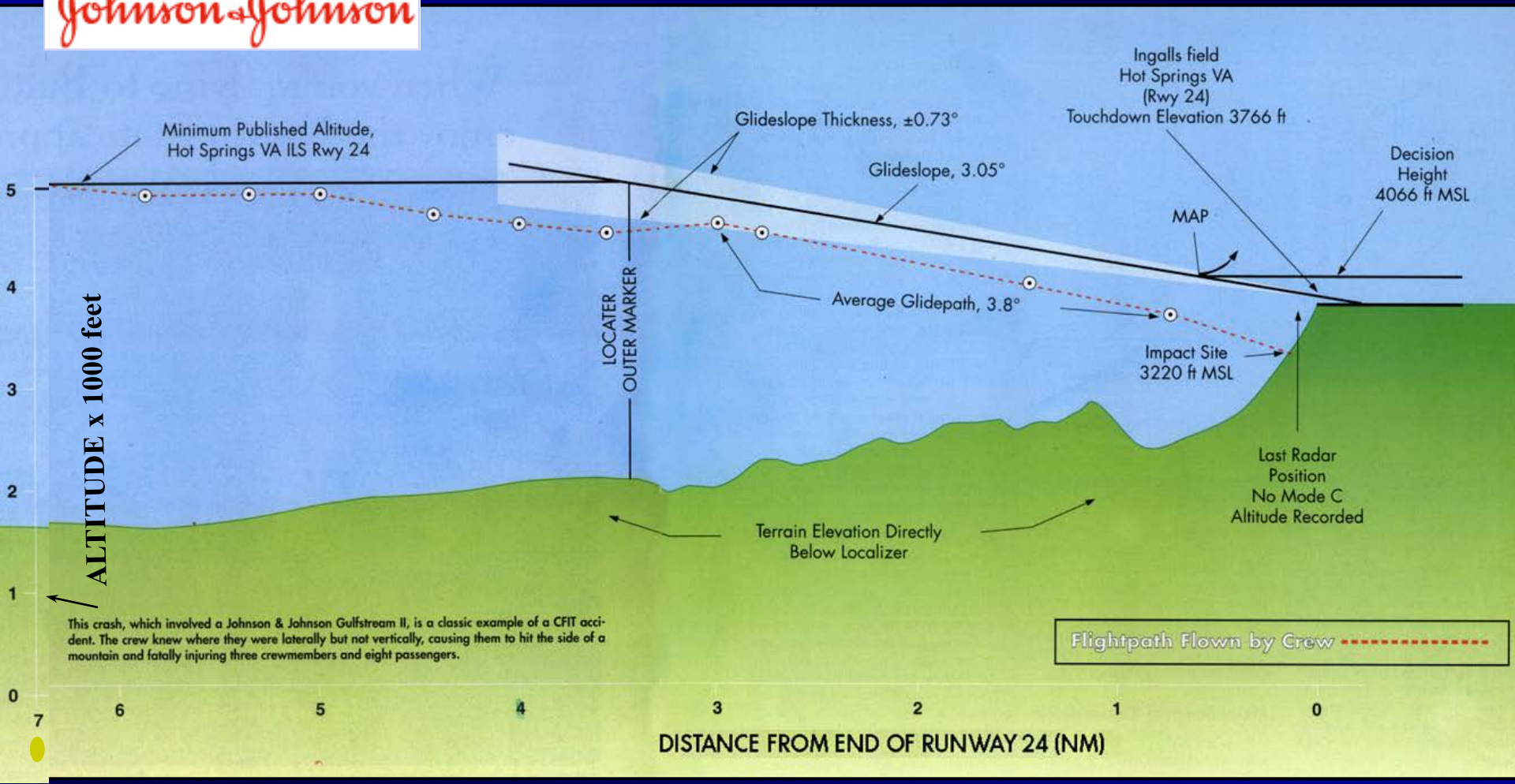
Controlled Flight Into Terrain (CFIT)

The Problem That Never Went Away

Robert Sumwalt
US National Transportation Safety Board

Gulfstream GII Accident



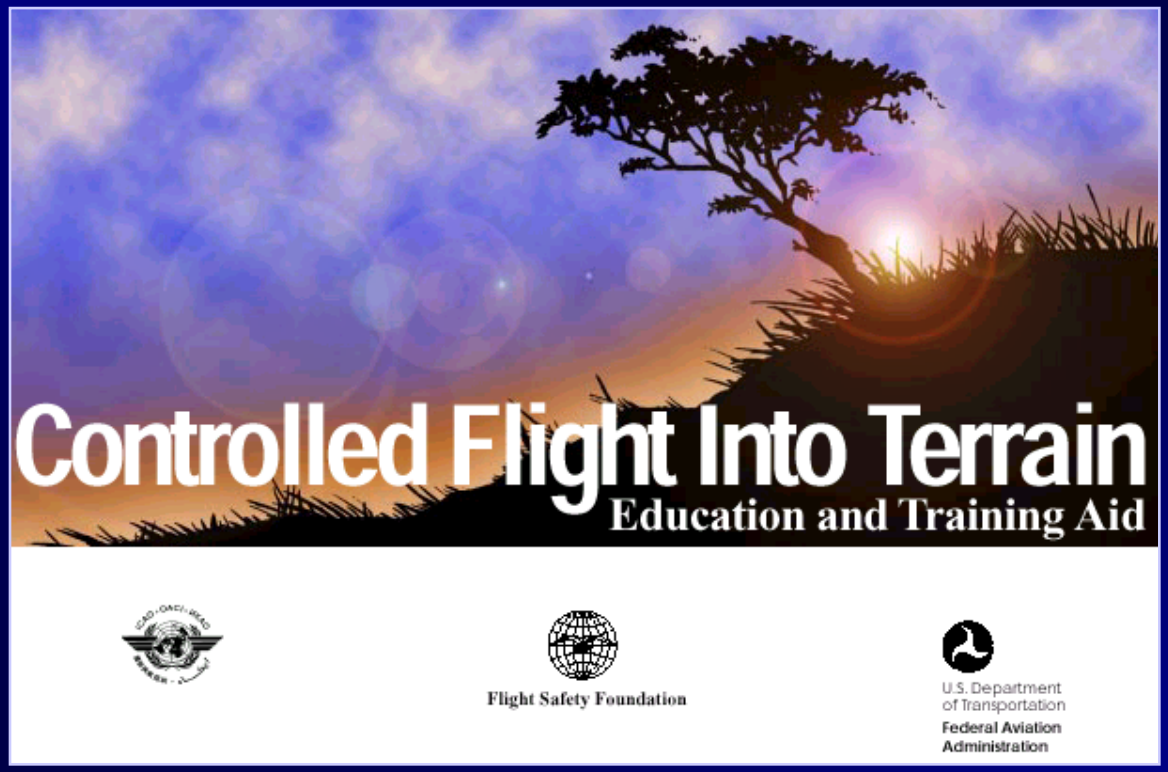
September 26, 1976
11 Fatalities

Hot Springs, Virginia

Cessna 401 Accident

October 24, 1976 Hot Springs, Virginia 0 Fatalities

A great CFIT resource!



CFIT Defined

When an airworthy aircraft under the control of the flight crew is flown unintentionally into terrain, obstacles or water, usually with no prior awareness by the crew.

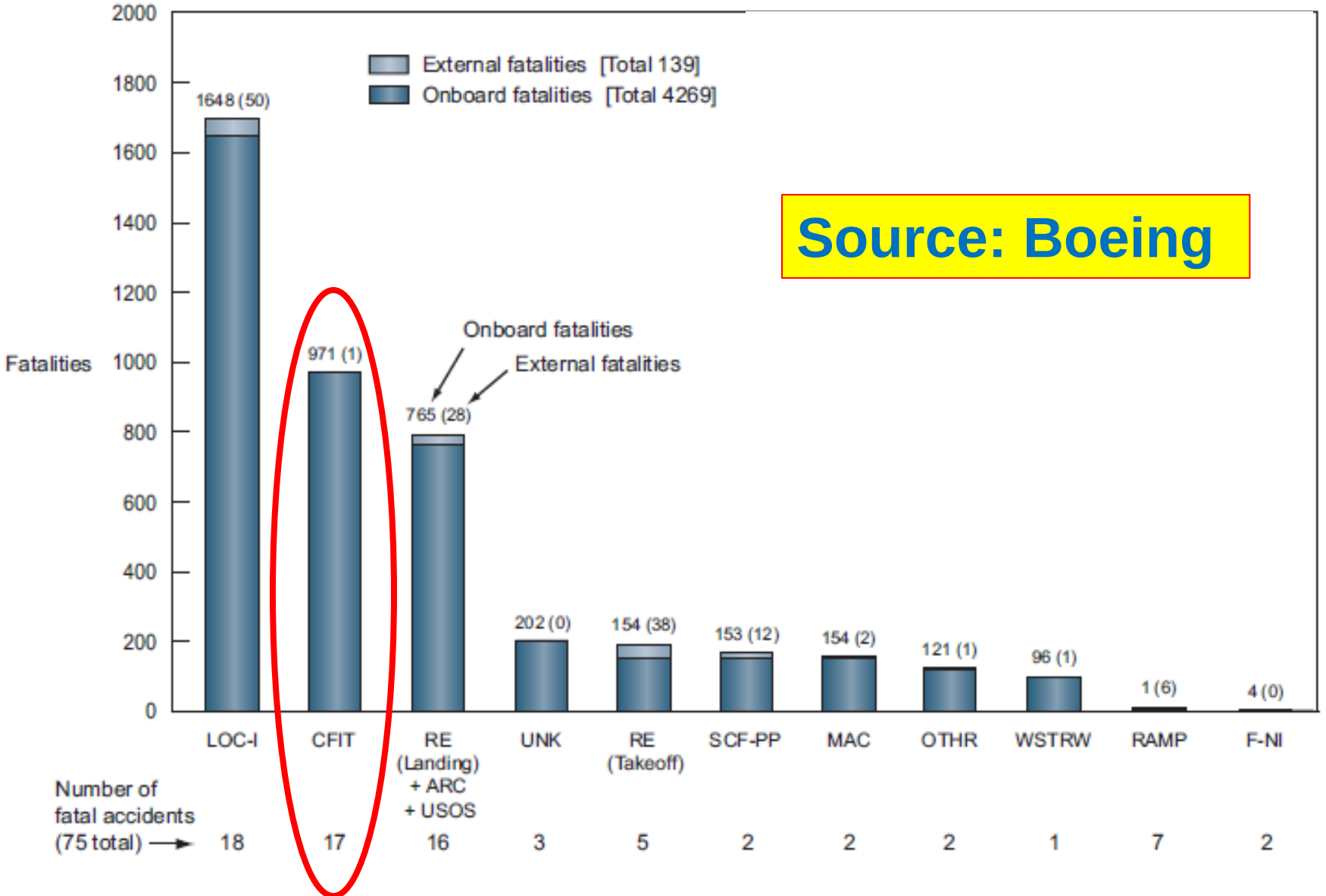
Source: CFIT Training Aid

In the past 3 ½ years:

- CFIT has claimed over 500 lives in worldwide airplane crashes
  - In the vast majority of these crashes, the aircraft was not equipped with an operational TAWS.

Fatalities by CAST/ICAO Common Taxonomy Team (CICTT) Aviation Occurrence Categories

Fatal Accidents – Worldwide Commercial Jet Fleet – 2003 Through 2012



CFIT Accidents: 2014

Date	Location	Aircraft type	Fatalities
3 February 2014	Oklahoma, USA	Cessna 525	0
8 April 2014	Alaska, USA	Cessna 208	2
19 April 2014	Mexico	BAe-125-700	8
8 May 2014	Colombia	DC-3	5

Source: Don Bateman (Honeywell); NTSB files; Jim Burin (Flight Safety Foundation)

CFIT Accidents: 2013

Date	Location	Aircraft type	Fatalities
23 January 2013	Antarctica	DHC-6	3
29 January 2013	Kazakhstan	CRJ-200	21
4 March 2013	Congo	Fokker 50	0
13 April 2013	Indonesia	Boeing 737-800	0
10 October 2013	Malaysia	DHC-6	2
16 October 2013	Laos	ATR-42	49
19 October 2013	Papua New Guinea	ATR-42	0
3 November 2013	Bolivia	Metro III	8
10 November 2013	Ontario Canada	Metro IV	5
29 November 2013	Alaska. USA	Cessna 208	4
2 December 2013	Puerto Rico	Metro III	2
26 December 2013	Russia	An-12	9

CFIT Accidents: 2013

Date	Location	Aircraft type	Fatalities
30 January 2012	Congo	An-28	2
15 March 2012	Sweden	C-130J	5
9 May 2012	Indonesia	Su-95	45
14 May 2012	Nepal	Dornier 228	15
22 June 2012	West Virginia, USA	Beech King Air C90GT	1
19 August 2012	Sudan	An-24	31
12 September 2012	Russia	An-28	10
30 November 2012	Congo	IL-76	32
17 December 2012	Peru	An-26	4
18 December 2012	Montana, USA	Beech King Air 100	2
25 December 2012	Myanmar	Fokker 100	2

CFIT Accidents: 2011

Date	Location	Aircraft type	Fatalities
2 February 2011	Congo	L-410	2
2 February 2011	Honduras	L-410	14
8 February 2011	South Africa	PC-12	9
4 April 2011	Congo	CRJ-100	31
20 June 2011	Petrozavodsk	TU-134	44
6 July 2011	Kabul	IL-76	9
10 July 2011	Congo	Boeing 727	63
9 August 2011	Russia	An-24	0
20 August 2011	Canada	Boeing 737-200	12
7 September 2011	Bolivia	SA-227	8
25 September 2011	Nepal	Beech 1900D	19
29 September 2011	Indonesia	Casa 212	18
23 November 2011	Arizona, US	Aero Commander 690	6

Helicopter CFIT in United States: 2008 - present

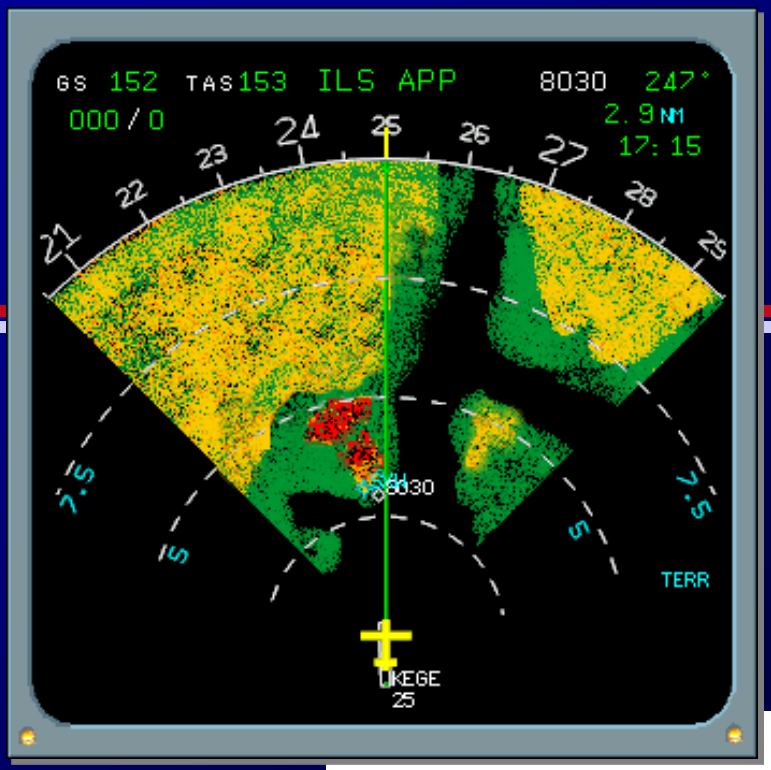
- Since January 1, 2008 – present:
  - 22 Helicopter CFIT accidents in US
  - 37 Fatalities

Don Bateman

Terrain Warning and Alerting System (TAWS)

TAWS

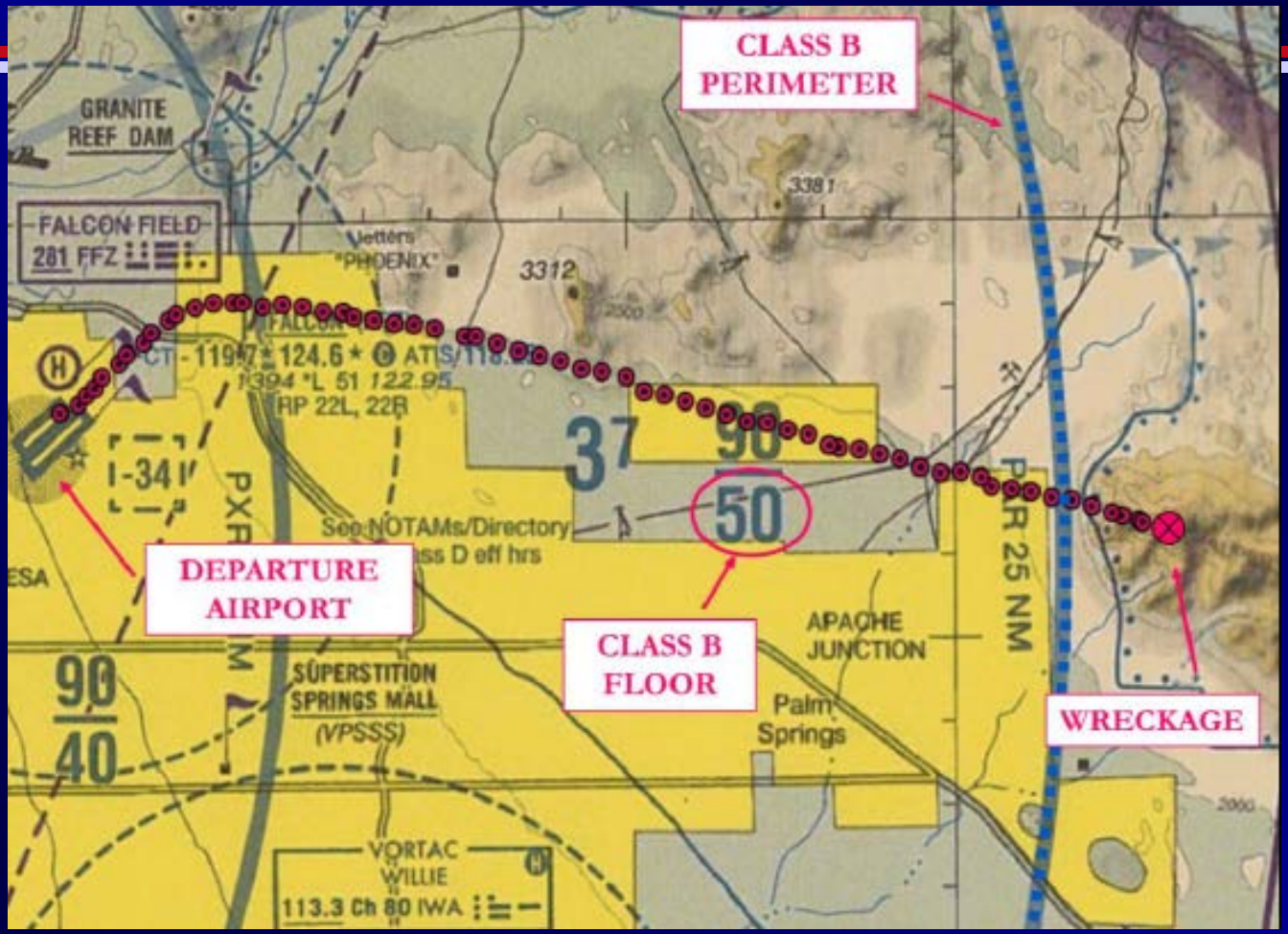
- Worldwide terrain database
- Through GPS and FMS, the system knows aircraft position and altitude
- Scans ahead to check for terrain threats
- Provides aural and visual WARNINGS/ CAUTIONS up to 60 seconds before predicted terrain conflict


GS 152 TAS 153 ILS APP 8030 247°
000 / 0
2.9 NM
17:15
21
22
23
24
25
26
27
28
29
7.5
5
5
7.5
8030
TERR
KEGE
25

WARNING


A320
A320
WARNING
CAUTION


ACCIDENT
FLIGHT PATH
WRECKAGE
FALCON
FIELD
OUTBOUND
INBOUND


CLASS B PERIMETER
GRANITE REEF DAM
FALCON FIELD
281 FFZ
Letters "PHOENIX"
3312
3381
37
90
50
See NOTAMs/Directory
DEPARTURE AIRPORT
CLASS B FLOOR
APACHE JUNCTION
PXR 25 NM
SUPERSTITION SPRINGS MALL
(VPSSS)
Palm Springs
WRECKAGE
90
40
VORTAC
WILLIE
113.3 Ch 80 IWA


PEAK ≈ 5,000 ft
PEAK ≈ 4,800 ft
WRECKAGE
≈ 4,700 ft
RADAR RETURN
≈ 4,500 ft
FLIGHT
PATH


Main Wreckage

Probable Cause

- The pilot's failure to maintain a safe ground track and altitude combination for the moonless night visual flight rules flight, which resulted in controlled flight into terrain.
- Contributing to the accident were the pilot's complacency and lack of situational awareness and his failure to use air traffic control visual flight rules flight following or minimum safe altitude warning services.
- Also contributing to the accident was the airplane's lack of onboard terrain awareness and warning system equipment.

A Threat & Error Management (TEM) Approach to Reducing CFIT

“Threats”

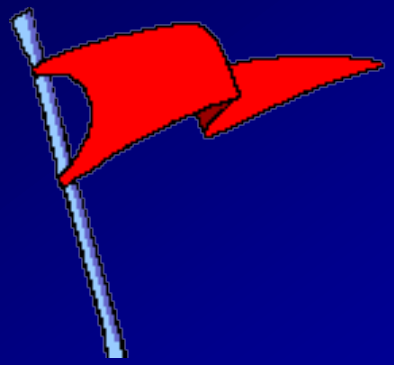
- Those things that can increase the operational complexity, and if not handled correctly, can decrease the safety margins

  - Weather
  - Delays
  - Mechanical Malfunctions
  - Stress

  - Time pressure
  - Distractions
  - ? ?

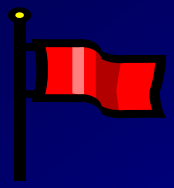
Threats

- Threats
  - Threats can increase error potential
  - Threats “put holes in” or weaken our barriers against error
- Threats = **Red Flags**



Be aware of threats!

- "Snakes in the grass"
  - What are the things that can bite you on this flight?
- We want crewmembers to identify, talk about and think about threats, and
- those things that are different about this operation or flight
  - Unfamiliar airport
  - Flying with new pilot
  - New procedures



- This puts the threats in the employees "mental RAM" and makes it readily available for retrieval
  - Example: mentally rehearse CFIT escape maneuver

Errors

OIT
IS 49ERS
4 1,10C
E WINLESS
ER REVIEW, 1C
RT, 1,10,13C
V JONES
TODAY'S
LEAGUE
OF THE YEAR
R ANOTHER STAR IN
ONSTELLATION, 1C

26, 1995
INE

ndustrial average rises
ails 7.24 to 1046.15; 30-
t 6.58%. 1,3B.

uhen, 3, is buried; she
hit by gunfire on Los
ect arrested. 4A.

administration walks
mmitment with pledge
ign relations. 9A.

epreneur Sir Freddie
unch U.S.-based trans-
rida to Britain. 1B.

r Viswanathan Anand,
, beats reigning champ
rry Kasparov in the
th game, breaking se-
s of draws and record-
the first win in Profes-
nal Chess Association
rld championship in
w York. 13C.

ELANY DIES:
ssie Delany, second
ck female dentist in

USA TODAY

NO. 1 IN THE USA . . . FIRST IN DAILY READERS

HOME SALE
HIT HIGHES
POINT IN
15 MONTHS
EVEN IF SURGE FALTERS,
ECONOMY WILL GET BOO

NEW FILMS FEATU
WOMEN AND ISSU
THEY FACE TOGETH
SISTERHOOD TO OUTSHINE
SHOWGIRLS, DRAG QUEENS

FIRST IN A 3-PART SERIES

WARNING: PILOT ERROR

How regional airlines failed to heed warning signals about pilots who didn't belong in the cockpit

“To err is human”

“Errar e humano”

Why error management?

- Traditional thinking focused on eliminating human error in aviation
- Contemporary thinking acknowledges that error is a way of life
  - given the acceptance that human error may occur, the focus has become “How do you effectively manage error?”
  - proper error management greatly enhances safety

Errors will occur

"So we must create an error management system in which the crew recognizes and corrects errors before negative consequences occur."

- Captain Frank J. Tullo

"Aviation Week and Space Technology"

May 21, 2001

Threat and Error Management

Helps us avoid and trap errors.

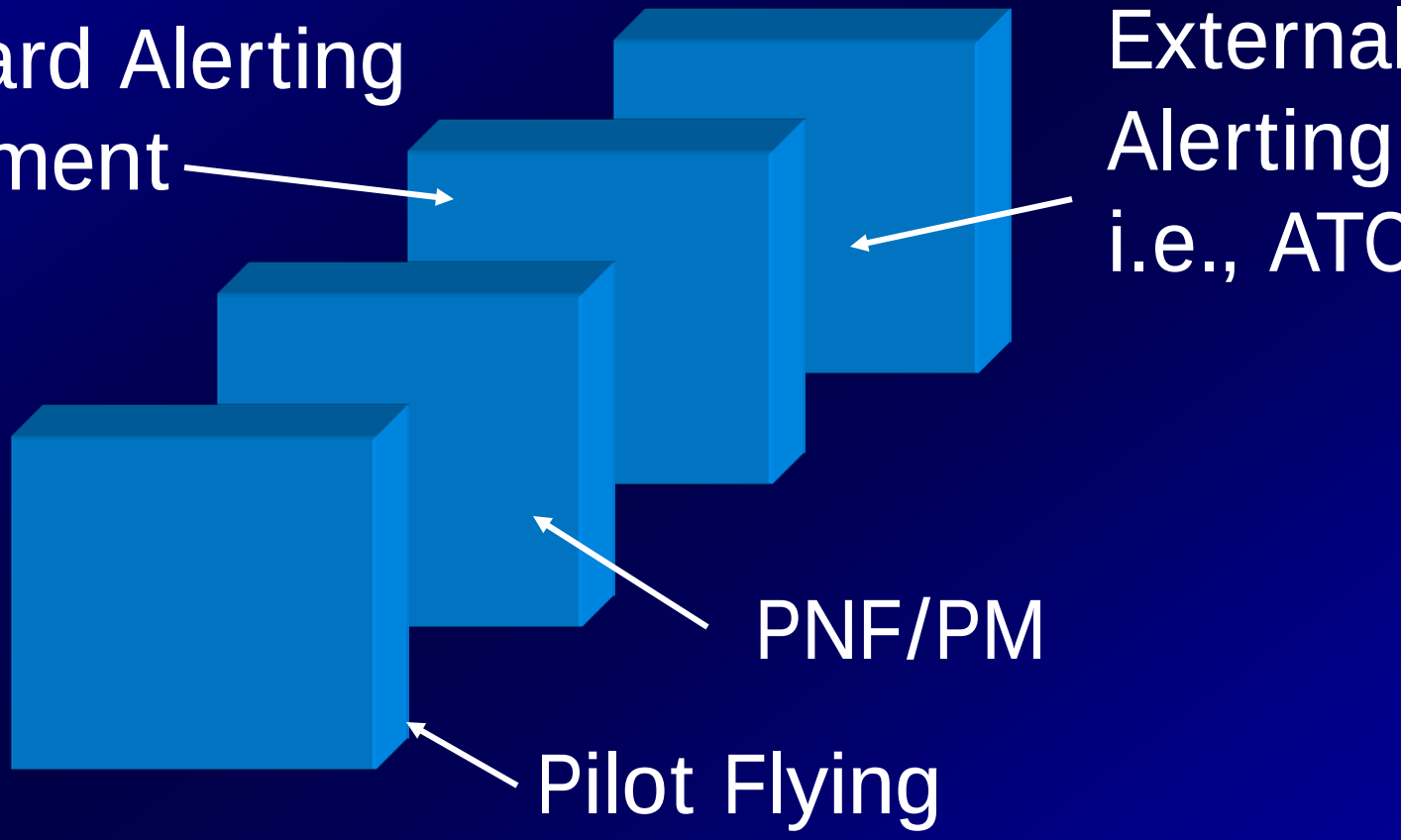
Avoiding Errors

- Good training
- High levels of proficiency
- Following SOPs
- Minimizing distractions
- Planning ahead
- Maintaining situational awareness
- CRM – the effective use of all available resources

Trapping Errors

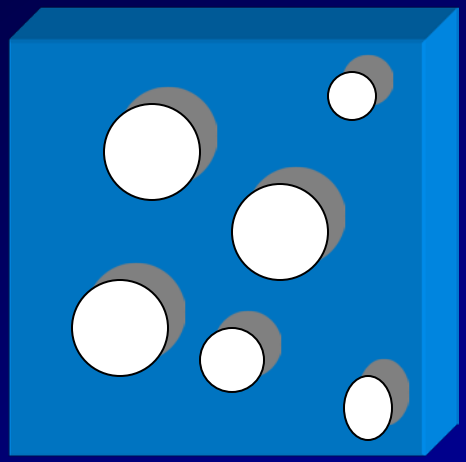
- Once an error is committed, it is difficult to catch (trap) your own error
- Other people are often more likely to catch your error
- Therefore, redundancy is one strong defense against error

Layers of Defense (barriers) to trap crew errors

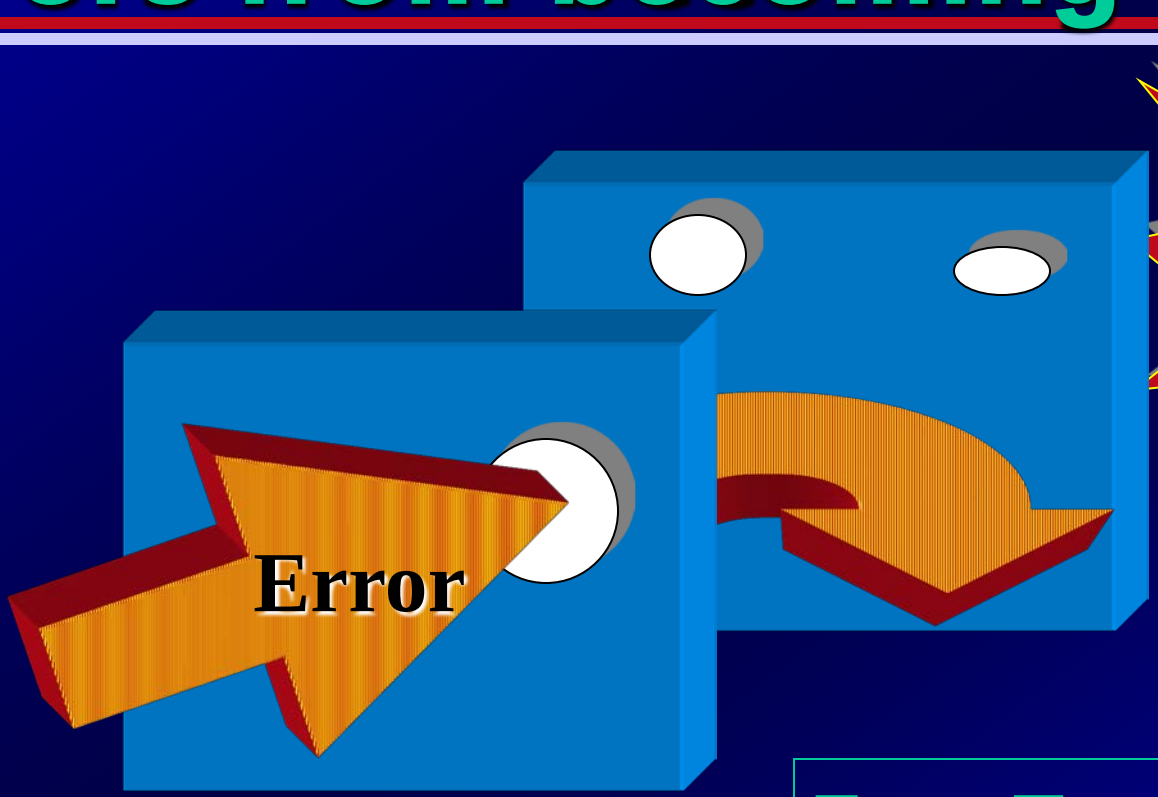


Examples of how “holes in defenses” can be formed

- Increasing workload
- Time pressure
- Fatigue
- Procedural non-compliance
- Poor crew coordination
- Interruptions / Distractions

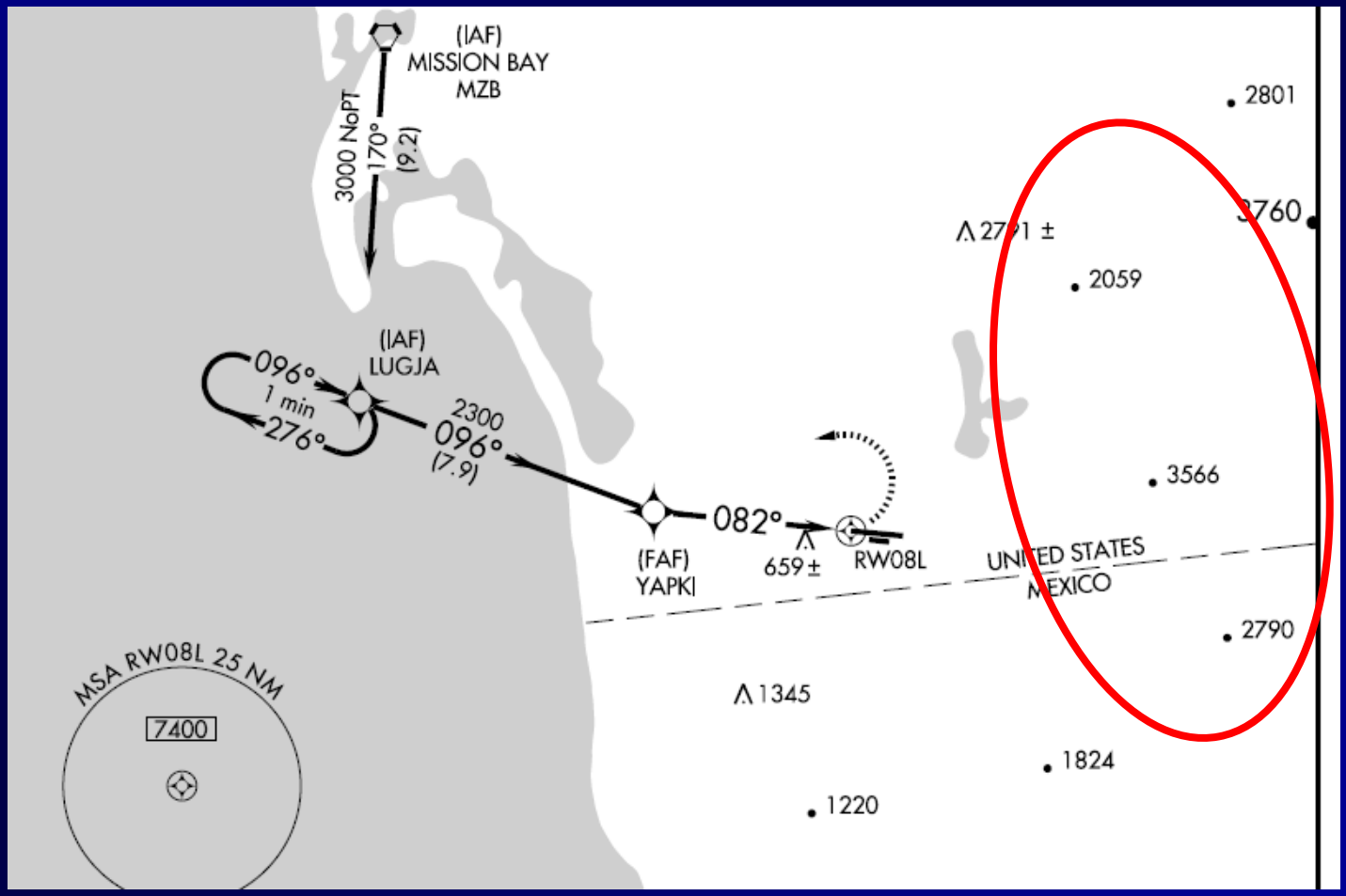


Layers of defense help deflect errors from becoming hazards



Error Trapped.
Hazard Averted

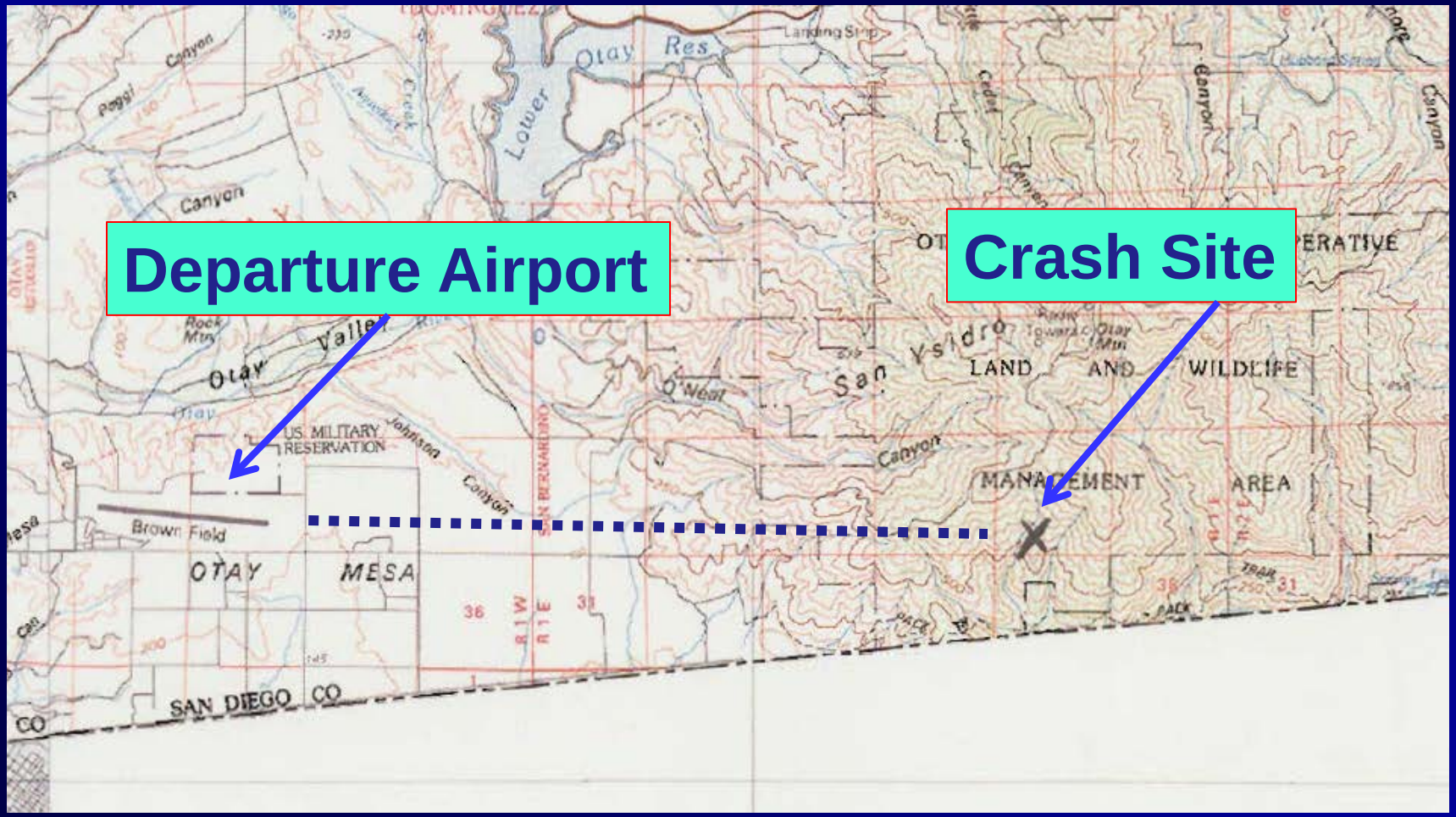
Learjet 35A
October 24, 2004
San Diego, CA
5 Fatalities


(IAF)
MISSION BAY
MZB
3000 NoPT
170°
(9.2)
(IAF)
LUGJA
096°
1 min
276°
2300
096°
(7.9)
082°
(FAF)
YAPKI
659±
RW08L
UNITED STATES
MEXICO
MSA RW08L 25 NM
7400
2801
2059
3566
2790
1345
1824
1220

SAN DIEGO, CA

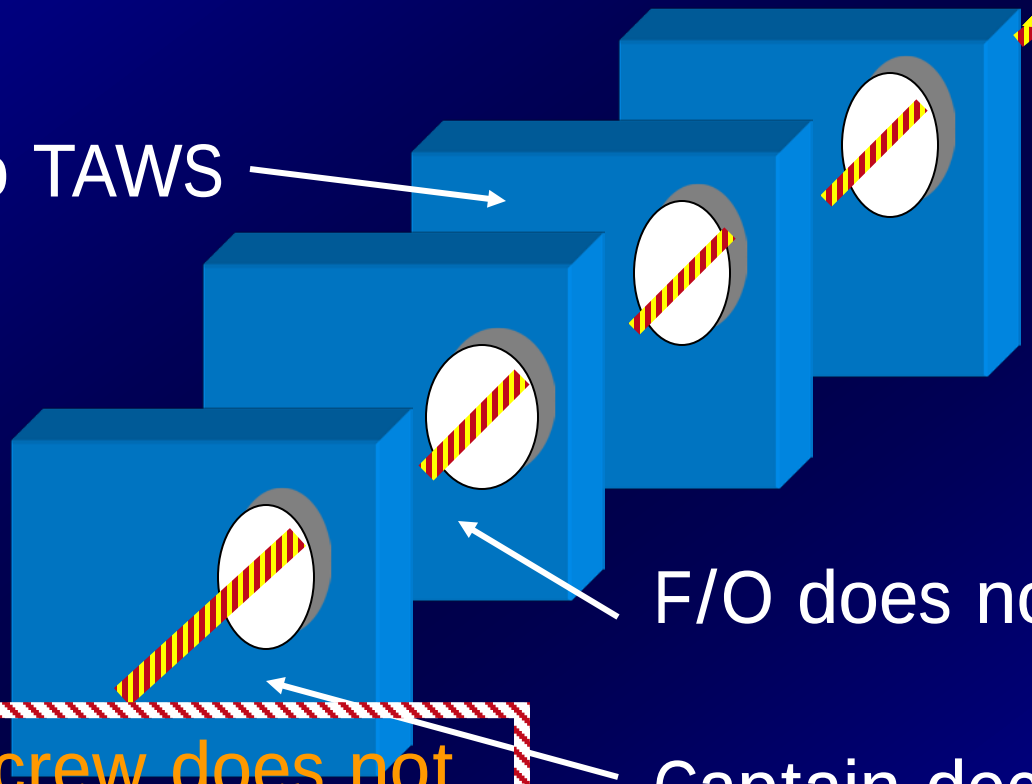
BROWN FIELD MUNI

DEPARTURE PROCEDURE: **Rwys 8L,8R,** climbing left turn. **Rwys 26L,26R,** climbing right turn. **All aircraft** climb heading 280° to intercept MZB R-160 northwestbound to MZB VORTAC.


Departure Airport
Crash Site
Lower Otay Res
Otay Valley
US MILITARY RESERVATION
Brown Field
OTAY MESA
SAN DIEGO CO
Johnson Canyon
San Ysidro
LAND AND WILDLIFE
MANAGEMENT AREA
O'Neal Canyon
Peggi Canyon
Cedar Canyon
Rock Mtn
Otay Mtn
R1W
R1E
36
31

Holes in defenses

Accident



No TAWS

ATC does not issue MSAW

F/O does not get weather

Captain decides to depart without IFR clearance

Error – crew does not follow terrain avoidance procedure

Probable Cause

The failure of the flight crew to maintain terrain clearance during a VFR departure, which resulted in controlled flight into terrain; and,

The air traffic controller's issuance of a clearance that transferred the responsibility for terrain clearance from the flight crew to the controller, failure to provide terrain clearance instructions to the flight crew, and failure to advise the flight crew of the MSAW alerts.

Contributing Factors

Contributing to the accident was the pilots' fatigue, which likely contributed to their degraded decision-making.

Threat and Error Management ABCD'SS

Acknowledge that we are error prone

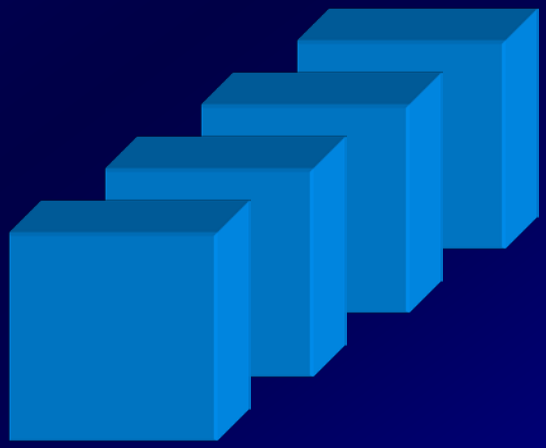
Threat and Error Management ABCD'SS

- This does not mean that errors are okay
  - Naturally we would prefer not to make them
  - However, the reality is that we will make mistakes, so acceptance and awareness are vital
- Acknowledge that threats can affect performance

Acknowledge errors

Threat and Error Management ABCD'SS

Maximize Barriers



Realize the importance of redundancies

- Keep as much redundancy in the operation, for as long as possible
- Plan best time for being “out of the loop” (split cockpit)
  - lowest workload
  - least risk
- Both pilots “cross-verify” critical checklist items (“killer items”) and ATC clearances

Maximize **Barriers**

Flight Crew Example:

- Climbing out of 10,000 feet, with clearance to 12,000
  - Timing of "10,000 foot announcement"

Maximize **Barriers**

Planing and awareness are the keys

- We’re not saying don’t do these things - obviously you must do them
- The point is to PLAN them (when able) to conduct them during lowest workload, least risk periods
- We realize that not everything can be planned, so when one pilot is out of loop, be very aware of reduced redundancy

Maximize **Barriers**

Threat and Error Management ABCD'SS

Communicate

Threats and Intentions Effectively

Communicate

Anything that can:

- Reduce your ability to detect errors
- Anything that can increase your chance of making errors

Communicate

Communicate threats

- "Snakes in the grass"
  - What are the things that can bite you on this flight or operation?
  - Identify, discuss and think about these things (threats) and those that are different about this operation

Communicate


TV

Ways communications can be improved

- Research shows that the way a crew communicates can be a predictor of the way that the crew performs.
  - Crews who communicated better were those crews who made fewer errors

Communicate

Improving communications

- Improved performance (i.e., fewer errors) was associated with crews who showed increased number of :
  - commands
  - inquiries
  - acknowledgements
  - verbal observations about flight status

- Foushee & Manos (1981)
- Foushe, Lauber, et al (1986)

Communicate

“Hint and Hope”

- Someone drops a subtle hint, hoping the other person will get the message
  - Ineffective
  - Very Risky

Communicate

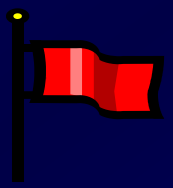
Effective Assertion Model

1. Opening
2. Statement of Concern
3. State the problem
4. Propose a solution
5. Achieve agreement

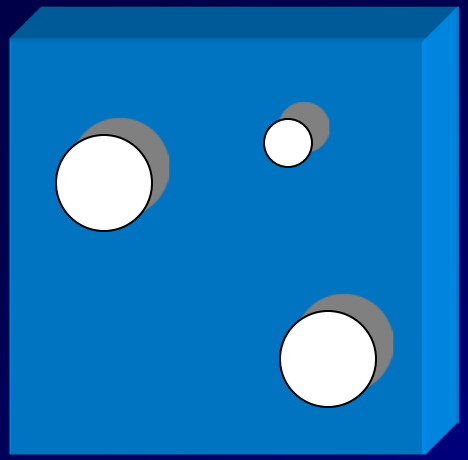
Pilot Example: Robert, I'm concerned. There is high terrain to the east. I think we should get our IFR clearance before we depart. What do you think?

Threat and Error Management ABCD'SS

Distractions and Interruptions



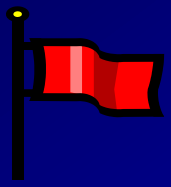
Distractions & Interruptions can form “holes in defenses”



Manage Distractions

Distractions & Interruptions are Red Flags

- Treat Distractions and Interruptions as Red Flags



Manage Distractions

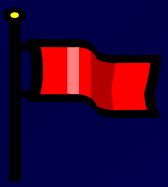
"Interruptions Always Distract"

I A D

Identify – the interruption

Ask – what was I doing before being interrupted?

Decide – what action to take to get back on track



Manage Distractions

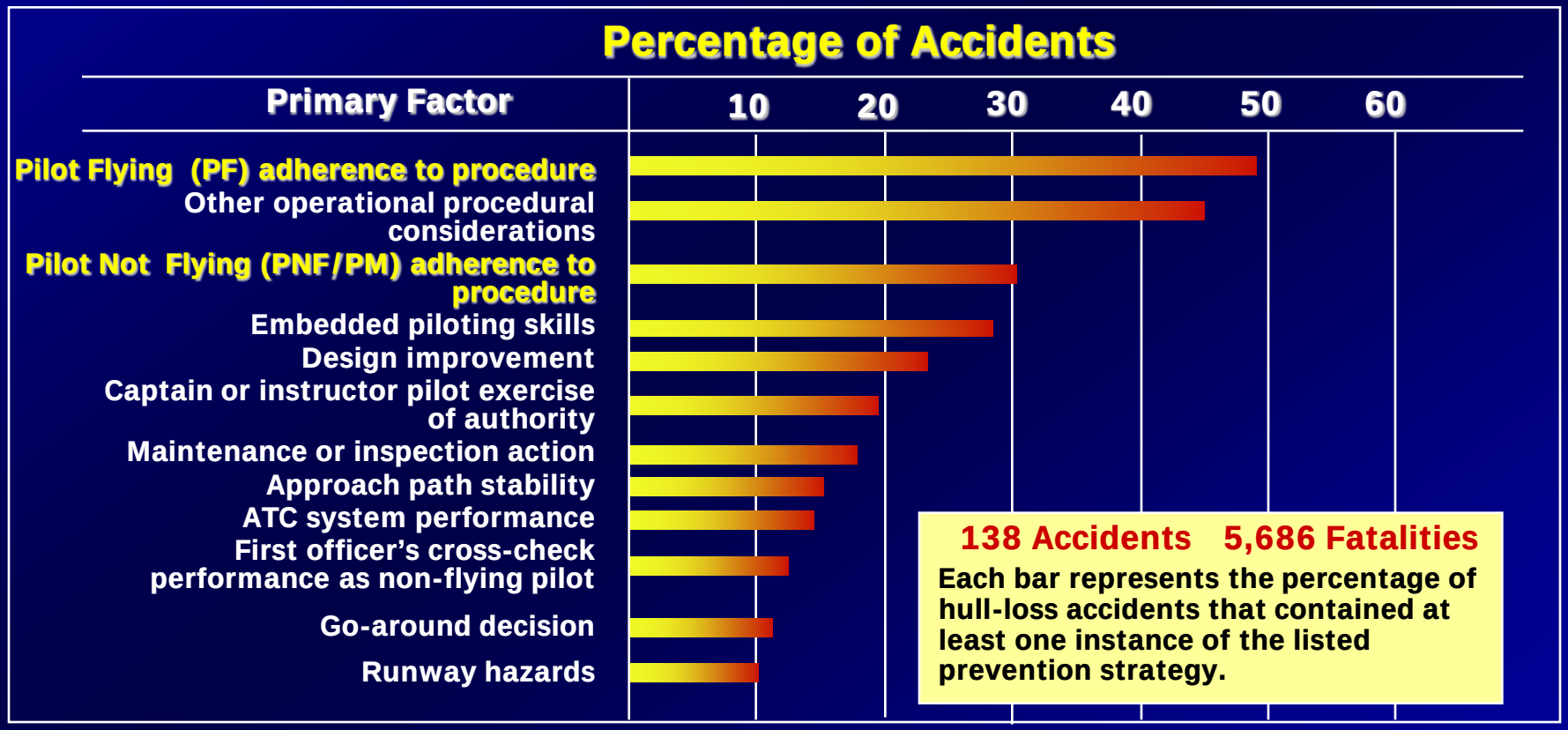
Threat and Error Management ABCD'SS

Follow SOPs

Standard Operating Procedures

Accident Prevention Strategies

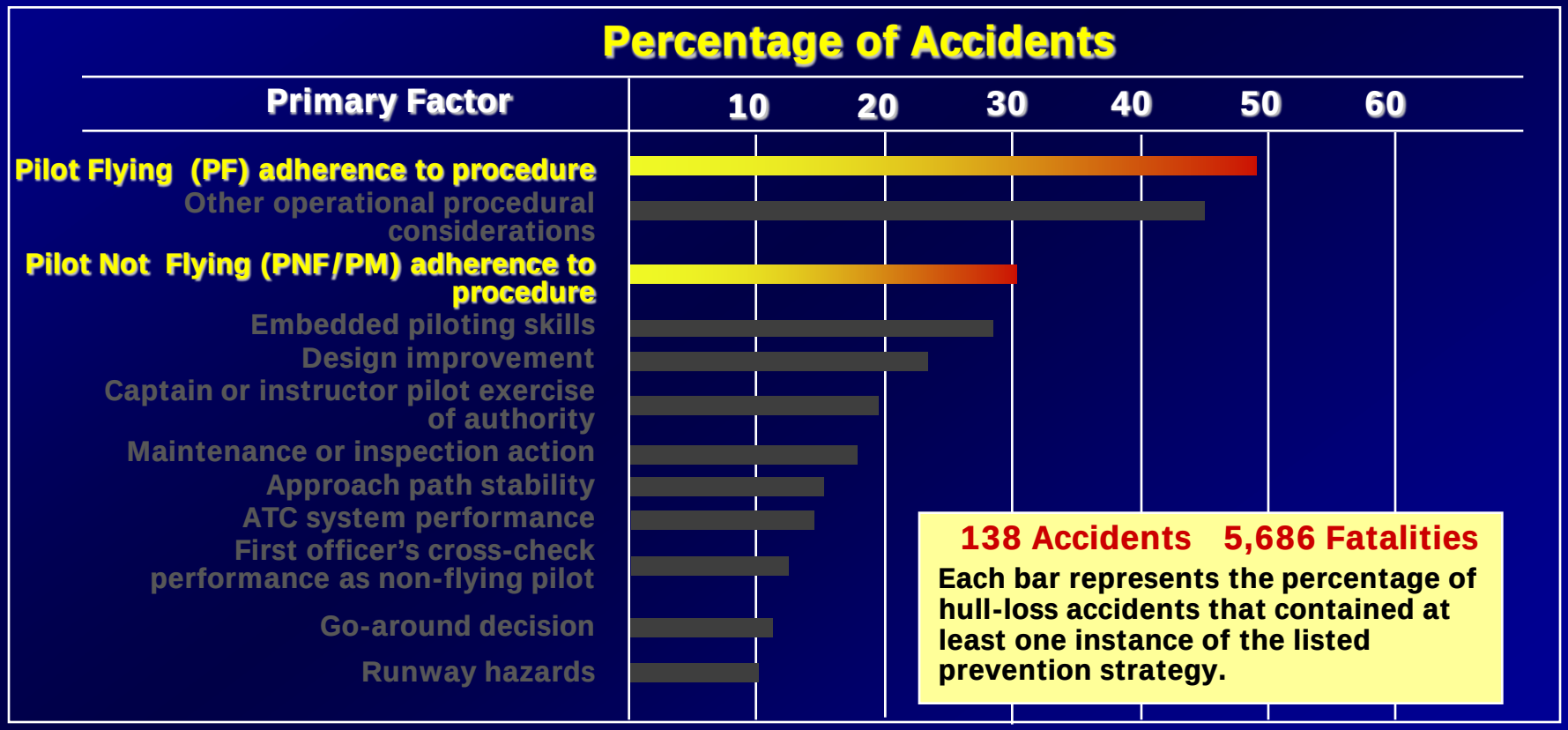
Hull-loss Accidents over 10 Year Period



Source: Boeing study of accident prevention strategies

Accident Prevention Strategies

Hull-loss Accidents over 10 Year Period



Source: Boeing study of accident prevention strategies

How SOPs relate to error

- Line Operations Safety Audit (LOSA) data show that crews who intentionally erred by not following SOPs were 3 times more likely to commit another error with consequential results

- “Normalization of Deviance”

Follow **SOPs**

Standard Operating Procedures

- SOPs establish a consistent baseline for performance
- Because the baseline is established, deviations from it can be identified easier
  - "Hmm, I don't usually miss things like that."
- Allows crewmembers to concentrate on issues not covered by SOPs

Follow **SOPs**

Threat and Error Management ABCD'SS

Sensible?

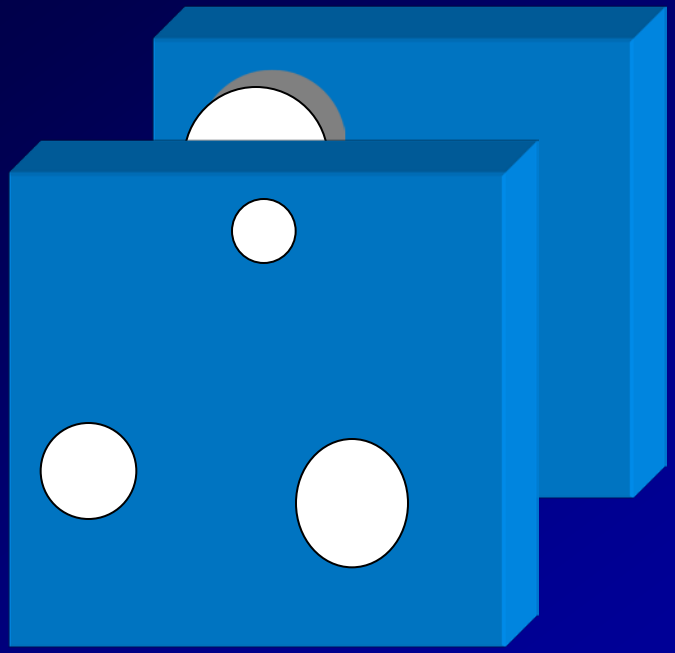
Sensible?

- Ask yourself and make sure that what you are doing (and are about to do) is sensible

Sensible?

Threat and Error Management ABCD'SS

- **A** Acknowledge
- **B** Barriers
- **C** Communicate
- **D** Distractions
- **S** SOPs
- **S** Sensible



SAFETY STANDDOWN

Take Away Slide

Controlled Flight Into Terrain:
The problem that never went away

Learn...

- CFIT is still a safety problem!
- A good defense against CFIT is having an operational TAWS with latest software updates.

Apply...

- TAWS is not the absolute answer.
- Practice ABCD's of Threat and Error Management.

Share...

- Share this message with those that you fly with and your co-workers.

NTSB