Controlled Flight Into Terrain (CFIT)

Maputo, 20 May 2015

Chamsou Andjorin
Aviation Safety Africa and ME
Boeing Commercial Airplanes

Agenda

- **What is CFIT?**
  - Definition
  - Statistics
  - SOP's / Mitigations
  - Equipment
- **PBN and RNAV / RNP**
  - Benefits

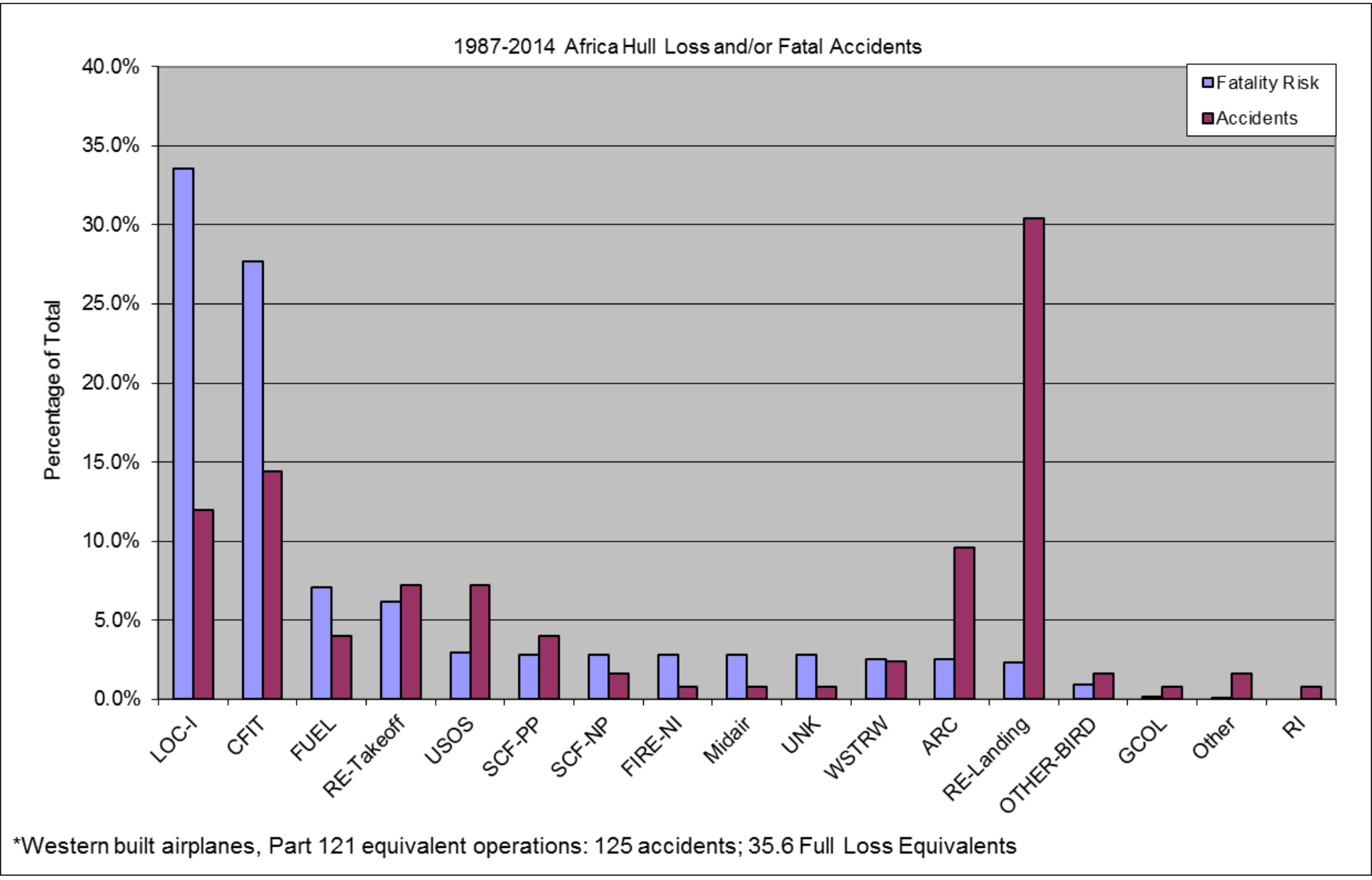
CFIT Definition

IATA defines CFIT as:

“In-flight collision with terrain, water, or obstacle without indication of loss of control”

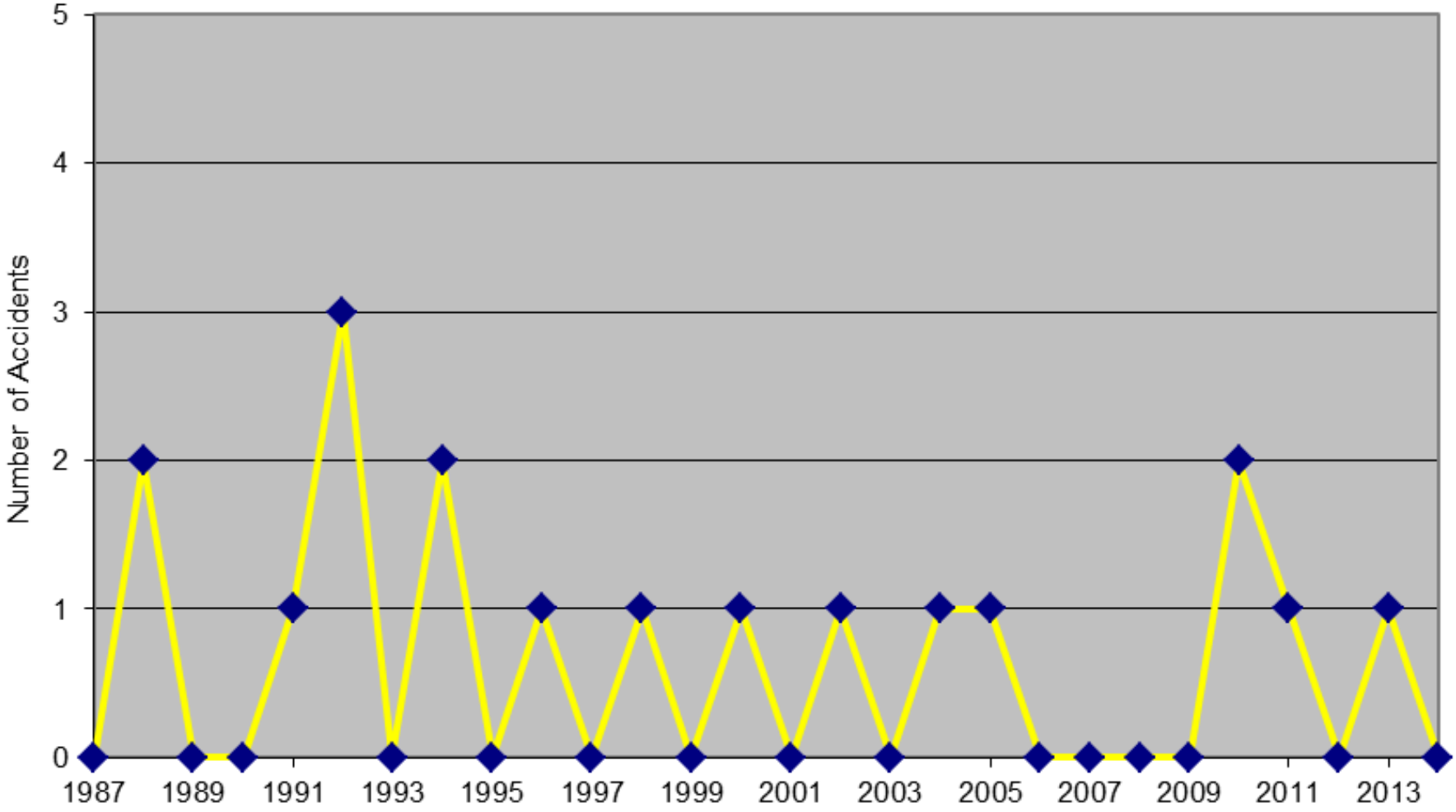
CFIT accidents include: Human Factors, violations and errors by both aircrew and Air Traffic Control (ATC)

- ✓ Situational awareness
- ✓ False ATC assumptions
- ✓ ATC monitors the airplane's position on radar
- ✓ ATC is responsible for terrain clearance
- ✓ Failure to adhere to landing minimums
- ✓ Altimeter-setting errors
- ✓ Perform proper EGPWS recovery procedure
- ✓ Language difficulties
- ✓ ATC Communications
- ✓ Poor CFIT training..
- ✓ Lack of cross checking, crew coordination, or cooperation - CRM
- ✓ Violating procedures
- ✓ Poor SOP adherence
- ✓ Approach procedures - misinterpreted
- ✓ Crew complacency
- ✓ Weather



*Western built airplanes, Part 121 equivalent operations: 125 accidents; 35.6 Full Loss Equivalents

CFIT - Operator Domicile: Africa



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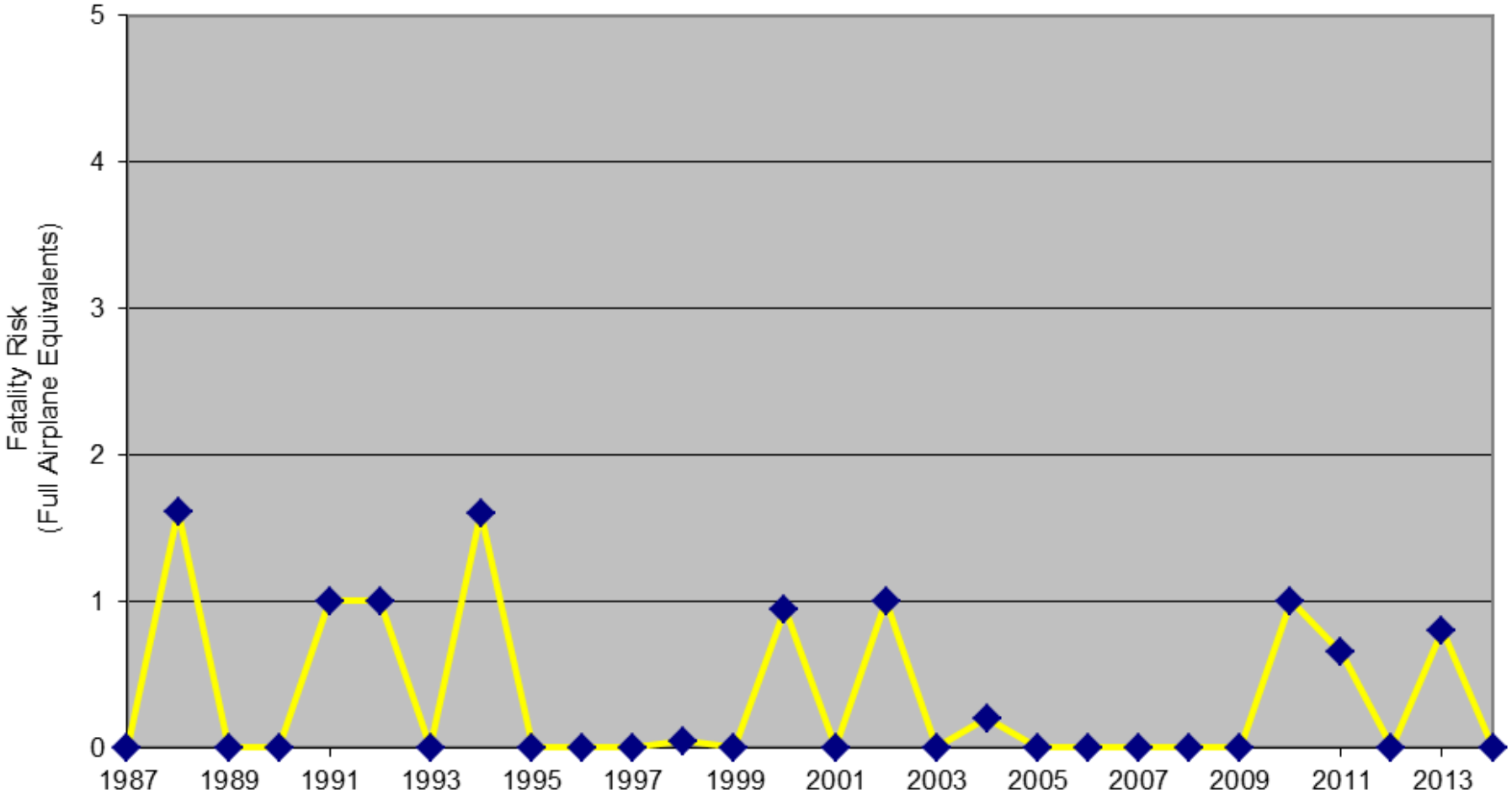

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SOP and Mitigations

To understand and mitigate CFIT accidents consider:

- Strong adherence to crew procedures
  - Departure and Approach briefings
  - Terrain awareness - all phases
  - Stable approach
  - Go around awareness
- Use of current charting
- Language proficiency – ATC
- Altimetry (QFE / QNH and metric)
  - QNH, QFE, QNE
  - Millibars, HectoPascals, Feet or Meters
  - Cold weather corrections

SOP and Mitigations

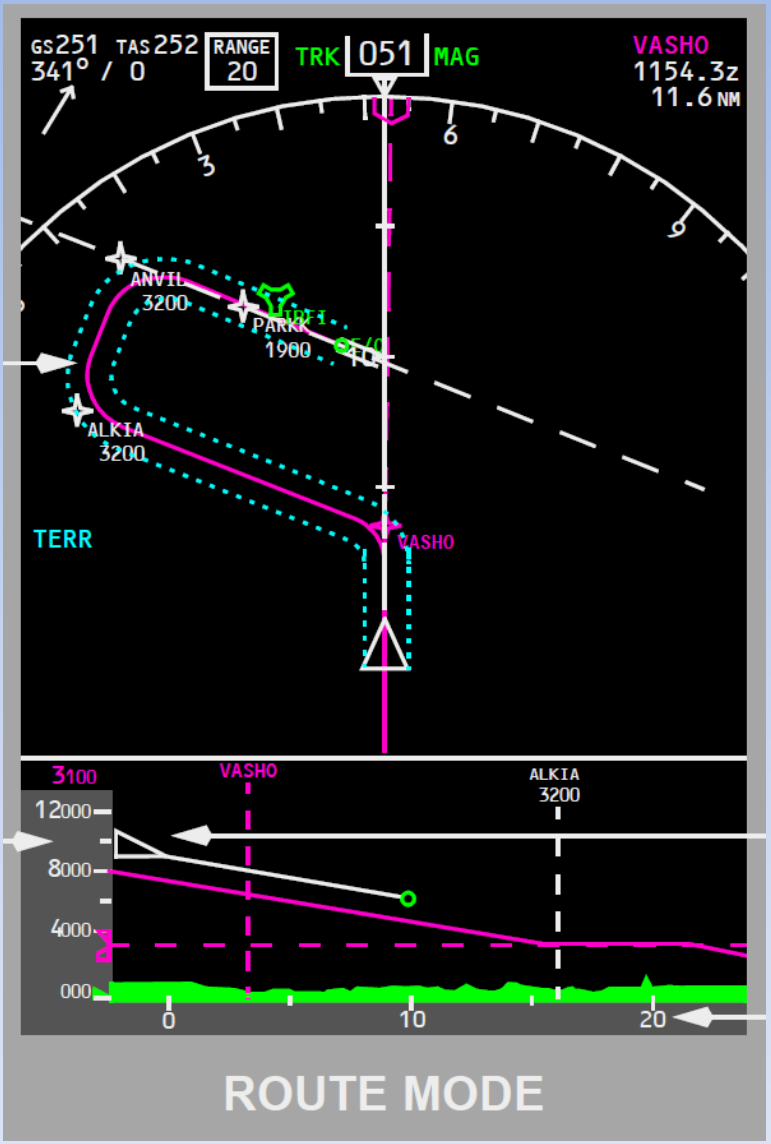
CFIT accident….

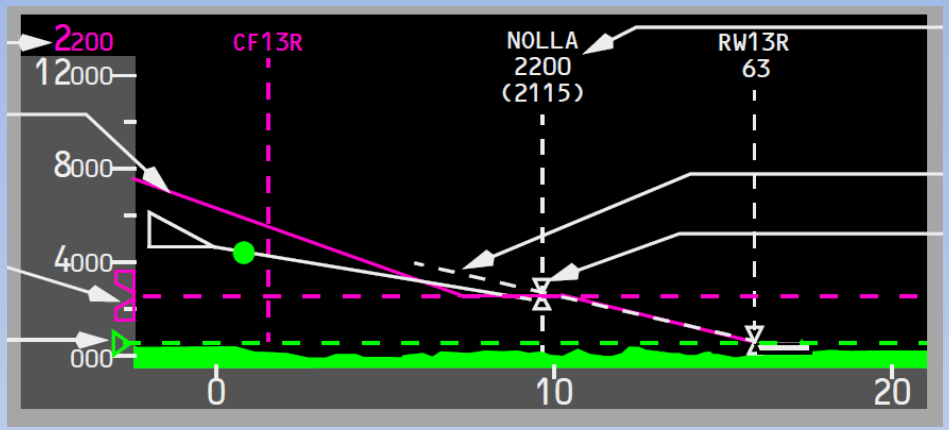
- Elimination of circling approaches
  - Air Blue - India
- RNP approaches
  - Increased utilization
- Centralized safety function
- Flight Standards
  - Insist that you fly the way you train

Equipment

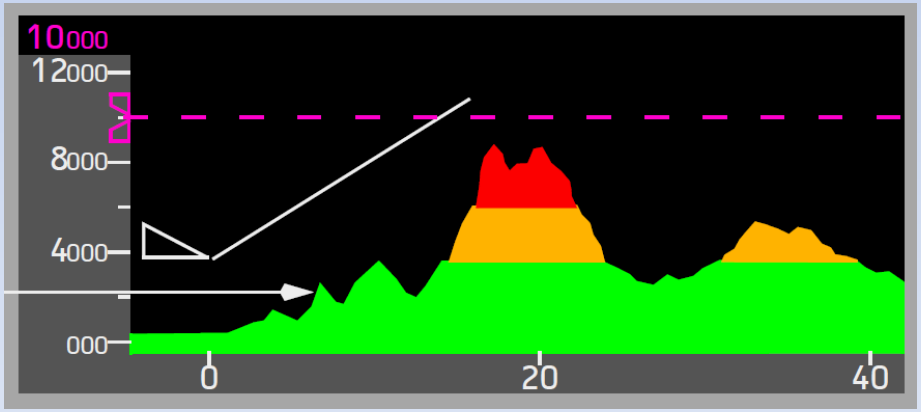
What aircraft equipment may mitigate CFIT?

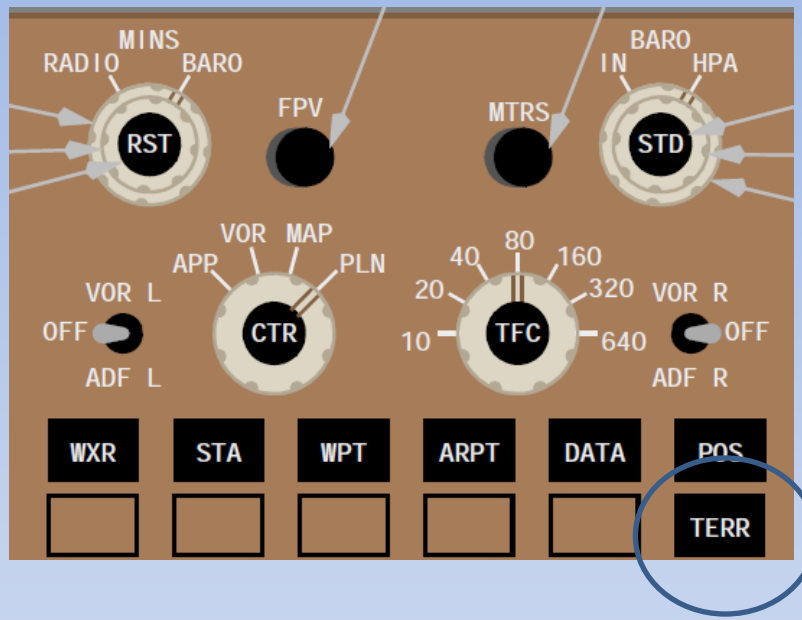
- EGPWS
  - Updated databases
  - No regulatory requirement
- Vertical Situation Display (VSD)
- Dual FMC / GPS
  - Nav Data Bases
  - LNAV / VNAV Capability
- Use of Autoflight – Vertical Speed mode
- Use of TERR mode

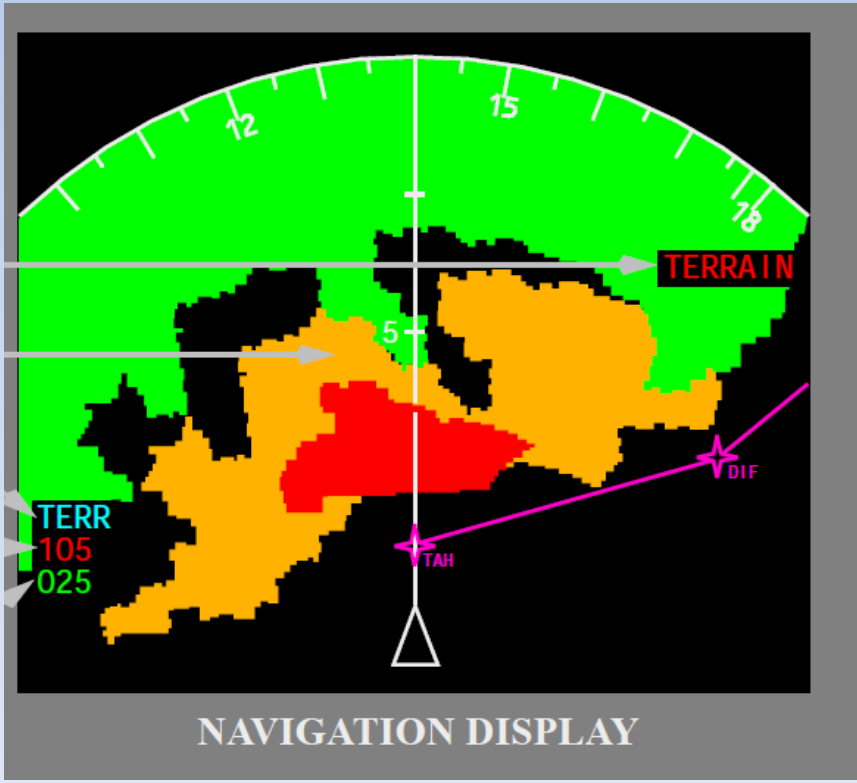




VSD Examples







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ALAR

APPROACH-AND-LANDING ACCIDENT REDUCTION

TOOL KIT

UPDATE

This is a product of the Flight Safety Foundation Approach and landing Accident Reduction (ALAR) Task Force and includes a variety of information to help reduce the risk of approach and landing accidents, including those involving controlled flight into terrain (CFIT).

This information is not intended to supersede operators'/manufacturers' policies, practices or requirements, or to supersede government regulations.

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601 Madison Street, Suite 300, Alexandria, Virginia 22314-1756 USA

Telephone: +1 703.739.6700; Fax: +1 703.739.6708

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Pilot Guide to Preventing CFIT

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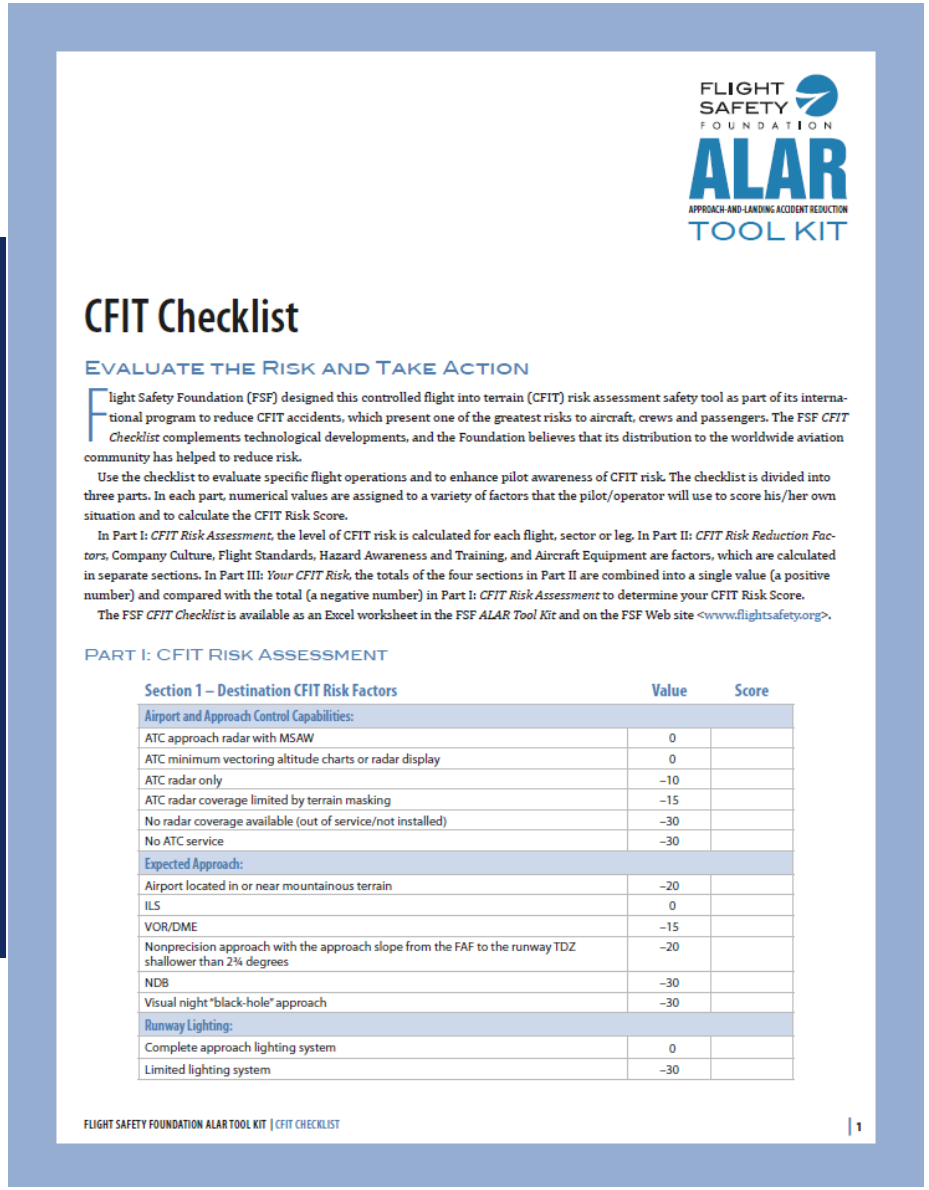

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CFIT Checklist

Evaluate the Risk and Take Action

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 one of the greatest risks to aircraft, crews and passengers. The FSF *CFIT Checklist* complements technological developments, and the Foundation believes that its distribution to the worldwide aviation community has helped to reduce risk.

Use the checklist to evaluate specific flight operations and to enhance pilot awareness of 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 the CFIT Risk Score.

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.

The FSF *CFIT Checklist* is available as an Excel worksheet in the FSF *ALAR Tool Kit* and on the FSF Web site <www.flightsafety.org>.

Part I: CFIT Risk Assessment

Section 1 – Destination CFIT Risk Factors	Value	Score
Airport and Approach Control Capabilities:		
ATC approach radar with MSAW	0	
ATC minimum vectoring altitude charts or radar display	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 runway TDZ shallower than 2¾ degrees	–20	
NDB	–30	
Visual night "black-hole" approach	–30	
Runway Lighting:		
Complete approach lighting system	0	
Limited lighting system	–30	

Flight Safety Foundation Africa Concern

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	
Central America/South America/Mexico/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 (–)		

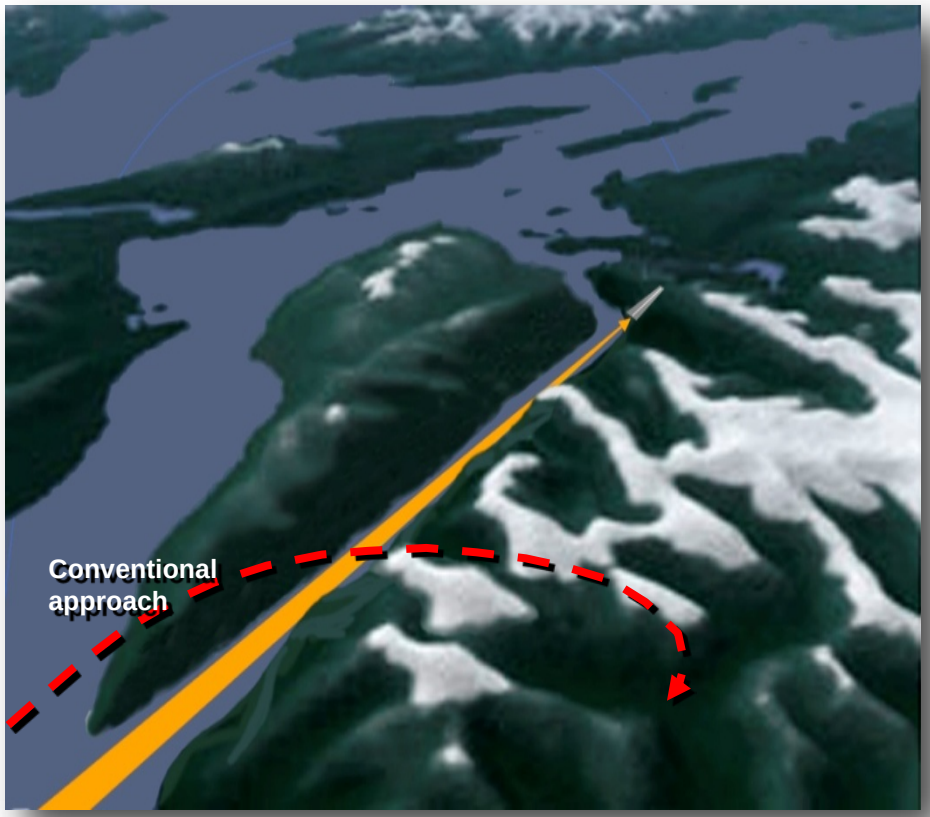
Part II: CFIT Risk-Reduction Factors

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	

PBN and RNAV-RNP

Performance-Based Navigation (PBN)

- Concept - enables the aircraft to navigate precisely along a defined path in space
- Uses aircraft FMS avionic capabilities
- PBN needs navigation infrastructure (GNSS)
- Operational requirements defined as:
  - Accuracy
  - Integrity
  - Continuity
  - Availability
  - Functionality



CFIT Mitigation Summary

To Lower Worldwide Accident Rates:

- Charting
- Use of RNP
- Strong SOPs
- Updated, current EGPWS (and database)
- Language Standardization
- Altimetry Standardization
- Use of FlightSafety Foundation CFIT Checklist

Thank you!

2nd African / Indian Ocean Aviation Safety Symposium

20th – 21st May 2015

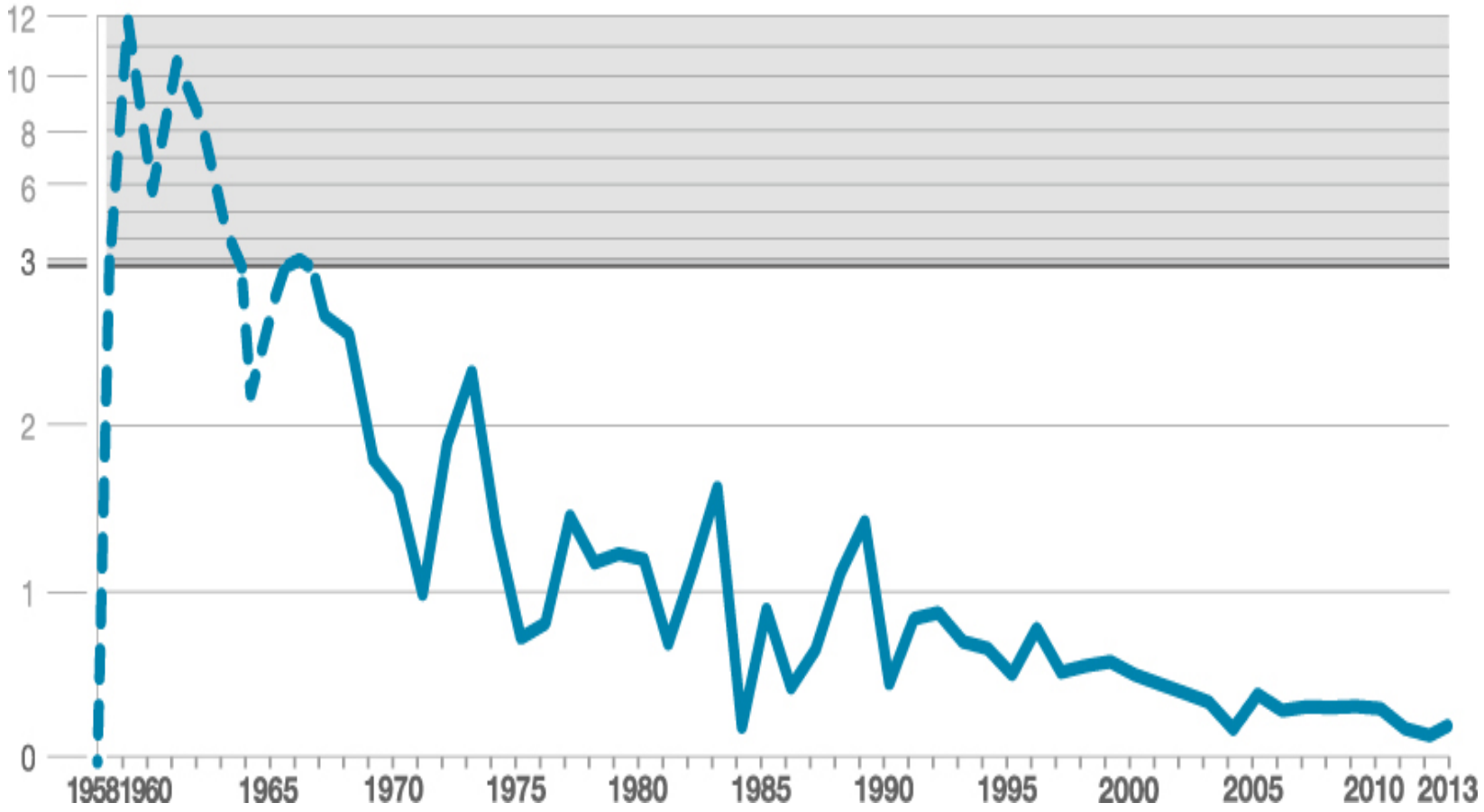
Harry Nelson

Controlled Flight Into Terrain CFIT –

"Gather the low hanging fruit"

Safety has significantly improved over the years…

Yearly fatal accident rate per million flights



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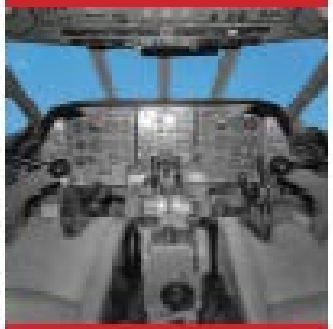
Significant evolution of aircraft technology

Detail of Aircraft Generations

In 2013

First Generation
Early commercial jets



10,000 flights
50 aircraft

Second Generation
More integrated Auto Flight System

1 million flights
1,000 aircraft

Third Generation
Glass cockpit and FMS

16 million flights
12,000 aircraft

Fourth Generation
Fly-By-Wire with flight envelope protection

11 million flights
6,000 aircraft

1st year of entry into service:

1952
Caravelle, Comet, BAC 111, Trident, VC-10, B707, B720, Convair 880/990, DC-8

1964
Concorde, A300 (except A300-600), BAE 146, Mercure, B727, B737-100/200, B747-100/SP/200/300, F-28, L-1011, DC-9, DC-10, VFW 614

1980
A300-600, A310, Avro RJ series, B717, B737-300/400/500, B737 NG -600/700/800/ 900, B757, B767, B747-400, B747-8, Bombardier CRJ Series, Embraer ERJ Series, 328JET, F-70, F-100, MD-11, MD-80, MD-90

1988
A318/A319/A320/A321, A330, A340-200/300/500/ 600, A380, B777, B787, Embraer E Series

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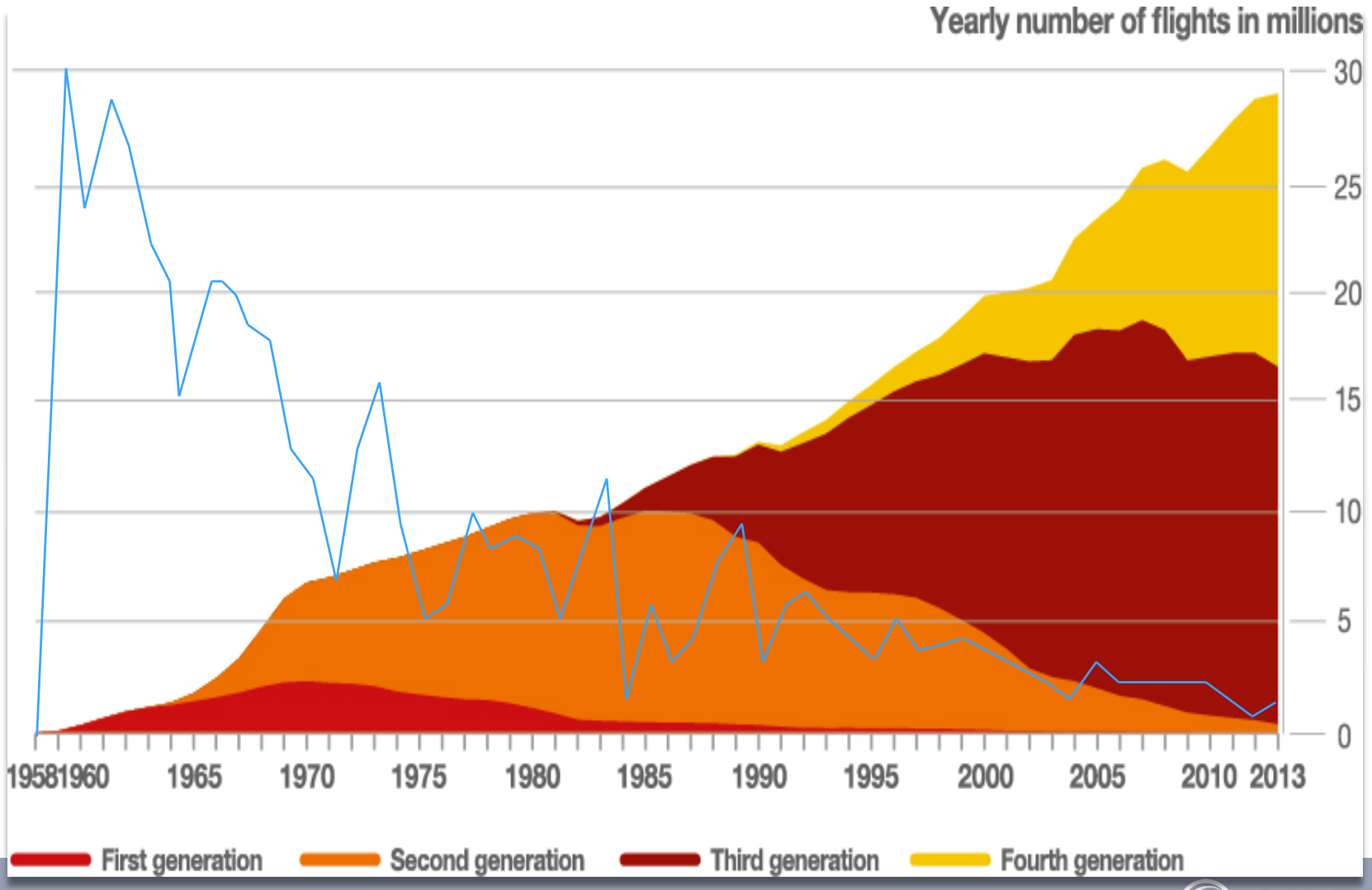
Yearly fatal accident rate per million flights

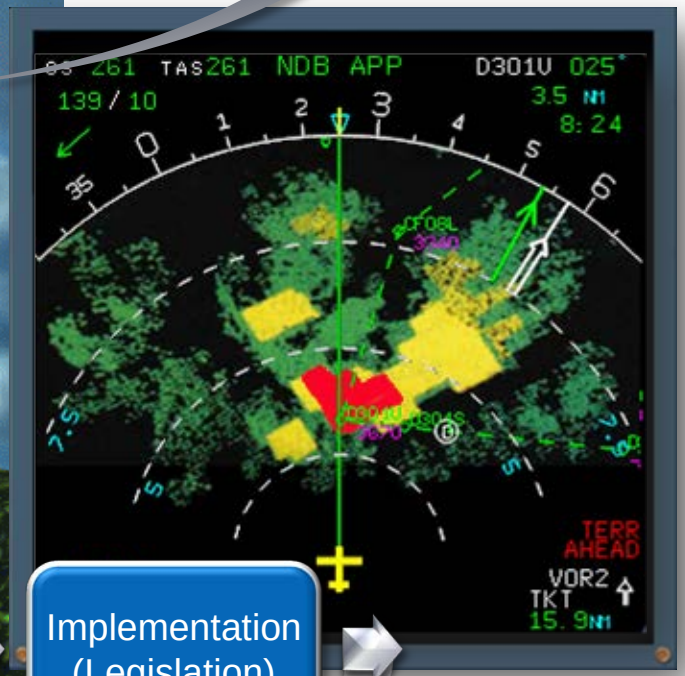


EGPWS / TAWS

Accidents

Technology "Solution"

Implementation (Legislation)



Controlled Flight Into Terrain

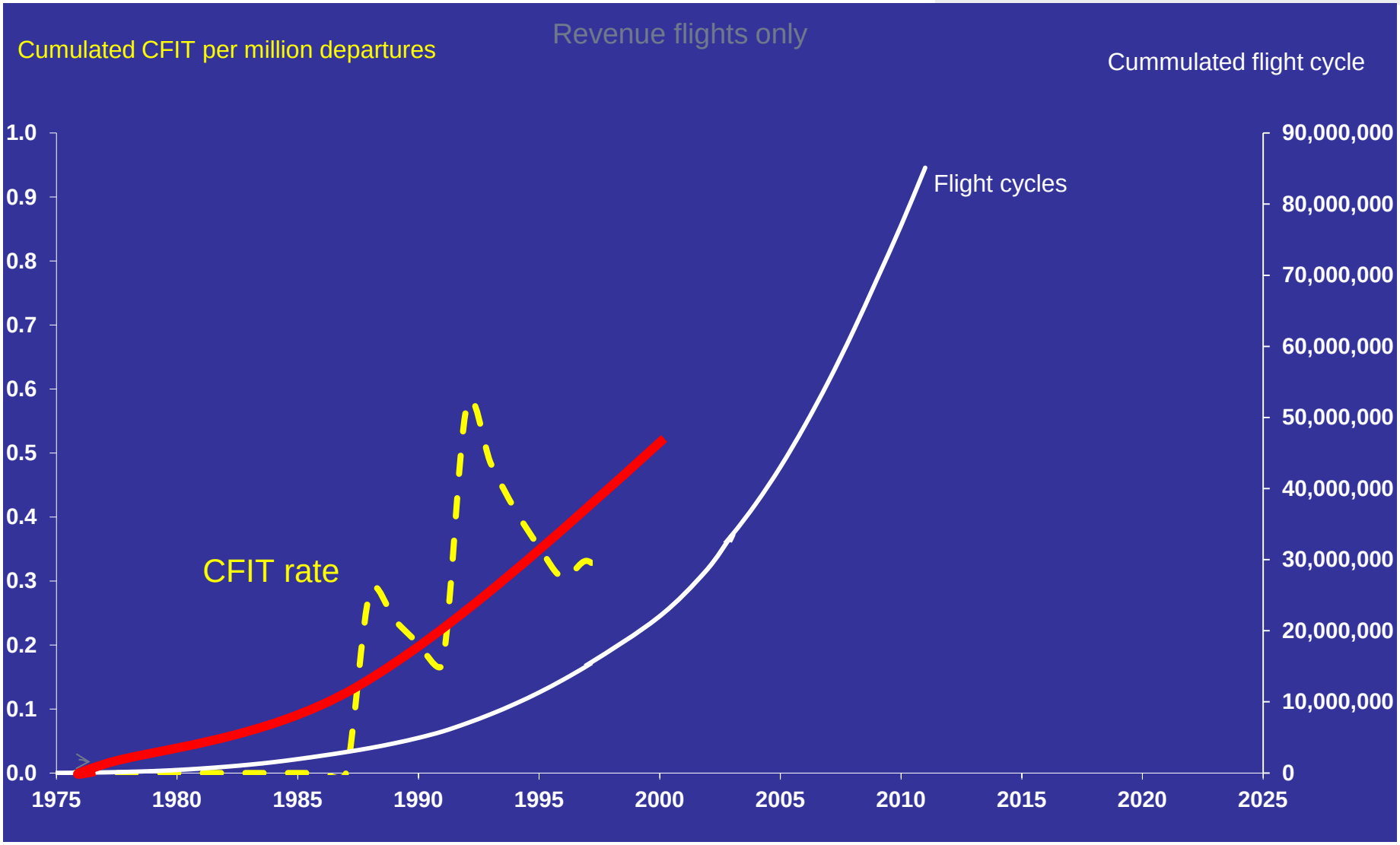
GPWS and EGPWS TAWS

Implementation (Legislation)

Reduced CFIT

AIRBUS

All Airbus aircraft – Effect of EGPWS / TAWS
Controlled Flight Into Terrain



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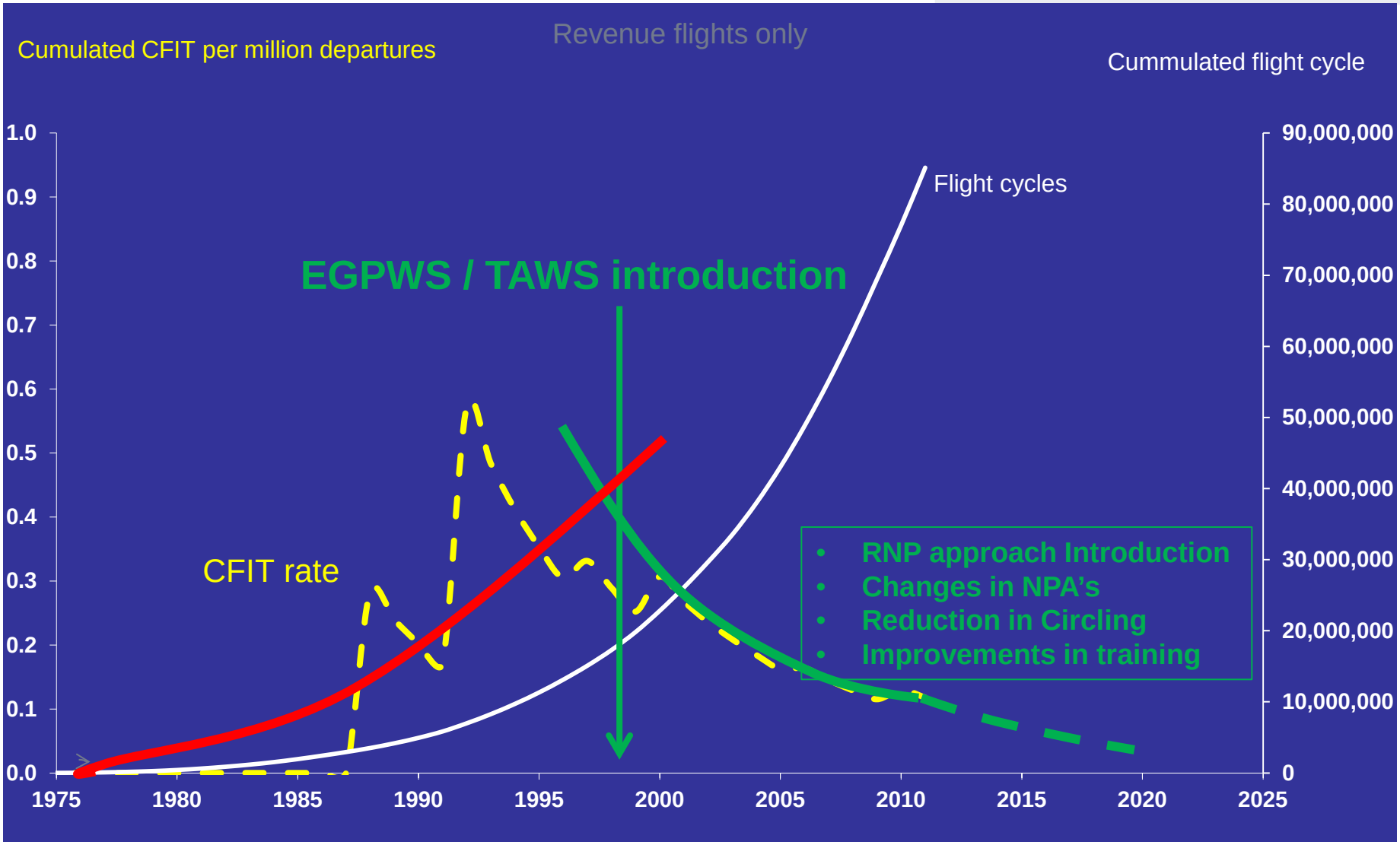
All Airbus aircraft – Effect of EGPWS / TAWS
Controlled Flight Into Terrain



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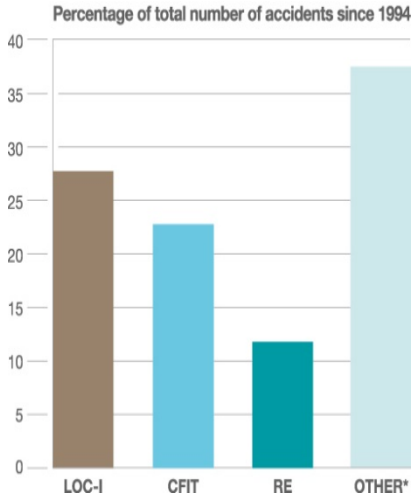
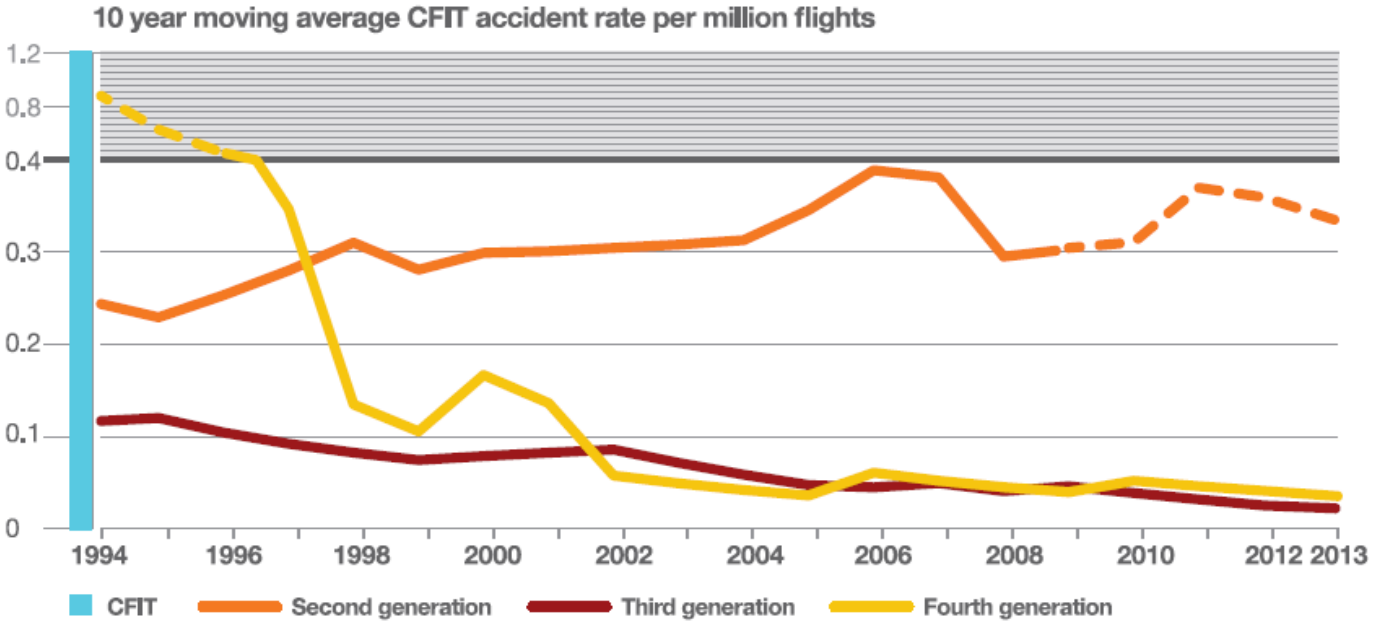
Technology as an efficient safety net





Technology to address Controlled Flight Into Terrain:

☑ combination of TAWS, Improved Navigation performance, Glass Cockpit/FMS equipped a/c, precision based approach (mainly 3rd and 4th generation of a/c)

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Causes and effects

1. The technological solutions to date have attacked two areas.
    a) Providing last line of defence
    b) Improving situational awareness

2. Future work will emphasise the need to understand root causes and to deal more with the disease and less the symptoms “

3 Key Messages

1. Avoidance :

Know when CFIT's are likely and what to do to avoid them

2. Recognition :

Know what to look for as one approaches these conditions

3. Recovery :

"Acknowledge and accept" that you are in one of those situations and then take immediate action

1. Avoidance – Know when they are likely to occur

Most likely during descent, approach and go around phases of flight

Higher risk with non precision approaches, especially those:

- that are of “dive and drive” design (Interrupted descent)
- that have no DME, or a displaced DME

When ATC directs a “higher than normal” initial approach altitude

When descending into mountainous or hilly terrain

Circling approaches

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1. Avoidance – Know what to do to avoid them

Ensure both crew members are " on the same page" as regards the planned descent and approach

- This requires a thorough pre descent brief:
  - Runway and high ground orientation
  - Weather
  - Type of approach
  - Monitoring expectations *"Call me ranges from touchdown and heights"*
  - Many crews use "PLAN" mode to brief as an aid in orientation
  - The go around routing

Agree a plan and fly the plan

- Choose a safer type of approach if available
- e.g RNP, FLS, Managed continuous descent
- Look closely at the weather to "predict" its effect on the plan

If ATC directs a "higher than normal" initial approach altitude re-brief the importance of a final stable section of the approach

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2. Recognition – Know what to look for

Changes from the briefed plan

Changes from the expected weather

Increases in crew workload

- *"I have lost the mental plan"*
- *"My/our situational awareness is becoming limited"*

Fatigue driven deterioration in performance

- Non standard procedures
- No call outs
- Failure to respond in a timely way
- Changing the plan without discussion

1. Recover – Accept and then take Action

When either: The crew recognise that they are at risk of a CFIT
or
A TAWS or GPWS warning sounds

Stay calm and TAKE RECOVERY ACTION IMMEDIATELY

Be prepared for potential confusion and possibly a “height bust” during the “recovery”

Level off at a safe height and select a safe heading

Re-establish situational awareness

Inform ATC and re-brief a new approach

PBN and CFIT

May 2015

ANDREW SMIT

PILOT A340/330 & NAVIGATION SPECIALIST

WHAT IS PBN?

ACCURATE NAVIGATION, INDEPENDENT OF TRADITIONAL GROUND BASED NAV AIDS.


SOUTH AFRICAN CARGO
ZS-SBB
WHAT IS CFIT?
CONTROLLED flight into TERRAIN

REASONS FOR CFIT

AUTOMATION CONFUSION

MANUAL FLIGHT DISORIENTATION

NON ADHERENCE TO SOP

HOW CAN PBN PREVENT CFIT?

MODERN PBN PROCEDURES DESIGNED FOR MODERN AUTOPILOT AND NAVIGATION SYSTEMS

DESIGNS CATOR NOT ONLY OPTIMISED FOR TERRAIN BUT ALSO FOR AIRSPACE

CDM MEANS PROCEDURE DESIGNERS, PILOTS AND CONTROLLERS HAVE DESIGN INPUT.

RNP - AR

19 May2015

An ANSP perspective

Background

- SA CAA approved and published RNP AR procedures at CT in 2014
- RNP AR
  - Approval is operator specific
  - Stringent licensing requirements
    - ✓ Approach specific
    - ✓ On board equipage specific
    - ✓ Crew specific

Operational Experience

- Different operators, different fleets, different levels of certification and equipage
- ATM / RNP-AR approaches integrated with “conventional navigation”
- Air Traffic Control: balance safety and expeditiousness
- Congested airspace
- Challenges:
  - Training of cockpit crews and Air Traffic Controllers
  - AIP and other publications

Parting thought

Introducing the top end of advancement
in navigation methodologies
are challenging and are not necessarily the
solution to all ills in ATM

Questions / answers

Thank you