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
1987-2014 Africa Hull Loss and/or Fatal Accidents

*Western built airplanes, Part 121 equivalent operations: 125 accidents; 35.6 Full Loss Equivalents
CFIT - Operator Domicile: Africa

*Western built airplanes, Part 121 equivalent operations
CFIT - Operator Domicile: Africa

*Western built airplanes, Part 121 equivalent operations
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
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
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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flightsafety.org
CFIT Checklist

Evaluate the Risk and Take Action

Flight Safety Foundation (FSF) designed this controlled flight into terrain (CFIT) risk assessment 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, User 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.flight safety.org.

Part I: CFIT Risk Assessment

<table>
<thead>
<tr>
<th>Section 1 – Destination CFIT Risk Factors</th>
<th>Value</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach and Approach Control Capabilities:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATC approach radar with MLS/NAV</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ATC minimum vectoring altitude charts or radar display</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ATC radar only</td>
<td>-10</td>
<td>-10</td>
</tr>
<tr>
<td>ATC radar coverage limited by terrain masking</td>
<td>-15</td>
<td>-15</td>
</tr>
<tr>
<td>No radar coverage available (out of service/not installed)</td>
<td>-30</td>
<td>-30</td>
</tr>
<tr>
<td>No ATC service</td>
<td>-30</td>
<td>-30</td>
</tr>
<tr>
<td>Expected Approach:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airport located in or near mountainous terrain</td>
<td>-20</td>
<td>-20</td>
</tr>
<tr>
<td>ILS</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>VOR/DME</td>
<td>-15</td>
<td>-15</td>
</tr>
<tr>
<td>Nonprecision approach with the approach slope from the FAA to the runway TISZ shallower than 2% degrees</td>
<td>-20</td>
<td>-20</td>
</tr>
<tr>
<td>NDB</td>
<td>-30</td>
<td>-30</td>
</tr>
<tr>
<td>Visual night &quot;Black-hole&quot; approach</td>
<td>-40</td>
<td>-40</td>
</tr>
<tr>
<td>Runway Lighting:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete approach lighting system</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Limited lighting system</td>
<td>-30</td>
<td>-30</td>
</tr>
</tbody>
</table>
### Flight Safety Foundation

**Africa Concern**

#### Section 2: Risk Multiplier

<table>
<thead>
<tr>
<th>Your Company’s Type of Operation (select only one value):</th>
<th>Value</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheduled</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Nonscheduled</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Corporate</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Charter</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Business owner/pilot</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Regional</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Freight</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Domestic</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>International</td>
<td>3.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Departure/Airport (select single highest applicable value):</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia/New Zealand</td>
<td>1.0</td>
</tr>
<tr>
<td>United States/Canada</td>
<td>1.0</td>
</tr>
<tr>
<td>Western Europe</td>
<td>1.3</td>
</tr>
<tr>
<td>Middle East</td>
<td>1.1</td>
</tr>
<tr>
<td>Southeast Asia</td>
<td>2.0</td>
</tr>
<tr>
<td>East Asia/Central Europe and Commonwealth of Independent States</td>
<td>1.0</td>
</tr>
<tr>
<td>Central America/South America/Mexico/Caribbean</td>
<td>5.0</td>
</tr>
<tr>
<td>Africa</td>
<td>8.0</td>
</tr>
</tbody>
</table>

#### Risk Flight Conditions (select only one value):

| Night — no moon                                        | 2.0   |
| IMC                                                     | 3.0   |
| Moge and IMC                                            | 5.0   |

<table>
<thead>
<tr>
<th>Crew (select only one value):</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-pilot flight crew</td>
<td>1.5</td>
</tr>
<tr>
<td>Flight crew, duty day at maximum and ending with a night nonprecision approach</td>
<td>1.2</td>
</tr>
<tr>
<td>Flight crew, crosses five or more time zones</td>
<td>1.2</td>
</tr>
<tr>
<td>Third day of multiple time zone crossings</td>
<td>1.2</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Corporate/company management:</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Places safety before schedule</td>
<td>20</td>
</tr>
<tr>
<td>CEO signs off on flight operations manual</td>
<td>20</td>
</tr>
<tr>
<td>Maintains a centralized safety function</td>
<td>20</td>
</tr>
<tr>
<td>Fosters reporting of all CFIT incidents without threat of discipline</td>
<td>20</td>
</tr>
<tr>
<td>Fosters communication of hazards to others</td>
<td>15</td>
</tr>
</tbody>
</table>
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!
Controlled Flight Into Terrain - CFIT - 
“Gather the low hanging fruit"

Harry Nelson

2nd African / Indian Ocean Aviation Safety Symposium
20th – 21st May 2015
Safety has significantly improved over the years…

Yearly fatal accident rate per million flights

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Significant evolution of aircraft technology

First Generation
Early commercial jets
- Concorde, Comet, BAC 111, Trident, VC-10, B707, B720, Convair 880/990, DC-8
- 10,000 flights in 50 aircraft

Second Generation
More integrated Auto Flight System
- A300, 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
- 1 million flights in 1,000 aircraft

Third Generation
Glass cockpit and FMS
- 16 million flights in 12,000 aircraft

Fourth Generation
Fly-By-Wire with flight envelope protection
- 11 million flights in 8,000 aircraft

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Safety has significantly improved over the years…

Yearly fatal accident rate per million flights

Yearly number of flights in millions

First generation
Second generation
Third generation
Fourth generation
EGPWS / TAWS

- Accidents
- Technology "Solution"
- Implementation (Legislation)

Controlled Flight Into Terrain
GPWS and EGPWS TAWS
Implementation (Legislation)
Reduced CFIT
All Airbus aircraft – Effect of EGPWS / TAWS
Controlled Flight Into Terrain

Cumulated CFIT per million departures

Revenue flights only

Cumulated flight cycle

Flight cycles

CFIT rate

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

Cumulated CFIT per million departures

Revenue flights only

CFIT rate

EGPWS / TAWS introduction

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

Flight cycles

0 10,000,000 20,000,000 30,000,000 40,000,000 50,000,000 60,000,000 70,000,000 80,000,000 90,000,000

- RNP approach Introduction
- Changes in NPA's
- Reduction in Circling
- Improvements in training

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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 3\textsuperscript{rd} and 4\textsuperscript{th} generation of a/c)
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
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
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.
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.
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
Introducing the top end of advancement in navigation methodologies are challenging and are not necessarily the solution to all ills in ATM
Questions / answers