Blame and the Fallacy of Root Cause Analysis

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Background

- Me, an engineer, and:
  - Flying instructor
  - Oil exploration engineer
  - Photojournalist
  - Humanitarian worker
  - Software engineer

- I have seen many accidents and near misses
  - I might have even been complicit in some of them

- I have developed a professional interest in human error
  - Mainly to avoid further disappointment

- Blame

- Root Cause Analysis

- Investigating Disaster

- **Blame**

- Root Cause Analysis

- Investigating Disaster

Blame Fallacies

- Fundamental attribution error

- Outlier assumption

- Fair world hypothesis

- Illusion of free will

- Administrative convenience

  - Particularly if there is a regulator

- Blame eliminates a reporting culture

Blame

AIRCRAFT ACCIDENT REPORT 14/75
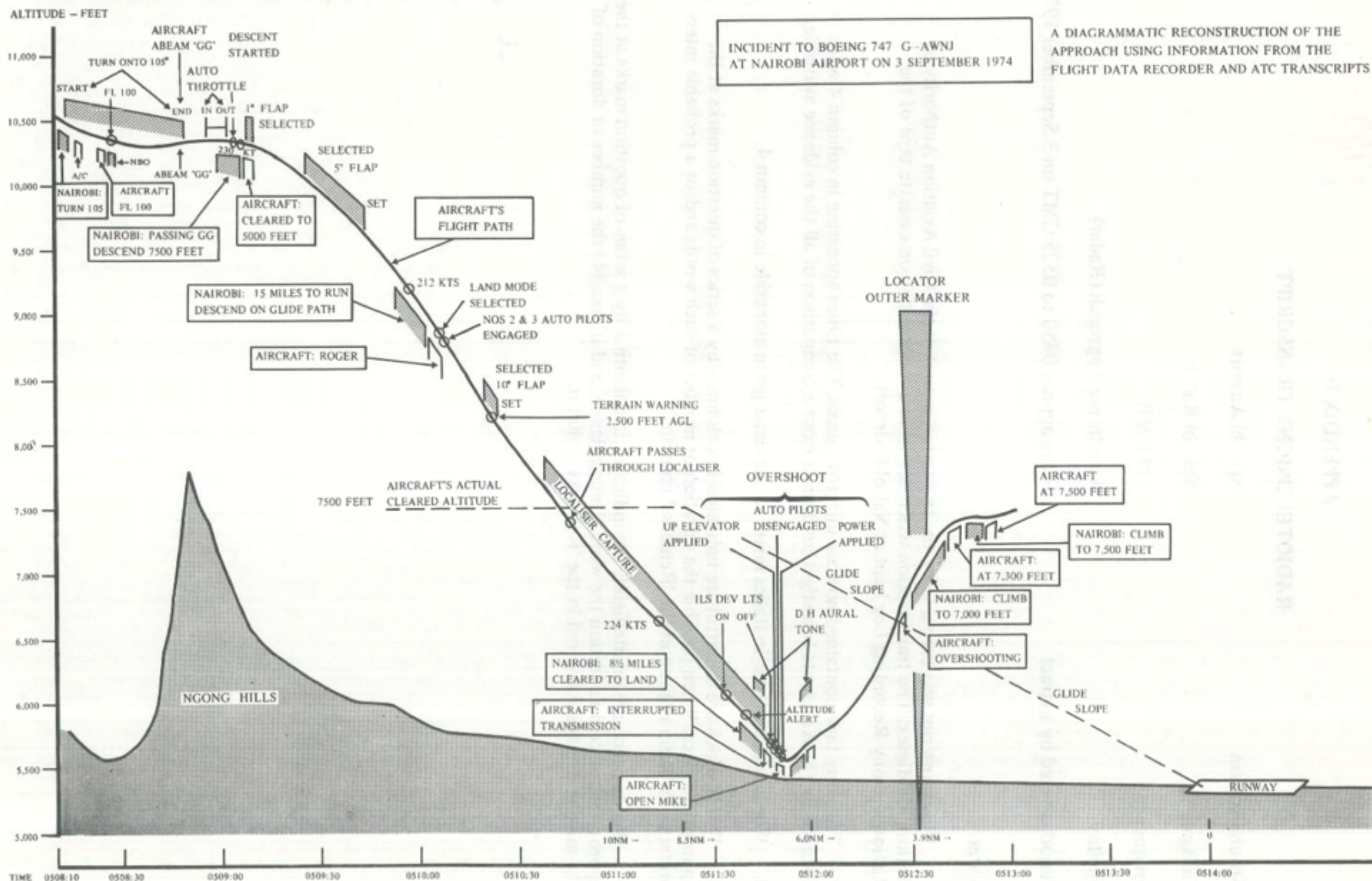
Department of Trade

ACCIDENTS INVESTIGATION BRANCH

Boeing 747 - 136 G-AWNJ
Report on the incident near Nairobi Airport,
Kenya, on 3 September 1974

VERTICAL CROSS SECTION OF FLIGHT — APPENDIX C
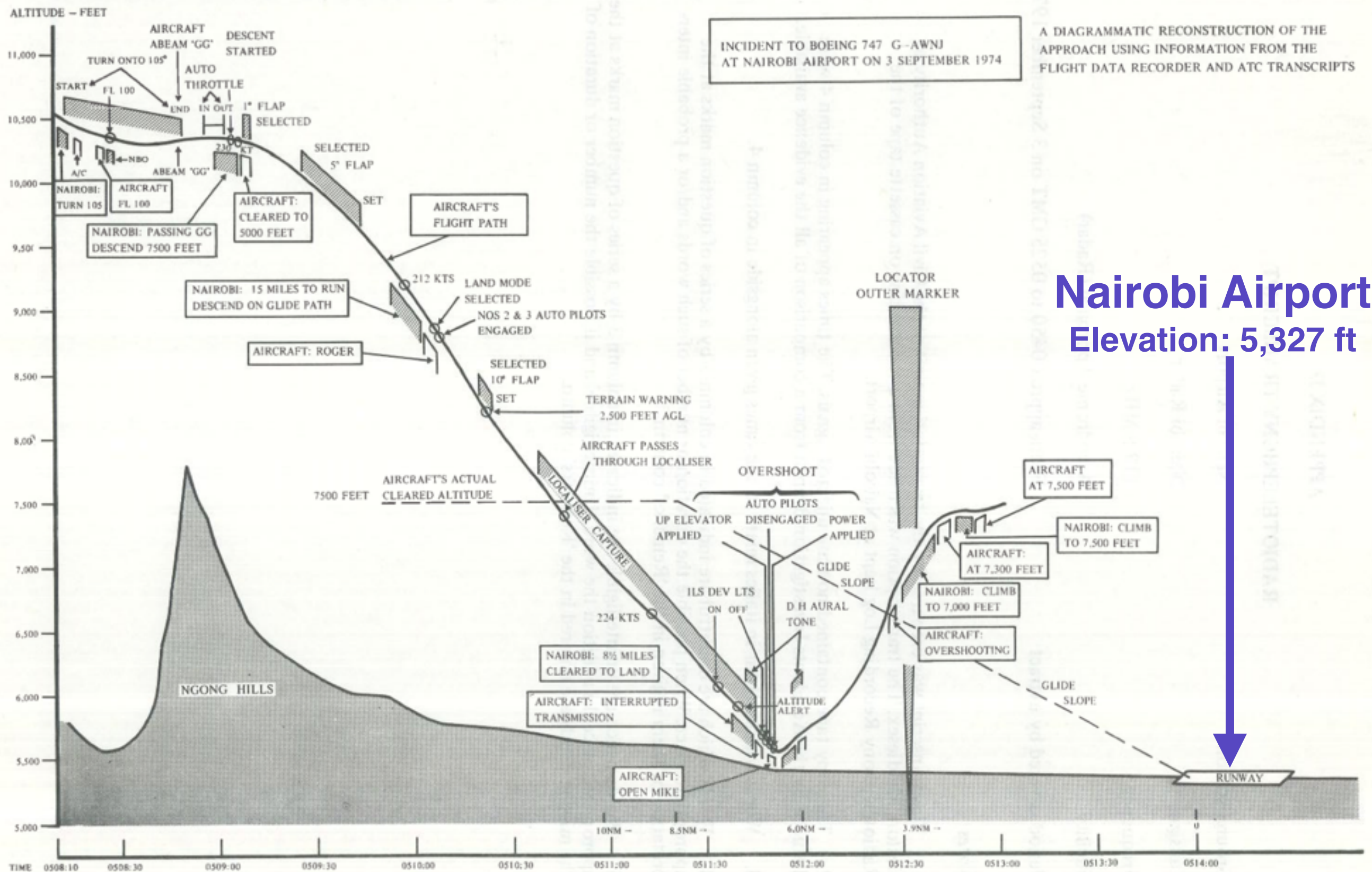
ALTITUDE — FEET

INCIDENT TO BOEING 747 G-AWNJ
AT NAIROBI AIRPORT ON 3 SEPTEMBER 1974

A DIAGRAMMATIC RECONSTRUCTION OF THE
APPROACH USING INFORMATION FROM THE
FLIGHT DATA RECORDER AND ATC TRANSCRIPTS

Source: AAIB Report 14/75.

VERTICAL CROSS SECTION OF FLIGHT — APPENDIX C

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ALTITUDE — FEET

AIRCRAFT ABEAM 'GG'

DESCENT STARTED

TURN ONTO 105°

AUTO THROTTLE

START FL 100

END IN OUT 1° FLAP SELECTED

A/C ←NBO

NAIROBI: TURN 105 AIRCRAFT FL 100

ABEAM 'GG'

230 KT

SELECTED 5° FLAP

SELECTED

AIRCRAFT: CLEARED TO 7500 FEET

SET

AIRCRAFT'S FLIGHT PATH

NAIROBI: PASSING GG DESCEND 7500 FEET

NAIROBI: 15 MILES TO RUN DESCEND ON GLIDE PATH

212 KTS LAND MODE SELECTED

NOS 2 & 3 AUTO PILOTS ENGAGED

AIRCRAFT: ROGER

SELECTED 10° FLAP

SET

TERRAIN WARNING 2,500 FEET AGL

AIRCRAFT PASSES THROUGH LOCALISER

LOCATOR OUTER MARKER

OVERSHOOT

AIRCRAFT'S ACTUAL CLEARED ALTITUDE

7500 FEET

LOCALISER CAPTURE

AUTO PILOTS DISENGAGED POWER
UP ELEVATOR   APPLIED
APPLIED

GLIDE SLOPE

AIRCRAFT AT 7,500 FEET

NAIROBI: CLIMB TO 7,500 FEET

AIRCRAFT: AT 7,300 FEET

224 KTS

ILS DEV LTS
ON OFF

D H AURAL TONE

NAIROBI: CLIMB TO 7,000 FEET

AIRCRAFT: OVERSHOOTING

GLIDE SLOPE

NAIROBI: 8½ MILES CLEARED TO LAND

AIRCRAFT: INTERRUPTED TRANSMISSION

ALTITUDE ALERT

NGONG HILLS

AIRCRAFT: OPEN MIKE

RUNWAY

10NM 8.5NM 6.0NM 3.9NM

TIME 0508:10 0508:30 0509:00 0509:30 0510:00 0510:30 0511:00 0511:30 0512:00 0512:30 0513:00 0513:30 0514:00

Source: AAIB Report 14/75.

VERTICAL CROSS SECTION OF FLIGHT — APPENDIX C

A DIAGRAMMATIC RECONSTRUCTION OF THE APPROACH USING INFORMATION FROM THE FLIGHT DATA RECORDER AND ATC TRANSCRIPTS

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AIRCRAFT ABEAM 'GG'
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TURN ONTO 105°
AUTO THROTTLE
END   IN OUT
1° FLAP SELECTED
START   FL 100

SELECTED 5° FLAP

A/C   ←NBO
ABEAM 'GG'
230 KT

NAIROBI: TURN 105
AIRCRAFT FL 100
AIRCRAFT: CLEARED TO 5000 FEET
AIRCRAFT'S FLIGHT PATH

NAIROBI: PASSING GG DESCEND 7500 FEET

212 KTS   LAND MODE SELECTED
NAIROBI: 15 MILES TO RUN DESCEND ON GLIDE PATH
NOS 2 & 3 AUTO PILOTS ENGAGED
AIRCRAFT: ROGER
SELECTED 10° FLAP SET

LOCATOR OUTER MARKER

TERRAIN WARNING 2,500 FEET AGL

AIRCRAFT PASSES THROUGH LOCALISER
OVERSHOOT

AIRCRAFT'S ACTUAL CLEARED ALTITUDE   7500 FEET

AUTO PILOTS DISENGAGED
UP ELEVATOR APPLIED   POWER APPLIED

AIRCRAFT AT 7,500 FEET
NAIROBI: CLIMB TO 7,500 FEET
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10NM   8.5NM   6.0NM   3.9NM

TIME 0508:10 0508:30 0509:00 0509:30 0510:00 0510:30 0511:00 0511:30 0512:00 0512:30 0513:00 0513:30 0514:00

11,000
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Source: AAIB Report 14/75.

Blame

"This incident first came to light because the Captain reported it immediately. This was clearly a highly responsible action on his part and one which he took without thought of the possible consequences to himself."

"It is of course impossible to predict what effect the action taken against the crew will have on the future of incident reporting by flight crew but it would seem likely that it may well be discouraging."

Source: AAIB Report 14/75.

Equifax Ex-CEO Blames One Employee For Patch Failures

Richard Smith testifies Oct. 3 before the House Committee on Energy and Commerce. (Source: C-SPAN)

- Blame

- **Root Cause Analysis**

- Investigating Disaster

Root Cause Analysis

- A single failure causes a cascade of other failures

  - Example: Electricity grid failure

- Very seductive in software engineering

  - There is no hiding place

  - Perhaps dangerously seductive?

- Perfect for blame

$Xm Data Error (1980s)

The Shop

6	BS [IN]	16

6	CALI [IN]	16

0	CGR2 [GAPI]	150

0	SGR2 [GAPI]	150

0.45	NPHI [V/V]	-0.15

0.3	NPOR [V/V]	-0.1

1.95	RHOB [G/C3]	2.95

0.3	TNPH [V/V]	-0.1

0	PEF	10	-0.25	DRHO [G/C3]	0.25

Company:	B.E.B.
Well:	BECKLINGEN Z#1
Field:	BECKLINGEN
Rig:	CELLE
Country:	D.

BECKLINGEN Z#1 "BHC-GR" 21/11/8

TotalDepth

LOCATION		
LAND		Elev: KB **0 (M)**
		GL **83 (M)**
		DF **9 (M)**

Permanent Datum:	**ACKERSOHLE**	Elev:	
Log Measured From:	**AS**	**0 (M)**	above permanent datum
Drilling Measured From:	**AS**		

	Max. Well Deviation	Latitude **58 61 485**	Longitude **35 61 120**
Logging Date		Other Services:	
Run Number	**5**	**DLL-MSFL**	
Depth Driller	**5131 (M)**	**LDL-CNL**	
Depth Logger	**5139.6 (M)**	**NGS**	
Bottom Log Interval	**5137.3 (M)**	**HDT**	
Top Log Interval	**4730.5 (M)**	**FILM SKALA:**	
Casing Driller Size @ Depth	**0 (IN)** @	**1/200**	
Casing Logger			
Bit Size	**5.875 (IN)**		
Type of Fluid in the Hole	**KREIDE**		
Mud: Density, Viscosity			
Mud: Fluid Loss, Ph			
Mud: Source of Sample	**UMLAUF**		
Rm @ Measured Temperature	**0.196 (OHMM)** @ **16 (DEGC)**		
Rmf @ Measured Temperature	**0.0797 (OHMM)** @ **16 (DEGC)**		
Rmc @ Measured Temperature	**0.266 (OHMM)** @ **16 (DEGC)**		
Source: Rmf, Rmc			
Rm @ MRT, Rmf @ MRT			
Max. Recorded Temperature	**153.3 (DEGC)**		
Time circulation stopped	**08:30 21-NOV**		
Time logger at bottom	**19:50 21-NOV**		
Logging unit and location	**DIEPHOLZ**		
Recorded by	**M. LORSIGNOL**		
Witnessed by	**HR. KRONHARDT**		

Company:	B.E.B.
Well:	BECKLINGEN Z#1
Field:	BECKLINGEN
Rig:	CELLE	Country: D.

BECKLINGEN Z#1 "BHC-GR" 21/11/8

TotalDepth

LAND		Elev:	KB	0 (M)
			GL	83 (M)
			DF	9 (M)

Permanent Datum:	ACKERSOHLE	Elev:	
Log Measured From:	AS	0 (M)	above permanent datum
Drilling Measured From:	AS		

	Max. Well Deviation	Latitude 58 61 485	Longitude 35 61 120

		Other Services:
Logging Date		
Run Number	5	DLL-MSFL
Depth Driller	5131 (M)	LDL-CNL
Depth Logger	5139.6 (M)	NGS
Bottom Log Interval	5137.3 (M)	HDT
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Casing Driller Size @ Depth	0 (IN) @	1/200
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$Xm Data Error

- Set the data directly:

```
$ SET LATI 52 41 23.125
$ SET LONG  1 11 14.308
```

$Xm Data Error

- Set the data directly:
```
$ SET LATI 52 41 23.125
$ SET LONG  1 11 14.308
```

- Be asked for the data:
```
$ RUN WSD

...
WELL LONGITUDE? 52 41 23.125
WELL LATITUDE?   1 11 14.308
...
```

$Xm Data Error

Permanent Datum:	Permanent datum	Elev:		
Log Measured From:	DF	17 (FT)	above permanent datum	
Drilling Measured From:	DF			
	Max. Well Deviation 12.7 (DEG)	**Latitude** 2 12' 12.196"W	**Longitude** 52 31' 47.369"N	
	2012-01-05	Other Services:		

Start of Multi-Well Analysis
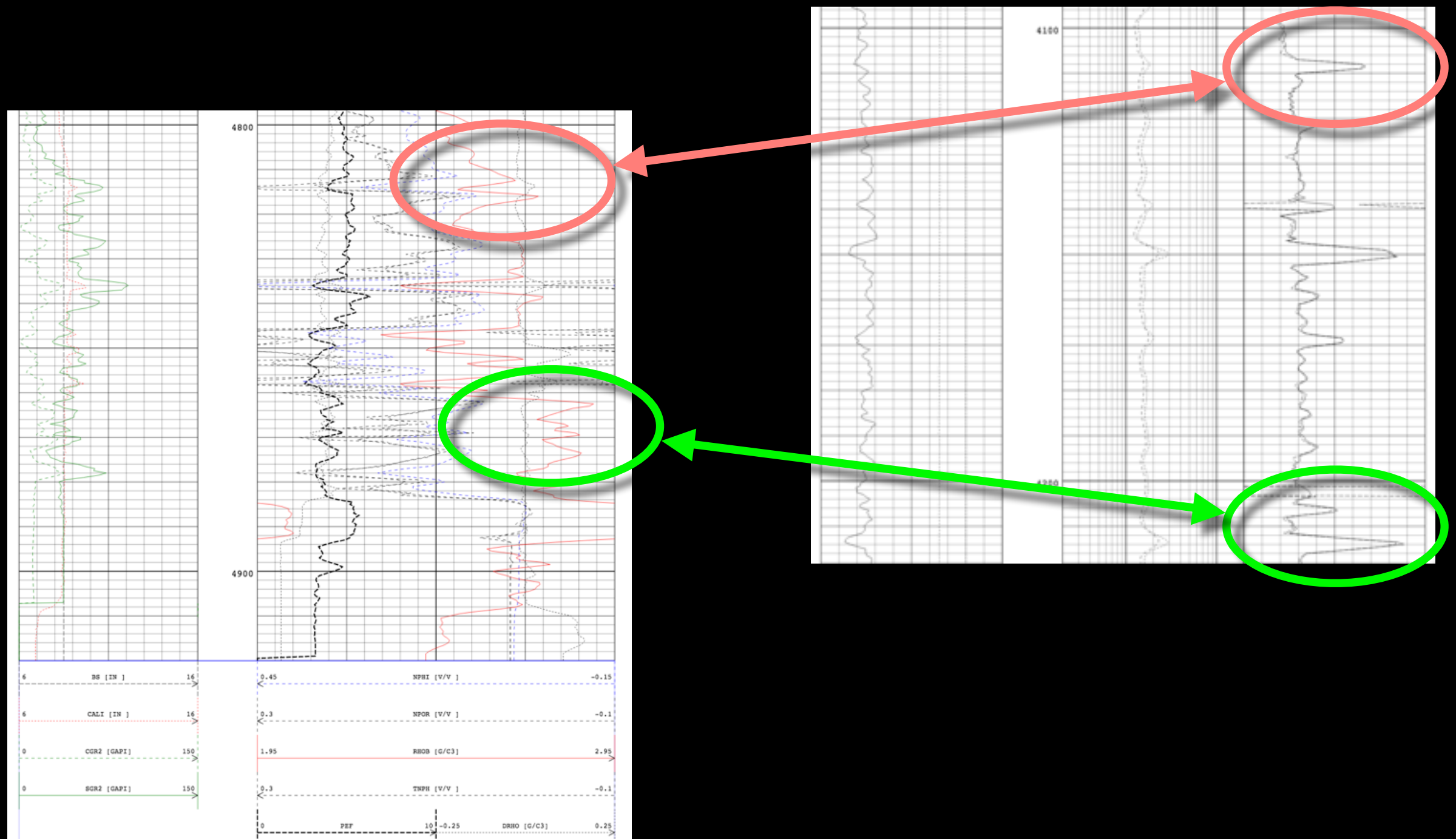
West Africa…
X° 21'N   X° 15'E
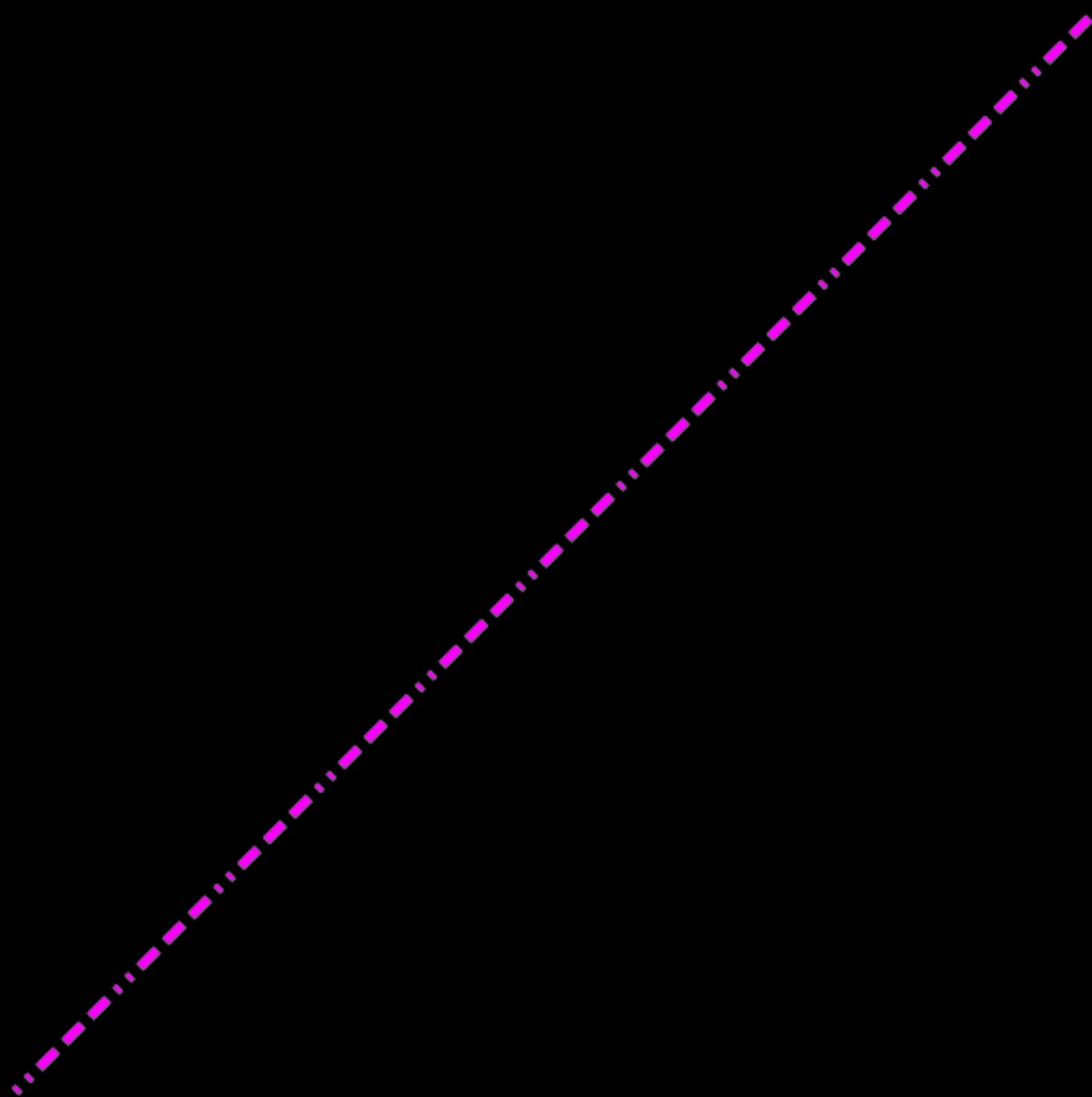
West Africa…
X° 21'N   X° 15'E

West Africa…
X° 21'N   X° 15'E

Correct Position
Assumed Position
Actual Position
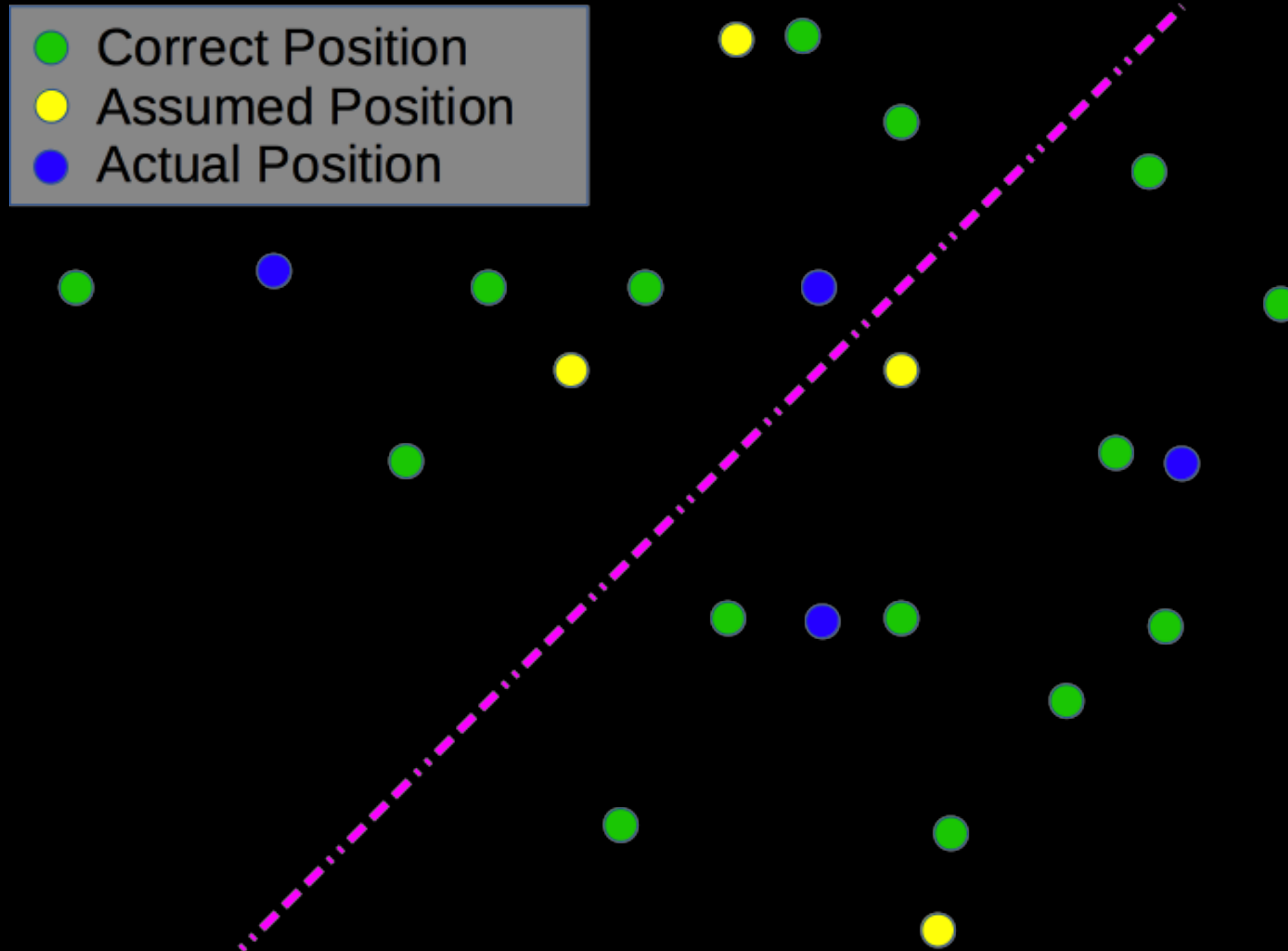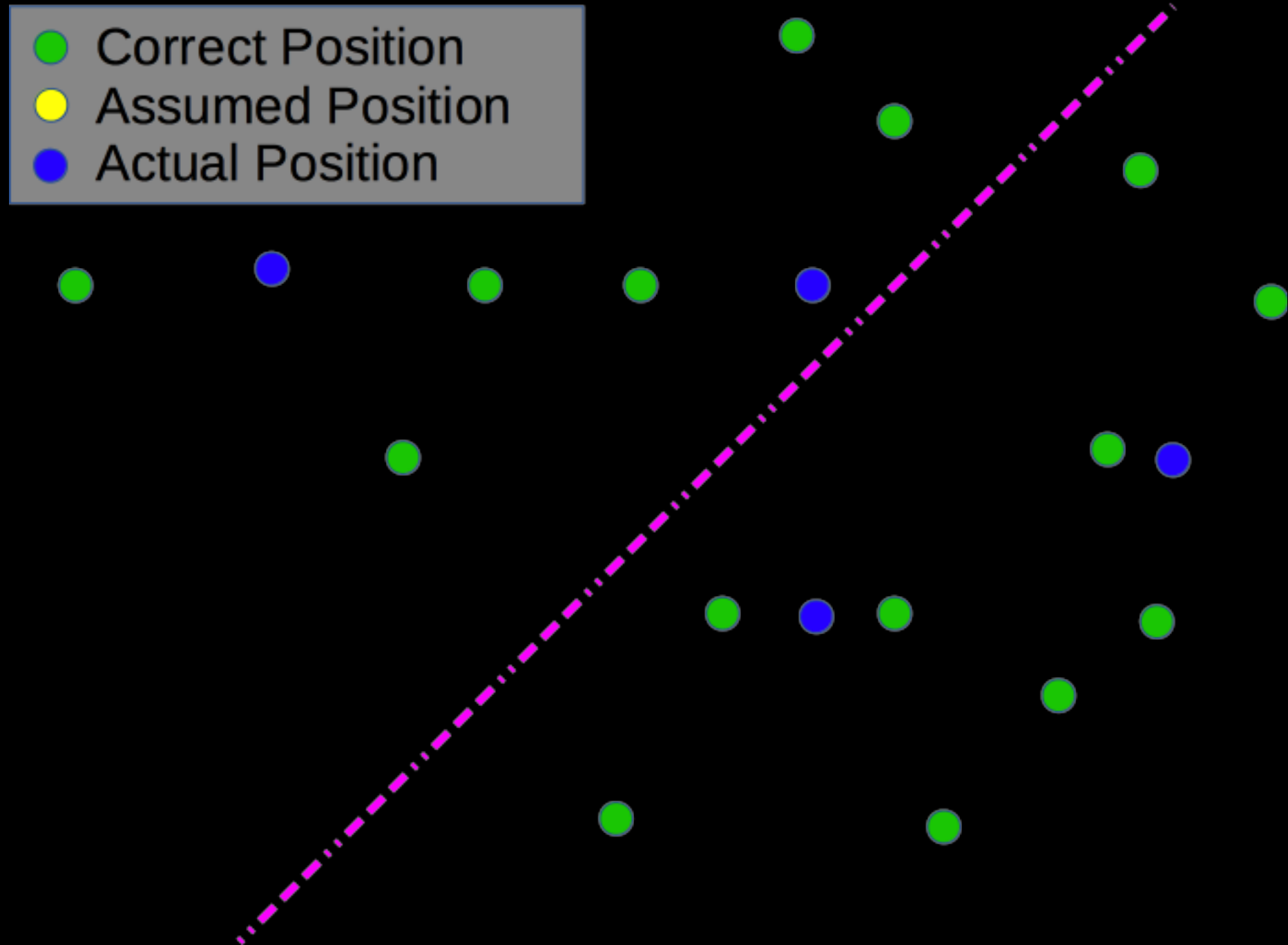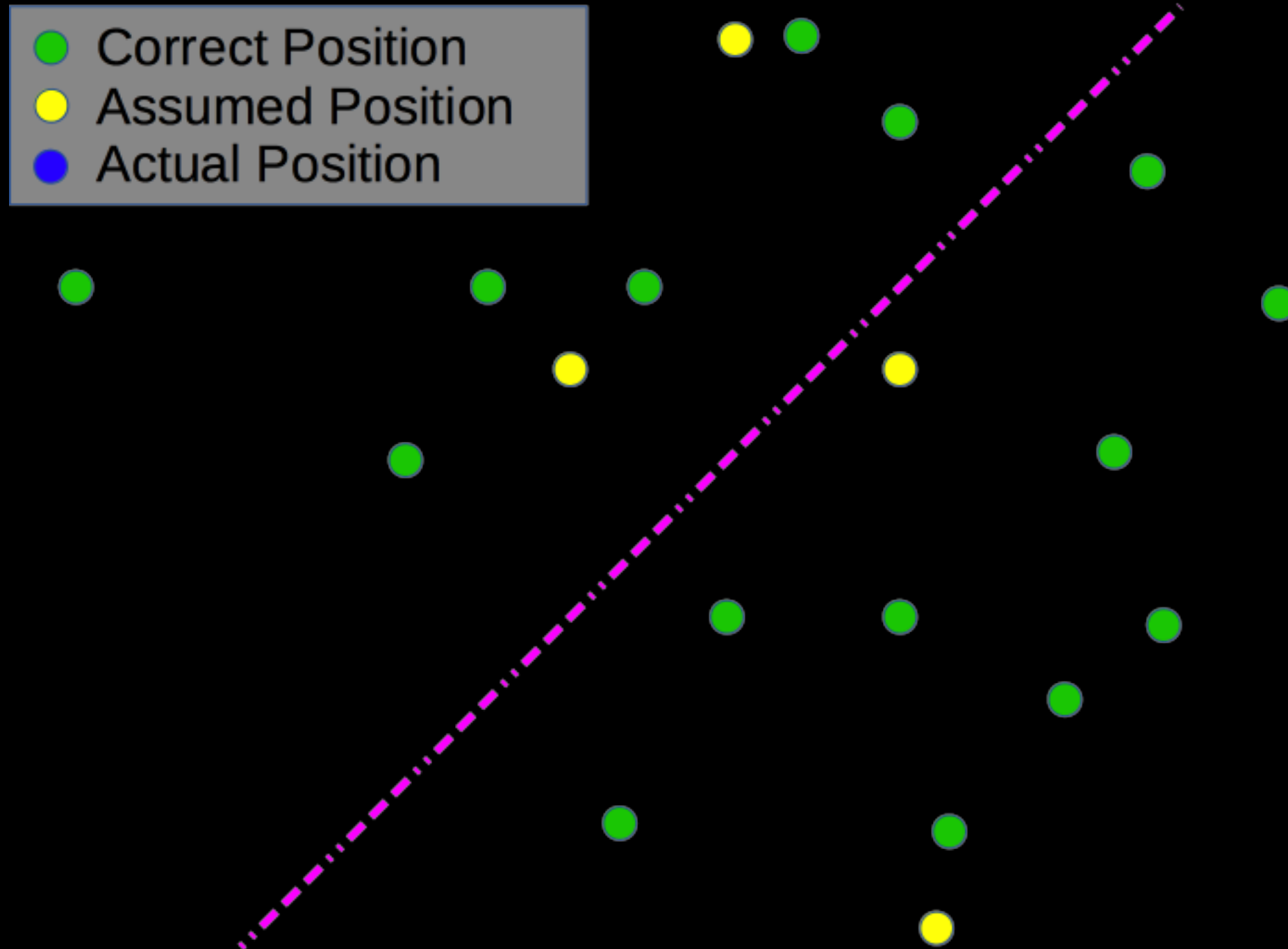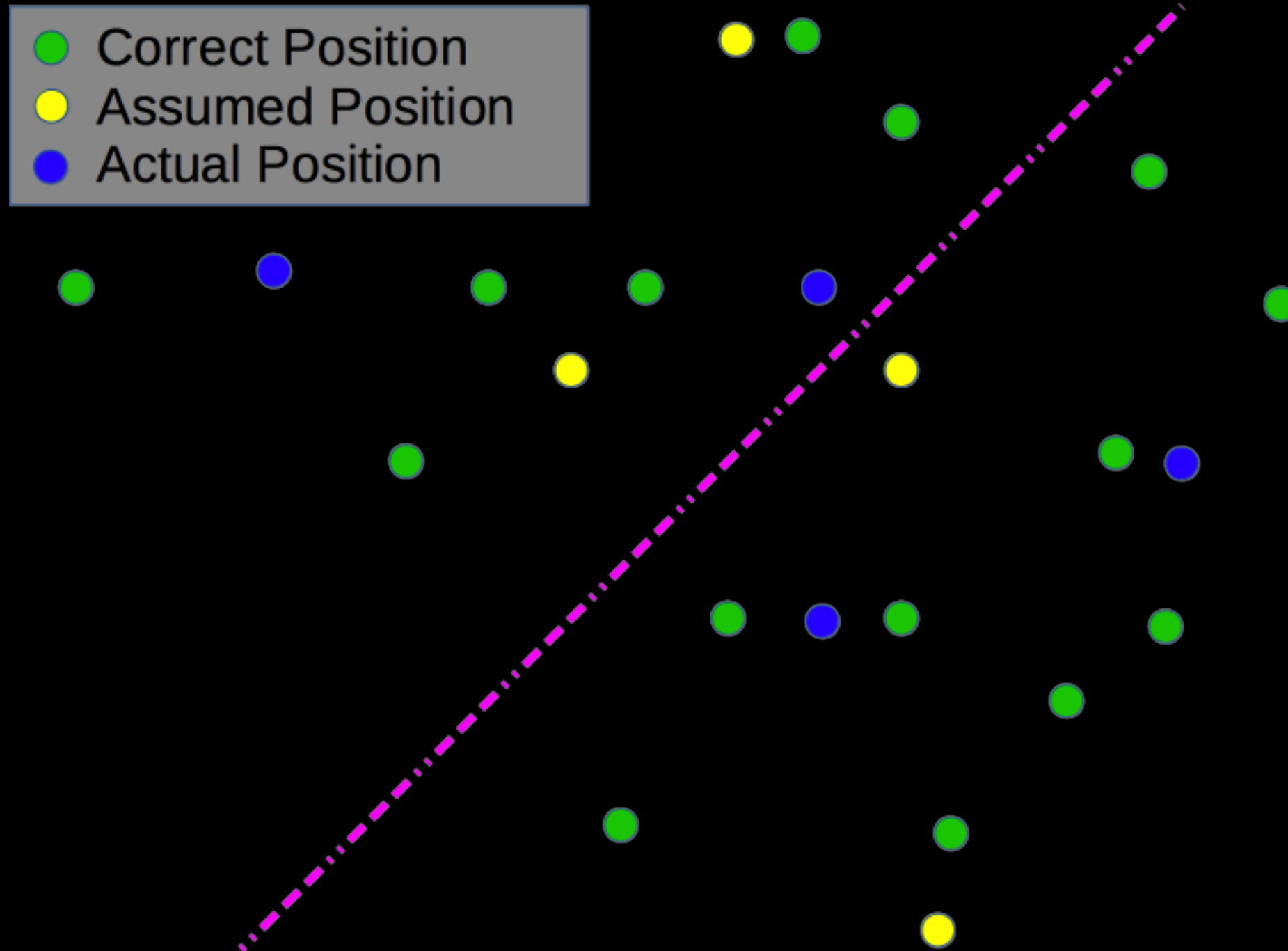
Root Cause?

- **Engineer**: Entered incorrect data

- **Software designer**: Unintuitive order of questions

- **People in the know**: Failed to prosecute this as an issue

- **Data processing company**: No cross checking with other data

- **Client**: Hiring all these people

- **Root Cause**: The Big Bang

"Cause"

- Cause is something that you construct after the event

- How you construct it, and from what evidence, depends on where you look

- "Root cause" is merely where you decide to stop looking

Causes vs Conditions

Causes vs Conditions

Decisionmaking processes at Macondo did not adequately ensure that personnel fully considered the risks created by time- and money-saving decisions. Whether purposeful or not, many of the decisions that BP, Halliburton, and Transocean made that increased the risk of the Macondo blowout clearly saved those companies significant time (and money).*

Causes vs Conditions

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FIGURE 4.10: Examples of Decisions That Increased Risk At Macondo While Potentially Saving Time

Decision	Was There A Less Risky Alternative Available?	Less Time Than Alternative?	Decision-maker
Not Waiting for More Centralizers of Preferred Design	Yes	Saved Time	BP on Shore
Not Waiting for Foam Stability Test Results and/or Redesigning Slurry	Yes	Saved Time	Halliburton (and Perhaps BP) on Shore
Not Running Cement Evaluation Log	Yes	Saved Time	BP on Shore
Using Spacer Made from Combined Lost Circulation Materials to Avoid Disposal Issues	Yes	Saved Time	BP on Shore
Displacing Mud from Riser Before Setting Surface Cement Plug	Yes	Unclear	BP on Shore
Setting Surface Cement Plug 3,000 Feet Below Mud Line in Seawater	Yes	Unclear	BP on Shore (Approved by MMS)
Not Installing Additional Physical Barriers During Temporary Abandonment Procedure	Yes	Saved Time	BP on Shore
Not Performing Further Well Integrity Diagnostics in Light of Troubling and Unexplained Negative Pressure Test Results	Yes	Saved Time	BP (and Perhaps Transocean) on Rig
Bypassing Pits and Conducting Other Simultaneous Operations During Displacement	Yes	Saved Time	Transocean (and Perhaps BP) on Rig

- Blame

- Root Cause Analysis

- **Investigating Disaster**

Investigation

- To understand, objectively, what happened

So that:

- Further, not similar, accidents can be prevented

What is your Accident Model?

- Sequence-of-events model

  - Accidents can be prevented by removing one link in the chain

- Epidemiological model

  - Accidents can be prevented by knocking out latent pathogens

- Systemic model

  - Accidents can be prevented by understanding how people and organisations function

Sequence of Events Model

- Focuses on cause→effect relationships

- Tells a relatively simple story that is easy to communicate

- Encourages simple countermeasures

  - Most likely to be ineffective

- Easily outrun by the complexity of real systems

Epidemiological Model

- Accidents consist of:

  - *Active errors* (or unsafe acts) committed by operators

  - *Latent errors* that can be triggered by a particular set of circumstances

- Encourages thinking about defences and resilience

- It is often difficult to make meaningful predictions

  - What is a Latent Error?

  - What is a *significant* Latent Error?

Macondo 2010
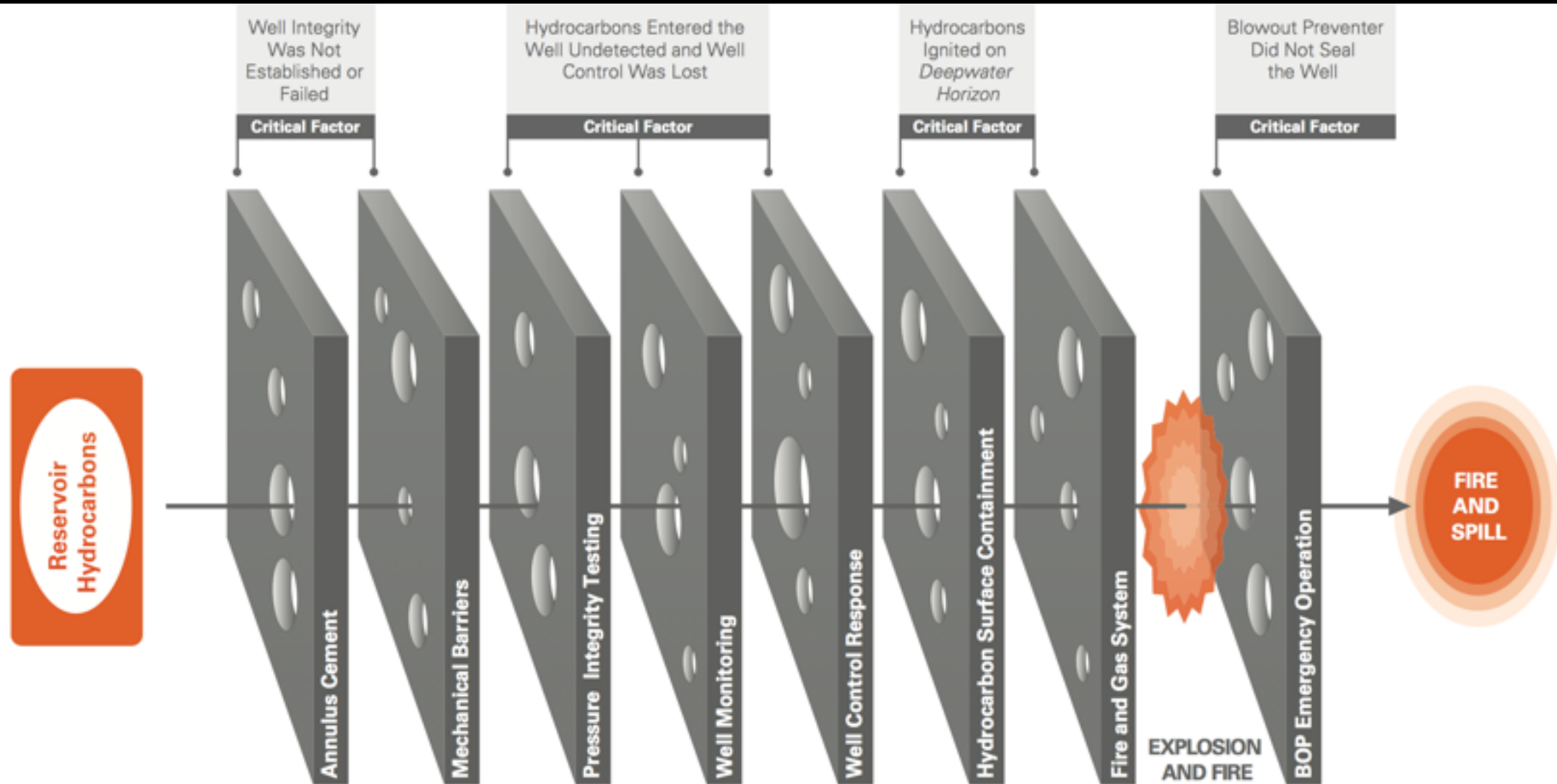
Adapted from James Reason (Hampshire: Ashgate Publishing Limited, 1997).

Figure 1. Barriers Breached and the Relationship of Barriers to the Critical Factors.

Systemic Accident Model

- Focuses on the whole system rather than dividing it into parts

- Recognises that systems are continuously changing

- Tries to understand why a particular decision made sense at the time
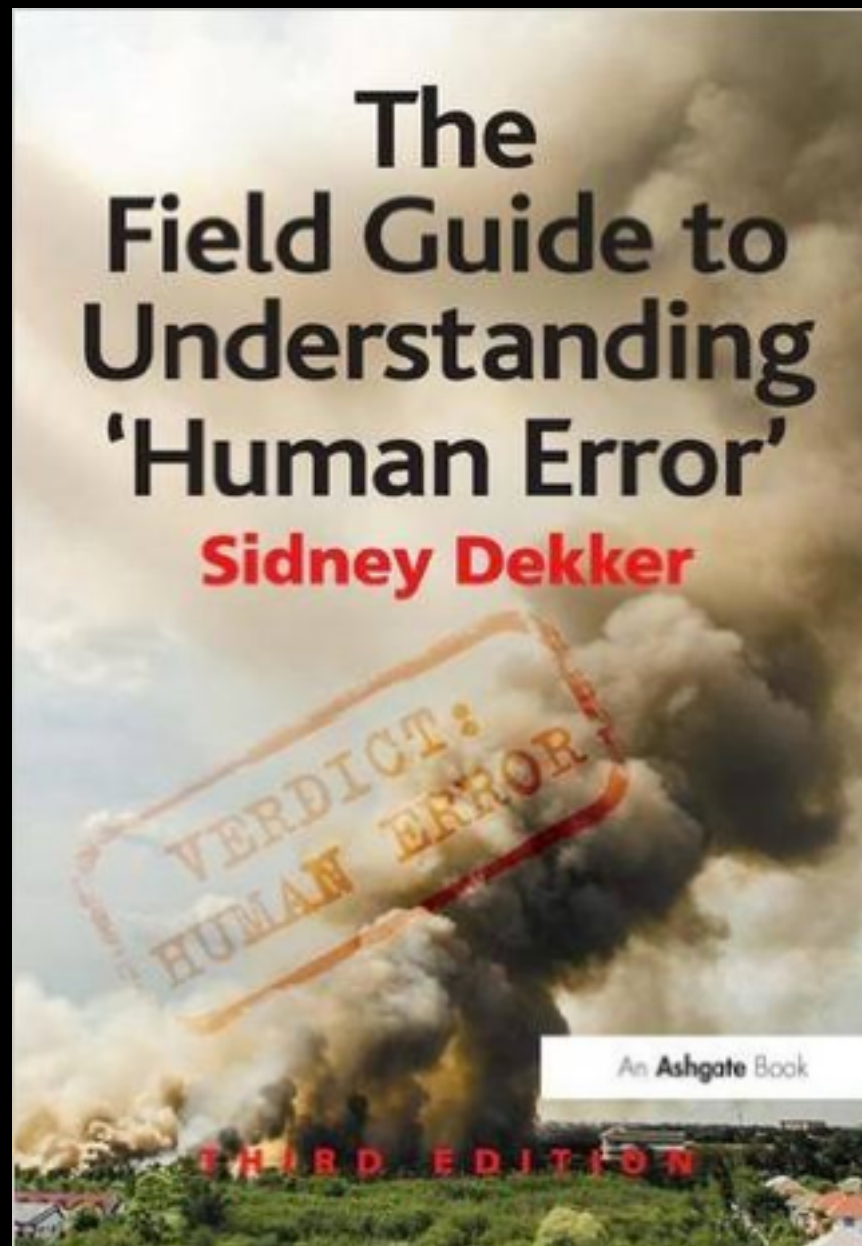
Investigating Human Error

- Nobody comes to work to do a bad job

- Human error is not the cause of failure, it is the effect

  - It is the starting point of the investigation, not the conclusion

  - Human error is inevitable and systematic, not random

  - Human error is the effect of trouble deeper inside your system

- Complex systems need a human contribution

  - Because the human element is the most adaptable

- Hindsight bias is the biggest obstruction to an effective investigation

Source: The Field Guide to Understanding Human Error by Sidney Dekker

Making Progress on Reliability

- Your organisation is not inherently safe

  - People create safety whilst balancing the need for production

  - Recognise those trade-offs, make it clear what is legitimate and desirable

- Look for the gaps:

  - Between work-as-imagined and work-as-done

  - Responsibility-authority mismatches

- This is a never ending process as catastrophe is just around the corner
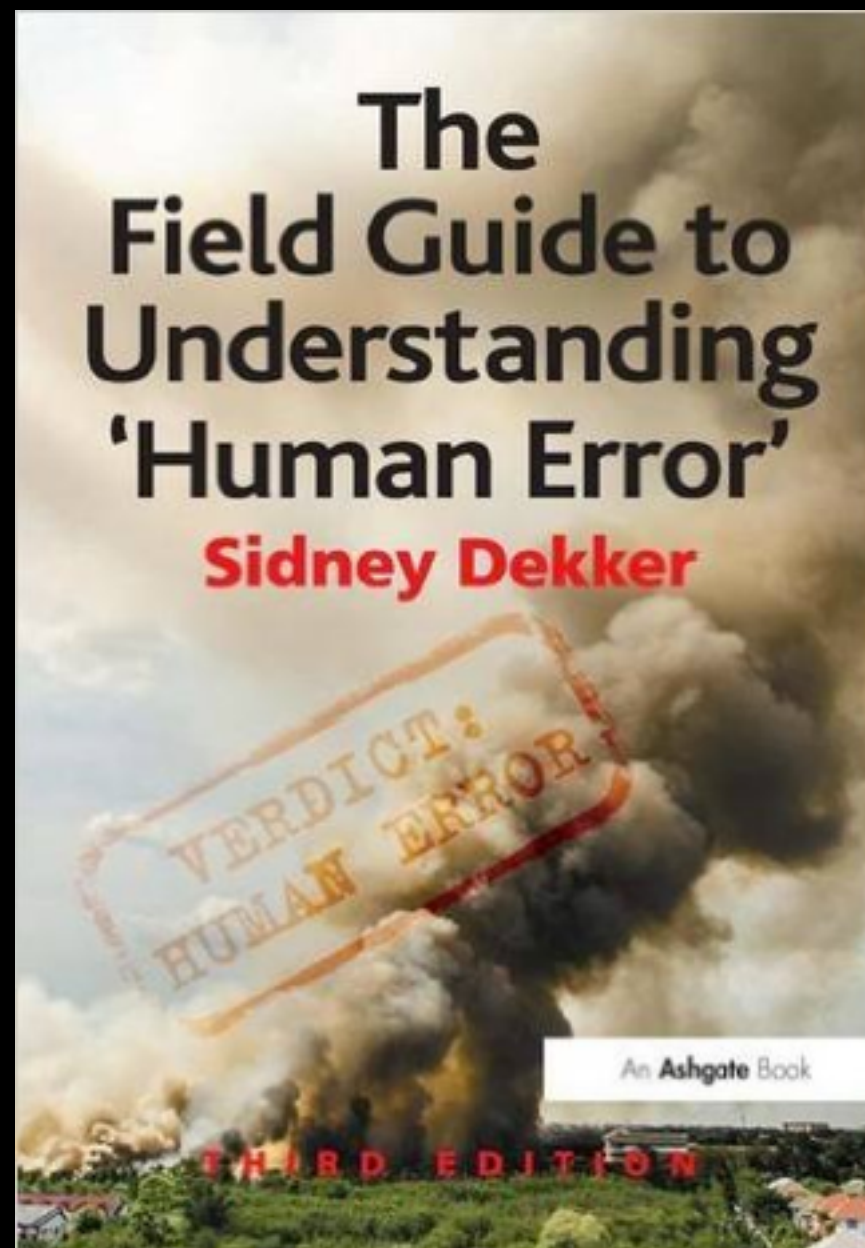
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Pythonic C
extensions

Cython traps

Dtrace & Python

Thread safe
SkipList

The
Field Guide to
Understanding
'Human Error'
Sidney Dekker

VERDICT:
HUMAN ERROR

An Ashgate Book

THIRD EDITION

C preprocessor in
Python

All about
Concorde

Petrophysical
software