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Evolving Commercial Rotorcraft Cockpits

Herb Moran

Experimental Test Pilot

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Discussion

- Historical Look at Rotorcraft Safety
- Rotorcraft Technology Changes Last 10 years
- Vision of the Future Commercial Rotorcraft Cockpit
- The Challenge for Rotorcraft Testers

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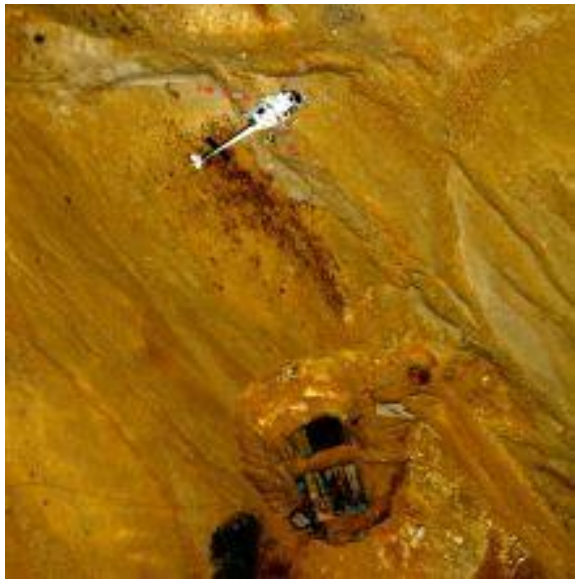

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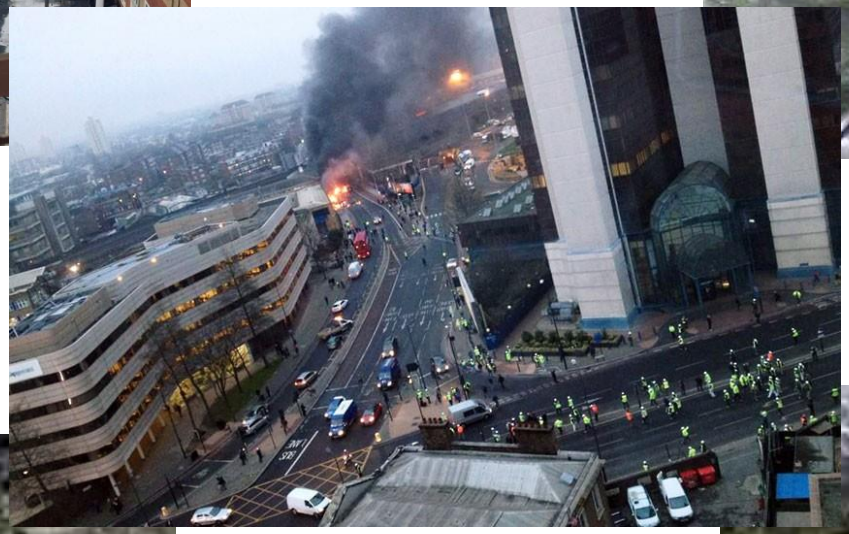
But this presentation is about **SAFETY!**



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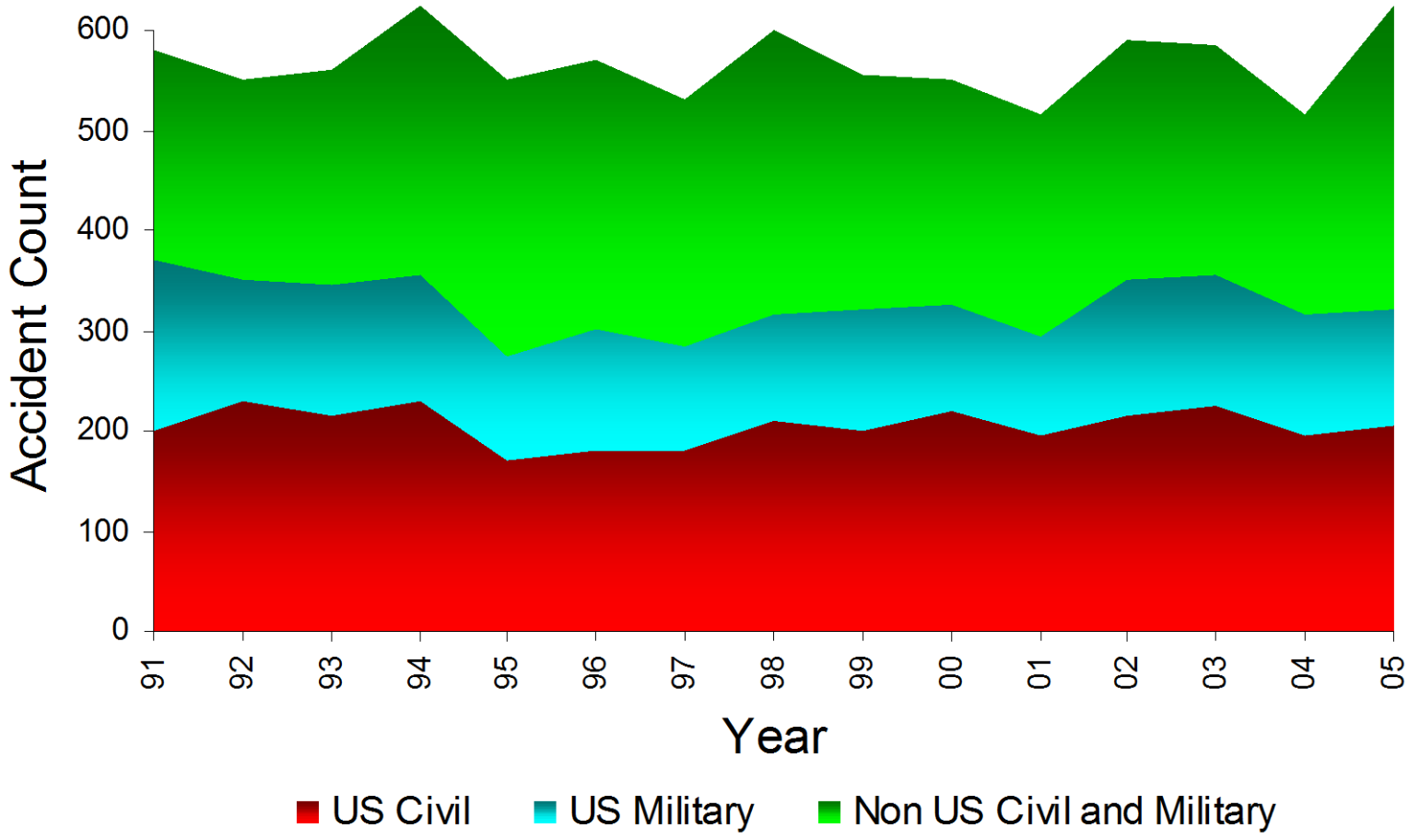
Helicopter Crash Statistics



Statictics taken from the International Helicopter Safety Team, Year 2000 Report, Published Sep 2007

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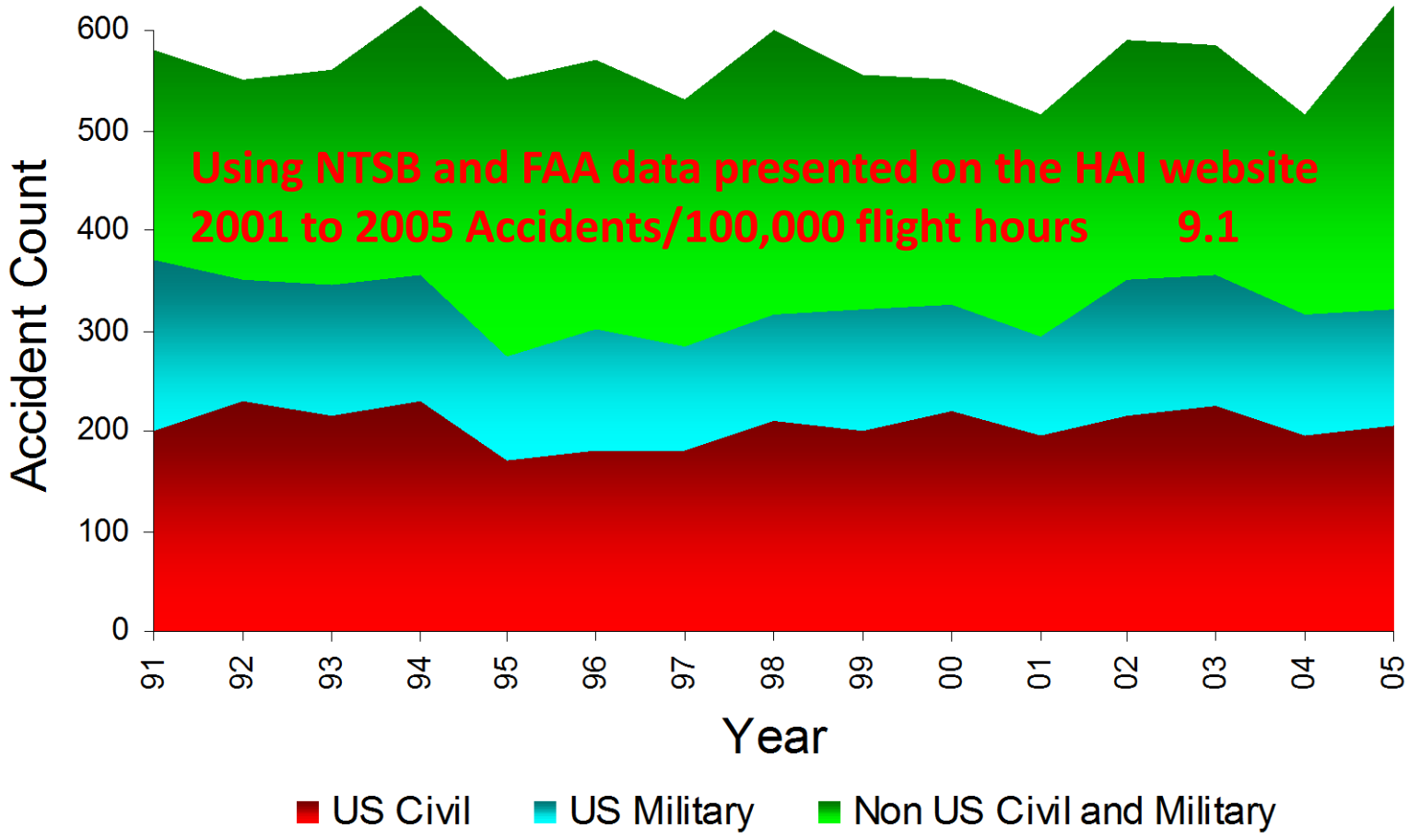
Helicopter Crash Statistics



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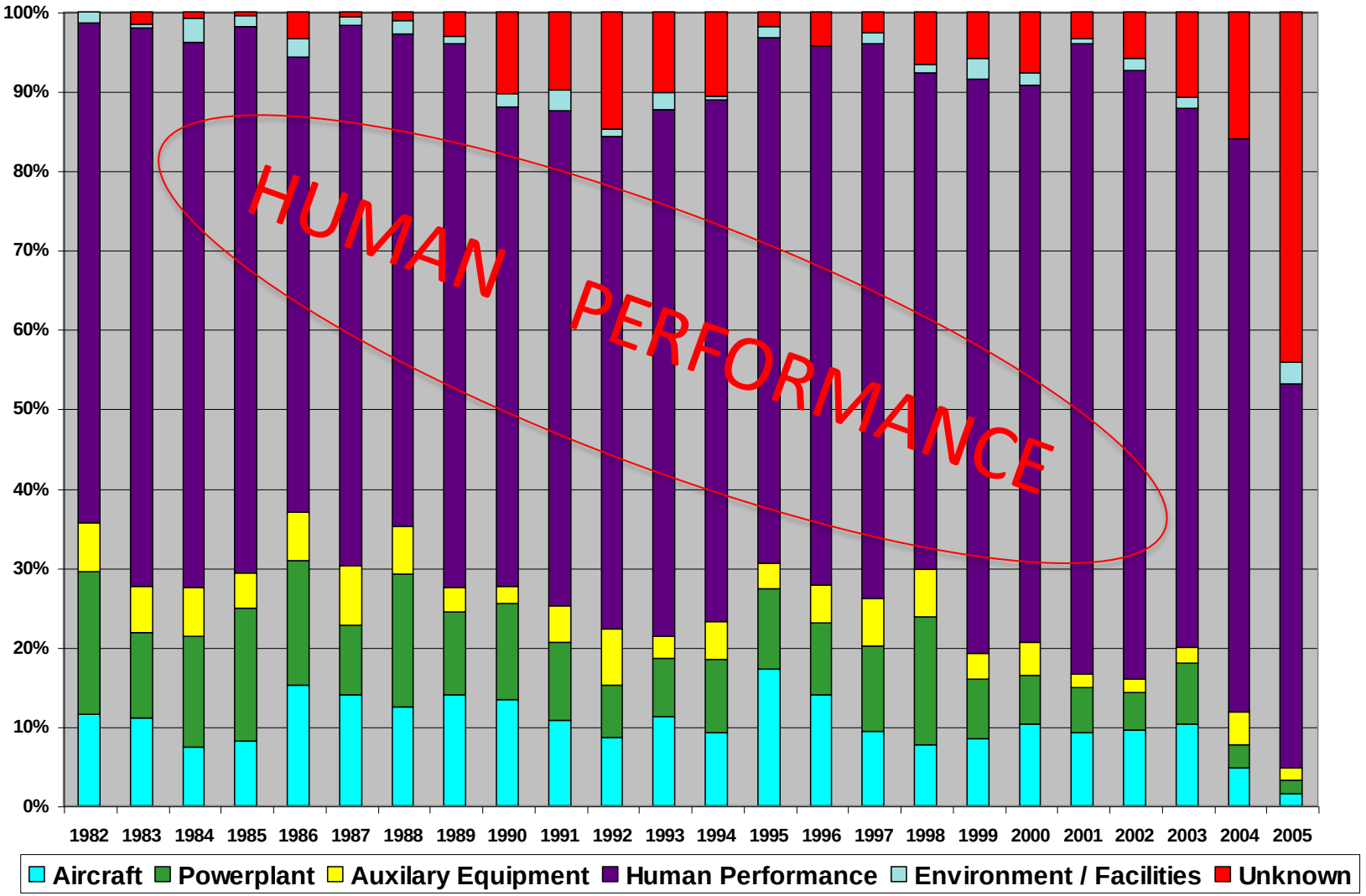
Causal Factors



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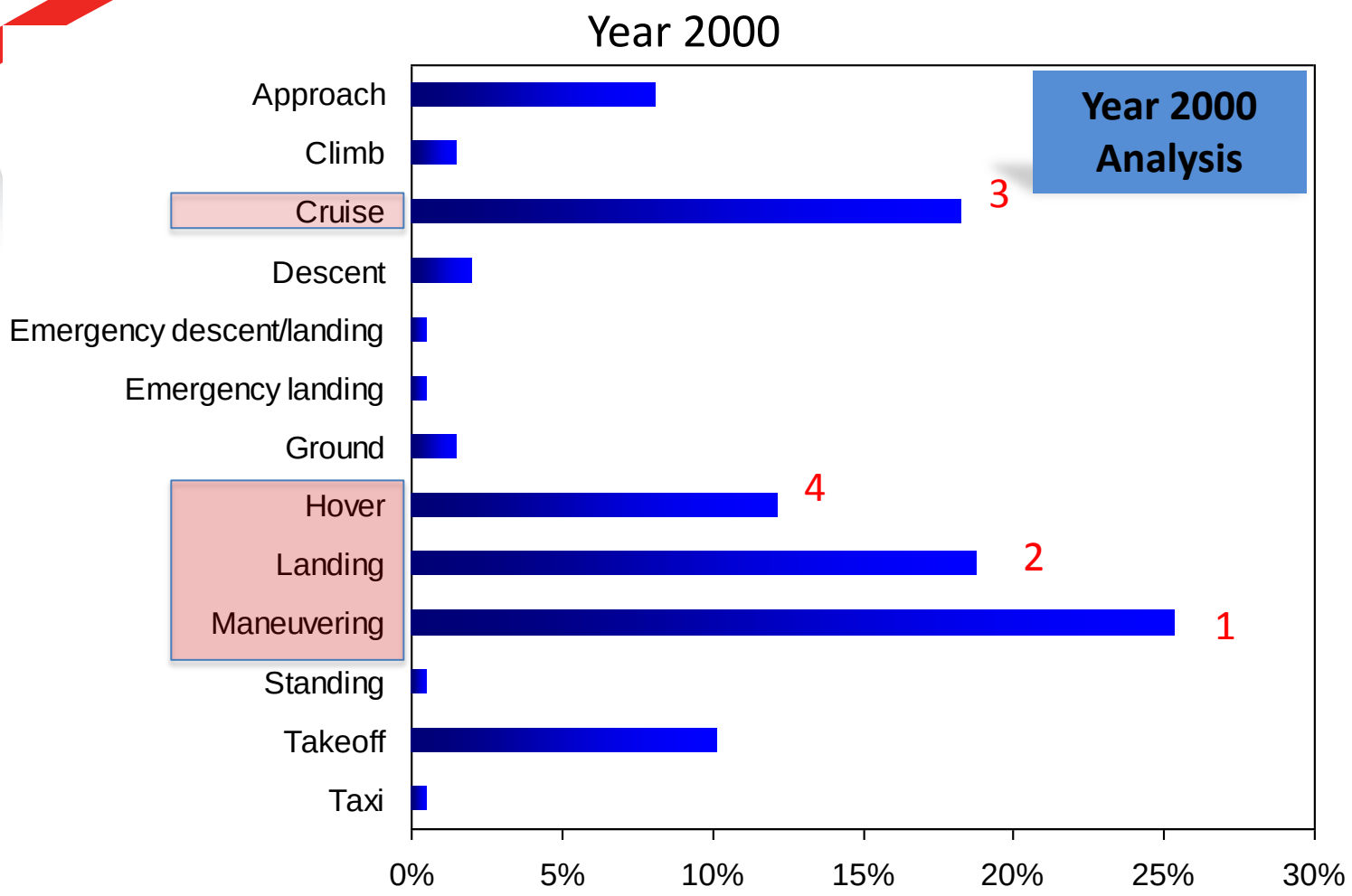
Phase of Flight



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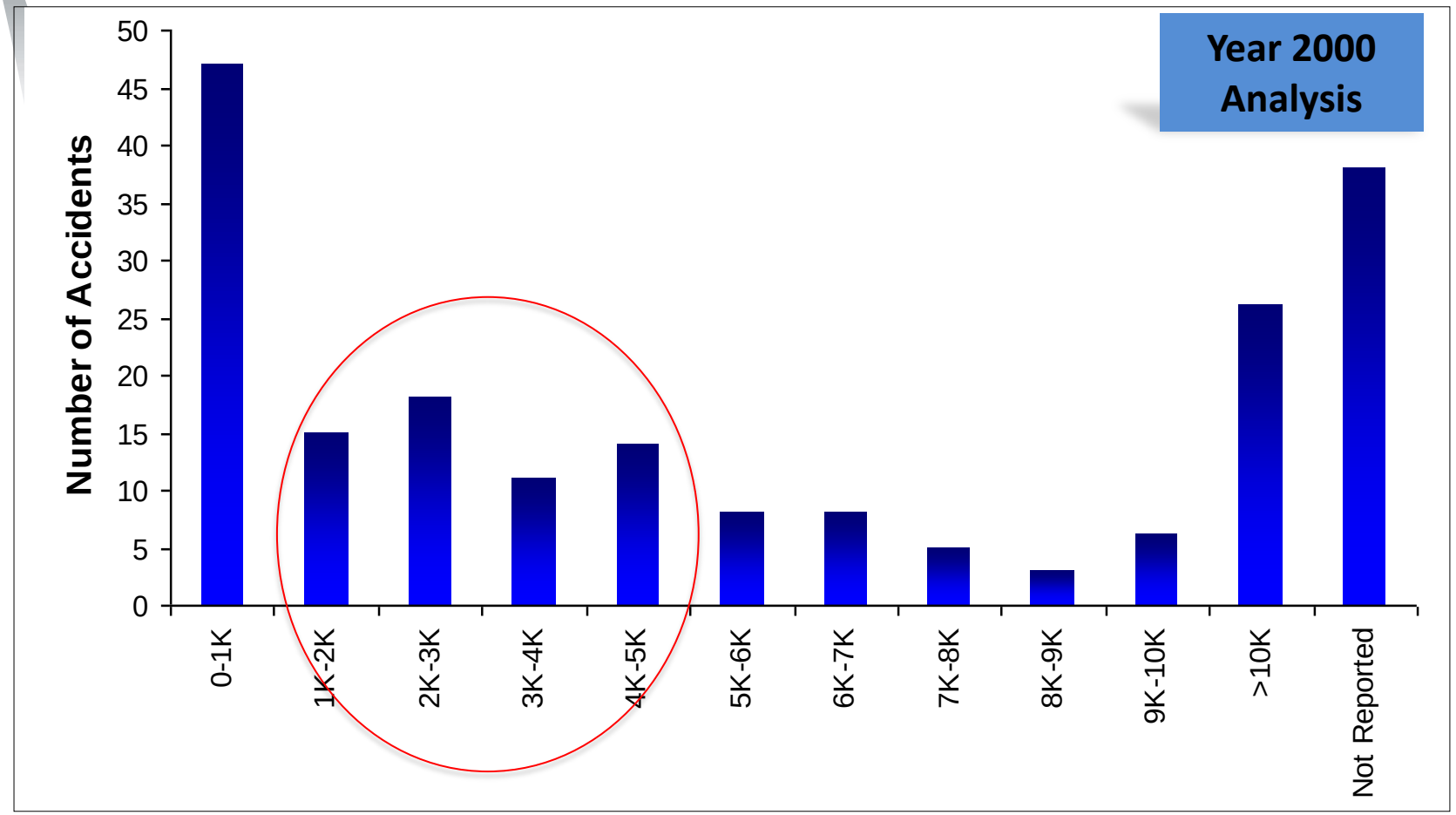
Flight Hours of Mishap PIC

Year 2000



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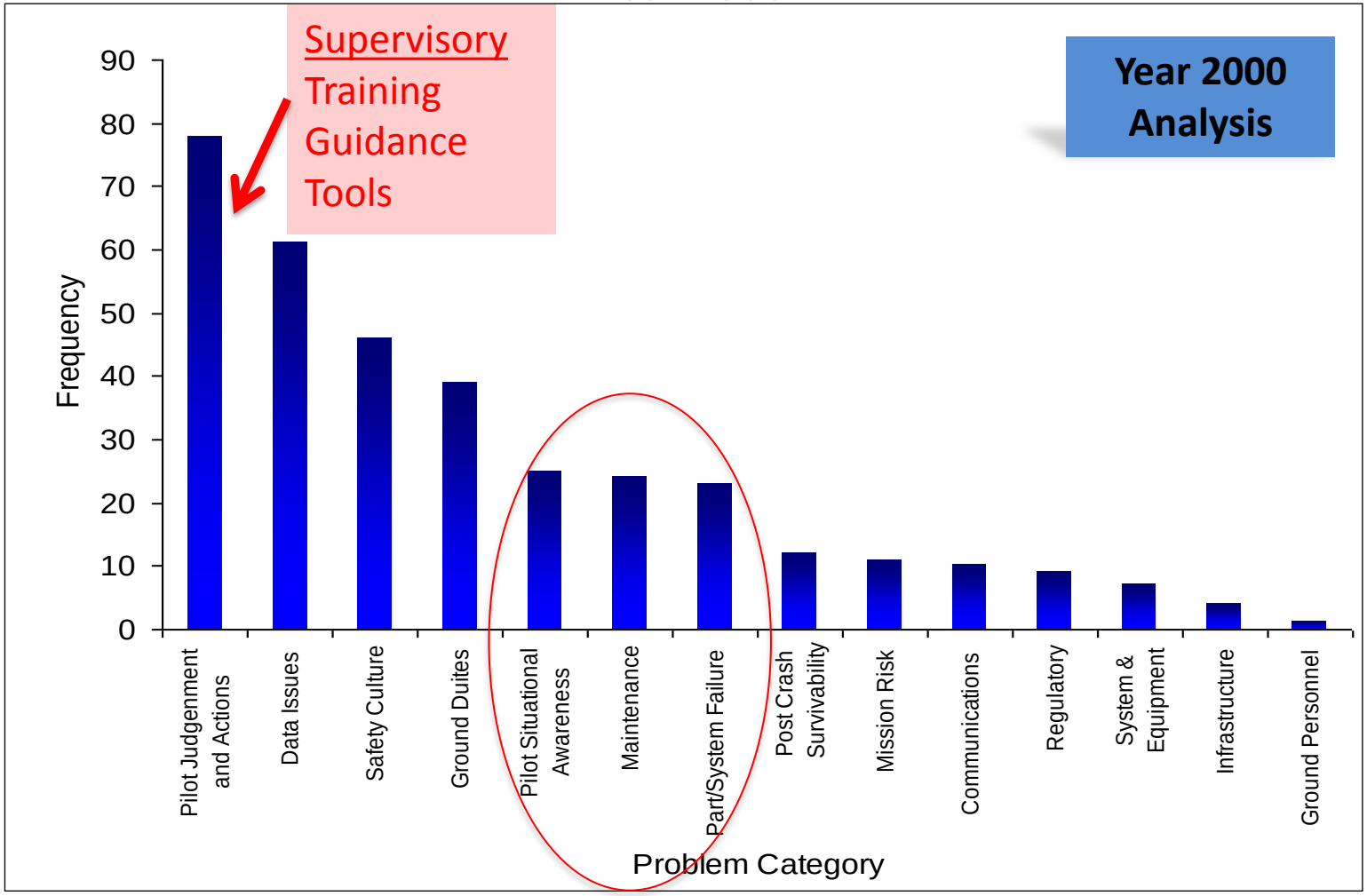
Crash Causal Factors

Year 2000



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2001 to 2005 Accidents/100,000 flight hours

9.1

But this photo is 2013!

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IHST 2000 Report: 15 Helicopter Missions Analysed Technoloy Based Recommendations

Recommendation	Examples of Technology Solution Suggested	#of Missions With This
Improve Investigation	Cockpit Recorder Voice/Data/Video	15 / 15
Prevent Parts and Systems Failures	Health Monitoring HOMP / HUMS	14 / 15
Increase Pilot Situational Awareness External Environment	RADALT, SVS, Dig Map, EVS, NVG, GPWS, AWOS, Radar, Multi Axis Video, Obstacle Detection, Stabilization, Coupled modes	10 / 15
Improve Crash Survivability	Crash Resistant Systems Crash worthy fuel systems, structure, seats	10 / 15
Increase Pilot Situational Awareness of Aircraft State	Caution, Warning on systems, Low Rotor, Roll Over, Low speed, Low Fuel, High ROD, Door Position	7 / 15
Prevent Catastrophic Strike	Wire strike and T/R strike protection	7 / 15
Improve Judgement with better Weather Reporting	Ground Systems	11 / 15
Avoid Inadvertent IMC	IIMC Avoidance Training and IIMC Emergency Training	9/15

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CHANGE IS HAPPENING

- Authorities: Regulation
  - JAROPS 2004 (Now EASA CAT)
    - Environment Based Requirements
  - FAA 2012
    - Emergency Medical Services Requirements
- Manufactures: Technology Push ($Investment$)
- Operators: Change Market Paradigms ($Operator buy-in to Value$)

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AW139

First Certified in Europe 2003
Modified Honeywell Epic Flight Deck

Best Selling Medium Class Helicopter in World

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Manufactures: Technology Push

Operators: Change Market Paradigms

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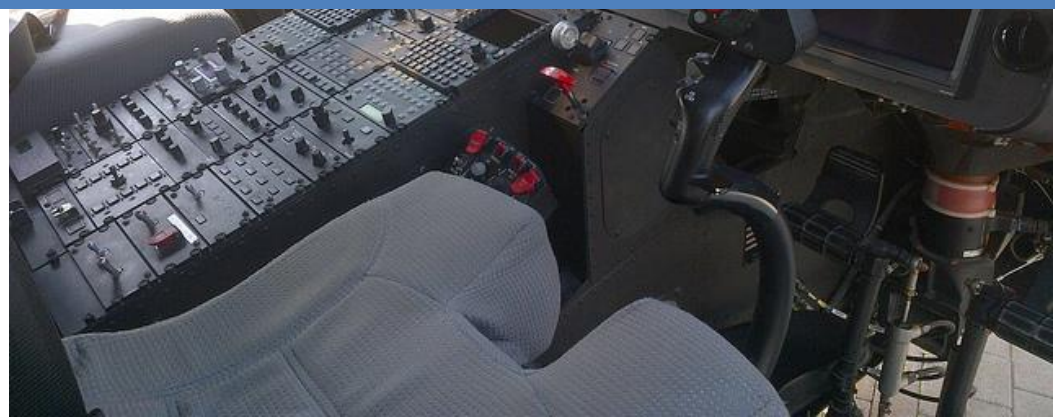

REGULATION

COMPETITION

DEMAND

Technology Race!

VALUE!

2003-2013 SAFETY!

RELIABILTY!

SAFETY!

CAPABILITY!

PERFORMANCE!

COST!

Workload

SA

HMI

SVS

IFR

AIRCRAFT STATE

DIG MAP

EVS

ATTD MODES

TCASII

CPLD MODES

CPLD VFR APPR

OEI

LPV

HUMS

CPLD

TAWS

OBSTACLE DETECTION

NVG

RADAR

AWOS

FLIR

Video

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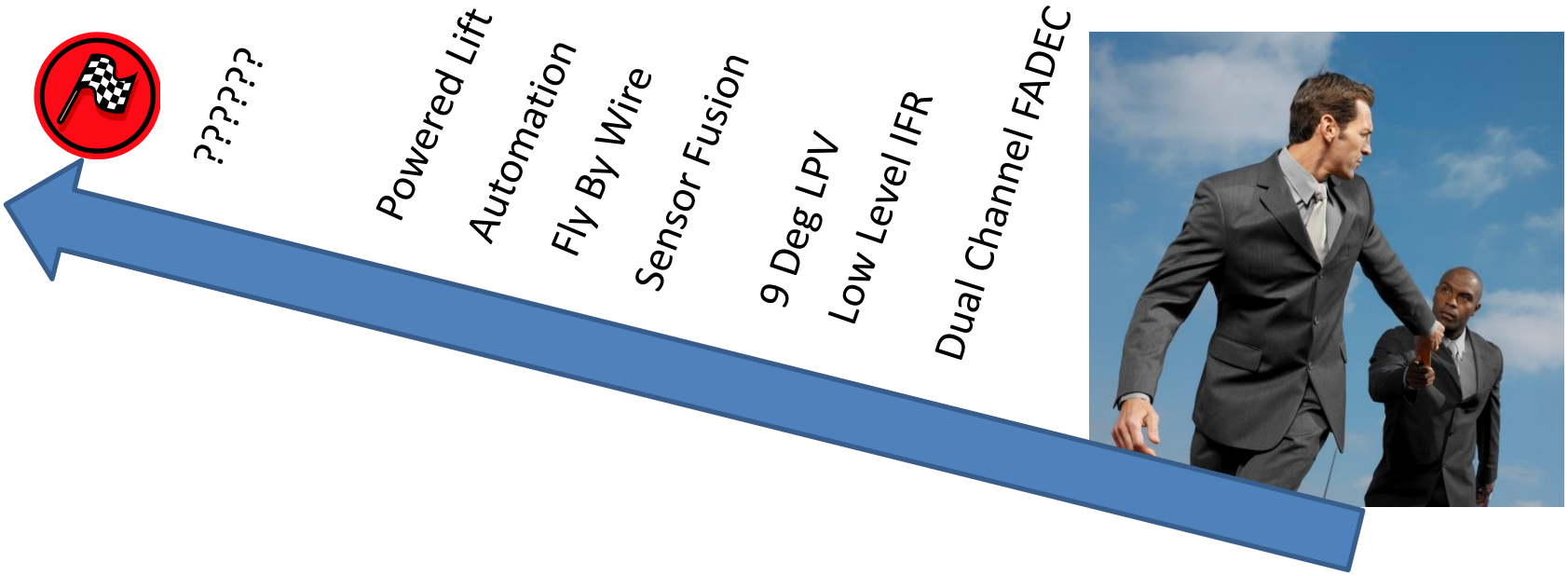
The Race Continues

Future Rotorcraft Technology



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The Market Yesterday

IFR, SVS, EVS, TAWS, DIG MAP, TCAS, ADSB CPLD VMC APPR, VIDEO, FLIR, LPV 9 Deg, Increased Aircraft State Indications, human error prevention

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The Market Today

Integrated and Automated.
-No ECLs or Manual modes
-Centralized Systems Interface
-Cursor Interface
-Hands on Controls Interface
-Automated Systems Pages

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The Market Tomorrow

-Touch Screens
-Icon driven menus
-Advanced AC State graphics

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Future Rotorcraft

-Touch Screen MFD and PFD
-Automated Flaps
-Automated RPM Control
-Automated Nacelle
-Dark Cockpit
-Tactile Cueing

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Future Rotorcraft

Our Hope for the future
-Human Friendly Flight Cues
-Intuitive SA of External World
-Very Low Work Load Cockpit
-Human Error Tolerant
-Human Error Prevention
-Easy Emergency Procedures

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So What Does This Mean for Testers?

- Testing is always challenging
- Testing new technology even more challenging
- But What is New or Changing?
  - Fly By Wire? Not new.
  - Software? Well standardized.
  - Structure, Systems, Propulsion? Nothing new.
  - Flight Displays? Yes, they continue to evolve.
  - Highly integrated complex systems co-managed by computer and human? YES! This worries me!

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Highly Integrated Complex Systems Co-Managed by Computer and Human

- How Do We Test This?
  - What are the test tools?
  - What is the standard?
  - How do we cover all the possible interactions?
  - Can we avoid/reduce human startle factor?
  - Can we stop humans from creative interactions?
  - What are the lessons already learned?
- I am here to learn!
- I do have some opinions to offer.

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Two Personal Examples

- Lose of Engine Control
  - Sticky fuel metering spool
  - Computer monitoring design error
  - Computer error, human did not understand
- Lose of Control In Flight
  - Air data failure
  - Unexpected Pilot Intervention
  - Human error ,computer did not understand
- Both in a Controlled Test Environment
- Good Test Data
- Not Part of a Planned Test Point

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Some Testing Suggestions

- Design Concepts
  - Computer Responsibility vs. Human Responsibility
  - HMI or CRM?
- Early Involvement in Design
  - HMI Meetings with all contributors
  - Testers, Controls, Avionics, Contractors…….
  - My Example; Weekly Meetings, Focused Discussion
- Laboratory, Ground and/or Air
  - The more realistic the better
  - Extensive play time in laboratory
  - My Example; Vehicle Man Systems Interface Lab

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What About Flight Test?

- Full up Testing of Computer-Human interactions?
- Computer response to failure modes and human reaction?
- Hard To Do in a comprehensive manner!

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Questions!

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2006 Report

- World Accident rate 6.5
- US Accident Rate 5.6

SPS Group (Level 1)	Count of Usage	Count of Accidents	% of Accidents
Pilot Judgment & Actions	299	140	92.1%
Data issues	*176*	*122*	*80.3%*
Safety Management	81	56	36.8%
Pilot Situation Awareness	67	50	32.9%
Ground Duties	58	50	32.9%
System Component Failure	51	46	30.3%
Mission Risk	32	28	18.4%
Maintenance	44	25	16.4%
Post-crash survival	27	20	13.2%
Regulatory	14	12	7.9%
Communications	11	11	7.2%
Safety Systems and Equipment	9	9	5.9%
Infrastructure	7	7	4.6%
Personnel - Non Crew	4	4	2.6%

Table 8. Level 1 Standard Problem Statements by Accident

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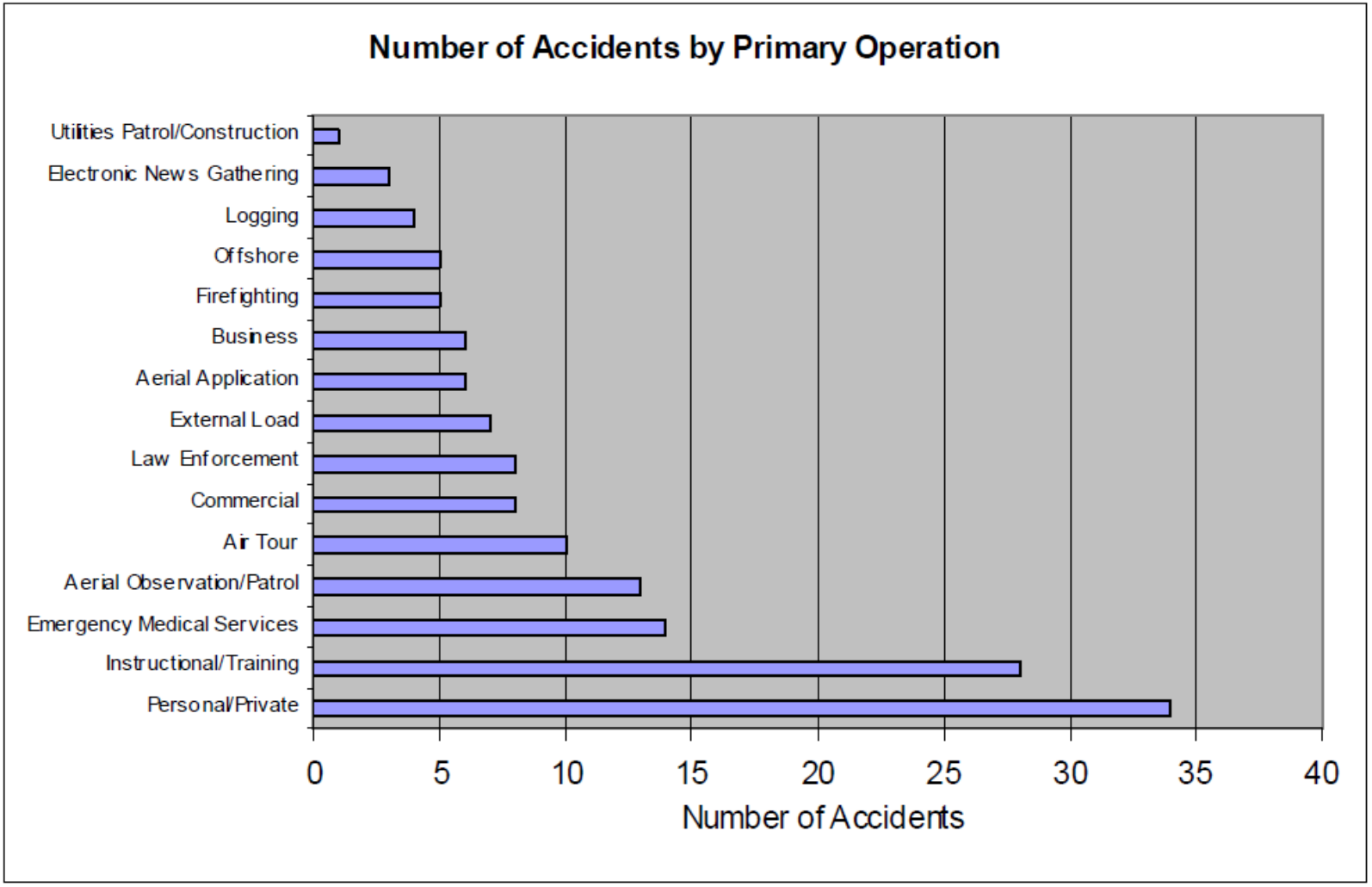
2006 Report



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2006 report

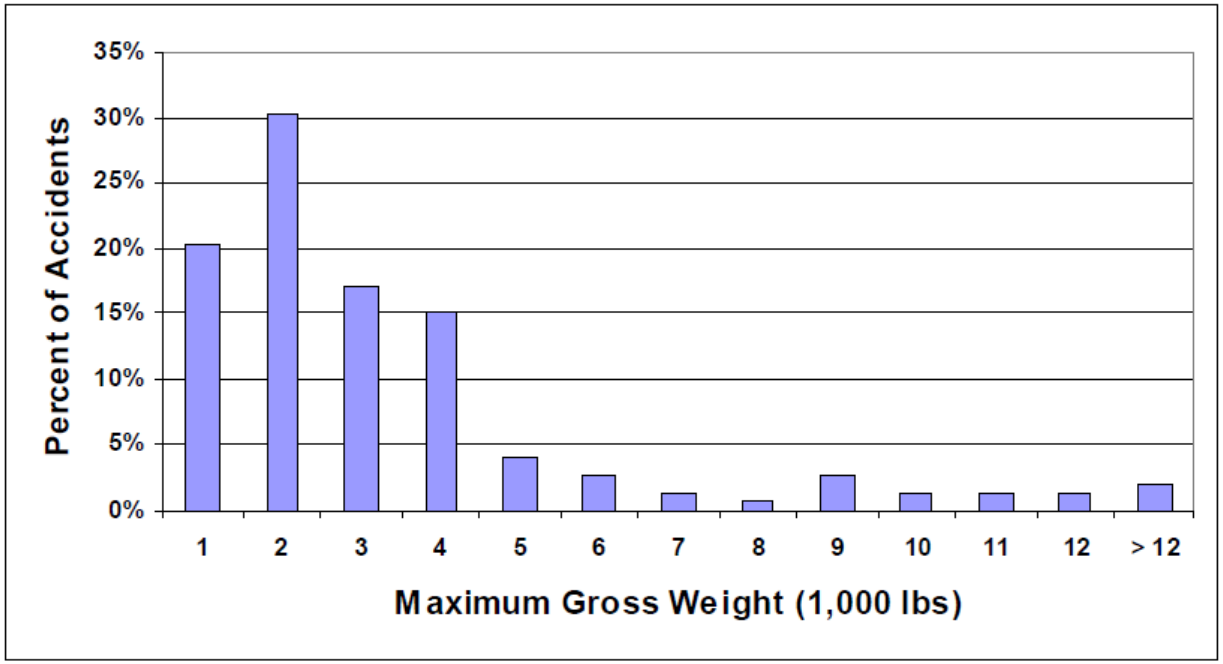

Figure 3. Accidents and Fleet Weight Group Distributions

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For CY2006, the accident analysis continued to reveal that the dominance of accidents include Pilot Judgment & Actions Standard Problem Statements (SPS). This is similar to conclusions of previous years. The absence of adequate preparation or planning by a pilot is often the initiating event in the accident sequence. Improving pilot judgment and the ability to safely handle problems is the most effective way to improve helicopter safety. The pilot is in the best position to change the outcome of a sequence of events; therefore, most interventions must affect pilot performance in a positive way. A specific problem with pilot situational awareness is often connected in accidents to Pilot's Judgment & Action.

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The JHSAT found in its first year of analysis that a major factor contributing to helicopter accidents was the failure to adequately manage known risks. Due to the lack of a systematic process, including leadership and accountability, operators did not adequately prioritize and mitigate the risks that led to accidents. Analysis of the accidents revealed continuing operational safety issues that could be corrected by more effective and systematic management of risk and by better training.

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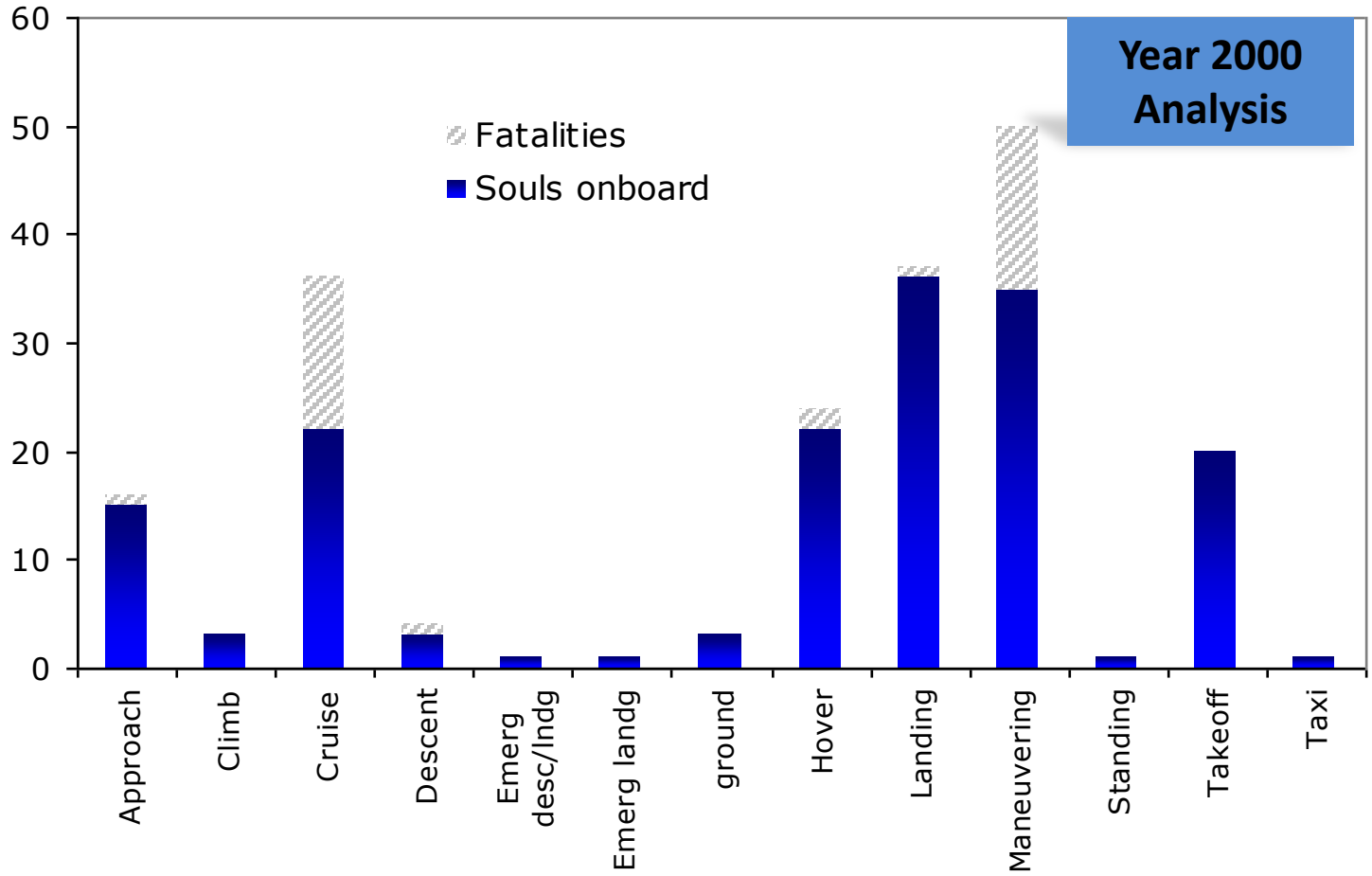
Fatalities
Based on Phase of Flight



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