



**wats2013**  
ORLANDO

17 April 2013

**“Reduce Continuing CFIT Accidents by  
Training Constant Descent Final Approaches  
Using Distance-Altitude Tables to Follow the  
Glideslope Angle to an Accuracy of 30ft”**

*Including LOC-DME Accident 14 Aug 13  
of UPS A300-600F into Birmingham, Alabama*

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**1958-92**

FO Pilot Navigator

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**CAPTAIN HUGH DIBLEY**

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**1995-2002 Airbus A320/A330/A340**

Flight Instructor/Training Captain  
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**2002 – Aviation Consultant**

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# Hugh Dibley's Main Aviation Activities



# Reduce Continuing CFIT NPA Accidents

**Overview of Approach Development**

**Reminder of Stepped NPA Issues**

**Constant Angle NPAs Using DME**

**Accidents from Stepped Descents**

**Use of Distance-Altitude tables all types**

**Improvements to approach charts**

**Crew training/competence**

**Summary – *after WATS UPS Accident KBMH***

# Overview of Approach Development

Actual distance from runway only known at Beacon crossings therefore Descents and Approaches had to be Step Downs.

ILS Approaches on 3 degree glideslope transmitted from ground 5 times safer than Step Down/"Dive & Drive" Non Precision Approaches.

1970s - DMEs installed worldwide, Descents and Approaches could be based on distances accurate to 0.1 nautical mile.

Constant Angle 3 degree Non Precision Approaches possible to 30ft accuracy using DME-Altitude tables on approach charts or simple aids.

1980s - Airbus policy to fly Constant Angle NPAs flown automatically by the FMGS or selecting Flight Path Angle & crosschecking profile from tables.

Step Down/Dive & Drive NPA Accidents continued despite GPWS.

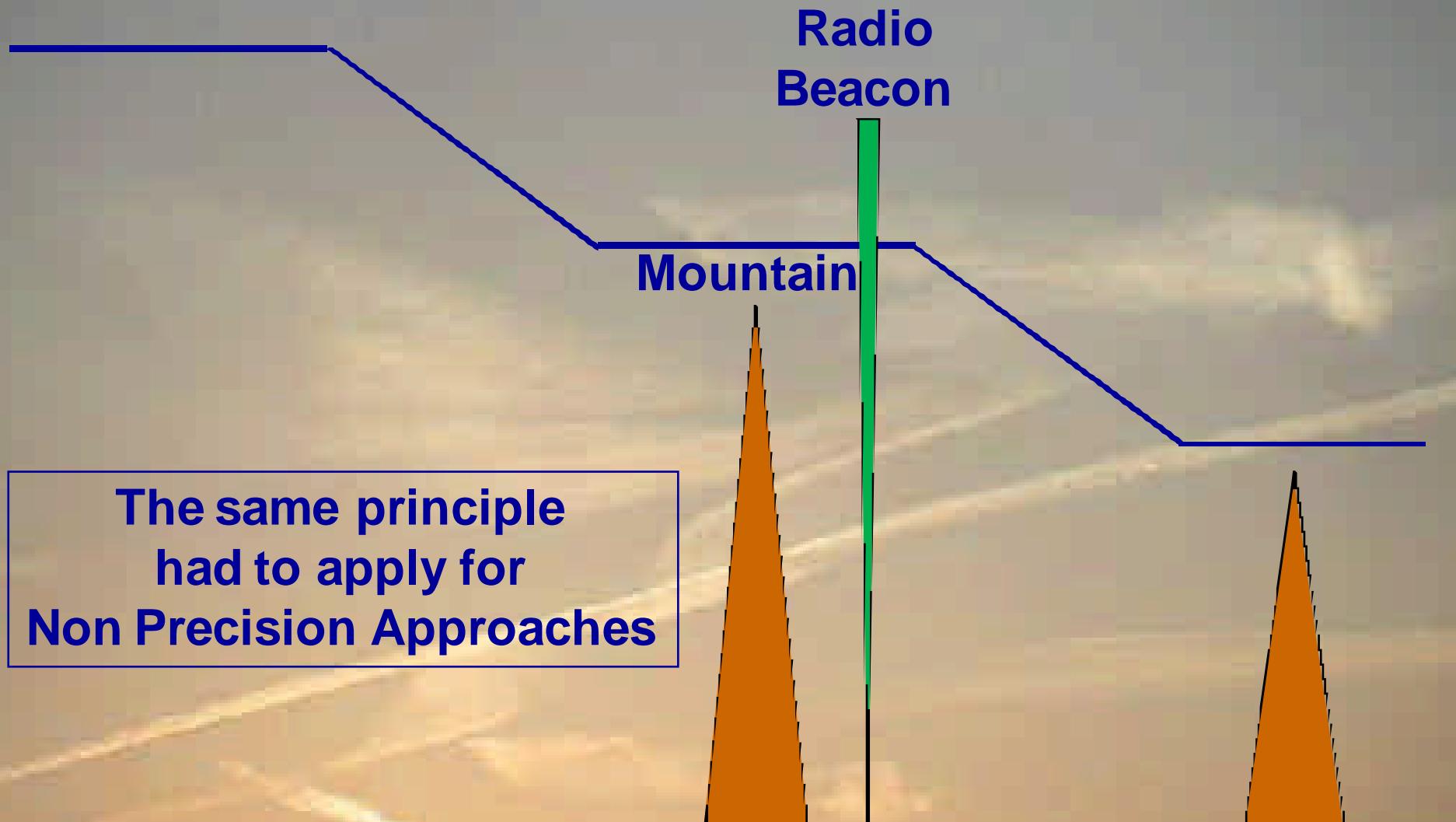
2000 - FAA required aircraft to be capable of flying CANPAs using on board navigation systems within 10 years.

2010 - US operators started CANPA implementation requiring FMS/GPS.

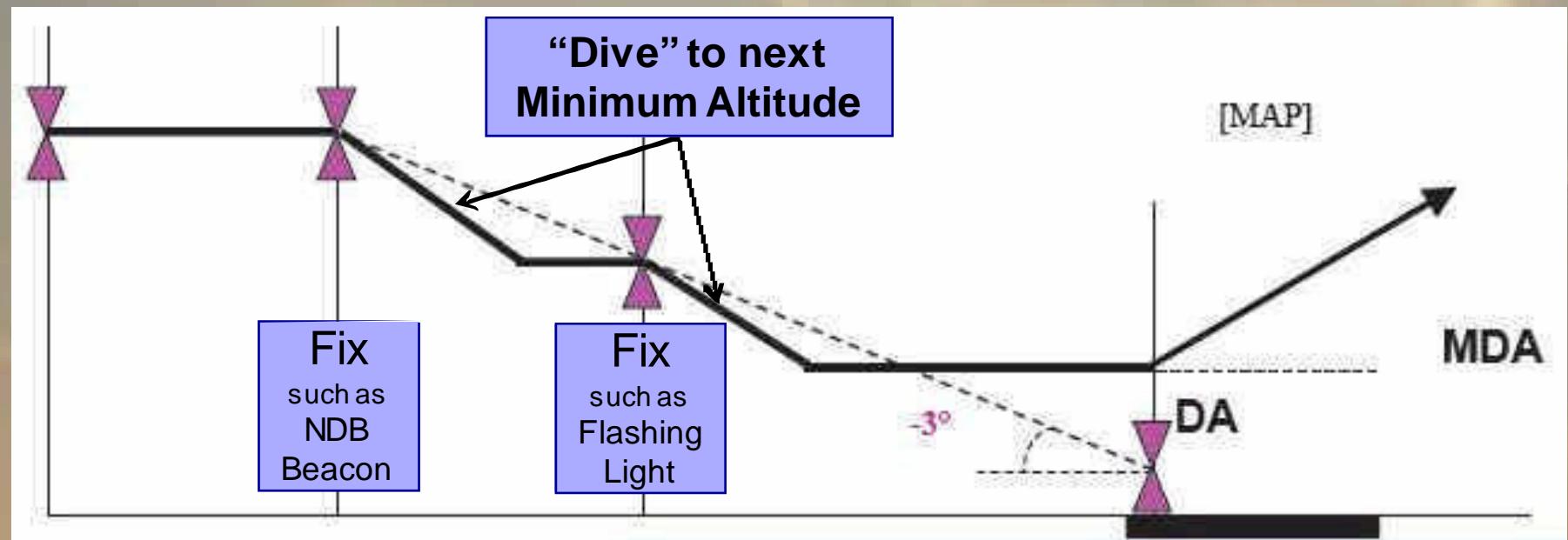
2011 - FAA AC 120-108 introduced Continuous Descent Final Approach but Distance-Altitude tables to monitor the glideslope not emphasised.

**Some large operators' policy remains to use Dive & Drive.**

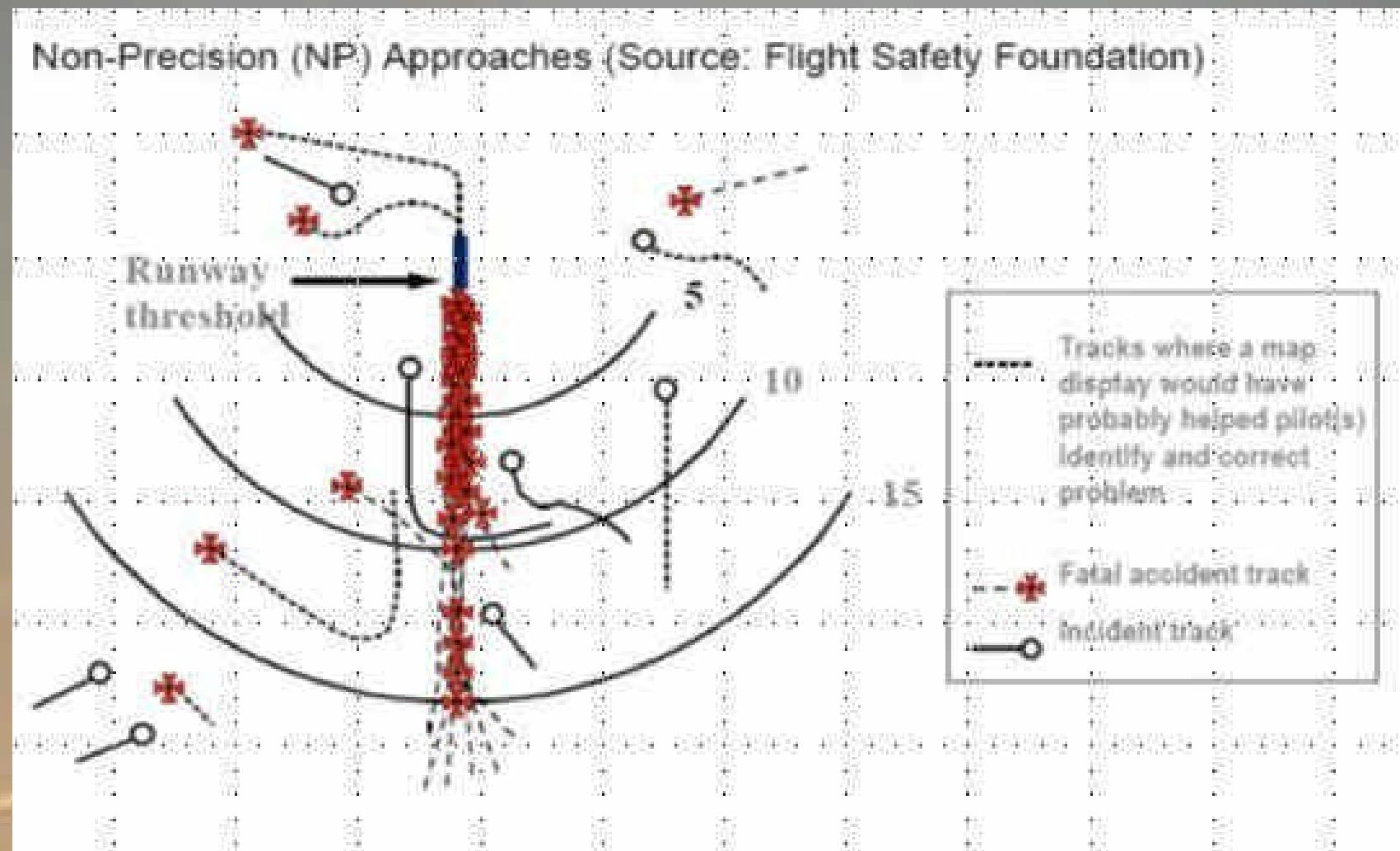
# Reason for Frequent CFIT Accidents up to 1970s - Where No Ground Radar, Descents Made in Steps, Continuing Descent Passing Radio Beacons



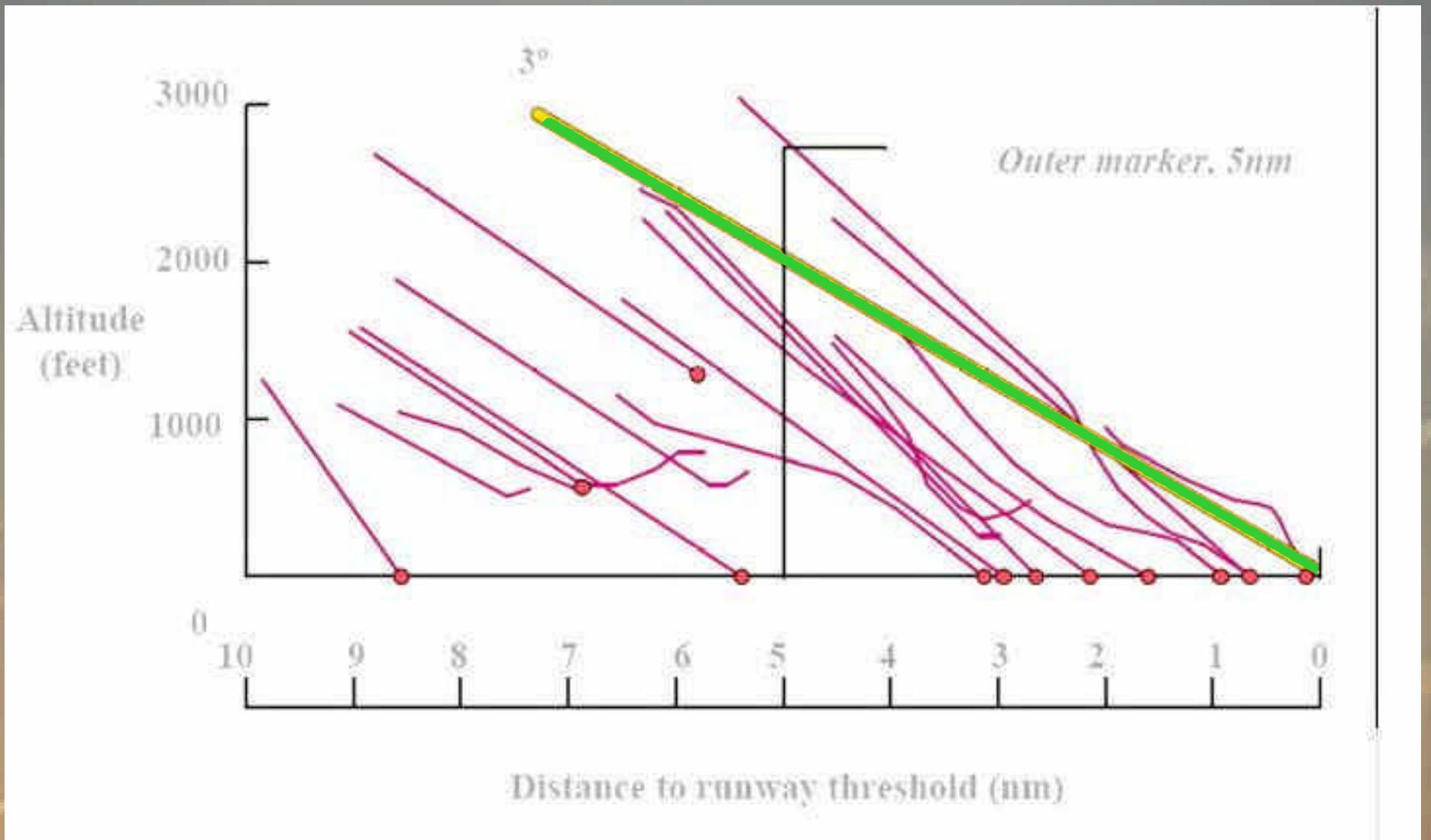
# Before DME / reliable distance information NPAs Had to be Step Down or “Dive and Drive”



# Lateral Navigation was not the Main Problem Accidents sites were mainly in line with runway



# The Difficulty was in Vertical Navigation - Flying below the 3° glide path to crash short of the runway



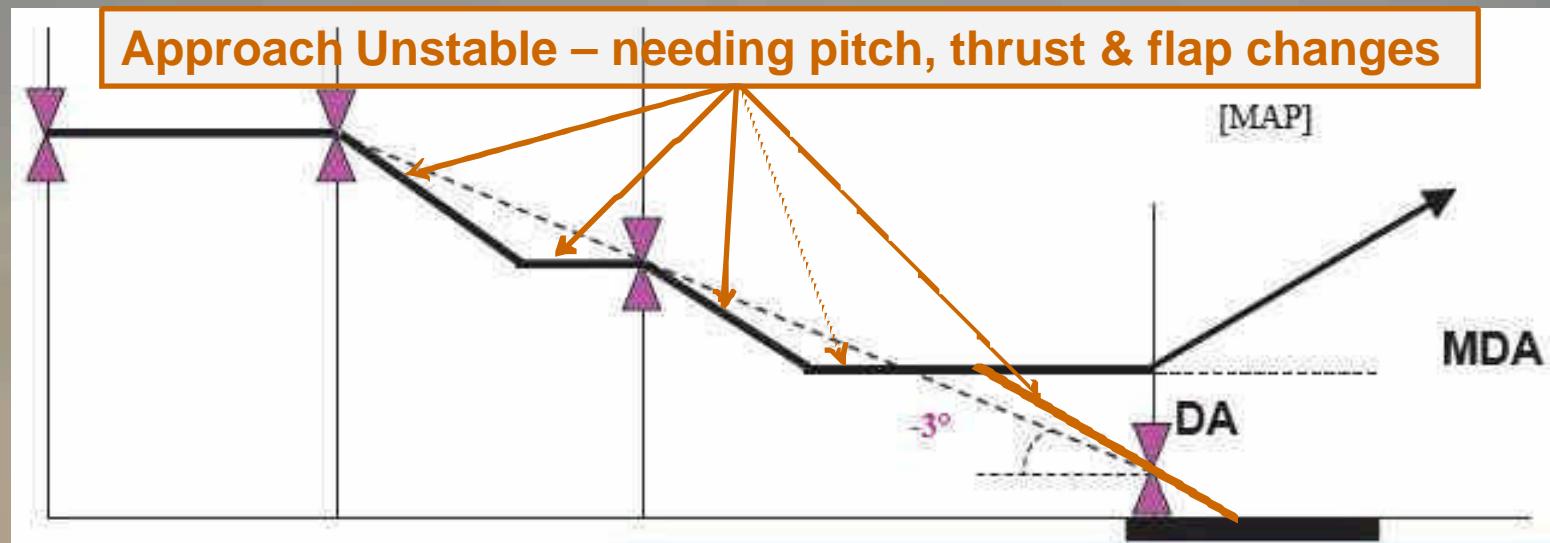
# The Majority of CFIT Accidents have involved NPAs

**CFIT was involved in 37% of 76 approach and landing accidents and incidents and that 57% of CFIT accidents and incidents occurred during Non Precision Approaches**

*Flight Safety Foundation*

# Hazards of a “Dive & Drive” NPA Profile

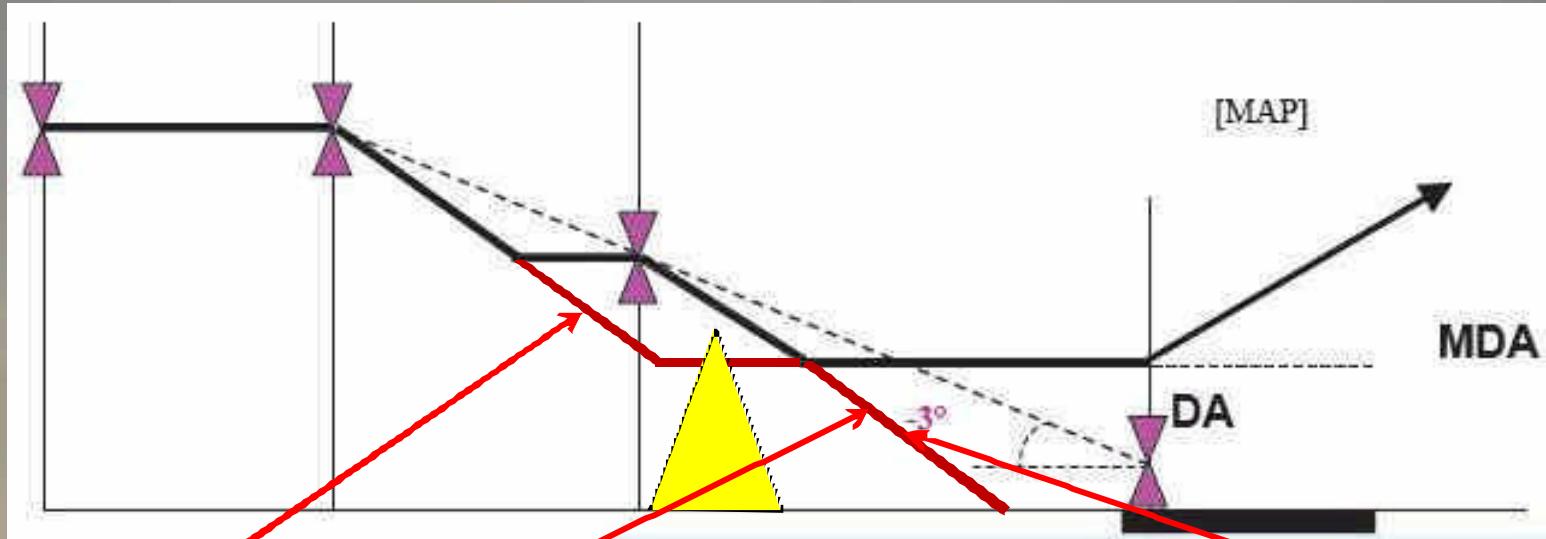
## Unstable profile



Unstable profile leading to unstable approaches

# Hazards of a “Dive & Drive” NPA Profile

Missed step or late stabilisation causes accidents



Crew missed a step, stabilised late, or failed to monitor DME-Altitude glideslope

01 Dec 1974 TWA 727 VOR DME approach into Washington Dulles

08 Feb 1989 Flying Tigers 747 VOR DME approach accident into Kuala Lumpur

12 Nov 1995 American MD82 VOR DME approach into Windsor Locks Conn, USA

06 Aug 1997 Korean 747 LOC No Glidepath DME approach accident into Guam

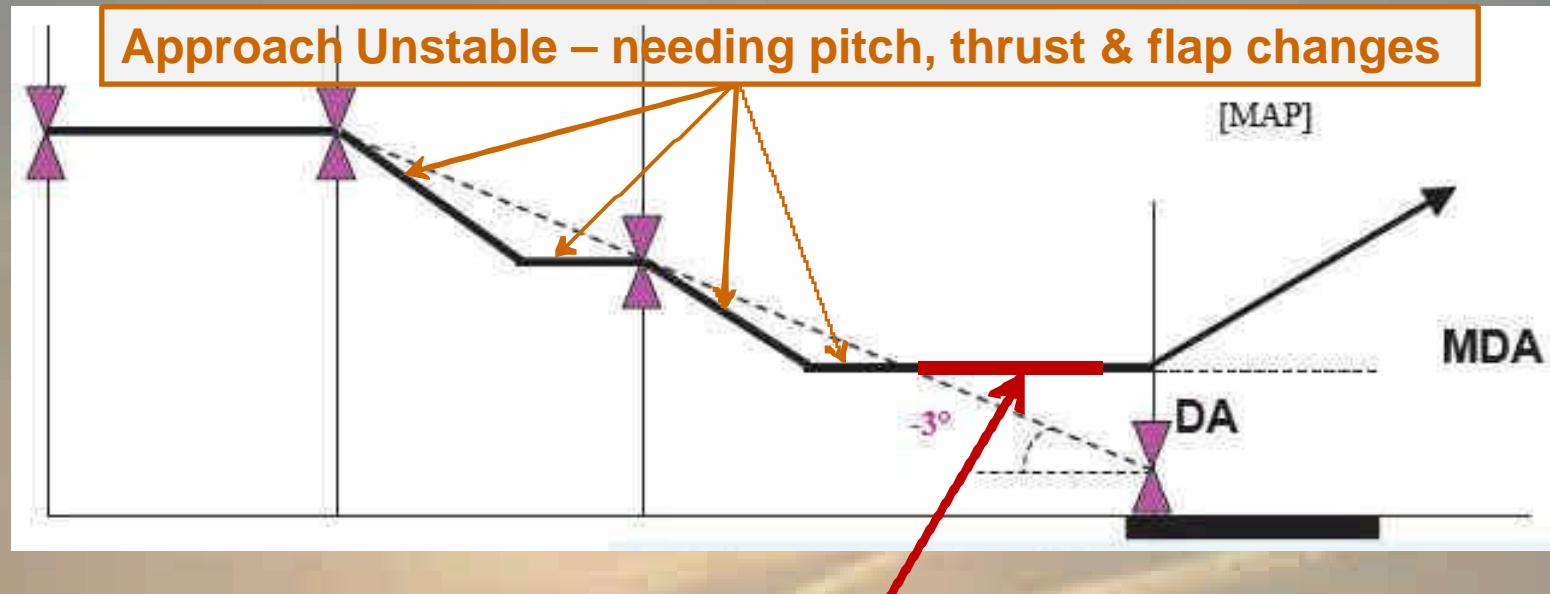
24 Nov 2001 Crossair RJ 100 VOR DME approach accident into Zurich R/W 28

**14 Aug 2013 UPS A300-600F LOC-DME into Birmingham Alabama?**

Above a small sample – many other accidents/near misses, eg at old HKG Kai Tak IGS Glidepath out approach, a 747 missed a step and descended early towards a hill, but error advised by Hong Kong Approach Radar.

# Hazards of a “Dive & Drive” NPA Profile

Chance of hard landing or runway over-run



Flying level pitched up at MDA obtaining visual reference causes late “dive” at the runway with hard or deep landing and runway over-run.

*Runway safety related accidents are ICAO's highest accident cause*

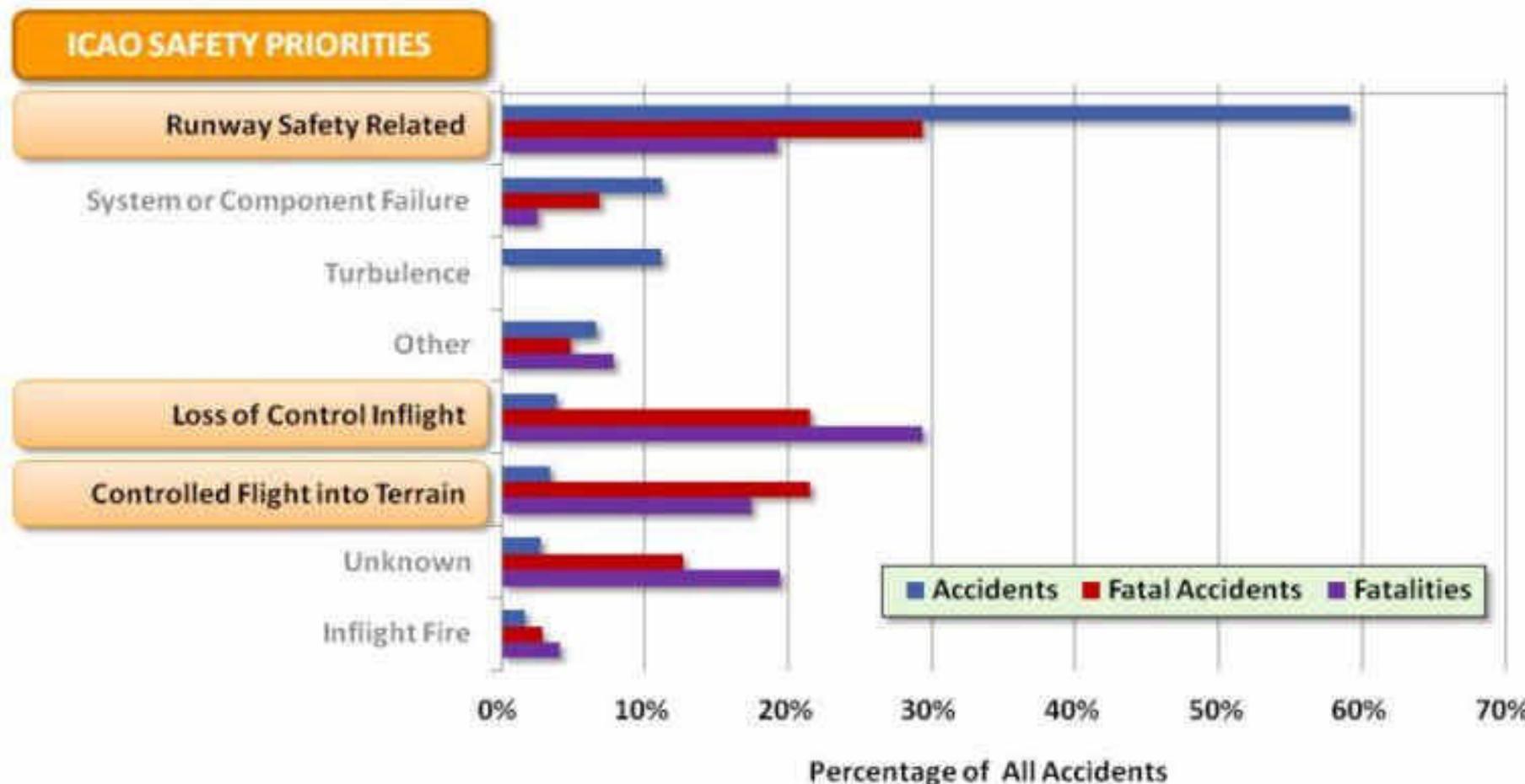
Late final configuration means checklists being read at low altitude



# Safety Performance – the main killers

## Accidents & Related Fatalities by Occurrence Categories

Scheduled Commercial Traffic – MTOW > 2 250 kg (Yrs 2006- 2010 )



## *Despite this Some Operators Are Still Flying Dive and Drive Non Precision Approaches*

**2 airlines trained recently still using D &D**

**Pilot with US A320 Type Rating trained for D&D**

**Any aircraft can fly Constant Angle Approaches  
using a DME in line with the runway**

**No need for any FMS/GPS equipment**

**Reports of some Authorities reluctant to approve**

**NPA Approach charts with clear Distance-Altitude  
checks for checks/monitoring essential even for the  
latest aircraft.**

## Descent Path Calculated from DME

Altitude on continuous 3° descent path can be calculated from a DME in line with the runway  
*as in example given later*

**GUAM No Glide Path approach at 5 nm DME –**  
**Approach Altitude = (5+3.3) x 300 + 310 = 2,800ft**

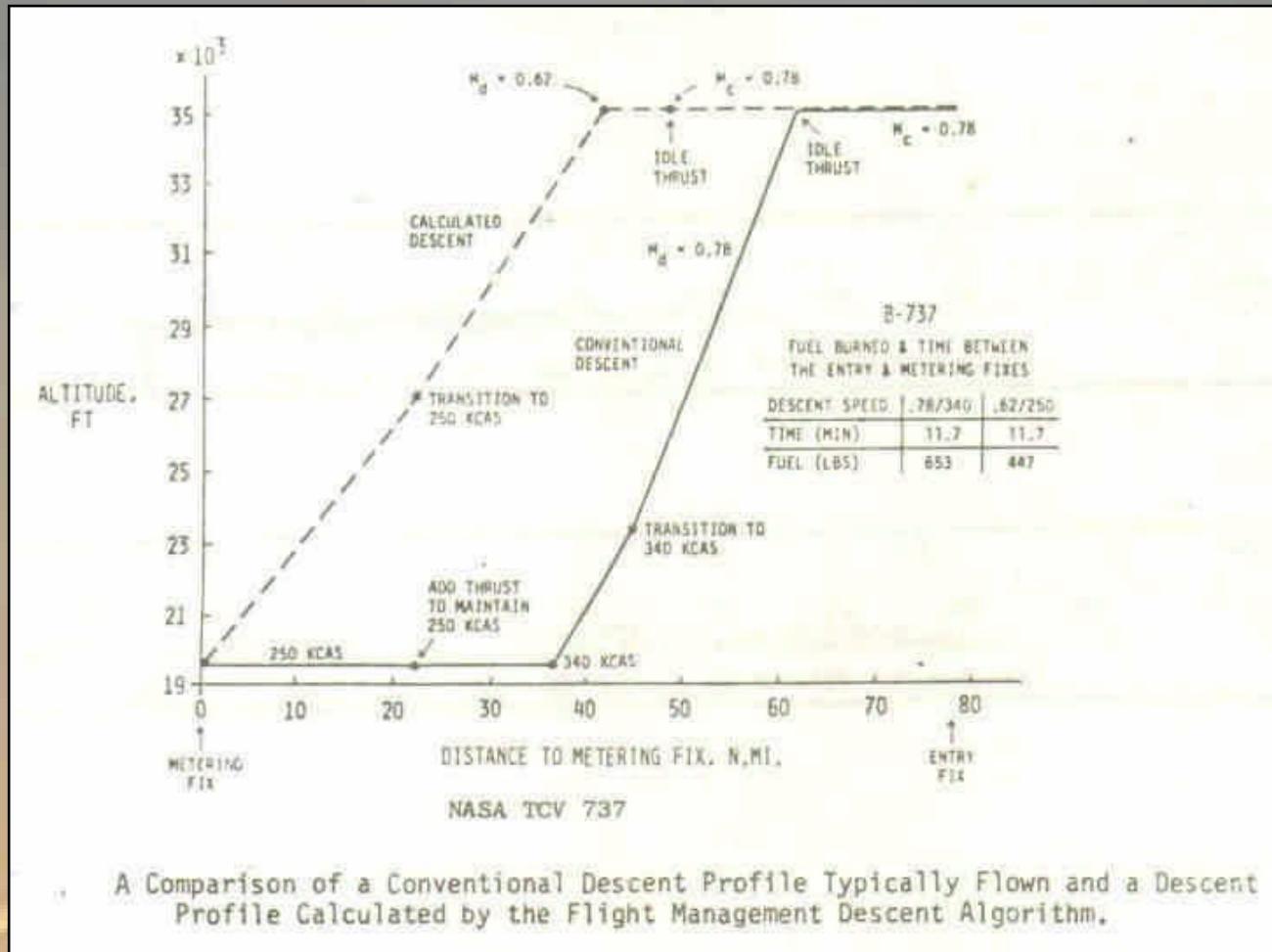
*Best by using*  
**Direct DME – Altitude Display**  
**Otherwise crews tend to descend early**



Distance to runway threshold (nm)

# Similar Calculations Needed for Accurate ATC Descent Clearance to DME Crossing Altitude

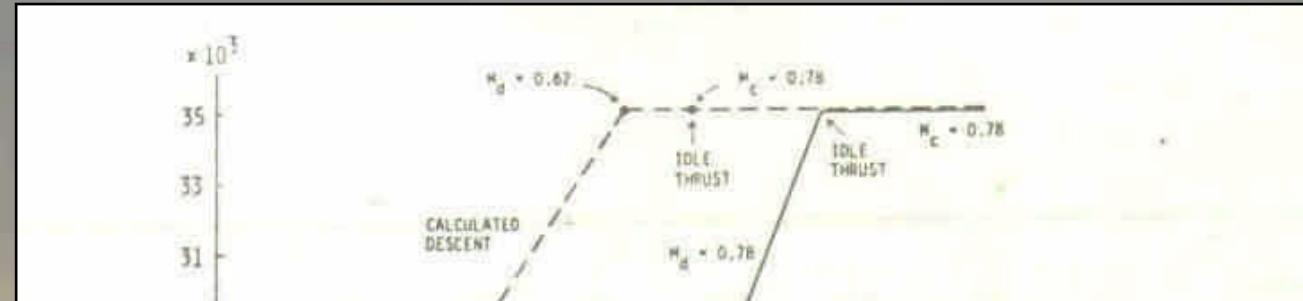
NASA found crews descended early rather than on optimum profile



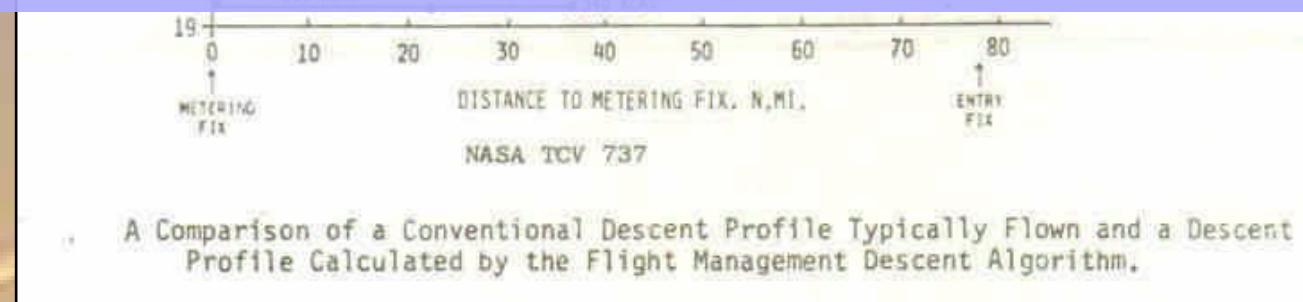
Mentally computed descent profiles are usually not optimum

## Similar Calculations Needed for Accurate ATC Descent Clearance to DME Crossing Altitude

NASA found crews descended early rather than on optimum profile



US ATC made good use of DME during descent when moving to next ATC sector – Descend to 8000', cross 23 DME of XYZ at 8000' (and at 250kts IAS).



Mentally computed descent profiles are usually not optimum

# Crews can easily fly efficient descents with simple aids

Circular slide rule primarily designed to help crews follow an efficient flight idle descent profile to comply with an ATC clearance such as to cross 23 DME XYZ at 8,000ft at 250kts.

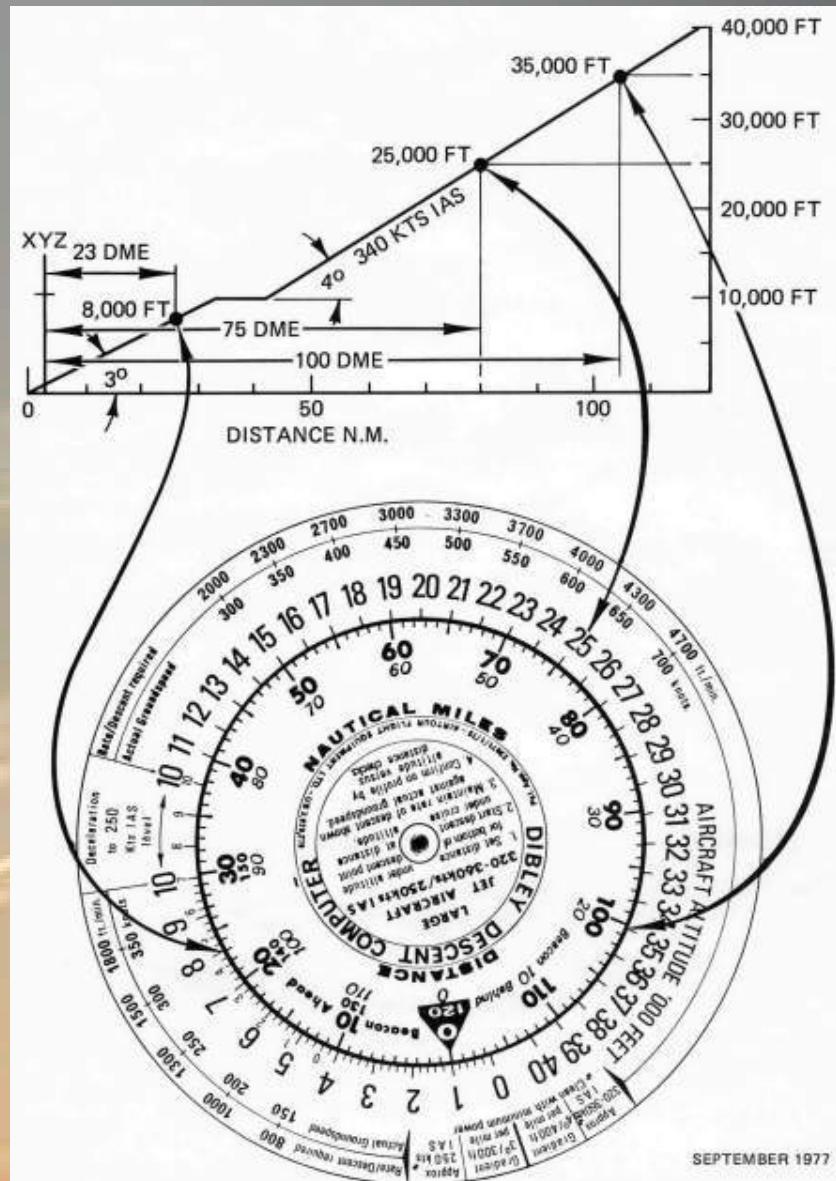
Profile easily followed by flying Sink Rate required for actual Groundspeed shown on the outer scale.

DME-Altitude checks to confirm on profile immediately available and Sink Rate adjusted accordingly if high or low.

Checking the profile mentally, normally by 300ft per mile, less accurate for this profile, requires regular computation of an equation, such as at 50 DME:

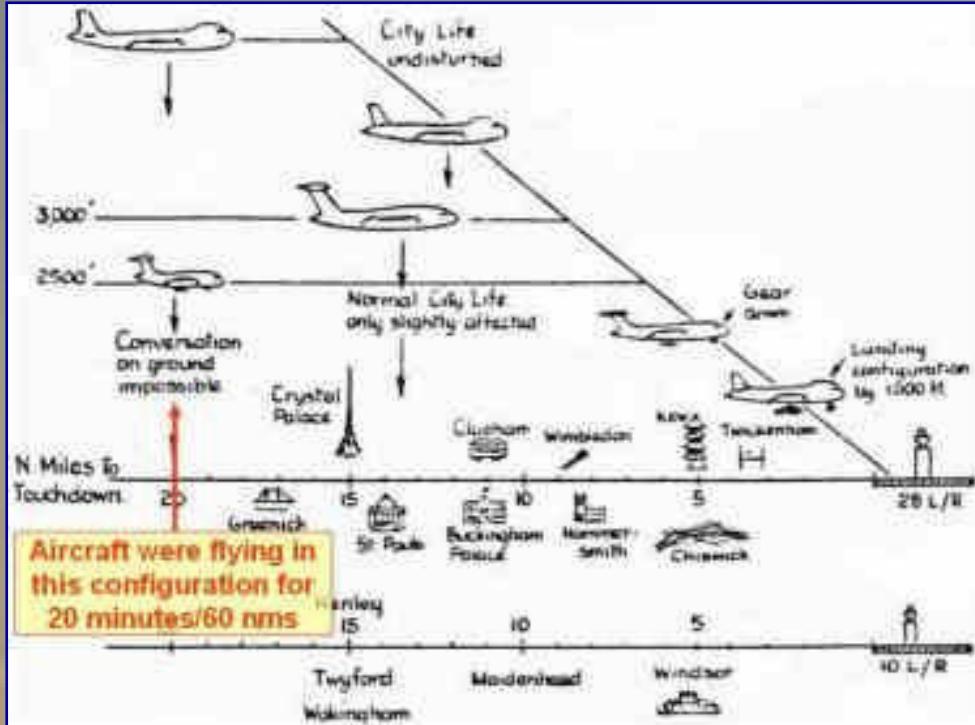
$$(50-8-23) \times 300 = 5,700 + 8,000 = 13,700\text{ft}$$

Calculating the profile efficiently and regularly diverts mental capacity from other important tasks, increases fatigue, etc.

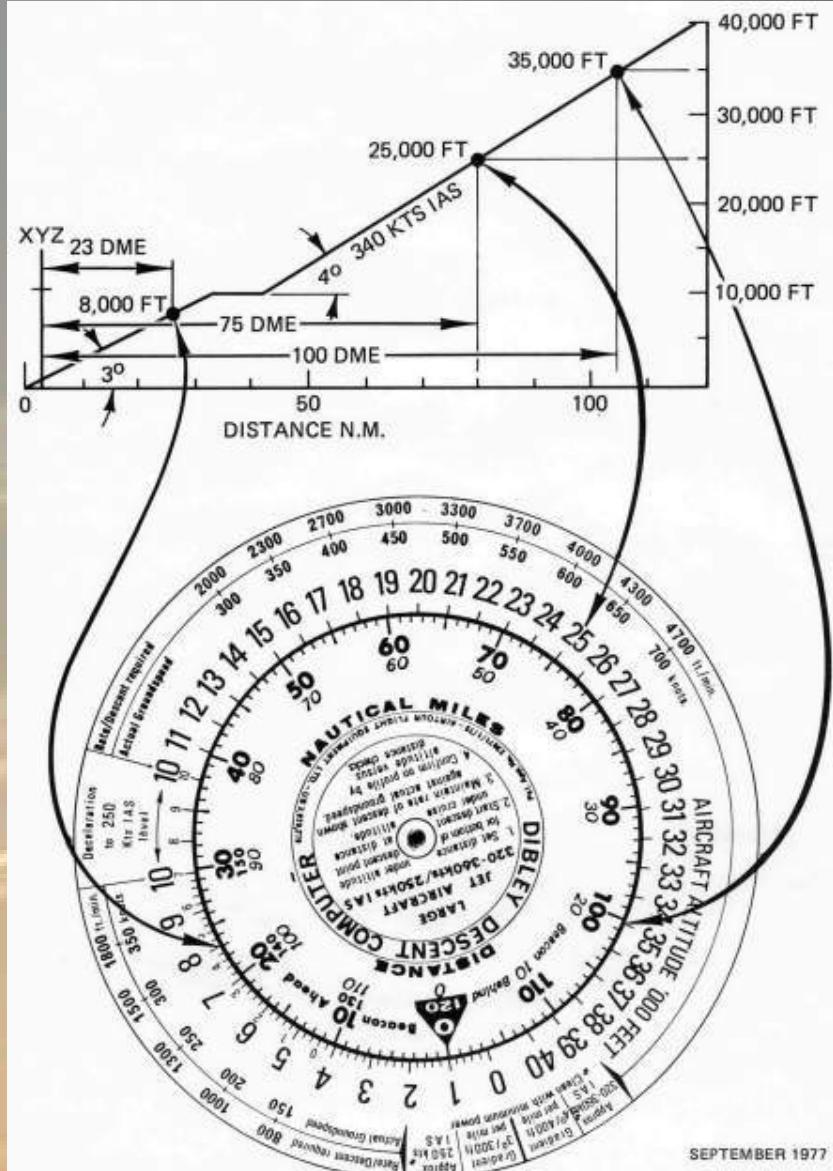


# Crews can easily fly efficient descents with simple aids

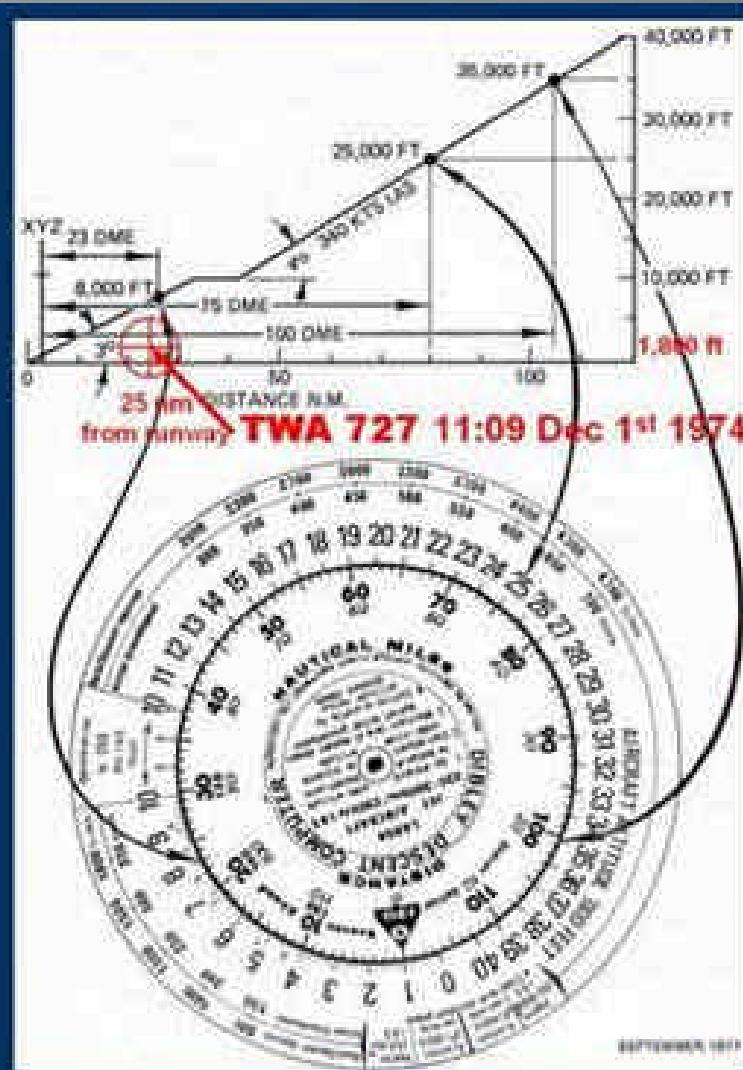
Fuel efficient quiet Constant Descent Approaches from the holding fix altitude were introduced into London Heathrow in 1975 using ATC distance to run & DME distance from the runway for guidance.



*Besides minimising fuel burn and noise, following this profile improves safety by keeping the aircraft well clear of the ground into nearly all airfields.*



# Use of such an aid might have saved the FO flown TWA Flt 514 B727 CFIT VOR DME Accident in to Washington Dulles in 1974



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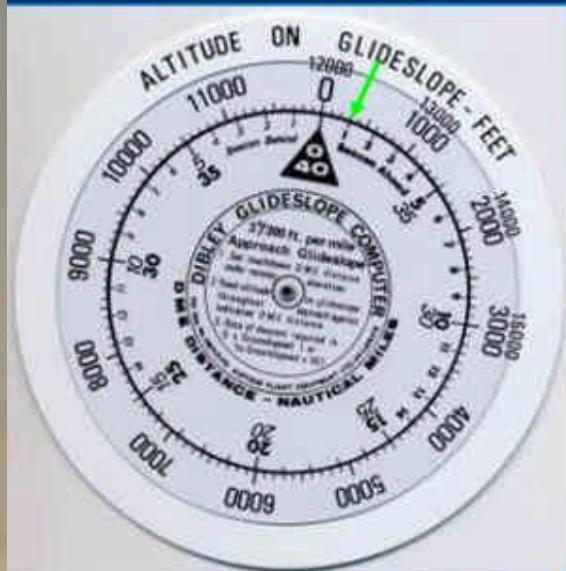


The aircraft diverted due to strong cross winds from Washington National to Dulles International for a VOR DME NPA to runway 12. The captain gave control to the FO and read the approach chart. ATC gave descent clearance to 7,000ft and then for the approach. The crew concluded this allowed descent to the FAF at 1,800ft and the FO started descent immediately at 44nm DME when 25nm would be more efficient for fuel and noise. The aircraft levelled off over 20nm early and below the 3,400ft minimum altitude for the sector. Due to high winds and turbulence the aircraft descended below 1,800ft and hit the ground at 1,670ft.

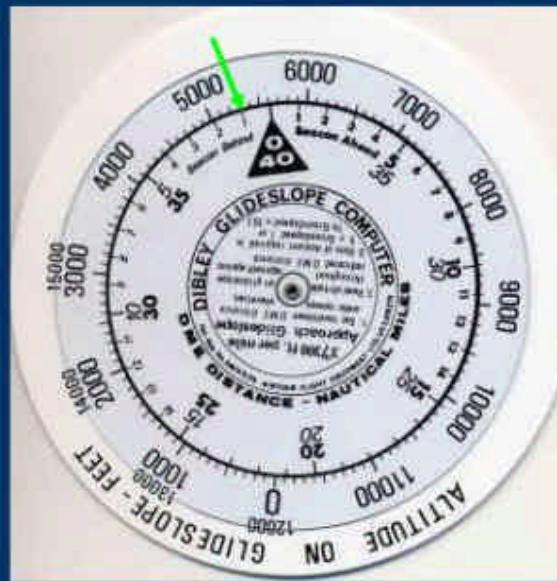
***The FAA then mandated GPWS to be fitted to all US registered aircraft***

# An expanded scale can show a 3° Constant Angle Approach glide path

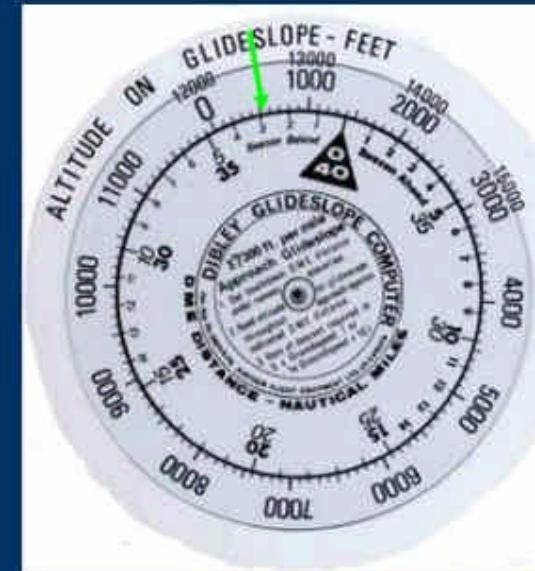
## Approach Slide Rule Set for Washington, Nairobi and Toulouse / Guam



IAD 12 – set ahead 1.2 DME at 360 ft



NBO 24 – set behind 1.0 DME at 5,300 ft



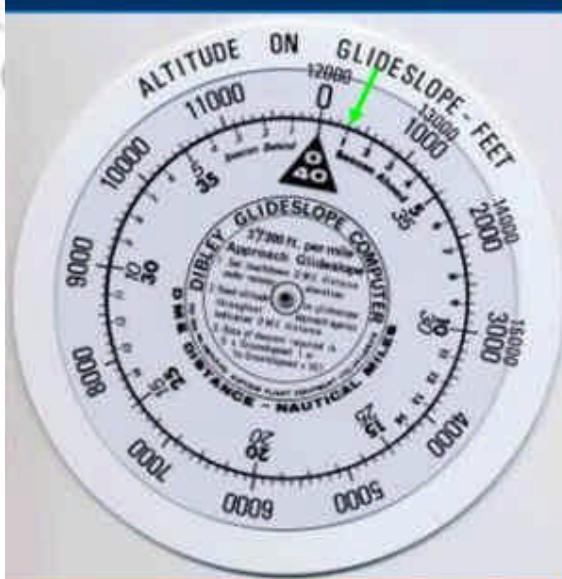
TLS 14R – set behind 2.7 DME at 550 ft  
or Guam 06 – set behind 3.3 at 310 ft

**Table on approach chart can give similar guidance**

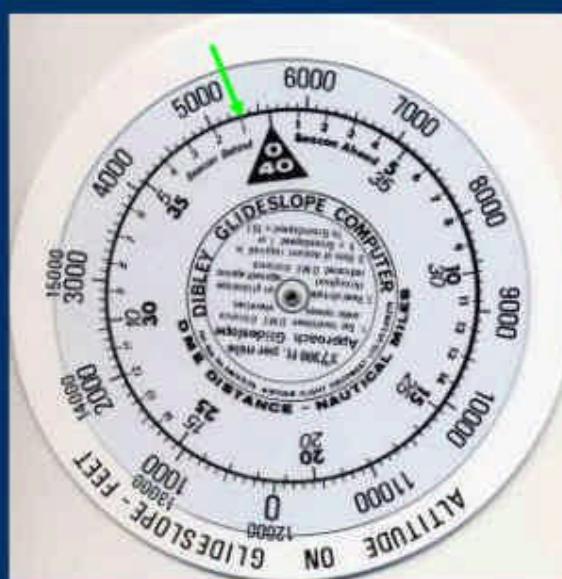
The sliderule/tables give similar help vertically as the RMI did laterally – *nobody wanted to keep RBIs!*

Aids for crews not skilled in mental arithmetic  
— like bookmakers' clerks calculating betting odds

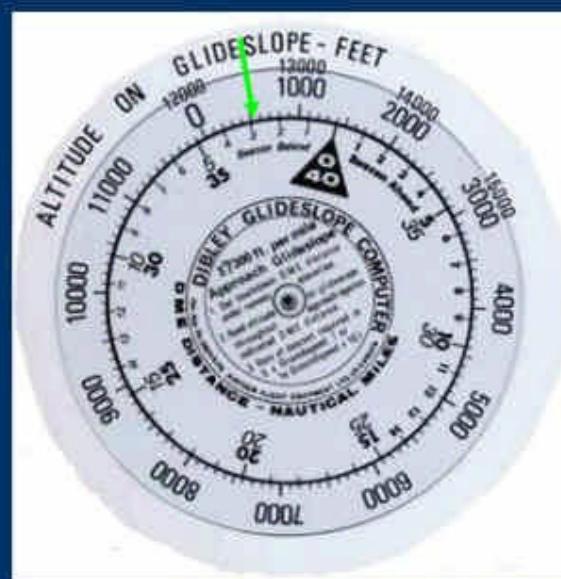
### Approach Slide Rule Set for Washington, Nairobi and Toulouse / Guam



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### Approach Slide Rule Set for Washington, Nairobi and Toulouse / Guam



Similar to using the improved  
ADF RMI (Radio Magnetic Indicator) versus an old  
RBI (Relative Bearing Indicator)  
to which Magnetic Heading must be added to calculate the  
Magnetic course to the beacon – no longer in use!

IAD 12 – set ahead 1.2 DME at 360 ft

NBO 24 – set behind 1.0 DME at 5,300 ft

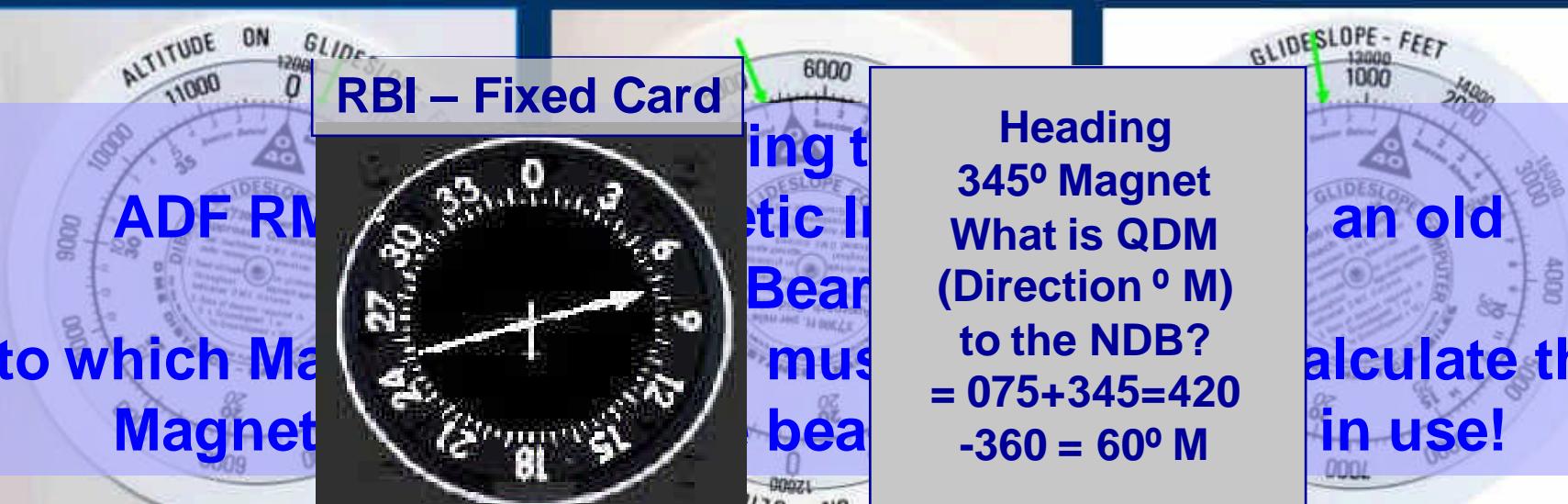
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Approach Slide Rule Set for Washington, Nairobi and Toulouse / Guam

***Nobody wanted to keep RBIs!***

RBI – Fixed Card

RMI Heading Mag

ADF RM

to which Mag  
Magnet

an old

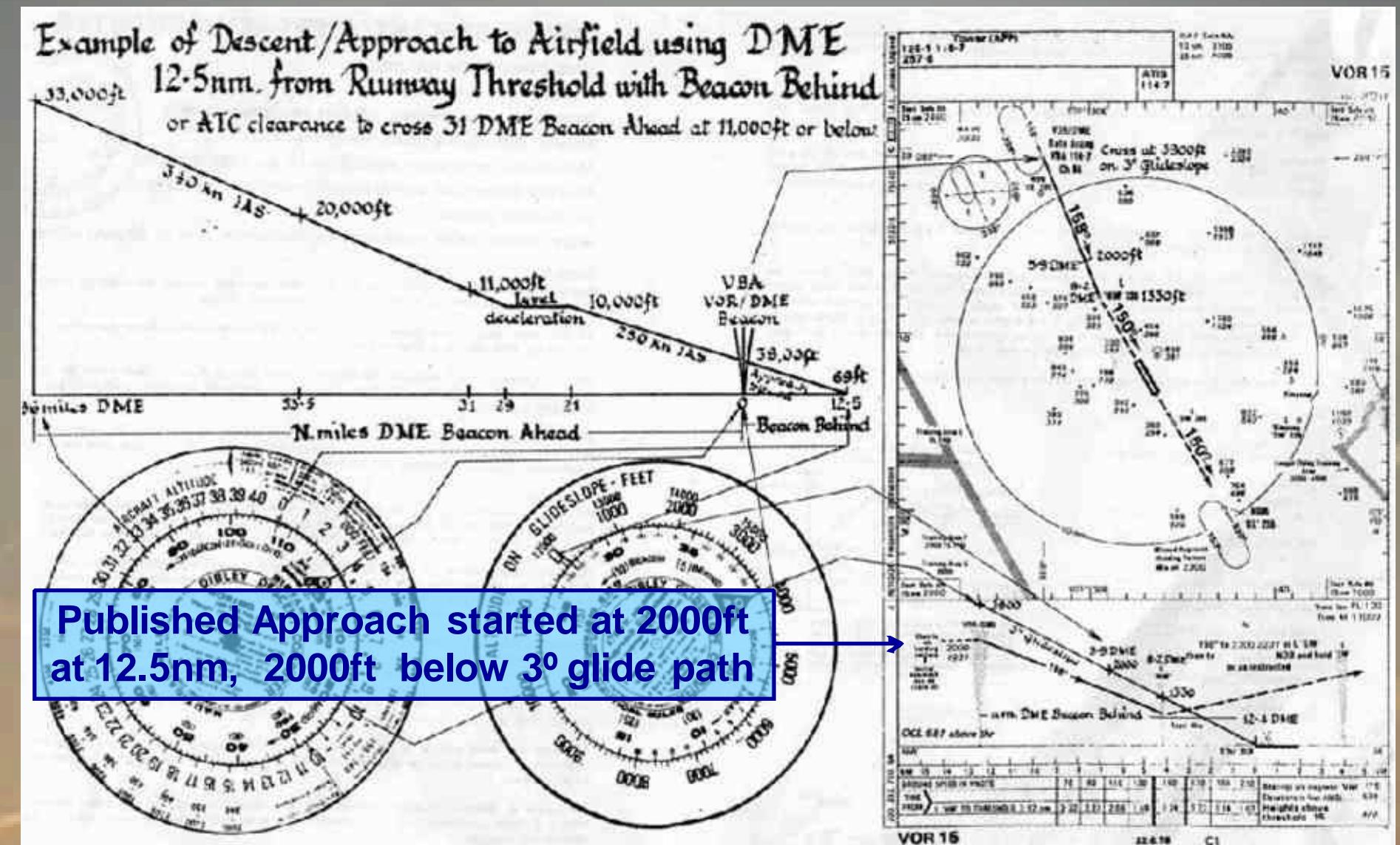
calculate the  
in use!

IAD 12 – set ahead 1.2 DME at 360 ft

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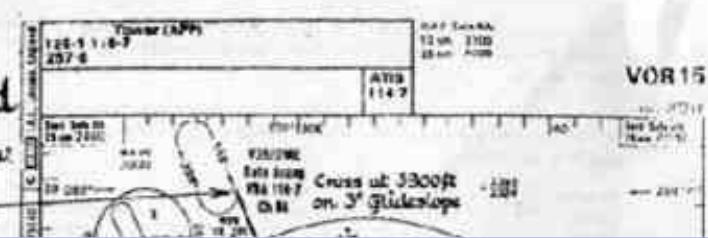
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# In 1976 Close Call to BAOD 747 flying NPA with 1.5° glidepath



In 1976 Close Call to BAOD 747 flying NPA with 1.5° glidepath

Example of Descent/Approach to Airfield using DME  
12.5nm. from Runway Threshold with Beacon Behind  
or ATC clearance to cross 31 DME Beacon Ahead at 11,000ft or below



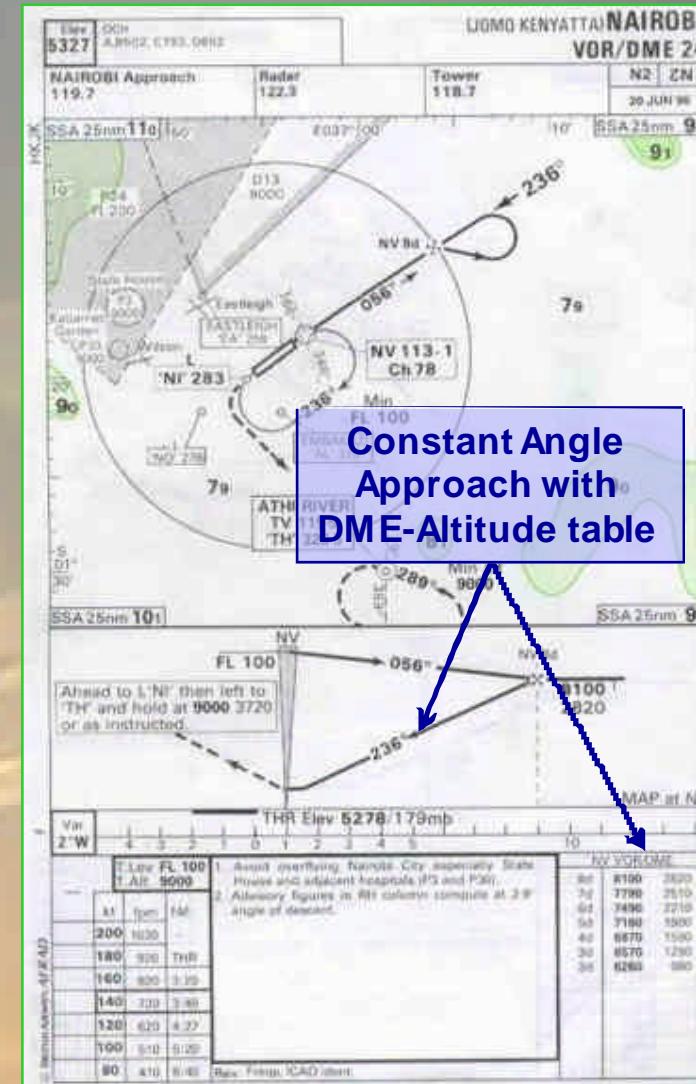
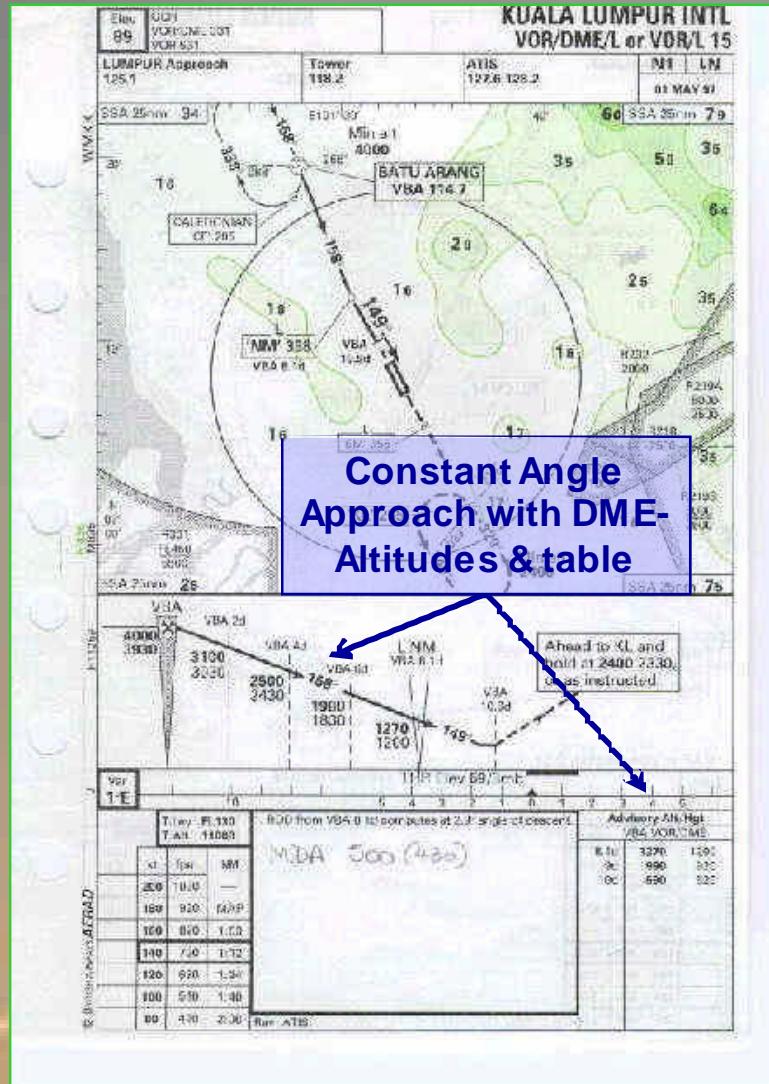
The “Black Hole” approach over forest with no visual cues started from the VOR DME at 2000ft, 12.5nm from the runway 2000ft below a 3° glide path.

The aircraft brushed trees in a Go Around from MDA.

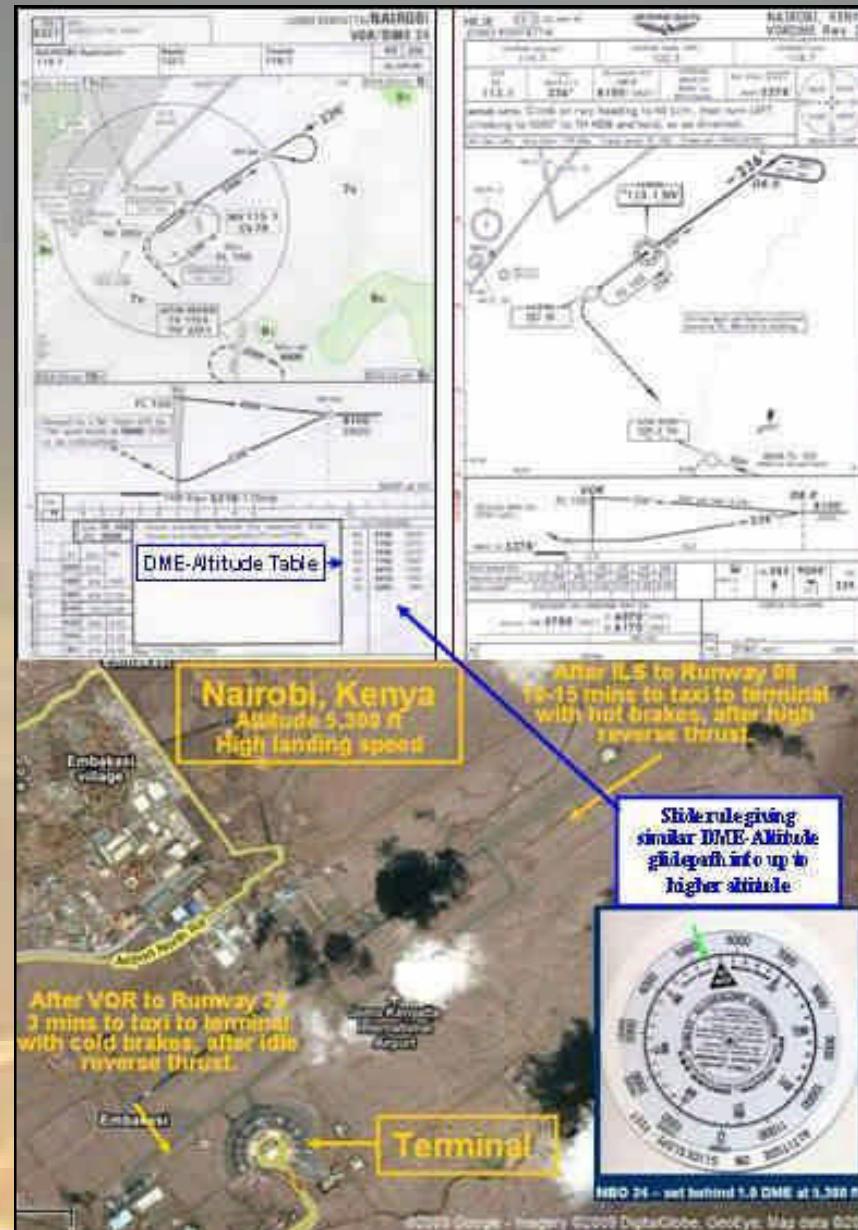
The approach procedure was revised to follow a 3° path with DME-Altitude checks tables, being incorporated on all BA Aerad charts.

BA had no similar NPA incidents thereafter.

# BA/Aerad Provided DME-Altitude Tables Permitting Constant Angle NPAs starting in 1975



# 20 min Time Saving Flying VOR-DME NPA NBO 24 vice ILS 06



## 20 min Time Saving Flying VOR-DME NPA NBO 24 vice ILS 06



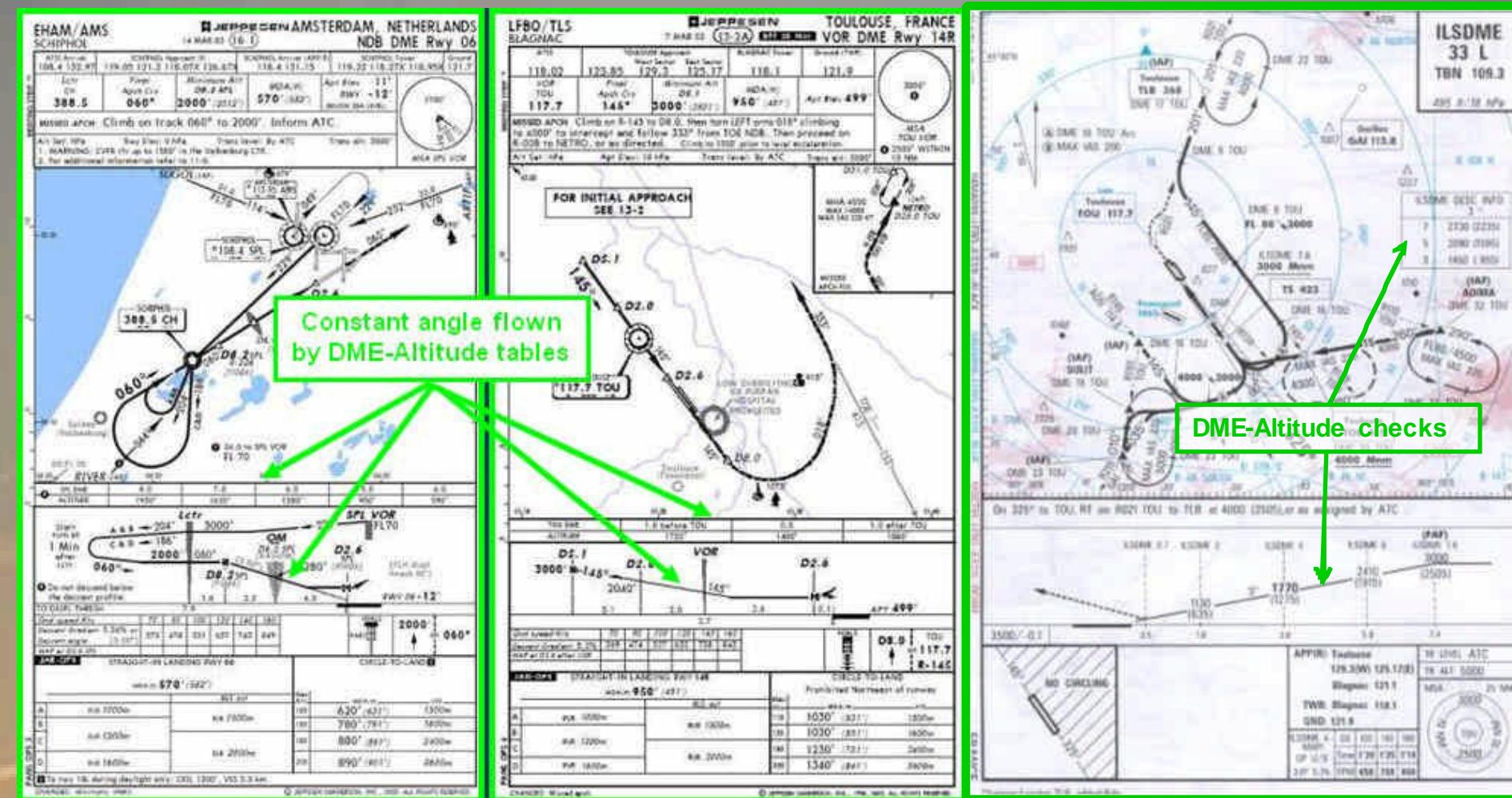
**A VOR DME on runway 24 became a simple matter using a slide rule or DME-Altitude table.**

**This could save 20 mins over an ILS on 06, which required back tracking the runway, arriving with hot brakes due to landing at max landing weight from fuel tankering.**

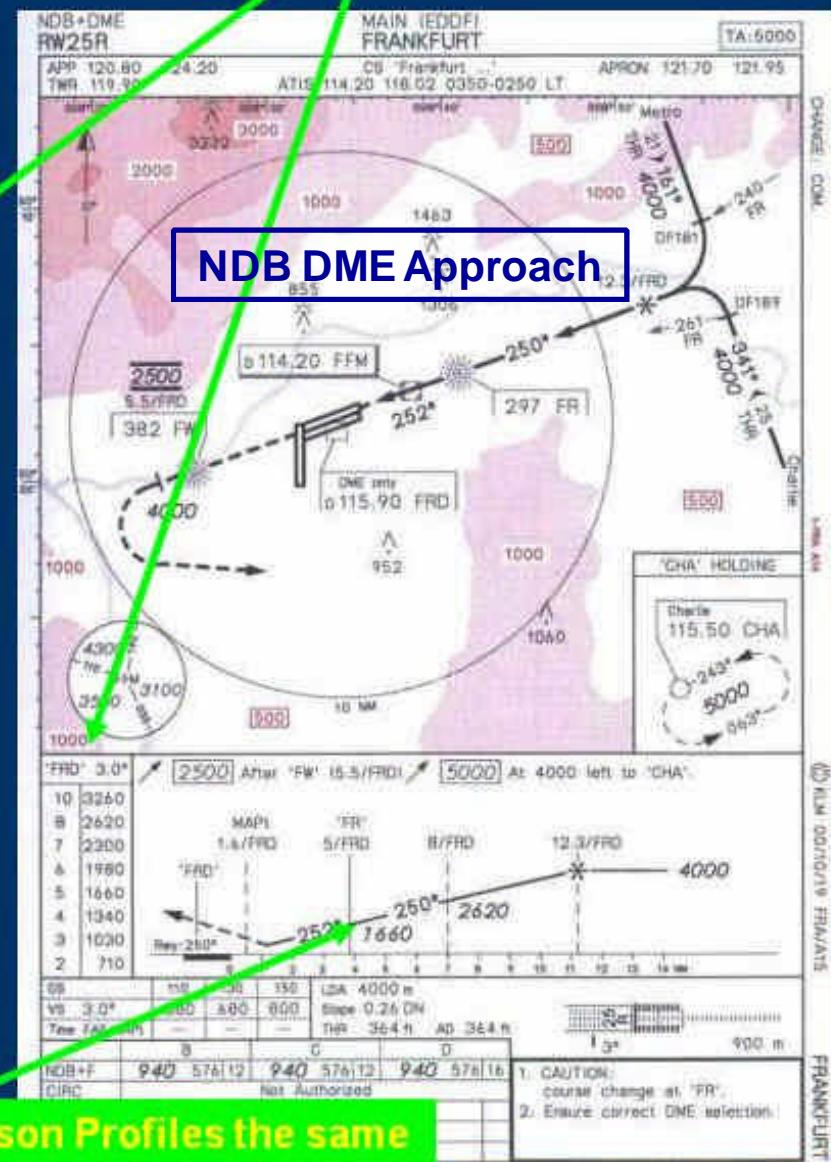
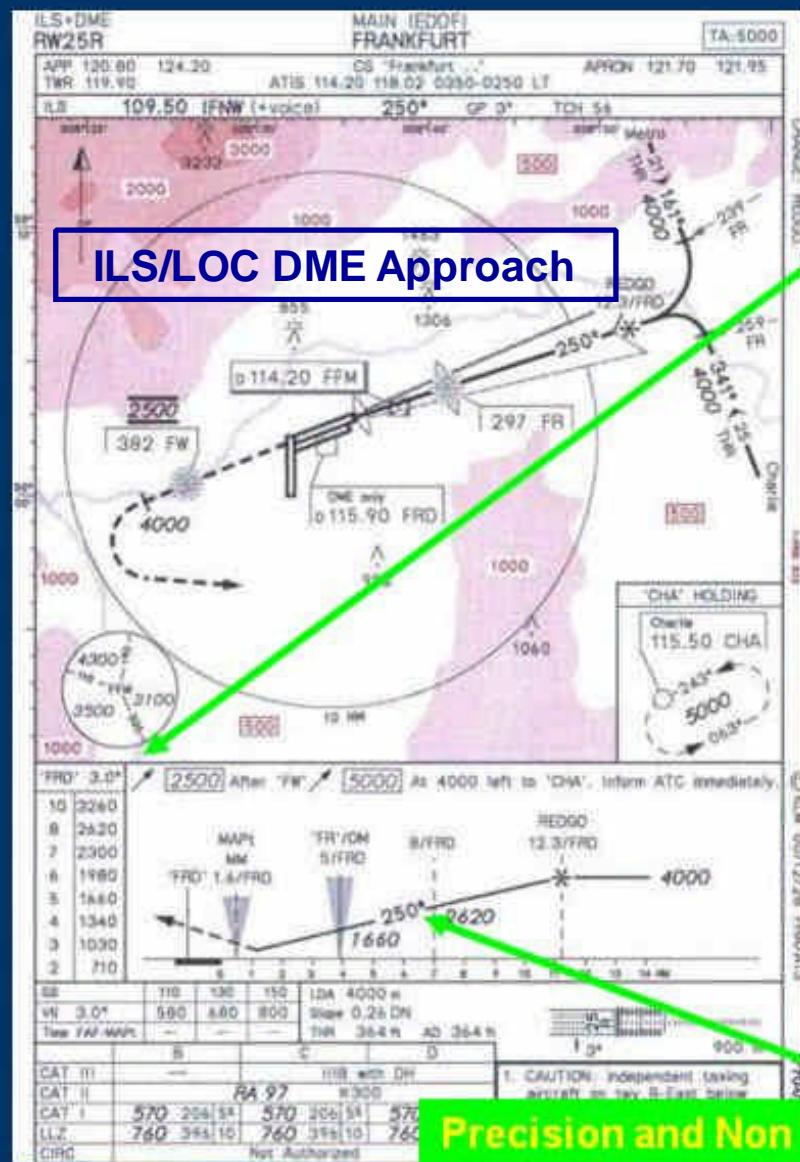
**Some who said altitude calculations could be done mentally so no need for any aid – would choose an ILS as a VOR DME considered too difficult!**



# By the 1980s Most European Authorities provided DME-Altitude Information for Constant Angle NPAs,

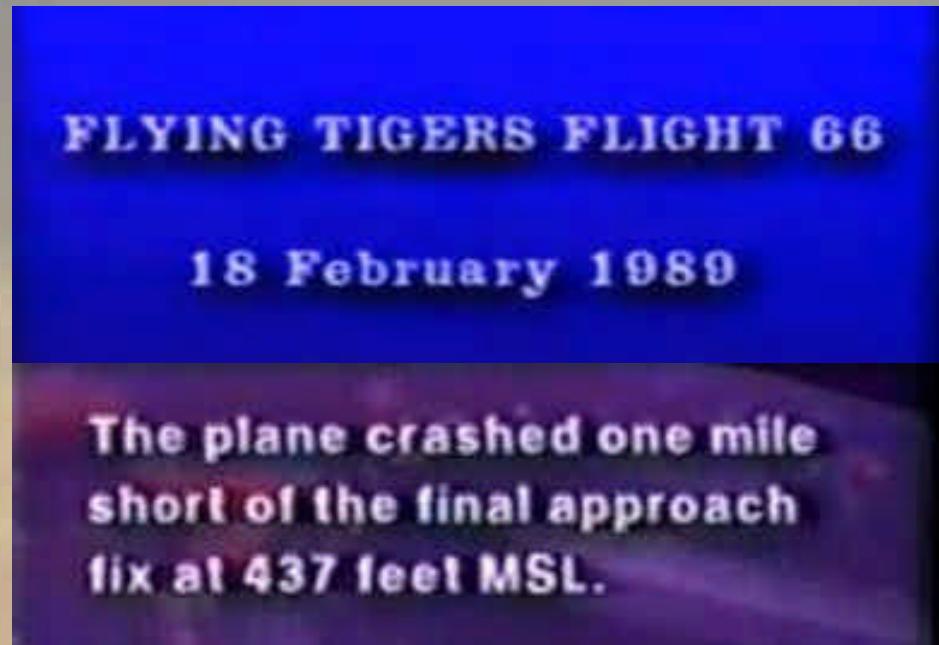


# KLM ILS and NDB Approach Charts with DME-Altitude Tables



**Precision and Non Precision Profiles the same**

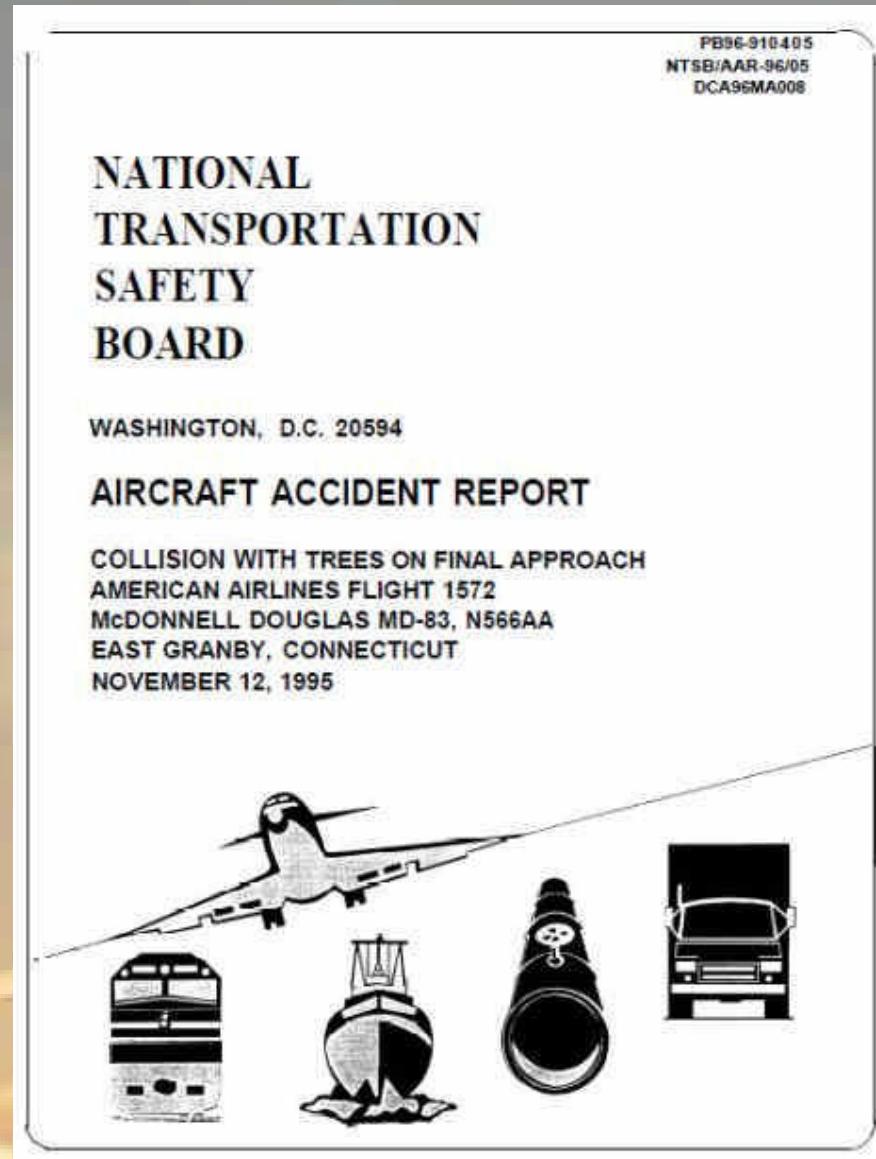
# In 1989 Flying Tigers B747 Crashed with the FO flying a VOR-DME Approach in to Kuala Lumpur



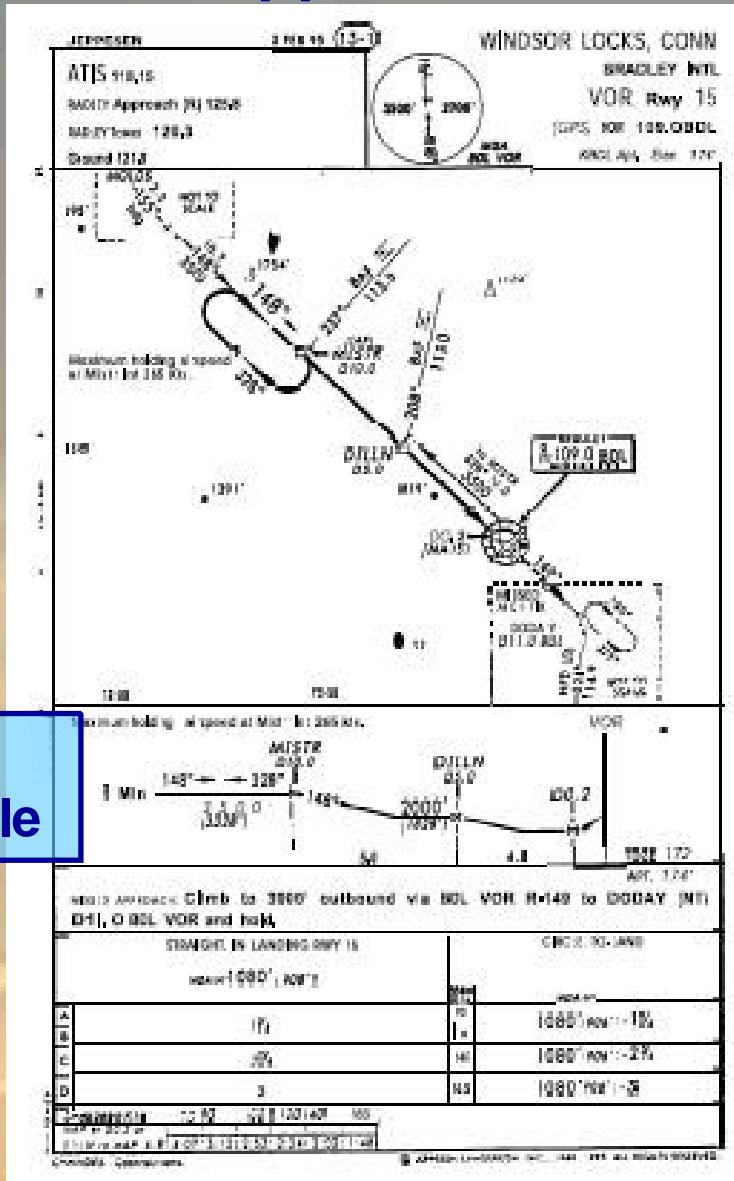
**Hit hill at 427ft - Final Approach Fix Altitude 2400ft  
GPWS “Pull Up, Pull Up” ignored for 25 seconds**

***(13 years after BAOD’s close call into same airfield)***

# 12 November 1995 American Airlines 1572 MD 82 Hit trees on VOR DME Approach into Bradley Connecticut

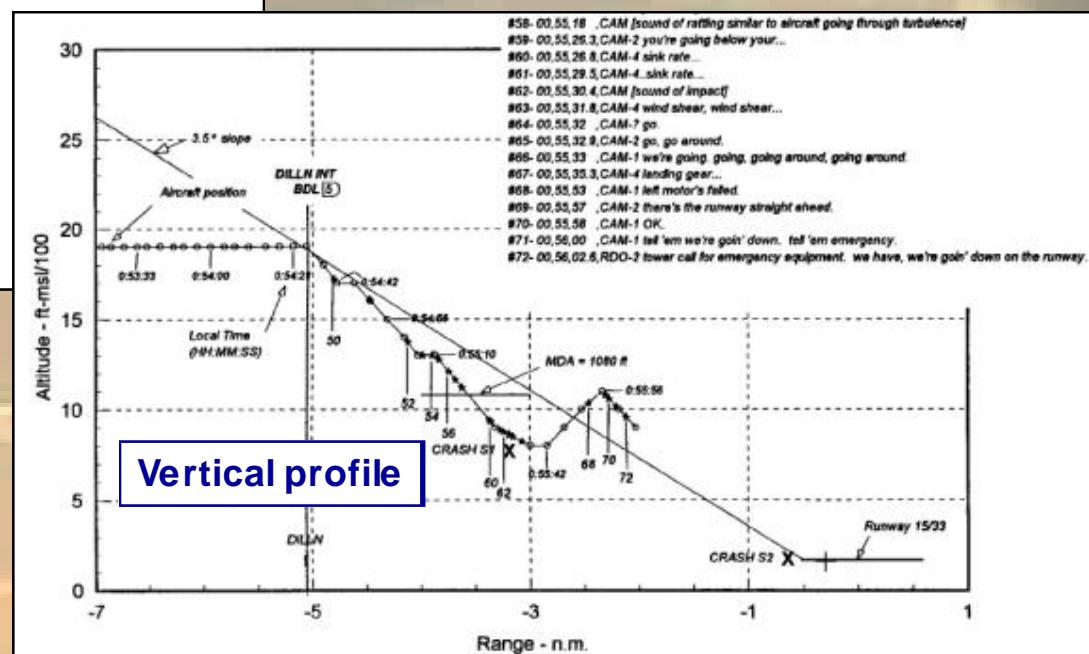
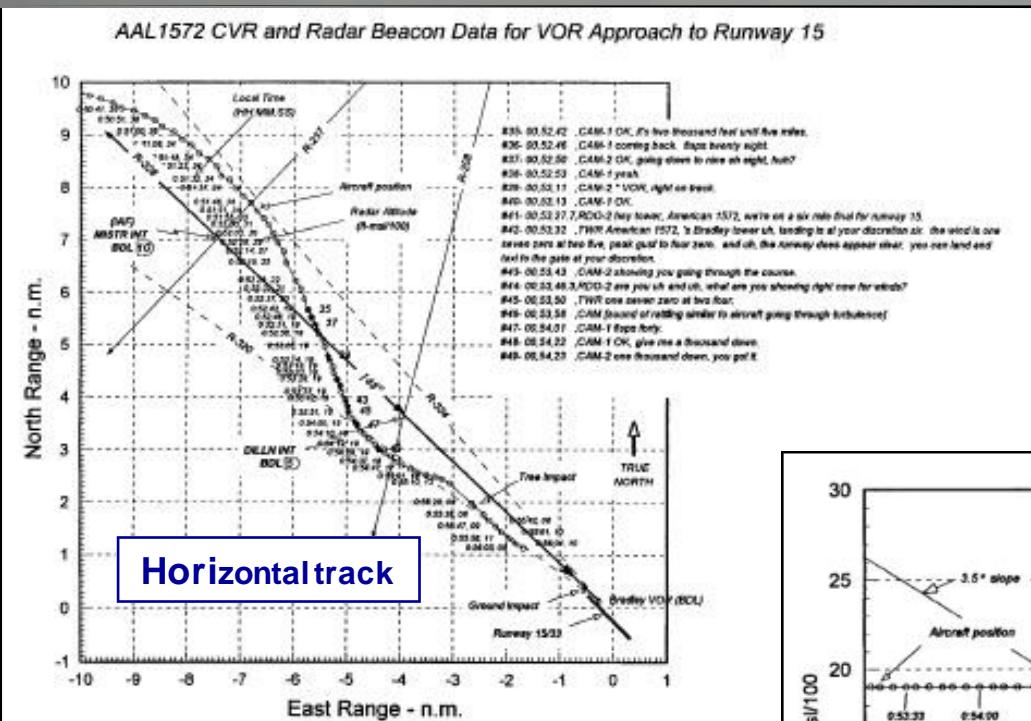


12 November 1995 American Airlines 1572 MD 82  
Hit trees on VOR DME Approach into Bradley Connecticut



## Step Down Profile No DME Altitude table

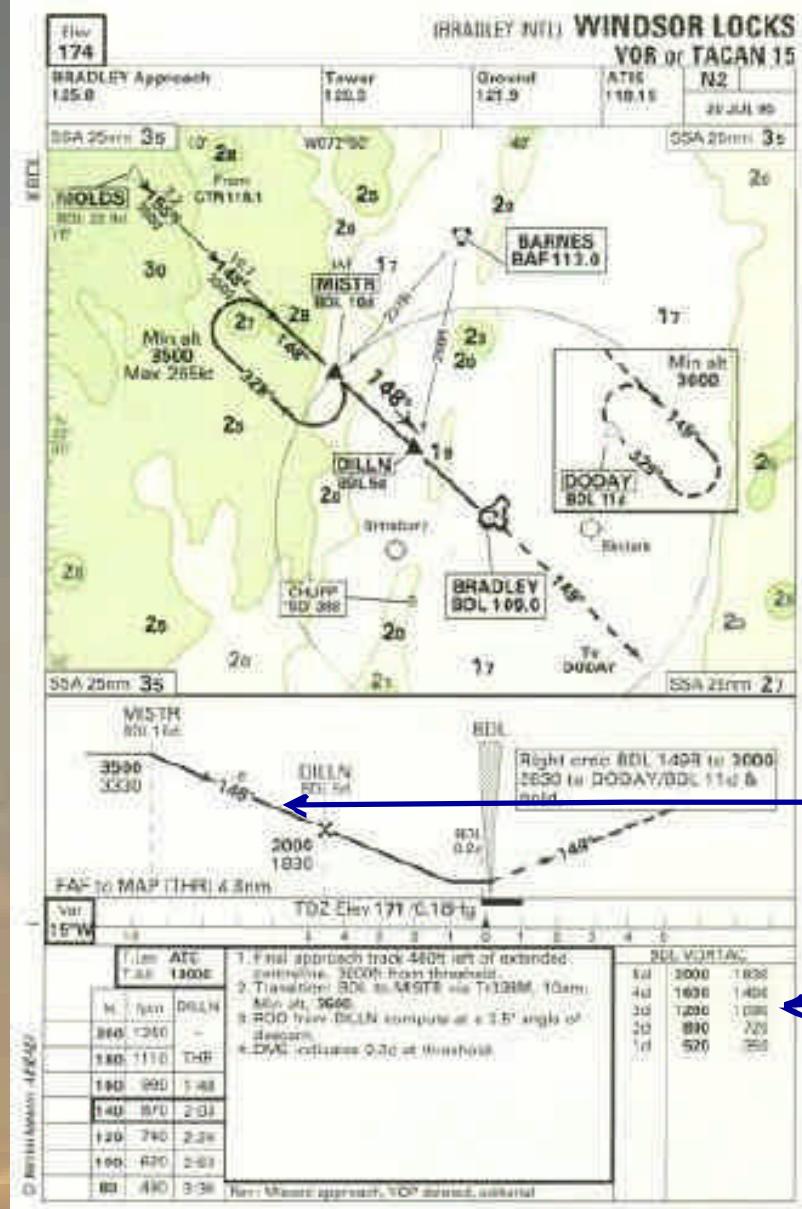
12 November 1995 American Airlines 1572 MD 82  
Hit trees on VOR DME Approach into Bradley Connecticut



# NTSB Analysis AA 1572 MD82 12 Nov 95

terrain close to other airports should be fully depicted on the appropriate approach charts. As an example, see Figure 4, the BDL approach plate used by British Airways. The Safety Board continues to believe, as reflected in Safety Recommendation A-96-102, following the accident near Buga, Colombia, that the FAA should require that all approach and navigation charts graphically present terrain information.

# NTSB Analysis AA 1572 MD82 12 Nov 95



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As an example, see Figure 4, the BDL approach plate used. The Safety Board continues to believe, as reflected in recommendation A-96-102, following the accident near Buga, that the FAA should require that all approach and navigation charts include terrain information.

**Example given of British Airways chart showing terrain information –**

***But why no emphasis given to the Constant Angle Approach checked by DME-Altitude table which keeps the aircraft above terrain?***

**Constant Angle Approach**

**DME –Altitude Tables to fly Constant Angle Approach of primary assistance**

# NTSB Conclusions AA 1572 MD82 12 Nov 95

## 3. CONCLUSIONS

### 3.1 Findings

17. There is great value in flying non-precision approaches with a constant rate or angle of descent until the airport environment can be visually acquired, if the avionics aboard the airplane can safely support such a procedure.

**No additional avionics required.  
Just DME-Altitude Cross checks on 3° profile  
by tables or slide rule –  
as used on hand flown CANPAs since 1970s  
on aircraft such as B707s with no FD or autopilot.**

# NTSB Recommendations - 13 Nov 1996

## 4. RECOMMENDATIONS

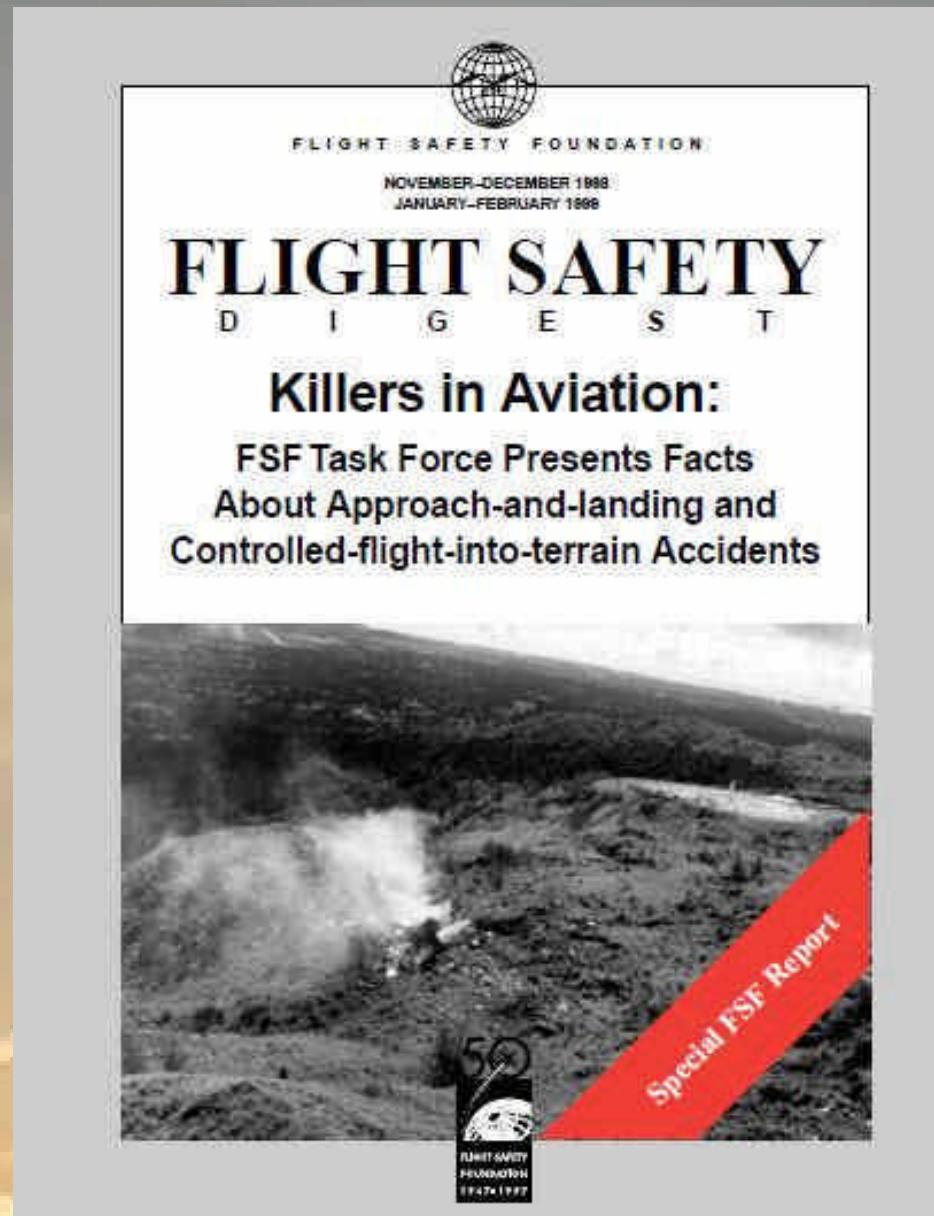
As a result of the investigation of this accident, the National Transportation Safety Board makes the following recommendations:

--to the Federal Aviation Administration:

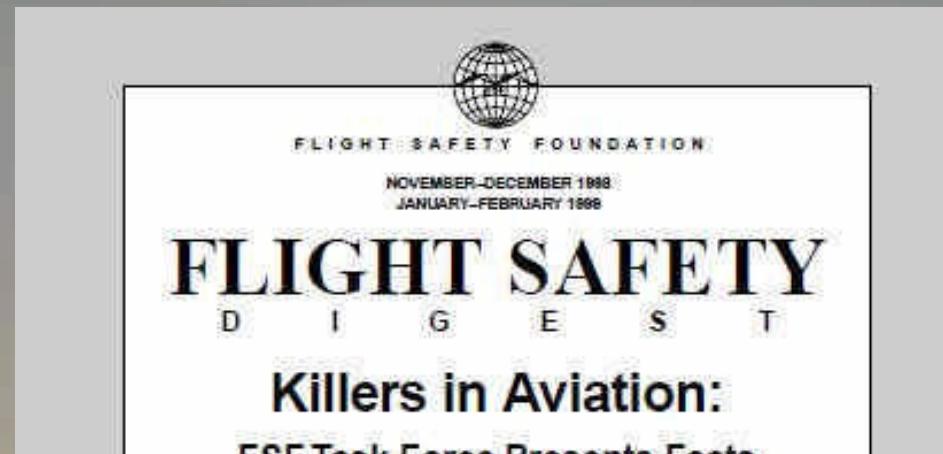
Evaluate Terminal Instrument Procedures (TERPS) design criteria for non-precision approaches to consider the incorporation of a constant rate or constant angle of descent to minimum descent altitude in lieu of step-down criteria. (A-96-128)

**Required descent angle can be followed by flying sink rate for indicated groundspeed – allowing for airspeed wind component changes – adjusted if checks show deviation from profile.**

# Ability to fly DME-Altitude CANPAs not stressed



# Ability to fly DME-Altitude CANPAs not stressed



FSF 278 page Nov-Dec 1998 CFIT Task Force Report  
only reference?

**Aircraft Equipment Working Group** Page 93  
“Operators should furnish crews with charts depicting constant-angle profiles and recommended altitudes along the glide path for nonprecision approaches;”

# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

## B747 Guam August 1997

AIR TRANSPORT

### Guam Crash Underscores Navaid, Training Concerns

By Carl E. MASTERS, AIRLINE DAILY, PA.

NTSB calls CVR, FDR for clues to Korean Air crew's familiarity with end execution of approach procedures

**L**ast week's crash of a Korean Air 747-300 over the southern mountains of Guam underscored the importance of familiarity with approach procedures as well as the training and performance of the crew of that plane.

The day it crashed, the flight indicators were functioning properly and identifying the aircraft as a Boeing 747-300, according to the National Transportation Safety Board, which is investigating the accident.

The NTSB, however, found a safety board recommendation had been ignored, calling for the removal of all the markers of extended runway in use.

Flight crews were not given approach instructions from Guam International Airport, which is 10 miles from the runway.

The Korean air approach to runway 4R at Guam required a descent in altitude to 4,000 ft before the final approach to runway 4R and VOR/DME. At 4,000 ft, the minimum altitude is 3,500 ft.



possibly the problem. During its interview, the Korean Air flight crew stated they had been given the runway 4R approach, which was not the correct one. The flight crew was performing a 'step down' approach to runway 4R, assuming

that runway 4R was the correct one. The flight crew was not performing a 'dive and drive' approach to runway 4R, assuming

that runway 4R was the correct one.

The NTSB, however, found a safety

board recommendation had been ignored, calling for the removal of all the markers of extended runway in use.

Flight crews were not given approach

instructions from Guam International

Airport, which is 10 miles from the runway.

The Korean air approach to runway 4R at Guam required a descent in altitude to

4,000 ft before the final approach to

runway 4R and VOR/DME. At 4,000 ft,

the minimum altitude is 3,500 ft.

Korean Air Flight 857 crashed near the VOR/DME in Guam between 10 and 11 minutes before impact. The investigation is ongoing to determine whether the crew followed navigation rules on approach to the airport.

It is important for the NTSB to determine whether the glideslope was cleared for the approach because the glideslope indicator did not show a constant level of one-half mile.

The aircraft struck the top of a 1,000-foot-tall mountain, which is 100 feet above the VOR/DME. The aircraft cleared the mountain, but then descended to 3,500 ft, which is 100 feet above the VOR/DME, at which point it struck the ground.

Flight crews should be trained to identify when the aircraft is above the minimum altitude for the approach and to take corrective action to bring the aircraft back to the correct altitude.

Flight crews should be trained to identify when the aircraft is above the minimum altitude for the approach and to take corrective action to bring the aircraft back to the correct altitude.



LOC GS Out Approach but DME on VOR 3.3 nm short of r/w

Step down / Dive & Drive Approach

No clear DME-Altitude Tables for VNAV checks

Glideslope flag was occasionally cleared by local FM radio station to indicate on the glideslope.



# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

B747 Guam August 1997

AIR TRANSPORT

Guam Crash Underscores

Navrad Training Concerns

NSB calls CVR, FDR for clues to Korean Aircrew's

failure to detect false glide slope signals

and to maintain altitude above the runway

despite the aircraft's proximity to the ground

and the crew's failure to respond to the

multiple false signals from the

glide slope system.

Flight crews only approach to Runway 6L

from the north, using DME and an approach

chart to determine the final approach

path to the runway.

Runway 6L is the only runway at

Guam featuring a false glide slope system.

Guam's runway 6L has a false glide slope system.

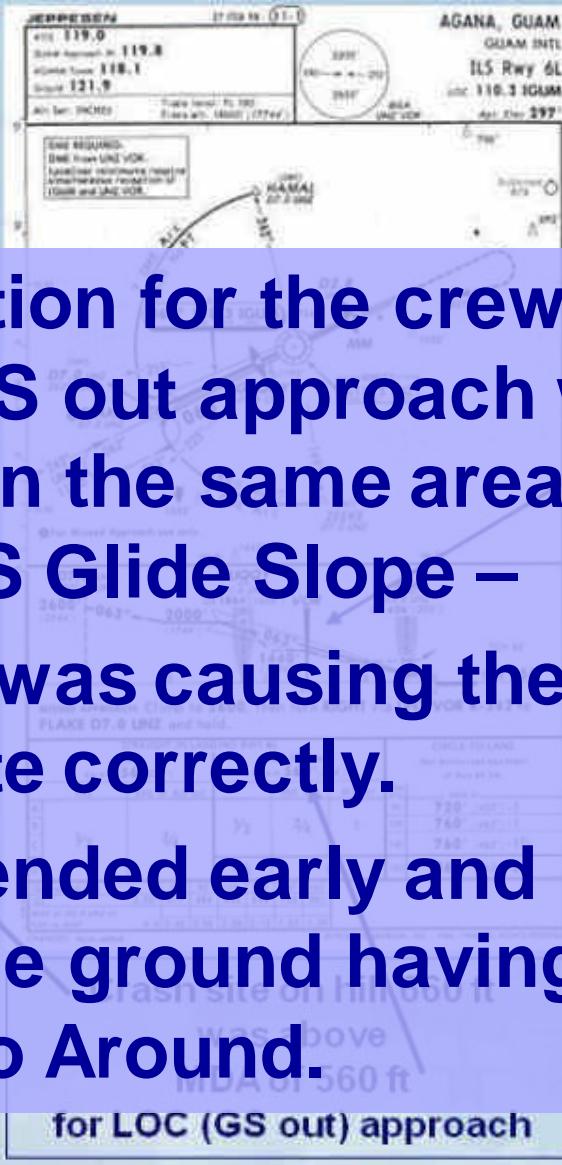
Guam's runway 6L has a false glide slope system.

Guam's runway 6L has a false glide slope system.

Guam's runway 6L has a false glide slope system.

Guam's runway 6L has a false glide slope system.

Guam's runway 6L has a false glide slope system.



A confusing situation for the crew as the profile of the LOC GS out approach was Dive & Drive although in the same area as the normal ILS Glide Slope –

and a false signal was causing the GS to indicate correctly.

The aircraft descended early and before reaching MDA hit the ground having started to Go Around.

# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

CAM-? check the glide slope if working?  
CAM-? why is it working?  
CAM-2 not usable.



# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

CAM-? check the glide slope if working?  
CAM-? why is it working?  
CAM-2 not usable.

**With the Glide Slope transmitter out of service, a radio signal was clearing the GS Fail flag giving an indication of on Glide Slope to the pilots.**

**This was a surprising/confusing distraction.**

**The captain asks if the glide slope is working and the FO confirms it is not.**



# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

CAM-1 since today's glide slope condition is not good, we need to maintain one thousand four hundred forty. please set it.

Having briefly thought the aircraft was on a serviceable glideslope, the captain has to switch back mentally to the lower Dive & Drive profile. He correctly asked the FO to set the next step of 1440ft to be maintained to the VOR, adding considerably to their workload – On a Constant Angle approach this change of profile and new altitude setting is not made.

15:40:38

2331

NTSB

2311

# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

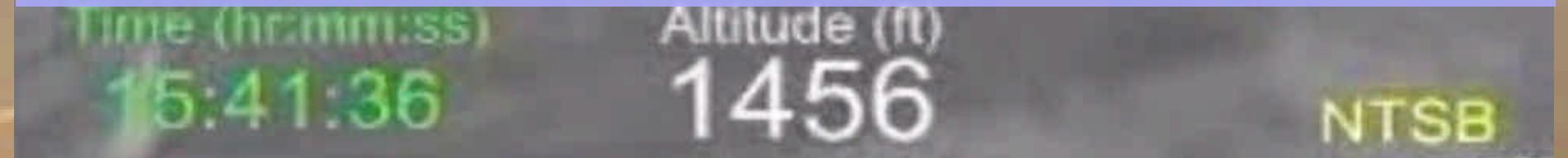


# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

CAM-1 set five hundred sixty feet. [noise increased]  
CAM [sound of rattle, similar to that of stabilizer trim]  
CAM-2 set.

**When the FO warns Approaching 1400ft the captain asks him to set the MDA of 560ft. But continues descending rather than flying level until the VOR.**

**Perhaps forgetting that the DME was not at the airfield but 3 miles closer at the VOR, although he had mentioned the 3 miles in his briefing while at cruise altitude?**

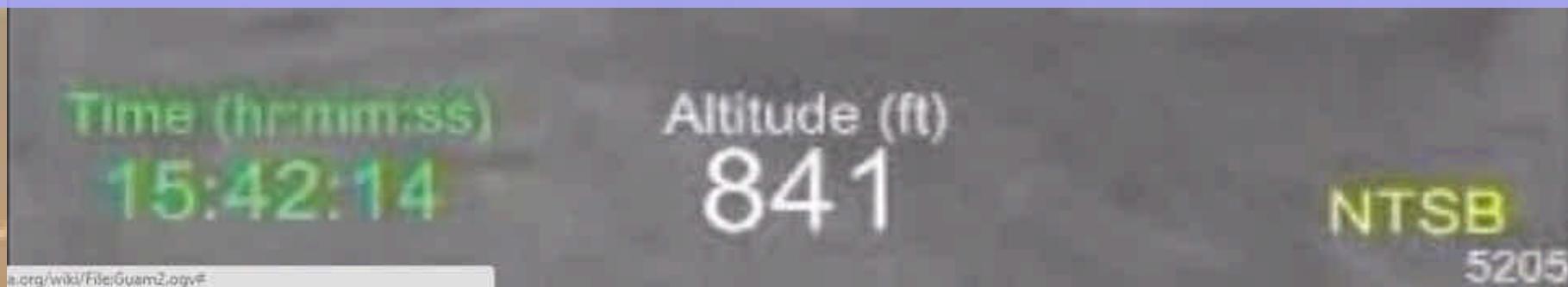


# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

CAM-? thirty thirty green.  
GPWS minimums minimums.  
CAM-3 hydraulics.

**The Flight Engineer was still reading the Landing Checklist at 600ft above the airfield altitude causing further distraction to the pilots.**

**A disadvantage of the Dive and Drive approach is that the landing configuration is achieved later than during a Constant Angle Approach**

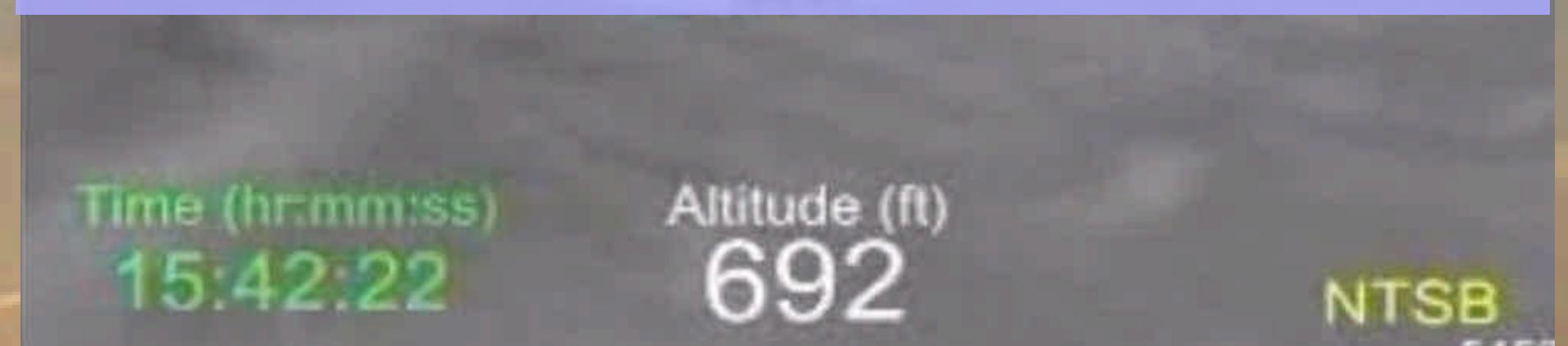


# KAL B747-300 CFIT Accident into Guam 6 Aug 1997



CAM-3 go around.  
CAM-1 go around.

**The captain started a Go Around at 692ft amsl, 130ft above the 560ft MDA, but did not pitch up quickly enough and the aircraft hit the hill of 660ft close to the VOR site.**



Time (hr:mm:ss)  
15:42:22

Altitude (ft)  
692

NTSB

# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

## B747 Guam August 1997 Airbus proposal

*The profile is identical to  
TLS VOR 14/R  
flown successfully by thousands  
of students of all nationalities,  
managed or selected approaches.*

**Airbus policy is to fly  
Constant Angle  
Approaches**

**Providing clear  
DME-Altitude tables,  
so profile can be cross-  
checked by crew and  
easily flown accurately**

**NTSB report recommendation No 9  
erroneously suggests tables showing  
Altitude - Distance to Runway.  
\*\* Altitude - Distance to DME \*\*  
is essential for instant cross-checks**



# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

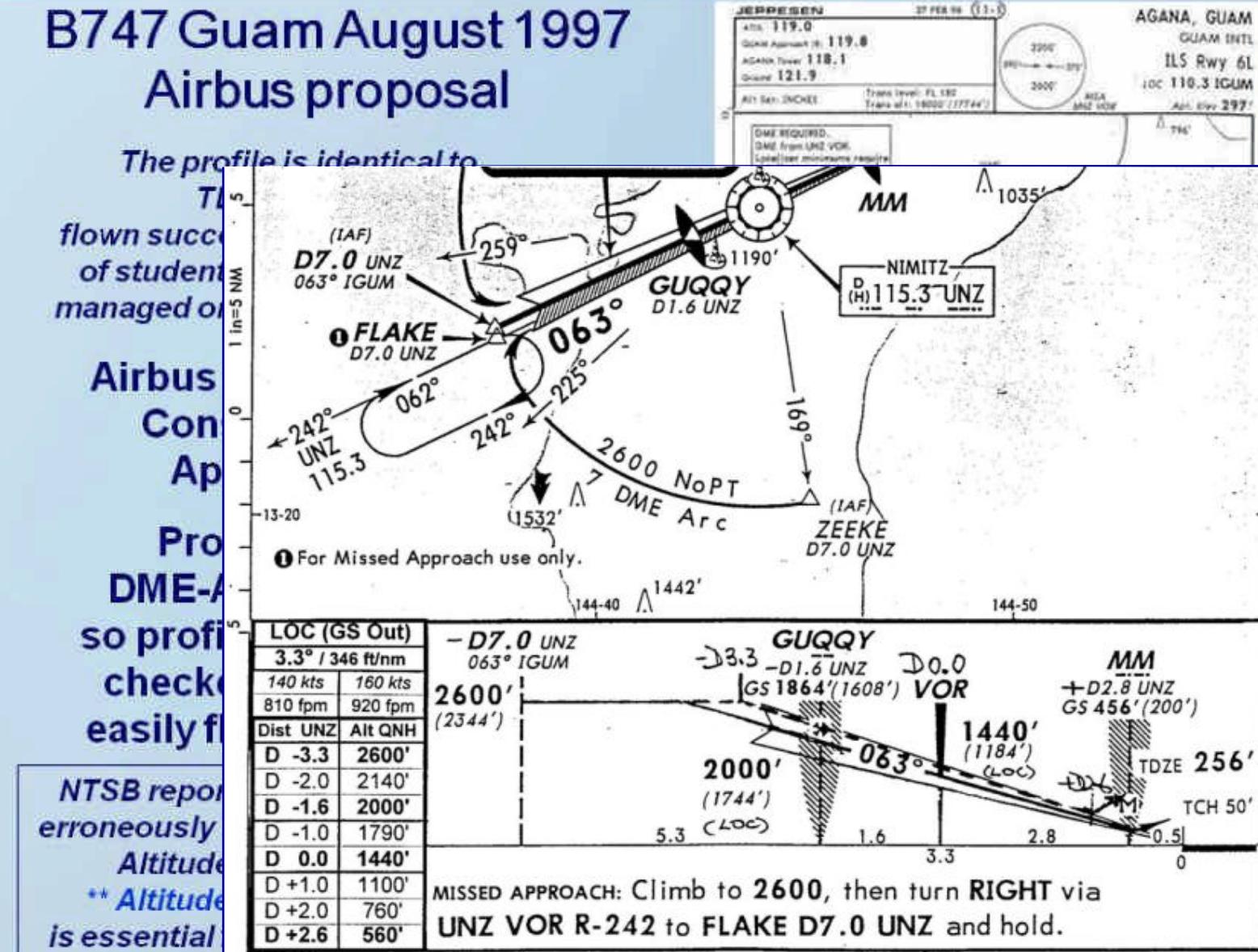
## B747 Guam August 1997 Airbus proposal

The profile is identical to

flown successfully  
of student  
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Airbus  
Con  
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DME-A  
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NTSB report  
erroneously  
Altitude  
\*\* Altitude  
is essential



# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

## B747 Guam August 1997 Airbus proposal

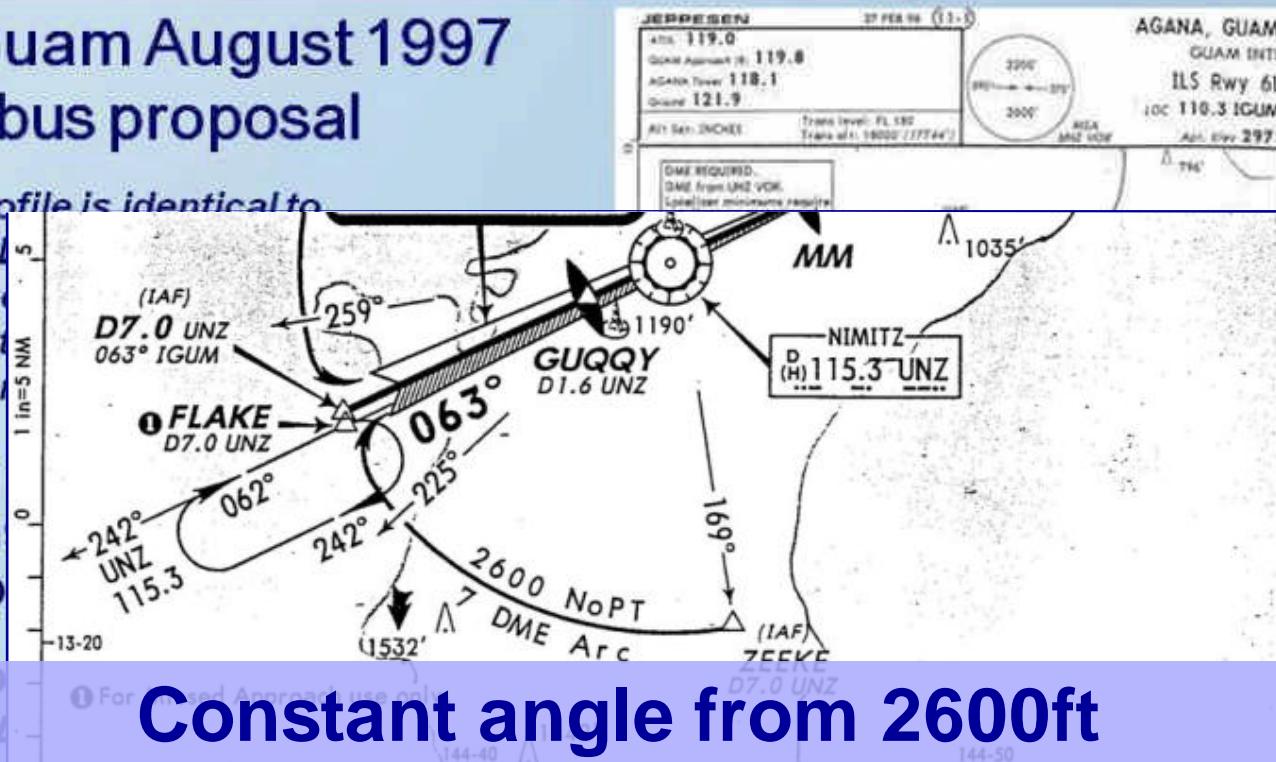
The profile is identical to

flown successfully by student managed on  
Airbus  
Con  
Ap

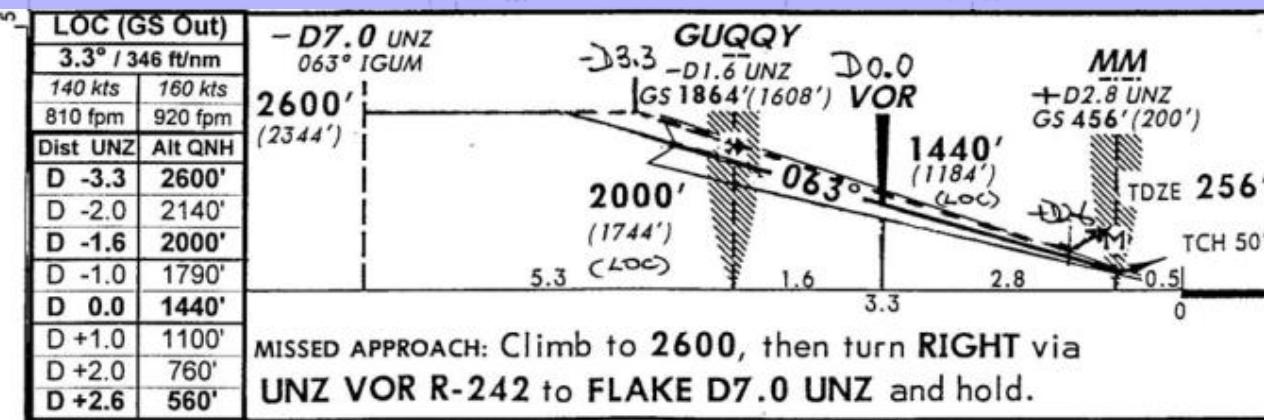
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NTSB report  
erroneously  
Altitude  
\*\* Altitude  
is essential



## Constant angle from 2600ft



# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

## B747 Guam August 1997

Airbus p

The profile is in  
The profile is in  
flown success  
of student  
managed on

Airbus

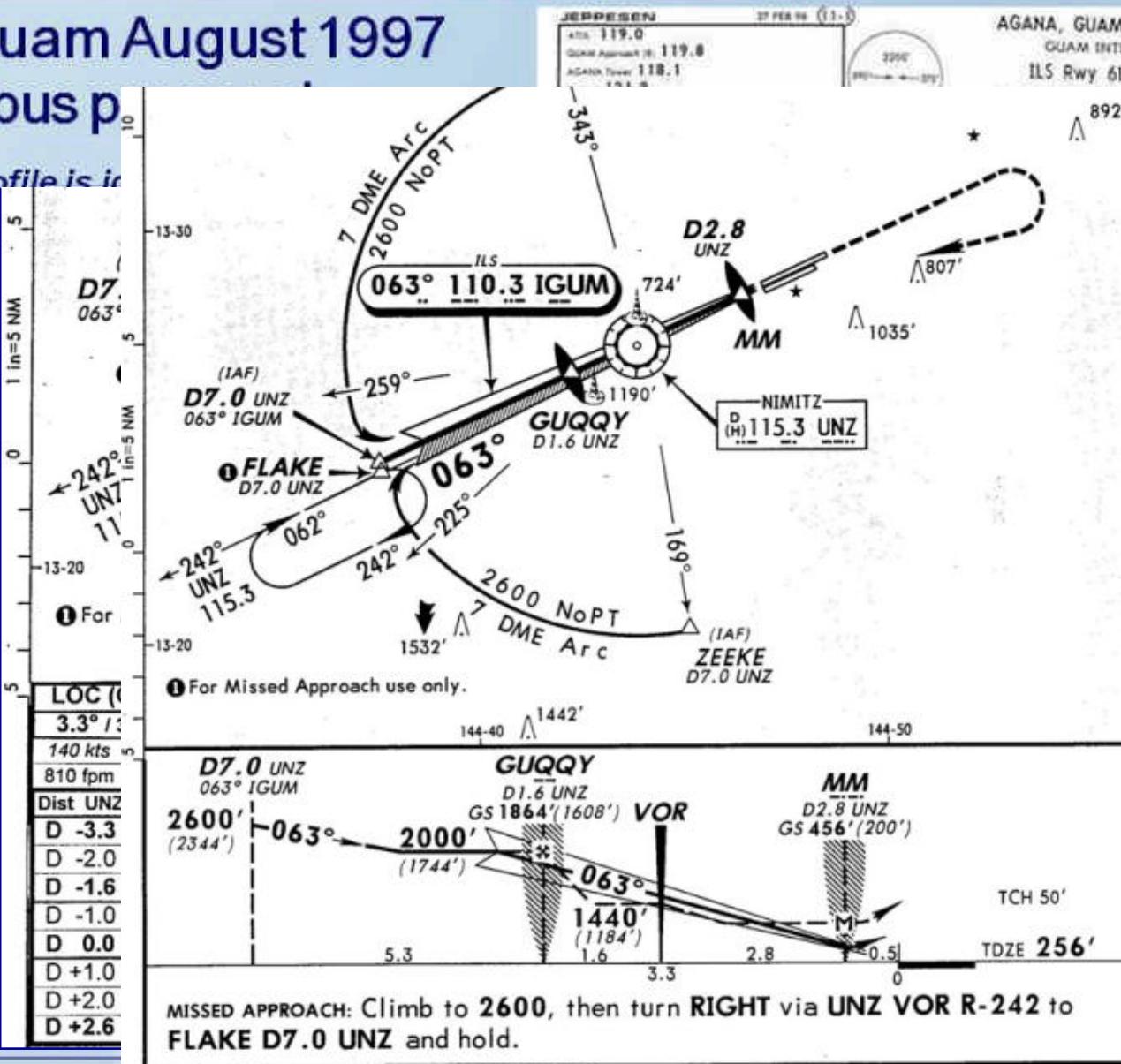
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\*\* Altitude  
is essential

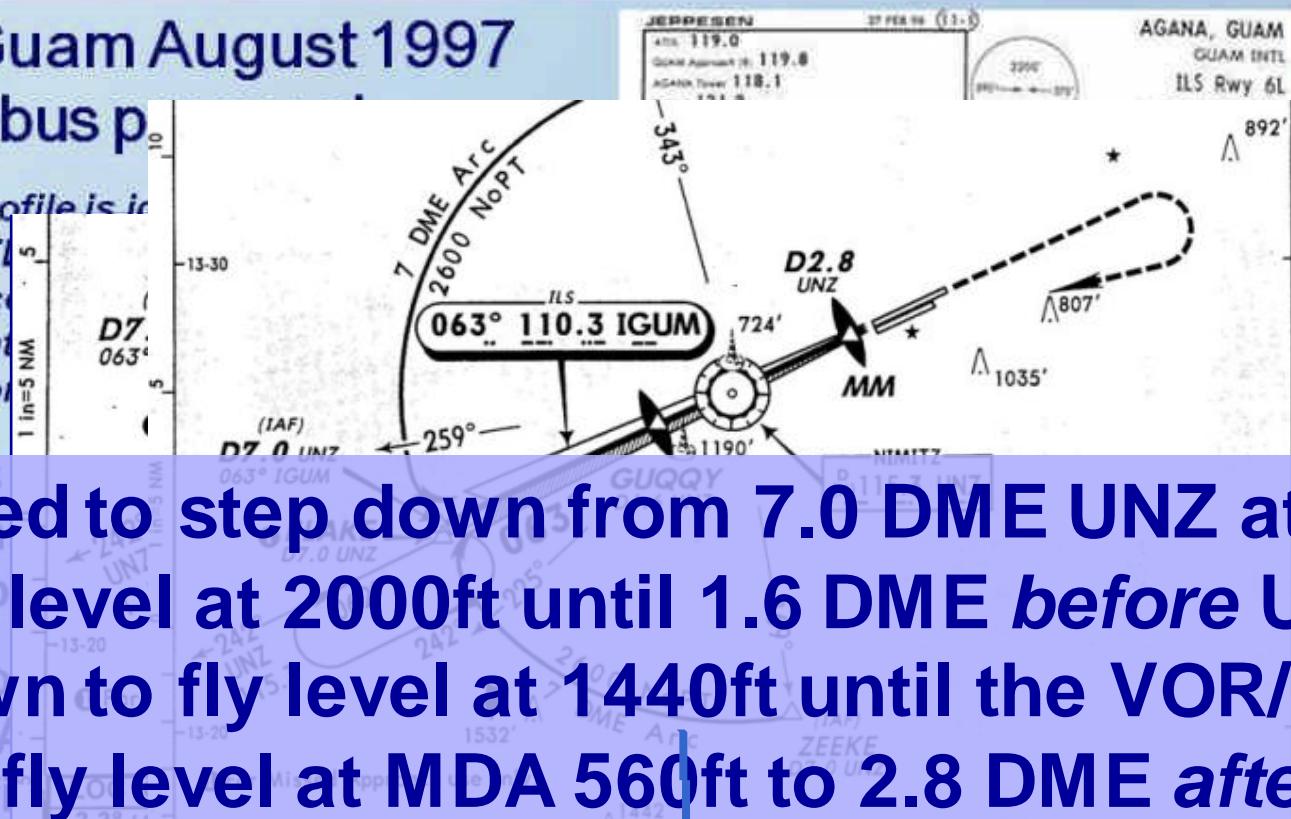


# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

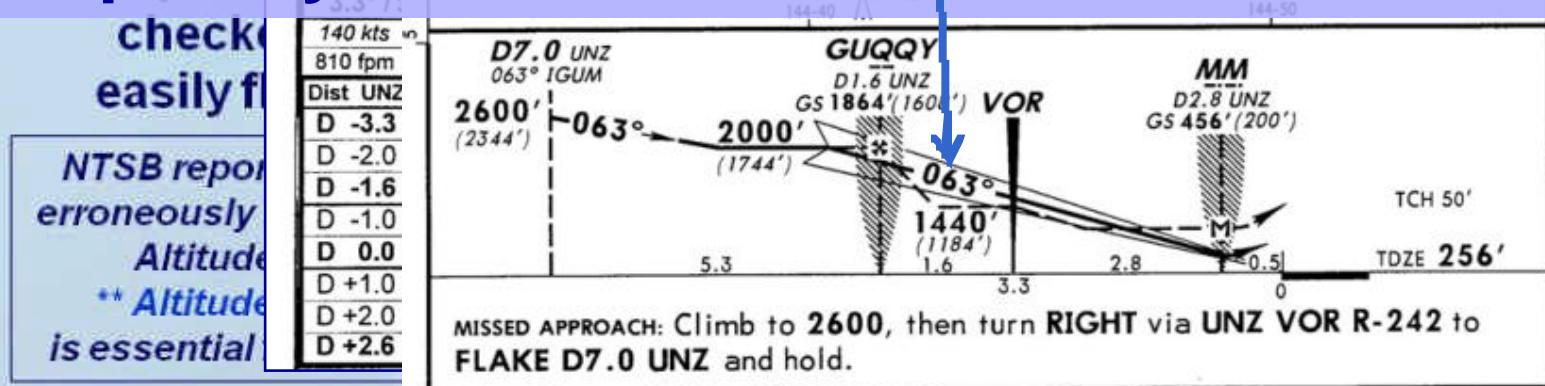
B747 Guam August 1997

Airbus p

The profile is in  
The  
flown succe  
of student  
managed on



Compared to step down from 7.0 DME UNZ at 2600ft to fly level at 2000ft until 1.6 DME before UNZ, step down to fly level at 1440ft until the VOR/0 DME, step to fly level at MDA 560ft to 2.8 DME after UNZ



2/12 Taken from - 16th Human Factors Symposium - Singapore 2002



Hugh DIBLEY : "Reduce Continuing CFIT Accidents by Supplying & Training Constant Angle NP Approaches" 59/127

# KAL B747-300 CFIT Accident into Guam 6 Aug 1997

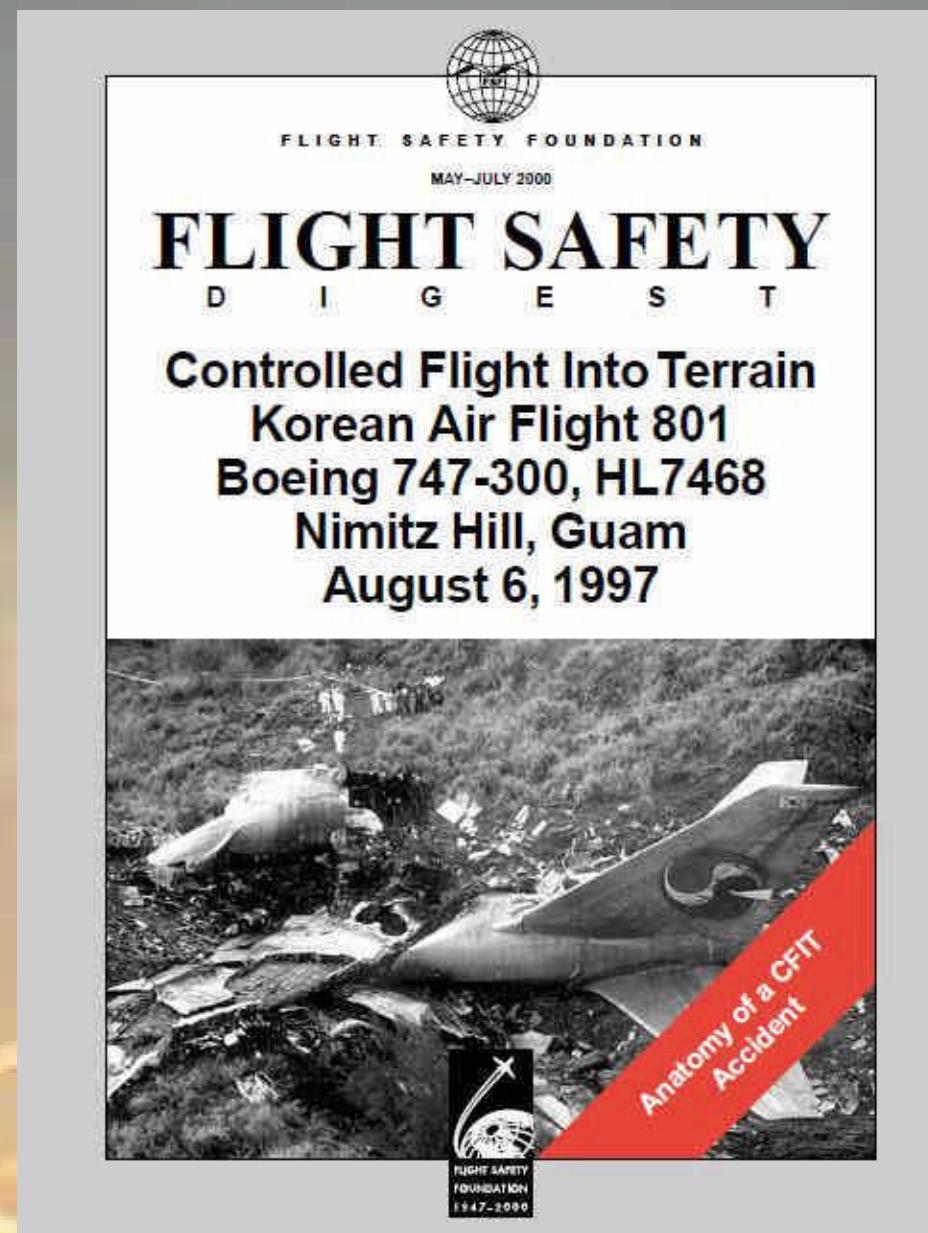
## B747 Guam August 1997 Airbus proposal

*The profile is identical to  
TLS VOR 14/R  
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Airbus policy is to fly  
Approaches  
Providing clear  
DME Altitude tables,  
so profile can be cross-  
checked by crew and  
checked by crew and  
is essential for instant cross-checks*

**If the LOC GS out approach profile has been a Constant Angle like the normal ILS glideslope, with a clear DME-Altitude table for the crew to check the aircraft to be on the correct profile, and the crew trained to use this procedure, being stabilised in the landing configuration before starting the final descent.... would the accident have still occurred?**



# NTSB Report of KAL 747 Accident Guam 8 Aug 1997



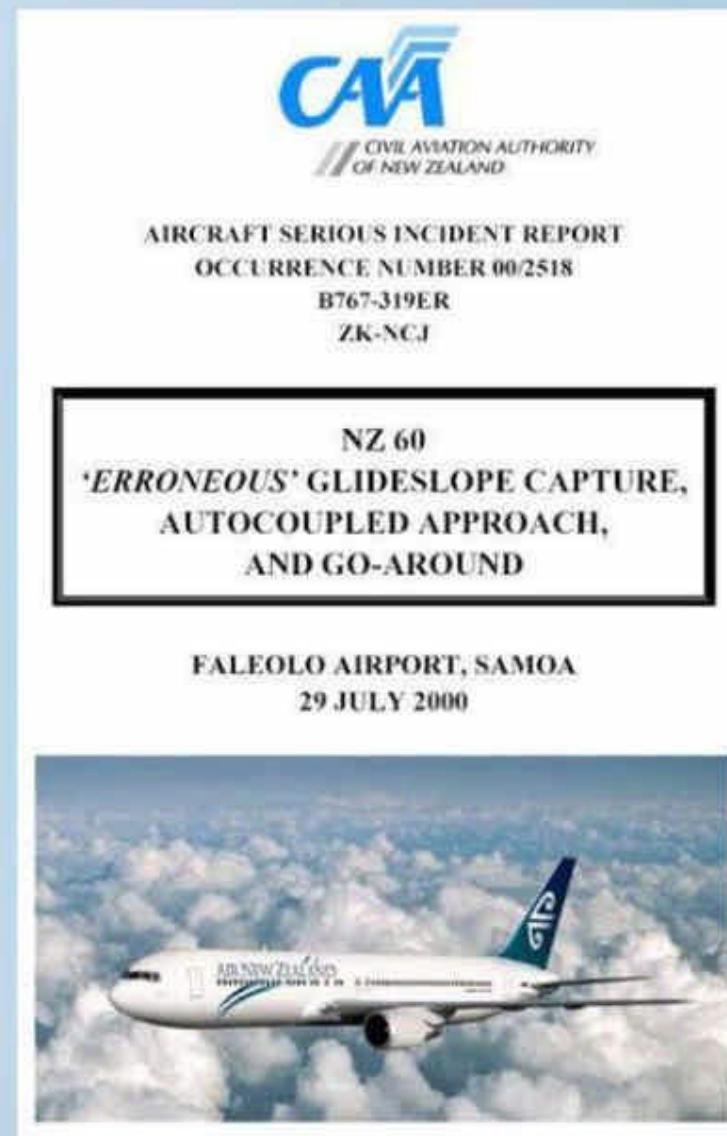


**NTSB report in FSF May-Jul 2000 FS Digest made 12 recommendations – Aircraft with suitable systems required to provide vertical flightpath guidance for constant angle nonprecision approaches, and all air carriers' aircraft to be so equipped in 10 years.**

**– “Tabular information to allow Constant Angle of Descent by cross referencing distance from the airport and barometric altitude.”**

***But distance from airport is only available from FMS/GPS equipped aircraft so the distance reference must be the local DME when FMS/GPS is not available.***

# July 2000 ANZ Erroneous GS Capture Resolved by DME-Altitude Checks



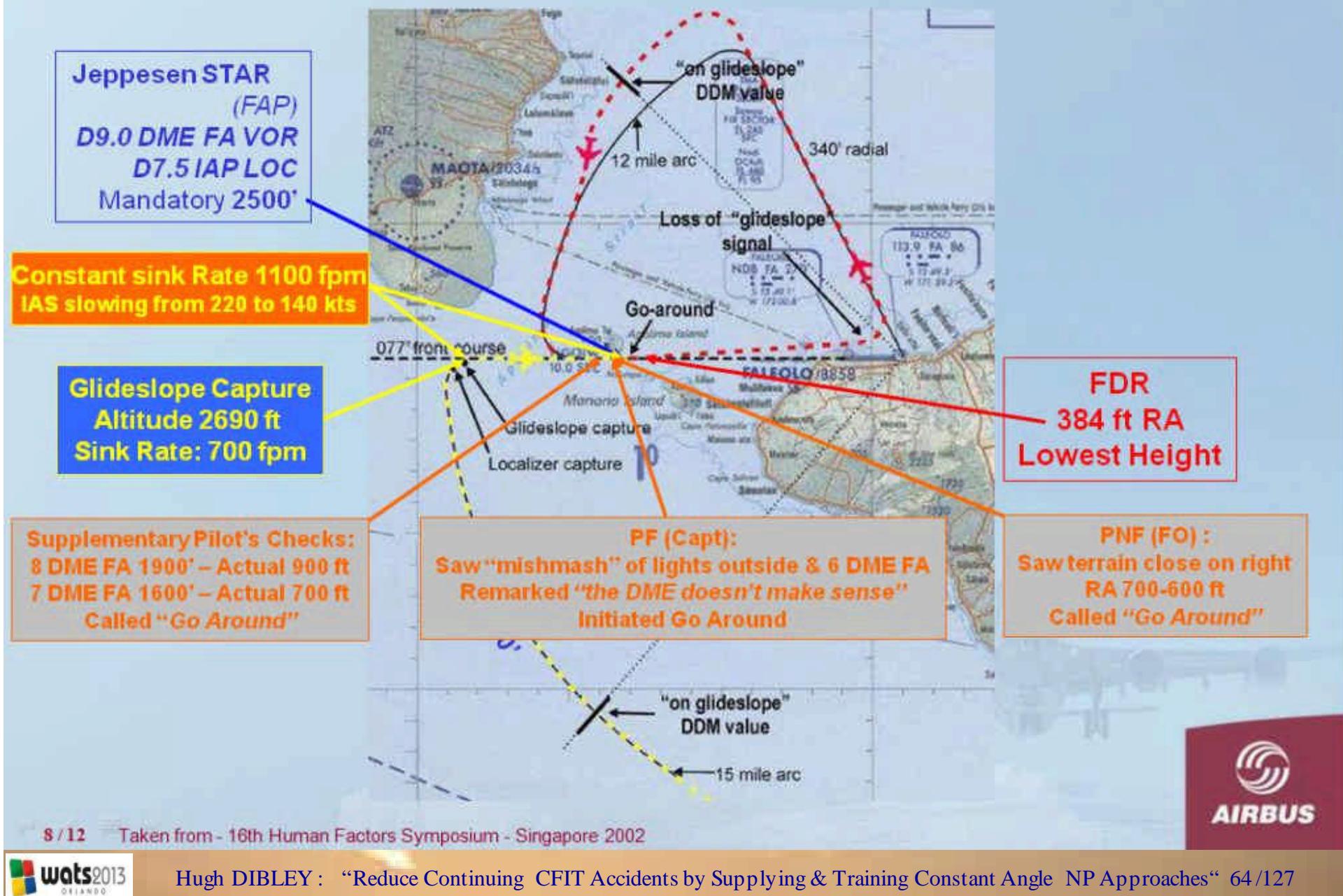
7/12 Taken from - 16th Human Factors Symposium - Singapore 2002



Hugh DIBLEY : "Reduce Continuing CFIT Accidents by Supplying & Training Constant Angle NP Approaches" 63/127



# ANZ Erroneous GS Capture Resolved by DME-Altitude Checks



## ANZ Erroneous GS Capture Resolved by DME-Altitude Checks

Jeppesen STAR  
(FAP)  
D9.0 DME FA VOR  
D7.5 IAP LOC  
Mandatory 2500'

Constant sink Rate 1100 fpm

Aircraft captured and flew an erroneous GS signal flying well below the correct glidepath.

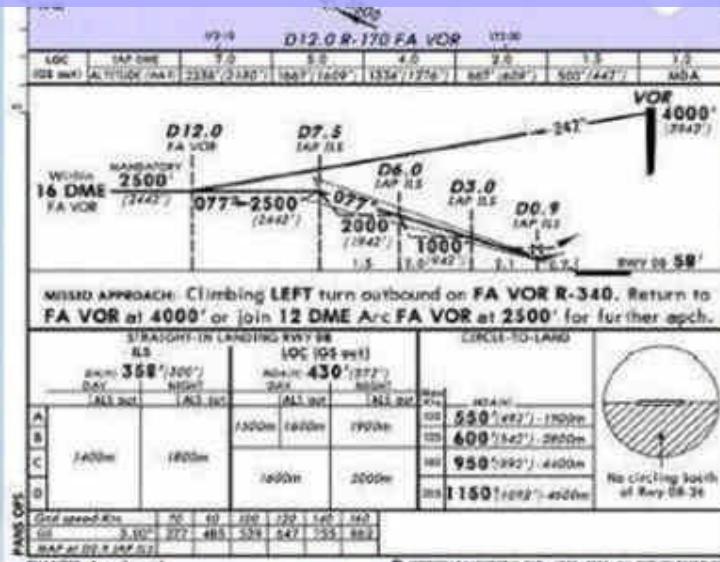
The Third Pilot called Go Around when he calculated from the DME the aircraft was 1000ft low.  
(NTSB report commented that use of the chart DME-Altitude tables would have detected the error sooner.)

# ANZ Erroneous GS Capture Resolved by DME-Altitude Checks

Jeppesen  
APIA, W SAMOA  
VOR DME ILS DME Rwy 08  
Chart In Use



## Chart in use had DME-Altitude table



9/12 Taken from - 16th Human Factors Symposium - Singapore 2002



Hugh DIBLEY : "Reduce Continuing CFIT Accidents by Supplying & Training Constant Angle NP Approaches" 66/127

## ANZ Erroneous GS Capture Resolved by DME-Altitude Checks

APW ILS LOC DME 08		
Gradient: 3.0° 323 f/nm		
120 kts	140 kts	160 kts
650 fpm	750 fpm	860 fpm
<b>D IAP</b>	Alt QNH	(HAT)
<b>D -7.5</b>	<b>2500'</b>	<b>(2442')</b>
<b>D -7.0</b>	<b>2340'</b>	<b>(2282')</b>
<b>D -6.0</b>	<b>2020'</b>	<b>(1962')</b>
<b>D -5.0</b>	<b>1690'</b>	<b>(1632')</b>
<b>D -4.0</b>	<b>1370'</b>	<b>(1312')</b>
<b>D -3.0</b>	<b>1050'</b>	<b>(1000')</b>
<b>D -2.0</b>	<b>720'</b>	<b>(662')</b>
<b>D -1.1</b>	<b>430'</b>	<b>(372')</b>

### Clear ILS Glideslope DME-Altitude, FPA, Sink Rate Tables

ILS DME IAP

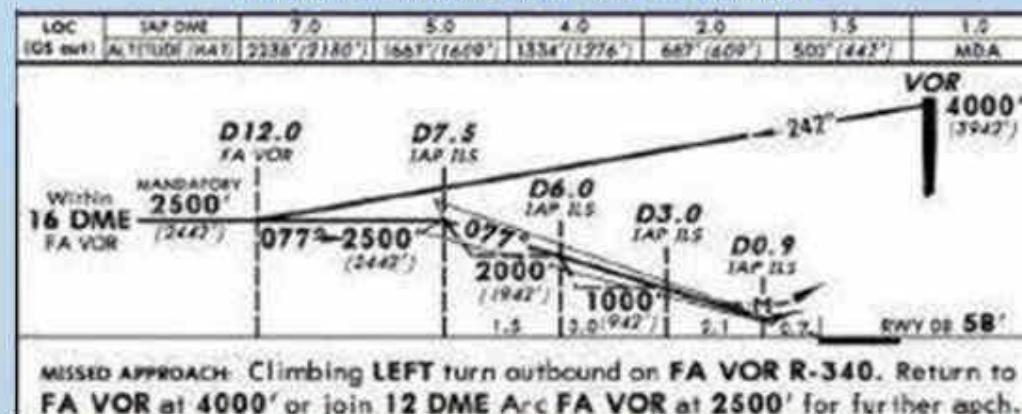
VOR DME

Supplementary Pilot's Checks:  
8 DME FA 1900' – Actual 900 ft  
7 DME FA 1600' – Actual 700 ft  
Called "Go Around"

APW ILS VOR DME 08		
Gradient: 3.0° 323 f/nm		
120 kts	140 kts	160 kts
650 fpm	750 fpm	860 fpm
<b>D KA</b>	Alt QNH	(HAT)
<b>D -9.0</b>	<b>2500'</b>	<b>(2442')</b>
<b>D -8.0</b>	<b>2180'</b>	<b>(2122')</b>
<b>D -7.0</b>	<b>1850'</b>	<b>(1792')</b>
<b>D -6.0</b>	<b>1530'</b>	<b>(1472')</b>

Third pilot's mental calculations were 300ft in error

### Jeppesen DME-Altitude Glideslope Table & Dive and Drive LOC Profile



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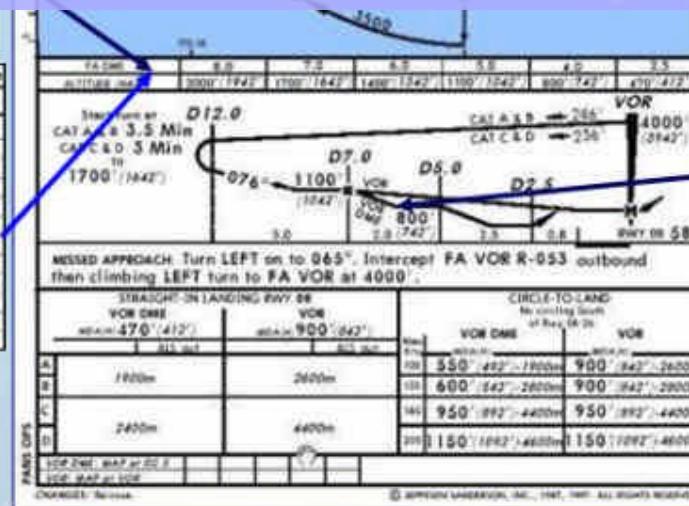
## ANZ Erroneous GS Capture Resolved by DME-Altitude Checks

Current Jeppesen  
APIA, W SAMOA  
VOR or VOR Rwy 08



## Official Procedure “Dive and Drive” Profile

## Jeppesen DME-Altitude VOR Constant Angle Profile



APW VOR DME 08		
Gradient:	1.4°	150 fpm
120 kts	140 kts	160 kts
300 fpm	350 fpm	400 fpm
D KA	Alt QNH	(HAT)
D -9.0	1400'	(1342')
D -8.0	1250'	(1192')
D -7.0	1100'	(1042')
D -6.0	950'	(892')
D -5.0	800'	(742')
D -4.0	650'	(592')
D -3.0	500'	(442')
D -2.8	470'	(412')



# ANZ Erroneous GS Capture Resolved by DME-Altitude Checks

Current Jeppesen  
APIA, W SAMOA  
VOR or VOR Rwy 08

Jeppesen DME-Altitude  
VOR Constant Angle  
Profile

Jeppesen DME-ALT Table						
APW VOR DME 08						
Gradient	2.8°	3.0°	3.5°	4.0°	4.5°	5.0°
120 kts	140 kts	160 kts				
300 fpm	350 fpm	400 fpm				
<b>D KA</b>	Alt QNH	(HAT)				
<b>D -9.0</b>	1400'	(1342')				
<b>D -8.0</b>	1250'	(1192')				
<b>D -7.0</b>	1100'	(1042')				
<b>D -6.0</b>	950'	(892')				
<b>D -5.0</b>	800'	(742')				
<b>D -4.0</b>	650'	(592')				
<b>D -3.0</b>	500'	(442')				
<b>D -2.8</b>	470'	(412')				



The industry has  
been campaigning to  
eliminate Dive & Drive

Official Procedure  
“Dive and Drive”  
Profile

VOR DME Profile		
APW VOR DME 08		
Gradient:	<b>1.4°</b>	150 fpm
120 kts	140 kts	160 kts
300 fpm	350 fpm	400 fpm
<b>D KA</b>	Alt QNH	(HAT)
<b>D -9.0</b>	1400'	(1342')
<b>D -8.0</b>	1250'	(1192')
<b>D -7.0</b>	1100'	(1042')
<b>D -6.0</b>	950'	(892')
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<b>D -4.0</b>	650'	(592')
<b>D -3.0</b>	500'	(442')
<b>D -2.8</b>	470'	(412')



11 / 12 Taken from - 16th Human Factors Symposium - Singapore 2002



Hugh DIBLEY : “Reduce Continuing CFIT Accidents by Supplying & Training Constant Angle NP Approaches” 69/127

### Standardised DME-Altitude Tables on Approach Charts will :

- Present all information together – DME-Altitudes, FPA and Sink Rate required
- Make Crews aware of tables – *Jeppesen tables not always noticed by crews*
- On precision approaches, allow Baro Altimeter setting accuracy checks at each mile, rather than at 1 quoted DME distance on chart
- Allow false glideslopes / anomalies / failures to be easily detected
- Enhance crew awareness of Baro Altimeter variation with temperature, so improve chances of detecting / correcting QNH setting errors, reduce cases of incorrect crew reports – and NPA threats
- Keep crews familiar with NPA procedures and thus avoid threat of LOC / VOR DMEs accidents.



# CFIT NPA Accidents Continued –

## In 2002 Don Bateman, father of GPWS/EGPWS, published 9 NPA CFIT accidents which could have been saved if EGPWS had been fitted

**SOME RECENT CFIT ACCIDENT EXAMPLES  
SUMMER 2001 TO SUMMER 2002 (ONE YEAR)  
IATA SAC 12/13 AND IATA SAC 14**

This booklet is an incomplete brief of nine large civil aircraft accidents suspected to be CFIT that have occurred over the last year:

24 Nov 2001	Zurich, SR	RJ-100 No DME/Alt. 24 F of 23
27 Nov 2001	Port Harcourt, Nigeria	B747 No DME/Alt. 1 F of 14
18 Jan 2002	Nr. Ipiales, Colombia	FH-227 -222000 26 F
28 Jan 2002	Tulcan, Ecuador	B-727 92 F
12 Feb 2002	Khorramabad, Iran	Tu-154 No DME/Alt. 11 F
15 Apr 2002	Pusan, Korea	B707[No DME/Alt] 130 F of 167
07 May 2002	Tunis, Tunisia	B737* [No DME/Alt] 18 F of 62
01 June 2002	George, South Africa	HS-748[No DME/Alt] 3 F of 3
26 July 2002	Tallahassee, Florida	B727 0 of 3

**Described on following slides**

**DME Available for Approach – but No DME-Altitude table to show Constant Descent Approach Angle.**

***But 5 had DME available but no DME-Altitude tables on the charts which could have avoided an accident.***

# Crossair RJ 100 CFIT Accident Zurich 24 Nov 2001

## RJ100 Zurich November 2001

SAFETY DAVID LEARMOUNT/LONDON

### Swiss crash puts noise rules in spotlight

Crossair's fatal crash during final approach to Zurich Kloten airport on 24 November came just a month after a new noise abatement procedure began forcing pilots to use a non-precision approach to the airport at night.

Instrument landing system (ILS) precision approaches were available at Kloten on the night of the crash, when the visibility was poor in light snow, but only on runways affected by the new noise-abatement rules.

Crossair says that its BAE

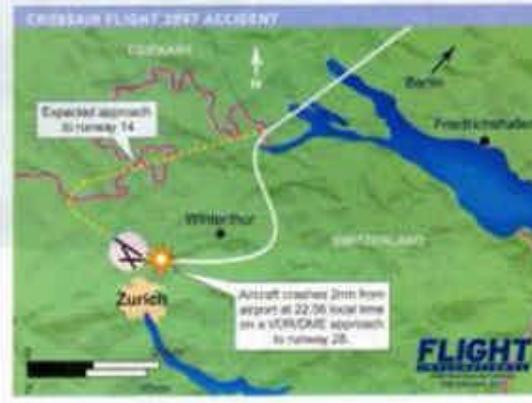
Systems Avro RJ100 (HB-DCM) was "too low" for that stage of its approach, though the airline does not yet know why. Inbound to Zurich from Berlin, it hit the ground in a wooded area 2nm (3km) from the threshold of runway 28. The airline confirms that 21 of the 28 passengers and three out of the crew of five died.

The pilots originally briefed for an ILS approach to runway 14, but were told the approach would be a VOR/DME approach to runway 28. This entails flying on range and

bearing information from a navigation beacon on the airfield, but it does not give the glidepath guidance that an ILS provides.

The radio altimeter warned the crew when they reached 500ft (150m) and then 300ft above ground level (AGL), but the crew had still not reported the airfield in sight. Just after that, say investigators, the captain - who was the pilot flying - told the co-pilot he was going-around (abandoning the approach), but it was too late and the aircraft hit tree tops.

The new noise abatement procedures, agreed between Germany and Switzerland, rule out all except essential use of the two main ILS runways (14 and 16) after 22:00 because an approach from the north means the aircraft flies low over southern Germany. The accident occurred at 22:06. Switzerland's aviation authority says that Zurich has been planning to install an ILS for runway 28, but the authority says that it would be more than a year before it could be operational.



#### The big difference

The Flight Safety Foundation (FSF) says that studies by its Approach and Landing Accident Reduction (ALAR) working group have established that the use of non-precision approaches raises the risk of serious accidents by a multiple of between five and seven compared with statistics for precision approaches. Before the initial ALAR study was published five years ago, it was tacitly accepted by the industry that precision approaches were better, but no-one had established what the difference was. It was also assumed that divergence between performance probably resulted from the fact that small operators at remote airfields usually used non-precision aids. But the ALAR found that, since the crews of large airlines carry out proportionately fewer non-precision approaches than pilots in small aircraft, they are worse at them. Since then the FSF has been campaigning for phasing-out approaches like that used by the RJ100 at Zurich.

[www.flighthinternational.com](http://www.flighthinternational.com)

What was the main threat that caused the accident?



3 / 12 Taken from - 16th Human Factors Symposium - Singapore 2002



Hugh DIBLEY : "Reduce Continuing CFIT Accidents by Supplying & Training Constant Angle NP Approaches" 72/127

# Crossair RJ 100 CFIT Accident Zurich 24 Nov 2001

## VORDME Rwy 28 Chart in use



## Threats?

### No DME-Altitude Table.

**Crew cannot cross-check profile continuously during approach.  
PNF unable to monitor properly.**

(Aircraft descended below profile and hit hill. Captain remarks having visual contact.)

## Dual Segment NPA

## Start Approach at 8 DME - 4,000 ft

On 5.3% [3.0°] gradient to  
6 DME - 3,360 ft

**Continue on 5.3% gradient,  
‘When in Visual contact with 3.7° PAPIs  
Descend with 394 ft/nm (6.5%)’**

# Crossair RJ 100 CFIT Accident Zurich 24 Nov 2001

VOR DME Rwy 28 Chart in use



Threats?

No DME-Altitude Table.

Crew cannot cross-check profile continuously during approach.  
PNF unable to monitor properly.

*(Aircraft descended below profile and hit hill. Captain remarks having visual contact.)*

The FO had no way of monitoring the descent path.



Start Approach  
at 8 DME - 4,000 ft

On 5.3% [3.0°] gradient to  
6 DME - 3,360 ft

Continue on 5.3% gradient,  
'When in Visual contact with 3.7° PAPIs  
Descend with 394 ft/nm (6.5%)'



# Crossair RJ 100 CFIT Accident Zurich 24 Nov 2001

## Airbus chart with 3.7° DME-Altitude Table



**Threat Reduction :**  
Constant Angle NPAs are  
now recommended by ICAO.  
Should not also standardised  
DME-Altitude tables  
required to be shown on all charts?

Airbus FMGC Database contains ZRH 28  
VOR DME Approach with 3.7° Profile,  
which can be flown 'managed',  
automatically to MDA.

The same 3.7° approach  
can easily be flown selected,  
using a DME – Altitude Table.  
Providing a simple monitoring task,  
even for inexperienced  
crew members.

max 3.15° GS only applies to Cat 3



# Crossair RJ 100 CFIT Accident Zurich 24 Nov 2001

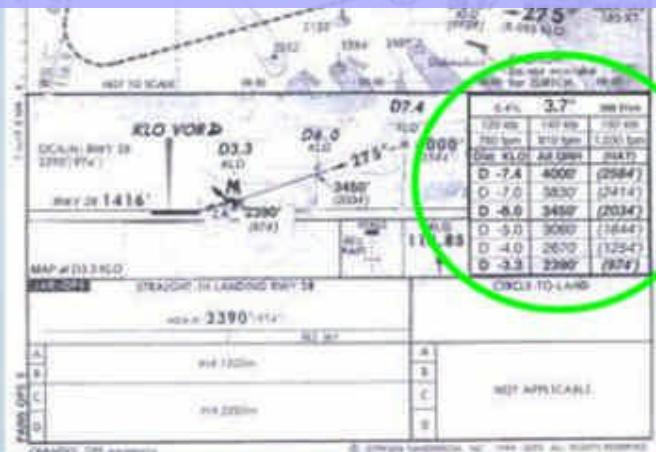
## Airbus chart with 3.7° DME-Altitude Table



Threat Reduction :  
Constant Angle NPAs are  
now recommended by ICAO.  
Should not also standardise  
DME-Altitude tables  
required to be shown on all charts?

Airbus FMGC Database contains ZRH 28

**The FO could have easily checked the aircraft was low from the tables and advised the captain.**



The same 3.7° approach  
can easily be flown selected,  
— using a DME – Altitude Table.  
Providing a simple monitoring task,  
even for inexperienced  
crew members

*max 3.15° GS only applies to Cat 3*





# **Flight Safety Foundation CFIT Accident Data 1998 to 2011 from Jim BURIN**

# CFIT

All Commercial Turbojets



# CFIT

95% of all commercial jets have been equipped with TAWS (Terrain Awareness and Warning Systems) since 2007. Over the last 6 years, there have been 37 commercial aircraft CFIT accidents (14 jet, 23 turboprop). Only 3 equipped with a functioning TAWS

Over the last 2 years, over 50% of the commercial jet fatalities have been caused by 6 CFIT accidents,. Because of this, CFIT is about to regain its title as the leading killer.

The vast majority of CFIT accidents continue to involve aircraft without a functioning TAWS, and most have no TAWS installed

# Flight Safety Foundation CFIT Accident Data 1998 to 2011 from Jim BURIN – involving NPAs

## 2001 (3: 2/1)

25 Nov 2001	Crossair	RJ100	Zurich, Switzerland
<i>VOR DME NPA with no DME-Altitude cross checks – could have flown CDA</i>			
27 Nov 2001	MK Airlines	B747	Port Harcourt, Nigeria
<i>LOC DME NPA with no DME-Altitude cross checks – could have flown CDA</i>			

---

## 2002 (5: 4/1)

28 Jan 2002	TAME	B727	Ipiales, Columbia
<i>Flew into terrain as flying too fast took outside holding pattern into volcano</i>			
15 Apr 2002	Air China	B767	Pusan, South Korea
<i>Flew into terrain after loss visual reference on extended downwind of circling approach</i>			
7 May 2002	Egyptair	B737	Tunis, Tunisia
<i>Flew into terrain 3.8nm from airport on second approach – DME-Altitude info on chart not used</i>			
26 July 2002	Federal Express	B727	Tallahassee, Florida(0)
<i>Flew into trees when low late on the approach – fatigue etc a factor</i>			

---

## 2003 (6: 4/2) (First time Eastern Aircraft included on list)

8 Jan 2003	Turkish Airlines	RJ100	Diyarbak, Turkey
<i>Crashed 800m short of r/w 34 on VOR DME Approach – could have flown CDA</i>			
8 Jan 2003	TANS	F28	Chachapoyas, Peru
<i>On approach flew into mountainous terrain in heavy rain</i>			

# Flight Safety Foundation CFIT Accident Data

1998 to 2011 from Jim BURIN – involving NPAs

But only 4 involving accidents on NPAs  
and none since 2003....(Don Bateman records 3)

One recent accident classified as loss of control.....

A recent serious incident caused by capturing the  
false/mirror ILS glideslope.....

Airlines which are expanding rapidly still using  
Dive and Drive for Non Precision approaches.....

(Remark of crew on first CANPA “This is very easy!”)

Thousands of approach charts drawn to  
questionably safe Step Down profiles and no  
Distance – Altitude tables.....

Indicates that there is still work to be done.....

**Also crews do not always respond to GPWS -  
During 3 recent CFIT accidents crews have  
ignored or even cancelled EGPWS warnings**

**10 April 2010 Polish Air Force Tu-154 continued  
after Terrain Ahead & Pull Up warnings**

**20 Apr 2012 Bhoja Air Boeing 737 into Islamabad.  
Captain continued downwind despite  
EGPWS warning and advice from FO.**

**10 May 2012 Sukhoi Superjet-100 descended below  
MSA and into side of volcano.**

**In a recent accident crew responded to EGPWS  
but then lost control during the Go Around**

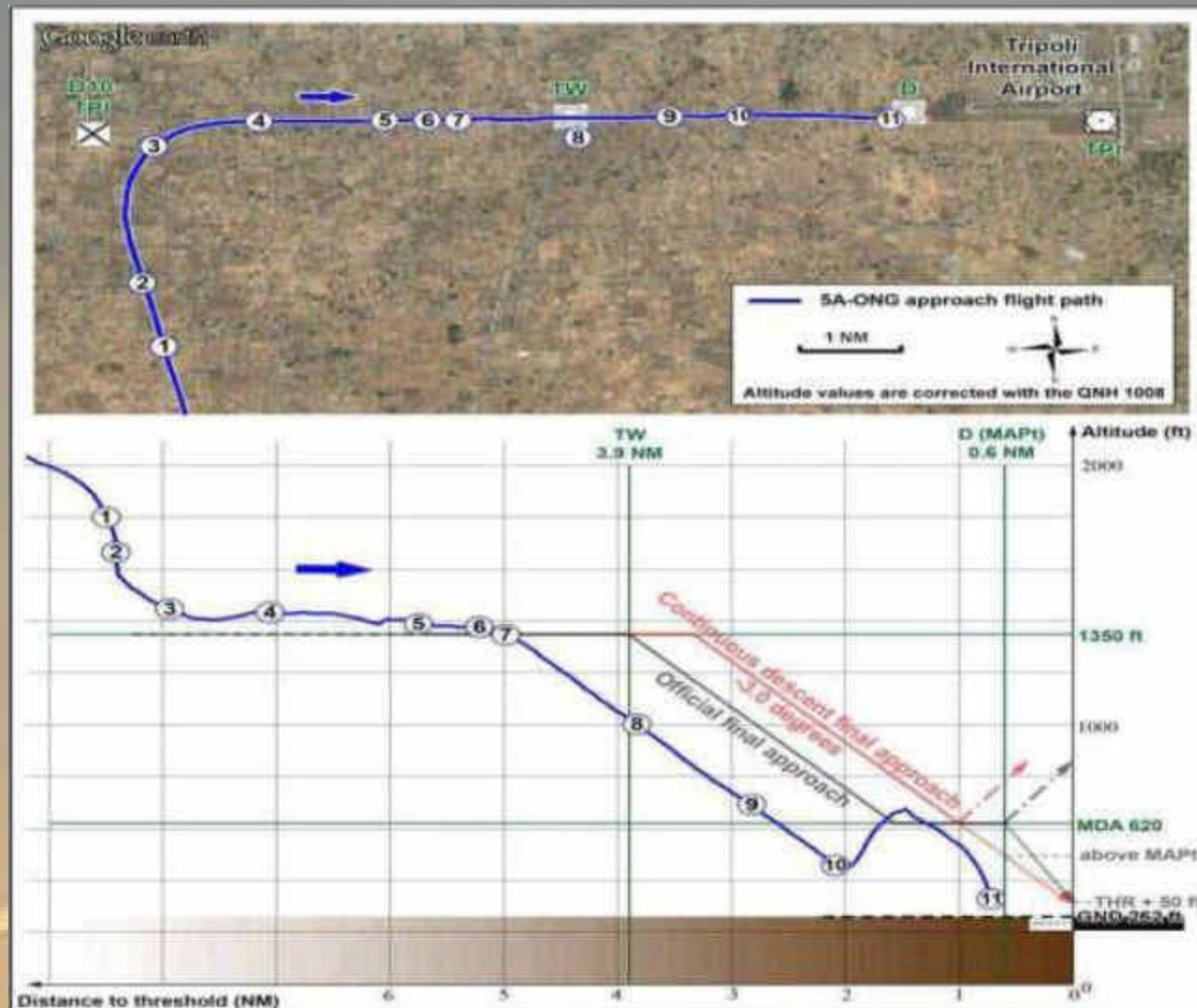
**On 12 May 2010 Afriqiyah A330 Crashed during Go  
Around after an incorrectly flown NDB Approach**



### **Final Report**

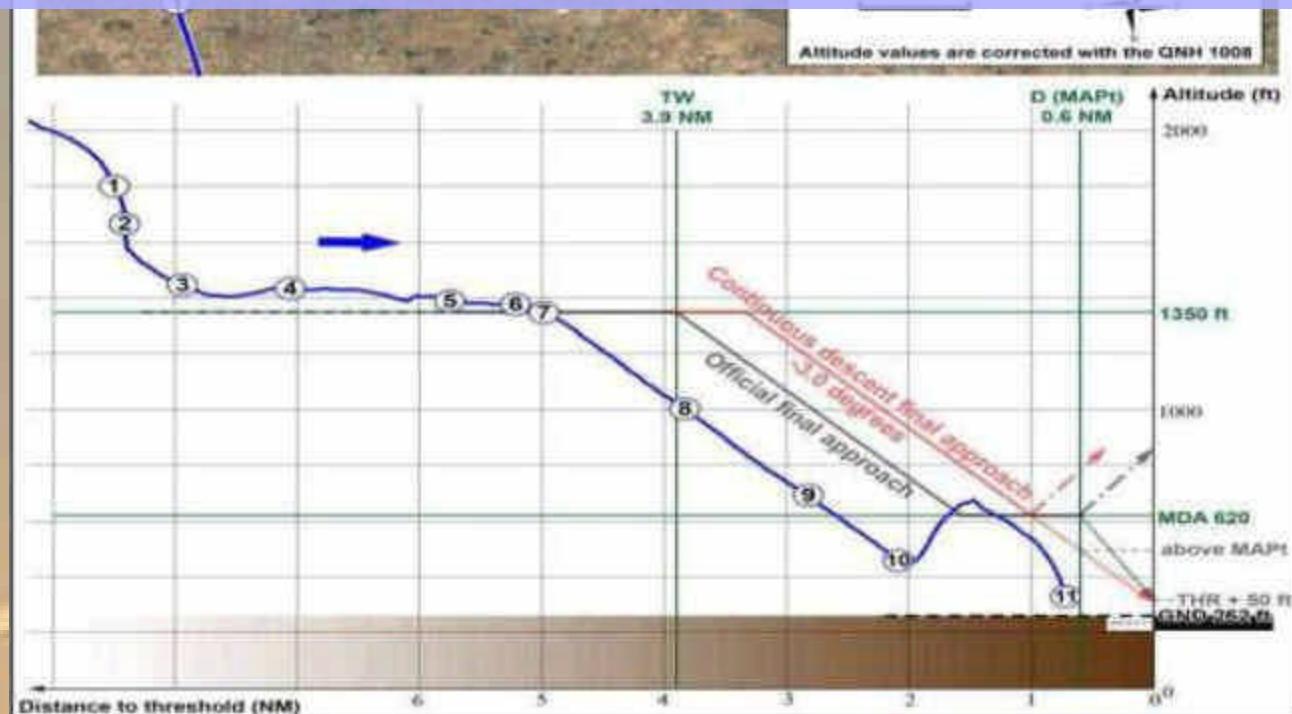
of AFRIQIYAH Airways Aircraft  
Airbus A330-202, 5A-ONG Crash  
Occurred at Tripoli (LIBYA)  
on 12/05/2010

# On 12 May 2010 Afriqiyah A330 Crashed during Go Around after an incorrectly flown NDB Approach

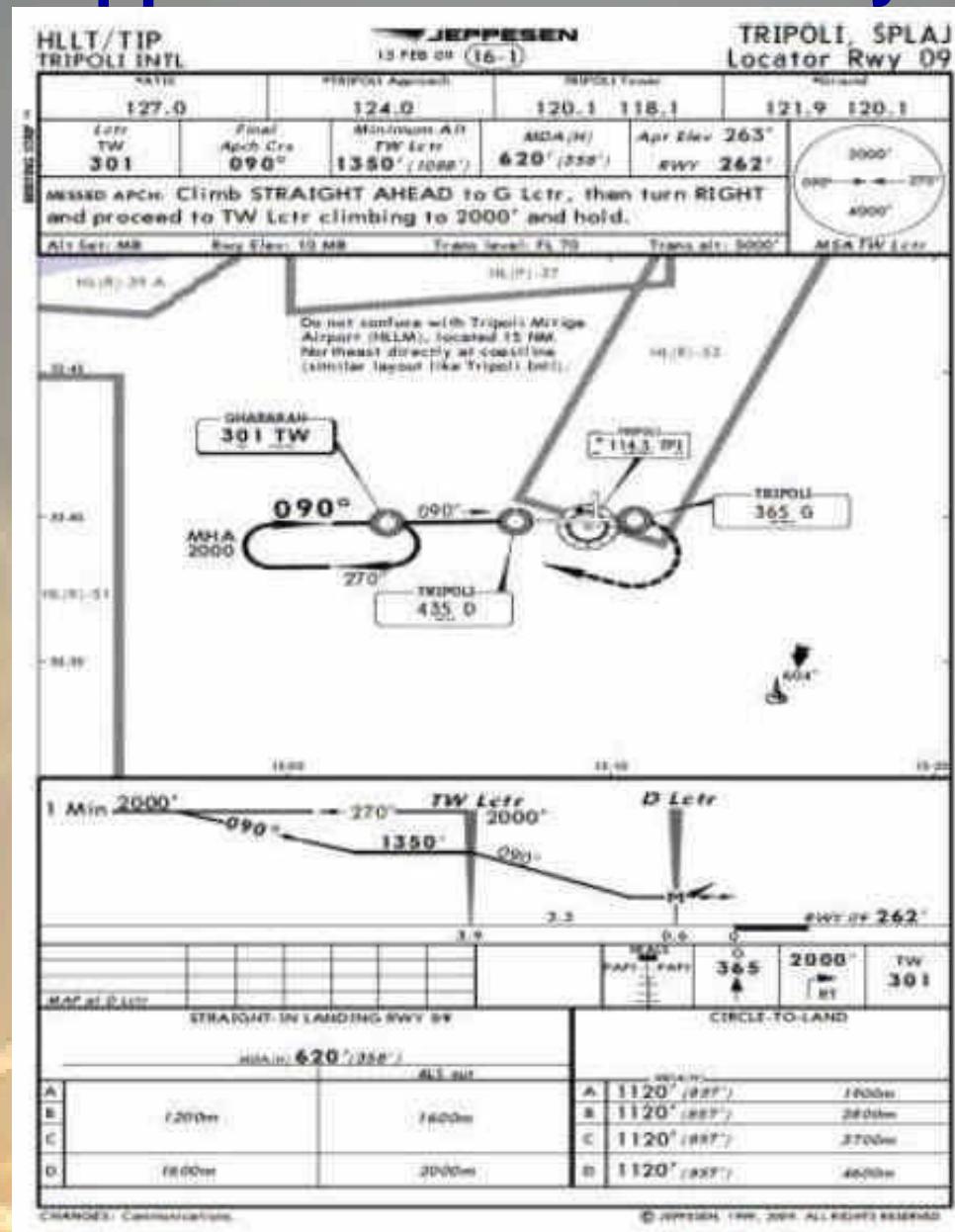


## On 12 May 2010 Afriqiyah A330 Crashed during Go Around after an incorrectly flown NDB Approach

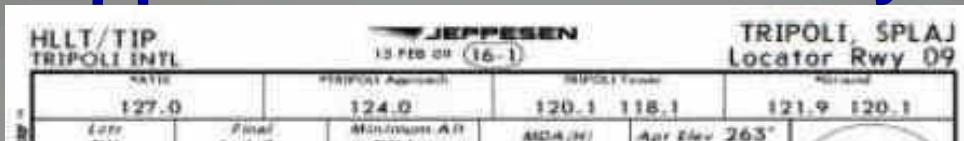
The FO selected the correct Flight Path Angle for the final approach but about 1.8 nm early. Perhaps because confused with the DME distance to descend on a separate VOR DME approach.



# NDB Approach Chart Used by crew



# NDB Approach Chart Used by crew



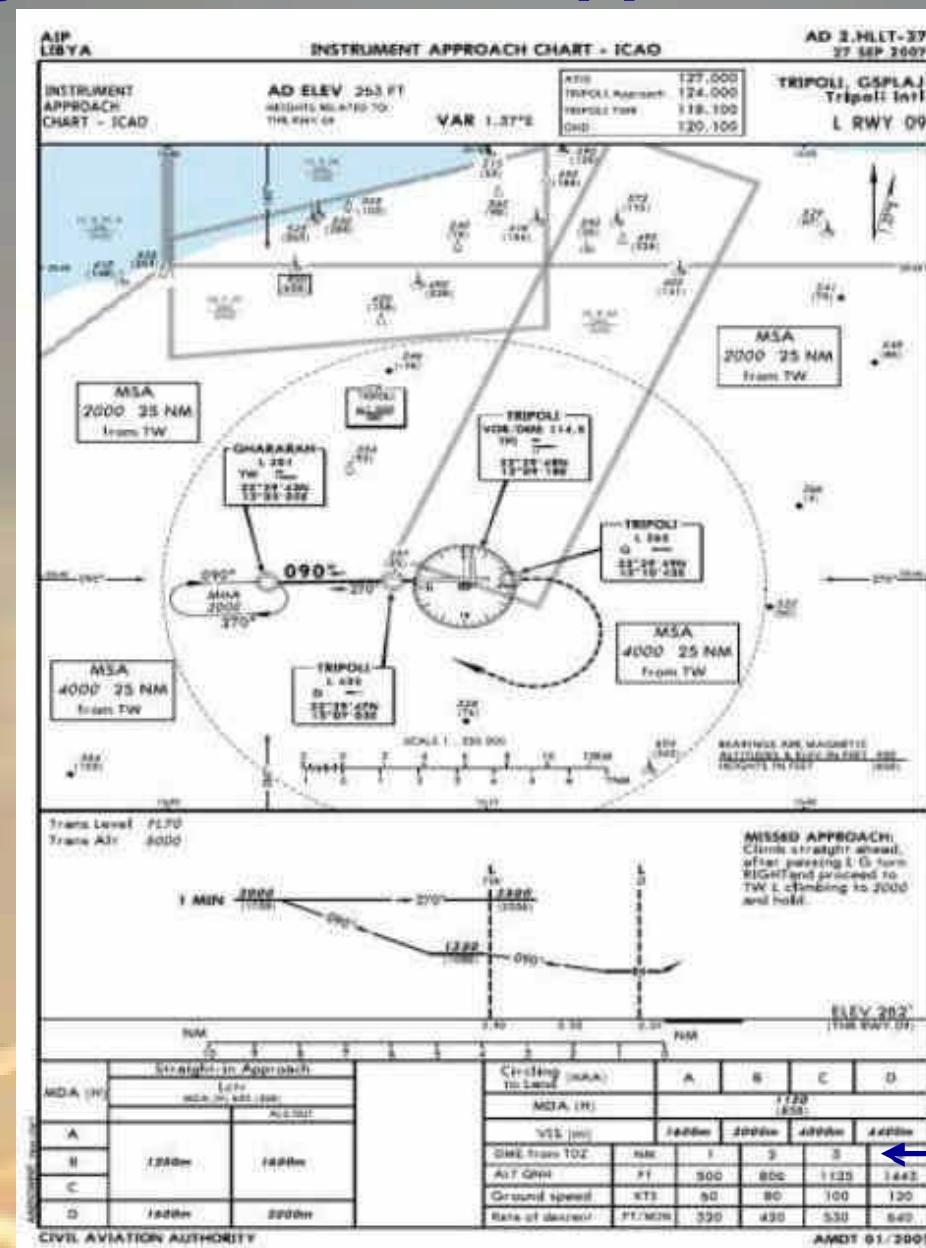
Final Report  
of AFRIQIYAH Airways Aircraft  
Airbus A330-202, 5A-ONG Crash  
Occurred at Tripoli (LIBYA) on 12/05/2010

## 1.17.2.1.5 Documentation on board

*“The Jeppesen chart did not provide any glide path after the FAF and did not include the table in the official map identifying crossing altitudes in relation the distance to the runway threshold 09 and rates of descent in relation the speed of the aircraft.”*



# Libyan State NDB Approach Chart



## DME from TDZ

# Libyan State NDB Approach Chart



Distance-Altitude table on the Libyan state chart shows distance from the runway threshold but is labelled “DME from TDZ”.

This is confusing as the DME is 1.3 nm from the TDZ

*Distance-Altitude tables are essential for efficient final approach profile monitoring but the distances used must be clearly described and appropriate for the navigational state of the aircraft.*

*Crews must be absolutely sure of what information they are using.*

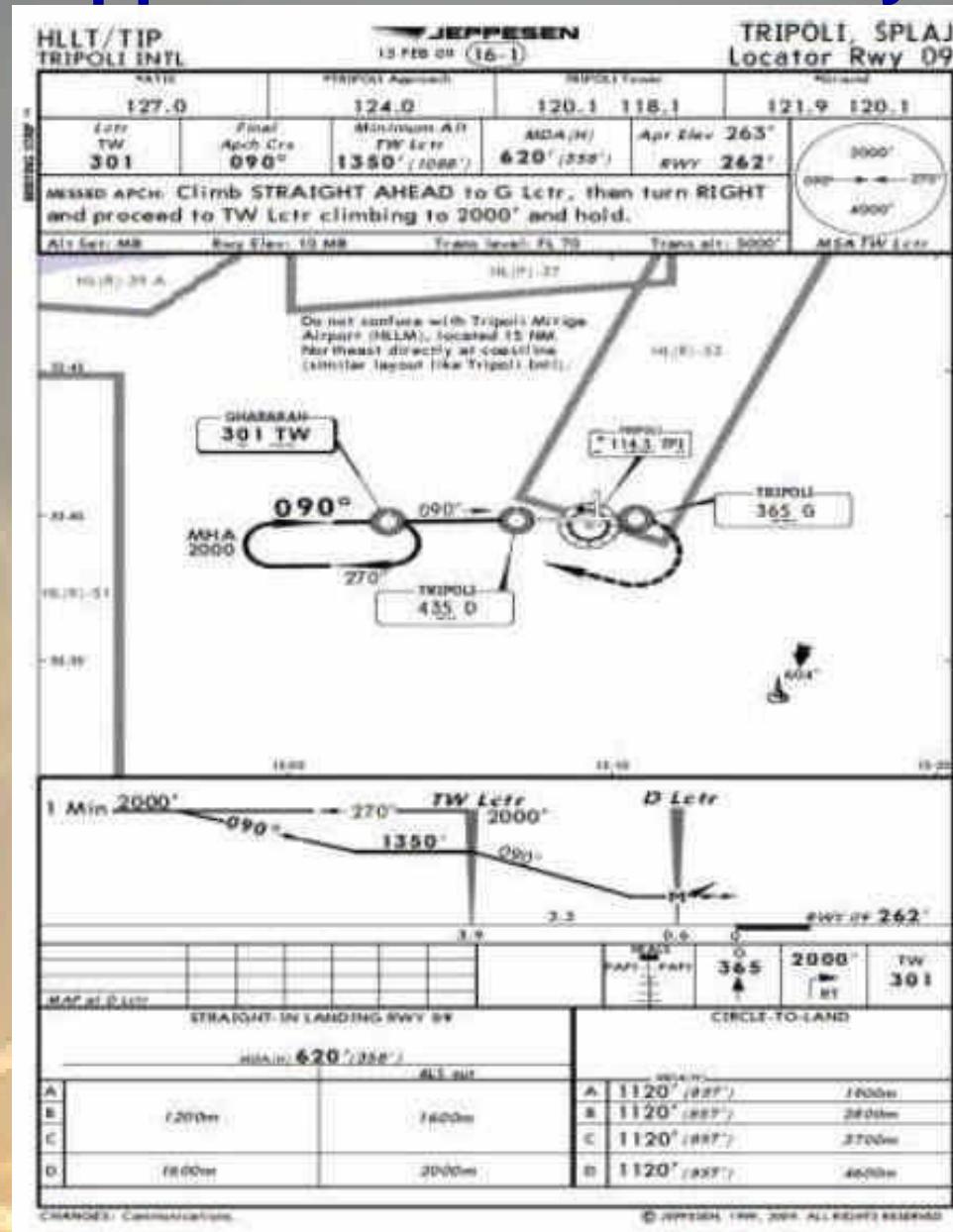
DME from TDZ



MIN. IN. 4000 FT		MAX. IN. 10000 FT			
		1700	3400	5100	6800
A					
B	1700ft	3400ft			
C					
D	1700ft	3400ft			

CIVIL AVIATION AUTHORITY

# NDB Approach Chart used by crew



# NDB Approach Chart used by crew

HLLT/TIP TRIPOLI INTL		JEPPESEN 13 FEB 04 (16-1)		TRIPOLI, SPLAJ Locator Rwy 09			
NDB		TERRAIN Aeronav		TRIPOLI Tower		4014ft	
127.0		124.0		120.1 118.1		121.9 120.1	
Dist		Final	Apath Crs	Minimum A/R			
Dist	TW	Apch Crs	090°	1350' (100ft)	AGDA (H)	Apr Elev 263°	
	301				620' (250')	Rwy 262°	3000'

A single distance of 3.9 nm from the runway is shown to start descent from 1350ft.

A Constant Angle approach path from 2000ft to the runway with a Distance-Altitude table where checks can be make at several distances must help avoid this error leading to an accident.

*The Distance used must be clearly specified –  
From the DME or*

*From the runway for FMS/GPS equipped aircraft.*

1 Min 2000'		270° TW Left 2000'		D-Letr					
090°		1350'		Rwy 262°					
MAP AT D-Letr									
STRAIGHT-IN LANDING									
A	1120' (337')	B	1120' (337')	C	1120' (337')				
D	1120' (337')	E	1120' (337')	F	1120' (337')				
G	1120' (337')	H	1120' (337')	I	1120' (337')				
CHANGES: Communication									
© JEPPESEN 1999, 2001. ALL RIGHTS RESERVED									

# Need for Distance-Altitude Tables in Future Aircraft



# Need for Distance-Altitude Tables in Future Aircraft

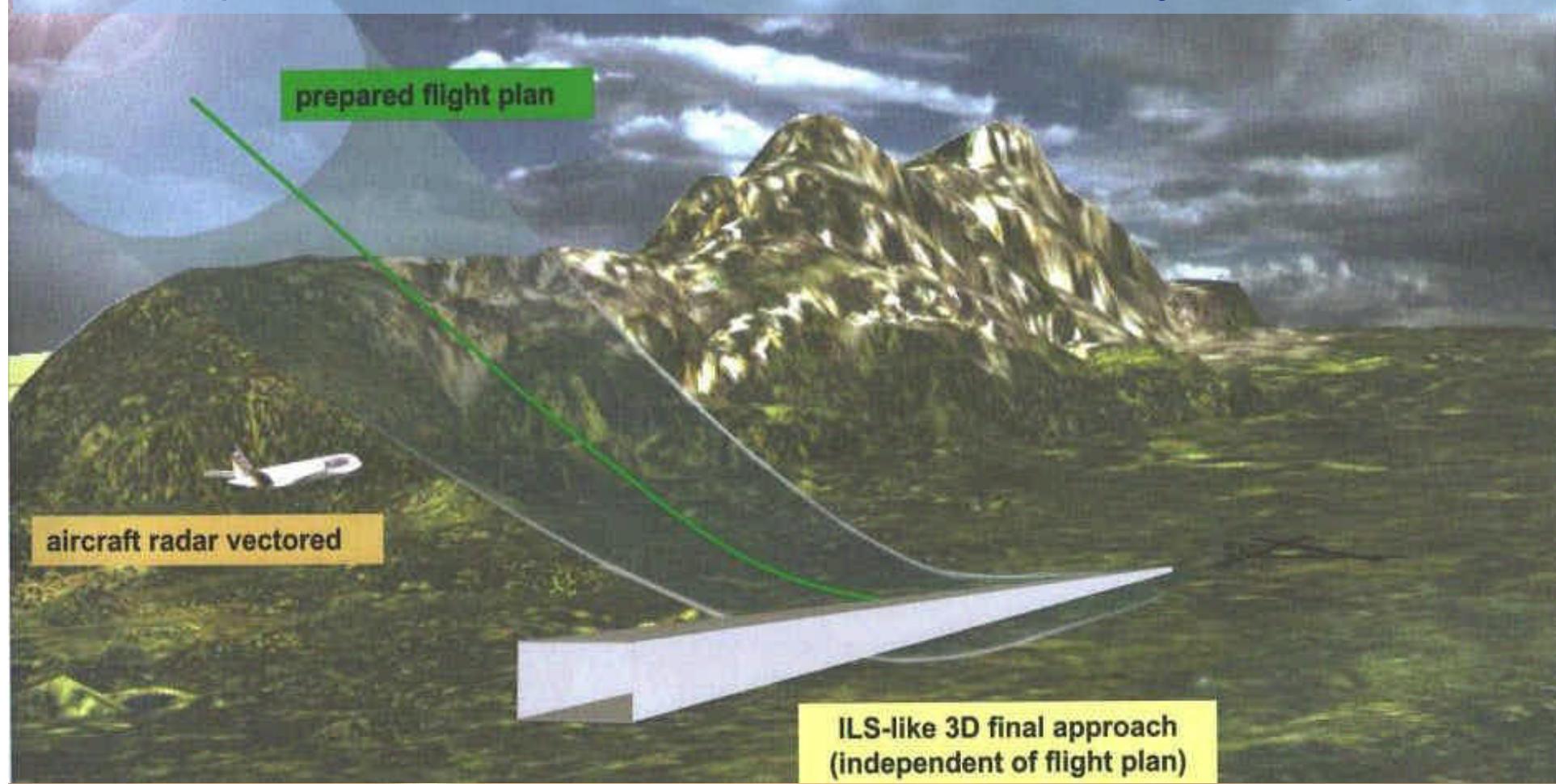


# Need for Distance-Altitude Tables in Future Aircraft

## Latest Airbus aircraft can fly FLS – ILS Look-alike

### Fms generated Landing System

*(other manufacturers have similar systems)*

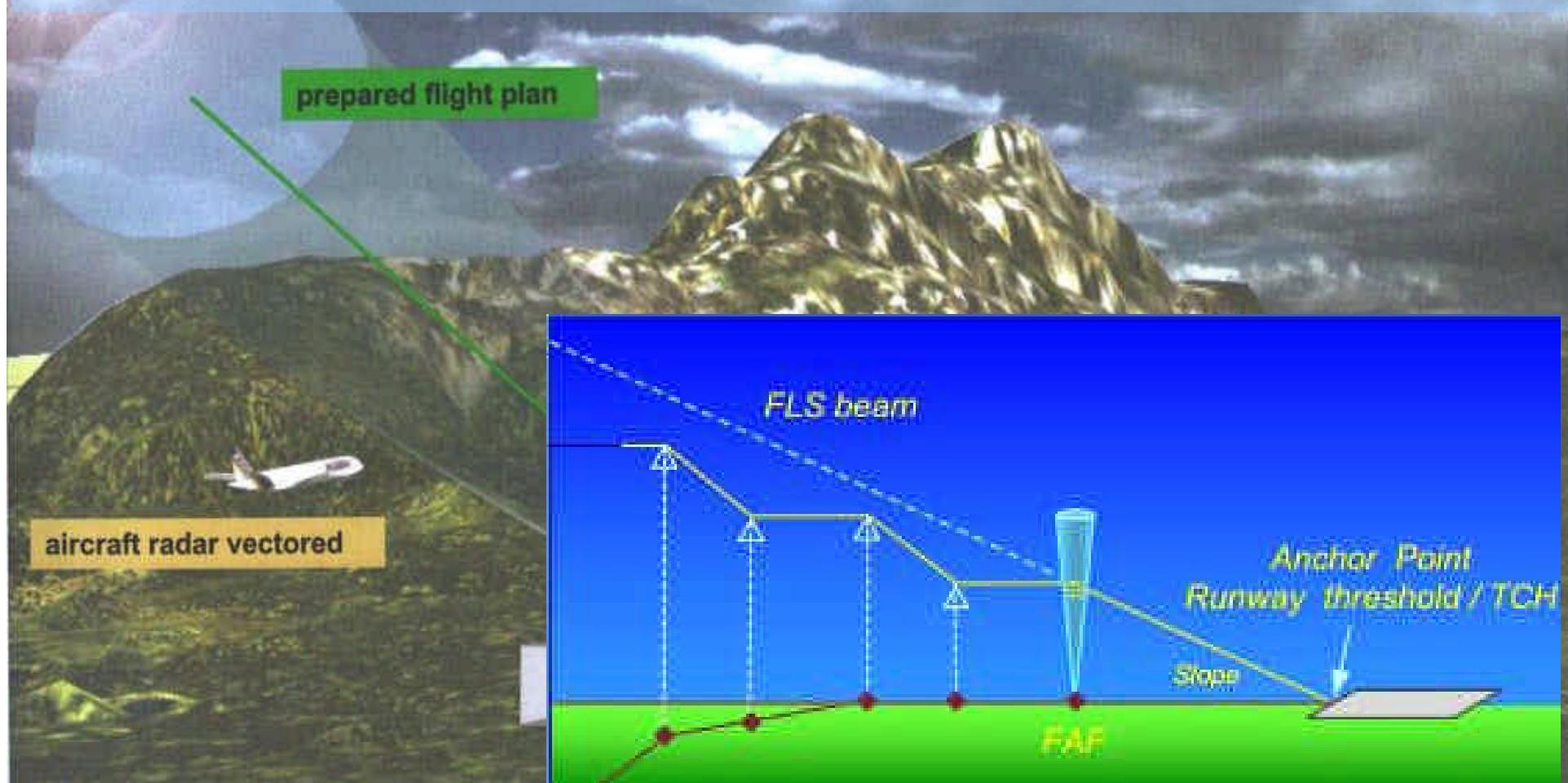


# Need for Distance-Altitude Tables in Future Aircraft

## Latest Airbus aircraft can fly FLS – ILS Look-alike

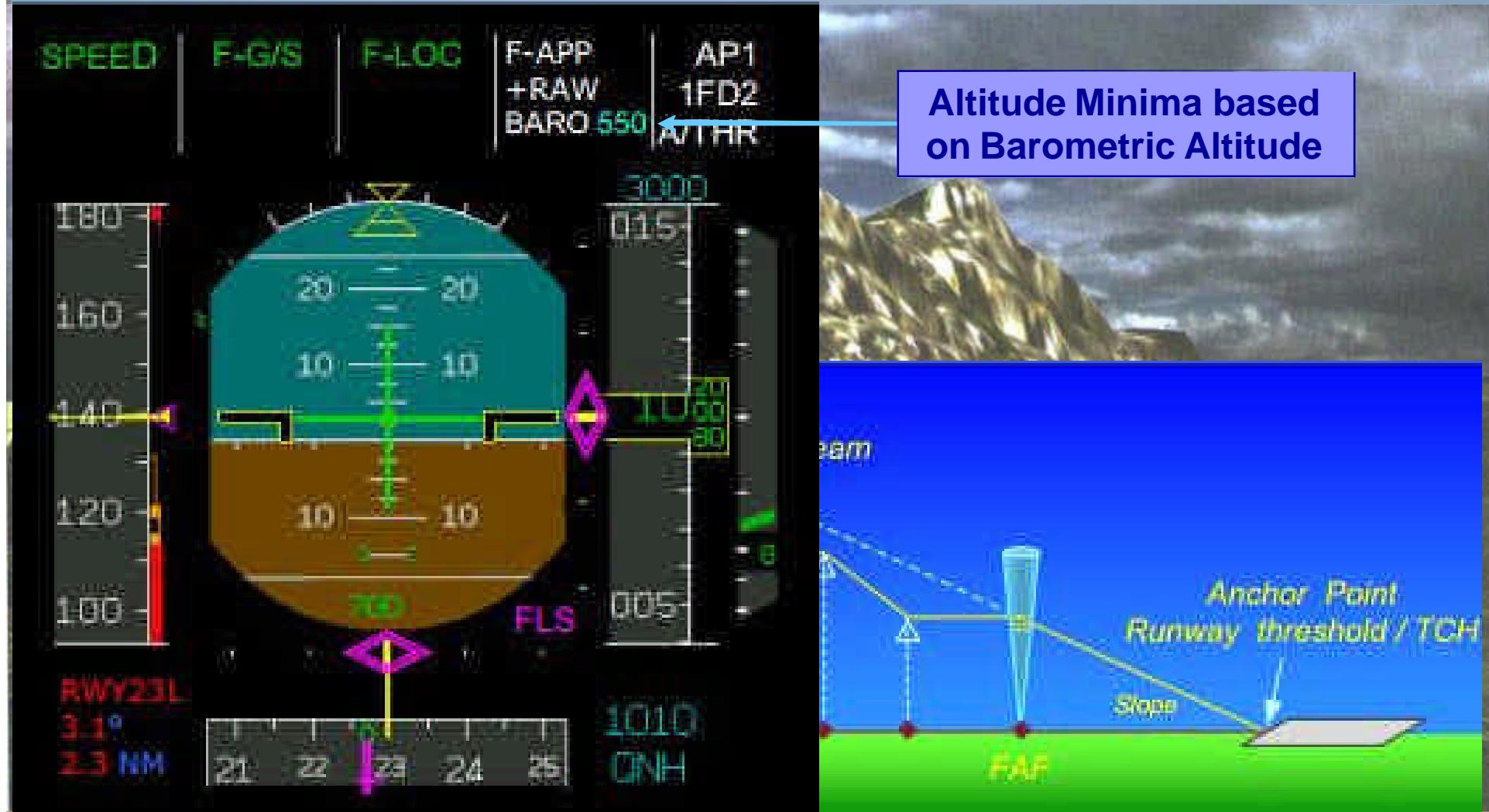
### Fms generated Landing System

*(other manufacturers have similar systems)*



# Need for Distance-Altitude Tables in Future Aircraft

## Latest Airbus aircraft can fly FLS – ILS Look-alike (Fms generated Landing System)



# Need for Distance-Altitude Tables in Future Aircraft

**Latest Airbus aircraft can fly FLS – ILS Look-alike  
(Fms generated Landing System)**

Based on GPS and independent of any ground aid.

If “GPS Primary” no accuracy checks required. *But*

As Minima based on Barometric Altitude a

Distance-Altitude check required on the glideslope to confirm the correct QNH/altimeter setting has been set....remember

***Events show incorrect QNH values are still passed by ATC therefore Distance to Runway-Altitude info required.***

If systems are downgraded due to aircraft or GPS failures navigation may revert to raw data, *therefore*

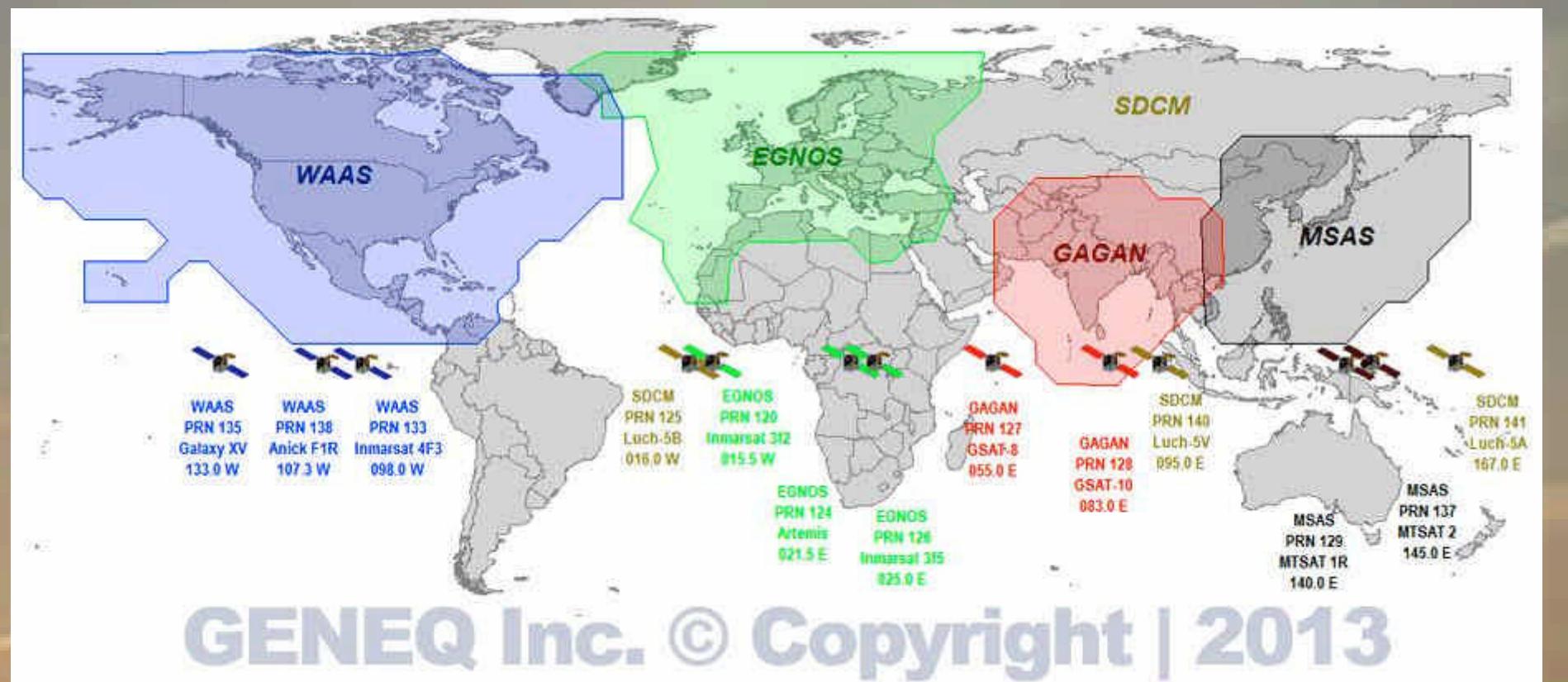
***DME-Altitude distance info may occasionally be required.***

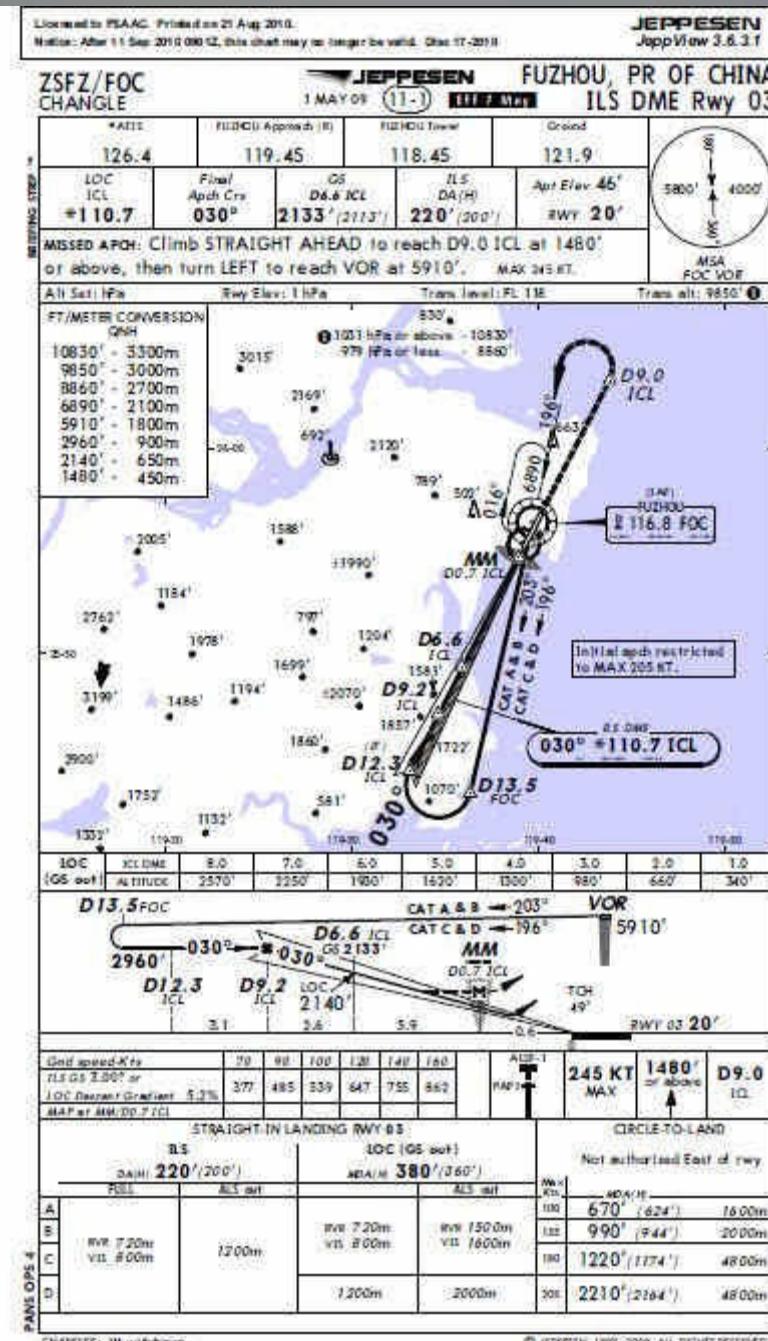
***Chart tables will be required for the foreseeable future!***

# Need for Distance-Altitude Tables in Future Aircraft

All aircraft should progressively be equipped with SBAS (Space Based Augmented System) to fly CAT1 precision approaches and eliminate Non Precision Approaches, but altitudes will still be based on Barometric Altitude.

*This will take time so current NPAs will continue...*





Procedures and charts are improving –  
LOC GS out glidepath is the same profile as the  
ILS glideslope (*unlike at Guam*).

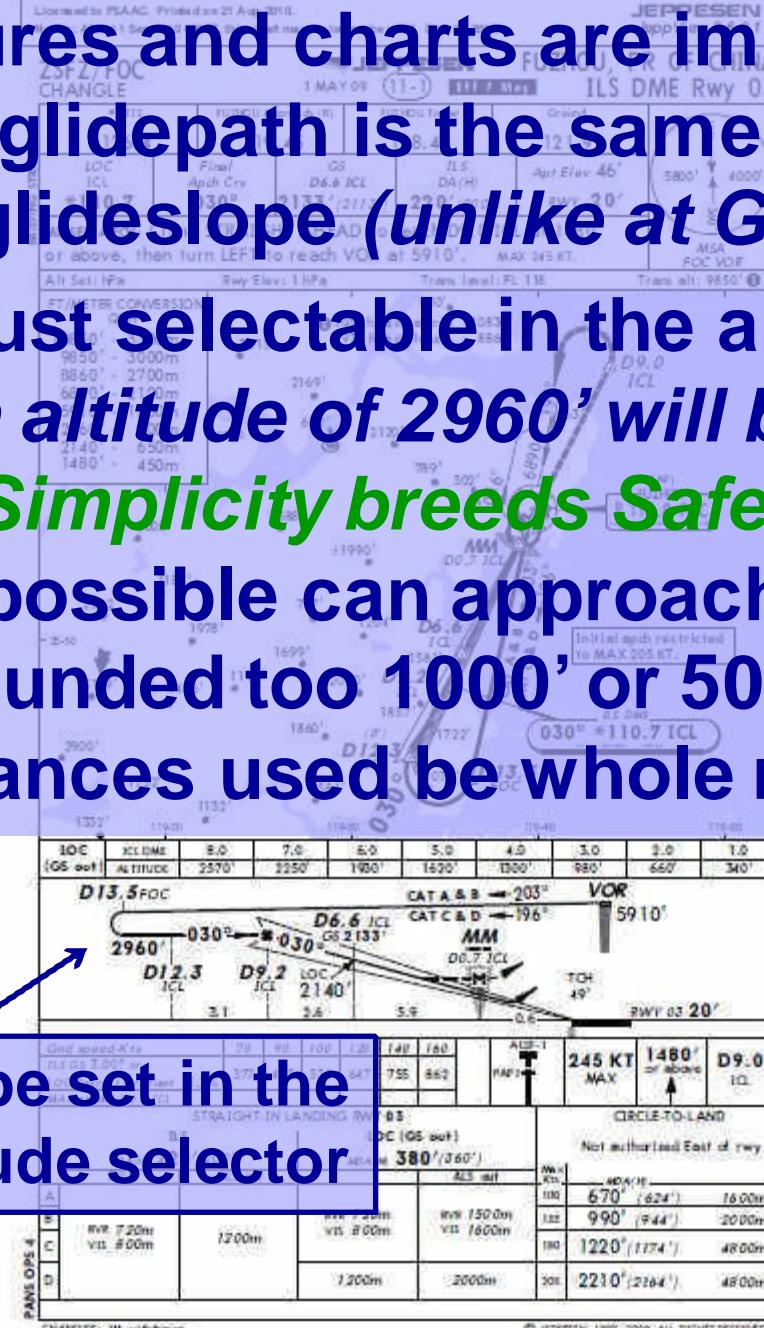
Altitudes must selectable in the autopilot FCU.  
*The approach altitude of 2960' will be set as 3000'.*

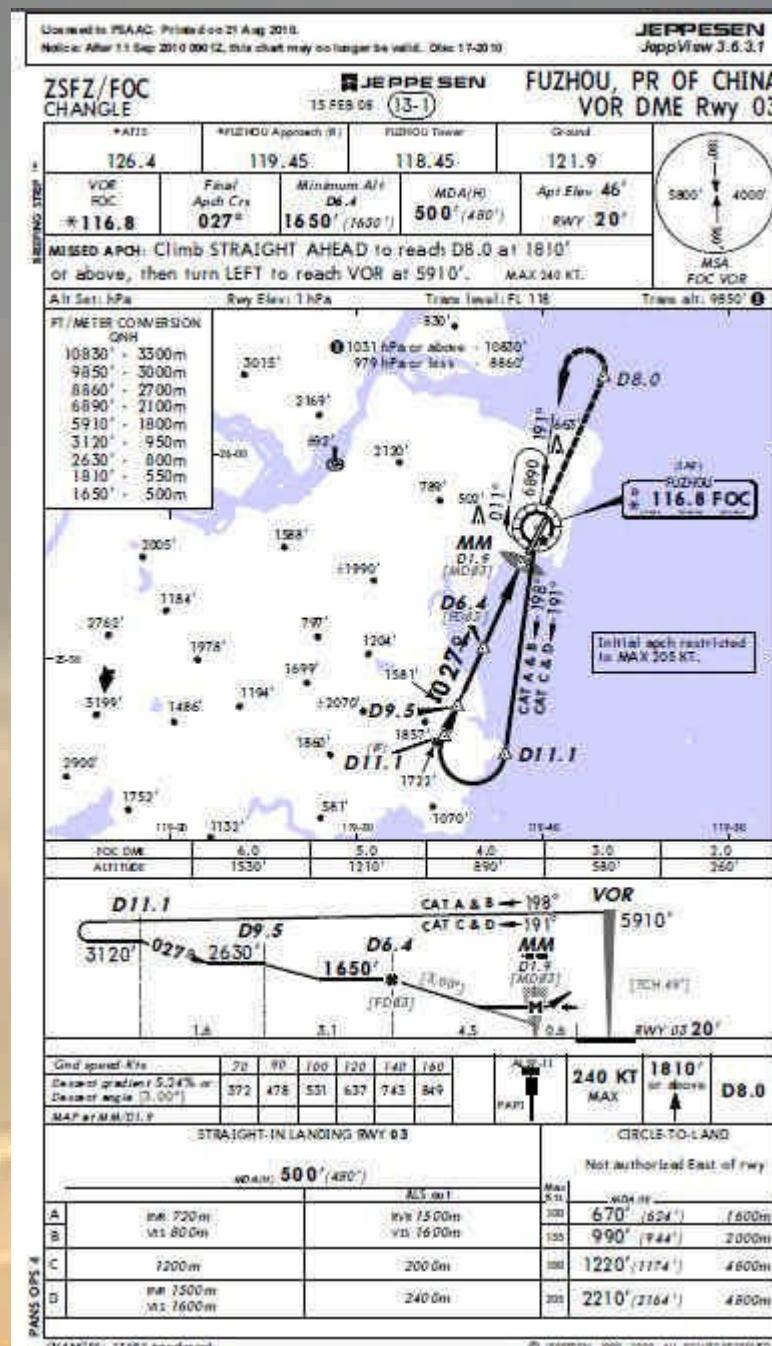
*Simplicity breeds Safety*

Whenever possible can approach altitudes be  
rounded too 1000' or 500'?

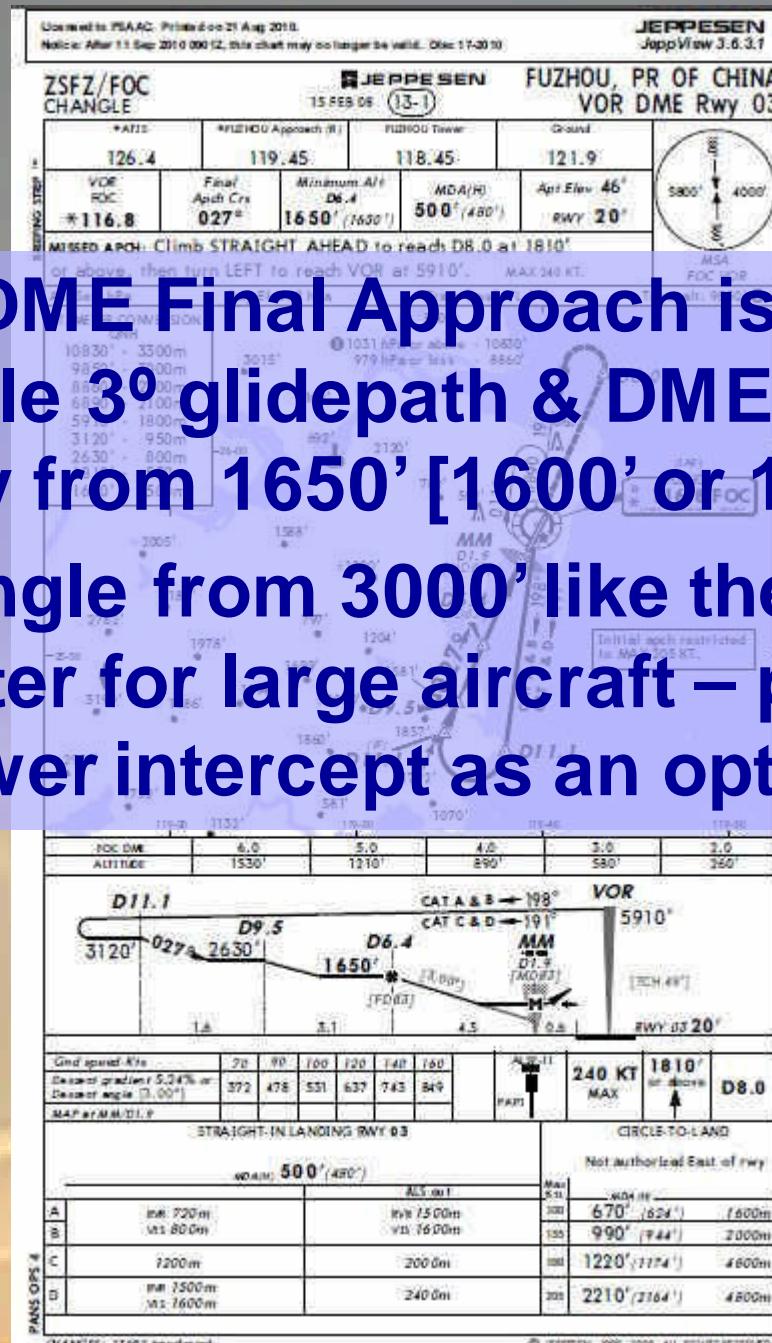
And distances used be whole numbers?

2960' cannot be set in the  
autopilot altitude selector



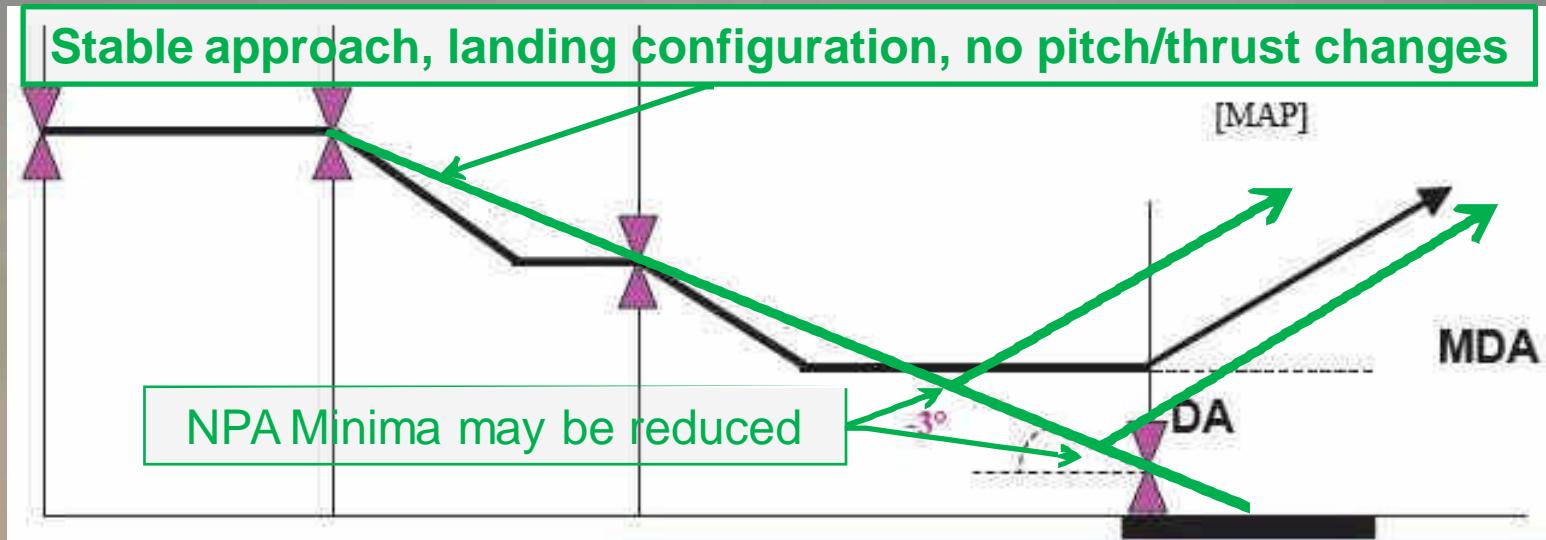


The VOR DME Final Approach is now also a Constant Angle 30° glidepath & DME-Altitude table. But why only from 1650' [1600' or 1700' in FCU]? A Constant Angle from 3000' like the ILS approach would be better for large aircraft – perhaps with a lower intercept as an option.



# Back to Benefits of a Constant Angle NPA Profile

## Stable Approach – established as many orders safer



6.5%	3.7°	393 f/nm
120 kts	140 kts	160 kts
790 fpm	920 fpm	1,050 fpm
Dist KLO	Alt QNH	(HAT)
D -7.4	4000'	(2584')
D -7.0	3860'	(2444')
D -6.0	3470'	(2054')
D -5.0	3080'	(1664')
D -4.0	2680'	(1264')
D -3.3	2390'	(974')
D -2.0	1900'	(484')
D -1.0	1510'	(94')
D -0.9	1470'	(54')

DME-Altitude Tables can provide regular checks to confirm aircraft on the correct profile to 30ft accuracy. Rather than checks at single points which might be interrupted by ATC request, crew action etc.



U.S. Department  
of Transportation  
Federal Aviation  
Administration

# Advisory Circular

**Subject:** Continuous Descent Final Approach

**Date:** 1/20/11

**AC No:** 120-108

**Initiated by:** AFS-400

**Change:**

**1. PURPOSE.** This advisory circular (AC) provides guidance for all operators using the continuous descent final approach (CDFA) technique while conducting a Nonprecision Approach (NPA) procedure. It describes the rationale for using the CDFA technique, as well as recommended general procedures and training guidelines for implementing CDFA as a standard operating procedure (SOP). While the use of CDFA is beneficial to all aircraft operators, we intend this AC for those operators governed by Title 14 of the Code of Federal Regulations (14 CFR) parts 91 subpart K (91K), 121, 125, and 135. This guidance and information describes an acceptable means, but not the only means, of implementing the use of CDFA during NPAs and does not constitute a regulation.

## 2. RELATED TITLE 14 CFR REGULATIONS.

- Part 91, General Operating and Flight Rules.
- Part 97, Standard Instrument Procedures.
- Part 119, Certification: Air Carriers and Commercial Operators.
- Part 121, Operating Requirements: Domestic, Flag and Supplemental Operations.
- Part 125, Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload Capacity of 6,000 Pounds or More; and Rules Governing Persons On Board Such Aircraft.
- Part 135, Operating Requirements; Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft.

## 3. RELATED READING MATERIAL (current editions).

- AC 120-71, Standard Operating Procedures for Flight Deck Crewmembers.
- Federal Aviation Administration (FAA) Aeronautical Information Manual (AIM).
- FAA Instrument Procedures Handbook (FAA-H-8261-1A).

**4. BACKGROUND.** Controlled flight into terrain (CFIT) is a primary cause of worldwide commercial aviation fatal accidents. Unstabilized approaches are a key contributor to CFIT

# FAA AC 120-108 January 20th 2011



## Introduced the CDFA

### Constant Descent Final Approach,

flown using sink rate calculated from the published glideslope angle and current groundspeed, or by Flight Path Angle.

Examples starting from FAF 1900ft & 1500ft aal.

### But when possible should be CAFA

### Constant Angle Final Approach using Distance-Altitude Tables

(DME or FMS distance to runway)

to monitor final glideslope like an ILS.

Charts must incorporate Distance-Altitude tables.

To allow early stabilisation profiles should include CAFA from at least 2500ft with option to intercept the glideslope from a lower altitude if required.

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This advisory circular (AC) provides guidance for all operators using the continuous descent final approach (CDFA) technique while conducting a Nonprecision Approach (NPA) procedure. It describes the rationale for using the CDFA technique, as well as recommended operational procedures and training guidelines for implementing CDFA as a standard operating procedure (SOP). While the use of CDFA is beneficial to all aircraft operators, we intend the AC for those operators governed by Title 14 of the Code of Federal Regulations (14 CFR) parts 121, 123, 125, 131 K (91K), 121, 125, and 135. This guidance and information describes an acceptable means, but not the only means, of implementing the use of CDFA during NPAs and does not constitute a regulation.

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Part 135, Operating Requirements: Commuter and On Demand Operations and Rules for Carrying Passengers On Board Such Aircraft.

#### 3. RELATED READING MATERIAL

Part 65, Airman Certification Requirements: Training Procedures for Flight Deck Crewmembers.

- Federal Aviation Administration (FAA) Aeronautical Information Manual (AIM).

FAA Instrument Procedures Handbook (FAA-H-8261-1A).

By October 2009, controlled flight into terrain (CFIT) is a primary cause of worldwide commercial aviation fatal accidents. Unstabilized approaches are a key contributor to CFIT

# DME-Altitude Constant Angle NPAs remain a good backup

The new RNP Approaches generally require an accuracy of 0.1 n mile....

DME (Distance Measuring Equipment) reads to 0.1 n mile, therefore:  
Altitudes on a 3 degree glidepath can be checked / flown to within 30ft (300 x .1)  
(It is important to use the correct DME - ILS or VOR if both are available!)



A DME in line with a runway can show an accurate glidepath on a Non Precision Approach by a simple DME-Altitude table for a Constant Descent Angle approach. Many Step Down NPAs accidents could have been avoided over the past 30 years.

## DME-Altitude Constant Angle NPAs remain a good backup

## The new RNP Approach

## DME (Distance Meas

Altitudes on a 3 degree gl  
(It is important to use t



# **DME-Altitude Table for LOC-DME R/W 18 Birmingham Alabama**

BHM LOC-DME 18

Gradient:	3.2°	342 fNm
120 kts	140 kts	160 kts
680 fpm	800 fpm	910 fpm
D I-BXO	Alt QNH	(HAT)
D -14.1	5070'	(4426')
D -9.5	3500'	(2856')
D -8.0	2980'	(2336')
D -7.0	2640'	(1996')
D -6.0	2300'	(1656')
D -5.0	1960'	(1316')
D -4.0	1620'	(976')
D -3.3	1380'	(736')
D -2.0	930'	(286')

## A DME in line with a runway Approach by a simple DME- Many Step Down NPAs acci

acy of 0.1 n mile....

**1 n mile**, therefore:  
to within 30ft ( $300 \times .1$ )  
both are available!



path on a Non Precision Descent Angle approach. Used over the past 30 years.

# Flight Safety Foundation - The Best Safety System is a Well Trained Crew

**Train both pilots to the same standard.**

**Give maximum responsibility to the FO on their leg.**

**Then each will be competent to monitor the other.**

## Conclusion

**Educate those who are unaware of CANPA benefits.**

**Emphasise no extra on board systems required –**

**Can be implemented immediately on any aircraft,**

**Fly/Monitor sink rate for glideslope angle and**

**groundspeed - use Flight Path Angle if available,**

**Make monitoring Distance-Altitude checks to**

**confirm on glideslope to 30ft accuracy.**

**Train crews to monitor each other equally well.**

**Stimulate authorities who are slow to approve.**

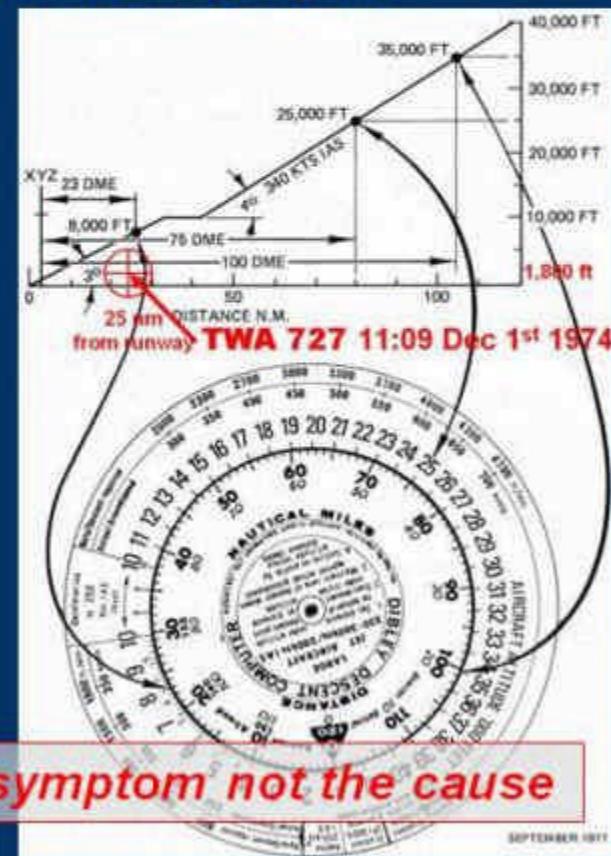
**Provide simplest/clearest approach procedures.**

***(Avoid unnecessary confusion - such as 4 ILS procedures for one runway, different titles for similar GPS systems, etc.)***

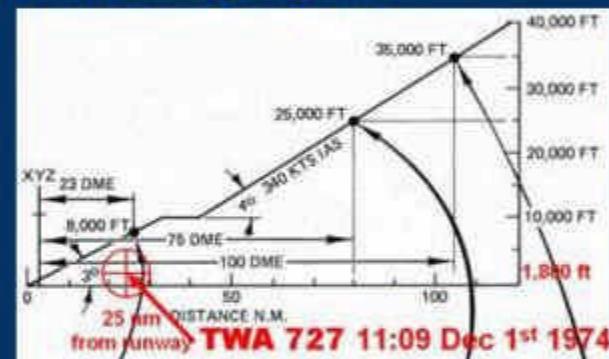
**Think about the last 40 years.....**

## • TWA B727 Accident into Washington Dulles in 1974

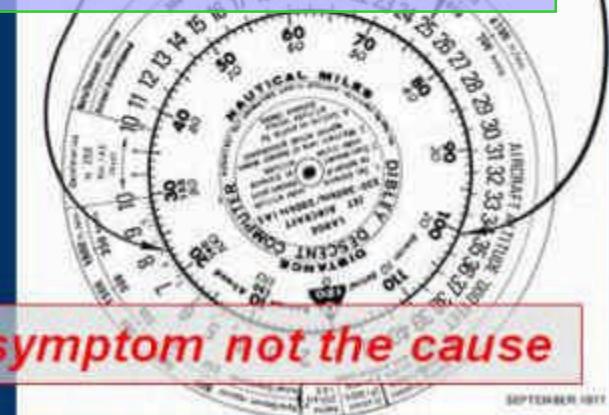
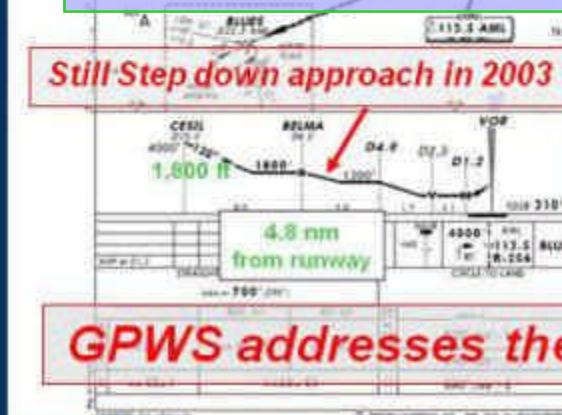
- Hit hill at 1,700ft at 25 nm when should have crossed 1,800ft at 4.8 nm
- FAA mandated all US carriers to fit GPWS
- No comment about better use of DME during descent and approach?
- ***If the FAA had also mandated that DME approaches must be Constant Angle – Many lives could have been saved in the following 30 years***



- **TWA B727 Accident into Washington Dulles in 1974**
  - Hit hill at 1,700ft at 25 nm when should have crossed 1,800ft at 4.8 nm
  - FAA mandated all US carriers to fit GPWS
  - No comment about better use of DME during descent and approach?
  - *If the FAA had also mandated that DME approaches must be Constant Angle – Many lives could have been saved in the following 30 years*



Indicates Prevention of an event is Prime





Let us never have to say –  
that accident need not have happened.

.....*but*

Let us never have to say –  
that accident need not have happened.  
*.....but only 4 months later...*

Crash UPS A306 at Birmingham on Aug 14th 2013, contacted trees and touched down outside airport



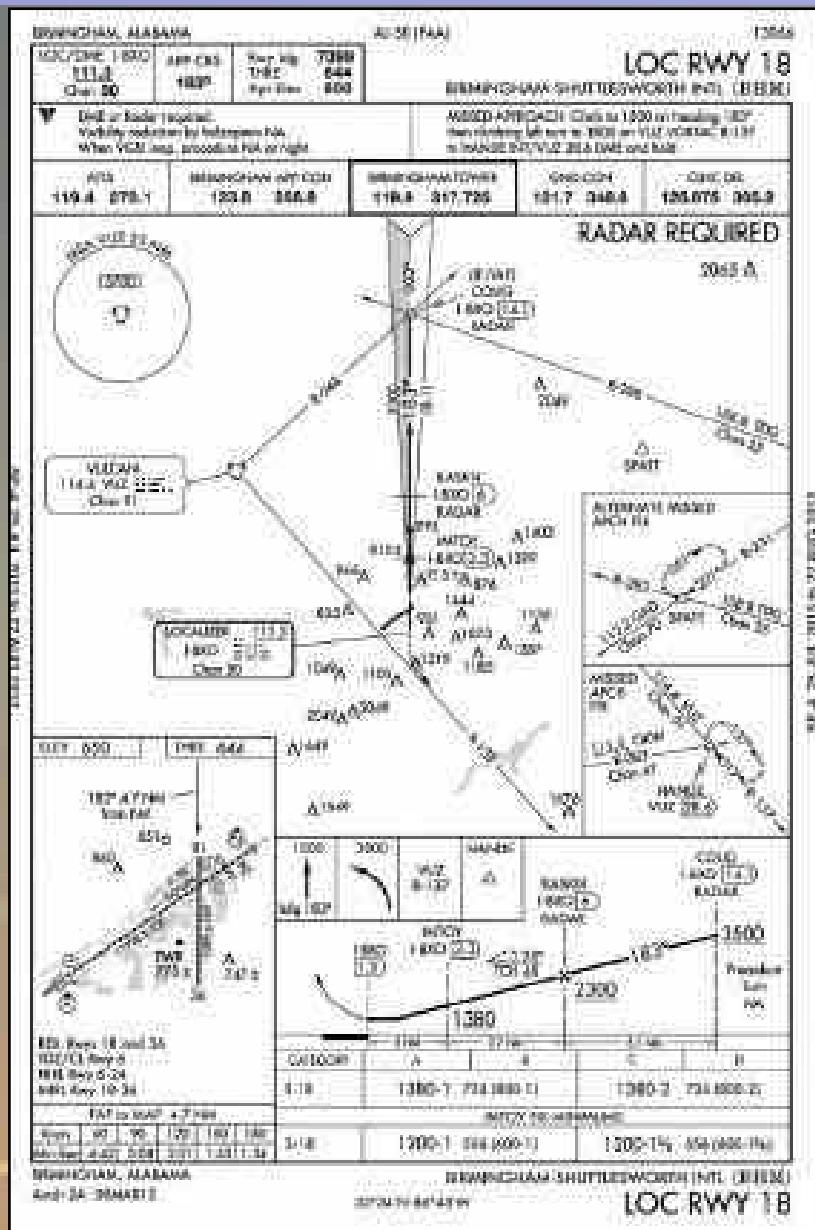
**On 14Aug 2013 UPS 5X-1354 Airbus A300-600F N155UP freighter crashed short of the runway on a LOC-DME approach to R/W 18 Birmingham AL.**



BHM LOC-DME 18		
Gradient:	3.2°	342 ft/nm
120 kts	140 kts	160 kts
680 fpm	800 fpm	910 fpm
D I-BX0	Alt QNH	(HAT)
D -14.1	5070'	(4426')
D -9.5	3500'	(2856')
D -8.0	2980'	(2336')
D -7.0	2640'	(1996')
D -6.0	2300'	(1656')
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D -4.0	1620'	(976')
D -3.3	1380'	(736')
D -2.0	930'	(286')

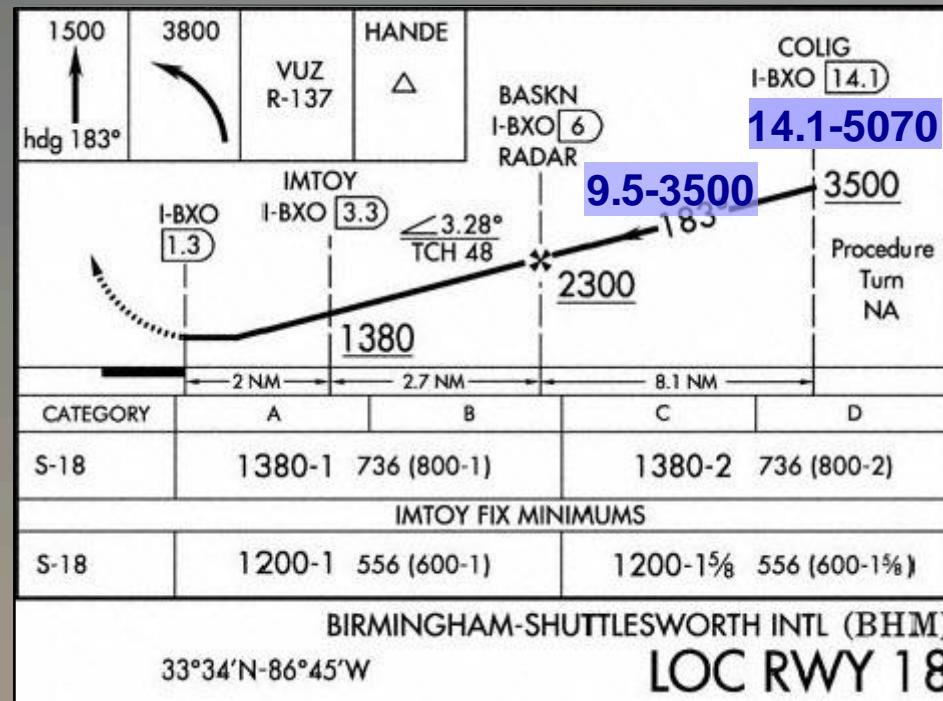
**The FAA LOC-DME chart does not include a DME-Altitude table, such as on the right showing that the straight line profile is not realistic.**

## FAA LOC-DME Chart without table & Possible Table



BHM LOC-DME 18		
Gradient:	3.2°	342 ft/nm
120 kts	140 kts	160 kts
680 fpm	800 fpm	910 fpm
D -18.0	Alt QNH	(HAT)
D -14.1	5070'	(4426')
D -9.5	3500'	(2856')
D -8.0	2980'	(2336')
D -7.0	2640'	(1996')
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# FAA LOC-DME Chart without table & Possible Table



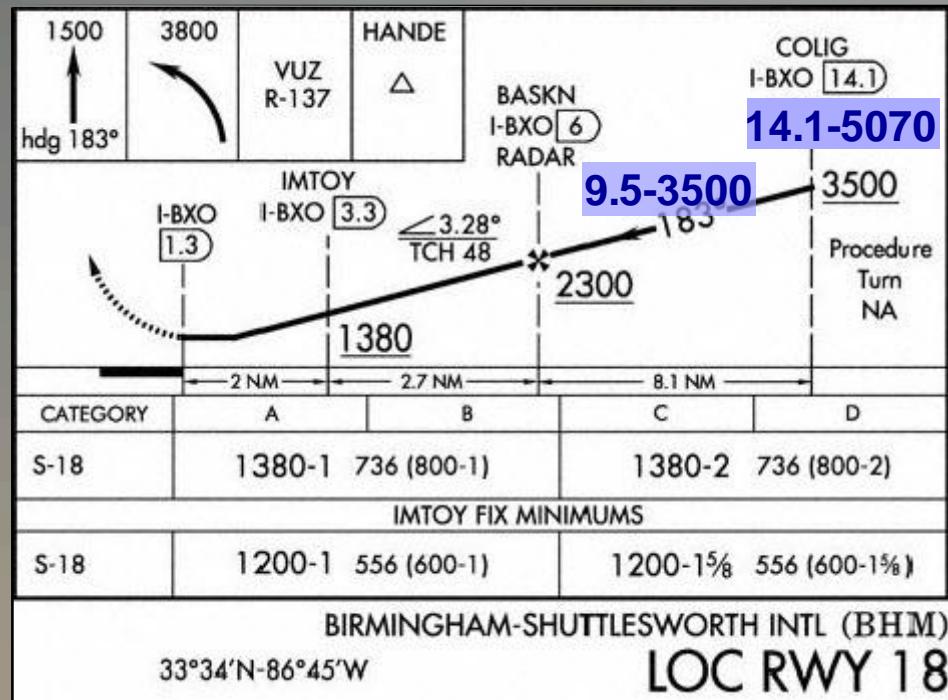
The chart profile is a linear path from 3500ft at 14.1D.

The table shows on a  $3.2^{\circ}$  GS 5070' at 14.1D & 3500' at 9.5D.

The profile is not realistic.

BHM LOC-DME 18		
Gradient:	3.2°	342 f/nm
D 14.1	5070'	(4426')
D 9.5	3500'	(2856')
D -8.0	2980'	(2336')
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## FAA LOC-DME Chart without a DME-Altitude table



**The chart profile is a linear path from 3500ft at 14.1D.**

The table shows on a 3.2° GS 5070' at 14.1D & 3500' at 9.5D.

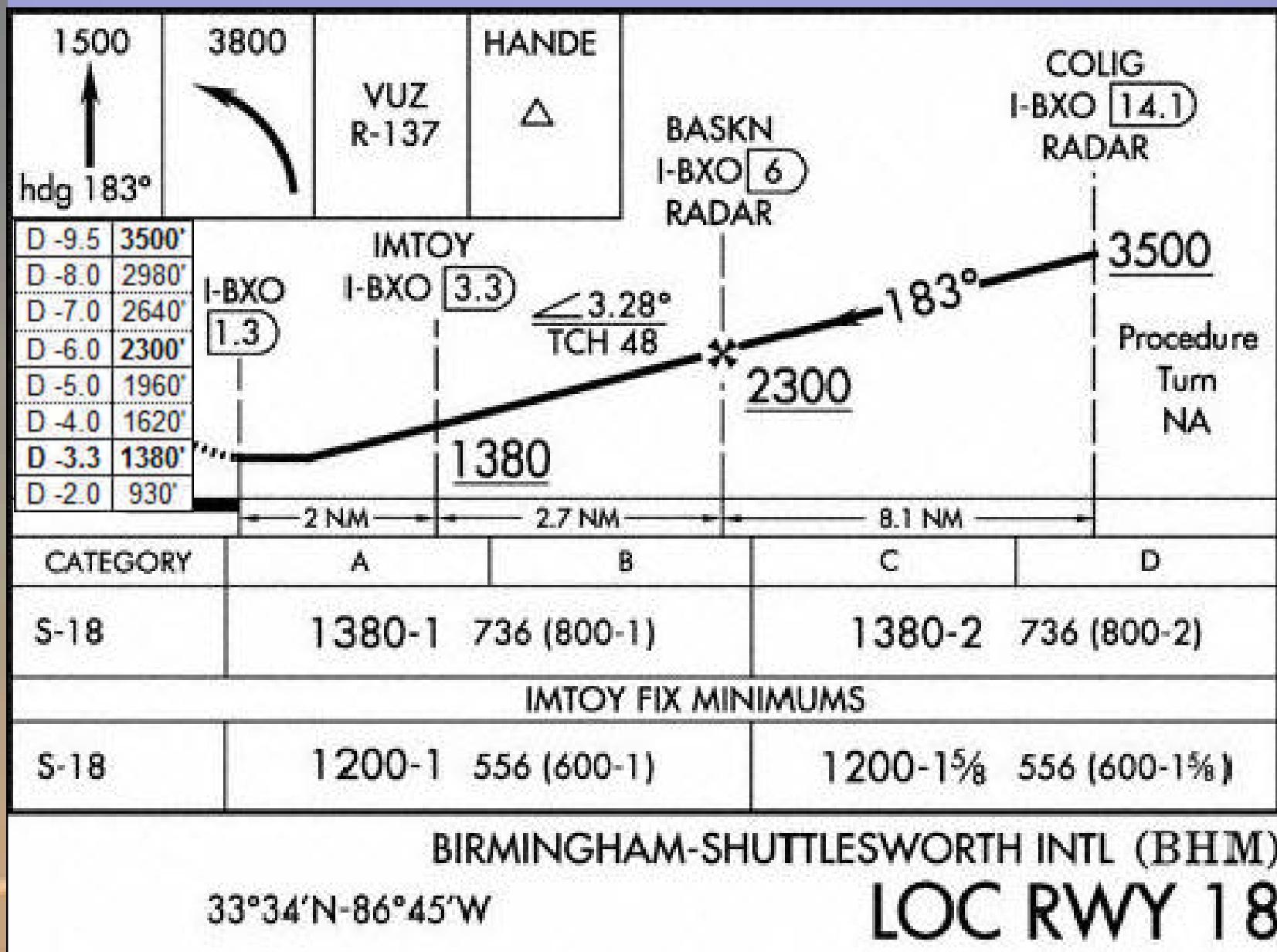
## The profile is not realistic.

**FAA AC advises that a CDFA may start at or above the FAF.**

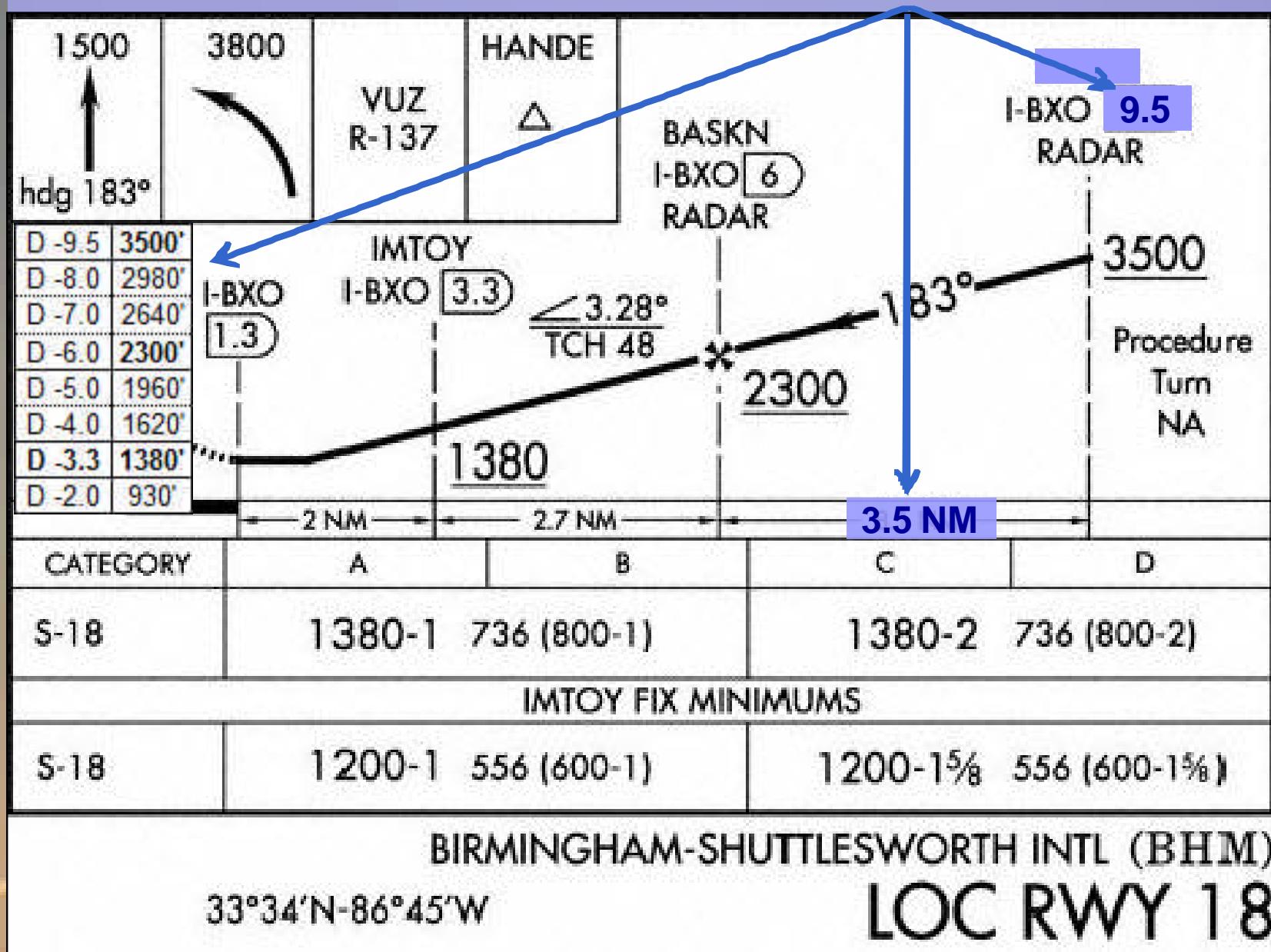
Based on the profile, a crew would probably descend below the glideslope if starting a constant descent from 3500ft before 9.5 DME.

***The chart must show a realistic profile according to Distances & Altitudes with a DME-Altitude table for the crew to monitor the profile is being followed.***

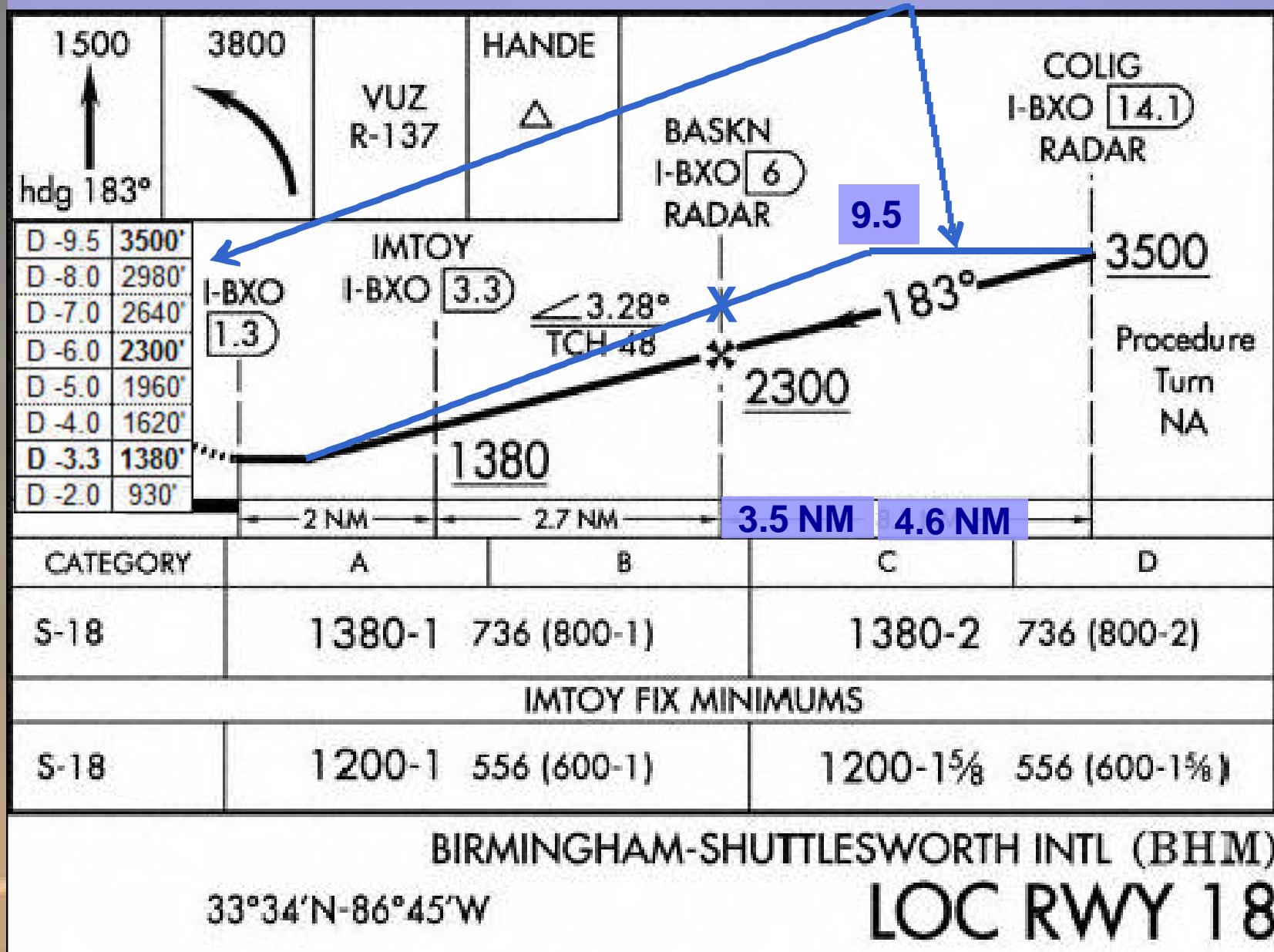
# BHM LOC-DME Chart – Unrealistic Published Profile



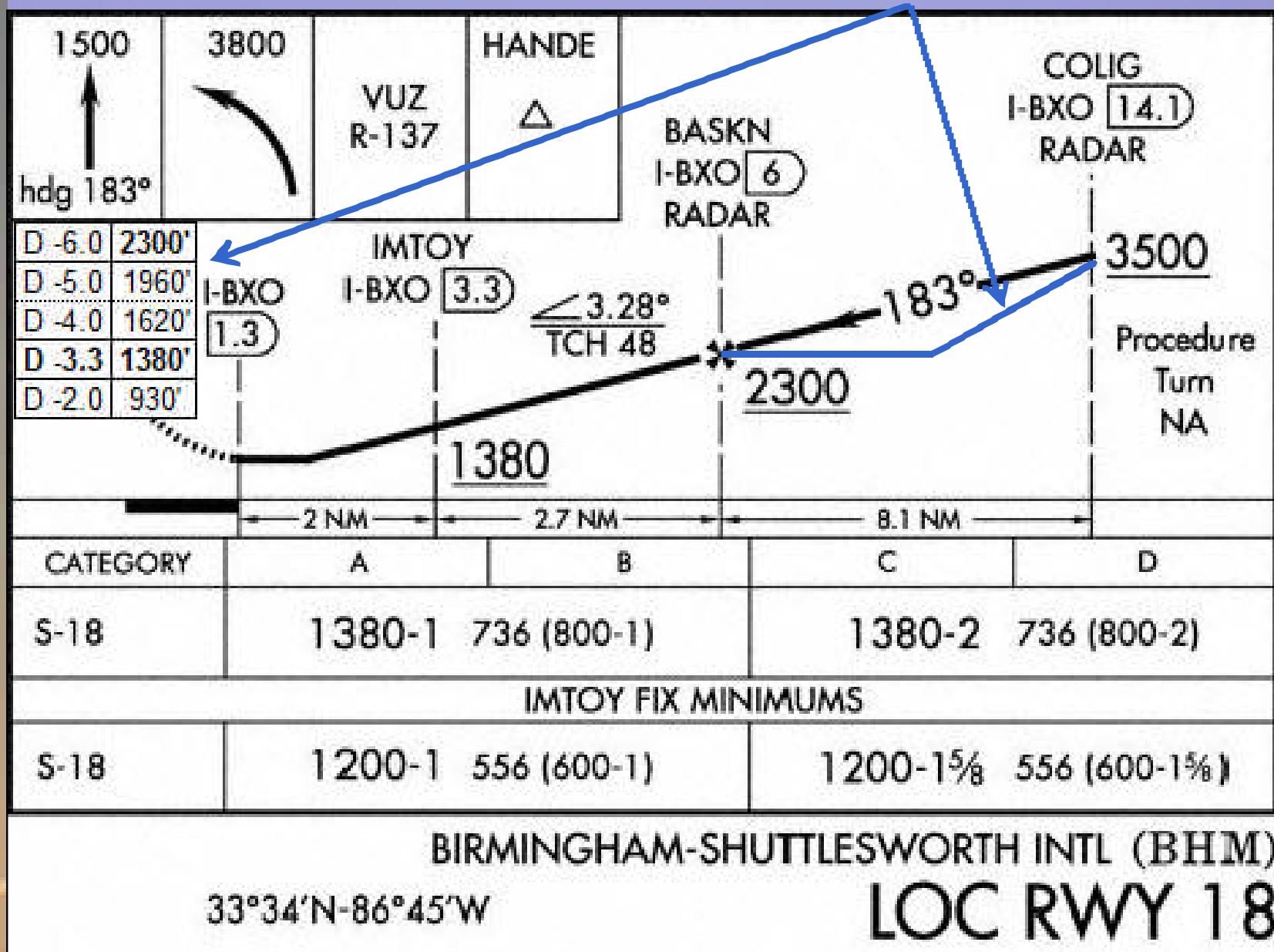
## BHM LOC-DME Chart - *Correct Distances for Profile*



# BHM LOC-DME Chart *Correct Profile for Distances 1*



## BHM LOC-DME Chart *Correct Profile for Distances 2*



# Best Capability for Monitoring LOC-DME Approach

**It is impossible to know the cause(s) of the accident without further information from the NTSB...but**

**If the Monitoring Pilot had:**

**A realistic vertical profile shown on the chart,**

**A DME-Altitude table allowing accurate monitoring of the glideslope at times suitable to the crew -**

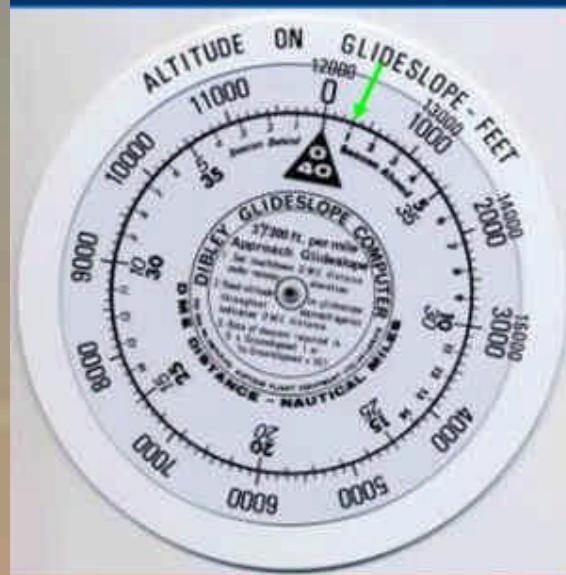
**The crew would then have  
the best capability to monitor & maintain  
the correct glideslope to the runway.**

*(Perhaps their Jeppesen had one they didn't use?)*

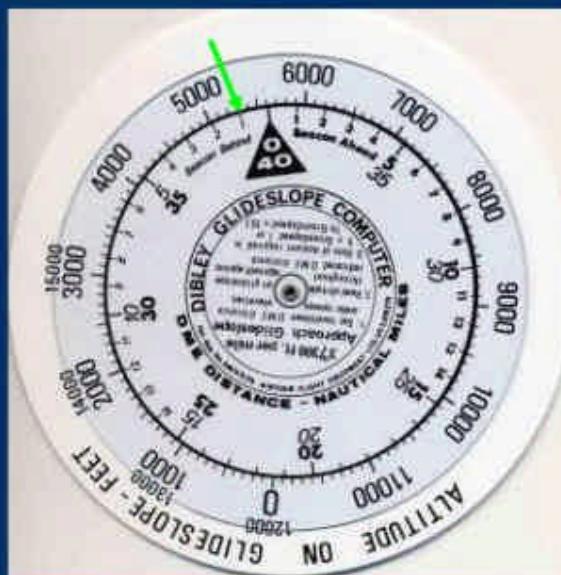
# Essential Info for Monitoring LOC-DME Approach

*If no chart table available – Use another system*

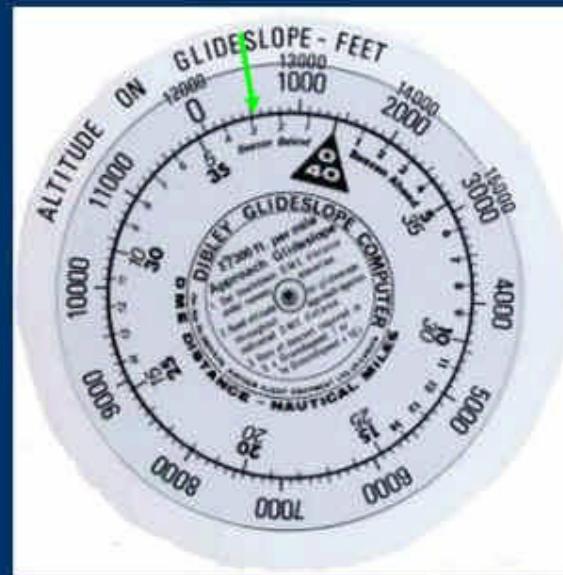
## Approach Slide Rule Set for Washington, Nairobi and Toulouse / Guam



IAD 12 – set ahead 1.2 DME at 360 ft



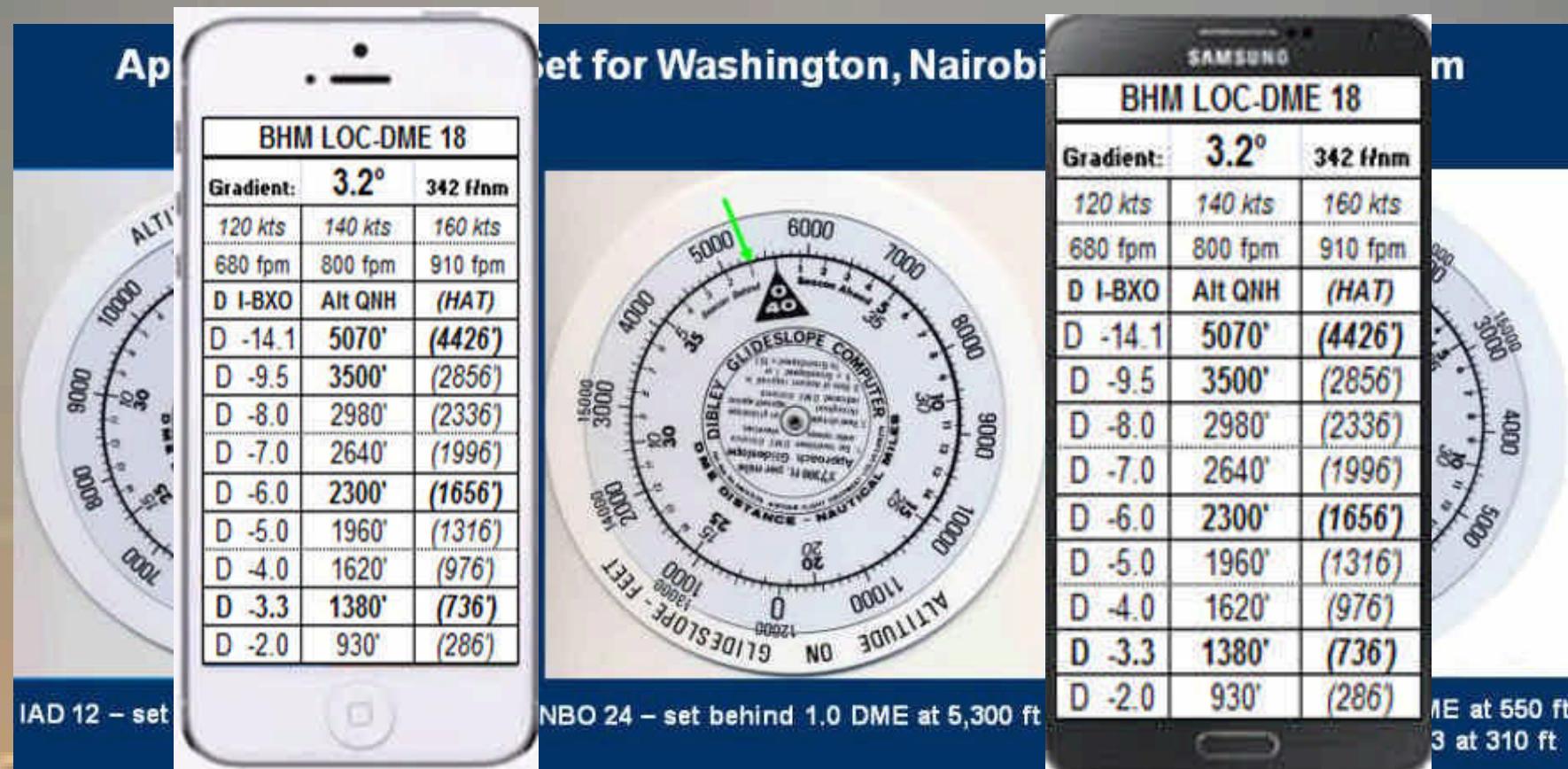
NBO 24 – set behind 1.0 DME at 5,300 ft



TLS 14R – set behind 2.7 DME at 550 ft  
or Guam 06 – set behind 3.3 at 310 ft

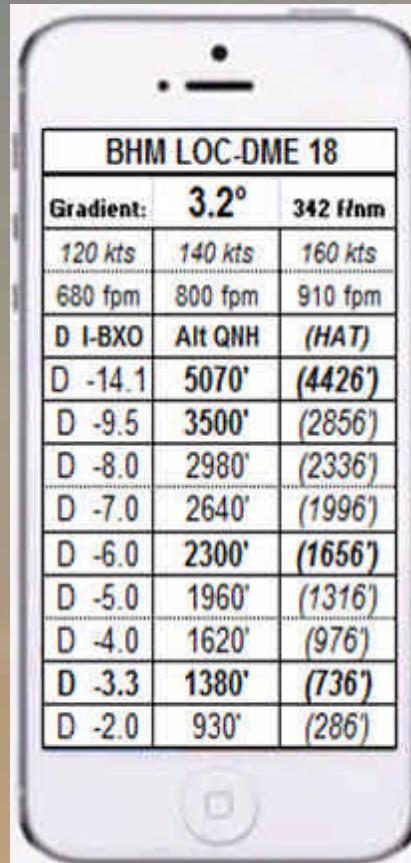
# Essential Info for Monitoring LOC-DME Approach

*If no chart table available – Use another system*

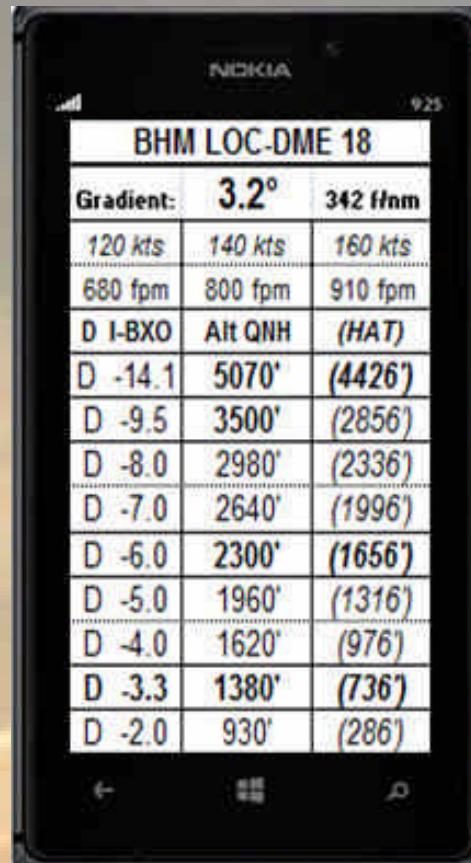


# Essential Info for Monitoring LOC-DME Approach

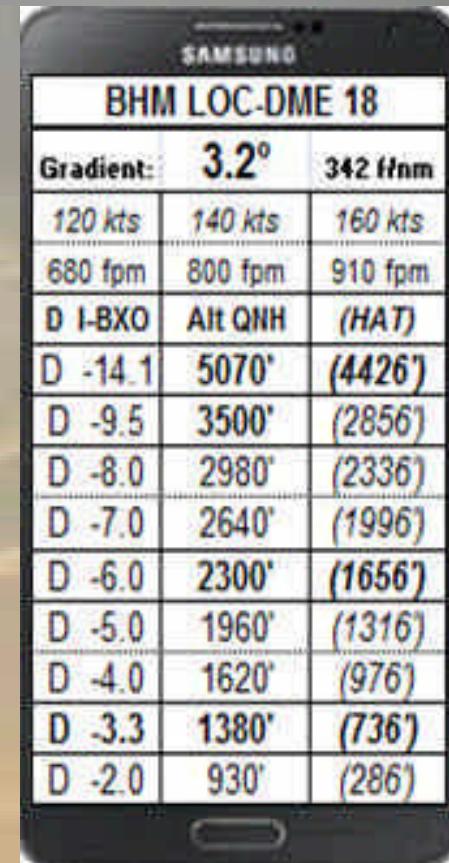
Smart phone/tablet Applications could provide info for cross-checks if not available elsewhere



Apple iPhone 5



Nokia Windows phone



Samsung Android phone

**Comment Post UPS A300-600F Accident into KBHM**  
**Since the 1970s some operators have NOT provided**  
**clear Distance-Altitude checks and failed to train**  
**crews to fly Constant Angle Final Approaches with**  
**regular/accurate checks to confirm on the glideslope**  
**as Avionics/GPS/EPGWS will provide the solution.**  
***Continuing NPA Accidents show this to be incorrect.***

**By whatever means,  
we must make sure that  
Non Precision Approaches  
with DME/GPS Distance available  
do not continue to occur.**



End



# Extra slides

# 1 March 2012 A340 Captured False 9° Glideslope

INVESTIGATION DAVID KAMINSKI-MORROW LONDON

## Glideslope trap snared A340 at Paris

Badly-managed low-visibility descent to Charles de Gaulle left Air France jet vulnerable to false approach guidance signal

Pilots of an Air France Airbus A340-300 fell into a false glideslope trap as the jet descended far above the normal approach profile, leading to serious instability during the low-visibility landing.

The aircraft, arriving from Malian capital Bamako, had been attempting a Category III approach to Paris Charles de Gaulle's runway 08R. It had been initially cleared to 8,000ft (2,440m) while 30nm (55km) from the threshold, maintaining 250kt (463km/h), but almost immediately overflew the top of descent for a 3° glideslope and began diverging from the normal approach profile.

While traffic constraints had initially forced the approach controller to keep the A340 above the glideslope, he subsequently forgot to clear the crew for further descent. At 17.5nm from the threshold, the aircraft was 1,275ft too high.

The controller apologised for his error, clearing the crew to descend to 3,000ft and intercept the glideslope from above.

French investigation authority BEA says the controller assumed the crew would mention any dif-



Inquiries found the Airbus was flying far above the true glidepath

deviation from the glideslope.

When the flight was transferred to Paris tower, the controllers were not informed that the A340 was above the glideslope. Further instructions to reduce speed continued to worsen the deviation and, 4nm from the threshold, the aircraft was still at 3,700ft – about

2,100ft too high. Such was the height discrepancy the aircraft became vulnerable to a false glideslope. The phenomenon is caused by mirroring of the ILS antenna transmissions, and creates the illusion of a second glideslope located above – and therefore steeper than – the true one.

When the A340's glideslope capture engaged, at 2,850ft, the aircraft rapidly pitched up, reaching 12° nose-up in 12s. As the attitude increased, the airspeed fell from 163kt to only 130kt.

The crew disengaged the autopilot, and the captain pushed his sidestick fully forward to raise the airspeed.

BEA says the aircraft passed the runway threshold at 3,700ft. The captain realised the approach was unstable and executed a go-around at 2,000ft.

Investigators are attributing the serious incident – which took place on 13 March 2012 – to inadequate monitoring of the A340's trajectory by both crew and controller, the pilots' use of an "inappropriate" technique to capture the glideslope from above, and possible fatigue. ■

SAFETY DAVID LEARMOUNT LONDON

## Cockpit representatives criticise inadequate pilot training

European pilot representatives have concluded current cockpit training is becoming increasingly inadequate for preparing crews to conduct the

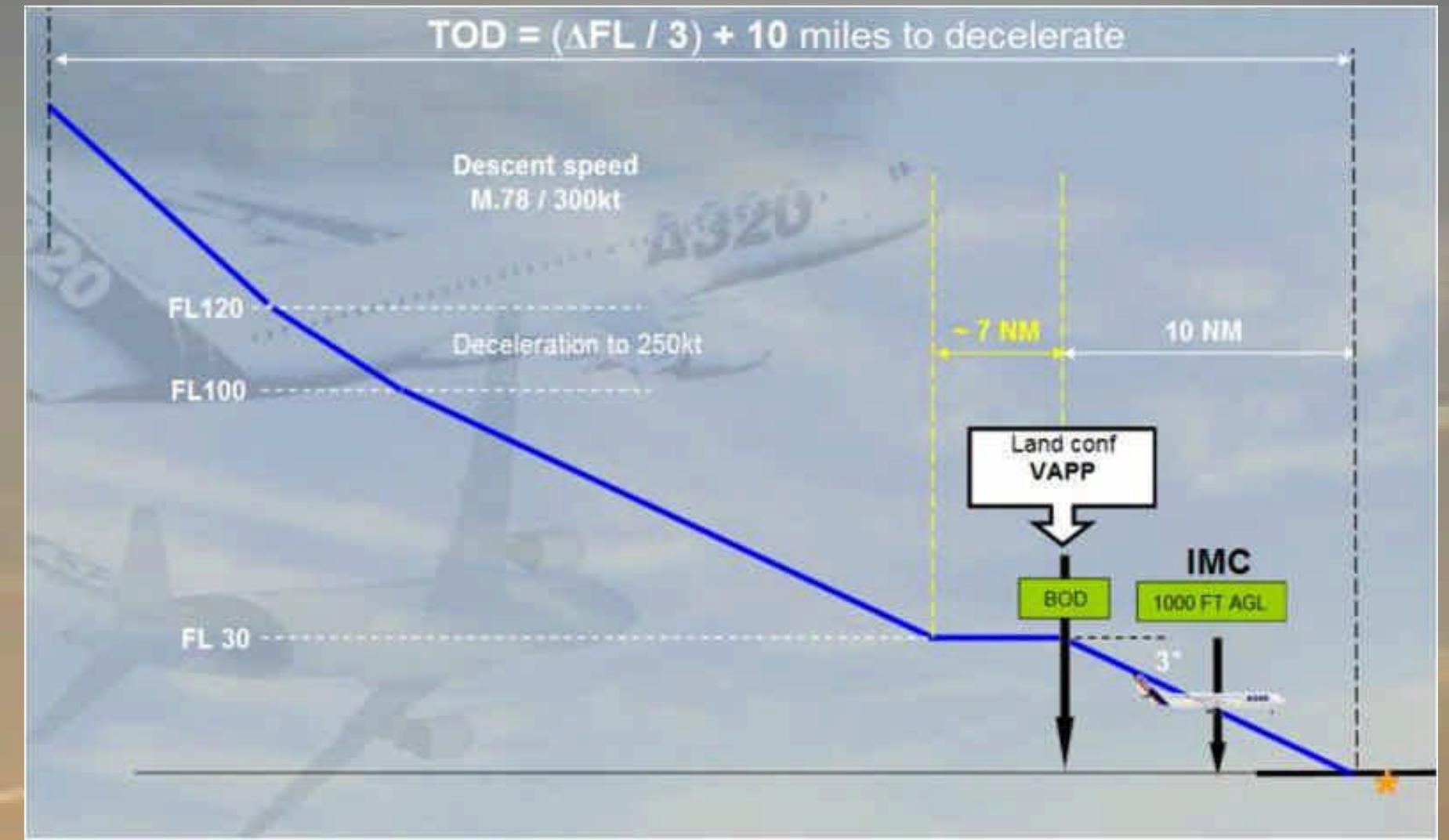
positions with low-cost carriers.

Because cost is such a significant factor for both candidate and airline, the association says: "Much

approach and, as such, risks being an incomplete one. How do we deal with automation for example? The increasing amount of automation

# 1 March 2012 A340 Captured False 9° Glideslope

New pilots are taught to multiply by the distance in nautical miles by 3 for a descent profile and a final 3° approach.



# 1 March 2012 A340 Captured False 9° Glideslope

New pilots are taught to multiply by the distance in nautical miles by 3 for a descent profile and a final 3° approach.

Perhaps there is still a need for an aid to help some people when tired to do the arithmetic when outside the range of the Distance-Altitude tables!?

