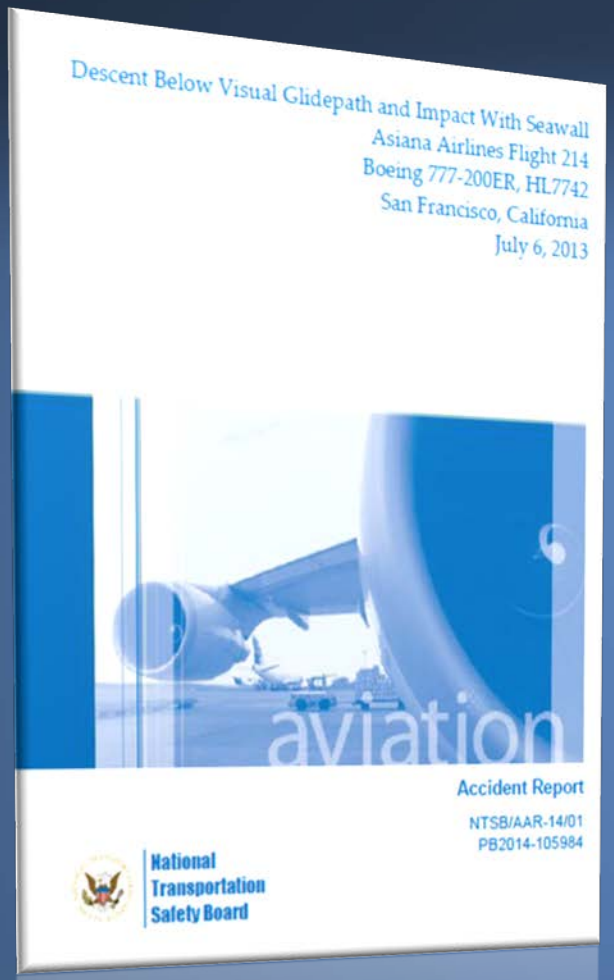
National Transportation Safety Board

A Tale of Two Cities

The San Francisco Crash
The Birmingham Crash

Robert L. Sumwalt, III



Chapter 1: San Francisco

Asiana flight 214

- July 6, 2013
- San Francisco, California
- 3 Fatalities

NTSB

ASIANA AIRLINES

Spirit of America
UNITED STATES OF AMERICA

777 Mode Control Panel

Flight Level Change (FLCH) Button

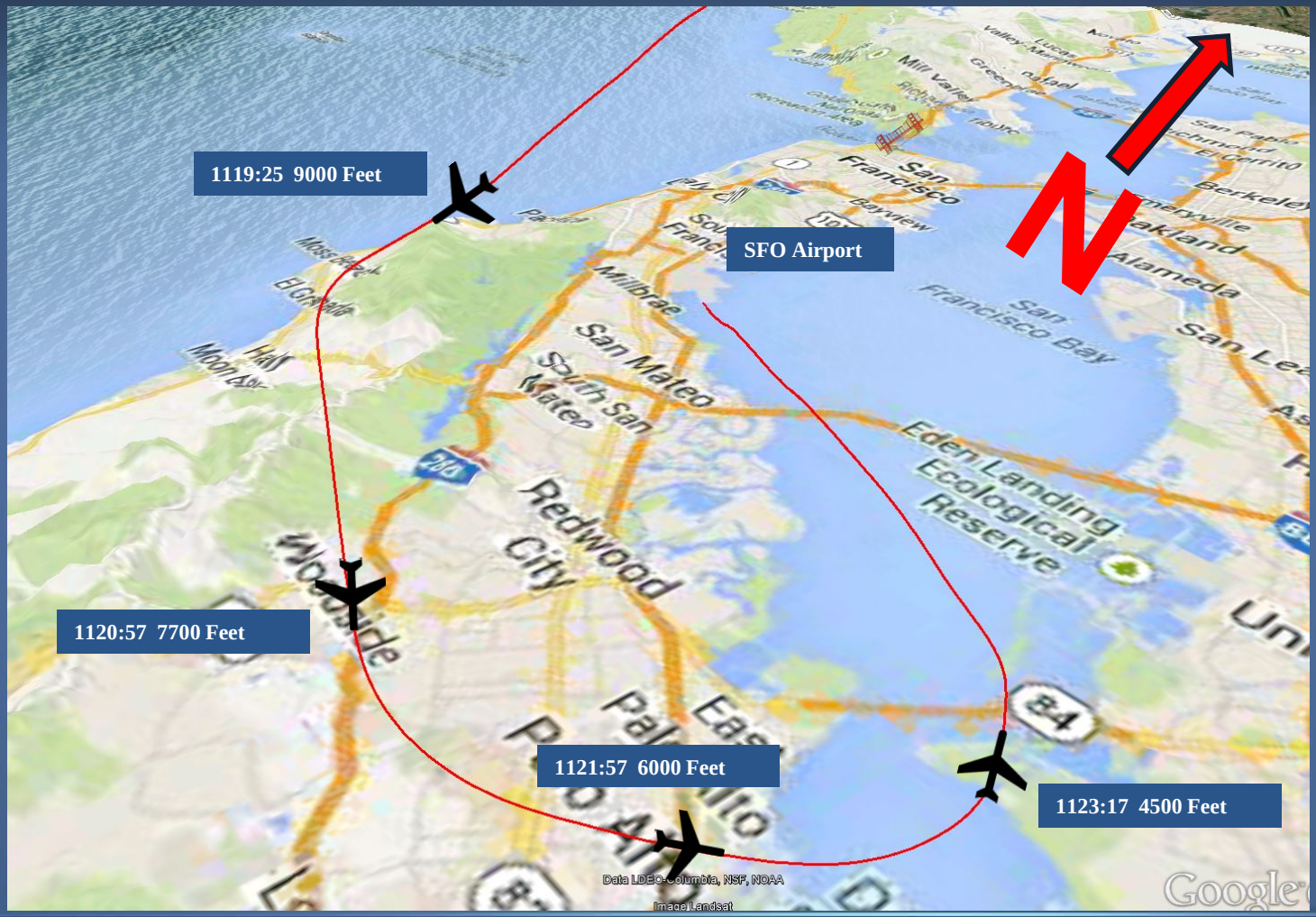
Altitude Select Window

NTSB

General Details

- 10 ½ hour flight from Korea
- Clear skies, light winds
- About 11:28 am local time (3:28 am Korean time)
- Visual approach
- Glideslope out of service
- 3 Fatal injuries
- 49 serious injuries
- 138 minor injuries
- 117 no injuries

Arrival Information



NTSB

Pilot Roles and Experience

- LEFT SEAT: Pilot Flying
  - 9,700 hours total
  - 45 hours in B777
- RIGHT SEAT: Instructor Pilot
  - 12,000 hours total
  - 3,200 hours in B777
  - New B777 instructor, first trip as instructor
- JUMPSEAT: Relief Pilot (First Officer)

Flight Mode Annunciator

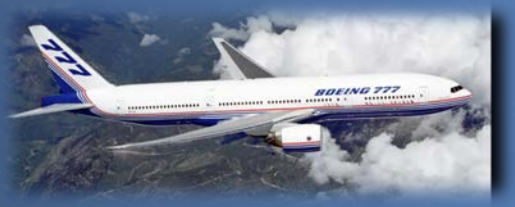
Mode Control Panel

Primary Flight Display

Disconnect switches

Photos are for orientation purposes only and do not reflect the exact status of the accident airplane.

NTSB



5000 feet

CLIMB Thrust

Altitude Above You

IDLE Thrust

Altitude Below You

NTSB

Final Approach Before FLCH Selected

Final Approach: FLCH SPD Selected

NTSB

Final Approach: A/T in HOLD mode

777 AT Wake-up

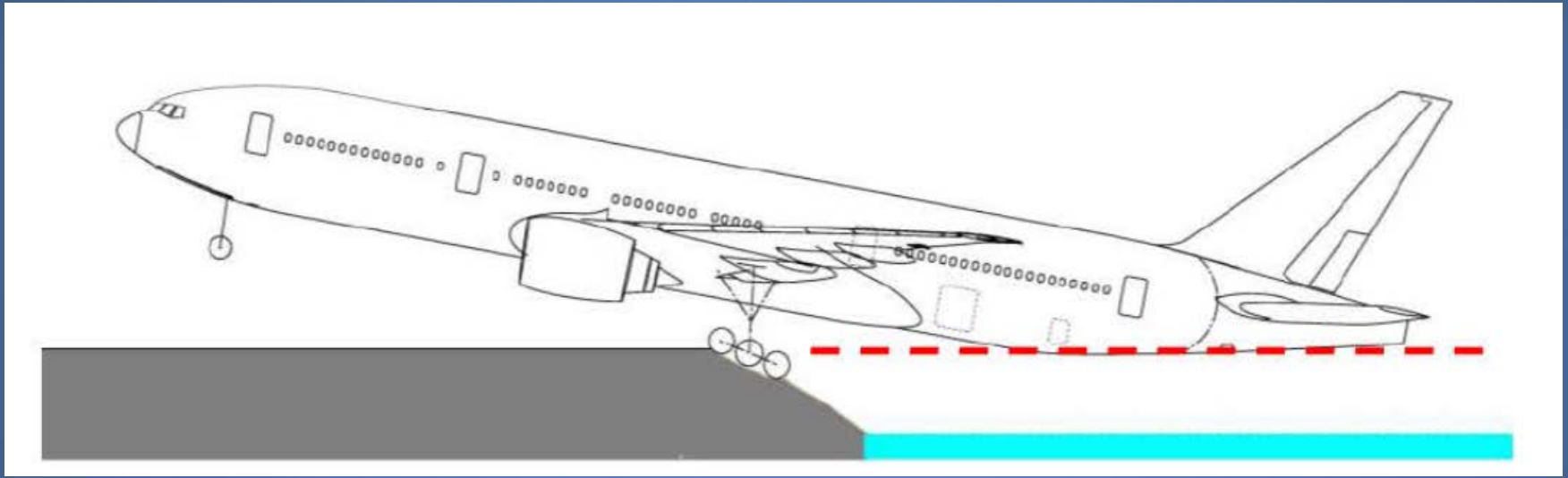
- If the autothrottles are disconnected, if speed gets too slow, the autothrottles will reactivate (“wake up”) and increase speed.
- If autothrottles are armed in their normal operating mode, but in HOLD mode, if speed gets slow, the autothrottles will not wake up.

Final Approach

- Flight passed through a 3° glidepath at about 500 feet
- Stabilized approach criteria not met
- Descent rate 1,200 fpm, throttles remained at idle

Final Approach

- PM – “speed” at 90 ft and 110 knots
- PM – added go-around thrust
- Column full aft
- Stick shaker activated
- Airplane did not have the performance to go around at that point



Estimated aircraft position at impact with seawall

NTSB

The Big Question

How could an airline crew crash an airplane on a perfectly clear day with calm winds on a visual approach?

Some Answers

- Poor monitoring due to expectancy, increased workload, fatigue, and automation reliance
- Complexities in the 777 automation and inadequacies in related training and documentation
  - Led to PF's inadvertent deactivation of automatic airspeed control

Autothrottle failing to wake up

- August 2010 - 787 certification test flight.
  - FAA test pilot noted concern
  - Autothrottle behavior “less than desirable”

Autothrottle failing to wake up - EASA Concerns -

- “although the … ‘Autothrottle wake up’ feature is not required per certification requirements, these two exceptions look from a pilot’s perspective as an inconsistency in the automation behavior of the airplane.”

- “the manufacturer would enhance the safety of the product by avoiding exceptions in the ‘Autothrottle wake up’ mode condition.”

Autothrottle failing to wake up

Addition to 787 Manual

During a descent in FLCH mode or VNAV SPD mode, the A/T may activate in HOLD mode. When in HOLD mode, the A/T will not wake up even during large deviations from target speed and does not support stall protection.

Addition to 777 Manual

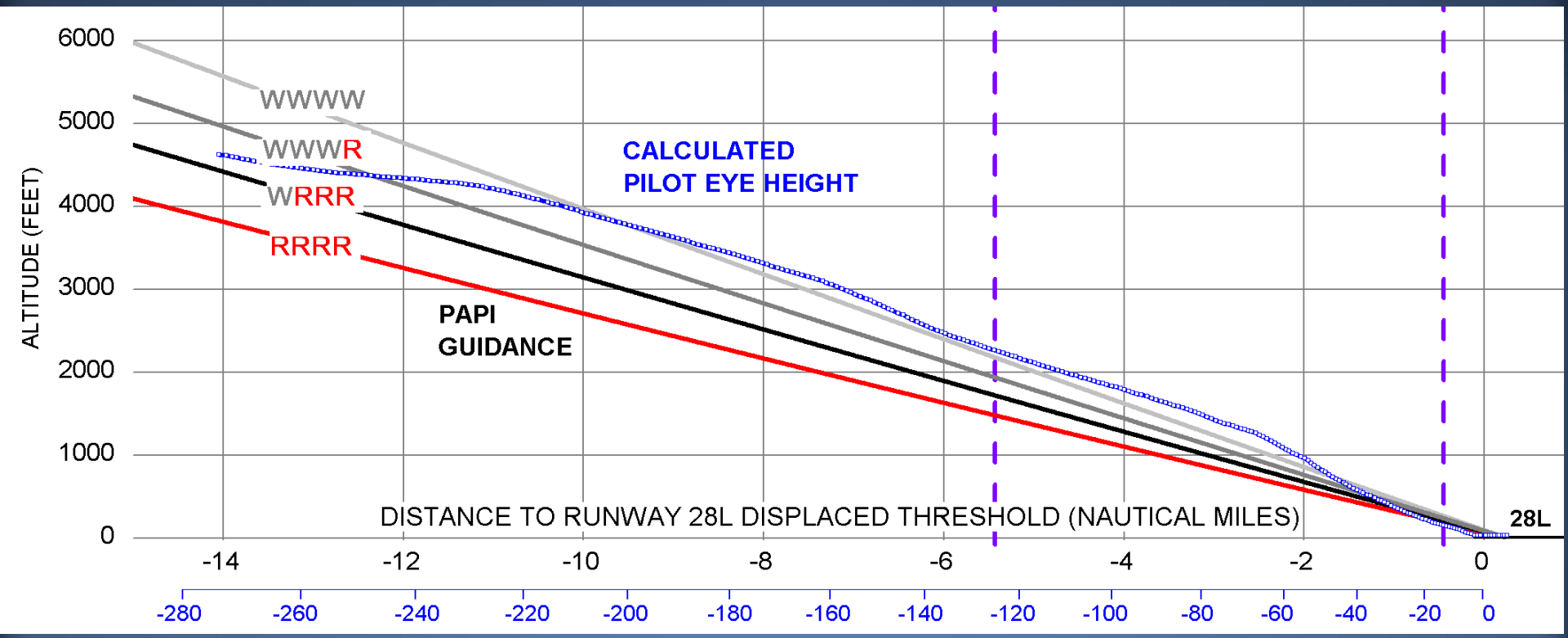
Autothrottle failing to wake up

- PF's ground instructor
  - "anomaly"
  - Happened to him 3 times

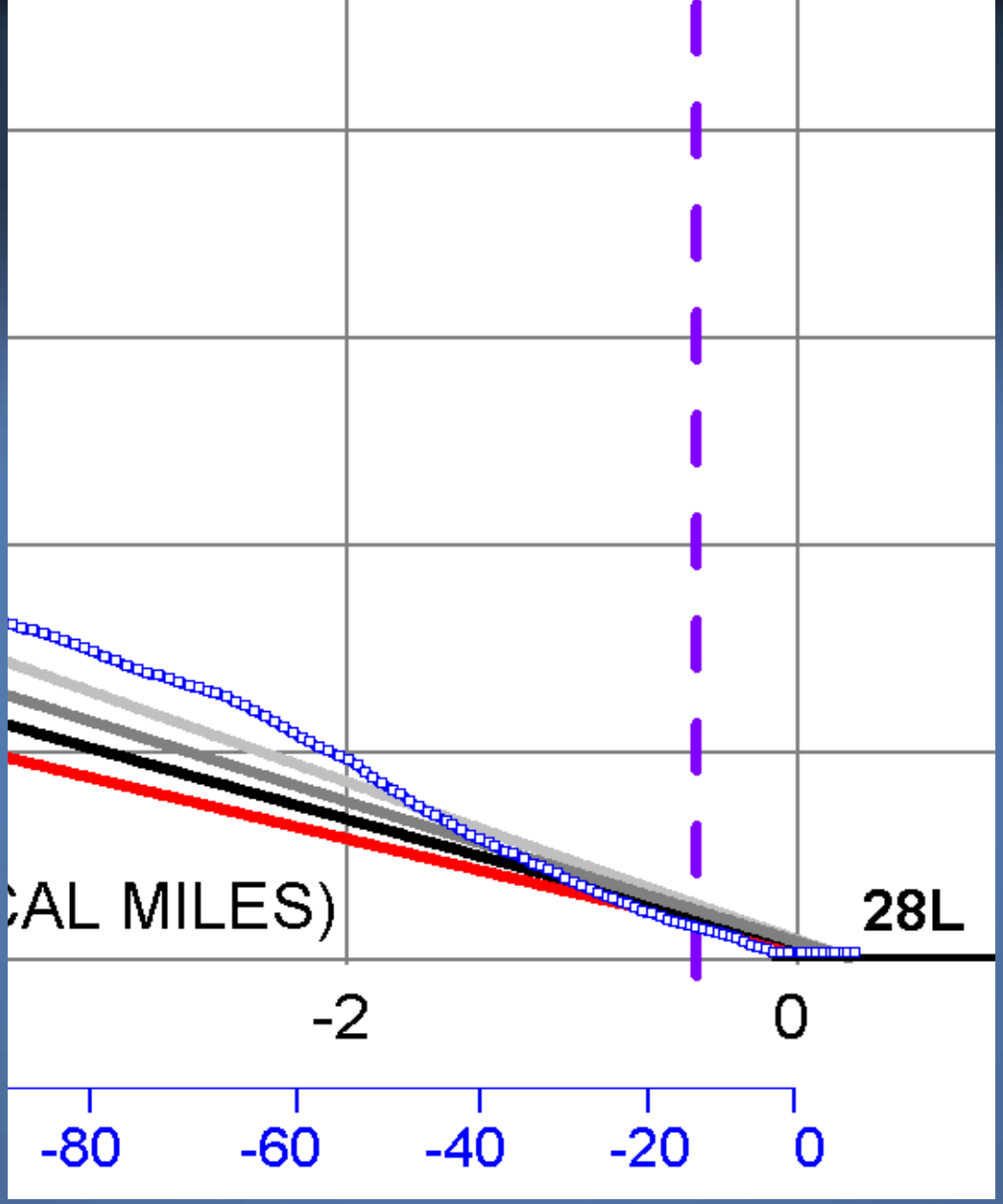
NTSB Finding

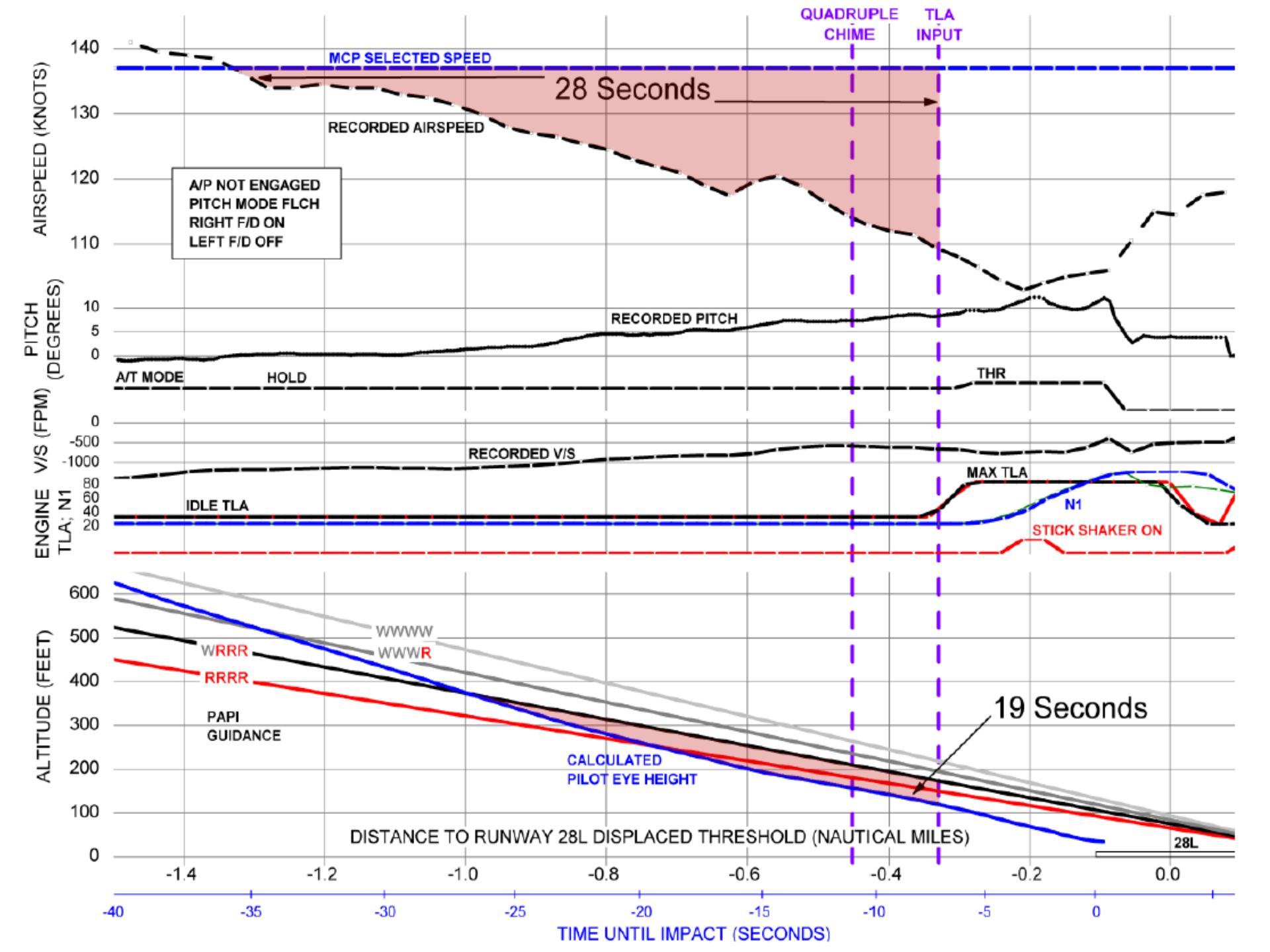
"If the autothrottle automatic engagement function ("wakeup"), or a system with similar functionality, had been available during the final approach, it would likely have activated and increased power about 20 seconds before impact, which may have prevented the accident."

Profile View of Approach

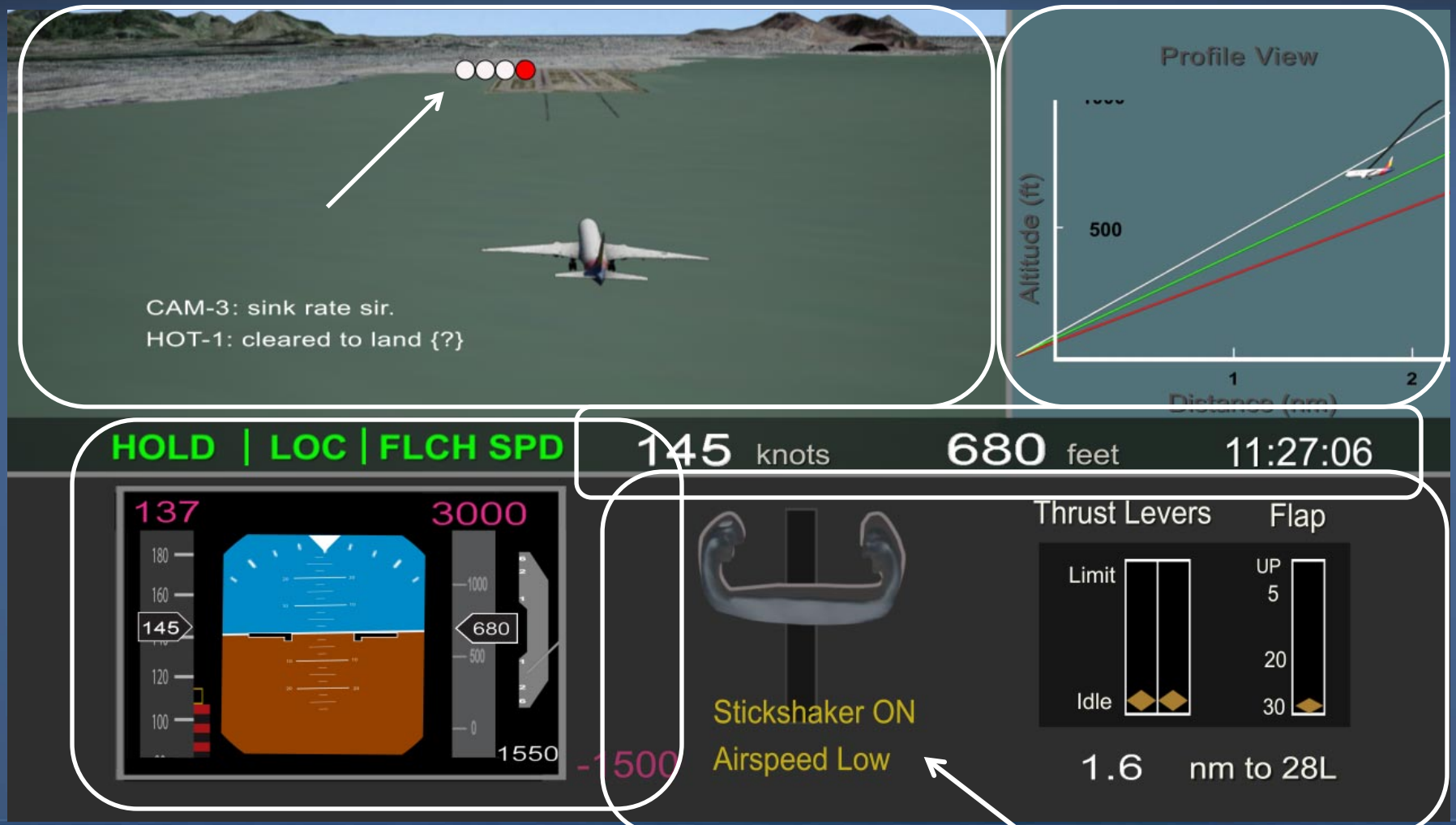


NTSB


CAL MILES)
28L
-2
0
-80
-60
-40
-20
0


QUADRUPLE CHIME
TLA INPUT
AIRSPEED (KNOTS)
MCP SELECTED SPEED
28 Seconds
RECORDED AIRSPEED
A/P NOT ENGAGED
PITCH MODE FLCH
RIGHT F/D ON
LEFT F/D OFF
PITCH (DEGREES)
RECORDED PITCH
A/T MODE
HOLD
THR
V/S (FPM)
RECORDED V/S
ENGINE TLA; N1
IDLE TLA
MAX TLA
N1
STICK SHAKER ON
ALTITUDE (FEET)
WWWW
WWWR
WRRR
RRRR
PAPI GUIDANCE
CALCULATED PILOT EYE HEIGHT
19 Seconds
DISTANCE TO RUNWAY 28L DISPLACED THRESHOLD (NAUTICAL MILES)
28L
TIME UNTIL IMPACT (SECONDS)

Animation Items



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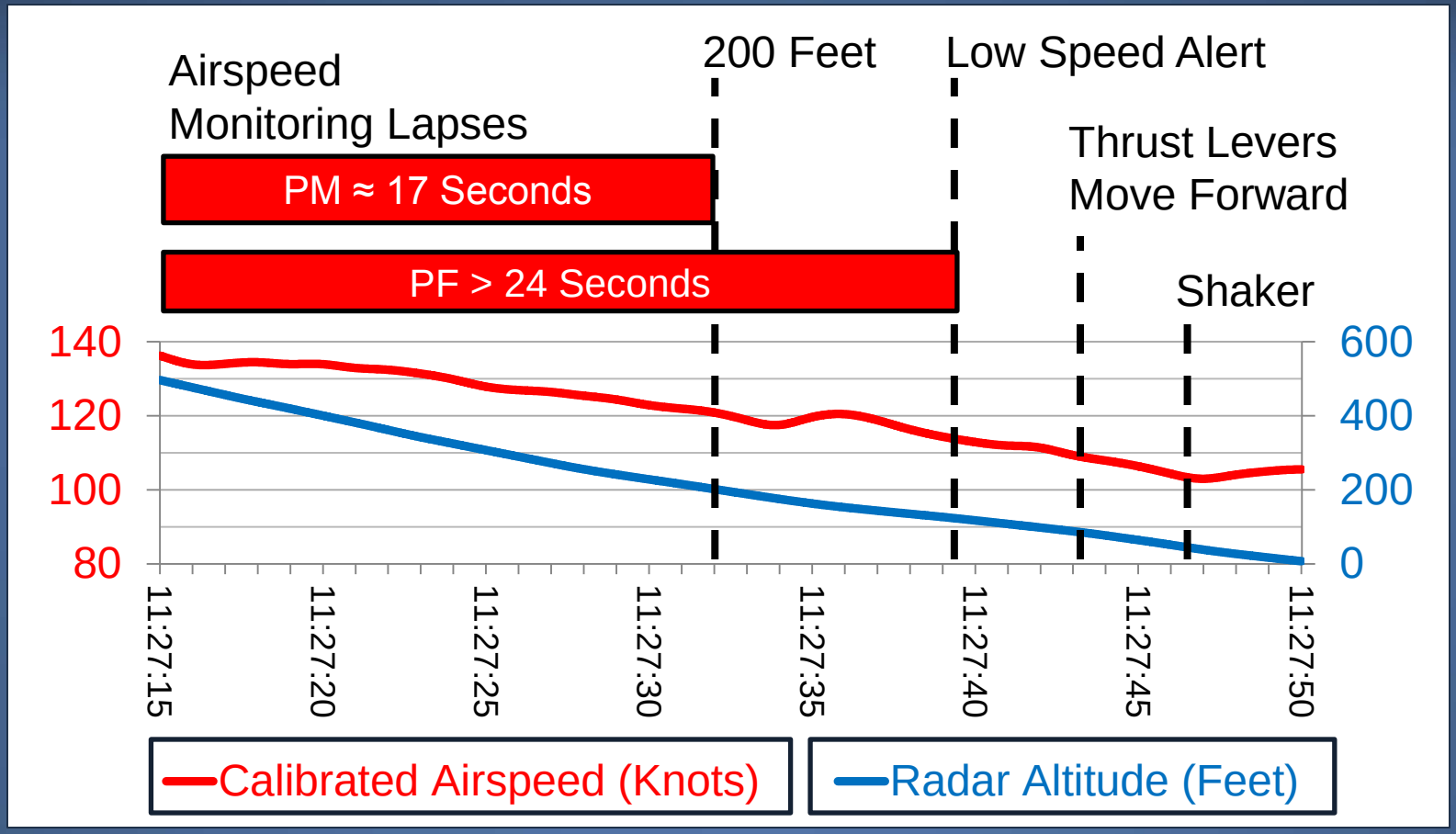
National Transportation Safety Board

Descent Below Visual Glidepath and Impact with Seawall

Asiana Airlines Flight 214
Boeing 777-200ER, HL7742
San Francisco, California
July 6, 2013
DCA13MA120

Monitoring


Airspeed
Monitoring Lapses
200 Feet
Low Speed Alert
Thrust Levers
Move Forward
PM ≈ 17 Seconds
PF > 24 Seconds
Shaker
140
120
100
80
600
400
200
0
11:27:15
11:27:20
11:27:25
11:27:30
11:27:35
11:27:40
11:27:45
11:27:50
Calibrated Airspeed (Knots)
Radar Altitude (Feet)

NTSB Finding

“Insufficient flight crew monitoring of airspeed indications during the approach likely resulted from expectancy, increased workload, fatigue, and automation reliance.”

Probable Cause

- The flight crew's mismanagement of the airplane's descent during the visual approach
- The pilot flying's unintended deactivation of automatic airspeed control
- The flight crew's inadequate monitoring of airspeed
- The flight crew's delayed execution of a go-around after they became aware that the airplane was below acceptable glidepath and airspeed tolerances.

Contributing to the accident:

(1) the complexities of the autothrottle and autopilot flight director systems that were inadequately described in Boeing's documentation and Asiana's pilot training, which increased the likelihood of mode error

(2) the flight crew's nonstandard communication and coordination regarding the use of the autothrottle and autopilot flight director systems

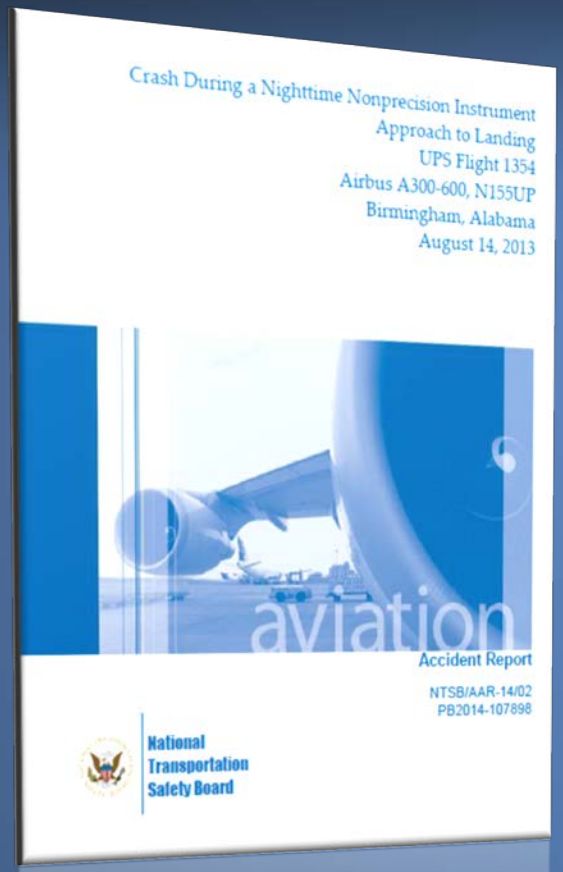
(3) the pilot flying's inadequate training on the planning and executing of visual approaches

(4) the pilot monitoring/instructor pilot's inadequate supervision of the pilot flying

(5) flight crew fatigue which likely degraded their performance.

27 Recommendations

- FAA (15)
- Asiana Airlines (4)
- Boeing (2)
- ARFF Working Group (4)
- City of San Francisco (2)



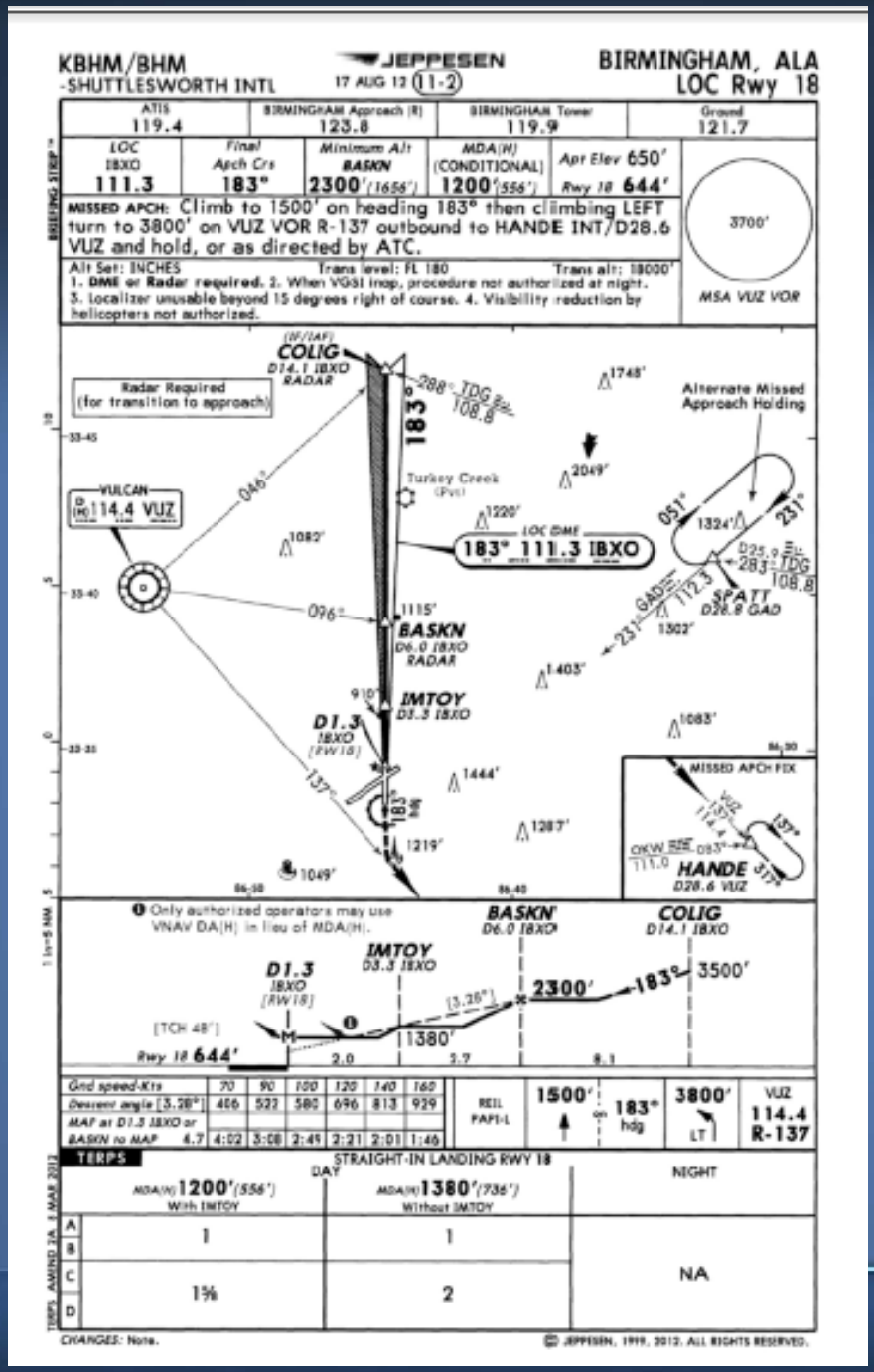
Chapter 2: Birmingham

UPS flight 1354

- August 14, 2013
- Birmingham, AL
- 4:47 am
- 2 fatalities

Sequence of Events

- Captain: pilot flying
- First officer: pilot monitoring
- Runway 6/24 closed for repairs between 0400 and 0500 local time


KBHM/BHM
-SHUTTLESWORTH INTL
JEPPESEN
17 AUG 13 (11-2)
BIRMINGHAM, ALA
LOC Rwy 18
ATIS 119.4
BIRMINGHAM Approach (R) 123.8
BIRMINGHAM Tower 119.9
Ground 121.7
LOC IBXO 111.3
Final Apch Crs 183°
Minimum Alt BASKN 2300'(1656')
MDA(H) (CONDITIONAL) 1200'(556')
Apr Elev 650'
Rwy 18 644'
MISSED APCH: Climb to 1500' on heading 183° then climbing LEFT turn to 3800' on VUZ VOR R-137 outbound to HANDE INT/D28.6 VUZ and hold, or as directed by ATC.
Alt Set: INCHES
Trans level: FL 180
Trans alt: 18000'
1. DME or Radar required. 2. When VGSI inop, procedure not authorized at night. 3. Localizer unusable beyond 15 degrees right of course. 4. Visibility reduction by helicopters not authorized.
3700'
MSA VUZ VOR
(IF/IAF)
COLIG
D14.1 IBXO
RADAR
Radar Required
(for transition to approach)
288° TDG 108.8
183
Alternate Missed Approach Holding
VULCAN
114.4 VUZ
046°
096°
Turkey Creek
LOC DME
183° 111.3 IBXO
051°
231°
D25.9
283° TDG 108.8
SPATT
D28.8 GAD
112.3
GAD
231°
BASKN
D6.0 IBXO
RADAR
IMTOY
D3.3 IBXO
D1.3
IBXO
(RW18)
137°
183° mag
MISSED APCH FIX
VUZ 114.4
137°
OKW 111.0
083°
HANDE
D28.6 VUZ
317°
1 in=5 NM
Only authorized operators may use VNAV DA(H) in lieu of MDA(H).
BASKN
D6.0 IBXO
COLIG
D14.1 IBXO
IMTOY
D3.3 IBXO
D1.3
IBXO
(RW18)
[3.28°]
2300'
183°
3500'
[TCH 48']
1380'
Rwy 18 644'
2.0
3.7
8.1
Grid speed-Kts 70 90 100 120 140 160
Descent angle [3.28°] 406 522 580 696 813 929
MAP at D1.3 IBXO or
BASKN to MAP 6.7 4:02 3:08 2:49 2:21 2:01 1:46
REIL
PAPI-L
1500'
183° hdg
3800'
LT
VUZ
114.4
R-137
TERPS
STRAIGHT-IN LANDING RWY 18
DAY
NIGHT
MDA(H) 1200'(556') With IMTOY
MDA(H) 1380'(736') Without IMTOY
A 1
B 1
C 1¾ 2 NA
D
TERPS, AMDT 2A, 3 MAR 2011
CHANGES: None.
© JEPPESEN, 1999, 2013. ALL RIGHTS RESERVED.

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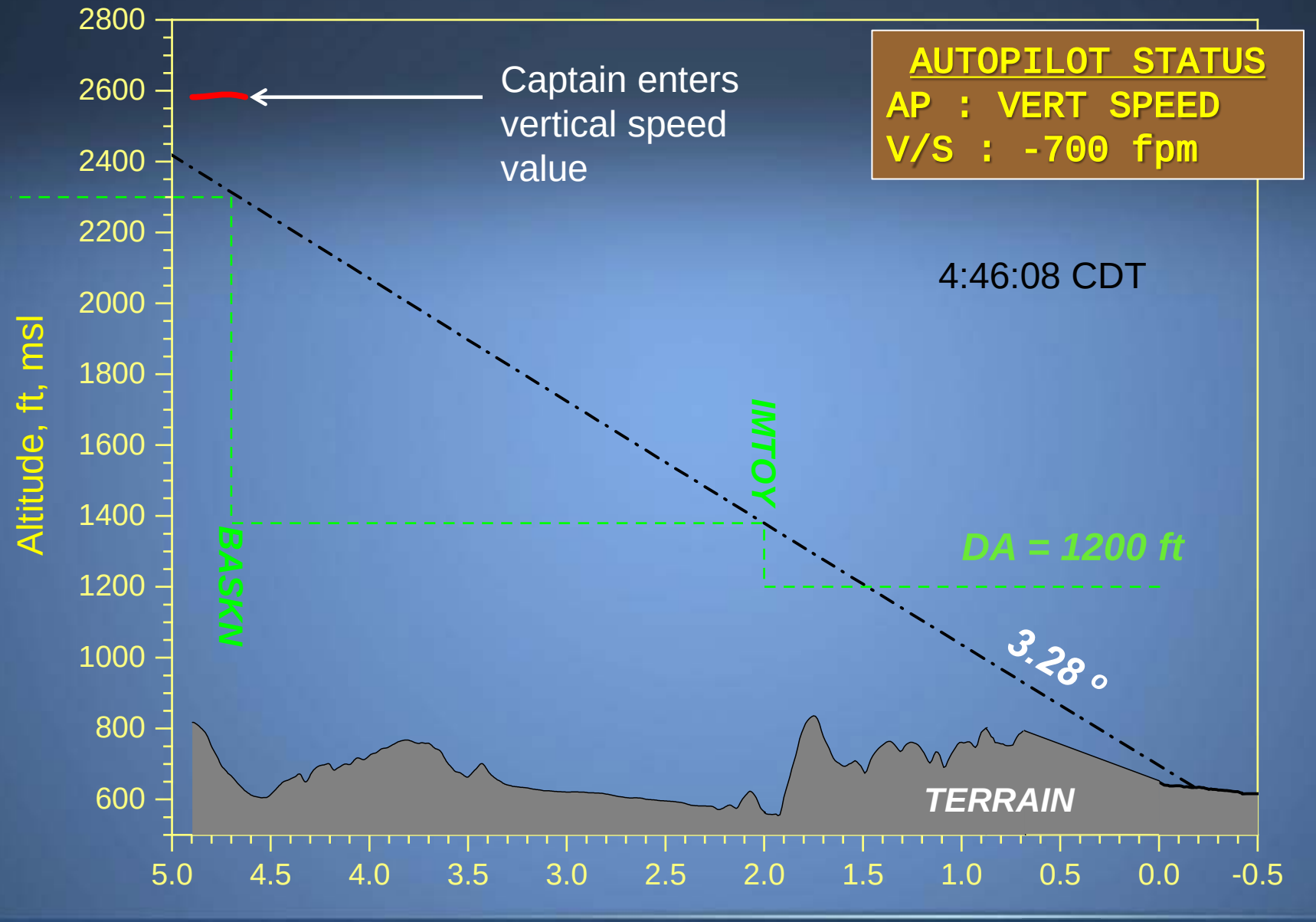
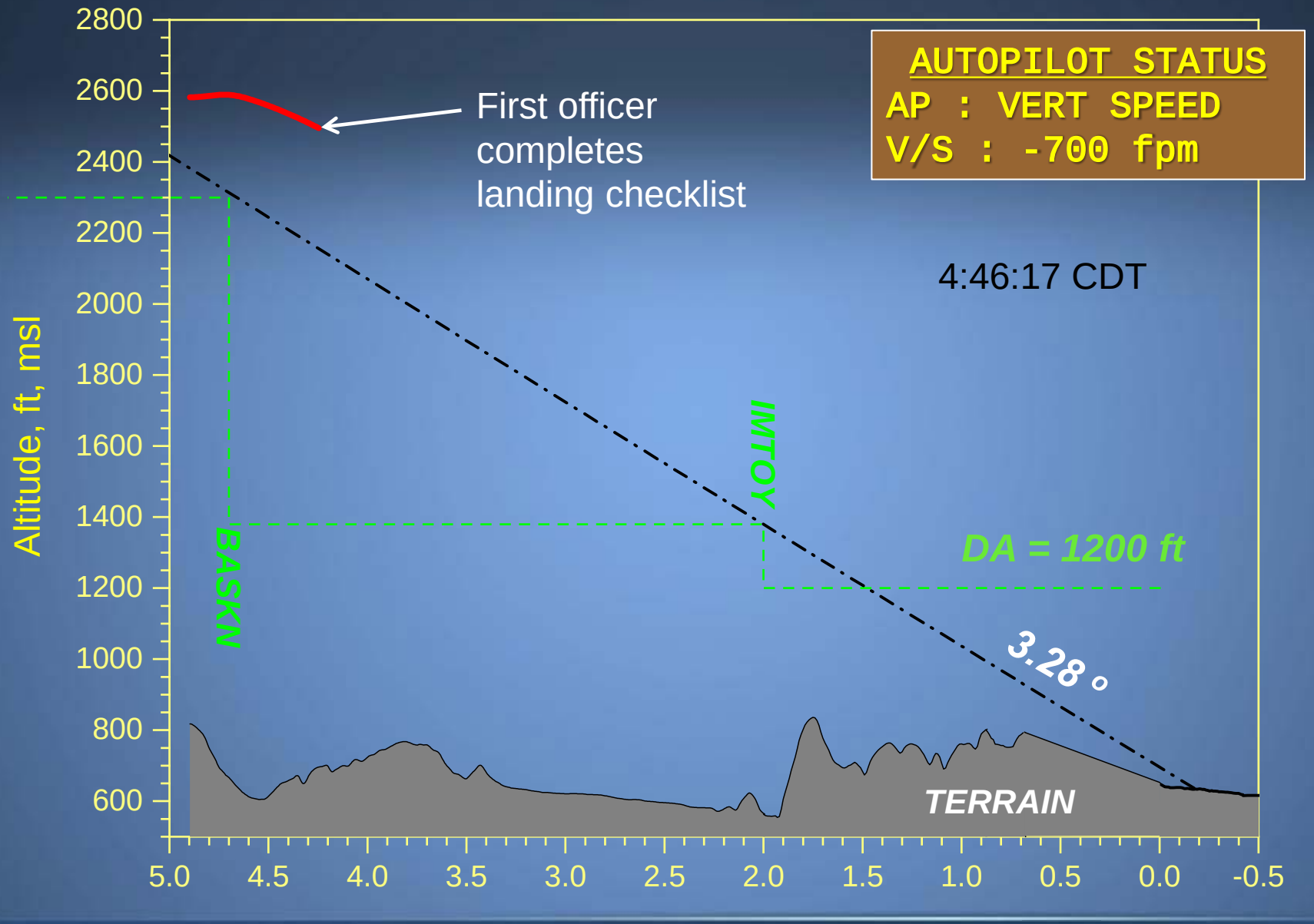
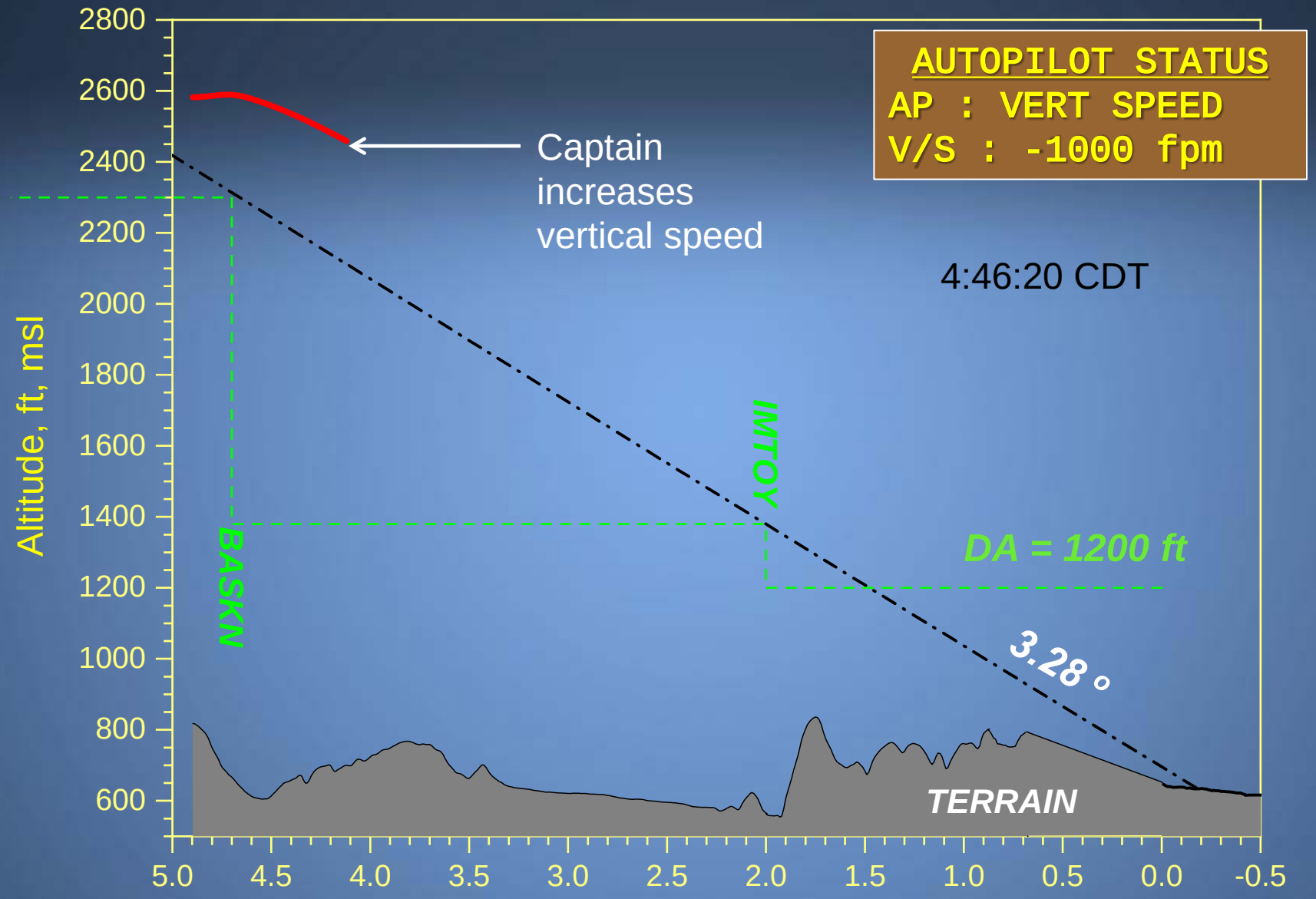
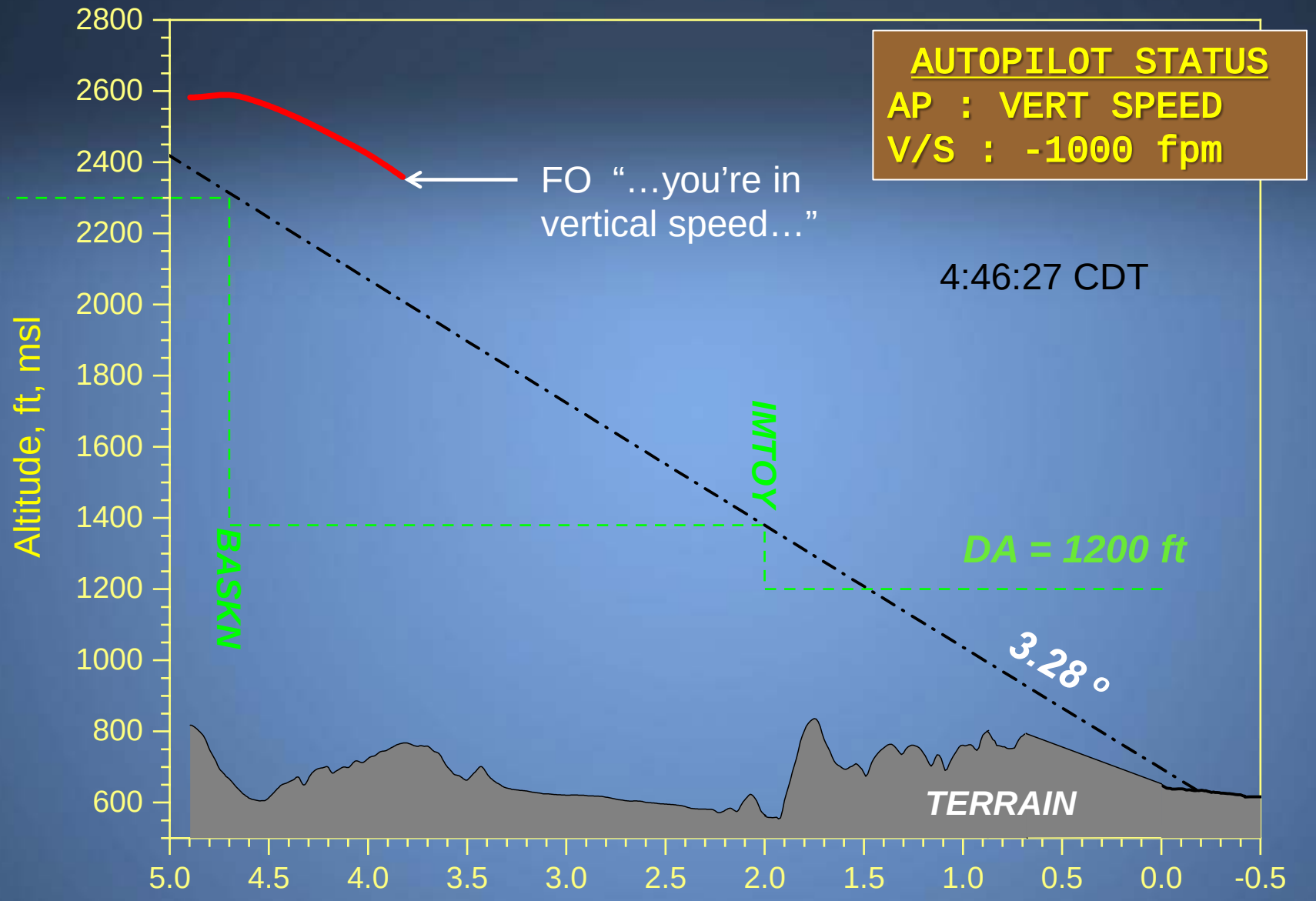
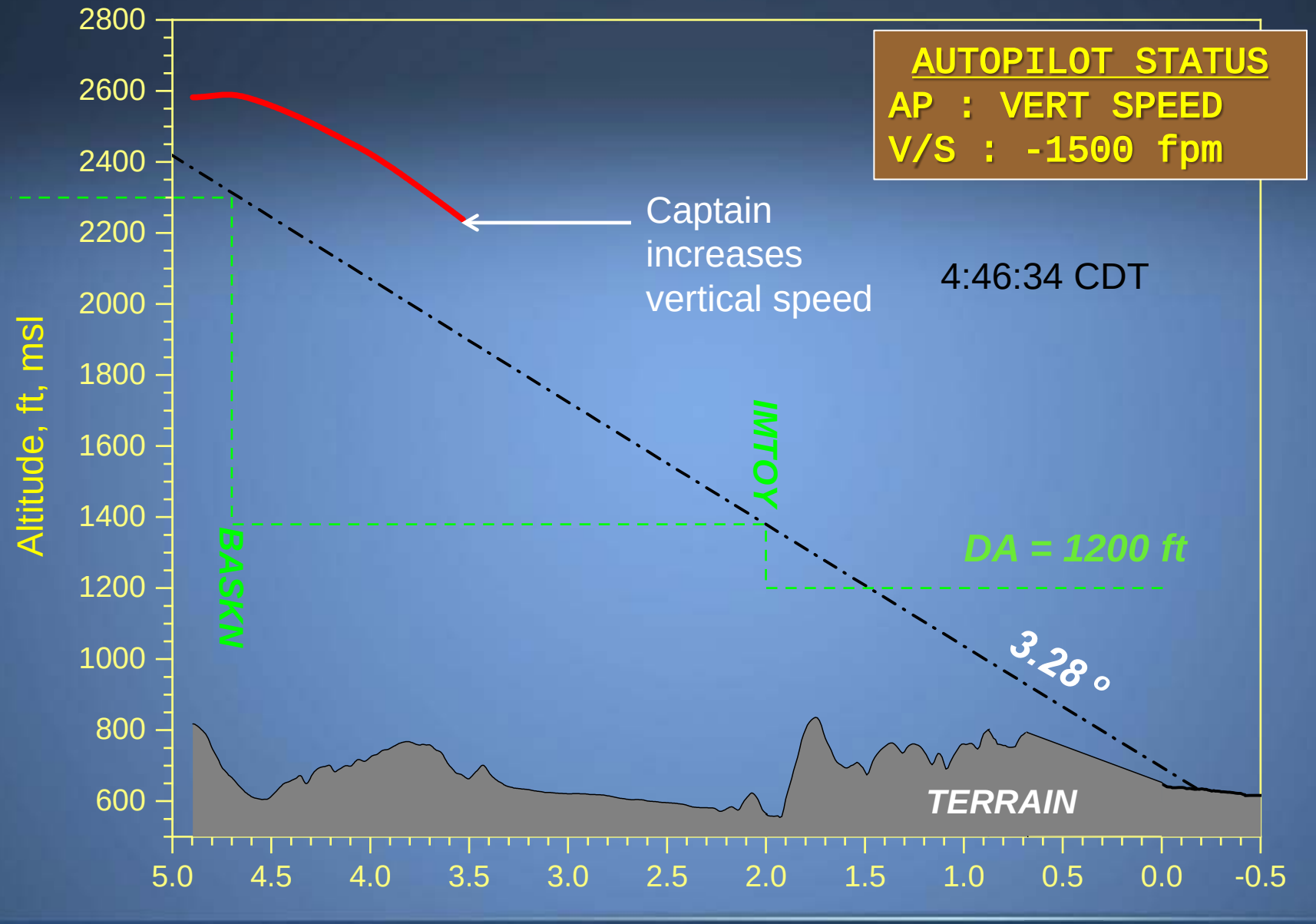
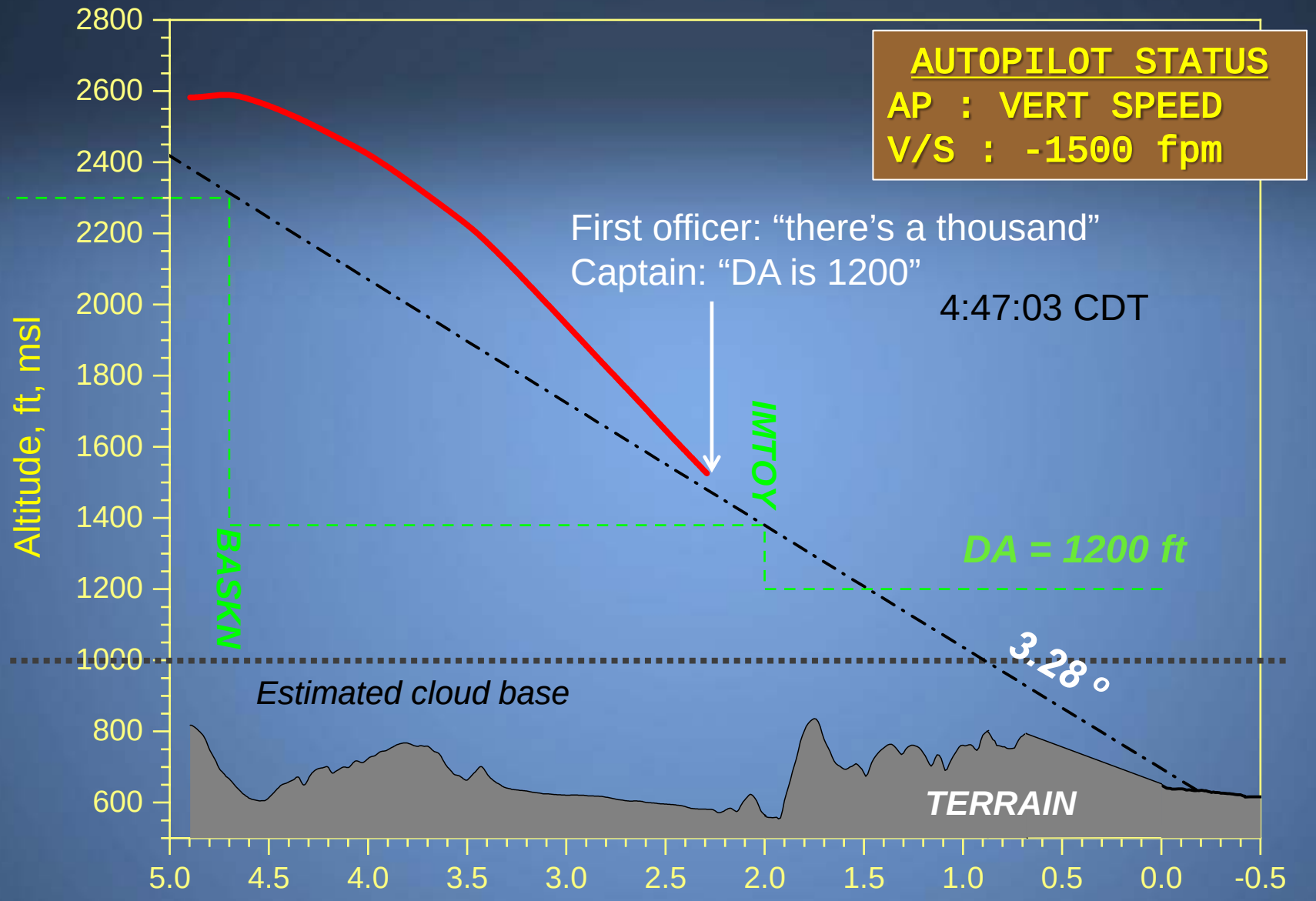

AUTOPILOT STATUS
AP : VERT SPEED
V/S : -700 fpm
Captain enters vertical speed value
4:46:08 CDT
BASKN
IMTOY
DA = 1200 ft
3.28°
TERRAIN
Altitude, ft, msl
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
Distance north of Birmingham runway 18 threshold, nm
NTSB

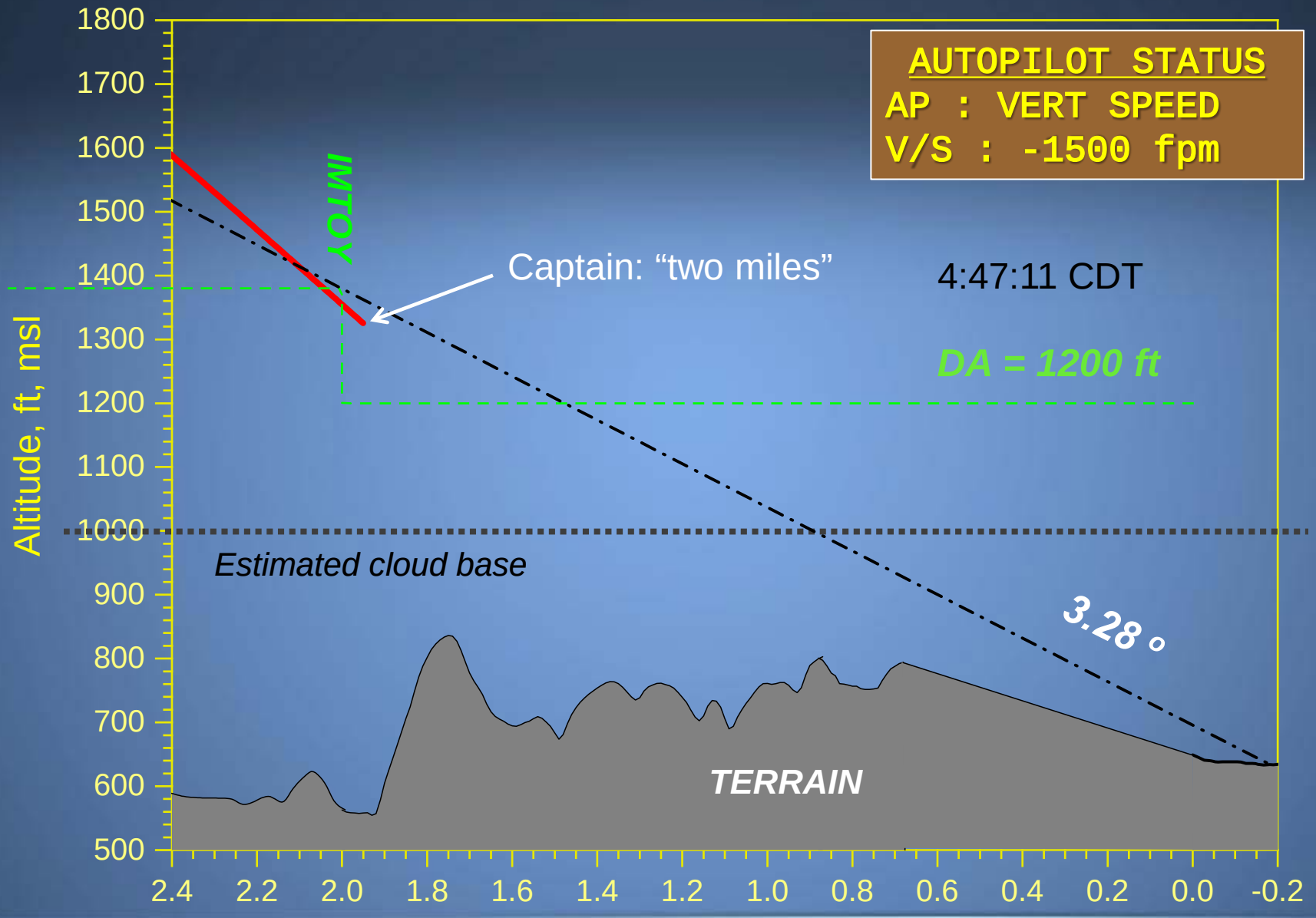

AUTOPILOT STATUS
AP : VERT SPEED
V/S : -700 fpm
First officer completes landing checklist
4:46:17 CDT
BASKN
IMTOY
DA = 1200 ft
3.28°
TERRAIN
Altitude, ft, msl
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
Distance north of Birmingham runway 18 threshold, nm
NTSB

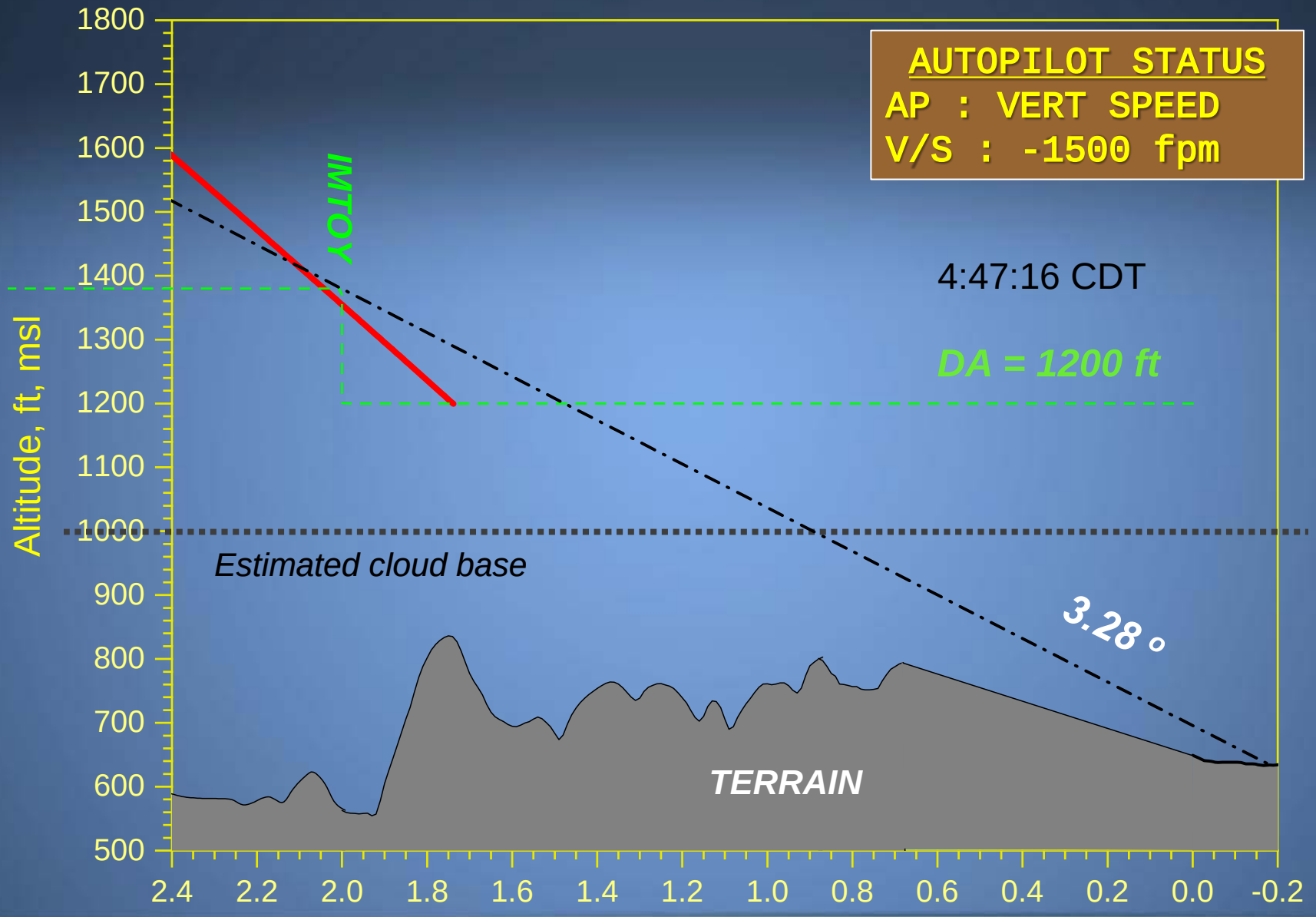

AUTOPILOT STATUS
AP : VERT SPEED
V/S : -1000 fpm
Captain increases vertical speed
4:46:20 CDT
BASKN
IMTOY
DA = 1200 ft
3.28°
TERRAIN
Altitude, ft, msl
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
Distance north of Birmingham runway 18 threshold, nm
NTSB

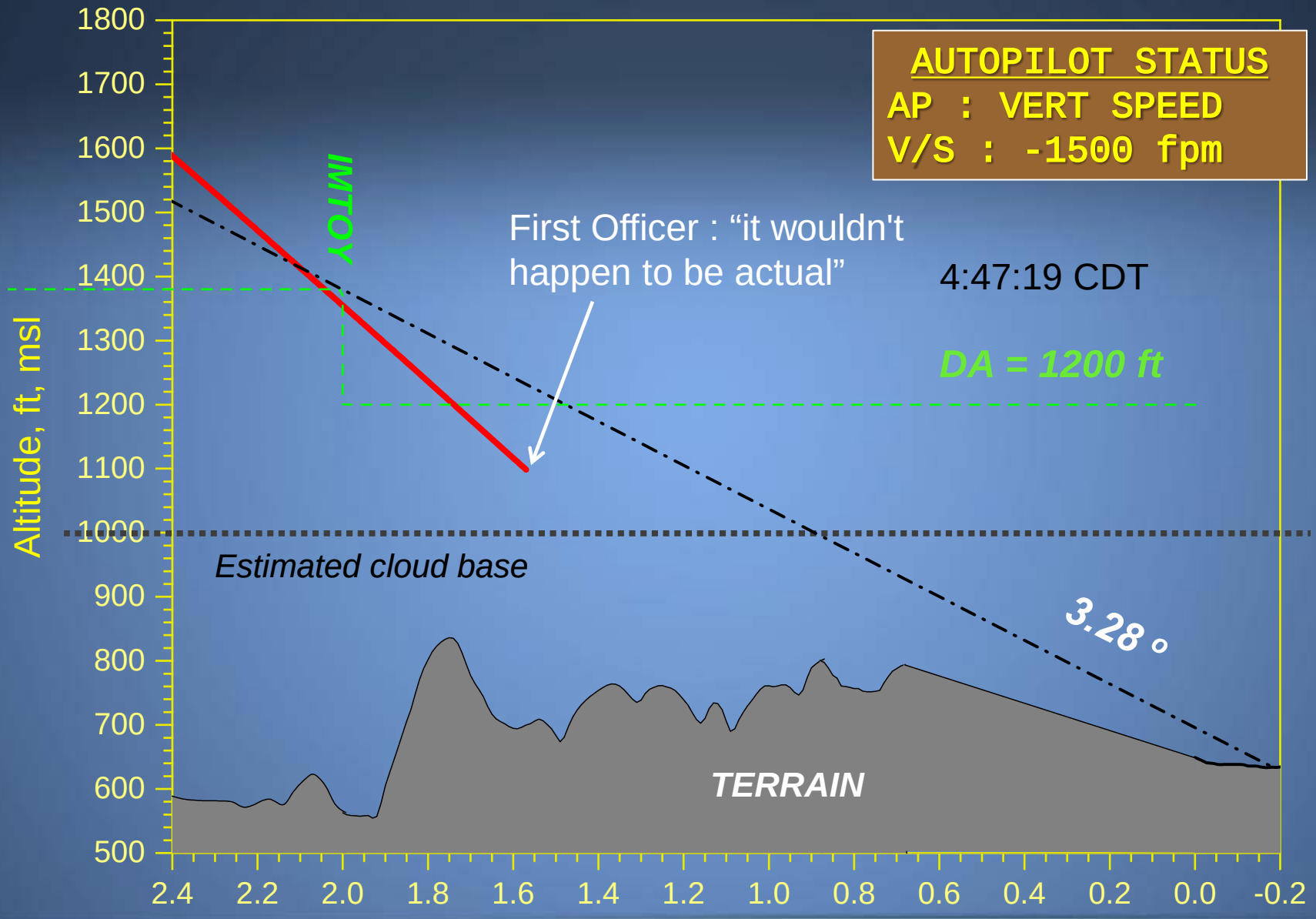

AUTOPILOT STATUS
AP : VERT SPEED
V/S : -1000 fpm
FO "…you're in vertical speed…"
4:46:27 CDT
BASKN
IMTOY
DA = 1200 ft
3.28°
TERRAIN
Altitude, ft, msl
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
Distance north of Birmingham runway 18 threshold, nm
NTSB

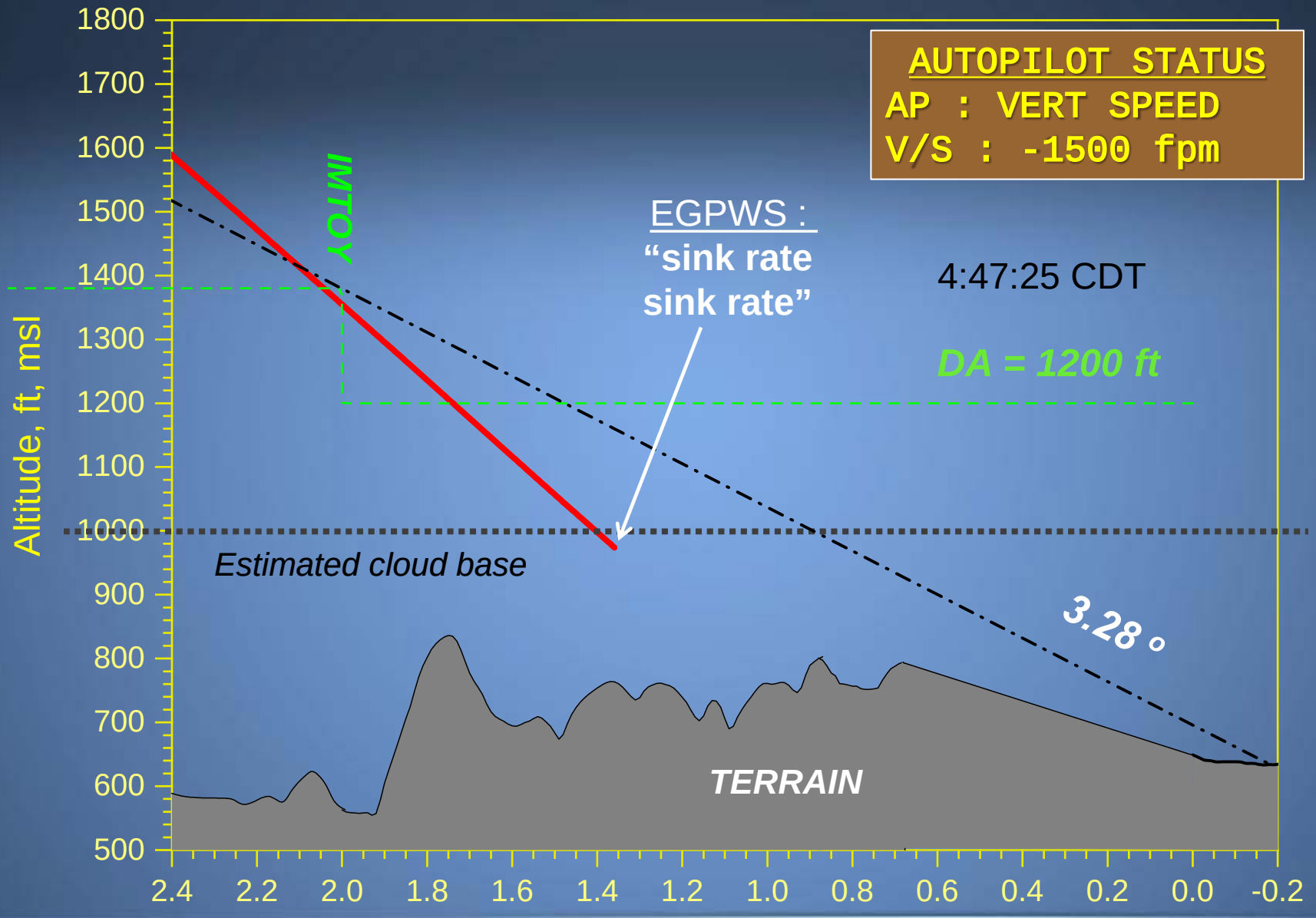

AUTOPILOT STATUS
AP : VERT SPEED
V/S : -1500 fpm
Captain increases vertical speed
4:46:34 CDT
BASKN
IMTOY
DA = 1200 ft
3.28°
TERRAIN
Altitude, ft, msl
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
Distance north of Birmingham runway 18 threshold, nm
NTSB

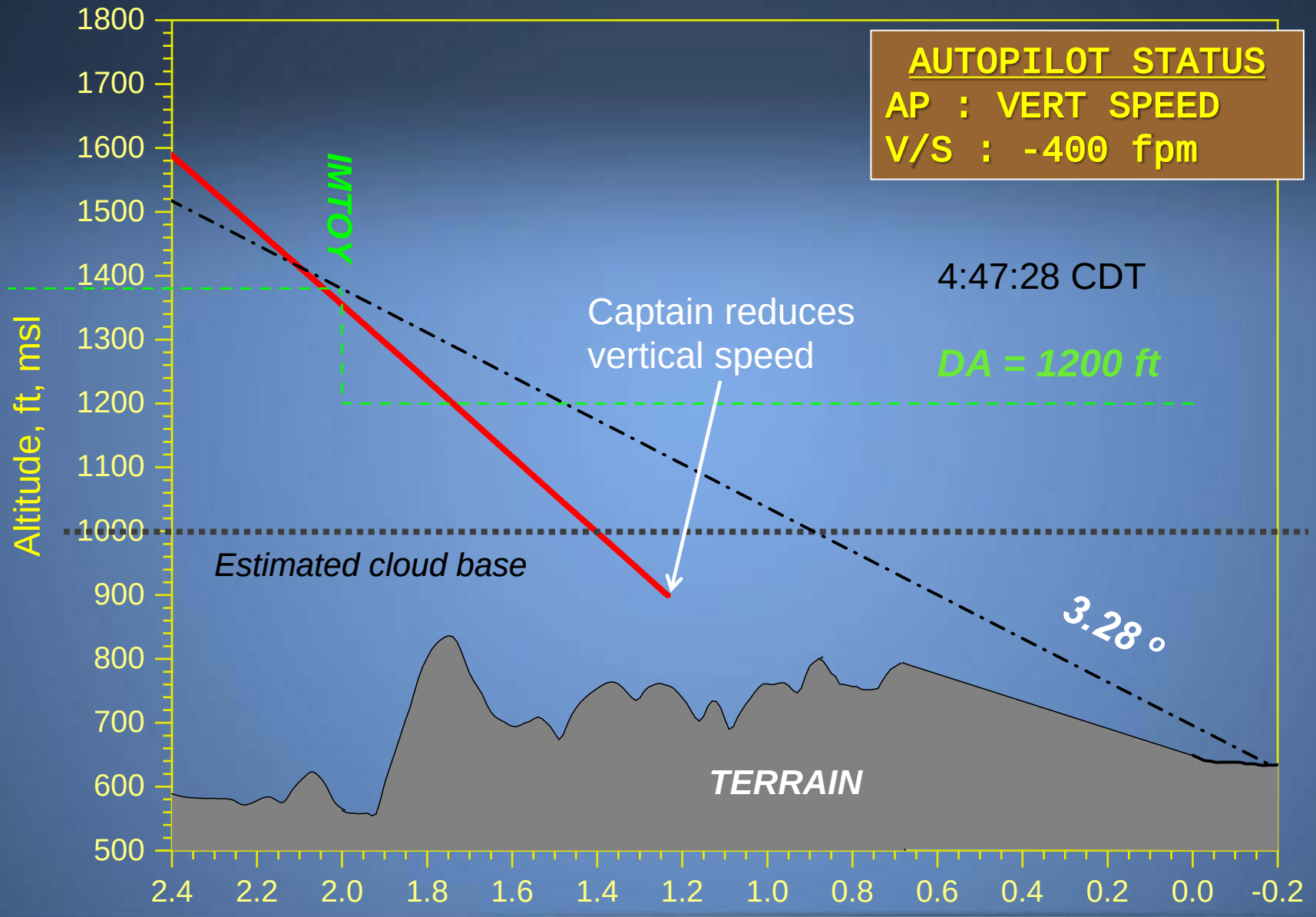

AUTOPILOT STATUS
AP : VERT SPEED
V/S : -1500 fpm
First officer: “there’s a thousand”
Captain: “DA is 1200”
4:47:03 CDT
IMTOY
BASKN
DA = 1200 ft
3.28°
Estimated cloud base
TERRAIN
Altitude, ft, msl
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
Distance north of Birmingham runway 18 threshold, nm
NTSB

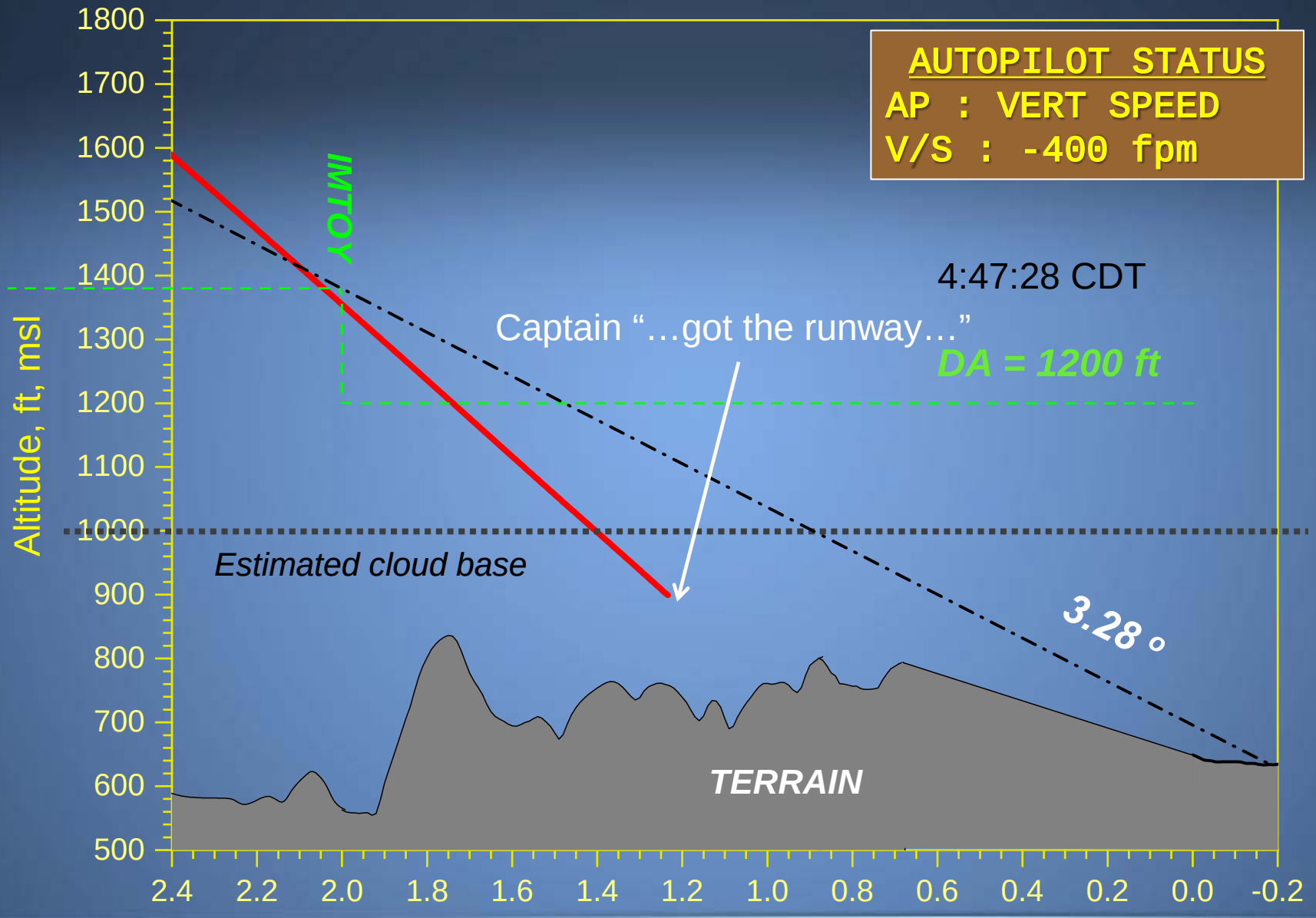

AUTOPILOT STATUS
AP : VERT SPEED
V/S : -1500 fpm
IMTOY
Captain: “two miles”
4:47:11 CDT
DA = 1200 ft
Estimated cloud base
3.28 °
TERRAIN
Altitude, ft, msl
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Distance north of Birmingham runway 18 threshold, nm
NTSB

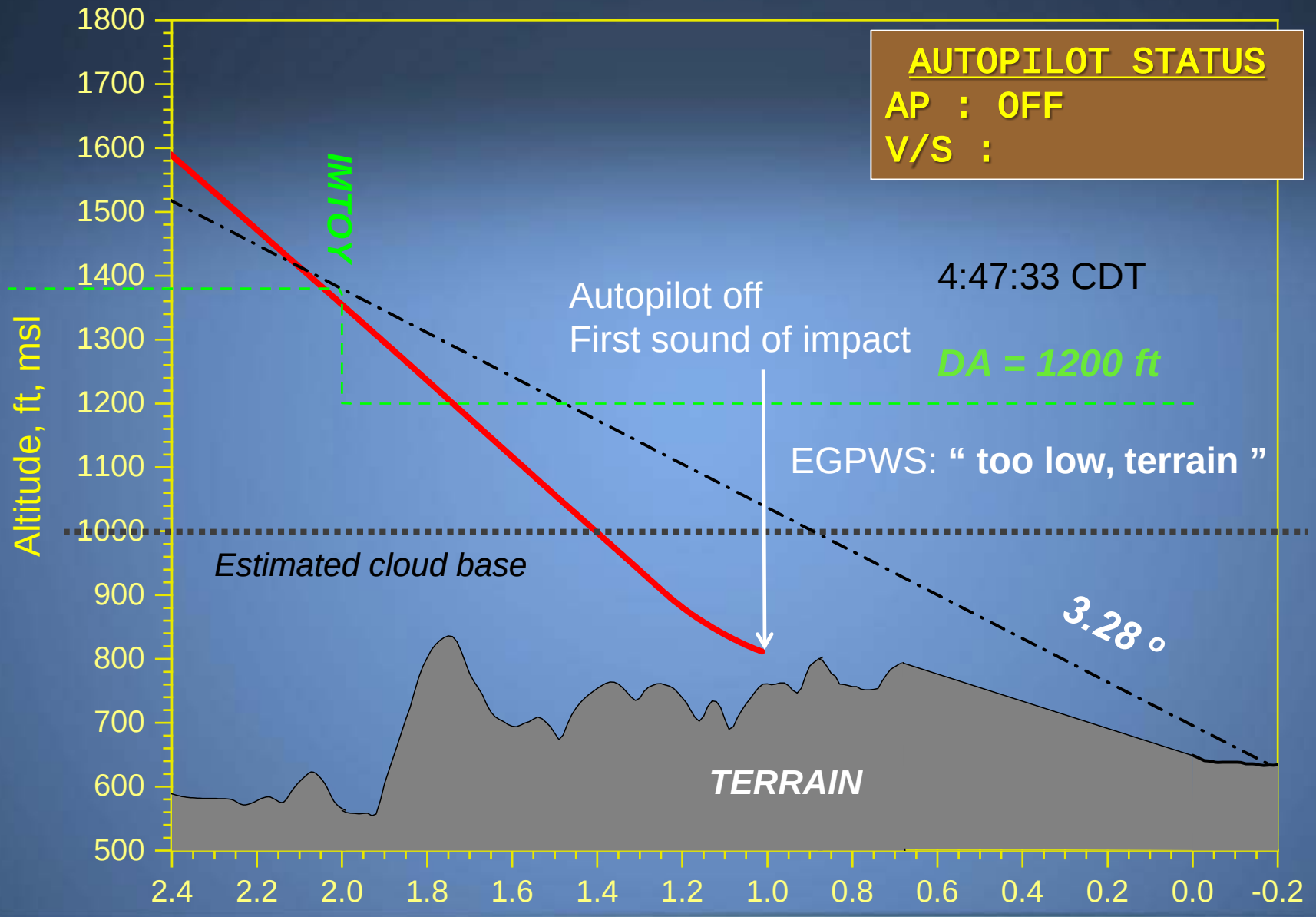

AUTOPILOT STATUS
AP : VERT SPEED
V/S : -1500 fpm
4:47:16 CDT
DA = 1200 ft
IMTOY
Estimated cloud base
3.28 °
TERRAIN
Altitude, ft, msl
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Distance north of Birmingham runway 18 threshold, nm
NTSB


AUTOPILOT STATUS
AP : VERT SPEED
V/S : -1500 fpm
First Officer : “it wouldn't happen to be actual”
4:47:19 CDT
DA = 1200 ft
IMTOY
Estimated cloud base
3.28 °
TERRAIN
Altitude, ft, msl
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Distance north of Birmingham runway 18 threshold, nm
NTSB


AUTOPILOT STATUS
AP : VERT SPEED
V/S : -1500 fpm
EGPWS :
"sink rate
sink rate"
4:47:25 CDT
DA = 1200 ft
IMTOY
Estimated cloud base
3.28 °
TERRAIN
Altitude, ft, msl
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Distance north of Birmingham runway 18 threshold, nm
NTSB


AUTOPILOT STATUS
AP : VERT SPEED
V/S : -400 fpm
4:47:28 CDT
Captain reduces vertical speed
DA = 1200 ft
IMTOY
Estimated cloud base
3.28 °
TERRAIN
Altitude, ft, msl
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Distance north of Birmingham runway 18 threshold, nm
NTSB


AUTOPILOT STATUS
AP : VERT SPEED
V/S : -400 fpm
4:47:28 CDT
Captain "…got the runway…"
DA = 1200 ft
IMTOY
Estimated cloud base
3.28 °
TERRAIN
Altitude, ft, msl
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Distance north of Birmingham runway 18 threshold, nm
NTSB


AUTOPILOT STATUS
AP : OFF
V/S :
4:47:33 CDT
Autopilot off
First sound of impact
DA = 1200 ft
EGPWS: " too low, terrain "
IMTOY
Estimated cloud base
3.28 °
TERRAIN
Altitude, ft, msl
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Distance north of Birmingham runway 18 threshold, nm
NTSB

runway 18 threshold
aft fuselage
engines and forward fuselage
rising terrain
ground contact
first tree strike

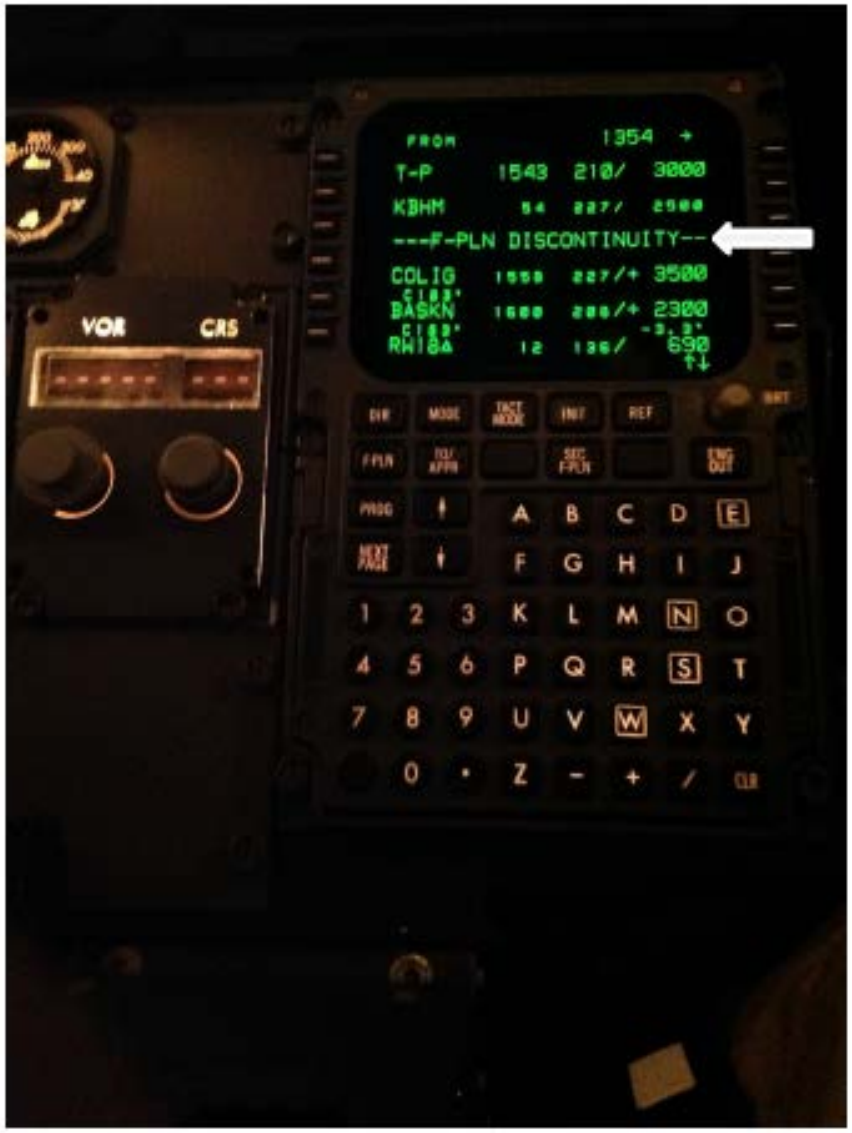
worldwide services
world of commerce

NTSB

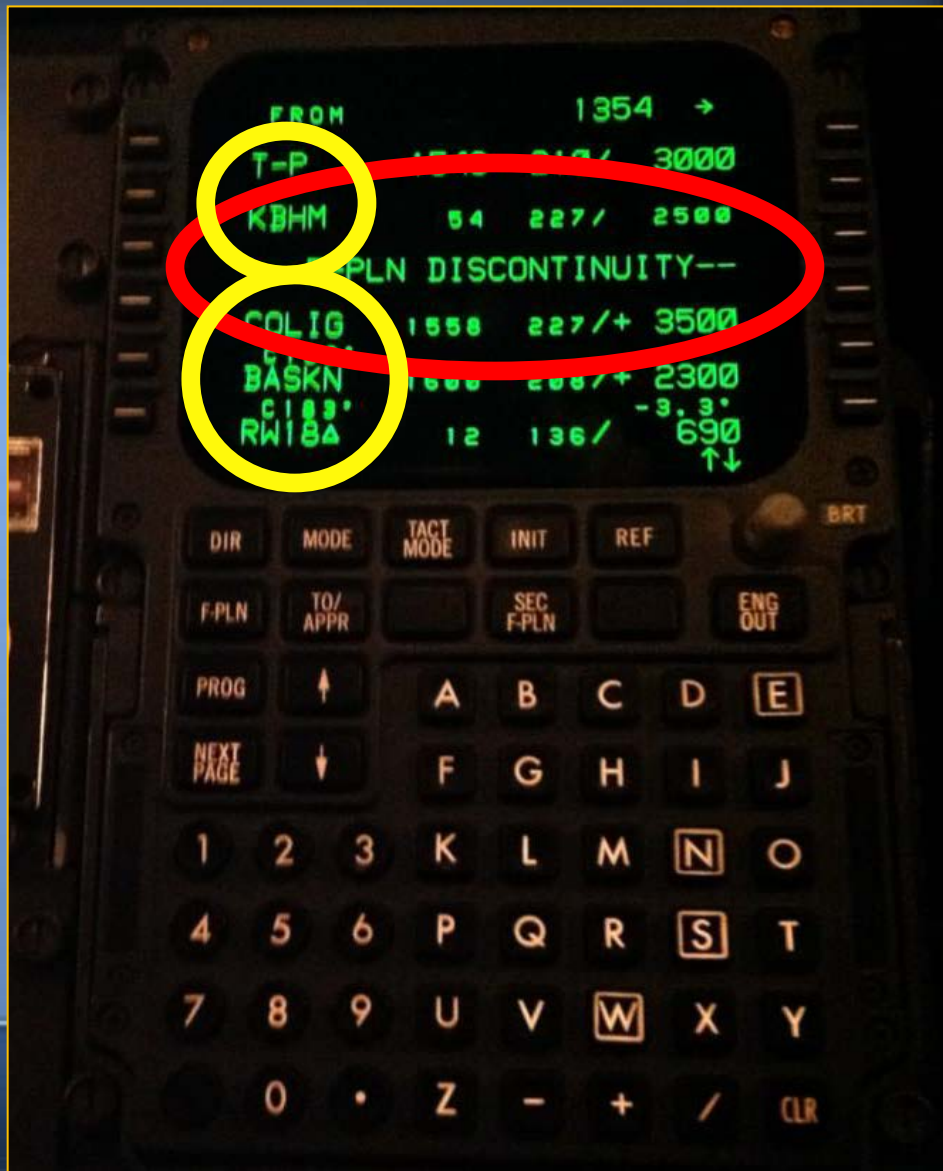
Two critical errors

- Not sequencing the FMS flight plan
- Not monitoring

Not sequencing the flight plan



Approach Setup



Navigation Display

The distraction

- F/O: “I don’t think we have many choices if runway 6 is closed” [laughter]
- Captain: “Ahhh [laughter] I know. What else can we do” [laughing].
- F/O: “I’m like, ahhh, well, what else ahh you gonna – unroll another one out there for us real quick or whatever” [chucking]
- Captain: “It’s like, okay, yeah, you got another… yeah you got an ILS on some’m else?” [chuckling]
- F/O: “Uhh… I know” [chuckling]

During the Approach

Captain

- Changed from previously briefed profile mode to vertical speed mode
- Did not verbalize his intentions to first officer
- Increased descent rate to 1,500 fpm

Approach Callouts

- First officer made 1,000-foot callout
- Descent rate exceeded stable approach criteria
- First officer did not make:
  - 500-foot callout
  - “Approaching minimums” callout
  - “Minimums” callout
- TAWS low-altitude aural callouts (“smart callouts”) were not enabled by UPS

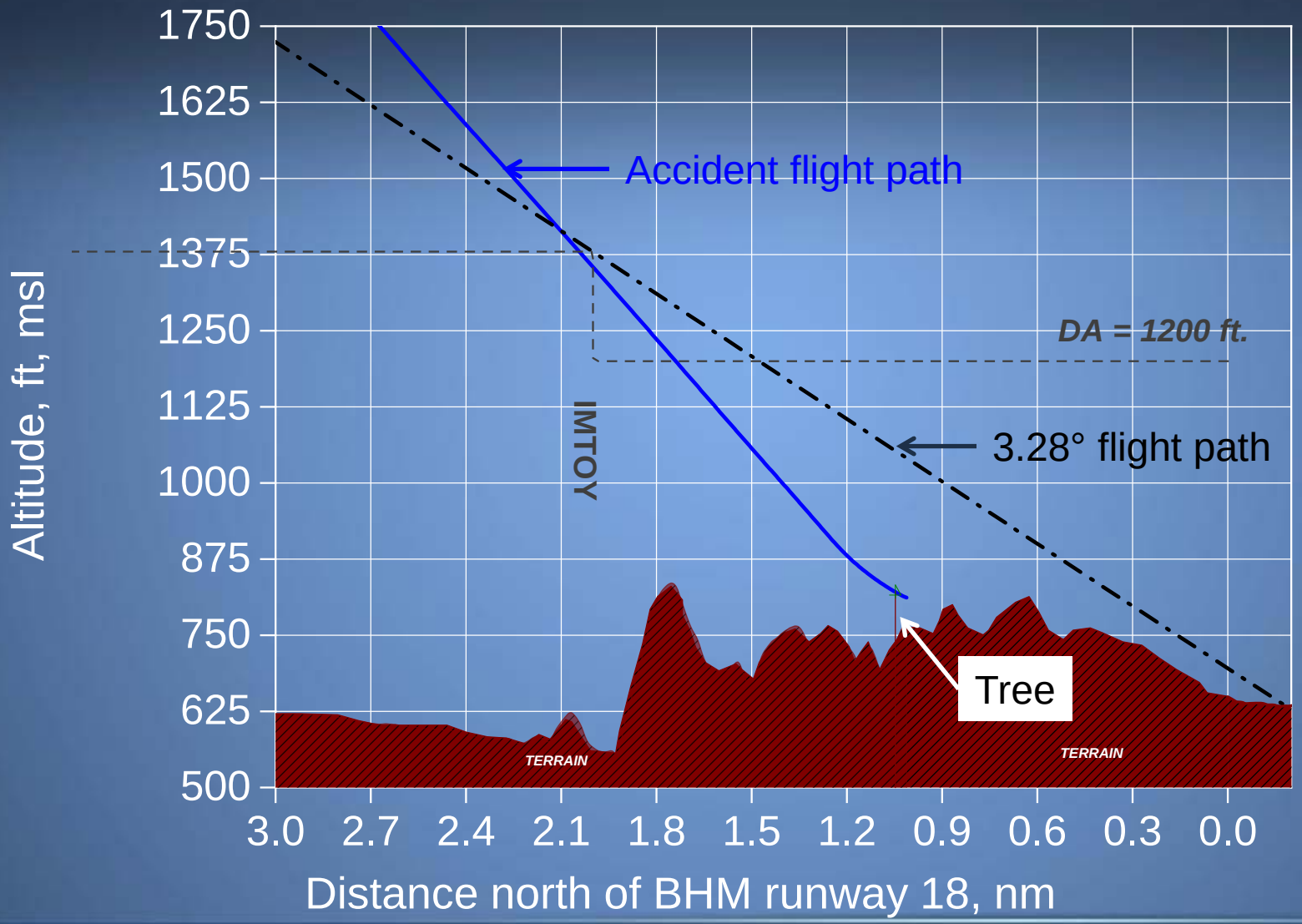
Workload: First Officer

- Had to mentally process change in autopilot mode
- No shared expectation of approach
- 1500-fpm descent twice as fast as normal descent rate
- Pace of duties increased

Expectancy

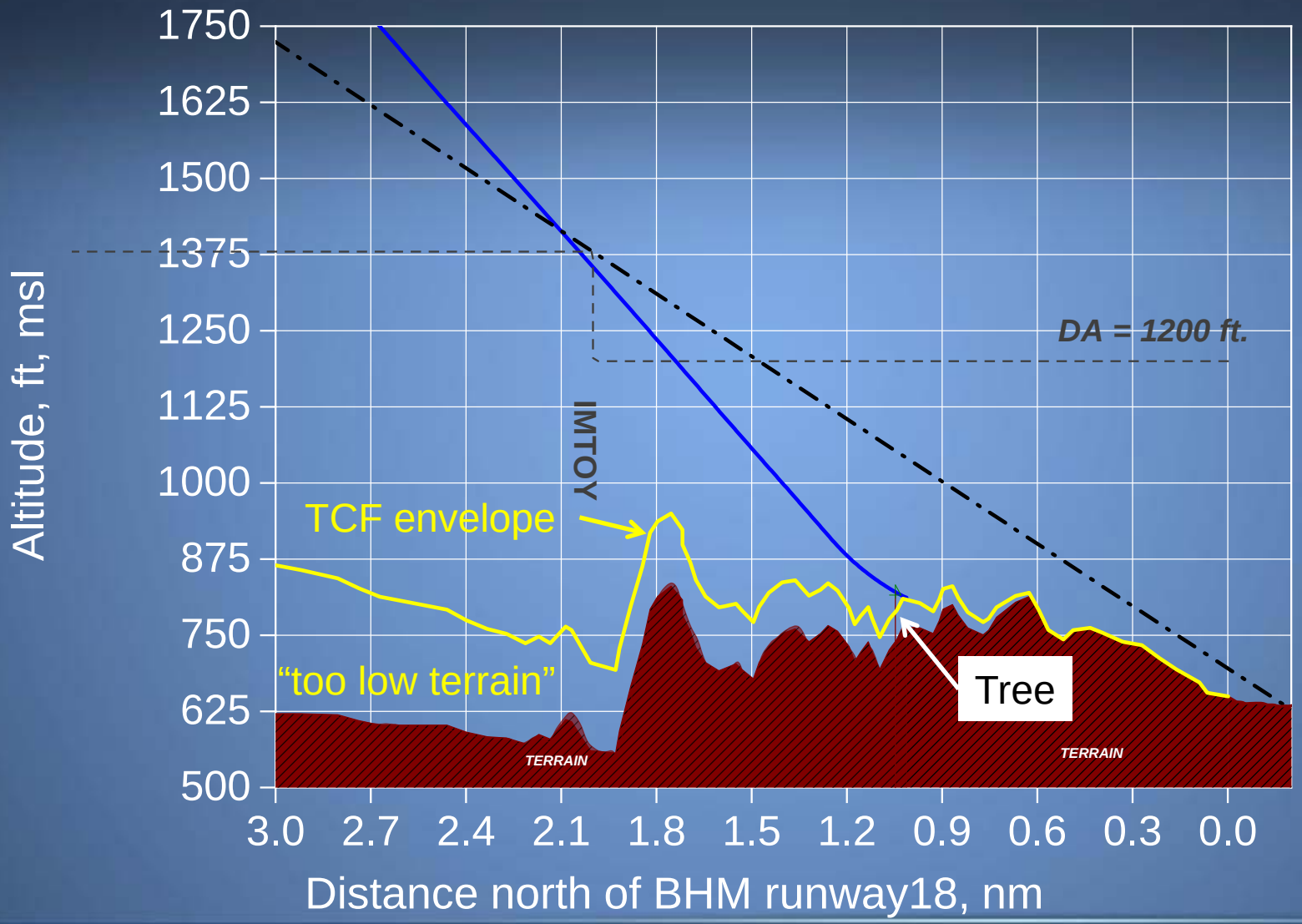
- They were high on the approach
- They would break out of the clouds at 1,000 agl.

EGPWS Terrain Clearance Floor



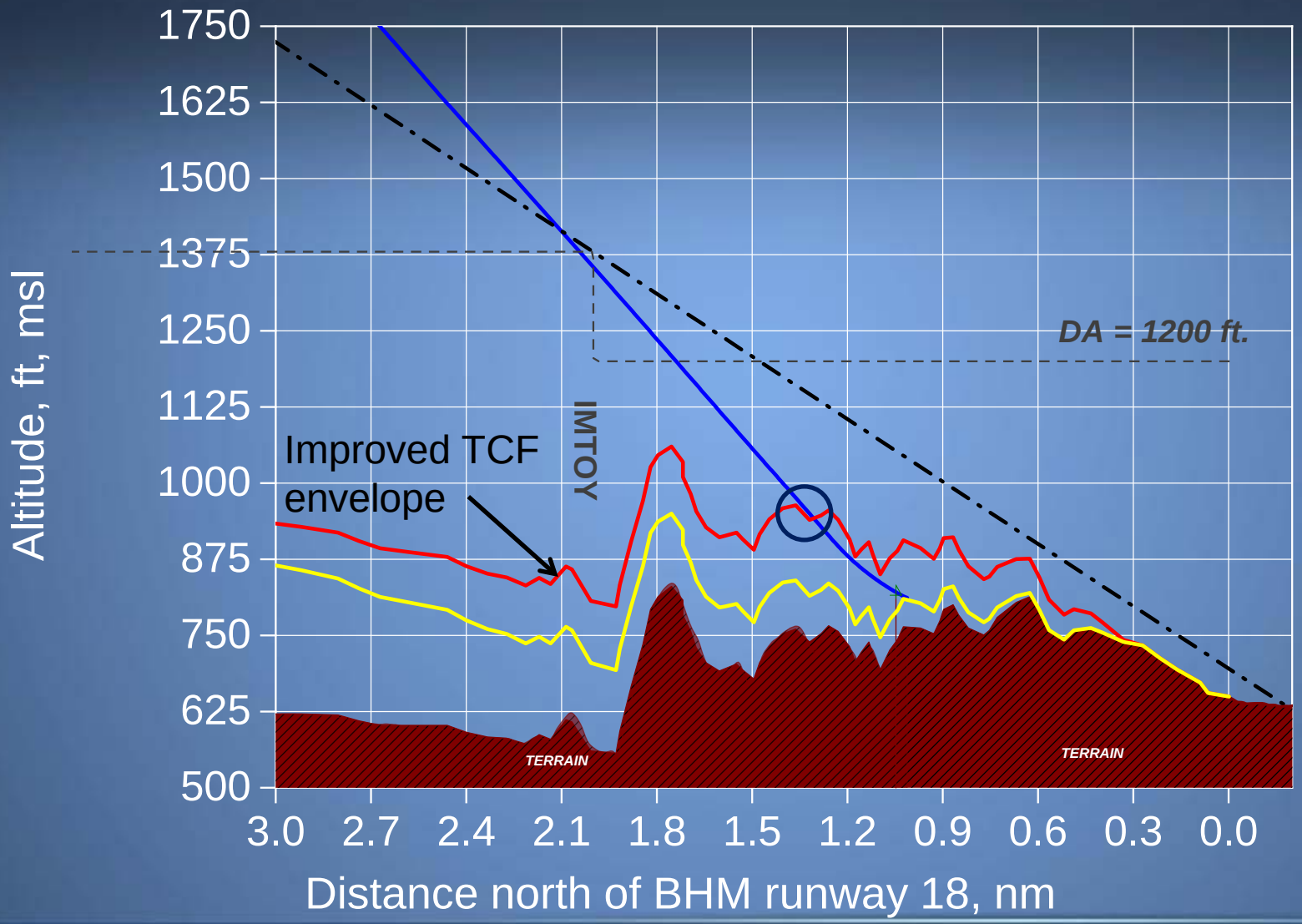
NTSB

EGPWS Terrain Clearance Floor



NTSB

EGPWS Terrain Clearance Floor



NTSB

NTSB Findings: TAWS

- Newer TAWS software would have provided a “too low terrain” caution alert 6.5 seconds sooner and 150 feet higher.
  - Because of the excessive descent rate and not knowing how aggressively the pilots would have responded, the effect on the accident could not be determined.

- An escalating series of TAWS alerts before impact with terrain or obstacles is not always guaranteed due to technological limitations, which reduces the safety effectiveness of the TAWS during the approach to landing.

NTSB Findings: “Smart Callouts”

- An automated “minimums” and/or altitude above terrain alert would have potentially provided the flight crewmembers with additional situational awareness upon their arrival at the MDA.
- In the absence of the automated “minimums” alert, an automated “500-ft” callout could have made the flight crewmembers aware of their proximity to the ground, and they could have taken action to arrest the descent.

NTSB Finding: Monitoring

"The flight crew did not sufficiently monitor the airplane's altitude during the approach and subsequently allowed the airplane to descend below the minimum altitude without having the runway environment in sight."

NTSB Finding: F/O's performance

"The first officer poorly managed her off-duty time by not acquiring sufficient sleep, and she did not call in fatigued; she was fatigued due to acute sleep loss and circadian factors, which, when combined with the time compression and the change in approach modes, likely resulted in the multiple errors she made during the flight."

Probable Cause

The flight crew's continuation of an unstabilized approach and their failure to monitor the aircraft's altitude during the approach, which led to an inadvertent descent below the minimum approach altitude and subsequently into terrain.

Contributing to the accident

(1) the flight crew's failure to properly configure and verify the FMS for the profile approach;

(2) the captain's failure to communicate his intentions to the first officer once it became apparent the vertical profile was not captured;

(3) the flight crew's expectation that they would break out of the clouds at 1,000 feet above ground level due to incomplete weather information;

Contributing to the accident

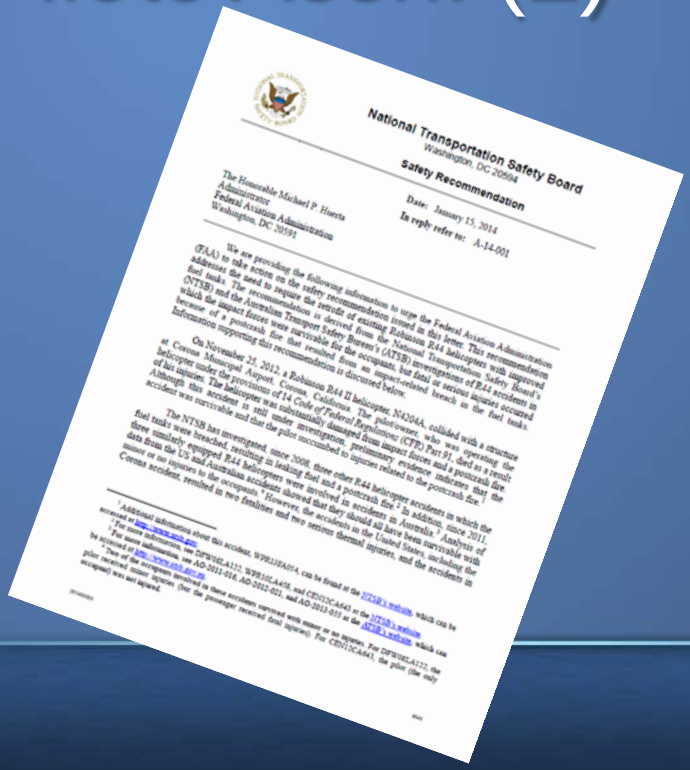
(4) the first officer's failure to make the required minimums callouts;

(5) the captain's performance deficiencies likely due to factors including, but not limited to, fatigue, distraction, or confusion, consistent with performance deficiencies exhibited during training; and

(6) the first officer's fatigue due to acute sleep loss resulting from her ineffective off-duty time management and circadian factors.

20 Recommendations

- FAA (15)
- Independent Pilots Assn. (2)
- UPS (2)
- Airbus (1)



National Transportation Safety Board
Washington, DC 20594

Safety Recommendation

Date: January 15, 2014
In reply refer to: A-14-001

The Honorable Michael P. Huerta
Administrator
Federal Aviation Administration
Washington, DC 20591

We are providing the following information to urge the Federal Aviation Administration (FAA) to take action on the safety recommendation issued in this letter. This recommendation addresses the need to require the retrofit of existing Robinson R44 helicopters with improved fuel tanks. The recommendation is derived from the National Transportation Safety Board's (NTSB) and the Australian Transport Safety Bureau's (ATSB) investigations of R44 accidents in which the impact forces were survivable for the occupants, but fatal or serious injuries occurred because of a postcrash fire that resulted from an impact-related breach in the fuel tanks. Information supporting this recommendation is discussed below.

On November 25, 2012, a Robinson R44 II helicopter, N4204A, collided with a structure at Corona Municipal Airport, Corona, California. The pilot/owner, who was operating the helicopter under the provisions of 14 Code of Federal Regulations (CFR) Part 91, died as a result of his injuries. The helicopter was substantially damaged from impact forces and a postcrash fire. Although this accident is still under investigation, preliminary evidence indicates that the accident was survivable and that the pilot succumbed to injuries related to the postcrash fire.[1]

The NTSB has investigated, since 2008, three other R44 helicopter accidents in which the fuel tanks were breached, resulting in leaking fuel and a postcrash fire.[2] In addition, since 2011, three similarly equipped R44 helicopters were involved in accidents in Australia.[3] Analysis of data from the US and Australian accidents showed that they should all have been survivable with minor or no injuries to the occupants.[4] However, the accidents in the United States, including the Corona accident, resulted in two fatalities and two serious thermal injuries, and the accidents in

[1] Additional information about this accident, WPR13FA054, can be found at the NTSB's website, which can be accessed at http://www.ntsb.gov.
[2] For more information, see DFW08LA122, WPR10LA458, and CEN12CA643 at the NTSB's website.
[3] For more information, see AD-2011-018, AD-2012-021, and AD-2013-035 at the ATSB's website, which can be accessed at http://www.atsb.gov.au.
[4] Two of the occupants involved in these accidents survived with minor or no injuries. For DFW08LA122, the pilot received minor injuries (but the passenger received fatal injuries). For CEN12CA643, the pilot (the only occupant) was not injured.

Recommendation to FAA

- Prohibit “dive and drive” approaches.

Recommendation to FAA

- Advise operators that, in certain situations, an escalating series of TAWS warnings may not occur before impact with terrain or obstacles.
- Encourage operators to review their procedures for responding to alerts on final approach to ensure that these procedures are sufficient to enable pilots to avoid impact with terrain or obstacles in such situations.

Recommendation to FAA

- Require all operators of airplanes equipped with the automated “minimums” alert to activate it, and to activate the TAWS 500-ft voice callout or similar alert.

Common Threads

- Neither approach was stabilized
- Neither had effective monitoring
- Neither had effective intra-cockpit communications
- ILS was unavailable in both cases
- Fatigue

National Transportation Safety Board