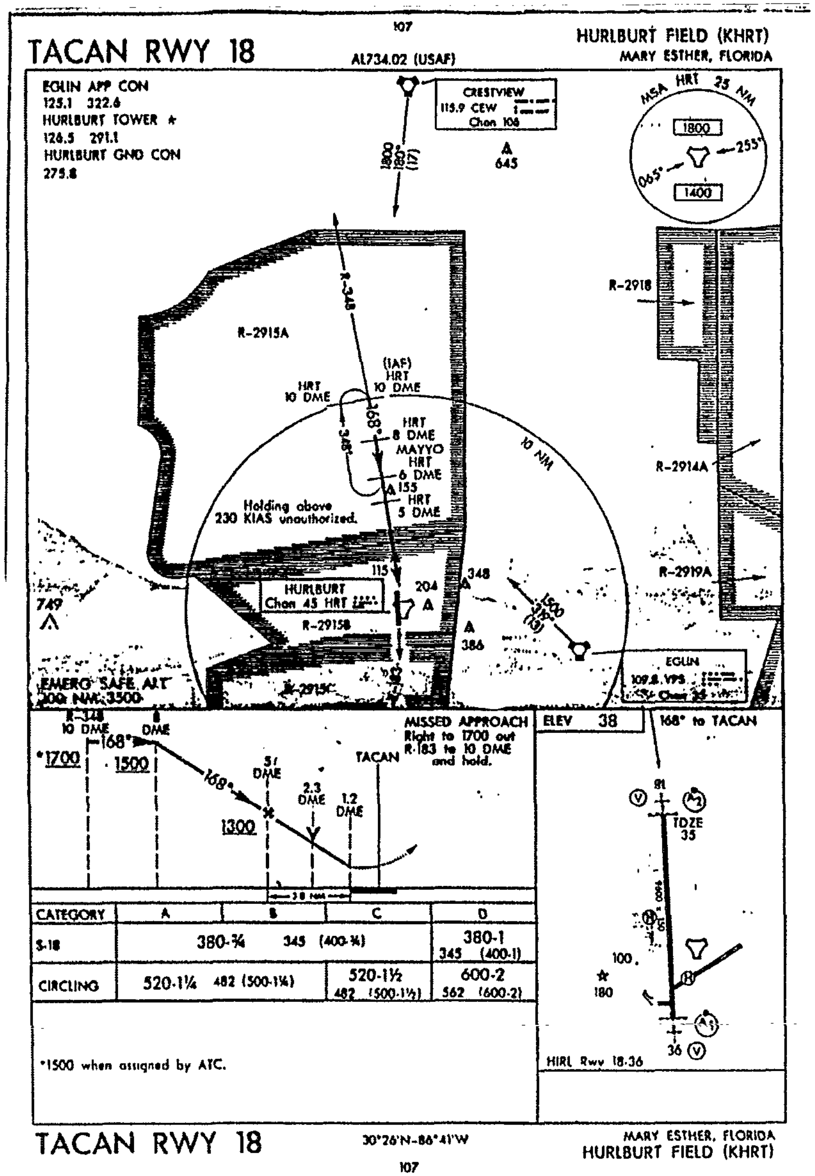
OTHER: This accident illustrates the need for GPWS to identify cause of warning.

FLIGHT PATH PROFILE
U.S. Air Force C-141B
Hurlburt Field, Florida
20 February, 1989



Don Bateman

Return to TOC



Air Force Plane Crashes

HURLBURT FIELD, Fla., Feb 20 (AP) — An Air Force cargo plane with eight people on board crashed and exploded tonight north of this base in the Florida Panhandle, officials said. It was not known whether anyone survived the crash.

The Lockheed C-141 Starlifter from Colorado Springs, was preparing to land at Hurlburt Field when air traffic controllers from adjacent Eglin Air Force Base lost radio and radar contact about 8 P.M., said Airman Joe Geract, duty officer at the air field.

Army Rangers reported an explosion about four miles north of the field, he said. Seven people on board were crew members and one was a passenger.

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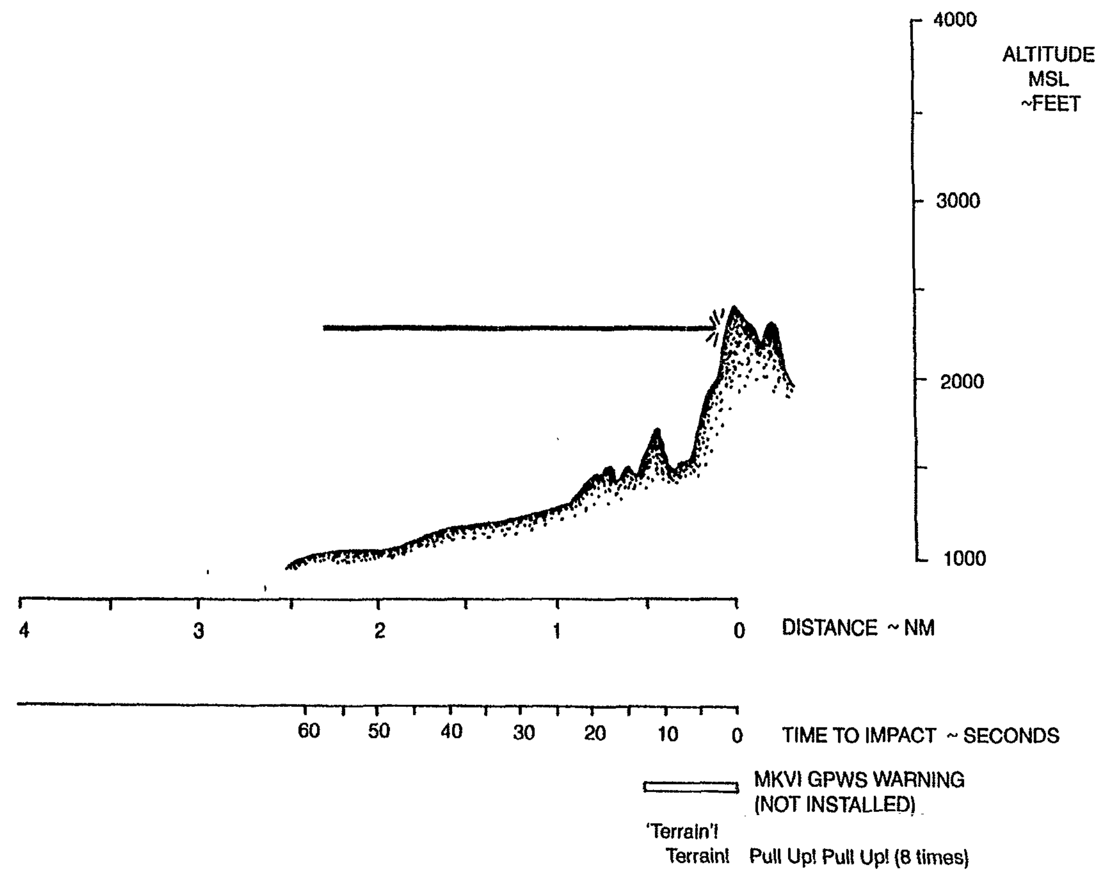
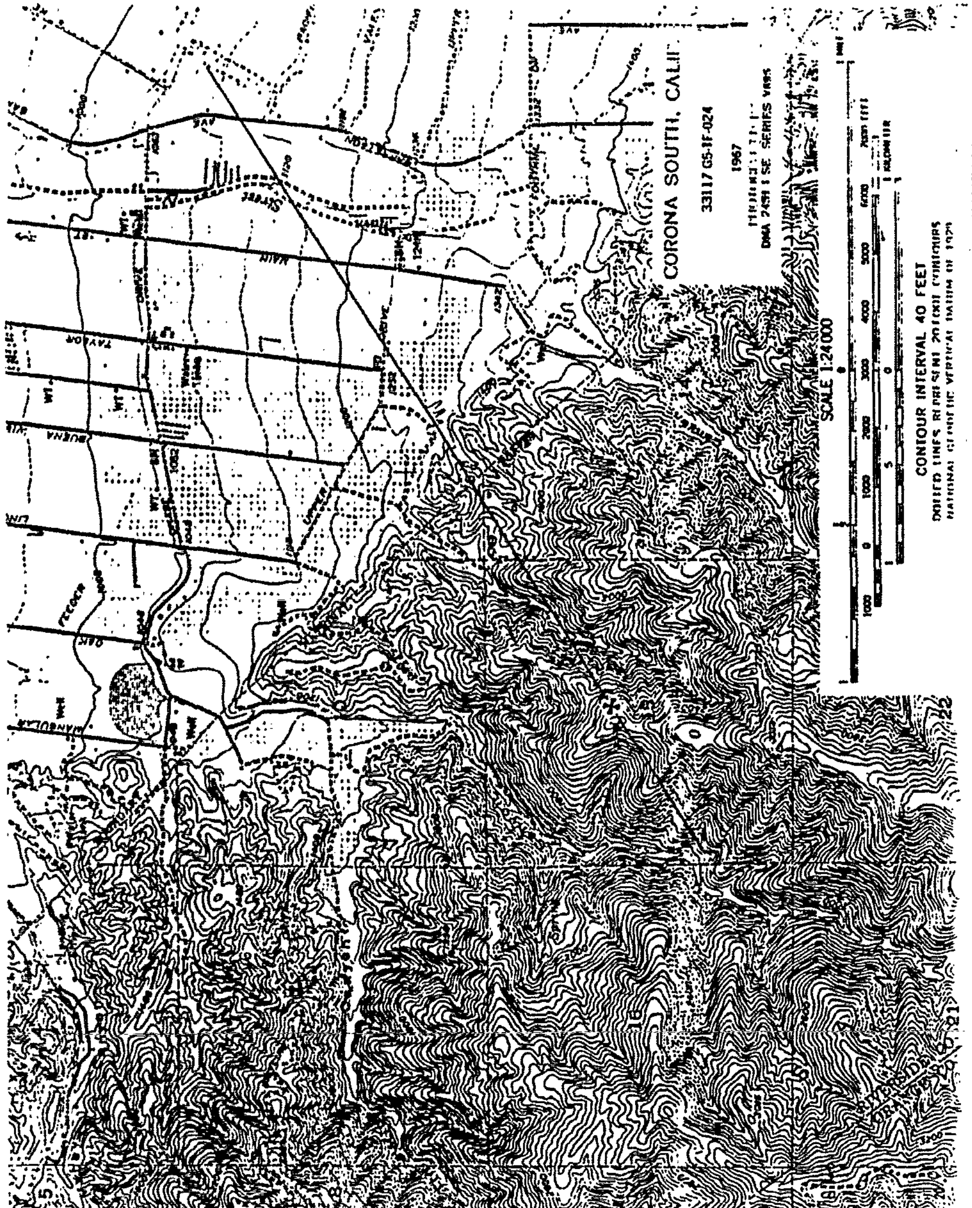
90-282

Circumstances:	Charted aircraft enroute to Orange Co. John Wayne airport hit mountain 20 miles short.
Weather:	Overcast, drizzle, scattered clouds in area
Time:	12:00 PDT
Fatalities:	10.

FLIGHT PATH PROFILE

Ce-404
Orange, Co.
John Wayne Airport
19 February, 1989





Tuesday 21 Feb. '89 Seattle Times

Tragedy hits a flight to Disneyland; crash kills 10

by Louis Sahagun
and John Kendall
Los Angeles Times

Associated Press
The wreckage of a twin-engine chartered plane lies scattered on a mountainside southeast of Los Angeles.

CORONA, Calif. – The shattered wreckage of a chartered twin-engine plane carrying five children, their parents and two other relatives on an outing from Las Vegas to Disneyland was found yesterday on a chaparral-covered peak. All 10 aboard, including the pilot, were dead.

The Cessna 402, flying in drizzly overcast weather at midday Sunday, failed to clear a 2,274-foot crest by approximately 100 feet and hit a peak overlooking Hagador Canyon in the Santa Ana Mountains.

The plane went down about 20 miles short of its intended destination, Orange County's John Wayne Airport.

The Riverside County coroner's office tentatively identified the victims as Michael Cranson, 36, a Las Vegas metropolitan police officer; his wife, Raeann, 33; their five children, Shauna, 15, Stephanie, 14, Nicole, 12, Joshua, 11, and Kyle, 7; James Montano, 24, and Cynthia Montano, 23, identified by officials in Las Vegas as Raeann's sister and brother-in-law; and Hassan Berro, the pilot.

Cranson, a 10-year police veteran, was an Explorer Scout leader and was president of the Sunrise Villa Ward of the Young Men's Mutual Improvement Association, a Mormon youth group. His wife was a counselor in a Mormon children's group, said a spokeswoman for the Church of Jesus Christ of Latter-day Saints in the Nevada city.

"They were very excited," she said of the family. "They had been planning this as a family weekend together. They were very devoted to their church and always were concerned about each other. They were just a beautiful family."

Berro was identified as the co-owner of Las Vegas Flyers, which owned the downed Cessna.

The crash was under investigation by the National Transportation Safety Board, whose crew arrived at the crash site late yesterday morning.

The wreckage was spotted by the crew of a radio-station helicopter.

A sheriff's rescue team and coroner's deputies were airlifted to the wreckage.

"There were toys in the airplane, including two little stuffed Mickey Mouses," said Mickey Worthington, supervising forensic embalmer for the coroner's office.

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Flight Path Profile
Kuala Lumpur, Malaysia
B747-200
19 February, 1989

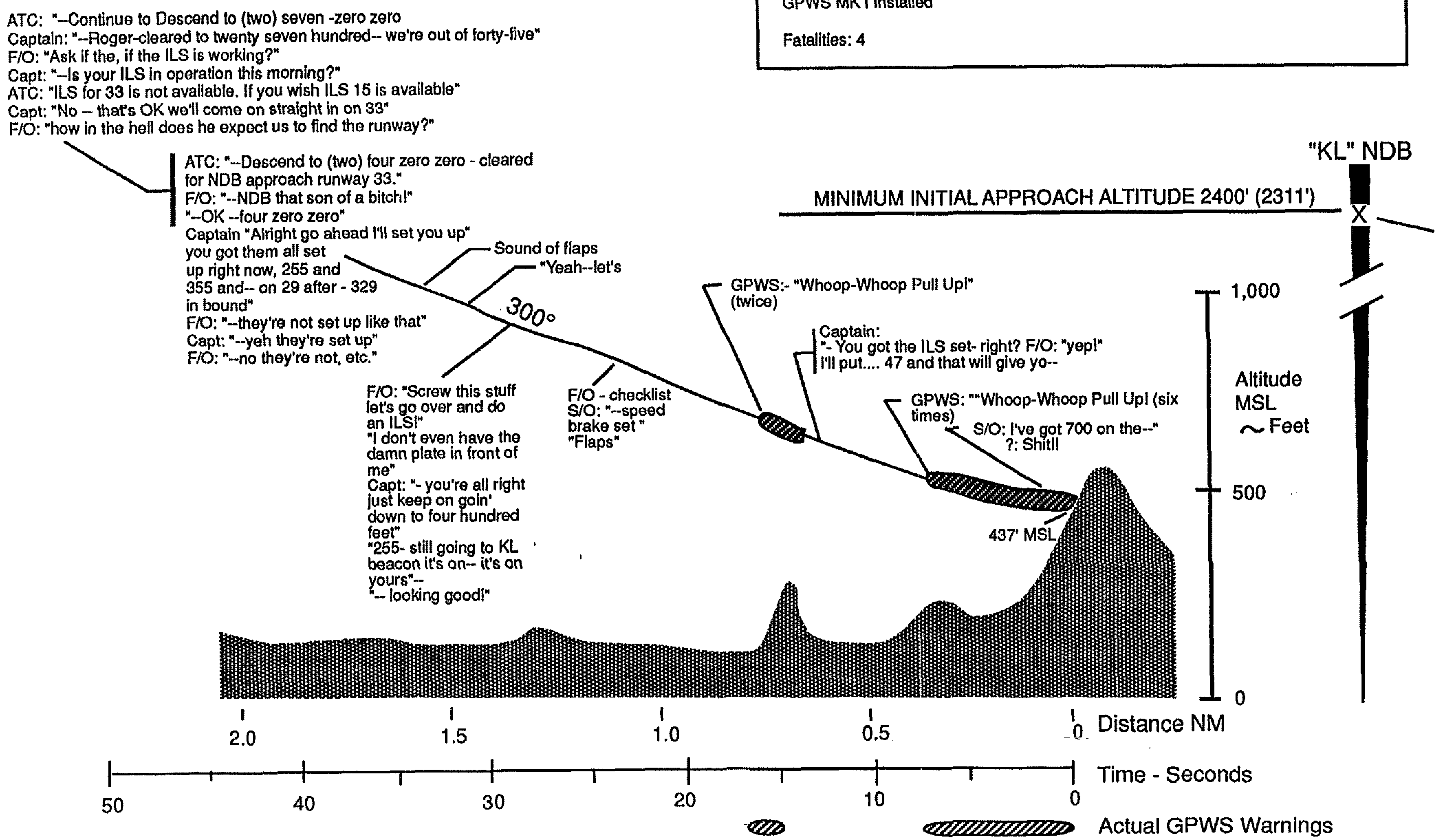
Circumstances: Aircraft hit hill 1NM short of FAF ('KL'NDB) during NDB approach to Runway 33.
(+8NM short) (ILS & VASI Inoperative)

Time: 06:36AM Local - Dark (just before dawn)

Weather: 1100 foot scattered, wind calm, localized mist/fog

Configuration: Landing Gear down, Flaps 20
GPWS MK I Installed

Fatalities: 4



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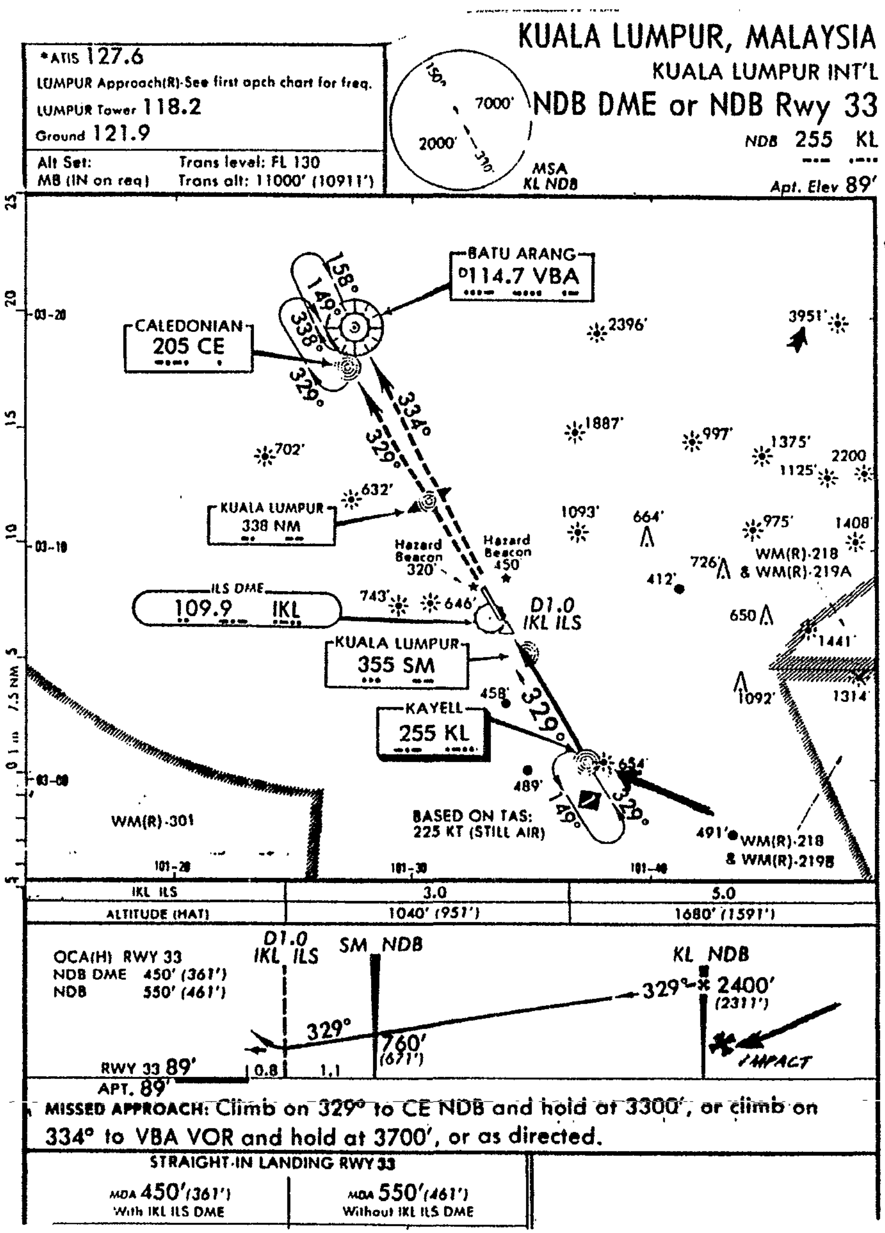

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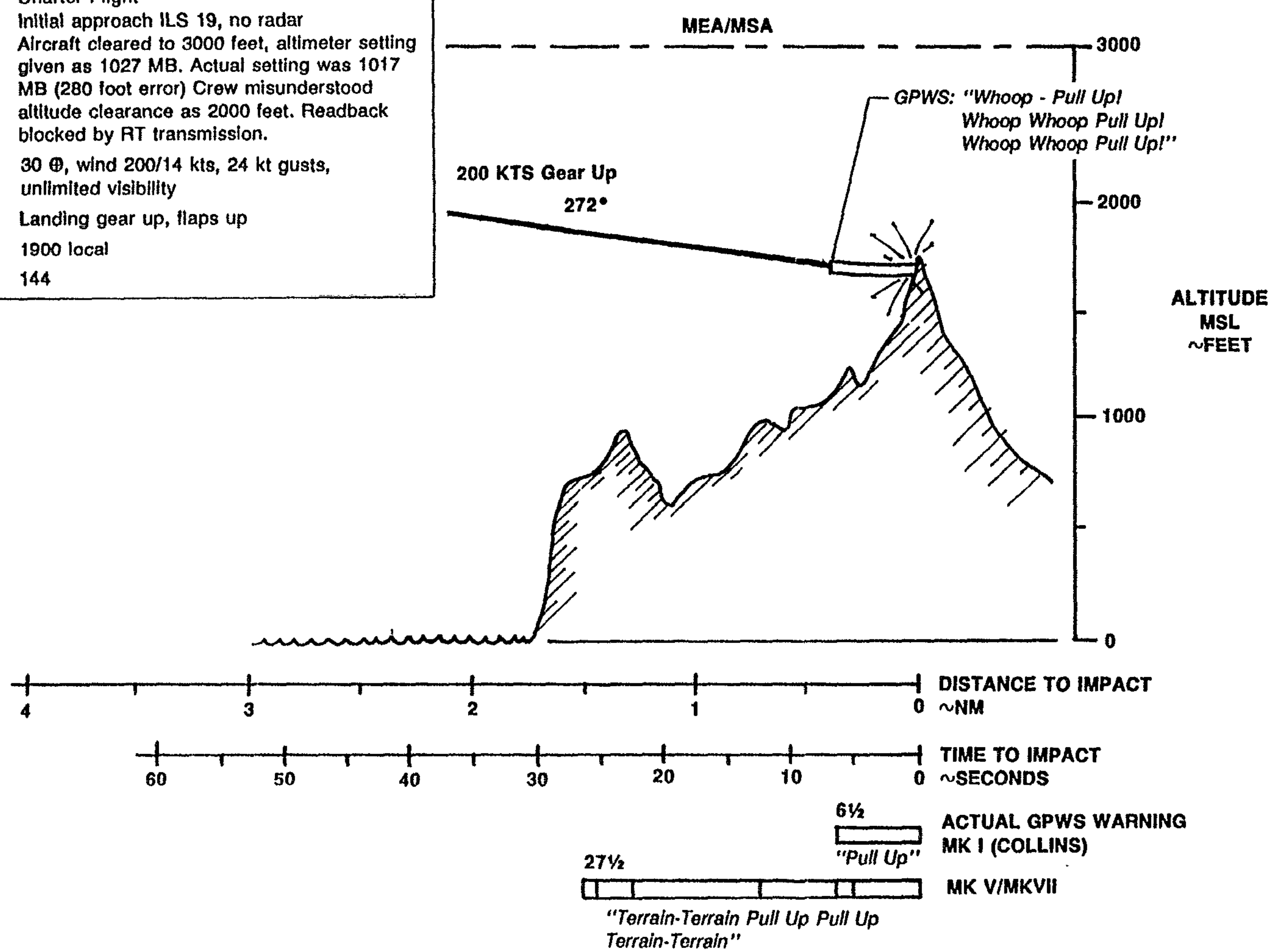
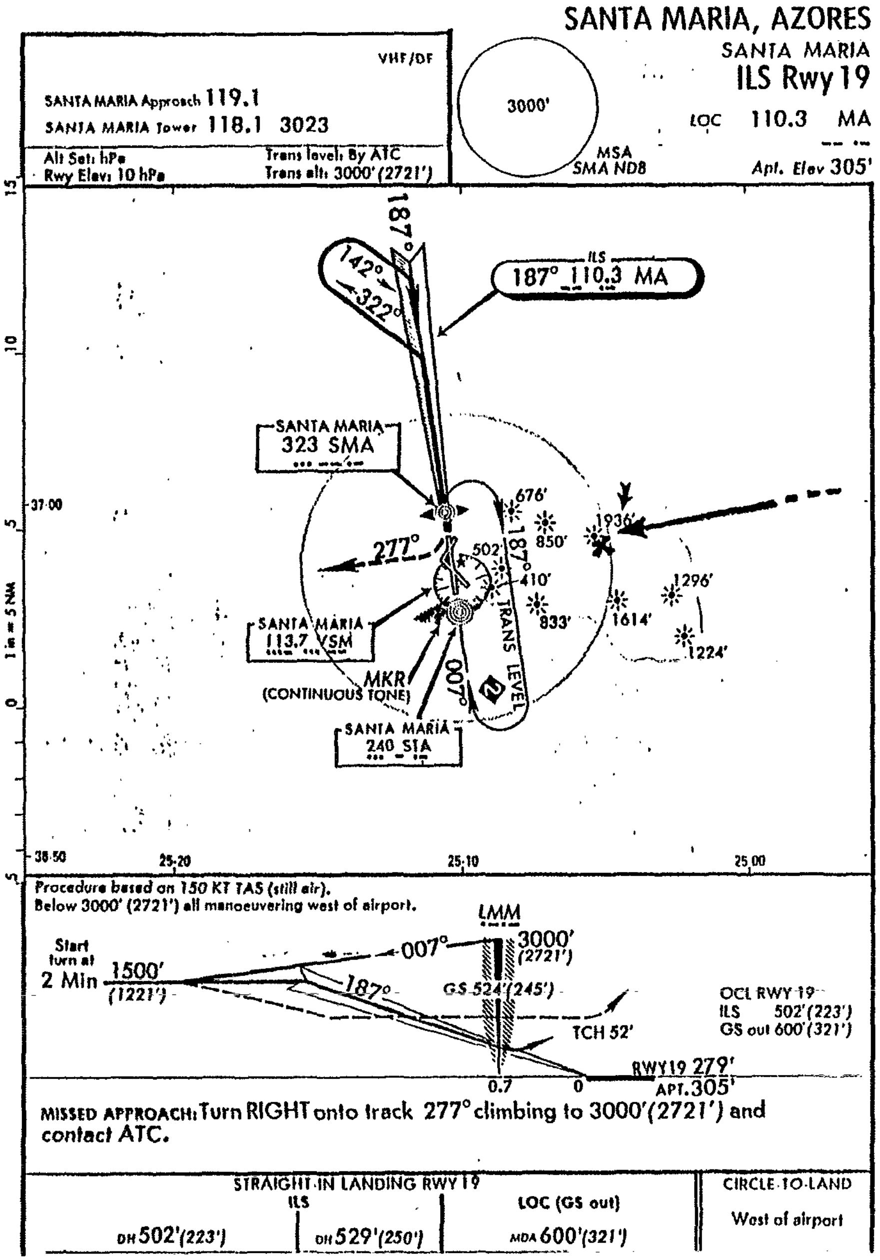
Flight Path Profile
SANTA MARIA, AZORES
B-707-300
8 FEBRUARY, 1989

CIRCUMSTANCES:	Charter Flight Initial approach ILS 19, no radar Aircraft cleared to 3000 feet, altimeter setting given as 1027 MB. Actual setting was 1017 MB (280 foot error) Crew misunderstood altitude clearance as 2000 feet. Readback blocked by RT transmission.
WEATHER:	30 ⊕, wind 200/14 kts, 24 kt gusts, unlimited visibility
CONFIGURATION:	Landing gear up, flaps up
TIME:	1900 local
FATALITIES:	144



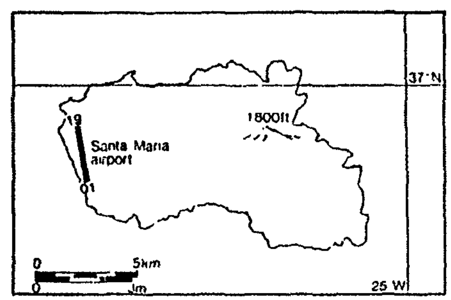


707 hits hill

A 1968-built, hushkitted Boeing 707-331B (N7231T) of Tennessee-based American charter airline Independent Air crashed into a 1,800ft mountain on Santa Maria island in the Azores while on approach to Santa Maria Airport on the afternoon of February 8.

All seven American crew and 137 Italian passengers died. The flight was a holiday charter from Bergamo, northern Italy, to the Dominican Republic, and the aircraft was about to make a planned fuel stop at Santa Maria Airport, on the island's west coast.

Air traffic controllers report that the aircrew had elected to carry out a visual (rather than procedural) approach. Lowest (broken) cloud was at 500ft, and there was further cloud at 1,200ft. The aircraft hit the mountain at about 1,500ft. The aircraft had been cleared to descent to 3,000ft, but then the pilot said he was going visual. Standard local procedure is that descent below 3,000ft is carried out either on approach to runway 01/19, or to the west of the airport, over the sea. Approaches to the runways are over the sea, but the 707 approached from the north-east.



Procedural approaches are over the sea in line with runway 01/19. Local advice is not to descend below 3,000ft except to the west of the airport. The 707 was approaching from the north-east

FLIGHT INTERNATIONAL, 18 February 1989

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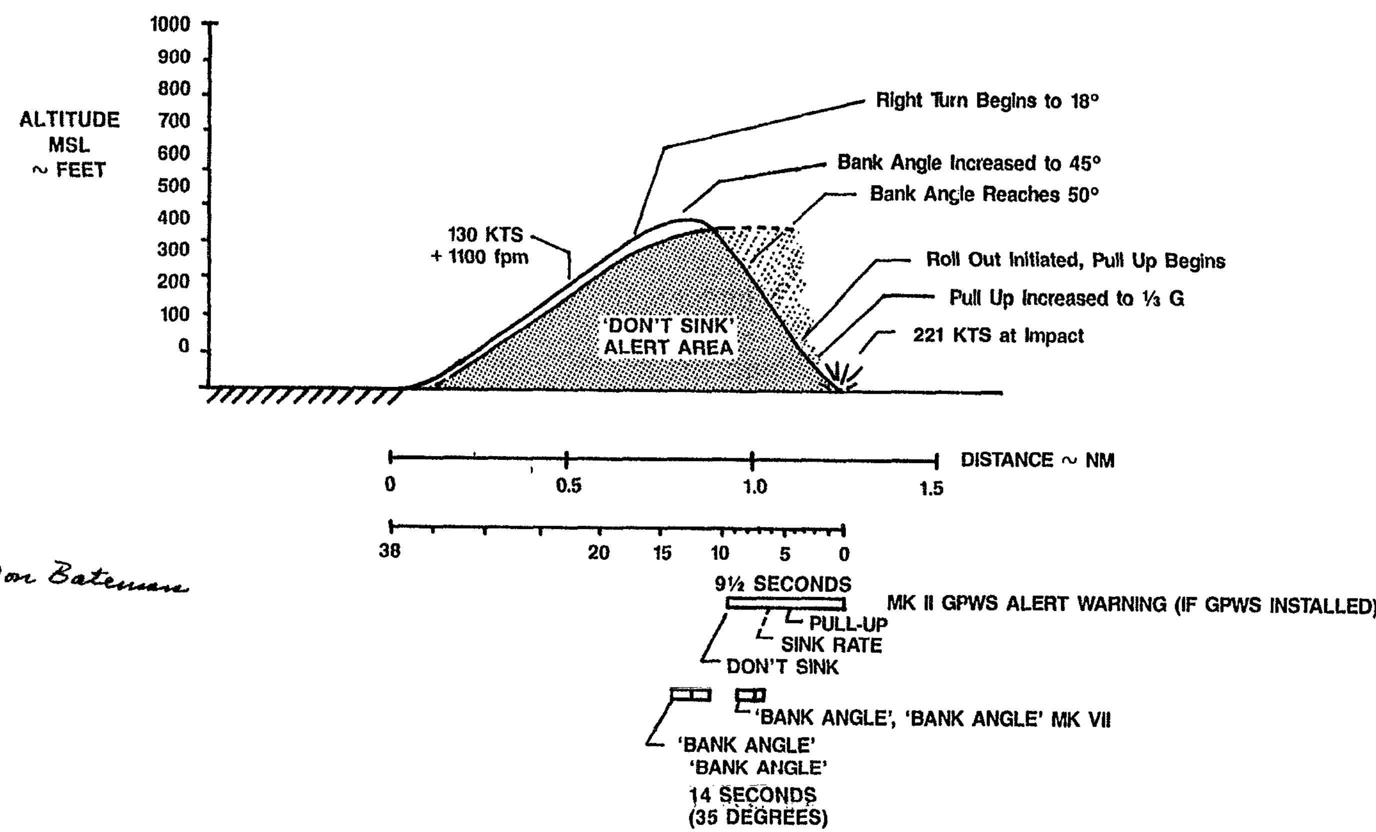
Flight Path Profile

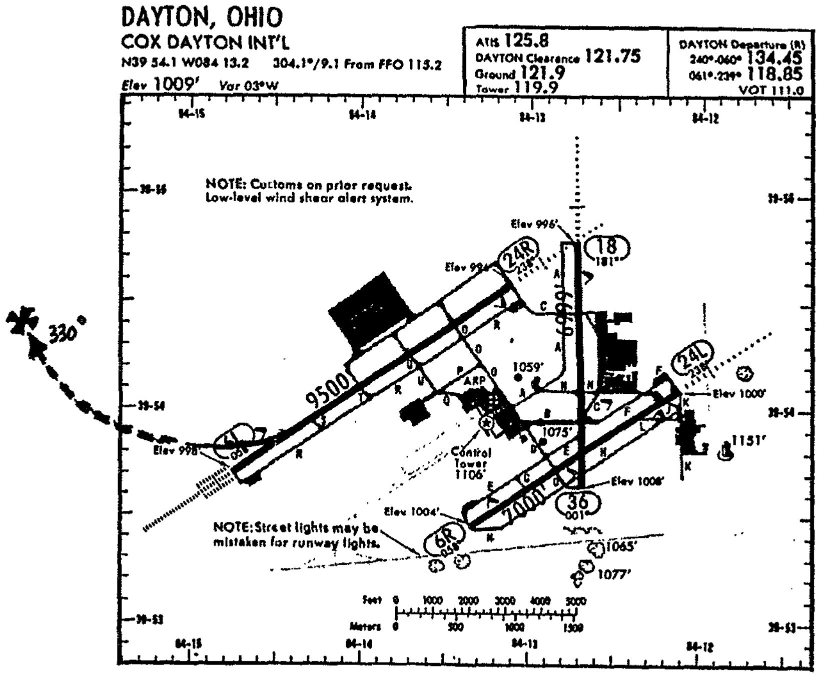
Undetected Descent (Acceleration) During Initial Climb
HS 748
DAYTON, OHIO
12 JANUARY, 1989

Conditions:	Night Take-off runway 24 No GPWS Installed
Fatalities:	2

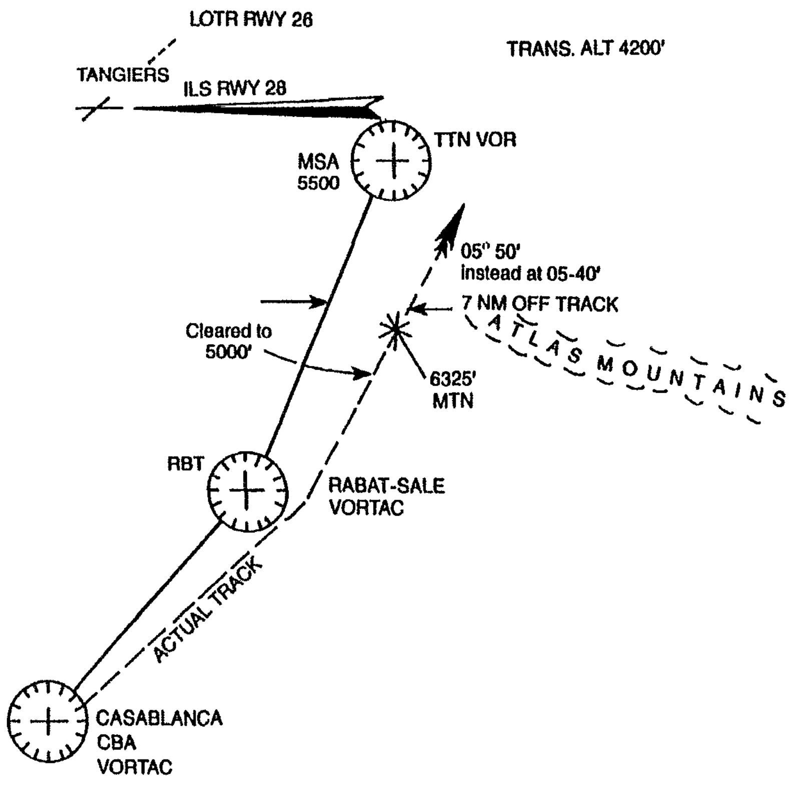
Similar Accidents:	METRO III	19 FEB 88
	C-141	12 NOV 80
	B-747	1 JAN 78



Don Bateman


DAYTON, OHIO
COX DAYTON INT'L
N39 54.1 W084 13.2 304.1°/9.1 From FFO 115.2
Elev 1009' Var 03°W
ATIS 125.8
DAYTON Clearance 121.75
Ground 121.9
Tower 119.9
DAYTON Departure (R)
240°-060° 134.45
061°-239° 118.85
VOT 111.0
NOTE: Customs on prior request.
Low-level wind shear alert system.
NOTE: Street lights may be mistaken for runway lights.
330°
9500
7000
6999
24R
24L
6R
18
36
Elev 998'
Elev 1000'
Elev 1004'
Elev 1008'
1059'
1075'
1151'
1065'
1077'
Control Tower 1106'
ARP
Feet
Meters

90-282



EFIS MAP SHIFT

Incident Location:	Southeast of Tangiers Morocco near Telle Atlas Mountains (approximately 30 min. from Tangiers)
Date:	Sometime in December, 1988
Aircraft Type:	B737-300
Owner/Operator:	
Type of Operation:	Scheduled passenger
Weather:	IMC overcast and 500 feet ceiling
Description of Incident:	During initial descent and approach, into Tangiers, a momentary MK V GPWS "Terrain" alert occurred. The radio altimeter dipped to 1500 feet or so. Aircraft was descending to 5000 feet. The CRT map display showed the aircraft centered on the published track clear of any signficant terrain. However, a cross check of IRS #1 and #2 position and raw VOR radials indicated aircraft was approximately 7 min. west of desired track. The captain decided to climb and because of the conflicting navigation data, elected to make an NDB approach. This was performed successfully. The incident was reported by the crew to their airline later.
Post Analysis:	It was later confirmed that the aircraft was indeed west of track and a serious FMS error in position had been presented to the pilot via the EFIS map display. The error apparently was related to the Casablanca VORTAC and also involved some type of FMS algorithm problem. The incident has been reported to the airframe and equipment manufacturer.
Moral of the Story:	Don't put your complete trust in the FMS— ever! Continuous cross checking all sources of raw navigation data is still a wise, prudent policy.

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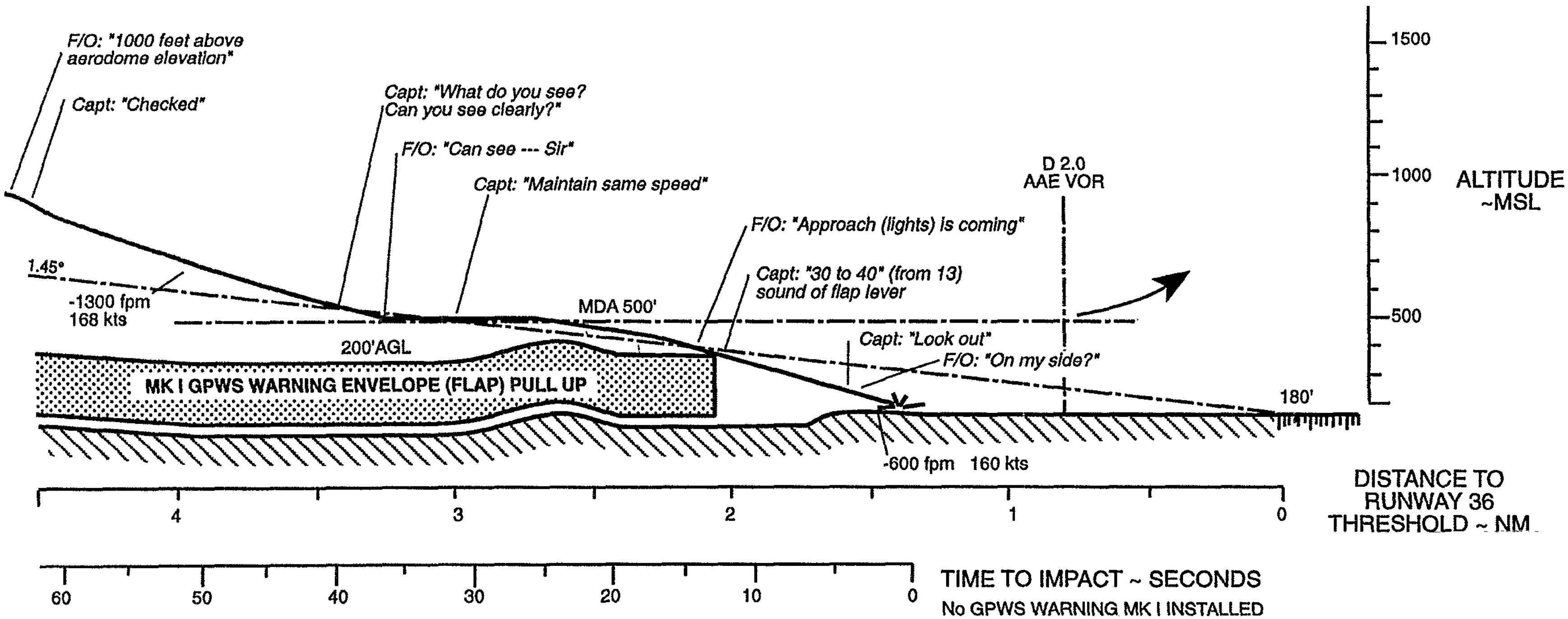
CIRCUMSTANCES:	During LOC DME approach to runway 23 aircraft impacted some 1.4 NM from runway 23 threshold.
WEATHER:	Visibility reported as 2 KM haze winds calm to 270/04 Temperature 23ºC.
TIME:	Daylight 023 UTC (0653 Local).
CONFIGURATION:	Landing.
FATALITIES:	139 out of 141 on board. Heavy uncontrolled fire.
OTHER:	Possible F/O altimeter error of 320 feet. Fire trucks did not arrive until 25 minutes after crash. Construction Lights 1-1/2 NM short of the runway may have misled the pilots to believe they were over the runway.

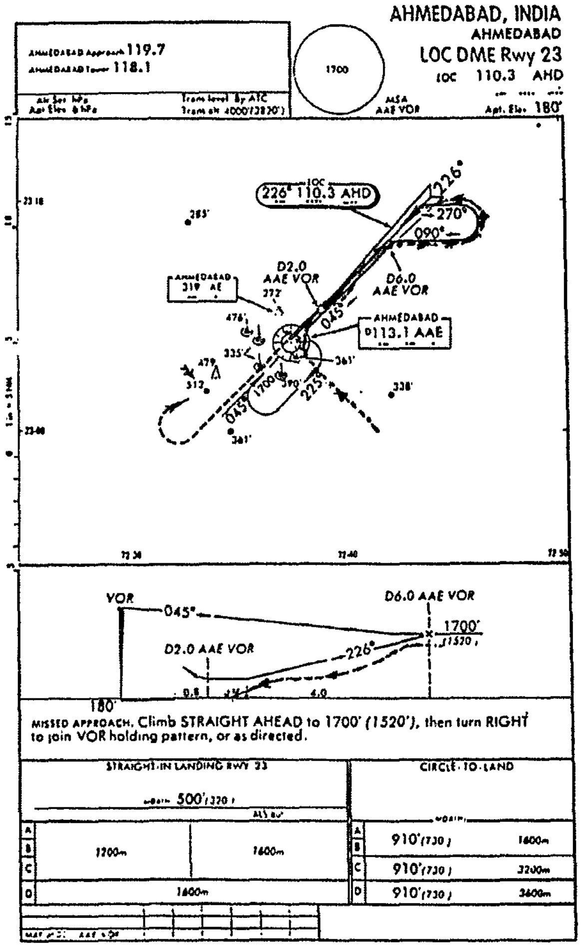
Flight Path Profile
B737-200
Ahmedabad, India
19 October, 1988

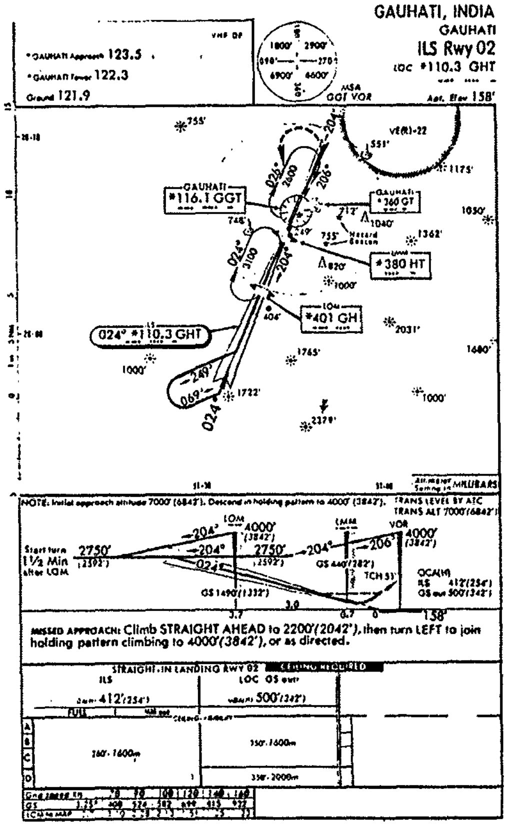
NOTE: Approach procedure has low approach slope 2-1/3°



☐ Alert if MK VII had been installed.
'500'

Return to TOC





Exact location of Accident site or any other details not available

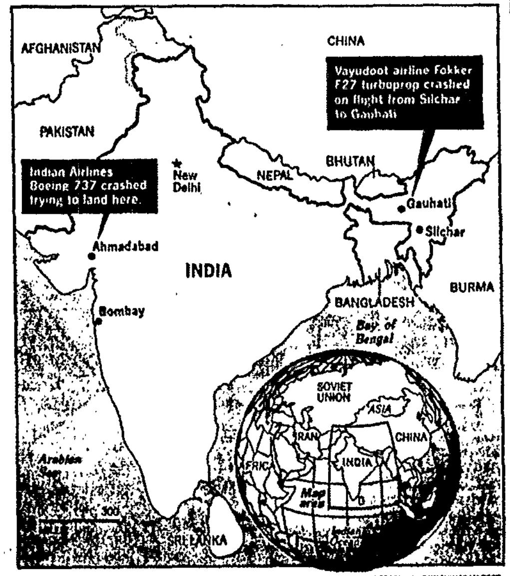
164 Die in Two Separate Crashes Of Airliners in India in One Day

By Siddharth Dube
Special to The Washington Post

NEW DELHI, Oct. 19—Two Indian airliners crashed in separate accidents today, killing 164 people, the highest one-day death toll in Indian domestic aviation.

The crashes came as India's two government-owned and -operated domestic airlines have faced mounting criticism of slipshod maintenance practices.

While the causes of today's crashes are unlikely to be known for some time, both airplanes were among the oldest of their type in India. One, an Indian Airlines Boeing 737 crashed as it approached Ahmadabad in heavy fog, killing 130 of the 135 people aboard. It was part of India's first purchase of the U.S.-made aircraft in 1970, an airline official said.



BY LARRY FOGEL—THE WASHINGTON POST

The plane burst into flames after hurtling to the ground in a northeastern suburb of Ahmadabad, this morning, a little more than two miles from the airport of that industrial city in western India. The New Delhi-bound flight originated in Bombay.

The explosion scattered charred bodies and baggage over a two-mile area. Three of the five survivors were reported in critical condition. Six foreigners were killed in the crash, but Indian Airline officials could not say whether any U.S. citizens had been on board.

One survivor, Vinod Tripathy, said there were two explosions, one in the air and the second after the plane crashed, the Press Trust of India reported.

The second crash, in the northeastern state of Assam, killed all 31 passengers and the crew of three. The Fokker F27, operated by the domestic airline Vayudoot, smashed into a 1,400-foot hill near the state capital of Gauhati. The exact age of the aircraft that crashed is not known, airline officials said, but it was manufactured in the 1960s. Similar aircraft have been involved in four crashes in India, killing a total of 138 people.

Today, near-zero visibility hampered location of the plane's wreckage, and rescue parties were having difficulties reaching the crash site, in a remote corner of India. Officials expected no survivors.

Prime Minister Rajiv Gandhi, for years a pilot with Indian Airlines, and other top government officials expressed their condolences.

Once held to be the success story of aviation in the developing world—both India's international and domestic services rank among the world's largest—the country's airlines have been hobbled lately by growing difficulties meeting demand for air travel and reported mismanagement.

"Yes, we have been charged with poor maintenance practices," a top-level Indian Airlines official said, "but we have not accepted these charges. We make no compromises on safety, and we have one of the world's best track records to date."

Today's crash was Indian Airlines' 16th in the past 25 years. More recently, Indian Airline planes have been involved in a variety of mishaps, though none fatal. Planes have belly-flopped onto runways, doors of smaller aircraft have blown open in flight, and large animals and birds have been hit on takeoffs and landings. A shortage of planes reportedly has forced the domestic carriers to overuse aging aircraft and the airlines have been accused of allowing maintenance standards to become lax.

Vayudoot, the smaller of the two domestic airlines, in particular has been at the center of criticism. Eight of the 18 planes remaining in its fleet are throwbacks to another era, Indian aviation experts have charged. The airline's practice of trying to squeeze every possible mile out its planes, led the manufacturer of its 10 new Dornier 228 airplanes, to state publicly last year that Indian-operated aircraft no longer met the company's safety standards and should be grounded.

Similarly, Indian Airlines' fleet of 47 planes is aging and buckling under overuse and poor maintenance. The airline runs 26 Boeing 737s, 11 Airbus A300s purchased from France since 1976, six aged Avro H48s and four Fokkers similar to the one that crashed today. According to the latest issue of the country's leading news magazine, India Today, doctors who test pilots for alcohol use before flights often just sign the reports and leave the pilots to fill in the particulars.

CIRCUMSTANCES:	During radar vectors (south of V327 off the airway) for an ILS Runway 30 approach, a miscommunication developed on the descent altitude clearance. The pilot believed it was 5000 feet, and the controller 7000 feet. A timely GPWS Warning and controller alert, and prompt pilot response allowed an expedient recovery from terrain (probable MSAW alert).
TIME:	Night
WEATHER:	VMC, 15 mile visibility

Flight Path Profile
MD-80
LONG BEACH, CALIFORNIA
October, 1988

INCIDENT

See 9 Nov. 1989, Spokane Wash for an almost identical incident.

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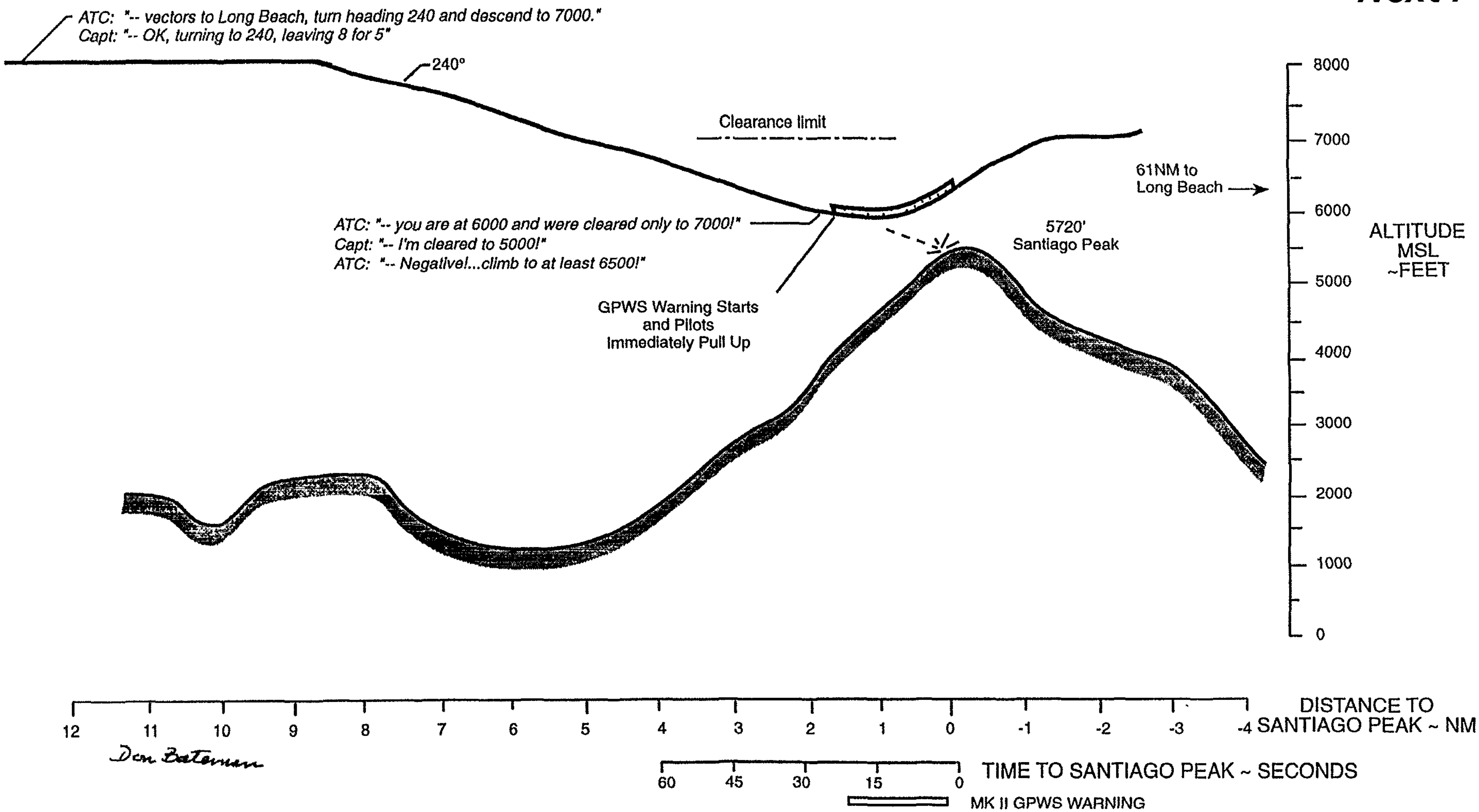
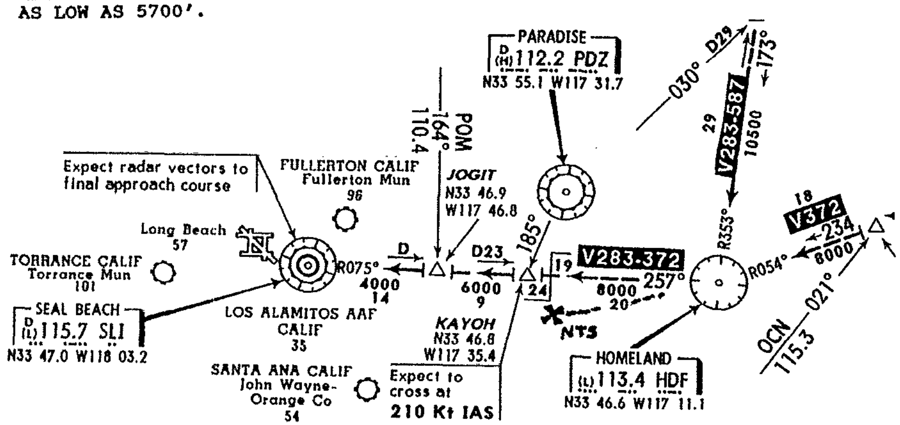


Return to TOC

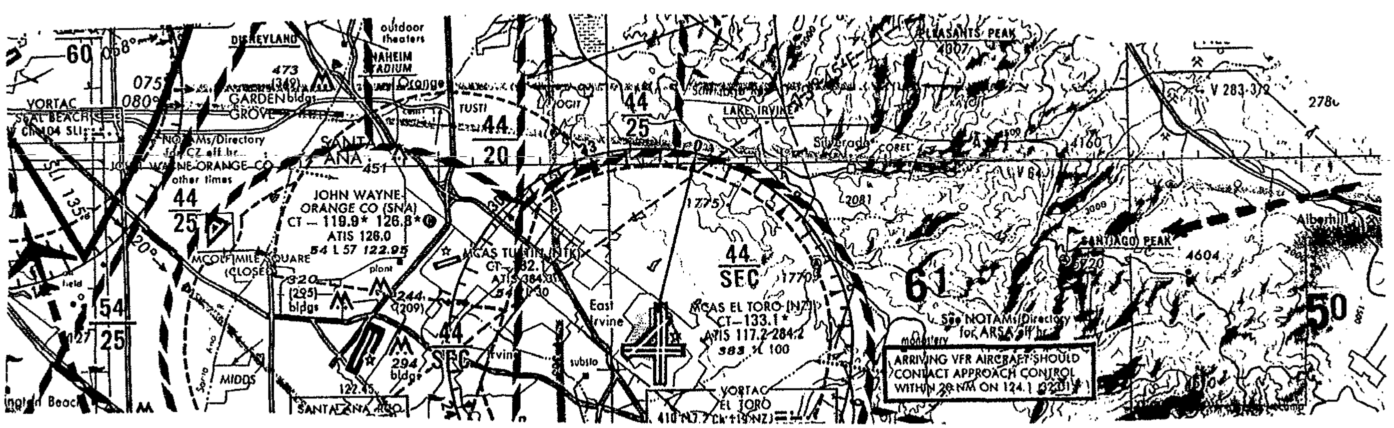
SOURCE : ASRS ACN #96032

Narrative

ON 10/SUN/88, DURING THE TIME XA16Z, MLG CHKED IN APPROX 10 MI E OF COREL INTXN WBOUND DSNDING TO 8000'. I DSNDED HIM TO 7000' (THAT IS THE MVA IN THE AREA). I WAS THEN SCANNING MY RADAR SCOPE FOR TFC THAT SAN DIEGO TRACON HAD PREVIOUSLY TRIED TO POINT OUT WHEN I NOTICED MLG DSNDING THROUGH 6400'. I IMMEDIATELY INSTRUCTED MLG TO CLB TO AT LEAST 6500'. THE PLT RESPONDED WITH "I WAS CLRED TO 5000'." I SAID, "NEGATIVE, CLB TO AT LEAST 6500'." THE PLT RESPONDED AND CLBED TO 6900'. I LATER HEARD A RECORDING OF THE INCIDENT AND I HAD TOLD THE PLT TO DSND TO 7000' BUT HE READ BACK THAT HE WAS DSNDING TO 5000'. THE ALT READOUT WAS 6400' WHEN I CLBED HIM, BUT PRIOR TO CLBING THE READOUT GOT AS LOW AS 5700'.



SUPPLEMENTAL INFO FROM ACN 96167: UNDER THE CTL OF COAST APCH ON V372 JUST W OF HOMELAND (HDF 13.4) WE WERE AT 8000' MSL. WE WERE DIRECTED TO THE S OF V372 ON HDG 240 DEGS, VECTOR FOR LNDG AT LGB. WE "HEARD" A CLRNC TO 5000' AND RESPONDED MLG TO 5000'. PASSING THROUGH 6000' THE CTLR COMMENTED THAT WE WERE AT 6000' AND CLRED TO 7000'. WITH BACKLIGHTING THE SHAPE OF MOUNTAINOUS TERRAIN CAME INTO VIEW. I SAID WE WERE CLRED TO 5000' IN MY REPLY TO THE CTLR AND IN THE SAME BREATH ORDERED "CLB" TO THE F/O WHO WAS AT THE CONTROLS. SECONDS LATER "TERRAIN" WAS ANNOUNCED BY GND PROX WARNING. BOTH F/O AND I ABRUPTLY PULLED BACK ON THE CONTROL COLUMN AND WERE PASSING 6500' ABOUT THE TIME THE CTLR SAID SOMETHING LIKE "YOU CAN LEVEL AT 6500'," THEN SEEING OUR RATE OF CLB SAID 7000' WOULD BE OK. WE LEVELED AT 7000' THEN WERE IMMEDIATELY CLRED TO 5000'. I SAW THE HAZARD DUE TO BACKLIGHTING BUT DON'T KNOW HOW MUCH CLRNC FROM THE HILLS THAT WE HAD. LATER I SPOKE WITH APCH SUPVR WHO REVIEWED THE TAPE. THE CTLR HAD CLRED US TO 7000' FROM 8000' NOT 5000'. WHY I HEARD 5000' IS A MYSTERY TO ME AS I WAS CERTAIN IN MIND OF THE CLRNC TO 5000'. THE CTLR MISSED MY READBACK OF 5000'. 7 DOES NOT SOUND LIKE 5, SO I CAN'T EXPLAIN THAT. I HAD REVIEWED THE LA AREA CHART WHICH IS BETTER THAN THE LOW ALT CHART AND I KNEW THAT V372 MSA W OF HDF WAS 5000'. IN EVERY PREVIOUS APCH TO LGB THAT I HAVE MADE I CONTINUED TO SLI ON V372 THEN WAS VECTORED OVER THE PACIFIC FOR A LEFT 270+ DEG TURN BACK TO INTERCEPT THE LOC FOR RWY 30. THIS TIME THE VECTOR OF 240 DEGS FOR A NIGHT TURN IN TOOK US OVER HIGHER TERRAIN. I'M NOT CONSCIOUS OF THOUGHTS ABOUT THE 5000' MSA AS THE CTLR GAVE CLRNC TO 7000', BUT I "HEARD" 5000' AND READ BACK 5000'. FORTUNATELY THE CTLR CALLED US AT 6000', AS WE DSNDED TO PERHAPS 5700' BEFORE REVERSING TO 7000'. HAD HE NOT NOTICED, THE BACKLIGHTING OF THE MOUNTAIN WOULD HAVE MADE THE NEED FOR A CLB APPARENT (I THINK), BUT THE TERRAIN WARNING WAS THE ICING ON THE CAKE. IT'S SIGNAL WAS FOLLOWED BY IMMEDIATE CREW RESPONSE AND A HAPPY ENDING. I DON'T KNOW THE ALT OR TOPS OF THE MOUNTAINS ON OUR ASSIGNED HDG. I DON'T KNOW HOW MUCH CLRNC FROM THE MOUNTAINS WE HAD, BUT IT CERTAINLY MAKES CLEAR THE IMPORTANCE OF GOOD COM BTWN THE CTLR THE PLT.



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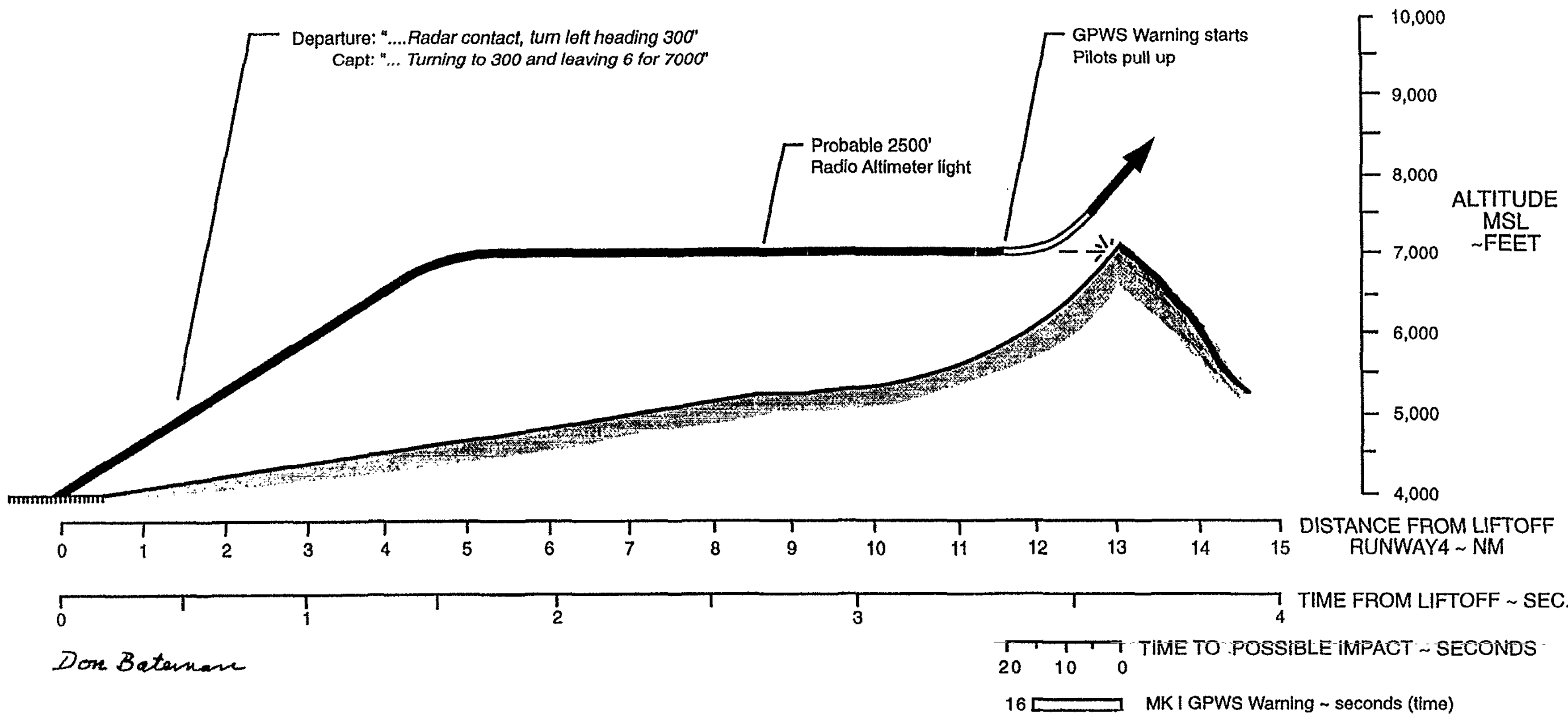
CIRCUMSTANCES:	On departure from Runway 4, the aircraft was cleared to climb, *maintain 7000 feet and to turn to a heading of 300 degrees.* A timely Mark I GPWS warning and a prompt pilot response preceeded by a 2500 foot AGL Radio Altimeter light led to a successful escape and recovery from terrain.
TIME:	Night
WEATHER:	VMC

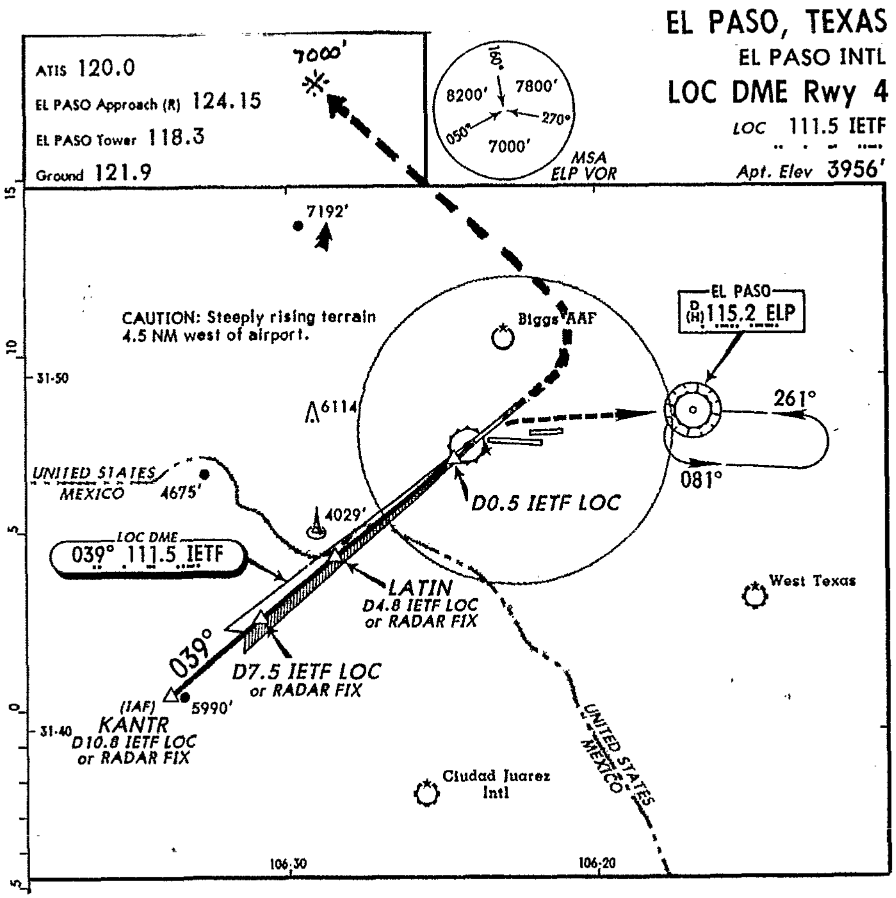
Flight Path Profile
B737-200
EL PASO, TEXAS
October 1988

INCIDENT



Don Bateman

Return to TOC



SOURCE: ASRS ACN 95474

Narrative

EL PASO CLRNC DEL:CLRED TO SALT LAKE CITY ARPT, FULL RTE CLRNC, RADAR VECTORS TCS, DIRECT GUP, DIRECT HVE, DIRECT SLC, MAINTAIN 7000', EXPECT FL350 10 MINS AFTER DEP, DEP CTL FREQ 118.3 SQUAWK. AFTER TKOF, FLY HDG 070 DEGS. I READ THE ABOVE CLRNC BACK AS WRITTEN ABOVE. EL PASO CLRNC DEL RESPONDED: "READBACK CORRECT." RWY 08 IN USE AT THE TIME. WINDS RPTED CALM. SEVERAL MINS LATER, I REQUESTED IF RWY 04 WOULD BE AVAILABLE (WHILE STILL AT THE GATE). EL PASO CLRNC DEL REPLIED: "AFFIRMATIVE, I'LL FORWARD YOUR REQUEST FOR RWY 04." NO AMENDMENTS OR CHANGES TO THE ORIGINAL CLRNC WERE ISSUED UNTIL RECEIVING TKOF CLRNC FROM TWR. APPROX 25 MINS LATER WE DEPARTED RWY 04 WITH THE FOLLOWING INSTRUCTIONS FROM EL PASO TWR: "AFTER TKOF TURN LEFT HDG 330 DEGS, CLRED FOR TKOF." WHILE IN A LEFT TURN TO 330 DEGS AFTER TKOF, COMBINED TWR/DEP CTL SAID: "RADAR CONTACT, TURN LEFT HDG 300 DEGS." WE RESPONDED BY ACKNOWLEDGING THE HDG AND "LEAVING 6 FOR 7000." ACFT WAS LEVELED OFF AT 7000' MSL. CAPT ASKED CTLR THE ELEVATION OF THE TERRAIN BELOW US. TWR REPLIED: "5800'." AFTER APPROX 1 MIN LEVEL AT 7000' MSL, THE RADAR ALTIMETER LIGHT CAME ON INDICATING TERRAIN LESS THAN 2500'. A CLB WAS IMMEDIATELY INITIATED WHEN THE GPWS WARNED: "TERRAIN, TERRAIN." ATC WAS ADVISED WE WERE CLBING. ATC REPLIED: "VERIFY YOU'RE CLBING TO ONE SEVEN THOUSAND." CAPT REPLIED THAT WE WERE ISSUED 7000'. ATC REPLIED: "CLB AND MAINTAIN ONE SEVEN THOUSAND." ATC SAID LATER THE CTLR WORKING CLRNC DEL "HAS GONE HOME NOW. I'LL CHK WITH HIM IN THE MORNING." WOULD HAVE POSSIBLY BEEN FATAL HAD 7000' ALT BEEN MAINTAINED FOR ANY LONGER. SUPPLEMENTAL INFO FROM ACN 95621: DUE TO THE HIGH TERRAIN W OF ELP IN EXCESS OF 7000', I CALLED THE CTLR LEAVING 6000' FOR 7000. HIS REPLY WAS, "THANK YOU." I INSTRUCTED THE F/O WHO WAS THE PF TO CLB! HE DID NOT RESPONSE. WHEN TO RADAR ALTIMETER READ 2000' AGL I TOOK CTL OF THE ACFT AND STARTED A CLB. THE CTLR SAID: "CLB AND MAINTAIN 17000'." THEN HE SAID: "CONFIRM YOU WERE CLRED TO 17000 AND NOT 7000'." THE F/O MAINTAINED WE HAD A CLRNC LIMIT OF 7000'. I THEN CONVEYED THIS TO THE CTLR. THE CTLR SAID HE WAS THE REPLACEMENT FOR THE CTLR WHO GIVEN US THE CLRNC.

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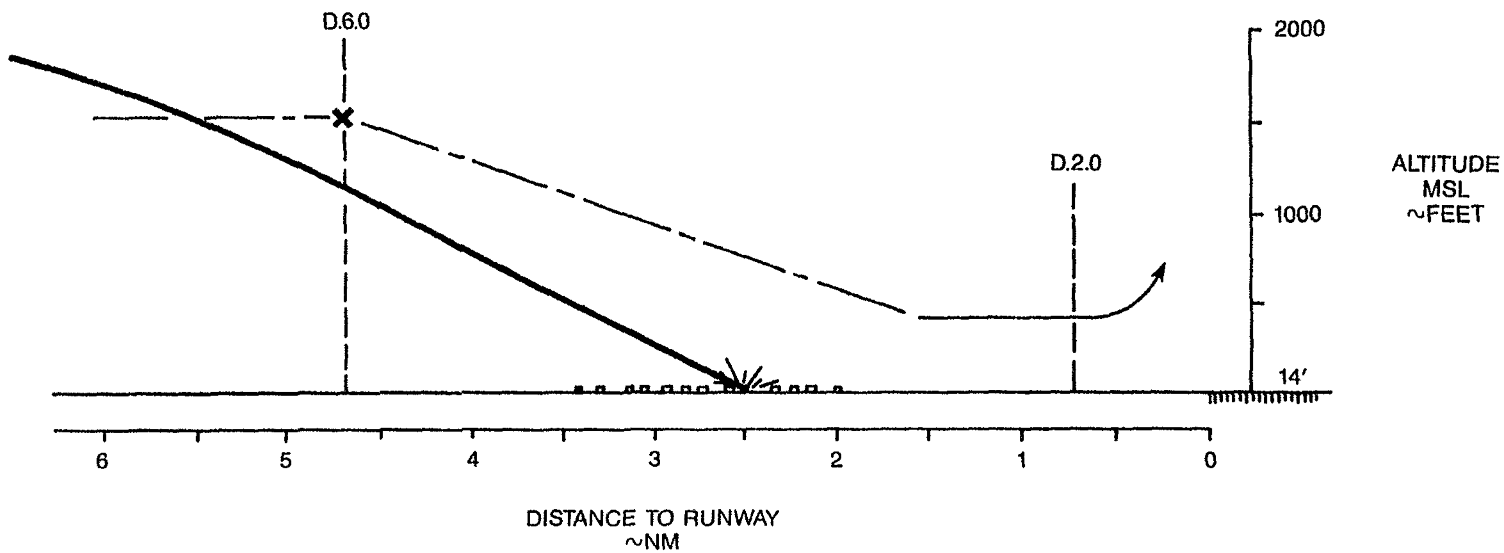
FLIGHT PATH PROFILE
B707-300
Rome, Italy
17 October, 1988

Circumstances:	The aircraft hit the roof of a house 2½ miles short during a VOR/DME approach to runway 34L.
Weather:	Heavy fog.
Configuration:	Landing.
Time:	12:30 local.
Fatalities:	32 out of 52 onboard.



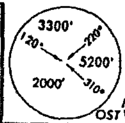
Return to TOC

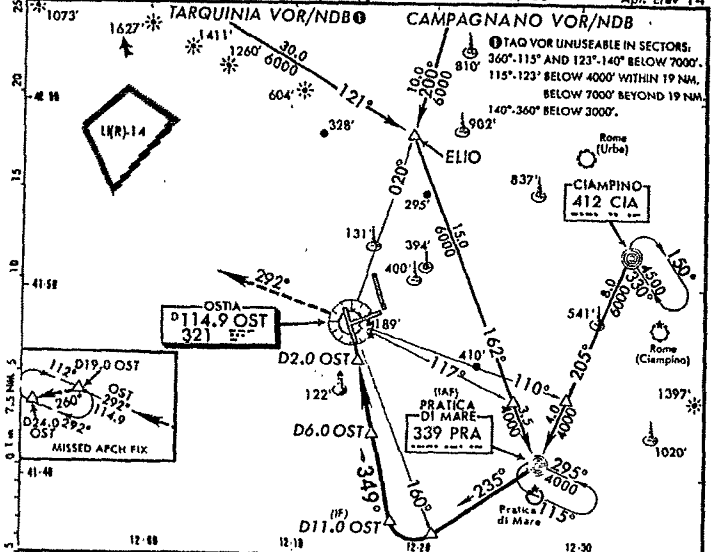
ROME, ITALY
FIUMICINO
VORDME Rwy 34L
NDB+DME Rwy 34L

VOR 114.9 OST
NDB 321

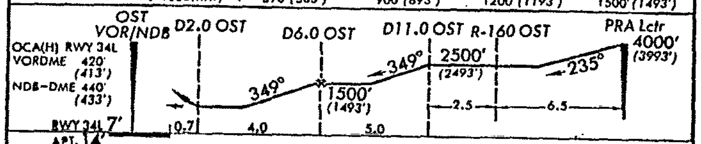
Apt. Elev 14'

ATIS Arrival 114.9	VHF/DF
ROME Arrivals (R) 119.2	
FIUME Tower 118.7	
Ground 121.9	
Alt Set: MB	Trans level: By ATC Trans alt: 6000'(5993')





VOR DME or NDB + DME	OST DME	3.0	4.0	5.0	6.0
	ALTITUDE (HAT)	590' (583')	900' (893')	1200' (1193')	1500' (1493')



MISSED APPROACH: Turn LEFT climb on R-292 outbound OST VOR to 1000' (993') and maintain until D12.0 OST, then continue climb to 2000' (1993') to D19.0 OST and join the holding.

STRAIGHT-IN LANDING RWY 34L

	VORDME MDA(H) 420' (413')	VORDME ALS out	NDB + DME MDA(H) 440' (433')	NDB + DME ALS out
A	1200m	RVR 1500m VIS 1600m	1200m	RVR 1500m VIS 1600m
B	1200m	RVR 1500m VIS 1600m	1200m	RVR 1500m VIS 1600m
C	RVR 1800m VIS 2000m		RVR 1800m VIS 2000m	
D	RVR 1800m VIS 2000m		2400m	

CIRCLE-TO-LAND

	MDA(H)	
A	500' (486')	1600m
B	700' (686')	1600m
C	800' (786')	3600m
D	800' (786')	4000m

Gnd speed-Kts	70	90	100	120	140	160
Descent Gradient 5.0%	355	456	507	608	709	811
D6.0 OST to MAP 4.0 or MAP at D2.0 OST	3:26	2:40	2:24	2:00	1:43	1:30

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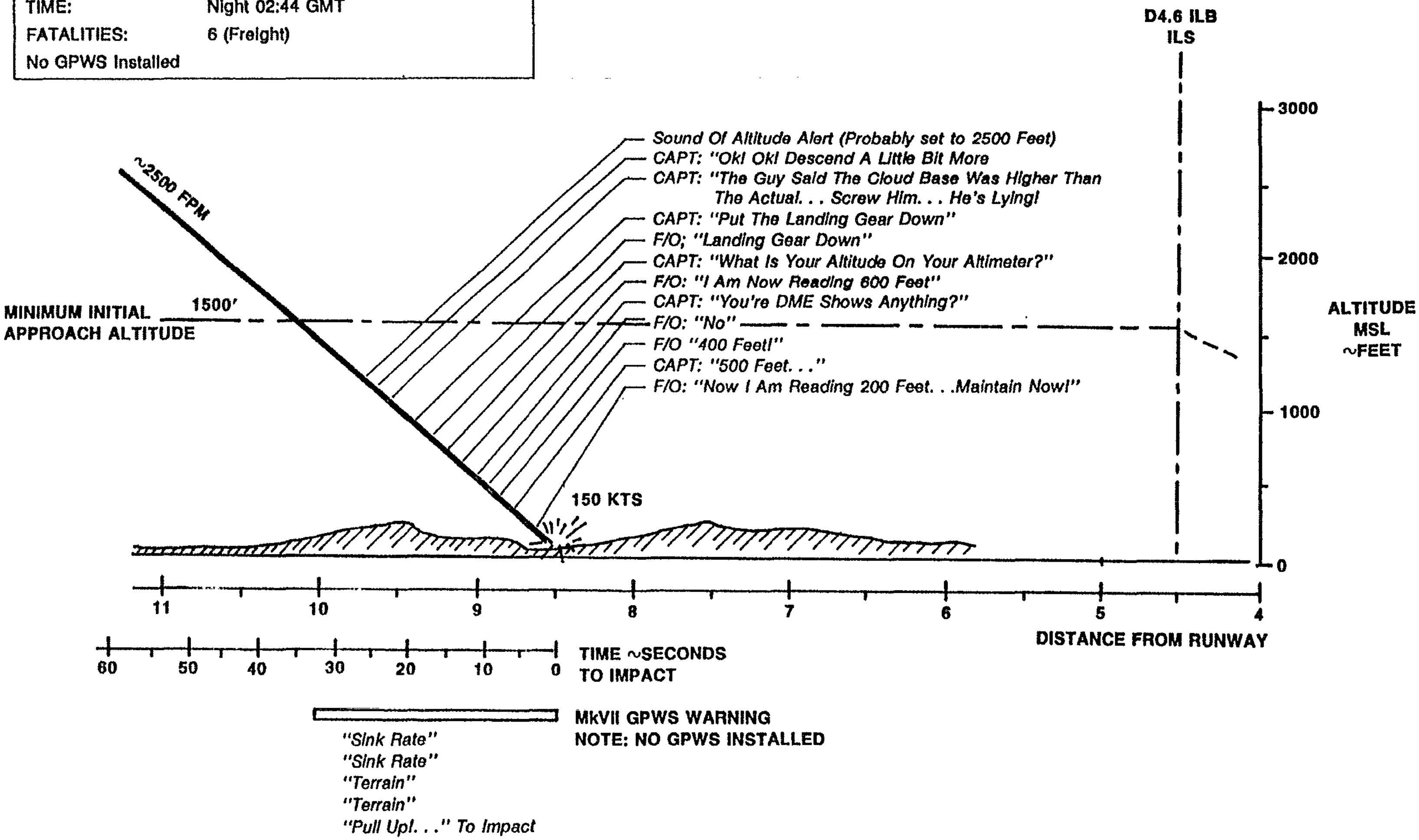
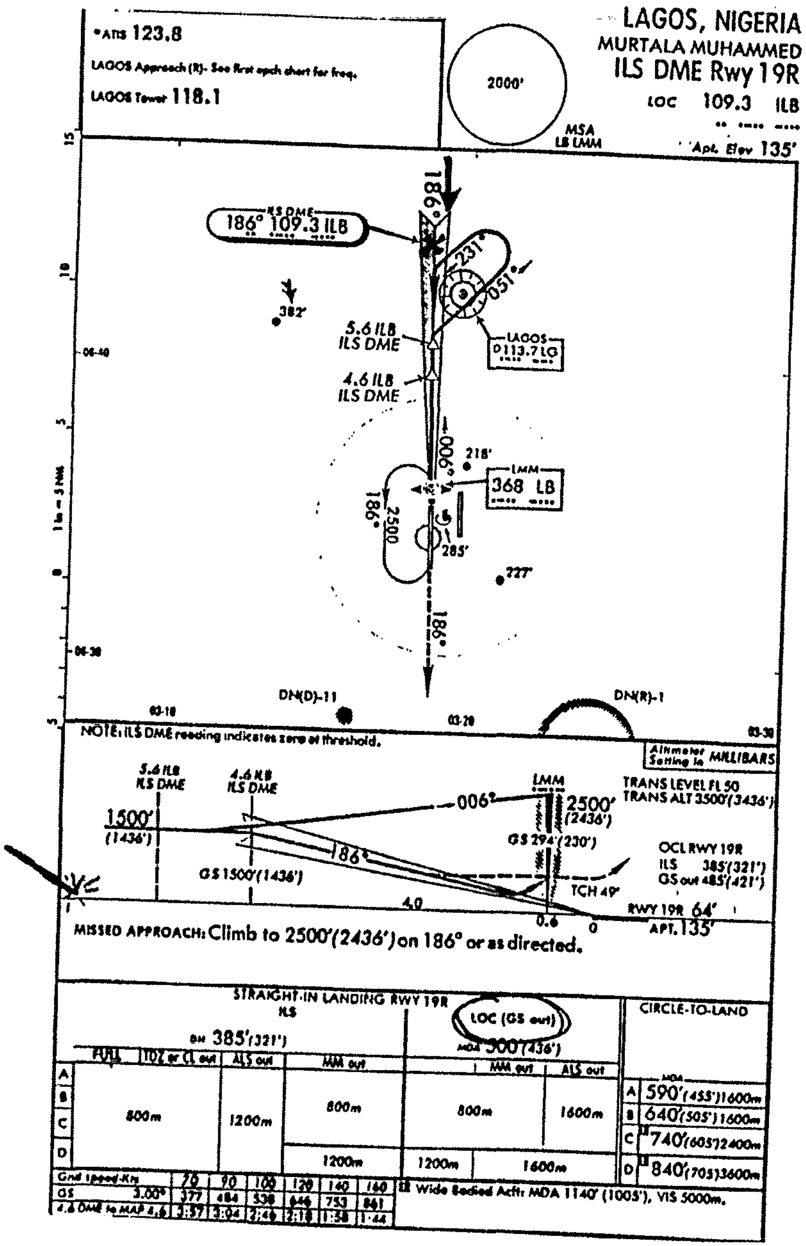
Flight Path Profile

B707 - 320
LAGOS NIGERIA
21 JULY, 1988

CIRCUMSTANCES:	Aircraft hit 1½nm short of VOR, 8.5nm from runway
CONFIGURATION:	Gear down, 25 flap
WEATHER:	Wind calm 3200m 3 octers 300m 2 octer
TIME:	Night 02:44 GMT
FATALITIES:	6 (Freight)
No GPWS Installed	




LAGOS, NIGERIA
MURTALA MUHAMMED
ILS DME Rwy 19R
LOC 109.3 ILB
Apt. Elev 135'
ATIS 123.8
LAGOS Approach (R)- See first apch chart for freq.
LAGOS Tower 118.1
2000'
MSA LB LMM
186° 109.3 ILB
LAGOS 113.7 LG
5.6 ILB ILS DME
4.6 ILB ILS DME
368 LB
NOTE: ILS DME reading indicates zero at threshold.
Altimeter Setting in MILLIBARS
TRANS LEVEL FL 50
TRANS ALT 3500'(3436')
OCL RWY 19R
ILS 385'(321')
GS out 485'(421')
MISSED APPROACH: Climb to 2500'(2436') on 186° or as directed.
STRAIGHT-IN LANDING RWY 19R
ILS
DH 385'(321')
LOC (GS out)
MDA 500'(436')
CIRCLE-TO-LAND
A 590'(455') 1600m
B 640'(505') 1600m
C 740'(605') 2400m
D 840'(705') 3600m
Wide Bodied Acft: MDA 1140' (1005'), VIS 5000m.

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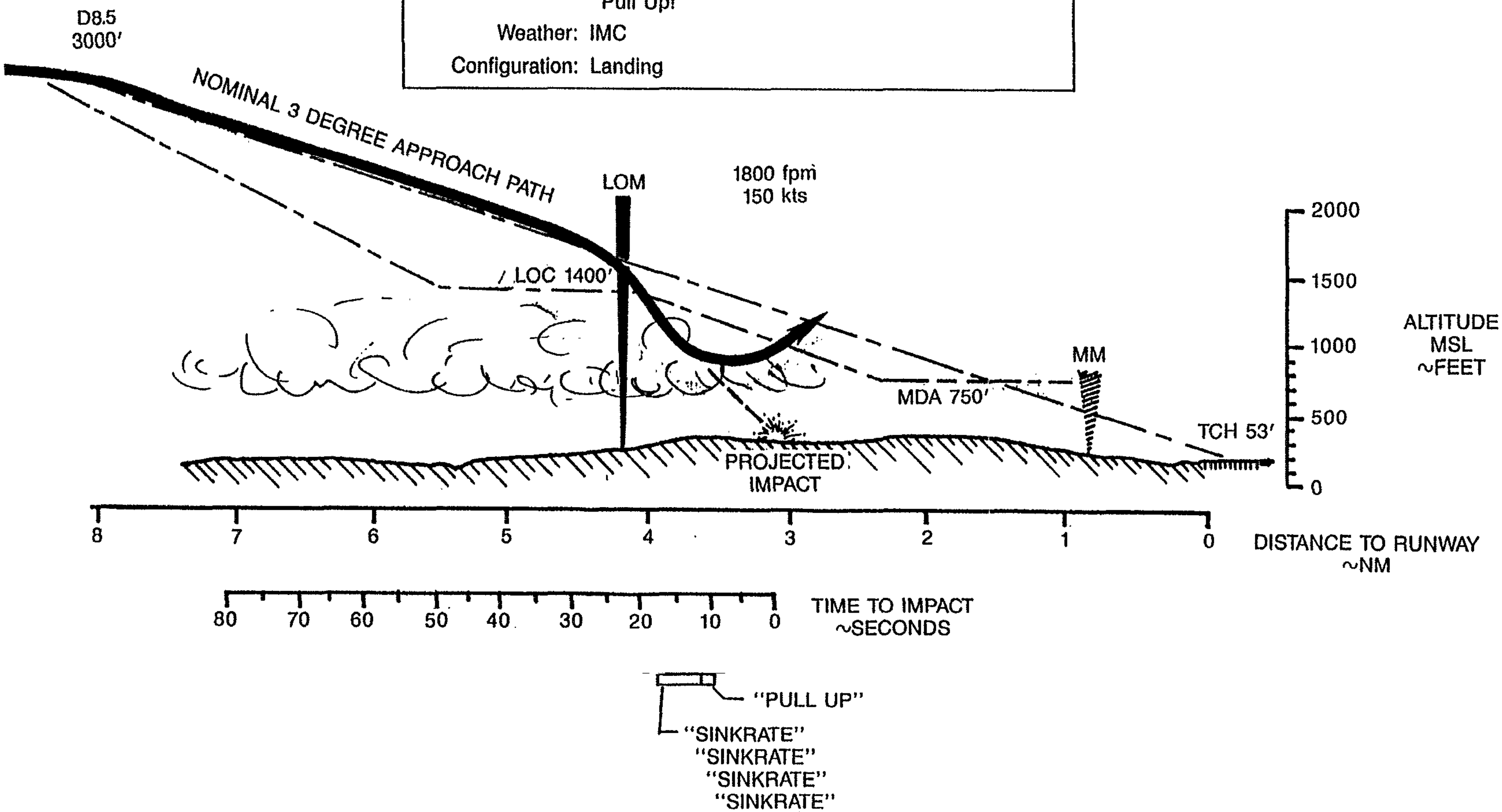
FLIGHT PATH PROFILE
A-320
London, Gatwick
3 July, 1988

Circumstances: While on a Localizer approach to runway 08, aircraft almost went in short some 3 NM from the runway. The FMS/FGS had been programmed for a -3 degree flight path, but inadvertently was in a Vertical Speed Mode.

A MK III GPWS was installed and gave a timely excessive "Sink Rate" alert and "Pull Up!"

Weather: IMC

Configuration: Landing



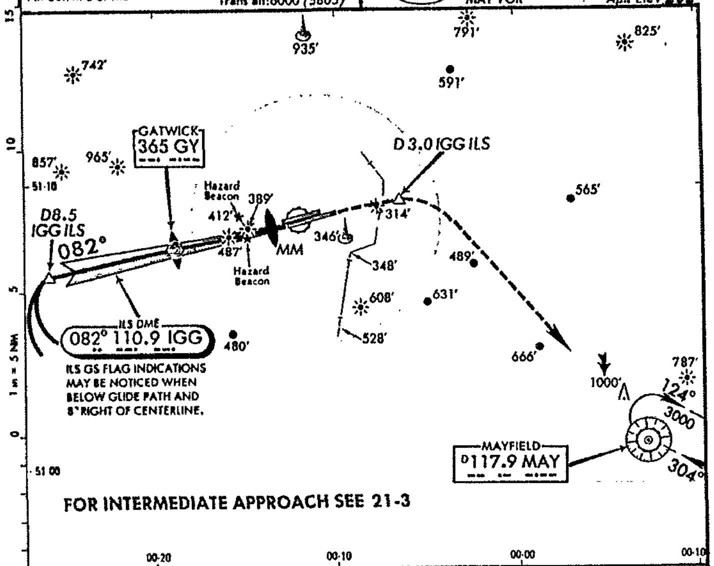
* ATIS Arrival 117.9	
GATWICK Approach (R) 119.6	
GATWICK Tower 124.22	
Ground 121.8	
Alt Set: hPa or MB	Trans level: By ATC Trans alt: 6000' (5805')

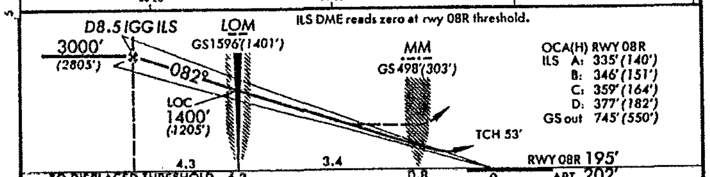
MSA MAY VOR: 2200' / 2300' / 2000'

LONDON, U.K.
GATWICK
ILS Rwy 08R

LOC 110.9 IGG

Apt. Elev 202'





MISSED APPROACH: Climb STRAIGHT AHEAD to D3.0 IGG ILS (if DME u/s, as directed) then turn RIGHT to MAY VOR climbing to 3000' (2805'). Climb to 1100' (905') prior to level acceleration. Contact ATC. Missed apch restricted to MAX IAS 250 KT.

STRAIGHT-IN LANDING RWY 08R

	ILS DA(H) 395'(200') FULL	ILS DA(H) 395'(200') TDZ or CL out	ILS DA(H) 395'(200') ALS out	ILS DA(H) 445'(250') MM out	LOC (GS out) MDA(H) 750'(555')	LOC (GS out) MM out	LOC (GS out) ALS out
A, B, C	RVR 600m VIS 800m	RVR 720m VIS 800m	[1] 1200m	[2] RVR 720m VIS 800m	1300m	NA	RVR 1500m VIS 1600m
D	RVR 600m VIS 800m	RVR 720m VIS 800m	[1] 1200m	[2] 1200m	1300m	NA	RVR 1500m VIS 1600m

CIRCLE-TO-LAND

	MDA(H)	
A	810'(608')	1900m
B	810'(608')	2800m
C	1110'(908')	3700m
D	1110'(908')	4600m

Gnd speed-Kts	70	90	100	120	140	160
ILS GS 3.00°	377	484	538	646	753	861
LOC Descent Gradient 5.2%	369	474	527	632	738	843
MAP at MM						

[1] UK auth RVR 1100m.
[2] UK auth RVR 700m.

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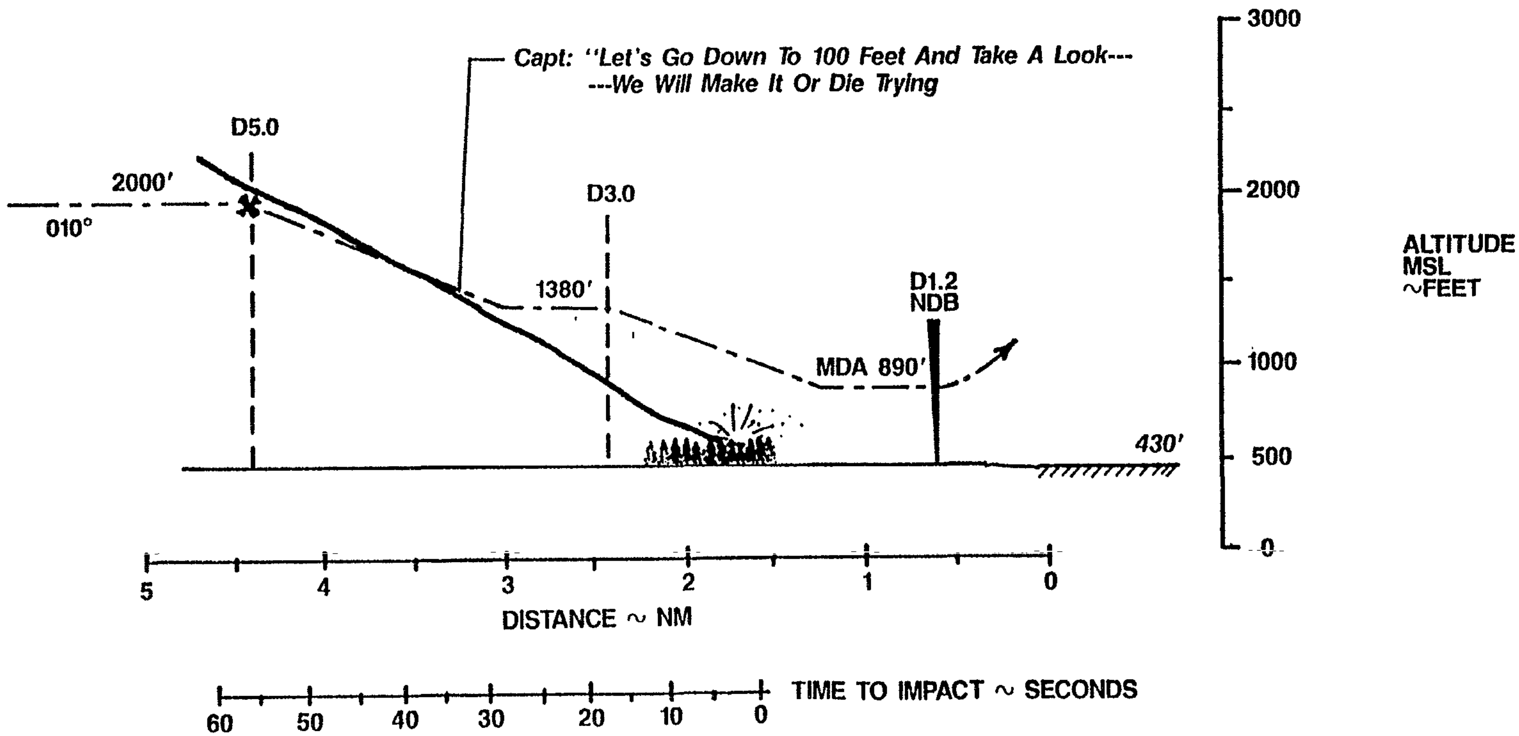
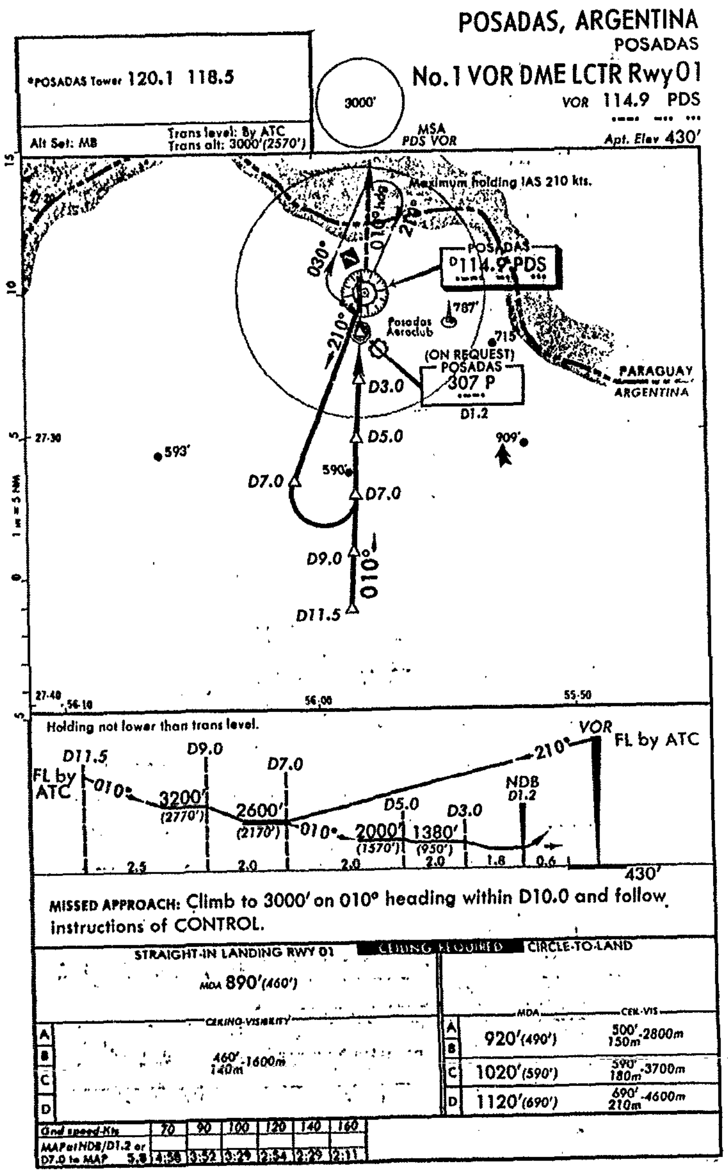
Flight Path Profile

MD-81
POSADAS, ARGENTINA
12 JUNE, 1988

Conditions:	VOR/DME Locator Approach To Runway 01
Weather:	Thick Fog
	Hit Trees 65 To 80 Feet High And Crashed Short Of Runway By 1.7 NM
Fatalities:	23
MK II GPWS Installed - No Warning	





Argentine Jet Crashes; 22 Are Presumed Dead

POSADAS, Argentina, June 12 (AP) — A DC-9 jetliner with 22 people on board crashed in heavy fog today while trying to land at an airport in northeastern Argentina, officials said. All those on board were presumed dead.

Six bodies were recovered from the wreckage of the plane, but intense heat prevented a complete search of the crash scene, the authorities said.

Austral Air Lines said 15 passengers and a crew of 7 were on board the plane, which left Buenos Aires at 7 a.m. today and landed in the river port city of Resistencia. The airline said the plane headed north from Resistencia and crashed into a grove of eucalyptus trees at 9:50 a.m. about half a mile short of the Posadas airport.

Posadas, the capital of Misiones province, is about 650 miles northeast of Buenos Aires, across the Paraná River from Encarnación, Paraguay.

The airline said the plane, Flight 46, crashed "for unknown reasons."

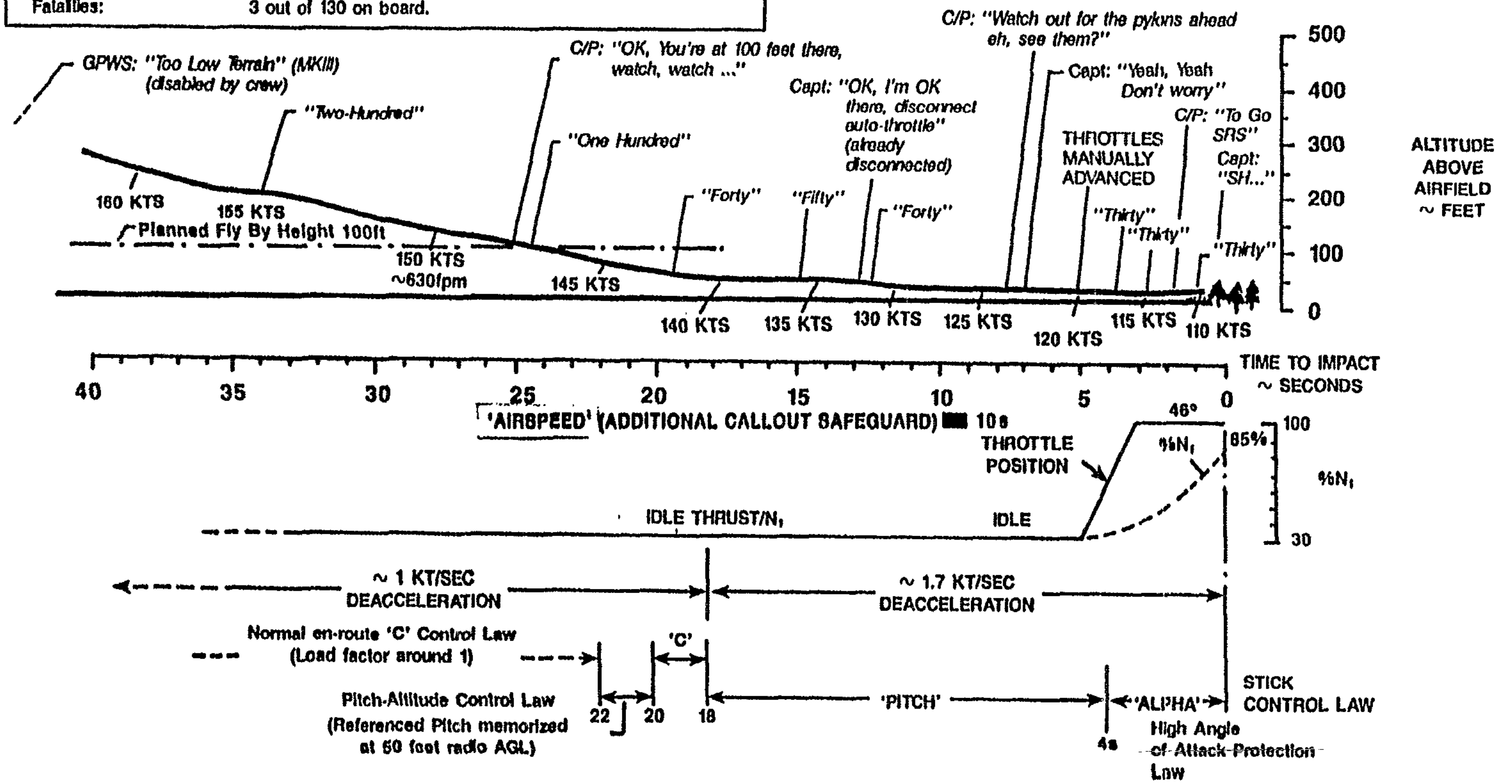
"Given the magnitude of the accident, it is presumed there are no survivors," the airline said.

Flight Path Profile

Return to TOC

A-320
HABSHEM, FRANCE
JUNE, 1988

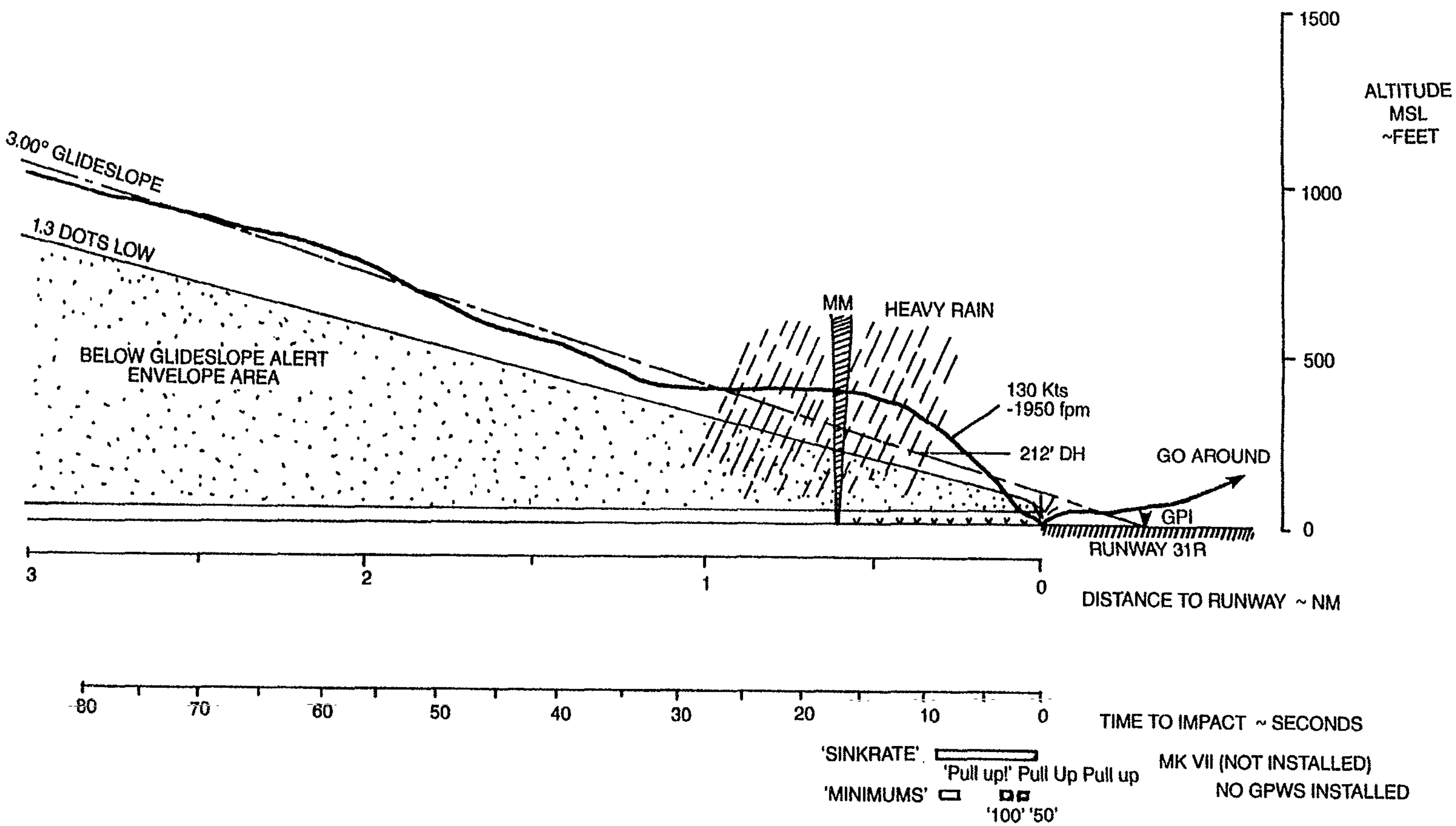
Circumstances:	During fly-by over grass runway (2000') 34R, aircraft ranout of kinetic energy and crashed into woods at end of runway. Auto-throttles were disconnected. Altimeters set to QFE.
Weather:	Not a factor. Wind 300/6 KTS
Configuration:	Landing gear down Flaps 3
Time:	12:45 Local Time
Engines:	CFM 56-5 (Response idle to Full Power: 8 seconds
Fatalities:	3 out of 130 on board.



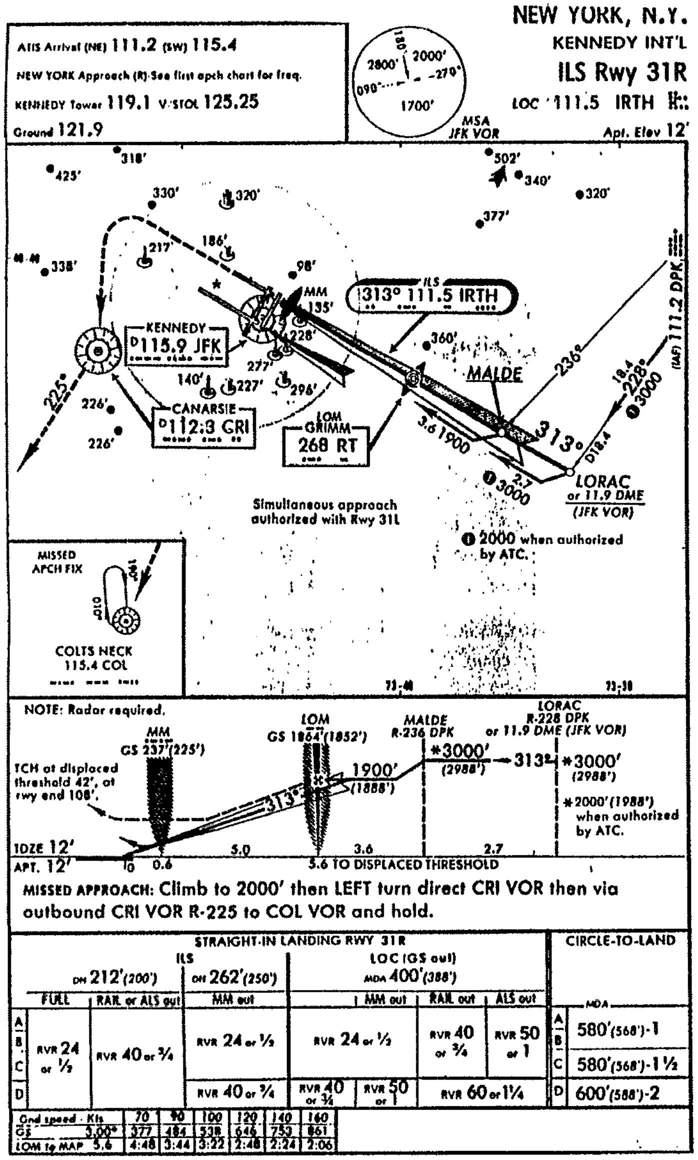
Circumstances:	During approach to runway 31R, the aircraft entered a heavy rain cell and visibility went to zero at about 400 feet AGL. The aircraft developed an uncorrected descent rate of about 1950 fpm until impact, resulting in considerable damage.
Weather:	Rain showers, but no reported wind shear
Time:	16:31 EDT
Injuries:	None of 155 on board.

90-282

FLIGHT PATH PROFILE
B747-200
JFK, New York
1 June 1988



Return to TOC

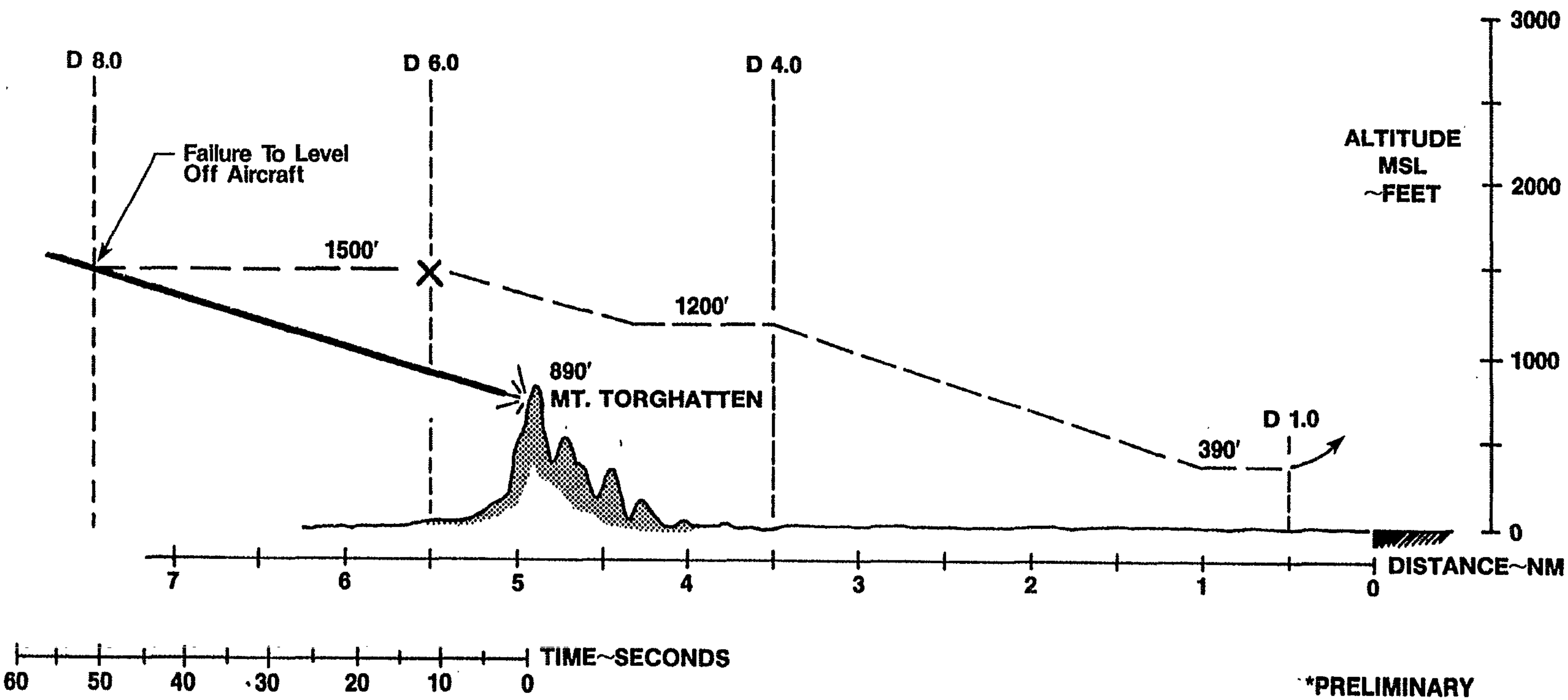


Next Page

Flight Path Profile*

DHC-7
BRONNOYSUND, NORWAY
6 May, 1988

Circumstances:	Aircraft Hit Precipitous Terrain 5 NM Short Of Runway On VOR/DME Approach To Runway 04. (2625′ Length) With Circle To Land Runway 22. F/O Flying, Captain Distracted By Person In Jump Seat. Autopilot Engaged - 'Special' Company Approach Prodedure Being Used
Configuration:	Landing, Flap 25
Weather:	Fog, Rain
Time:	20:32 Local
Fatalities:	36



*PRELIMINARY

□ MK II GPWS "MINIMUMS-MINIMUMS"
1½ SECONDS BEFORE IMPACT

Return to TOC

BRONNOYSUND, NORWAY

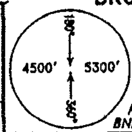
BRONNOY

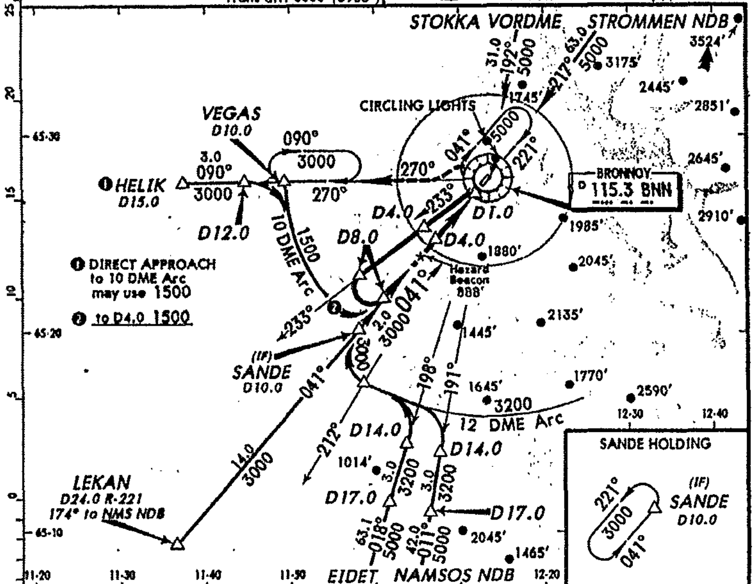
CAT A & B VORDME Rwy 04

VOR 115.3 BNN

Apt. Elev 28'

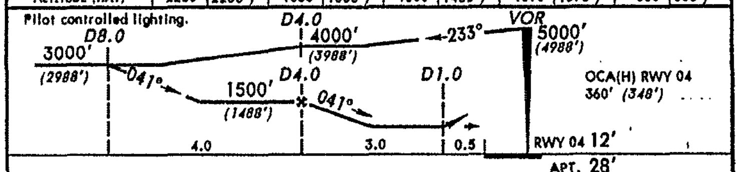
*BRONNOY Information	119.6
Alt Set: hPa	Trans level: By ATC Trans alt: 6000' (5988')





BNN DME	6.0	5.0	4.0	3.0	2.0
ALTITUDE (HAT)	2250' (2238')	1880' (1868')	1500' (1488')	1090' (1078')	680' (668')

Pilot controlled lighting.



MISSED APPROACH: Climbing turn LEFT on R-270 to join VEGAS holding at 3000' (2988') (MAX IAS 130 KT). Climb to 710' (698') prior to level acceleration.

	STRAIGHT-IN LANDING RWY 04	Max Kts	CIRCLE-TO-LAND	
	MDA(H) 360' (348')		Not authorized East of airport	
	ALS out		MDA(H)	
A	RVR 1500m VIS 1600m	100	460' (432')	1600m
B		135	710' (682')	1600m
C	NOT APPLICABLE	C	NOT APPLICABLE	
D		D		

Gnd speed-Kts	70	90	100	120	140	160
Descent Gradient 6.6%	468	602	669	803	936	1070
MAP at D1.0						

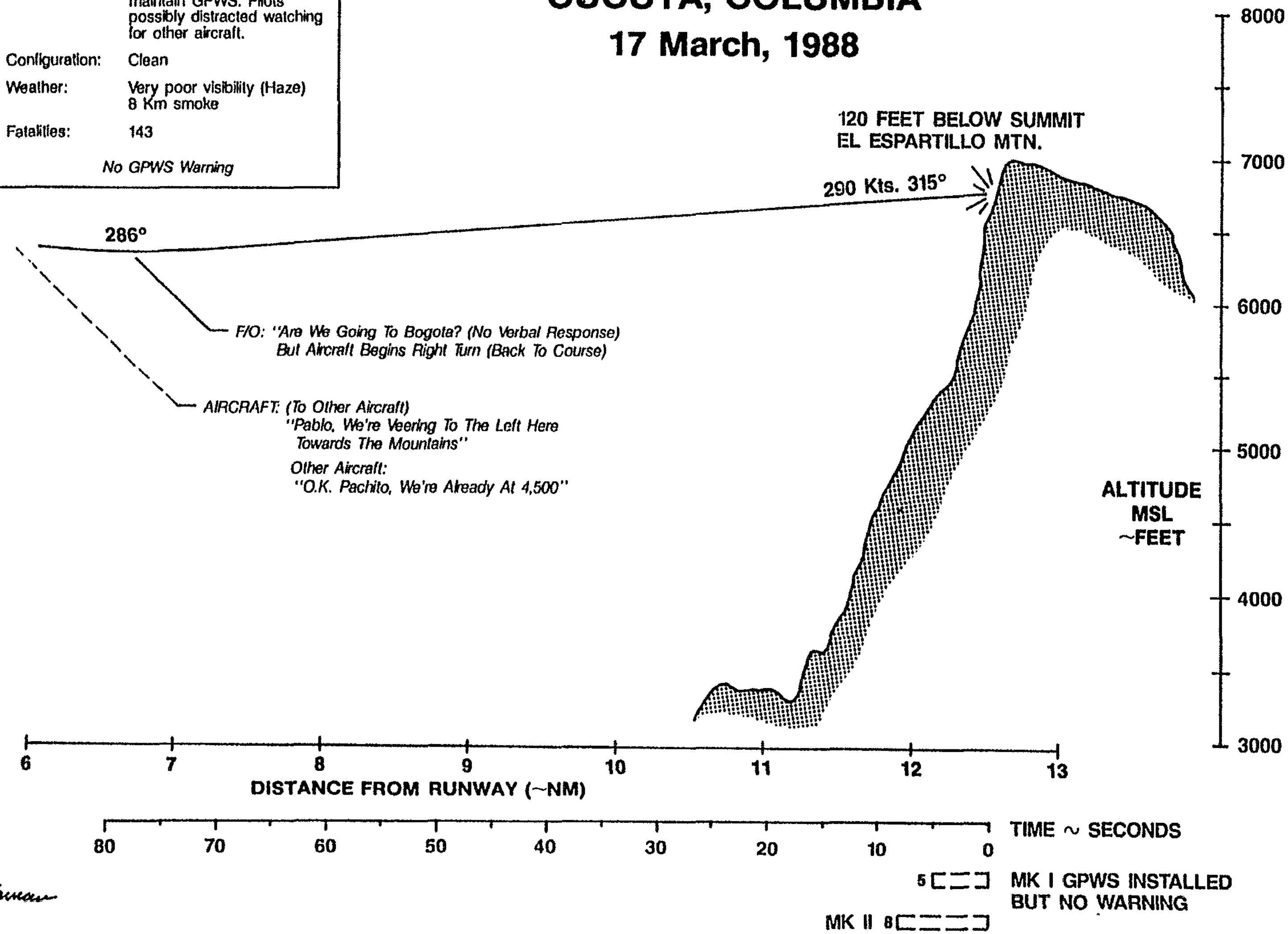
Next Page

Flight Path Profile

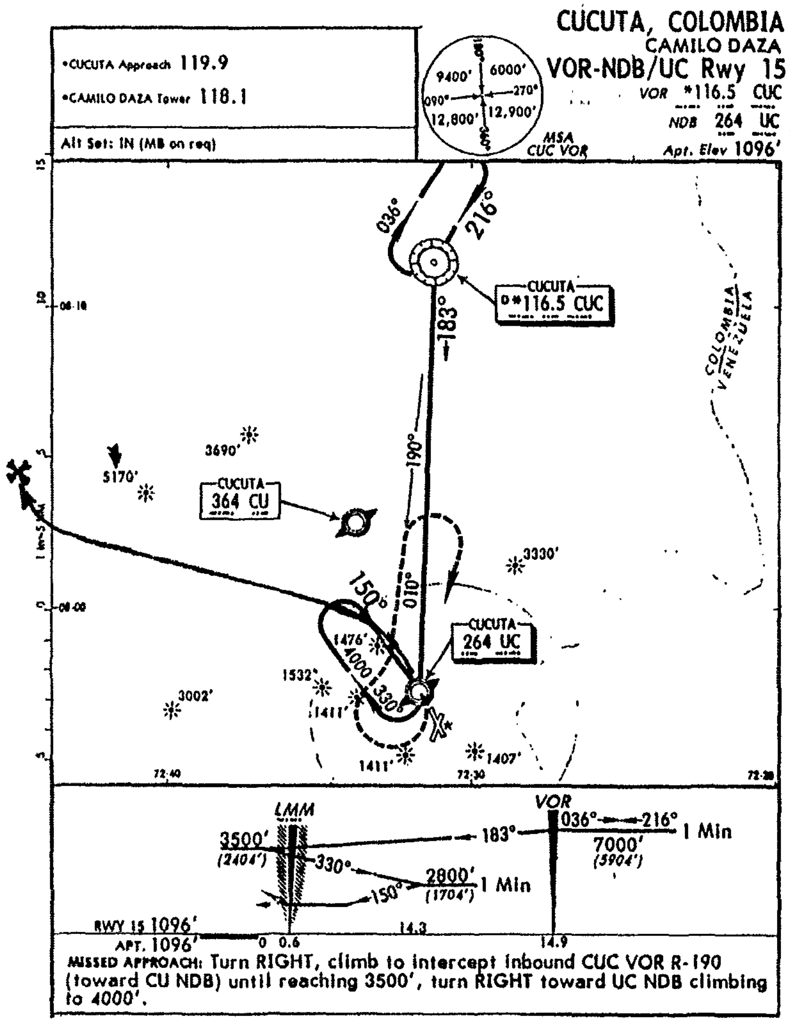
B727-100
CUCUTA, COLUMBIA
17 March, 1988

Circumstances:	Pilot trying to make up time (3 hrs. late). Departed VFR, watching for inbound aircraft. Hit mountain top on abnormally low climb profile. GPWS installed but circuit breaker probably clipped. Airline's policy was *not* to maintain GPWS. Pilots possibly distracted watching for other aircraft.
Configuration:	Clean
Weather:	Very poor visibility (Haze) 8 Km smoke
Fatalities:	143

No GPWS Warning



Don Bateman



The following communications and significant cabin conversations took place between the ATC, the HK 1716 and the HK 727, from the moment the plane was authorized to enter into position on runway 33, until the HK 1716 crashed at an altitude of 6,295 feet:

18:12:35.1-C2 To Cartagena W19, /illegible/ and 10 climb on course and 2216; in ready position.

18:12:36.4-TWR Maintain position.
Note: This order is given by the Tower due to the landing of the HK 2670 on runway 02.

18:13:19.9-TWR: Avianca 1716 authorized to take off, wind 015° 10 knots.

18:13:25.1-C2: 1716

18:13:27.4-TWR For your information, a 727 from your company is about to leave the VOR on ILS procedure.

18:13:33.2-C2 1716
18:13 35 TAKE-OFF

18:14:17.6-C1: Have taken off and proceeding according to plan, Avianca /illegible/.

18:14:23.8-TWR Received, call on 119.9

18:15:01./illegible/-C1: Avianca 1716 has taken off and proceding according to plan.

18:15:05.1-TWR: 1716 proceed on planned course. Traffic leaving the VOR Boeing 727 on ILS approach. Leave the VOR then; notify on 190, O.K.

18:15:16.4-C1: Correct.

The conversaion between the HK 1716 and the HK 727 is transcribed below:

18:15:54.3-C1: Pablo, we're veering to the left here towards the mountain.

18:15:57.3-C1 HK 727: O.K., Pachito. We're already at 4,500.

18:17:48. 7-C1 HK 727: Leaving the exterior Avianca 727.

18:17:54.7-TWR to the 727:
~~Tell us when you see the field and begin circling.~~

18:17:58.7-C1 HK 727: O.K. we're going to approach full ILS for the 15

18:18:01.7 Impact.

Return to TOC

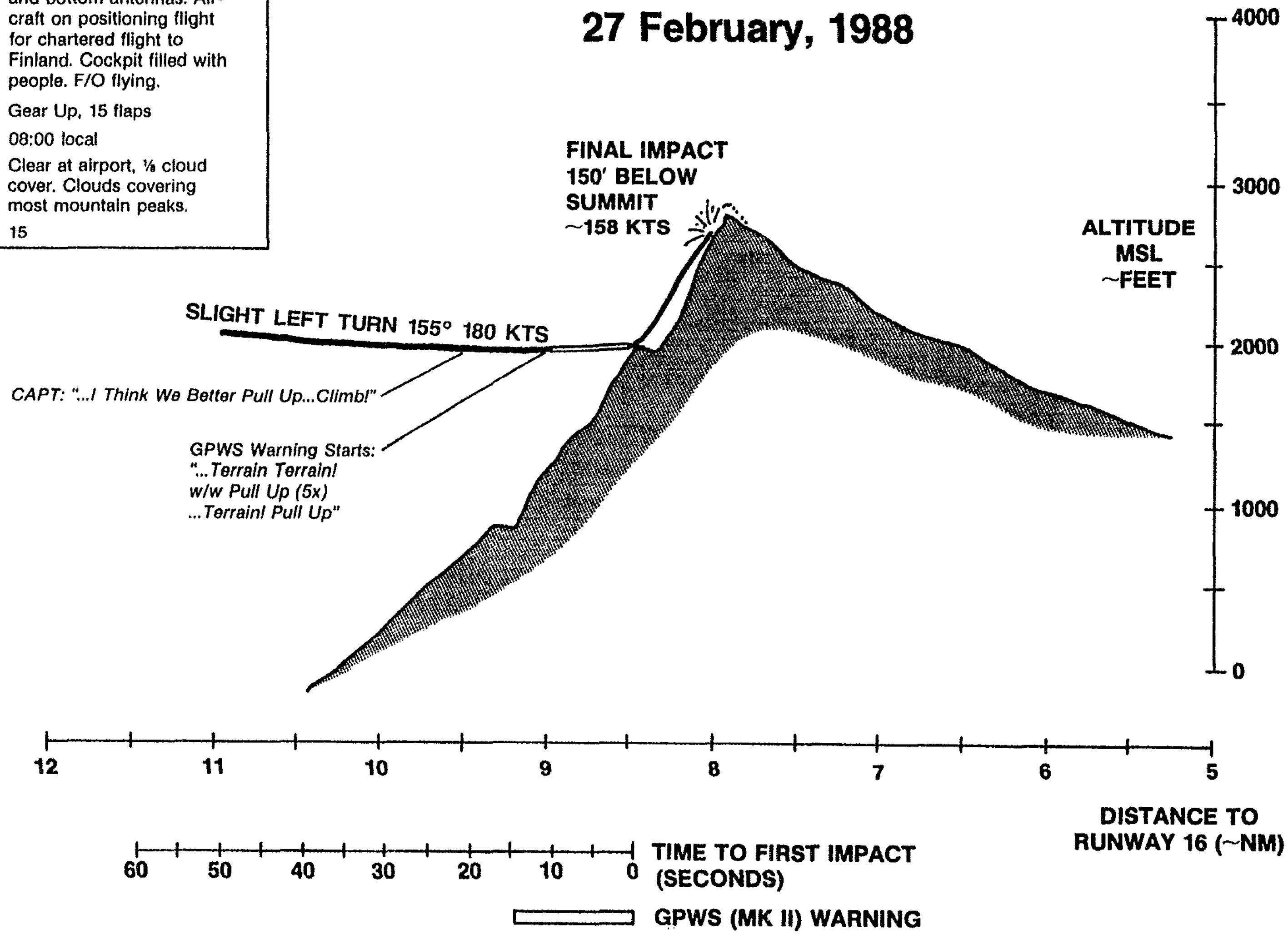
Circumstances:	Apparently aircraft deliberately deviated from instrument VOR Rwy 16 procedures. Perhaps to sight see Buffavento Castle (left of course). Hit mountain after first clipping trees, removing fairings and bottom antennas. Aircraft on positioning flight for chartered flight to Finland. Cockpit filled with people. F/O flying.
Configuration:	Gear Up, 15 flaps
Time:	08:00 local
Weather:	Clear at airport, ⅛ cloud cover. Clouds covering most mountain peaks.
Fatalities:	15

Flight Path Profile

B727-200

ERCAN (NICOSIA), CYPRUS

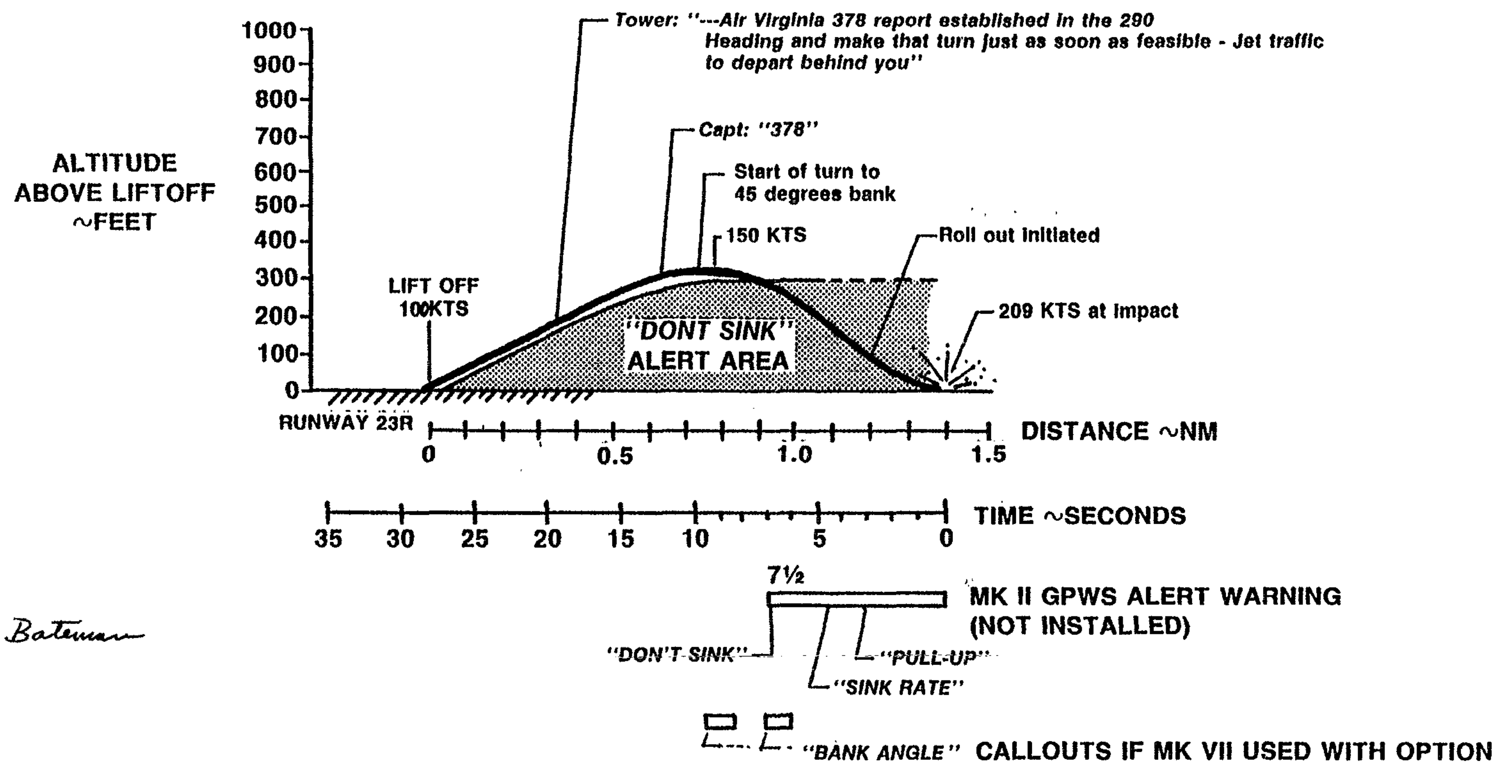
27 February, 1988



Don Bateman

Undetected descent (Acceleration) During Initial Climb Fairchild Metro III
RALEIGH - DURHAM
19 FEBRUARY, 1988

Conditions:	Hurried turn on climb out
Weather:	Very bad visibility
Time:	21:25 EST night
Fatalities:	12

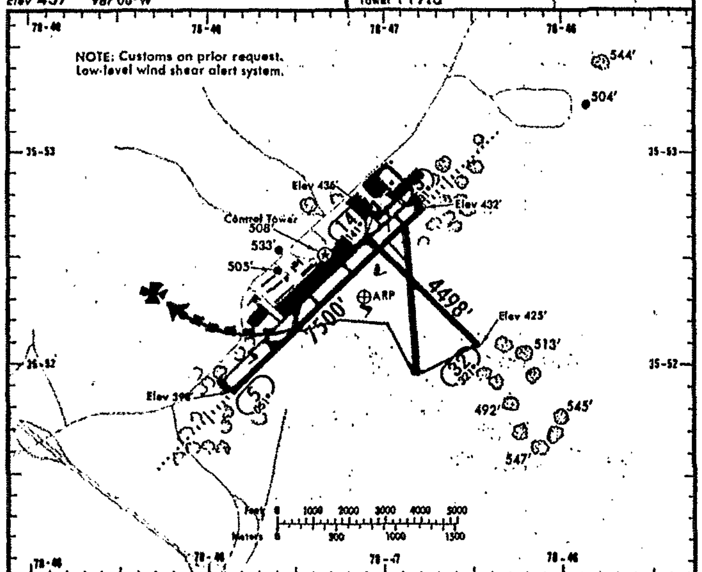


Don Bateman

RALEIGH-DURHAM, N.C. KRDU
RALEIGH-DURHAM
N35 52.3 W078 47.1 RDU 117.2-On Airport
Elev 437' Var 06°W

ATIS 123.8
RALEIGH Clearance 120.1
Ground 121.9
Tower 119.3

RALEIGH Departure (R)
230°-041° 118.05
042°-229° 125.3



ADDITIONAL RUNWAY INFORMATION

RWY		USABLE LENGTHS LANDING BEYOND Threshold	Glide Slope	TAKE-OFF	WIDTH
5	HIRL SSALR VASI-L grooved RVR		6475'		150'
23	HIRL MALSR VASI-L grooved		6500'		
14	MIRL				100'
32	MIRL REIL VASI-L (angle 3.5°)				

TAKE-OFF & IFR DEPARTURE PROCEDURE

All Rwys	Forward Vis Ref	STD
1 & 2 Eng	RVR 16 or ¼	RVR 50 or 1
3 & 4 Eng		RVR 24 or ½

FOR FILING AS ALTERNATE

	Precision	VOR Rwy 32 Without DME	Other
A B C	600-2	800-2	800-2
D		800-2¼	

IFR DEPARTURE PROCEDURE: Rwy 32, climb on rwy heading to 600' before turning left.

Air Crashes Kill 18 in Carolina and New Jersey

Eighteen people were killed last night in the crashes of two airplanes, 12 aboard an American Eagle commuter plane taking off from Raleigh-Durham airport in North Carolina and six in the crash a small plane in a wooded area near Atlantic City.

Both crashes occurred in dense fog caused by a storm system that was moving rapidly up the Atlantic Seaboard from the south. It was also raining heavily at the time of the New Jersey crash. Officials of the Federal Aviation Administration in Washington said it was too early to know whether the weather was a factor in the crashes, although an air traffic controller at the Raleigh-Durham airport said officials there did not think the fog was a factor.

The crash near Atlantic City involved a twin-engine Piper Navajo that was on the way from Norwood, Mass., to Pomona, N.J. The crash occurred about 10 P.M.

In the North Carolina crash, a twin-engine American Eagle plane, flight 3378 bound for Richmond, Va., crashed about 3,000 feet from the runway at about 9:27 P.M., just after taking off. There were 10 passengers and two crew members on board.

The plane, a Sweringen-4, holds up to 19 passengers. The names of the passengers were not immediately available. There were reports that most of the victims were from the Richmond area, and that one of them was a 13-year-old child.

American Eagle, a subsidiary of American Airlines, had recently resumed flights from its base at Raleigh-Durham airport after filing for reorganization in Federal bankruptcy court on Jan. 15.

The cause of the crash was unknown. The National Transportation Safety Board and Federal Aviation Administration dispatched investigators to the scene, said Roger Myers, public information officer for the F.A.A. in Atlanta.

Plane Had Just Taken Off

An airport spokeswoman said the pilot took off to the south and banked to the west, a normal maneuver, just before the crash. "We have not heard that there was any communication between the tower and the pilot," she said.

Witnesses said they heard an explosion and saw a fireball before the plane went down near a small residential area.

Mary H. Ward, who lives in a mobile home three miles from the airport, said, "It sounded like a blast or something because they've been blasting down on this road putting in sewer lines and that's the way it sounded."

The plane took off from a new 10,000 foot runway near the American Airlines terminal. The runway was closed shortly after the crash but reopened at 10:15 P.M. The airport also closed briefly. A temporary morgue was to be set up at a National Guard Armory.

In Richmond, airline officials escorted about a dozen family members and others waiting for the plane to a private lounge where they were told of the accident.

Fog had settled over the Raleigh-Durham area during the afternoon with visibility dropping below one mile at 4:40 P.M. Visibility at the airport's control tower at 9:30 P.M. was zero and on the ground visibility was an eighth of a mile, said Rod F. Gonski, a National Weather Service meteorologist at the airport.

The other crash occurred about two miles northwest of Atlantic City International Airport, officials said.

Anthony Willett, an F.A.A. spokesman, said the victims were not immediately identified. He said the twin-engine Piper Navajo, which is 32 feet long with a 40-foot wing span, is a type commonly used by commuter airlines. However, he said the plane may have been privately owned.

The plane was en route to the airport in Pomona when its radar signal was lost at 10:10 P.M., Mr. Willett said. The crash was found an hour later.

A police dispatcher in Norwood said the small airport there serves privately owned aircraft.

3 Killed in Texas

EL PASO, Tex., Feb. 19 (AP) — A twin-engine plane skimmed over rush-hour traffic here today and crashed on a freeway access road, killing all three people aboard and spewing flaming debris that destroyed two parked cars, the authorities said.

"It looked like it was going to attempt maybe to come onto the freeway, but as soon as it got over the freeway, it just nosedived," said Victor Armendariz, who was waiting at a stop light near the crash site.

The Gulfstream Commander [illegible] went down in moderate snow and light fog after takeoff from El Paso International Airport shortly before 9 A.M., said Tommy McFall, a National Transportation Safety Board spokesman.

The victims' identities were not immediately released. The plane's destination was not available. The cause of the crash was under investigation.

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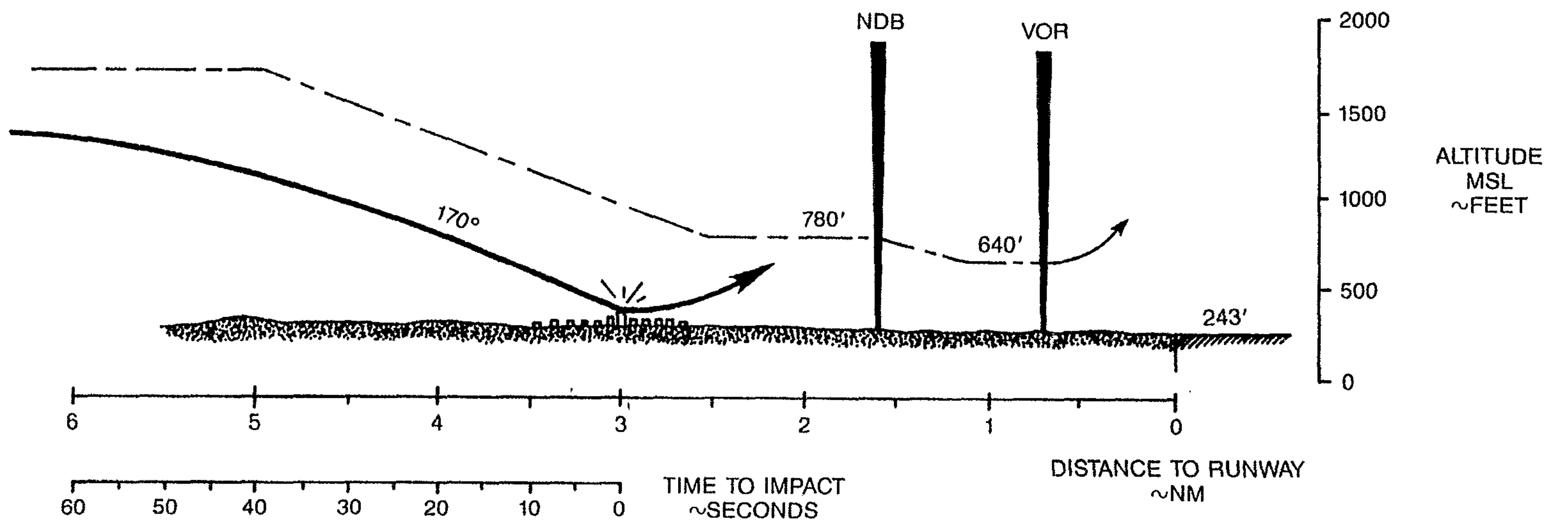
Circumstances:	During a non-standard VOR/NDB approach, the F/O thought he had sighted the airport and descended. The right wing struck a communication tower installed on a 12 story apartment building. A missed approach was initiated by the Captain. The aircraft carried a 20 foot 6 inch diameter sectionof steel communications antenna wrapped around leading edge of right wing.
Time:	Night 04:50 local.
Weather:	100 meters/fog, wind calm.
Configuration:	Landing
Damage:	Severely damaged right wing, spars, flaps, engine, flaps, fuselage. Aircraft was written off.

FLIGHT PATH PROFILE
B707-300QC
Luanda, Angola
8 February, 1988



Return to TOC

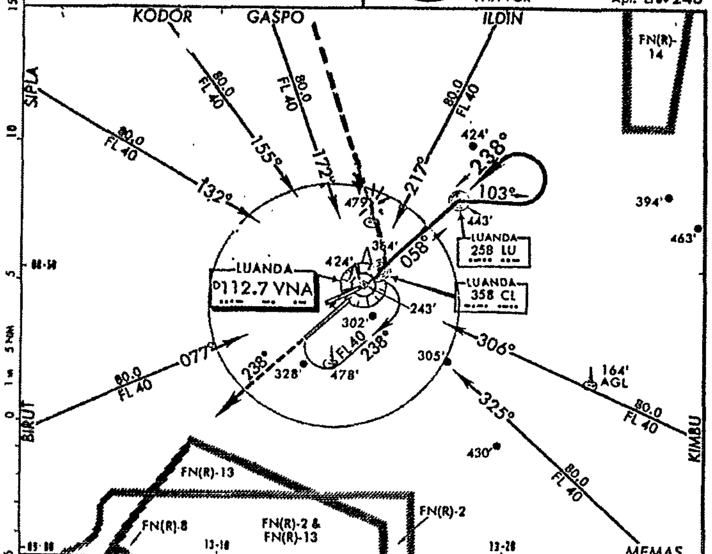
LUANDA Approach 119.1
LUANDA Tower 118.1 121.9

2500'
MSA
VNA VOR

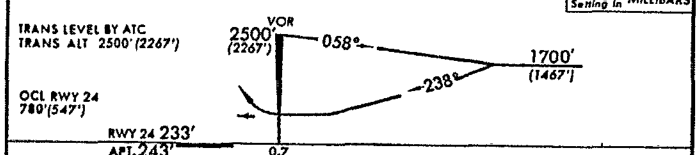
LUANDA, ANGOLA
4TH OF FEBRUARY
VOR Rwy24

VOR 112.7 VNA

Apt. Elev 243'



Altimeter Setting in MILLIBARS



MISSED APPROACH: Climb to 2500' on track 238° and contact ATC.

STRAIGHT-IN LANDING RWY 24

MDA 780' (547')

		ALS out
A	800m	1600m
B		
C	1600m	2400m
D	2000m	2800m

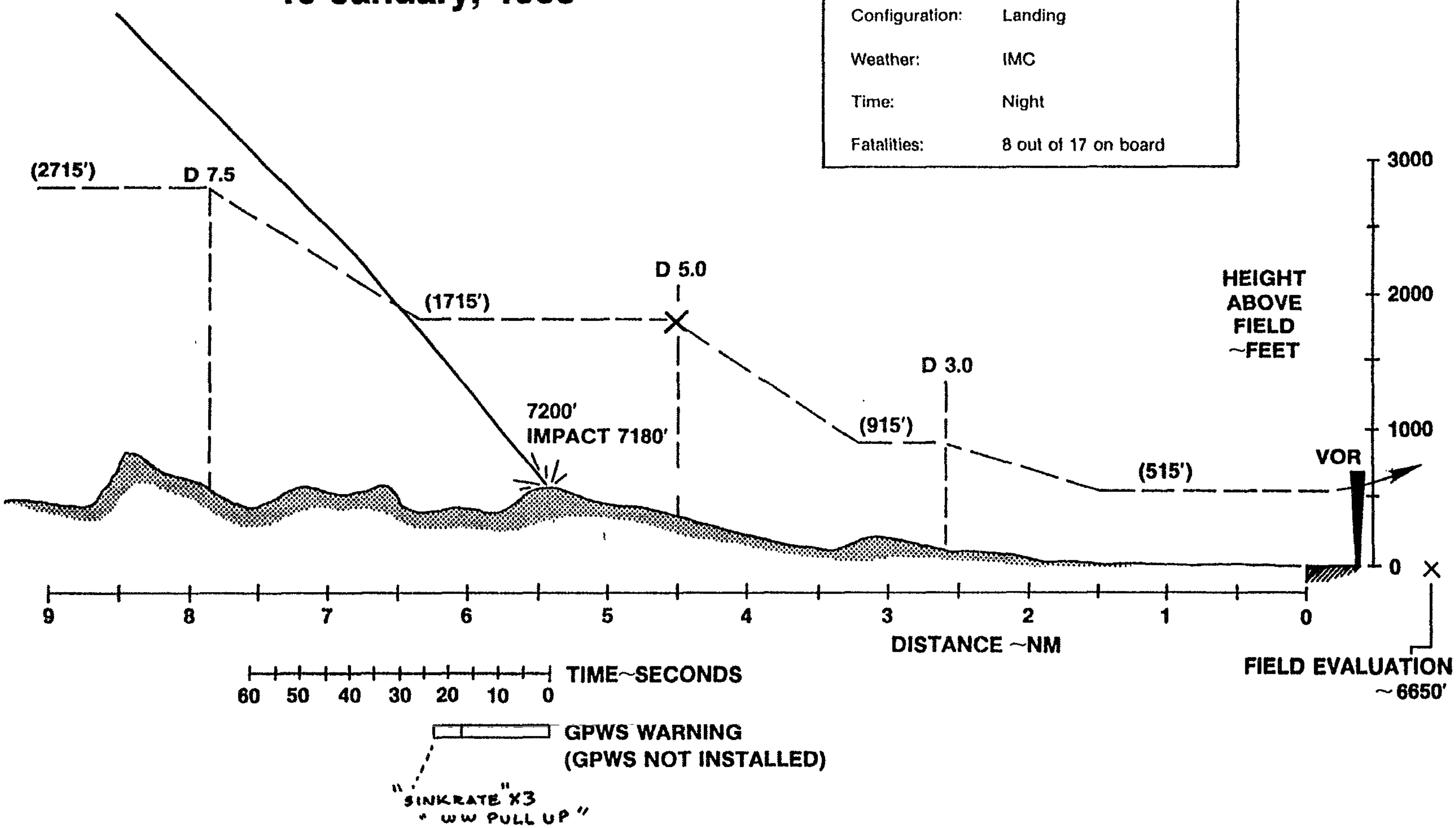
MAP at VOR

Next Page

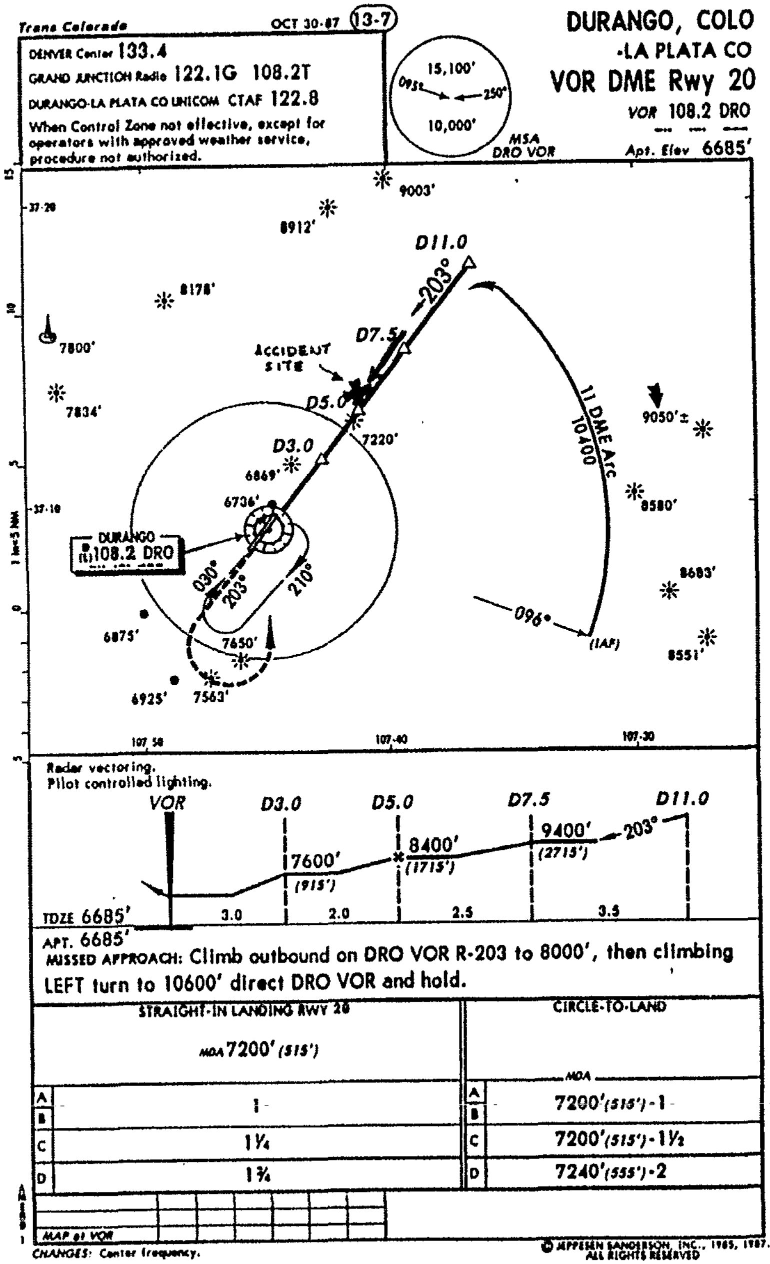
Flight Path Profile

Metro Twin Commuter
DURANGO, COLORADO
19 January, 1988

Circumstances:	Aircraft hit ridge 5.3NM short, during a VOR/DME approach to runway 20.
Configuration:	Landing
Weather:	IMC
Time:	Night
Fatalities:	8 out of 17 on board



Return to TOC



Commuter Plane Down With 12 People Injured

DURANGO, Colo., Jan. 19 (AP) — A commuter airliner with 16 people aboard crashed near here tonight, and officials said there were at least 12 people seriously injured. There was no word on fatalities.

"What we do know, we have survivors," said Bruce Hicks, a spokesman for Continental Airlines. The commuter plane was leased by a subsidiary of Continental, officials said.

Mr. Hicks said there were 14 passengers and two crew members aboard the Denver-to-Durango flight. He said the twin-engine, turboprop plane, went down about 7:30 P.M. about 10 miles east of Durango, near the town of Bayfield. Weather in the area was overcast with light snow. The region had gotten more than two feet of snow in the past few days.

A spokeswoman for the La Plata County Sheriff's Office said it received the first notification of the crash at 8 P.M. She said officials issued a call for persons with snowmobiles to assist in the rescue effort.

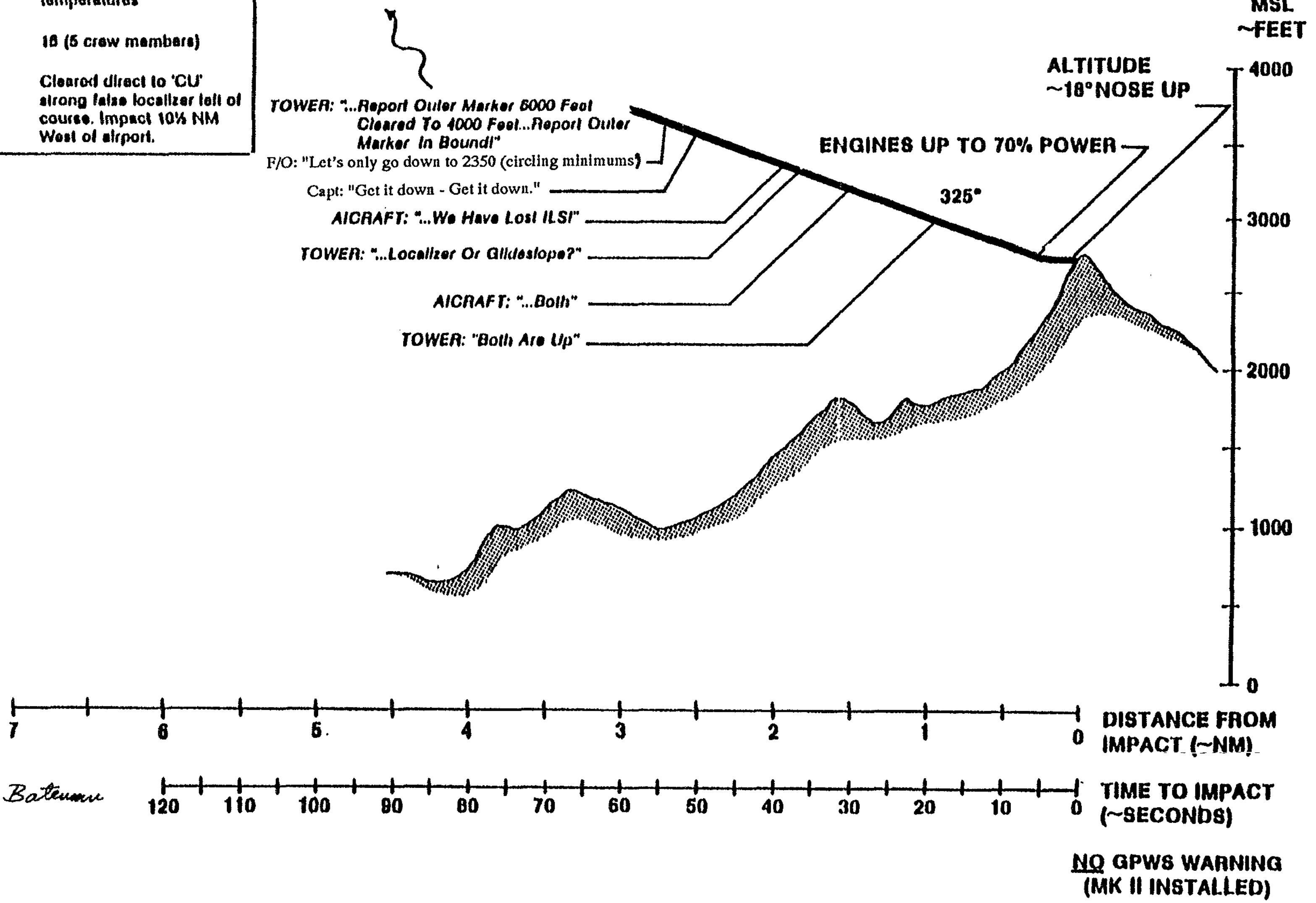
The plane is owned by Colorado Springs-based Trans Colorado, which leases planes and crew to Rocky Mountain Airways, officials said.

Next Page

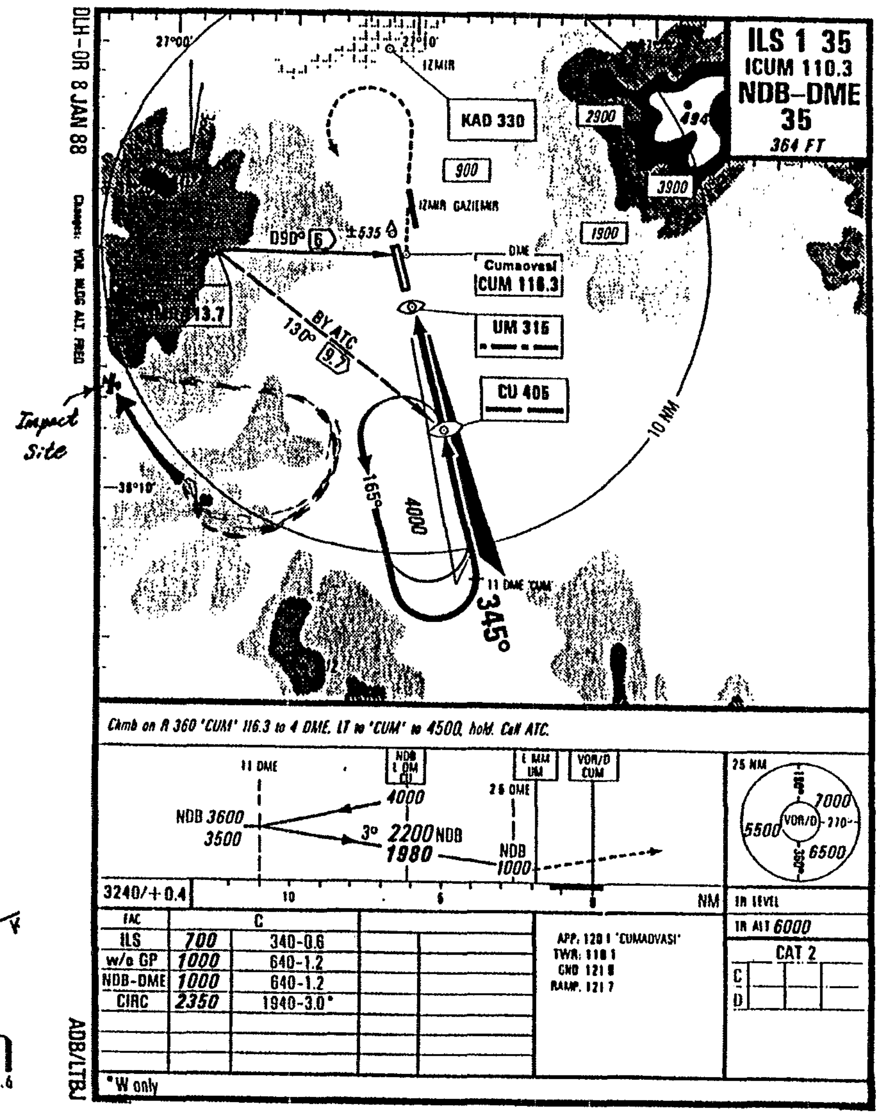
Flight Path Profile

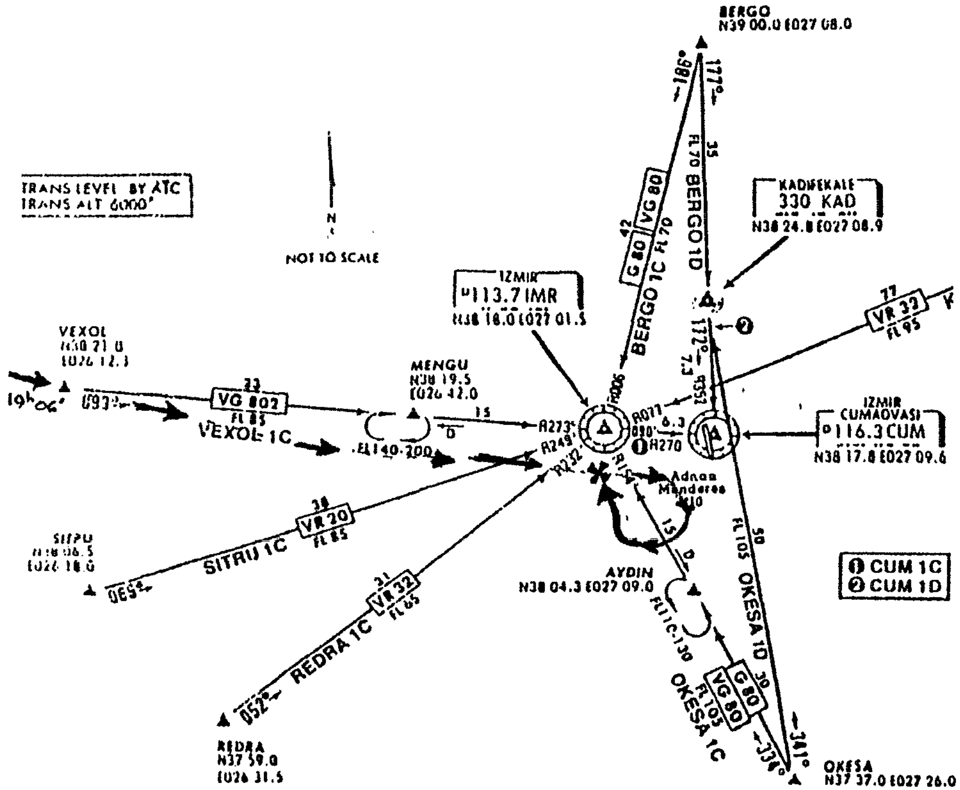
B737-200
IZMIR, TURKEY
2 January, 1988

Circumstances:	Night. Positioning flight.ILS VOR/DME approach
Configuration:	Landing
Weather:	Heavy rain, zero spread in temperatures
Fatalities:	16 (5 crew members)
Other:	Cleared direct to 'CU' strong false localizer left of course. Impact 10½ NM West of airport.



Don Bateman

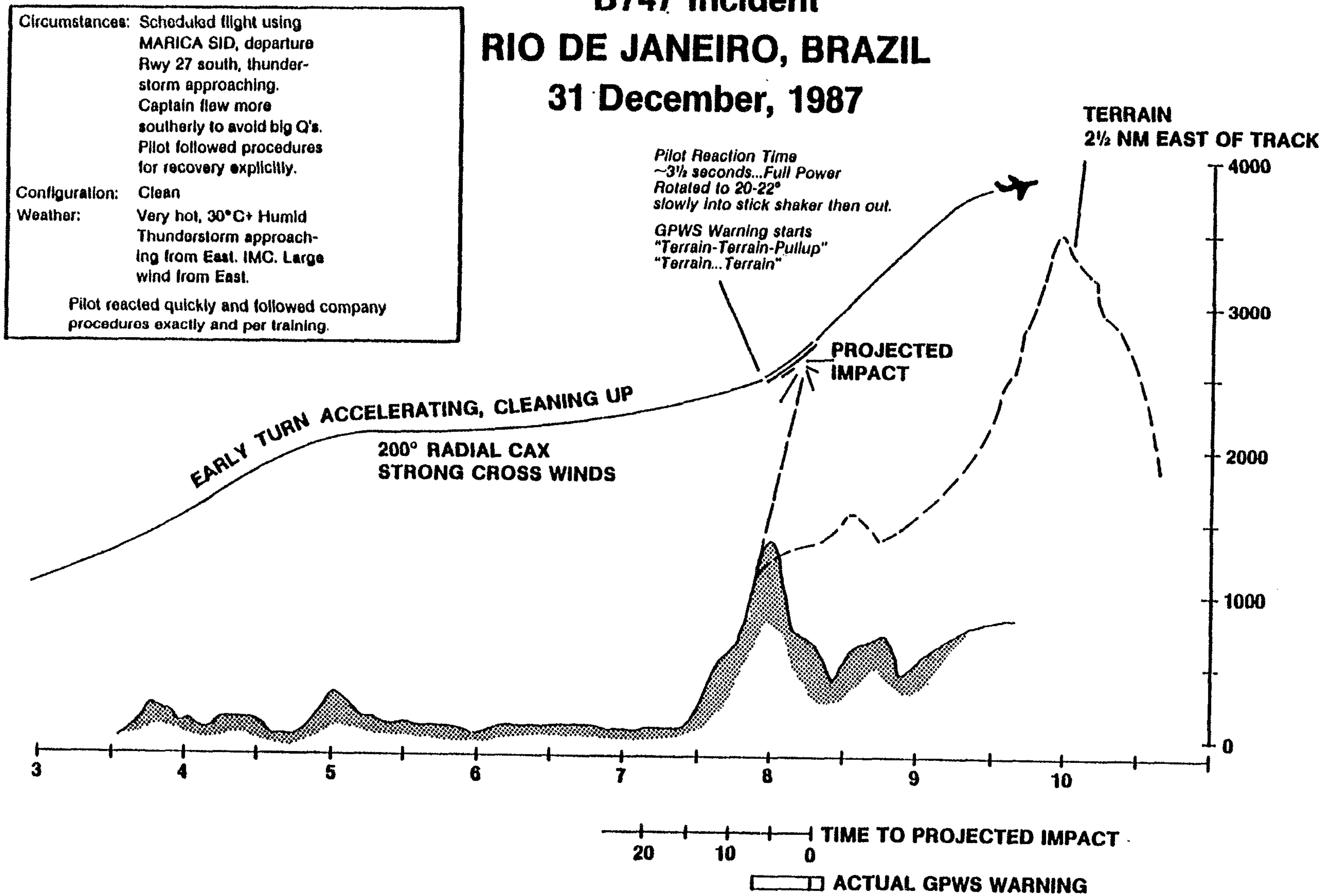

DLH-OR 8 JAN 88
ILS 1 35
ICUM 110.3
NDB-DME
35
364 FT
KAD 330
IZMIR
900
2900
3900
1900
IZMIR GAZIEMIR
D90° 6
DME
Cumaovasi
CUM 116.3
113.7
BY ATC
130°
9.7
UM 315
CU 405
10 NM
165°
4000
11 DME 'CUM'
345°
Impact site
Climb on R 360 'CUM' 116.3 to 4 DME, LT to 'CUM' to 4500, hold. Call ATC.
11 DME
NDB 3600
3500
4000
3° 2200 NDB
1980
NDB
1000
3240/+0.4
25 NM
7000
5500
6500
TR LEVEL
TR ALT 6000
CAT 2
ILS 700 340-0.6
w/o GP 1000 640-1.2
NDB-DME 1000 640-1.2
CIRC 2350 1940-3.0*
*W only
ADB/LTBJ

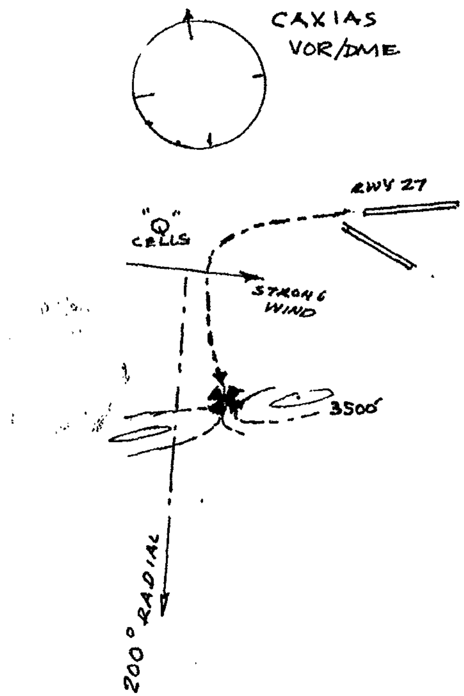

BERGO
N39 00.0 E027 08.0
TRANS LEVEL BY ATC
TRANS ALT 6000'
NOT TO SCALE
KADIFEKALE
330 KAD
N38 24.8 E027 08.9
IZMIR
113.7 IMR
N38 18.0 E027 01.5
BERGO 1C
BERGO 1D
VEXOL
MENGU
VEXOL 1C
VG 802
IZMIR
CUMAOVASI
116.3 CUM
N38 17.8 E027 09.6
Adnan Menderes
SITRU 1C
VR 20
REDRA 1C
VR 32
AYDIN
N38 04.3 E027 09.0
OKESA 1D
OKESA 1C
1 CUM 1C
2 CUM 1D
REDRA
N37 59.0
E026 31.5
OKESA
N37 37.0 E027 26.0

Next Page

Flight Path Profile

B747 Incident
RIO DE JANEIRO, BRAZIL
31 December, 1987




CAXIAS
VOR/DME
RWY 27
"Q"
CELLS
STRONG
WIND
3500'
200° RADIAL

Next Page

CIRCUMSTANCES: Aircraft hit 3 NM short of ILS 23 runway threshold. Aircraft had been high and fast, leading to a de-stabilized approach.

WEATHER: Visibility 200 meters, wind calm, indefinite ceiling Temperature 5ºC, Dew point 5ºC.

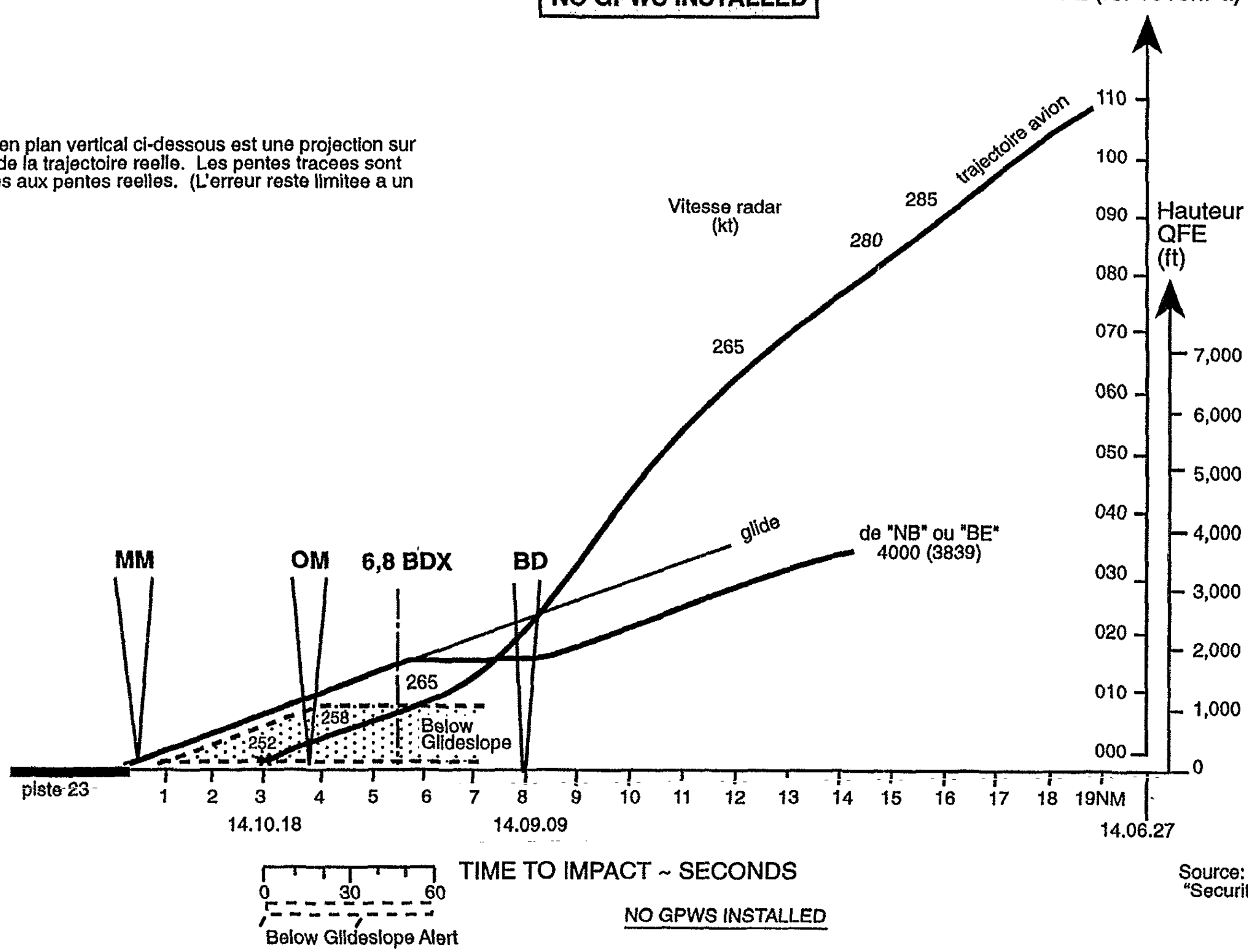
OTHER: 'Glass' (CRT) cockpit

FATALITIES: 16

Flight Path Profile
EMB 120
BORDEAUX, FRANCE
21 December, 1987

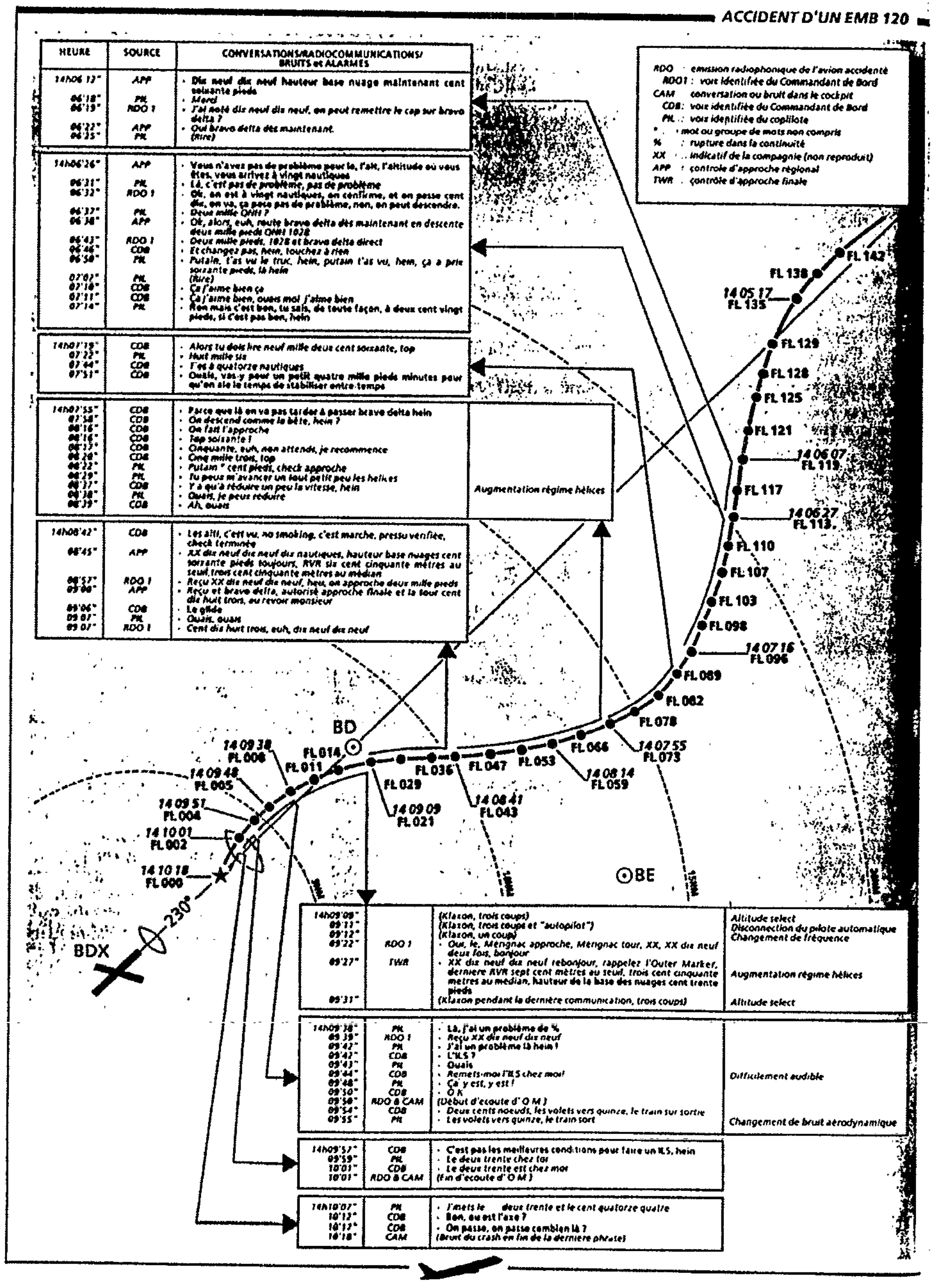
NO GPWS INSTALLED

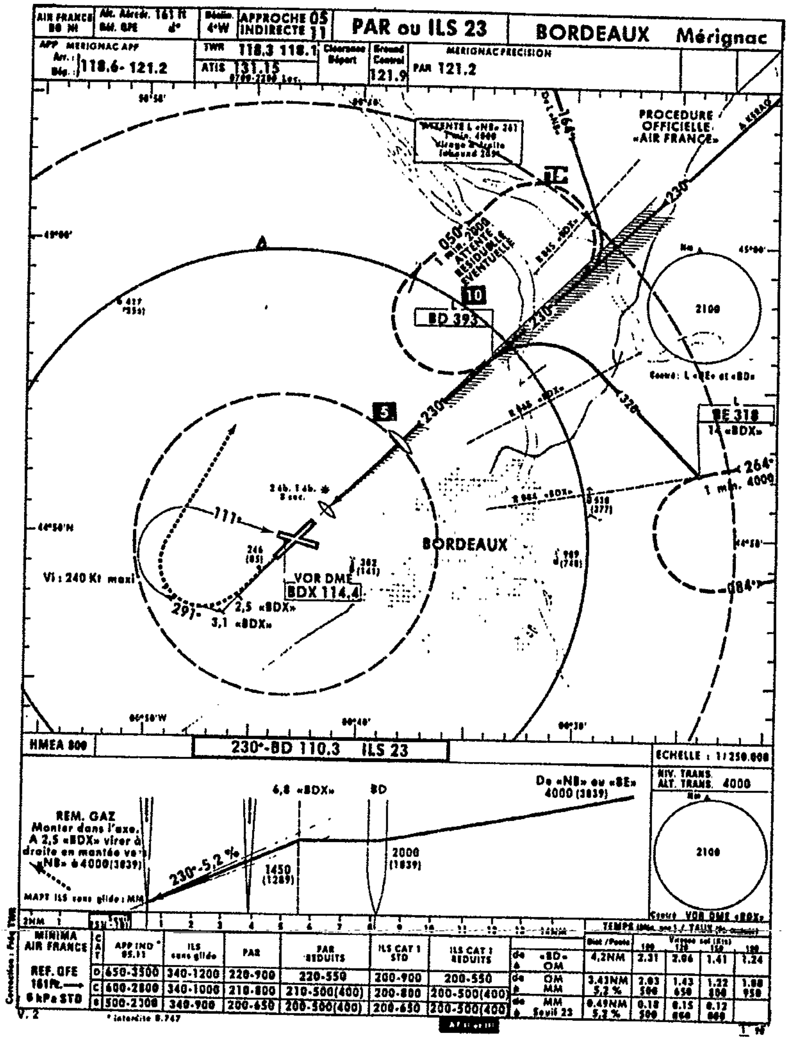
Attention! La coupe en plan vertical ci-dessous est une projection sur l'axe du localizer 23 de la trajectoire reelle. Les pentes tracees sont superieures ou egales aux pentes reelles. (L'erreur reste limitee a un maximum de 30%)



NO GPWS INSTALLED

Source: Air Inter #44
"Securite Des Vols" APR 193


ACCIDENT D'UN EMB 120
HEURE | SOURCE | CONVERSATIONS/RADIOCOMMUNICATIONS/ BRUITS et ALARMES
14h06'12" APP · Dix neuf dix neuf hauteur base nuage maintenant cent soixante pieds
06'18" PIL · Merci
06'19" RDO 1 · J'ai noté dix neuf dix neuf, on peut remettre le cap sur bravo delta ?
06'22" APP · Oui bravo delta dès maintenant.
06'25" PIL (Rire)
14h06'26" APP · Vous n'avez pas de problème pour le, l'alt, l'altitude où vous êtes, vous arrivez à vingt nautiques
06'31" PIL · Là, c'est pas de problème, pas de problème
06'32" RDO 1 · Ok, on est à vingt nautiques, on confirme, et on passe cent dix, on va, ça pose pas de problème, non, on peut descendre.
06'37" PIL · Deux mille QNH ?
06'38" APP · Ok, alors, euh, route bravo delta dès maintenant en descente deux mille pieds QNH 1028
06'43" RDO 1 · Deux mille pieds, 1028 et bravo delta direct
06'46" CDB · Et changez pas, hein, touchez à rien
06'50" PIL · Putain, t'as vu le truc, hein, putain t'as vu, hein, ça a pris soixante pieds, là hein
07'02" PIL (Rire)
07'10" CDB · Ça j'aime bien ça
07'11" CDB · Ça j'aime bien, ouais moi j'aime bien
07'14" PIL · Non mais c'est bon, tu sais, de toute façon, à deux cent vingt pieds, si c'est pas bon, hein
14h07'19" CDB · Alors tu dois lire neuf mille deux cent soixante, top
07'22" PIL · Huit mille six
07'44" CDB · T'es à quatorze nautiques
07'51" CDB · Ouais, vas-y pour un petit quatre mille pieds minutes pour qu'on ait le temps de stabiliser entre-temps
14h07'55" CDB · Parce que là on va pas tarder à passer bravo delta hein
07'58" CDB · On descend comme la bête, hein ?
08'16" CDB · On fait l'approche
08'16" CDB · Top soixante !
08'17" CDB · Cinquante, euh, non attends, je recommence
08'20" CDB · Cinq mille trois, top
08'22" PIL · Putain * cent pieds, check approche
08'29" PIL · Tu peux m'avancer un tout petit peu les hélices
08'37" CDB · Y a qu'à réduire un peu la vitesse, hein
08'38" PIL · Ouais, je peux réduire
08'39" CDB · Ah, ouais
Augmentation régime hélices
14h08'42" CDB · Les alti, c'est vu, no smoking, c'est marche, pressu vérifiée, check terminée
08'45" APP · XX dix neuf dix neuf dix nautiques, hauteur base nuages cent soixante pieds toujours, RVR six cent cinquante mètres au seuil, trois cent cinquante mètres au médian
08'57" RDO 1 · Reçu XX dix neuf dix neuf, heu, on approche deux mille pieds
09'00" APP · Reçu et bravo delta, autorisé approche finale et la tour cent dix huit trois, au revoir monsieur
09'06" CDB · Le glide
09'07" PIL · Ouais, ouais
09'07" RDO 1 · Cent dix huit trois, euh, dix neuf dix neuf
RDO : émission radiophonique de l'avion accidenté
RDO1 : voix identifiée du Commandant de Bord
CAM conversation ou bruit dans le cockpit
CDB : voix identifiée du Commandant de Bord
PIL : voix identifiée du copilote
* : mot ou groupe de mots non compris
% : rupture dans la continuité
XX : indicatif de la compagnie (non reproduit)
APP : contrôle d'approche régional
TWR : contrôle d'approche finale
FL 142
FL 138
14 05 17 FL 135
FL 129
FL 128
FL 125
FL 121
14 06 07 FL 119
FL 117
14 06 27 FL 113
FL 110
FL 107
FL 103
FL 098
14 07 16 FL 096
FL 089
FL 082
FL 078
14 07 55 FL 073
FL 066
14 08 14 FL 059
FL 053
FL 047
14 08 41 FL 043
FL 036
FL 029
14 09 09 FL 021
BD
FL 014
14 09 38 FL 008
FL 011
14 09 48 FL 005
14 09 51 FL 004
14 10 01 FL 002
14 10 18 FL 000
230°
BDX
BE
14h09'09" (Klaxon, trois coups) Altitude select
09'11" (Klaxon, trois coups et "autopilot") Disconnection du pilote automatique
09'12" (Klaxon, un coup) Changement de fréquence
09'22" RDO 1 · Oui, le, Mérignac approche, Mérignac tour, XX, XX dix neuf deux fois, bonjour
09'27" TWR · XX dix neuf dix neuf rebonjour, rappelez l'Outer Marker, dernière RVR sept cent mètres au seuil, trois cent cinquante mètres au médian, hauteur de la base des nuages cent trente pieds Augmentation régime hélices
09'31" (Klaxon pendant la dernière communication, trois coups) Altitude select
14h09'38" PIL · Là, j'ai un problème de %
09'39" RDO 1 · Reçu XX dix neuf dix neuf
09'42" PIL · J'ai un problème là hein !
09'42" CDB · L'ILS ?
09'43" PIL · Ouais
09'44" CDB · Remets-moi l'ILS chez moi
09'48" PIL · Ça y est, y est ! Difficilement audible
09'50" CDB · O K
09'50" RDO & CAM (Début d'écoute d'O M)
09'54" CDB · Deux cents noeuds, les volets vers quinze, le train sur sortie
09'55" PIL · Les volets vers quinze, le train sort Changement de bruit aérodynamique
14h09'57" CDB · C'est pas les meilleures conditions pour faire un ILS, hein
09'59" PIL · Le deux trente chez toi
10'01" CDB · Le deux trente est chez moi
10'01" RDO & CAM (Fin d'écoute d'O M)
14h10'07" PIL · J'mets le deux trente et le cent quatorze quatre
10'12" CDB · Bon, où est l'axe ?
10'17" CDB · On passe, on passe combien là ?
10'18" CAM (Bruit du crash en fin de la dernière phrase)


AIR FRANCE
APPROCHE INDIRECTE
PAR ou ILS 23
BORDEAUX Mérignac
MERIGNAC APP
118.6- 121.2
TWR 118.3 118.1
ATIS 131.15
121.9
PAR 121.2
PROCEDURE OFFICIELLE «AIR FRANCE»
BD 393
5
10
230°
BE 318
264°
084°
BORDEAUX
VOR DME BDX 114.4
Vi : 240 Kt maxi
111°
291°
2,5 «BDX»
3,1 «BDX»
050°
HMEA 800
230°-BD 110.3 ILS 23
ECHELLE : 1/250.000
NIV. TRANS. ALT. TRANS. 4000
2100
REM. GAZ
6,8 «BDX»
BD
2000 (1839)
1450 (1289)
4000 (3839)
MINIMA AIR FRANCE
REF. QFE 161ft.
PAR
ILS CAT 1
ILS CAT 1 REDUITS
V. 2

Next Page

GPWS Saves Crew Who Flew Localizer Approach Tuned to VOR Frequency

2 4 NOVEMBER 1987

This event is a human factors classic in which well known shortcomings in equipment standardization, equipment design, and procedures came to bear on the crew at a critical time. In the end, the GPWS saved the day, even though the captain required a second warning — 10 seconds after the first activation — to begin his pull up. —Ed.

A flight safety source reports:

24 November 1987,

Last ~~December~~, during a back course localizer approach to runway 33 at Prince George, British Columbia, in IMC, a 737-200 was saved by its GPWS from striking a mountain about 7.5 miles right of the final approach course. The incident was caused in part by confusion over non-standard avionics displays, equipment operating differences in the airline's recently-acquired 737 fleet, and failure to hear ATC warnings after VHF comm volume had been inadvertently turned down during a frequency change.

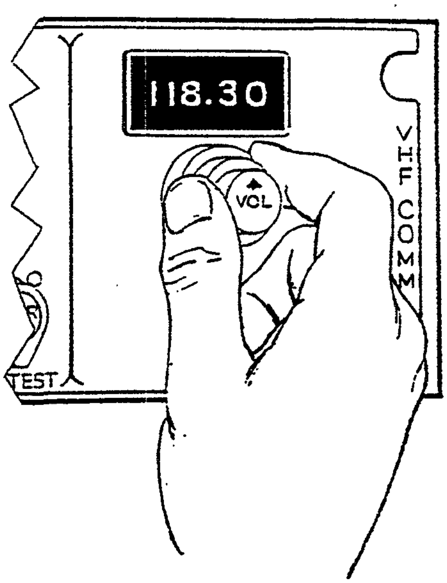
The flight approached Prince George Airport from the south with the captain's VHF nav tuned to the runway 33 localizer back course, and as far as he knew, his HSI course bar indicating flight exactly on centerline. The first officer's VHF nav was tuned to Prince George VOR, 7.5 miles east of the airport, to define Tabor intersection from which the flight could descend below 5000 ft to the final approach fix.

Unknown to the crew, the captain's VHF nav, although properly tuned to the localizer frequency, was actually switched over to the first officer's VHF nav. And rather than flying the localizer back course, he was actually tracking the 327 deg course inbound to Prince George VOR, about 7.5 miles east of the published final approach track. This error may have occurred in part because, on this particular 737, there was no VHF nav cross-over annunciator; other aircraft in the fleet were so equipped.

About this time, approach control handed the flight off to the tower, requiring a frequency change from 133.8 to 118.3 MHz. While switching frequencies, the volume knob, in the center of the frequency control was inadvertently turned down to an inaudible level precluding communications with the tower which was attempting to alert the flight to its off-course situation.

Apparently, no cross check of the Prince George NDB bearing was made by the first officer or the captain.

The captain, thinking that he was established inbound on the final approach course, descended at approximately 1000 ft/min toward 5000 ft MSL, his initial approach altitude until passing Tabor intersection.



While switching frequencies, the volume knob, in the center of the frequency control was inadvertently turned down to an inaudible level precluding communications with the tower which was attempting to alert the flight to its off-course situation.

Mt. George, a 5750 ft cloud-obscured mountain peak, situated on the Prince George VOR 146 deg radial at 16.8 miles, lay directly in the flight's path. Minimum sector altitude southeast of the airport is 7600 ft MSL.

Descending through approximately 6900 ft MSL with gear and flaps up, approximately 6 miles from Mt. George and about 22 DME south of the VOR, in IMC, three GPWS "Terrain-terrain" warnings occurred followed in rapid succession by three "Pull-up" warnings. The captain continued for another 8 seconds whereupon three more "Terrain-terrain" warnings occurred as the flight passed within approximately 800 ft of a 5300 ft peak. At that point the captain pulled up and began a missed approach.

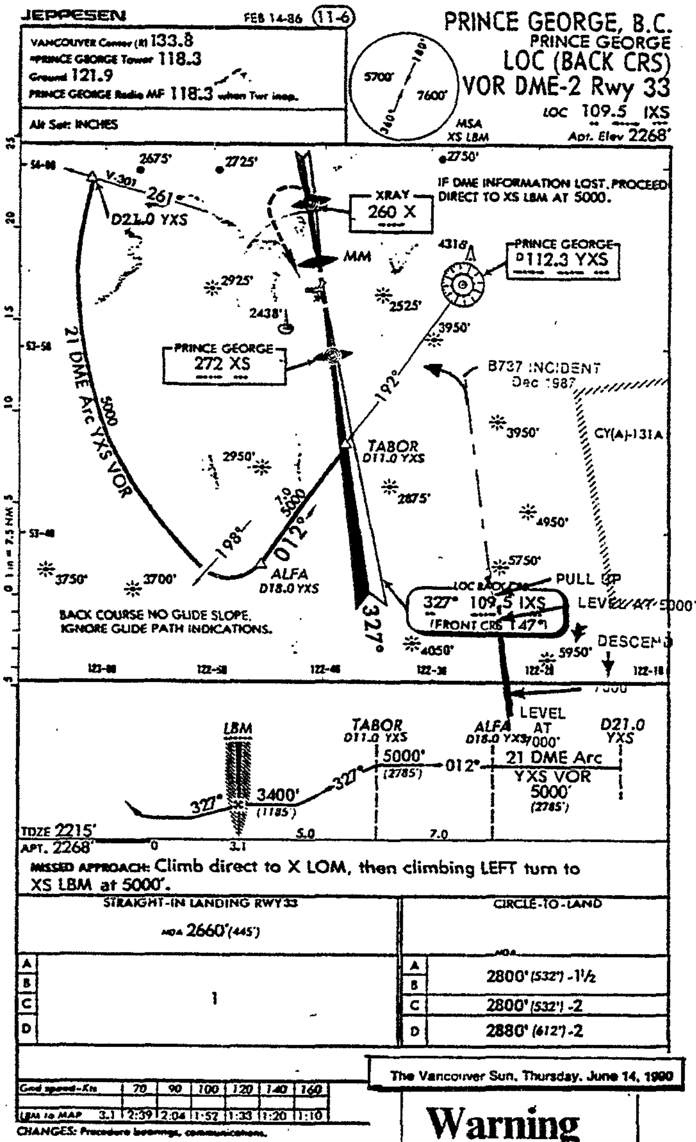
Had the flight continued down to level off at 5000 ft before reaching the mountain, the crew would have heard 3 "Too-low-gear" warnings about 35 seconds from impact and 3 "Pull-up" warnings less than 2 seconds before striking the mountain.

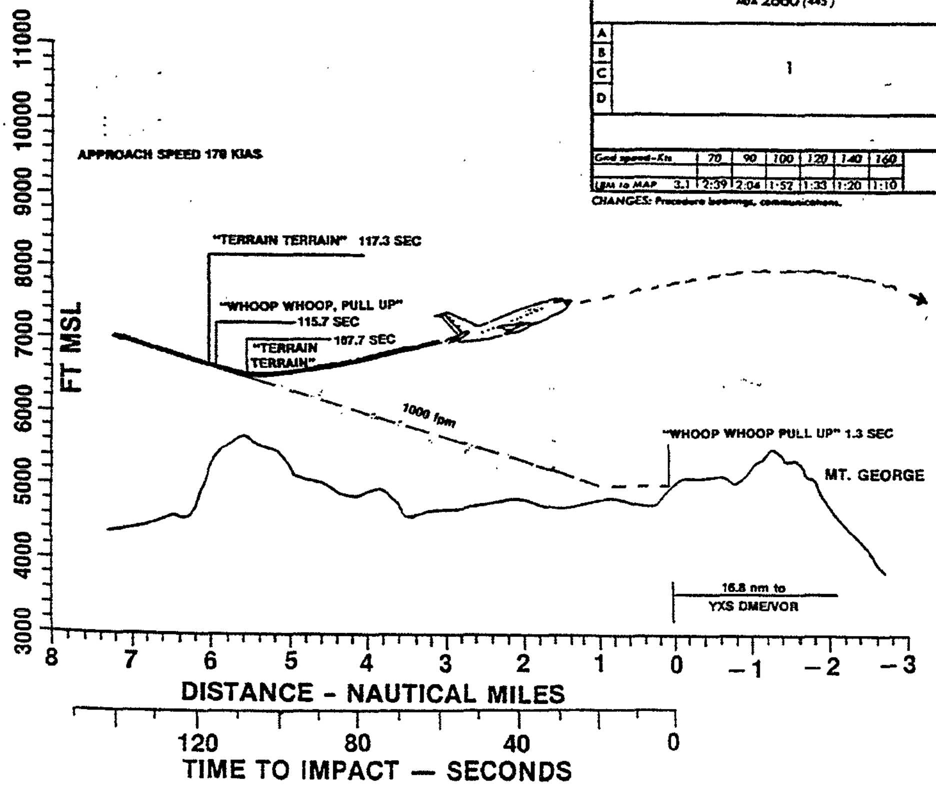
(Continued on page 16)

PAN AM 'FLT OPS'

Right
The 737's track is depicted in blue on the approach chart. Note the 5750 ft peak beneath the 326° course to YXS VOR.

Below
The blue line depicts the 737's pullup profile. Other warnings depicted below the pullup path are the GPWS activations which would have occurred had the flight continued its descent.





The Vancouver Sun, Thursday, June 14, 1990

Warning credited for saving 96

Canadian Press

A device that warns pilots they are too close to the ground may have saved the lives of 96 people aboard a Canadian Airlines plane flying into Prince George in late 1987, the Canadian Accident Investigation and Safety Board said Wednesday.

As the jet flew through clouds during its descent to Prince George, the device's warning horn sounded and the pilots pulled up, the board said in a report released in Ottawa.

However, the report said, the pilots thought it was a fault in the system and resumed their descent. Just as an aircraft traffic controller told them they were off course, the warning horn sounded again.

This time, they discovered their navigation equipment wasn't properly set, said the report, probably because they were unfamiliar with the cockpit instrument layout and weren't properly trained.

The board's investigation says the warning system may well have saved the lives of those on board that day — such systems weren't mandatory at the time, although they are now.

The board has also recommended airlines work toward standardizing their aircraft cockpits. It said Canadian Airlines has 66 Boeing 737s with at least 10 different cockpit arrangements.

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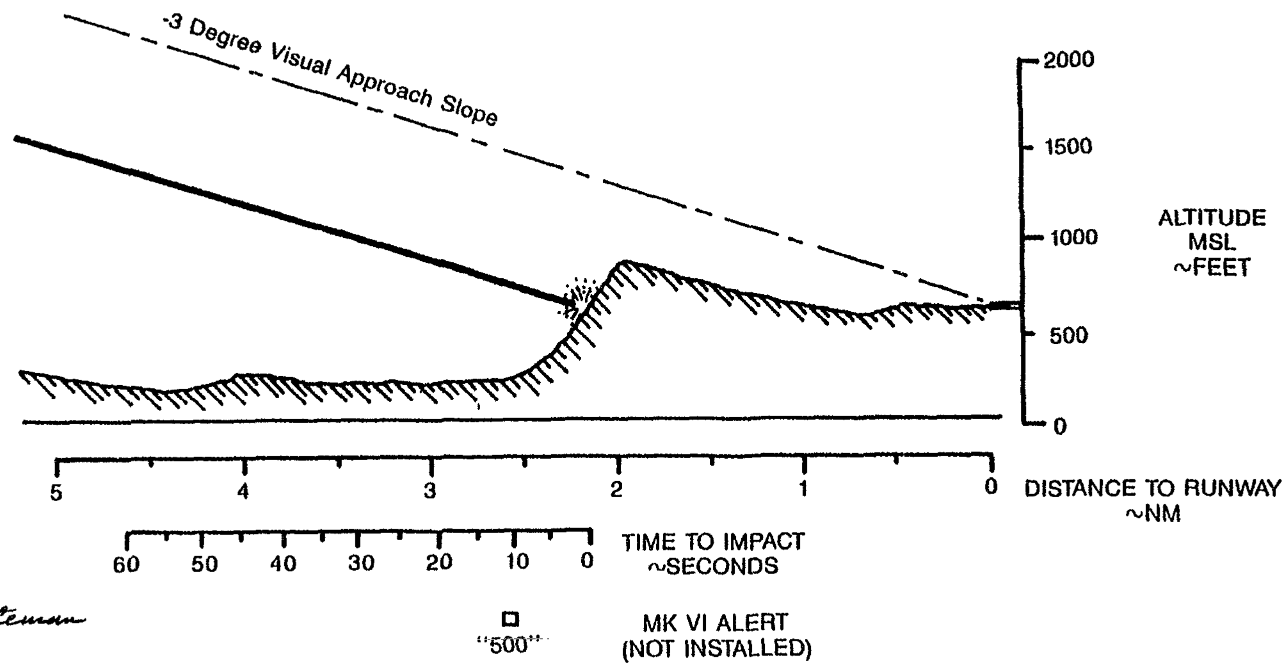
FLIGHT PATH PROFILE
Be-200
Leeds/Bradford, England
19 October, 1987

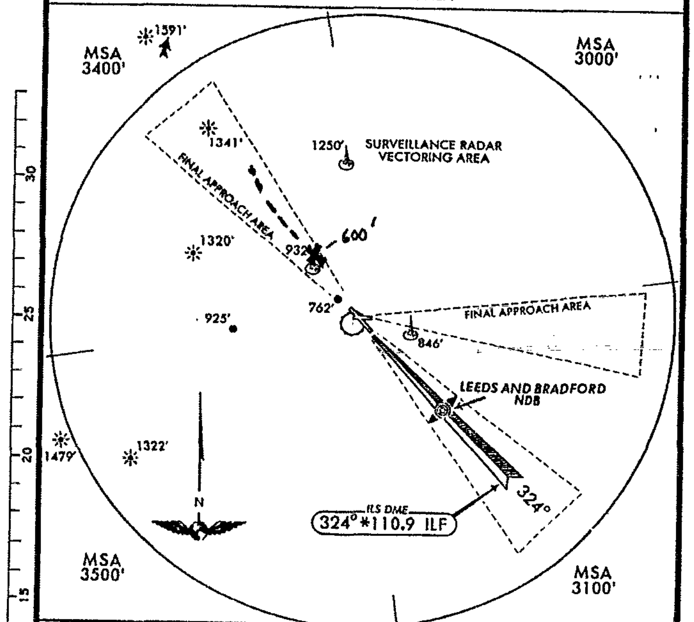
Circumstances:	During approach to runway 14, aircraft hit short by 2 NM. Apparently pilot had incorrectly set his altimeter for QFE, using 998 instead of 1008. (F)
Fatalities:	1



Don Bateman

LEEDS AND BRADFORD, U.K.
LEEDS AND BRADFORD

RADAR VECTORING AREA



Within the Radar Vectoring Area 3000' is the minimum initial altitude to be allocated by the Radar Controller. Descent below 3000' may be given on base leg to 2500'. Subsequent descent may be given within the Surveillance Radar final approach area when on 40° leg or final approach.

LOSS OF COMMUNICATION PROCEDURE

PROCEDURE	ON DOWNWIND	ON BASE LEG or 40° LEG	WITHIN FINAL APPROACH AREA
Rwy 14	Continue approach visually or proceed to NDB at 3000' or last assigned level if higher.	Continue approach visually or proceed to NDB at 3000'.	Continue approach visually or climb ahead to NDB at 3000'.
Rwy 28	Continue approach visually or proceed to NDB at 3000' or last assigned level if higher.	Continue approach visually or proceed to NDB at 3000'.	Continue approach visually or climb to overhead the airport and, at not below 1700', turn LEFT and proceed to NDB at 3000'.
Rwy 32	Continue approach visually or proceed to NDB at 3000' or last assigned level if higher.	Continue approach visually or by using the alternative aid. If not possible proceed to NDB at 3000'.	Continue approach visually or by using the alternative aid. If not possible climb to overhead the airport and, at not below 1700', turn RIGHT and proceed to NDB at 3000'.

Configuration Warning Horn disabled. Reason for circuit breaker pulled not explained (Aircraft may have taken off with horn disabled). Tower visually detected situation.

INCIDENT

B747-100
London, Heathrow
July 1987

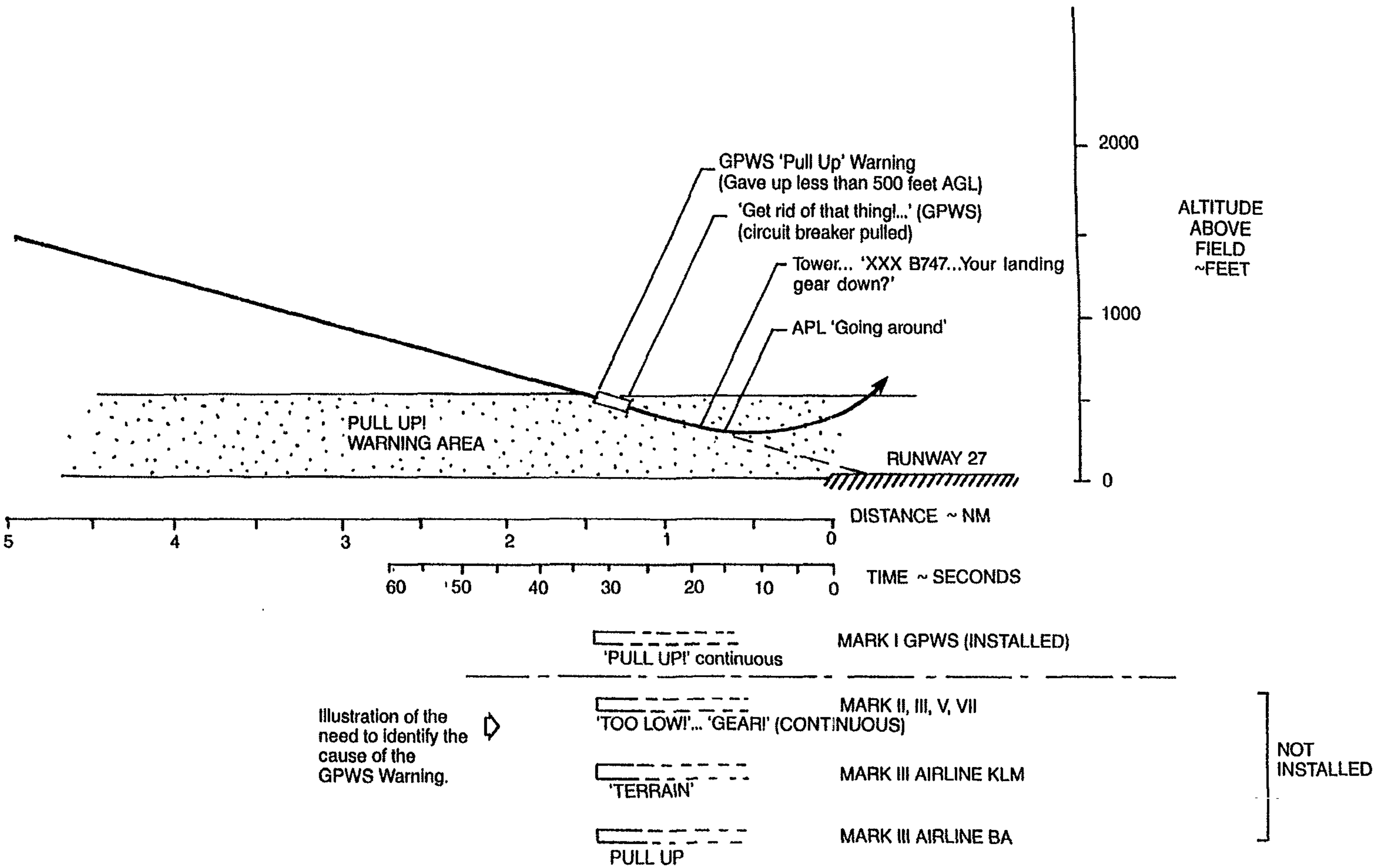


TABLE 1 - Some Air Carrier Inadvertent Wheels Up Landings:

Date	Type	Place	Approximate Damage	Type of Flight
4 Feb '86	B747	Islamabad	$15 million USD	Scheduled Pass.
7 Feb '85	B737	Calcutta	$ 2 million USD	Scheduled Pass.
3 Jan '83	B737	Berlin	$ 1 million USD	Training Partial Flaps
11 Mar '83	B737	Casper, Wyo	$1 1/2 million USD	Scheduled Pass.
7 Nov '82	DHC-5	U.S.A.	$0.1 million USD	Training
9 Aug '82	B727	Mexico	$ 2 million USD	Training - Partial Flaps
24 Aug '78	B737	Buenos Aires	$ 7 million USD (destroyed)	Scheduled
4 Apr '78	BAC-1-11	England	$ 3/4 million USD	Training - Partial Flaps

Recent Incidents (Did not land wheels up)

5 Jul '87	B737	Cincinnati	- Visual Approach -	Gear handle not fully down-MK I 'Pull Up', assumed false C/B pulled --- Configuration warning C/B pulled after taxiing single engine-Tower alerted crew of 'gear not down'.
Jul '87	B747	Heathrow	ILS Approach	Tower called 'gear not down' MK I GPWS - 'Pull Up' GPWS considered false and C/B pulled.

All of the above were equipped with MK I GPWS and all gave 'Pull Up' warnings. All had the Configuration Warning System disabled for various reasons. However, in each case the flight path and its relationship to the runway appeared normal. The flight crew believed the 'Pull Up' warning to be false, and they disabled the GPWS and proceeded with full intentions to land.

In second generation GPWS models (MKII, III, V and VII) specific unique messages are given for the cause of the alert or warning much like 'Glideslope'. These messages also vary by phase of flight. If the gear is inadvertently left up on final approach, instead of 'Pull Up!", a "Too Low-Gear" message is given. There has never been a reported wheels up incident for aircraft fitted with a MKII, et al.

Note: This author knows of no DC-9 series aircraft involved in an inadvertent wheels up or near wheels up incident. Apparently the DC-9 configuration warning system has performed as designed.

This author believes the difference between the DC-9 and the B737 is in the throttle handle switches. In the DC-9 both throttle handles must be advanced to arm the configuration warning horn. The B737 requires only one handle to be advanced. For single engine taxiing, the DC-9 configuration warning horn is silent, while the B737 will often sound. It appears that the B737 configuration warning horn is often deliberately disabled by the crew, and that is why there was no configuration warning for gear up on final approach. The implication is that the configuration warning was disabled at take-off, and that some number of B737 aircraft have probably taken off with no flaps. For the MD-80, the design engineers went to a throttle switch arrangement similar to the B737. Whether this was a factor at the fatal MD-80 Detroit accident or not, is one of conjecture.

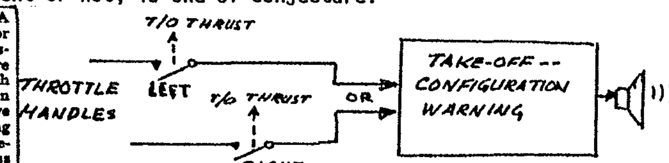
AD for Take-off Warning. FAA issued an Airworthiness Directive for certain Boeing 727 and 737 transports requiring EPR (engine pressure ratio) information for the logic which enables the Takeoff Configuration Warning System. The new directive will reduce nuisance warnings during taxi when flaps are intentionally retracted, or while taxiing with less than all engines operating (now considered normal). Such nuisance warnings frequently cause the crew to deactivate the system, which could endanger the takeoff.

Some airlines protested the rule, saying this is a pilot training and discipline problem, but FAA argued that nuisance warnings reduce the function of aircraft systems to an unsafe level.

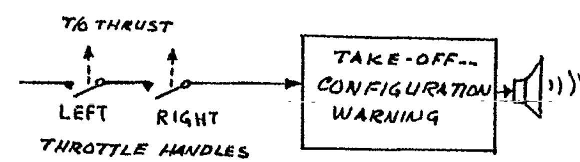
In the original warning system, the input depended on throttle position. The enhanced version will add EPR to the logic, triggering the alarm if 1.4 is exceeded.

Some commenters pointed out that nuisance warnings could still occur, and FAA agreed that an EPR of 1.4 is high thrust setting, equal to thrust at brake release on takeoff, but added that this would not normally be attained during taxi. The agency said it would reduce nuisance warnings to an acceptable level. For more information, contact Boeing in Seattle or FAA at 206/431-1938.

Avionics
March '90



B737/MD-80



DC-9

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Flight Path Profile

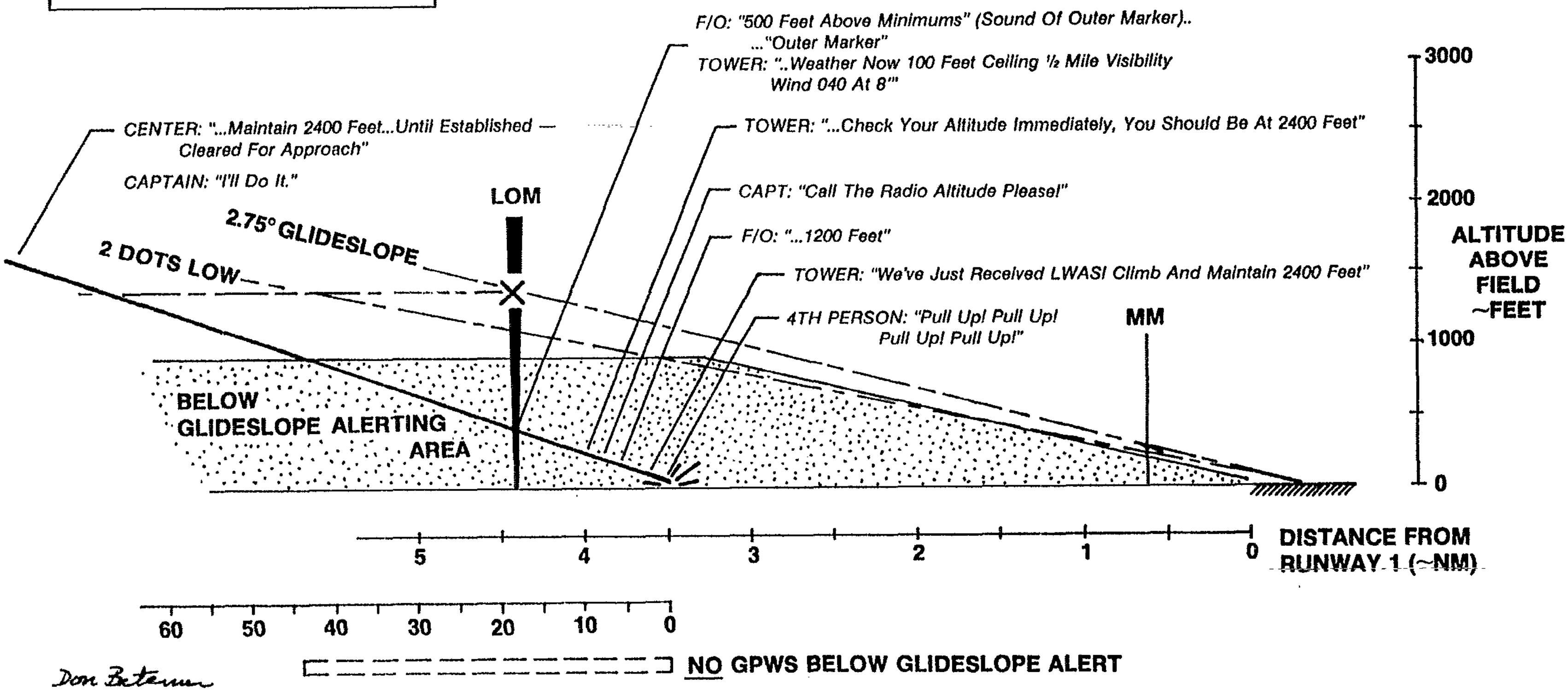
B-707

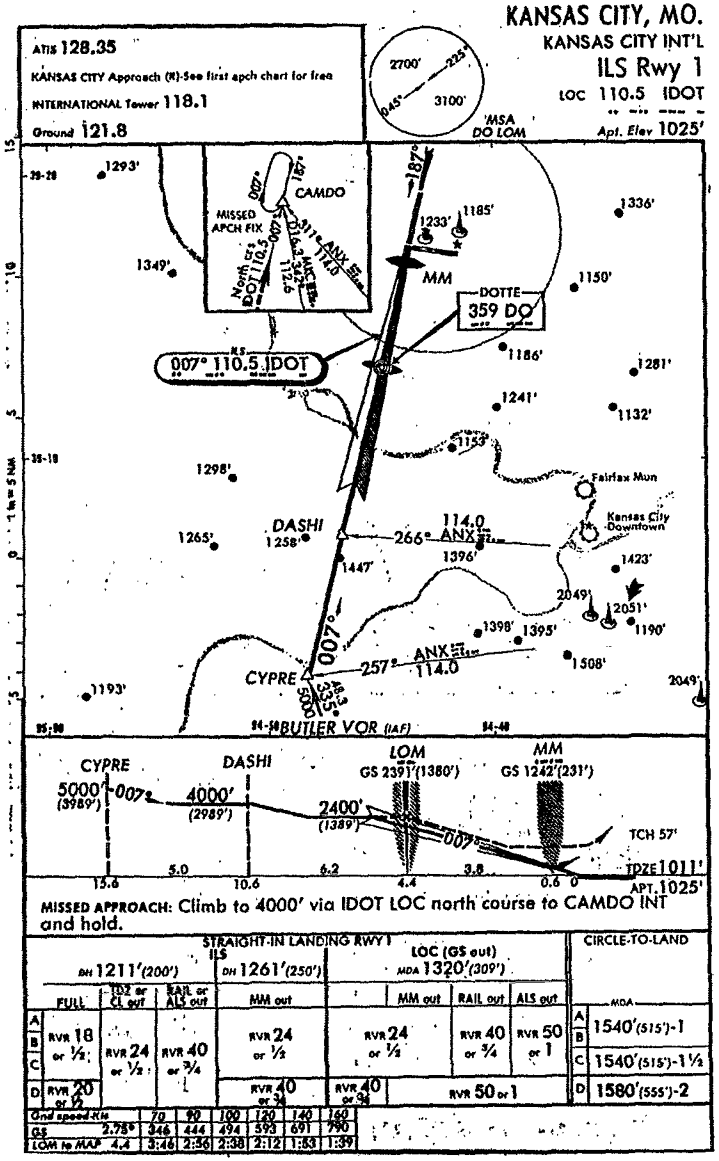
KANSAS CITY, MISSOURI

13 April, 1987

Circumstances:	Aircraft hits short on ILS approach to Runway 1
Configuration:	Landing
Weather:	100' ceiling, ½ mile visibility (rain/fog), 040/8 Thundershowers
Time:	Night
Fatalities:	4

Possible Contributing Causes:
1) Failure to couple Flight Director to glideslope
2) Failed radio altimeter
3) Faulty glideslope receiver
4) Faulty GPWS





Boeing-707 Cargo Jet Crashes, Killing Three

KANSAS CITY, Mo., April 13 (AP) — A Boeing-707 cargo jet crashed in light fog tonight as it was preparing to land at Kansas City International Airport, killing three people aboard the plane, the authorities said.

The plane, registered to Burlington Air Express, formerly known as Burlington Northern Air Freight, crashed in a field near the airport, which is about 20 miles north of Downtown Kansas City, said Ron Cop, regional duty officer of the Federal Aviation Administration.

It was the first large plane to crash at the airport since it opened in 1972.

A Burlington official in Wichita, Kan., who would not give his name, said the flight originated in Oklahoma City.

The crash occurred about 10 P.M. Visibility at the time was about one-half mile.

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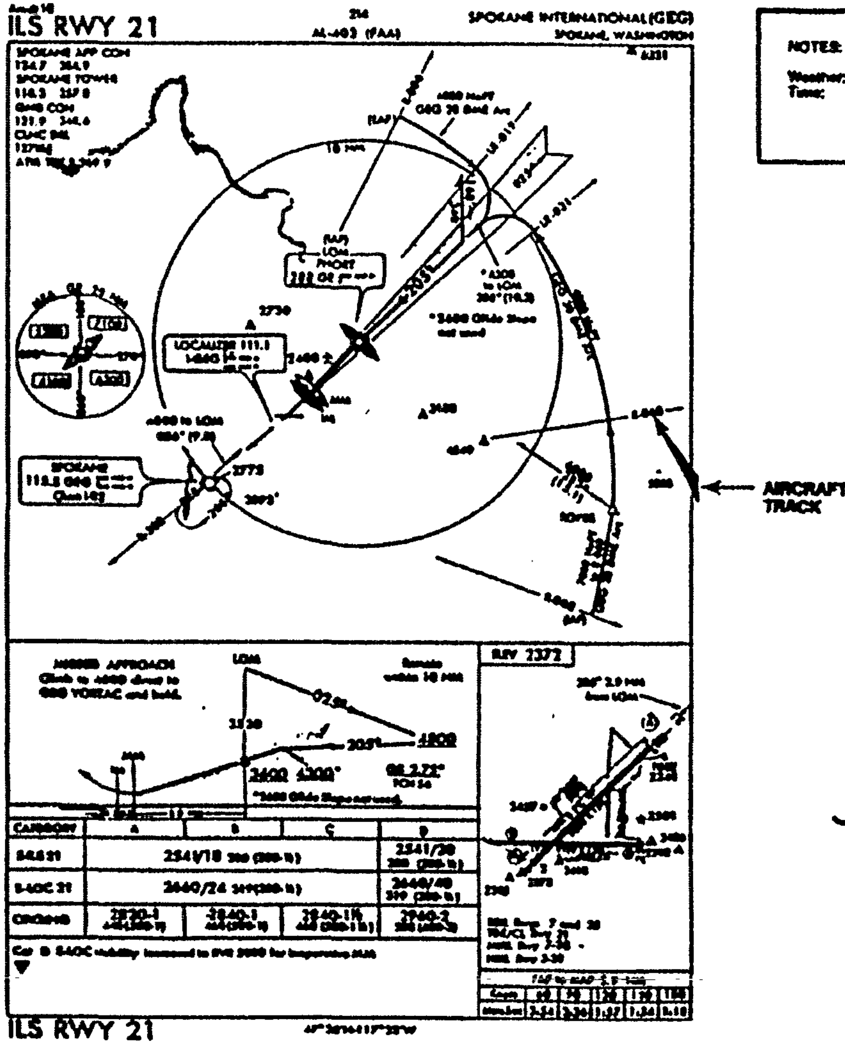
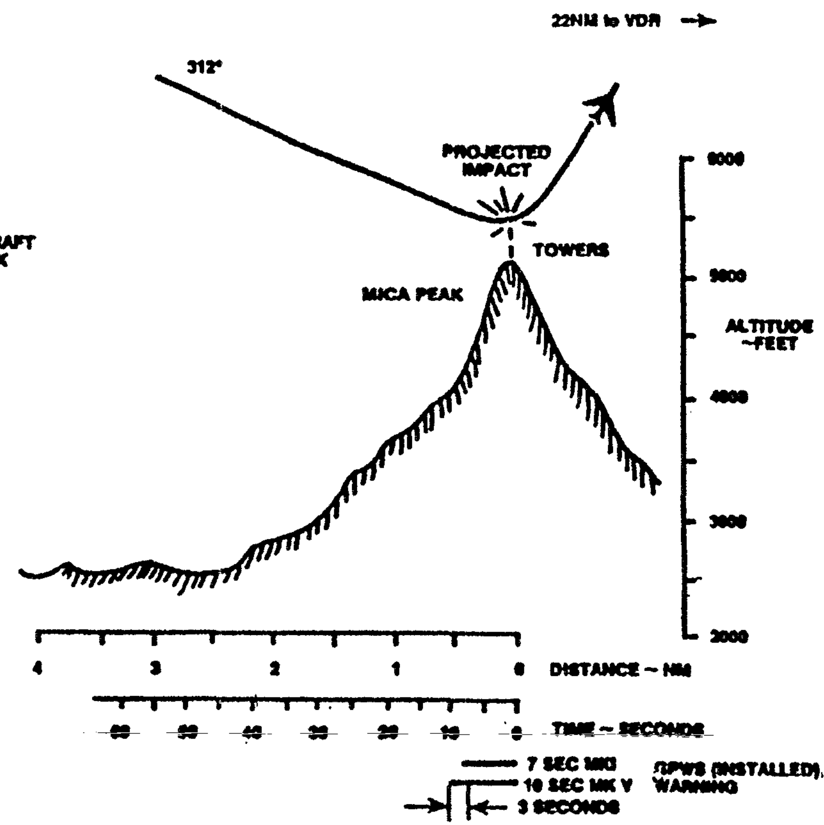
Flight Path Profile

B-727-200
SPOKANE, WASHINGTON
14 DECEMBER, 1986



NOTES: Premature descent clearance while on vector to ILS Runway 21
Weather: IMC
Time: 15.50 Local

Controller error
MKI installed and working



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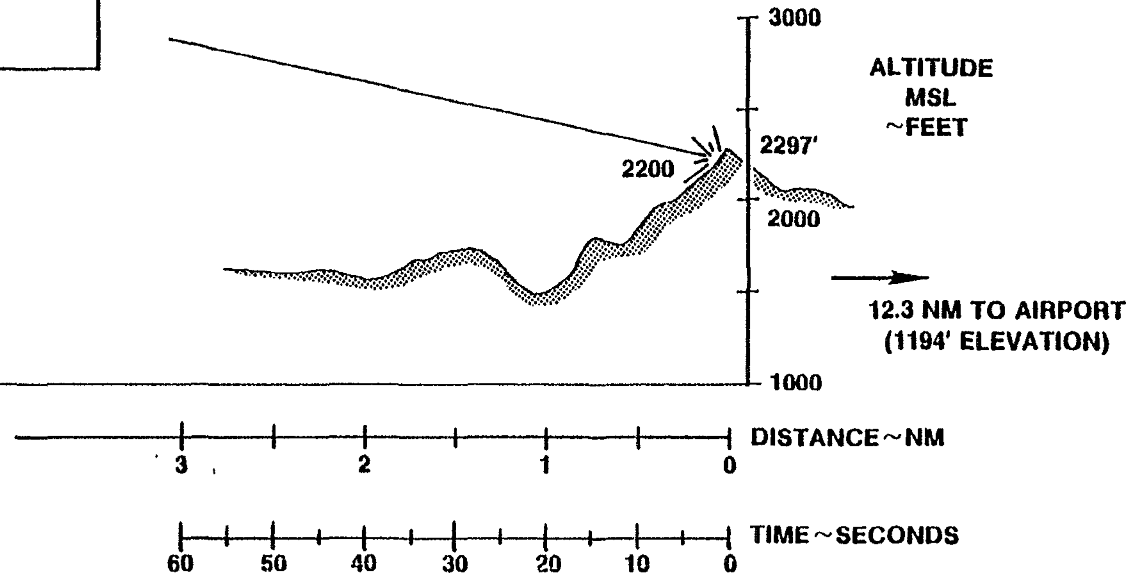
Flight Path Profile

BE-100
PITTSFIELD, MASS.
10 December, 1986

Circumstances:	During an approach LOC runway 26, the aircraft struck a mountain 12.3 NM short of runway.
Configuration:	Clean
Weather:	⊕ 800 feet
Time:	0930 EST
Fatalities:	6



6 Die in Plane Crash in Berkshires

WINDSOR, Mass., Dec. 10 (UPI) — A twin-engine plane from the Middle West with six people aboard crashed into the side of a low mountain and burst into flame today, killing all those aboard, officials said.

Officials of the Federal Aviation Administration said the plane, bound for Pittsfield Airport, crashed shortly after 9:30 A.M. in a rugged, heavily wooded area of the Berkshire Mountains. The identities of the victims were not immediately released.

The accident occurred in overcast conditions with an 800 foot cloud ceiling and visibility at about seven miles, the agency said.

A witness said the plane all but disintegrated upon impact. All that remained of it was its tail section, with a blackened outline burned into the mountainside, according to the witness, Don Carlson, *an employee of* Lyon Aviation. He had flown out to find the plane when it failed to arrive at the airport on schedule.

He said that from the air it appeared that flames had consumed the entire craft except the vertical stabilizer.

The crash site was in the extreme northwestern corner of the state, about 12 to 15 miles from the New York and Vermont borders and about eight miles northeast of the airport, the F.A.A. said.

Spokesmen for the agency said the turboprop jet was registered to the Teledyne Corporation of Los Angeles. They said the flight originated at Palwaukee Airport outside Des Plaines, Ill., at about 6 A.M. with two pilots and three passengers aboard, and picked up another passenger at Lorain, Ohio, before continuing on toward Pittsfield. The passengers, all men, were employees of Teledyne Post Inc., the spokesmen said.

"The aircraft was making an instrument approach into Pittsfield and for some reason it looked like he just nosed right into a mountain," Mr. Carlson said. "We don't know why."

"The clouds may have obscured the mountain," Mr. Carlson continued, "but he was on an instrument approach and if he was doing everything right he should have cleared it."

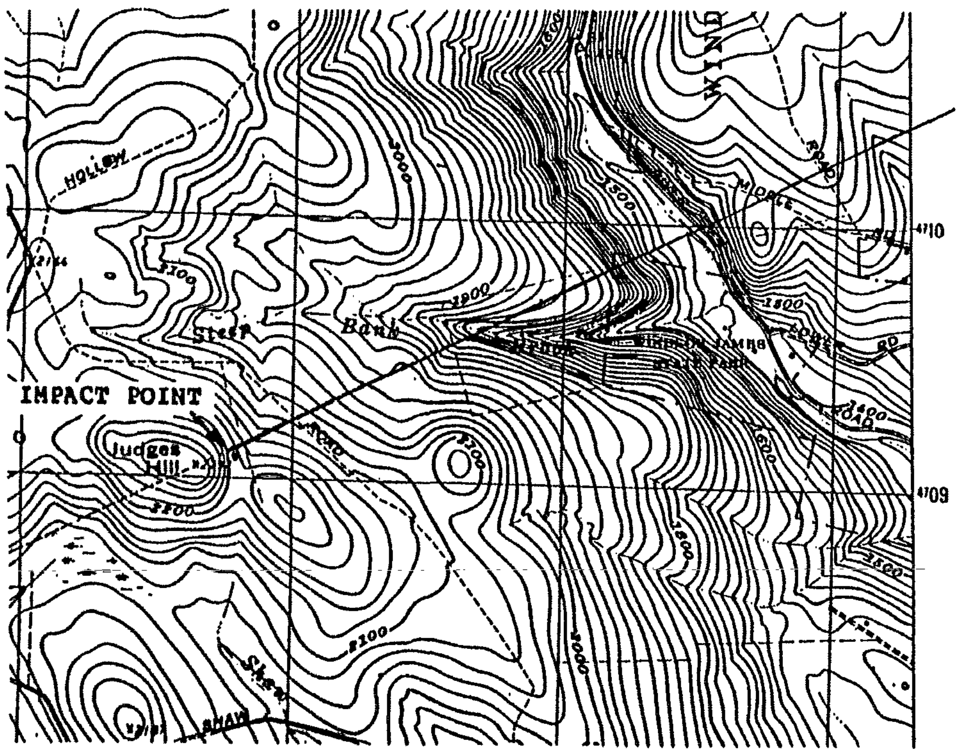
Return to TOC

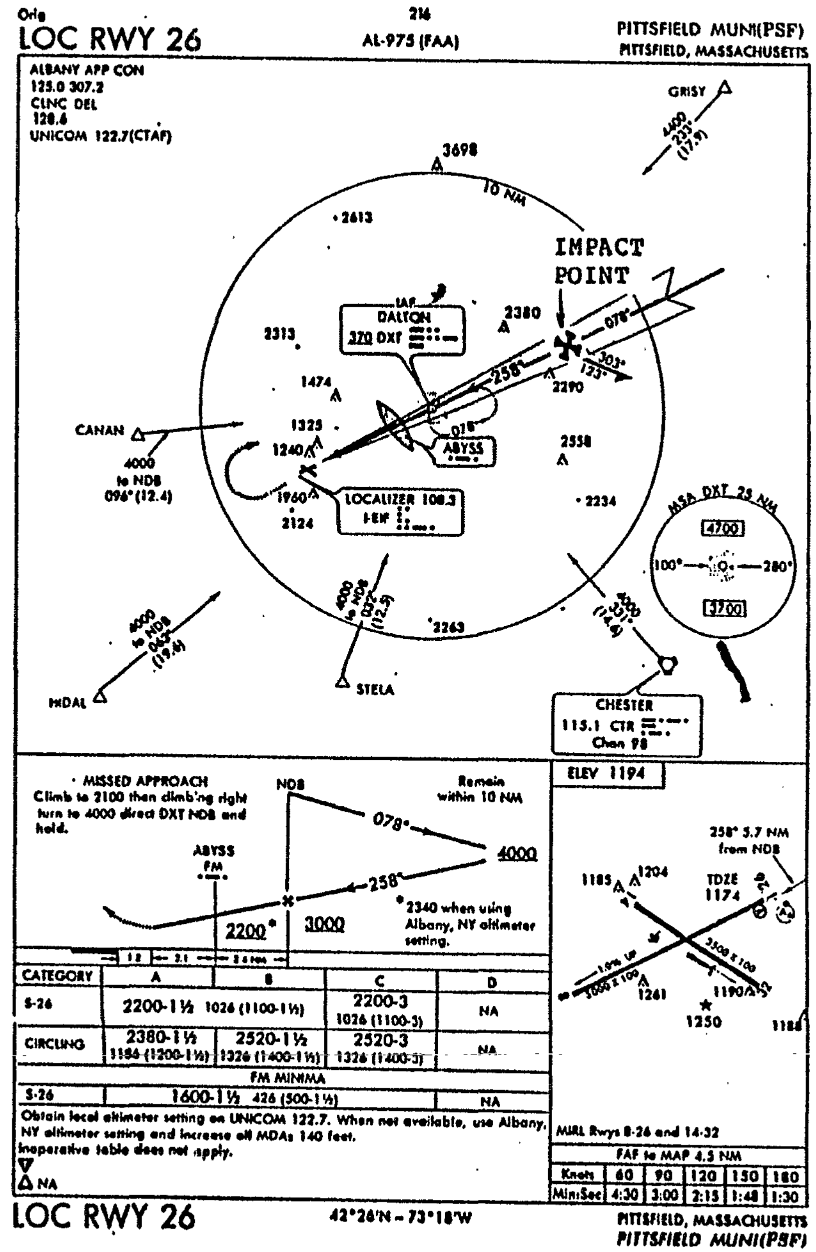
FLIGHT PATH PROFILE
CFIT ACCIDENT
CORPORATE AIRCRAFT
BE-100, KING AIR
PITTSFIELD, MASSACHUSETTS
10 DECEMBER 1986

Conditions: The King Air was on an IFR flight plan and was cleared by Albany approach control for a localizer approach to Pittsfield's RWY 26. The aircraft hit Judges Hill near Windsor at an elevation of 2200 ft, 297 feet below the crest, at a distance of 12.3 nm east of RWY 26.
Gear and flaps were up.

Weather: Overcast with a ceiling of 800 ft.
Time 09:30 EST

Fatalities: 6





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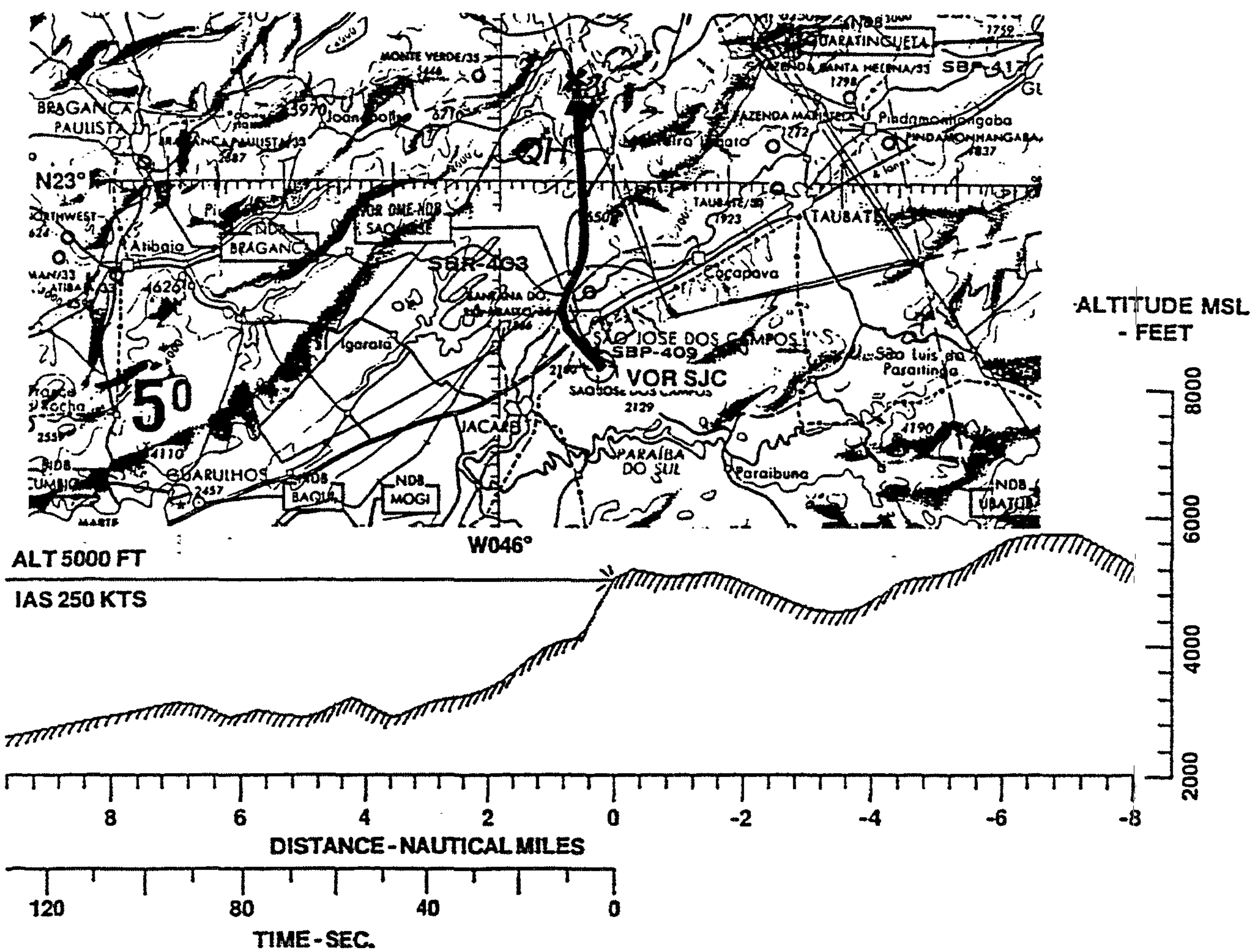
FLIGHT PATH PROFILE

EMBRAER BRASILIA
ATLANTIC SOUTHEAST AIRLINES
SAO JOSE DOS CAMPOS, BRAZIL
19 SEPTEMBER 1986

Conditions:	Hit 5150 ft. mountain at 5000 ft. after take-off on radial 11.7 deg. SJC
Weather:	4,000 ft. overcast 15,000 ft. cloud tops
Time:	3:05 PM
Fatalities:	5



"TOO LOW TERRAIN"(4 TIMES) 12.6 ▬
"TERRAIN - TERRAIN" (2 TIMES) 6.0 ▪
"PULL UP! PULL UP" (2 TIMES) 4.6 ▪

{ PREDICTED MK II GPWS WARNINGS (NOT INSTALLED)

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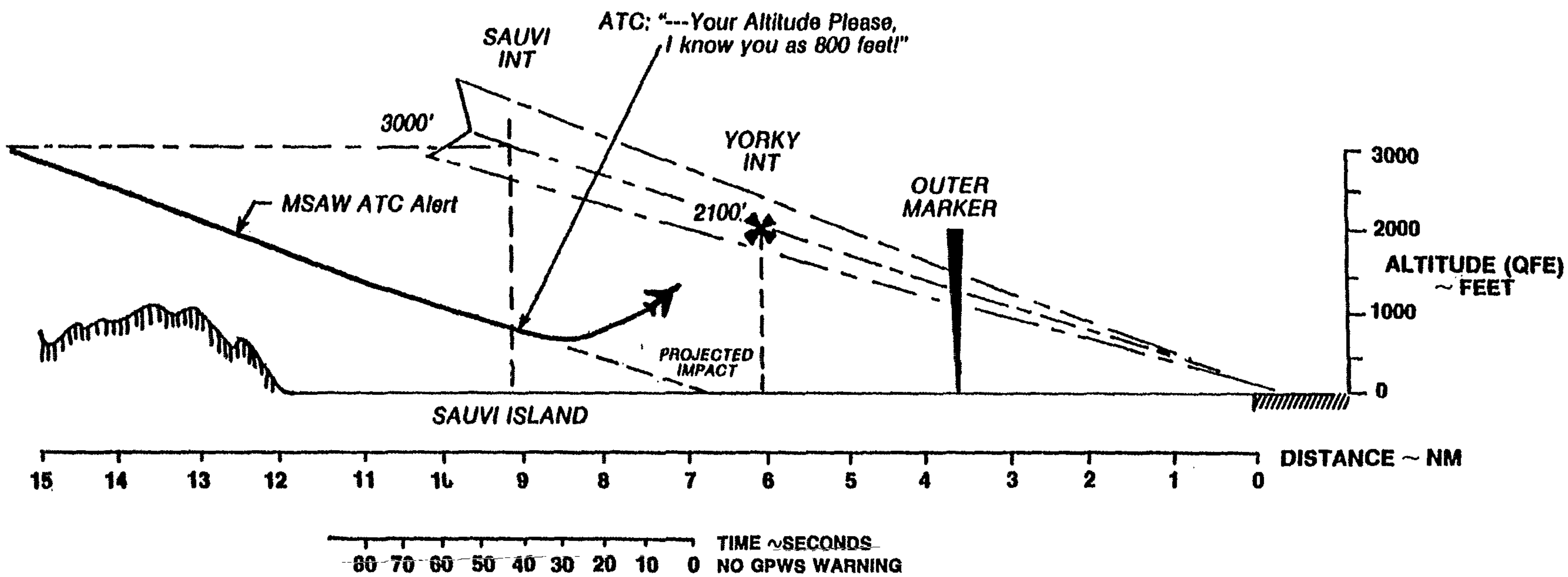
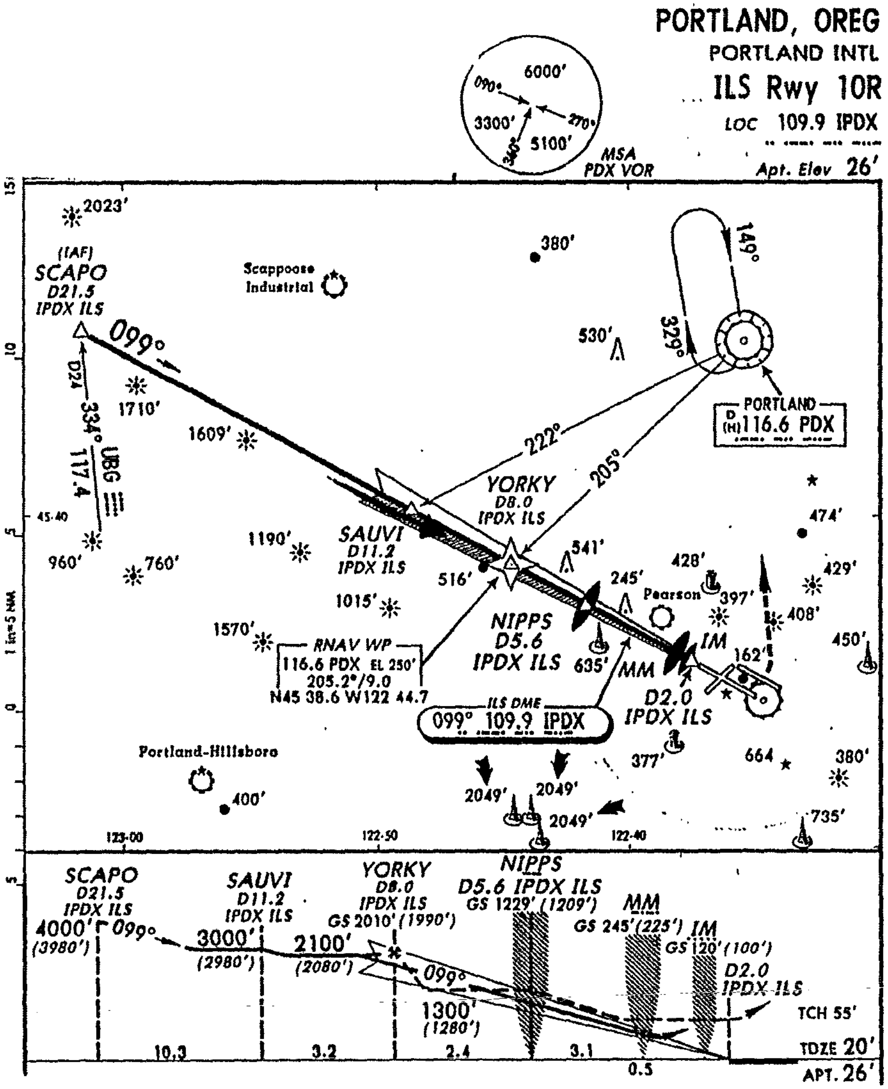
DC-10 INCIDENT
ILS RUNWAY 10R
PORTLAND, OREGON
28 JUNE, 1986

Circumstances: Captain monitoring 'PDX' VOR (no ILS to Captain's ADI and GPWS) F/O flying Flight Director in vertical speed mode. Aircraft cleared for final approach. IMC conditions. Controller received MSAW alert. No GPWS warning as no ILS signal and aircraft in landing configuration and stabilized.



[Return to TOC](#)



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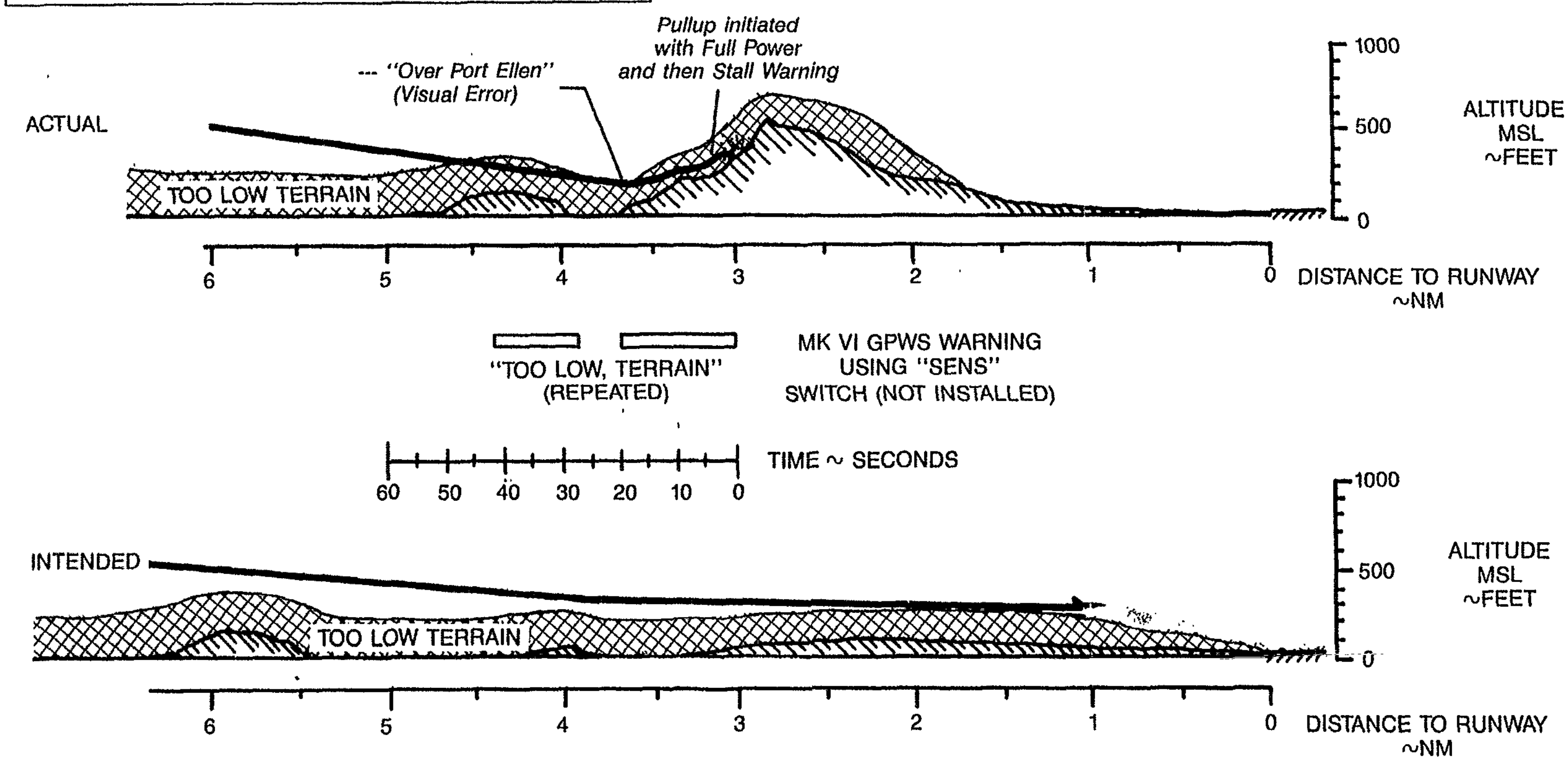
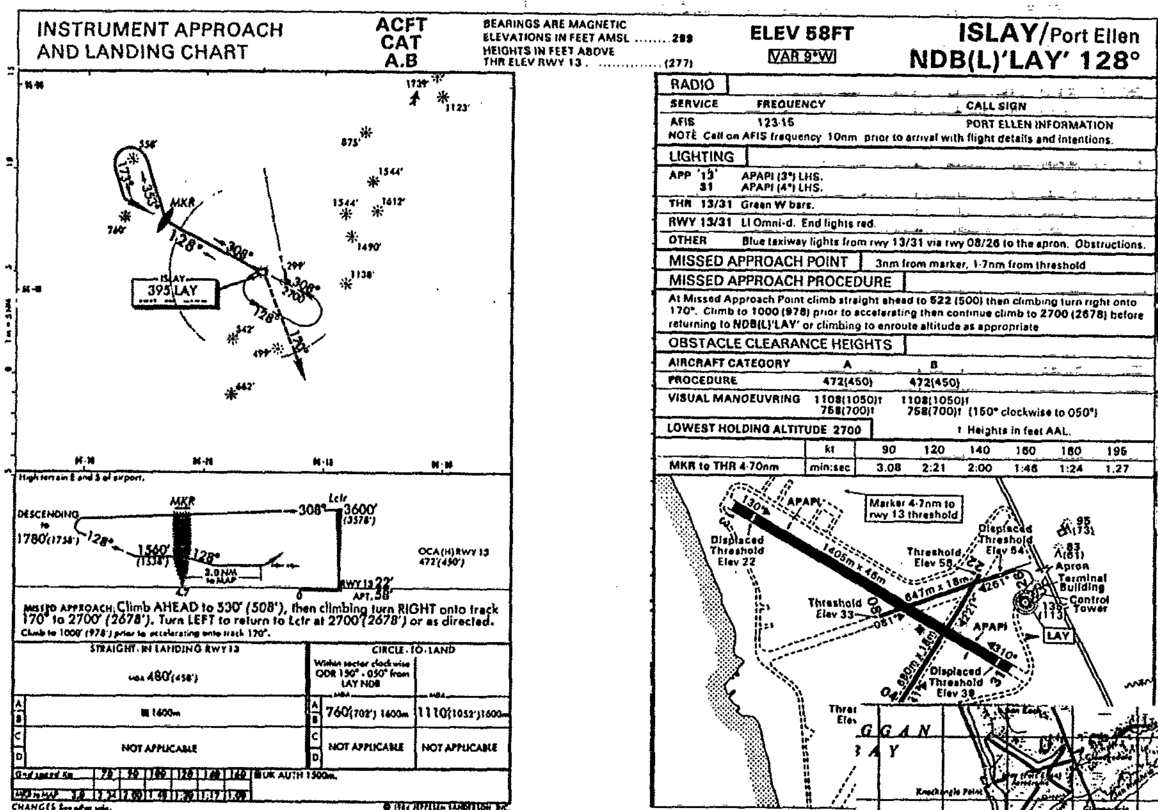
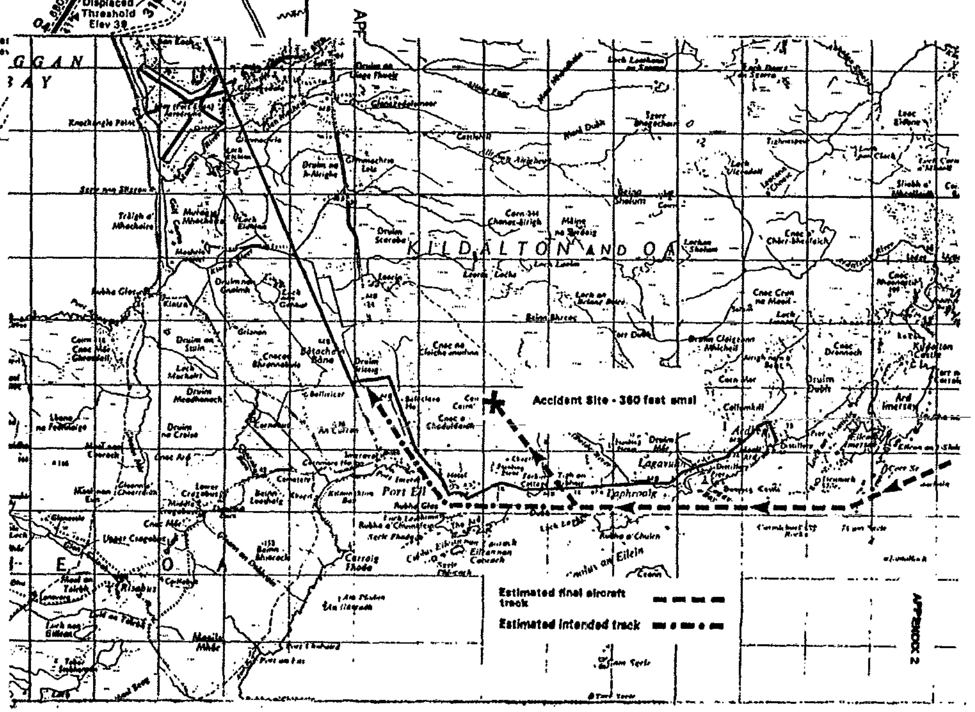
FLIGHT PATH PROFILE
DHC-6
Port Ellen, Islay, Scotland
12 June, 1986

Circumstances: Attempted visual approach into unsuitable metrological conditions after making an error in visual position.
Weather: S to SW 5-10 kts 11°C
2000′ -230° True 20 kts
5 to 70 kts stratus base 500-800′
Local 300′ in patches covering high ground.
Visibility 5 KM-2 KM
200 m in hill fog.
Rain—Drizzle
Configuration: 11 degrees flap
Fatalities: 1 of 15 on board 11 serious injuries



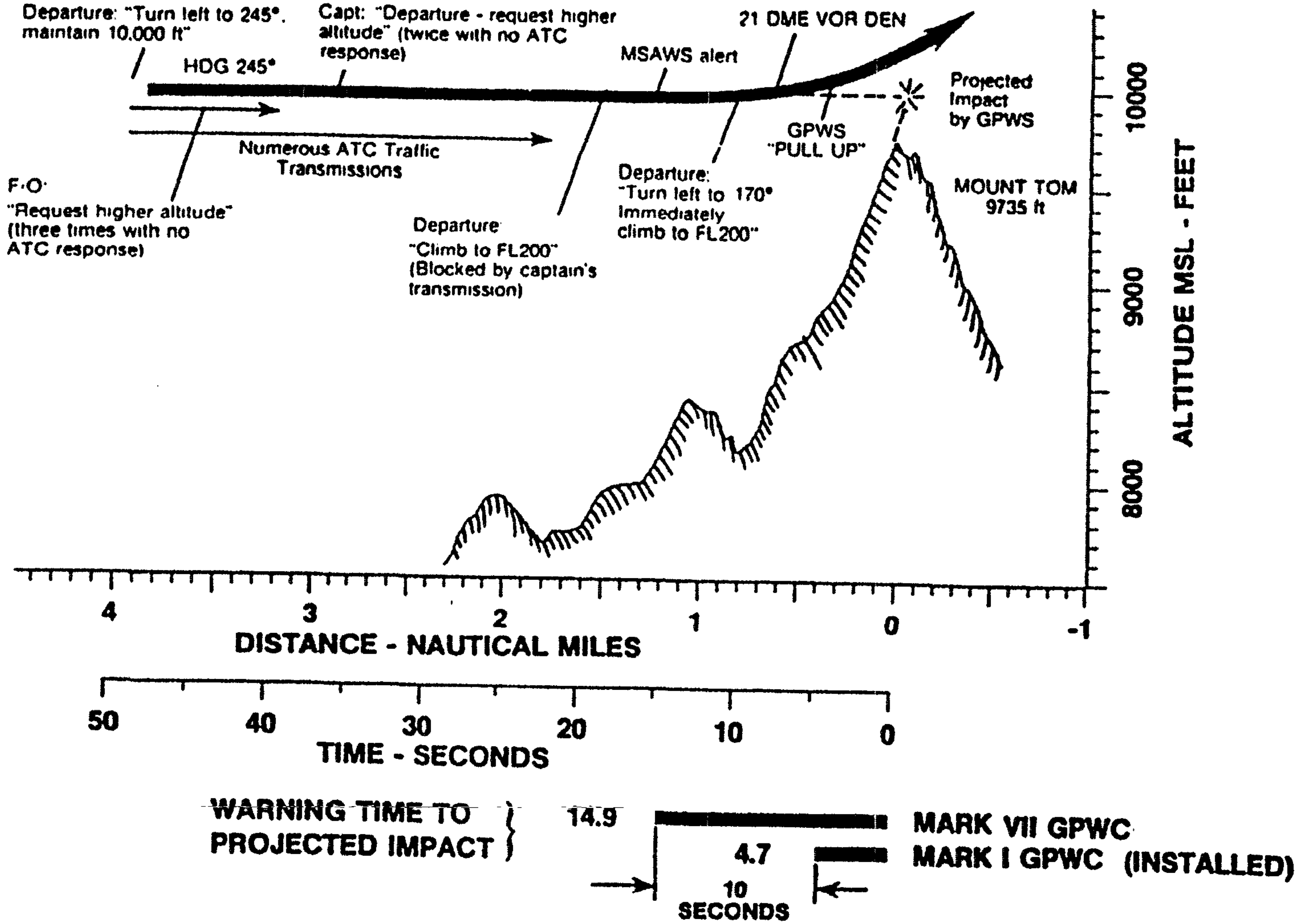


The Accident Site



FLIGHT PATH PROFILE

B-727 INCIDENT
DENVER, COLORADO
16 MAY 1986



Return to TOC

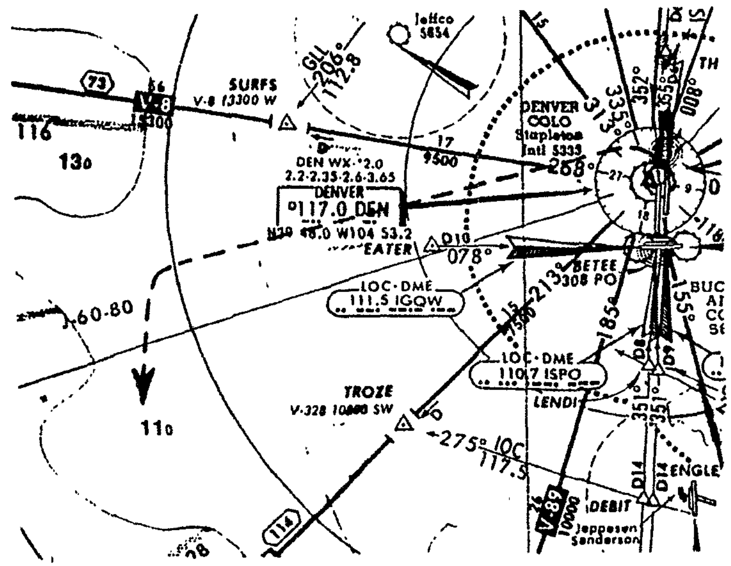
GPWS PULL-UP WEST OF DENVER...
An Unassertive Crew Heads for the Hills

Another airline reports:

Last May, a 737 flew directly at steeply rising terrain west of Denver, causing a GPWS activation and subsequent pull-up when the controller forgot about the flight; and the crew, unable to communicate with ATC because of frequency congestion, waited too long to take evasive action.

The flight departed Denver to the north with a clearance to 10,000 ft and a left turn to 245 deg. At 15 DME, the captain told the first officer to ask for a higher altitude. The first officer called departure control three times but frequency congestion prevented a response. At 20 DME, the captain called Denver for a higher altitude with no response. About that time, the controller's minimum safe altitude warning (MSAW) apparently activated. At 21 DME, Denver departure control instructed the flight to climb immediately to FL200 for terrain clearance and to turn left to 170 deg. and, near simultaneously, the Mark I GPWS activated once. The climb was accomplished at approximately 15 deg pitch up with go-around thrust, resulting in a vertical speed of 5000 to 6000 ft/min. According to reports, passengers were not aware of the event.

According to the airline, following the incident, the controller was decertified for additional training, the FAA reevaluated the west SID with a view toward pilot-initiated climbs during westerly departures and the captain's use of emergency authority was reemphasized to all crewmembers. □



FROM: "FLIGHT OPS"
AUG-SEPT '86

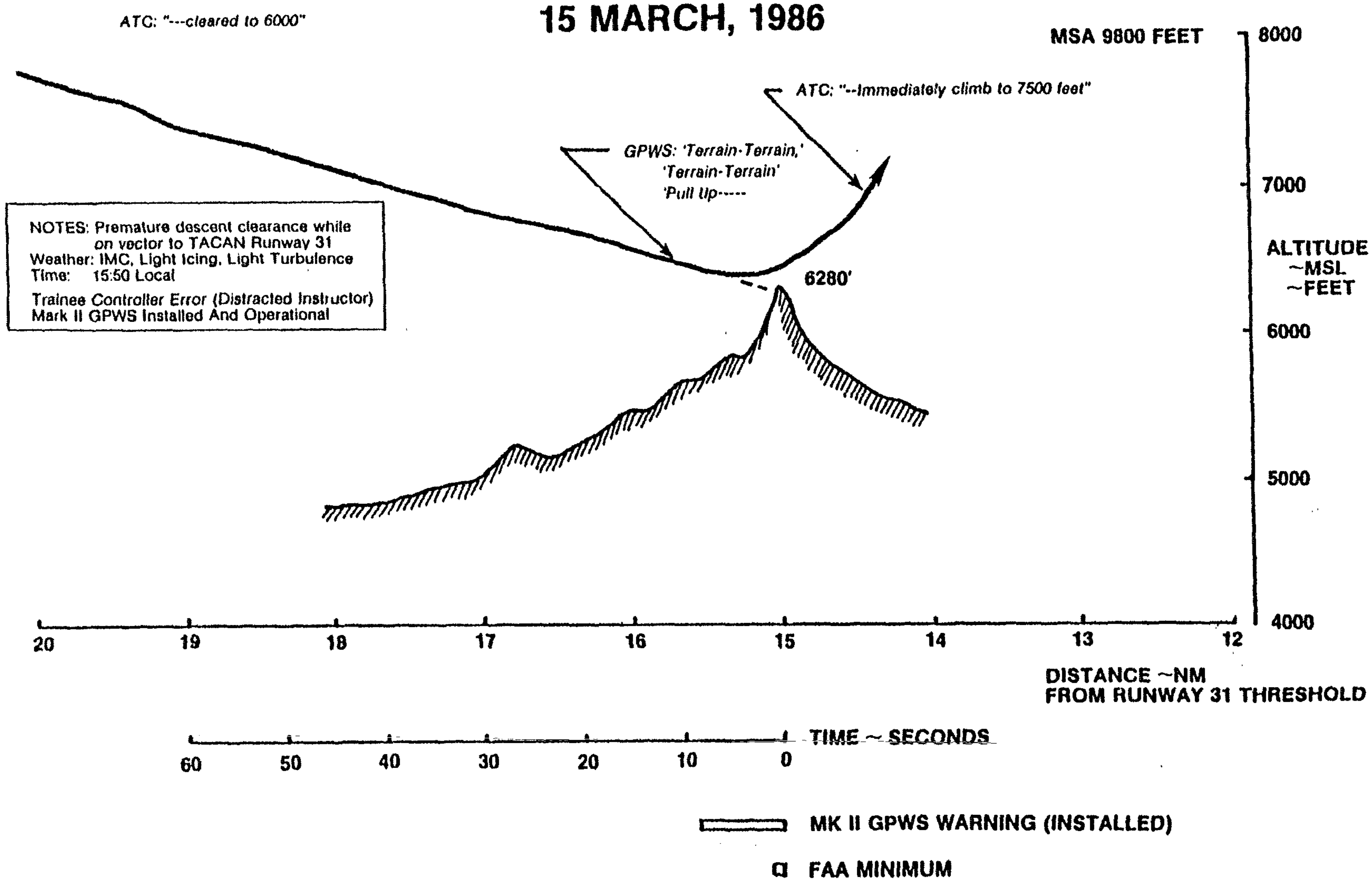
Next Page

Flight Path Profile

U.S. Navy C9B

FALLON, NEVADA

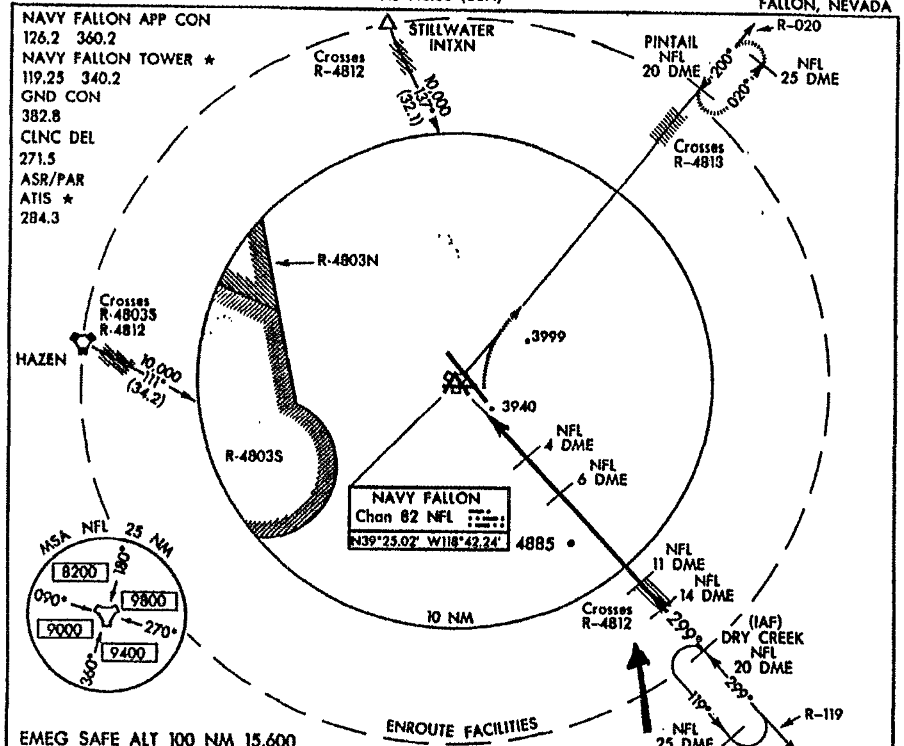
15 MARCH, 1986



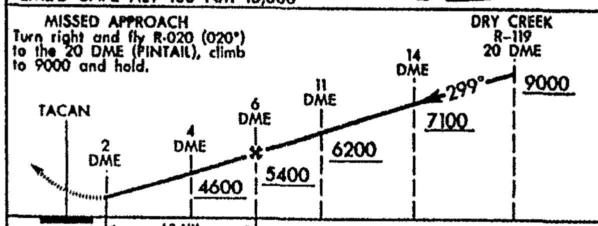
Return to TOC

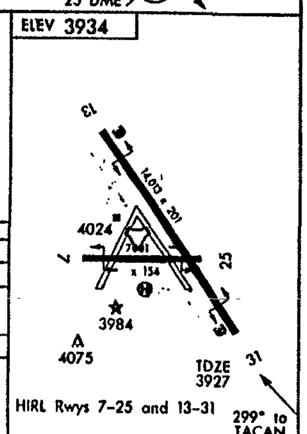
TACAN 1 RWY 31

AL-143.03 (USN) FALLON NAS (VAN VOORHIS FIELD) (NFL)
FALLON, NEVADA



MISSED APPROACH
Turn right and fly R-020 (020°) to the 20 DME (PINTAIL), climb to 9000 and hold.





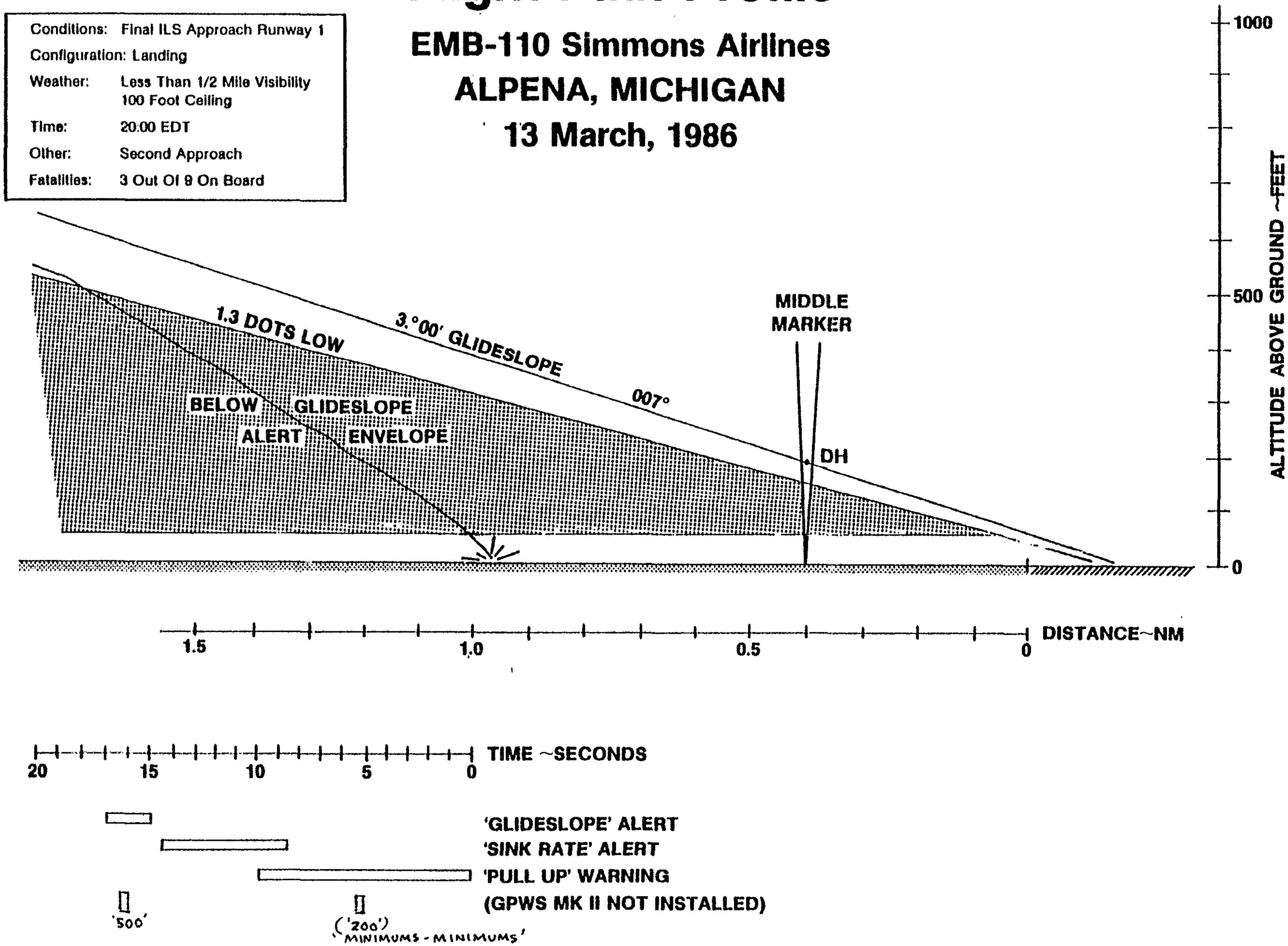
CATEGORY	A	B	C	D
S-TAC 31	4200-1 273 (300-1)			
CIRCLING	4380-1 446 (500-1)		4380-1½ 446 (500-1½)	4520-2 586 (600-2)
S-PAR 31	4127-¾ 200 (200-¾) GS 3.0°			

Next Page

Flight Path Profile

EMB-110 Simmons Airlines
ALPENA, MICHIGAN
13 March, 1986

Conditions:	Final ILS Approach Runway 1
Configuration:	Landing
Weather:	Less Than 1/2 Mile Visibility 100 Foot Ceiling
Time:	20:00 EDT
Other:	Second Approach
Fatalities:	3 Out Of 9 On Board



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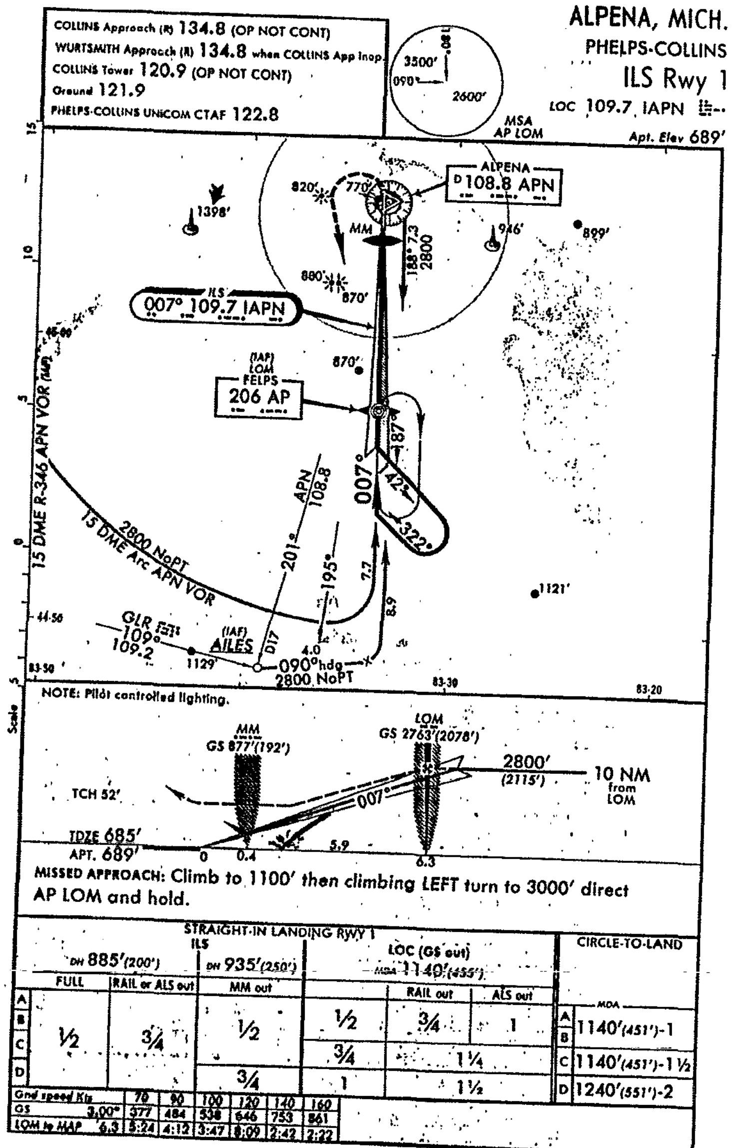


Commuter Crash Kills 3 in Michigan Woods

ALPENA, Mich., March 13 (UPI) — A Simmons Airlines commuter flight carrying nine people crashed in heavy fog and rain tonight, killing three people and injuring six, Alpena County sheriff's deputies said.

The police said the plane crashed around 10 P.M. in a wooded area two miles south of Phelps Collins Airport.

The Federal Aviation Administration was notified of the crash, sheriff's deputies said. No further details were immediately available.

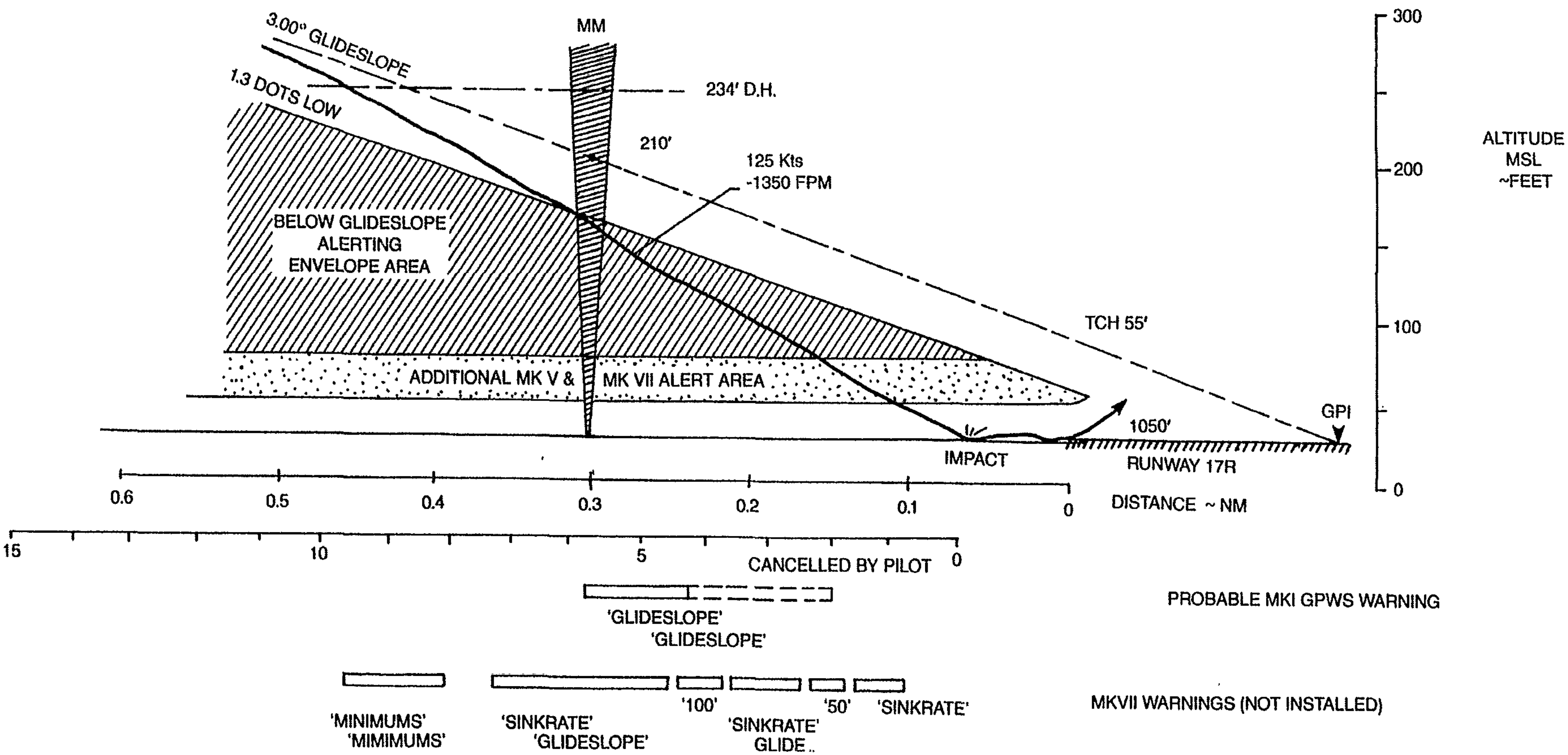
Next Page

90-282

Circumstances:	During a manually flown approach to ILS Runway 17R, the aircraft hit short by 400 feet into approach lights and rolled along 200 feet between lights and made a missed approach to alternate. The manual approach had been preceeded by two unsuccessful coupled approaches.
Weather:	Near or at minimum visibility

FLIGHT PATH PROFILE

B727-200
Harlingen, Texas
4 February 1986



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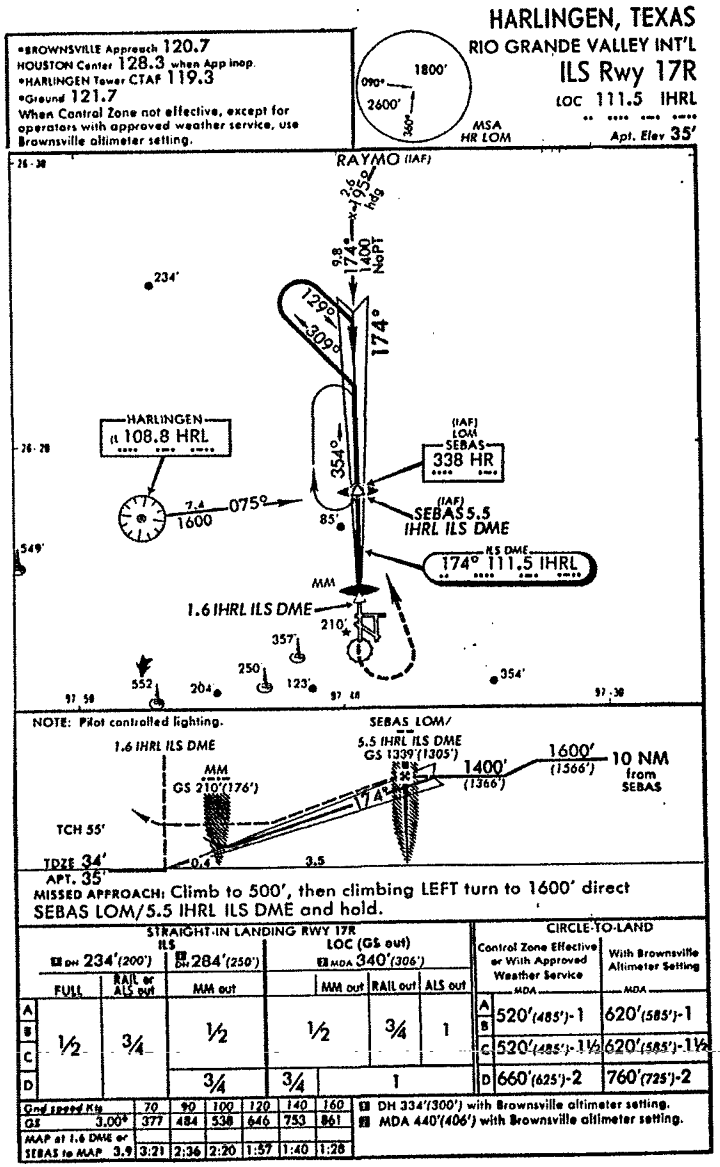
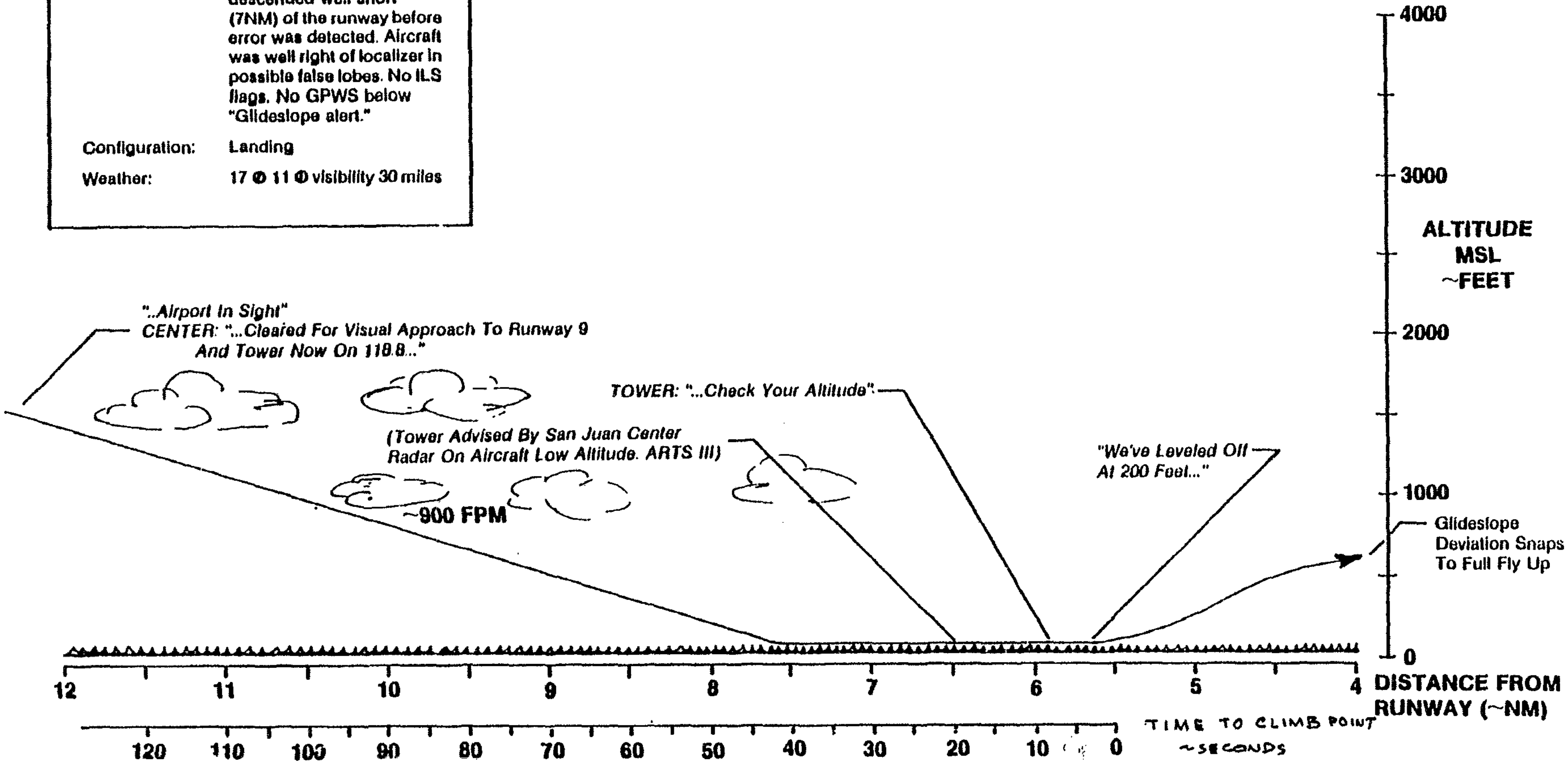


Flight Path Profile

Next Page

B727-200 Incident
ST. THOMAS I, VIRGIN ISLANDS
4 January, 1986

Circumstances:	During visual night approach to Runway 9, the aircraft inadvertantly descended well short (7NM) of the runway before error was detected. Aircraft was well right of localizer in possible false lobes. No ILS flags. No GPWS below "Glideslope alert."
Configuration:	Landing
Weather:	17 Ⓞ 11 Ⓞ visibility 30 miles



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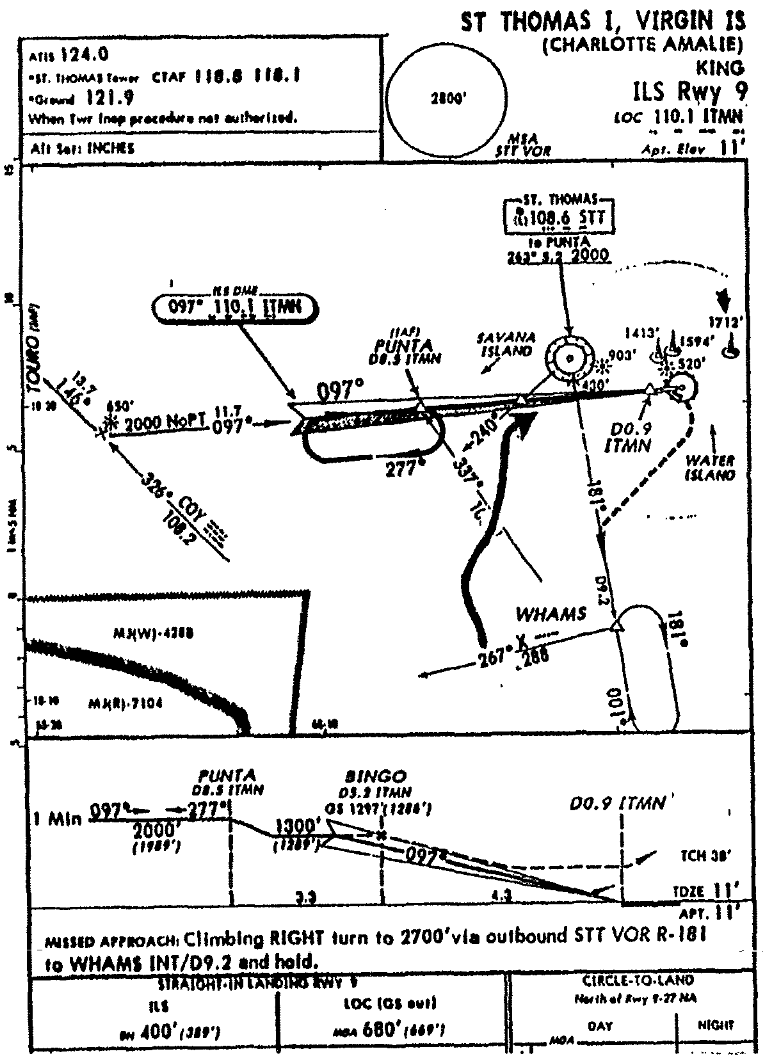


Off Profile Approach At St. Thomas

On January 4, a 727-221 approaching St. Thomas at night, in VMC, descended to within 50 ft of the water for approximately 40 seconds between 7 and 5.5 miles of the airport, then climbed to approximately 600 ft and continued uneventfully to a landing on runway 9.

The flight departed St. Croix and climbed to 3000 ft then was cleared to 5000 ft and cruised for a short period. A few minutes later San Juan Center cleared the flight to descend to 2800 ft at pilot's discretion. About 15 miles south of St. Thomas, according to the captain, the crew reported the airport in sight and were cleared by San Juan Center for a visual approach to runway 9 and handed off to the tower.

At that point, according to the captain, crewmembers accomplished their approach and pre-landing duties. The captain reported descending beneath a cloud deck between about 1700 ft and 1200 ft but he reported that the field was in sight, for the most part, throughout the approach after leaving 2500 ft.

Details of the approach briefing could not be recalled although the captain stated that the shortness of the runway was discussed. There was no discussion of visual approach descent profiles or height versus distance from the runway with regard to either VOR DME or ILS DME references.

The captain reported seeing on-glidepath indications during the approach. The flight director was not used nor was a radio check accomplished. The descent and approach continued using outside visual cues (visibility was reported at 30 miles) and, what the crew reported to be, on-localizer and on-glidepath indications. At no time, according to the crew, were any ILS warning flags in view.

Radar plots from San Juan Center show the flight descending from 2300 ft in a northwesterly direction about 11 nautical miles south southwest of the airport. About 8 miles southwest of the airport the flight was down to 1300 ft and had begun a turn to the north northeast.

The descent continued with the airplane heading toward St. Thomas VOR, located 3 miles west northwest of the runway. At 0142:11Z, the flight descended through 400 ft, 7.5 miles southwest of the runway, and 4.5 miles (approximately 37°) right of the centerline.

At 0142:27Z, still on the same approximate north northeasterly heading, ATC radar showed the 727 below 50 ft where it remained until shortly before 0143:14Z, a period of 47 seconds, when San Juan radar indicated a height of 100 ft. During that time it traveled about 2 miles.

Seeing the abnormally low approach, the San Juan Center controller contacted St. Thomas Tower which in turn called the flight and advised the crew to check their altitude. The crew answered that they were at 200 ft. During this time, the captain reported that, in spite of on-glidepath indications, the airplane was unusually low for its distance out from the runway and he stated that he leveled off at about 200 ft; the flight engineer later stated that he too saw 200 ft at about that time.

Following the tower's transmission, the aircraft climbed to about 600 ft and the glideslope snapped to a full fly up position, according to the crew's report. The flight continued to the airport close to the localizer centerline and landed uneventfully on runway 9.

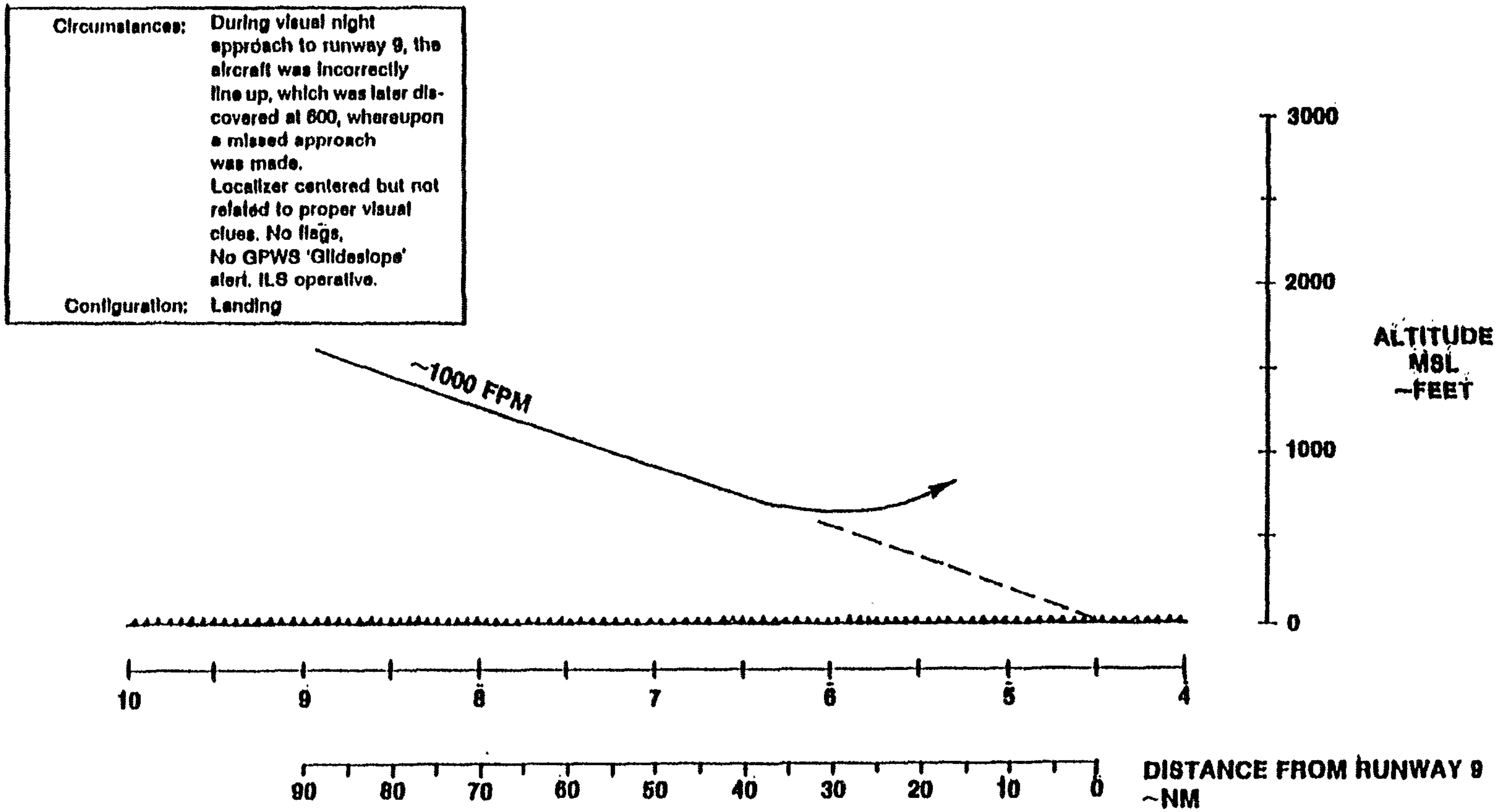
The GPWS never activated. According to Sundstrand, this is normal. The GPWS is programmed to discount extreme and rapid glidepath needle deflections because, under normal circumstances, it's indicative of short-term signal irregularities. Also, the airplane was in the landing configuration and was not descending excessively.

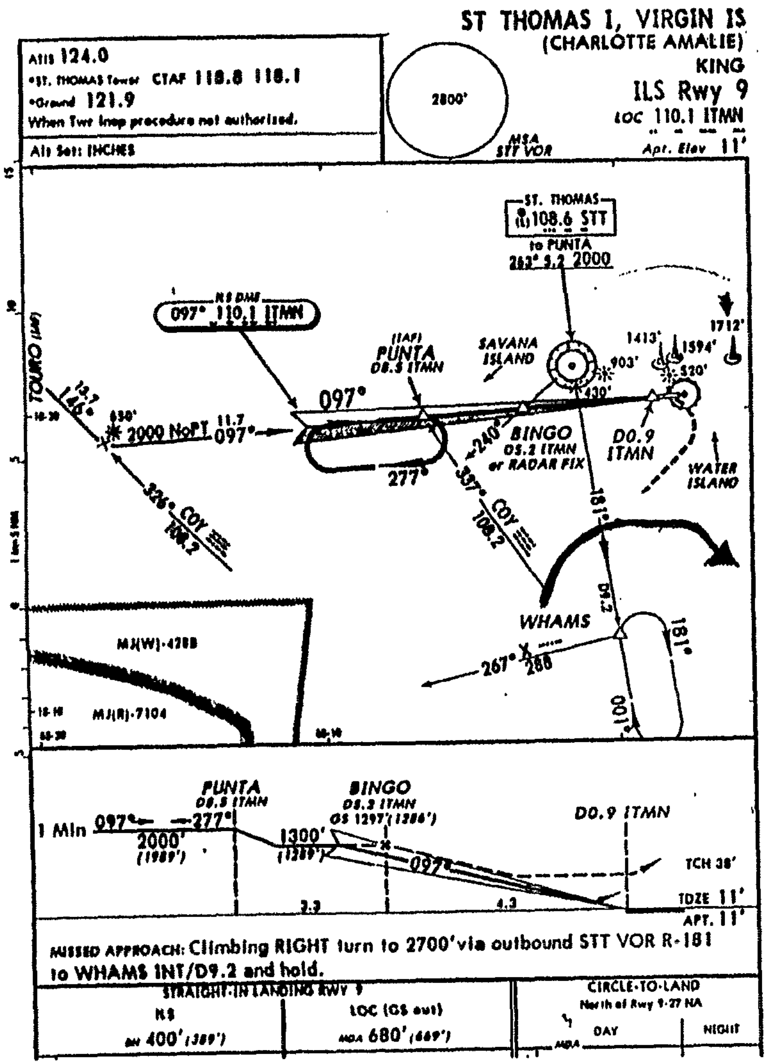
FOM (page 7/11) specifies the following localizer signal tolerances: The ILS signal (meaning the localizer signal) is reliable up to 4500 ft AGL within 35° of the centerline up to 10 nautical miles from the antenna and, from 10 to 18 nautical miles of the antenna, the signal is reliable within 10° of the centerline. The FAA's Flight Inspection Manual specifies that the ILS glideslope must be reliable within 10 nautical miles of the transmitter 8° either side of the localizer centerline. Glideslope coverage information will be added to the FOM.

A check with the Wilcox Company, manufacturers of the St. Thomas ILS, revealed that various spurious reflected signals are possible outside the normal certificated range of instrument landing systems. Such out-of-tolerance signals could cause an on-glidepath indication, or for that matter, an infinite range of erroneous indications. □

Flight Path Profile

B727-200 Incident
ST. THOMAS I, VIRGIN ISLANDS
1 January, 1986





Incorrect Line Up At St. Thomas

On the night of January 1, a 727 crew mistakenly lined up on an object other than the runway during a visual approach to runway 9 at St. Thomas. The crew discovered their error at about 600 ft and a missed approach was made followed by an uneventful landing.

Weather was VMC. The flight departed St. Croix, tracking out the St. Croix 337 radial and climbed to 5000 ft. About 15 to 20 miles southeast of St. Thomas the flight was descended to 2500 ft by San Juan Center and, upon reporting the field in sight, was cleared for a visual approach.

The first officer was the first to spot what he thought was the runway and provided heading guidance to the captain to turn right onto the final approach leg. The captain reported overshooting the localizer and "never catching the glideslope" during his descent. During the approach, the captain asked for an ILS frequency check several times because of confusing visual cues. The tower was also asked if the ILS was operating properly. The tower responded that it was. No flight instrument flags were visible.

The flight director was not used. Passing about 600 ft and approximately 3.5 miles abeam St. Thomas to the south, the captain realized that, in his words, "the lights just didn't look right" even though the localizer was centered. He then pushed up the power, leveled off, and began a missed approach to the south.

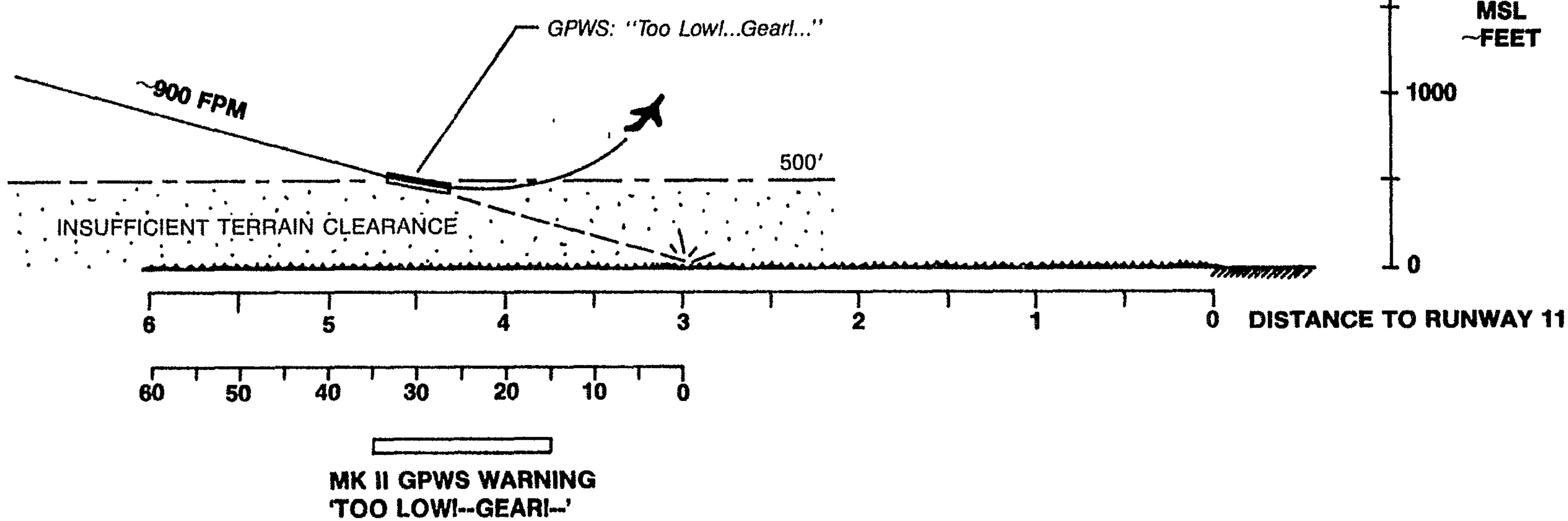
On the next approach a normal localizer and glideslope intercept was made, culminating in a routine landing. ▢

Next Page

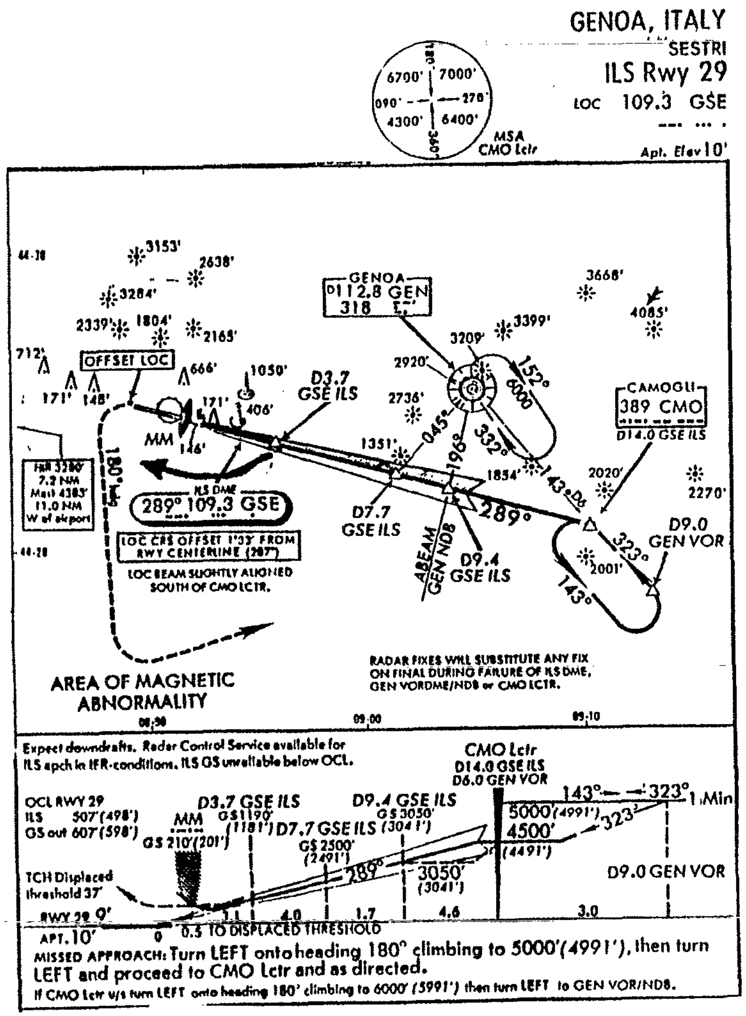
Autopilot Management
Flight Path Profile

MD-80 Incident
GENOA, ITALY
10 November, 1985

Circumstances:	Aicraft almost flew into sea during circling to land after ILS approach to Runway 29. Autopilot engaged throughout. Coupled ILS approach with altitude hold to circle. Did not couple into altitude hold continued to descend. At 500 feet timely MK II GPWS warning began.
Configuration:	15° flap, gear up
Weather:	5KM in rain, cloud base 1000 feet
Time:	Night



Return to TOC



It was an ILS approach to runway 29 to be followed by a circling approach to runway 11.

It was night, with a visibility of 5 Km in rain, and a cloud base reported at 1000 ft.

Circling is over the sea, to be flown at an altitude of 1000 ft (company minima).

Autopilot was coupled to the ILS (Loc trk/ GS trk), autothrottle ON, speed 170 Kts, flaps 15°/Ext, gear up.

Reaching 1000 ft the altitude hold button was pushed with the intent of leveling the a/c at circling altitude, and the a/c was turned through the use of the heading selector knob to a heading suitable to enter the downwind leg.

Pushing the altitude hold button during an ILS coupled approach caused the autopilot to revert to its basic mode (vertical speed and heading hold); the a/c therefore continued its descent through 1000 ft with the existing rate of descend.

To level the a/c the altitude hold button should have been pressed a second time.

The descend went unnoticed to the crew. At 500 ft R.A. the GPWS activated in the mode 4 A (too low-gear).

Autopilot was disengaged and the a/c rotated to a pitch altitude of about 15° nose up, to regain 1000 ft;

The flight was continued to a normal landing.

Findings : autopilot was not properly managed, nor properly monitored by the crew. The a/c flight path was not properly monitored by the crew.

Next Page

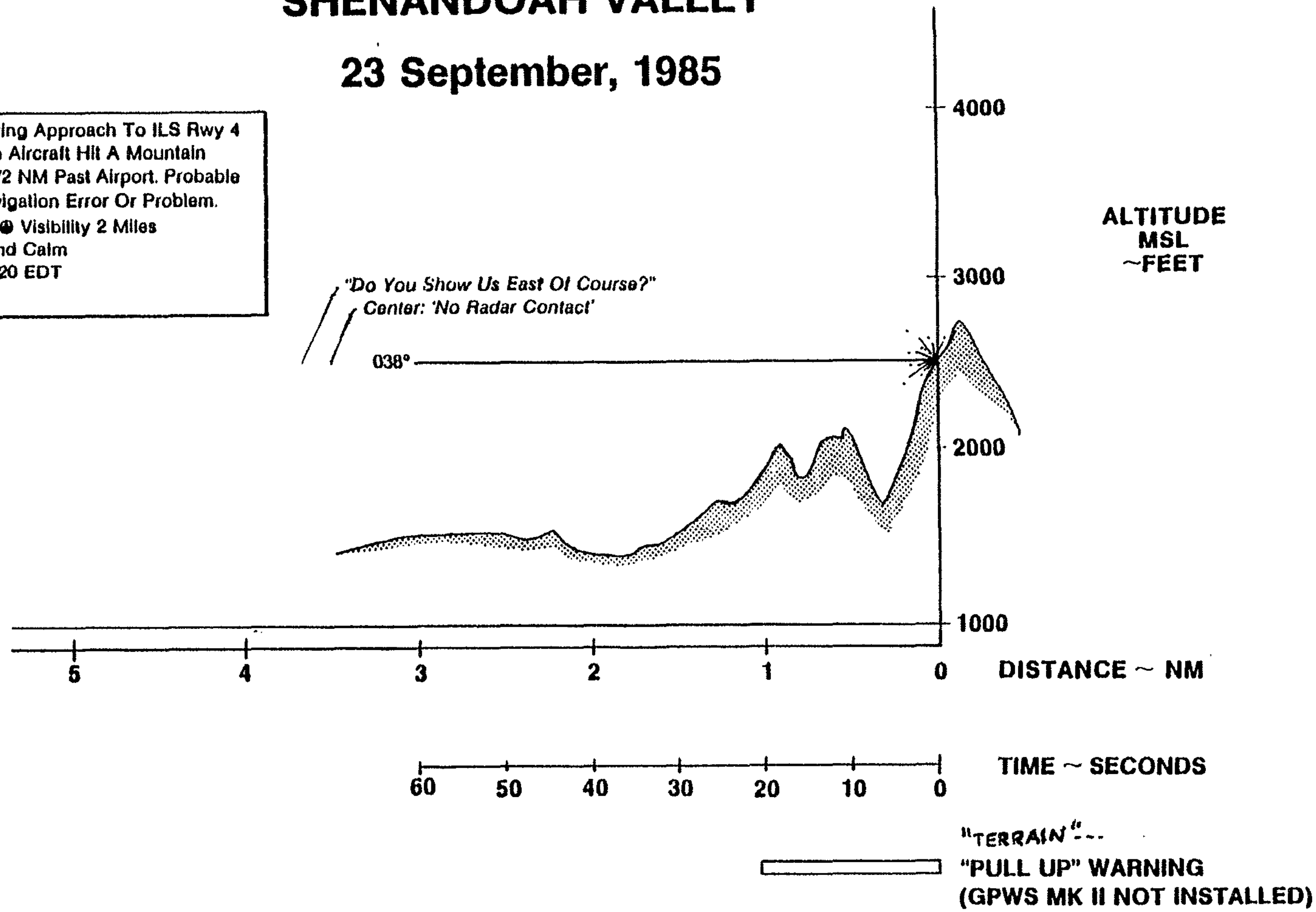
Flight Path Profile

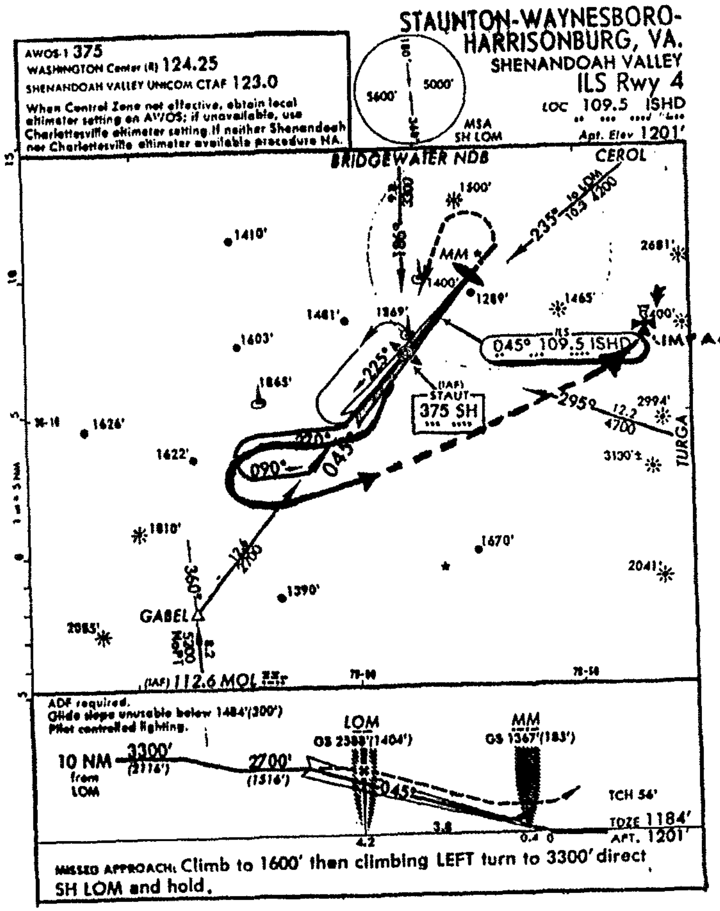
BE-99

SHENANDOAH VALLEY

23 September, 1985

Conditions:	During Approach To ILS Rwy 4 The Aircraft Hit A Mountain 6 1/2 NM Past Airport. Probable Navigation Error Or Problem.
Weather:	10 ⊕ Visibility 2 Miles Wind Calm
Time:	10:20 EDT
Fatalities:	14





NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: September 30, 1986

HENSON AIRLINES FLIGHT 1517
BEECH B99, N339HA
GROTTOES, VIRGINIA
SEPTEMBER 23, 1985

SYNOPSIS

Henson Airlines Flight 1517, a Beech B99, was cleared for an instrument approach to the Shenandoah Valley Airport, Weyers Cave, Virginia, at 0959 on September 23, 1985, after a routine flight from Baltimore-Washington International Airport, Baltimore, Maryland. Instrument meteorological conditions prevailed at Shenandoah Valley Airport. There were 12 passengers and 2 crewmembers aboard the scheduled domestic passenger flight operating under 14 CFR 135. Radar service was terminated at 1003. The crew of flight 1517 subsequently contacted the Henson station agent and Shenandoah UNICOM. The last recorded radar return was at 1011, at which time, the airplane was east of the localizer course at 2,700 feet mean sea level and on a magnetic track of about 075°. At 1014 the pilot said, ". . . we're showin a little west of course . . ." and at 1015 he asked if he was east of course. At 1017, the controller suggested a missed approach if the airplane was not established on the localizer course. There was no response from the crew of flight 1517 whose last recorded transmission was at 1016.

The wreckage of flight 1517 was located about 1842 approximately 6 miles east of the airport. Both crewmembers and all 12 passengers were fatally injured.

The National Transportation Safety Board determines that the probable cause of this accident was a navigational error by the flightcrew resulting from their use of the incorrect navigational facility and their failure to adequately monitor the flight instruments. Factors which contributed to the flightcrew's errors were: the nonstandardized navigational radio systems installed in the airline's Beech 99 fleet; intra-cockpit communications difficulties associated with high ambient noise levels in the airplane; inadequate training of the pilots by the airline; the first officer's limited multiengine and instrument flying experience; the pilots' limited experience in their positions in the Beech 99; and stress-inducing events in the lives of the pilots. Also contributing to the accident was the inadequate surveillance of the airline by the Federal Aviation Administration which failed to detect the deficiencies which led to the accident.

1. FACTUAL INFORMATION

1.1 History of Flight

Henson Airlines (Piedmont Regional) Flight 1517, a Beech B99, N339HA, was cleared for takeoff from Baltimore-Washington International Airport (BWI) at 0922 e.d.t. 1/ on September 23, 1985. Two crewmembers and 12 passengers were aboard the scheduled domestic passenger flight (commuter) operating under 14 CFR 135.

1/ All times herein are eastern daylight based on the 24-hour clock.

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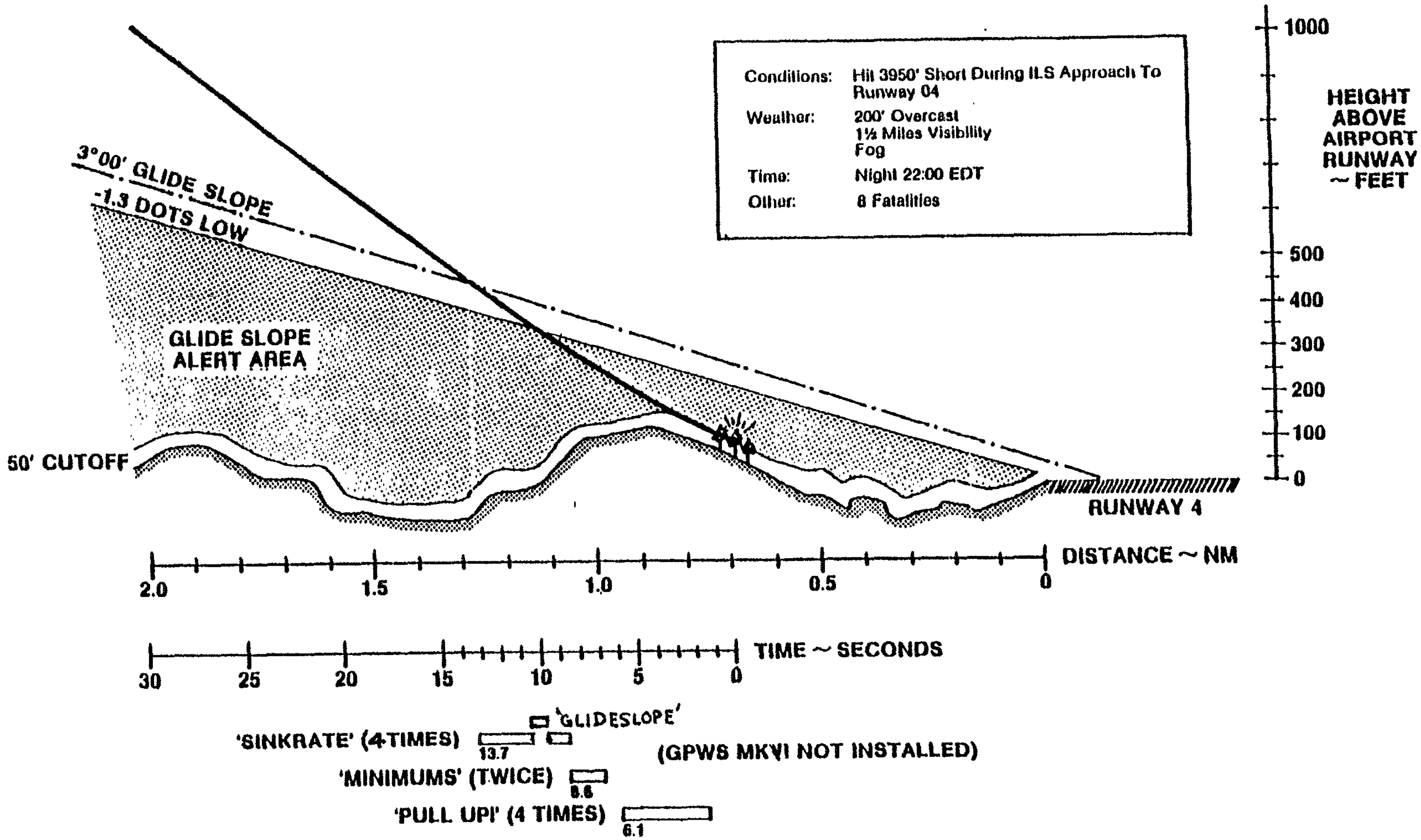
Flight Path Profile

BE-99

LEWISTON, MAINE
25 AUGUST, 1985



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8 Killed in Maine Plane Crash

AUBURN, Maine (UPI) — Samantha Smith, the girl who visited the Soviet Union after writing a letter to the former Soviet President Yuri Andropov, was on the passenger list of a plane that crashed near Auburn-Lewiston Municipal Airport, killing eight people, sources said.

The Bar Harbor Airlines plane crashed as the pilot was trying to land there, the police said.

Lieut. Norman Guerette of the Auburn police said the crash of the Beechcraft 99 jet occurred at about 10 P.M. about a half-mile from the airport, about 30 miles north of Portland.

"We have eight fatalities," Lieutenant Guerette said. "We have no report that anyone is alive. The report we have is that there were eight fatalities."

The police received a report of a fire and arrived on the scene to find the wreckage in a field off Foster Road, he said. The Auburn Fire Department doused the burning wreckage, he said.

The plane apparently failed to clear a wooded hill directly in the flight path.

There was no immediate indication of what caused the crash, Lieutenant Guerette said.

"Details are really sketchy right now," said Gary Linscott, director of airline market planning for Bar Harbor Airlines. "We've never had an incident such as this."

Mr. Linscott said Flight 1808 originated in Boston and was bound for Bangor, with stops in Augusta and Waterville, when the crash occurred.

Investigators from the Federal Aviation Administration were called to the scene and an airline operation team was sent to the crash site shortly before midnight Sunday, Mr. Linscott said.

"Debris was scattered around, but we don't know how wide," Lieutenant Guerette said.

The police were awaiting the arrival of a medical examiner before removing any of the bodies.

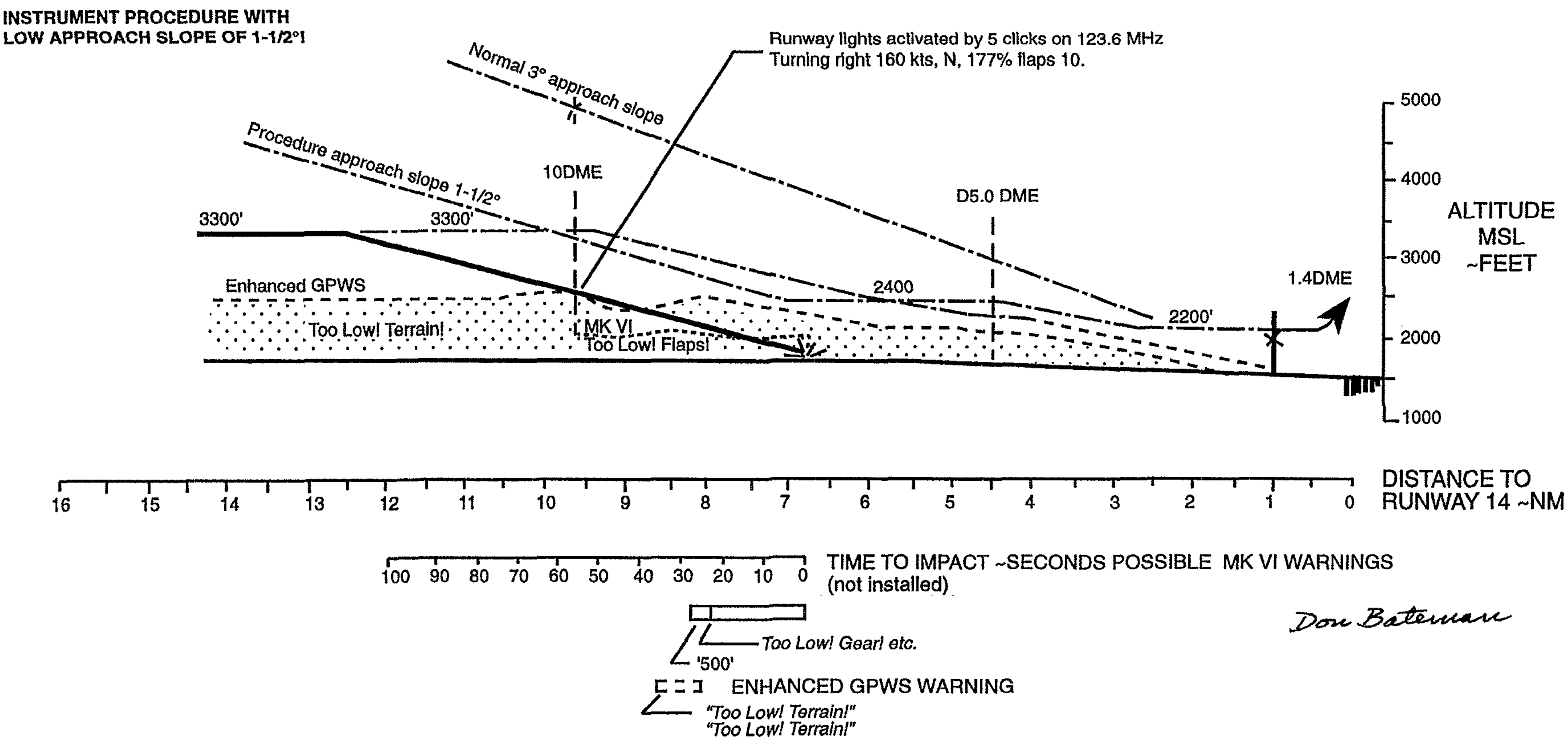
Deaths: SMITH, Samantha,
Facts on File, August 30, 1985,
Section: MISCELLANEOUS

13, the Maine schoolgirl who gained worldwide publicity in 1983 when she received and accepted a personal invitation from the late Soviet leader Yuri Andropov to visit the Soviet Union after she had written him a letter expressing her fear of nuclear war; she spent two weeks there in the summer of 1983 and, upon her return to the U.S., appeared on many television talk shows and, in 1984, hosted a television special called Samantha Smith Goes to Washington—Campaign 1984, in wh ich she interviewed presidential candidates; killed Aug. 26 along with her father and six other people in the crash of a commuter plane near Auburn-Lewiston (Maine) Airport; she and her father had boarded the plane in Boston while on their way home from London, where she had been filming a new television series, Lime Street, with Robert Wagn er.

CIRCUMSTANCES:	While on an ARC DME intercept to VOR runway 14, the aircraft impacted terrain right wing down in a turn to the final approach course at 7.4 NM short of the runway.
OPERATIONS:	Part 135 Air Taxi carrying spare parts for pipeline
CONFIGURATIONS:	Landing gear up, flaps 10
WEATHER:	Wind 170/7 kts, 47° dew point 40° 29.95" AMOS out of service
TIME:	Early morning 02:05 local
FATALITIES:	3
OTHER:	Captain had 5000 hours, 200+ in type but very tired from high duty time.

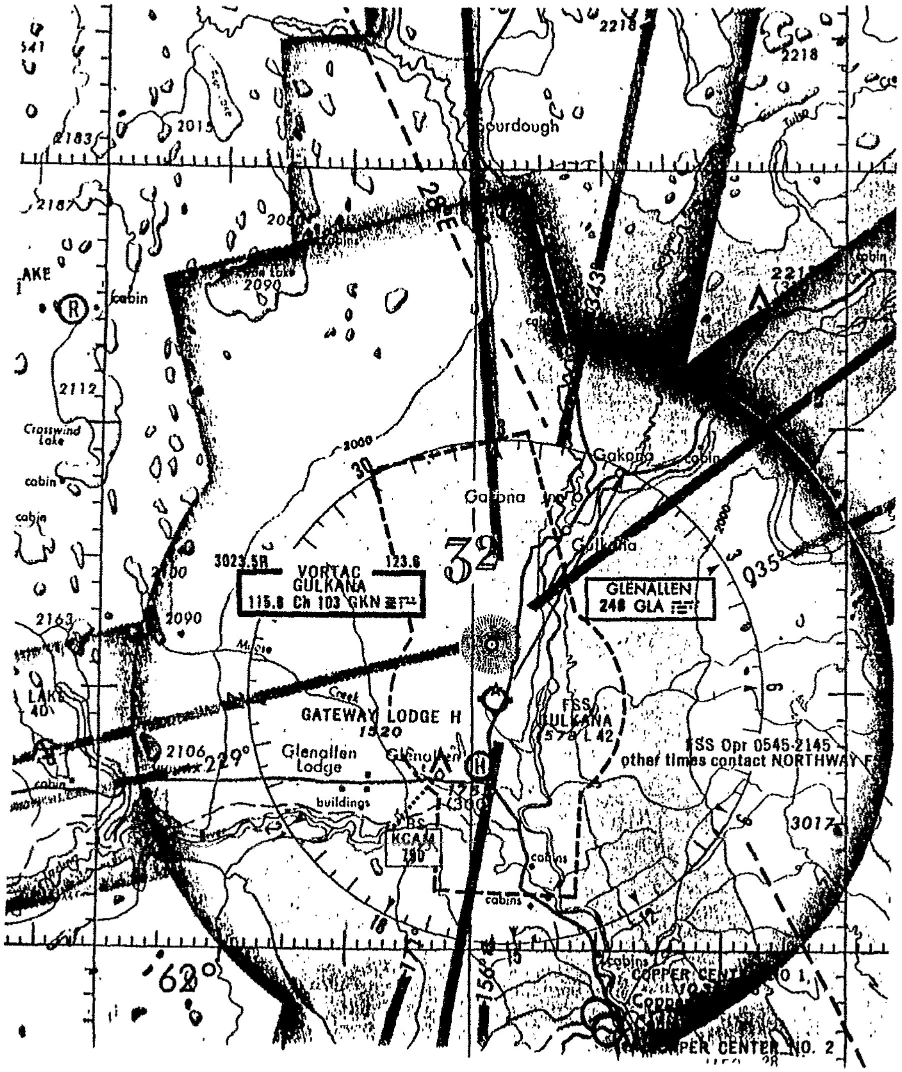
THE LOW APPROACH SLOPE INSTRUMENT PROCEDURE 'TRAP'

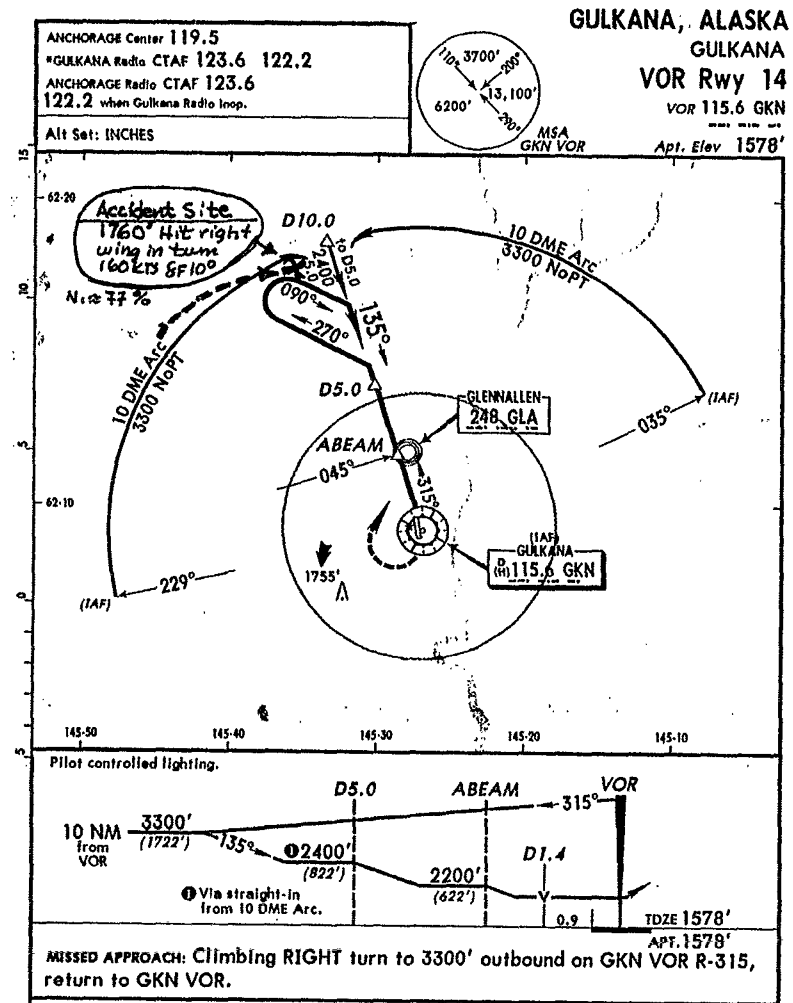
Flight Path Profile
Lear Jet - 24D
GULKANA, ALASKA
20 August, 1985



Don Bateman

Return to TOC





	STRAIGHT-IN LANDING RWY 14		CIRCLE-TO-LAND		
	MDA(H) 1900' (322') With Abeam	MDA(H) 2200' (622') Without Abeam	Max Kts	With Abeam MDA(H)	Without Abeam MDA(H)
A	1	1	90	1960' (382') - 1	2200' (622') - 1
B			120	2040' (462') - 1	
C		1¾	140	2040' (462') - 1½	2200' (622') - 1¾
D	1¼	2¼	165	2140' (562') - 2	2200' (622') - 2¼

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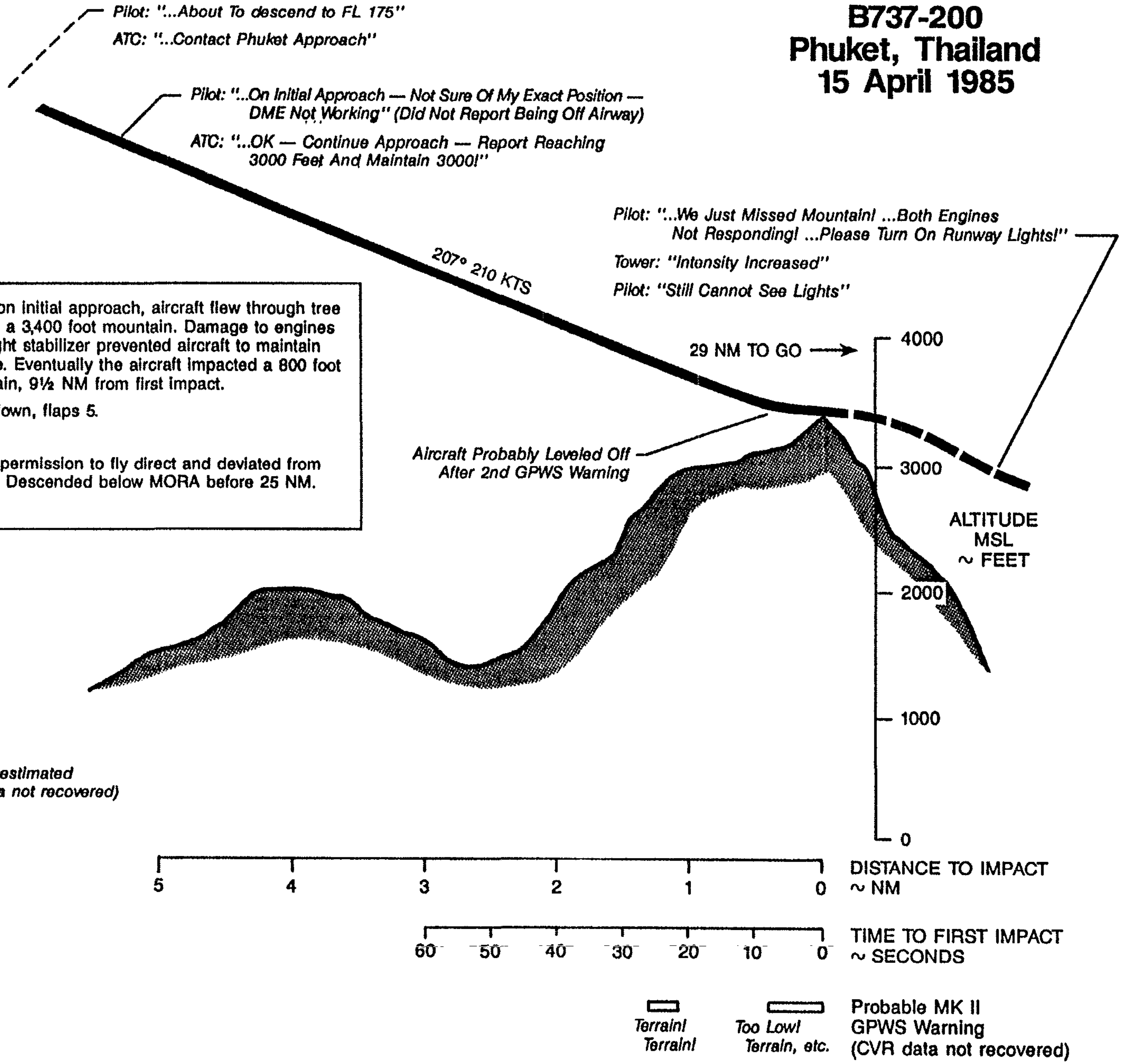
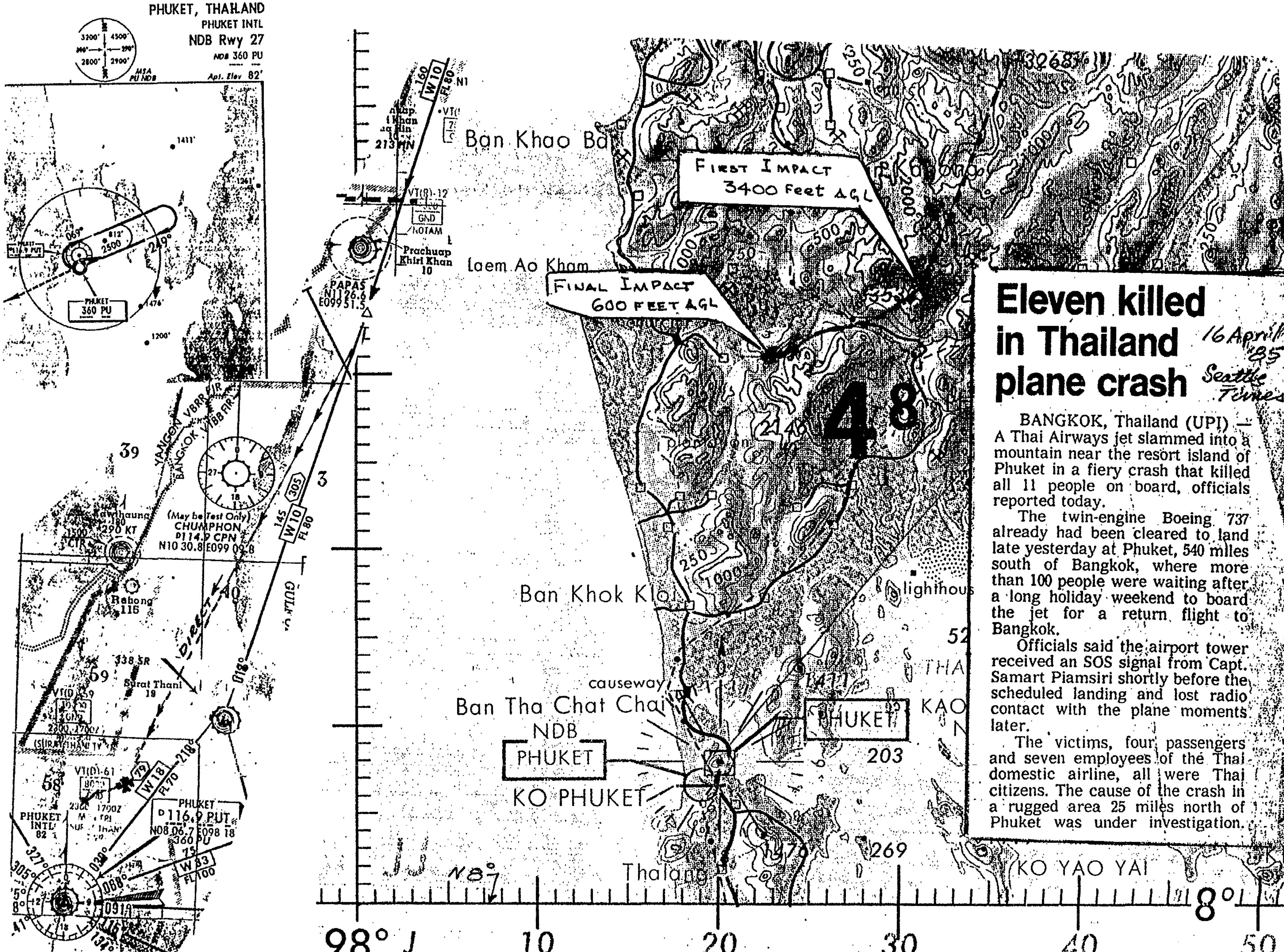
FLIGHT PATH PROFILE
B737-200
Phuket, Thailand
15 April 1985



Circumstances:	While on initial approach, aircraft flew through tree tops of a 3,400 foot mountain. Damage to engines and right stabilizer prevented aircraft to maintain altitude. Eventually the aircraft impacted a 800 foot mountain, 9½ NM from first impact.
Configuration:	Gear down, flaps 5.
Time:	16:26
Other:	Asked permission to fly direct and deviated from airway. Descended below MORA before 25 NM.
Fatalities:	11

Profile and terrain estimated
(Both CVR and FDR data not recovered)



Eleven killed in Thailand plane crash

16 April '85 Seattle Times

BANGKOK, Thailand (UPI) — A Thai Airways jet slammed into a mountain near the resort island of Phuket in a fiery crash that killed all 11 people on board, officials reported today.

The twin-engine Boeing 737 already had been cleared to land late yesterday at Phuket, 540 miles south of Bangkok, where more than 100 people were waiting after a long holiday weekend to board the jet for a return flight to Bangkok.

Officials said the airport tower received an SOS signal from Capt. Samart Piamsiri shortly before the scheduled landing and lost radio contact with the plane moments later.

The victims, four passengers and seven employees of the Thai domestic airline, all were Thai citizens. The cause of the crash in a rugged area 25 miles north of Phuket was under investigation.

Next Page

Procedure Turn - Altitude Error

B727 19 FEBRUARY, 1985 BILBAO, SPAIN

On 19th February 1985, a B727 on a scheduled morning flight from Madrid to Bilbao hit a tower on top of Oiz mountain during its outbound procedure turn. The aircraft was configured gear up and was on an approximate heading of 080 degrees and an airspeed of about 210 knots. It was some 980 feet below procedure altitude of 4360 feet. It was daylight and there were light clouds in the area. There were 148 fatalities.

This aircraft was not equipped with GPWS.

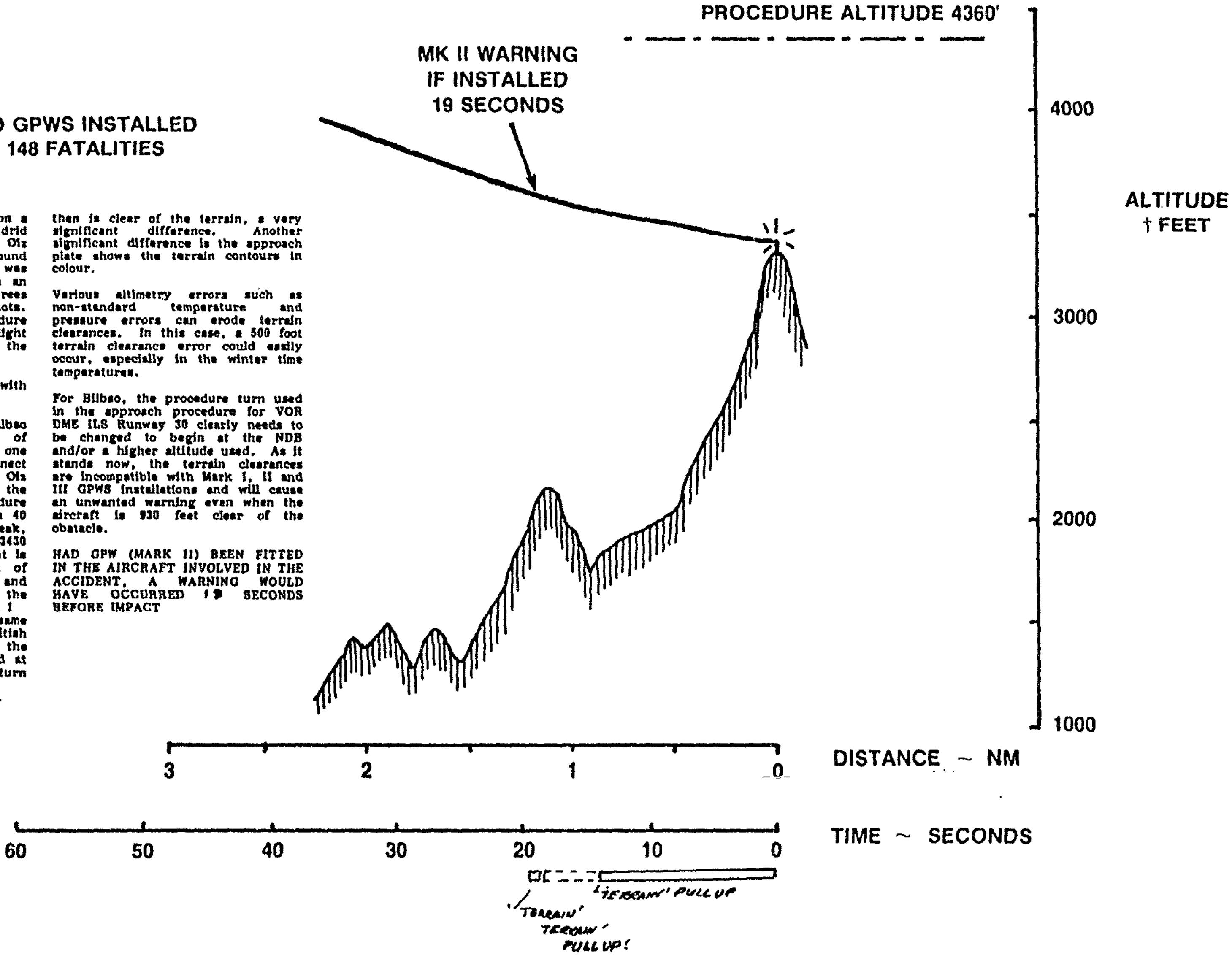
Other operators flying into Bilbao have received pilot reports of 'unwanted'GPWS warnings, and one operator instructs pilots to disconnect the GPWS for flights into Bilbao. Oiz mountain is located directly along the flight path of the outbound procedure turn and is 3366 feet high with 40 meter towers above the peak, probably raising the height to 3430 feet or so. The procedure height is 4360 feet giving only 930 feet of nominal clearance. The mountain and the tower were not shown on the Jeppesen approach plate VOR DME 1 Runway 30 (left below) The same approach procedure used by British Airways (below right) shows the outbound procedure turn initiated at the 'BIL' NDB. The procedure turn then is clear of the terrain, a very significant difference. Another significant difference is the approach plate shows the terrain contours in colour.

Various altimetry errors such as non-standard temperature and pressure errors can erode terrain clearances. In this case, a 500 foot terrain clearance error could easily occur, especially in the winter time temperatures.

For Bilbao, the procedure turn used in the approach procedure for VOR DME ILS Runway 30 clearly needs to be changed to begin at the NDB and/or a higher altitude used. As it stands now, the terrain clearances are incompatible with Mark I, II and III GPWS installations and will cause an unwanted warning even when the aircraft is 930 feet clear of the obstacle.

HAD GPW (MARK II) BEEN FITTED IN THE AIRCRAFT INVOLVED IN THE ACCIDENT, A WARNING WOULD HAVE OCCURRED 19 SECONDS BEFORE IMPACT

FROM: CATHAY PACIFIC 'KAI'



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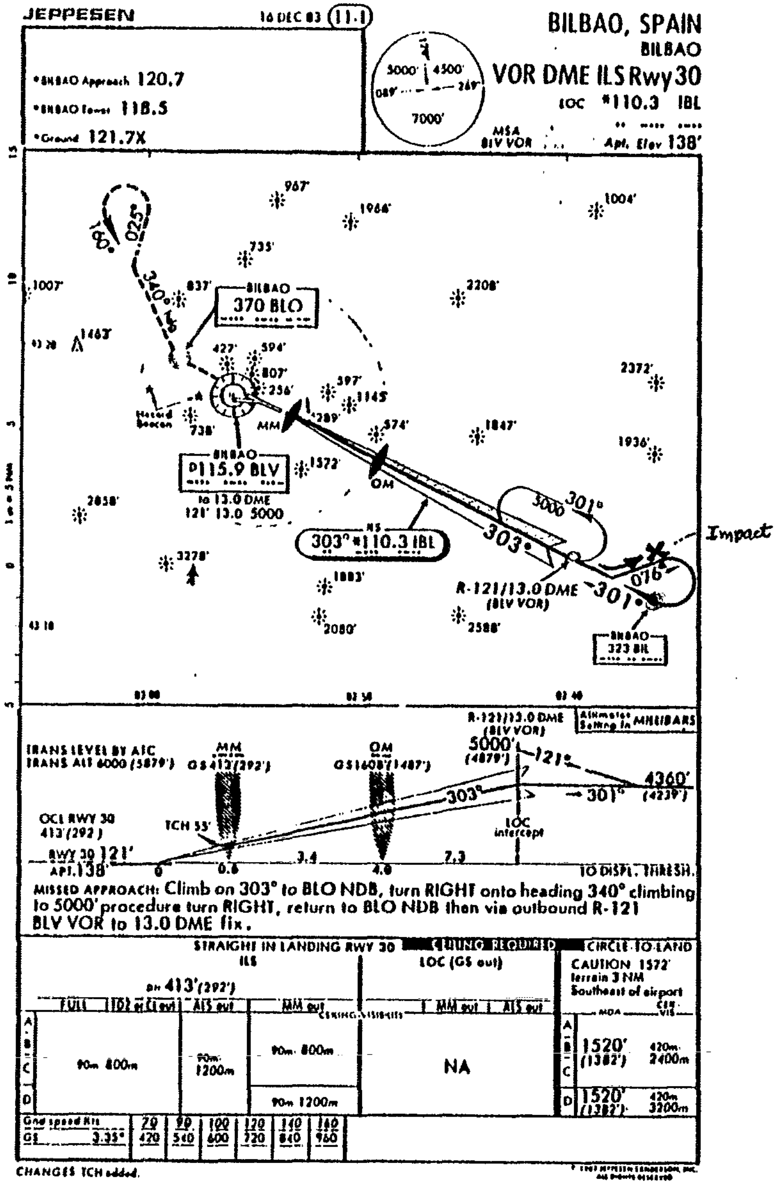
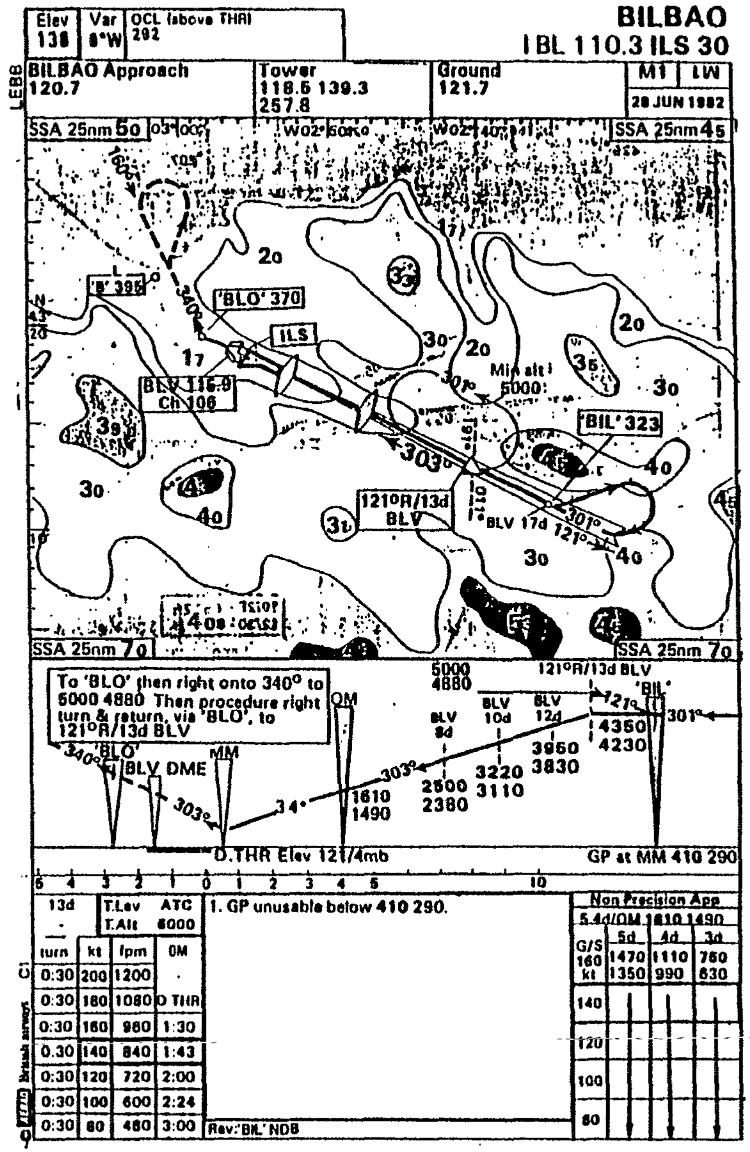


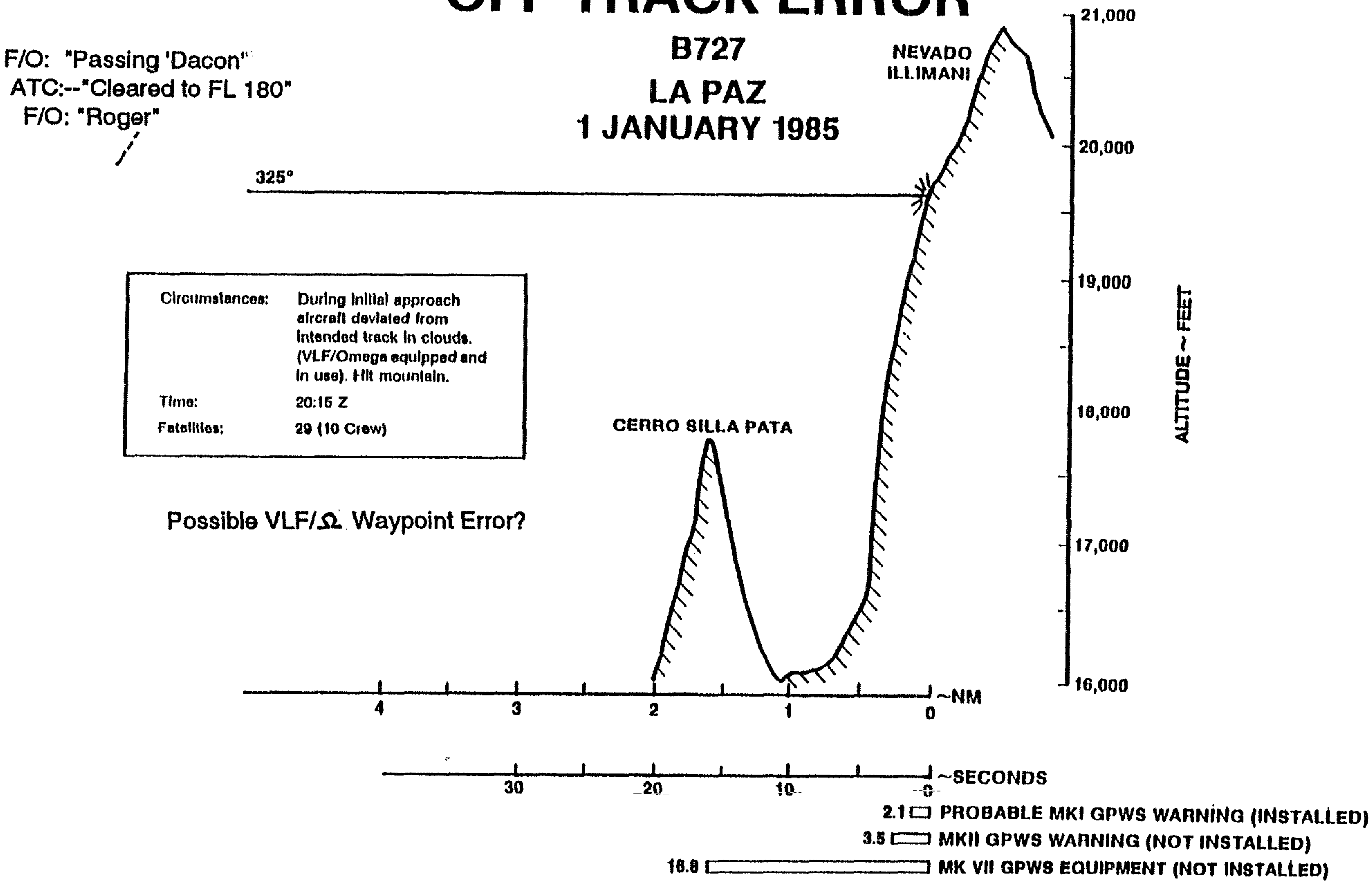
Approved Government Procedure

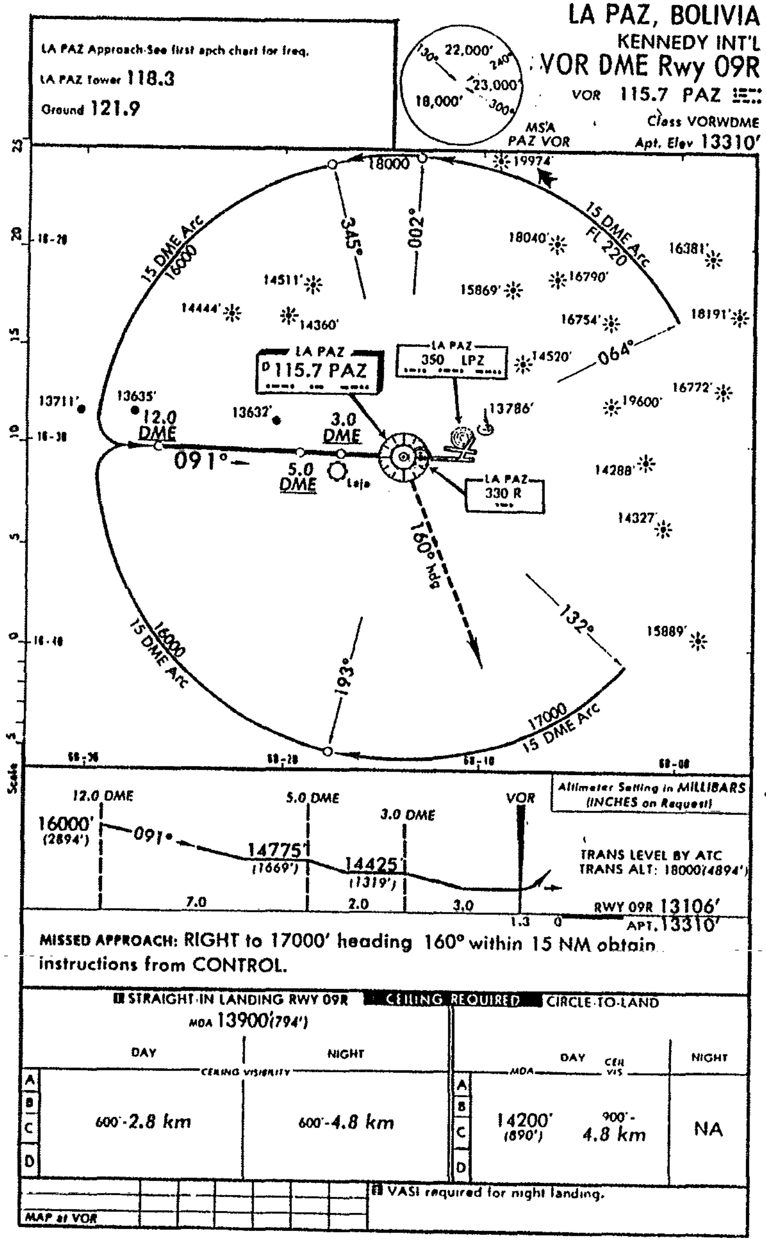


Non Government Procedure used by some airlines.
(Note that procedure turn relocated to 'BIL' NDB to ensure that procedure turn clear of terrain)

Next Page

INITIAL APPROACH — WEATHER AVOIDANCE
OFF TRACK ERROR





29 Reported Dead in Bolivia Jet Crash

By RICHARD WITKIN

The wreckage of an Eastern Airlines jet was located late yesterday on the side of a mountain southeast of La Paz, Bolivia, 20 hours after it disappeared on a flight to La Paz from Asunción, Paraguay, airline officials said.

Reports from the scene said that none of the 29 people on board had survived and that the wreckage was scattered over a large area, embedded in thick snow, with only the tail visible.

Among the American passengers reported aboard the Boeing 727 plane was Marian Davis, wife of Arthur H. Davis, the Ambassador to Paraguay, according to Alan Romberg, a State Department spokesman. Airport officials at El Alto Airport, where the plane had been headed, identified another of the American passengers as William Kelley, director of the Peace Corps in Paraguay. A third American passenger was identified by Eastern as Jonathan Watson. No further information on Mr. Watson was immediately available.

Officials of the airline said the wreckage had been positively identified by a company employee who apparently was aboard a plane used in the wide air and ground search, which had been hampered all day by foggy weather. The site of the crash was reported to be at an altitude of 19,600 feet, not far below the 21,000-foot crest of Illimani Mountain.

Nineteen of the 29 victims were passengers. The others included three American pilots and five flight attendants, all of whom were believed to have been South Americans. The remaining people aboard were two American airline employees, identified as J. B. Loseth Jr., of Miami, and Haywood H. Hargrove Jr., of Houston, who were riding as nonpaying passengers.

A spokesman for the United States Embassy in Paz said the plane had been sighted above the Urana Mine, about 30 miles southeast of La Paz, The Associated Press reported. A Red Cross team was reported en route to the mine but it was apparently not possible to reach the wreckage by road. The attempt, in any case, was not to begin until today because it was getting dark when the aerial searchers finally sighted the plane. The village closest to the site is La Palca.

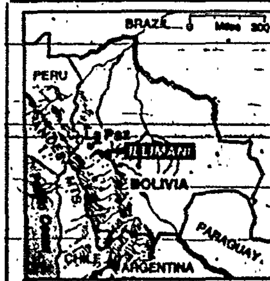
The last fatal crash involving a major United States airline on a passenger flight occurred two and a half years ago when a Pan American World Airways 727 went down just after takeoff from the main airport in New Orleans, killing 154 people.

The Eastern plane that crashed in Bolivia, Flight 980, had taken off from Asunción at 5:57 P.M. New York time on New Year's Day and had been due at La Paz at 7:48, according to Eastern spokesmen.

The National Transportation Safety Board sent an accident investigator, John Young, to La Paz as this country's representative in the inquiry the Bolivians will conduct. The F.A.A., which promulgates the rules governing operation of this country's aircraft, also sent representatives in case anything turns up that requires regulatory action.

One issue expected to draw immediate attention will be the accuracy of navigation aids that the crew would have been depending on to keep the plane on the proper flight path as it made the descent over treacherous terrain to the La Paz airport.

Unlike many major airports around the world, officials said, the La Paz air-traffic-control center is not equipped with a radar system that could have followed the plane's course and its altitude as it descended to the airport.



The New York Times/Jan. 3, 1985

Wreckage was found scattered on side of Illimani Mountain.

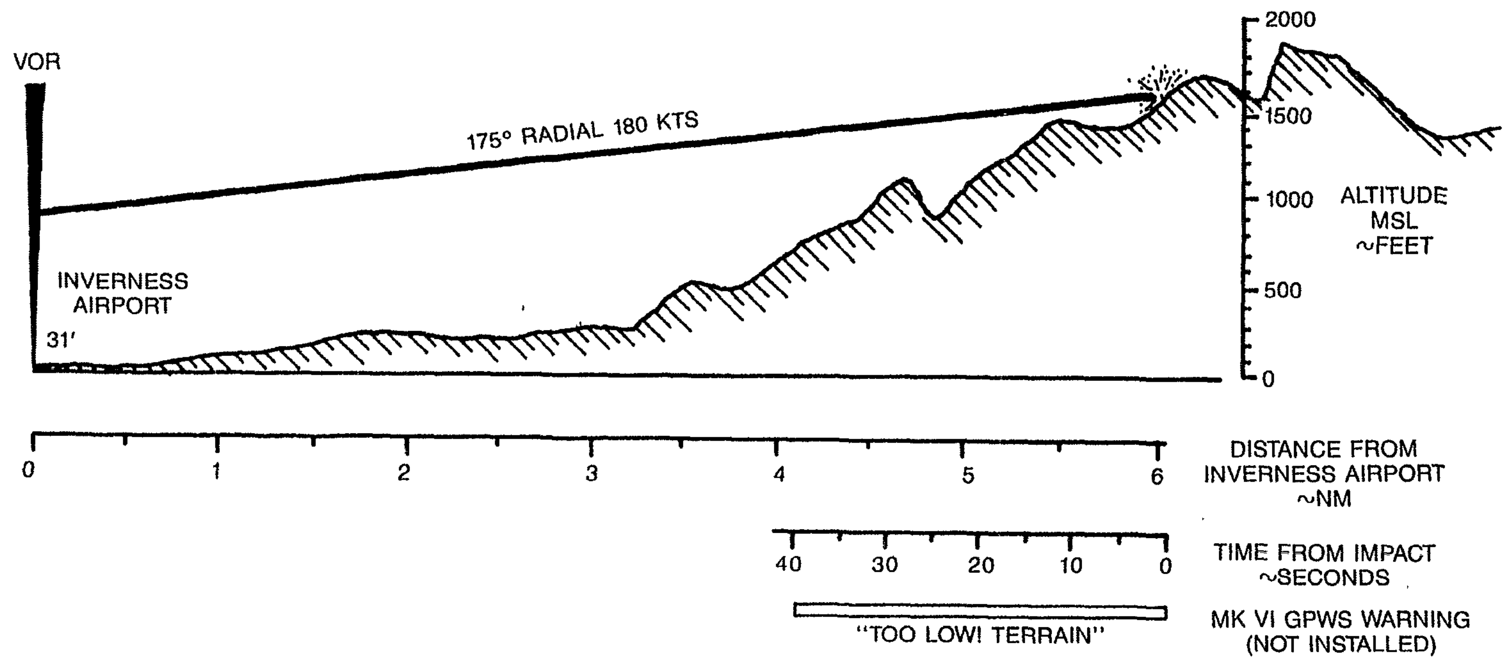
26 DME
106°
325°

AIRWAY UA 320 (134° Radial)

Next Page

FLIGHT PATH PROFILE
Bandeirante
Inverness, Scotland
19 November, 1984

Circumstances:	Aircraft was cleared to fly direct Edinburgh at FL95 after a departure from runway 24. Aircraft did not climb to attitude over field, and impacted hill. freight operation.
Time:	2055
Weather:	Overcast. Cloud bases 1400 Wind 020/5 kts. +6°C.
Fatalities:	1
Other:	Autopilot engaged (Pitch Attitude Hold and Heading Mode)



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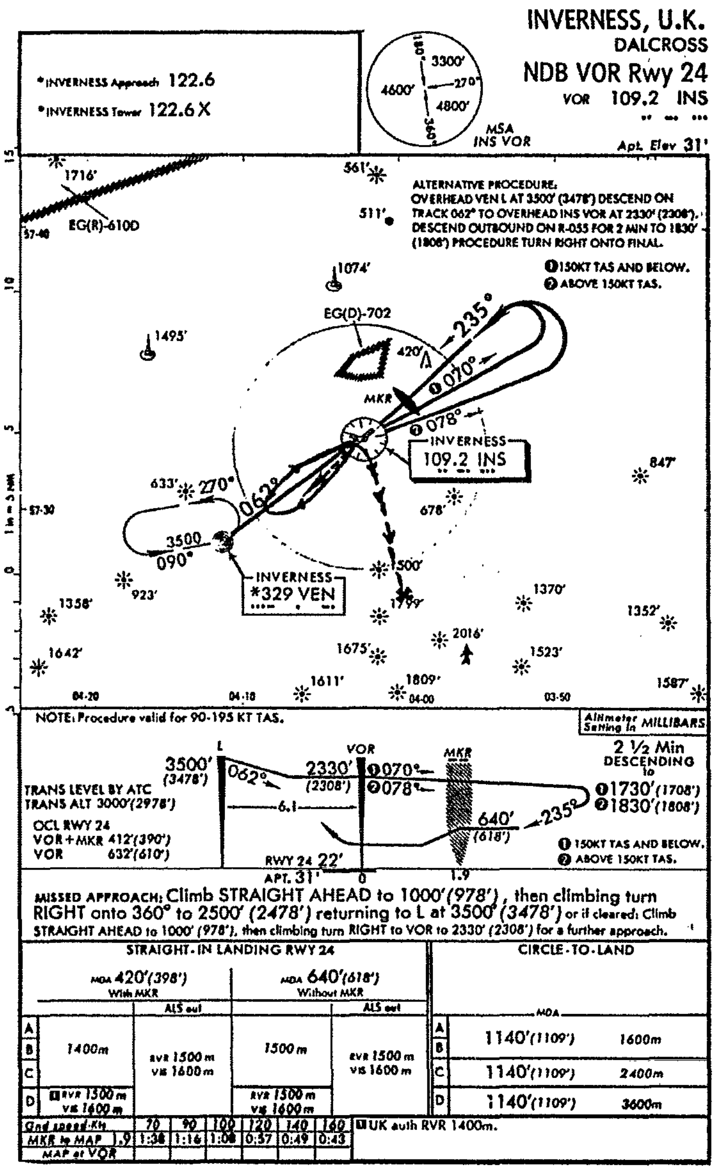


727 Hits Lights During Low Visibility ILS Approach

This is a preliminary report from another carrier.

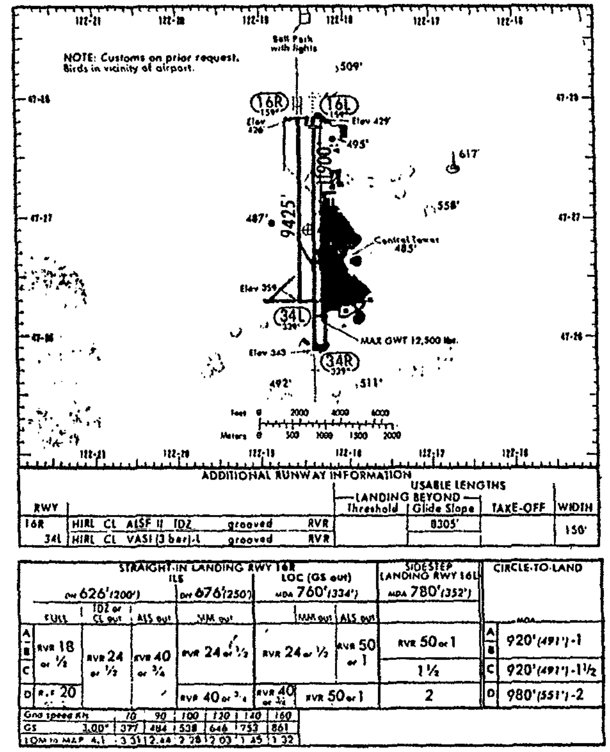
On January 4, 1984 at 1400 local time, a 727-100 on a repositioning ferry flight with six crewmen on board, descended into the runway 16R approach lights at Seattle-Tacoma Airport during a low visibility CAT I ILS approach. The descent through the frangible lights was arrested and the airplane climbed sufficiently to land on the runway with only minor damage.

Weather was: sky obscured, ceiling 200 feet, visibility 1/8 mile, runway 16R RVR 1800 variable 800 to 3000 feet, wind 010° at 3 knots. The captain was at the controls and flew a normal descent profile until decision height. A callout was made at 200 and 100 feet above minimums and decision height. Following the "minimums" callout, the GPWS activated with two "Glideslope" and three "Sink-Rate" warnings. *("Sink Rate" warnings take priority over "Glideslope" warnings when the envelopes overlap.-Ed.)* Then, a crewmember called out, "Pull it up," three times. Sounds of impact followed.

The airplane descended into the frangible approach lights near the inner marker, knocking out three rows, then pulled up above the lights. First ground marks from main gear wheels appeared in the berm just short of the runway. The airplane then became airborne and next touched down on the runway at a point which could not be determined. Then, following the rollout, the captain taxied normally to the gate.

None of the operating or deadheading crew were injured. Crew interaction during the approach could not be confirmed since ship's power remained on for an extended period after landing and all portions of the approach were erased before the "two hundred above minimums" callout.

Maintenance found the left main gear tire damaged and flat, the right main gear door ~~separated and extensive~~ damage to trailing edge flaps as well as punctures in the underside of the fuselage. □



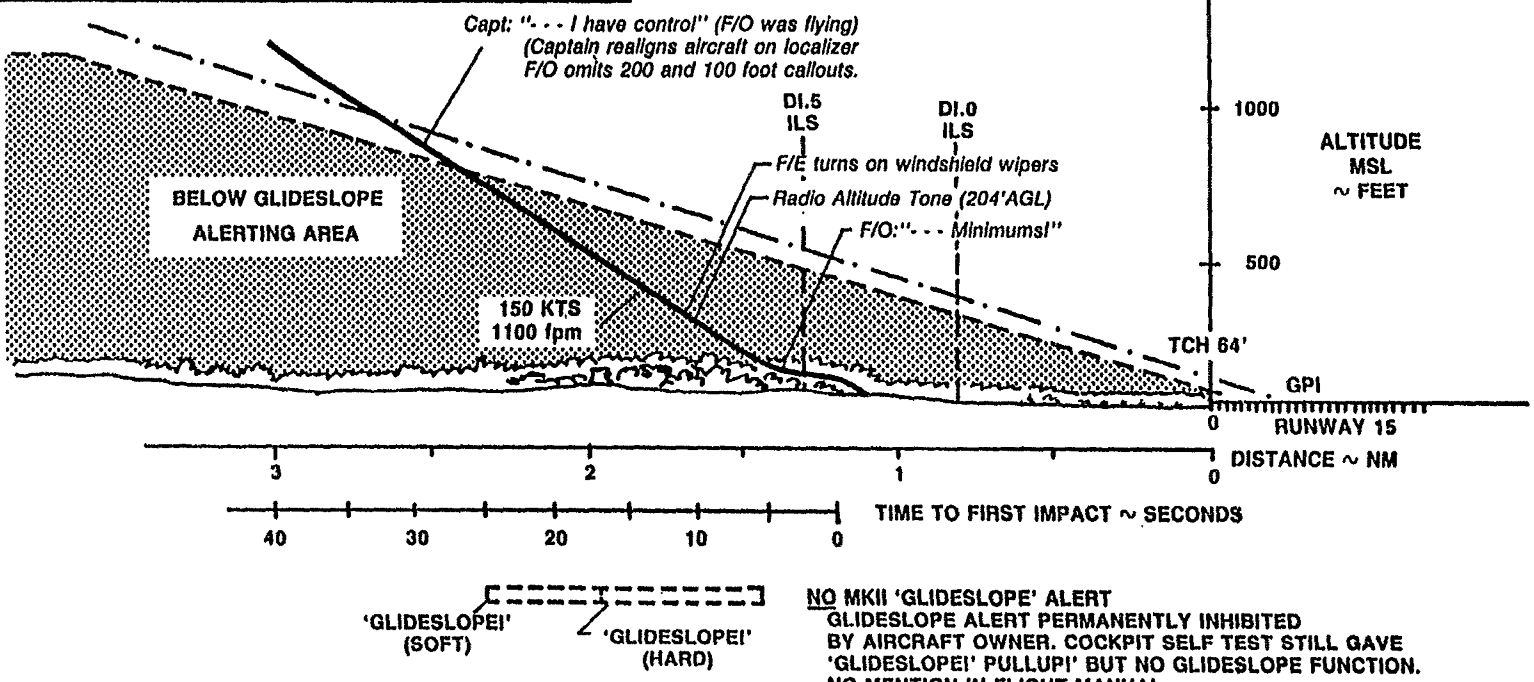
FROM: PAN AM 'FLT OPS'

Next Page

Flight Path Profile

A-300
KUALA LUMPUR, MALAYSIA
18 DECEMBER, 1983

Circumstances:	Aircraft under shot ILS Approach to runway 15 during heavy rain.
Time:	Dusk
Weather:	4 KM visibility, 2/8 500, 2/8 LB 1-700 Rain and thunderstorm east to southeast, northwest and southwest. Temperature 25/24 RVR 450 meters.
	Aircraft destroyed by fire. All 241 on board escaped.



<u>NO</u> MKII 'GLIDESLOPE' ALERT
GLIDESLOPE ALERT PERMANENTLY INHIBITED BY AIRCRAFT OWNER. COCKPIT SELF TEST STILL GAVE 'GLIDESLOPE!' PULLUP!' BUT NO GLIDESLOPE FUNCTION. NO MENTION IN FLIGHT MANUAL.

Return to TOC

MALAYSIA A300 ACCIDENT SUMMARY

The following paraphrased summary is excerpted from the Malaysian Department of Civil Aviation accident report:

On March 18, 1984, in evening twilight, a Malaysian Airlines A300B4 undershot runway 15 by 4595 ft in heavy rain showers on approach to Subang Airport near Kuala Lumpur and was destroyed by impact and fire. The approach, initially flown by the copilot, was unstabilized and the captain eventually took control about 30 seconds before impact. The captain continued descending after passing decision height even though visual reference to the approach lights was not established. All 233 passengers and 14 crewmembers evacuated the airplane without serious injury and shortly thereafter the fuselage was destroyed by post-impact fire.

During the flight's arrival in the Kuala Lumpur area the crew was advised of heavy rain showers at the airport and that RVR was 450 meters; company minimums were 800 meters for the ILS to runway 15. The flight continued. The first officer began the approach "fairly high" and right of the centerline. The captain, seeing the first officer's difficulty, advised him several times to "fly the aircraft" but provided no other guidance.

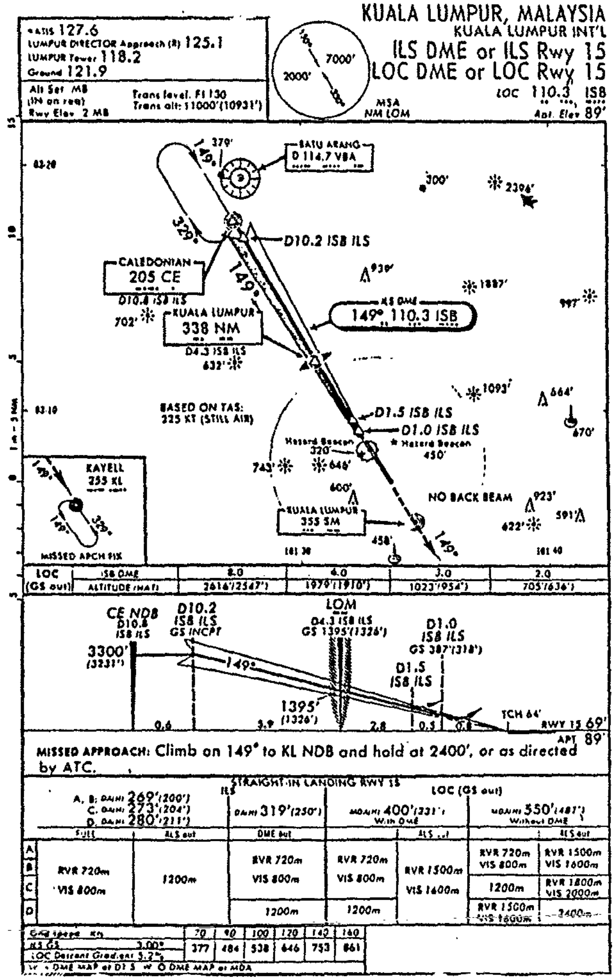
After passing the outer marker, sink rate increased to 1123 ft/min and the airplane went below the glidepath. The company's required "1000 ft flags check" callout normally accomplished by the pilot not flying, was not made. About 30 seconds before impact, with the airplane still not stabilized on the glideslope, the captain took control. Descent was continued (later the captain stated he thought he was on the glideslope and only had to worry about localizer alignment).

The copilot, who resumed support duties after the captain took control, missed the "200" and "100 above minimums" company-required callouts (he was setting the INS to read wind at the time), but he did call "minimums." No GPWS "glideslope" warning occurred as the airplane descended progressively further below the glideslope because SAS, the airplane's owner (the airplane was on lease to Malasian Airlines), had previously disconnected Mode 5 in accordance with their company policy.

A radio altimeter alert tone activated when the airplane passed the preset bug height above touchdown (about 204 ft AGL) but none of the crewmembers responded to the alert. At the time, the report speculated, the flight engineer was somewhat distracted by the act of loosening his seat belt to gain access to the windshield wiper controls on the pilot's overhead panel. The first officer belatedly called out "minimums" about six seconds after the radio altimeter tone. At that point, the captain stated he looked up, saw lights, and continued down. Initial impact with tree tops occurred a few seconds later 1.08 nautical miles from the threshold on the localizer centerline.

The airplane cut a 2000 foot swath on a 4.5 deg angle, banked about 7 to 8 deg right, through rubber, fruit and secondary forest trees, finally skidding to a stop in several feet of water about 4600 feet from runway 15. The main gear and both engines were torn from the aircraft, the nose gear collapsed aft into the fuselage and post-impact fire, fed by fuel from ruptured wing tanks, totally consumed the cabin from the cockpit to the aft pressure bulkhead, burning away the fuselage crown from the nose to the vertical stabilizer. Impact forces were less than 3 g's and all seats remained in place.

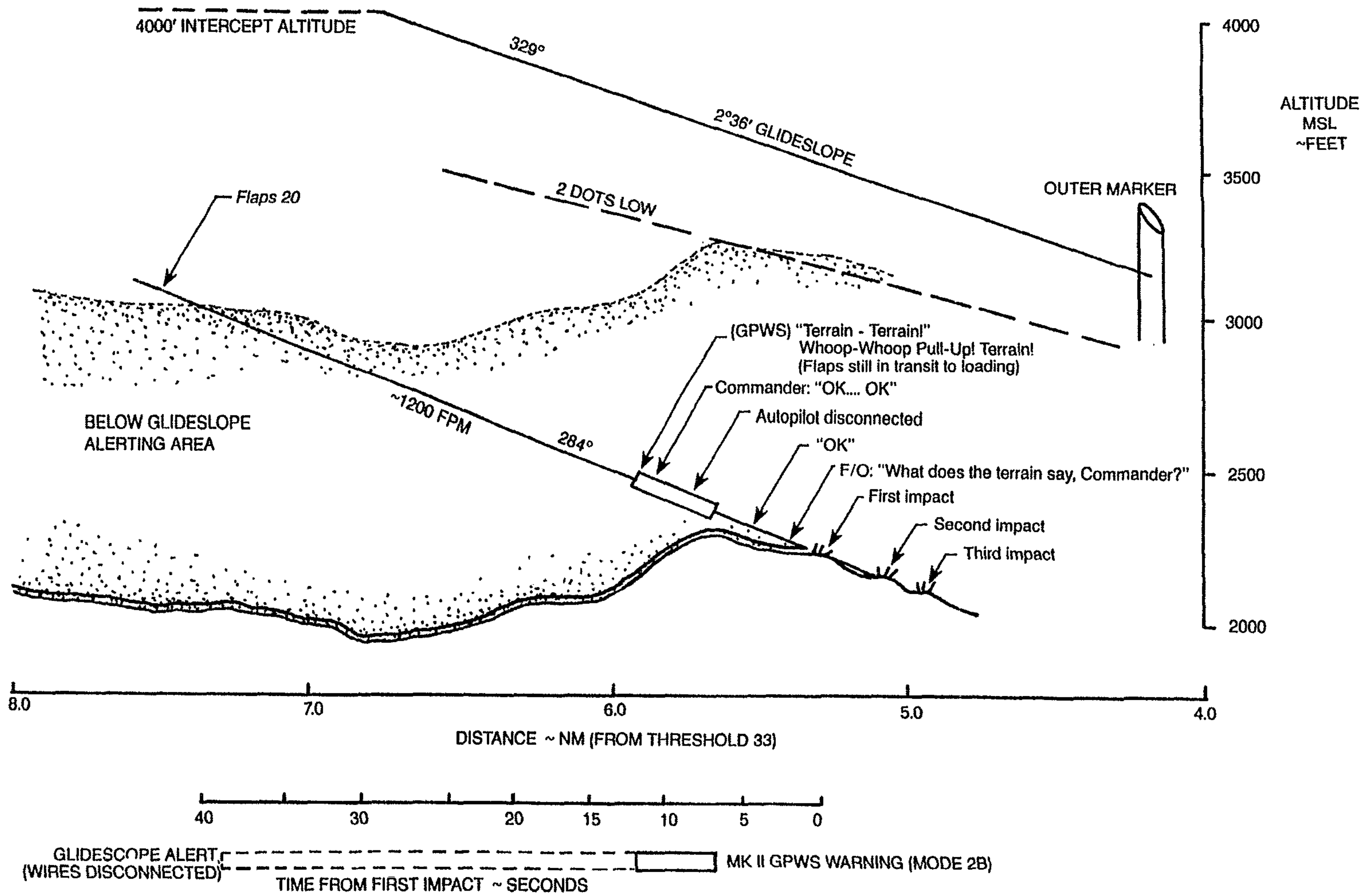
The report credited the flight attendant's selective use of cabin doors and slides (LH 1 and 4 and RH 1 and 2) for the prevention of injuries from the post impact fuel fire outside the airplane and the retardation of the fire entering the fuselage until everyone had gotten out. Evacuation took about 5 minutes. □

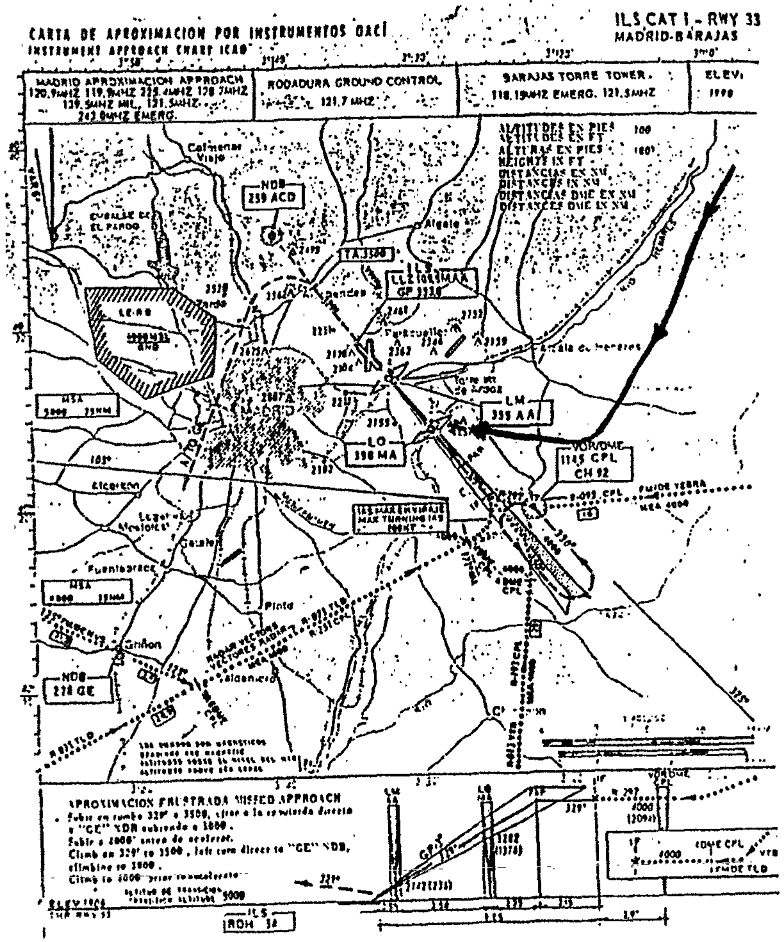


90-282

Circumstances:	Aircraft undershot near outer marker on ILS approach to runway 33.
Time:	Night midnight
Weather:	Wind 180/05 - Good visual condition
Other:	Autopilot altitude controller set inadvertently to 2382' instead of 3282' (transposed digits). GPWS partially disabled! Glideslope wires to GPWS permanently disconnected by aircraft owner - no mention in FLT OPS manual.
Fatalities:	181 out of 192 on board.

FLIGHT PATH PROFILE
B747-200
Madrid
27 November 1983





THE NEW YORK TIMES, MONDAY, NOVEMBER 28, 1983

Death Toll in the Crash of 747 Jet Near Madrid Airport Rises to 183

MADRID, Nov. 27 (AP) — The known death toll in the crash of a Colombian Boeing 747 here today has risen to 183, officials said. The toll made it one of the 10 worst crashes in aviation history.

Only 11 of the 194 people aboard survived the impact and fire, and four of them were in very serious condition, the officials said.

The plane, Avianca's Paris to Bogotá flight, crashed and exploded in a hilly area five miles east of Madrid's Barajas airport soon after 1 A.M.

Airport officials said the jumbo jet carried 170 passengers, 20 crew members and four airline workers who were not on duty.

Authors Aboard Plane

Avianca officials said that the plane, rented from Scandanavian Airlines System, was scheduled to stop in Madrid and Caracas, Venezuela, and that many of those aboard were French and German citizens. It was not immediately known if there were any United States citizens aboard.

Four Latin American authors, two Colombian artists and a Colombian Senator were among those killed.

The writers were on their way to Bogotá for the First Hispano-American Conference on Culture, which was to open Monday. They were Marta Traba, an Argentine-born Colombian citizen; her husband, Angel Rama of Uruguay; Manuel Scorza of Peru, and Jorge Ibargüen Goyta of Mexico.

The Colombian Senator killed was Ana Sixta González de Cuadros. She was installed in office only two weeks ago, replacing a Senator who was killed in a traffic accident.

The two Colombian artists were Tiberio Vanegas and Jairo Téllez.

Also among the reported dead were five Swedish couples on their way to Colombia to pick up five orphans for adoption, Swedish officials said. They said the children were waiting for their future parents at orphanages in different parts of Colombia.

The plane was flying in clear skies at an altitude of 1,000 feet when the pilot, Tulio Hernández, and the co-pilot, Edgard Ramirez, communicated with Avianca officials 25 minutes before the crash.

There were unconfirmed reports one of the four engines caught fire before the plane plunged to earth, but Transportation Minister Enrique Barón said 747's can land with two engines, especially when they are so close to an airport.

Rescue parties using searchlights made their way past charred luggage and blackened pieces of metal to haul bodies away in bags and metal coffins. The bodies were taken by ambulance and helicopter to a hangar at the Madrid airport.

Relatives of some of those aboard the plane gathered outside the makeshift morgue today, waiting their turn to be led by officials past the bodies to identify them.

Modesto Augusto Gómez Rico, a special judge named to investigate the crash, said identification of the bodies would take at least 10 days. "It is a difficult job," he said, "because most of the bodies are charred."

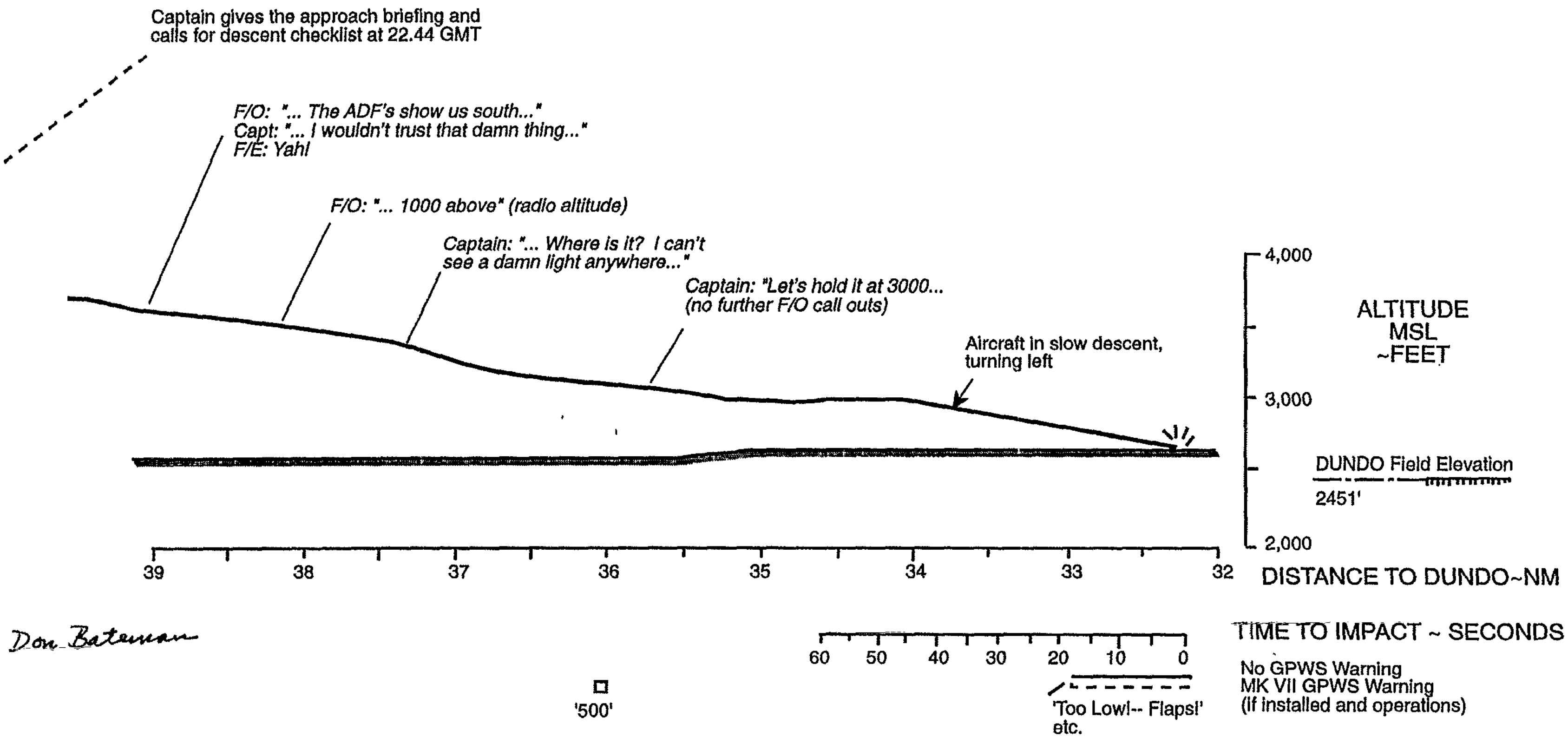
Searchers said they had found the flight data recorder, or "black box," which records information about the airplane's course and conversations in the cockpit. Officials said it could help determine what caused the crash.

The world's worst airline accident occurred on Spanish territory on March 27, 1977, when two Boeing 747's operated by Pan American World Airways and KLM Royal Dutch Airlines collided at the airport at Santa Cruz de Tenerife in the Canary Islands. That incident killed 582 people.

Next Page

CIRCUMSTANCES:	Aircraft let down on approach using dual INS. The crew looking for visual contact, but impacted terrain some 32 nm south of the airport. ADF's indicated airport to north but were not trusted over the INS positions. Probable transposition of the Lauda and Dundo latitudes during initialization of the INS's.
TIME:	23:02 GMT Night
WEATHER:	Clear, dark, no moon.
CONFIGURATION:	Gear down, flaps maneuvering
FATALITIES:	7
OTHER:	Cargo, diesel fuel, 14 tons. Aircraft equipped with MK I GPWS. No warning on CVR. GPWS probably disabled. American aircraft, American crew.

Flight Path Profile
L-382
DUNDO, ANGOLA
27 August, 1983



Don Bateman

Return to TOC

Examination of the wreckage and the voice recorder do not indicate any evidence of mechanical failure or outside influences which might have caused this accident. The CVR conversations indicated that the two (2) Inertial Navigation Systems indicated the aircraft was overhead Dundo Airport when it was actually some thirty (30) nautical miles south of that location. An incorrect entry of the latitude for PGI by entry of the degrees south for PGI (7°S) and the minutes south for LAD (51.0 S) could produce this navigational error.

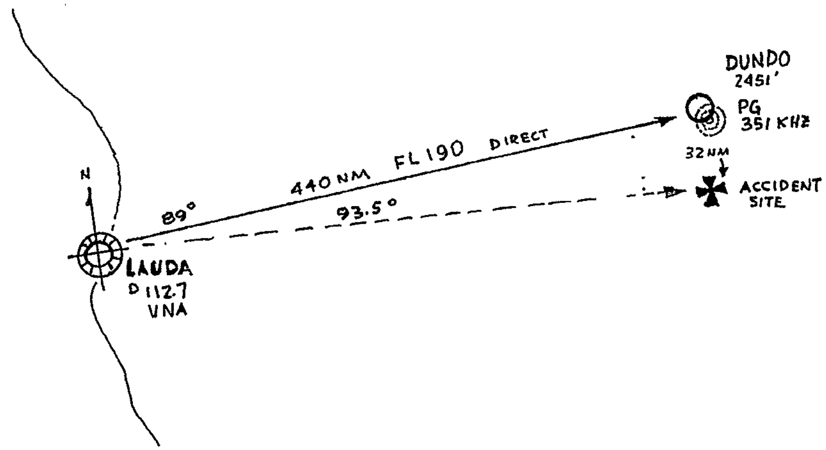
If this transposition of numbers actually occurred, the INS would have been programmed to go 31.4 statute miles (27.2 nautical miles) south of PGI. The Angola Operations Manual contains a chart which is used for determining the INS coordinates of various airports. The PGI and LAD coordinates are listed adjacent to one another, i.e.

(PGI/FNGP S 7° 23.8 E 20° 50.1)
(LAD/FNLU S 8° 51.0 E 13° 14.1) /10

After the accident site had been located, a Company aircraft entered the coordinates as described above at LAD and flew to a location within a mile or two of the accident site as a test of this theory.

The aircraft left its cruising altitude of FL 190 at 2241GMT. At 2244GMT the approach briefing was given by the Captain, including the airport elevation of 2451 feet and the descent checklist called for. There is no indication on the cockpit voice recorder of any mechanical difficulties whatsoever, or of any outside influences on the flight. At 2252GMT the First Officer reported the aircraft was 1,000 feet above the ground. The ADFs, in the opinion of the crew, were not homing reliably on PGI. At 2253MGT the crew feels they are at Dundo, /11 based on the INS information. The aircraft apparently is descended in VFR conditions to 3000' MSL (which is 350 feet above the ground at the accident site). From that time on, no altitude calls are made and the crew is apparently visually searching for the airport or its environs. Three (3) minutes later, at 2302GMT, the aircraft contacted tall trees and crashed. /12

The Accident Committee, based on information available to it, believes the accident resulted from the crews confusion caused by the inconsistent INS and ADF indications and allowing fixation on a visual contact with the ground to disrupt cockpit coordination and altitude awareness, thus flying the aircraft at too low an altitude for the surrounding terrain. The crew apparently considered the ADF bearings they were receiving from the Dundo NDB as being unreliable when it appears the needles were pointing in the direction of Dundo. Over-reliance on the INS led the crew to think they were somewhere where they were not. Being in the wrong location could have resulted from incorrect INS programming.



Don Bateman
8th October 1992

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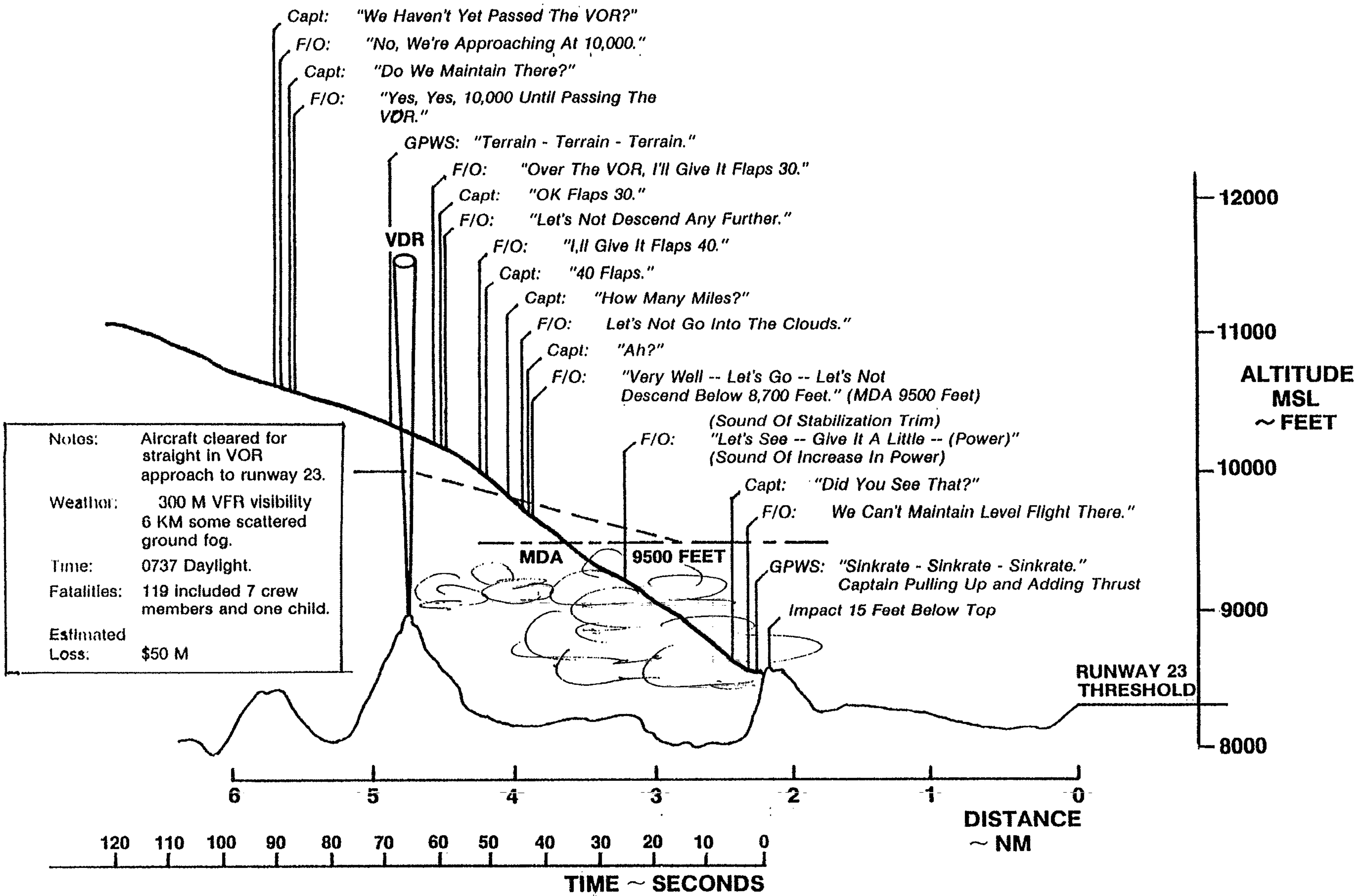
Flight Path Profile

B-737-200 HC-BIG TAME
CUENCA, ECUADOR 11 JULY, 1983



737 Strikes Hill One Mile Short Of Runway At Cuenca, Ecuador

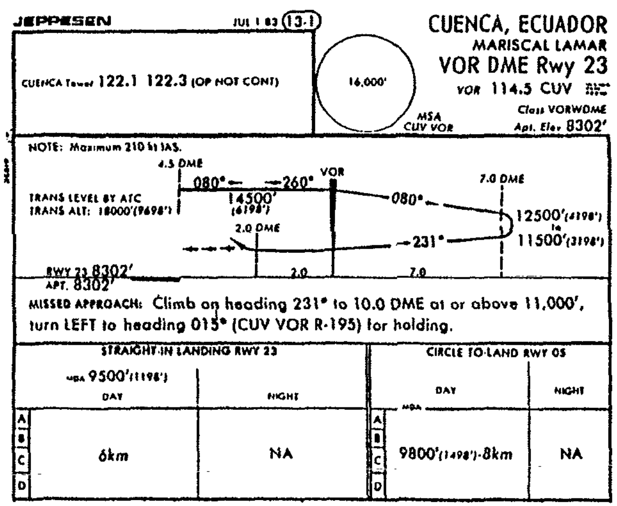
1983

On July 11, a TAME Airlines 737-200 owned and operated by the Ecuadorean Air Force, struck a hill during a daylight IMC approach to runway 23 at Mariscal Lamar Airport in Cuenca, fatally injuring all 119 people on board.

Weather at the airport was clear with approximately 6 miles visibility but hills beneath the aircraft's approach path were reportedly obscured by clouds.

The aircraft struck a cloud-shrouded hill, 200 ft above airport elevation, about 2 miles northeast of the airport. Witnesses said that the airplane disappeared into a cloud bank and that they heard the engines spin-up just before the sound of impact. Wreckage indicates that the aircraft struck the hill about 25 ft below the crest in a nose high attitude with the gear down and flaps set to 40°. The aircraft was equipped with a MK II type GPWS.

The airport is 8302 ft above sea level and has one runway 6234 ft long and 98 ft wide. Neither runway, VASI or approach lights are installed. The approach procedure requires that the crew continue the final three miles of the approach by visual reference to the ground after passing the 2DME missed approach point. Minimum descent altitude at the 2 DME MAP is 1198 ft AFE. This would have required a 400 ft/mi altitude loss from the MAP to the runway. It appears from witness statements, that the airplane descended from the MDA before reaching the MAP.



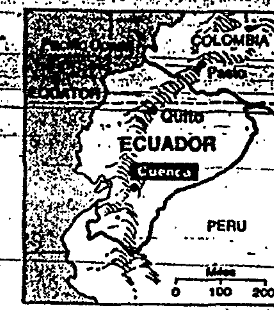
119 Die in Ecuador Airline Crash

QUITO, Ecuador, July 11 (AP) — An Ecuadorean jetliner struck a mountain and exploded while trying to land at the Andes city of Cuenca today, killing all 119 people aboard.

The civil aviation director, Gen. Eduardo Durán, said an investigation into possible sabotage had been ordered after a Cuenca radio station reported that witnesses saw the plane explode before crashing.

Aviation officials said they could not confirm the radio report, and the station later dropped reports of an explosion before the crash and said only that "the plane burst into flames when it hit the side of a mountain."

The Boeing 737 was on a scheduled 40-minute flight from Quito to Cuenca, 190 miles south of the Ecuadorean capital. It carried 112 passengers and a crew of 7, the aviation authority said.



The New York Times / July 12, 1983

Plane crashed on flight to Cuenca.

Most of the passengers were believed to be Ecuadorean civilians. Although the plane belonged to a military airline, Transportes Aereos Militares del Ecuador, it carried both civilians and military personnel and cargo.

The aviation authority said the jetliner crashed in clear weather and with visibility normal on the approach to the Cuenca aiport, which is situated at an altitude of 8,500 feet.

General Durán said that the plane was one of the airline's newest and that a maintenance report showed the jetliner to be in excellent condition.

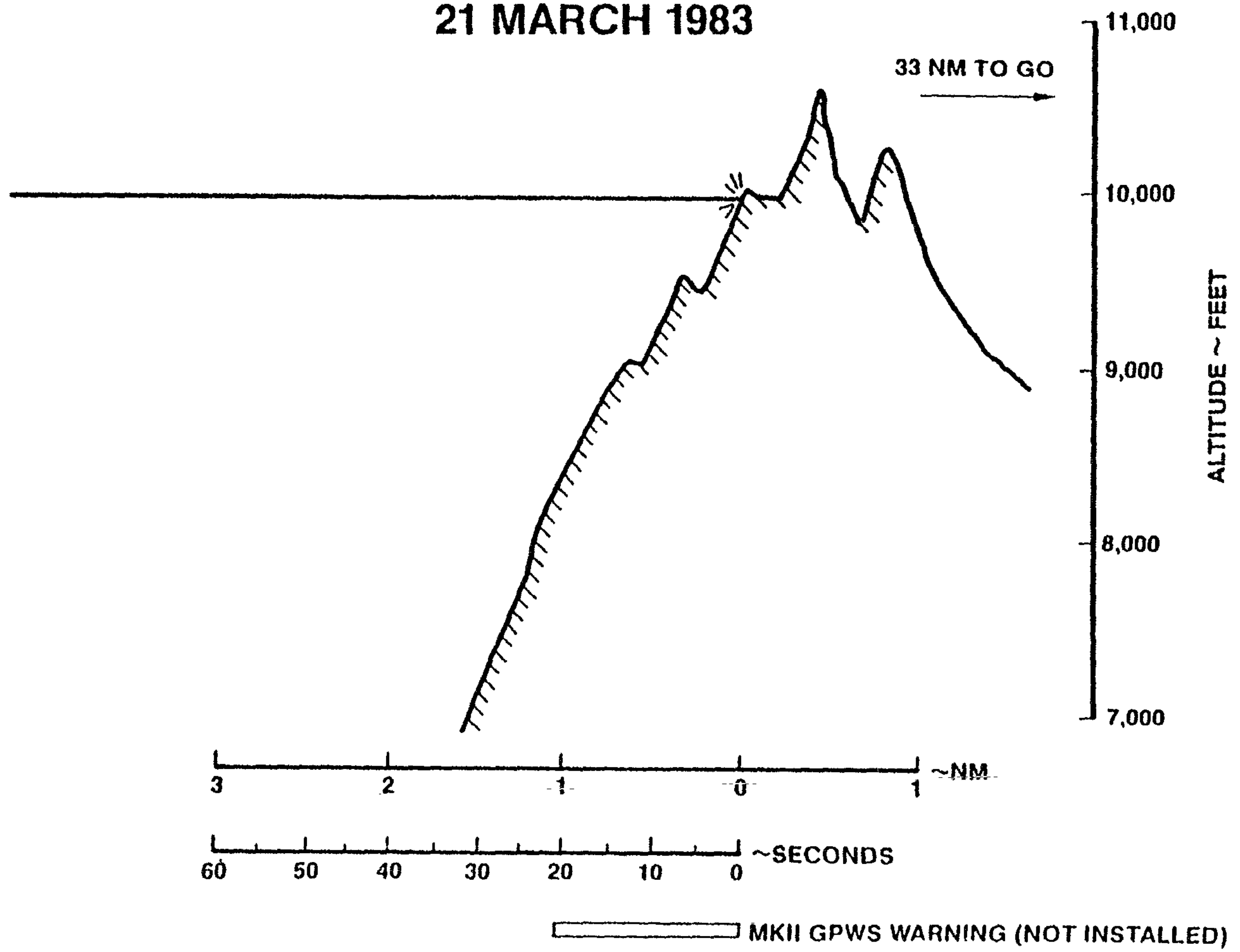
The Cuenca radio station said flames destroyed the plane's fuselage, which ended up about a mile from the end of the airport runway. Soldiers sealed off the crash site.

Officials said the crash occurred at 7:37 A.M. and was the worst civil aviation accident in Ecuadorean history.

In 1979, two jetliners operated by the domestic airline Saeta were involved in separate crashes in Ecuador that killed a total of 110 people.

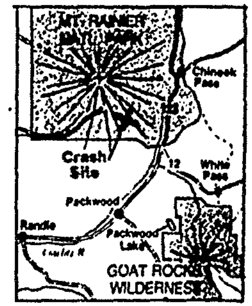
RADAR ENVIRONMENT
INCORRECT VORTAC FREQUENCY SETTING

MT. RAINIER
C-1A
21 MARCH 1983



Rescuers reach plane on Mt. Rainier

Times staff and news services



Search-and-rescue crews from two Air Force helicopters were lowered this afternoon to the wreckage of a Navy airplane with five people aboard that crashed on the southeast face of Mount Rainier yesterday afternoon.

It was not immediately known whether there were any survivors from the twin-engine plane, said Jim Lehman, search-and-rescue coordinator for the Lewis County Sheriff's department at Packwood.

The wreckage was sighted this morning at about the 10,000-foot level of the mountain by the crew of an Air Force Reserve unit helicopter from Portland, search leaders said.

A Navy helicopter from the Whidbey Island Naval Air Station took off at daybreak from Packwood, south of Mount Rainier National Park, said Maj. Thomas Marsh of the Air Force Rescue Coordination Center at Scott Air Force Base in Belleville, Ill.

Four more helicopters, two from the Army at Fort Lewis near Tacoma and two from the Air Force's 304th Air Rescue Division in Portland, joined the search after being refueled in Packwood.

The propeller-driven craft was assigned to the aircraft carrier Constellation, which arrived at the Puget Sound Naval Shipyard in Bremerton Dec. 4 for overhaul. The Constellation's home port is San Diego.

The names of the missing carrier personnel were withheld by the Navy until their families could be notified, said Lt. Cmdr. John Marchi, Seattle Naval Base public-affairs officer.

The plane took off at 1:25 p.m. yesterday on a three-hour instrument-training flight from Kitsap County Airport to Yakima, McChord Air Force Base and then back to the Kitsap County Airport.

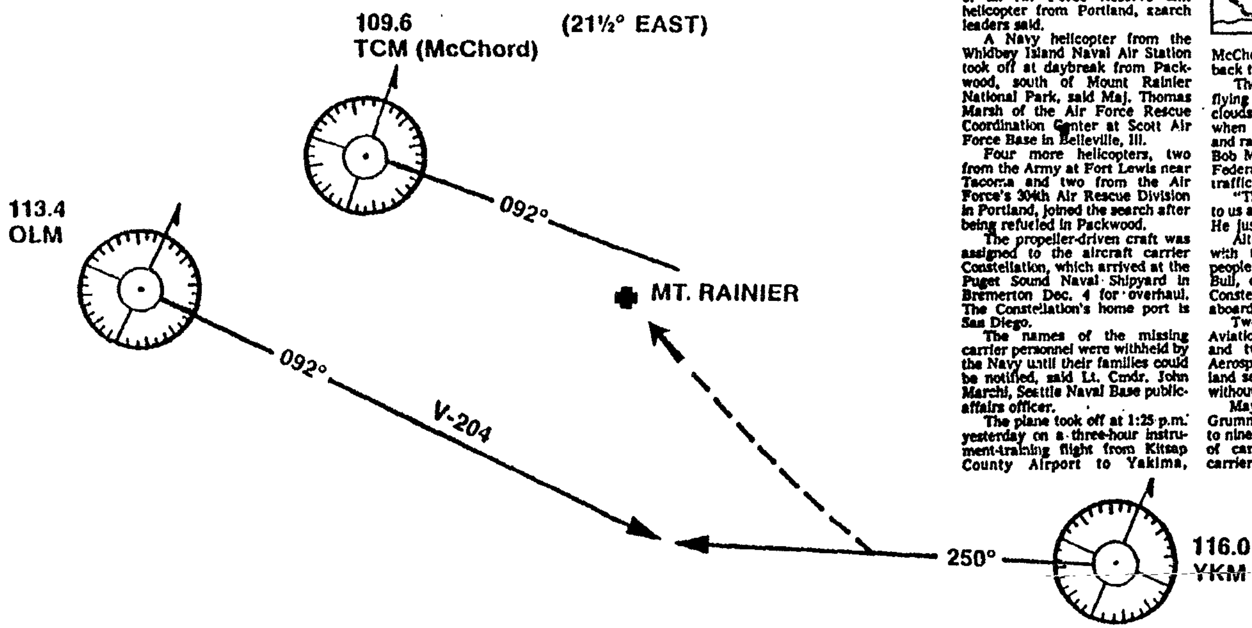
The plane, a C-1A Trader, was flying at 10,000 feet, in scattered clouds but "not bad weather," when it disappeared from radar and radio contact at 3:40 p.m., said Bob Mayo, area manager for the Federal Aviation Administration traffic-control center in Auburn.

"The pilot didn't say anything to us about any problems on board. He just disappeared," said Mayo.

Although the flight plan filed with the FAA listed only four people on the plane, Capt. Lyle Bull, commanding officer of the Constellation, indicated five were aboard.

Two helicopters from the 214th Aviation Battalion at Fort Lewis and two more from the 304th Aerospace Reserve Unit in Portland searched the area until dark without finding the plane.

Mayo said the plane, built by Grumman, is designed to carry up to nine passengers or 3,500 pounds of cargo to and from aircraft carriers at sea.

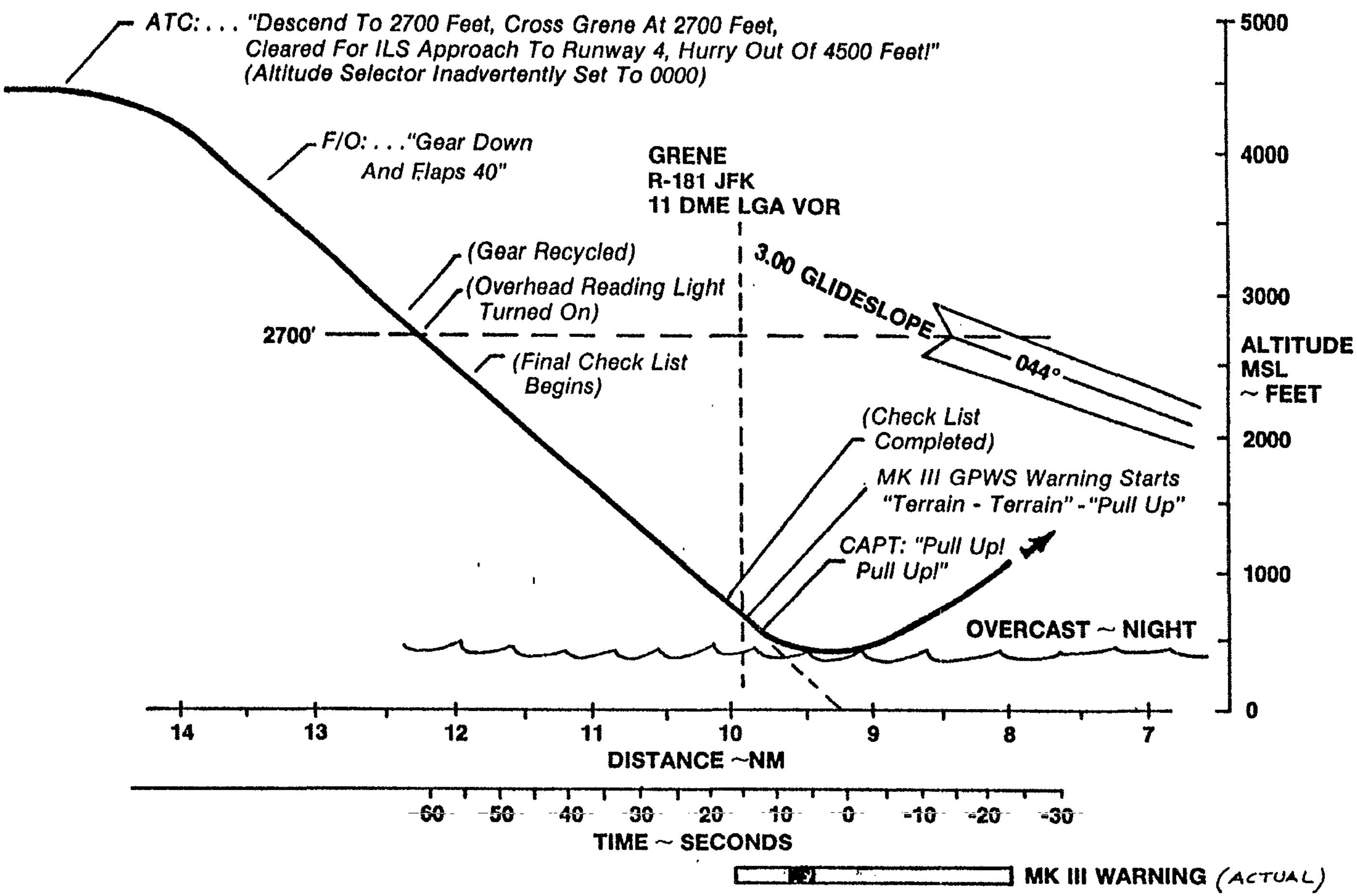


Next Page

The Last "Safety Net"--GPWS

B 767 LA GUARDIA FEBRUARY 1983

**BACK UP TO TWO PROFESSIONAL PILOTS
PROCEDURES, CHECK LISTS, ALL DIGITAL CRT
COCKPIT, FMS, AFCS, FWS, PROFESSIONAL ATC,
ARTS III MSAWS**



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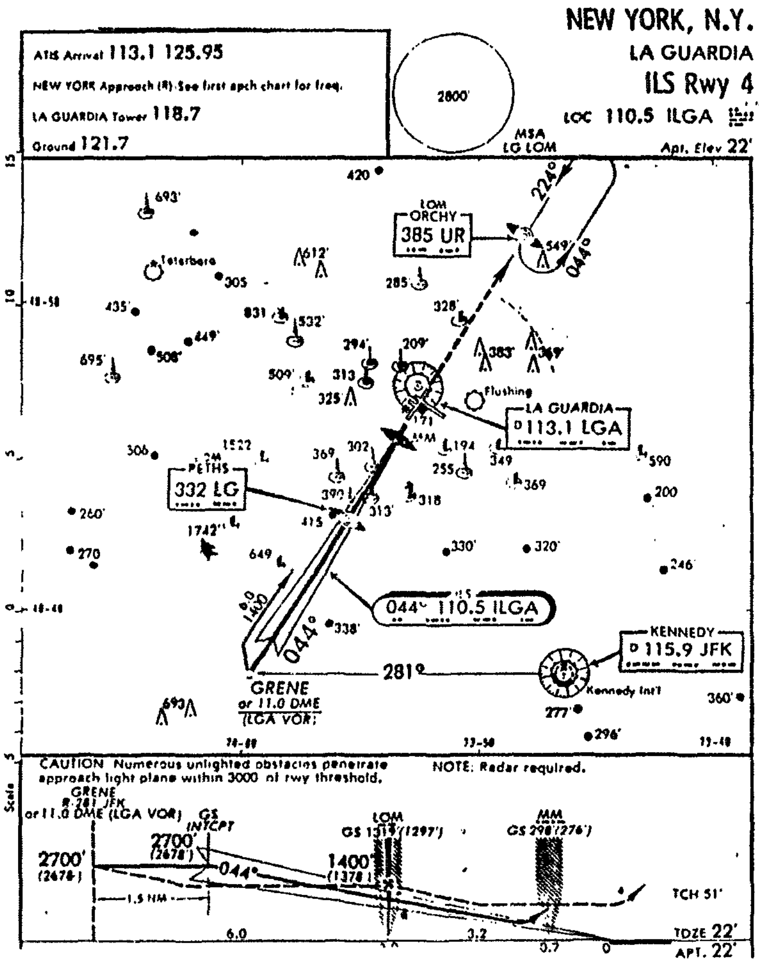

On final approach into LGA with the weather 400 foot overcast the descent was made below the minimum maneuvering altitude. I feel that a dangerous situation existed this time, and I will try to give a history of the events.

Our clearance was "descend to 2700 feet cross GRENE at 2700 feet, cleared for the ILS approach to runway 4, hurry out of 4500 feet". Using the flight level change mode on the mode control panel we descended to 2700 feet. The first officer was flying and asked for flaps 20, gear down. Acting as co-pilot and doing the co-pilot duties put the gear handle down and the flaps at 20°. The gear amber light was on, so it was necessary to recycle the landing gear.

Three green lights appeared after cycling. It was night time so I turned on the overhead reading light and completed landing check list. As I was replacing the check list to the card holder the GPWS sounded two pull-up warnings and I said "pull-up, pull-up". The auto pilot was disengaged and maximum power was added. At about this point we crossed the LOM. An attempt was then made to get back on the localizer and glide slope but we were not able to do so. A missed approach was made and another approach in landing was uneventful. On the missed approach the altitude select on the mode control panel indicated 0000. Neither of us know how they got there.

The aircraft was descending below the glide slope all the way down and did not capture, but was going to 0000 as asked for by the altitude selector.

I feel that there was some failure in the system as well as in the coordination of the flight crew, I feel that we all must be more cognizant of the fact that the monitoring of the B-767 instruments must be absolutely primary by both pilots. We may have been saved by the GPWS and I feel that closer monitoring by both pilots would have prevented this situation. The only reason I write this is to once again alert each of us to the many traps these new concepts and the new instrumentation can lead us into. Heads Up is the answer.

The author wants to alert B-767 crew members about the uniqueness of their aircraft and its instrumentation. Flight Safety would like to remind ALL crews, not just the B-767, one pilot must fly the aircraft and continually monitor its progress.

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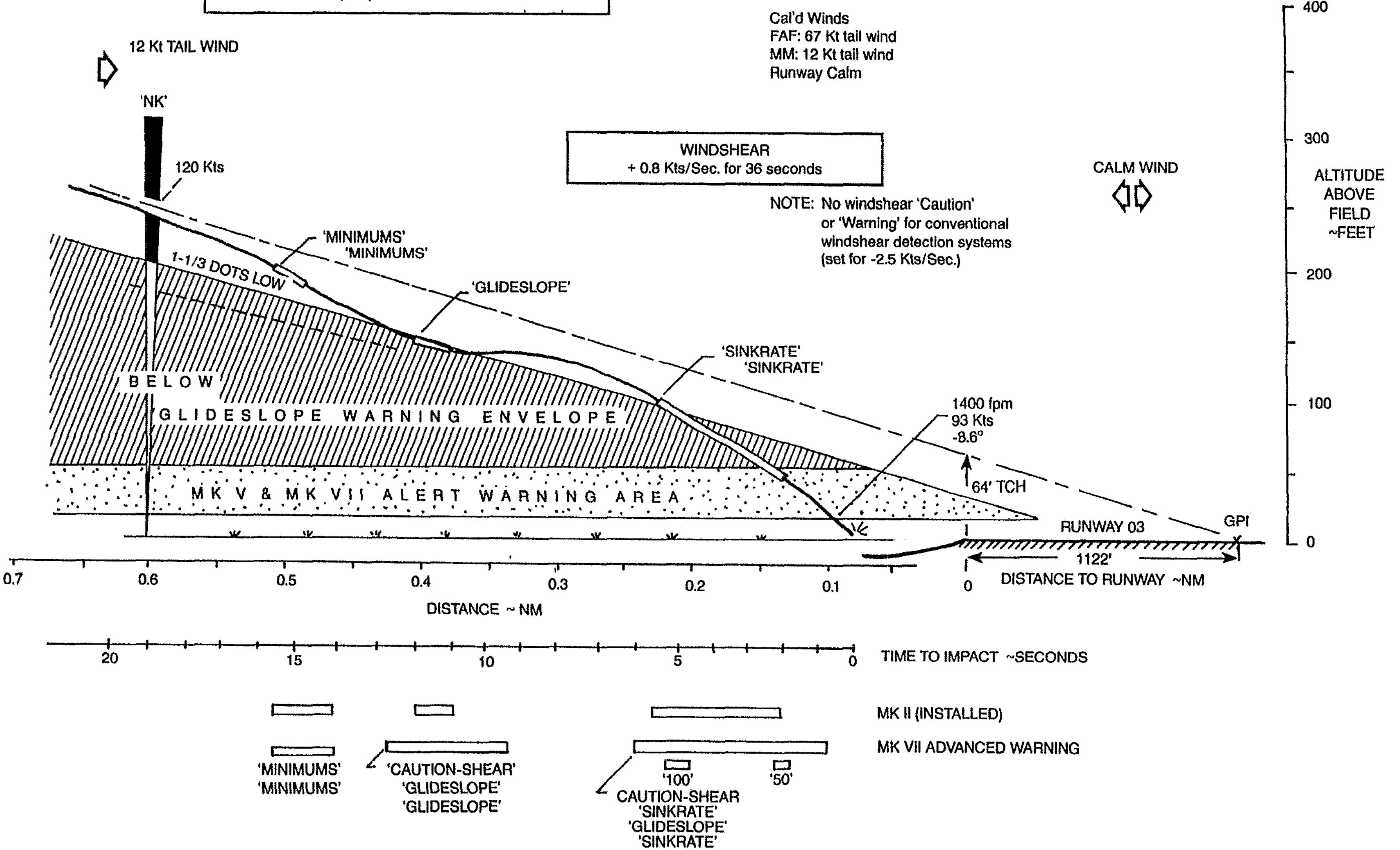
FLIGHT PATH PROFILE

90-282

B-727
Ankara, Turkey
16 January 1983

Circumstances:	Aircraft hit 150 m short during Cat II ILS runway 03 approach broke into three pieces and caught fire.
Time:	23:57 local
Weather:	Ceiling 200 feet. Wind Calm. Visibility 600m, snow
Fatalities:	(Fire) 47 out of 60 on board.



Return to TOC

MONDAY, JANUARY 17, 1983

46 Killed in Ankara As a Turkish Jetliner Goes Down in Storm

ANKARA, Turkey, Jan. 16 (AP) — A Turkish Airlines jetliner carrying 67 passengers and crew members crashed while landing in a storm at Ankara's airport today and 46 people were killed, the authorities reported.

Fourteen passengers and all seven crew members — a pilot, co-pilot and four flight attendants — survived the crash, officials said. The survivors were taken to hospitals, but their conditions were not known.

The semiofficial Anatolia News Agency said the Boeing 727 was arriving from Istanbul. Government officials said two foreign passengers were aboard. One was listed as a Briton and the other as a Rumanian, but further identification was not available.

Earlier reports said the flight originated in Luxembourg or Paris, but officials said it was a domestic flight.

Caught Fire as It Broke Up

The state radio reported that the road to Esenboga Airport was closed to traffic except for ambulances and official cars.

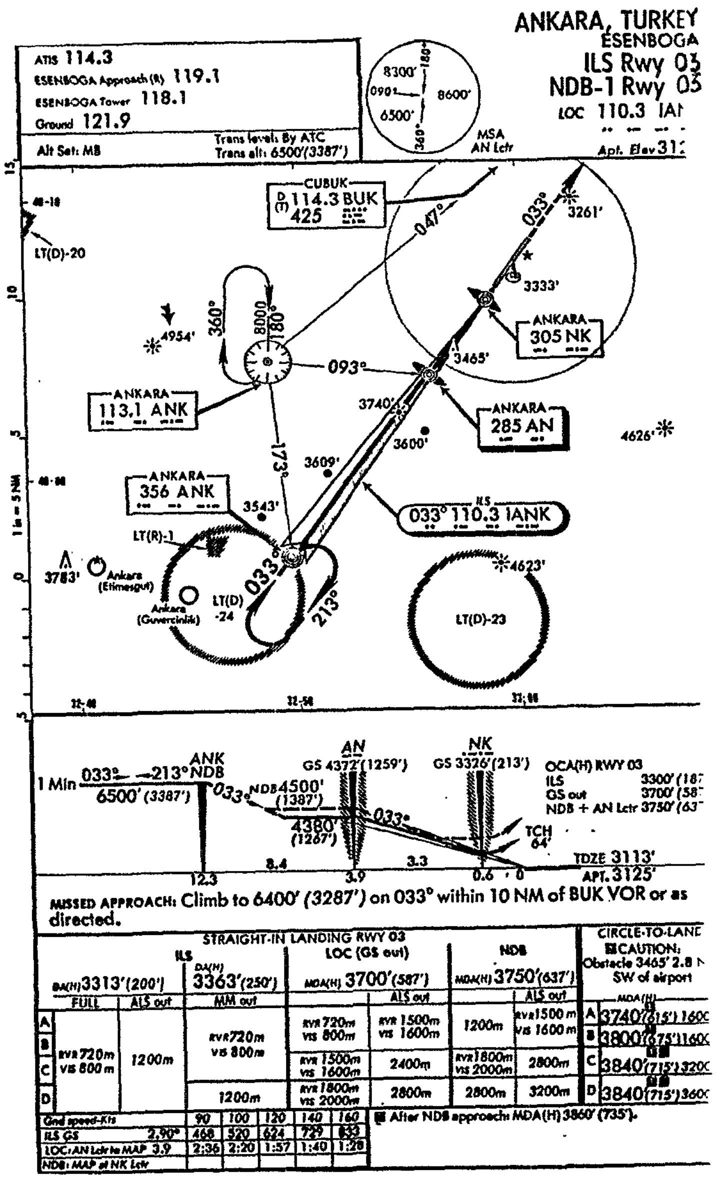
Airport officials said the plane crashed at 10:30 P.M. (2:30 P.M., New York time). They said heavy snow and high winds caused the craft to plunge off the runway and it caught fire as it broke up.

Anatolia said the three-engine jetliner split in two before catching fire. It reported that some rescue workers were fighting to extinguish the fire as others pulled the victims from the wreckage.

Most of the survivors were in the front section of the plane, the agency said.

Prime Minister Bulent Ulusu and Communications Minister Mustafa Aysan went to the scene to help oversee rescue efforts.

The crash was the sixth involving a Turkish Airlines planes in the last 10 years.



Next Page

ESTIMATED

Flight Path Profile

CL-600
HAILEY, IDAHO
3 JANUARY, 1983

NOTES:

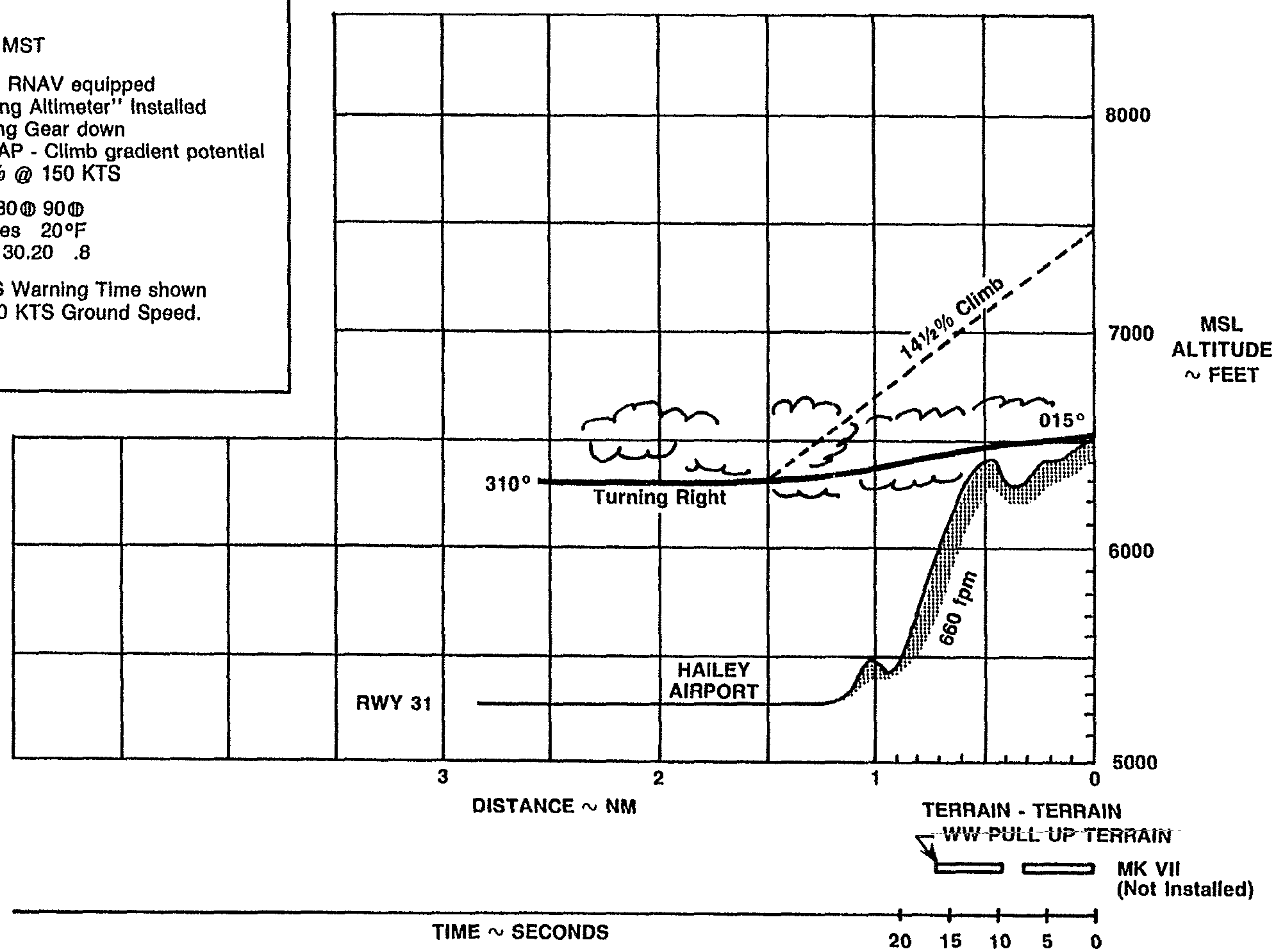
Time: 0 910 MST

VLF Ω RNAV equipped
"Talking Altimeter" installed
Landing Gear down
25 FLAP - Climb gradient potential
10½% @ 150 KTS

Wx: 10⌽ 30⦶ 90⦶
20 miles 20°F
34/4 30.20 .8

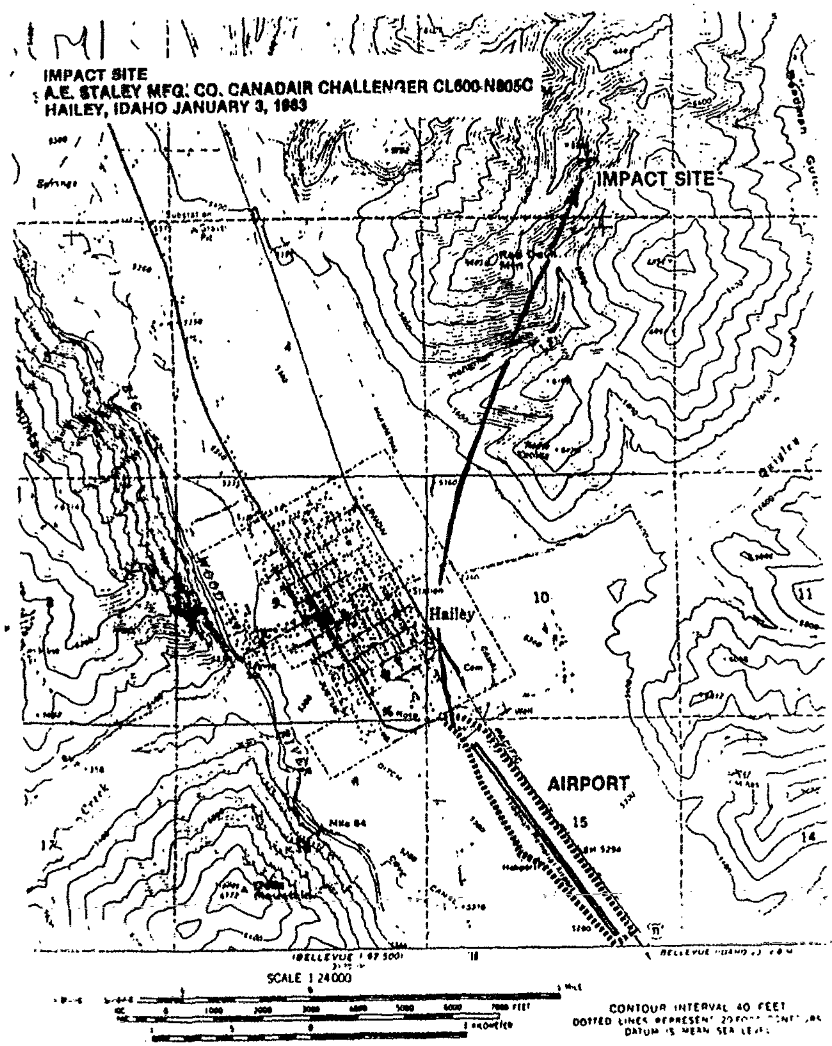
GPWS Warning Time shown
for 160 KTS Ground Speed.

Fatalaties: 2



APPENDIX D

IMPACT SITE



NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: September 7, 1983

A.E. STALEY MANUFACTURING COMPANY, INC.
CANADAIR CHALLENGER CL-600, N805C
HAILEY, IDAHO
JANUARY 3, 1983

SYNOPSIS

About 0910 mountain standard time on January 3, 1983, N805C, a Canadair Challenger CL-600, owned and operated by the A.E. Staley Manufacturing Company, Inc., Decatur, Illinois, crashed into a mountain about 2.2 nmi north of the Friedman Memorial Airport, Hailey, Idaho (Sun Valley Airport). At the time, the airplane was proceeding to land at the airport.

Shortly before the accident, N805C had completed an instrument flight rules (IFR) flight from Decatur to Sun Valley Airport and had descended in visual flight rules (VFR) flight conditions. The weather at the airport was overcast, ceilings were reported to have been between 800 and 1,500 feet overcast, and the visibility was 10 miles. The base of the clouds were below the tops of the surrounding mountains.

N805C missed the airport, flew to the north over the town of Hailey, and into an area of lowering ceilings and worsening visibility. After passing the airport, the pilot attempted to climb above the mountains.

The airplane was destroyed upon impact and the pilot and copilot, the only persons on board, were killed in the crash.

The National Transportation Safety Board determines that the probable cause of the accident was the flightcrew's failure to adhere to the recommended visual arrival procedures for the Sun Valley Airport and its failure to execute timely terrain avoidance actions. The reasons for the flightcrew's failures could not be established conclusively. Contributing to the accident were meteorological conditions and the obscuration of terrain features and landmarks by snow that made navigation by visual references and terrain avoidance difficult.

1. FACTUAL INFORMATION

1.1 History of the Flight

At 0613 m.s.t. 1/ on January 3, 1983, N805C, a Canadair Challenger owned and operated by the A.E. Staley Company departed Decatur, Illinois, was on an IFR RNAV 2/ flight plan to Friedman Memorial Airport, Hailey, Idaho. The route of flight was

1/ All times herein unless otherwise noted are mountain standard time based on the 24-hour clock.
2/ IFR - Instrument Flight Rules; RNAV - Area Navigation, a method of navigation that permits airplane operation on any desired course within coverage of a station.

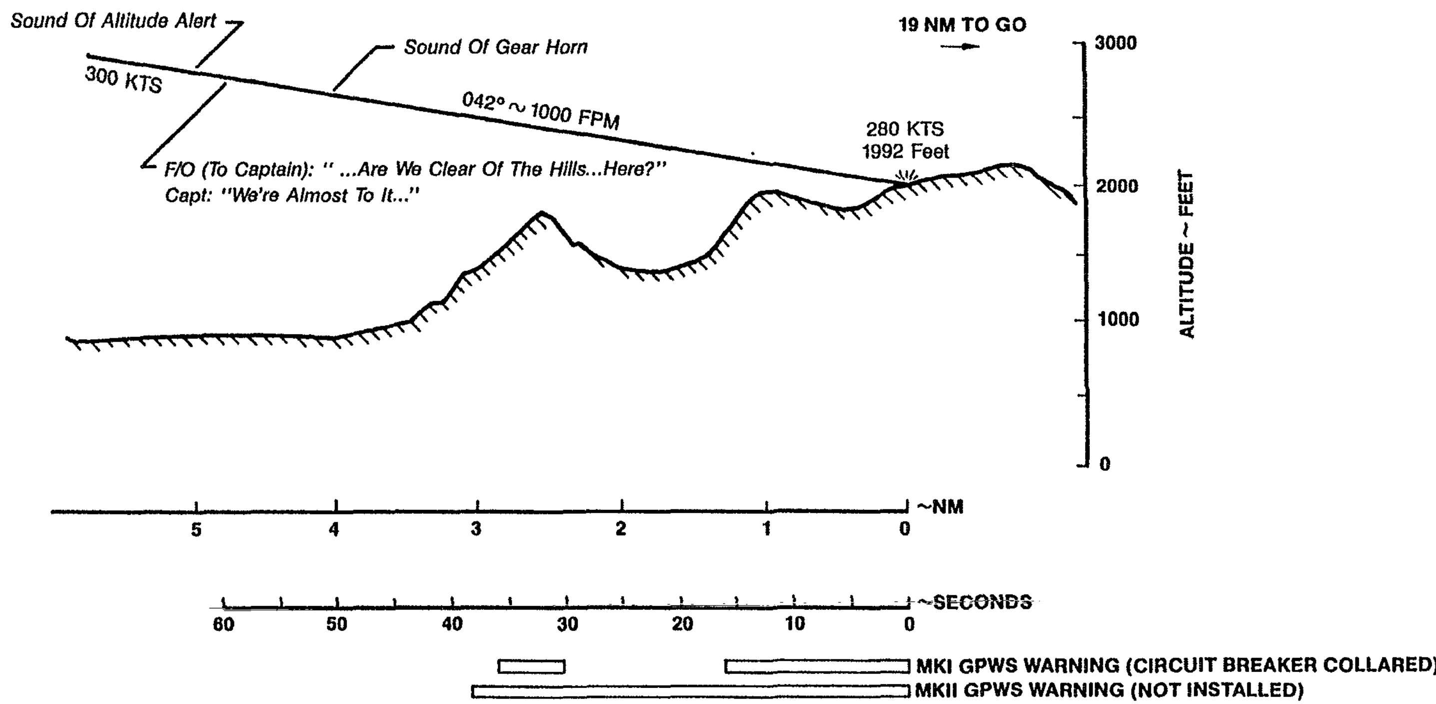
Next Page

INITIAL APPROACH
VISUAL PREMATURE DESCENT

FORTALEZA, BRAZIL
B727
8 JUNE 1982

Circumstances:	Hit hillside, on night *visual* initial approach. Mk I installed but circuit breaker clipped because GPWS was not installed on other airline aircraft. (Aircraft was leased from Singapore).
Time:	02:45 Local Time
Configuration:	Landing Gear Up
Fatalities:	137 (9 Crew)

Cleared to 5000 feet, but continued to descend to 2000 feet, the pattern height.



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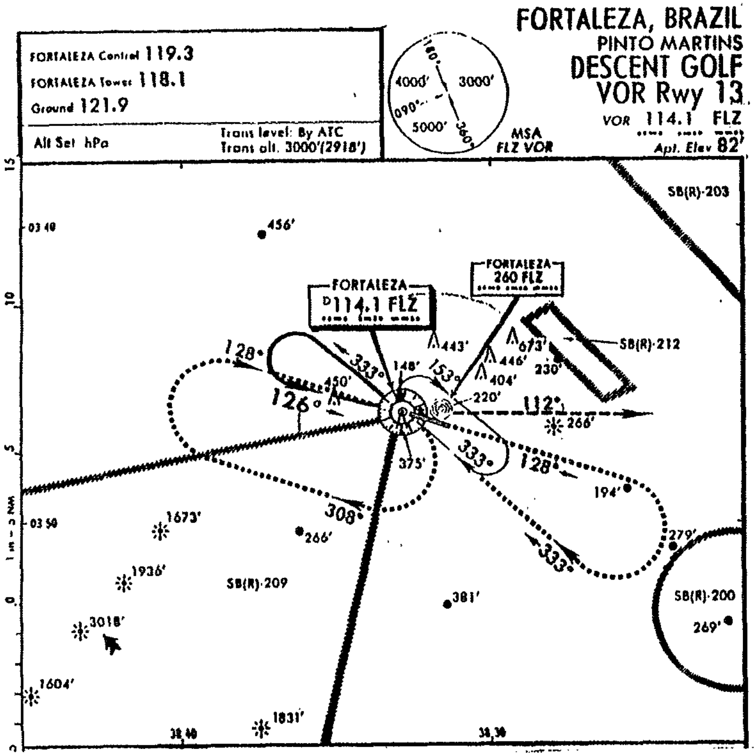

137 Said to Die in Crash Of Brazilian Airliner

FORTALEZA, Brazil, June 8 (AP) — A Brazilian airliner crashed into a mountaintop in heavy rain outside this northeastern coastal city early today, killing all 137 people on board, air force rescue teams reported.

The VASP airlines Boeing 727, carrying 128 passengers and 9 crew members, was on a regularly scheduled flight to Fortaleza from Rio de Janeiro when it crashed in the Pocatuba Mountains 30 miles south of here.

Maj. Luis Gonzaga Lopes, coordinator of the rescue operation, said in a television interview that "the helicopters have located the wreckage of the plane and have informed me that, unfortunately, there are no survivors.",

An airline spokesman said he was "waiting for the rescue patrols to come back" before making an official statement on casualties.

A report from the air force teams indicated the rescue operation was being hampered by heavy fog and the terrain at the crash site. The cause of the crash was not immediately known.

8.6	Boeing 727	PP-SRK	VASP	Nr Fortaleza Brazil	Scheduled Passenger	137	Crew	9	0	0	Destroyed
							Pass	128	0	0	

The aircraft, which was on a night flight from Rio de Janeiro, crashed into a 2500 ft wooded hillside on Pacatuba mountain during an IMC descent to Fortaleza. All 137 on board were killed and the aircraft was destroyed by impact and post-impact explosion and fire.

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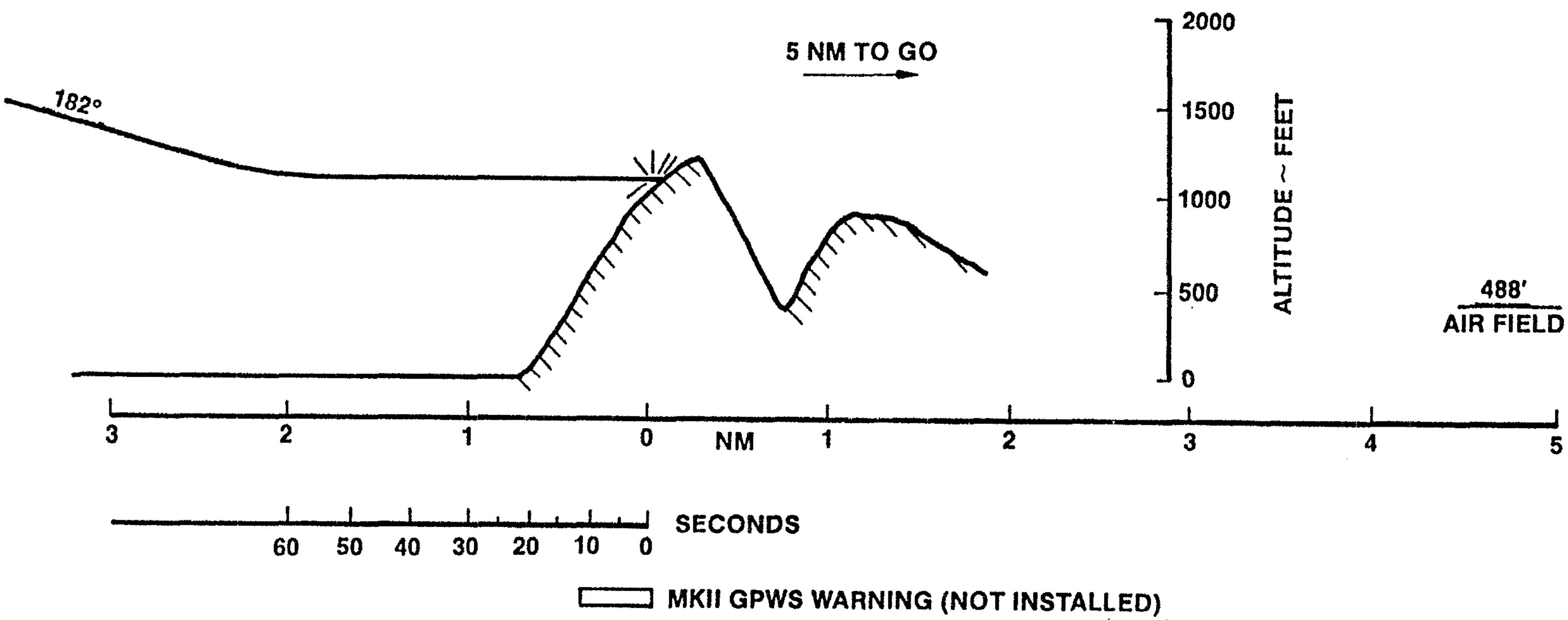
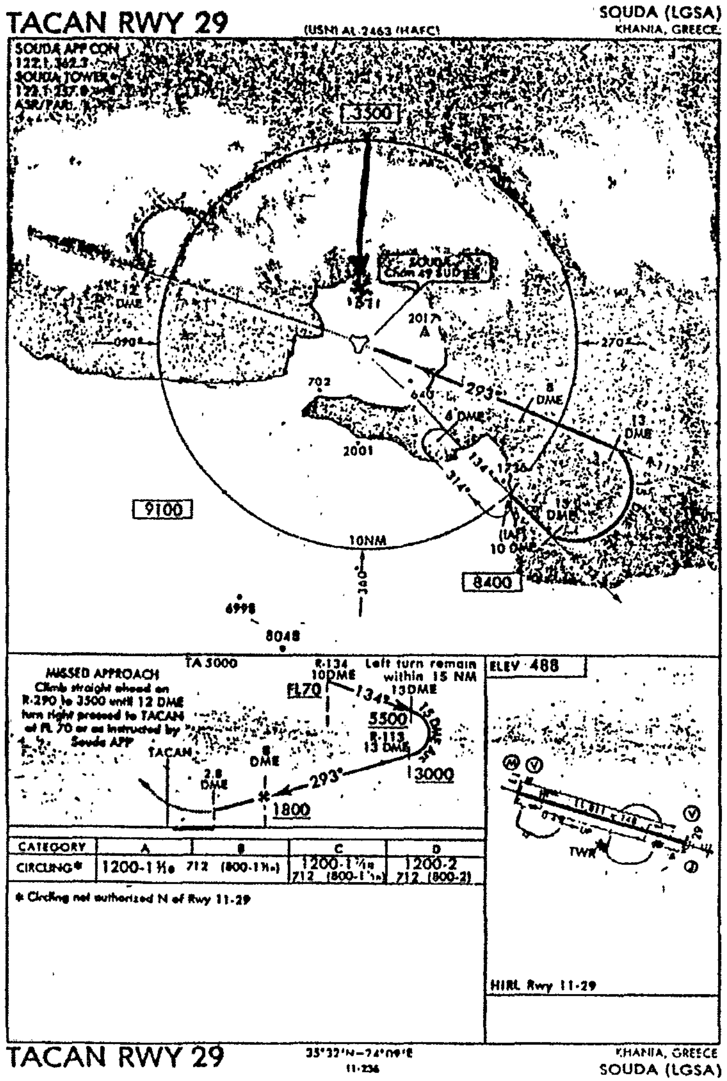
NIGHT VISUAL APPROACH — PREMATURE DESCENT

Notes: Aircraft departed USS Aircraft Carrier Eisenhower Night Tacan Approach.Gear Up. Unlimited Visibility. 11 Fatalities

SOULA BAY, CRETE
C-1A
3 APRIL 1982





A 10 The Seattle Times Monday, April 5, 1982

11 bodies taken from plane crash, say Greeks

CANEA, Crete (AP) — Rescuers have recovered the bodies of all 11 men from a U.S. Navy cargo-passenger plane that crashed into a mountainside on Crete, Greek military sources said today. The Navy said it could not immediately confirm the report.

Four crewmen and seven passengers were aboard the C-1A Trader when it took off from the Norfolk, Va.-based aircraft carrier Eisenhower on Friday for a flight to Souda Bay, Crete.

The wreckage was found yesterday, scattered 800 to 1,200 feet up a mountain [illegible] miles north of Souda Bay, said Lt. Cmdr. Tom Connor, spokesman for Naval Air Force Atlantic headquarters in Norfolk.

The Greek sources, who asked not to be identified, said all 11 bodies were found by a crew that began searching at dawn. Connor said he could not confirm the report.

The crew members were identified as Cmdr. Richard Beiser of Cincinnati, Ohio; Lt. Cmdr. Bruce Cook of Laporte, Ind.; Petty Officer 1st Class Carter Criz of Syracuse, N.Y., and Airman Brian Haley of South Yarmouth, Mass.

The passengers were identified as Petty Officer 1st Class David Newbill of Miami; Petty Officer 1st Class Michael Nichols of Phoenix, Ariz.; Petty Officer 1st Class Brian Lafferty of Aurora, Colo., member of a tactical electronic-warfare squadron based on Whidbey Island, Wash.; Petty Officer 3rd Class Miles Glover of Goose Creek, S.C.; Petty Officer 2nd [illegible] Michael Davis of Ellsworth, Maine; Petty Officer 3rd Class John [illegible] of Campbell, [illegible] and Petty Officer 2nd Class Kenneth Sorby of [illegible]derson, S.C.

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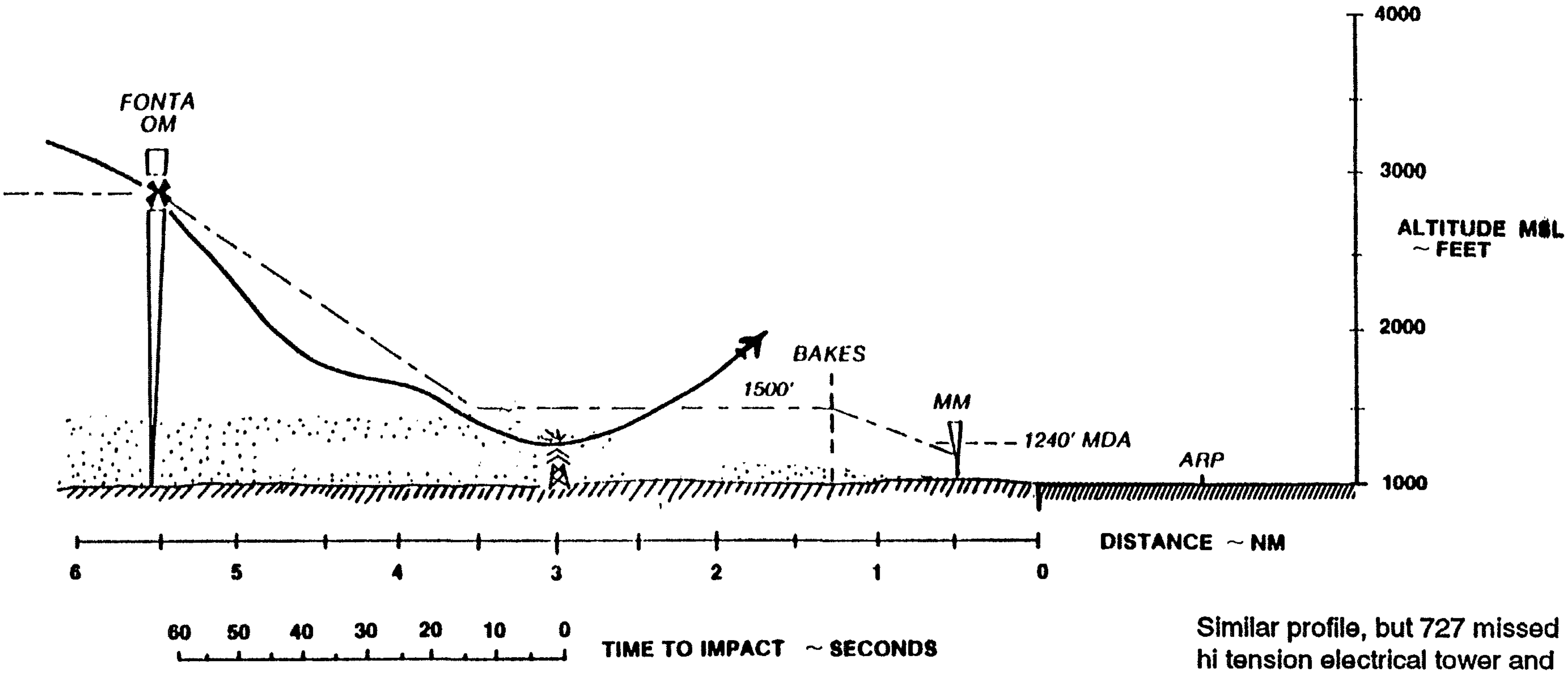
Flight Path Profile

B737, (122 ON BOARD)
LOCALIZER APPROACH TO RUNWAY 26L AT NIGHT
ONTARIO, CALIFORNIA
15 FEBRUARY, 1982

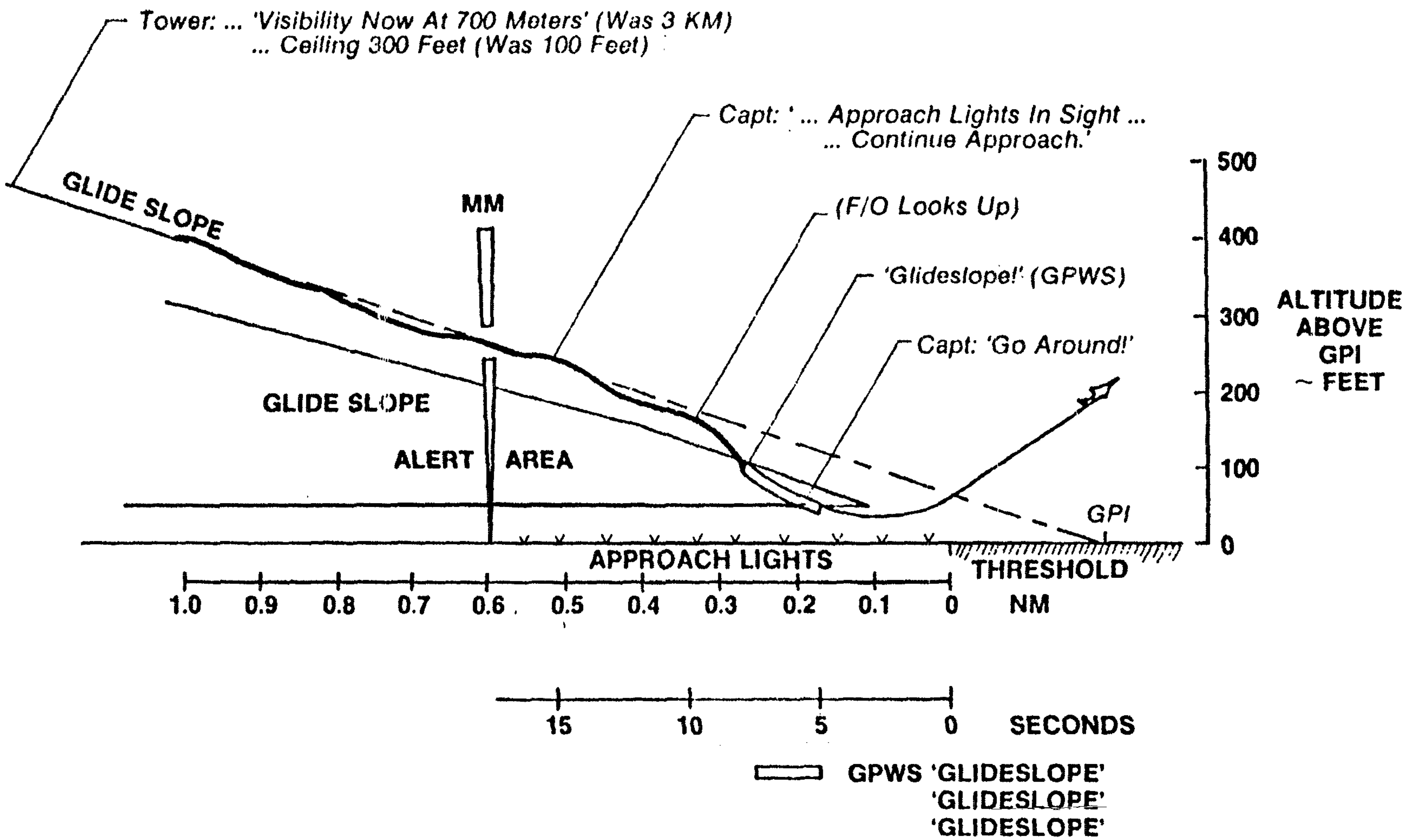


Similar profile, but 727 missed hi tension electrical tower and wires 15 minutes earlier.

SIMILAR INCIDENT:
8 Sept 1989 Kansas City B737

GPWS Incident - Visual Transition

B-737 DECEMBER 1981



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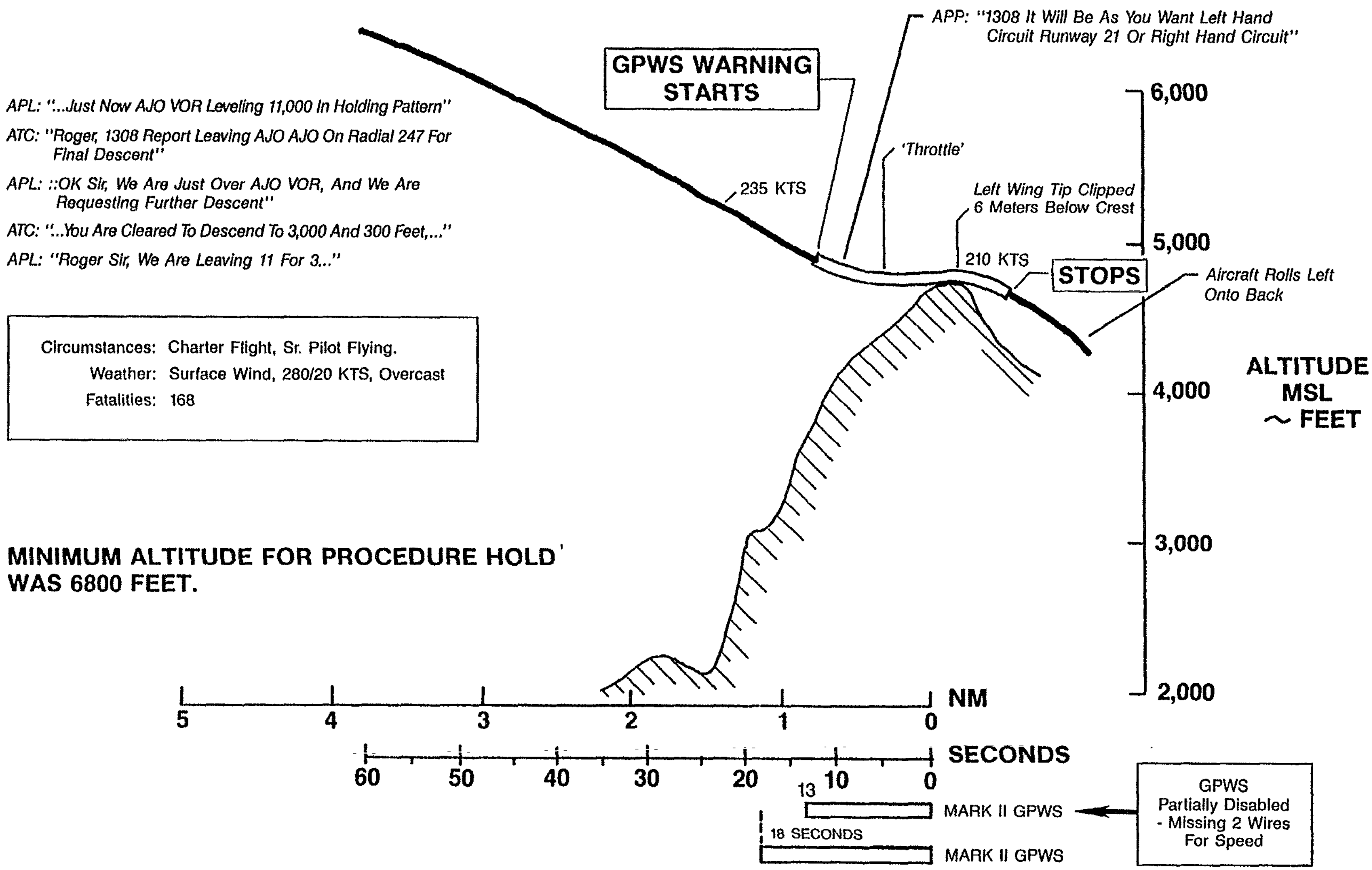
Radar Into Non-Radar Environment

AJACIO VOR/ILS03

MD-80 CORSICA 1 DECEMBER 1981



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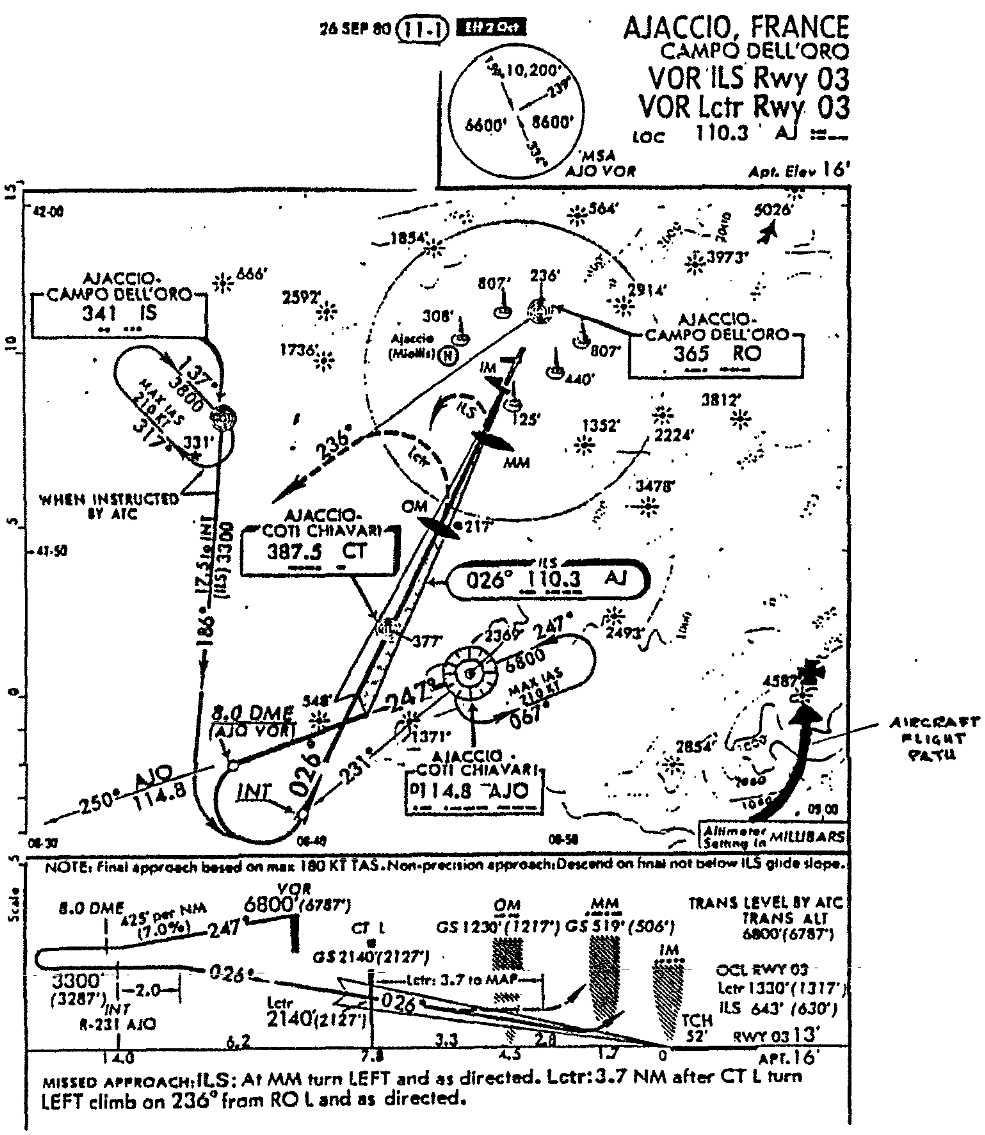


1 Oct '81

178 killed as Yugoslav jet hits mountain

AJACCIO, Corsica — (AP) — A chartered DC-9 airliner carrying 172 Yugoslav tourists and six crew members slammed into a fog-shrouded mountain 30 miles from the airport here today, killing all aboard.

Ajaccio police said the wreckage of the Yugoslavian Inex-Adria Airways craft was found by search parties on the slopes above Casa Casalabriva, about 30 miles south of Ajaccio airport, nearly four hours after radio and radar contact with the plane was lost.

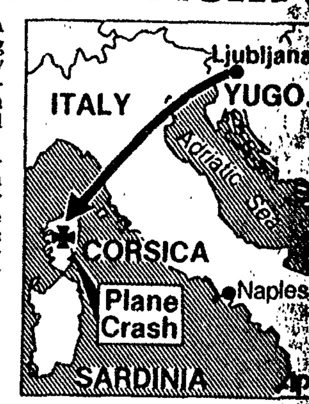
High winds and fog had hampered efforts to locate the downed plane.

Police said the DC-9 crashed on the west face of Mount San Pietro. Bodies were scattered on the sides of the mountain among the debris of the aircraft, they said.

Civil-defense workers were taken to the scene by police helicopter.

Ajaccio airport is blacklisted by the International Federation of Airline Pilots Associations, which says landing equipment aids are not modern enough to guide jetliners safely through surrounding mountains. The government contends not enough planes use the airport to justify the $9 million new equipment would cost.

Villagers reported seeing an aircraft apparently in trouble and others said they heard one or more explosions, possibly as the



aircraft crashed into Mount San Pietro.

The number of people aboard the airliner was announced in Yugoslavia, where the one-day excursion to Corsica was organized by the KOMPAS tourist company in Ljubljana. Tour organizers said there were 172 passengers, including three infants, and six crew members, all apparently Yugoslavian.

The aircraft sent a distress message shortly before it was due to land at Ajaccio airport, control tower officials said. The plane was on final approach to landing when the tower lost radio and radar contact with the craft, they said.

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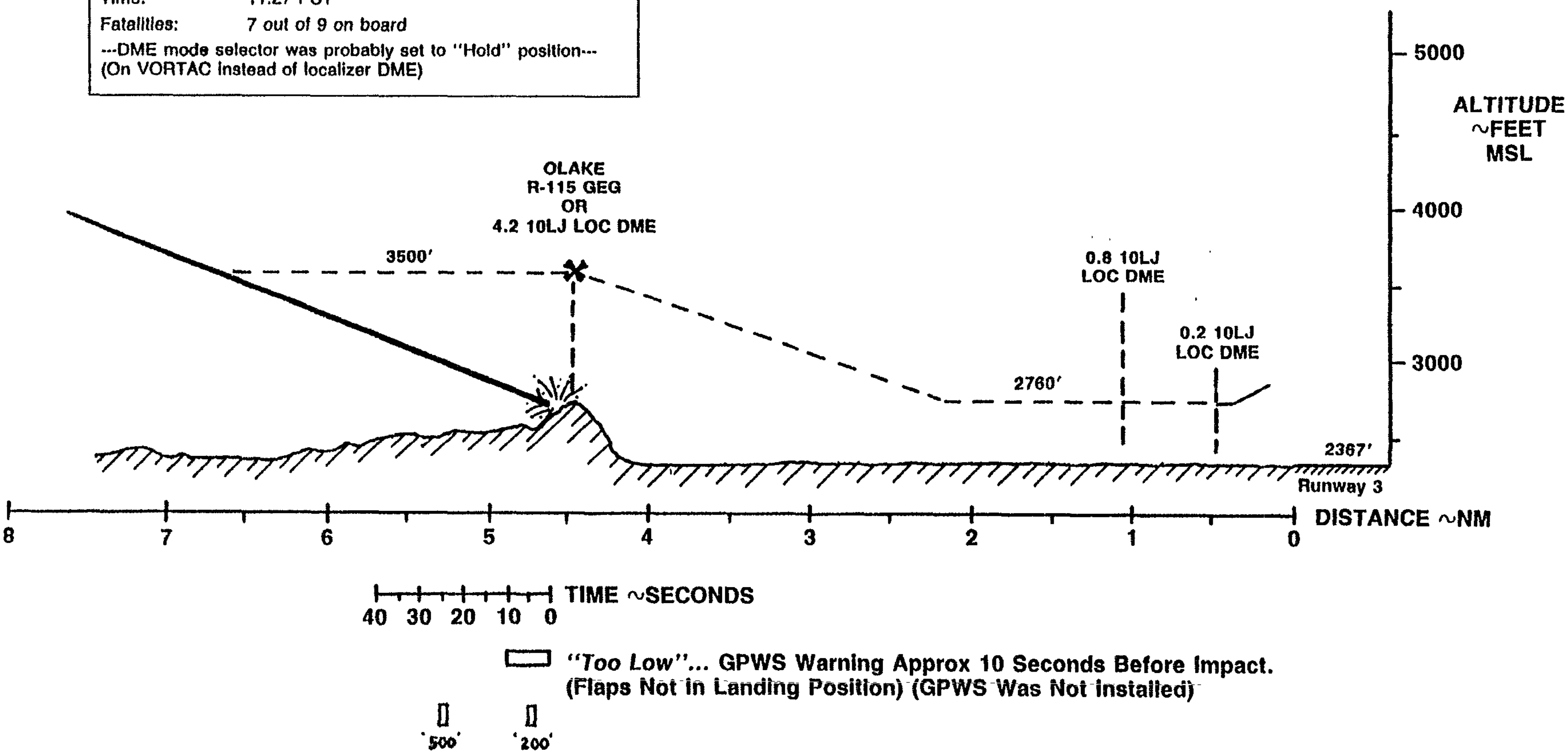
Flight Path Profile

BE-99 CASCADE AIRWAYS
SPOKANE, WASHINGTON
20 JANUARY, 1981

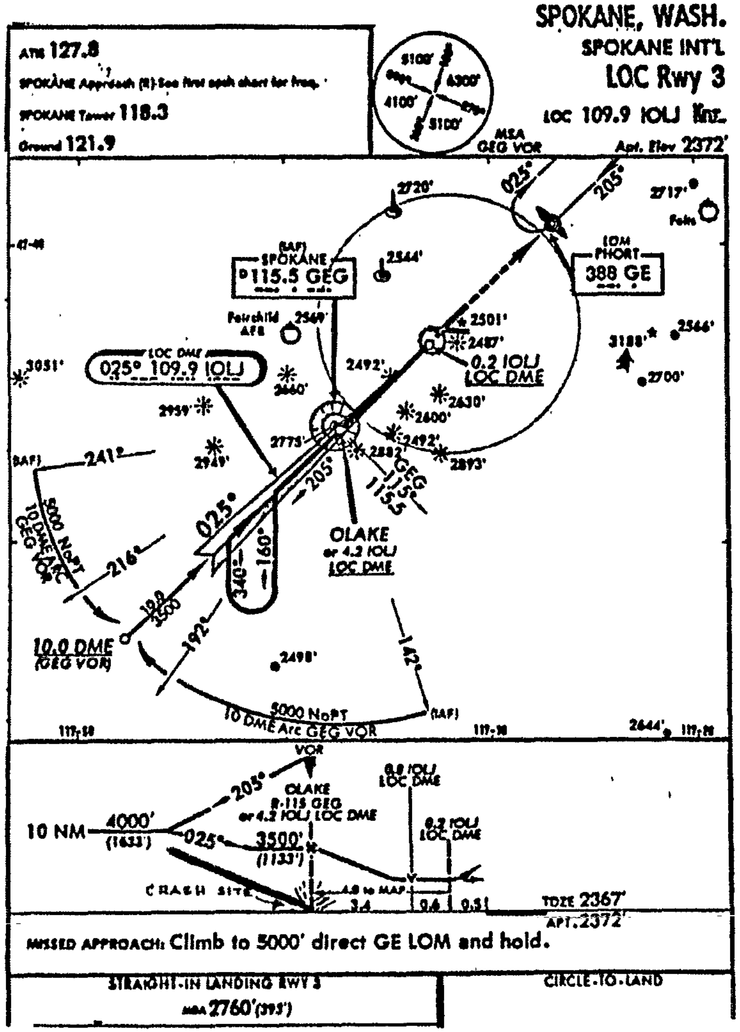
Circumstances:	Aircraft hit hill during an instrument approach Localizer runway 3.
Configuation:	Gear down, approach flaps
Weather:	IMC 3 ⓛ visibility 2 miles, fog
Time:	11:27 PST
Fatalities:	7 out of 9 on board

---DME mode selector was probably set to "Hold" position---
(On VORTAC instead of localizer DME)



Source: NTSB-AAR-81-11

Return to TOC



NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D. C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: July 21, 1981

CASCADE AIRWAYS, INC.
BEECHCRAFT 99A, N390CA,
SPOKANE, WASHINGTON
JANUARY 20, 1981

SYNOPSIS

About 1127 P.s.t., on January 20, 1981, a Cascade Airways, Inc., Beech 99A, operating as Flight 201, crashed during an instrument approach in instrument meteorological conditions at Spokane International Airport. The aircraft hit a hill about 4.5 miles from the runway threshold at an elevation of 2,646 feet. The minimum descent altitude for the instrument approach procedure was 2,760 feet. Of the nine persons aboard Flight 201, seven were killed and two were injured seriously.

The instrument approach procedure the flightcrew used required that an altitude of 3,500 feet be maintained until the aircraft passed the final approach fix, located 4.5 miles from the runway threshold. The aircraft impacted the ground near the location of the final approach fix, which was about 1,800 feet southeast of the Spokane VORTAC.

The National Transportation Safety Board determines that the probable cause of the accident was a premature descent to minimum descent altitude (MDA) based on the flightcrew's use of an incorrect distance measuring equipment (DME) frequency and the flightcrew's subsequent failure to remain at or above MDA. Contributing to the cause of the accident was the design of the DME mode selector which does not depict the frequency selected and the failure of the flightcrew to identify the localizer DME facility.

1. FACTUAL INFORMATION

1.1 History of the Flight

On January 20, 1981, Cascade Airways, Inc., Flight 201, a Beech 99A, N390CA, was being operated as a scheduled 14 CFR 135 passenger flight between Seattle, Washington, and Spokane, Washington, with intermediate en route stops at Yakima, Washington, and Moses Lake, Washington.

The flightcrew reported to the Cascade Airways operations facility in Walla Walla, Washington, about 0500 1/ and conducted the preflight activities according to Cascade Airways procedures. They departed Walla Walla at 0604 as the flightcrew of Flight 930 and made one scheduled en route stop at Richland, Washington, before arriving at Seattle at 0730.

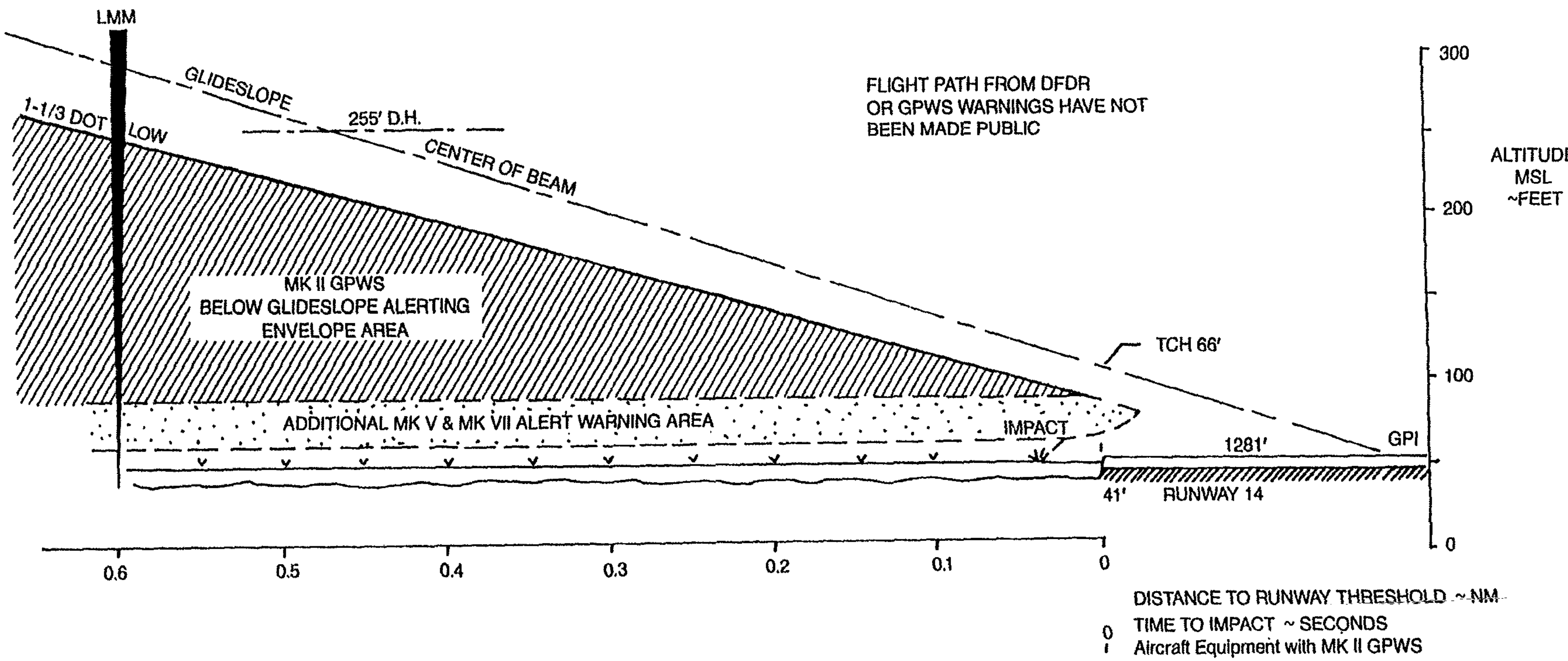
1/ All times herein are Pacific standard, based on the 24-hour clock.

90-282

FLIGHT PATH PROFILE

B747-200
Seoul, Korea
19 November 1980

Circumstances:	Aircraft hit short by 270 feet of runway 14 during ILS approach. Main gear hit 8 feet below runway and separated, with nose gear intact. Fire started destroyed the aircraft. Flight originated at LAX.
Weather:	Clear on top, but with fog patches 1000 M visibility at airfield. Temperature 2°, dew point 2°C. Wind calm.
Time:	0727 Local.
Fatalities:	15 (226 on board)



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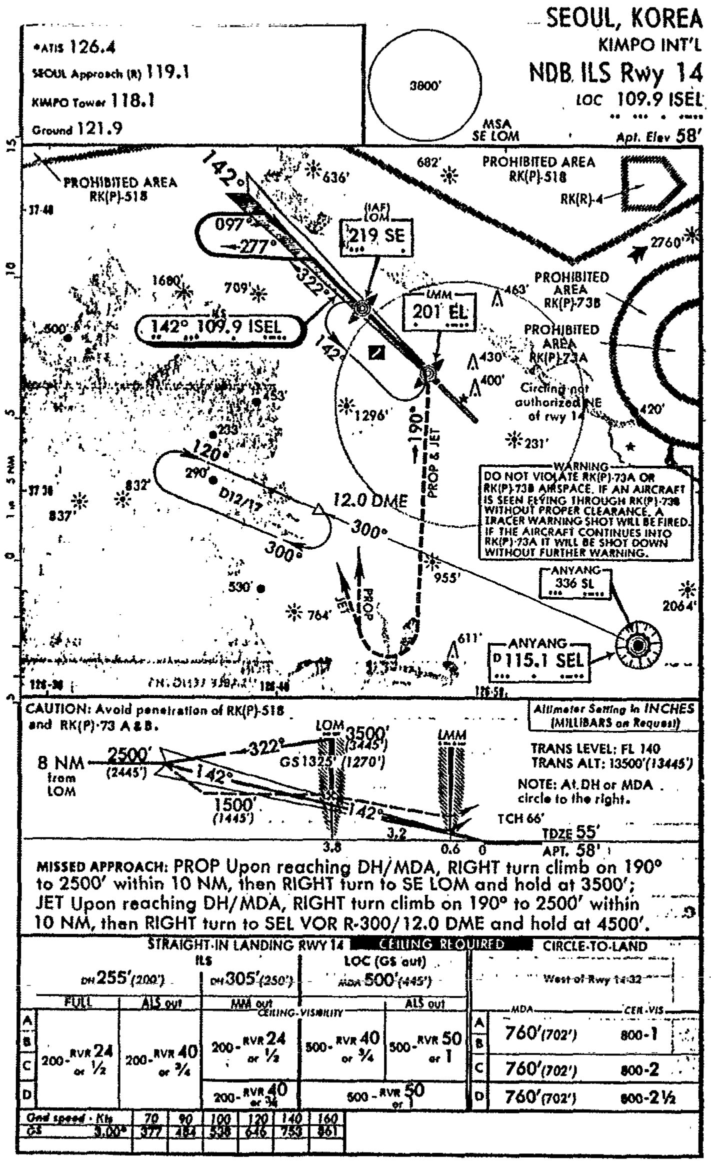
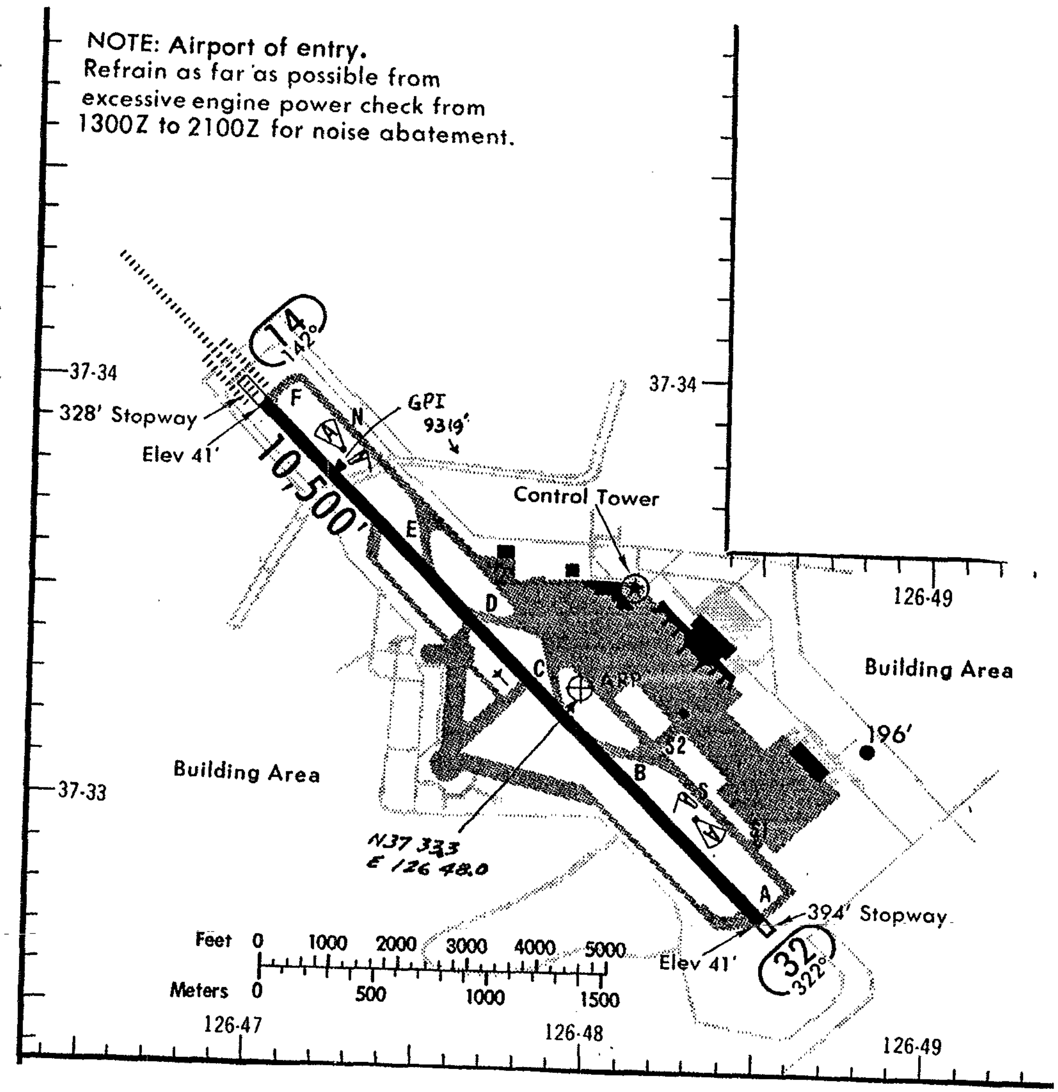
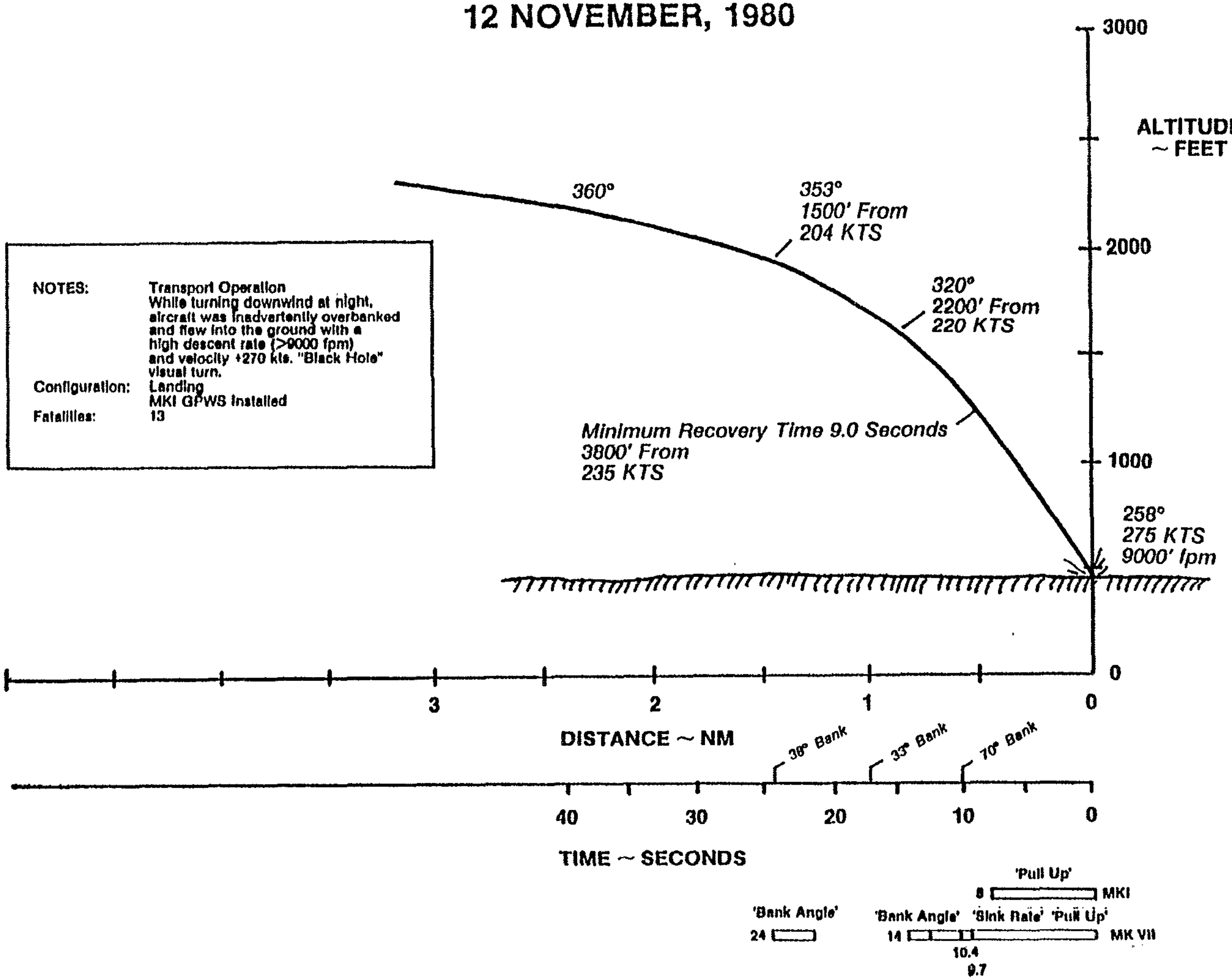




Return to TOC

Flight Path Profile

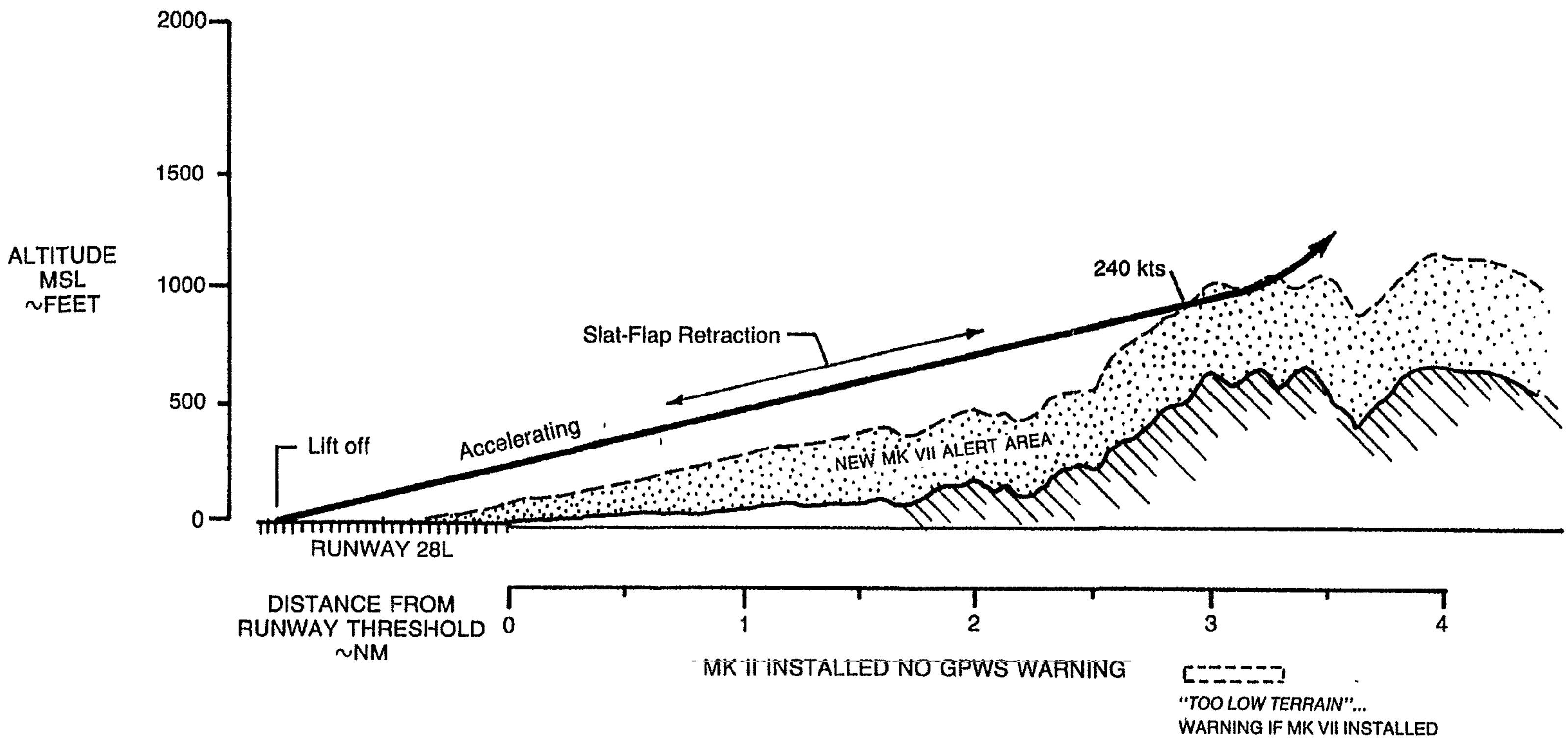
C-141A
USAF
CAIRO
12 NOVEMBER, 1980



Return to TOC

FLIGHT PATH PROFILE
B737-200
San Francisco, CA
October, 1980

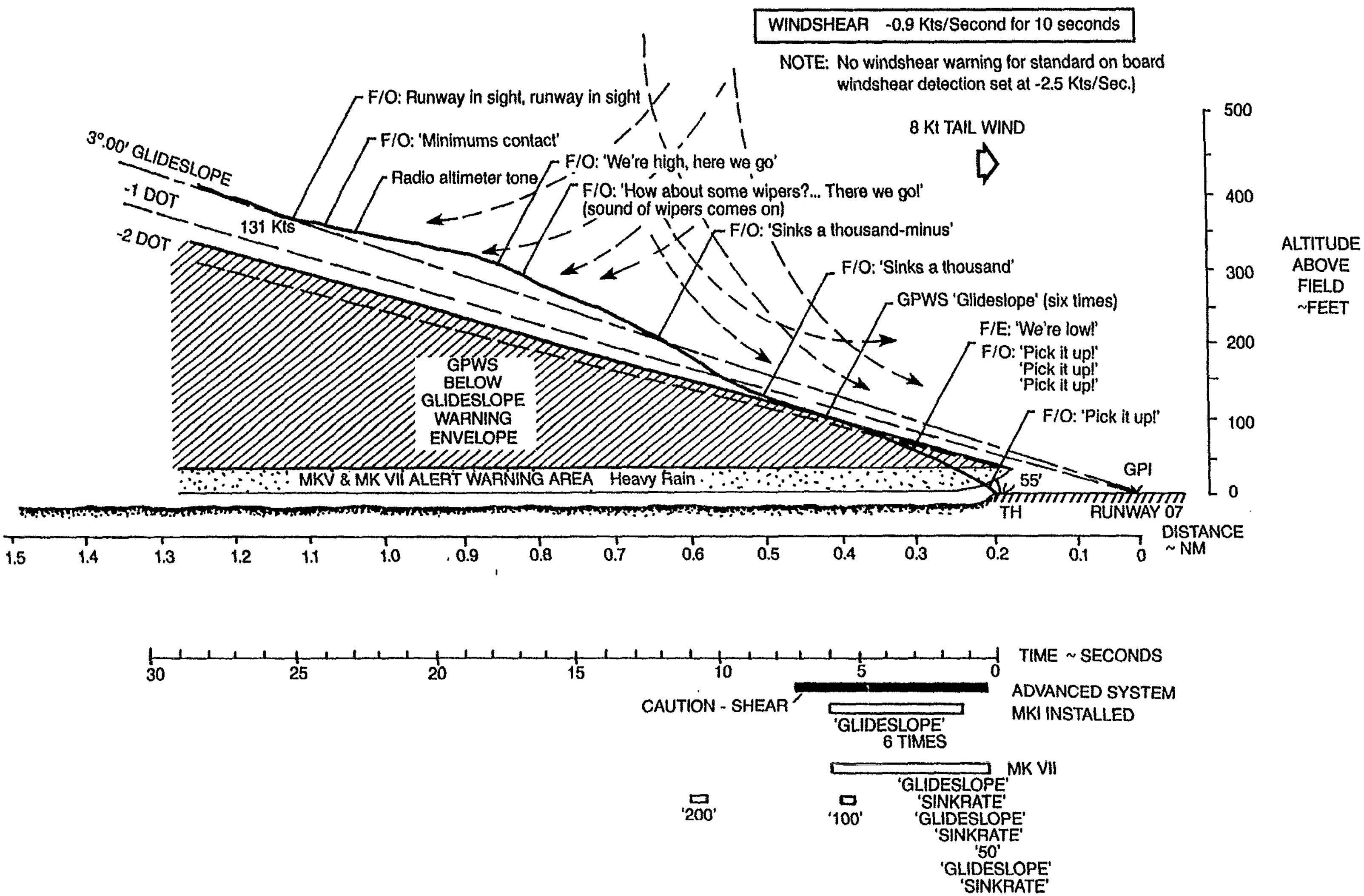
Circumstances:	On departure runway 28, the aircraft began an accelerating but shallow climb, towards terrain. The crew was alerted ty the tower and departure of the potential terrain problem. There was no GPWS warining. MK II installed.
Weather:	5 miles visibility, but clouds to the west covering hill tops.



90-282

NOTES:	
Circumstances:	Heavy rain showers. Airplane hit short by 203 feet at 14:30 local time on ILS DME Runway 07.
Configuration:	Gear down land flap. 134,000 lbs. V th (threshold)/ V ref 124 Kts
Weather:	IMC, wind 8 Kts 240° 3 km visibility, ceiling 130
Damage:	$5 million, 5 injured.

FLIGHT PATH PROFILE
B727-100
San Jose, C.R.
3 September 1980



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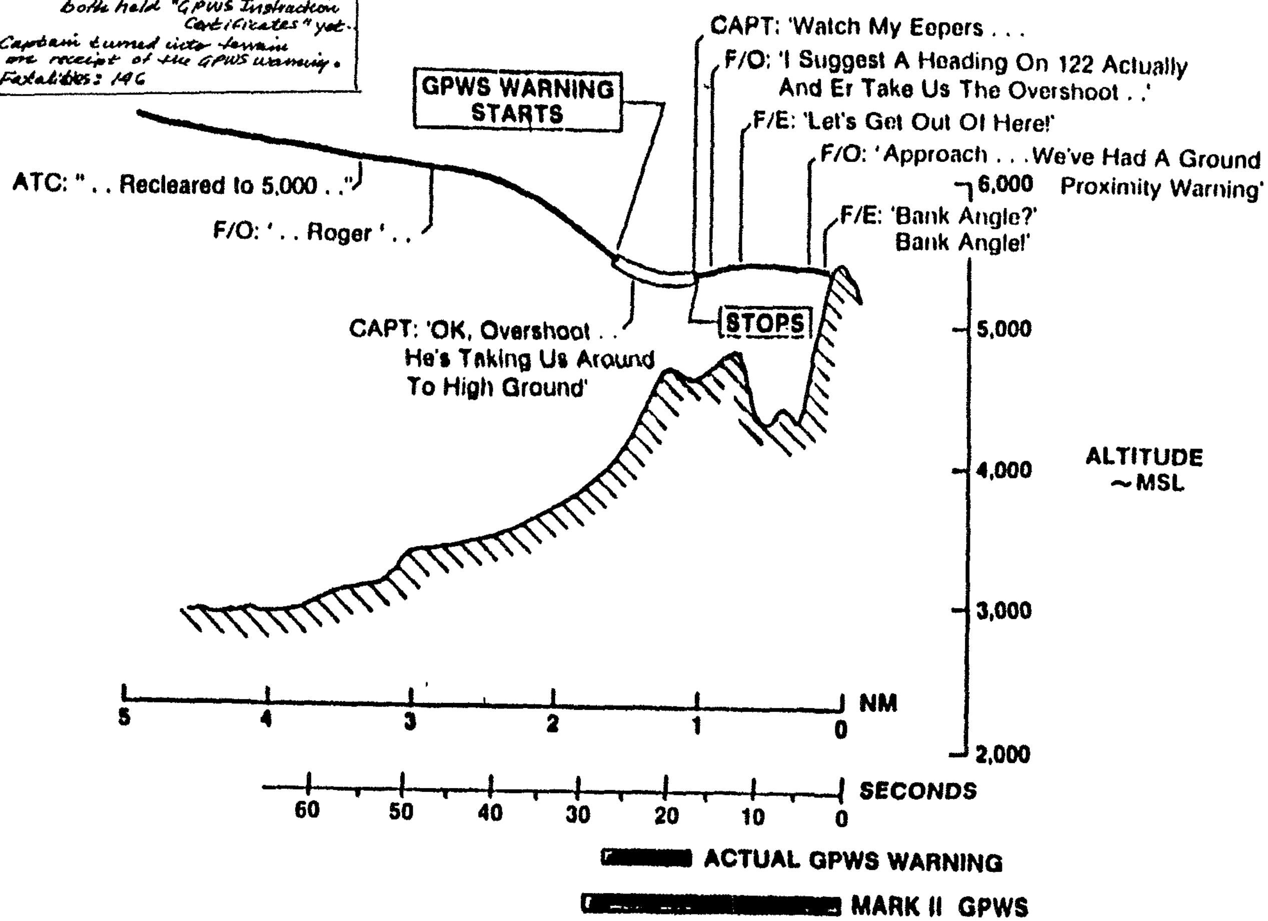
Circumstances : Charter Flight
Weather : Overcast · Solid cloud cover
Wind 160/10 kts
Time : 13:21 GMT

Both Captain and Flight Engineer both held "GPWS Instruction Certificates" yet.
Captain turned into terrain on receipt of the GPWS warning.
Fatalities : 146

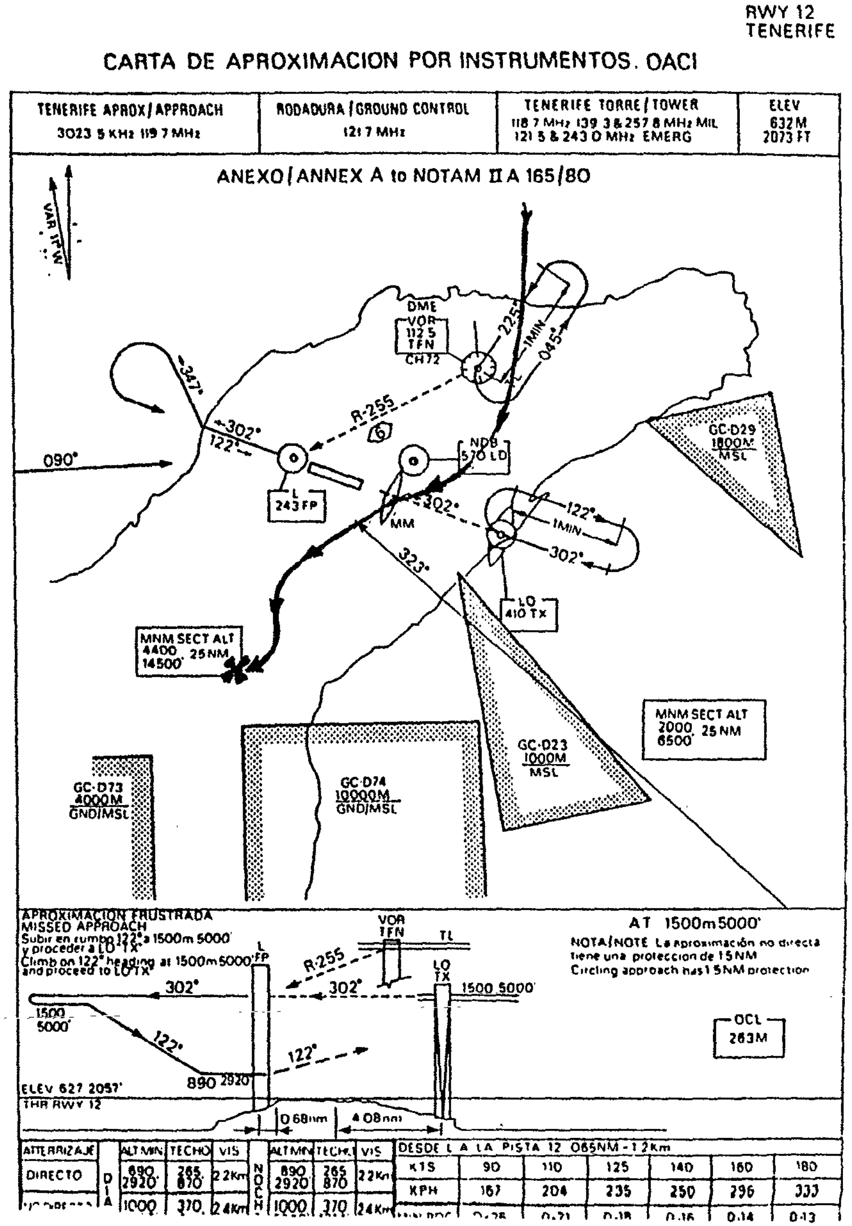
Flight Path Profile

B 727 TENERIFE 25 APRIL 1980

146 FATALITIES

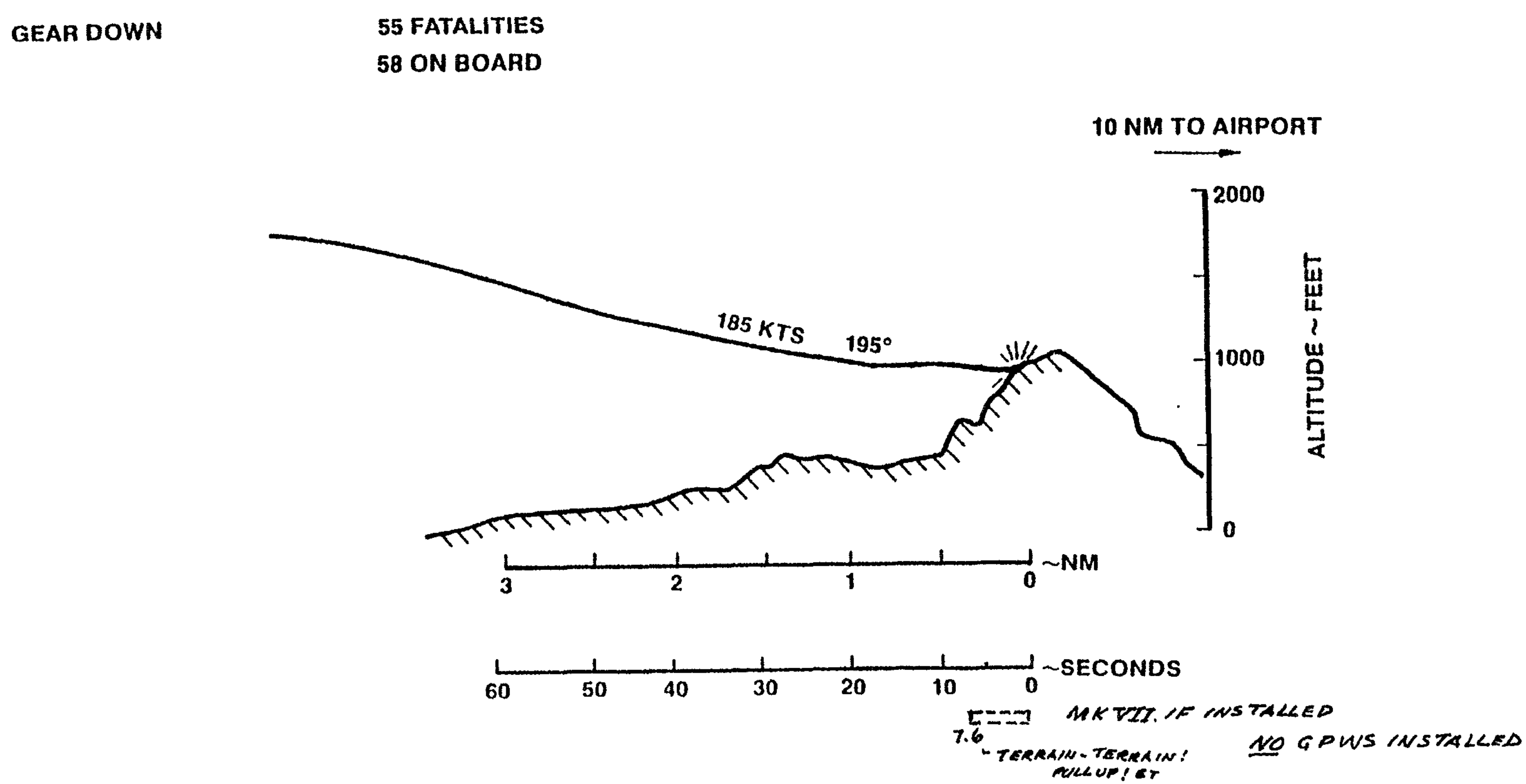


Time to Impact	GMT	From	Message
05:00	13.16:18	APP	Dan-Air one zero zero eight descend and maintain flight level six zero.
04:55	13.16:23	Aircraft	Roger leaving one one zero for six zero.
04:52	13.16:26	APP	Report your DME reading please.
04:50	13.16:28	Aircraft	Er we're reading seven DME Tango Fox November and requesting the QFE please.
04:44	13.16:34	APP	Nine four three.
04:42	13.16:36	Aircraft	Nine four three many thanks.
03.45	13.17:33	APP	One zero zero eight for your information Foxtrot Echo on runway one two is nine four one.
03.39	13.17:39	Aircraft	Roger nine four one for one two thanks.
03.20	13.17:58	APP	Iberia siete uno uno, notifique completando curva de procedimiento
03:16	13.18:02	Aircraft	Notificare, Iberia siete uno uno.
02:40.5	13.18:37.5	Aircraft	Tenerife buenas tardes Hapag-Lloyd five four two.
02:37	13.18:41	APP	Five four two, good afternoon report ready.
02:34.5	13.18:43.5	Aircraft	Wilco.
02:30	13.18:48	Aircraft	Dan-Air one zero zero eight has just passed the Tango Fox November heading to the er Fox Papa.
02:24	13.18:54	APP	Roger the er standard holding overhead Foxtrot Papa is inbound heading one five zero turn to the left call you back shortly.
02:17	13.19:01	Aircraft	Roger Dan-Air one zero zero eight.
01:27	13.19:51	Aircraft	Dan-Air one zero zero eight is the Foxtrot Papa level at six zero taking up the hold.
01:20.5	13.19:57.5	APP	Roger.
01:00.5	13.20:17.5	APP	Iberia siete uno uno notifique abandonando cinco mil.
00:57	13.20:21	Aircraft	Libre cinco mil, ahora estamos en curva de procedimiento.
00:52.5	13.20:25.5	APP	Recibido. Break.
00:52	13.20:26	APP	Dan-Air one zero zero eight recleared to five thousand on the Quebec Foxtrot Echo and Quebec November Hotel.
00:45	13.20:35	Aircraft	Roger cleared down to five thousand feet on the one zero one three Dan-Air one zero zero eight.
00:39	13.20:39	APP	Roger.
00:31.5	13.20:46.5	APP	Hapag-Lloyd five four two are you ready?
00.28.5	13.20:49.5	Aircraft	Affirmative Hapag-Lloyd five four two is ready.
00:26	13.20:52	APP	The wind is one three zero zero five cleared for take-off runway one two.
00.21	13.20:57	Aircraft	Hapag-Lloyd five four two is cleared for take-off runway one two
00.04.5	13.21:13.5	APP	Er Dan-Air one zero zero eight we've had a ground proximity warning.
		APP	Station calling ....
		APP	Iberia siete uno uno notifique establecido en final.
		Aircraft	Notificare.
		Aircraft	Estamos llegando a la costa en final, Iberia siete uno uno.
		APP	Iberia siete uno uno autorizado a aterrizar pista doce, viento uno tres cero cero cinco .... autorizado a aterrizar Iberia siete uno uno.
		APP	Dan-Air one zero zero eight, your position in the holding?
		APP	Ah, Dan-Air one zero zero eight, Tenerife, request your position in the holding.

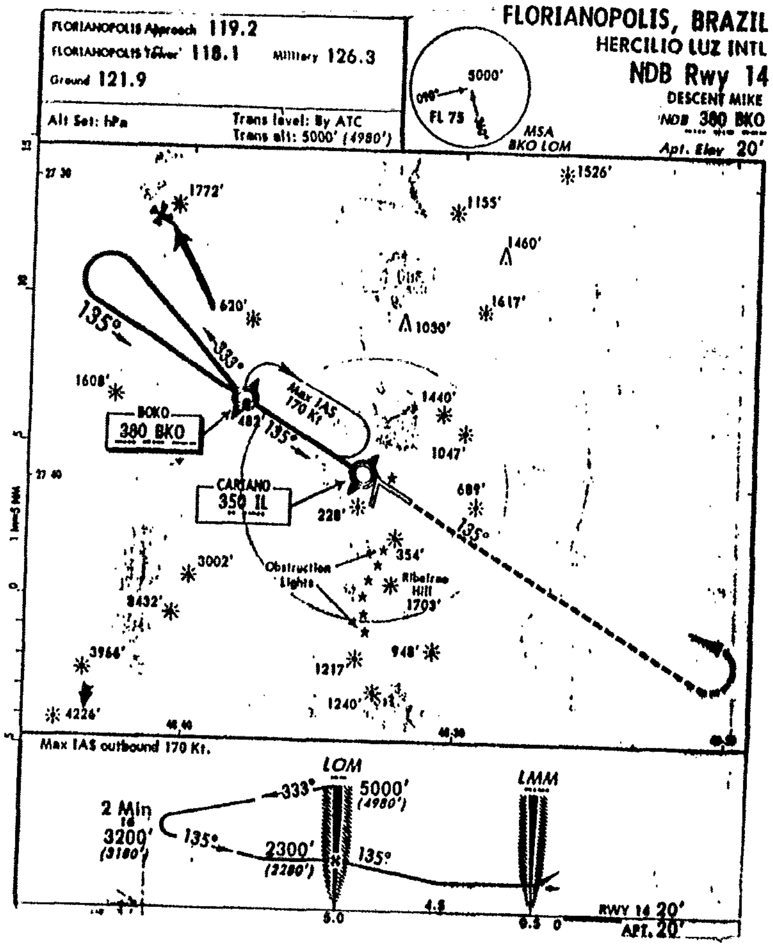


PROCEDURE TURN

FLORIANOPOLIS, BRAZIL
B727
12 APRIL 1980



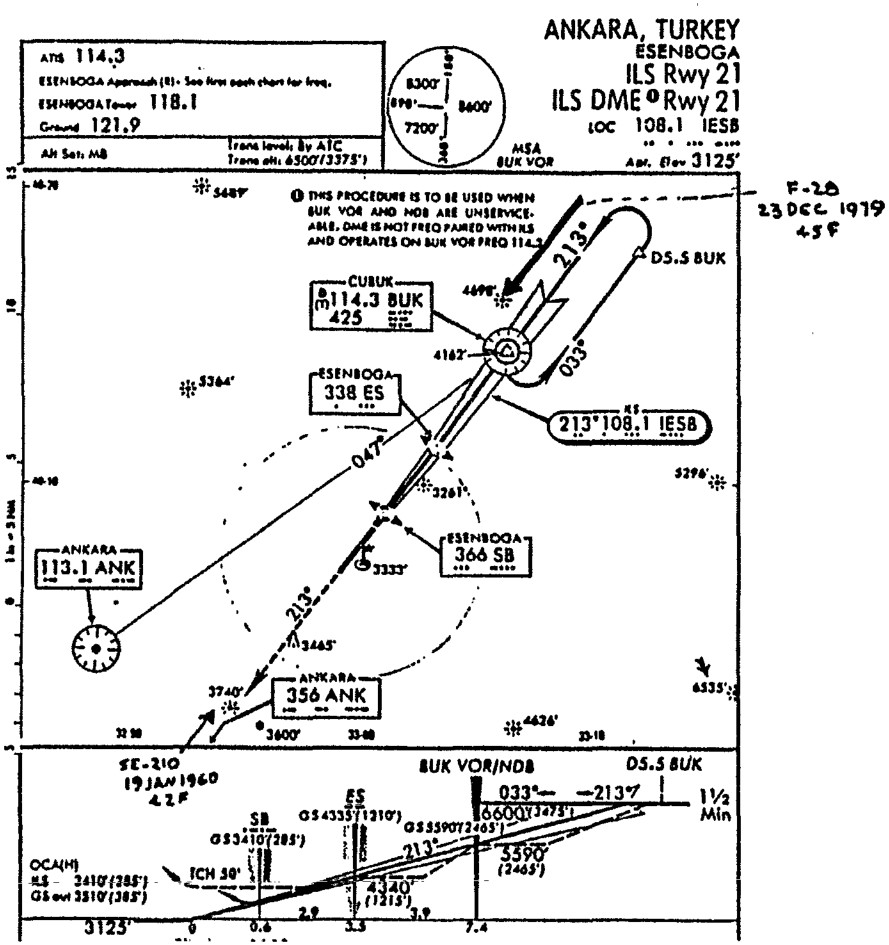
[Return to TOC]



12.4	Boeing 727	PT-TYS	Trans Brasil	Nr Florianopolis, Brazil	Scheduled Passenger	58	Crew	8	0	0	Destroyed
							Pass	47	3	0	

During an instrument approach the aircraft struck a hill located outside the normal instrument approach trajectory. (ICAO Summary No 6/80)

Return to TOC

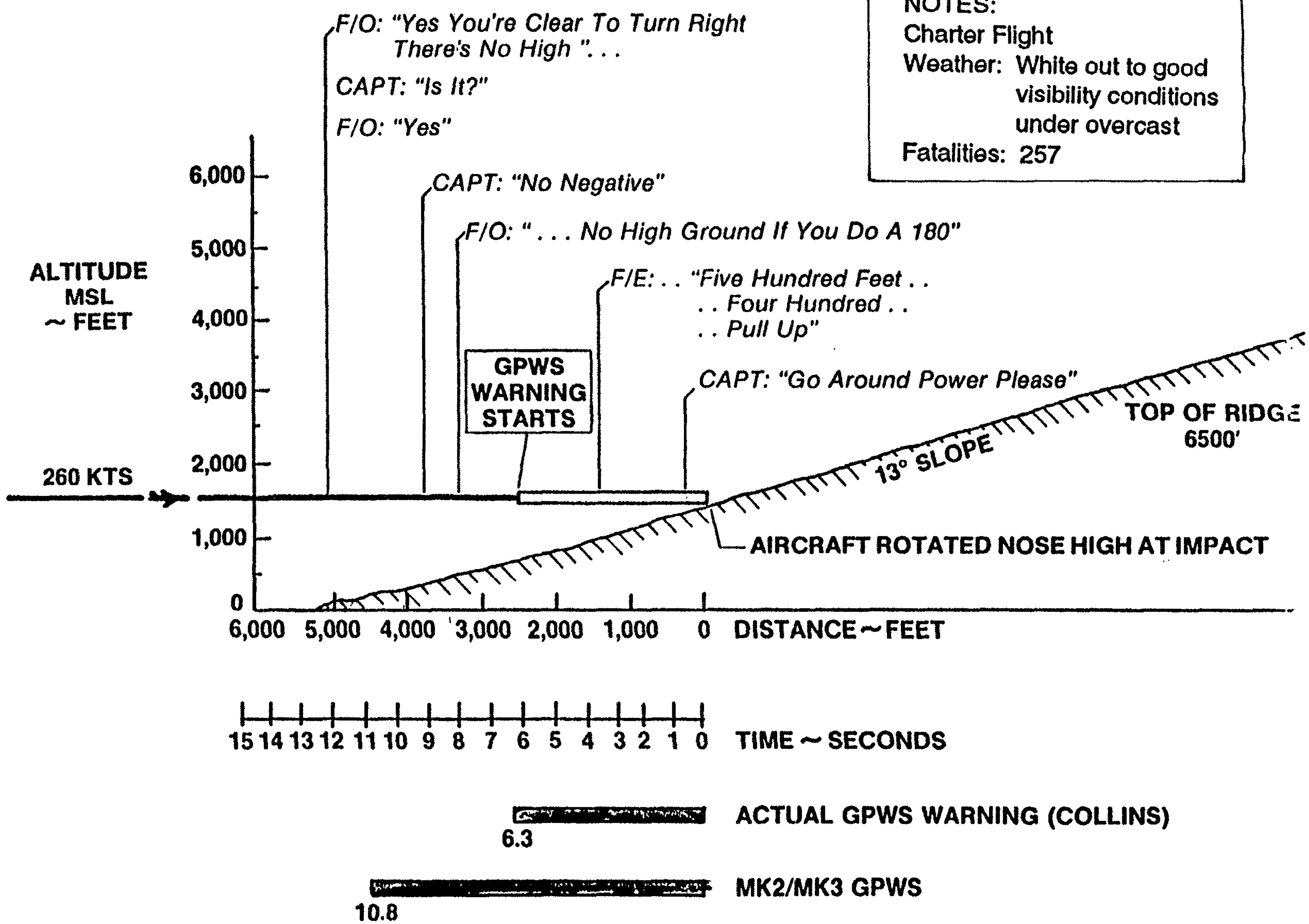


Next Page

Advancing The Warning Time With Speed

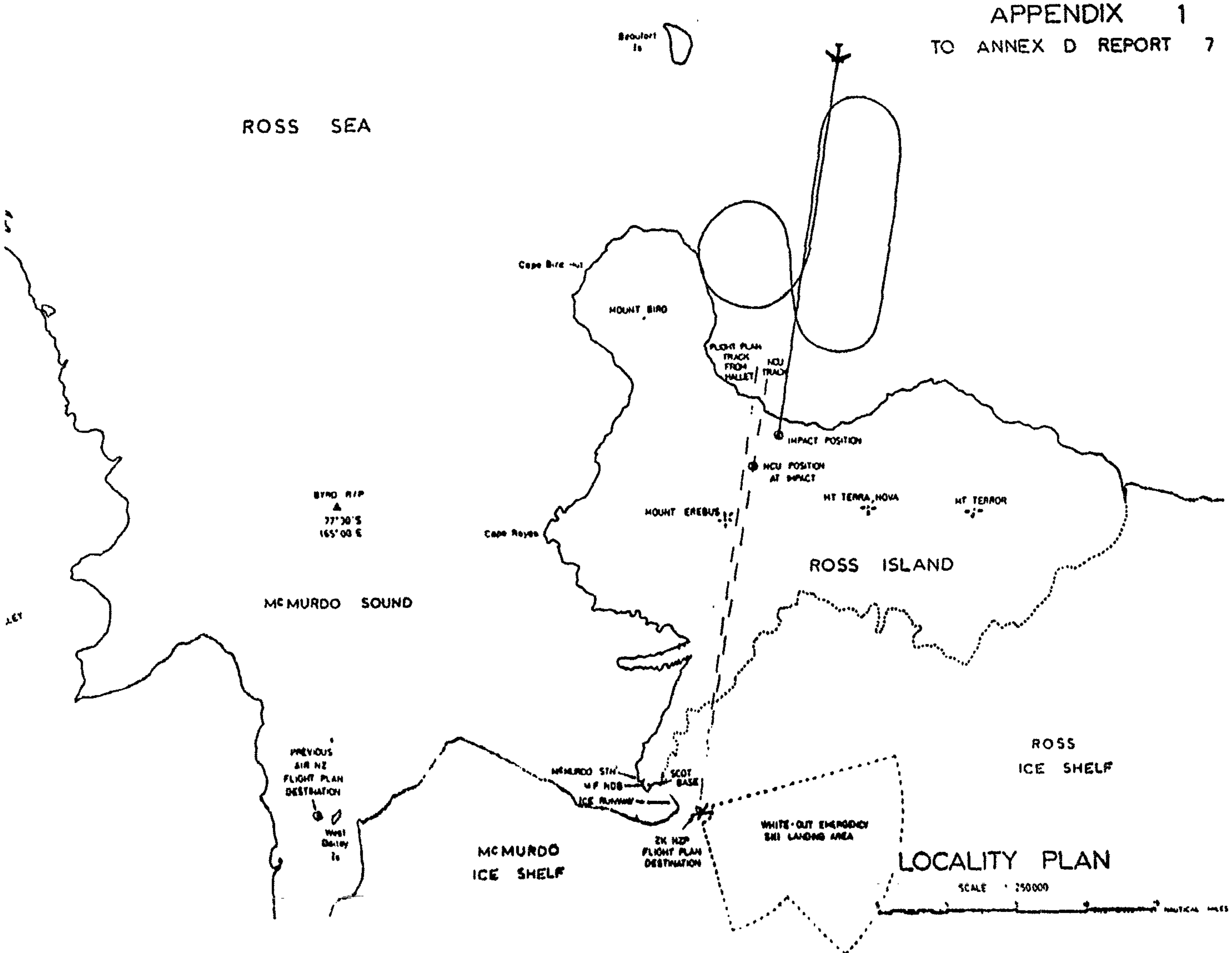
DC-10 ANTARTICA 28 NOVEMBER, 1979

NOTES:
Charter Flight
Weather: White out to good visibility conditions under overcast
Fatalities: 257



APPENDIX 1

TO ANNEX D REPORT 7



New Zealand

Computer-death

FROM OUR NEW ZEALAND CORRESPONDENT

It is hard to conceive of a more bizarre way to destroy an aircraft and its occupants than to programme the flight computer to fly straight at an active volcano, and not tell the pilot. According to an inquiry into the Air New Zealand crash on Mount Erebus in Antarctica in November, 1979, in which 257 people died, that is exactly what happened.

The aircraft was on a sightseeing tourist flight to Antarctica when it hit the 12,200ft mountain. An earlier report on the accident blamed the pilot for flying too low "when the crew was not certain of their position", a conclusion strongly endorsed by the airline. But the inquiry by Mr Justice Mahon, in a report issued on Monday, cleared the crew and blamed the airline.

The judge found that the computerised route for the flight, which was fed into the aircraft's automatic pilot, had been altered shortly before take-off because of an error in the original data. But the pilot was not told of the change, which sent the aircraft on a direct path over the volcano. When the pilot obtained clearance from the American research base at McMurdo to descend below the clouds so that the tourists could get a better view, he had no idea that he was flying straight at the mountain.

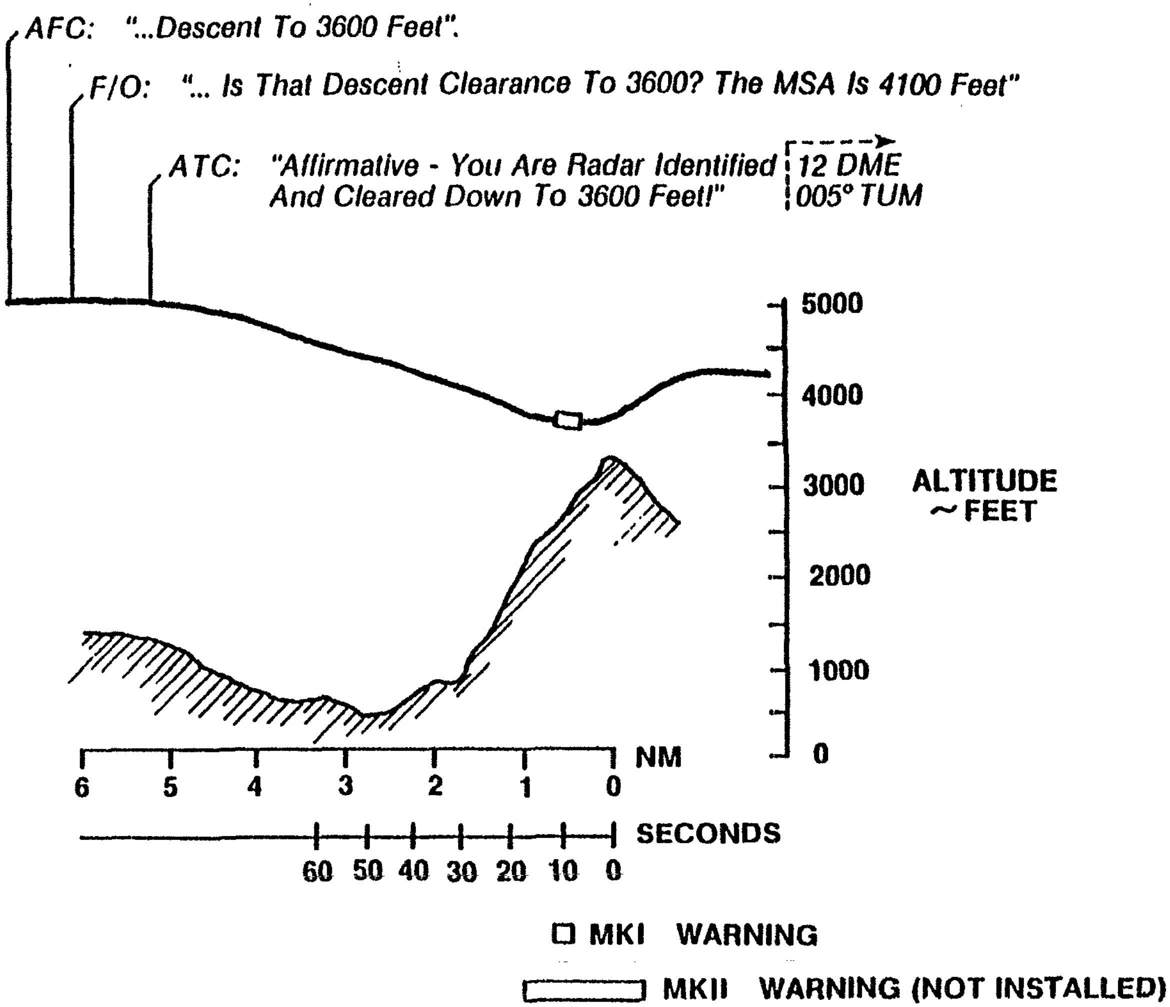
The Mahon report denounced the airline's "incompetent administrative procedures" and the "haphazard, informal" planning of Antarctic flights generally. But its fiercest criticism was directed at the airline's senior executives, including its chief executive, Mr Morrie Davis, who, said the judge, tried to fix the blame on the crew through an "orchestrated litany of lies". Mr Davis was also criticised for his "extraordinary" action in destroying many relevant documents.

Coming at a time when Air New Zealand faces a £20m loss, the Mahon report has raised questions about the airline's survival. But Air New Zealand is owned by the government and, in addition to high marks for safety and service, it is regarded (quite wrongly since its stranglehold on fares in fact keeps people away) as essential to the country's drive for trade, tourism and foreign exchange. The airline is to appeal against the judge's findings.

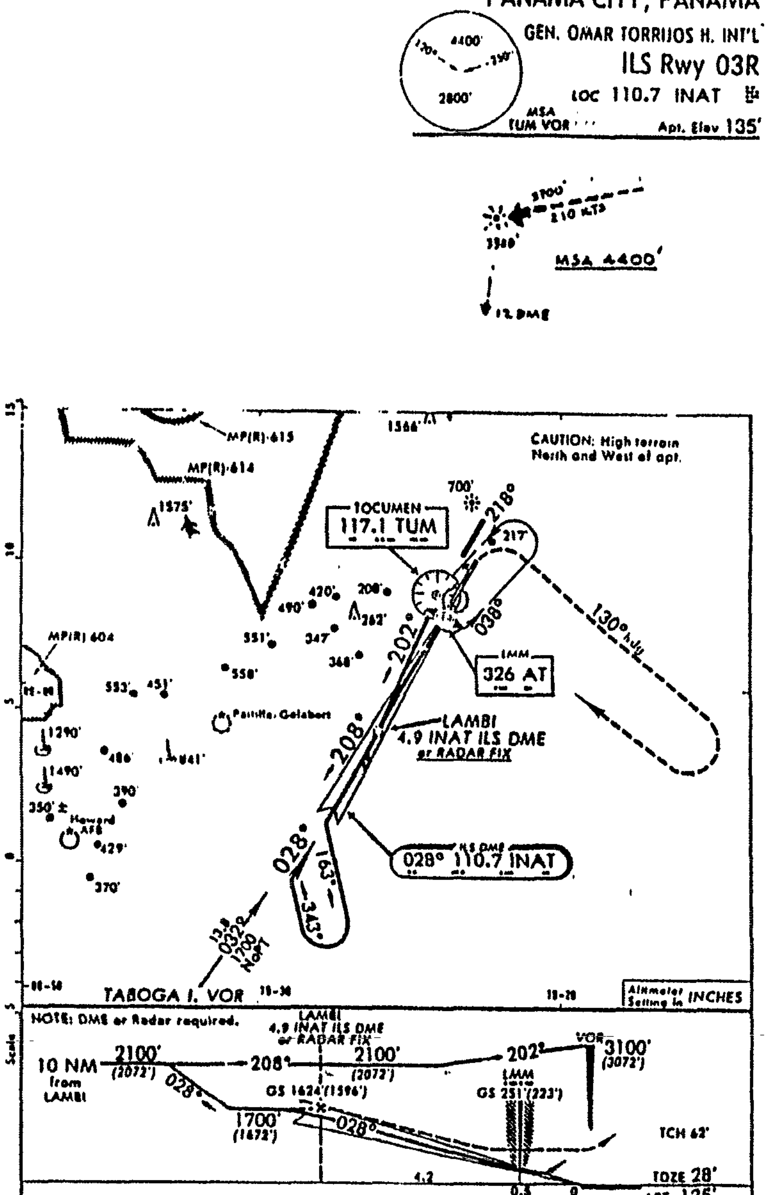
THE ECONOMIST
2-8 MAY 1981
P.44

Radar Vectors

INITIAL APPROACH PANAMA ILS 03R
B707 5 OCTOBER, 1979



PANAMA CITY, PANAMA
GEN. OMAR TORRIJOS H. INT'L
ILS Rwy 03R
LOC 110.7 INAT
Apt. Elev 135'



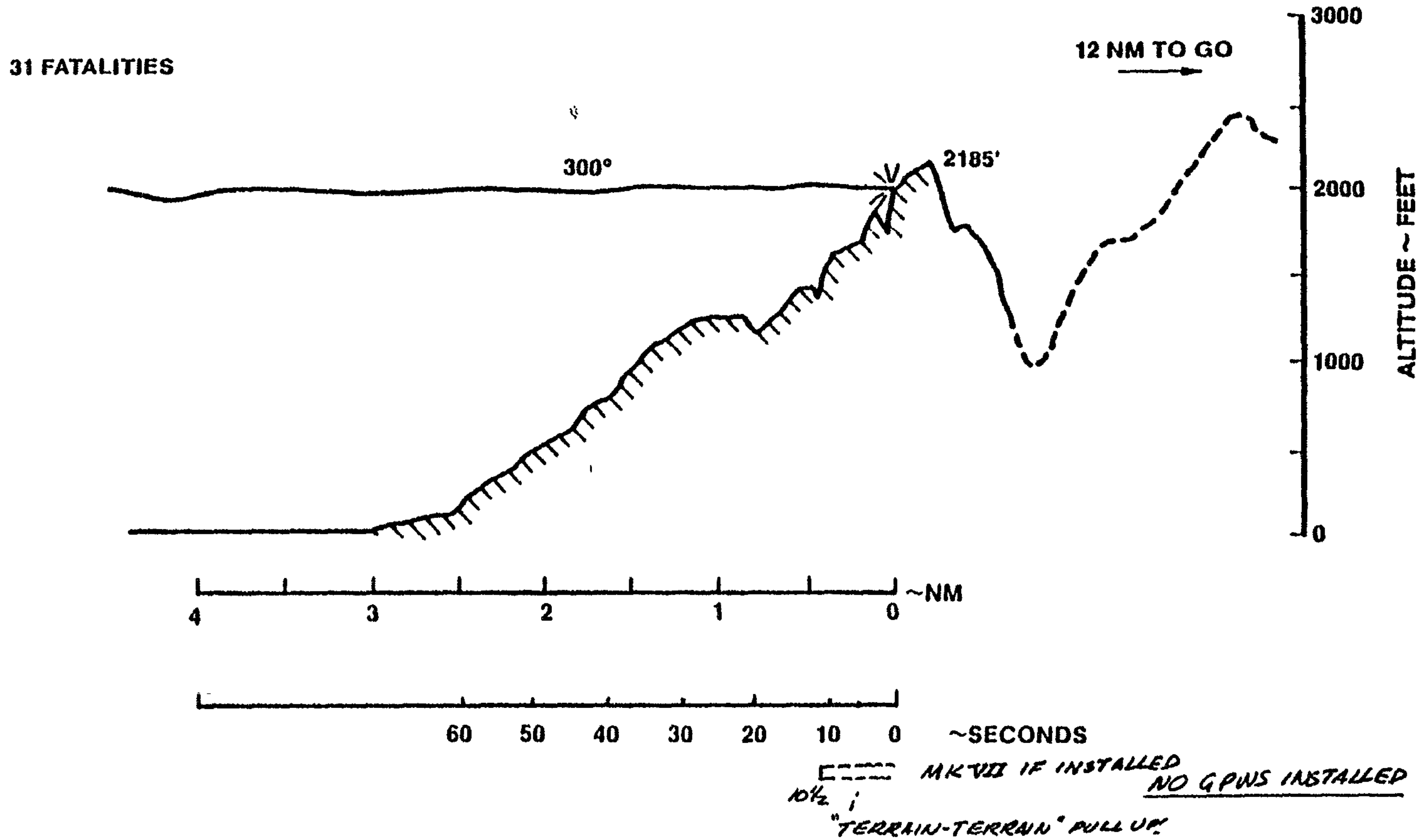
MISSED APPROACH: Climb STRAIGHT AHEAD to 440', immediately turn RIGHT to 130° heading climbing to 2100', immediately turn RIGHT to TUM VOR

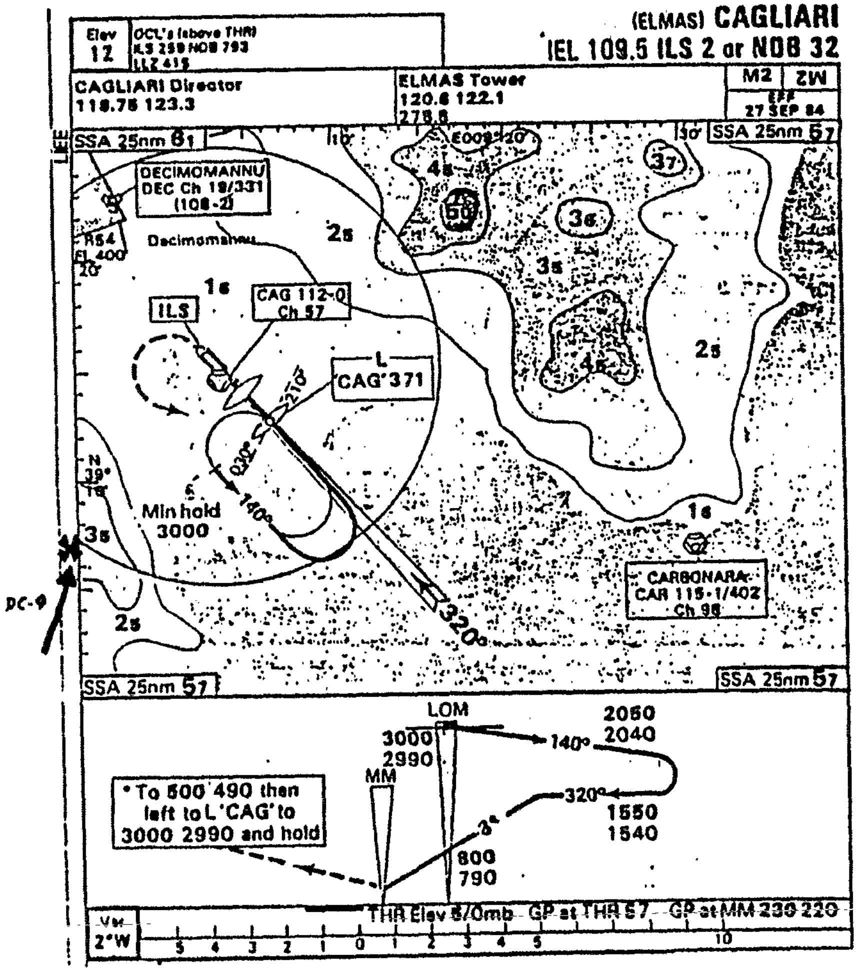
Next Page

VISUAL APPROACH RADAR CONTACT

CAGLIARI, SARDINIA
DC-9
14 SEPTEMBER 1979

NOTES:
During approach with radar, pilot reported visual ground contact and elected to not follow NDB approach procedure. He let down to the West to avoid weather.
Fatalities: 31 (4 crew)



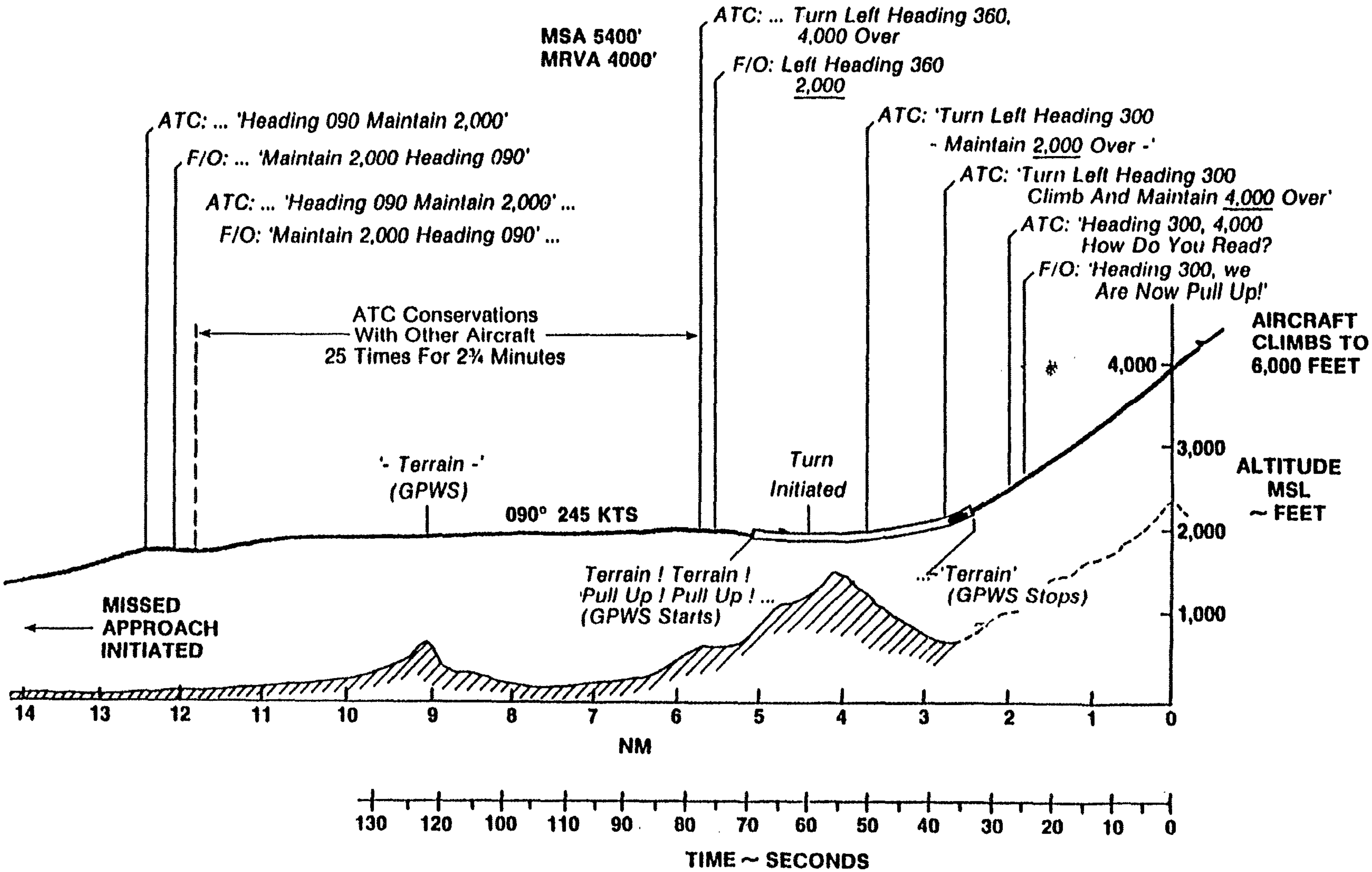

(ELMAS) CAGLIARI
IEL 109.5 ILS 2 or NDB 32
Elev 12
OCL's (above THR)
CAGLIARI Director
118.75 123.3
ELMAS Tower
120.6 122.1
278.8
M2
ZW
EFF 27 SEP 84
SSA 25nm 61
SSA 25nm 57
DECIMOMANNU
DEC Ch 19/331
(108-2)
Decimomannu
ILS
CAG 112-0
Ch 57
L
CAG 371
Min hold
3000
CARBONARA
CAR 115-1/402
Ch 98
320°
140°
LOM
MM
3000
2990
2050
2040
1550
1540
800
790
* To 500 490 then left to L 'CAG' to 3000 2990 and hold
3°
THR Elev 5/0mb
GP at THR 57
GP at MM 230 220
Var 2°W
DC-9

Next Page

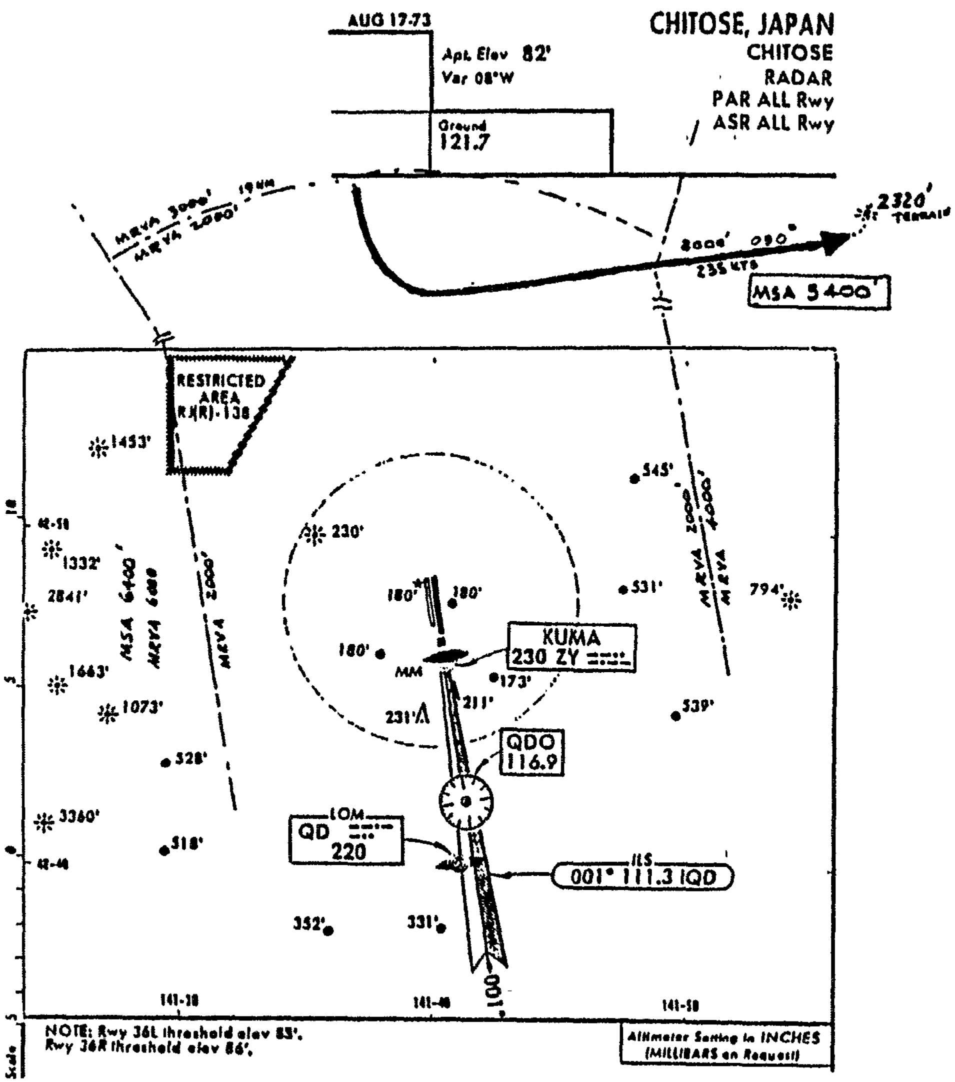
Radar Vectors

MISSED APPROACH CHITOSE PAR 18

B747 JAPAN 1 AUGUST, 1979



Return to TOC



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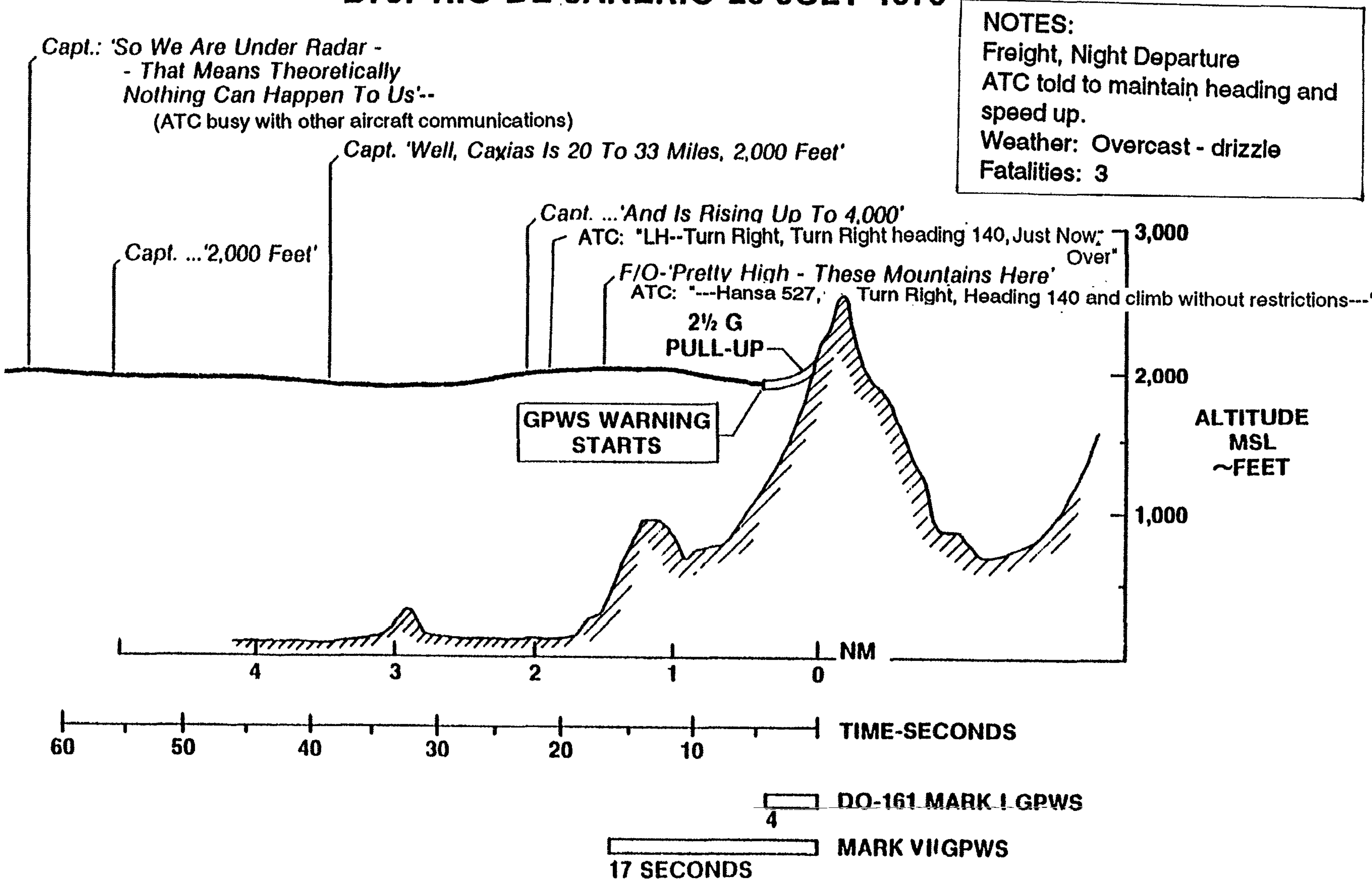
Radar Vectors

INITIAL CLIMB/DEPARTURE

B707 RIO DE JANERIO 26 JULY 1979



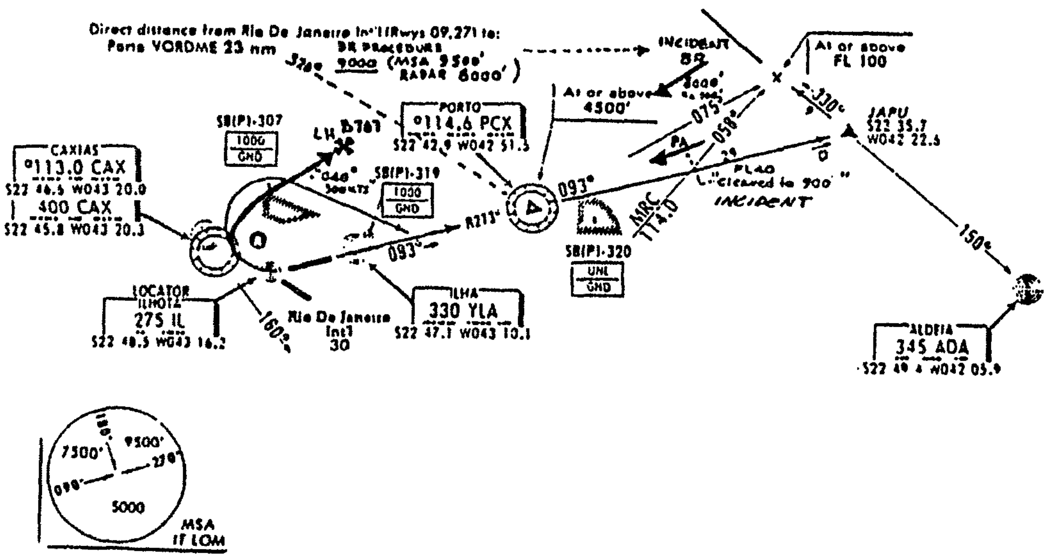
Return to TOC

SID

RIO DE JANEIRO, BRAZIL

RIO DE JANEIRO INT'L

DEPARTURE

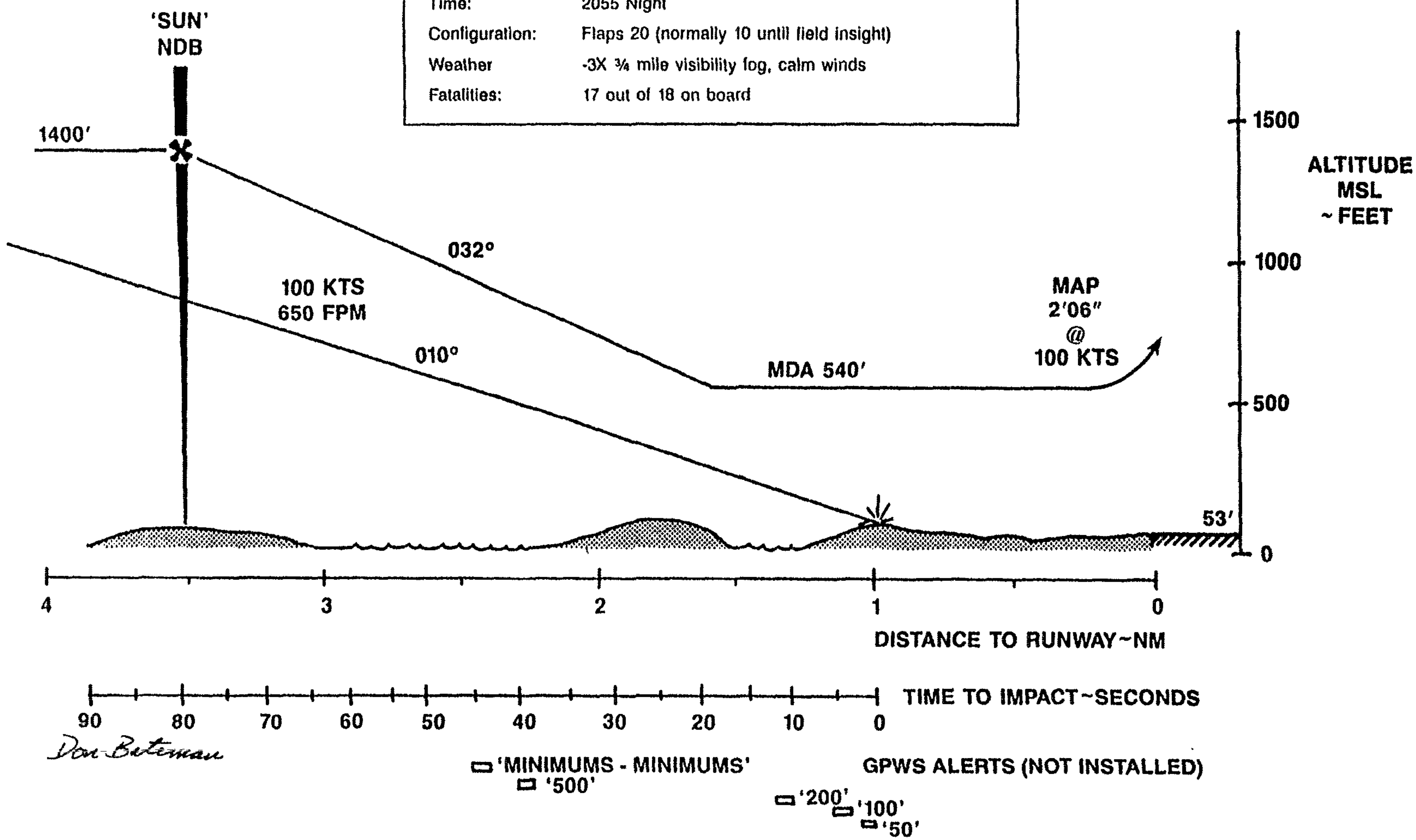


Flight Path Profile

Next Page

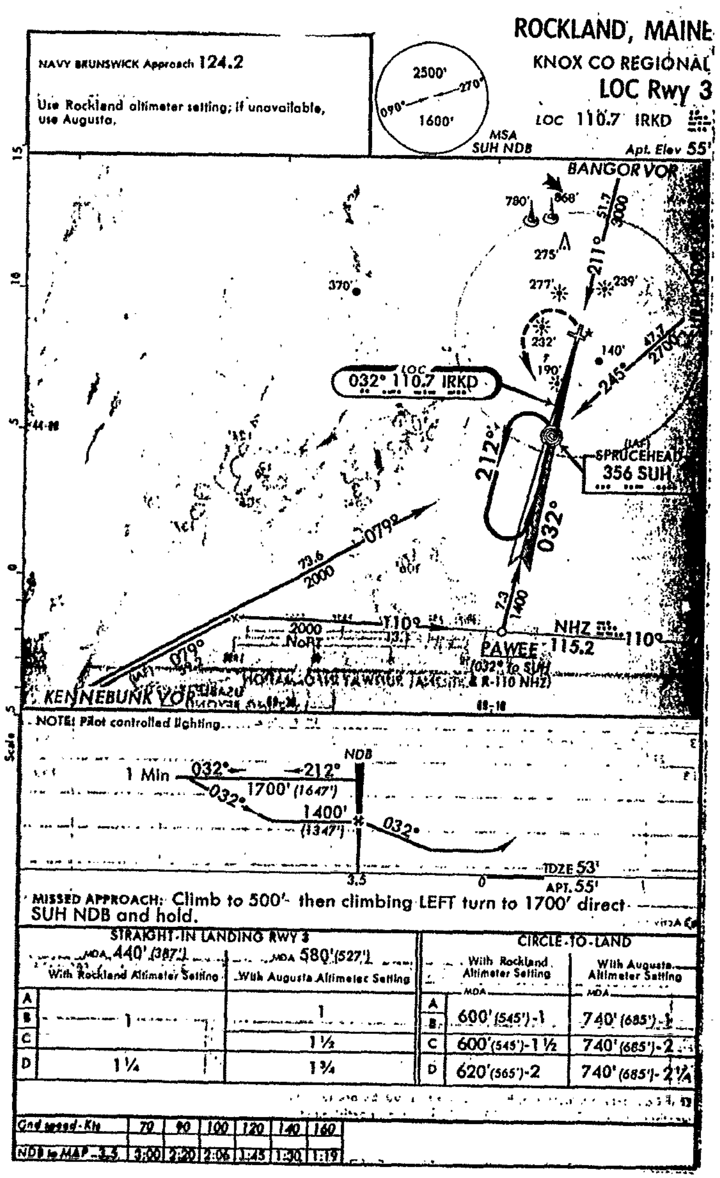
DHC-6
ROCKLAND, MAINE
30 MAY, 1979

Circumstances:	Aircraft hit short by 1.0 NM during NDB LOC Rwy 3 approach. F/O Flying
Time:	2055 Night
Configuration:	Flaps 20 (normally 10 until field insight)
Weather	-3X ¾ mile visibility fog, calm winds
Fatalities:	17 out of 18 on board



Don Bateman

Return to TOC



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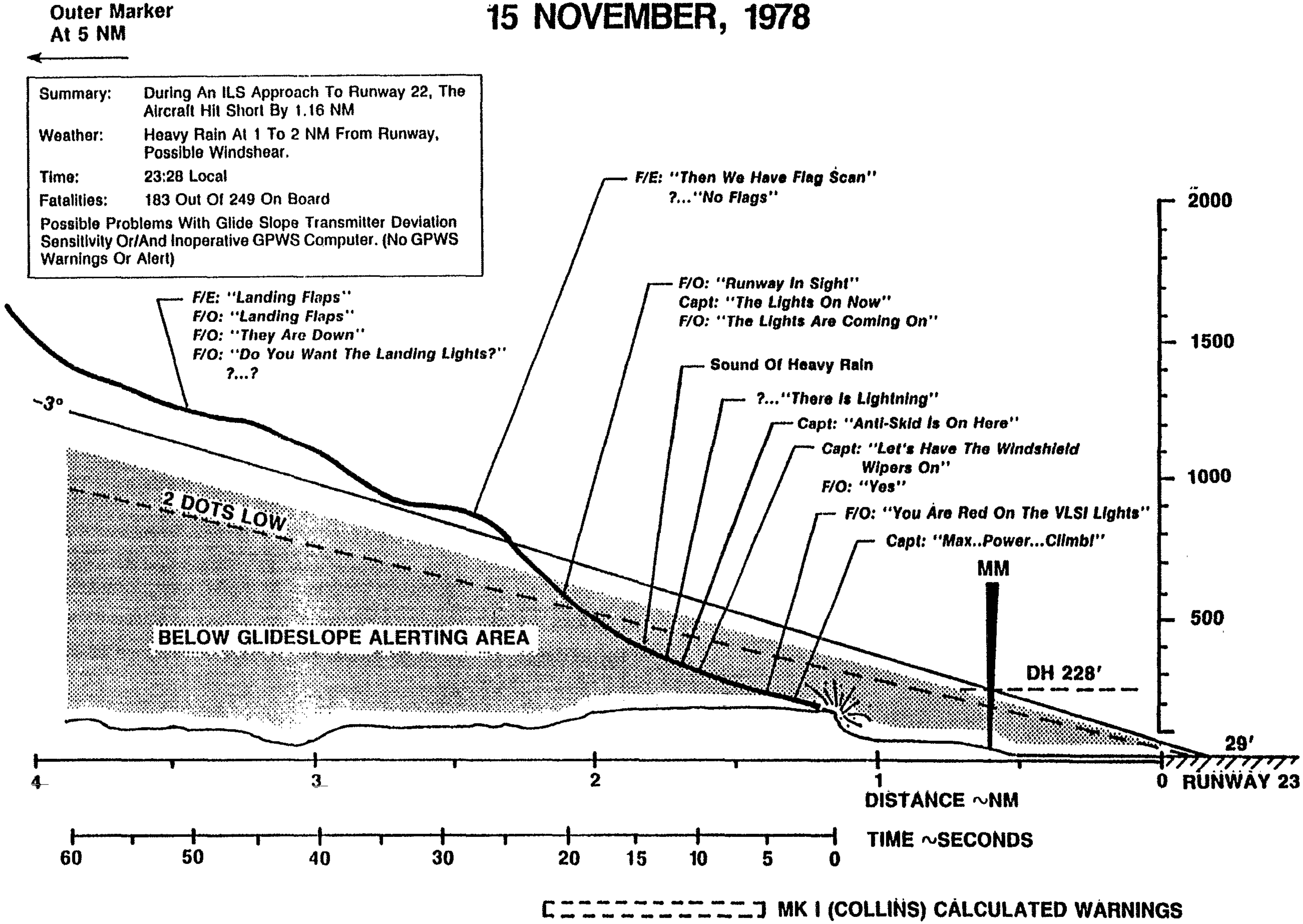
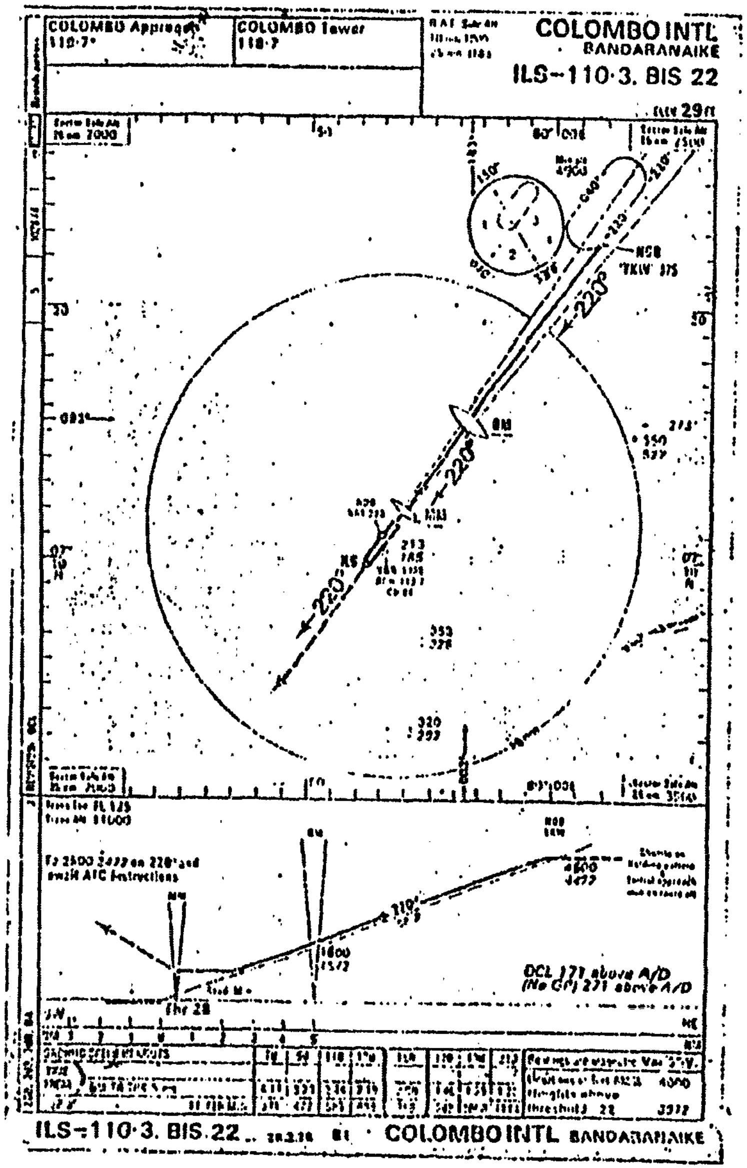
Flight Path Profile

DC-8-63F
COLOMBO, SRI LANKA
15 NOVEMBER, 1978

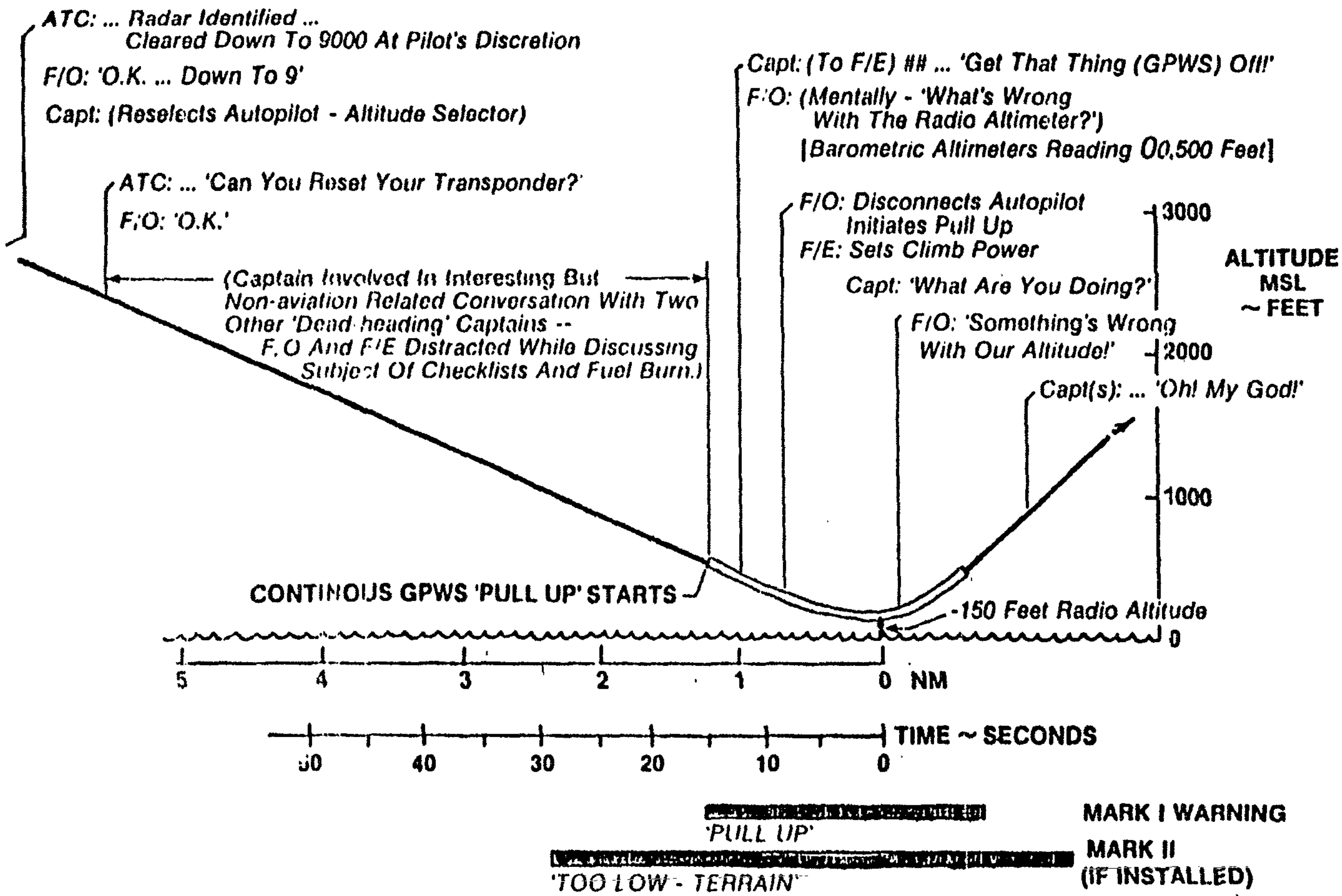


Return to TOC



GPWS Incident - Initial Descent

30 MILES WEST OF WEST OF SAN FRANCISCO B 747 OCTOBER 1978
398 PASSENGERS & CREW - NIGHT WITH LOW CLOUDS



Return to TOC

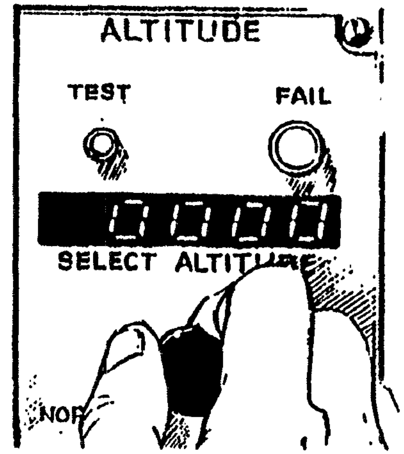
A COCKPIT MYSTERY and a Request for Information

An engineer and designer of GPWS equipment has requested that we ask your opinion about a puzzling crew activity which nearly caused three jet transport controlled flight into terrain accidents. More than likely, based on his statistical analysis, many more incidents of this type occur but are not reported.-Ed.

The engineer writes: "Buried in the multitude of commercial air carrier incidents, a cockpit mystery exists that needs examination by the industry.

"It appears that every million flight hours or so, the Altitude Selector in the glareshield is set to '0000' on approach with the Autopilot engaged. In most cases the pilots detected their error before getting too low, but in at least two separate incidents (one a 767 and the other a 747), the error went undetected until the GPWS activated. In another 747 incident, a Minimum Safe Altitude Warning (MSAW) activated and an alert air traffic controller saved the day.

"The 767 captain is to be highly commended for his report, but unfortunately most incidents go unreported. What is missing from these rarely reported incidents, is an explanation or suggestion on why the Altitude Selector was set to '0000' with the Autopilot engaged or engaged at a later time.



"Two thoughtful people have independently suggested that it may be related to the Altitude Alerter function. Their theory is that some pilots may habitually or subconsciously be setting the Altitude Selector to '0000' or some high altitude value that will eliminate the distraction of a possible Chord 'C' tone during final approach. The Altitude Alert, a descendent of the "Altitude Reminder" is now integral in most cockpit designs to the Flight Director/Autopilot Altitude Selector and it is possible that this is the making of a common mode error. However, the reason or reasons may be more subtle or complex than an altitude alert theory. But whatever the reason, we solicit your help in identifying the reason for this crew error. For certain, with no action, it will be only a matter of time until there is an accident."

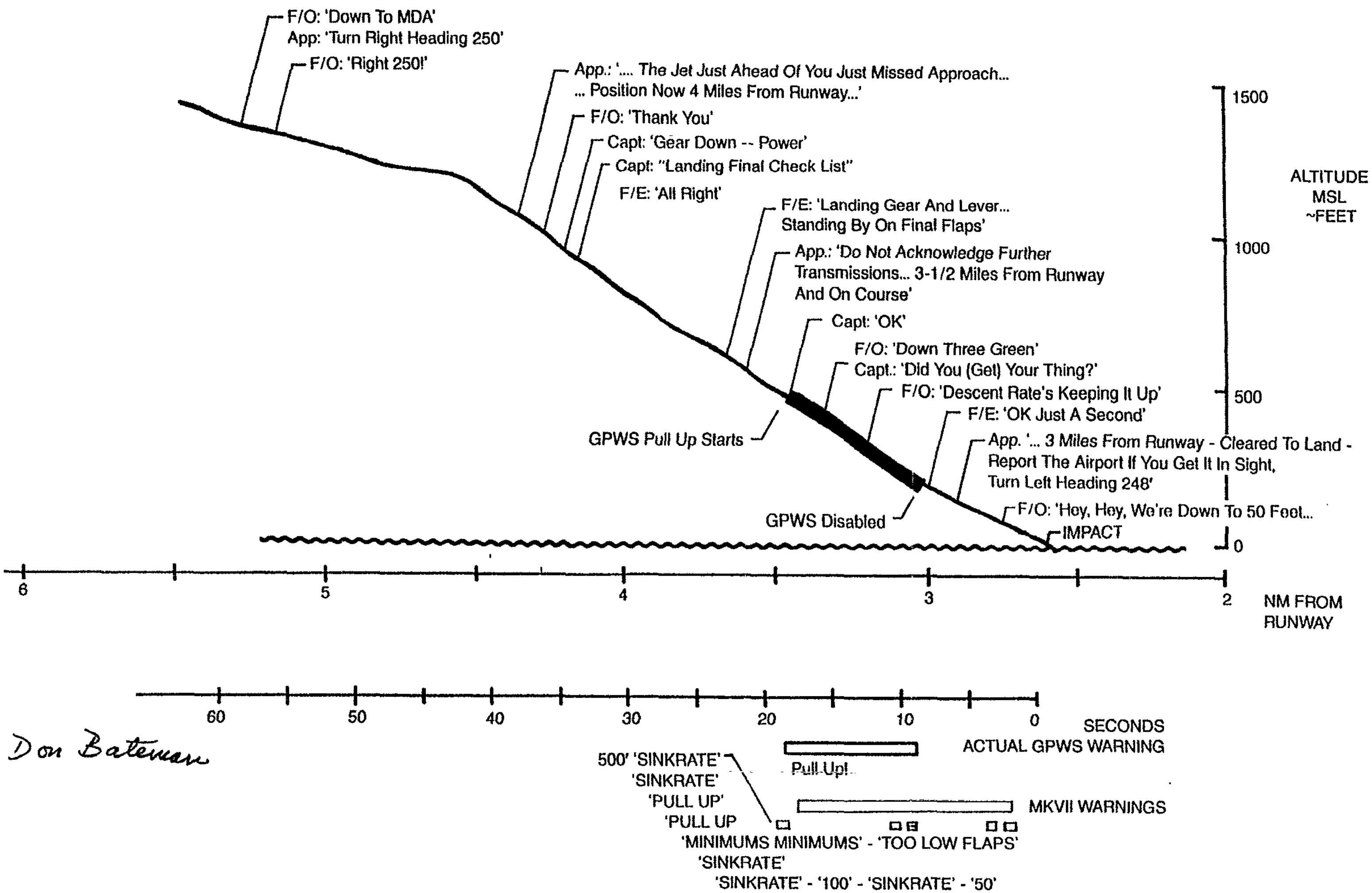
Can you help solve the mystery? If you have any thoughts on this, please let us know. □

Return to TOC

90 282

Circumstances:	Aircraft hit short, during ASR approach to runway 25.
Weather:	400 feet overcast, 4 mile visibility, fog and haze wind 190 degrees at 7 Kts.
Configuration:	Landing.
Time:	21:20 CDT Night
Other:	F/E turned off GPWS
Fatalities:	3 out of 58 on board.

FLIGHT PATH PROFILE
B727-200
Pensacola, Florida
8 May 1978



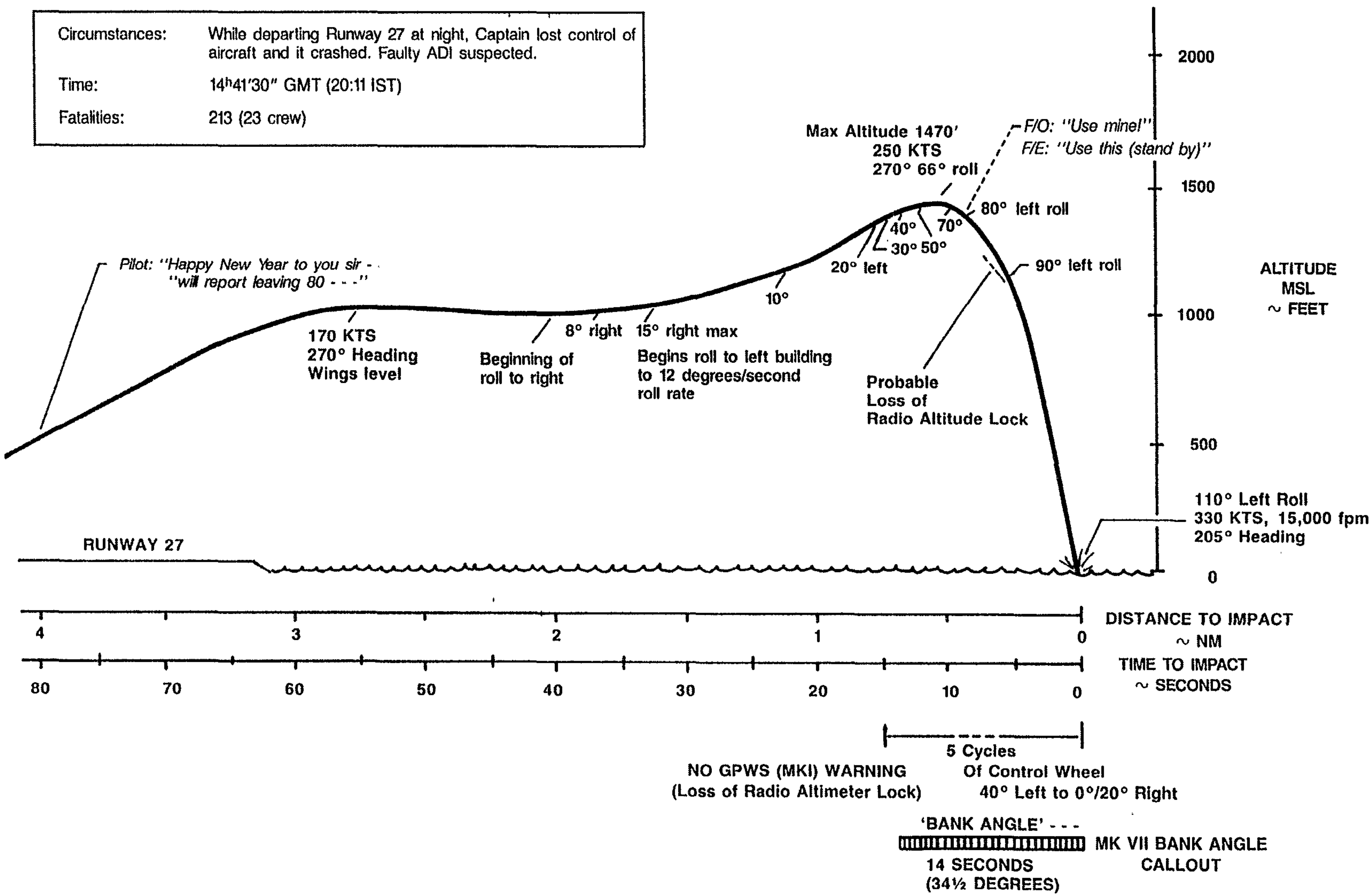
Don Bateman

Flight Path Profile

Return to TOC

B747
BOMBAY, INDIA
1 JANUARY, 1978

Circumstances:	While departing Runway 27 at night, Captain lost control of aircraft and it crashed. Faulty ADI suspected.
Time:	14h41'30" GMT (20:11 IST)
Fatalities:	213 (23 crew)



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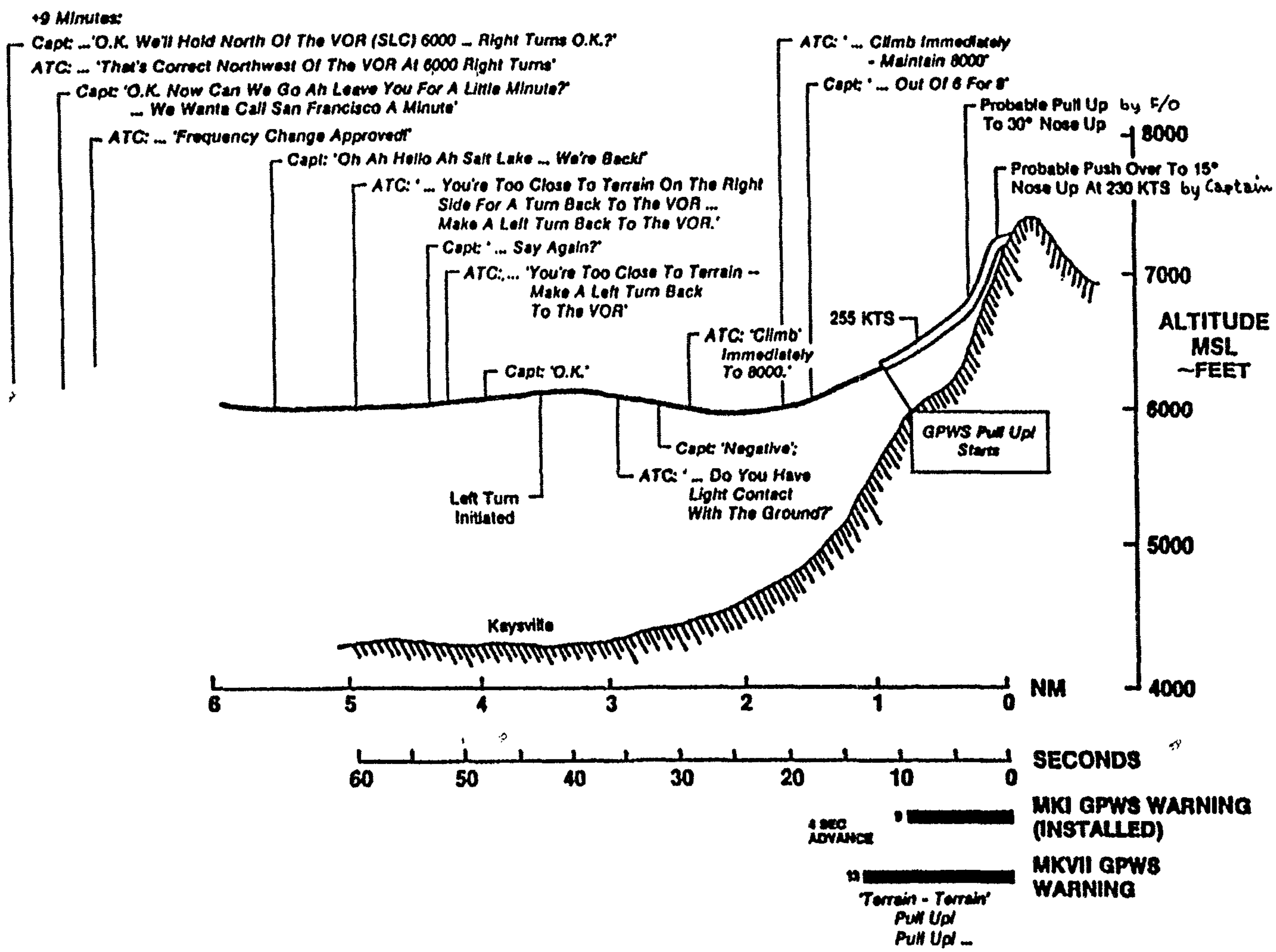
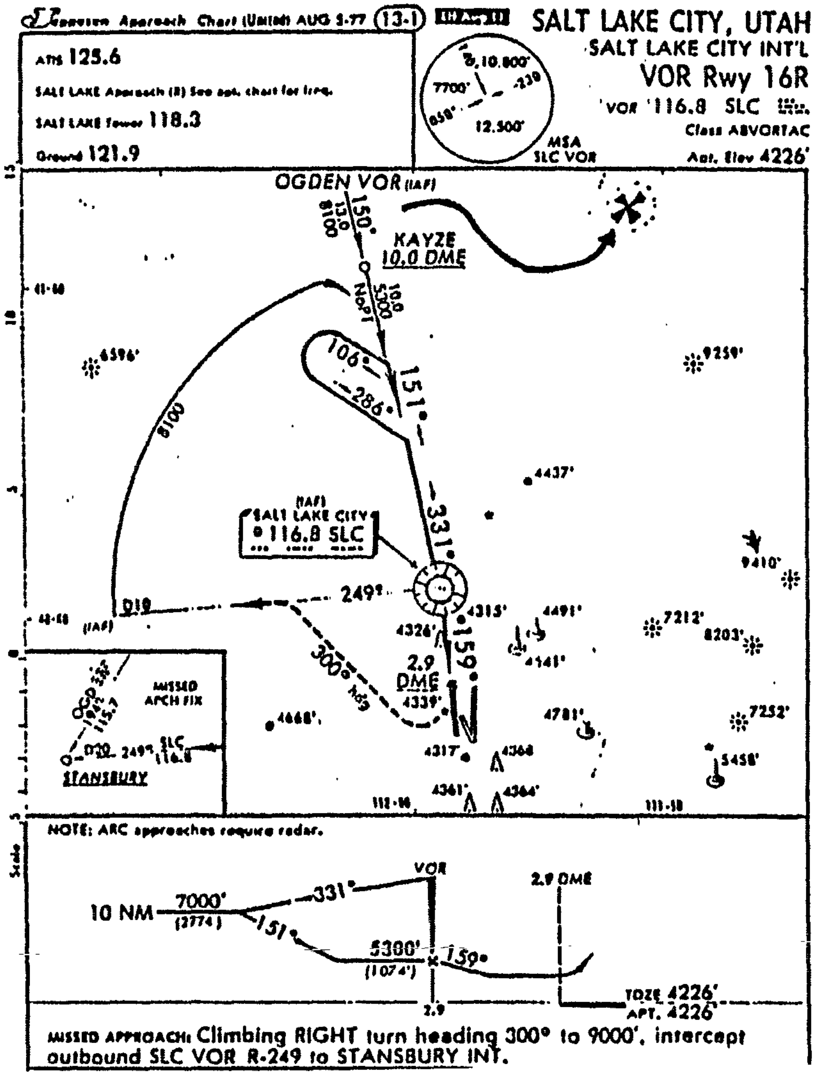
GPWS Accident - Radar Control

SALT LAKE CITY DC-8 18 DECEMBER, 1977



Return to TOC



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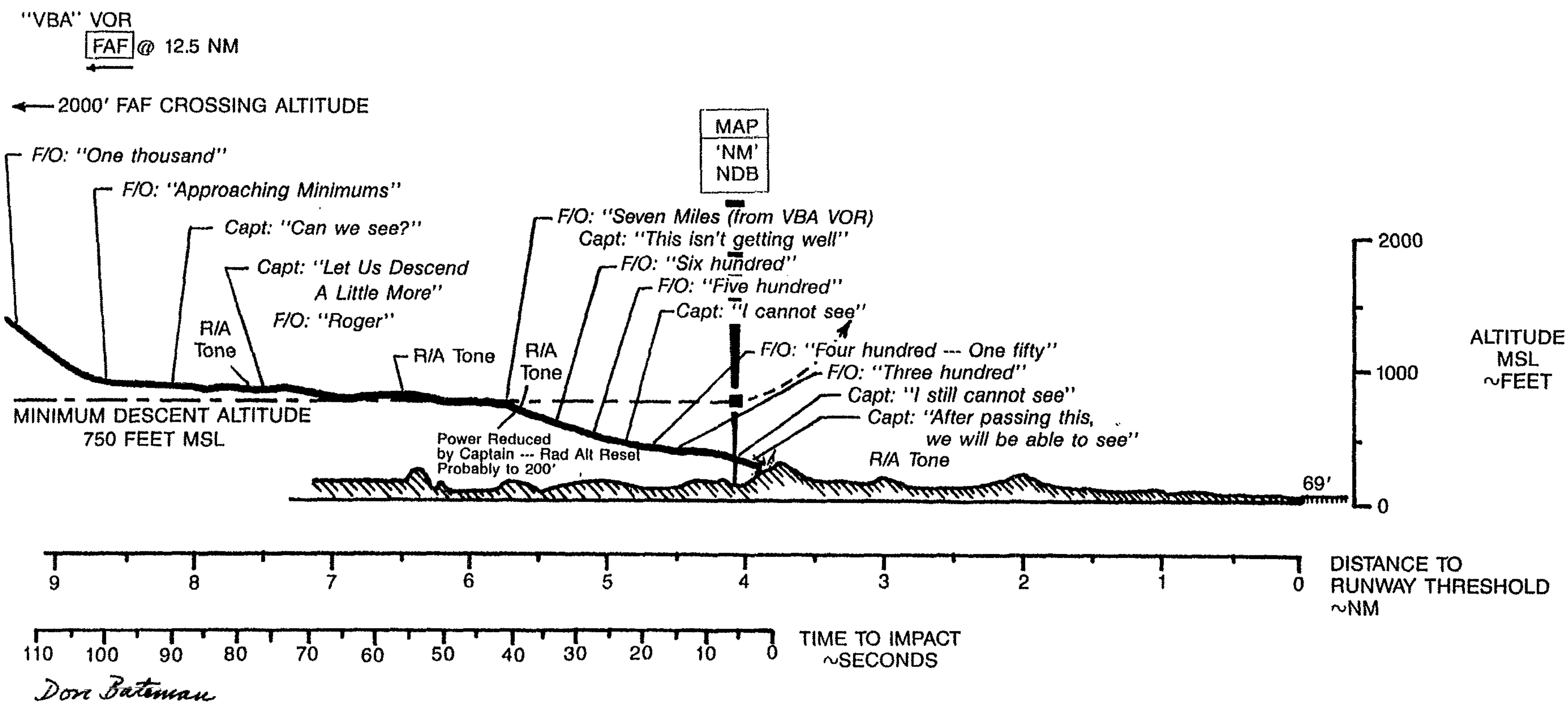
Circumstances:	During a VOR/NDB approach to runway 1, the aircraft impacted short of the threshold by about 4 NM.
Time:	Dusk, 1113 GMT (1843 Local)
Weather:	Heavy rain, wind 140/6 kts, visibility 4 KM 24/23 C
Configuration:	Landing, 35 flaps
Fatalities:	34 out of 90 on board. 42 seriously hurt.
Other:	Very shallow descent angle of 1.44 degrees from FAF, and 1.48 from MAP which was 4 NM from runway

FLIGHT PATH PROFILE

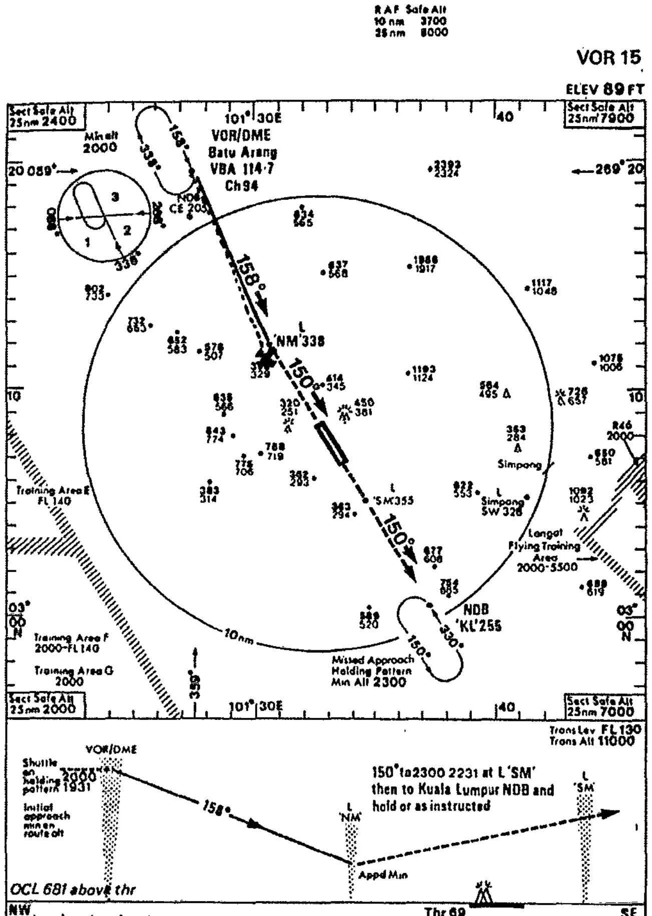
DC-8/62
Kuala Lumpur, Malaysia
27 September, 1977



NO GPWS INSTALLED

Return to TOC

KUALA LUMPUR INTL



GROUND SPEED IN KNOTS	70	90	110	130	150	170	190	210	Bearings are magnetic Var 1°E
TIME FROM L NM TO THRESHOLD 3.92nm	3 22	2 37	2 08	1.49	1.34	1.23	1.14	1.07	Elevations in feet AMSL 539
									Heights above threshold 15 470

22.6.76

Return to TOC

Calculated Flight Path Profile

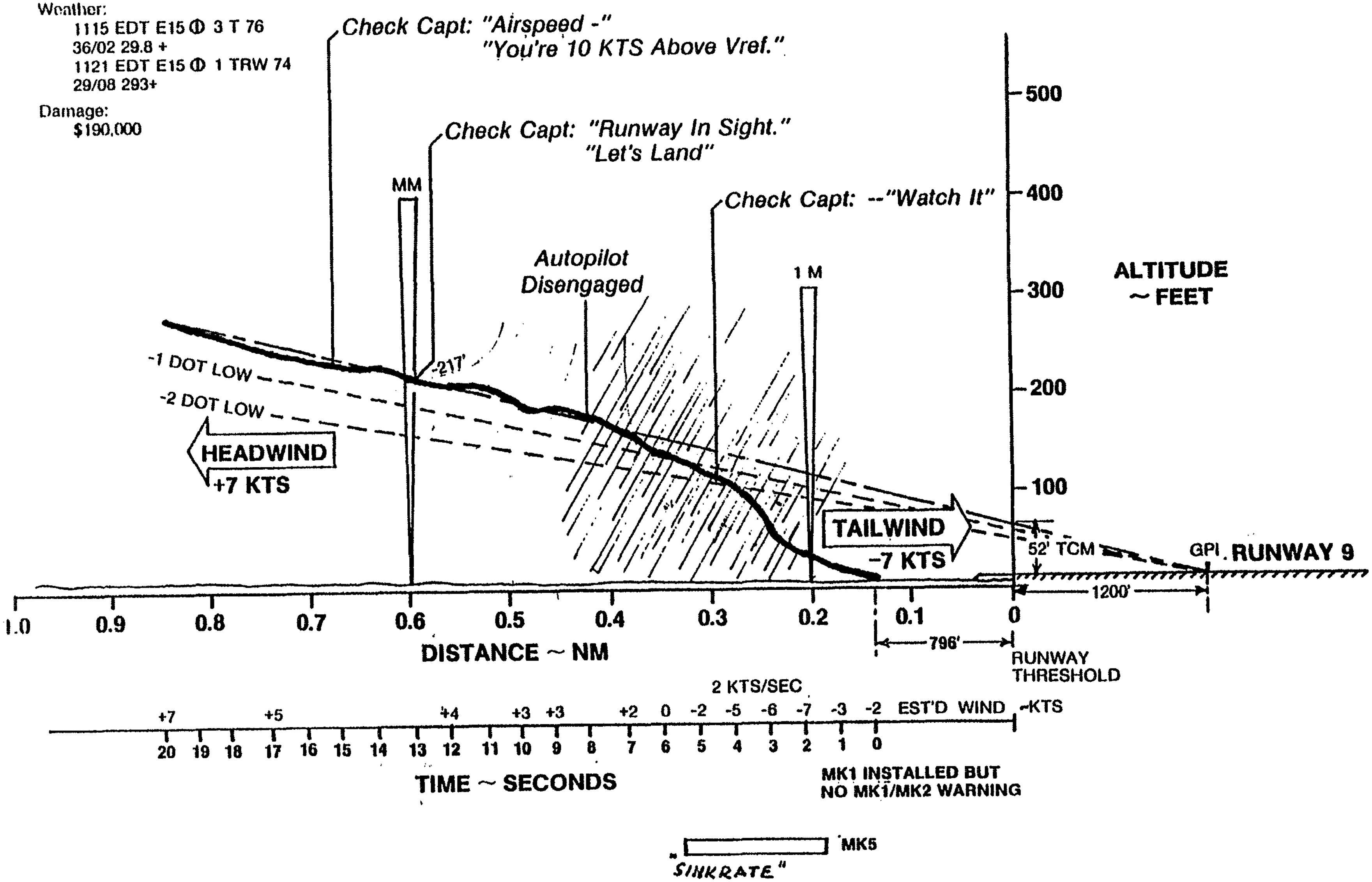
DC-8-62 N 1810 INCIDENT
DADE-COLLIER, FLA., 10 MAY, 1977

Notes:

Circumstances:
Pilot training incident. Auto-Coupled ILS approach to 150 feet. Missed approach initiated in heavy to moderate rain. Airplane touched down short.

Weather:
1115 EDT E15 Ⓘ 3 T 76
36/02 29.8 +
1121 EDT E15 Ⓘ 1 TRW 74
29/08 293+

Damage:
$190,000



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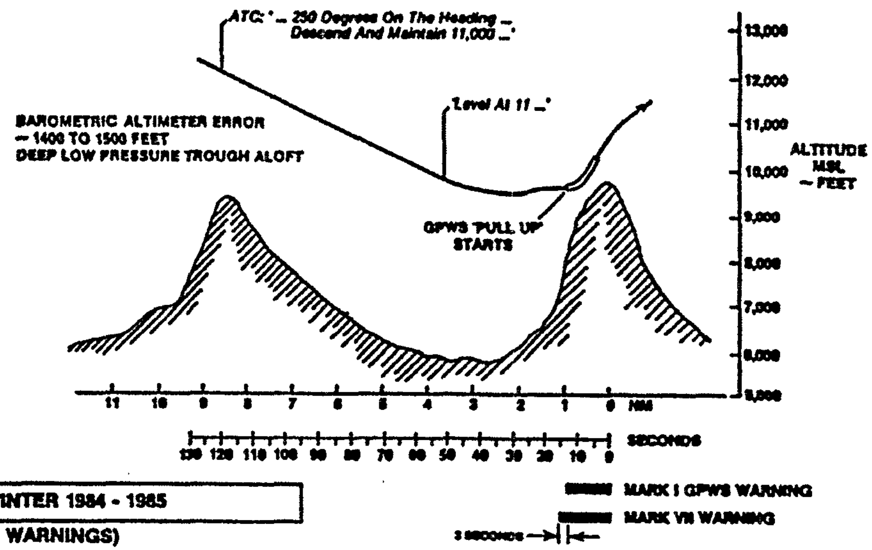
RADAR VECTORS

INITIAL APPROACH

QNH BAROMETRIC PRESSURE/TEMPERATURE ERROR (1400 TO 1500 FEET) DEEP LOW PRESSURE TROUGH ALOFT B727 SALT LAKE CITY - FEBRUARY 1977 IMC



ALTIMETRY ERRORS - WINTER 1984 - 1985

B757 DATA (GPWS WARNINGS)

AIRPORT	MINIMUM ERROR	DISTANCE FROM TOUCHDOWN
ABERDEEN	-331 FEET -411 FEET	16NM 17NM
GENEVA	-252 FEET -258 FEET	19NM 20NM
NEW CASTLE	-637 FEET	21NM

Radar Vectors
QNH Barometric Pressure/Temperature Error (1400 to 1500 Feet)
Deep Low Pressure Through Aloft - B727 Salt Lake City
(February 1977 IMC)

Return to TOC

NASA CR 166230

AN INVESTIGATION OF REPORTS OF CONTROLLED FLIGHT TOWARD TERRAIN

By Richard F. Porter and
James P. Loomis

April 6, 1981

Prepared under Contract No. NAS2-10060 by
BATTELLE COLUMBUS LABORATORIES
ASRS OFFICE
Mountain View, California

for
AMES RESEARCH CENTER
NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION

One occurrence report presented convincing evidence that the MVA in one locale was not adequate. In fact, the MVA has been raised since the reported incident occurred. There can be little doubt, but that the GPWS prevented a catastrophe in this incident:

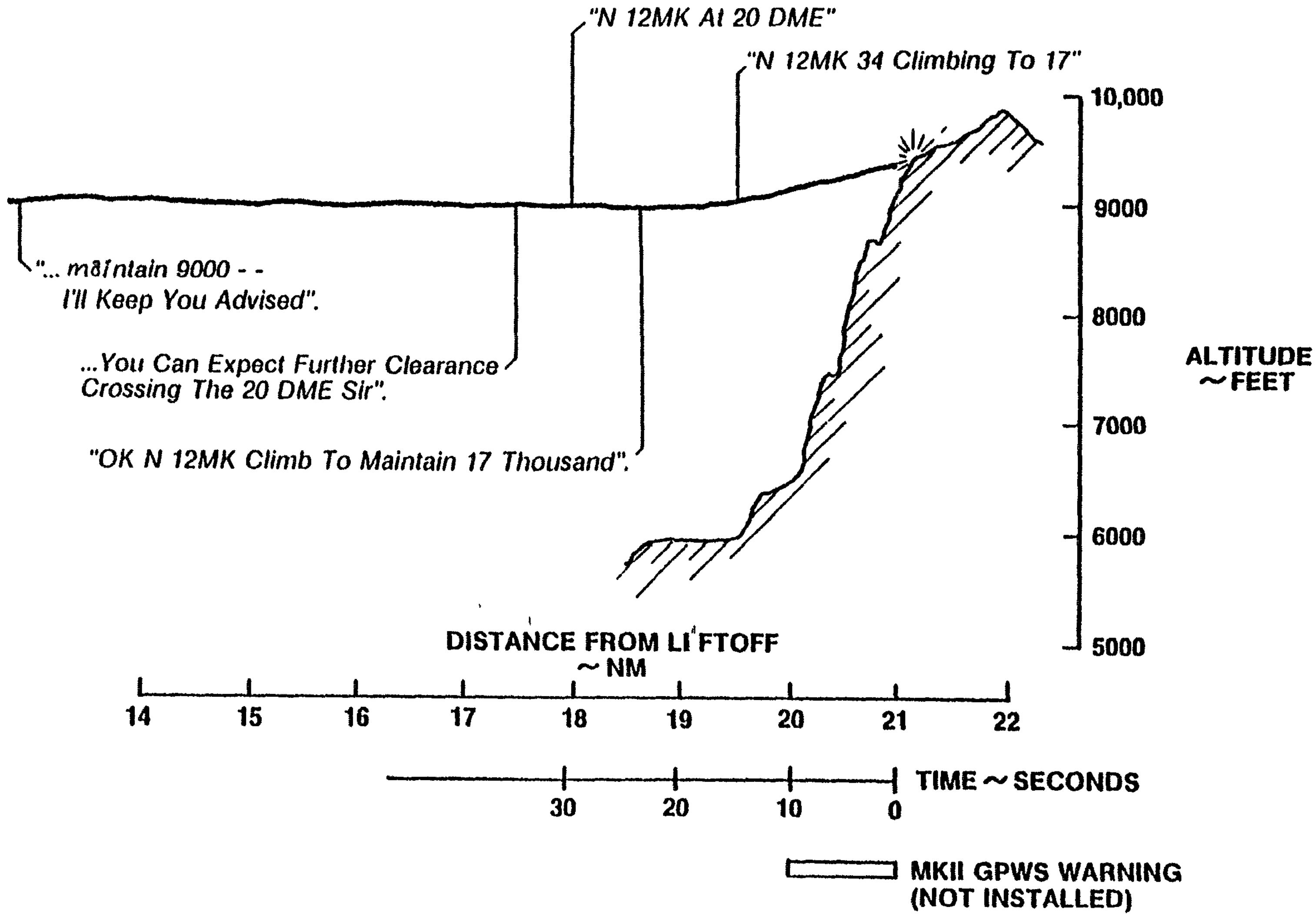
> "...on a radar vector to (name) the GPWS actuated with a red light and 'Whoop-Whoop Pull Up'. At this time we were...at an assigned altitude of 11,000 feet. ...radio altimeter was observed to pass 2500 feet rapidly and power was initiated, climb attitude established. The radio altimeter passed through 800 feet and gradually started up during the climb. ...there was a deep low (trough) aloft, and...the aircraft was 1400 feet lower than indicated..."

At the time of the occurrence, the MVA was intended to provide a 1000-foot margin. In the reporter's opinion, even a revised 2000-foot margin was not entirely adequate.

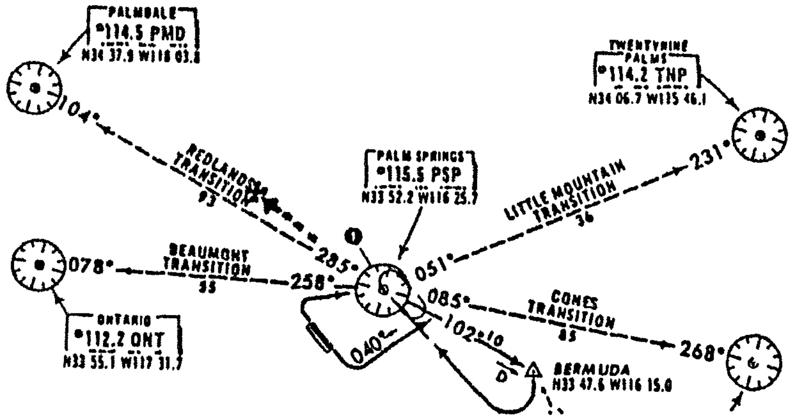
Radar Vectors

INITIAL DEPARTURE PALM SPRINGS 30

LEAR 24 6 JANUARY 1977

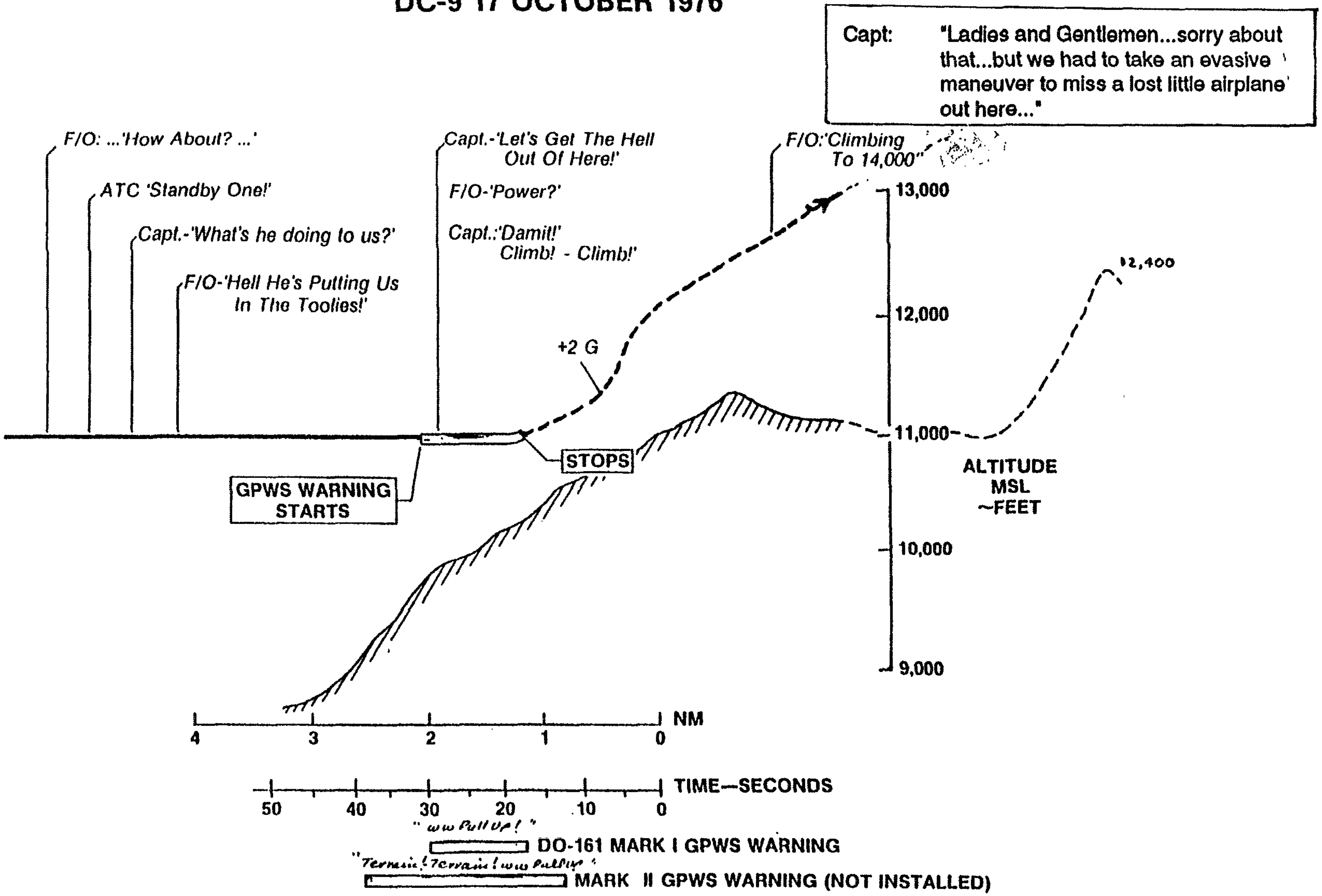


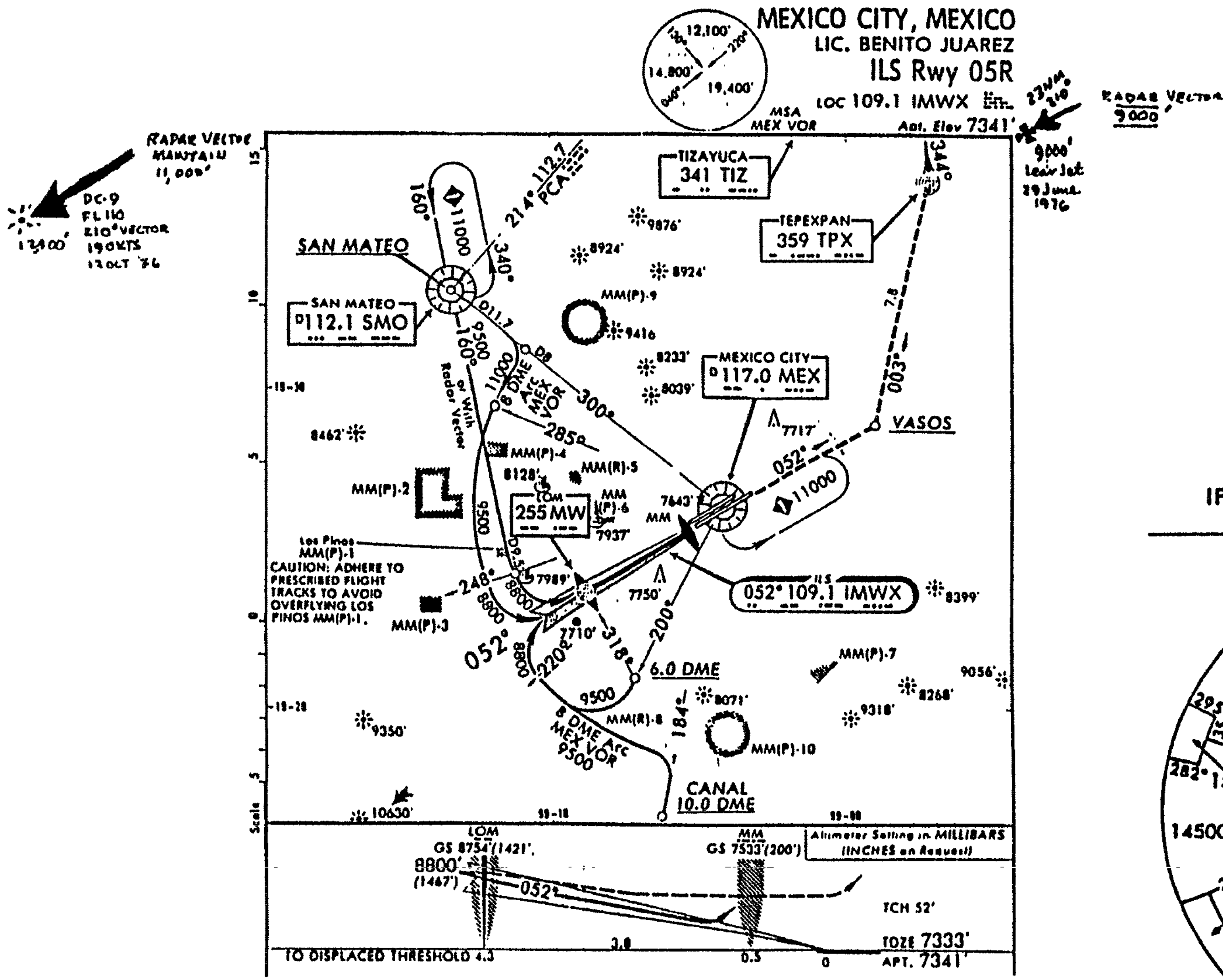
Return to TOC

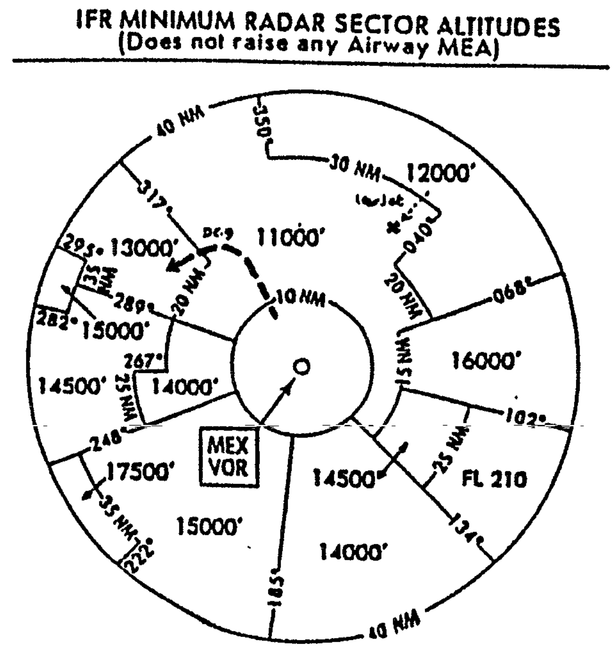


Radar Vectors

INITIAL APPROACH SPACING MEXICO CITY ILS 05
DC-9 17 OCTOBER 1976



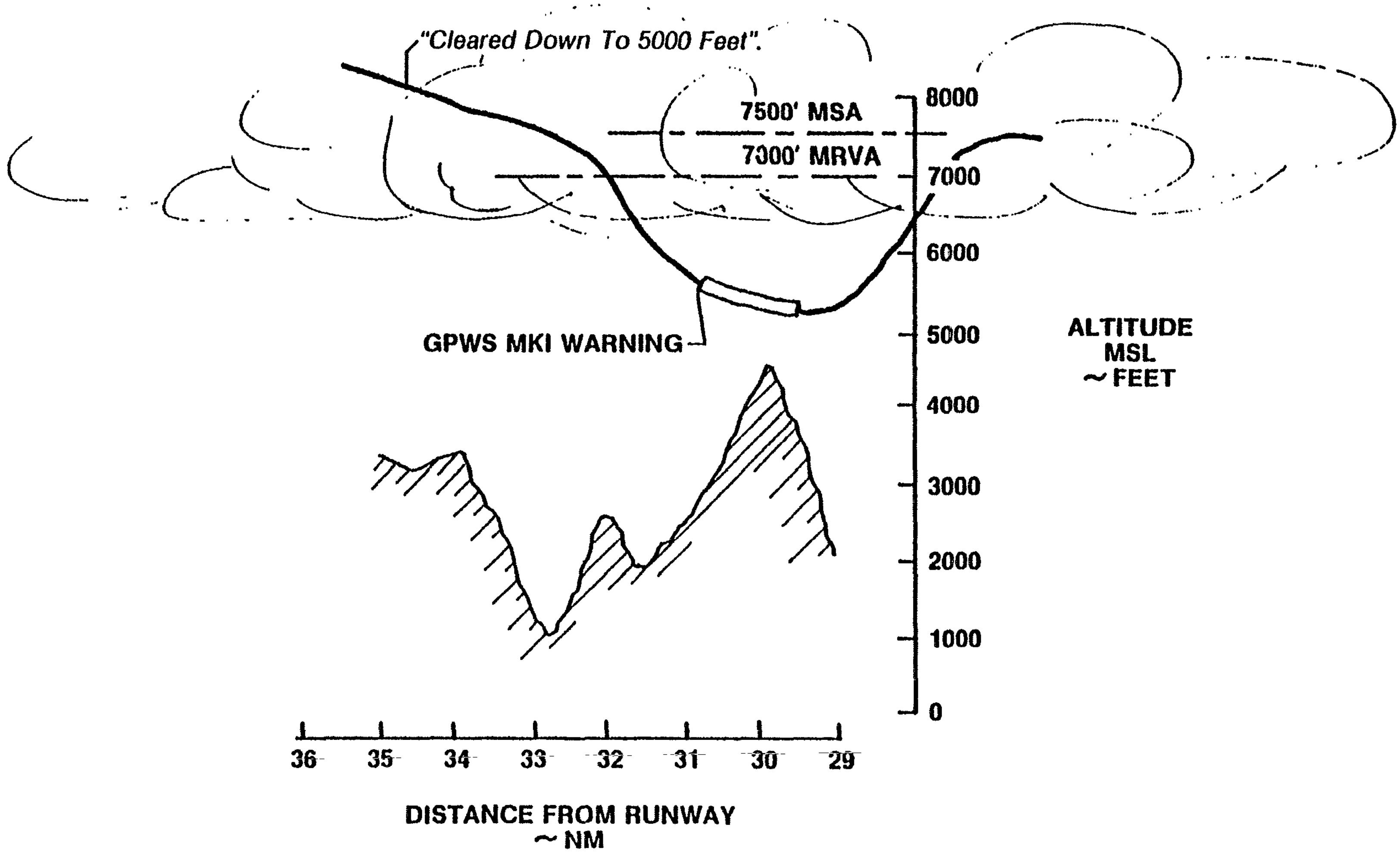

MEXICO CITY, MEXICO
LIC. BENITO JUAREZ
ILS Rwy 05R
LOC 109.1 IMWX
Apt. Elev 7341'
MSA MEX VOR
12,100'
14,800'
19,400'
TIZAYUCA
341 TIZ
TEPEXPAN
359 TPX
SAN MATEO
SAN MATEO
D112.1 SMO
MEXICO CITY
D117.0 MEX
VASOS
255 MW
052° 109.1 IMWX
CANAL
10.0 DME
6.0 DME
CAUTION: ADHERE TO PRESCRIBED FLIGHT TRACKS TO AVOID OVERFLYING LOS PINOS MM(P)-1.
RADAR VECTOR MAINTAIN 11,000'
DC-9 FL 110 210° VECTOR 190KTS 12 OCT '76
RADAR VECTOR 9000
9000' Lear Jet 29 June 1976
GS 8754' (1421')
GS 7533' (200')
Altimeter Setting in MILLIBARS (INCHES on Request)
TCH 52'
TDZE 7333'
APT. 7341'
TO DISPLACED THRESHOLD 4.3


IFR MINIMUM RADAR SECTOR ALTITUDES
(Does not raise any Airway MEA)
12000'
11000'
13000'
15000'
14000'
14500'
16000'
17500'
15000'
14500'
FL 210
14000'
MEX VOR
40 NM
30 NM
20 NM
10 NM
25 NM
35 NM

Next Page

Radar Vector

INITIAL APPROACH
PREMATURE ALTITUDE CLEARANCE
PORTLAND OREGON 20 JULY 1976



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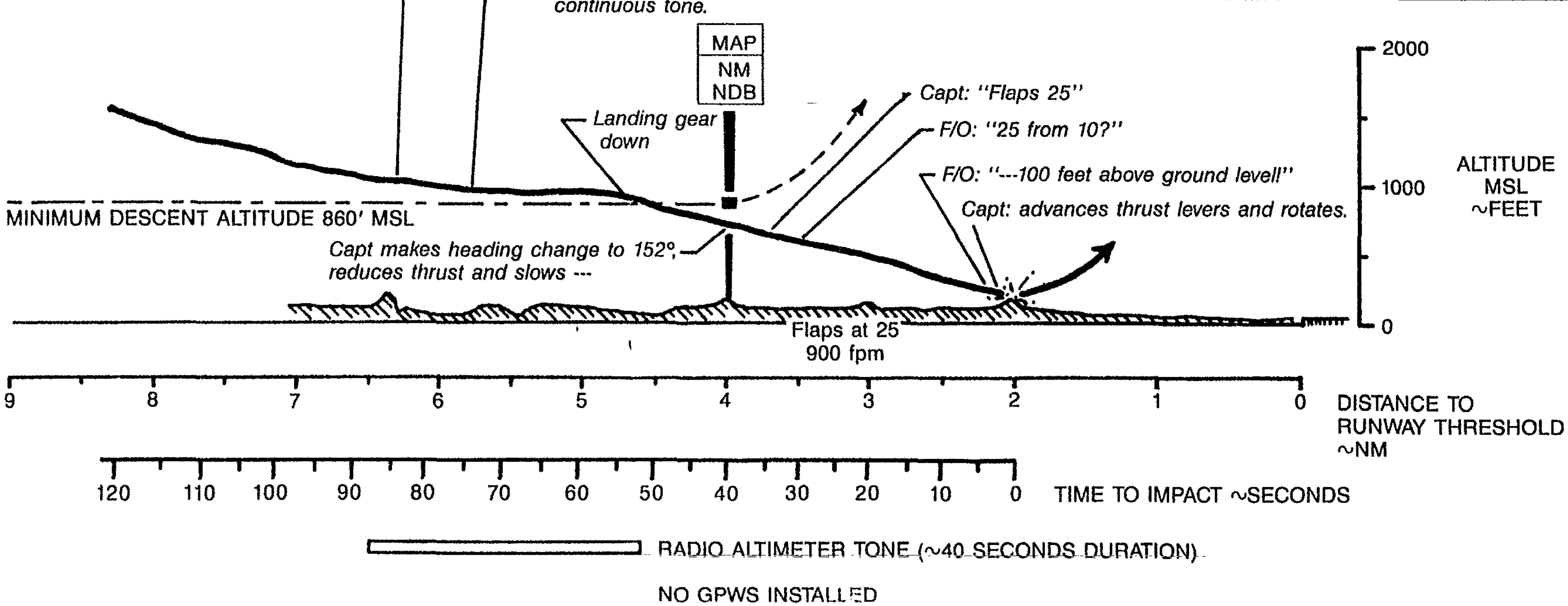
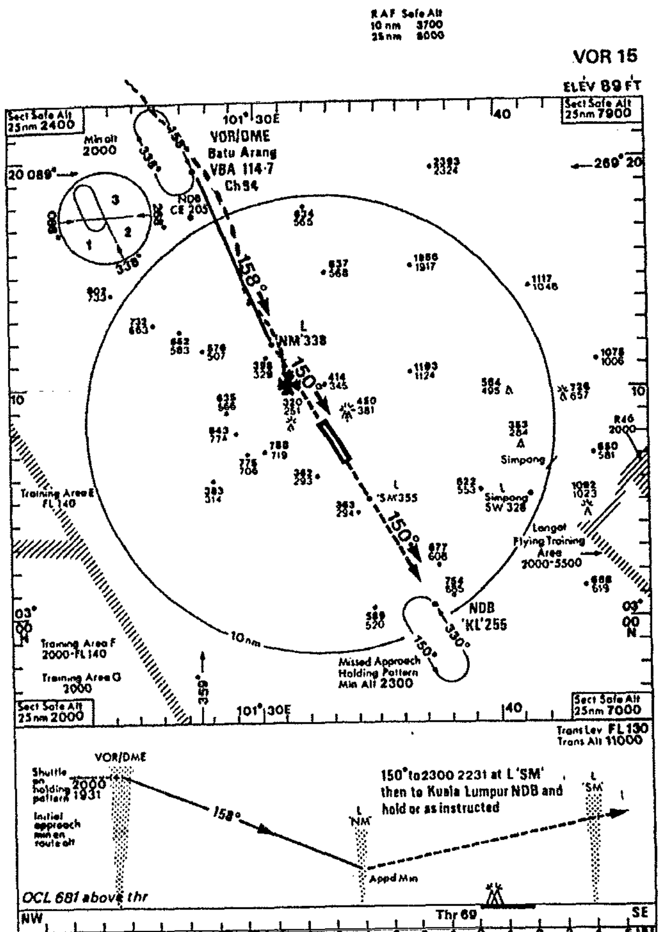
FLIGHT PATH PROFILE
B747-100
Kuala Lumpur, Malaysia
11 May, 1976

Circumstances:	During a VOR/NDB approach to runway 15, the aircraft flew through trees short of the threshold by about 2 NM.
Time:	Night, 1220 GMT (19:20 Local)
Weather:	Clear, 15 KM visibility, calm wind, 25/22 c
Configuration:	Landing, flap 25
Injury:	None to 122 on board.
Damage:	Damage to hydraulic and electrical systems on all main landing gear legs. Strike marks on fuselage, landing gear and engine intact.
Other:	This incident preceded 27 Sept. 1977 accident using the same VOR/NDB approach procedure. (Very shallow descent gradients and MAP 4 NM from runway).



Return to TOC

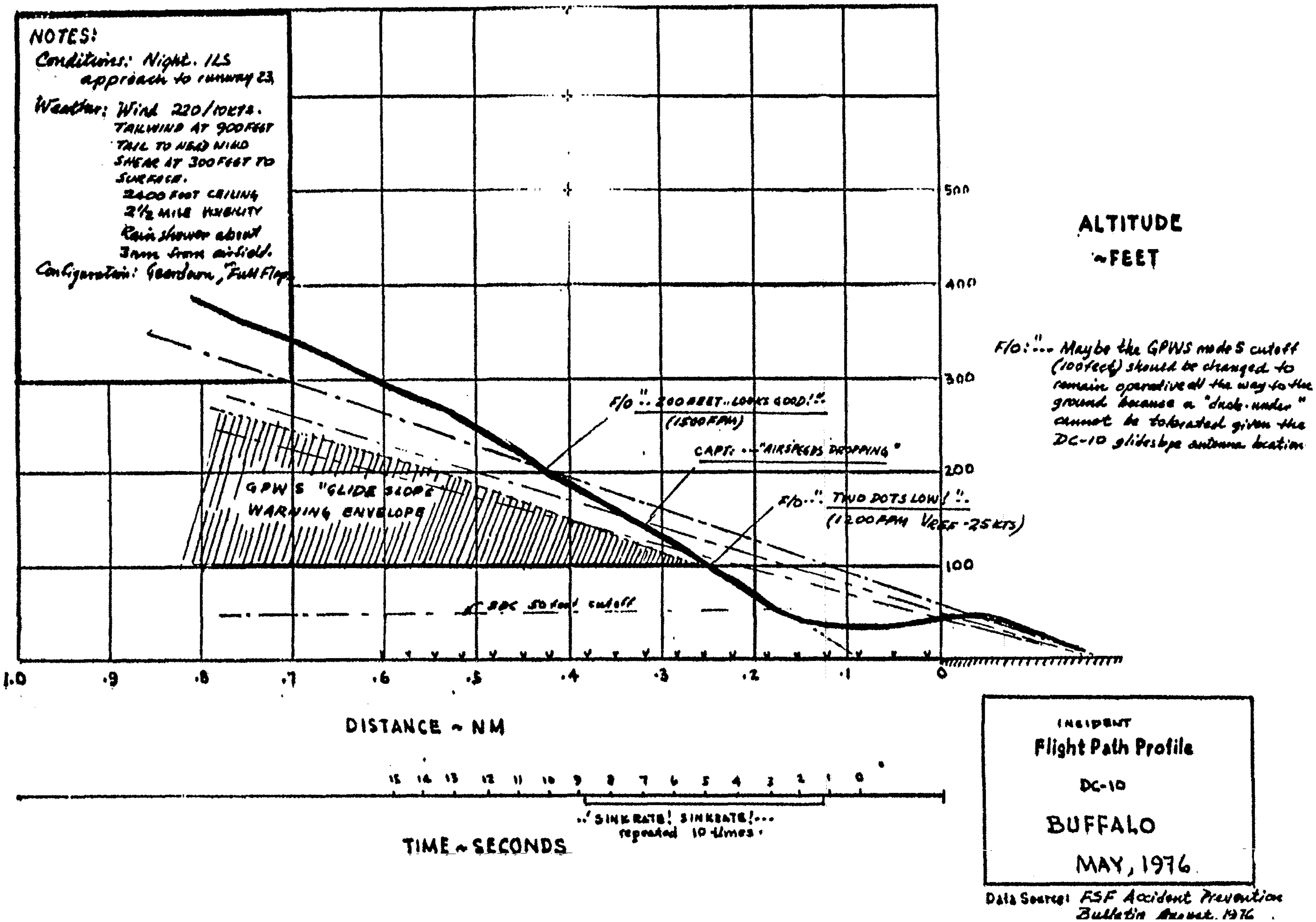
KUALA LUMPUR INTL



GROUND SPEED IN KNOTS	70	90	110	130	150	170	190	210	Bearings are magnetic Var 1°E
TIME FROM L'NM TO THRESHOLD 3 92nm	3 22	2.37	2 08	1.49	1.34	1.23	1.14	1.07	Elevations in feet AMSL 539
									Heights above threshold 15 470

22.6.76

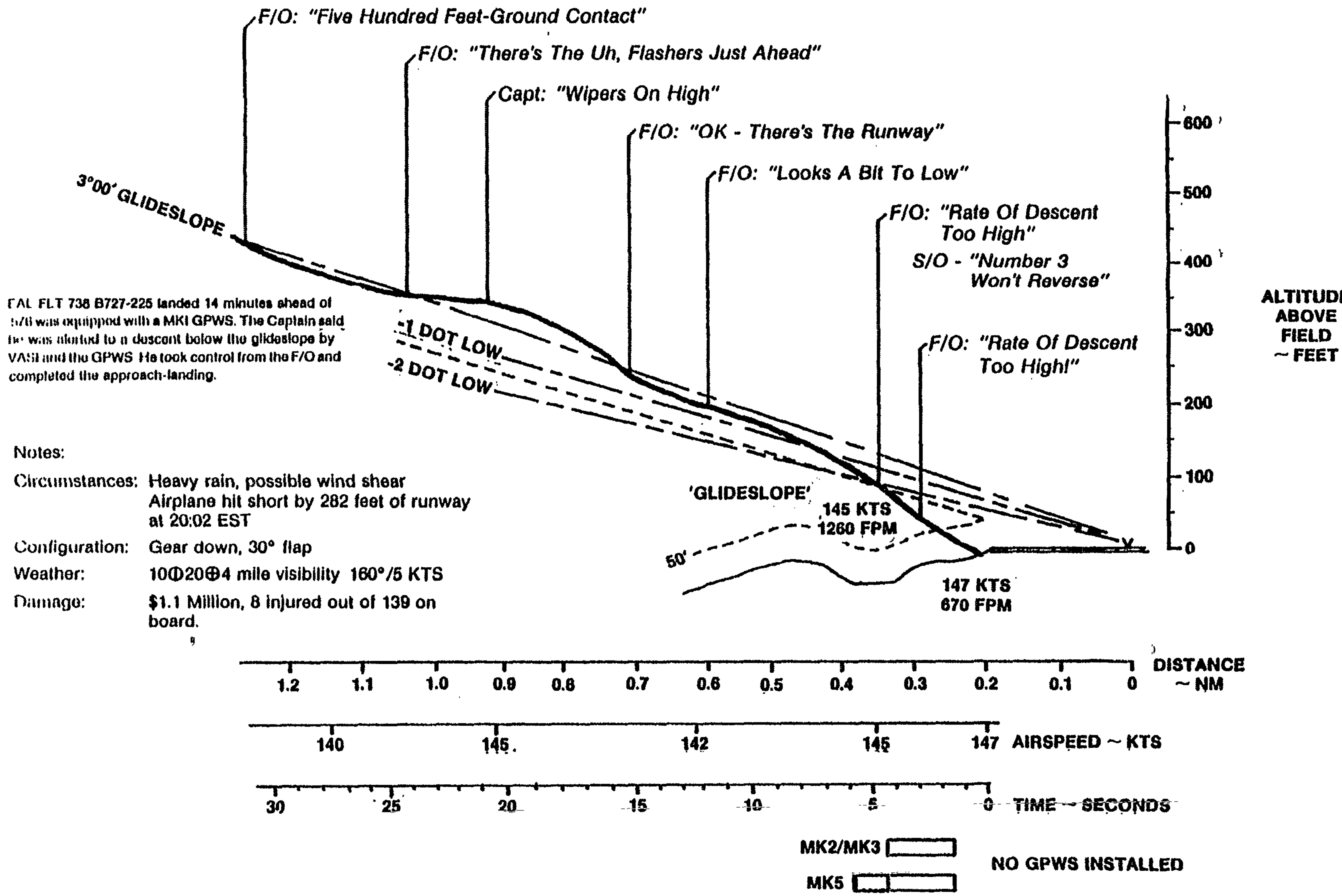
Return to TOC



Return to TOC

Flight Path Profile

EAL FLT 576, B727-225
RALEIGH, N.C., 12 NOV 1975



Notes:

Circumstances: Heavy rain, possible wind shear
Airplane hit short by 282 feet of runway at 20:02 EST

Configuration: Gear down, 30° flap

Weather: 10⦶20⊕4 mile visibility 160°/5 KTS

Damage: $1.1 Million, 8 injured out of 139 on board.

Next Page

PREMATURE DESCENT

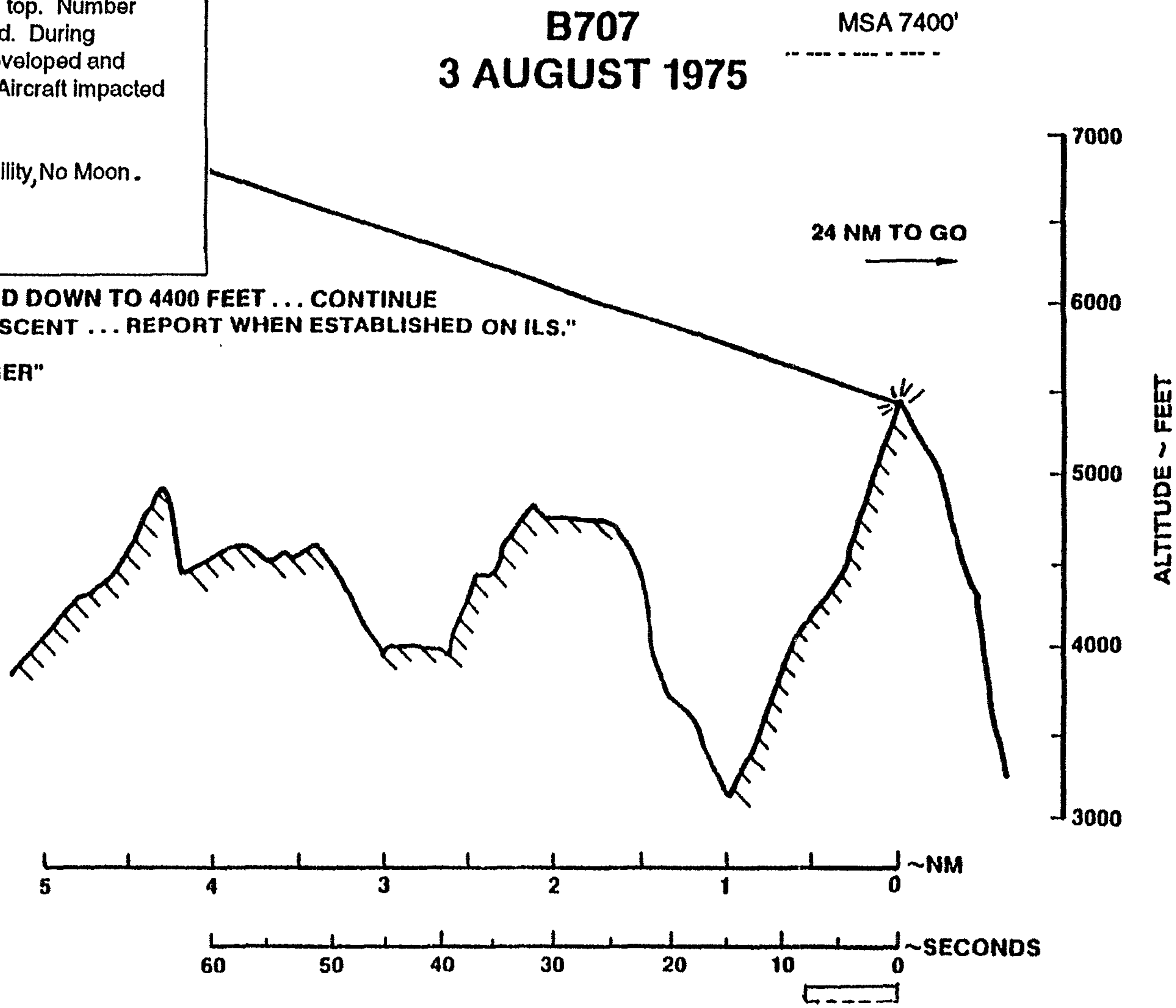
NOTES: Charter Flight
During initial descent aircraft's right wing tip clipped mountain top. Number 4 engine cacelle damaged. During recovery, a Dutch Roll developed and three engines came off. Aircraft impacted some 3 miles or so.

Weather: Unlimited Visibility, No Moon.
Time: 04:30 Local
Fatalities: 188 (7 crew)

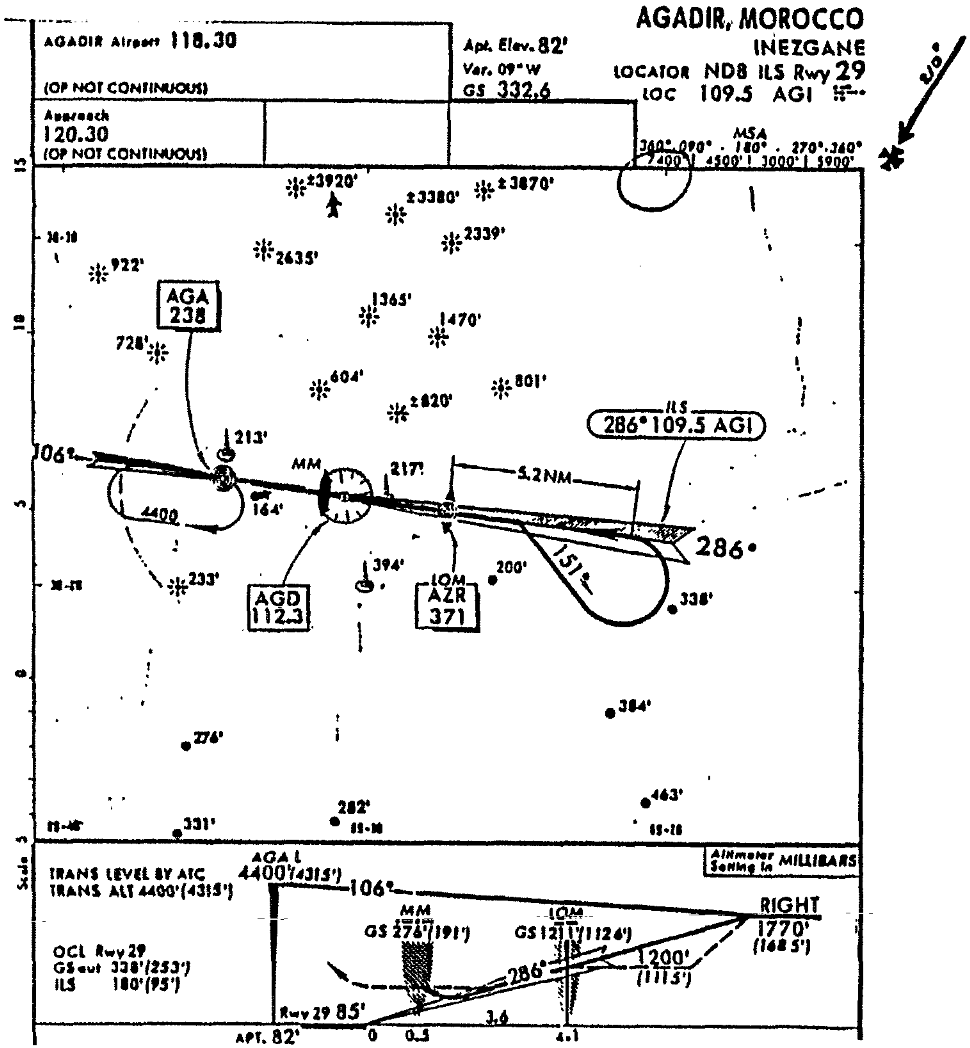
AGADIR, MAROCCO
B707
3 AUGUST 1975

ATC: " CLEARED DOWN TO 4400 FEET . . . CONTINUE YOUR DESCENT . . . REPORT WHEN ESTABLISHED ON ILS."

CAPT: " — ROGER"



Return to TOC



Next Page

Radar Control

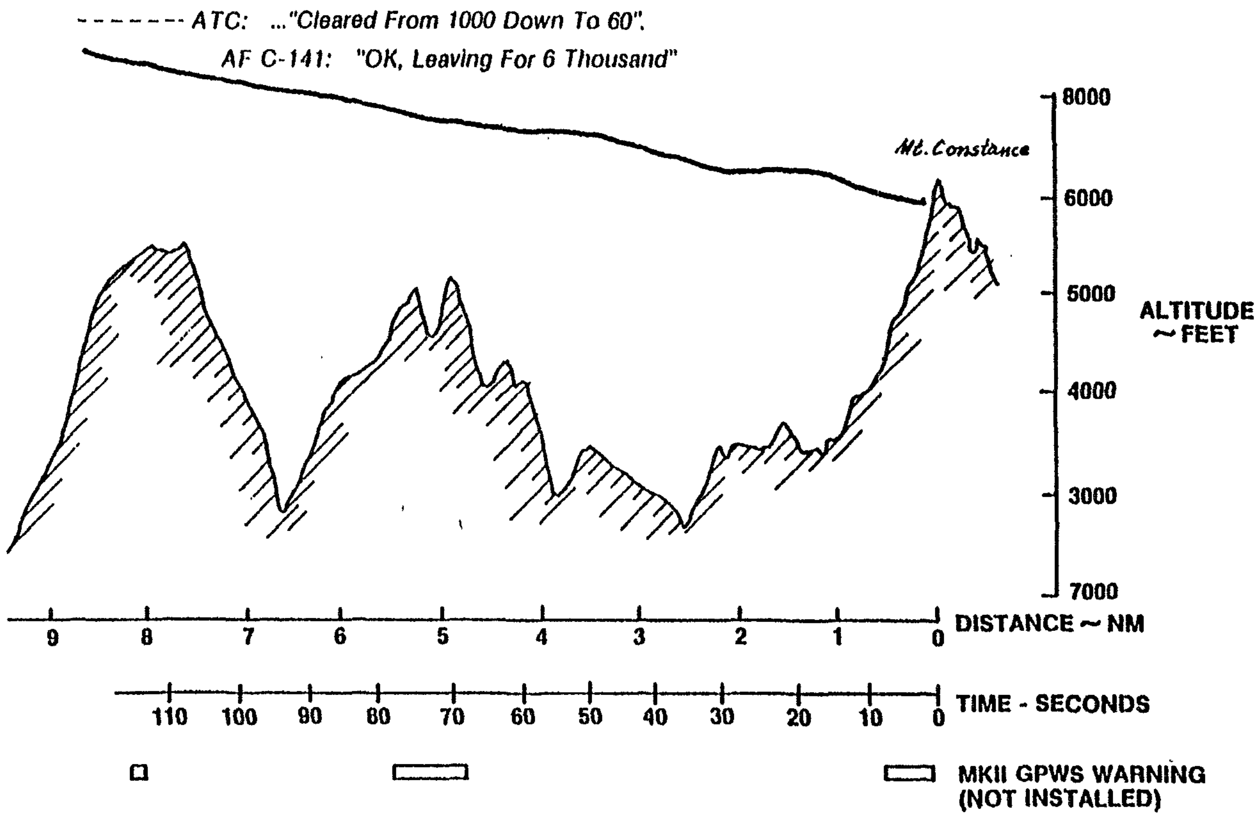
INITIAL APPROACH MCCHORD AFB (SEATTLE)

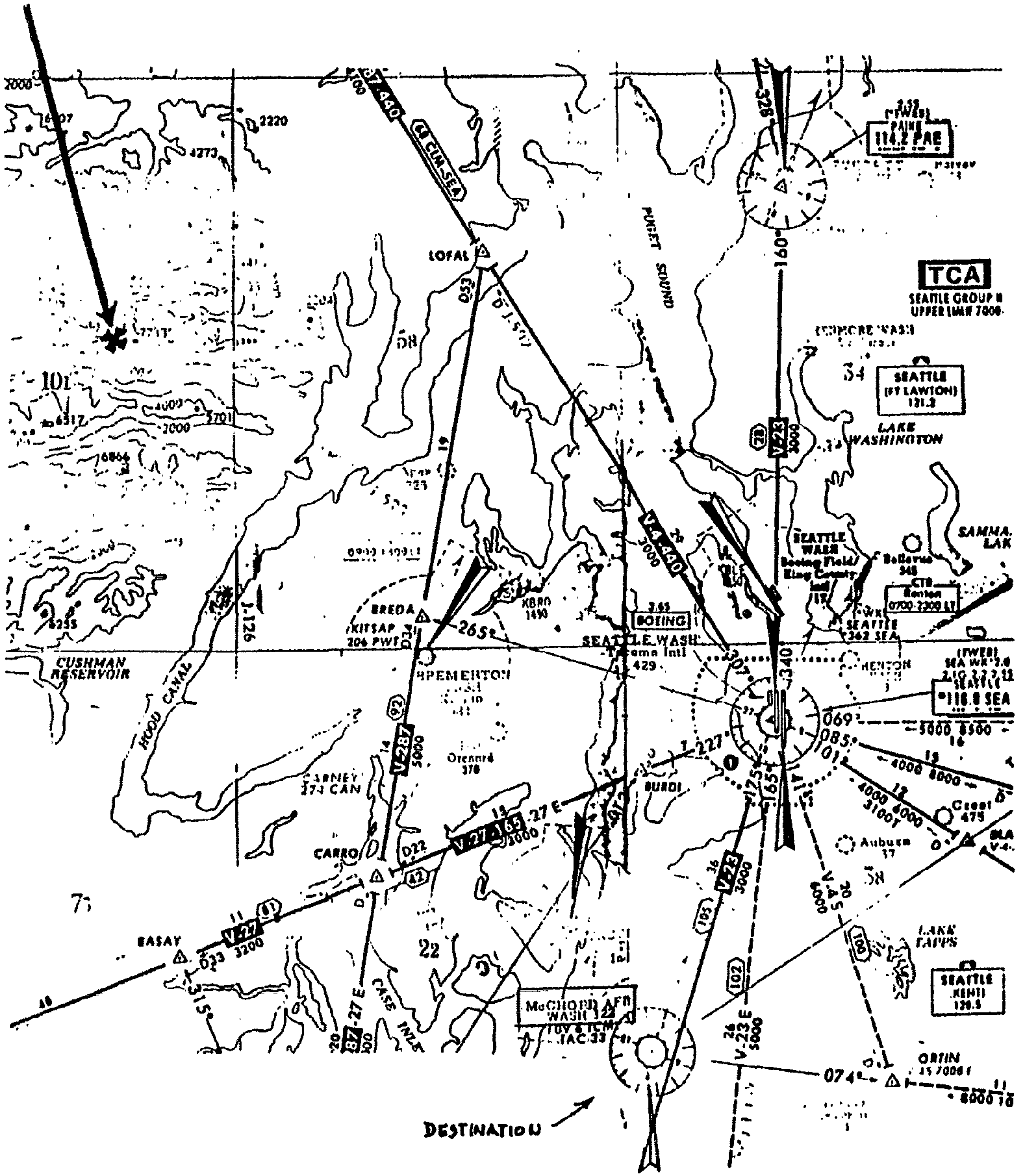
FAA Controller Cleared Wrong Aircraft To Descend

C-141 20 MARCH, 1975

ARTS III RADAR

NOTES: Aircraft hit 100 feet below ridge at night in IMC.
Fatalities: 16



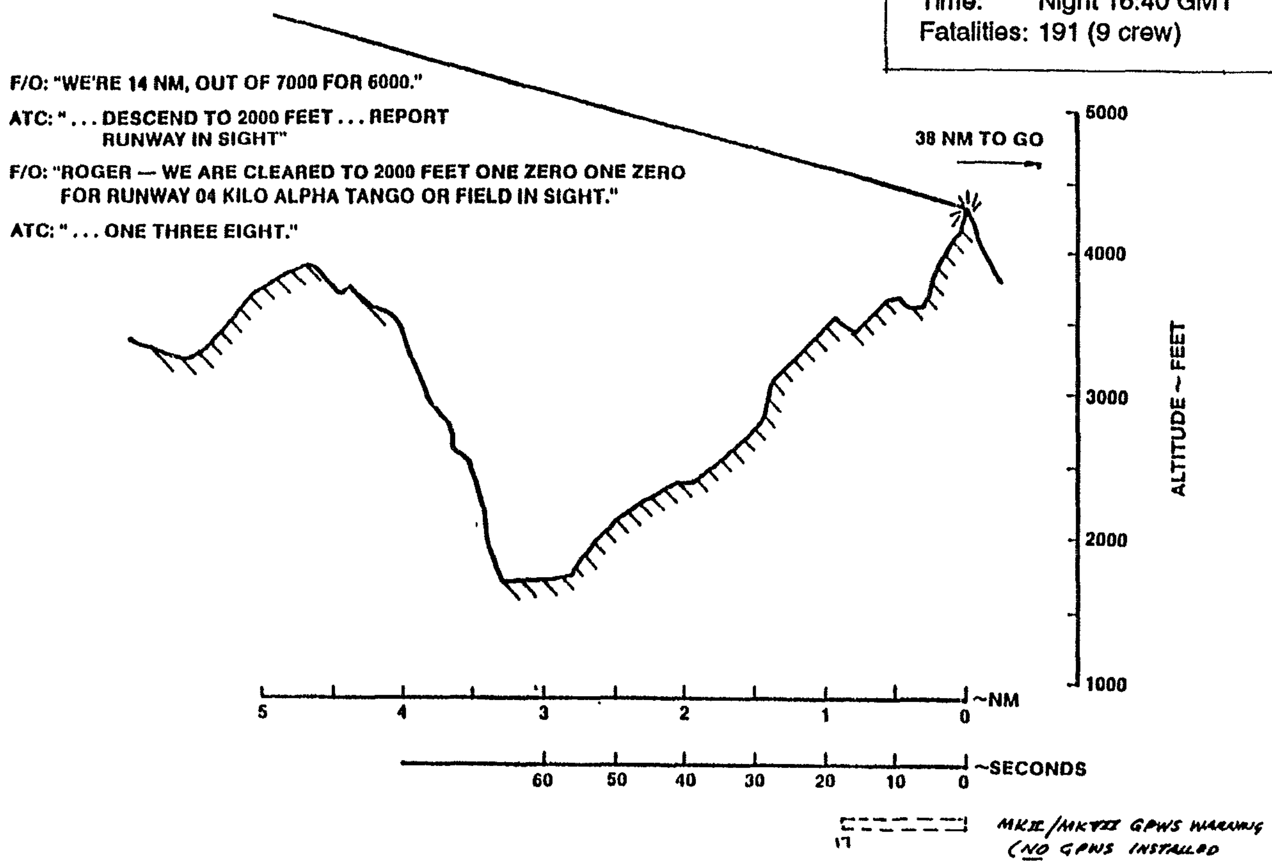

LOFAL
PUGET SOUND
TCA
SEATTLE GROUP II
UPPER LIMIT 7000
SEATTLE
LAKE WASHINGTON
114.2 PAE
CUSHMAN RESERVOIR
HOOD CANAL
BREDA
KITSAP
BREMERTON
BOEING
SEATTLE WASH
Tacoma Intl
BURDI
CARRO
BASAY
V-27
V-287
V-23
V-4-440
116.8 SEA
Bellevue
Auburn
LAKE TAPPS
SEATTLE (KENT)
McCHORD AFB
ORTIN
SAMMA. LAK
DESTINATION

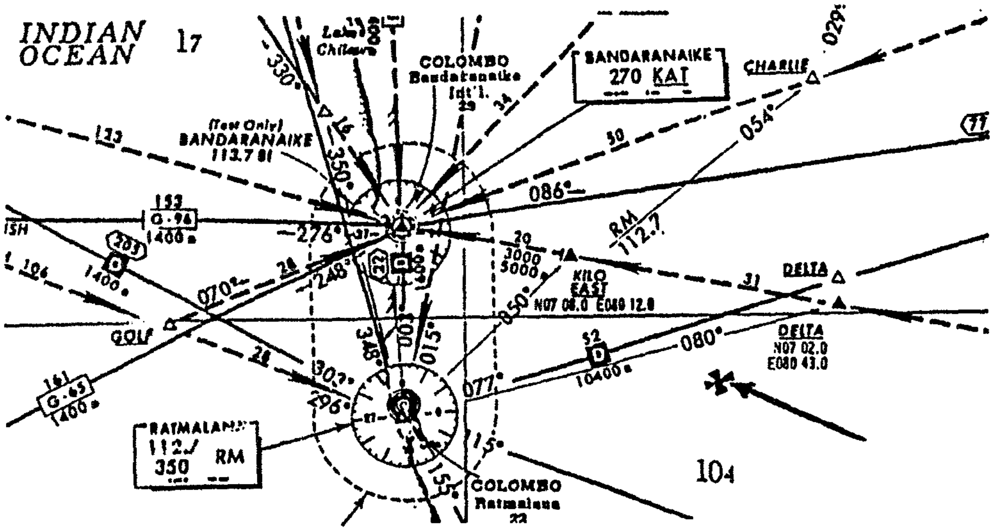
Next Page

NAVIGATION ERROR INITIAL APPROACH

COLOMBO, SRI LANKA
DC-8
4 DECEMBER 1974

NOTES:	Charter Non-sked Hit mountain during Initial Approach Reported incorrect position to ATC. Possibly misinterpreted range marks on Weather Radar used apparently to determine aircraft's position. Also possible large Doppler error.
Time:	Night 16:40 GMT
Fatalities:	191 (9 crew)

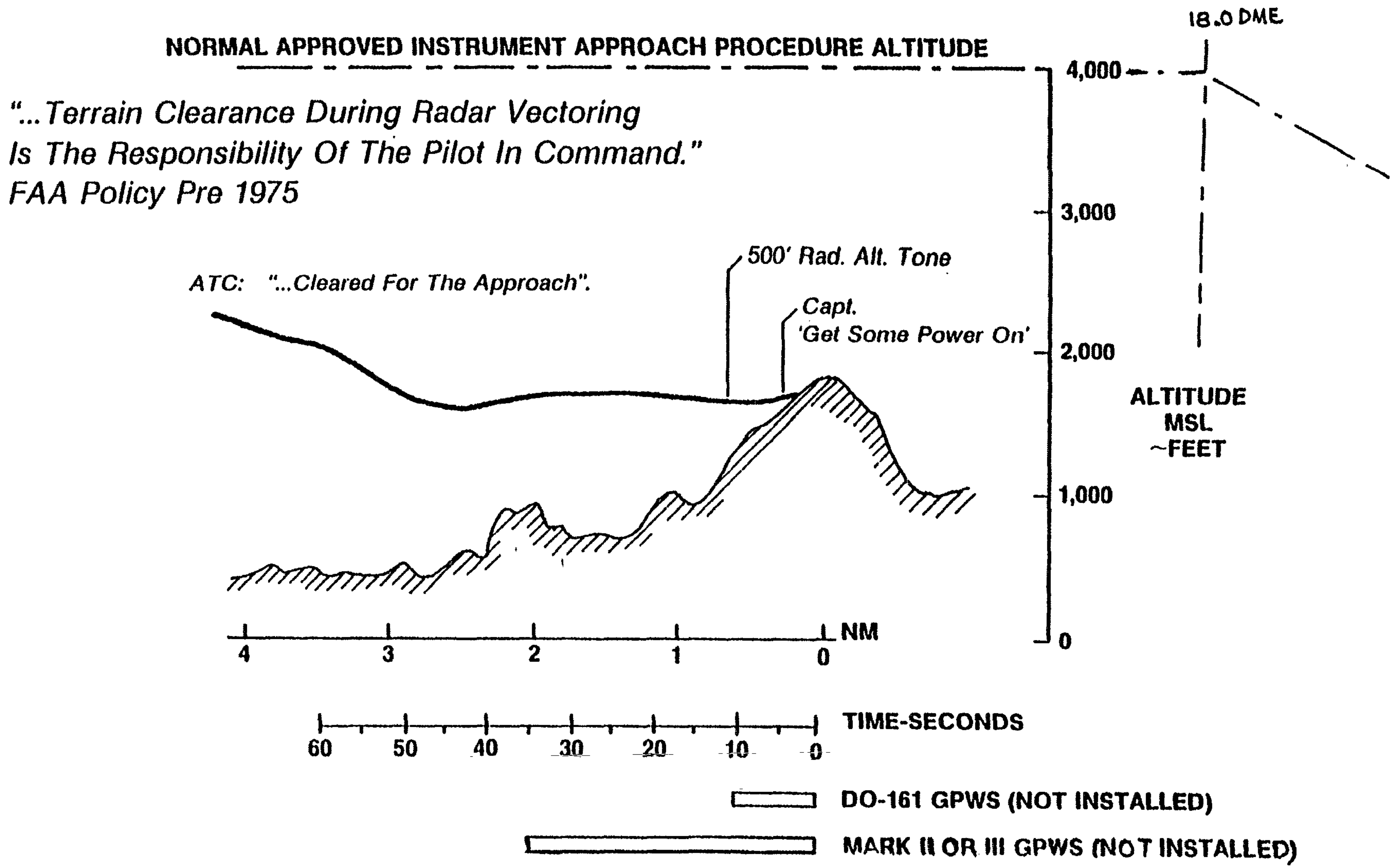



INDIAN OCEAN
COLOMBO Bandaranaike Int'l.
BANDARANAIKE 270 KAT
CHARLIE
(Test Only) BANDARANAIKE 113.7
086°
054°
RM 112.7
DELTA
KILO EAST N07 08.0 E080 12.0
DELTA N07 02.0 E080 43.0
GOLF
080°
077°
RATMALANA 112.7 350 RM
COLOMBO Ratmalana
104

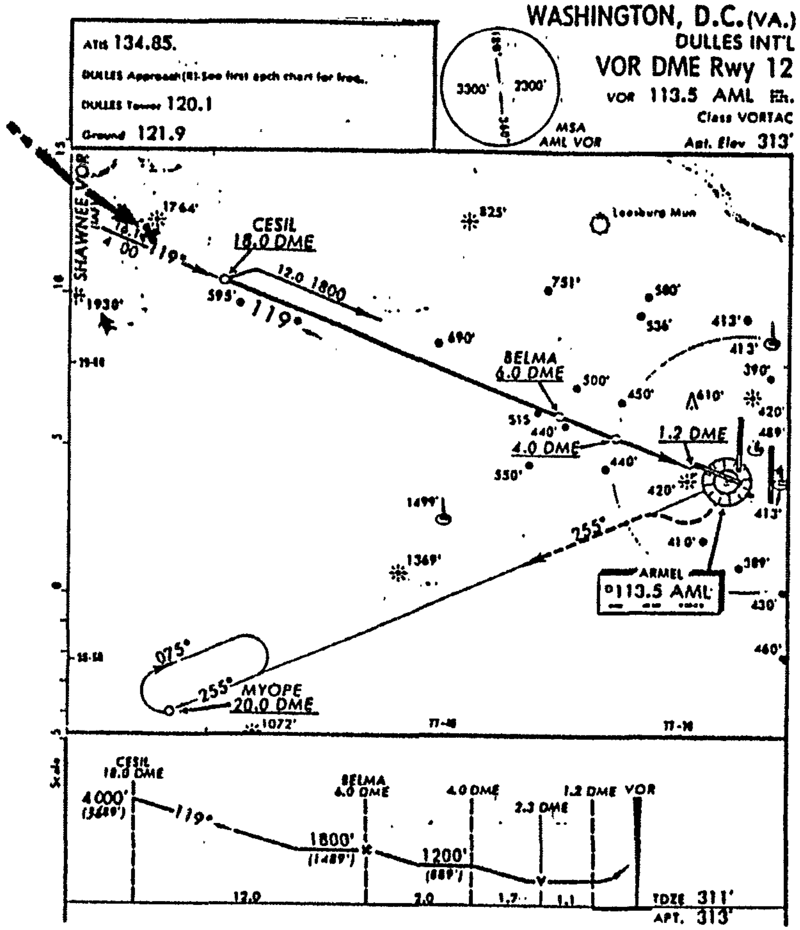
Next Page

Radar Vectors

INITIAL APPROACH DULLES VOR/DME 12
B727 1 DECEMBER, 1974



Return to TOC



Return to TOC

CIRCUMSTANCES: During a straight in VOR/DME Runway 33 approach after 4 hr 12 minutes flight from Edmonton, the aircraft impacted 2-1/2 NM short. Gear down 100% flap

TIME: 0016 MST

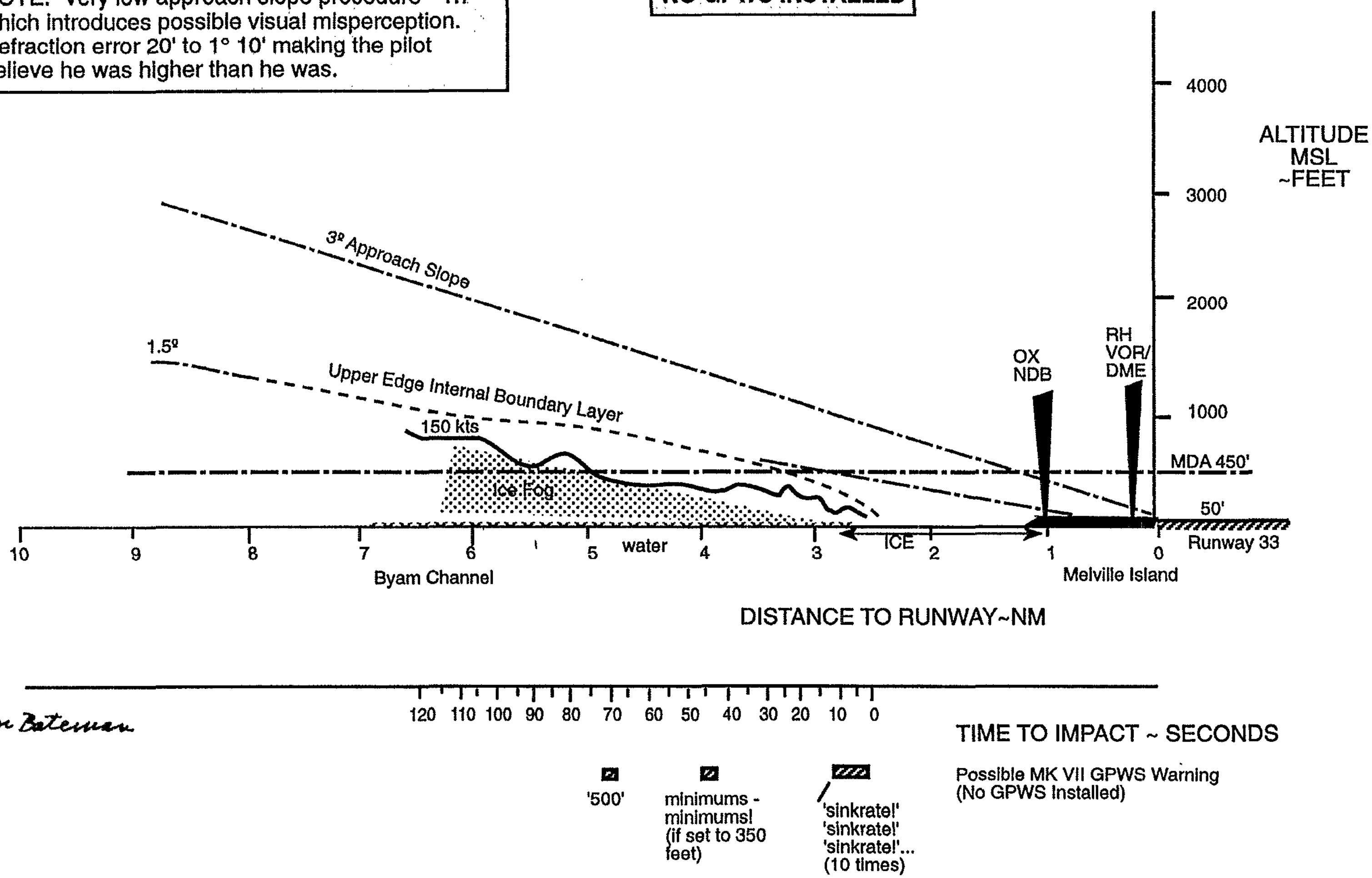
WEATHER: Initial ceiling thin obsured, visibility 1 mile, blowing snow. 312º/23 kts, later 1/8 mile -11ºF

FATALITIES: 32 out of 34 on board

Flight Path Profile
L-188
REA POINT, NWT
30 October, 1974

NOTE: Very low approach slope procedure ~1.7º which introduces possible visual misperception. Refraction error 20' to 1° 10' making the pilot believe he was higher than he was.

NO GPWS INSTALLED



Don Bateman

Return to TOC

CIRCUMSTANCES: VOR/DME non-precision approach to Runway 36. Airplane hit 2.9 nm short. Airplane equipped with QFE/QNE Altimeters (4) 2 Radio Altimeters and "EAL" terrain warning system set to sound if at 1000 feet and not on glideslope. Gear down - Landing flap

WEATHER: x - 40 ◐ 120 ◐ Patches of fog.

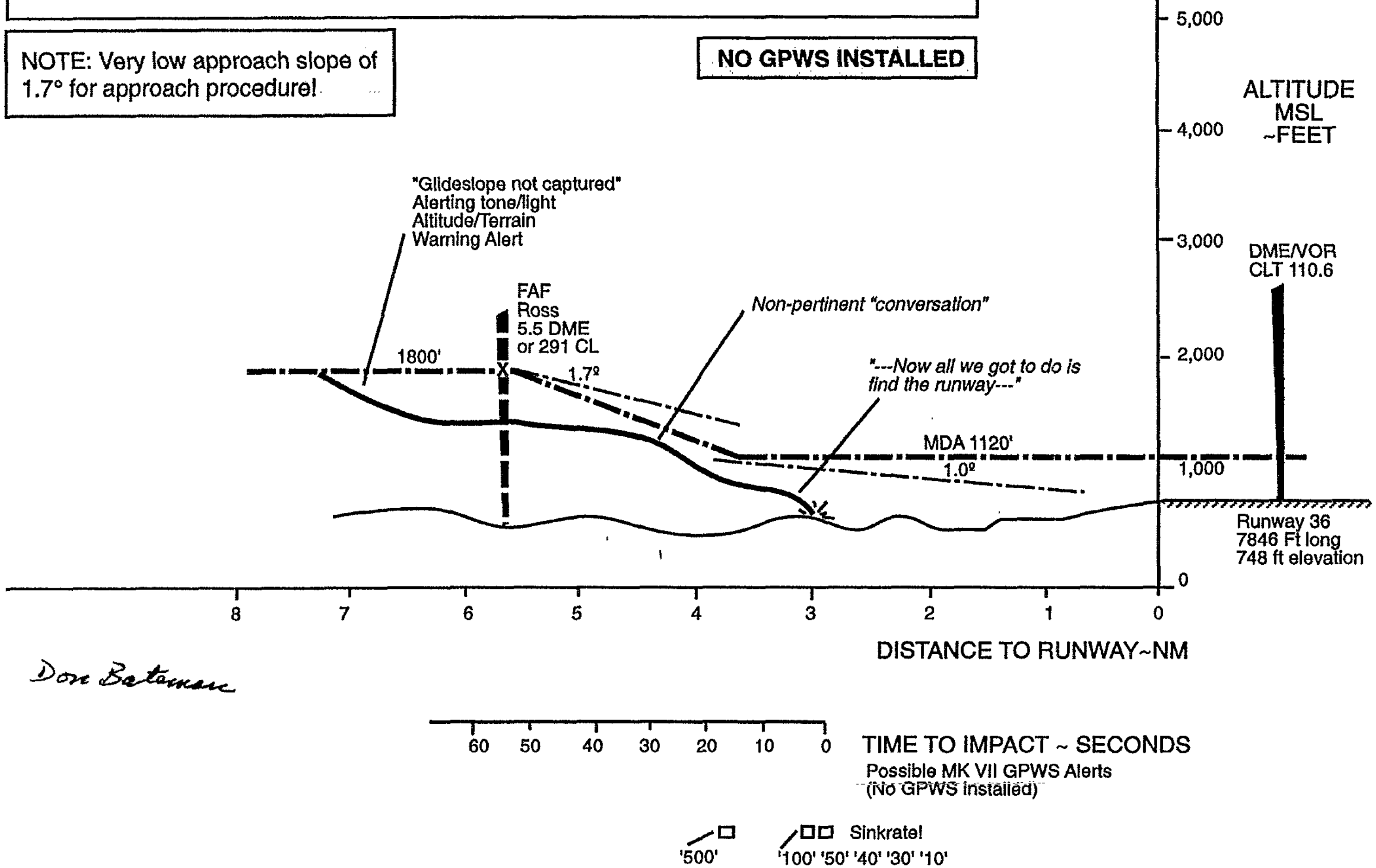
TIME: 07:34 E.D.T.

FATALITIES: 70 out of 82

Flight Path Profile
DC-9-30
CHARLOTTE, N.C.
11 September, 1974

NOTE: Very low approach slope of 1.7° for approach procedure!

NO GPWS INSTALLED



Don Bateman

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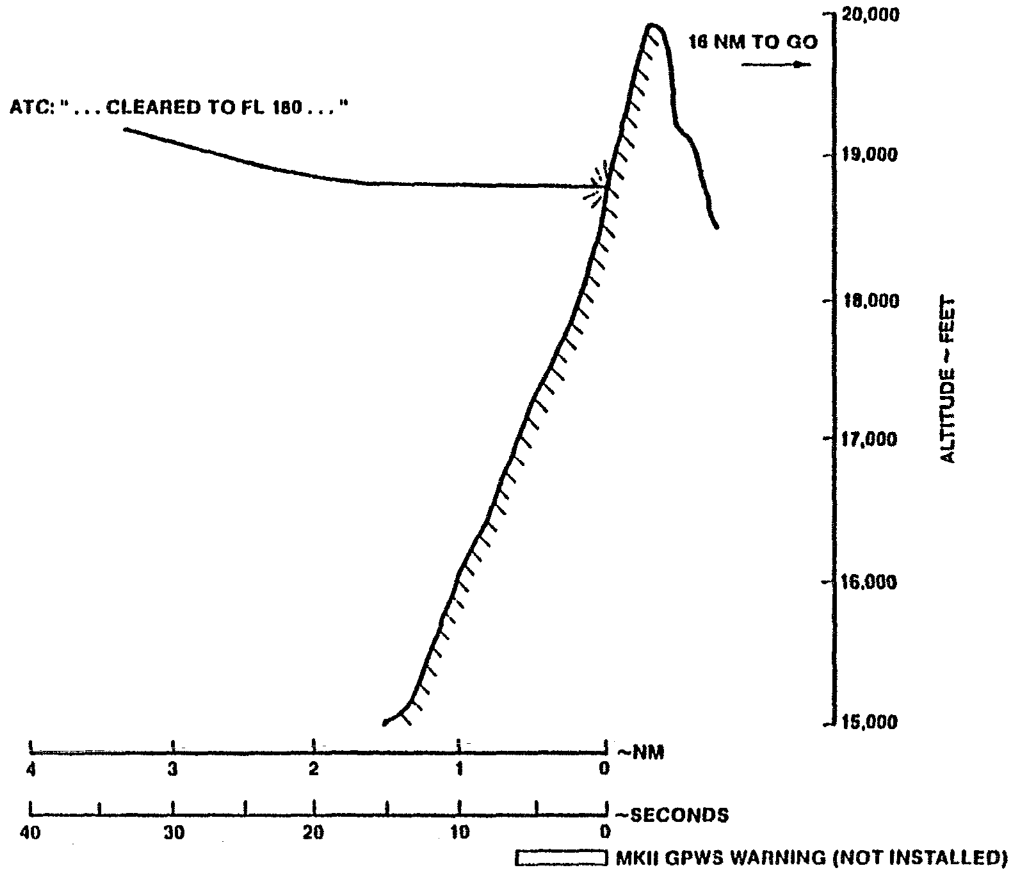
INITIAL APPROACH — WEATHER AVOIDANCE

LA PAZ
C-141
18 AUGUST 1974



Return to TOC

LA PAZ, BOLIVIA

KENNEDY INT'L

VOR DME Rwy 09R

VOR 115.7 PAZ

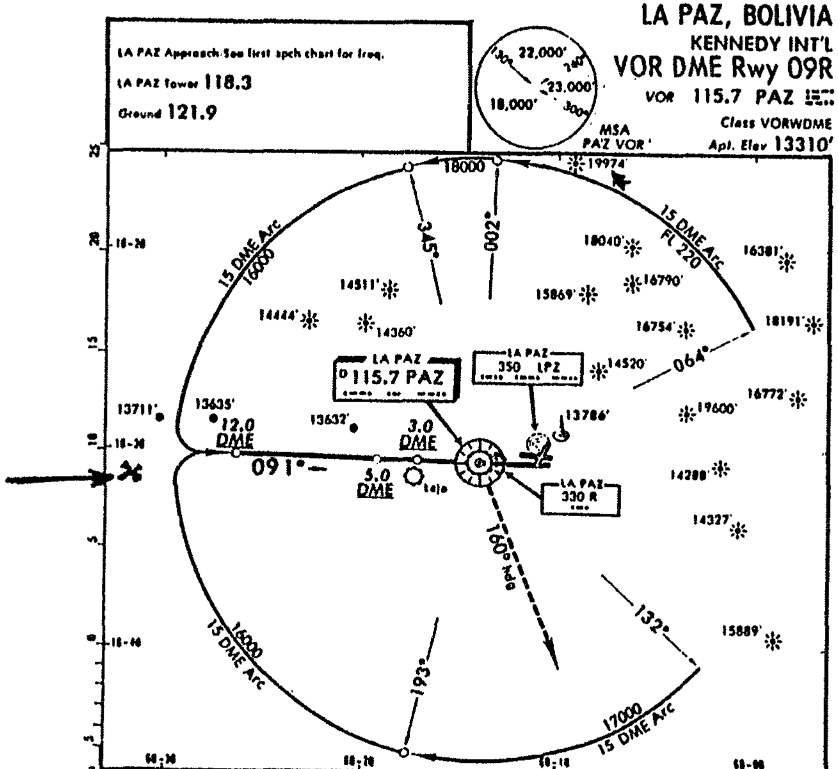
Class VORWDME

Apt. Elev 13310'

LA PAZ Approach: See first apch chart for freq.

LA PAZ Tower 118.3

Ground 121.9



MISSED APPROACH: RIGHT to 17000' heading 160° within 15 NM obtain instructions from CONTROL.

	STRAIGHT-IN LANDING RWY 09R MDA 13900'(794') DAY (Ceiling-Visibility)	NIGHT	CIRCLE-TO-LAND DAY MDA	CEIL-VIS	NIGHT
A B C D	600'-2.8 km	600'-4.8 km	14200' (890')	900'-4.8 km	NA

CEILING REQUIRED

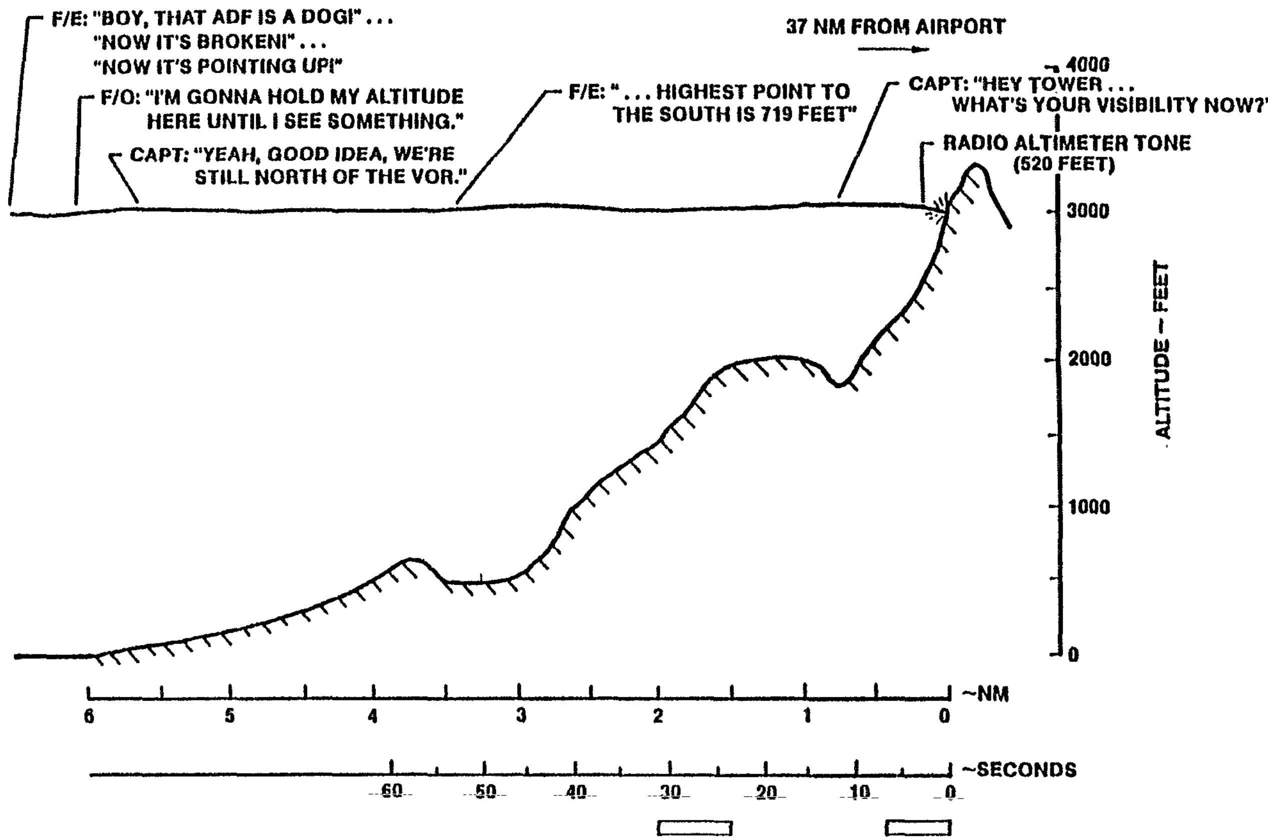
VASI required for night landing.

MAP at VOR

Return to TOC

NAVIGATION ERROR-INITIAL APPROACH

BALI
B707
APRIL 1974

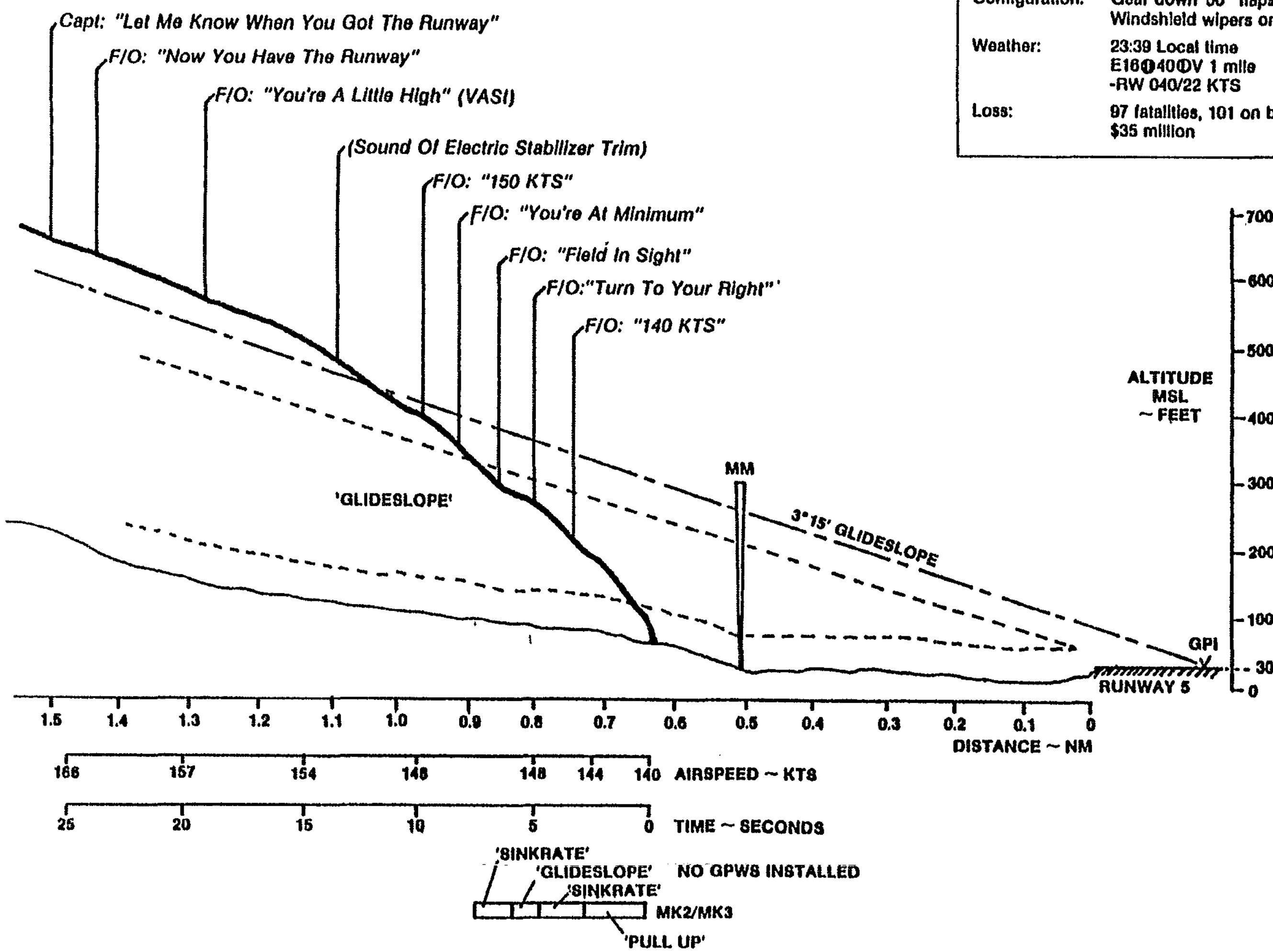


Return to TOC

Flight Path Profile

PAN AM FLT 806, B707-321B N45PA
PAGO PAGO, 30 JAN 1974

Notes:	Heavy rain, night ILS approach, possible wind shear
Configuration:	Gear down 50° flaps Windshield wipers on
Weather:	23:39 Local time E16Ⓑ40ⓄV 1 mile -RW 040/22 KTS
Loss:	97 fatalities, 101 on board $35 million

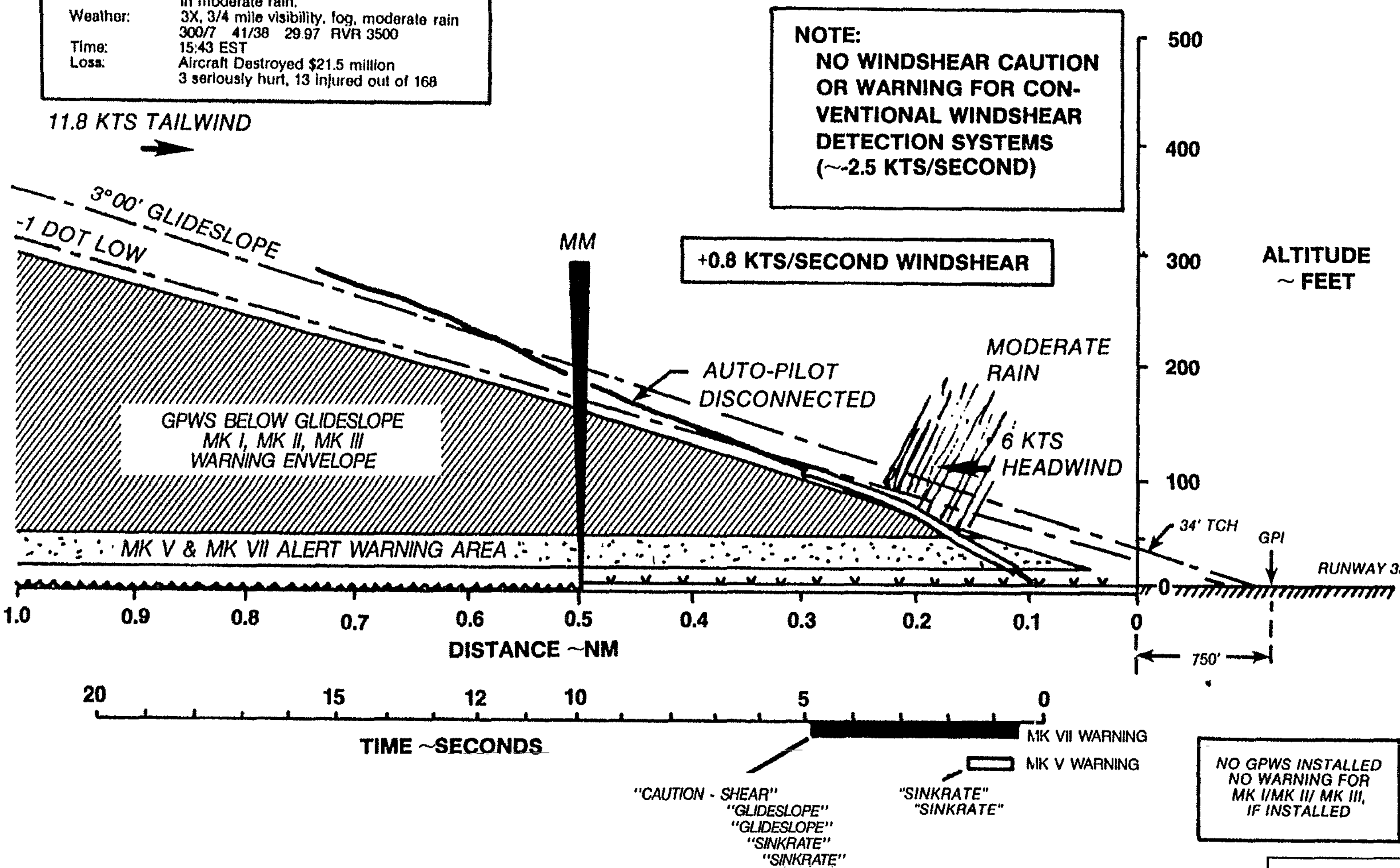


Flight Path Profile

DC-10-30
BOSTON, MASS.
17 DECEMBER, 1973

Return to TOC

NOTES:
Circumstances: Flight 933 scheduled flight
Auto-coupled ILS approach to
175 feet with tail to headwind shear.
Autothrottles left engaged.
Visual transition at 175 feet
in moderate rain.
Weather: 3X, 3/4 mile visibility, fog, moderate rain
300/7 41/38 29.97 RVR 3500
Time: 15:43 EST
Loss: Aircraft Destroyed $21.5 million
3 seriously hurt, 13 injured out of 168



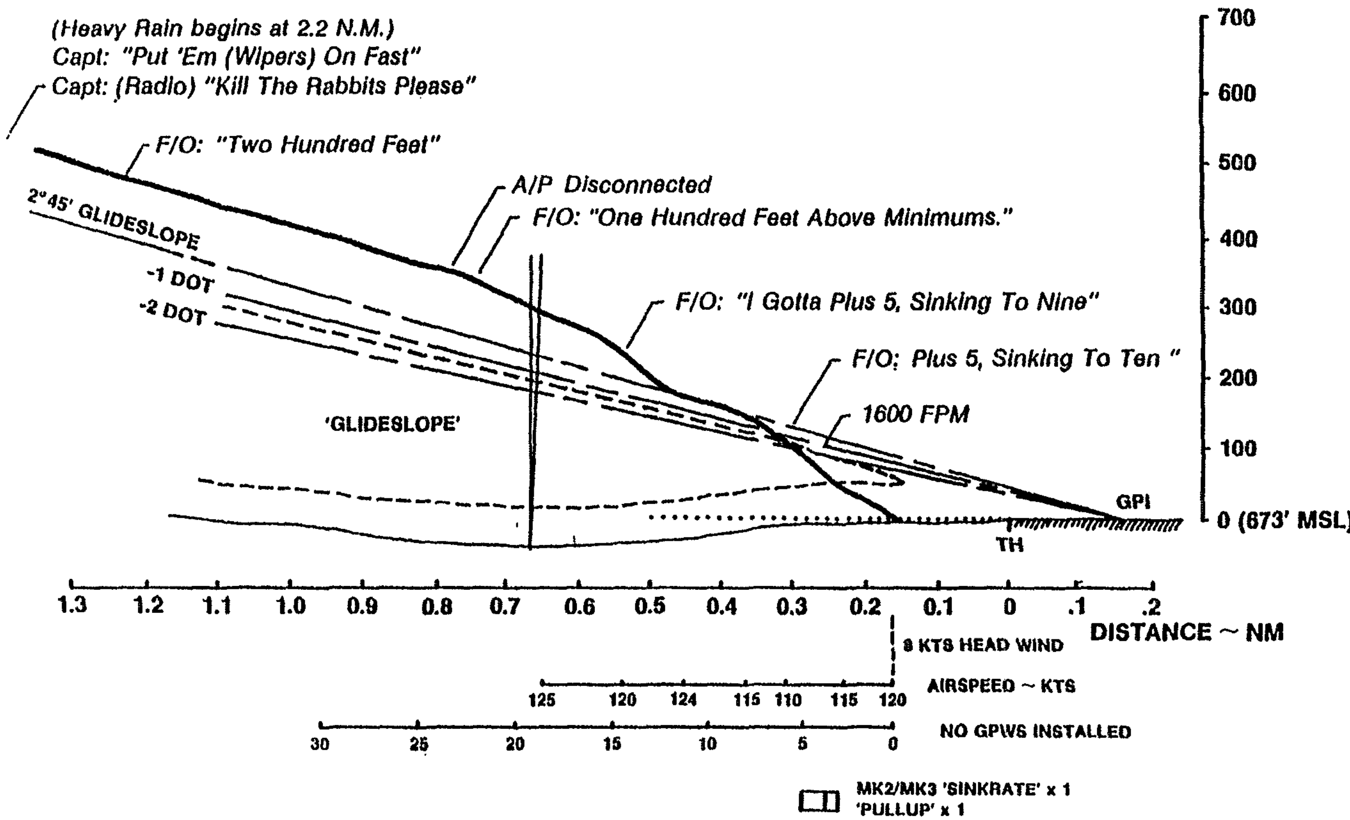
ADVANCED WARNING SYSTEMS

Return to TOC

Flight Path Profile

DELTA DC-9-30 FLT 516 N3323L
CHATTANOGA, TENN. 27 NOVEMBER, 1973

Notes:	
Circumstances:	Hit short in Heavy Rain, possible wind shear after ILS coupled approach to runway 20.
Weather:	4◐11⊕2 Miles visibility, thunderstorms calls nearby wind 160/6 30 KTS at 3000 feet. Heavy rain.
Configuration:	Landing
Loss:	Hull destroyed $2.5 million 10 injured out of 77 on board



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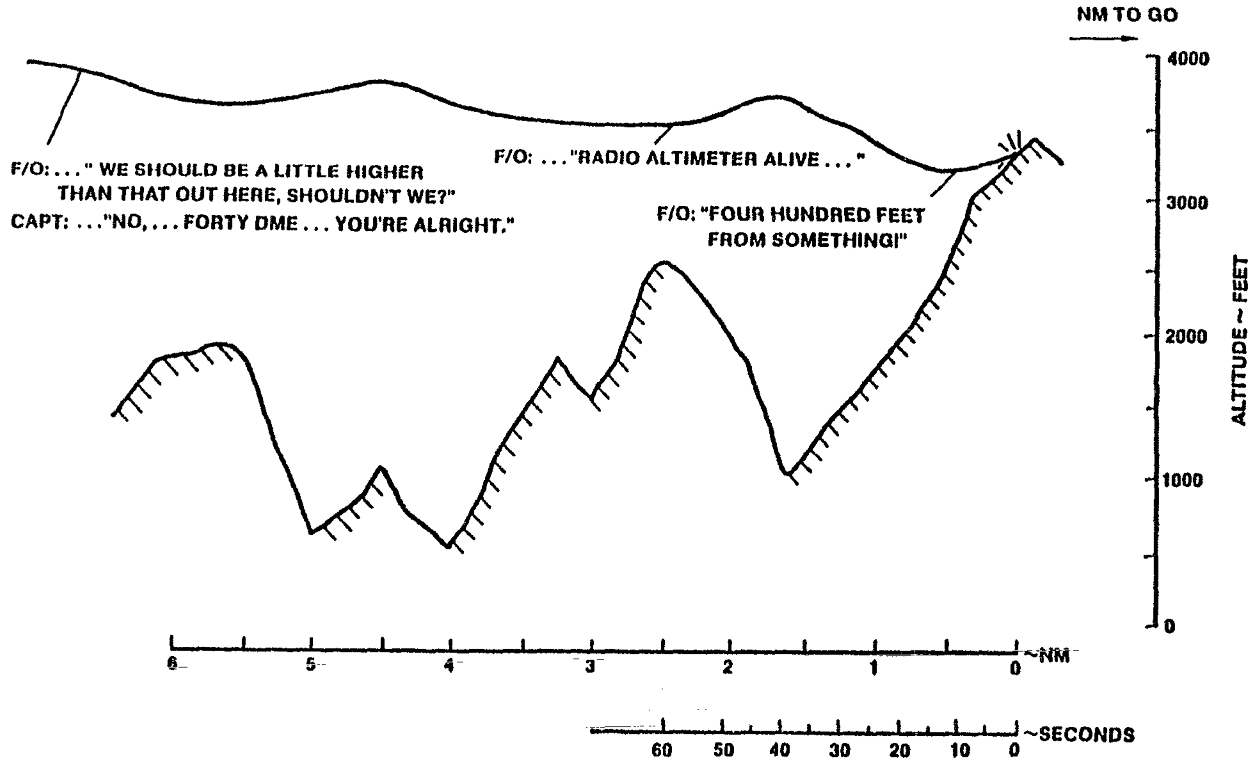
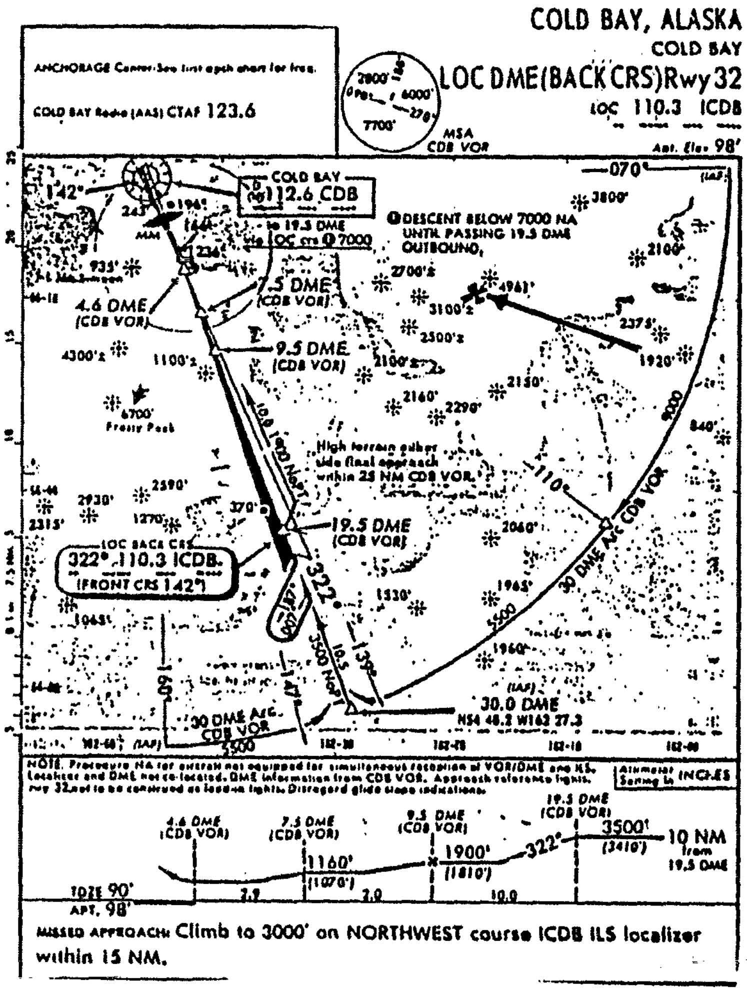
INITIAL APPROACH

COLD BAY, ALASKA
DC-8
8 SEPTEMBER 1973

NOTES:	Military Cargo Flight Contract Improvised approach procedure. Hit mountain slope while using VOR/LOC DME for Runway 27.
Time:	14:33 GMT Night
Weather:	M 5+ 45/45 300/25 G33
Fatalities:	6



Return to TOC

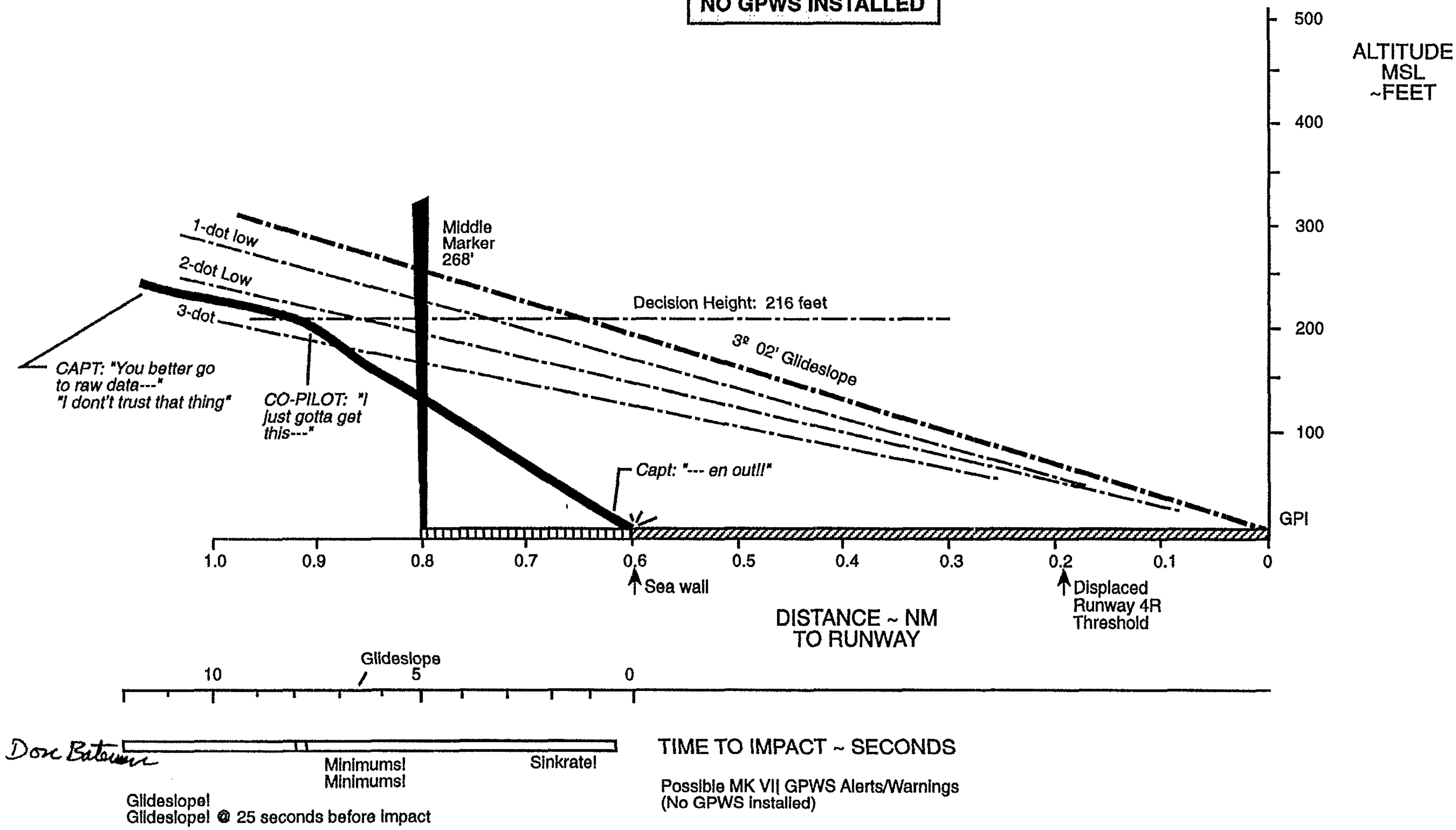


CIRCUMSTANCES:	Radar vectors to ILS approach runway 4R. Co-pilot flying. Flight Director a Sperry unit. Single mode selector. No Mode Annunciator - crew trained on Collins Flight Director, CW manual - CW - Go-around wings level. Radio altimeter installed and working.
WEATHER:	400 overcast 1/2 mile visibility fog 130º/4 kts R0 4 VR 14 0 6
TIME:	11:08 AM EST
FATALITIES:	90

Flight Path Profile
DC-9-31
BOSTON, MASS.
31 July, 1973

Return to TOC

NO GPWS INSTALLED



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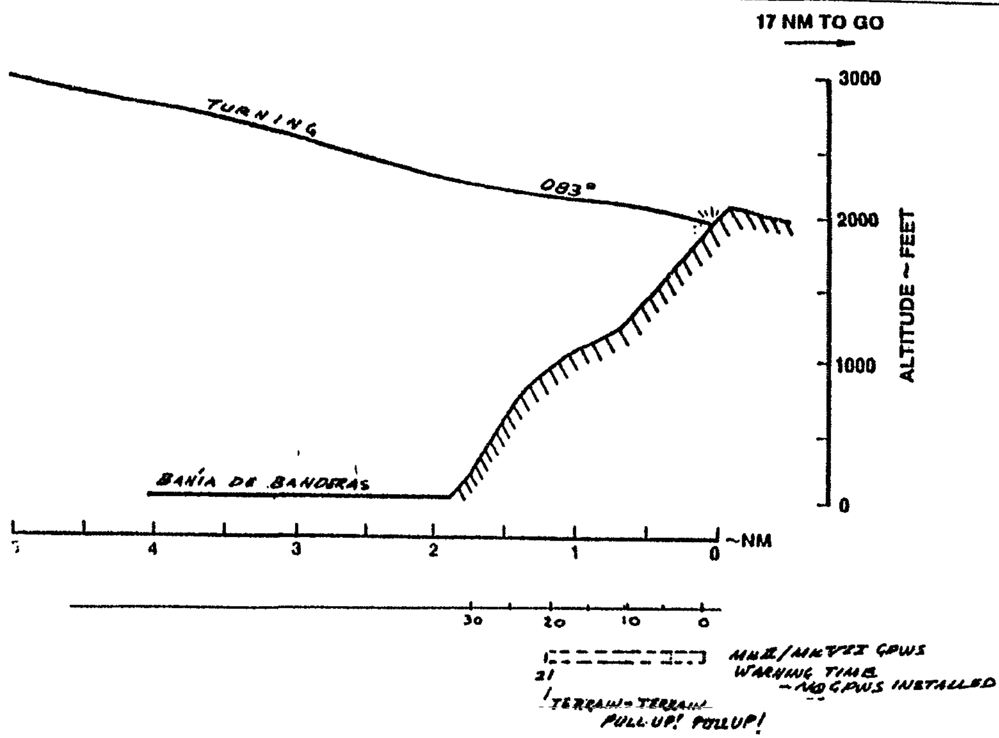
PROCEDURE TURN

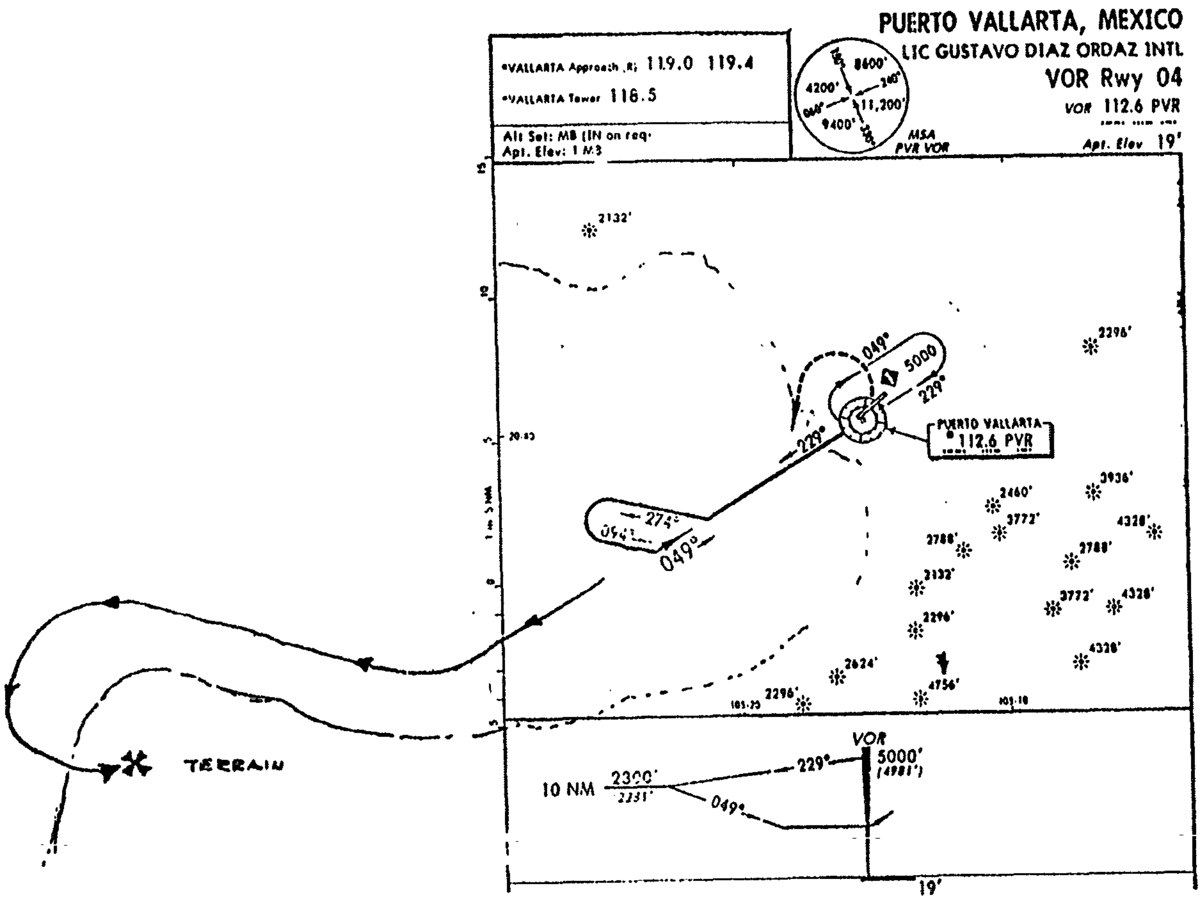
PUERTO VALLARTA
DC-9
20 JUNE 1973

CONDITIONS:
Scheduled Flight.
VOR runway 4. Fast and high outbound with procedure turn-off approach plate hit ridge.

Time:	22:00 Local
Configuration:	Landing gear down 15° flap
Fatalities:	27



Return to TOC



Return to TOC

Flight Path Profile
B-737-200
DELHI, INDIA
31 May, 1973

CIRCUMSTANCES: Flight from Madras to Delhi. ILS inoperative (reported just as approach approved) NDB approach Runway 28. Gear down, 40° flap. Struck power lines, boulders. Tore right wing off and right engine off... fire.

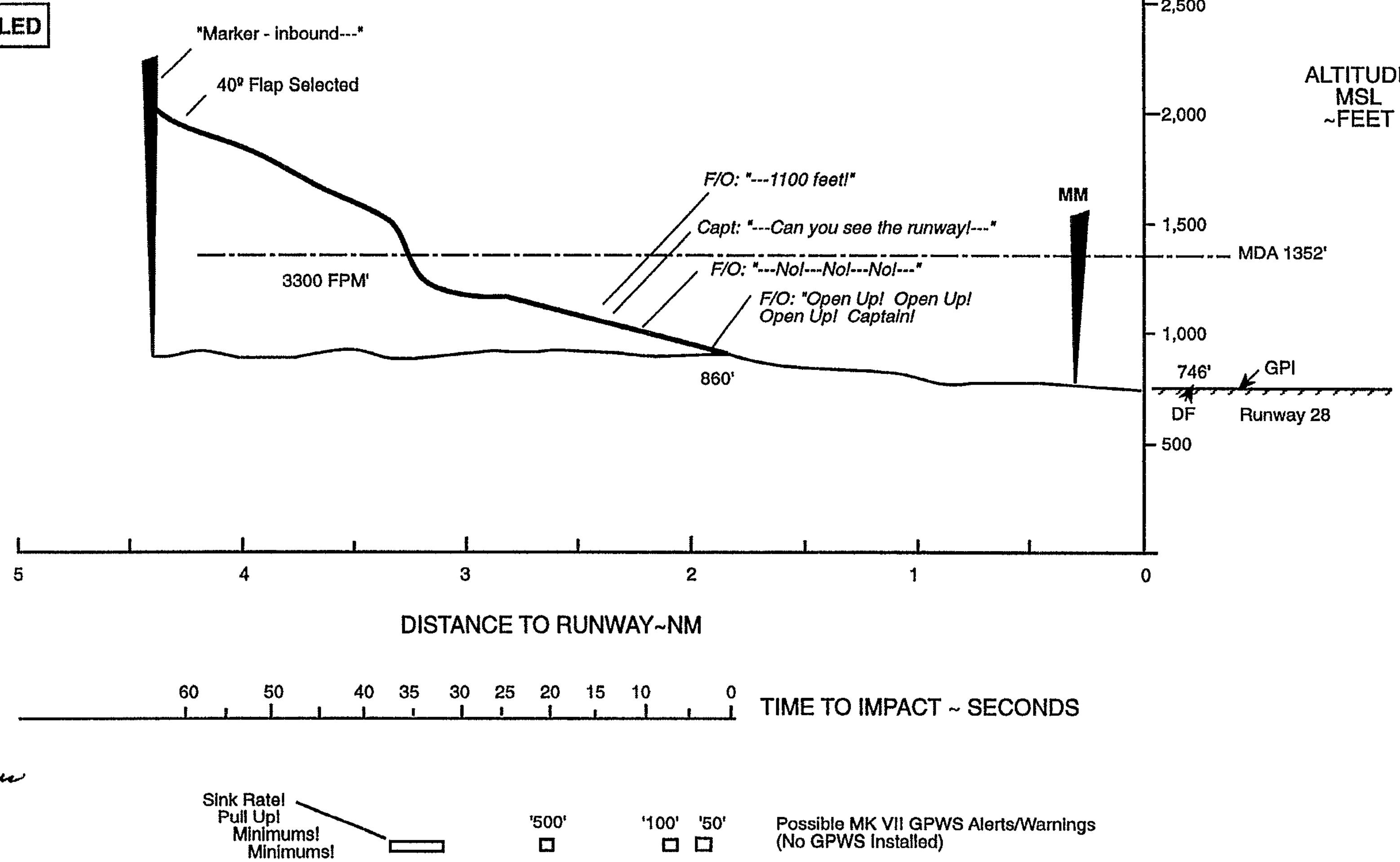
WEATHER: 3/8 1000 ft, 2/8 4000 ft, 800 meters visibility (a change from 5000 meters just before outer marker) Wind 220/20 kts dust storm

TIME: 21:57 IST (16:26 GMT)

FATALITIES: 48, 17 survivors

Radio Altimeters installed and working
Probable Cause: Inadvertent descent below minimums and a combination of circumstance weather, and pressure to complete approach on pilots.

NO GPWS INSTALLED



Don Bateman

Flight Path Profile
B-707-321C
EDMONTON
2 January, 1973

CIRCUMSTANCES: On a non-scheduled freight flight (horses), the airplane hit short of runway 89 by 1.8 nm. Minimums were 400' - 1 mile. Weather was blowing snow. Possible sheer

CONFIGURATION: Configuration was gear down flap 50º. CVR/DFR U.S. Back course approach with low intensity lights and strobed runway and lights.

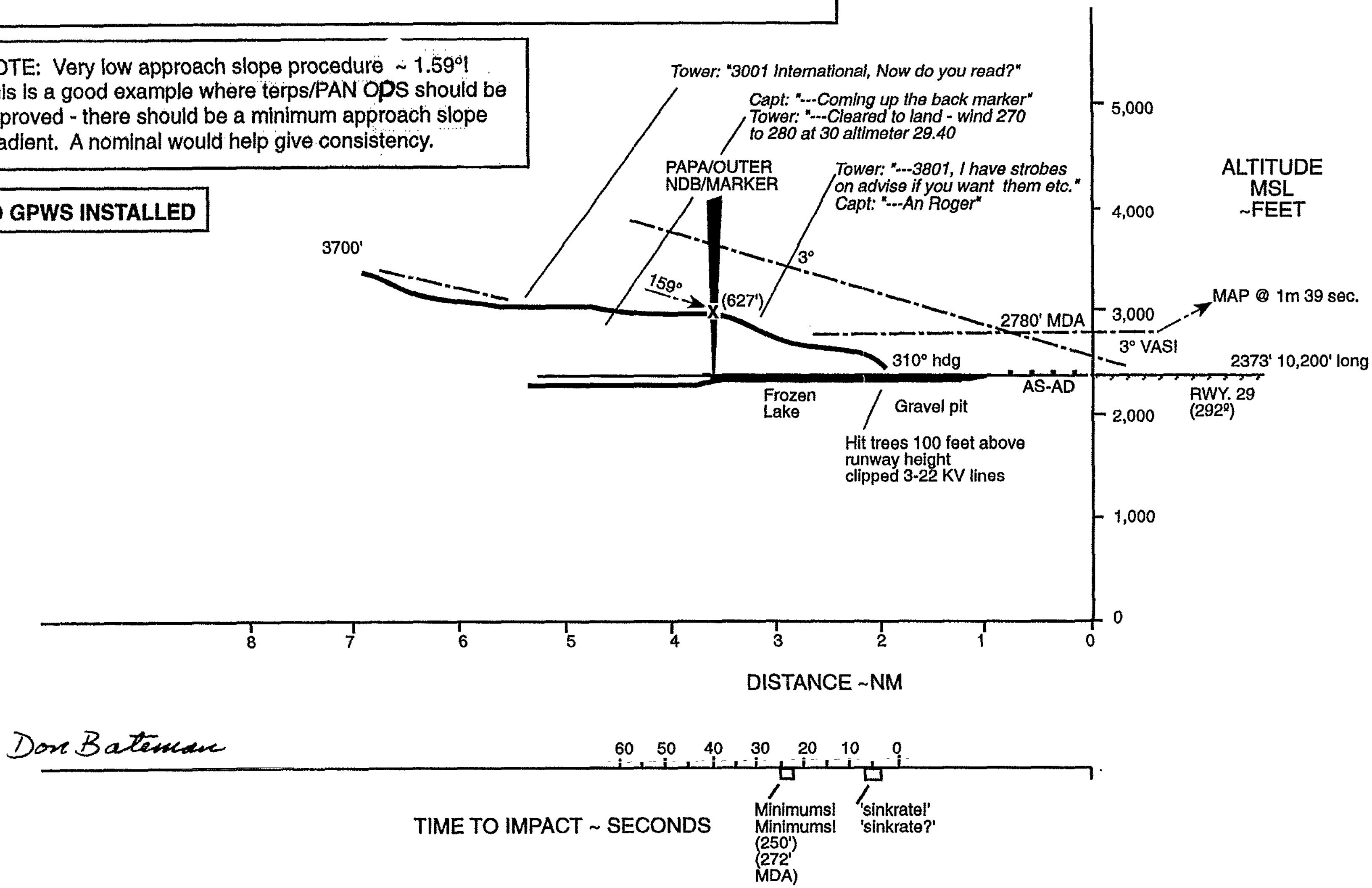
TIME: 01:07 AM local

FATALITIES: 5

Return to TOC

NOTE: Very low approach slope procedure ~ 1.59°! This is a good example where terps/PAN OPS should be improved - there should be a minimum approach slope gradient. A nominal would help give consistency.

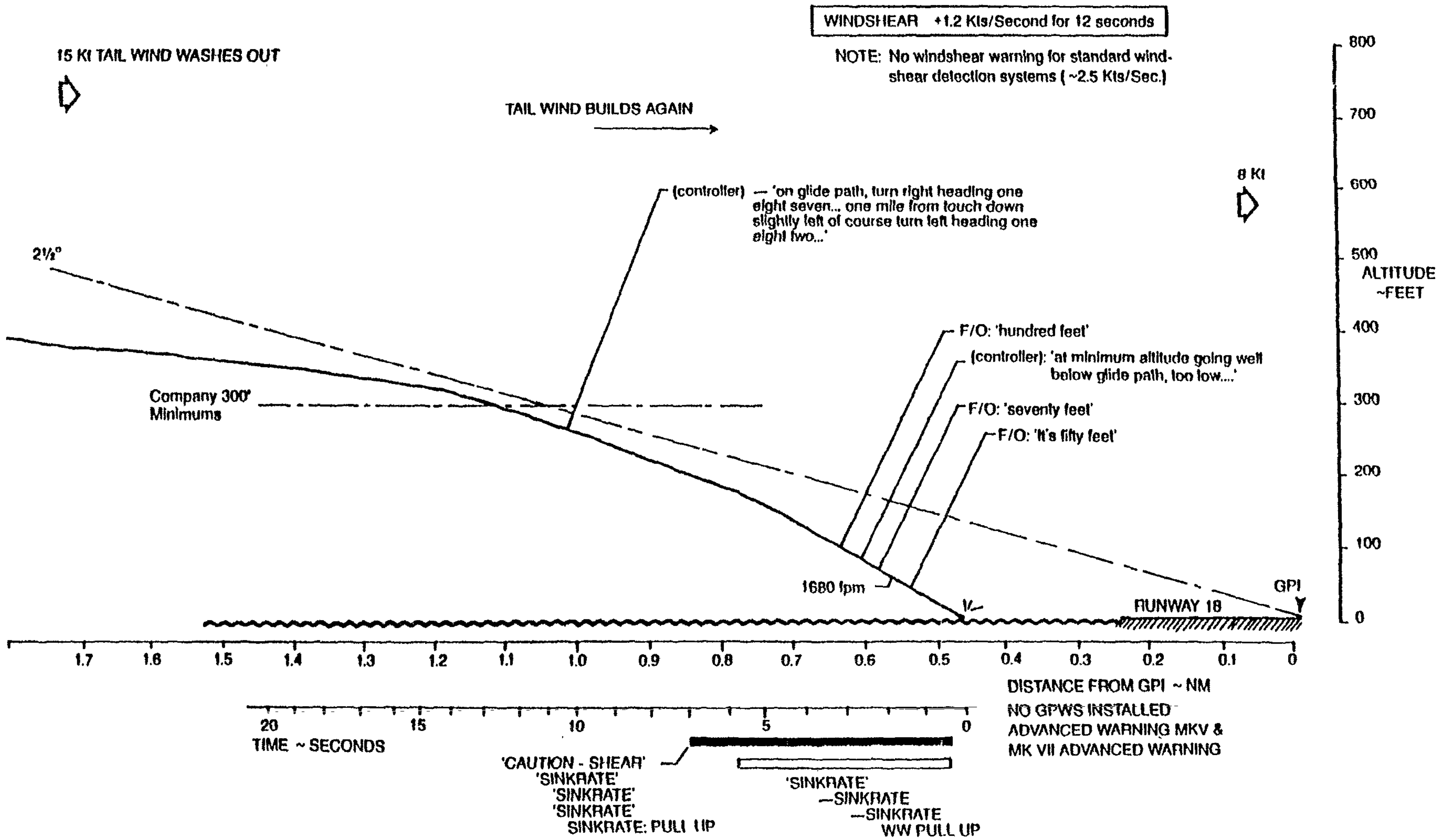
NO GPWS INSTALLED



90-282

Circumstances:	During GCA approach to runway 18, aircraft hit 1/2 NM short. Daylight 11:36 local time.
Weather:	Ceiling 1500 feet, visibility 10 miles. Wind 360/ 8 Kts 29.83 inches, light rain showers. Scattered Q, broken Q at 1500 feet, visibility to north 1.5 miles.
Fatalities:	4

FLIGHT PATH PROFILE
DC-8-63F
Naha, Okinawa
27 July 1970



Return to TOC

CIRCUMSTANCES: FLT 810 returning to Vancouver after No. 2 engine fire light. No other reported problems. No. 2 engine stowed. Only one buckled seat belt. All others unbuckled.

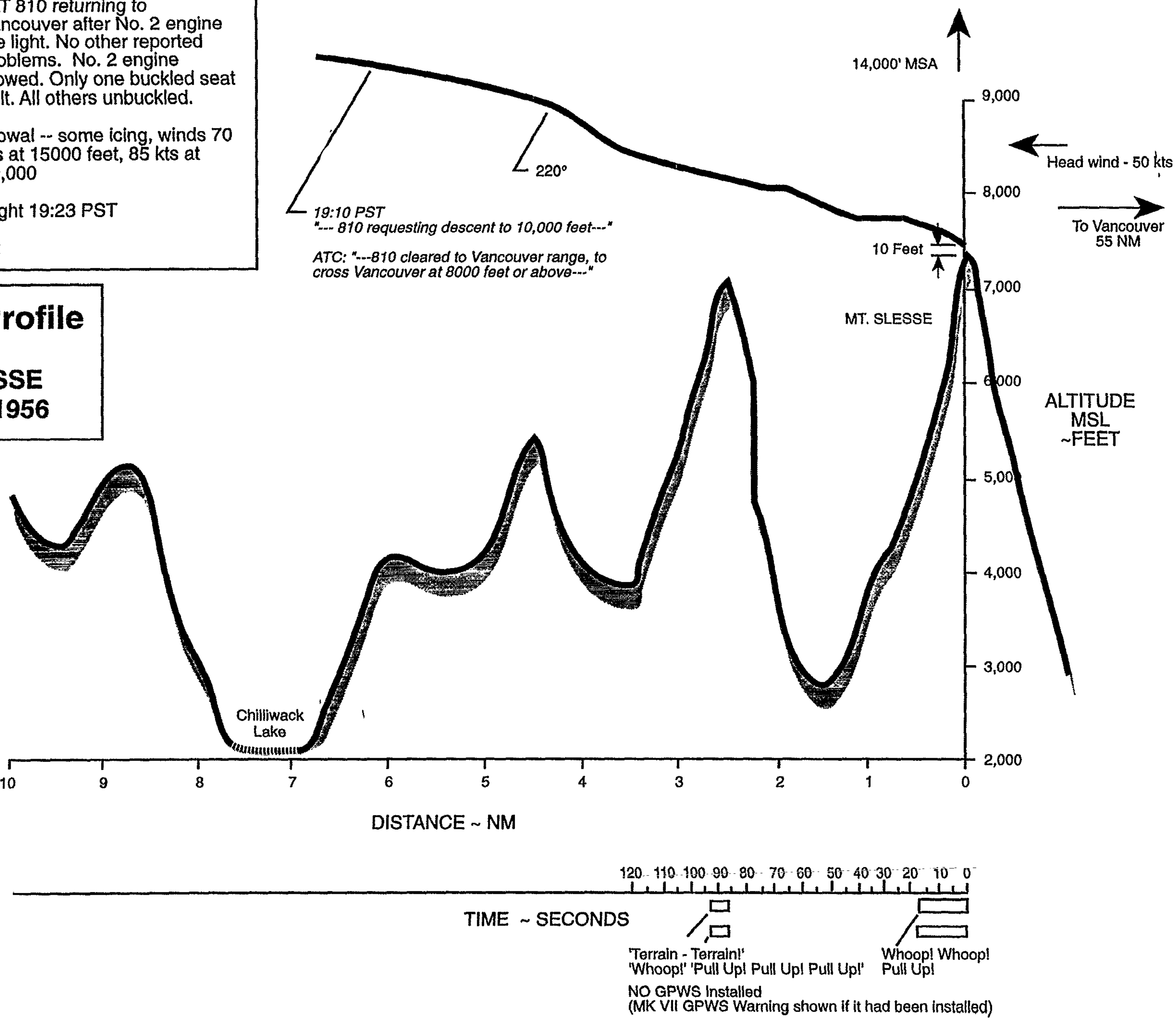
WEATHER: Trowal -- some icing, winds 70 kts at 15000 feet, 85 kts at 19,000

TIME: Night 19:23 PST

FATALITIES: 62

Flight Path Profile
DC-4-M2
MOUNT SLESSE
9 December, 1956

Data Source:
DOT REPORT #56-16
AirCanada Archives
27 Jan, 87 Don Bateman



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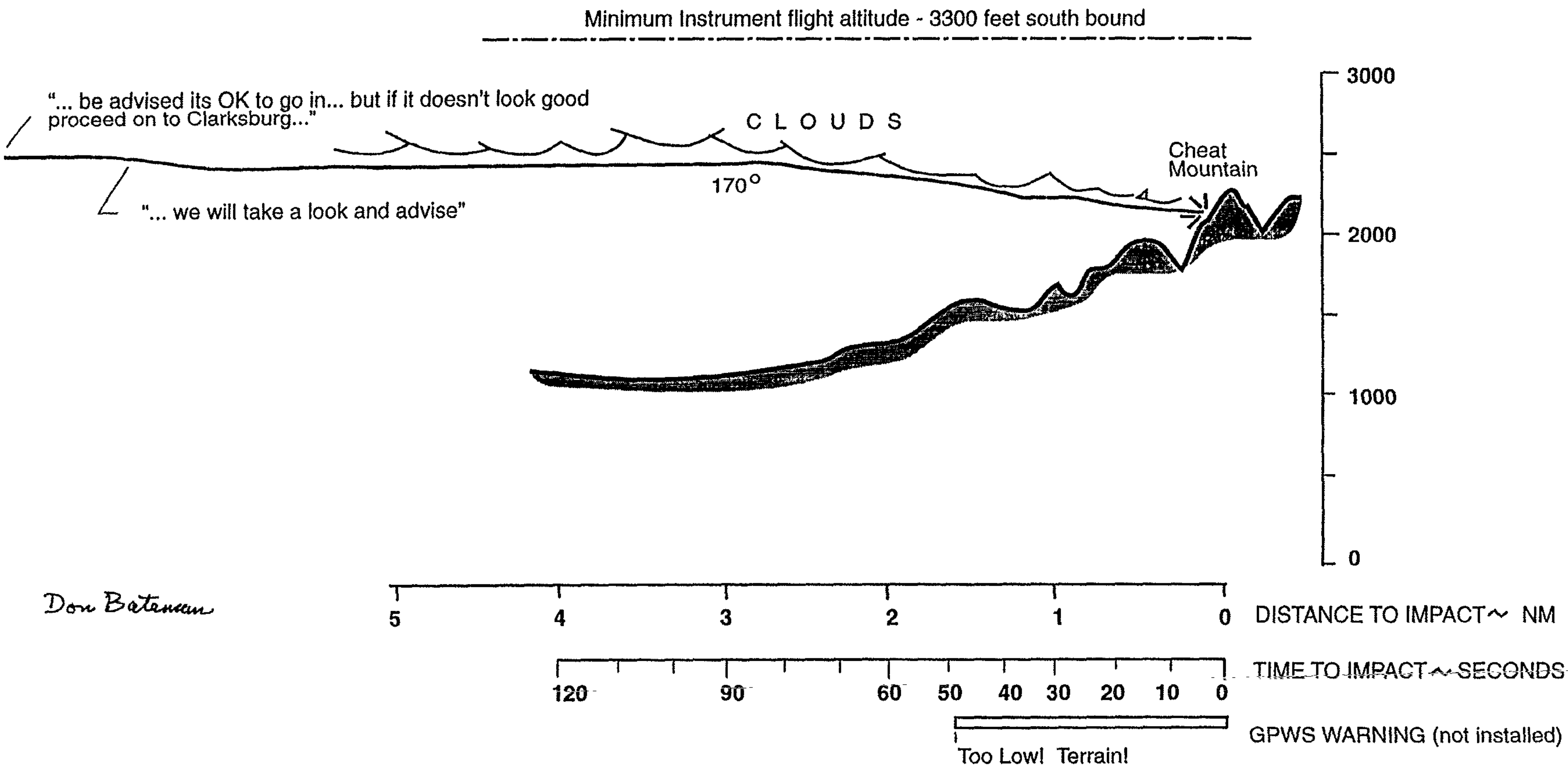
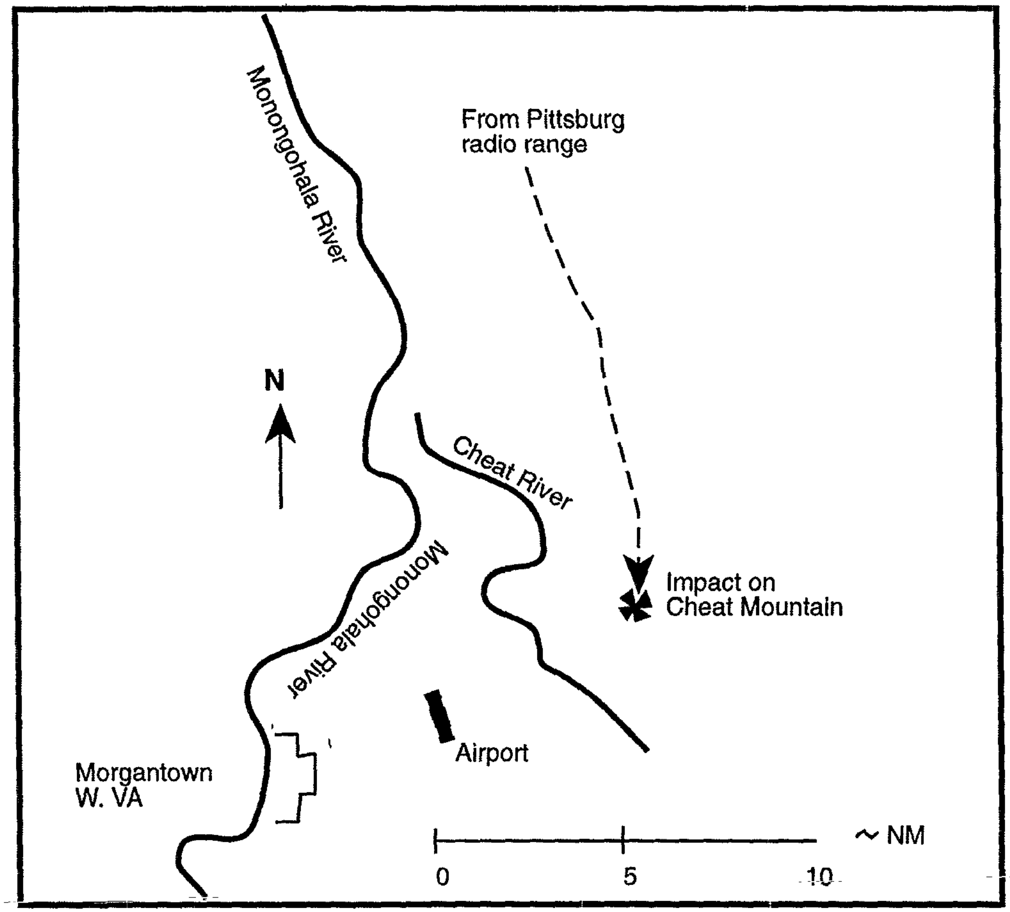
CIRCUMSTANCES:	While on a 'Contact Flight Rule' approach to Morgantown, the aircraft struck a mountain approx. 6NM ENE of the airport. Flight was from Pittsburg to Birmingham with a stop at Morgantown.
WEATHER:	1000 foot ceiling, one mile visibility.
CONFIGURATIONS:	Landing gear and flap retracted.
TIME:	17:00 EWT
FATALITIES:	20
OTHER:	50 watt radio homing beacon inoperative.

Flight Path Profile
DC-3
Morgantown, West VA
14 April, 1945

Pennsylvania – Central Airlines

It is most probable the pilots mistook the Cheat River (east of the airport) for the Monongohala River (west of the airport) while visually trying to locate the airport.




Mongongohala River
From Pittsburg
radio range
N
Cheat River
Mongongohala River
Impact on
Cheat Mountain
Airport
Morgantown
W. VA
~ NM
0
5
10

CFIT Accidents/Incidents Indexed by Region
Organized by Robert Chapin, http://captainslog.aero/?p=1395
Note the original pages are in reverse chronological order.

City	Region	Date	Type	Orig Page	PDF Page
Anniston	Alabama	6/8/1992	Be-C99	401	554
Anchorage	Alaska	11/1/1993	B-747-200	339	492
Cold Bay	Alaska	9/1/1973	DC-8	712	865
Gulkana	Alaska	8/20/1985	LJ-24D	614	767
Juneau	Alaska	11/12/1992	C-12F	387	540
Kodiak	Alaska	11/1/1993	BAe JS-31	341	494
Unalakleet	Alaska	6/2/1990	B-737	476	629
Edmonton	Alberta	4/2/1993	A-320	367	520
Edmonton	Alberta	1/2/1973	B-707-321	718	871
Tamanrasset	Algeria	9/18/1994	BAC1-11	287	440
Pago Pago	American Samoa	1/30/1974	B-707	709	862
Dundo	Angola	8/27/1983	L-382	629	782
Luanda	Angola	2/8/1988	B-707	570	723
Antarctica	Antarctica	11/28/1979	DC-10	661	814
Posadas	Argentina	6/12/1988	MD-81	558	711
Phoenix	Arizona	1/25/1994	A-320	317	470
Little Rock	Arkansas	1/29/1990	G-II	492	645
Alice Springs	Australia	4/17/1995	IAI-1124	257	410
Cairns	Australia	5/11/1990	Citation-II	479	632
Young	Australia	6/11/1993	PA-31-350	361	514
Santa Maria	Azores	2/8/1989	B-707	541	694
La Paz	Bolivia	1/1/1985	B-727	620	773
La Paz	Bolivia	8/18/1974	C-141	706	859
Cruzeiro Do Sul	Brazil	6/22/1992	B-737-200C	399	552
Florianopolis	Brazil	4/12/1980	B-727	658	811
Fortaleza	Brazil	6/8/1982	B-727	641	794
Manaus	Brazil	1/29/1995	DC-8-62	267	420
Rio de Janeiro	Brazil	12/31/1987	B-747	576	729
Rio de Janeiro	Brazil	7/26/1979	B-707	669	822
Sao Jose Dos Campos	Brazil	9/19/1986	EMB-120	591	744
Sao Paulo	Brazil	3/2/1996	LJ-25D	241	394
Fort St. John	British Columbia	1/1/1994	DHC-8	321	474
Masset	British Columbia	1/11/1994	LJ-25	275	428
Prince George	British Columbia	11/1/1987	B-737	580	733
Terrace	British Columbia	9/26/1989	SA-227	514	667
Vancouver	British Columbia	12/9/1956	DC-4-M2	720	873
Brown Field	California	3/15/1991	HS-125	457	610
Long Beach	California	10/1/1988	MD-80	548	701
Los Angeles	California	6/1/1994	Merlin III	297	450
Ontario	California	11/16/1990	B-737-300	468	621
Ontario	California	2/15/1982	B-737	645	798
Orange County	California	2/19/1989	Ce-404	537	690

City	Region	Date	Type	Orig Page	PDF Page
Palm Springs	California	4/13/1995	A-320	259	412
Palm Springs	California	1/6/1977	LJ-24	686	839
San Diego	California	6/1/1990	A-320	472	625
San Diego	California	6/1/1990	A-320	474	627
San Francisco	California	1/1/1995	B-737-300	279	432
San Francisco	California	10/1/1980	B-737	654	807
San Francisco	California	10/1/1978	B-747	675	828
San Jose	California	5/1/1994	B-737-400	311	464
Urumqi	China	11/14/1993	MD-82	335	488
Denver	Colorado	5/1/1992	DHC-7	407	560
Denver	Colorado	5/16/1986	B-727	596	749
Durango	Colorado	5/16/1986	FH-23	572	725
Grand Junction	Colorado	2/1/1994	BAe JS-31	313	466
Gunniston	Colorado	10/1/1993	B-737	349	Missing
Bogota	Columbia	3/10/1993	MD-80	371	524
Cali	Columbia	12/20/1995	B-757	245	398
Cartagena	Columbia	1/11/1995	DC-9-10	273	426
Cucuta	Columbia	3/17/1988	B-727	565	718
Medellin	Columbia	5/19/1993	B-727-100	363	516
Windsor Locks	Connecticut	11/12/1995	MD-80	247	400
Ajaccio	Corsica	12/1/1981	MD-80	647	800
San Jose	Costa Rica	1/15/1990	C-212	494	647
San Jose	Costa Rica	9/3/1980	B-727	655	808
Soula Bay	Crete	8/3/1982	C-1A	643	796
Dubrovnik	Croatia	4/3/1996	B-737-200	237	390
Ercan	Cyprus	2/27/1988	B-727	567	720
Copenhagen	Denmark	7/1/1989	DC-10	523	676
Djibouti	Djibouti	9/17/1991	L-100	443	596
Cuenca	Ecuador	7/11/1983	B-737	631	784
Quito	Ecuador	3/5/1996	MD-11	239	392
Quito	Ecuador	5/4/1995	G-II	255	408
Quito	Ecuador	12/10/1992	Sabre	383	536
Quito	Ecuador	3/1/1992	DC-8	417	570
Cairo	Egypt	11/12/1980	C-141	653	806
San Salvador	El Salvador	8/9/1995	B-737	249	402
Coventry	England	12/21/1994	B-737-200	285	438
Leeds-Bradford	England	10/19/1987	Be-200	582	735
London	England	7/3/1988	A-320	556	709
London	England	7/1/1987	B-747	584	737
Gambela	Ethiopia	8/7/1989	DHC-6	519	672
Ft. Lauderdale	Florida	5/1/1992	B-737-200	405	558
Hurlburt	Florida	2/20/1989	C-141B	535	688
Miami	Florida	5/10/1977	DC-8	683	836
Pensacola	Florida	11/1/1993	DC-8-72F	343	496
Pensacola	Florida	5/8/1978	B-727	677	830
Basle-Mulhouse	France	12/1/1991	MD-80	431	584

City	Region	Date	Type	Orig Page	PDF Page
Bordeaux	France	12/21/1987	EMB-120	578	731
Hebshem	France	6/1/1988	A-320	560	713
Paris	France	1/6/1993	DHC-8	379	532
Paris	France	9/15/1991	A-320	445	598
Strasbourg	France	1/20/1992	A-320	425	578
Valence	France	4/10/1989	FH-227	533	686
Atlanta	Georgia	1/1/1995	B-727	263	416
Rome	Georgia	12/11/1991	Be-400	433	586
Athens	Greece	1/9/1994	DO-228	319	472
Athens	Greece	3/24/1992	B-707	415	568
Nea Anghialos	Greece	2/5/1991	C-130	461	614
Samos	Greece	8/3/1989	SD-330	521	674
Point-A-Pitre	Guadaloupe	12/1/1989	B-747	500	653
Maui	Hawaii	4/22/1992	Be-19	413	566
Molokai	Hawaii	10/28/1989	DHC-6	506	659
Tegucigalpa	Honduras	10/21/1989	B-727	512	665
Boise	Idaho	2/17/1990	B-737	485	638
Hailey	Idaho	1/3/1983	CL-600	639	792
Chicago	Illinois	11/15/1993	B-727	333	486
Ahmedabad	India	10/19/1988	B-737	546	699
Bangalore	India	2/14/1990	A-320	487	640
Bhuntar	India	7/9/1994	Be-200	293	446
Bombay	India	1/1/1978	B-747	678	831
Delhi	India	5/31/1973	B-737-200	717	870
Imphal	India	8/16/1991	B-737	449	602
Ambon	Indonesia	7/24/1992	Vickers	395	548
Bali	Indonesia	4/1/1974	B-707	708	861
Palu	Indonesia	6/18/1994	F-27	303	456
Sorong	Indonesia	7/1/1993	F-28	359	512
Genoa	Italy	11/10/1985	MD-80	608	761
Rome	Italy	10/17/1988	B-707	552	705
Abidjan	Ivory Coast	6/26/1994	F-27	299	452
Abidjan	Ivory Coast	1/15/1993	B-707	375	528
Chitose	Japan	8/1/1979	B-747	667	820
Nairobi	Kenya	12/4/1990	B-707	463	616
Mokpo	Korea	7/26/1993	B-737-500	355	508
Seoul	Korea	11/19/1980	B-747	651	804
Taegu AB	Korea	6/13/1991	B-727-200	453	606
Tripoli	Libya	7/29/1989	DC-10	527	680
Baton Rouge	Louisiana	2/1/1994	B-737-400	315	468
Ohrid	Macedonia	11/20/1993	Y-42	331	484
Lewiston	Maine	8/25/1985	Be-99	612	765
Rockland	Maine	5/30/1979	DHC-6	671	824
Koto Kinabalu	Malaysia	9/4/1991	G-II	447	600
Kuala Lumpur	Malaysia	2/19/1989	B-747	539	692
Kuala Lumpur	Malaysia	12/18/1983	A-300	625	778

City	Region	Date	Type	Orig Page	PDF Page
Kuala Lumpur	Malaysia	9/27/1977	DC-8	681	834
Kuala Lumpur	Malaysia	5/11/1976	B-747	692	845
Thompson	Manitoba	5/31/1994	Merlin II	309	462
Fort De-France	Martinique	7/17/1994	BN 2B	291	444
Boston	Massachusetts	6/8/1989	B-767	531	684
Boston	Massachusetts	12/17/1973	DC-10	710	863
Boston	Massachusetts	7/31/1973	DC-9-31	714	867
Pittsfield	Massachusetts	12/10/1986	Be-100	589	742
Hermosilla	Mexico	1/8/1993	L-35A	377	530
Mexico City	Mexico	9/1/1991	A-300	439	592
Mexico City	Mexico	10/17/1976	DC-9	688	841
Puerto Vallarta	Mexico	6/20/1973	DC-9	715	868
Uruapan	Mexico	6/13/1994	Metro II	305	458
Alpena	Michigan	3/13/1986	EMB-110	600	753
Hibbing	Minnesota	12/1/1993	BAe JS-31	329	482
Kansas City	Missouri	9/8/1989	B-737	516	669
Kansas City	Missouri	4/13/1987	B-707	586	739
Helena	Montana	9/1/1993	B-727	351	Missing
Agadir	Morocco	8/3/1975	B-707	696	849
Tangiers	Morocco	12/1/1988	B-737-300	545	698
Bharatpur	Nepal	7/31/1993	DO-228	353	Missing
Kathmandu	Nepal	9/28/1992	A-300-B4	389	542
Kathmandu	Nepal	7/31/1992	A-310-300	393	546
Elko	Nevada	1/15/1990	SA-227	496	649
Fallon	Nevada	3/15/1986	C-9B	598	751
Las Vegas	Nevada	12/1/1994	EMB-110	281	434
Reno	Nevada	3/22/1995	Ce-208B	261	414
Buffalo	New York	5/1/1976	DC-10	694	847
New York	New York	1/25/1990	B-707-321	490	643
New York	New York	6/1/1988	B-747	561	714
New York	New York	2/1/1983	B-767	635	788
Sarnac Lake	New York	1/3/1992	Be-1900	427	580
Auckland	New Zealand	7/31/1989	CV-580	525	678
Palmerston North	New Zealand	6/9/1995	DHC-8	251	404
Gander	Newfoundland	10/1/1993	DC-8-73F	347	Missing
Abuja	Nigeria	9/13/1994	DHC-6	289	442
Kano	Nigeria	11/25/1992	B-707	385	538
Kano	Nigeria	2/15/1992	DC-8	421	574
Lagos	Nigeria	7/21/1988	B-707	554	707
Charlotte	North Carolina	9/11/1974	DC-9-30	705	858
Raleigh-Durham	North Carolina	2/19/1988	SA 227	568	721
Raleigh-Durham	North Carolina	11/12/1975	B-727	695	848
Bardufoss	Norway	11/14/1989	Ce-551	502	655
Bronnoysund	Norway	5/6/1988	DHC-7	563	716
Dagali	Norway	3/19/1993	Be-200	369	522
Oslo	Norway	5/20/1995	TU-204	253	406

City	Region	Date	Type	Orig Page	PDF Page
Tromso	Norway	10/27/1989	DC-9-30	508	661
Alert	Nunavut	10/30/1991	C-130	437	590
Rae Point	Nunavut	10/30/1974	L-188	704	857
Columbus	Ohio	1/7/1994	BAe-JS-41	323	476
Dayton	Ohio	1/12/1989	HS-748	543	696
Toledo	Ohio	2/15/1991	DC-8	419	572
Naha	Okinawa	7/27/1970	DC-8	719	872
Kingston	Ontario	1/20/1995	Be-E90	269	422
Moosonee	Ontario	4/30/1990	Be-C99	481	634
Sandy Lake	Ontario	11/10/1993	HS-748	337	490
Gold Beach	Oregon	8/21/1989	Be-90	518	671
Medford	Oregon	1/1/1992	B-737	423	576
Portland	Oregon	6/1/1994	A-320	295	448
Portland	Oregon	4/1/1993	L-1011	365	518
Portland	Oregon	4/1/1992	DC-10	409	562
Portland	Oregon	4/1/1992	B-727-200	411	564
Portland	Oregon	6/28/1986	DC-10	592	745
Portland	Oregon	7/20/1976	B-727	690	843
Panama City	Panama	10/5/1979	B-707	663	816
Arequipa	Peru	2/29/1996	B-737-200	243	396
Ilailo	Philippines	5/18/1990	B-737-300	478	631
Naga	Philippines	12/16/1993	C-130	325	478
Warsaw	Poland	12/17/1991	DC-9/30	429	582
Ivanovo	Russia	8/27/1992	TU-134	391	544
Petropavlovsk-Kamchatsky	Russia	4/5/1996	IL-76	235	388
Cagliari	Sardinia	9/14/1979	DC-9	665	818
Inverness	Scotland	11/19/1984	EMB-110	622	775
Isle of Harris	Scotland	4/30/1990	Shackleton	483	636
Mull of Kintyre	Scotland	6/2/1994	Chinook	307	460
Port Ellen	Scotland	6/12/1986	DHC-6	594	747
Guadalcanal	Solomon Islands	9/27/1991	DHC-6	441	594
Capetown	South Africa	7/1/1993	B-737-200	357	510
Bilbao	Spain	2/19/1985	B-727	618	771
Madrid	Spain	11/27/1983	B-747	627	780
Tenerife	Spain	4/25/1980	B-727	656	809
Colombo	Sri Lanka	11/15/1978	DC-8	673	826
Colombo	Sri Lanka	12/4/1974	DC-8	700	853
Paramaribo	Suriname	7/7/1989	DC-8	529	682
Zurich	Switzerland	11/14/1990	DC-9	470	623
Hualien	Taiwan	10/26/1989	B-737	510	663
Taipei	Taiwan	1/30/1995	ATR-72	265	418
Chattanooga	Tennessee	11/27/1973	DC-9	711	864
Nashville	Tennessee	5/15/1991	B-727	455	608
Dallas/Fort Worth	Texas	12/8/1993	B-737	327	480
El Paso	Texas	10/1/1988	B-737-200	550	703
Harlingen	Texas	2/4/1986	B-727	602	755

City	Region	Date	Type	Orig Page	PDF Page
Koh Samui	Thailand	11/21/1990	DHC-8	466	619
Phuket	Thailand	4/15/1985	B-737	616	769
Ankara	Turkey	1/16/1983	B-727	637	790
Ankara	Turkey	12/23/1979	F-28	660	813
Izmur	Turkey	1/2/1988	B-737	574	727
Van	Turkey	12/29/1994	B-737-400	283	436
St. Thomas	USVI	1/4/1986	B-727	604	757
St. Thomas	USVI	1/1/1986	B-727	606	759
Salt Lake City	Utah	12/18/1977	DC-8	679	832
Salt Lake City	Utah	2/1/1977	B-727	684	837
Caracas	Venezuela	6/17/1991	G-II	451	604
Margarita	Venezuela	6/23/1992	B-767-300ER	397	550
Santa Barbara	Venezuela	3/5/1991	DC-9	459	612
Charlottesville	Virginia	1/1/1995	BAe JS-31	277	430
Dulles	Virginia	6/18/1994	LJ-25D	301	454
Dulles	Virginia	5/1/1992	MD-80	403	556
Dulles	Virginia	12/1/1974	B-727	702	855
Shenandoah Valley	Virginia	9/23/1985	Be-99	610	763
Winchester	Virginia	10/26/1993	Be-90	345	498
Kelso	Washington	11/30/1990	AC-690	464	617
Mt. Rainier	Washington	3/21/1983	C-1A	633	786
Pasco	Washington	12/26/1989	BAe-31	498	651
Pullman	Washington	1/1/1993	DHC-8	373	526
Seattle	Washington	11/1/1991	CL-601	435	588
Seattle	Washington	1/4/1984	B-727	624	777
Seattle	Washington	3/20/1975	C-141	698	851
Spokane	Washington	1/27/1990	B-727	488	641
Spokane	Washington	11/9/1989	B-737	504	657
Spokane	Washington	12/14/1986	B-727	588	741
Spokane	Washington	1/20/1981	Be-99	649	802
Huntington	West Virginia	1/1/1995	BAe JS-31	271	424
Moragntown	West Virginia	4/14/1945	DC-3	721	874
Goma	Zaire	12/13/1992	F-27	381	534

APPENDIX

A-1 CFIT Losses & GPWS

- Chart: World Civil CFIT Accidents Turbine Powered Aircraft (Graph)
- Commercial Jet Aircraft (39 Losses)
  8 Years 1988 thru 1995
- Same with GPWS - Pie Chart
- Corporate, Regional, Air Taxi (148 Losses)
  6 Years 1989 thru 1995

A-2 North American CFIT Losses & GPWS
20 Years 1975 thru 1995 Airline Jet Aircraft

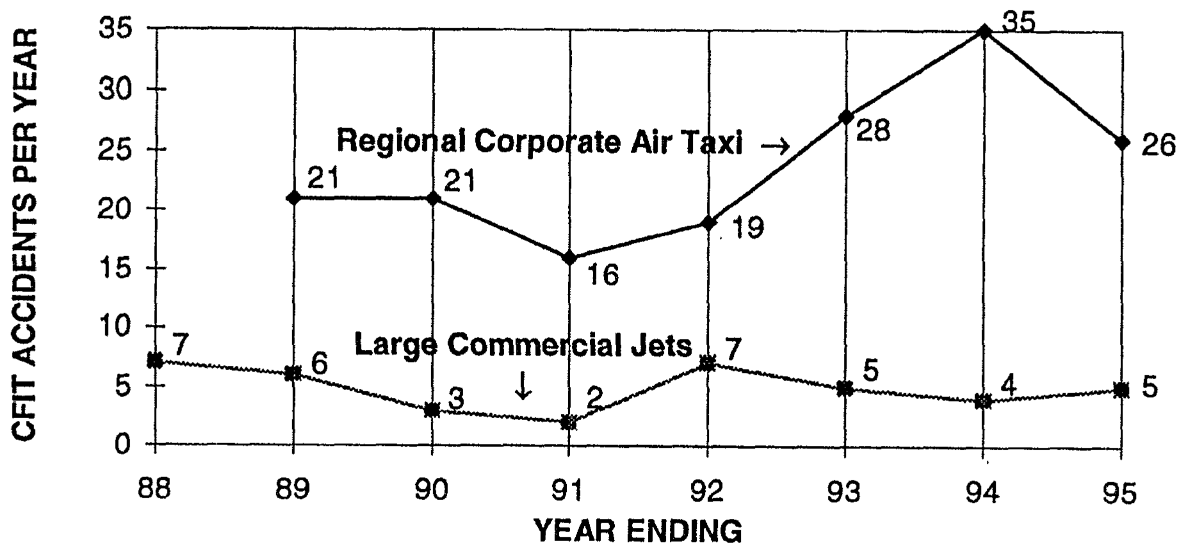
A-3 CFIT Accidents and Risk for U.S. Airlines - Large Commercial Jets
Pre 1975...................... 0.85 Accidents per million flights
Post 1975.................... 0.09 Accidents per millions flights

A-4 U.S.A. Part 135 Turbine Powered CFIT Losses 1982 thru 1995 (Graph)
~~Partial List (Table) of Part 135 CFIT Losses~~

A-5 Characteristics for Various Models of GPWS Equipment
and Bank Angle Description and Table of Accidents/Incidents

A-6 The Development of Ground Proximity Warning Systems

WORLD CIVIL CFIT ACCIDENTS
TURBINE POWERED AIRCRAFT



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CFIT ACCIDENTS (39) COMMERCIAL JET AIRCRAFT
EIGHT YEARS (1988 THROUGH 1995)

1995	• Cali, Colombia	B757
	• Windsor Locks, CT	MD-80
	• San Salvador	B737-200
	• Monrovia, Liberia	DC-9-31
	• Cartagena, Colombia	DC-9-16
1994	• Van, Turkey	B737-400
	• Coventry, U.K.	B737-200
	• Tamanrasset, Algeria	BAC1-11
	• Vigo, Spain	DC-9/32
1993	• Urumqi, China	MD-82
	• Mokpo, Korea	B737-500
	• Sorong, Indonesia	F-28
	• Medellin, Colombia	B727-100
	• Abijian, Ivory Coast	B707-320
1992	• Kano, Nigeria	B707-320
	• Kathmandu, Nepal	A300-B4
	• Kathmandu, Nepal	A310
	• Cruzeiro do Sol, Brazil	B737-200
	• Athens, Greece	B707-320
	• Kano, Nigeria	DC-8
	• Strasbourg, France	A320
1991	• Imphal, India	B737-200
	• Santa Barbara, Venezuela	DC-9/30
1990	• Nairobi, Kenya	B707-320
	• Zurich, Switzerland	DC-9/30
	• Unakleet, Alaska	B737-200
1989	• Hulien, Taiwan	B737-200
	• Tegucigalpa, Honduras	B727-200
	• Tripoli, Libya	DC-10/30
	• Paramaribo, Surinam	DC-8/62
	• Kuala Lumpur, Malasia	B747
	• Santa Maria, Azores	B707-320
1988	• Ahmedabad, India	B737-200
	• Rome, Italy	B707-300
	• Lagos, Nigeria	B707-320
	• Posadas, Argentina	MD-81
	• Cucuta, Colombia	B727-100
	• Ercan, Cypress	B727-200
	• Izmir, Turkey	B737-200

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1995 COMMERCIAL JET AIRCRAFT CFIT ACCIDENTS

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Scheduled	20 December	Cali, Colombia	B757	Hit Mtn 22 NM short of VOR DME Rwy 19. MKV GPWS installed and pilot pullup . Clipped top of mtn.	160 of 164; 5 rescues
Scheduled	12 November	Windsor Locks, CT	MD-80	Hit trees 2-3/4 NM from VOR Rwy 15. MK II GPWS.	of 72
Scheduled	9 August	San Salvador, G.S.	B737-200	Hit precipitous volcano on initial approach, VOR DME 25,; 12 second MK II GPWS Warning; Late pilot pull up.	65
Scheduled	26 July	Monrovia, Liberia	DC-9-31	Hit short of runway, tore off landing gear and burned.	12 S of 82
Scheduled	11 January	Cartagna, Colombia	DC-9-15	Premature descent 27 NM short of VOR-DME 36. MK I GPWS installed, but inoperative.	52

1994 COMMERCIAL JET AIRCRAFT CFIT ACCIDENTS

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Scheduled	29 December	Van, Turkey	B737-400	Improvised 2nd approach to runway 03 using autoflight. MKV GPWS installed (GPWS not applicable). IMC. 4 NM short	58 of 76
Freight	21 December	Coventry, England	B737-200	Surveillance Approach - 1 NM short, hit H.V. tower at 65' AGL. IMC. Crew very tired.	5
Charter	18 September	Tamanrasset, Algeria	BAC1-11/500	After holding for 2 hours and low on fuel, VOR DME 03 approach made. Hit short by 1-1/2 NM. IMC. MKI installed but no warning.	4
Scheduled	21 March	Vigo, Spain	DC-9/30	Hit into approach lights, MKII GPWS installed.	--

1993 COMMERCIAL JET AIRCRAFT CFIT ACCIDENTS

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Scheduled	13 November	Urumgi, China	MD-82	During ILS 25 approach, autopilot decoupled from glideslope. Aircraft hit into power line some 1-1/4 NM short of the runway. MKII GPWS operating.	12 of 92
Scheduled	26 July	Mokop, Korea	B737-500	During 3rd approach VOR-DME 06, the aircraft hit 4-1/2 NM short into 500' MSL ridge, MKV GPWS installed, no warning (No GPWS altitude callouts).	68 of 110
Scheduled	1 July	Sorong, Indonesia	F-28	During an NDB 26 approach, the aircraft impacted into the sea 0.6 short of the runway. No GPWS installed.	41 of 43
Scheduled	19 May	Medellin, Colombia	B727-100	During initial approach, the aircraft mistook NDB passage and turned away before reaching the NDB, and hit a mountain 30 NM from airport. No GPWS installed. IMC	132
Freight	15 January	Abidjan, Ivory Coast	B707-321	During an ILS approach to runway 21, the aircraft hit short by 10 feet. MKI GPWS installed. Glideslope function operative.	--

1992 COMMERCIAL JET AIRCRAFT CFIT ACCIDENTS

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Freight	25 November	Kano, Nigeria	B707-320C	During VOR DME 06 approach, aircraft impacted 8-1/2 NM short. No GPWS installed. Night.	--
Scheduled	28 September	Kathmandu, Nepal	A300-B4	During a VOR DME 02 approach, the aircraft prematurely descended, impacted a mountain 9-1/2 NM short of runway 02. MKII installed.	167
Scheduled	31 July	Kathmandu, Nepal	A310-300	During a missed approach, the pilot became unaware of high terrain, impacting some 24 NM past the airport. MKIII GPWS installed, 17-second warning.	113
Freight	22 June	Cruzeiro Do Sol, Brazil	B737-200C	During a VOR approach to runway 10, aircraft hit short by 7-1/3 NM. Crew distracted by cargo smoke alert. Night. No GPWS.	3
Freight	24 March	Athens, Greece	B707-320	During an ASR radar approach to runway 33R, aircraft hit a mountain 4 NM from the runway. MKI.	7
Freight	15 February	Kano, Nigeria	DC-8	During a VOR DME approach to runway 06, the aircraft impacted some 9 NM short at night. No GPWS.	--
Scheduled	20 January	Strasbourg, France	A320	During a VOR TAC approach to runway 05, the aircraft prematurely descended, impacting some 10-1/2 NM short at night. No GPWS.	87 of 96

1991 COMMERCIAL JET AIRCRAFT CFIT ACCIDENTS

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Scheduled	16 August	Imphal, India	B737-200	During initial approach and procedure turn to ILS/VOR runway 04, the aircraft hit a mountain 19 NM from the runway. IMC. MKI GPWS installed. 6-1/3 second warning (would have been 16 seconds with MKII).	69
Scheduled	5 March	Santa Barbara, Venezuela	DC-9/30	Enroute, the aircraft hit a 10,000 foot mountain. IMC. MKI GPWS working, but aircraft some 1700 feet below top. Pilot attempted recovery (almost made it). MKII would have given 4 seconds more warning time.	43

1990 COMMERCIAL JET AIRCRAFT CFIT ACCIDENTS

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Freight-Charter	4 December	Nairobi, Kenya	B-707-320	During a second ILS approach, the aircraft impacted short of runway 06. No GPWS.	10
Scheduled	14 November	Zurich, Switzerland	DC-9/30	During an ILS approach to runway 14, the aircraft impacted 5-1/4 NM short into a hill at night. A glideslope failure, zero deviation, no flag, is a possible cause. MKII GPWS installed, no warning.	46
Positioning	2 June	Unalkaleet, Alaska	B737-200	During an LOC/DME approach to runway 10, the aircraft prematurely descended and impacted a hill 6-2/3 NM short.	--

1989 COMMERCIAL JET AIRCRAFT CFIT ACCIDENTS

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Scheduled	26 October	Hualien, Taiwan	B737-200	During a night departure, the aircraft was turned the wrong direction toward terrain. During a turn back to the correct course, the aircraft hit a mountain. MKII GPWS installed and a warning given. Pilot tried to increase turn rate instead of pulling straight ahead.	54
Scheduled	21 October	Tegucigalpa, Honduras	B727-200	During a VOR DME approach to runway 01, the aircraft prematurely descended and impacted a mountain some 5-3/4 NM short. No GPWS.	131 of 146
Scheduled	27 July	Tripoli, Libya	DC-10/30	During a locator approach to runway 27, the aircraft hit short by 0.6 NM. IMC. Primitive GPWS (tone - MK1/2) installed, 7-1/2 seconds (MKII would have given 18 seconds).	75 of 199
Scheduled	7 July	Paramaribo, Suriname	DC-8/62	During a VOR DME (ILS up) to runway 10, the aircraft was being flown by Flight Director but locked in vertical speed with no glideslope capture. MKI GPWS installed. Six "Glideslope!" alerts given but F/O canceled alert. IMC.	175 of 183
Freight	19 February	Kuala Lumpur, Malaysia	B747-200	During an NDB DME approach to runway 33, the aircraft prematurely descended, impacting a hill 8-1/2 NM from the runway. MKI GPWS installed and warnings given some 16 seconds from impact.	4
Charter	8 February	Santa Maria, Azores	B-707-300	During an initial approach ILS 19, the aircraft hit a mountain some 5 NM from the airport. An MKI GPWS installed and gave a 6-1/2 second warning. MKII would have given 27-1/2 seconds of warning.	144

1988 COMMERCIAL JET AIRCRAFT CFIT ACCIDENTS

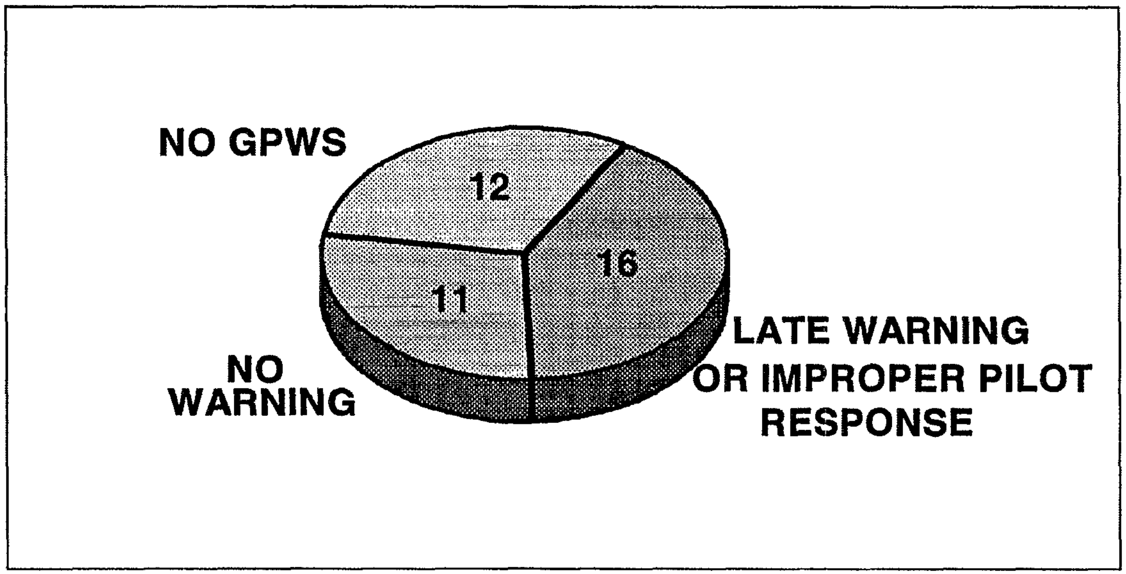
OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Scheduled	10 October	Ahmedabad, India	B737-200	During an LOC DME approach to runway 23, the aircraft hit short by 1.4 NM. IMC. MKI GPWS installed. No warning.	139 of 141
Scheduled	17 October	Rome, Italy	B707-300	During a VOR/DME approach to runway 34L, the aircraft hit short by 2-1/2 NM. IMC. No GPWS.	32 of 52
Scheduled	21 July	Lagos, Nigeria	B707-320	During an ILS DME approach to runway 19R, the aircraft impacted short by 8-1/2 NM from the runway. Night. IMC. No GPWS.	6
Freight	12 June	Posadas, Argentina	MD-81	During a VOR DME Locator approach to runway 01, the aircraft hit short of the runway by 1.7 NM. IMC. MKII GPWS installed.	23
Scheduled	17 March	Cucuta, Colombia	B727-100	During departure from runway 32, the aircraft diverted from the normal departure course because of traffic and impacted a mountain some 12-1/2 NM from liftoff. No GPWS.	143
Positioning	27 February	Ercan, Cyprus	B727-200	During a VOR approach to runway 16, the aircraft left the approach course and hit a mountain some 8 NM from the runway. MKII installed, timely alert, and pilot almost recovered.	15
Positioning	2 January	Izmir, Turkey	B737-200	During an ILS approach to runway 35, the aircraft impacted into a mountain some 19 NW west of the airport. MKI GPWS installed, but no warning.	16

1987 COMMERCIAL JET AIRCRAFT CFIT ACCIDENTS

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Freight	13 April	Kansas City, Missouri	B707	During a night ILS approach to runway 01, the aircraft impacted some 3-1/2 NM short of the runway. MKI GPWS installed but no alert or warning given. Failure of glideslope receiver to zero deviation and no flag suspected.	4

COMMERCIAL JET AIRCRAFT CFIT ACCIDENTS

EIGHT YEARS - 1988 THROUGH 1995



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1995 CORPORATE, REGIONAL, AIR TAXI CFIT ACCIDENTS (26)

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Medevac	11 January	Masset, BC	LJ-25	Hit 4 NM short on NDB-A approach	5
Corporate	20 January	Kingston, Ontario	Be-90	Hit ground 10 NM outbound on front course of runway 01	--
Corporate	25 January	Allendorf, Germany	Ce Citation II	Hit short into trees	2 (4)
Cargo	29 January	Manaus, Brazil	DC 8-62	Hit INM short on ILS 10, managed a missed approach	--
Repositioning	30 January	Taipei, Taiwan	ATR-72	Hit short 9 NM following a false glideslope lobe ILS 10 night. MK II GPWS inoperative.	4
Air taxi	21 February	Big Trout Lake, Ontario	Be-A100	Hit 3 NM short on approach	8 of 11
Private,	3 March	Gainsville, Georgia	Ce-208B	Hit 1/4 NM short on NDB04 - Night - Poor visibility	(2)
Cargo	22 March	Reno Nevada	Ce-208B	Hit mountain 9-1/4 NM short of rwy 16R	1
Cargo	27 April	Alice Springs, Australia	IAI-1124	Hit ridge 5-1/4 NM short ILS/LOC DME 7	3
Corporate	4 May	Quito, Equador	G-II	Hit mountain 23 NM short at night - Possible misinterpretation of procedure	7
Scheduled Regional	25 May	Leeds, Bradford	EMB110	During initial climb to 3600 feet, the captain's ADI failed with no flag. The aircraft entered a left turn overbanked, spiral.	12
Scheduled	3 June	Panama City	B747-200	Undershot ILS 03 by 230 feet (major damage) ragged weather	--
Private	7 June	Gainsville, Florida	PA-32	Circling at night	6
Scheduled Regional	8 June	Palmerston North, NZ	DHC-8	Hit hill 7 NM short VOR DME 25. Landing gear distraction. Short MK II GPWS warning. Radio Altimeter problem?	3 of 21
Air Taxi	17 June	Catumbela, Angolia	CASA 212	Hit 9-1/2 NM short of RWY 27	48
Corporate Air Taxi	22 June	Tepico, Mexico	LJ-35	Hit short 4-1/2 NM on approach at night	2 (6)
Charter	9 August	West New Guinea, Indonesia	HS-748	Hit at 9200 foot level of 9600 foot mountain enroute.	10
Scheduled	14 August	Near Clai, Colombia	EMB-110	Hit mountain enroute	7
Ferry	1 September	Farewell, Alaska	SC-7	Hit mountain at 4800 feet during departure	1
Corporate	18 September	Chino, California	SA-226T	Hit short by 0.15NM for ILS runway 26	--
Corporate	21 September	Smyrna, Tennessee	MU-2B	Descent in turn on departure from 600 feet	2 S
Scheduled	9 September	La Macareva, Colombia	Casa-300	Hit short by 5 NM from the runway in fog.	20 of 21
Scheduled	21 September	Moeron, Mongolia	An-24	Hit mountain 12 NM from airport	43
Medevac	21 September	Amenas D.Z.	LJ-36	Visual night circuit from Rwy 23 to Rwy 05. Hit 1.8 NM short	1 S of 3
Regional	31 October	Piedras Negras Mexico	Ce-208B	Hit 7 nm short of runway	9/2 "S" of 11
Civil-Military	9 November	Cordoba, Argentina	F-27	Hit mountain 48 NM from airport on initial approach	53
Corporate	30 December	Eagle River, WI	Ce-560	Hit 4 NM short on VOR/DME Rwy 4, IMC	2
Corporate	31 December	Naples, FL	Ce-550	Hit cables at 2NM on VOR/DME Rwy, 4 IMC	2

5) Large Turbo Prop
(6) ≤ 30 Seat Turbo Prop
(9) ≤ 10 Seat Turbo Prop
(7) ≥ 10 Seat Jet

No GPWS installed on above aircraft unless noted.

db95056

1994 CORPORATE, REGIONAL, AIR TAXI CFIT ACCIDENTS (35)

Don Bateman

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Regional	9 Jan	Athens, Greece	DO-228	Hit ridge-powerlines 7 NM from runway, VOR-DME 18L.	--
Freight	14 Jan	Sydney, Australia	AC 690	Flew into sea 10 NM short at night, rwy 34.	1
Positioning Air Taxi	18 Jan	Kinshasa, Zaire	LJ-24D	Hit short 10 NM at night, visual 24.	2
Charter	24 Jan	Attenrhein, Switzerland	Ce-425	Flew into lake - 2 NM, final 10.	5
Positioning	27 Jan	Meadow Lake, Sask.	IAI-1124	Hit 2 NM SE - stall?, circling 26.	2
Scheduled	23 Feb	Tingo Maria, Peru	Yak-40	Flew into mountain FL131, NDB departure.	31
Sales Demo	24 Feb	Cleveland, Ohio	Be-400	Hit off runway ILS 23	0 of 5
Positioning Air Taxi/Cargo	7 March	Hayden, CO	AC-690	Hit trees on approach	1
Freight	9 March	Australia	SA-226	Hit short on approach	1
Air Taxi	23 March	Bogota, Colombia	Ce-VI-650	Hit hillside, initial approach 25 NM NW.	4
Scheduled	6 April	Latacunga, Ecuador	DHC-6	Hit 13,400 mtn 300' below crest, premature descent.	17
Regional	25 April	Nangapinoh, Indonesia	BN-2A	Hit mtn at 5400' level, initial descent.	10
Regional	27 April	Stratford, CT	PA-31T	Hit 3 NM short, final 06.	8
Corporate	7 May	Zaire, Kinshase	Be-200	Hit short of runway	9
Medevac Air Taxi	27 May	Papeete, Tahiti	Mu 2B	Hit short by 4 NM on ILS Rwy 04 approach	5
Medevac	31 May	Thompson, Manitoba	Merlin II	Hit FAF NB 3.4 short, B/C LOC. rwy 33.	2
Regional	13 June	Uruapan, Mexico	Metro II	Hit terrain while maneuvering for 3rd approach.	9
Scheduled	18 June	Palu, Indonesia	F-27	Hit mtn 3-1/2 NM short, initial approach.	12
Charter	19 June	Washington DC-Dulles	LJ-25D	Hit 1-1/2 NM short, ILS 1R.	12
Charter	26 June	Abidjan, Ivory Coast	F-27	Hit 2-1/4 NM short, VOR/DME 21	17
Government	9 July	Kulu, India	Be-200	Hit mtn 7 NM SW of airport, NDB.	13
Charter	17 July	Fort de France	BN-2B	Hit at 2780' mtn, 15' below crest, 6 NM, VOR/DME.	6
Private	24 July	Portsmouth, OH	PA-32T	Hit trees on rising terrain, departure rwy 18.	5 of 6
Gov't (Drug Enforce)	27 Aug	Pucalpa, Peru	CASA-212	Hit hill, NDB/VOR.	5
Charter	13 Sept	Abuja, Nigeria	DHC-6	Hit 5 NM short, VOR-DME 22.	2 of 5
Corporate	17 Sept	Texas	HS-125	Hit Trees on approach	--
Private	10 Oct	Missouri	AC 690	Hit into ground in initial climb	1
Freight	29 Oct	Ust-Ilimsk, Russia	AN-12	Hit short on approach by 1-2 NM at night.	21
Charter, Freight	4 Nov	Kebu, Nabire, New Guinea	DHC-6	Hit hill, approach.	4
Air Taxi	19 Nov	Saumer, France	Be-C90	Hit ground while circling after successful locator; (NDB) approach.	7
Air Taxi	22 Nov	Bolvovig, New Guinea	BN2A-2D	Hit hillside on initial approach.	7
Scheduled	10 Dec	Koyuk, Alaska	Ce-402	Hit short on approach.	5
Business	16 Dec	Michigan	Ce-501	Hit short into approach lights	--
Scheduled	17 Dec	Tabubil, Papua N. Guinea	DHC-6	Hit ridge enroute to Selbang (25 miles east) on initial climb.	28
Freight	30 Dec	Melbourne, Australia	MU-2	Hit short on ILS - Poor visibility	1

(3) Large Turbo-prop
(6) 10 to 30 Seat Turbo-Prop

(8) ≤ 10 Seat Turbo Prop
(5) ≥ 6 Seat Jet

No GPWS equipment on any of the above aircraft

DB95038

1993 CORPORATE, REGIONAL, AIR TAXI CFIT ACCIDENTS

Don Bateman

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Regional-Schd	6 Jan	Paris, France	DHC-8	Hit short while repositioning ILS 27 to ILS 28	4
Air Taxi	8 Jan	Hermosillo, Mexico	L-35A	Hit Mountain on approach to VOR 23	9
Private	29 Jan	Marfa, TX	Be-90	Circling to runway 12, IMC after VOR 30	0 of 8
Regional-Schd	30 Jan	Ackh, Inur, Malaysia	SC-7	Hit terrain en route	16
Air Taxi	7 Feb	Iquacu, Brazil	Be-90	Hit 0.6 NM short - IMC; heavy rain	6
Air Taxi	8 Feb	Lima, Peru	PA-42-720	Hit mountain initial descent	6
AT-Non Sched	27 Feb	Rio de Janeiro	L-31	Hit short by 300 feet	--
Air Taxi	18 Mar	Trijillo, Peru	Be-90E	Hit mountain initial descent 50 NM short	4
Air Taxi	19 Mar	Dagali, Norway	Be-200	Hit 3 NM short LOC/DME 26, night	3 of 7
Reg'l-NonSchd	23 Mar	Cuiaba, Brazil	EMB 110	Hit terrain on climb out	6
Air Taxi-Med.	6 April	Casper, WY	MU-2B-35	Hit terrain on DME Arc ILS 8, night	4
Private	1 May	Mount Ida, AR	Be-90	Hit Mt. Ida (3 NM short). Climb IMC	2
Air Taxi-Trng	25 May	Sante Fe, NM	SA-226T	Hit hill while circling to Rwy 15 short 5 NM at night.	4
Reg' Cargo NS	5 June	El Yo Pal, Colombia	DHC-6	Hit short while circling	2
Regional-Schd	11 June	Young, Australia	PA-31	Hit rising ground while circling after ND approach	7
Reg-Carg-Sch	25 June	Atinues, Namibia	Be-200	Hit terrain on missed approach	3
Government	15 July	Bombay, India	Be-90	Hit hill on approach IMC	4
Regional-Schd	31 July	Bharatpur, Nepal	DO-228	Hit mountain on initial approach	19
Air Taxi-Med.	7 Aug	Augusta, GA	Be-90	Hit 1-1/2 NM short on approach IMC to ILS 17	4
AT-Positioning	17 Aug	Hartford, CT	SA-226T	Hit 1/3 NM short IMC to Rwy 02	2
AT-Positioning	27 Sept	Lansing, MI	Be-300	Hit 2 NM after 7.0 IMC turning	2
Regional-Schd	19 Oct	Orchid Is., Taiwan	DO-228	Undershoot	--
Regional-NS	25 Oct	Franz Josef Glacier, NZ	Nomad	Hit Glacier VMC into IMC	9
Gov't-FAA	26 Oct	Winchester, VA	Be-300	Hit terrain while awaiting IFR clearance	3
Regional-Schd	27 Oct	Namos, Norway	DHC-6	Hit 3 NM short on NDB approach	12
Regional-Schd	1 Dec	Hibbing, MN	BAe JS-31	Hit 3 NM short on LOC (B/C) Rwy 13	18
Regional-Schd	10 Dec	Sandy Lake, Ontario	HS 748	Climbing turn, back into terrain	7
AT-Positioning	30 Dec	Dijon, France	Be-90	Hit short on approach IMC	1

(2) Large Turbo-prop **(16) ≤ 10 Seat Prop** **Except for DHC-8, there was no GPWS on any of the above aircraft.**
(9) 10 to 30 Seat Turbo-prop **(2) ≥ 6 Seat Jet**

DB95038

1992 CORPORATE, REGIONAL, AIR TAXI CFIT ACCIDENTS

Don Bateman

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Regional-Schd	3 Jan	Sarnac Lake, NY	Be-1900	Hit short at FAF on ILS 23 IMC.	2F/2S
Private	11 Feb	Lakeland, FL	Ce-425	Hit short of runway 05 IMC.	1
Charter	16 Feb	Big Bear, CA	PA-31T	Hit terrain at 6740' 7 NM east of airport.	7
Private	5 Mar	New Castle, CO	MU-2B	Hit mtn - LOC/DME "A" Gear Down; Approach flaps 10-1/2 NM short.	6
Private	29 Mar	Taos, NM	AC-390	Hit rising terrain on climb out; IMC night 3940' (visual); radio altimeter installed.	1, 5S
State Aircraft	9 April	St. Augustine, FL	Be-90	Hit short on VOR approach 007: 10 EDT IMC.	2
Regional-Tour	22 April	Maui, Hawaii	Be-18	Hit mtn enroute.	9
Regional-Schd	8 June	Anniston, AL	Be-99	Hit terrain during LOC 5 approach.	3F/2S
Personal	24 June	Alamagordo, NM	MU-2B	Hit mtn VMC during climbout 23:21 MDT - Night.	6
Regional-Schd	24 July	Ambeu, Indonesia	Vickers Viscount	Hit mtn during initial approach ILS/04.	71
Personal	13 Aug	Osway, MO	PA-31	Hit short rwy 32-IMC.	--
Personal	4 Sept	Longton, KS	PA-42	Hit wires on approach.	--
Government	19 Oct	Pesqueria, Mex (Monterey)	AC-680T	Hit terrain during climbout IMC.	6
Comm/Air Taxi	31 Oct	Grand Junction, CO	PA-42	Hit mtn 10 NM north RNAV-Cleared to ILS rwy 11. "Macks" int. eastbound 9400'-7800' cliff; IMC day 0315.	3
National Guard	11 Nov	Juneau, AK	Be-200	Hit mtn LOC/DME 20+ NM from runway.	8
Government	10 Dec	Quito, Ecuador	Sabreliner	Hit 3 NM short during VOR/ILS 35 approach.	12
Regional-Schd	13 Dec	Goma, Zaire	F-27	Hit short into terrain during initial approach VOR/DME 36.	37
Government	22 Dec	Quito, Ecuador	PA-31	Hit 3 NM short during VOR/ILS 35 approach.	5

(2) Large Turbo Prop **(13) $\leq$ 10 Seat Prop**
(2) 10 to 30 Seat Turbo Prop **(1) $\geq$ 6 Seat Jet**

No GPWS Installed on any of the above aircraft.

DB95038

1991 CORPORATE, REGIONAL, AIR TAXI CFIT ACCIDENTS

Don Bateman

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Corporate	11 Jan	Belo Horizontes, Brazil	LJ-25	Hit 2 NM short.	5
Air Taxi-Ferry	8 Feb	Stansted, UK	Be-200	Hit 2-1/2 NM short of the runway; possible altimeter error.	2
Corporate	12 Feb	Uganda, Kenya	HS-125	Hit mtn on initial approach.	3
Air Taxi	15 Mar	Brown Fld, CA	HS-125	Hit mtn on departure 8L.	10
Corporate	18 Mar	Brasilia, Brazil	LJ-25	Hit short.	4
Corporate	21 May	Bauchi, Nigeria	Ce-550	Hit short.	3
Corporate	17 June	Caracas, Venezuela	G-II	Hit 5 NM short to rwy 10.	4
Corporate	4 Sept	Kota Kinabalu, Malaysia	G-II	Hit mtn during missed approach.	12
Charter	17 Sept	Djibouti	L-100	Hit mtn VMC during initial approach.	4
Corporate	25 Sept	Holtenou Klel, Germany	DS-20	Missed approach.	1
Regional-Schd	27 Sept	Guadalcanal, Sol.	DHC-6	Hit mtn enroute.	15
Corporate	8 Oct	Hanover, Germany	Ce-425	Hit short on ILS 27R.	7
Air Taxi	22 Nov	Romeo, MI	Be-100	Hit 3 NM short on VOR/DME approach, IMC-fog.	4
Corporate	27 Nov	Paloma, Majorca	Be-400	Hit 1/4 NM short.	--
Corporate	30 Nov	Kelso, WA	AC 690	Hit mtn 13 NM short.	5/1S
Corporate	11 Dec	Rome, GA	Be-400	Hit mtn on departure.	9

(1) Large Turbo Prop **(5) ≤ 10 Seat Prop**
(2) 10 to 30 Seat Turbo Prop **(8) ≥ 6 Seat Jet**

No GPWS Installed on any of the above aircraft.

DB95038

1990 CORPORATE, REGIONAL, AIR TAXI CFIT ACCIDENTS

Don Bateman

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Regional-Schd	15 Jan	Elko, Nevada	Metro III	Hit mtn at FAF VOR-A.	4-5/16
Regional-Schd	16 Jan	San Jose, Costa Rica	CASA	Hit mtn on departure.	23
Air Taxi-Cargo	17 Jan	Denver to Montrose, CO	Ce-208A	Hit 50' below Mt. Massive (14,221') near Leadville, CO.	1
Corporate	17 Jan	West Point, MS	Be-400	Undershoot.	--
Corporate	19 Jan	Little Rock, AR	G-II	Hit short on ILS.	7
Air Taxi-Cargo	29 Jan	Williston, VT	Ce-208B	Hit trees, power lines on climb out at major IMC.	2
Air Taxi-Cargo	29 Jan	Schuyler Falls, NY	Ce-208B	Hit 1-1/2 NM beyond rwy 19 during climb out IMC, night.	1
Schd-Freight	21 Mar	Tegucigalpa, Honduras	L-188	Hit mtn 6 NM short VOR/DME rwy 1.	3
Business	27 Mar	Uvalde, TX	Be-100	Hit terrain 4 NM south of field on approach in IMC-night.	--
Regional-Schd	20 April	Moosonee, Ontario	Be-99	Hit 7 NM short on VOR rwy 24.	1 of 4
Air Taxi	28 April	Tamanrasset, Algeria	Be-90A	Hit 4 NM short on approach.	6
Regional-Schd	4 May	Wilmington, NC	GN-24	Hit short on B/C Loc 16.	2
Air Taxi	11 May	Cairns, Australia	Ce-500	Hit mtn on initial approach.	11
Air Taxi	13 Aug	Cozuneil, Mexico	AC 1121	Undershoot.	1
Air Taxi	11 Sept	New Mexico	MS-760?	Hit mtn on departure.	2
Business	22 Sept	White Plains, NY	AC 690B	Hit short by 3 NM in IMC.	0 of 6
Air Taxi	24 Sept	San Luis Obispo, CA	Ce-500	Hit short on approach LOC 11.	4
Corporate	21 Nov	Keller Jock, Australia	Be-200	Initial approach.	3
Air Taxi	29 Nov	Sebring, FL	Ce-550	Undershot on approach rwy 11.	--
Business	30 Nov	Kelso, WA	AC-690A	Hit short by 8 NM night on initial approach into mountain.	5 of 6
Air Taxi-Cargo	21 Dec	Cold Bay, AK	Ce-208	Hit mountain enroute.	1

(1) Large Turbo Prop **(12) ≤ 10 Seat Prop**
(3) 10 to 30 Seat Turbo-Prop **(5) ≥ 6 Seat Jet**

No GPWS Installed on any of the above aircraft.

DB95038

1989 CORPORATE, REGIONAL, AIR TAXI CFIT ACCIDENTS

Don Bateman

OPERATION	DATE	PLACE	AIRCRAFT TYPE	COMMENTS	FATALITIES
Private	2 Jan	Mansfield, OH	MU-2B	Hit 8 NM short during an ILS 24 approach circle for 23. Night, IMC.	4
Private	7 Jan	Paducah, KY	Be-90	Hit mtn on departure.	3 of 15
Schd Freight	12 Jan	Dayton, OH	HS-748	Initial climb.	2
Air Taxi	12 Jan	Caracas, Venezuela	Be-200	Hit terrain while diverting in low cloud.	2
Charter	19 Feb	Orange County, CA	Ce-404	Hit mtn 20 NM short.	10
Air Taxi	23 Feb	Altenshein, Lake Contance, Switzerland	AC-690	Hit short to rwy 10. VMC into IMC.	11
Air Taxi	24 Feb	Helsinki, Finland	SA-226T	Hit short on ILS approach IMC.	6 of 7
Regional-Schd	10 April	Valence, France	FH-27T	Hit mtn, initial approach.	22
Air Taxi-Ferry	10 May	Azusa, CA	Be-200	Hit San Gabriel Mountain at 7300' level (departed Santa Monica).	1
Corporate	29 June	Cartersville, GA	DA-20	Initial climb, shallow into terrain.	2
Regional	31 July	Auckland, New Zealand	CV-580	Hit during initial climb.	34
Regional-Schd	3 Aug	Samos, Greece	SD-330	Hit mtn enroute.	16
Charter	7 Aug	Gambella, Ethiopia	DHC-6	Hit power lines - fog.	3 of 7
Air Taxi-Med	21 Aug	Mayfield, NY	Be-100	Hit 1/4 NM short at night IMC.	6
Business	15 Sept	Terrace, BC	Metro III	Missed approach LDA/DME.	7
Regional-Schd	26 Sept	Hurdle Mills, NC	Ce-550	Hit 2-1/2 NM short on approach.	2
Regional-Schd	28 Oct	Molokai, Hawaii	DHC-6	Hit mtn enroute.	20
Corporate	7 Nov	Ribeiro Das, Nevez	LJ	Hit hill on approach.	5
Private	2 Dec	Ruidoso, NM	Be-90	Hit short in procedure turn NDB approach IMC.	2
Air Taxi-Positioning	22 Dec	Beluga River, Alaska	PA-31T	Hit 8 NM short.	--
Regional-Schd	26 Dec	Pasco, WA	BAe JS-31	Hit short on ILS 21R.	4

(3) Large Turbo Prop
(6) 10 to 30 Seat Turbo-Prop
(10) ≤ 10 Seat Prop
(2) ≥ 6 Seat Jet

No GPWS installed on any of the above aircraft.

DB95038

NORTH AMERICAN CFIT ACCIDENTS - CANADA, MEXICO, USA
20 YEARS - 1976 THROUGH 1995
LARGE COMMERCIAL JET AIRCRAFT
1995: 6000 Aircraft ~ 9.0 x 10 Flights/Year
1976: 3200 Aircraft ~ 5.0 x 10 Flights/Year

YEAR	CFIT ACCIDENTS	AIRCRAFT TYPE	U.S. LOCATION	OUTSIDE U.S.	TYPE OF APPROACH	TYPE OF OPERATION	ARTS III MSAW COVERAGE	GPWS TYPE	GPWS WARNING TIME	FATAL-ITIES
1995	2	B757 MD-80	 Windsor Locks	Cali , Colombia	VOR DME 19 VOR 15	Scheduled Scheduled	No Yes	MK V MK II	11 sec 3 sec	160 of 164 5 rescued of 72
1994	0	--	--	--	--	--	--	--	--	--
1993	0	--	--	--	--	--	--	--	--	--
1992	0	--	--	--	--	--	--	--	--	--
1991	0	--	--	--	--	--	--	--	--	--
1990	1	B737-200	Unakaleet	--	LOC/DME	Repositioning	No	MK I	None	0
1989	2	B747-100 B747-300	-- --	Kuala Lumpur Santa Maria	NDB VOR	Freight Charter	No No	MK I MK I	11 Sec 6-1/3 Sec	4 144
1988	0	--	--	--	--	--	--	--	--	--
1987	1	B707-300	Kansas City	--	ILS	Freight	Yes	MK I	Inoperative*	4
1986	0	--	--	--	--	--	--	--	--	--
1985	1	B727-200		Lapaz	Initial VLF	Scheduled	No	MK I	<2 Sec	29
1984	0	--	--	--	--	--	--	--	--	--
1983	0	--	--	--	--	--	--	--	--	--
1982	0	--	--	--	--	--	--	--	--	--
1981	0	--	--	--	--	--	--	--	--	--
1980	0	--	--	--	--	--	--	--	--	--
1979	0	--	--	--	--	--	--	--	--	--
1978	1	B727-200	Pensacola	--	B/C LOC	Scheduled	No	MK I	9 Sec	3
1977	2	DC-8 DC-8	Salt Lake City --	-- Niamey, Africa	Radar Vector VOR	Freight Freight	Masked No	MK I MK I	9 Sec 0	3 2
1976	2	B-720 DC-10	-- --	Barranquil Instanbul	VOR VOR	Freight Freight	No No	MK I None	-- (HI Desent)	0 0

*Glideslope Failure (Zero deviation no flag)

DB95009.DOC

CFIT ACCIDENTS AND RISK FOR U.S. AIRLINES
Large Commercial Jets

TYPE OF CFIT LOSS		CFIT ACCIDENTS AND RISK PER MILLION FLIGHTS PRE-GPWS 1960 thru 1975		POST GPWS 1976 thru 1994		REDUCTION (-) OR INCREASE (+) (Times)
INITIAL CLIMB	Accelerating Descent	1	0.03	0	<0.001	>-100
INTO MOUNTAINOUS TERRAIN	-Climb Out -Initial Approach -Missed Approach	6	0.17	4	0.03	-5.7
LANDING SHORT	-Not Configured to Land	5	0.14	0	<0.01	-140
	-Configured to Land/No Glideslope	5	0.14	6	0.06	-2.3
	-Below Glideslope	8	0.22	0	0.001	-220
	-Excessive Descent Rate	5	0.14	0	0.001	-140
TOTAL CFIT ACCIDENTS & RISK		30	0.85×10^{-6}	10**	0.09×10^{-6}*	-9.6
	Flight Segments	35×10^{6}		108×10^{6}		+3.1
	Aircraft Numbers	2800 in 1976		4800 in 1994		+1.7

CFIT Risk 1990 thru 1994 (5 years)..............................0.028×10^{-6} flights
CFIT Risk 1985 thru 1994 (10 years)............................0.074×10^{-6} flights
In USA (2)——————————————0.033×10^{-6} flights
Outside USA (3)——————————————0.44×10^{-6} flights

10 CFIT Accidents
(1) Loss with NO GPWS installed
(1) Loss with glideslope receiver failure
(9) All lost equipped with MK I GPWS
- If aircraft had been fitted with MK II or better, losses would have been reduced probably to 6 (0.055×10^{-6}).
- If aircraft has been fitted with MK V/VI/VII system with "smart" altitude callouts, the losses would have probably been reduced to 3 (0.03×10^{-6}).

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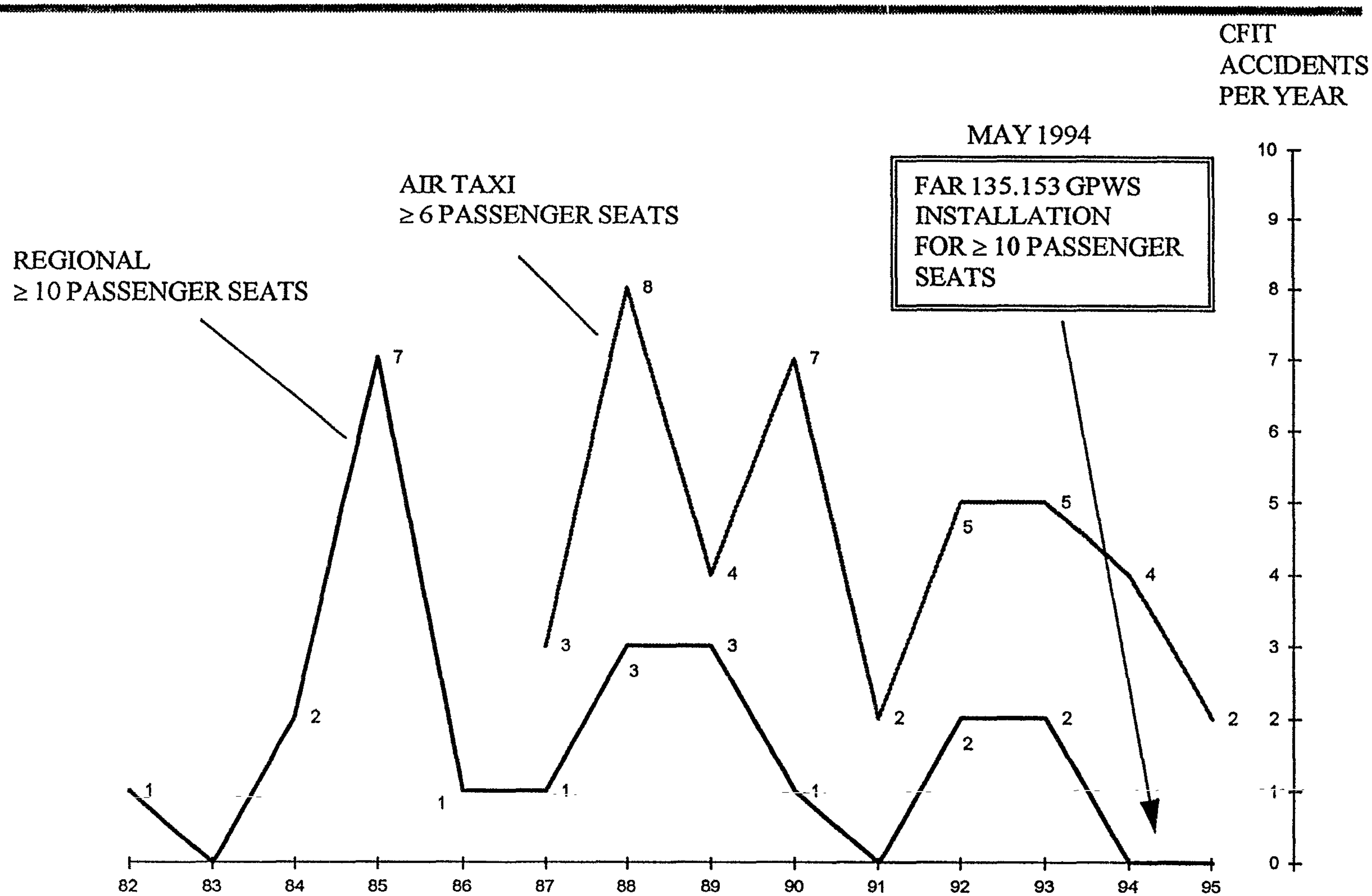
U.S.A. PART 135 CFIT ACCIDENTS
TURBINE POWERED AIRCRAFT



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A 4

A-4 - PARTIAL LIST OF U.S. PART 135 TURBINE POWERED AIRCRAFT CFIT ACCIDENT LOSSES 1992 TO 1993 (NO GPWS ON ANY OF THESE AIRCRAFT)

1 Dec 1993	Hibbing, MN	BAe 31	LOC B/C 13	18 Fatalities
25 May 1993	Sante Fe, NM	SA-227	Circle 15	4 Fatalities
8 June 1992	Anniston, AL	Be-C99	LOC 5	3 Fatalities out of 53
January 1992	Sarnac Lake, NY	Be-1900C	ILS 23	2 Fatalities out of 4
15 March 1991	Brown Field, CA	HS-125	Departure 8L	10 Fatalities
4 May 1990	Wilmington, NC	GN-24	B/C Loc 16	2 Fatalities
15 January 1990	Elko, NV	Metro III	VOR-A	4 Serious Injury out of 16
26 December 1989	Pasco, WA	BAe 31	ILS 21R	4 Fatalities
21 August 1989	Gold Beach, OR	Be-C90	34	3 Fatalities
26 April 1989	Jacksonville, FL	SA-226	I. Wheels Up	--
28 October 1989	Molokai, HI	DHC-6	Enroute	20 Fatalities
4 October 1988	East Sound, WA	Be-99	Departure	-- Out of 4
17 May 1988	Little Rock, AK	AC 690	Visual 22	1 Fatality
19 February 1988	Raleigh-Durham, NC	Metro III	Departure 23	12 Fatalities
19 January 1988	Durango, CO	Metro III	VOR-DME 20	8 Fatalities out of 17
8 January 1988	Monroe, LA	GLS-36	ILS 04	2 Fatalities
5 February 1987	Florence, SC	SA-226	I. Wheels Up 36	--
28 August 1986	Lander, WY	Ce-441	Departure 21	7 Fatalities
13 March 1986	Alpena, MI	EMB-110	ILS 1	3 Fatalities out of 9
22 October 1985	Juneau, AS	LJ-24	LDA 8	4 Fatalities
16 October 1985	El Paso, TX	MU-2	Enroute	1 Fatality
11 October 1985	Homer City, PA	DHC-6	Enroute	1 Fatality
23 September 1985	Shenandoah Valley VA	Be-99	ILS 4	14 Fatalities
25 August 1985	Lewiston, MA	Be-99	ILS 4	8 Fatalities
20 August 1985	Gulkana, AK	LJ-24	VOR/TVOR 14	3 Fatalities
7 August 1985	Dallas, TX	SA-226	J. Wheels Up	--
7 April 1985	Williston, ND	SA-227	I. Wheels Up	--
22 March 1985	Los Angeles, CA	SA-226	I. Wheels Up 25 SR	1 Serious Injury
12 March 1985	Barter Island, AK	DHC-6	Go-Around	2 Serious Injury
14 March 1984	Myrtle Beach, SC	Be-99	I. Wheels Up	--
30 January 1984	Terre Haute, IN	SA-226	Departure	3 Fatalities
6 April 1983	Indianapolis, IN	L-35A	ILS	--
12 July 1982	Pueblo, CO	Metro III	Departure	2 Fatalities

DB95038

CHARACTERISTICS OF VARIOUS MODELS OF GPWS EQUIPMENT

1. Basic Alert/Warnings (modes) applicable to all models:

MODE 1	Excessive sink rate close to terrain
MODE 2	Excessive closure rate towards terrain
MODE 3	Negative climb rate after take-off
MODE 4	Insufficient Terrain Clearance based on configuration
MODE 5	Significant fly up glide slope deviation on approach

2. Performance features of some GPWS models are:

Mark 1/2

- Early, primitive GPWS system. Could not warn for many flight path into terrain situations, including flight path below the glide slope.
- Warning was a warbling continuous tone (woop-woop).

This system was installed on some 150 to 200 DC-8 / DC-9 / DC-10 aircraft outside of the United States. These units do not meet ICAO, U.S.A. or UK specified Minimum Performance Standards. Most have been replaced.

Mark I

An early, now obsolete, GPWS system that met the specified Minimum Performance Standards of TSO-C92b and U.K. CAA Specification 14.. This system could not provide a warning for some flight path towards terrain situations. The average warning time for flight into mountainous terrain was seven (7) seconds.

Warning is a 'Pull Up!" (or "Terrain") and a "Glide slope" alert

- "Pull Up!" was heard often in some operational environments. Pilots often waited to determine the reason for the warning, which sometimes took too long to cross check and determine the cause.

Over 4,000 of these systems were installed world wide, mostly in the U.S.A. Many of these systems, in the U.S.A., have been replaced with the MK II or MK VII. ~~About 1100 remain in service in 1994.~~

Mark II An obsolete system now, but the MK II gave significant improvement in performance as compared to the MK I, exceeding both the U.S.A. and the UK specified Minimum Performance Standards.

- Airspeed/Mach utilized to expand and contract some of the warning envelopes to enhance the performance. The average warning time for flight into mountainous terrain increased to twelve (12) seconds from (7) seconds.
- Most warning envelopes were reshaped to reduce unwanted warnings. Later modifications, based on airline provided data, significantly reduced the possibility of warnings during Air Traffic Controlled radar vectoring off instrument approach routes and procedures.
- Alert messages ("Sink Rate", "Too Low", Terrain", etc.) replaced "Pull Up"giving the reason for the warning. The "Pull Up" message was retained only for very time critical recovary from flight into terrain. Airspeed enhanced warning envelopes (dependent on phase of flight) were also utilized to change the alert message format.

Over 5,000 of these systems are installed and are flying in revenue service around the world.

Mark III

- Digital bus interface version of the Mark II. Now also obsolete.
- Some further performance improvements, but because of radio altimeter sensor limitations, the MK III proved to have some additional unwanted warnings compared to the Mark II.
- A limited Envelope Modulation feature, in a terrain data table form was added to improve warning time and to also reduce terrain induced nuisance warnings at some twenty world wide airports. Unfortunately, this table being incorporated in the software made the addition off new airports very difficult.
- Pin selectable limited voice menu, call outs and features.

Mark III,s were installed on early B757's and B767's, the A300-600's, the A310's and A320's aircraft.
Most early B757 and B767 Mark III installations have been upgraded to the MK V system.

~~**Mark IV** This system was used on some special mission military aircraft.~~

Mark V

- This system has upgraded performance over the Mark III system.
- The Envelope Modulation feature was expanded and made easy to update via EE PROM programming at Of the 5,000 current world wide airports, a data base of only one hundred airports is in use. The airport data is available to the system via a look-up table that does not alter the operational software. This table can be expanded considerably if and when nuisance warnings, at a particular location, are brought to our attention and an analysis shows that the instrument and radar vectoring procedures give adequate terrain clearance.
- Pin selectable voice alitude call outs were expanded, and others such as " Bank Angle" added.
- To reduce the flight into terrain risk during non-precision approaches, an optional smart " 500 feet "call out and procedure are used.
- Wind shear detection algorithm and "Wind Shear " message, were added with priority.
- Available aircraft performance (total energy) is used to modulate some of the warning envelopes.

This system replaced the Mark III unit. The Mark V is installed on most new aircraft. It is basic equipment for all Airbus, Boeing new Fokker 100, BAE ATP and MD-11.

Mark VI

- This system's performance is similar to that of the Mark VII computer but designed especially for the special requirements of light business, regional turbo jet and turbo prop aircraft. Over 1200 aircraft in 1994 have MK VI GPWS installations. The number is rapidly growing.

Mark VII

- Upgraded performance is similar to the Mark V computer, but for analog avionic interfaces.
- Latest wind shear detection algorithm was implemented and built-in dual recovery guidance was provided.
- Pin selectable menu of call outs is provided, such as "Bank Angle ".
- To reduce the flight into terrain risk during non-precision approaches, an optional smart " 500 feet " call out and procedure is used by many of world wide airlines.

The latest versions of the MK VII offer an Envelope Modulation feature similar to the MK V. The Mark VII was designed to upgrade all Mark 1/2, Mark I and Mark II system installations giving superior performance and significantly reduced probability of unwanted warnings.

Enhanced GPWS V and Enhanced GPWS VII (EGPWS)

These new systems provide significantly improved performance over any past or present GPWS system. The EGPWS and installations. The basic GPWS independant functions are retained. The EGPWS has been designed to use the existing MK V and VII aircraft interfaces.

- **"Look Ahead" algorithms utilize present, and predicted position are related to a worldwide terrain data base with aircraft climb performance to give a nominal one minute time alert to possible impact with threatening terrain.**

- **The system also provides a terrain output signal for use with cockpit Map Displays. The threatening Terrain Situation can be displayed on most existing color Weather Radar or EHSI displays.**

- **A terrain clearance floor is provided that surrounds the world's known civilian and military airfields to alert the pilots to possible premature descent into terrain or water independent of the aircraft configuration.**

- **The system also provides alerts to possible flight into significant obstacle/structures. This feature is only limited by the availability of the obstacle data.**

- **The EPWS comes in two computer versions, one to directly replace the MK V and the other to directly replace the MK VII, utilizing the existing interface wiring and installations of the world's airline fleet to advantage.**

"Bank Angle" and other Forms of Alerting or Protection for Undetected Excessive Roll Angles

Aircraft have been lost when excessive roll angles have developed without detection by the flight crew. High undetected roll angles have resulted in high descent rates, during cruise buffet, loss of control, or scraped engine pods during landing. Some past incident/accident examples are shown in Table I. The risk of future incidents remain high.

These incidents have been caused by various factors:

- Undetected and uncommanded roll with autoflight or autopilot engaged (especially in cruise)
- Looking outside the cockpit at inadequate visual references during take-off climb or approach, Especially a problem at night with base turns circling and a lack of inside reference by the pilot to the panel attitude reference instruments. Other factors are looking for traffic, maneuvering for runway alignment, etc.
- Vertigo
- Expedited turns during take-off climb because of traffic, leading to uncoordinated flight control.
- Failed attitude reference display.

Many of these incidents arise because of lack of tactile sensory feedback. The tactile accelerations associated with coordinated steady high bank angle turns are often masked by the nose of the aircraft falling through with altitude loss.

To reduce the risk of such occurrences, various measures can be taken:

- Built in maximum bank limiters in "fly-by wire" automatic control systems.
- Enhance or emphasize high bank angles on the attitude display. On some displays, secondary data is dropped by the display to help the pilot focus on or correct the attitude problem.
- Visual and/or Aural Alerting when high or unusual roll angles are reached. Many forms are available; as an example, most GPWS equipment has options to annunciate "Bank Angle" when roll angles exceed $\pm$ 40 degrees or smaller angles when close to the ground. This capability provides independent means of protection against autopilot and instrument failures.

PARTIAL LIST OF EXCESSIVE BANK ANGLE CFIT ACCIDENTS/CFTT INCIDENTS

DATE	PLACE	AIRCRAFT TYPE	PHASE OF FLIGHT	CIRCUMSTANCES	FATALITIES
Various 1993-1992	Worldwide	Glass Cockpit	Enroute	Slow undetected rolls	--
6 June 1992	Panama	B737-200	Enroute	Slow undetected roll to 90 degrees believed to be ADI or Autopilot	47
15 Feb 1992	Toledo, Ohio	DC-8-63	Missed Approach	Slow undetected roll; autopilot; night	4
12 Dec 1991	N.W.T. Canada	B747-100	Enroute	Slow undetected roll; autopilot FL 310 to FL 190 for recovery	--
1990	Montreal-Paris	B747-200	Enroute	Slow undetected roll (71 degrees)	--
30 April 1989	Miami-London	B747-200	Enroute	Slow undetected roll (52 degrees)	--
Various	30 incidents +	B747-100/200	Various	Slow undetected rolls - at night or IMC	--
12 Jan 1989	Dayton, Ohio	HS-748	Take-off climb	Slow roll to 50 degrees for turn during climbout; night.	2
28 Oct 1988	Paris	B747-100	Final	Visual transition, alignment to runway at night, overbanked to 17 degrees at 100 ft.	--*
19 Feb 1988	Raleigh-Durham	Metro III	Take-off Climb	Expedited departure, overbanked to 45 degrees at 300 ft.	12
Dec 1987	Edmonton, Canada	DC-8-63F	Final	Visual transition at night to align with runway overbanked to 15 degrees at 150 ft.	--*
Nov 1986	London	B747-200	Final	Visual transition at night to align with runway.	--*
12 Nov 1980	Cairo	C-141	Turning base for final	Overbanked at night visual - no lights on ground	13
1 Jan 1978	Bombay	B747	Departure climb	Rolled to 80 degrees at 1400 ft --ADI failure no flag - night.	213
Oct 1977	Vancouver BC	B747	Turning base for Final	Slow roll to 50 degrees before detection in time	--
Sept 1977	Geneva (BA)	B747	Departure Climb	Roll slow but detected in time by F/O; ADI failure; no flag.	--

*Significant Damage

DEVELOPMENT OF GROUND PROXIMITY WARNING SYSTEMS (GPWS)

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DEVELOPMENT OF GROUND PROXIMITY WARNING SYSTEMS (GPWS)

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Abstract

Development of the GPWS in the early seventies and its installation into turbine powered commercial transport aircraft has significantly helped reduce Controlled Flight Into Terrain (CFIT) accidents. Today over 15,000 turbine transport aircraft in public commerce are fitted with this flight safety device. GPWS costs less than the exterior paint on the aircraft and easily repays its initial investment in less than two years. However, early GPWS had its limitations of unwanted warnings, late warnings, and no warnings when needed. Current Enhanced GPWS models will give the pilot much better awareness of flight into terrain situations, before a last moment mandatory escape maneuver is required, and will provide warnings in situations where the present system gives none. Greater immunity from unwanted warnings is also provided.

Controlled Flight Into Terrain (CFIT) Accidents and GPWS

In March 1931 a tri-motor Fokker, the *Southern Cloud*, took off on a flight from Sydney to Melbourne. It disappeared with its crew and passengers. All searching was in vain. The budding airline, ANA, could not bear the resulting negative publicity with its financial consequences and went into bankruptcy. In 1958, a surveyor discovered the wreckage near a summit in the Snowy mountains, 200 miles northwest of Melbourne.

Since the loss of the *Southern Cloud*, over 30,000 passengers and crew have lost their lives in terrain-related accidents. Flying a good airplane into the ground or water instead of the runway has resulted in about 60% of the total fatalities in public air transportation over the last ten years. With the advent of cockpit voice and data recorders in the 60's, it became evident that most of these CFIT accidents involved errors, not only in the cockpit, but often on the ground and in the procedures themselves. Flight procedures have evolved slowly to help reduce the risk, but the attitude of many in the industry has been that the pilots involved in such an accident were incompetent and should not have been flying in the first place. That attitude still persists today. "I would not have ever done anything so stupid!" was, and is, a common attitude.

Unfortunately, little thought or effort was given to building a broad pilot awareness of the CFIT hazard facing pilots and controllers. Very little training was given to pilots and controllers to help recognize CFIT "traps".

Today, many airlines are stressing pilot awareness programs that illustrate how a CFIT accident could happen to any pilot under the wrong fateful circumstances. This training is one of the most important cost effective safety measures that can be taken to reduce CFIT risk! Equipment such as GPWS takes a second place.

In the late 1960's, the introduction of the radio altimeter into large commercial jet aircraft as a pilot aid for reaching Category II Minimums also helped to reduce the CFIT accident risk. It made possible the simple concept of a GPWS, which originated in Europe at Scandinavian Airlines (SAS) in 1969. The concept was to give the pilots an alert based on abnormal aircraft flight path and abnormal terrain clearances with respect to the ground or water. The radio altimeter became the prime sensor. The system also utilized signals from other existing aircraft sensors, such as descent rate and glideslope deviation. My company, United Control at the time, became a pioneer in the development of the system.

The application and study of CFIT accident data, especially those derived from the aircraft flight path profile relative to the terrain, began to drive improvements in the system performance. With advent of the first EPROM digital memory, a synthesized voice "Pull Up!" replaced the original aural tone. In 1971, GPWS began to be installed voluntarily by SAS, CPAir, Maersk Air, Braniff, Pan American and other airlines. By 1973 Boeing was offering GPWS as a recommended safety device on all aircraft models, and in early 1974 Boeing made it basic to all models.

In late 1974, during the initial stages of a VOR-DME approach to Runway 2, at Washington Dulles airport, a B727 struck 50 feet below the last major ridge between the aircraft and the runway, some 20 NM from the runway. Ninety-two lives were lost. Many of the passengers worked and lived in the Washington DC area. The resulting public and media outcry forced the FAA to do something. Within two weeks, the FAA enacted operational rule FAR 121.360, requiring all large turbo-prop and jet aircraft to be fitted with GPWS within one year. Pilot training, mandatory reporting of warnings, or CFIT awareness programs were not required by the FAA.

The instant market created by the ruling was immediately filled by seven GPWS manufacturers, six of which had never built or flown such equipment. Performance meant little; the minimum to meet the rule. Price was all.

My company secured less than 25 percent of the US market, as many in the industry blamed my company, Boeing and Pan American for "forcing" GPWS on them: a useless annoyance they did not need.

Despite this very bad start for GPWS, with many nuisance warnings and many technical problems, CFIT losses in the USA Part 121 large turbo-prop and jet fleet began a significant and continuous drop (Ref. 1). As shown in Figure 1, the accident rate fell from an average of eight aircraft per year down to one aircraft every five years. The CFIT risk dropped from 2.2 aircraft per 10^6 flights to 0.07 aircraft per 10^6 flights! (During this time, the large US jet fleet increased from 2800 aircraft with 2.5×10^6 flights per year, to over 4800 aircraft with 7×10^6 flights per year.)

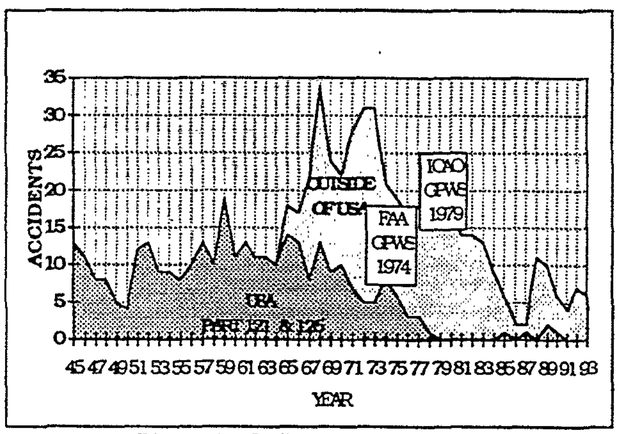

Figure 1 - CFIT Accident History

It would be an overstatement to claim GPWS is the sole contributor to this significant reduction. The continual investment by the FAA in expanding and upgrading the ATC radar and tools, such as ARTS III, Minimum Safe Altitude Warning System (MSAWS - a software add on to the radar), approach lighting, VASI, ILS, DME and other navigation aids, along with improved procedures, have all helped reduce the CFIT risk.

In sharp contrast, virtually none of the fleet of regional commuter (Part 135) turbine-powered aircraft with from 10 to 30 seats were equipped with a radio altimeter, let alone a GPWS. This fleet shared all of the improved ground aids and the ATC environment, but continued to lose an average of three aircraft per year in CFIT accidents. It took the FAA 20 years to extend GPWS requirements to Part 135 operations (10 seats to 30 seats). During that time, 33 aircraft were lost in CFIT accidents. All such aircraft are now fitted with a modern GPWS (but still with no requirements for training).

The largest CFIT losses now are found with Air Taxi aircraft, operating under Part 135 with less than ten seats. In the average year, eight twin turbo-prop Air Taxi aircraft are lost to CFIT.

An Assessment of the GPWS Record

Today there are approximately 15,000 civil transport aircraft worldwide fitted with some form of GPWS equipment. Half of this GPWS equipment is of 20 year-old vintage. The accumulated flight experience with GPWS since 1975 now exceeds 170 million flights and approximately 480 million flight hours. This is considerable experience for an avionics flight safety system. An assessment of the GPWS record reads as follows:

Positive Experience - North American Fleet. Where installed, GPWS has been effective in reducing CFIT risk:

- The demonstrated reduction in CFIT risk is about 20 times when using early generation GPWS equipment. For the latest GPWS equipment the reduction is about 50 times. GPWS has virtually eliminated many of types of terrain accidents which were so prevalent before 1975: undetected high descent rate, flight into mountainous terrain, descent back into the ground after takeoff, insufficient terrain clearance, and descent below the glideslope.
- If the pre-1975 average annual CFIT losses of eight large commercial jet aircraft per year had continued to 1993, we would have lost 150 aircraft and 7500 lives in CFIT accidents. Instead, the CFIT losses for the last 20 years have been seven aircraft and 187 lives. While aircraft accidents receive wide publicity, pilots and controllers rarely ever report CFIT incidents. Only a fraction of CFIT incidents ever become known. Incidents are most often reported when passengers or people on the ground become frightened. There were probably at least ten such incidents in North America last year, and five this year. A timely GPWS warning (even from primitive equipment) has been helpful in avoiding what might have become a CFIT accident.
- Many of the best airlines are educating their pilots to recognize and avoid potential CFIT traps. GPWS is

no panacea for eliminating CFIT accidents. In addition to GPWS, even better results can be obtained by making all pilots, controllers and managers aware of the CFIT hazard, and how any pilot or controller can be led into a trap. Flight standards and training need to be refocused and be shaped and emphasized to avoid these traps.

- The GPWS Minimum Operational Performance Standards (MOPS) written in 1975 and 1976 by the RTCA (DO-161a) and by the CAA (Specification 14) have served the industry well. The value of the MOPS has been proven over the last 19 years, and they should serve us well into the next century. Existing MOPS have not prevented evolutionary improvements in system performance, nor do they limit future improvements. Contrary to myth, there are no patents that prevent any manufacturer from meeting these well proven minimum standards.
- Analysis of reported GPWS alerts has led to the identification of a dozen airports where there were marginal terrain clearances for the published instrument approach procedures, as well as marginal radar vectoring altitudes. Many of these procedures have been improved by the FAA, making the procedure safer as well as compatible with GPWS.
- The incidence of unstabilized approaches has been reduced by a factor of five. GPWS alerts caused by these approaches have influenced pilot techniques in positive manner (at the cost of some pilot resentment). (Refs 2 and 3)
- GPWS costs much less than the paint on a typical large transport aircraft. The average investment in GPWS equipment and its installation has been paid back within 1 to 3 years, based on replacement aircraft costs and average settlement costs on the lives lost. Few avionics safety systems have been as cost effective.

Negative Experience - North American Fleet. Since 1975, seven aircraft fitted with GPWS equipment have been lost to CFIT accidents (see Table 1).

1977	Salt Lake City	DC-8
1978	Pensacola	B727
1985	La Paz	B727
1987	Kansas City	B707
1989	Santa Maria	B707
~~1989~~	~~Kuala Lumpur~~	~~B747~~
1990	Unakaleet	B737

Table 1 - U.S. CFIT Losses 1975 to 1993

It is instructive to examine the circumstances of these accidents in more detail:

- All seven CFIT loss were aircraft fitted with first generation, 1975 vintage, GPWS equipment (MK I). Much of this equipment has since been replaced with improved performance equipment. However, about 30% of the North American fleet is still fitted with MK I GPWS. This equipment does not inform the pilot of the reason for the "Pull Up!" ("Terrain!" on some aircraft), nor does it use aircraft speed logic for enhancing warning time (Ref. 4). It also has a relatively high unwanted "Pull Up!" warning rate.
- Identifying the cause of the warning allows the pilots to verify the specific cause and help reduce reaction time. This would have helped the flight crew at Pensacola recognize that inadvertent descent rate and insufficient terrain clearance over the water was the reason for the warning. At Santa Maria identifying the cause would have helped the pilots recognize that mountainous terrain was the reason for the warning. At Kuala Lumpur an aural message would have helped the pilots recognize the reason for the warning was that they were very close to the ground before reaching the Final Approach Fix (FAF).
- Later versions of GPWS would have significantly improved the warning times at Santa Maria, La Paz, and Salt Lake City, as shown in Table 2, had later generation equipment been installed:

Salt Lake City	13 seconds vs 9 seconds
La Paz	16 seconds vs 2 seconds
Santa Maria	27 seconds vs 6.3 seconds

Table 2- Warning Time Improvement Using Airspeed Logic

Unfortunately, the original implementation of the airspeed logic also caused an increase in the number of unwanted warnings during initial approach in parts of Europe and Australia. This was particularly bothersome for those states which do not have a speed limit at the lower altitudes. British Airways provided flight data for these incidents, and this helped our designers to reduce unwanted warnings significantly without losing the extra warning time provided by airspeed logic.

- For the Kansas City ILS approach accident, the GPWS glideslope function apparently was inoperative; the suspected cause being an inoperative ~~glideslope receiver (similar to the DC-9 Zurich~~ accident in 1991). A typical GPWS installation uses the Captain's glideslope receiver deviation and flag. GPWS is a "single thread" system, receiving only one radio altimeter, one set of air data signals, etc., all from the Captain's side. This is a system weakness in GPWS. At least two other incidents have occurred where the aircraft descended well below the glideslope. (A DC10 incident at Portland, Oregon is one example.) In each case the instrument procedure uses a VOR radial or DME value for determining the step down fixes along the approach path. Also in each case, the pilot flying was the co-pilot, and the Captain was monitoring with the #1 Navigation receiver in VOR-DME mode with no glideslope signal. In the modern glass cockpit architecture, the ILS (localizer and glideslope) receiver is independent of the VOR navigation receiver, and so there is less risk that the GPWS has no functioning glideslope deviation input.

The Unakaleet accident occurred from premature stable descent from an incorrect step down fix on a localizer-DME non-precision approach while in landing configuration. The GPWS gave no warning. This is a major weakness of GPWS systems for jet aircraft which normally change to landing configuration at the FAF, thus eliminating the 'insufficient terrain clearance' warning floors. Turbo-prop aircraft usually do not commit to landing flaps until the field is in sight. For this reason, GPWS has been more effective on turbo prop aircraft than turbojet aircraft. For a normal descent rate, with the aircraft in landing configuration and no glideslope, the GPWS cannot determine that there is no airport at the bottom of the descent path. On a worldwide basis, this 'no warning' situation for GPWS has occurred in about 40% of the cases of CFIT loss (see Figure 2).

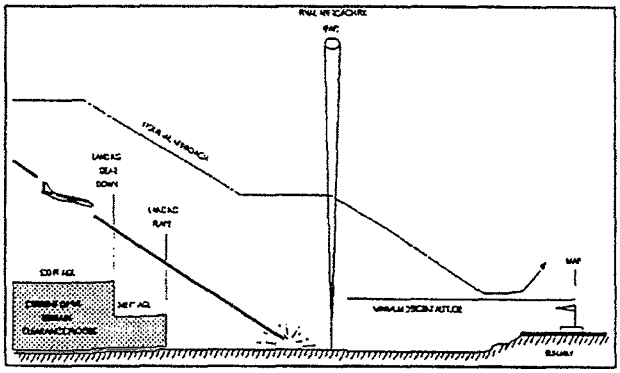

Figure 2 - The GPWS 'No Warning' Situation

- For each of the seven accidents shown in Table 1, none of the pilots had ever received training on CFIT hazard awareness or GPWS functions and limitations, nor had they practiced recoveries from terrain conflicts. Until recently, only a handful of airlines had invested in such valuable cost effective training measures. Training might have altered the outcome at Salt Lake City, where it is speculated that the co-pilot performed a late pull-up maneuver after a GPWS "Pull Up!" warning. His action resulted in an estimated pitch attitude of 28 degrees nose-up, and could have saved the aircraft had it not been for the subsequent actions of the Captain. Believing that stall was imminent, the Captain is presumed to have pushed the aircraft nose back down to 10 degrees. Two more seconds at the higher attitude was all that was required to clear the mountain. It is illogical that pilots are required to train for windshear recovery, while no training is required for terrain recovery. Training, and sharing details of CFIT incidents and accidents between pilots and controllers, are invaluable in achieving awareness of the hazard and in maximizing the value of GPWS (see Ref 5 for one example of how this can be accomplished).

While many pilots grumble about "false warnings," very few are formally reported in North America. The problem is real, but if the pilot has any reason to believe the warning could have possibly been caused by his or her flying, they don't get reported. A false engine fire warning is readily reported, but GPWS warnings are probably under-reported by a factor of some 50 times. Lack of pilot reports and flight data has been a significant impediment to improving the system. Much of the progress towards the elimination of false or unwanted warnings is owed to flight data from a few European air carriers who have encouraged their pilots to report such events. A major source of nuisance warnings has been caused by radio altimeters losing track of the ground and not dropping the flag signal. It is usually difficult to correct problems of this kind, since the radio altimeter is often essential to the auto-land integrity, and modifications require extensive software validation time and expense. It has been demonstrated that by voting and averaging three radio altimeters, a significant reduction in unwanted warnings can be achieved. Other techniques, such as modulation of the GPWS alert envelopes at specific locations, have also been used effectively. A major reduction in unwanted warnings is achievable without the loss of GPWS warning when truly needed.

<u>The Worldwide Experience With GPWS (See Ref 6).</u> By reviewing the world-wide CFIT losses over the last five years (1989 to 1993) for large commercial airline jet aircraft, the positives and negatives of GPWS experience correlate well with the previous discussion (see Table 3).

1993	Urumgi, China	MD-80
	Sorong, Indonesia	F-28
	Medellin, Columbia	B727-100
	Abijian, Ivory Coast	B707-320
1992	Kano, Nigeria	707-320
	Kathmandu, Nepal	A300-B4
	Kathmandu, Nepal	A310
	Cruzeiro do Sol, Brazil	B737-200
	Athens, Greece	B707-320
	Kano, Nigeria	DC-8
	Strasburg, France	A320
1991	Imphal, India	B737-200
	Santa Barbara, Venezuela	DC-9-30
1990	Nairobi, Kenya	B707-320
	Zurich, Switzerland	DC-9-30
	Unalakleet, Alaska	B737-200
	Bangalore India	A320
1989	Hulien, Taiwan	B737-200
	Tegucigalpa, Honduras	B727-200
	Tripoli, Libya	DC-10
	Paramaribo, Surinam	DC-8-62
	Kuala Lumpur, Malaysia	B747
	Santa Maria, Azores	B707-320

Table 3 -Commercial Large Jet Aircraft CFIT Accidents (23)

For the past five years we have lost about five aircraft per year to CFIT accidents (excluding Soviet built aircraft). Approximately one half of these CFIT losses were aircraft not equipped with GPWS. Of the world's fleet of 11,000 or so aircraft, 300 aircraft (3%) are not equipped with GPWS, and 50% of the CFIT losses are associated with this 3% of the fleet. Another thirty percent of CFIT accidents occur with the 470 or so 'first generation' jet aircraft (B707, DC-8, etc.) which today make up less than five percent of the world's civil jet fleet. Those aircraft that have GPWS are fitted with early, primitive performance, equipment.

Of the fourteen losses where GPWS was installed, nine aircraft were fitted with early MK I GPWS for which warning times can be very short, or too late for recovery. Later generation GPWS would have more than doubled the warning time, and told the pilots the specific problem or reason for the "Pull Up!"

Four aircraft were in 'no warning' situations, i.e. landing configuration, no glideslope, stable descent into a place where there was no runway. This is a weakness that is partially addressed in current GPWS equipment by the use of a 'Smart' altitude callout such as "five hundred", and with a specific cockpit procedure to go-around if the runway environment is not in view. A 'Smart' callout is not heard on normal ILS approaches, only on non-glideslope approaches (i.e. non-precision approaches). This procedure is being utilized by some major airlines. In new systems, introduced this year, a Minimum Terrain Clearance Floor around the airport will be used (see below).

Enhanced GPWS (refs 7, 8, and 9)

Several practical and cost effective system performance improvements have been introduced into new GPWS equipment this year. These improvements are backward-compatible with the GPWS installations presently installed on most glass cockpit digital aircraft. The enhanced system uses existing sensors and signals as presently provided to the GPWS. The form factor, power, and weight of the new computer are essentially the same as for the original GPWS computer. The enhancements are in addition to the original GPWS functions, and do not compromise basic system performance.

Some of the improved performance features are:

Terrain Clearance Floor. This additional terrain clearance floor, based on aircraft position, is independent of landing gear and landing flap settings, and provides a "Too Low, Terrain!" alert to the pilot if there is insufficient terrain clearance on approach. This feature could help save one aircraft per year in worldwide commercial large jet operations.

About 1½ aircraft per year world wide impact short of the runway with no GPWS warnings during non-precision approaches. The median impact point has been 5¼ NM short of the runway. The terrain clearance floor provides a warning if during an ILS approach the glideslope equipment (airborne or ground) has failed or, for some reason, is not being used by the crew and the aircraft prematurely descends short of the runway.

The 'floor' lies below the nominal 300 feet per NM final ~~approach slope (-2.8 degrees), and blankets the~~ terrain or water around the airport at 75 feet AGL per NM. (see figure 3 and 4). The floor is based on distance to the runway and radio altitude, distance to the runway being computed from current aircraft position (lat/long) and stored position of the airport.

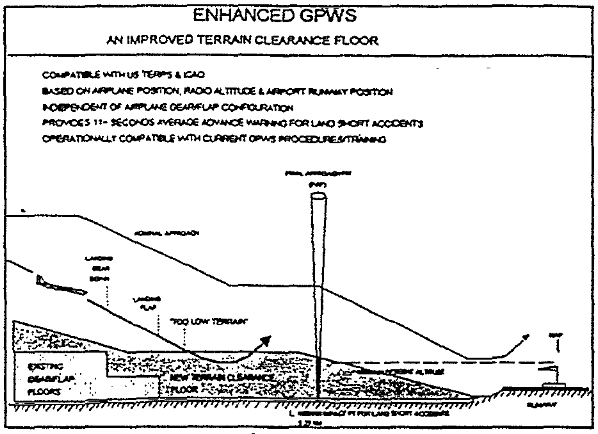

Figure 3 - Terrain Clearance Floor, Profile View

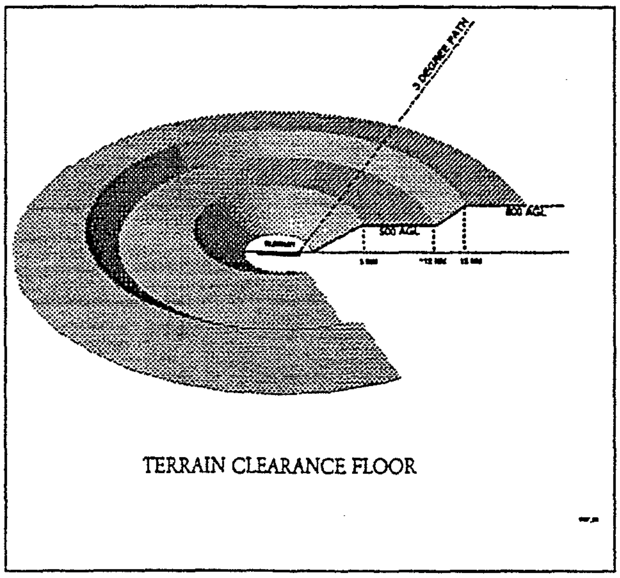

Figure 4 - Terrain Clearance Floor Viewed from Above

The 75 feet AGL per NM slope is well below the design criteria for terrain clearances and obstacles found in U.S. and ICAO standards, and provides an average of about 10 seconds of warning before impact.

The accuracy of the data defining aircraft present position and the runway threshold determines the timeliness of the warnings, and also the margin against unwanted warnings. Aircraft position from FMS/GPS is weighted against quality factor and the distance of floor cutoff from the runway is automatically modulated to prevent unwanted warnings. The runway data required is readily available in digital format, and needs only a moderate amount of memory (approximately 32k Bytes) to cover the 5000 civil and military airports worldwide which have runways of 4000 feet or longer.

Airports and runway data do change with time, but relatively slowly when compared to navigation data. It is anticipated that updates of such data will be infrequent, perhaps once every two or three years.

<u>"Terrain Ahead" Alerting And Warning</u>. If pilots could be alerted earlier for Controlled Flight Towards Terrain (CFTT) situation, before the aircraft is into precipitous terrain, then the CFIT risk and need for maximum effort recovery in response to a GPWS warning is significantly reduced.

In 1982, AlliedSignal (then Sundstrand Data Control) began developing 'look ahead' algorithms that used the present position and projected flight path of the aircraft, together with stored terrain data, to predict a potential terrain threat ahead of the aircraft. Because commercial transport aircraft do not typically fly in very close proximity to terrain (except when landing), relatively low resolution elevation data is sufficient to provide effective terrain awareness (typically 100 feet vertical resolution, and from ½ NM to 8 NM or more horizontal resolution, depending on distance from the airport). However, even this level of terrain data storage taxed the technology available in the 80's and made practical systems cost-prohibitive.

In the 90's, flash memory technology has progressed to the point where it is now not only possible, but practical, to store the terrain data for the entire world within current generation digital GPWS computers. Special terrain data compression routines have been developed to further minimize memory requirements and reduce costs.

Error-tolerant algorithms have been developed that consider aircraft position, track, absolute altitude and flight path in relation to stored terrain data to determine if the projected flight path conflicts with terrain ahead of the aircraft. This feature has been coined 'look ahead' alerting, and offers a significant improvement in advance alerting times for flight into very precipitous terrain. The voice messages "Caution! Terrain!" and "Terrain Ahead! Pull Up!" are given if the projected time to impact is less than predetermined values. It was recognized from the outset that such a function must be carefully designed to avoid unwanted alerts in order to be effective especially for airports in mountainous areas. Distance from the airport, navigation data quality, and terrain database quality factor are used to automatically determine how far ahead of the aircraft the trajectory can be reliably projected and used. The design approach for the 'look ahead' alerting has been to lean towards the prevention of unwanted alerts. The existing tried and proven GPWS warning modes continue to independently monitor the aircraft's flight path with respect to the terrain. In this manner, overall system effectiveness always meets or exceeds what is available and certified on aircraft operating today.

Two 'look ahead' algorithms are used to provide "Caution! Terrain!" and "Terrain Ahead! Pull Up!" alerting when needed (see Figure 5).

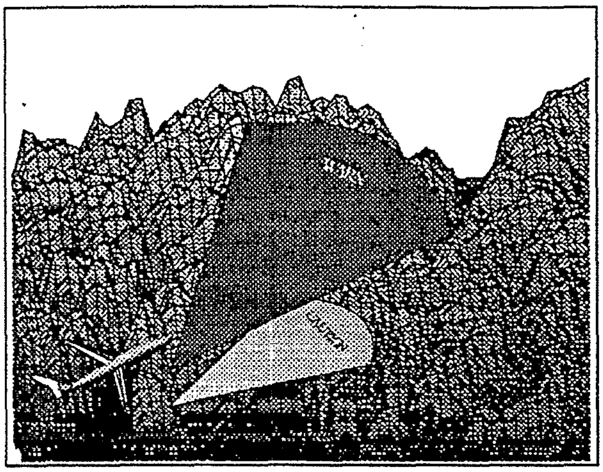

Figure 5 - Look Ahead Volumes

The "Caution! Terrain!" algorithm gives about 60 seconds of advance alerting for a potential flight path into terrain, while the "Terrain Ahead! Pull Up!" algorithm gives about 30 seconds of warning. Both algorithms are modulated by the terrain clearance floor around the airport. Both algorithms also look up a nominal 6 degrees of flight path climb angle to ensure that the alerts are timely. The "Terrain Ahead! Pull Up!" warning recovery procedure is identical to the existing GPWS recovery procedure. To validate the system, our test aircraft has been flown against worst case mountainous airports in North America. Many of North America's worst CFIT accident flight paths and locations have also been flown to demonstrate warning times that greatly exceed the current GPWS warnings. It is interesting to note, however, that current GPWS terrain warnings can occur earlier than the new 'look ahead' alerts if the aircraft flies over preamble terrain.

With the end of the cold war, terrain data bases to support this function are readily available in digital form for a significant fraction of the airports around the world, especially in the Northern hemisphere. Some airports are in areas for which digital terrain data is not available, at least not for civil use. In the majority of these cases, terrain data is available in map form. AlliedSignal has acquired or currently is in the process of acquiring all digital data that is available, and we are digitizing map data (with help from airlines) for places where digital data is not available. Again, the relatively low resolution requirements for this terrain data make it practical to generate the databases. Areas around international airports and alternate airports worldwide are being incorporated into the "Enhanced GPWS" terrain database. In the event that terrain data for some areas is simply not available in any reliable form at this time, then that area can be added to the database later. Of course, aircraft operating in areas that are not covered by the terrain database will still benefit from the independent GPWS warning modes.

Database updating is supported in the Enhanced GPWS computer through a front panel PCMCIA port. Our customers will be provided with flash memory cards which can be plugged into the PCMCIA port to update the terrain database. The upload is both quick and simple.

<u>Terrain Awareness Display.</u> For enhancing the pilot's awareness to potential threatening terrain in controlled flight towards terrain (CFTT) situations, a map display of the terrain situation is very helpful. The Enhanced GPWS is designed to provide an output which can be used to depict threatening terrain optionally on an EFIS Navigation Display or a dedicated Weather Radar indicator.

Adding terrain to a Navigation Display, while appearing to be a simple task, must meet several requirements:

- It must be accomplished in a clear, unambiguous manner, and be intuitively obvious to the pilot.
- It must require little, if any, pilot training.
- It must add a minimum of clutter to the existing display.
- It must not impair the display of basic navigation data
- It must integrate well and not be confused with presentations of weather (precipitation and turbulence), predictive windshear alerts and TCAS displays.
- It must not become an instrument to navigate by.
- It must be practical and cost effective.

Adding new information such as terrain to existing cockpit displays can be very expensive if it requires major changes the EFIS Symbol Generators. Adding a new display is in most cases out of the question. (The relative cost of installing identical equipment, such as TCAS II, into a "classic" (analog) aircraft and a glass cockpit is about $150,000 versus $450,000. The cost driver is the effort required in validating software changes in the symbol generators.)

One method of minimizing the changes to the cockpit and the EFIS symbol generators is to utilize the existing ARINC 453 Weather Radar data bus that is fed to the EFIS Navigation Display or the dedicated weather radar indicator. By proper use of colour and style of data presentation, the terrain display can be clearly differentiated from weather data. Very little change, if any, is required to the symbol generators.

Priority of information displayed, display range, when and how the pilot brings up such data are flight deck design considerations. One such Terrain Display is shown in Map Mode in Figure 6.

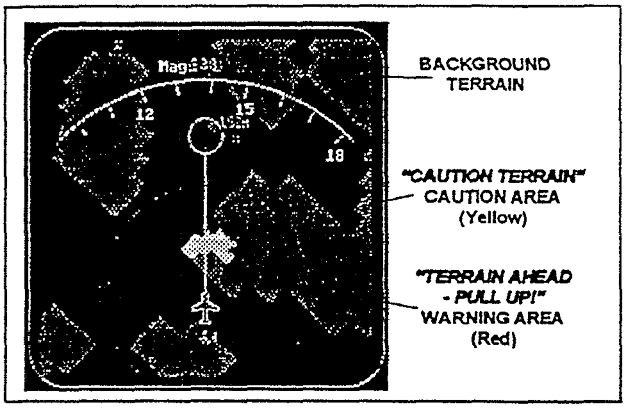

Figure 6 - Terrain Display

In our flight test and demonstration aircraft, threatening terrain can be displayed on the weather radar indicator. In the event of a 'look ahead' terrain alert, the terrain picture is presented and the display range is automatically set to 10 NM. Manual selection of terrain is also available to the pilots. The terrain is displayed referenced to the aircraft's altitude: terrain more than 2000 feet below the aircraft is not displayed, terrain closer than 2000 feet begins to be shown as low density pattern of yellow dots. As the terrain becomes closer to the aircraft, the density of the dots increases to a maximum value where the terrain is at or above the aircraft altitude. The display requires no mental calculations by the pilots in order for them to assess their relationship to threatening terrain. No charts or reference to instruments are required. Terrain depiction is free of elevation numbers and contours that add clutter. When the terrain threat is within the "Caution! Terrain!" range the conflicting terrain image turns solid yellow. (The terrain image is composed of a grid of overlapping rectangles, and is visually unique.) When the terrain threat progresses to the level of a "Terrain Ahead! Pull Up!" warning, the conflicting terrain image turns a solid red colour. As a successful recovery is made, the terrain image will change from red to solid yellow, and then to a dot pattern of progressively decreasing density until the altitude of the aircraft is more than 2000 feet above any terrain in the immediate 10 NM area, when the display will disappear entirely.

Some Conclusions

- Early GPWS equipment, in spite of its limitations, has been effective in reducing the CFIT risk, saving aircraft and lives. CFIT risk was reduced by about 20 times when the original GPWS equipment was installed, and by about 50 times when the latest GPWS is used.
- Significant improvements have been made to GPWS performance over the last 20 years.
- The greatest CFIT hazard remains the non-precision approach. About 40 percent of all CFIT losses are occurring during VOR-DME/LOC-DME approaches. For no-glideslope approaches where full landing flap is used, early generation GPWS provides little if any warning for stable descent into water or ground where there is no runway. This has not been a problem on turbo-prop aircraft, where landing flap is not usually selected until the field is in sight. GPWS is being upgraded to address this weakness.
- The recent availability of terrain data bases for civil use, and advances in solid state memory have made additional GPWS enhancements practical and cost effective. Earlier alerts can be given for flight paths into precipitous terrain, and flight paths short, or off, the airport. The threatening terrain can be displayed on most existing colour weather radar displays and or Electronic Flight Instrument System displays in a practical low cost manner.
- The Enhanced GPWS will again lower the CFIT accident risk significantly, probably to less than 0.01 aircraft per million flights. Perhaps this time, twenty years after the first installation of GPWS, there will be a bit more credibility in the estimate.

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