



DoD Helicopter Mishaps FY85-05: Recommendations

By

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DoD Helicopter Mishaps FY85-05: Findings and Recommendations

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Statement of Accountability

This brief represents the position of the researchers. It does not represent the position of any other organization including the United States Air Force or the Department of Defense.

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Background

- **This study describes all 917 U.S. DoD Class A-B Rotary Wing Mishaps from FY 85 to 05**
- **It studies 957 lost or severely damaged aircraft & over 3,800+ souls exposed to the mishap situations**
- **This data is based on a study of data archived in the mishap files of the Service Safety Centers**



Data Sets

- **USAF Data contains two sets:**
 - **AVSAS Data from FY 1993 through FY 2005**
 - **13 Years, 359 Mishaps, Class A – C**
 - **Safety Reports from FY 1985 Through FY 2005**
 - **21 Years, 88 Mishaps, Class A & B**
- **DON Data: 371 Mishaps, Class A & B, FY 85 – 05, 383 Vehicles**
- **USA Human Factor Mishap Data, Class A & B, FY 85 – 05, 251 Mishaps, 278 Vehicles**
- **USA Non-Human Factor Mishap Data, Class A & B, FY 85 – 05, 207 Mishaps, 207 Vehicles**



Method

- **Obtained & reviewed all available DoD Rotary Wing Aircraft Class A & B Mishap reports from FY 85 to FY 05 inclusive**
- **Created data bases for initial analysis**
- **No monetary value is associated with fatalities**
- **Major injuries resulted in approximately four weeks or more of lost duty time (5 days for DoN data)**
- **Minor injuries resulted in approximately less than four weeks of lost duty time (5 days for DoN data)**



Outline

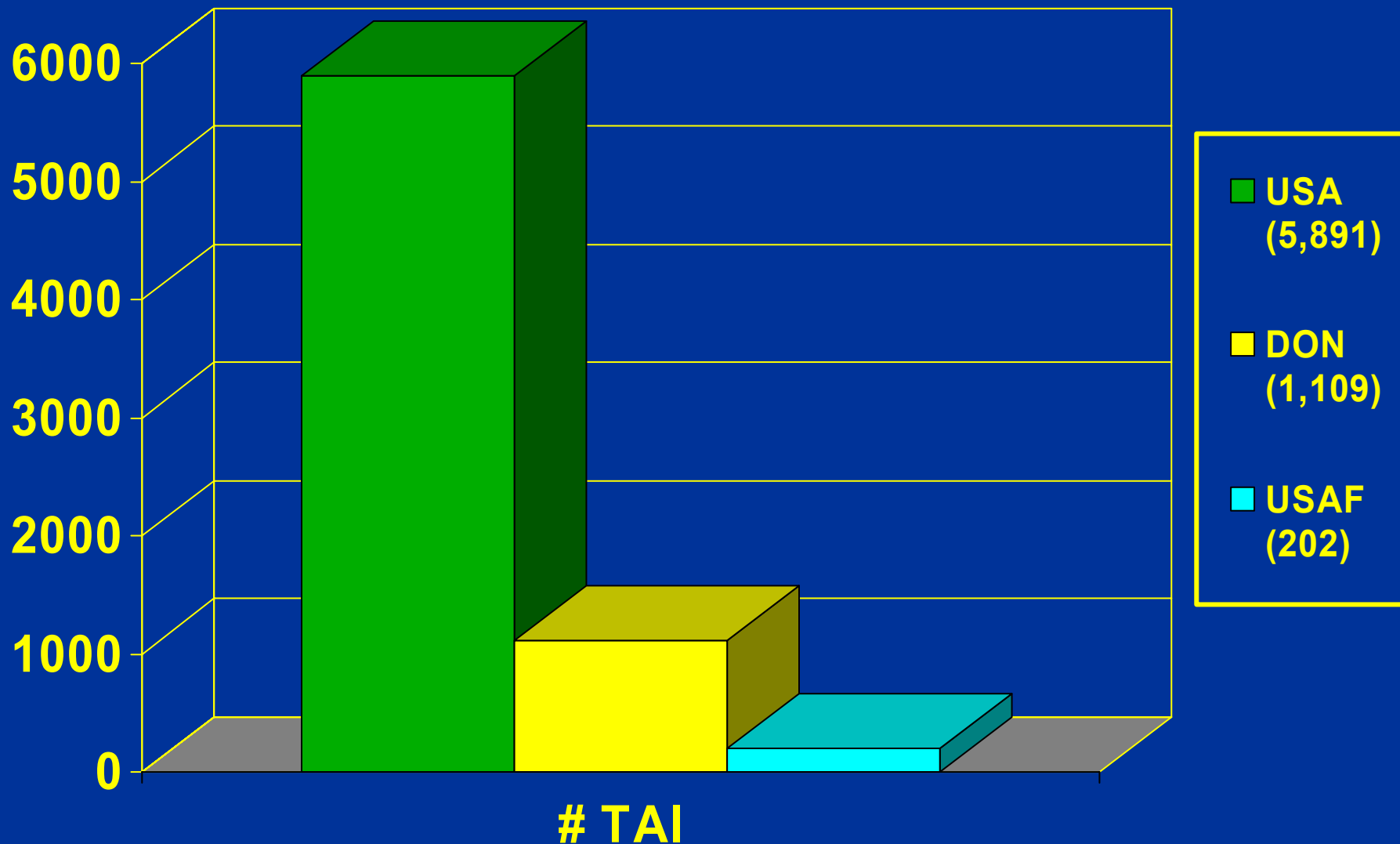
- **Fleet Size, Service Mishap Rates & Utilization**
- **Mishaps by Service, Phase of Flight & Cause**
- **Fatality & Injury Patterns**
 - **DoN Water Fatalities**
- **Whiteout, Brownout, Night, IMC**
- **Experience, Recency, Training & Supervision (USAF Data)**
- **MDS Specific Data**
- **Mishaps & Injuries By Phase Of Flight**
- **Findings**
- **Recommendations**



Fleet Size, Overall Mishap Rates & Utilization

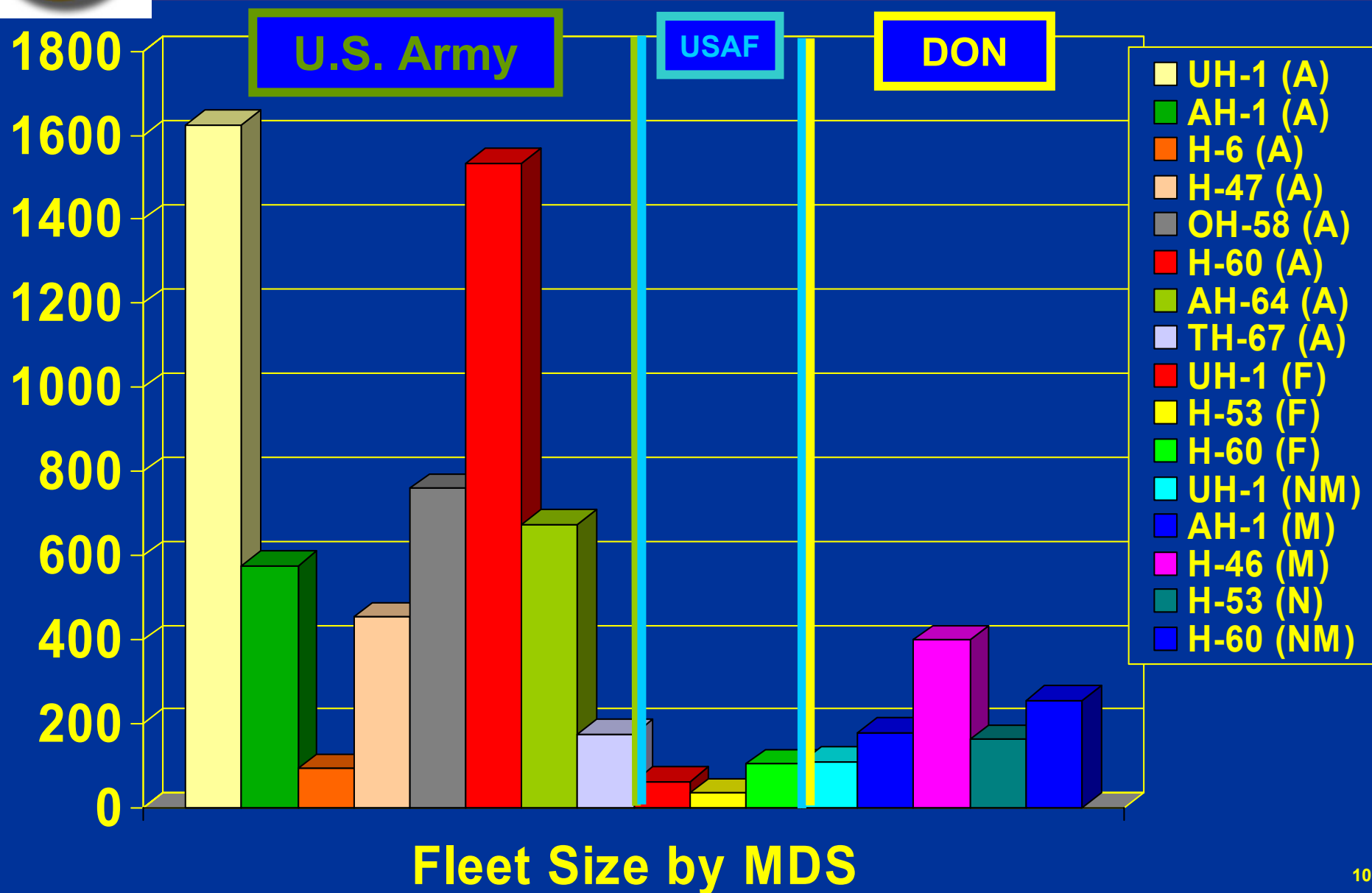


Size of the Active Inventory by Service FY 85 – 05



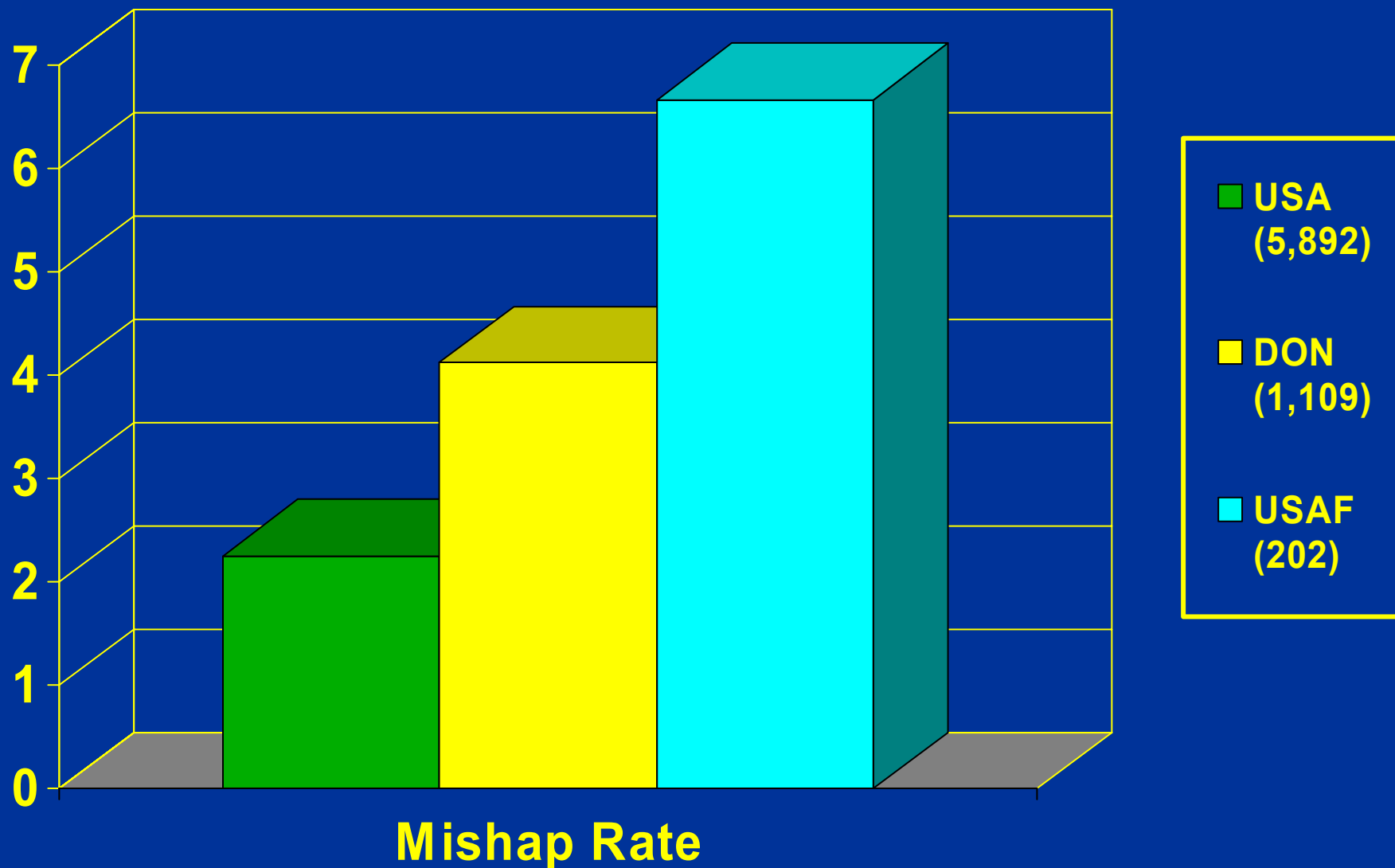


Fleet Size by Aircraft Type



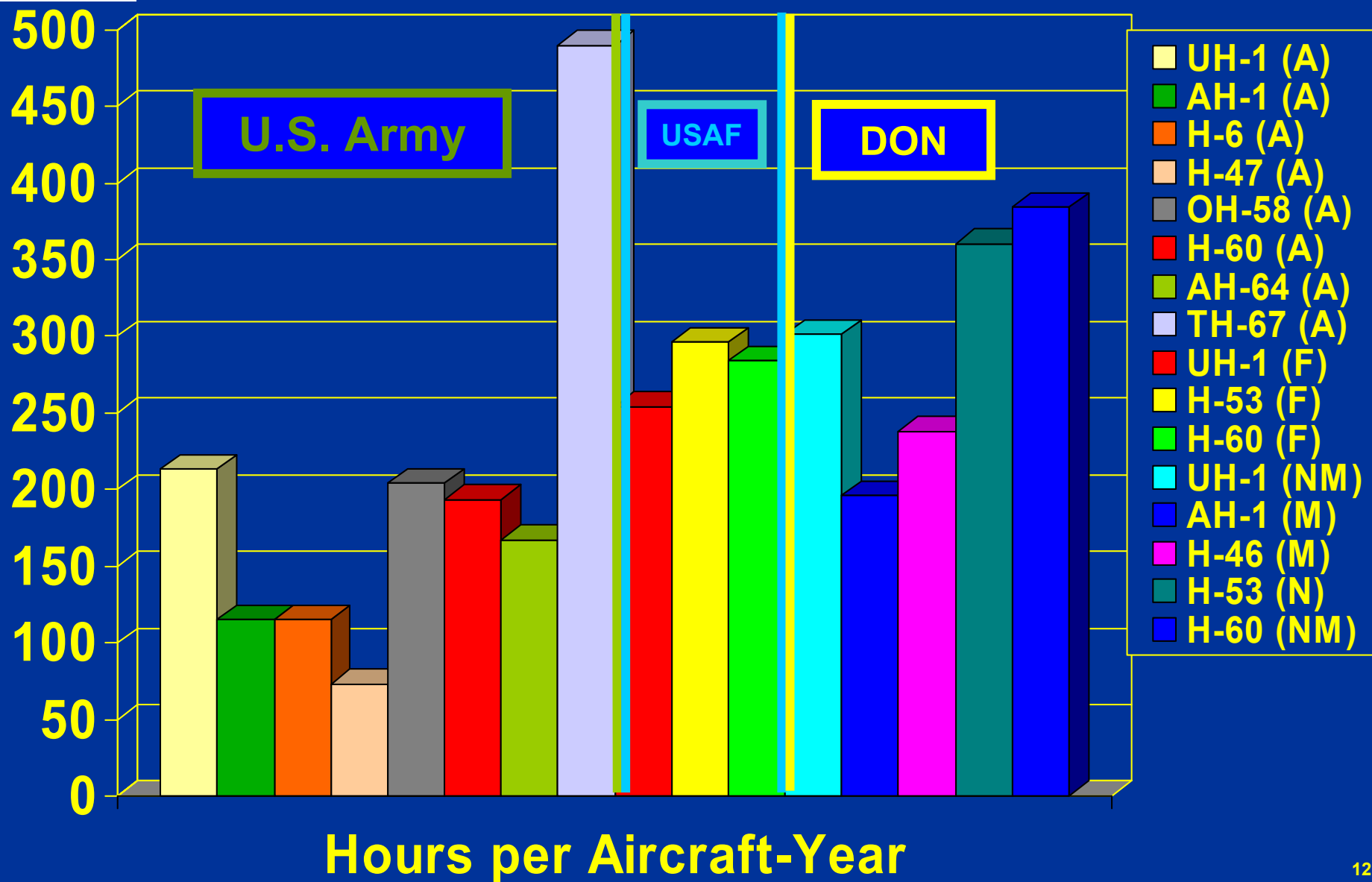


Class A & B Mishap Rate per 100Khrs by Service FY 85 – 05





Hours per Aircraft-Year

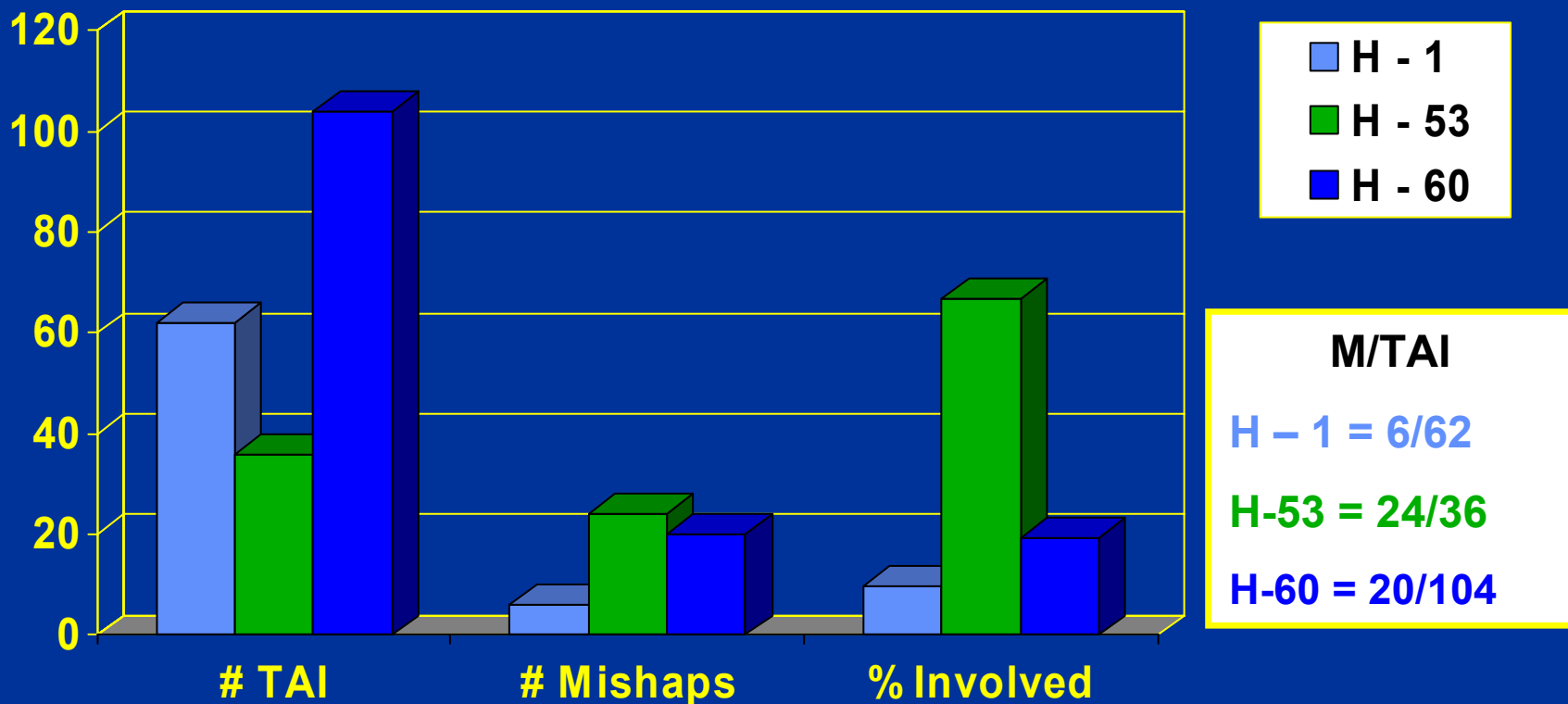




Mishaps by Service, Phase of Flight & Cause

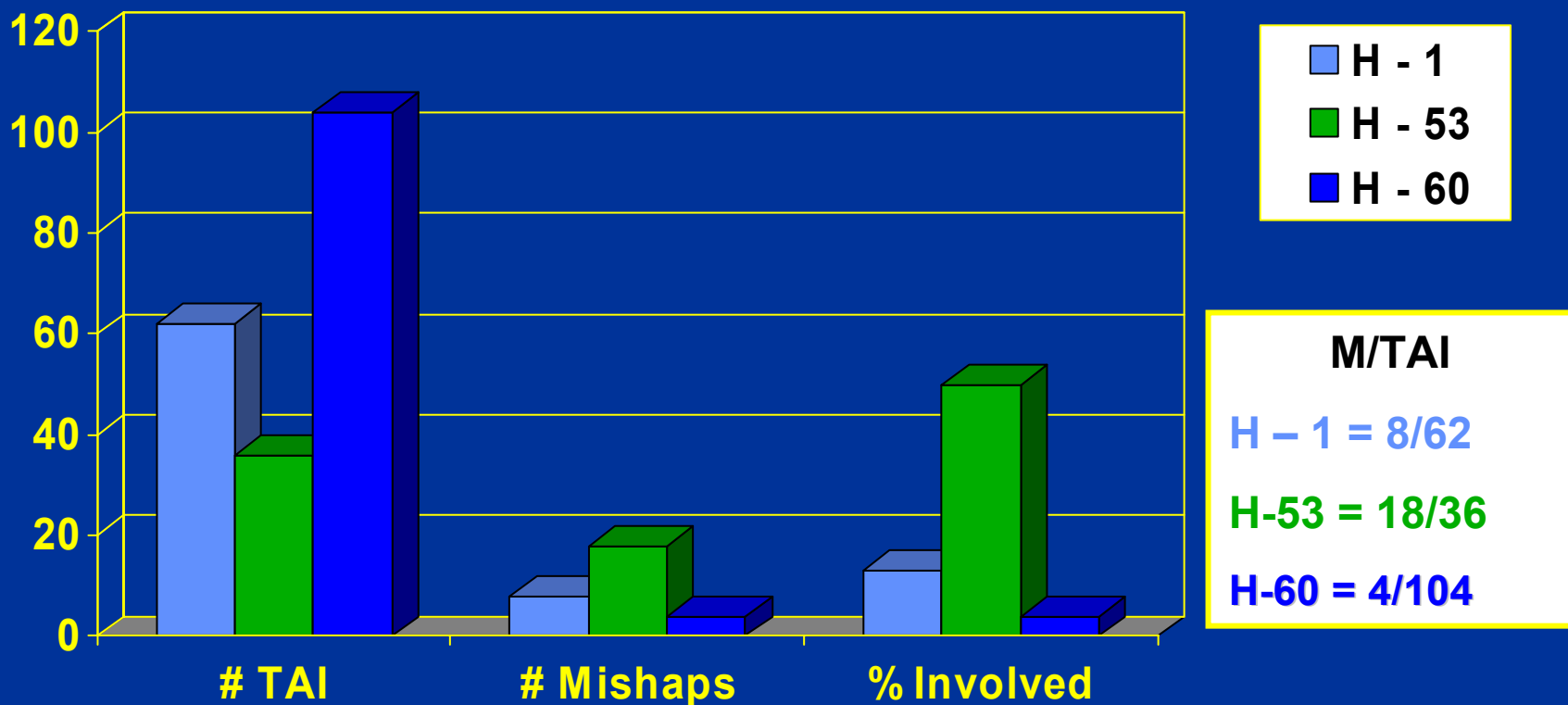


Fraction of Active USAF Inventory, FY 85 – 05, Involved in Class A or B HF Mishaps



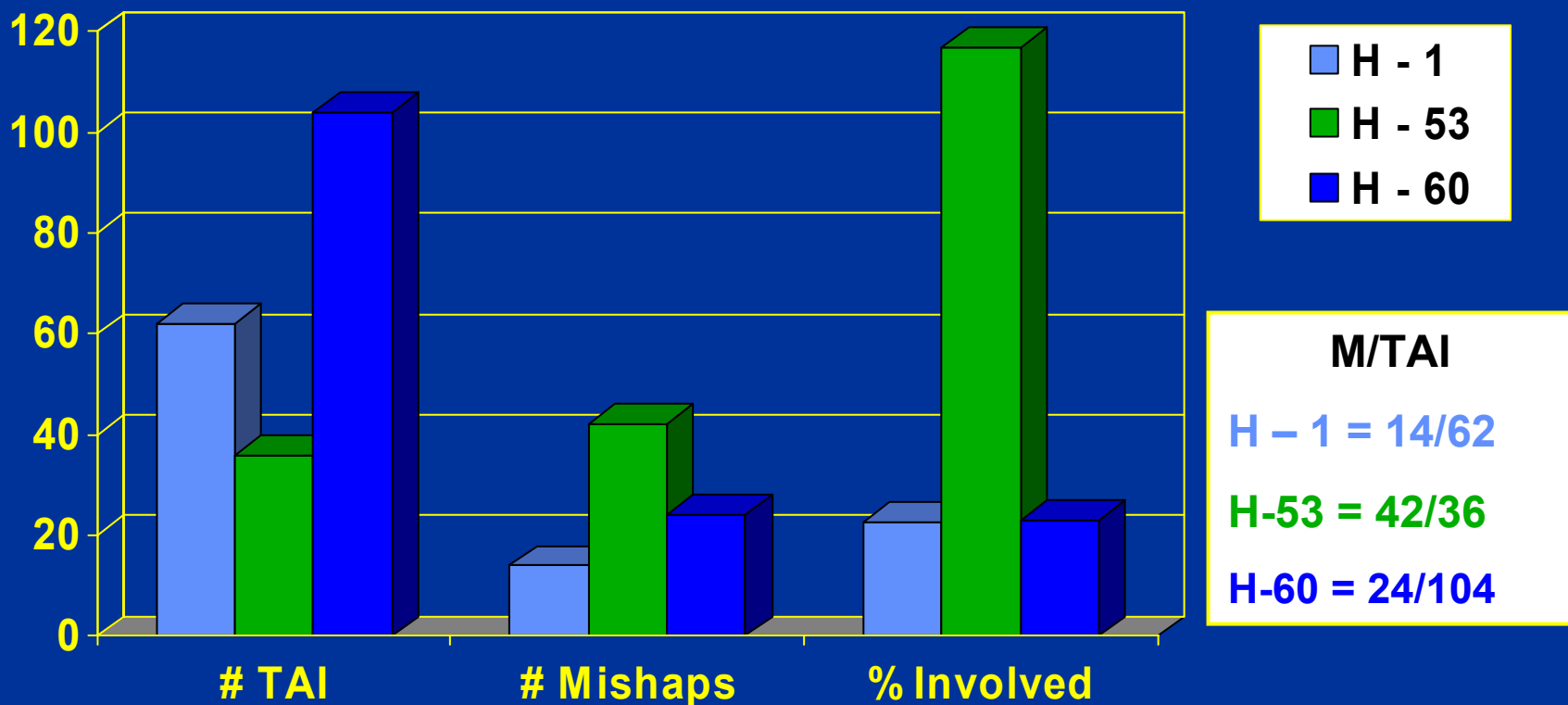


Fraction of Active USAF Inventory, FY 85 – 05, Involved in Class A or B NHF Mishaps



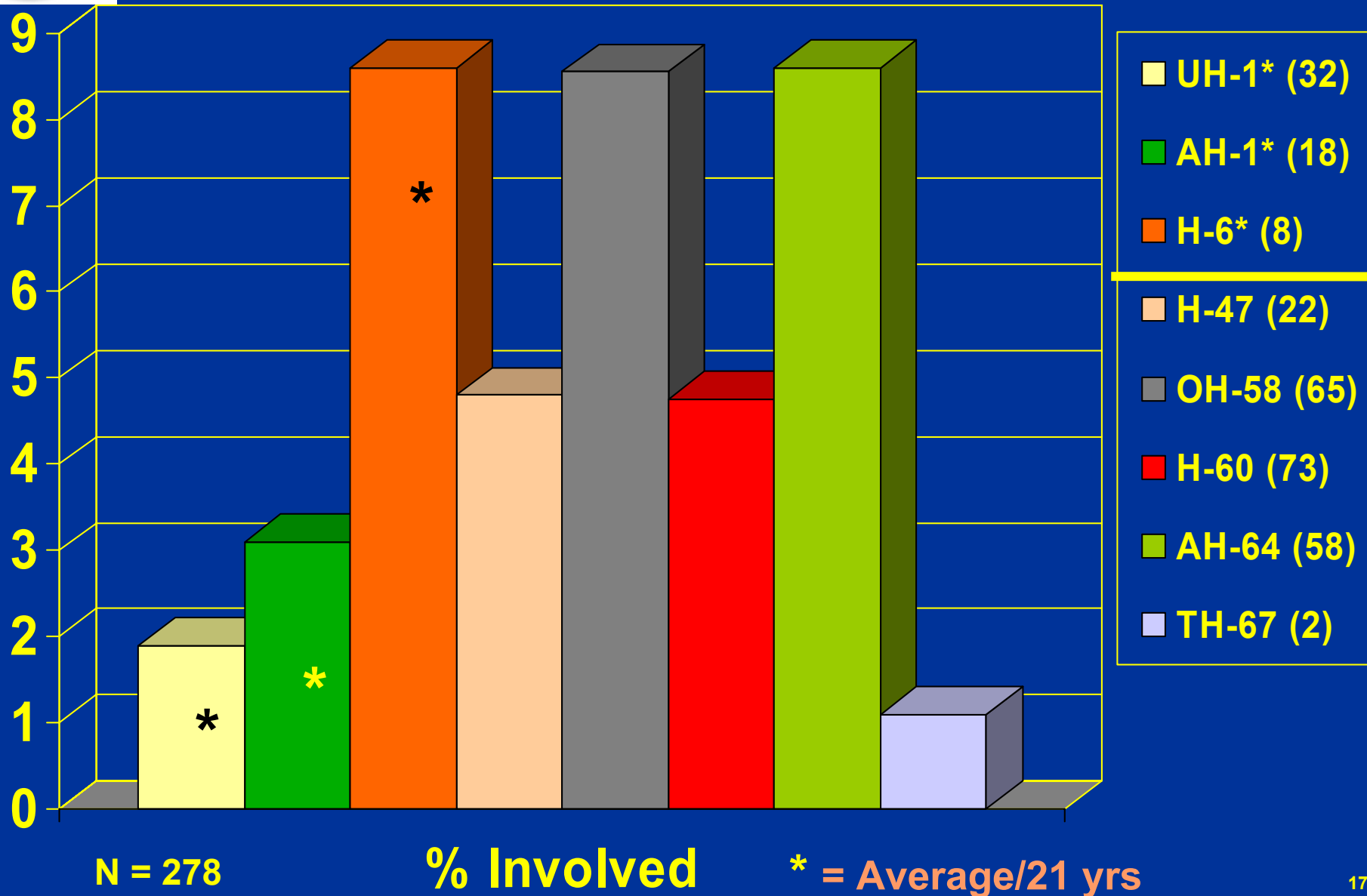


Fraction of Active USAF Inventory, FY 85 – 05, Involved in Class A or B Mishaps



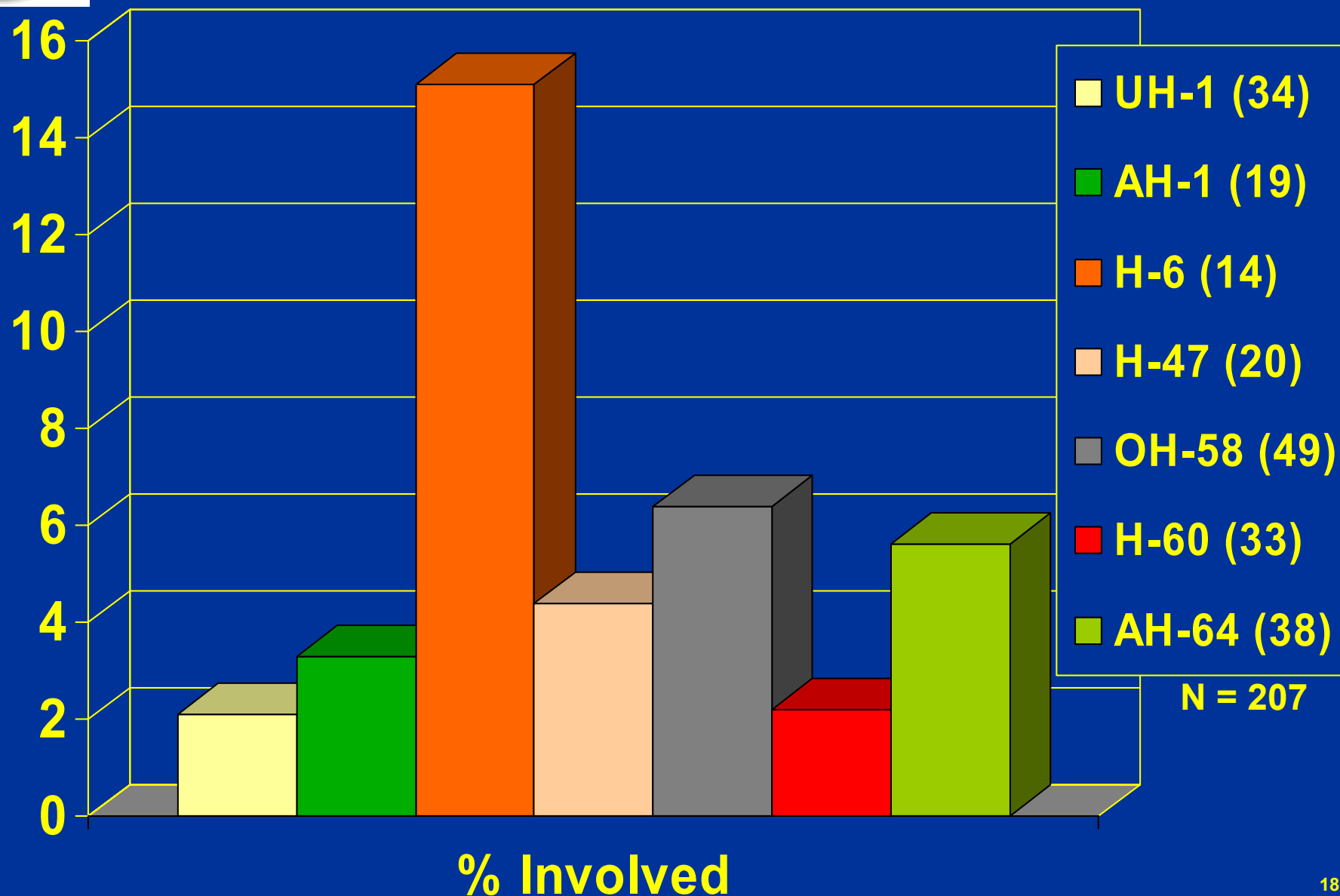


% of USA Inventory, FY 85 – 05, Involved in Class A or B HF Mishaps



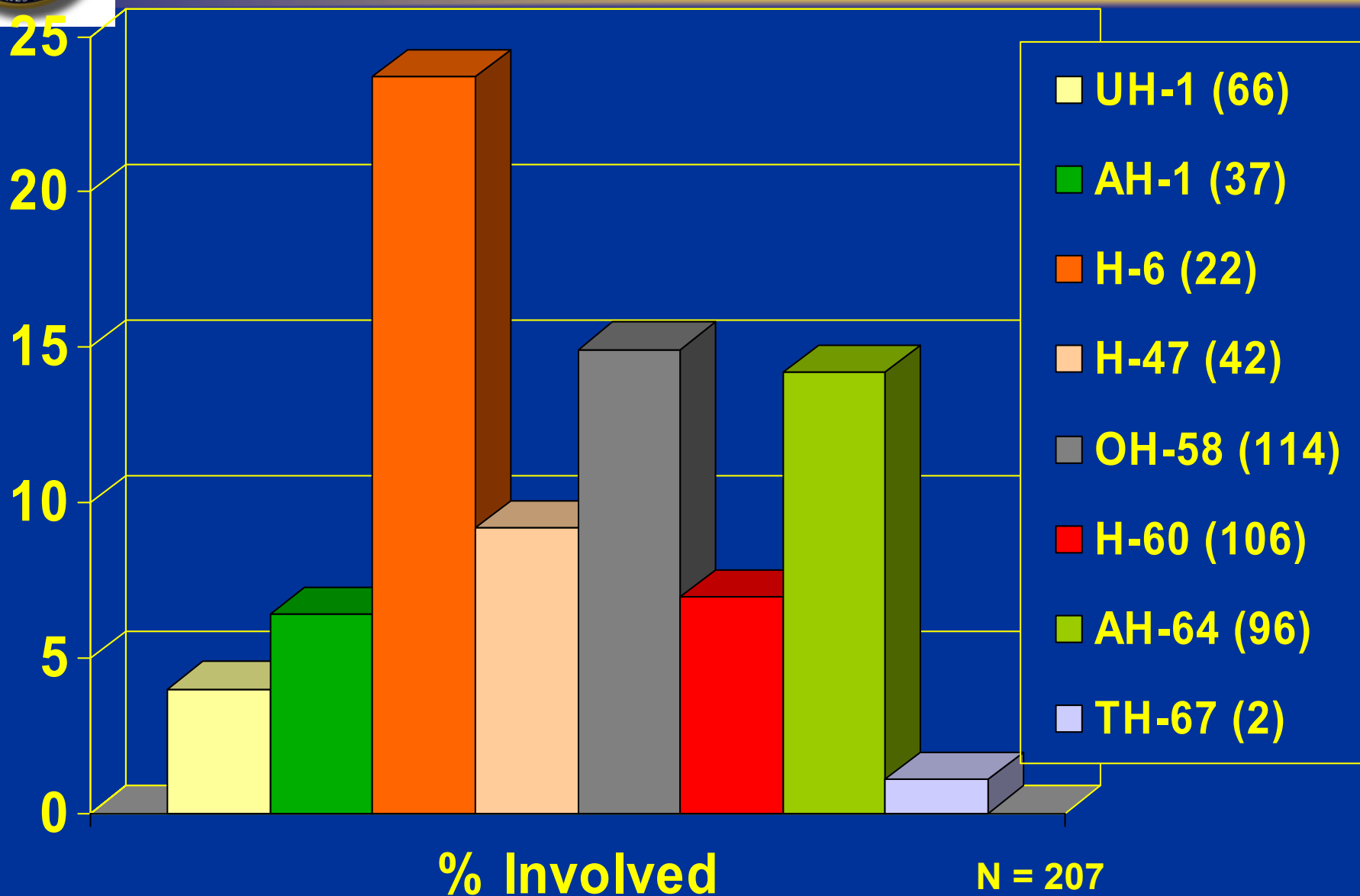


% of USA Inventory, FY 85 – 05, Involved in Class A or B NHF Mishaps



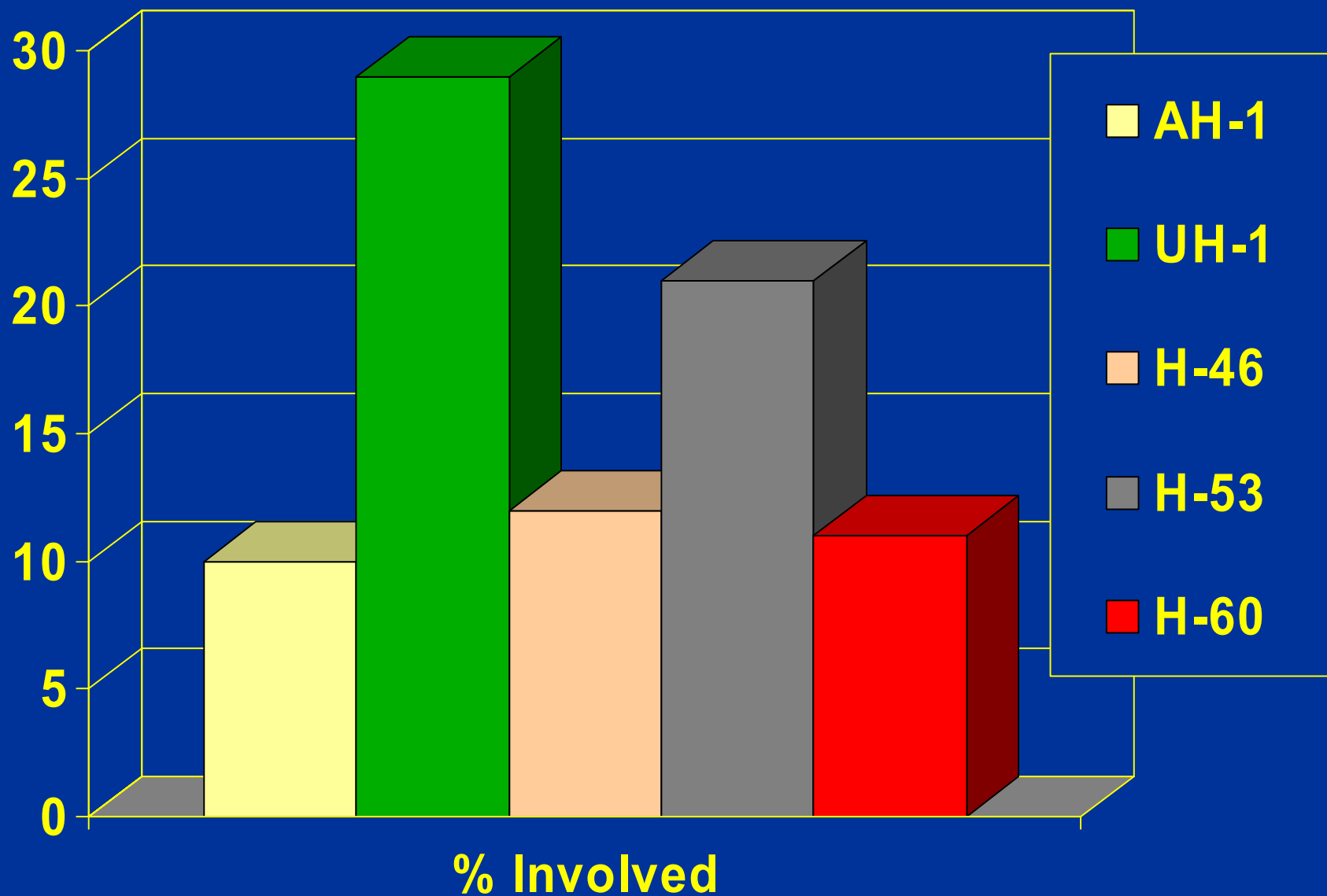


% of USA Inventory, FY 85 – 05, Involved in Class A or B Mishaps



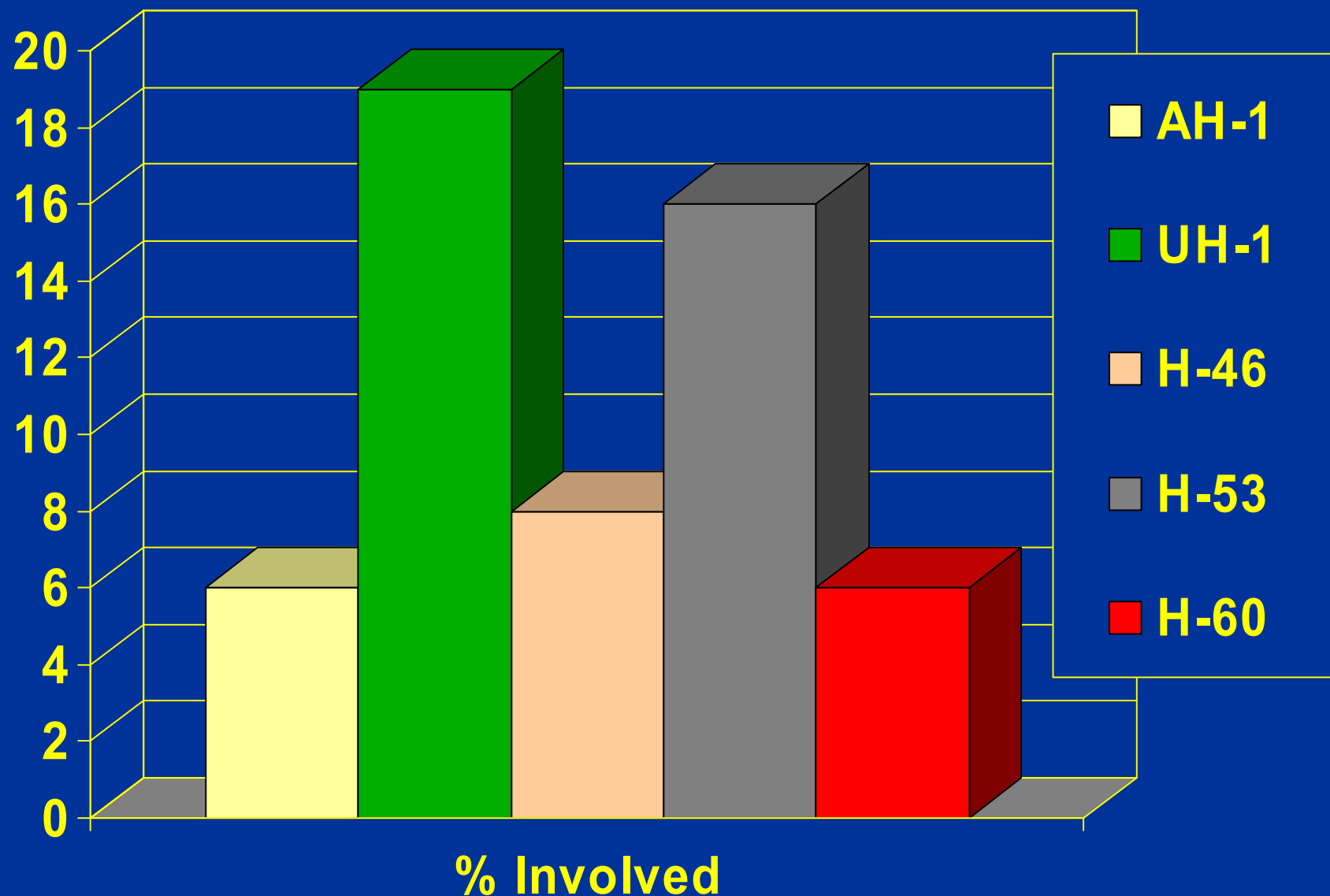


% of DON Inventory, FY 85 – 05, Involved in Class A or B HF Mishaps



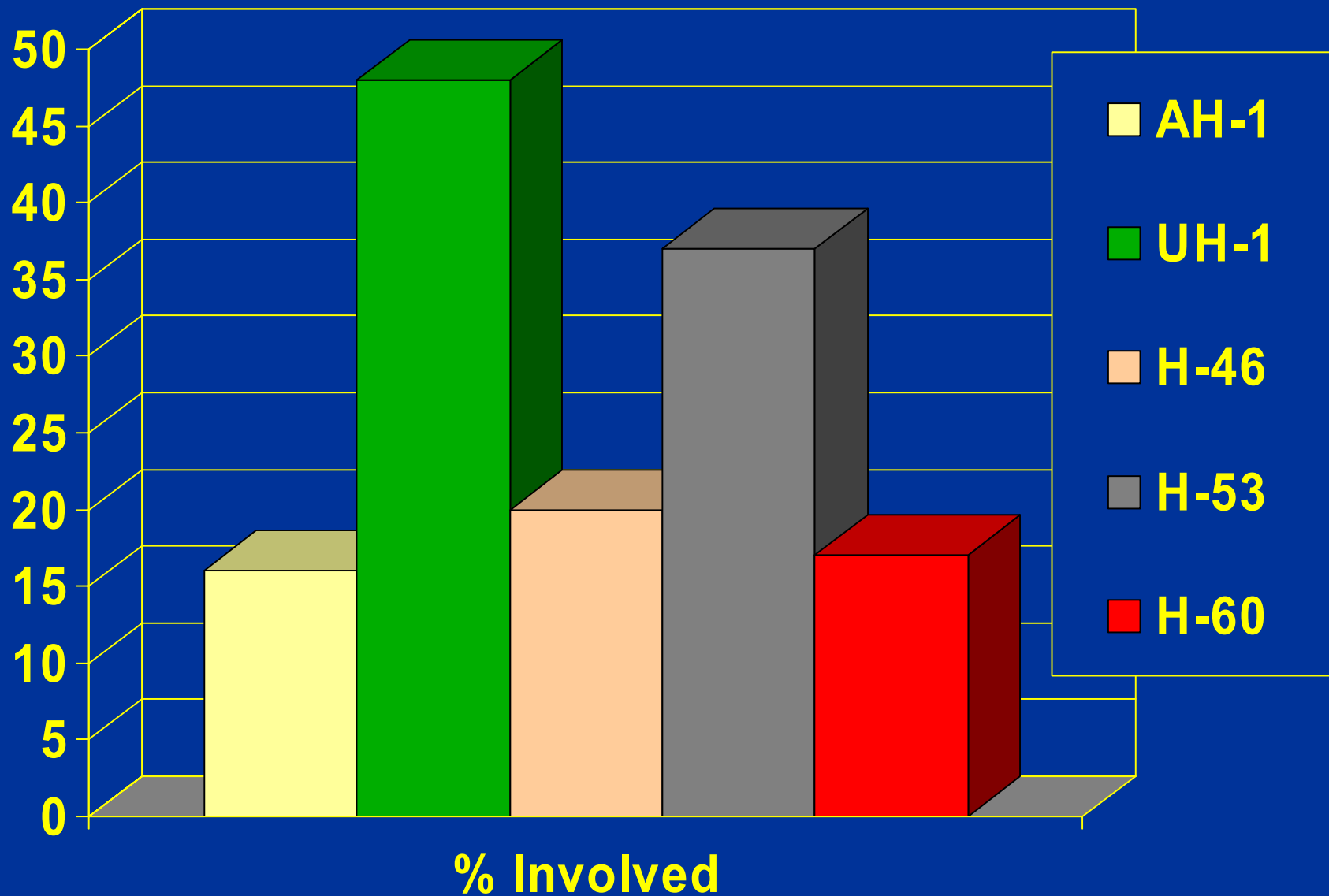


% of DON Inventory, FY 85 – 05, Involved in Class A or B NHF Mishaps



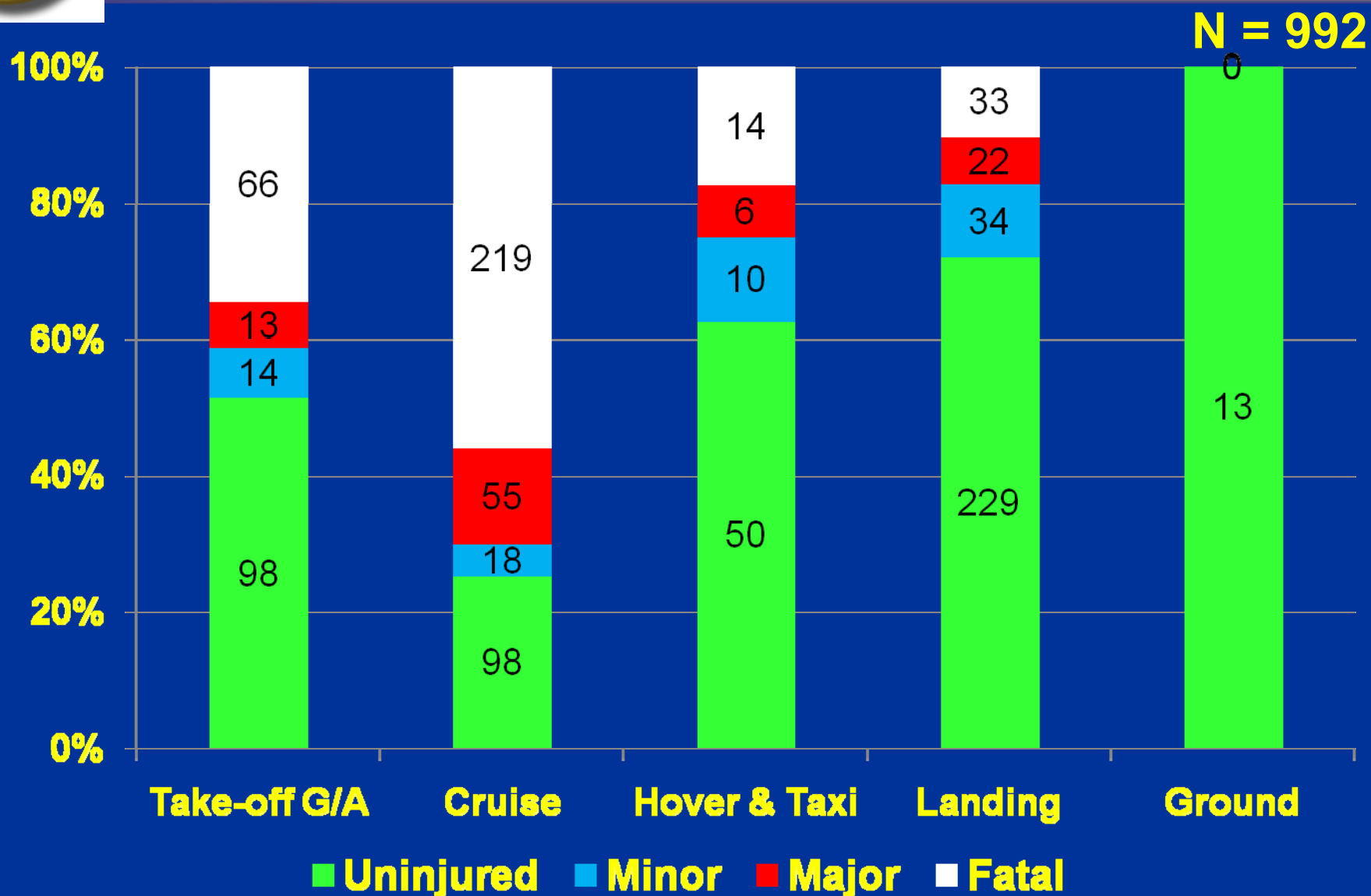


% of DON Inventory, FY 85 – 05, Involved in Class A or B Mishaps



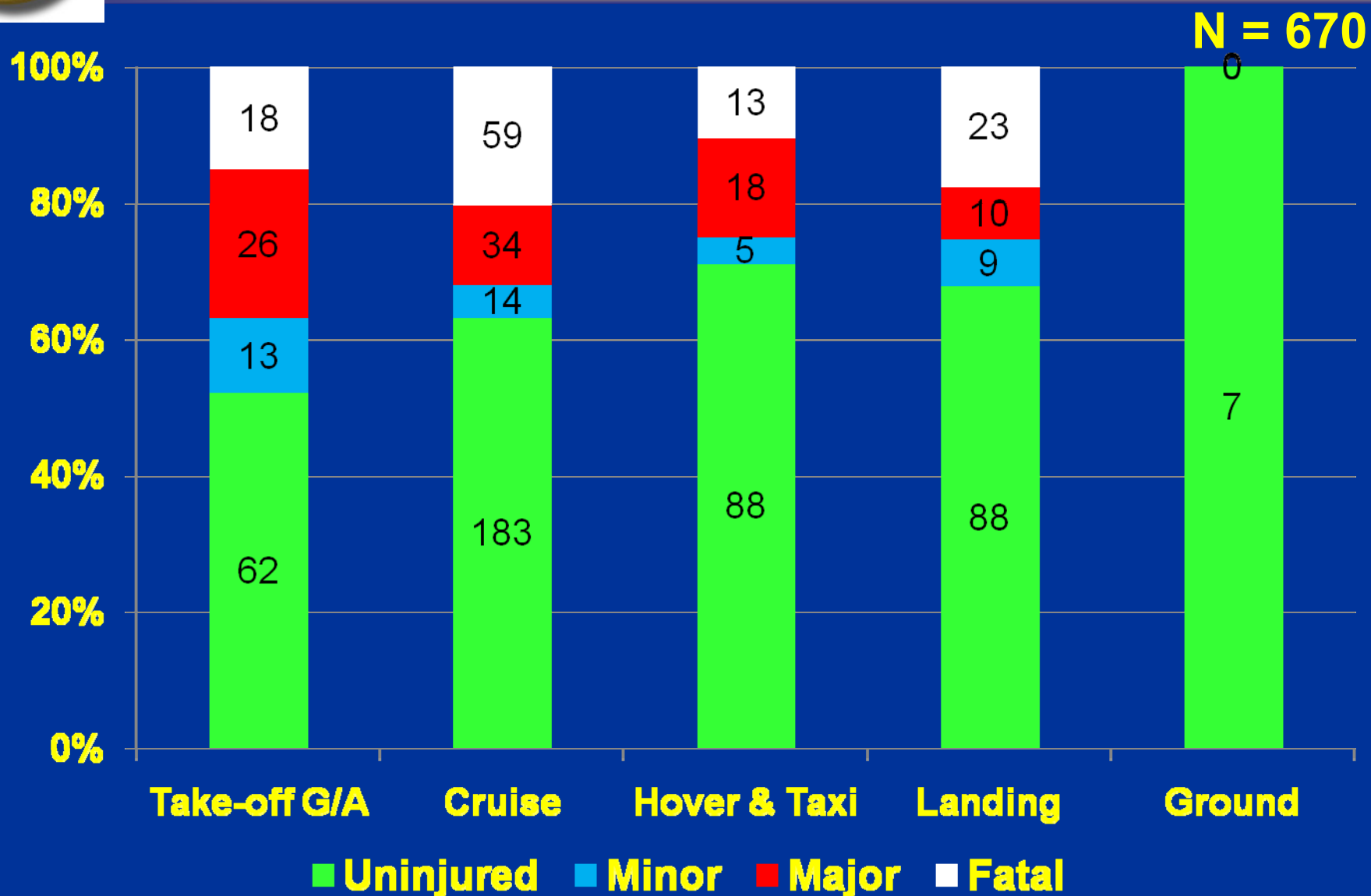


DoN ALL Rotary Wing - HF Cause Occupant Outcome by Phase of Flight



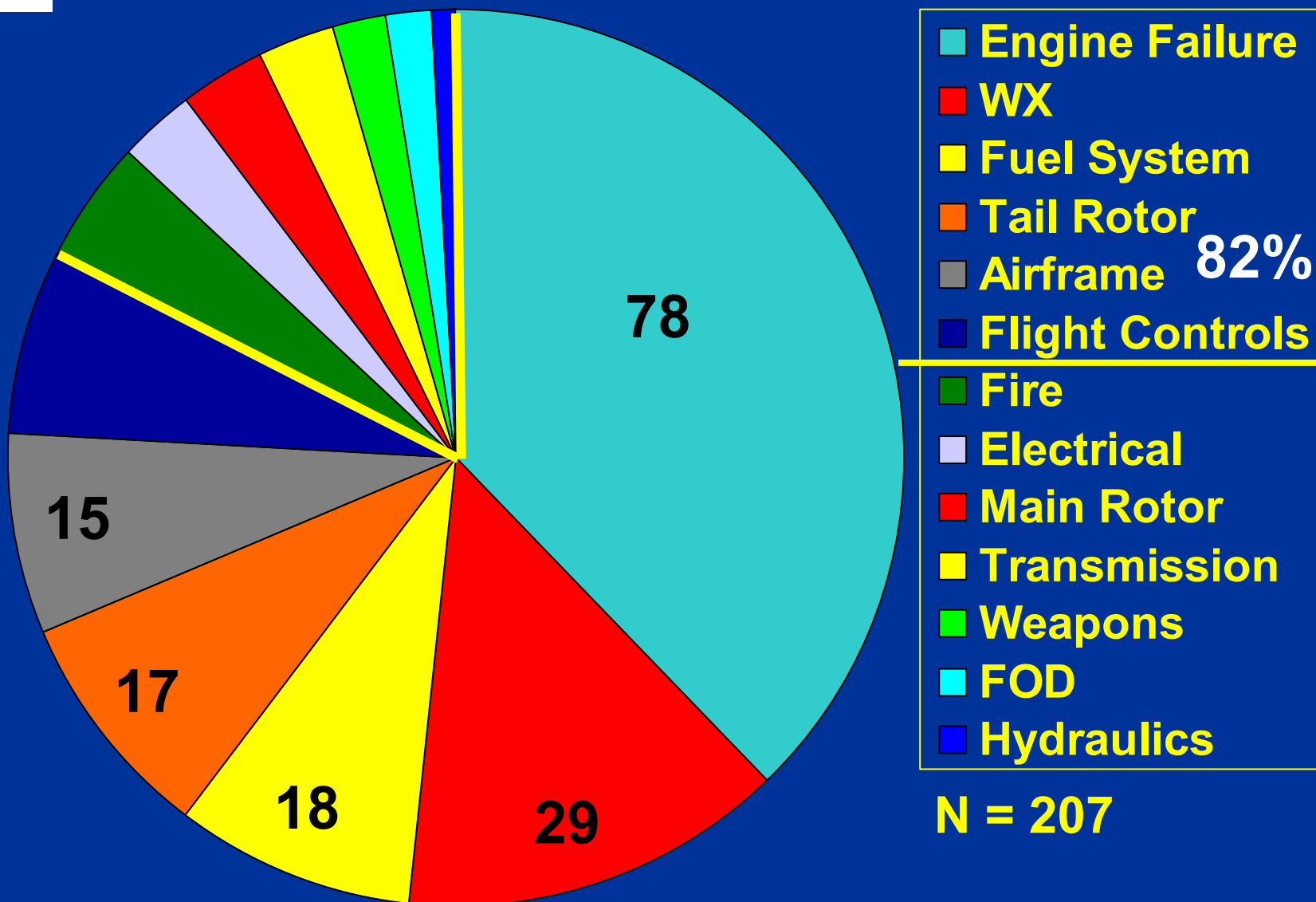


DoN ALL Rotary Wing – NHF Cause Occupant Outcome by Phase of Flight



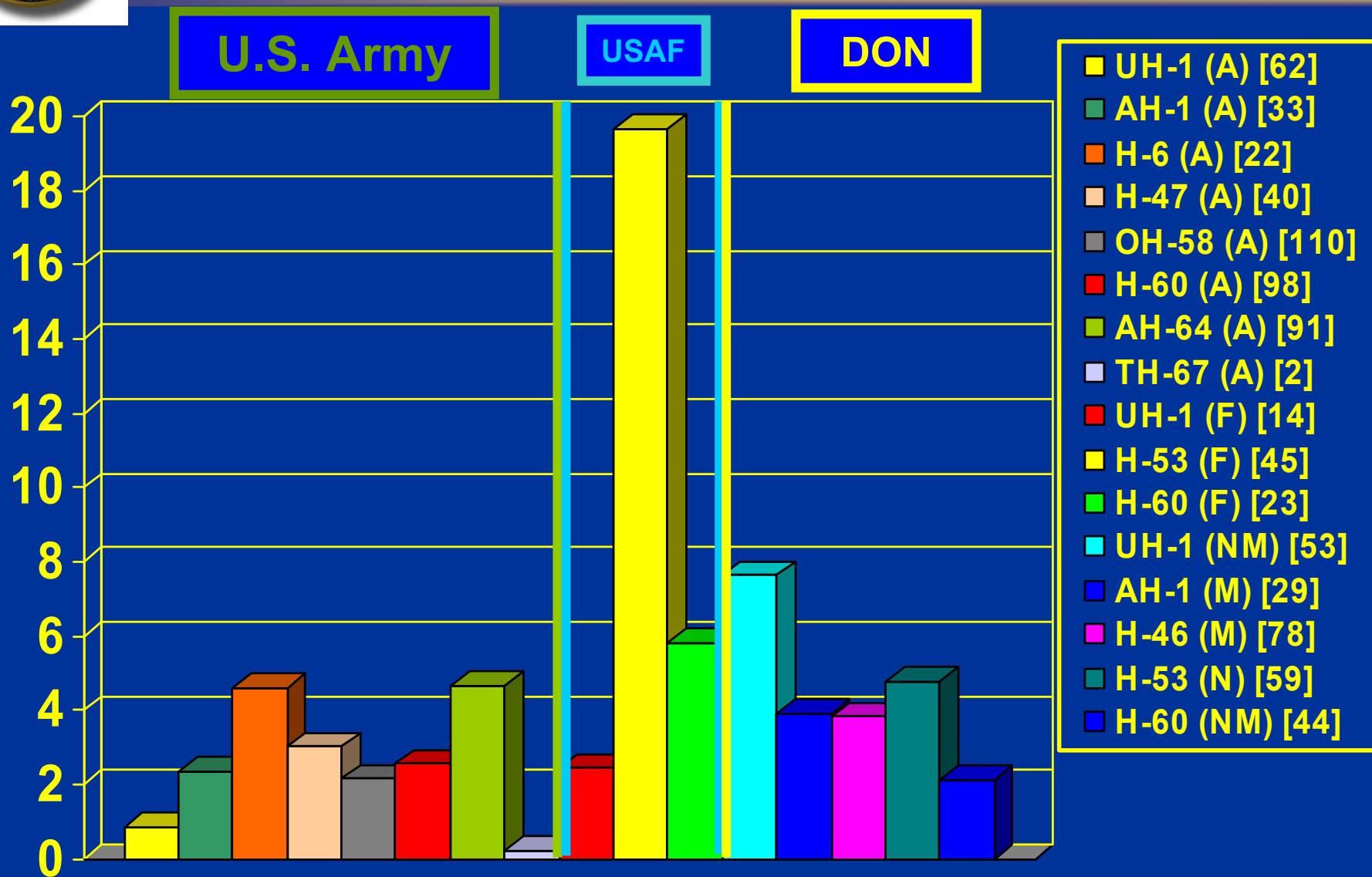


All USA NHF Mishaps Malfunction Categories



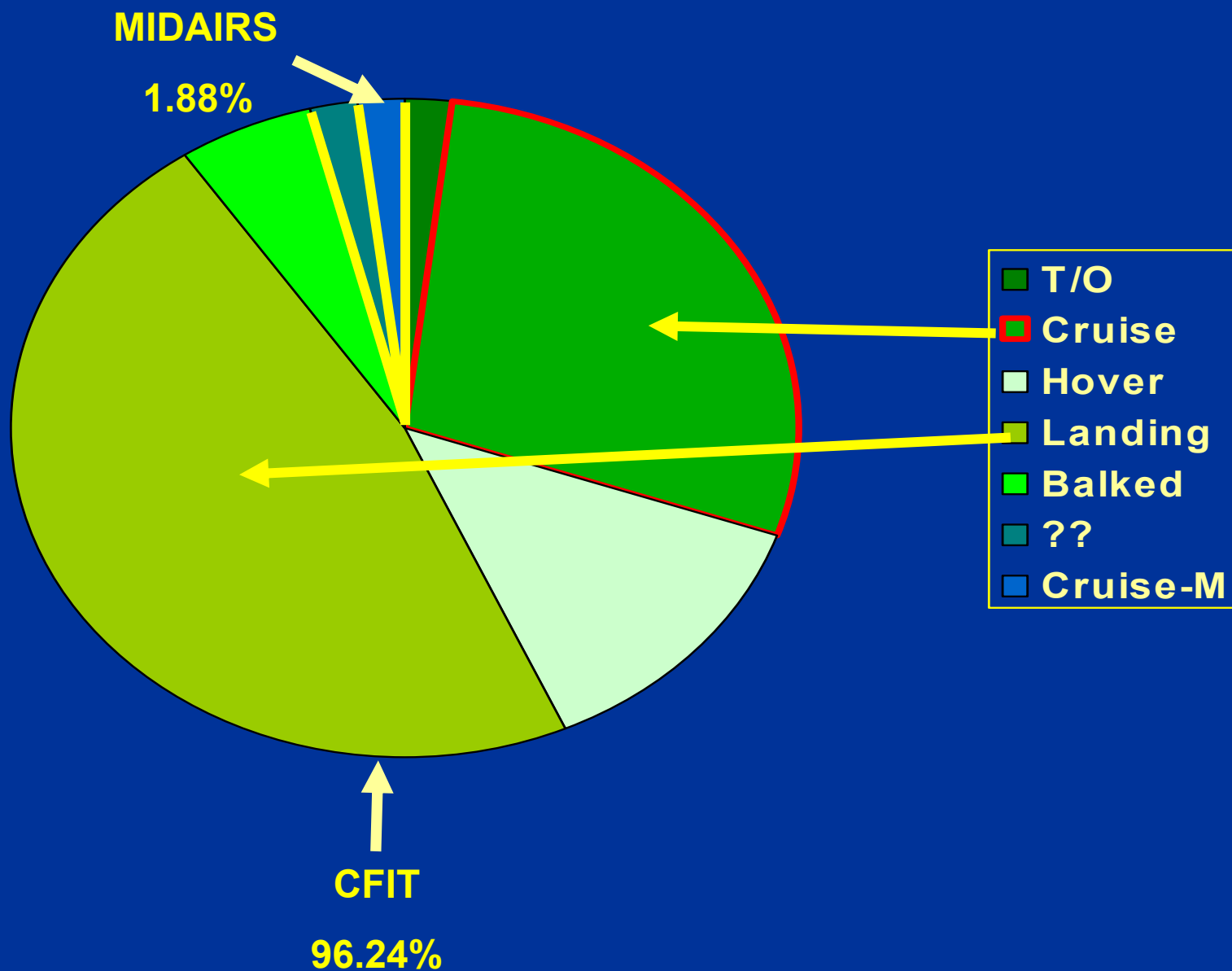


Class A & B Mishap Rates/100KHrs by MDS



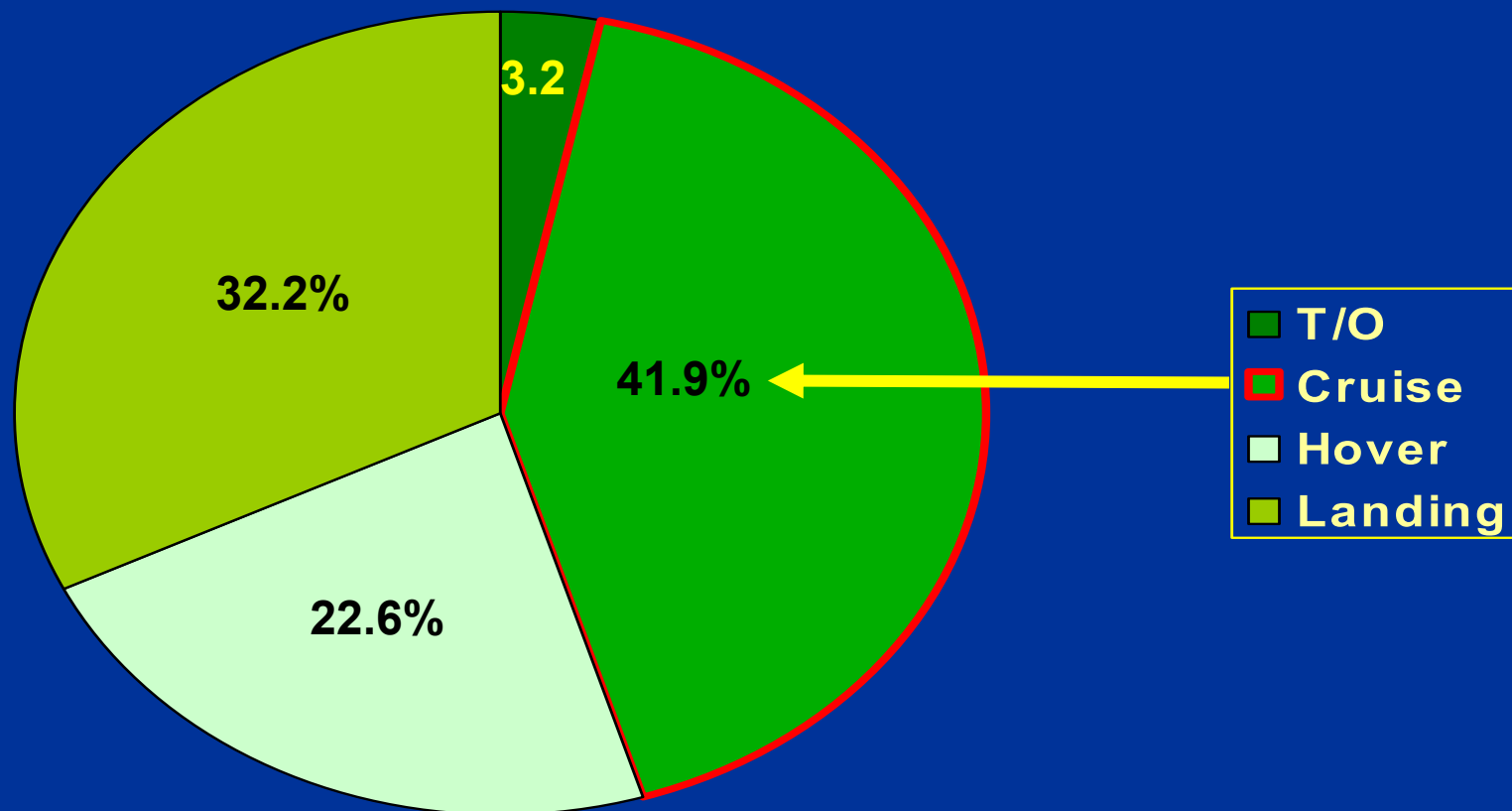


USAF HF Mishaps by Type & Phase





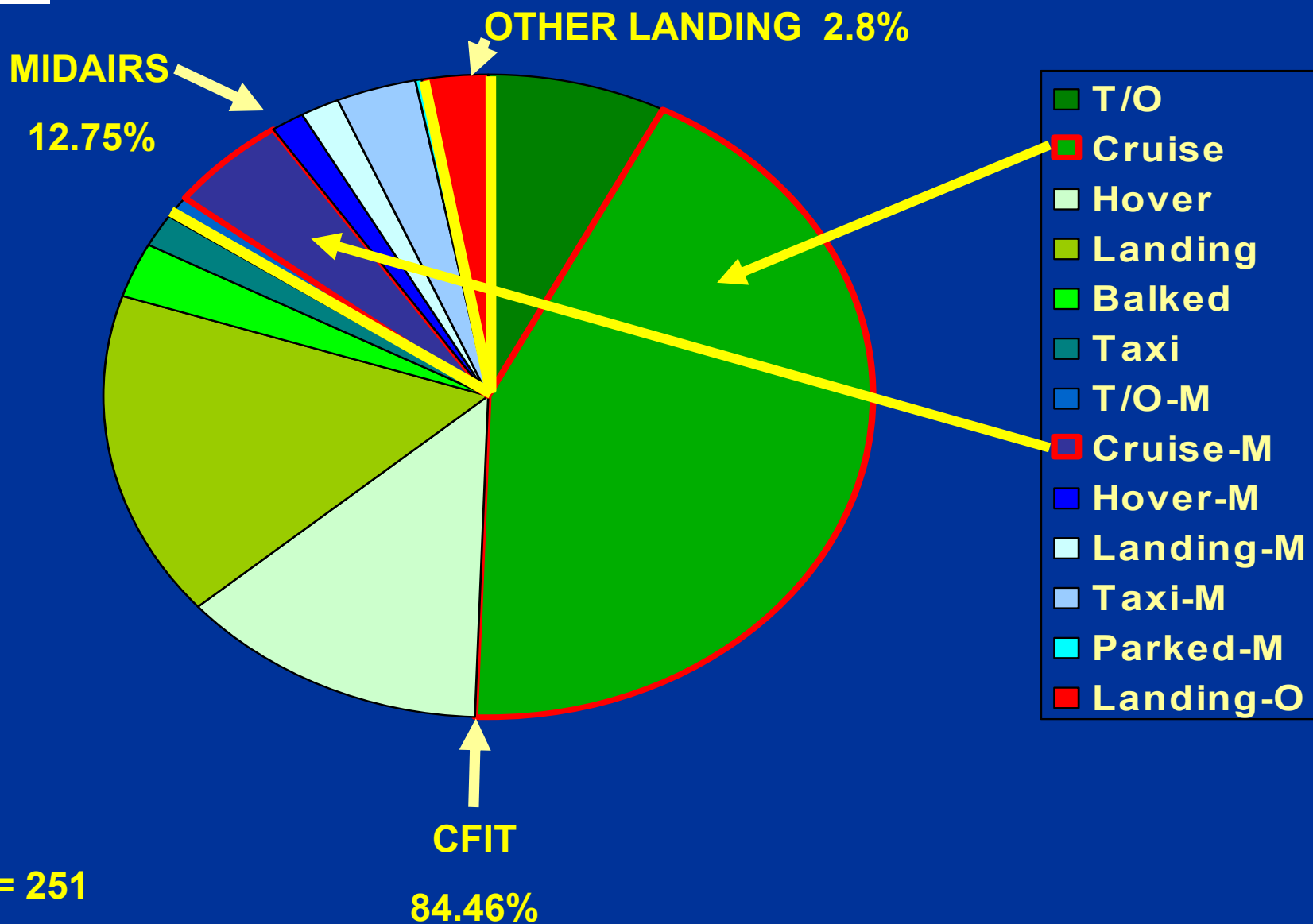
USAF NHF Mishaps by Phase



N = 32

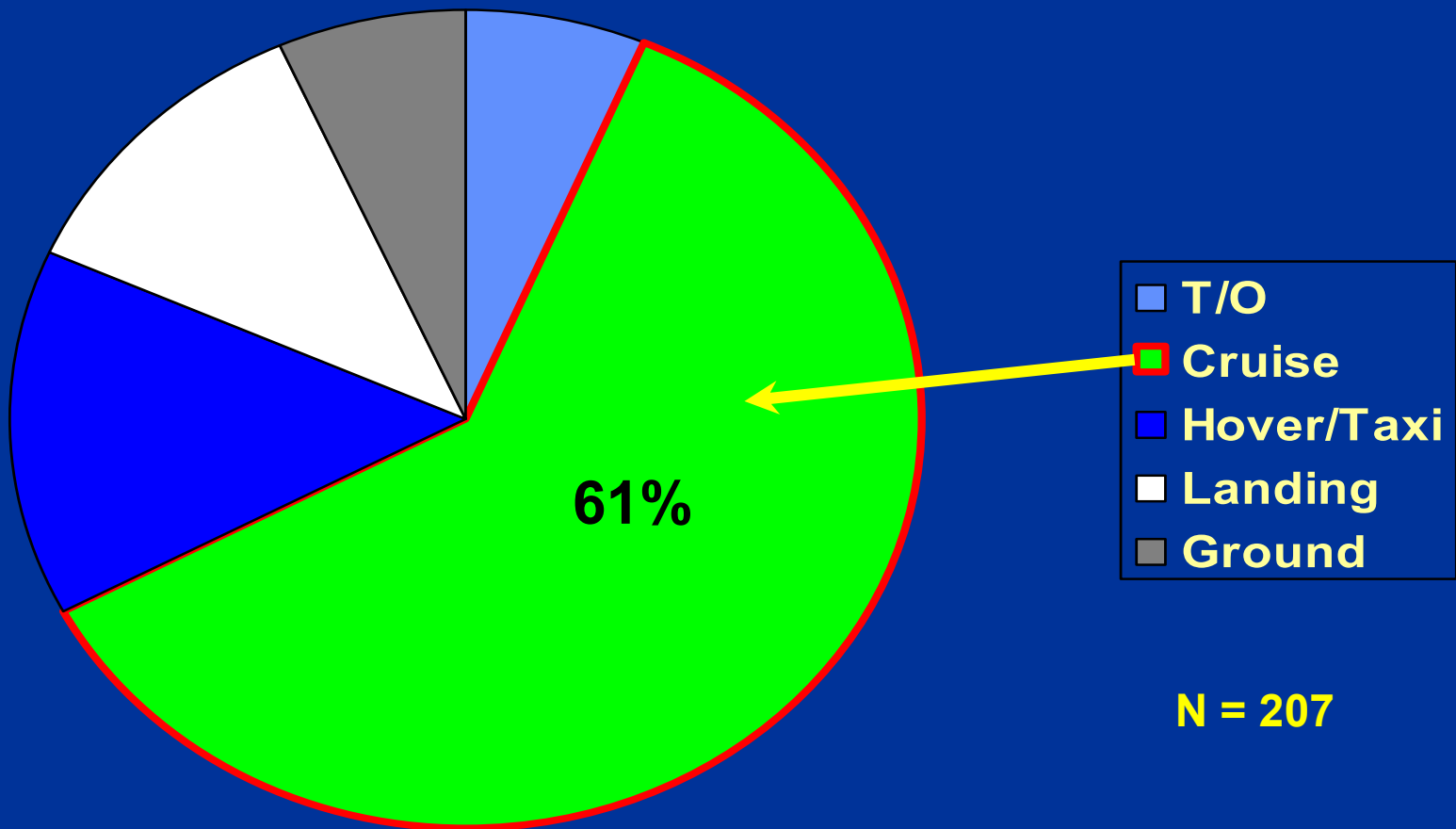


USA HF Mishaps by Type & Phase





USA NHF Mishaps by Phase of Flight FY 85-05

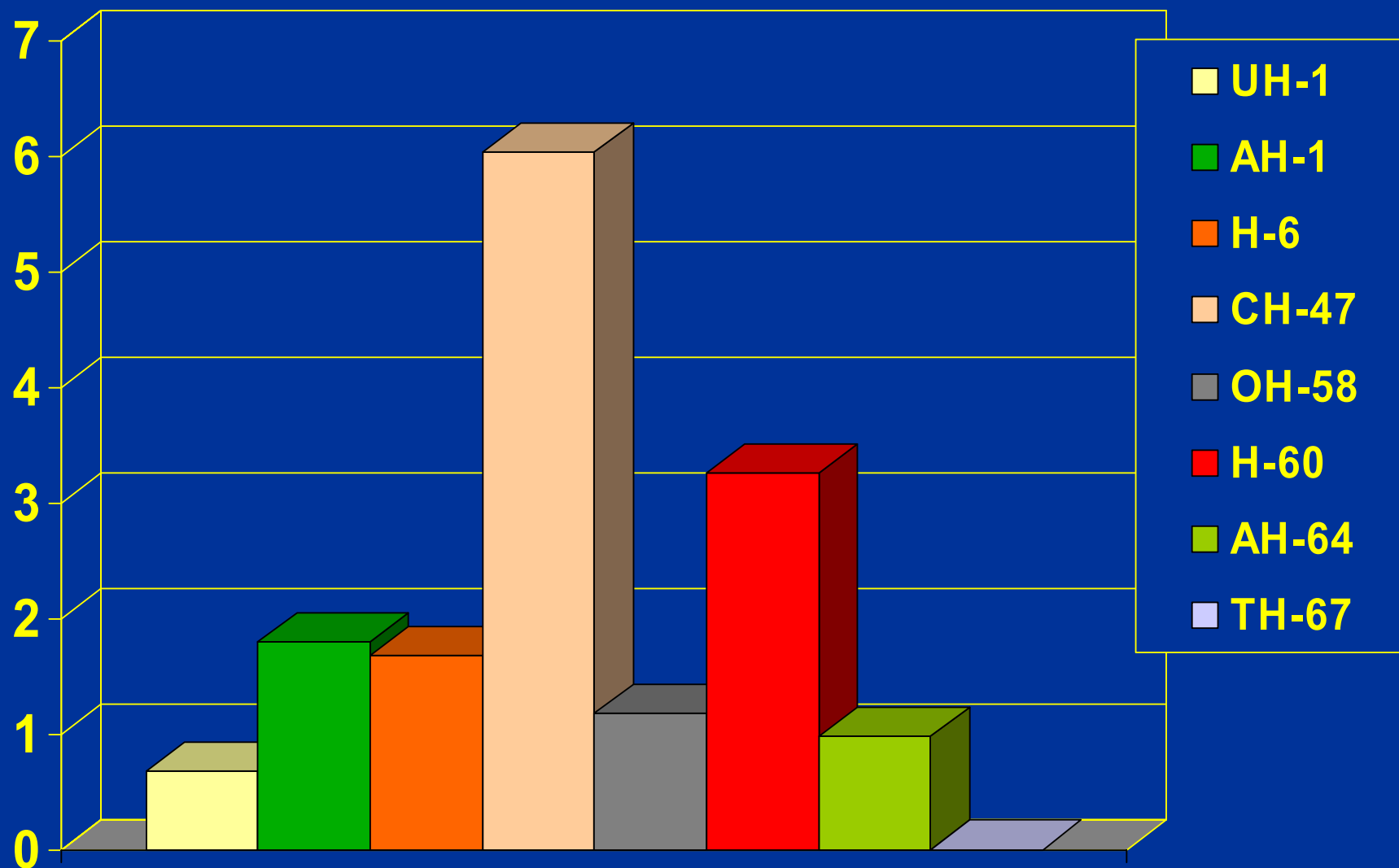




Fatality & Injury Patterns

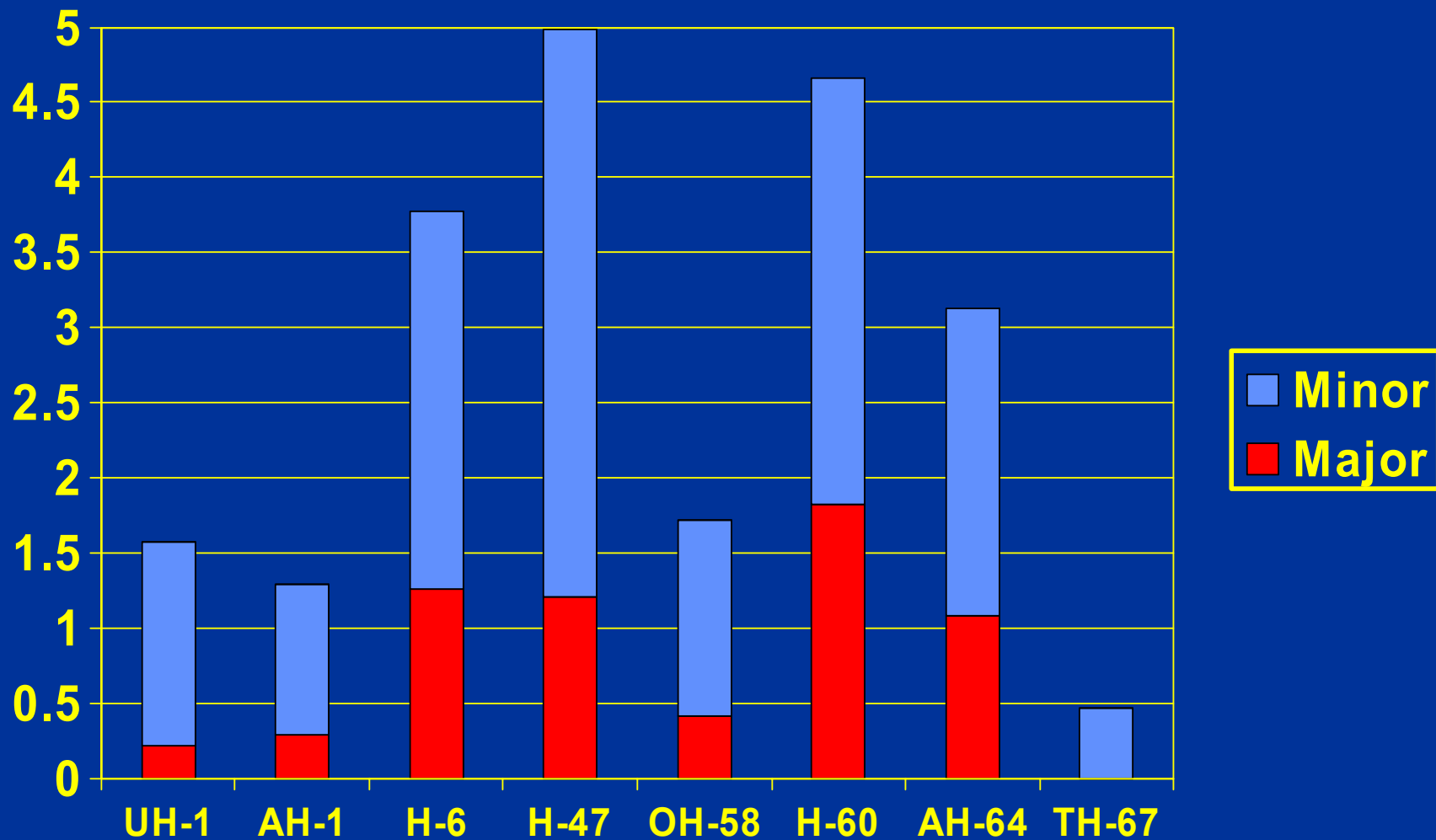


USA Fatality Rates/100KHrs by MDS



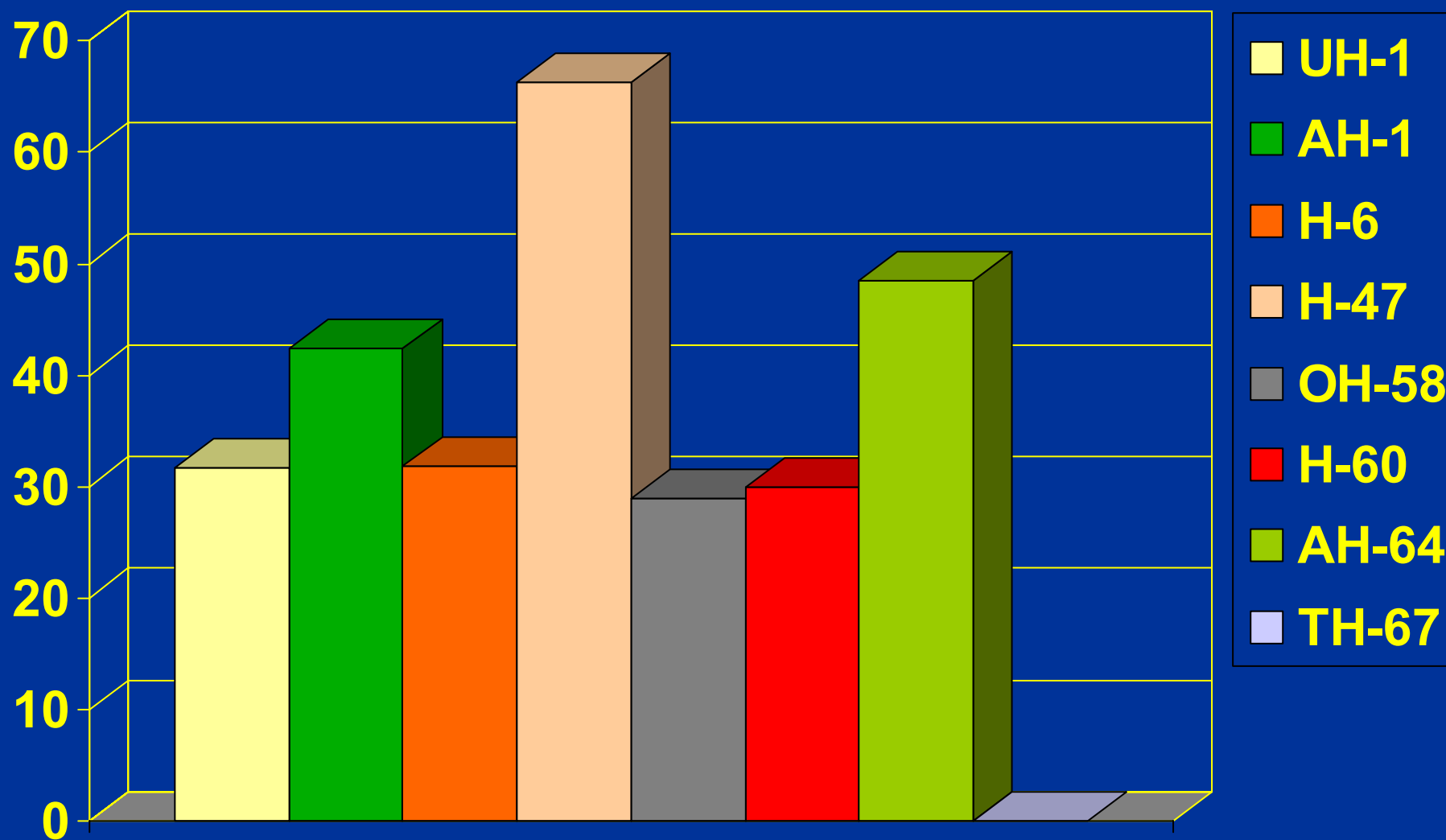


USA Injury Rates/100K Hours by MDS



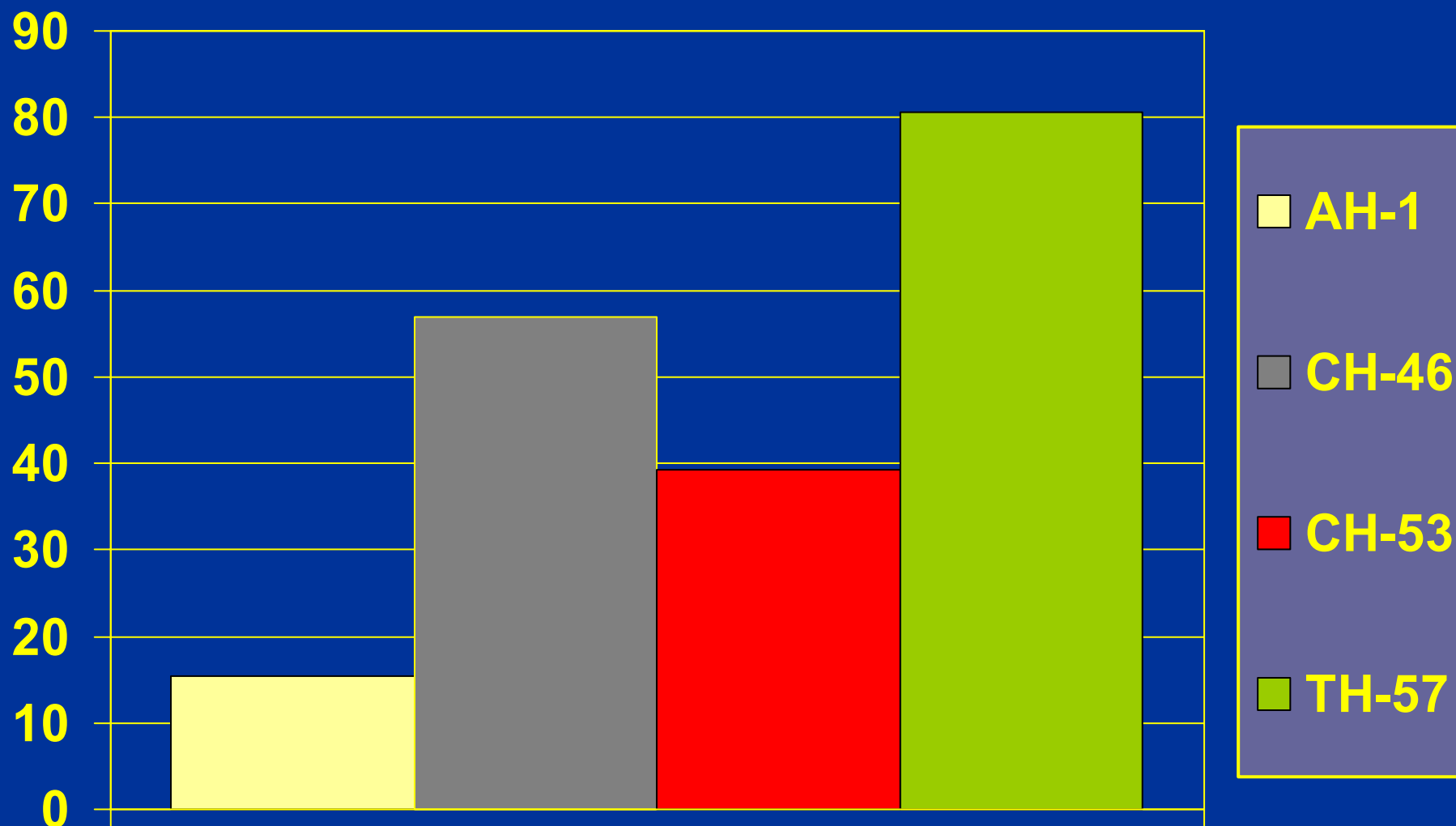


USA HF Mishap Protection Factor





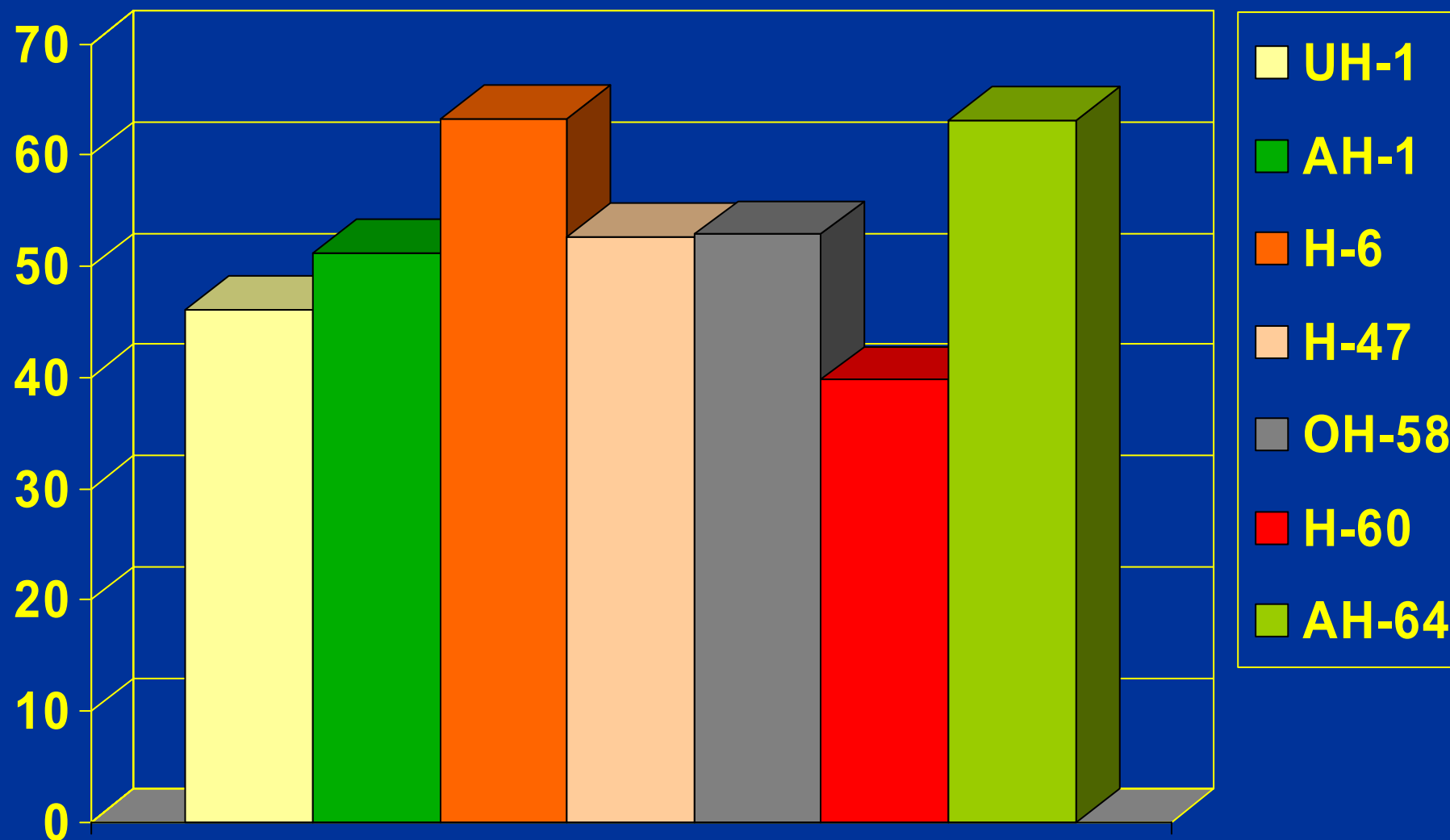
DoN HF Mishap Protection Factor



Cells with adequate power: $p < 0.05$

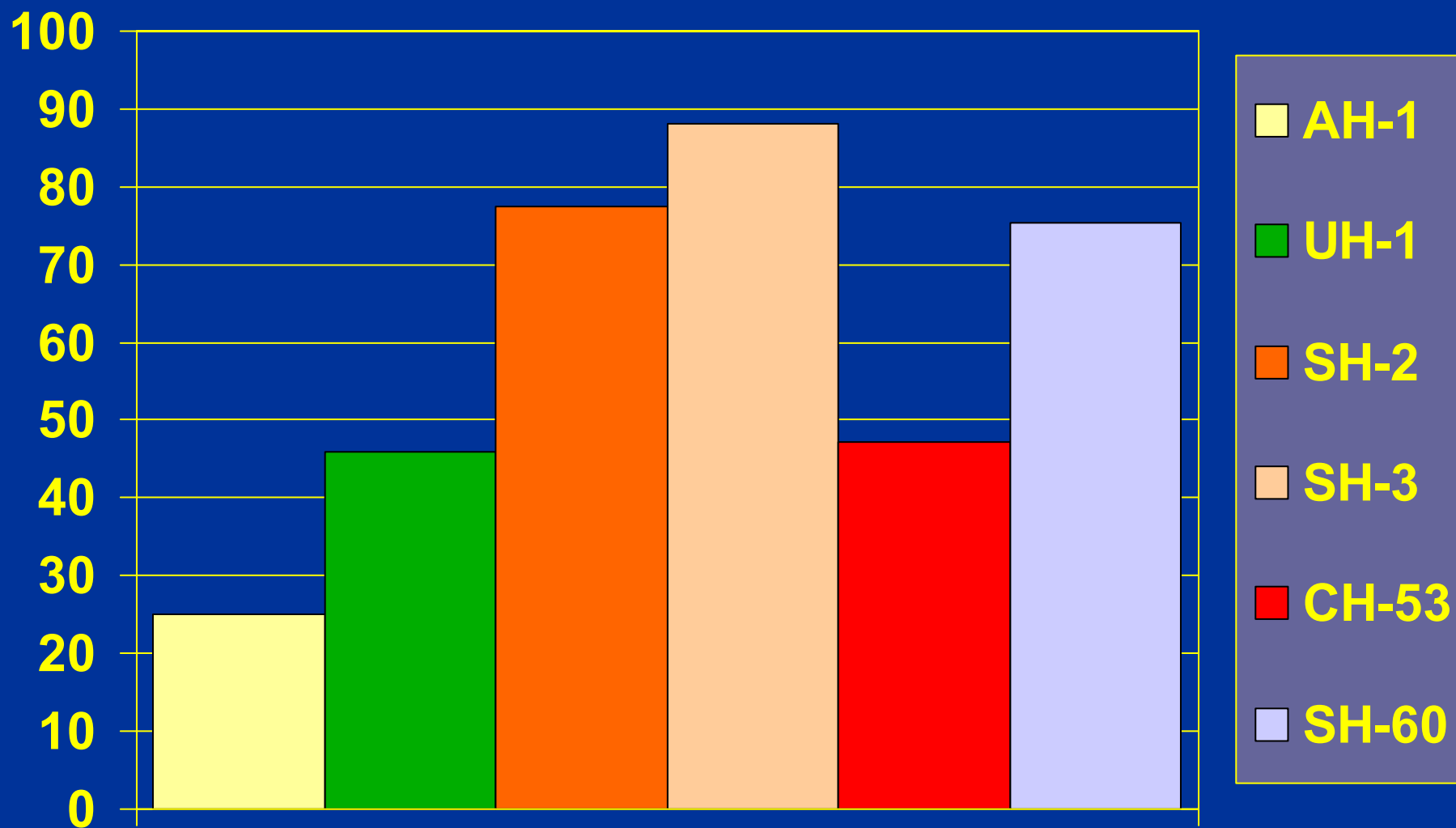


USA NHF Mishap Protection Factor





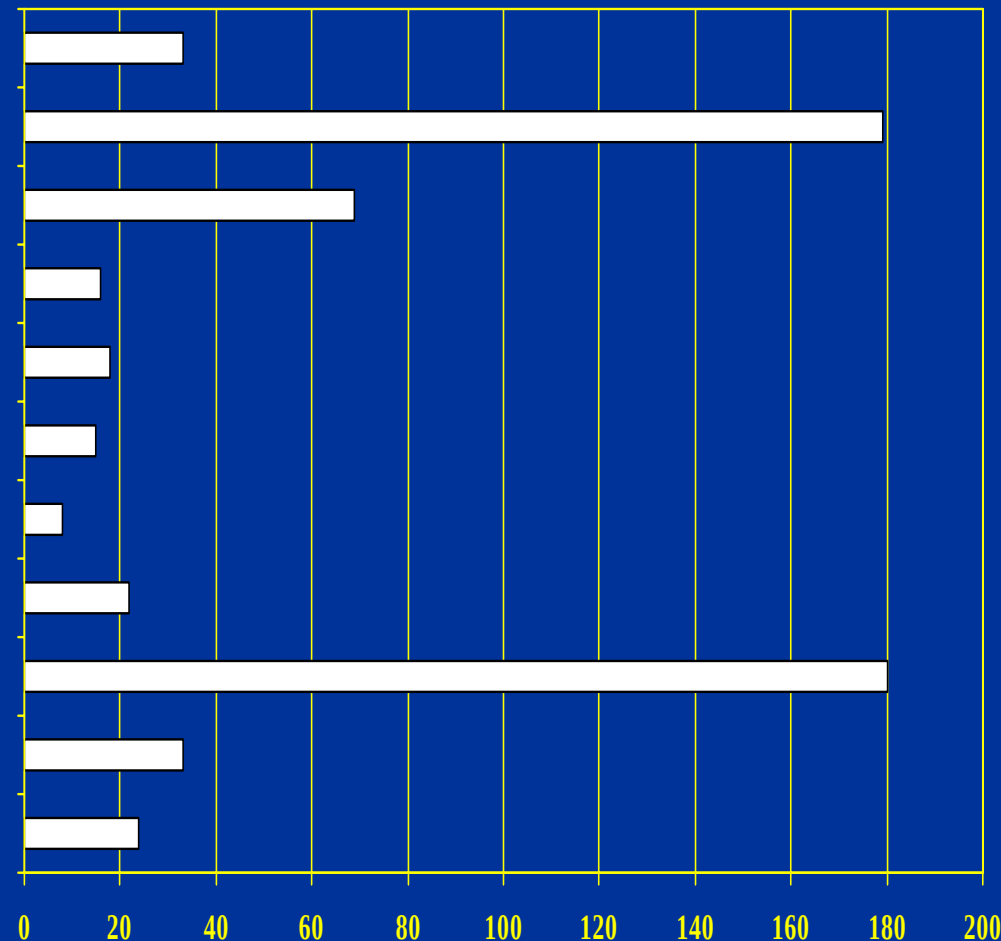
DoN NHF Mishap Protection Factor



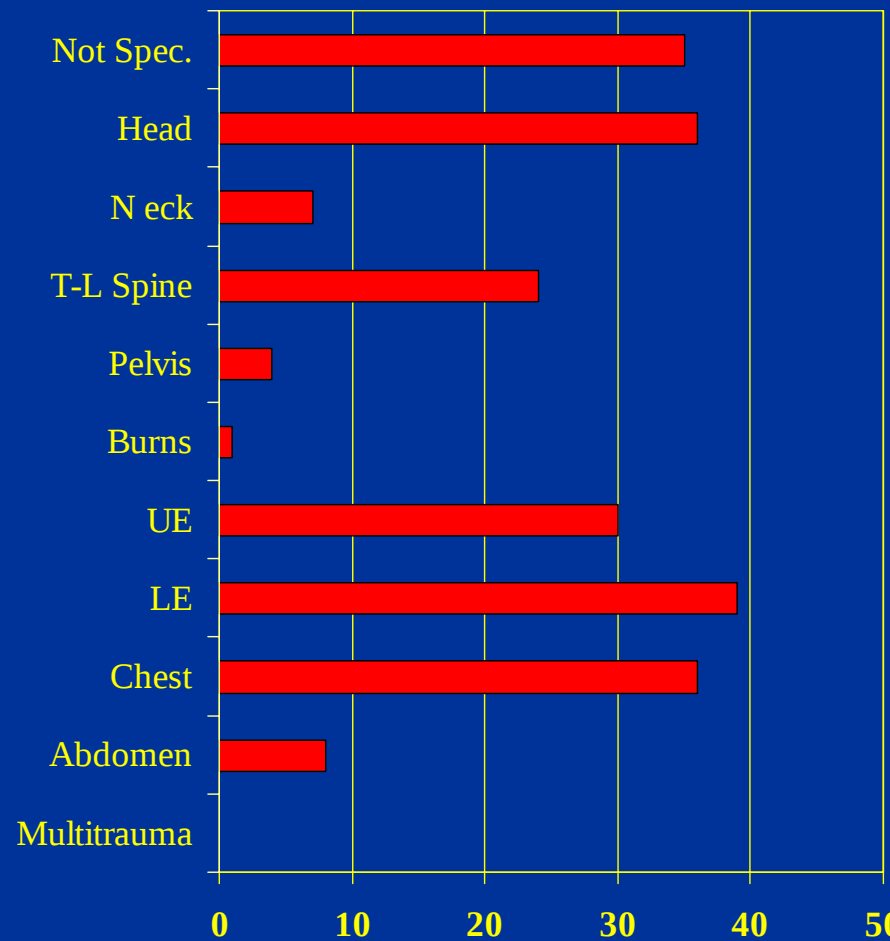
Cells with adequate power: $p < 0.05$



U.S. Army Rotary Wing Human Factor Mishap Fatalities & Injuries



FATAL (N=230)

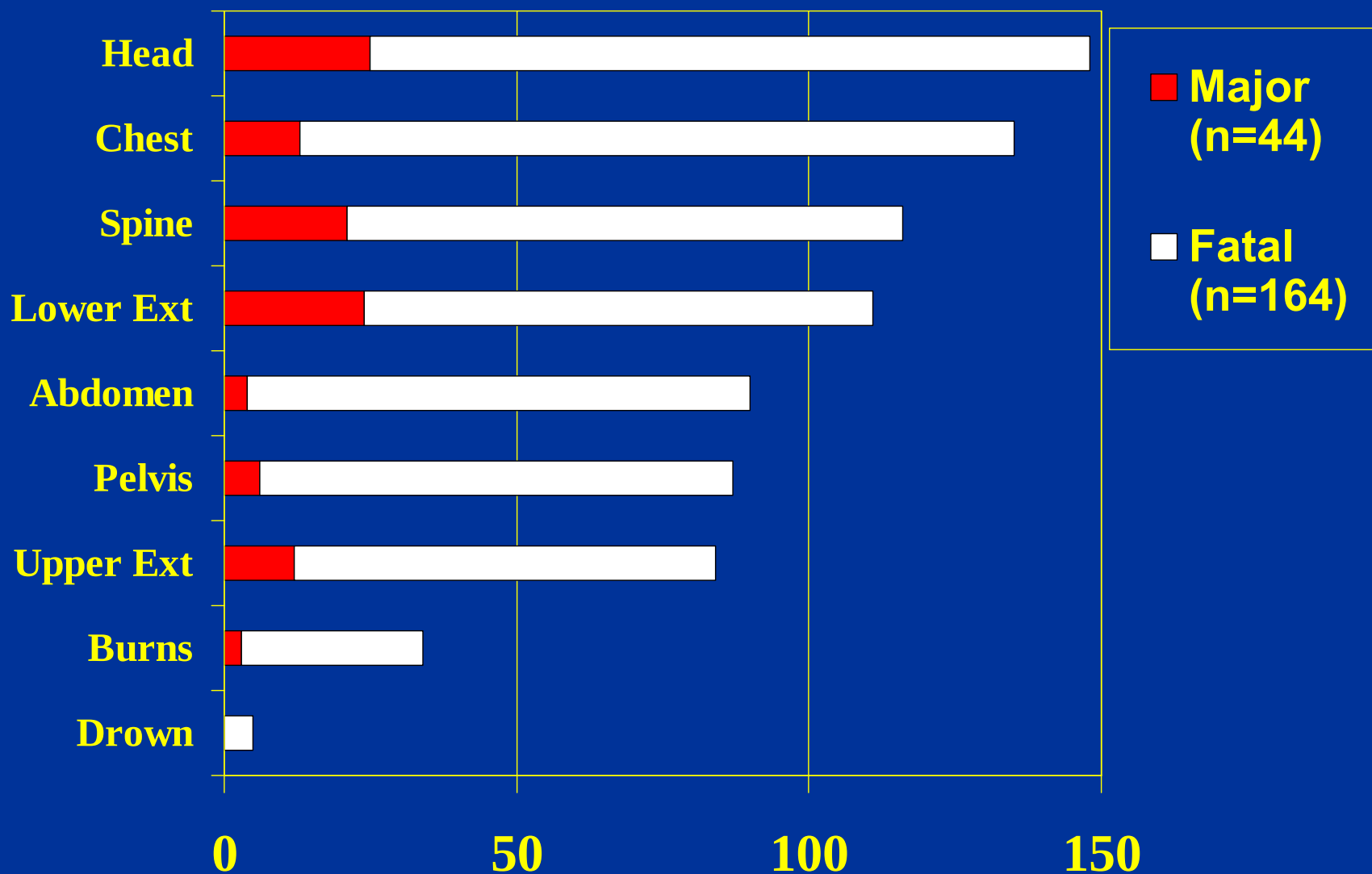


MAJOR INJURY

(N=140)

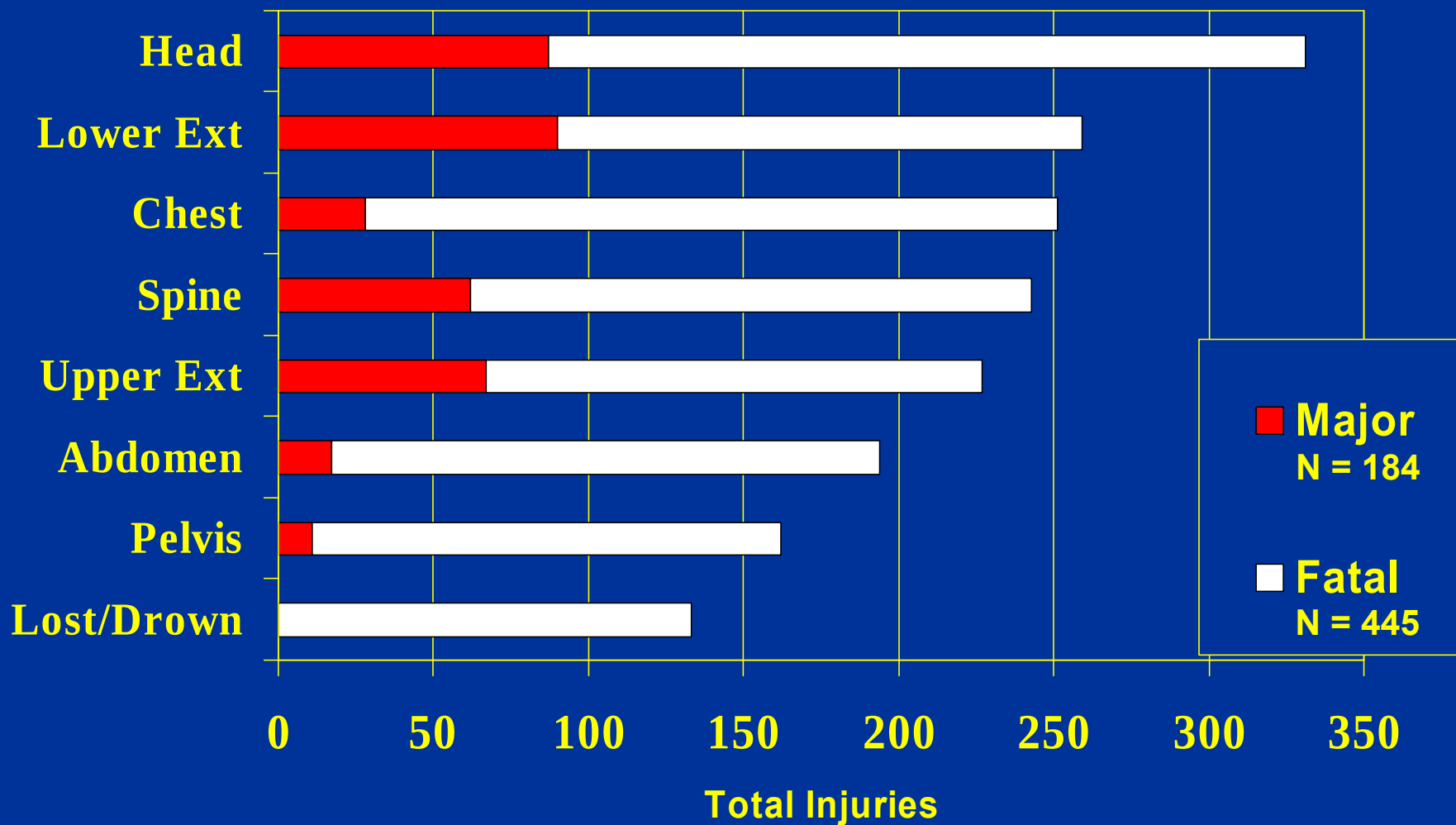


Army Rotary Wing Non-Human Factor Mishap Fatalities & Injuries





Location Of DoN Injuries





Paired Pilot VS. Passenger & Crew

U.S. Army Rotary Wing Human Factor Mishap Fatalities & Injuries

MISHAP N = 112 $p(X^2_{trend}) = .27$	PILOTS N = 232		PAX & CREW N = 431		$\Delta\%$ (p value)
	#	%	#	%	
NOT INJURED	88	37.9	140	32.5	- 5.4 (.159)
MINOR INJURY	67	28.9	113	26.2	-2.6 (.462)
MAJOR INJURY	22	9.5	70	16.2	+ 6.7 <u>(.016)</u>
DEAD	55	23.7	108	25.1	+ 1.4 (.699)



Pilot vs. Passenger & Crew USA Non-HF Injuries & Fatalities

MISHAPS N = 207	PILOTS N = 409		PAX & CREW N = 315		$\Delta\%$
	#	%	#	%	
NOT INJURED	218	53.3	132	41.9	-11.4 RR = .77 (p<.0011)
MINOR INJURY	99	24.2	67	21.3	-2.9 RR = .89 (p<.388)
MAJOR INJURY	23	5.6	21	6.7	+1.04 RR = 1.2 (P<.538)
FATAL	69	16.9	95	30.2	+13.3 RR = 1.75 (P<.00006)



What the Navy did...

- **Stroking seats in the cargo compartments of troop carrying helicopters for passenger use**
- **Instituted HEEDS: individual compressed air supply bottles for emergency escape**
- **Instituted anti-exposure suit availability policy for crew and passengers**
- **Required all crew and frequent passengers (selected fleet marine forces) to take and pass dunker training**
- **Maintained strict requirements for helmet wear for all passengers.**



DoN Fatality Rates

Overall Decrease: FY 85-94 vs. FY 95-05

$RR_1 = 1.84$ $(p < 0.0000001)$	Fatalities	Hours
FY 85 – 94 (1)	305	5,261,481
FY 95 – 05 (2)	140	4,439,551



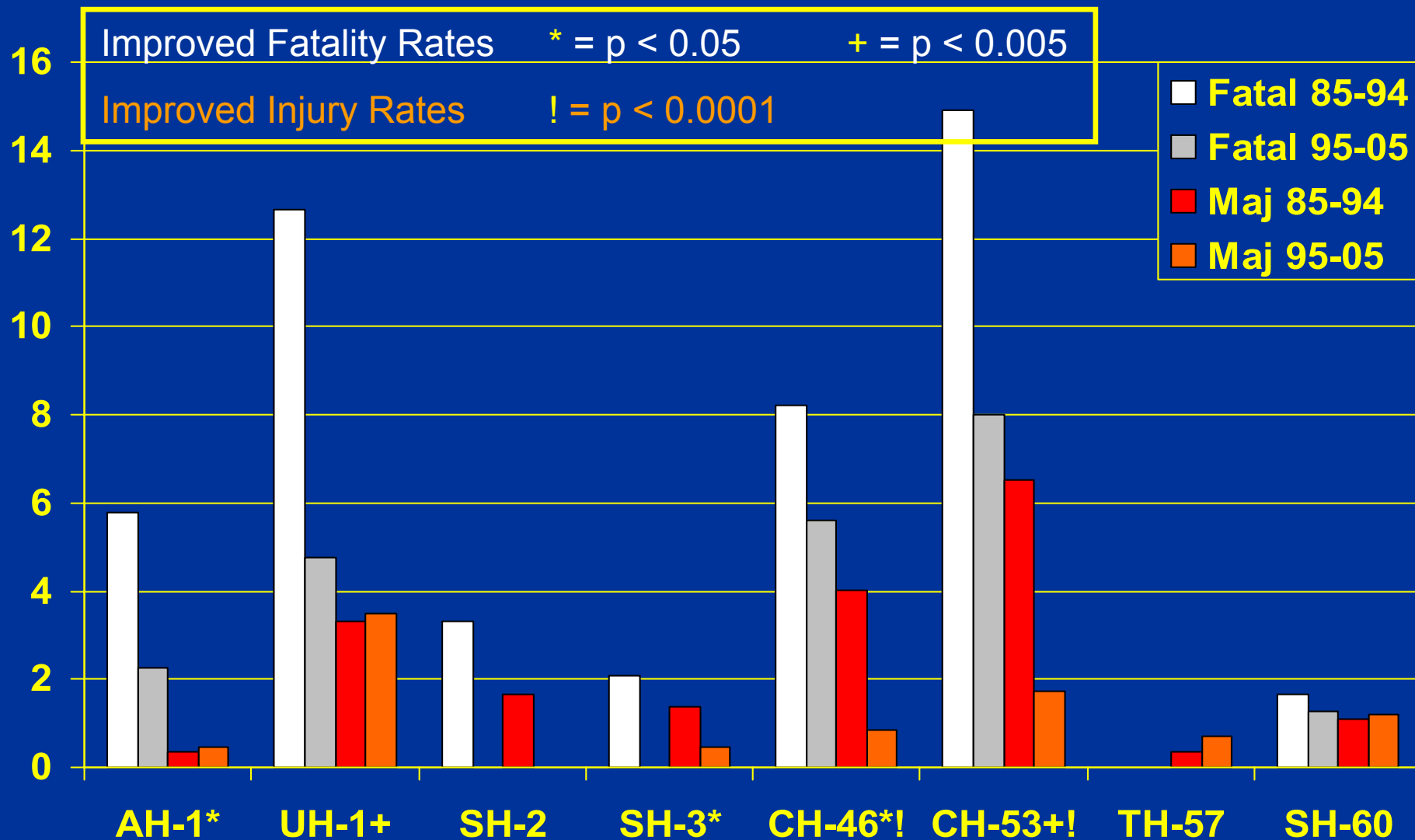
DoN Injury Rates

Overall Decrease: FY 85-94 vs. FY 95-05

$RR_1 = 1.83$ $(p < 0.0000008)$	Injuries	Hours
FY 85 – 94 (1)	206	5,261,481
FY 95 – 05 (2)	95	4,439,551



DoN Fatalities & Major Injury Rates per 100,000 Flying Hours by Type





Pilot vs. Passenger & Crew

DoN Injuries & Fatalities

MISHAP A/C N = 383	PILOTS N = 653		PAX & CREW N = 1013		$\Delta\%$
	Count	Percent	Count	Percent	
NOT INJURED	392	60.0	528	52.1	+7.9 RR = 1.15 (p<0.0015)
MINOR INJURY	38	5.8	79	7.8	-2.0 RR = 0.75 (p<0.123)
MAJOR INJURY	63	9.7	121	11.9	-2.2 RR = 0.81 (P<0.144)
FATAL	160	24.5	285	28.1	-3.6 RR = 0.87 (P<0.102)



Pilot vs. Passenger & Crew

DoN Injuries & Fatalities

All Aircraft With Rear Occupants

MISHAPS N = 271	PILOTS N = 560		PAX & CREW N = 1013		$\Delta\%$
	Count	Percent	Count	Percent	
NOT INJURED	339	60.5	528	52.1	+8.4 RR = 1.18 (P = 0.0004)
MINOR INJURY	33	5.9	79	7.8	-1.9 RR = 0.79 (P = 0.229)
MAJOR INJURY	53	9.5	121	11.9	-2.4 RR = 0.78 (P = 0.148)
FATAL	135	24.1	285	28.1	-4.0 RR = 0.85 (P = 0.07)

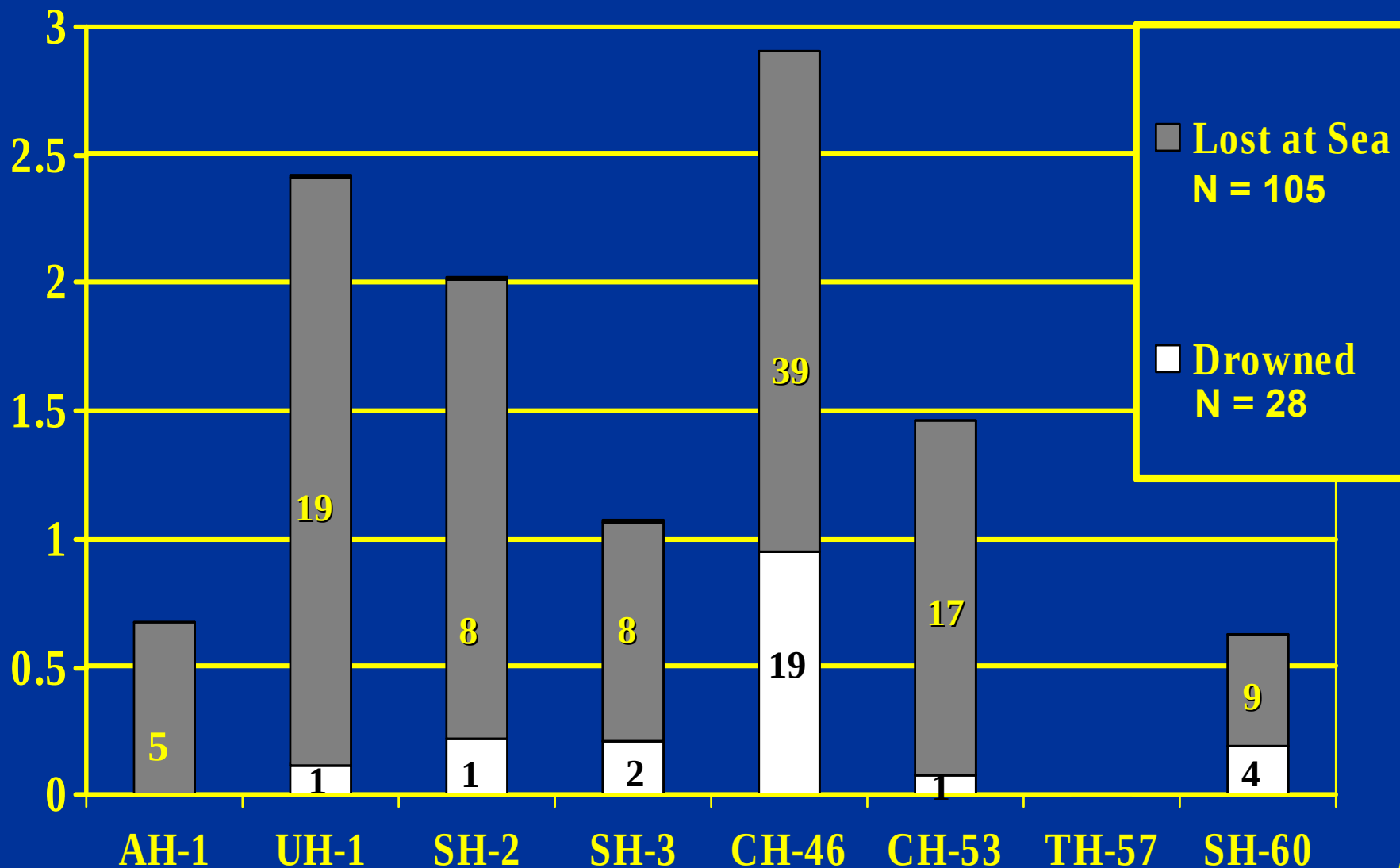


DoN Water Fatalities



USN Water Fatality Rates per 100,000 Hours

N = 133

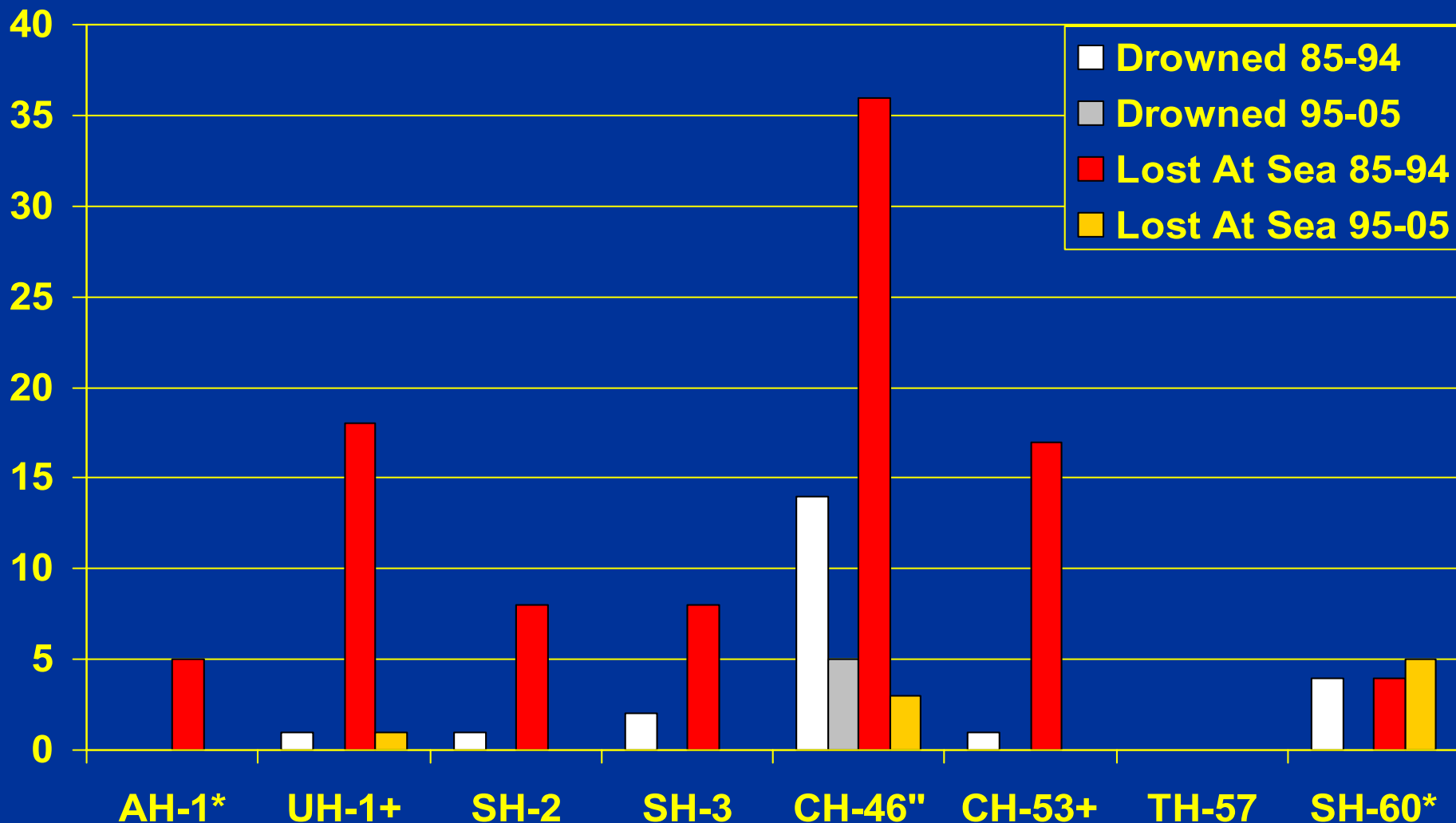




DoN Water Fatality Numbers

N = 133

Decreased Drownings/LAS: * < 0.05; + < 0.005; “ < 0.0005





Drowning/Lost at Sea Rates

Overall Decrease: FY 85-94 vs. FY 95-05

	D/LAS	Other Fatalities Hours	D/LAS:Total Ratio
FY 85 – 94 (1)	119 (2.26/100Khrs)	186 5,261,481	39.0%
FY 95 – 05 (2)	14 (0.315/100Khrs)	126 4,439,551	10.0%
RR_{Fatal1}	3.85 ($p < 0.0000001$)	RR_{Hours1}	7.71 ($p < 0.000000001$)



DoN Fatality Rates without D/LAS

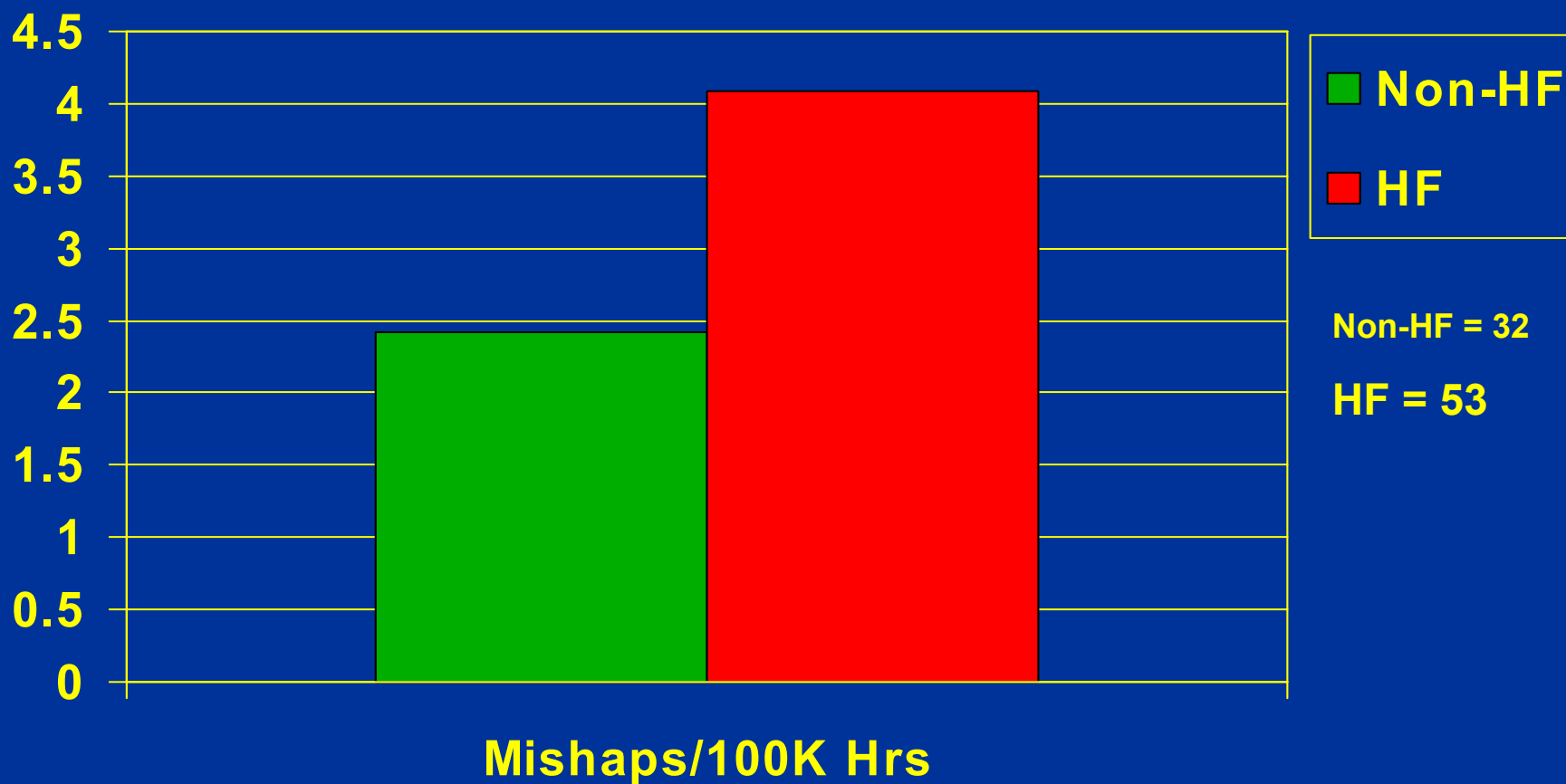
Overall Decrease: FY 85-94 vs. FY 95-05

$RR_1 = 1.25$ $(p < 0.056)$	Fatalities	Hours
FY 85 – 94 (1)	186	5,261,481
FY 95 – 05 (2)	126	4,439,551



Comparison USAF Rotary Wing Mishap Rates/100K Hrs by HF and Non-HF

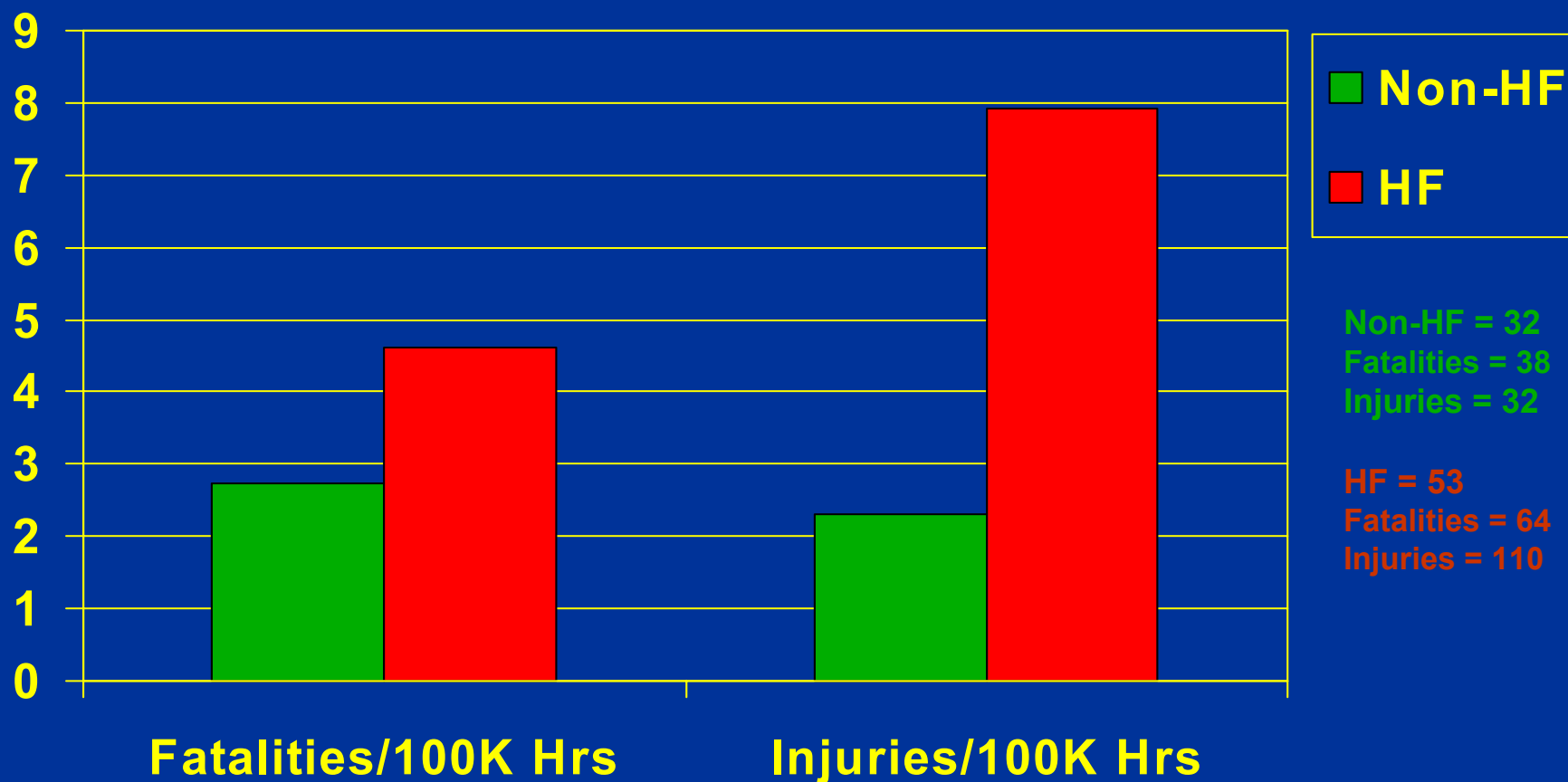
FY 85 - 05





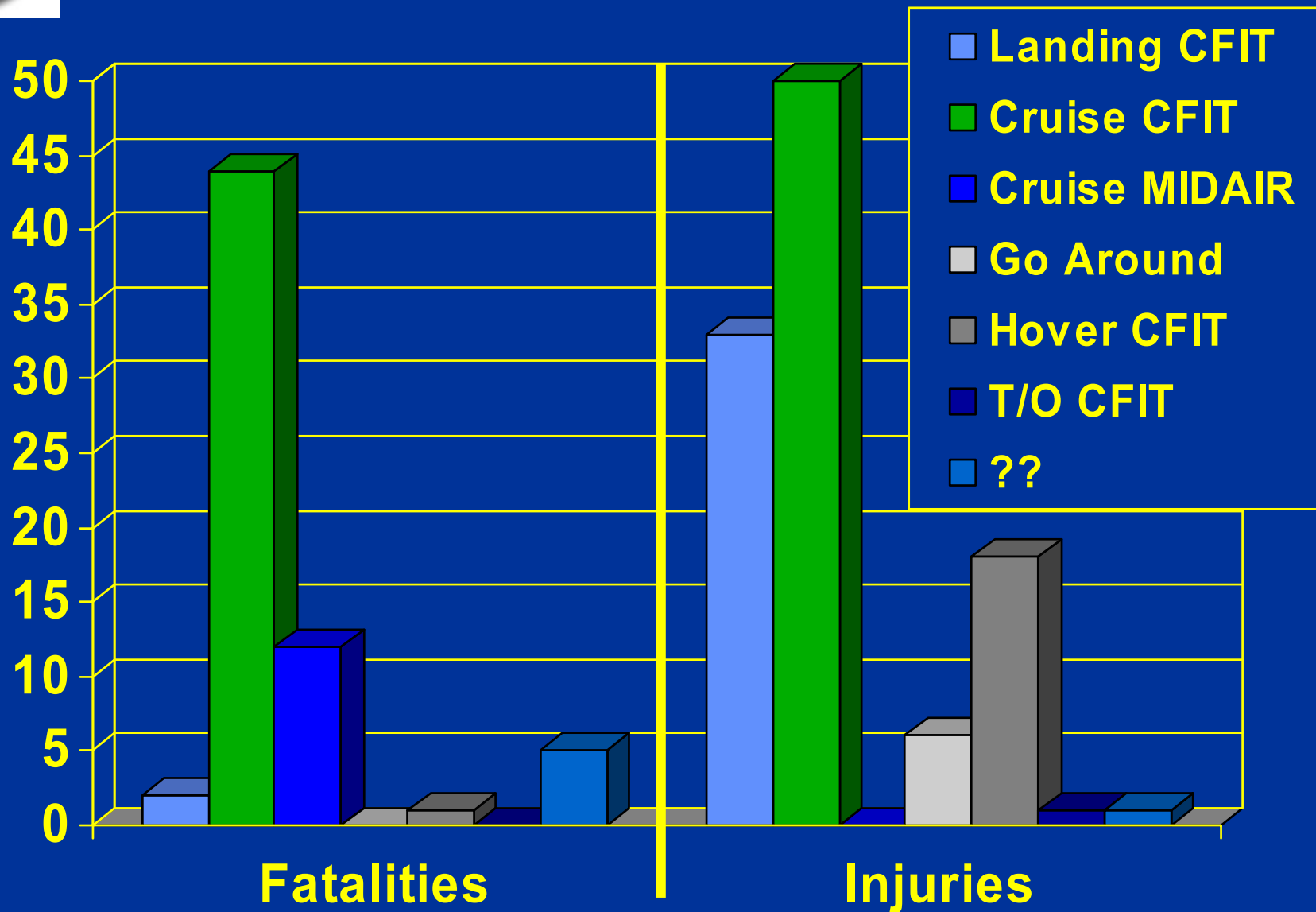
Comparison USAF Rotary Wing Fatality & Injury Rates by HF and Non-HF

FY 85 - 05



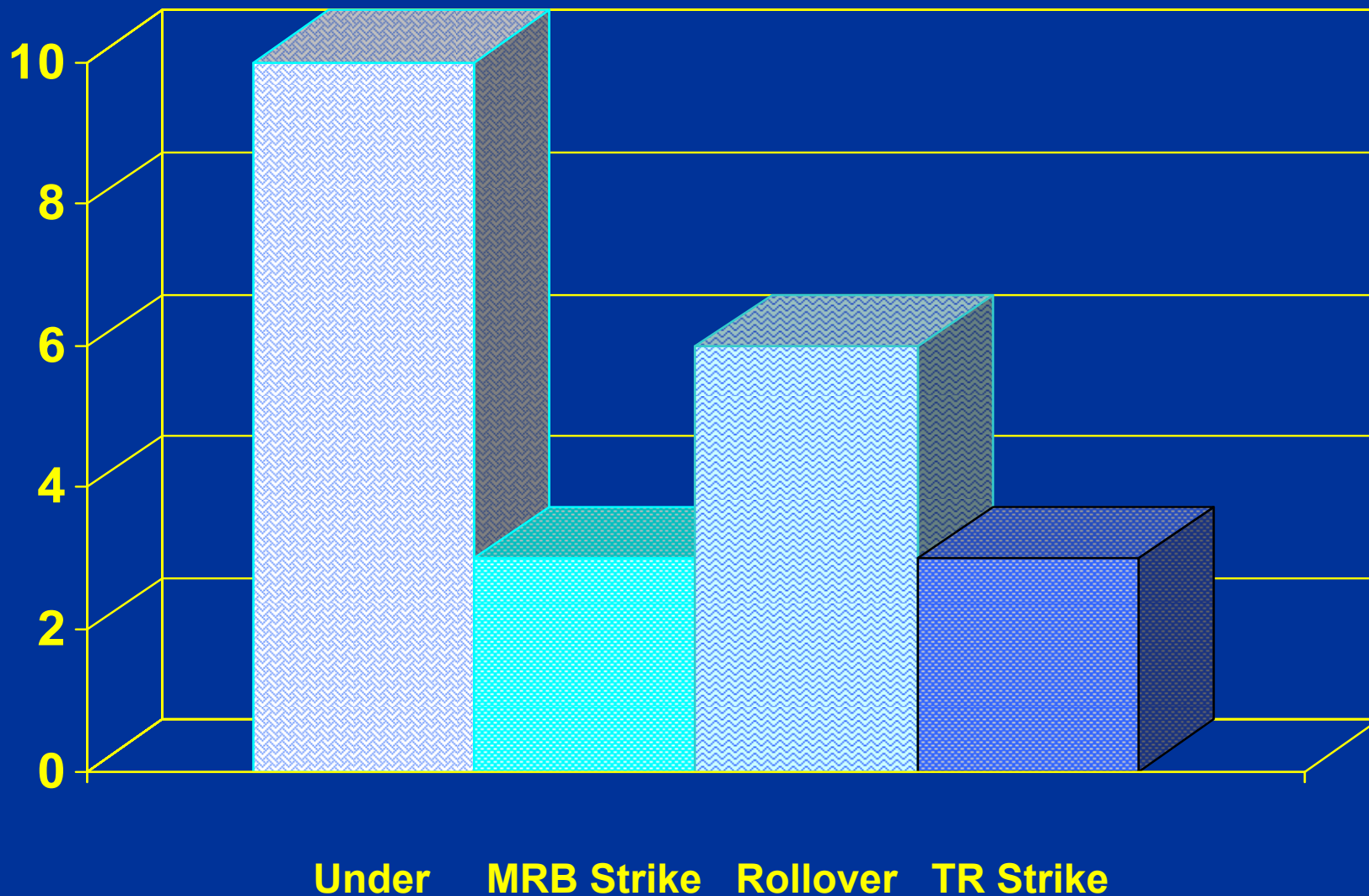


USAF Rotary Wing # of Fatalities & Injuries, FY 85-05, By Flight Operation



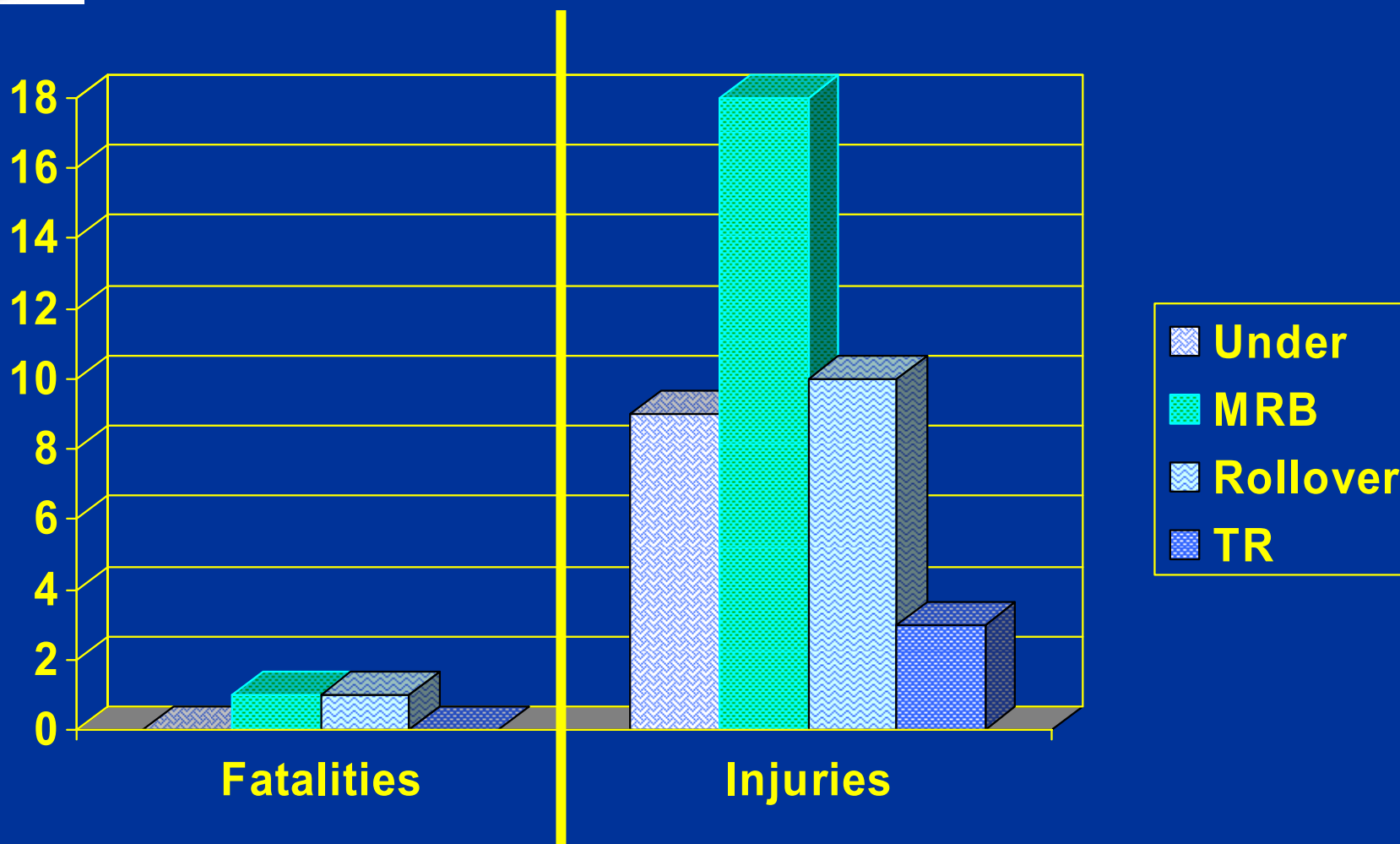


USAF Rotary Wing Landing Mishaps FY 85-05, By Mechanism





USAF Rotary Wing # Landing Fatalities & Injuries, FY 85-05, By Mechanism



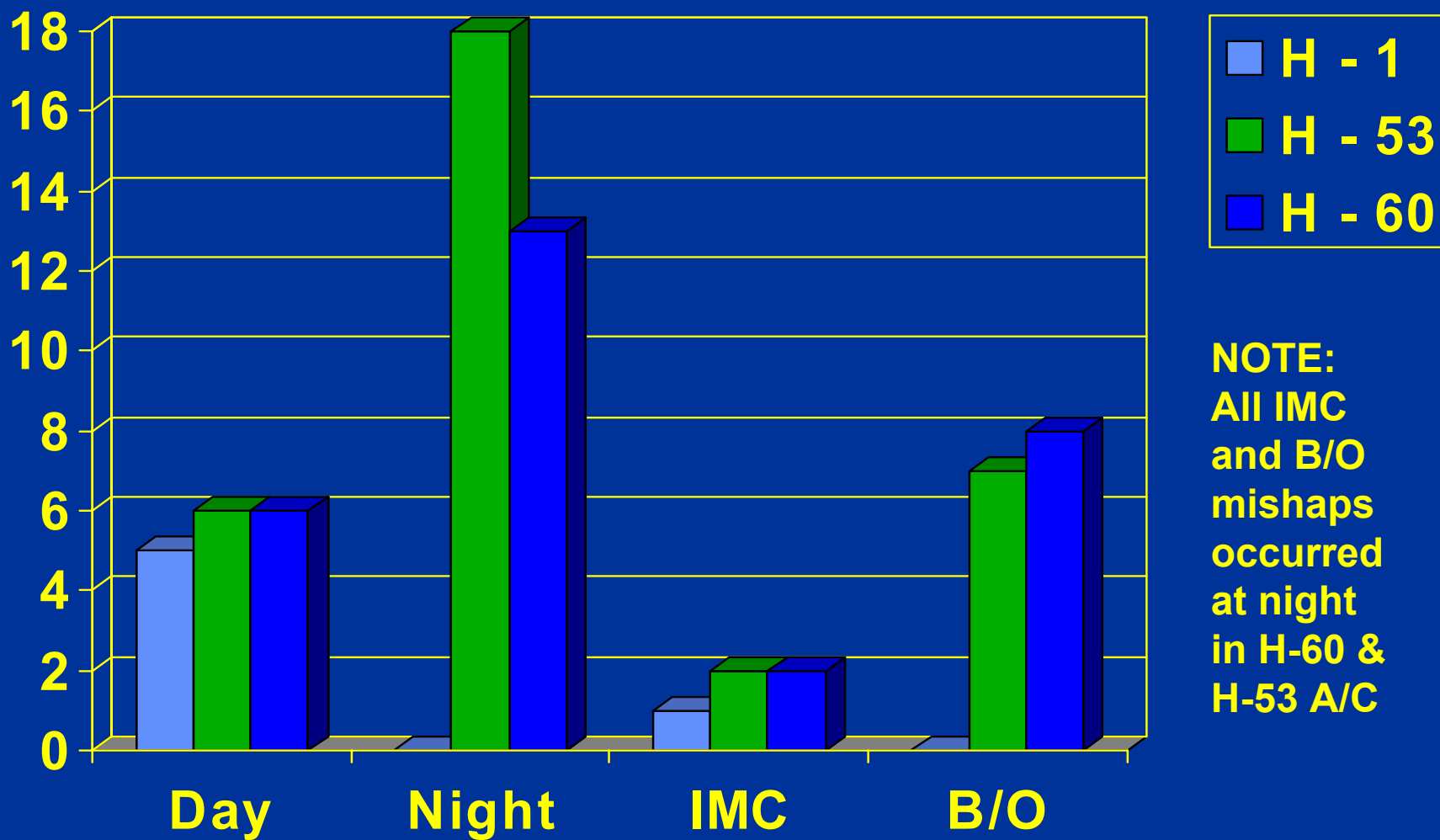
Note: Some Lat MRB due to droop



Whiteout – Brownout Night Instruments

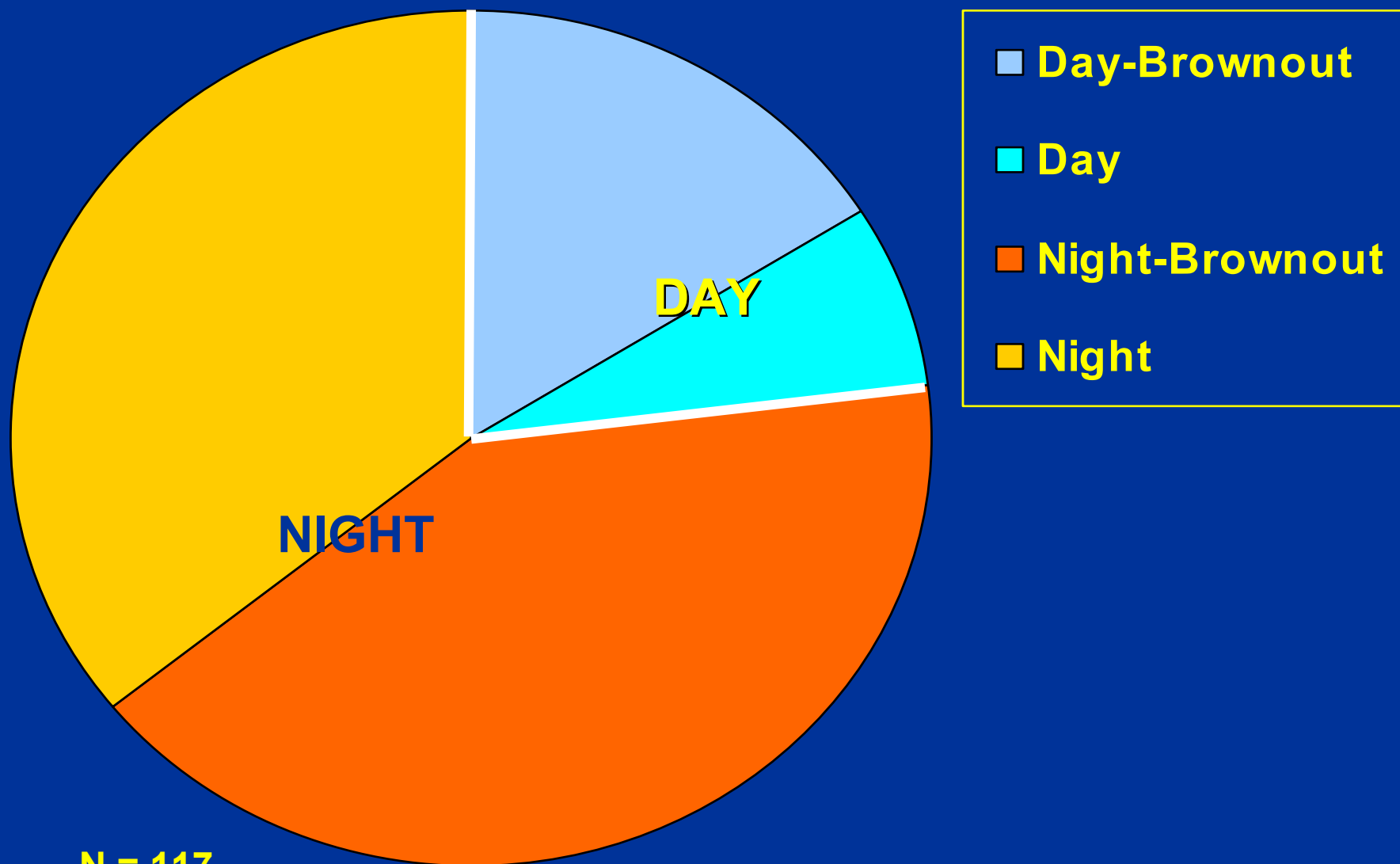


USAF Human Factor Class A & B Rotary Wing Mishaps, FY 85 – 05, Reduced Visibility/Night





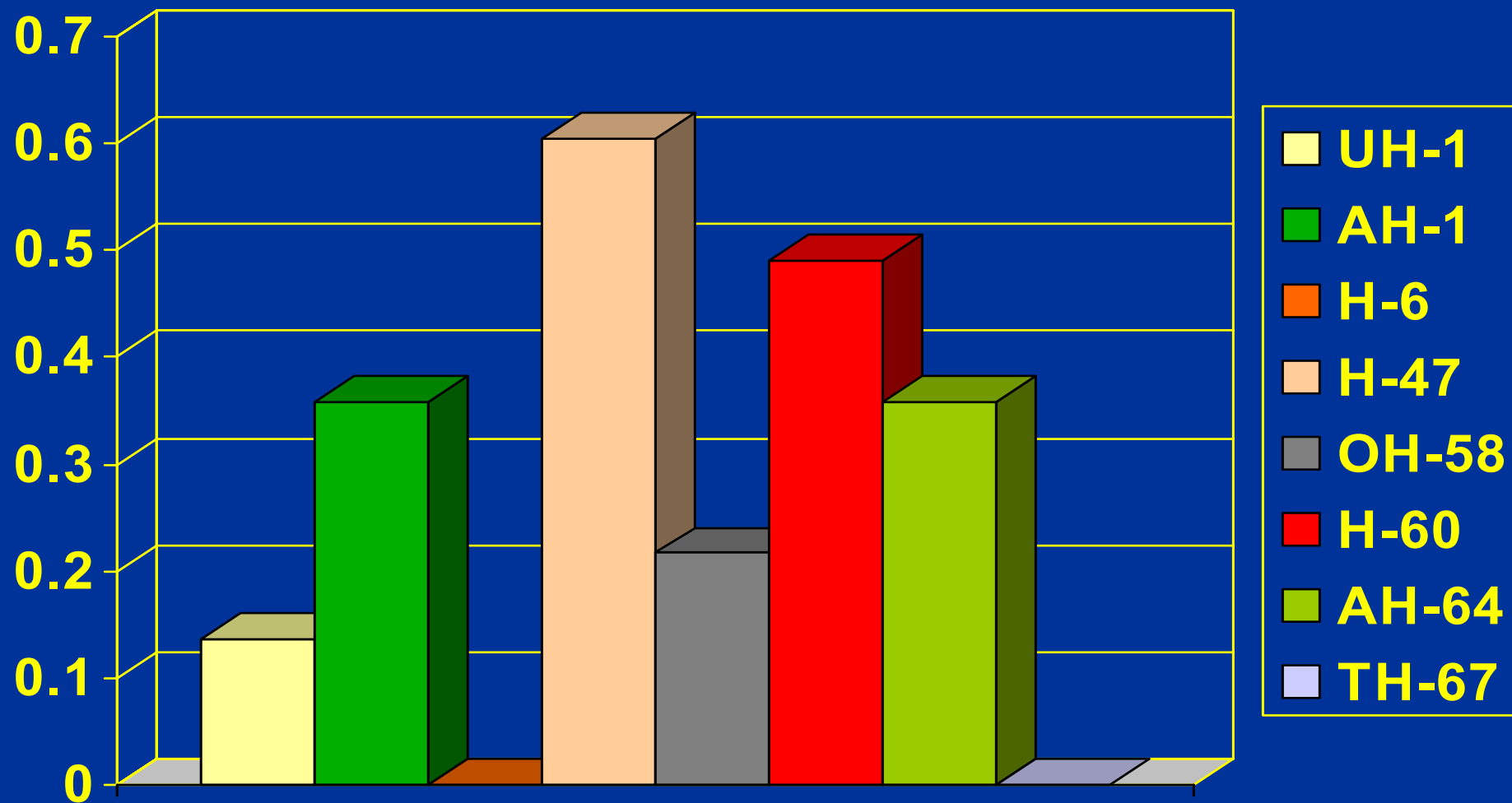
USA HF White/Brownout (& V-I) Prone Conditions



N = 117

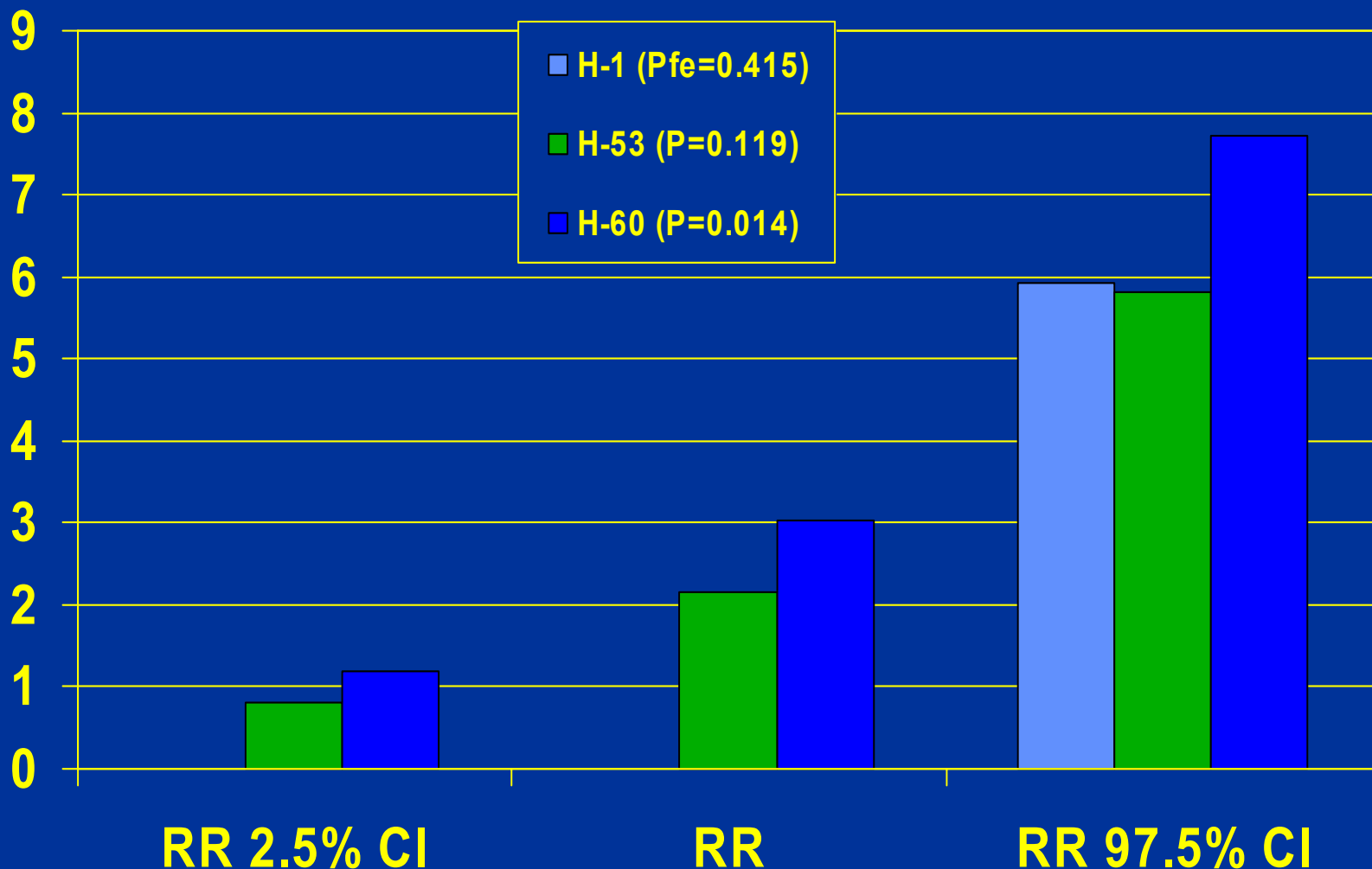


USA HF WHITEOUT/BROWNOUT RATES (/100K Hours) BY SYSTEM



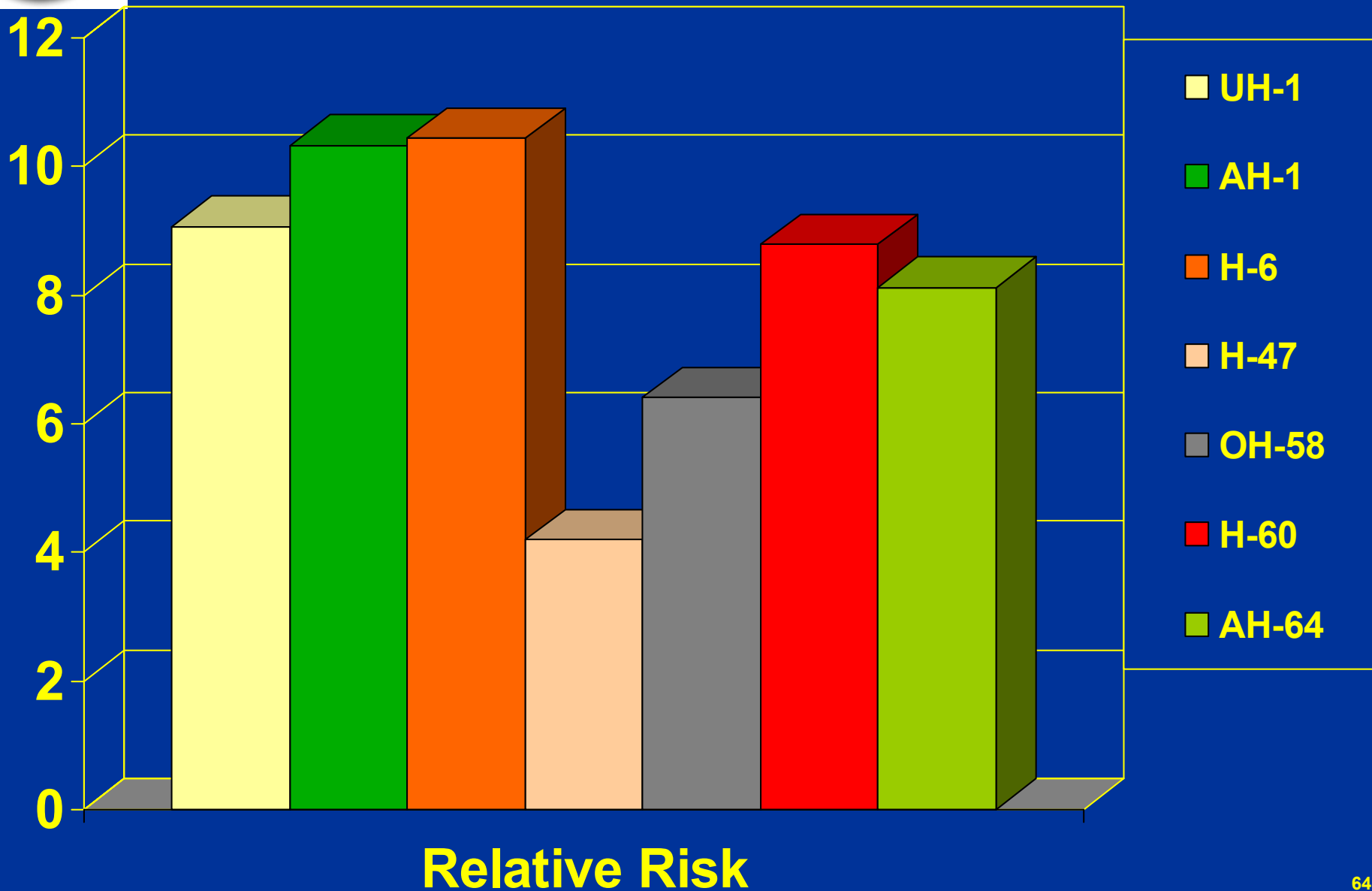


Relative Risk of Night USAF HF Class A & B Rotary Wing Mishaps, FY 85 – 05, By MDS





Relative Risk of Night USA HF Class A & B Mishaps, FY 85 – 05, By MDS



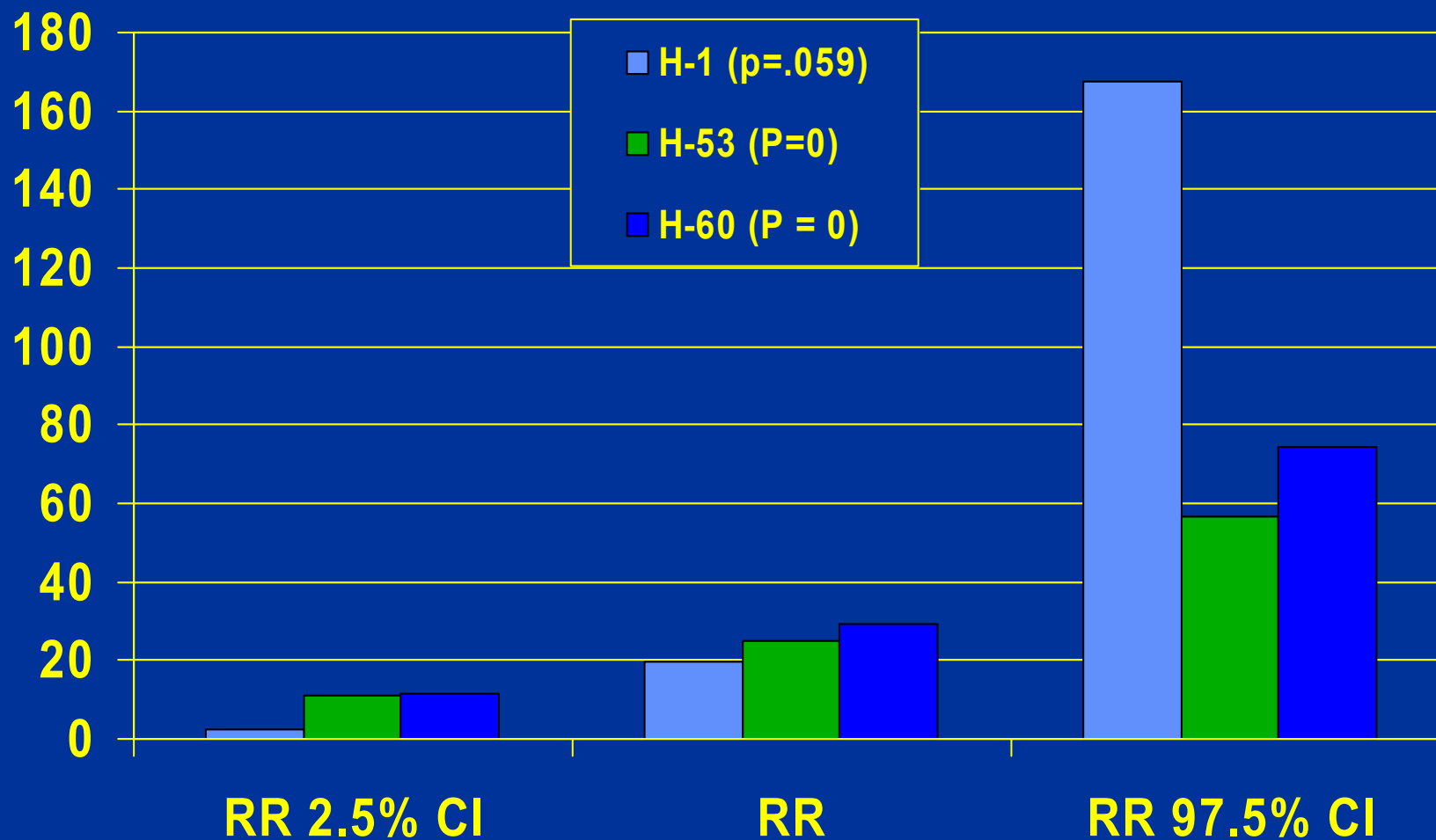


DON Risk at Night

- **Mishaps were compared for additive risk of night operations and no increased risk was identified with the exception of UH-1 operations from 1985 to 1994**
 - **UH-1 night operations between FY 85 – 94 inclusive showed 2.51 times the relative risk of day operations for a mishap 95% CI (1.1-5.71) $p = .024$**
 - **UH-1 night operations from FY 95 through FY 2005 had no increased risk**



Relative Risk of IMC USAF Class A & B Rotary Wing Mishaps, FY 85 – 05, By MDS

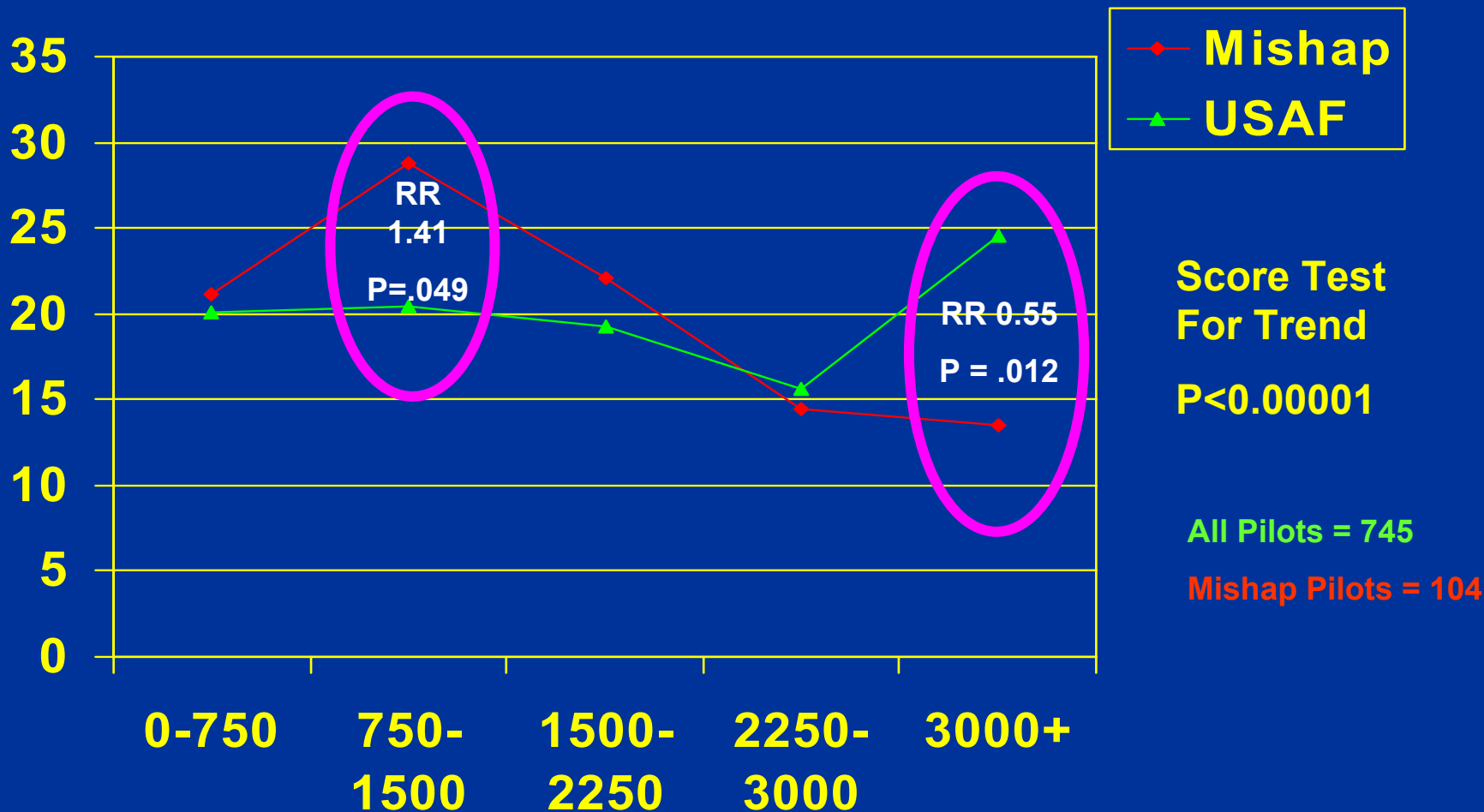




Experience, Recency, Training & Supervision (USAF Data)

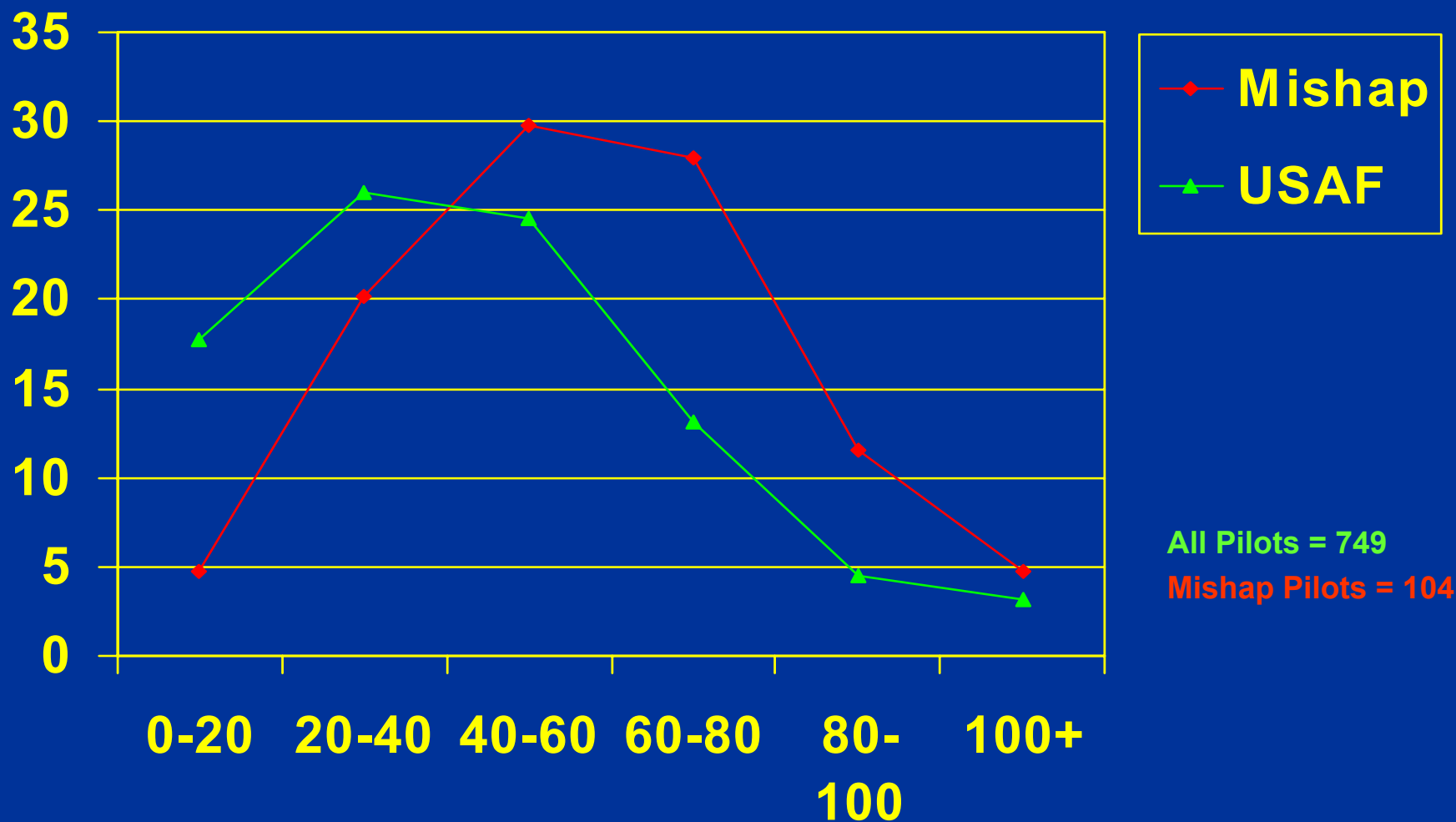


Total Flying Time & HF Mishaps, USAF Rotary Wing Pilots (FY85 – 05)



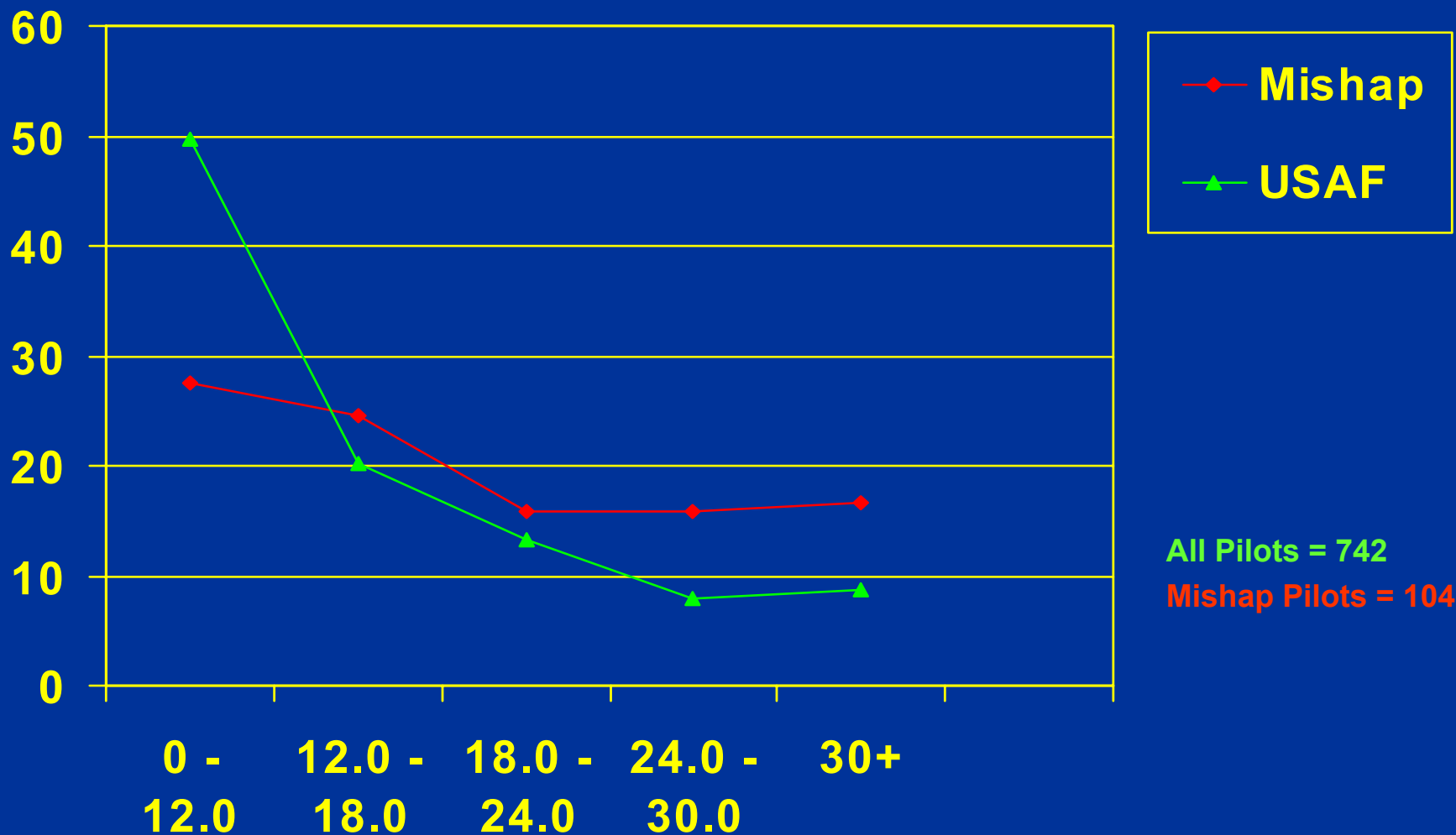


90 Day Recent Flying Time & HF Mishaps USAF Rotary Wing Pilots (FY85 – 05)





30 Day Recent Flying Time & HF Mishaps USAF Rotary Wing Pilots (FY85 - 05)





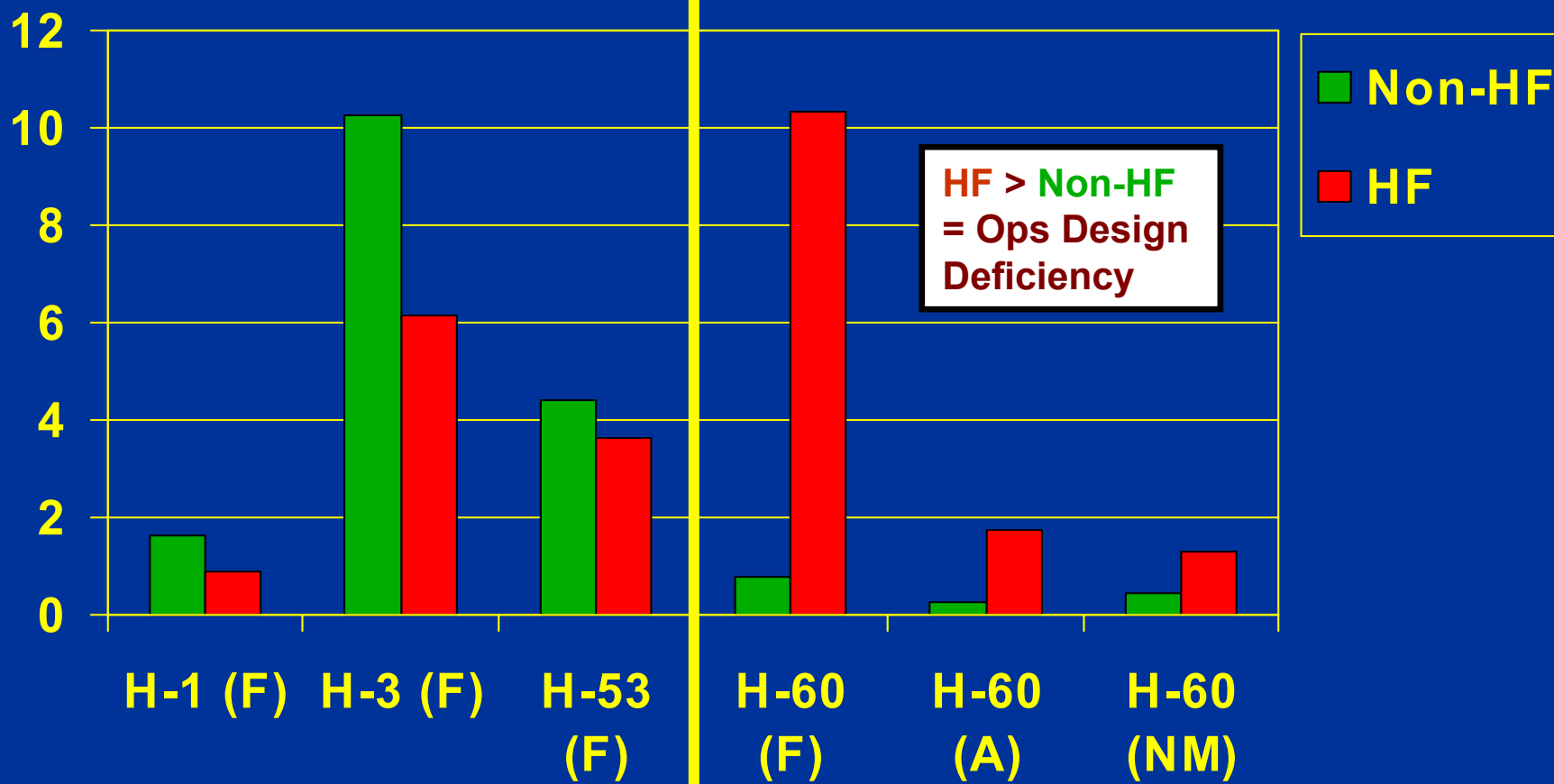
MDS Specific Data



USAF Rotary Wing Fatality Rates/100K Hours HF and Non-HF - By MDS + H-60

Non-HF > HF = Survival Design Deficiency

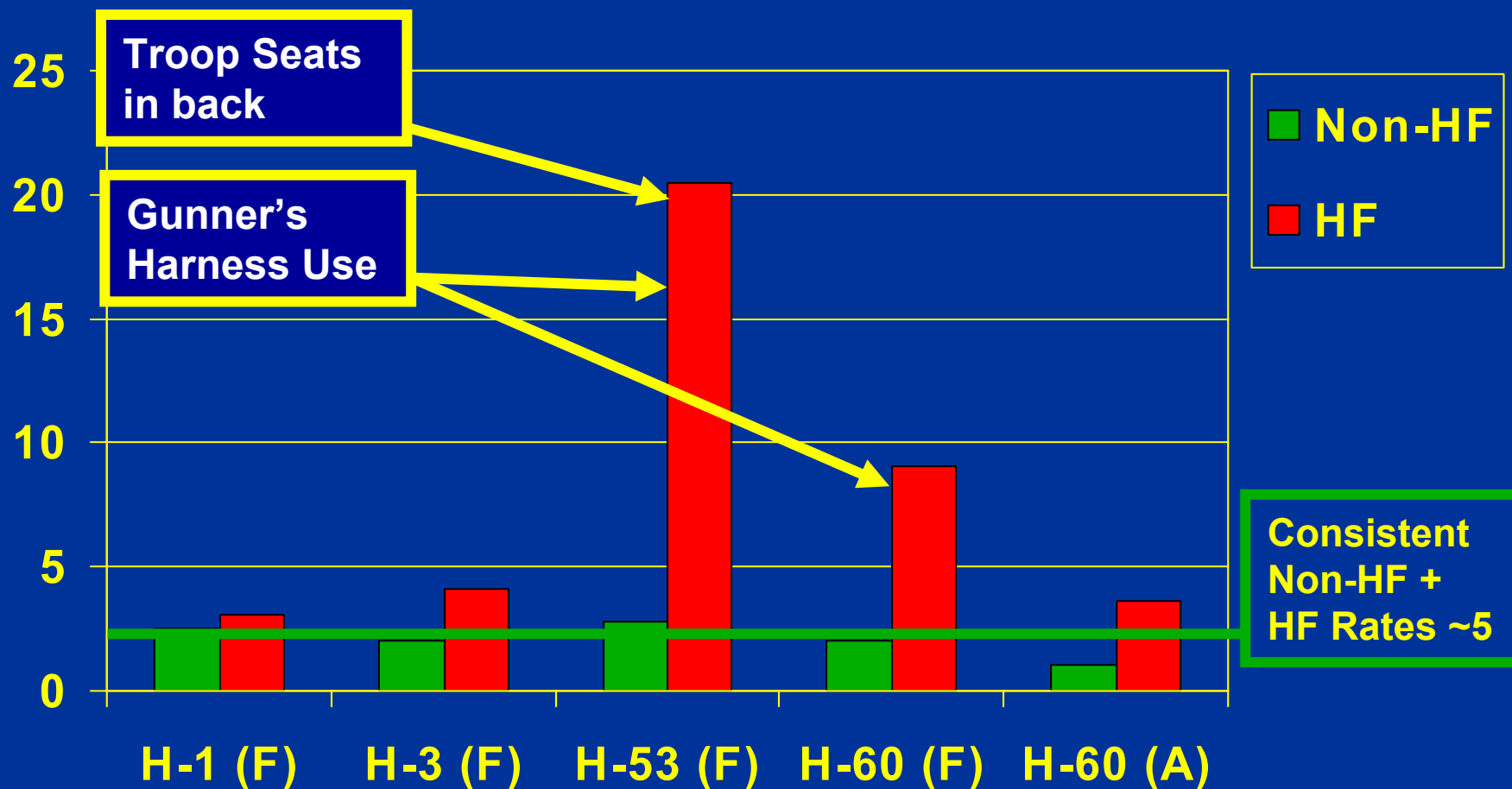
FY 85 - 05





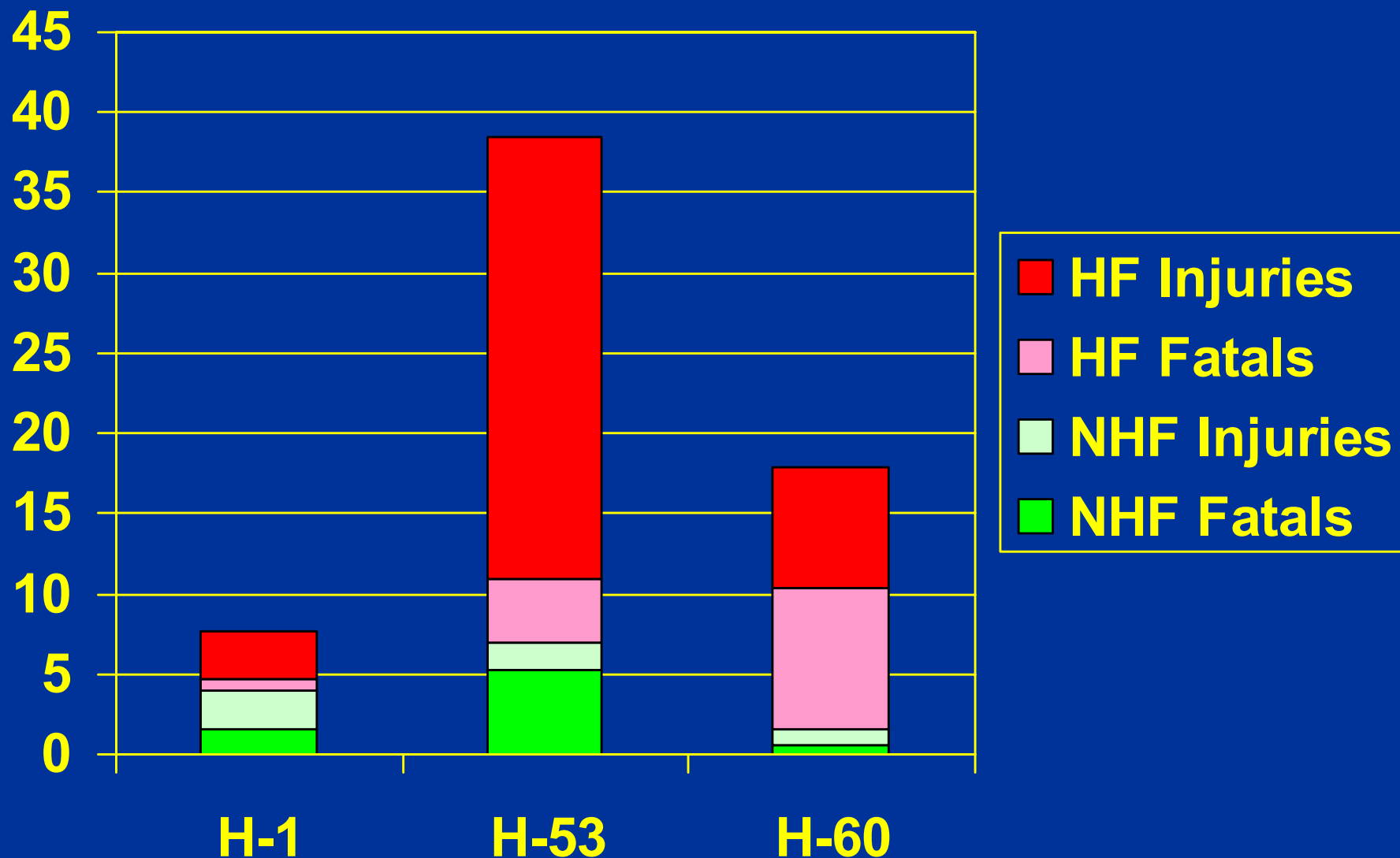
Comparison USAF & USA H-60 Rotary Wing Injury Rates/100K Hours by HF and Non-HF By MDS

FY 85 - 05





USAF Fatality & Injury Rates/100K Hours By MDS FY 85-05

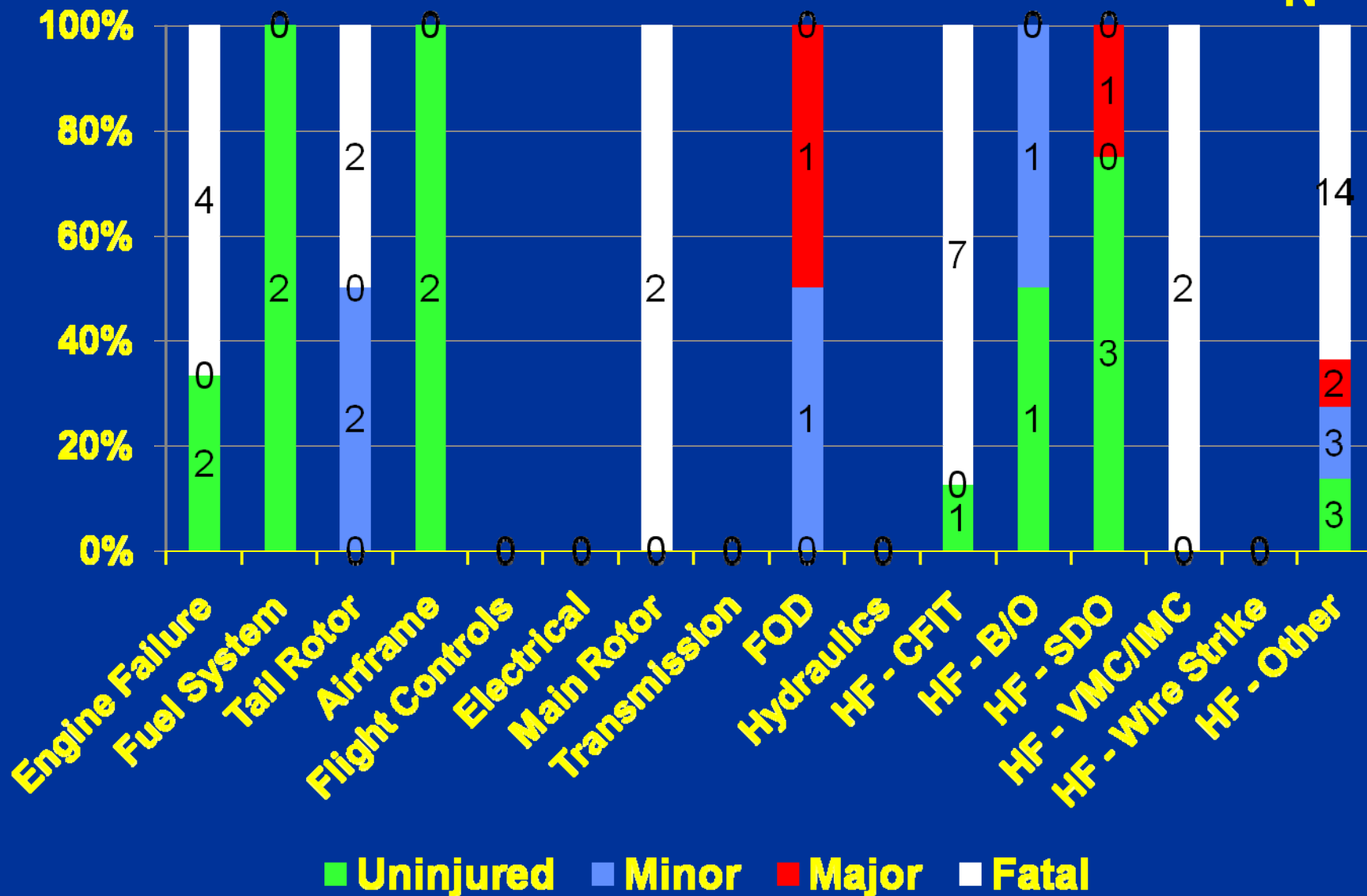




DoN AH-1

Occupant Outcome by Mishap Cause

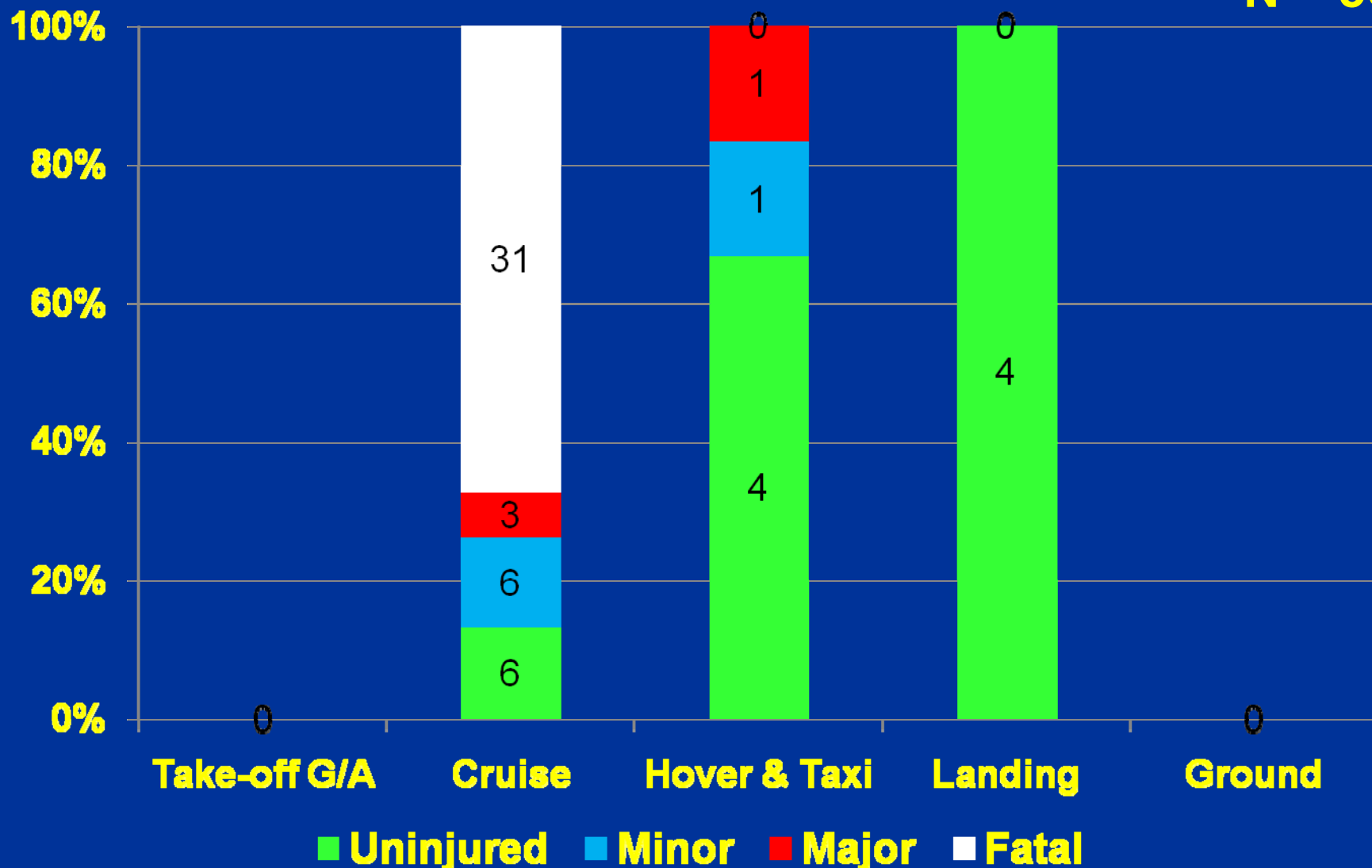
N = 56





DoN AH-1 Occupant Outcome by Phase of Flight

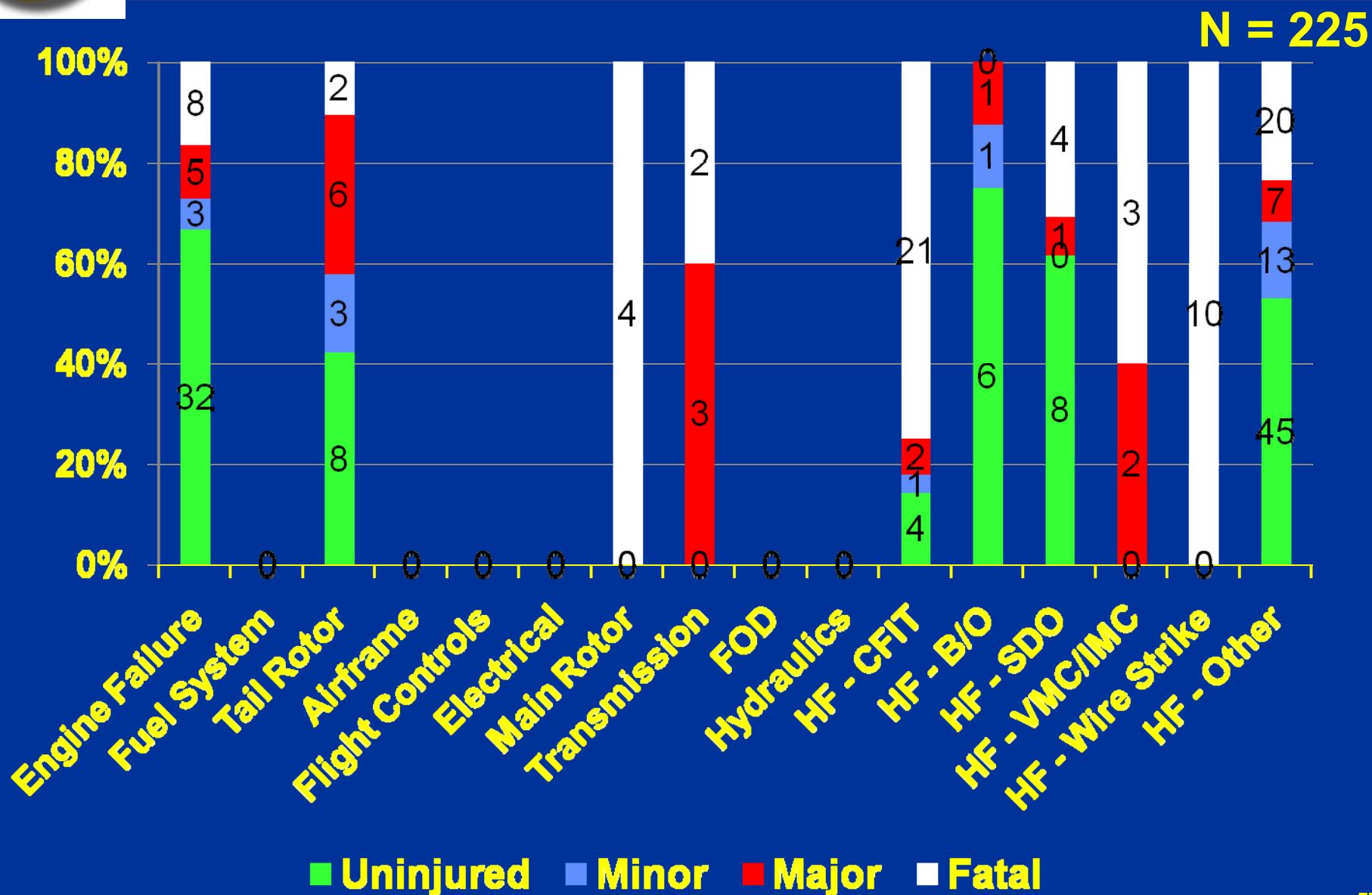
N = 56





DoN UH-1

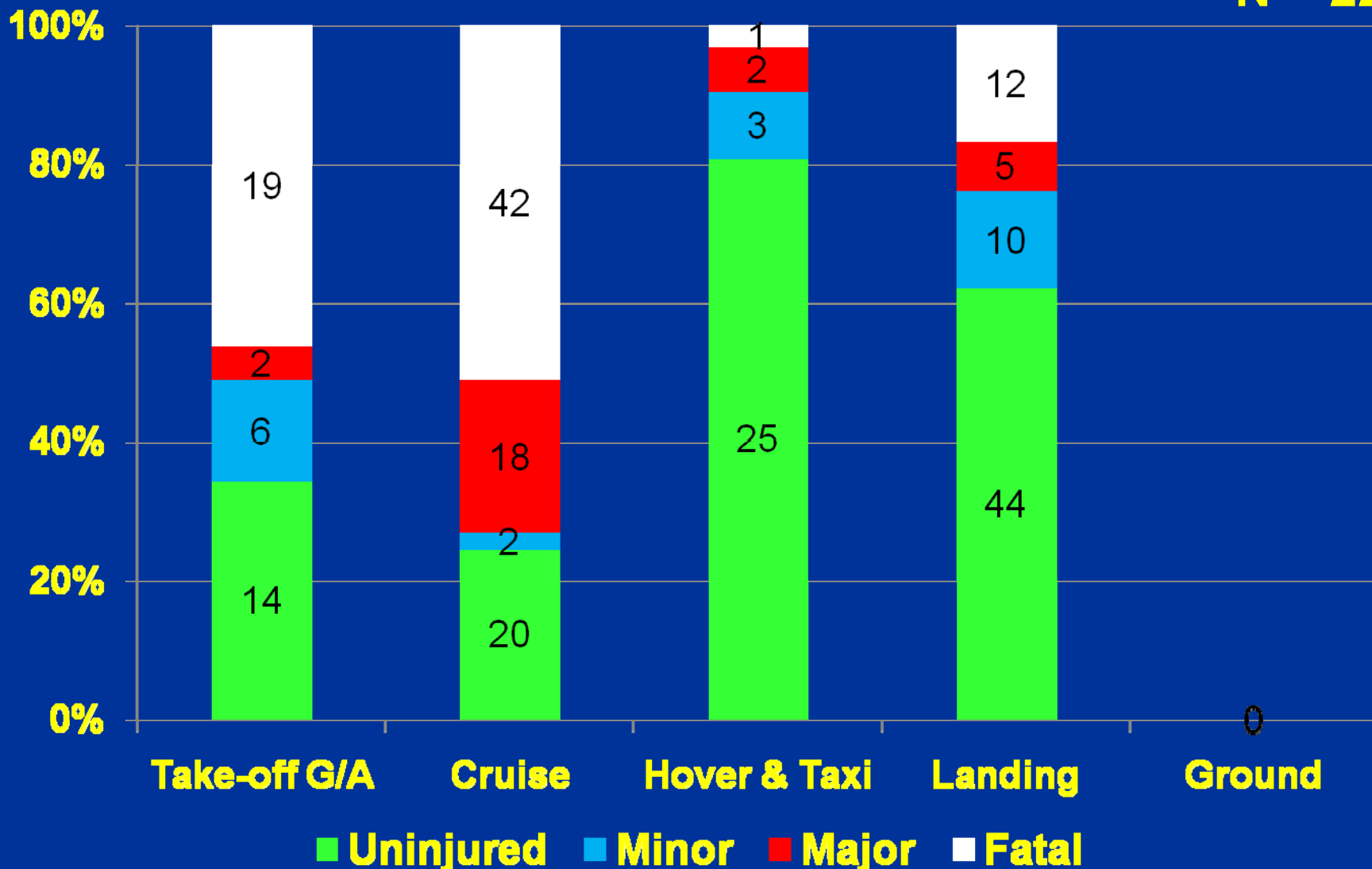
Occupant Outcome by Mishap Cause





DoN UH-1 Occupant Outcome by Phase of Flight

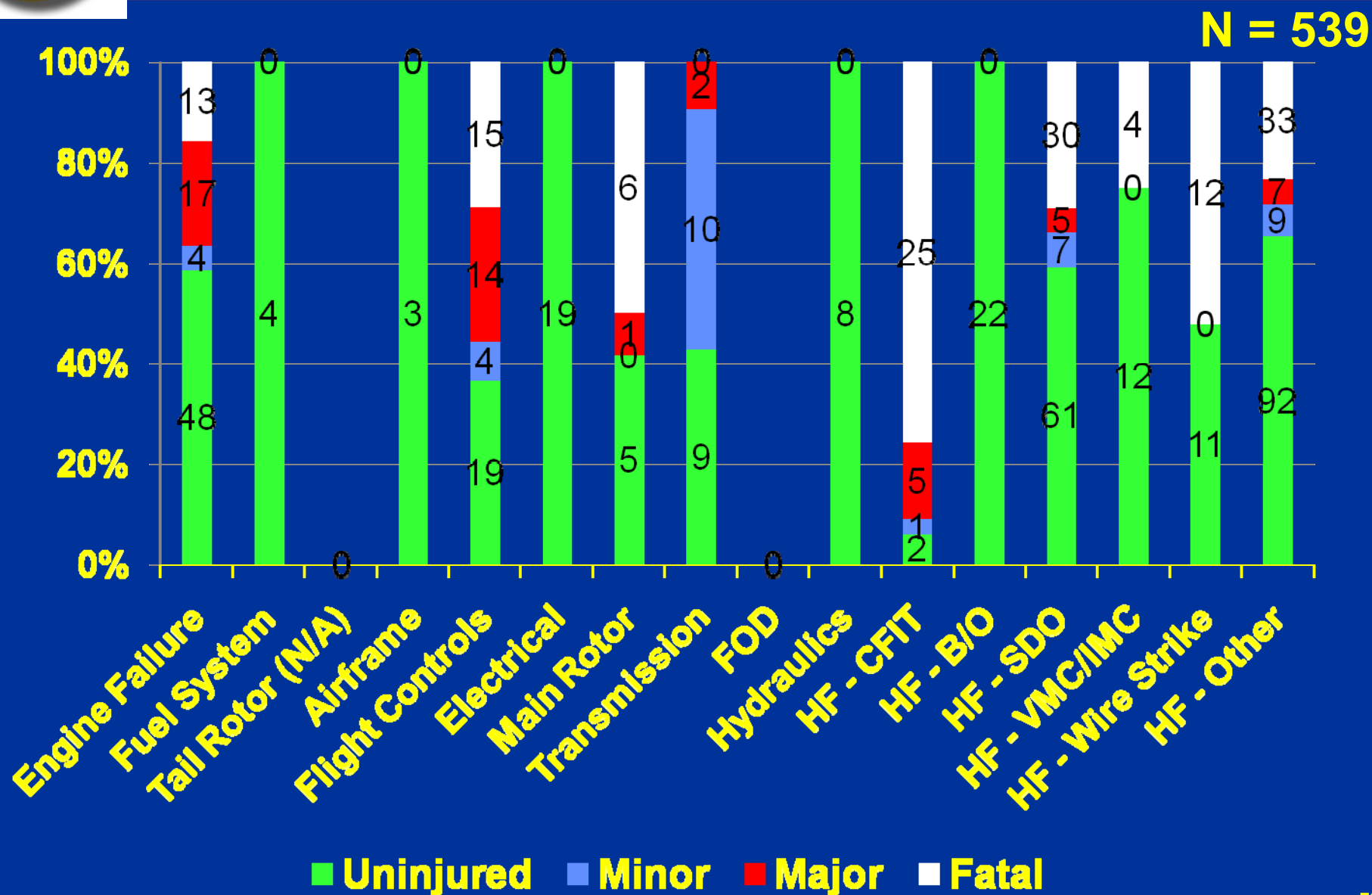
N = 225





DoN H-46

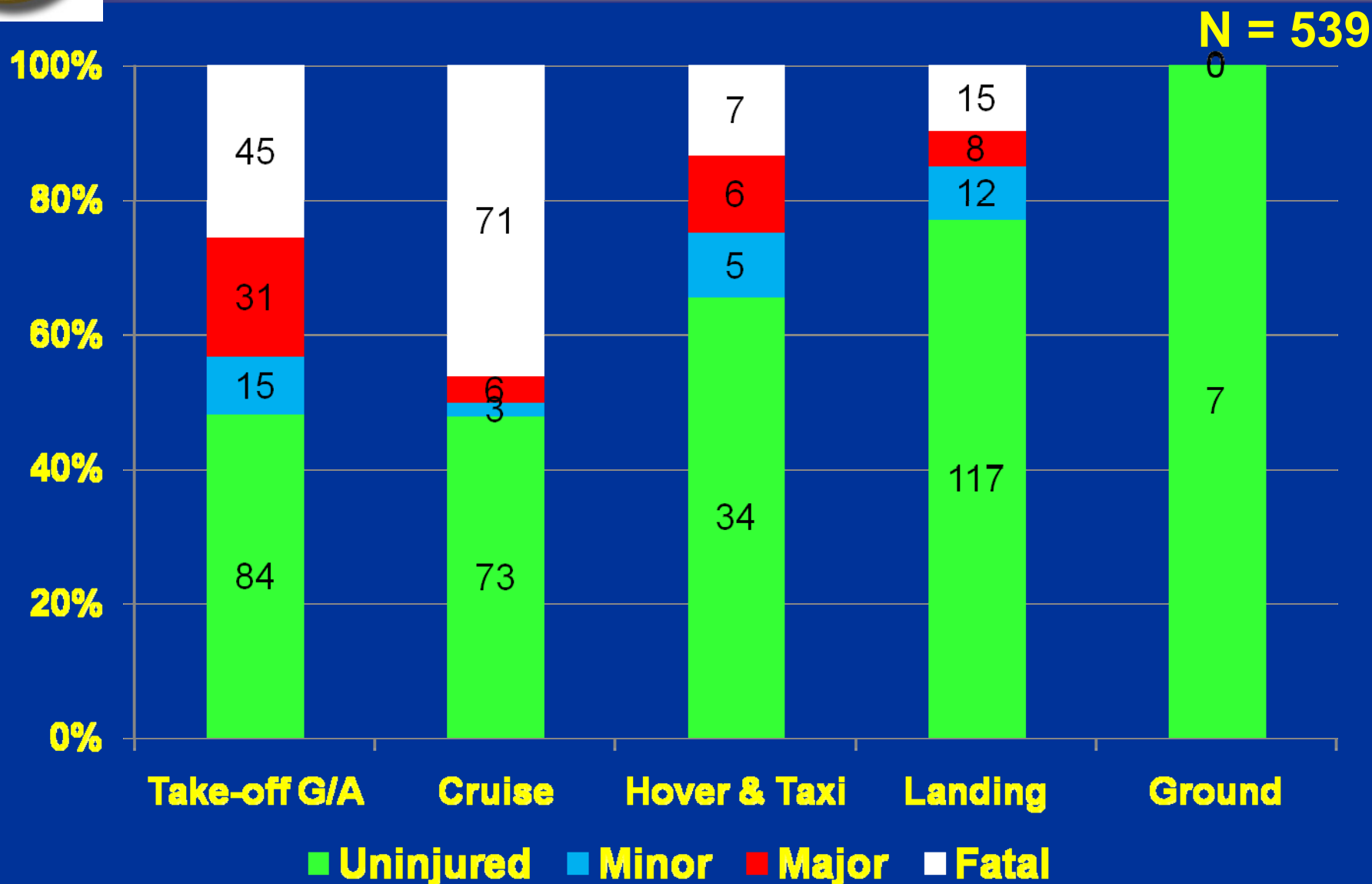
Occupant Outcome by Mishap Cause





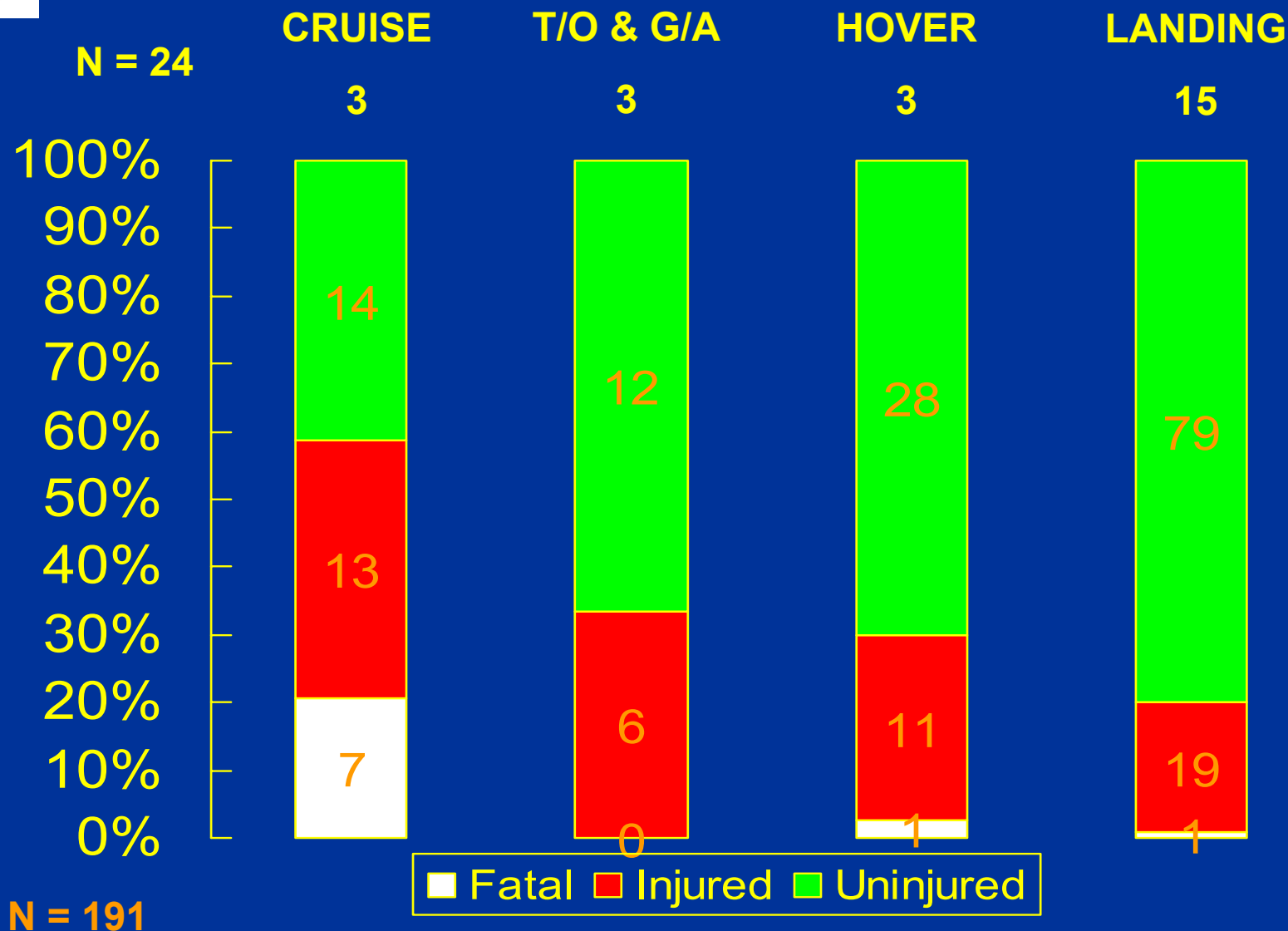
DoN H-46

Occupant Outcome by Phase of Flight



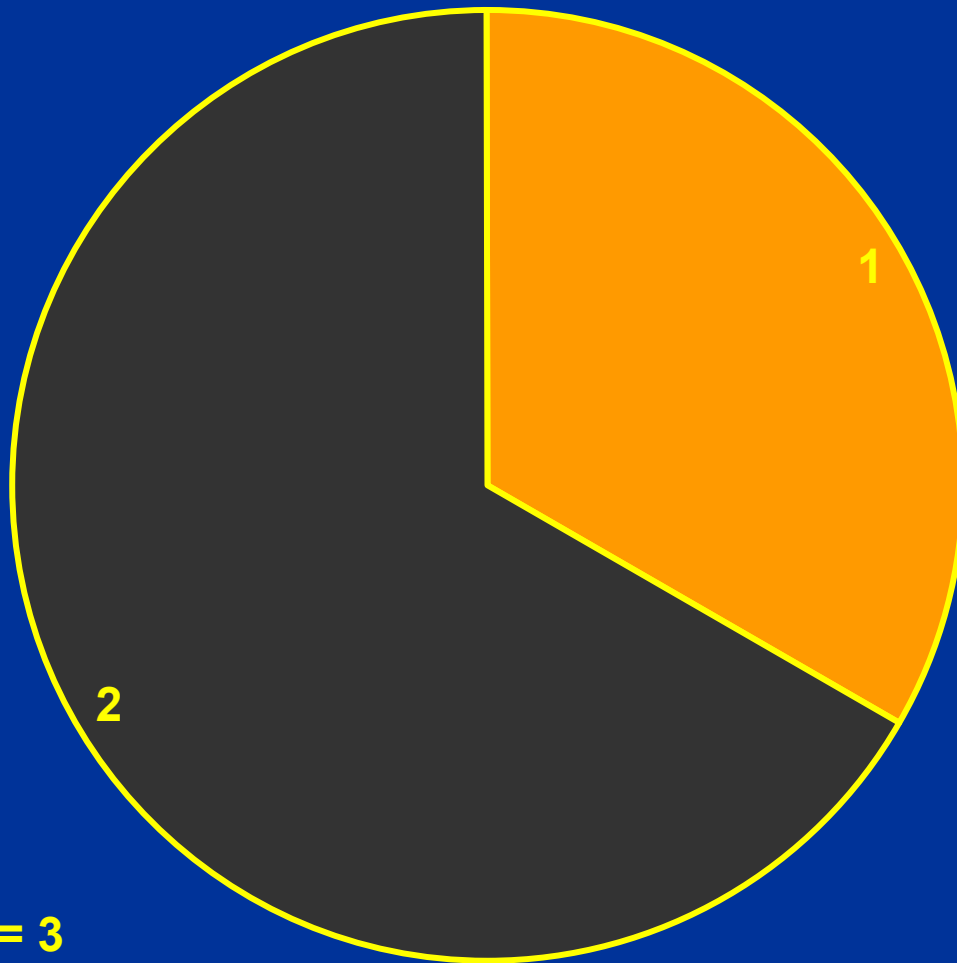


USAF HF Pave Low CFIT





USAF HF Pave Low Cruise CFIT

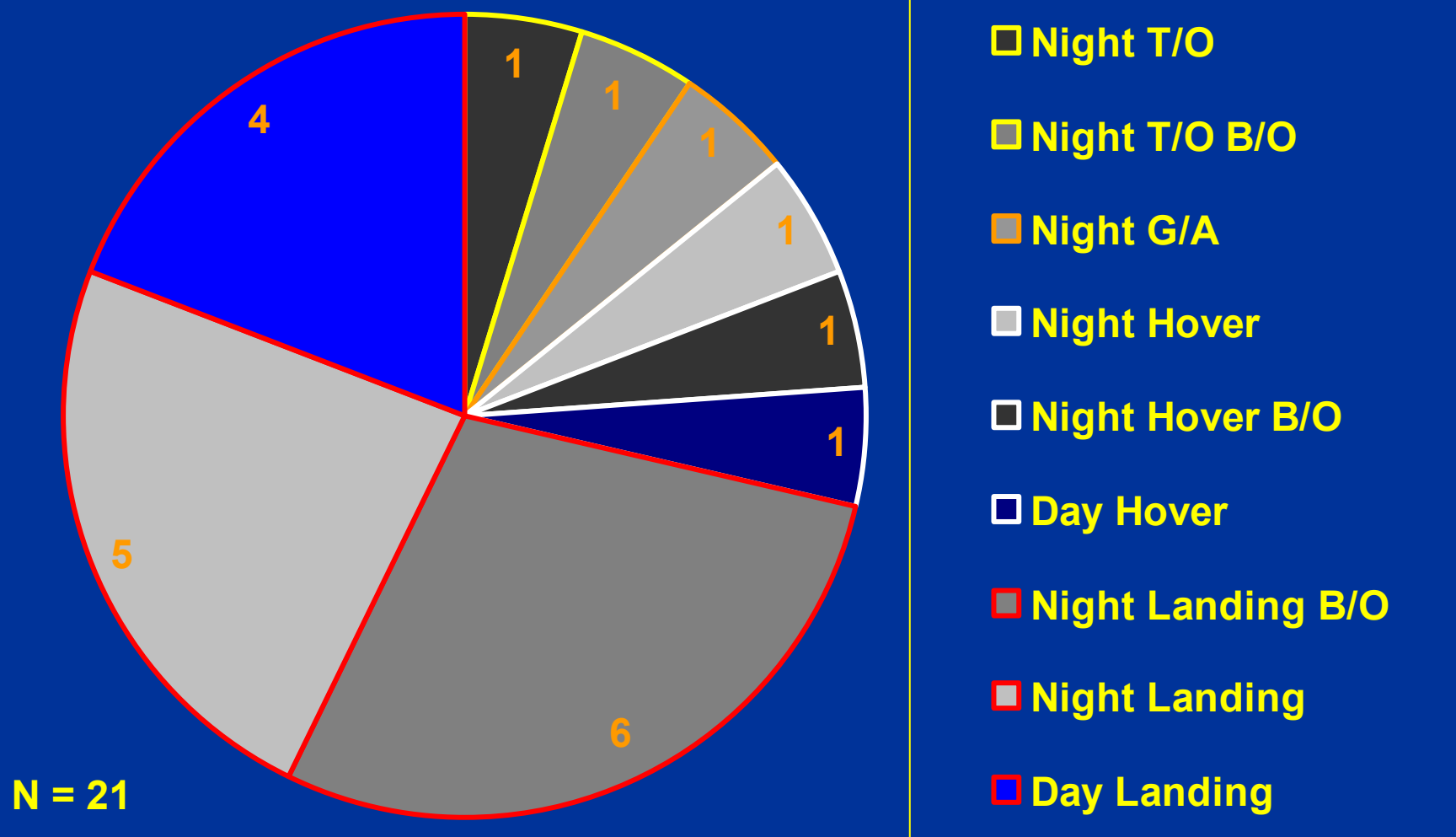


■ Unknown

■ Night IMC Terrain



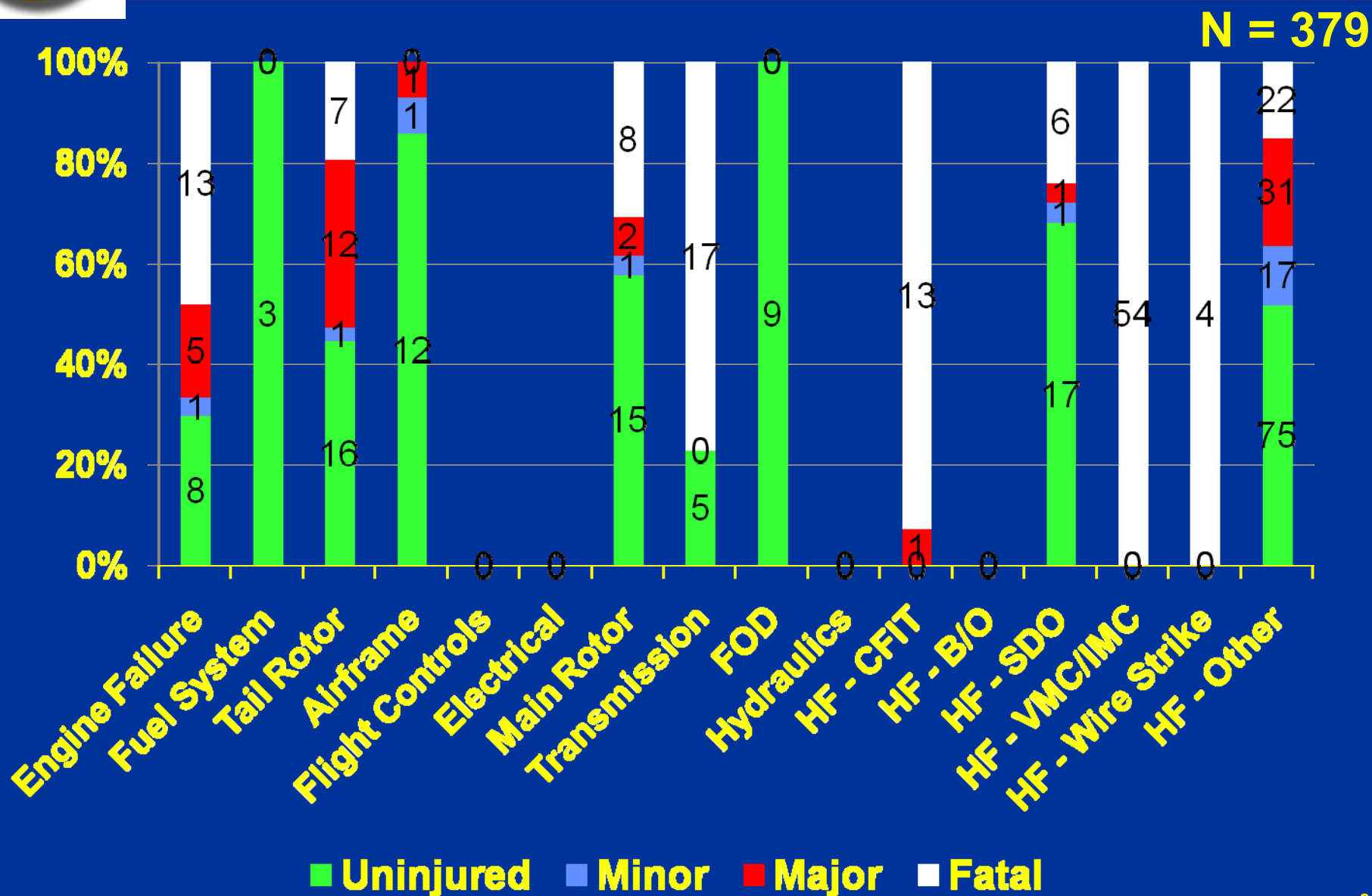
USAF HF Pave Low Slow CFIT





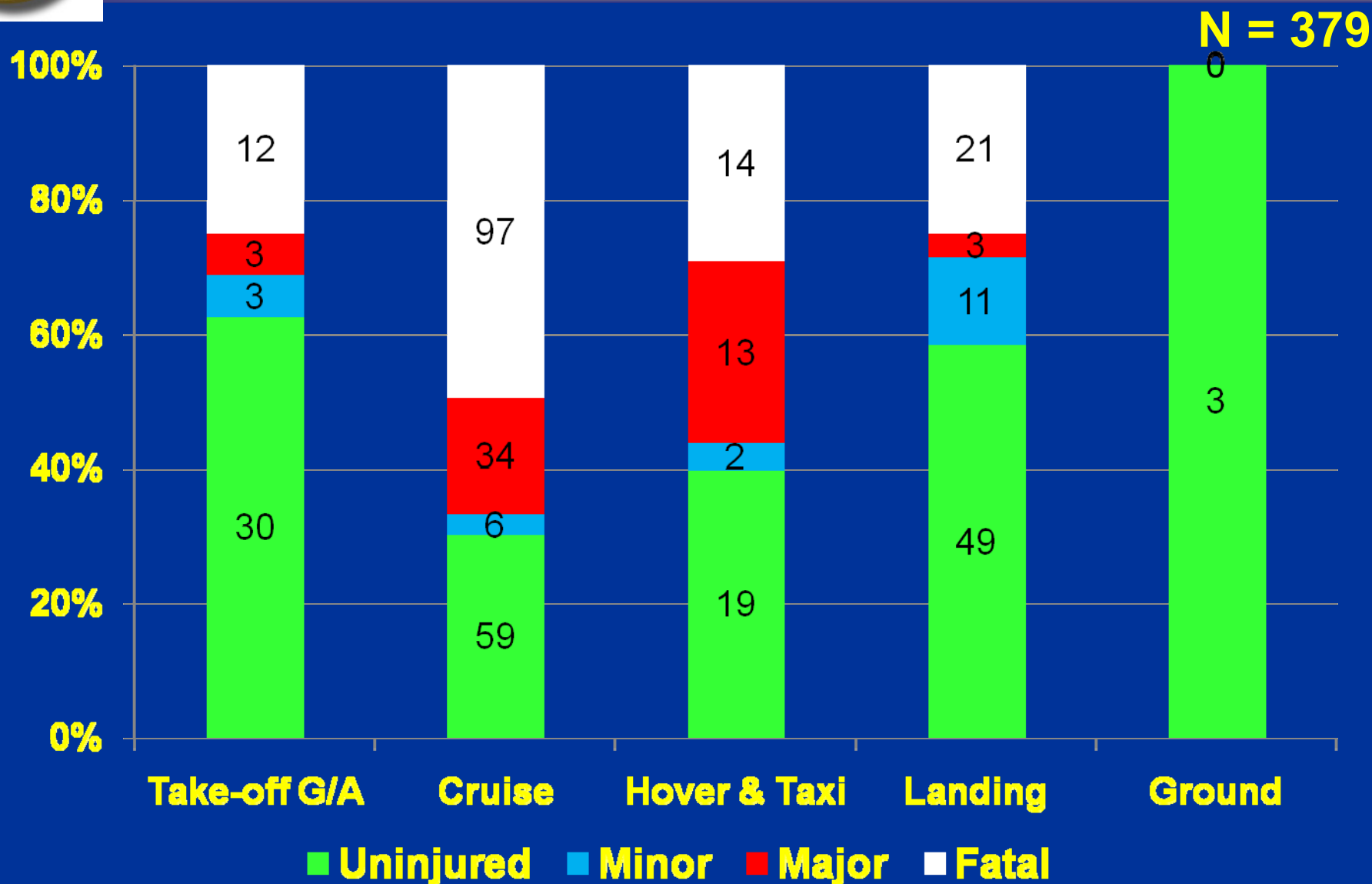
DoN H-53

Occupant Outcome by Mishap Cause



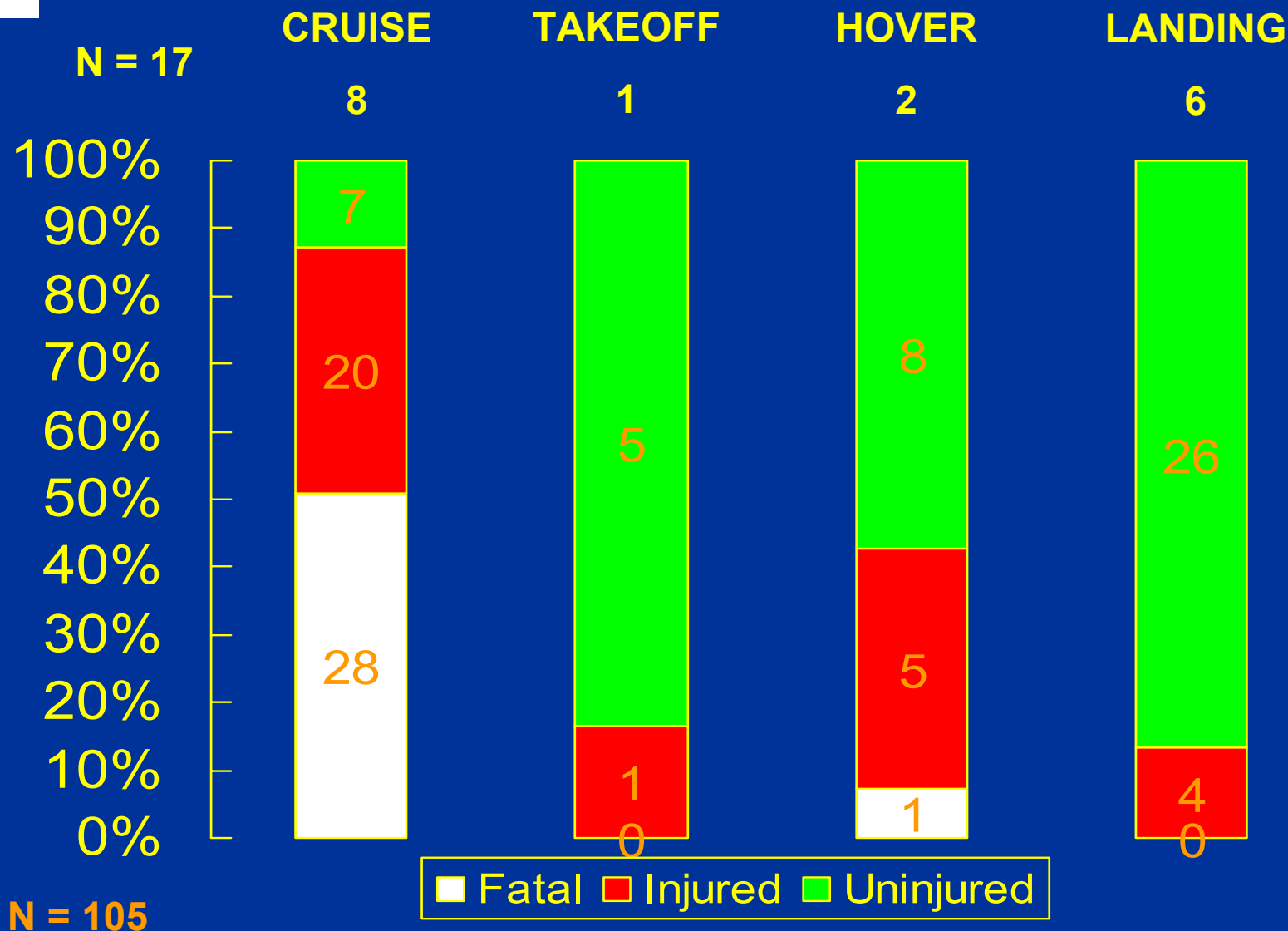


DoN H-53 Occupant Outcome by Phase of Flight



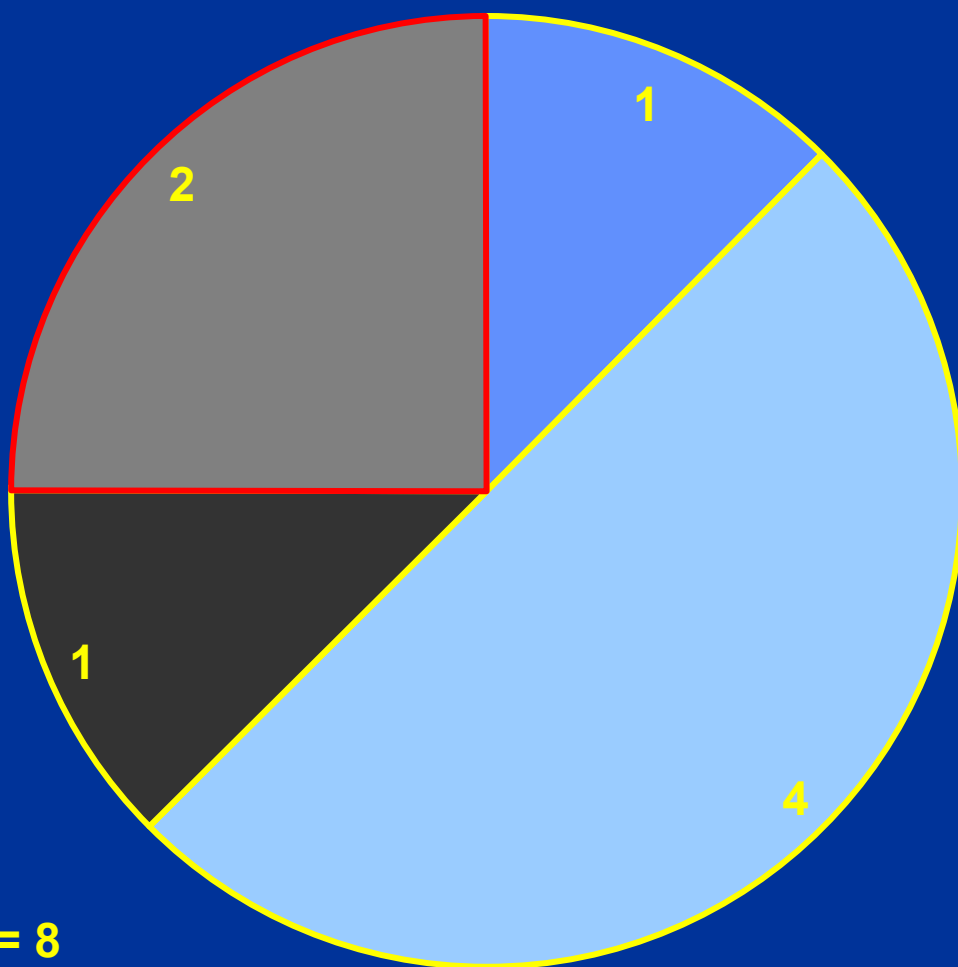


USAF HF Blackhawk CFIT





USAF HF Blackhawk Cruise CFIT



□ Day VMC Terrain

□ Day VMC Aero

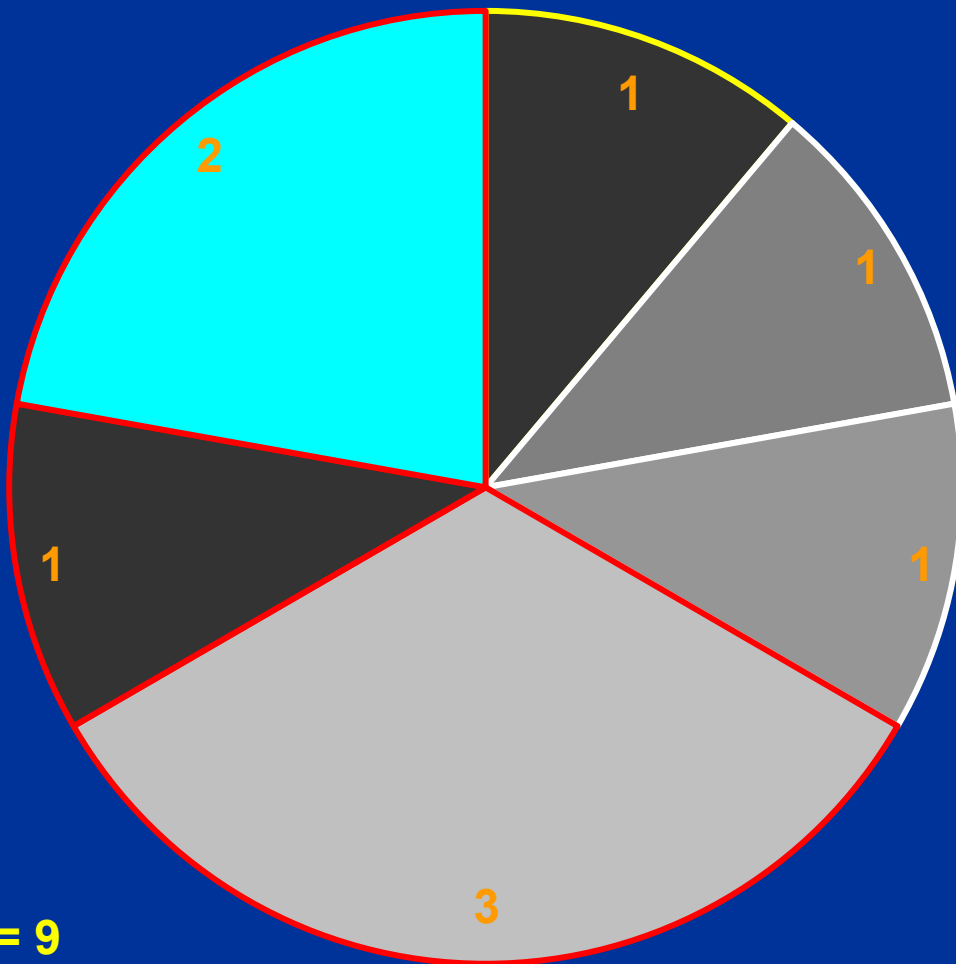
□ Night VMC Wire

□ Night IMC Terrain

N = 8



USAF HF Blackhawk Slow CFIT



N = 9

□ Night T/O B/O

□ Night Hover

□ Night Hover B/O

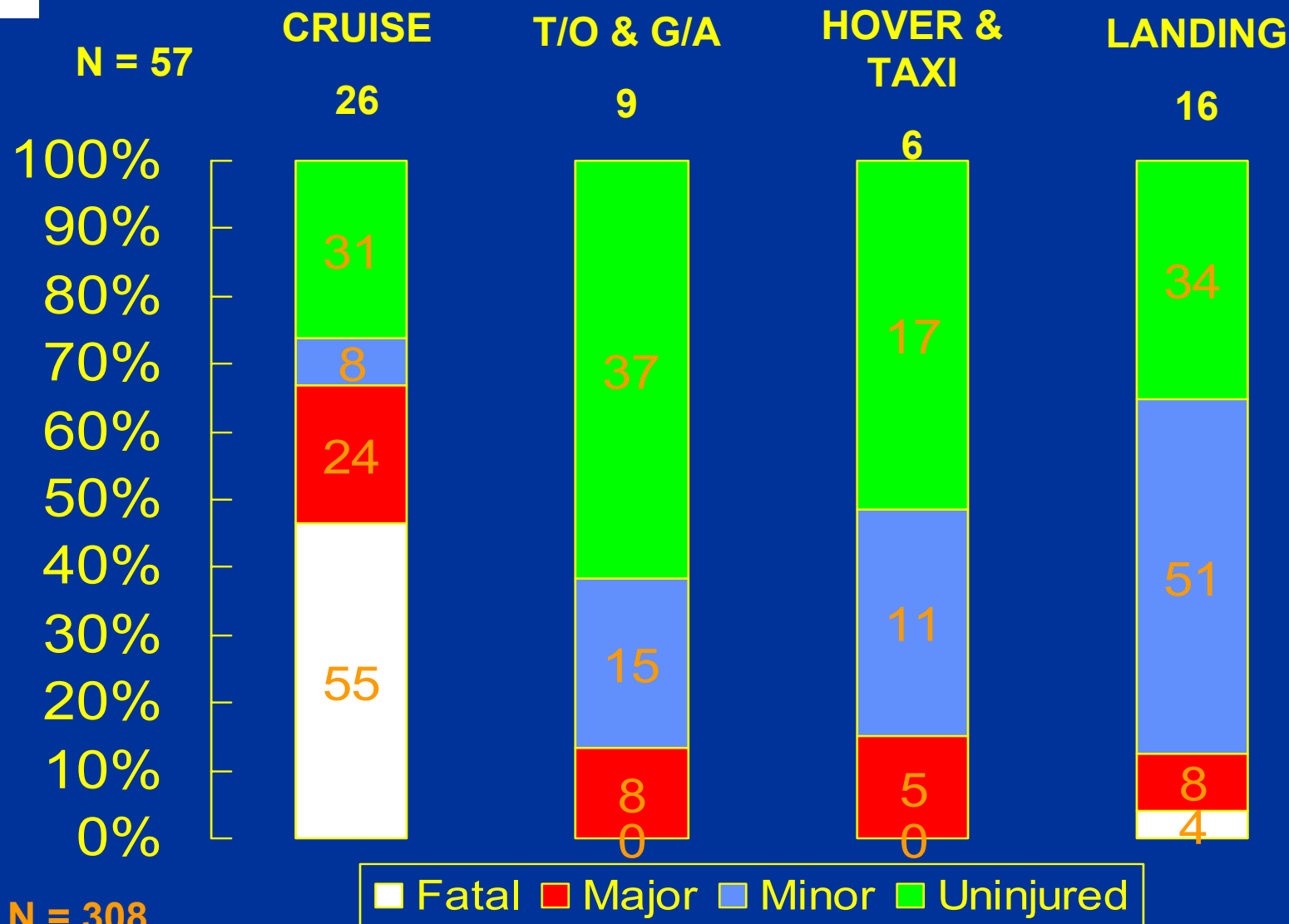
□ Night Landing B/O

□ Night Landing

□ Day Landing

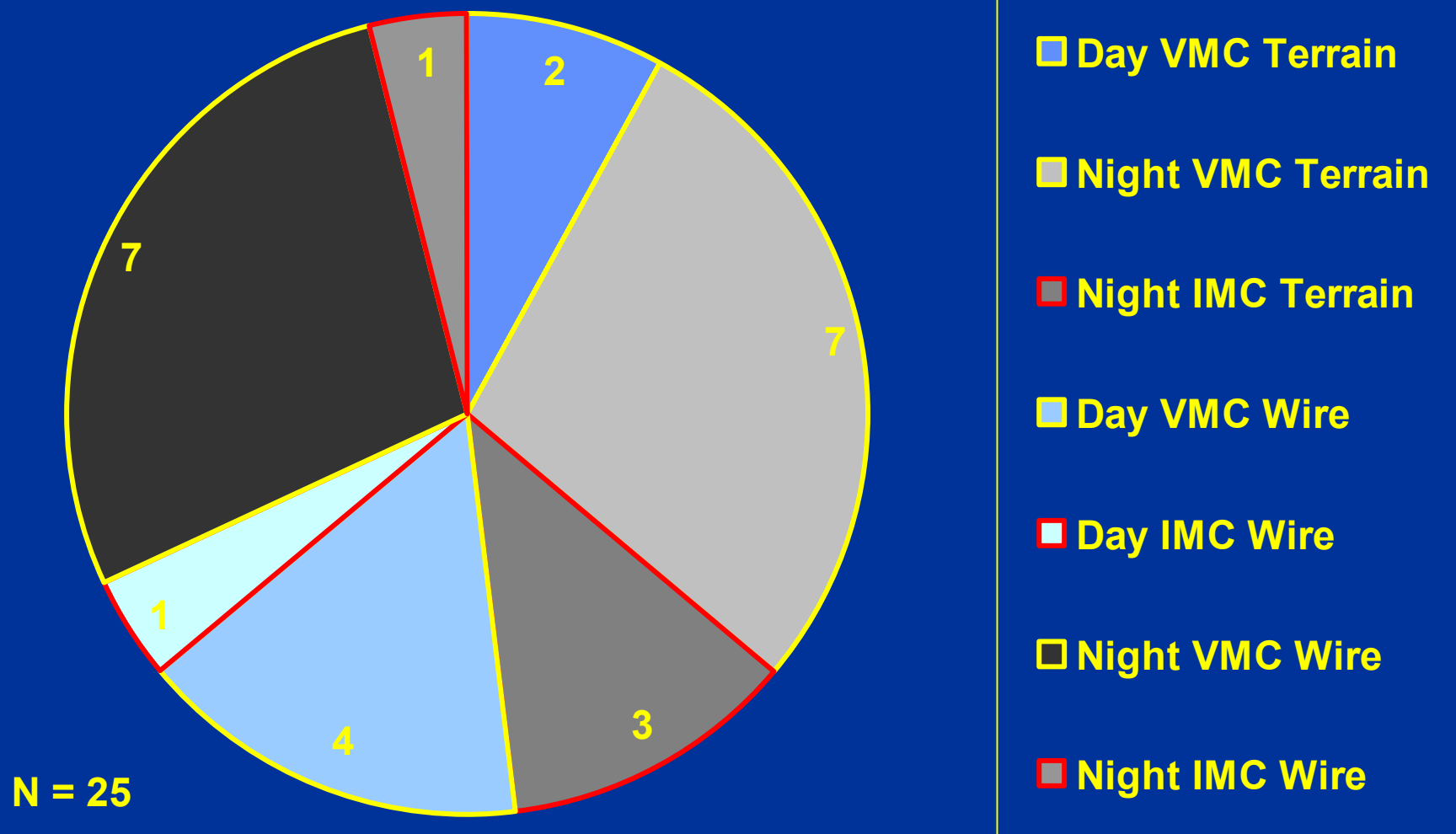


Army HF Blackhawk CFIT



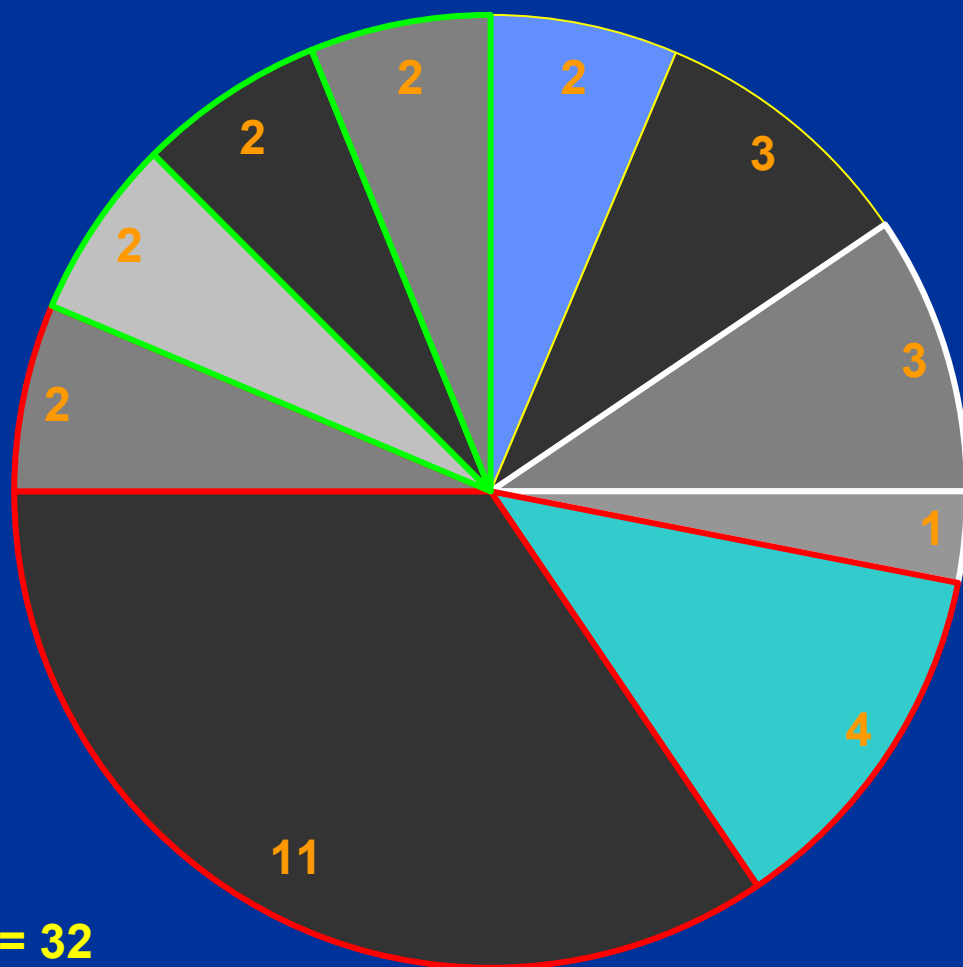


Army HF Blackhawk Cruise CFIT





Army HF Blackhawk Slow CFIT



N = 32

- Day T/O B/O
- Night T/O B/O
- Night G/A B/O
- Night G/A
- Day Landing B/O
- Night Landing B/O
- Night Landing
- Night Hover B/O
- Night Hover IMC
- Night Hover VMC



Army HF Blackhawk MIDAIR

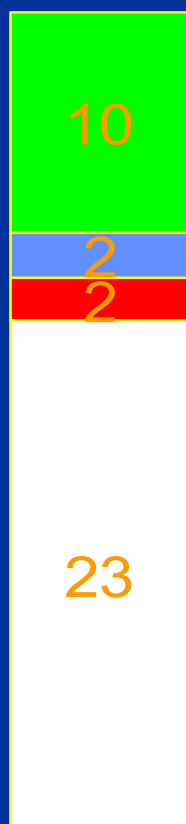
N = 9, All Night,
Clear Air

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

N = 101

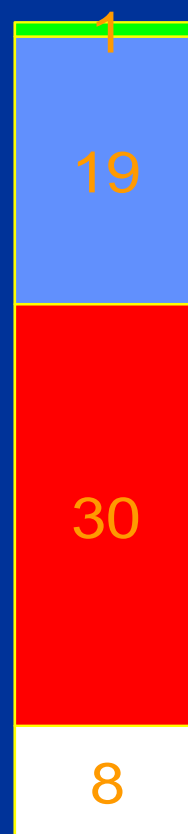
CRUISE

4 (C-182)



HOVER/TAXI

4 (AH-64)



PARKED

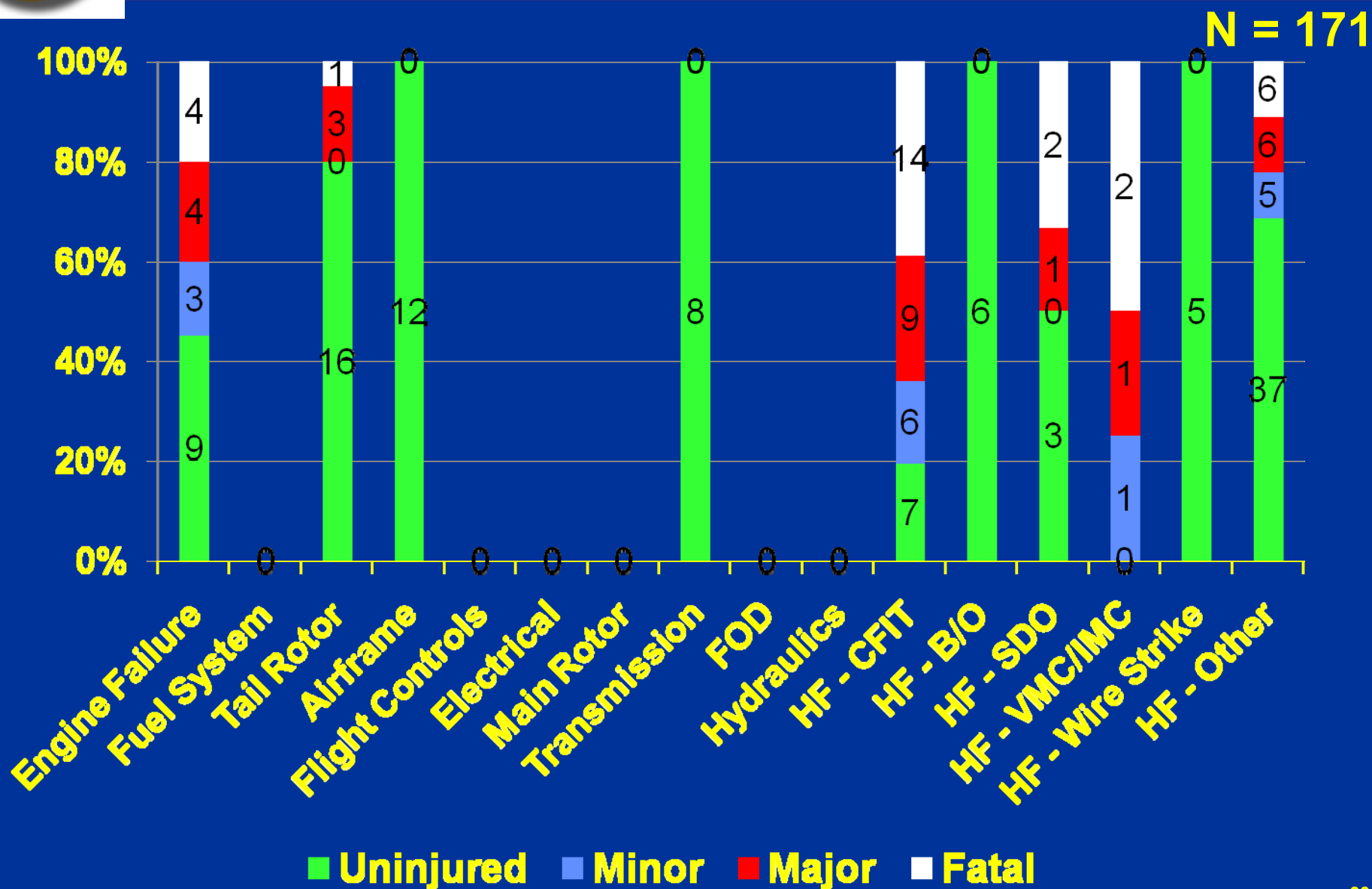
1 (hit by UH-1H)



■ Fatal ■ Major ■ Minor ■ Uninjured



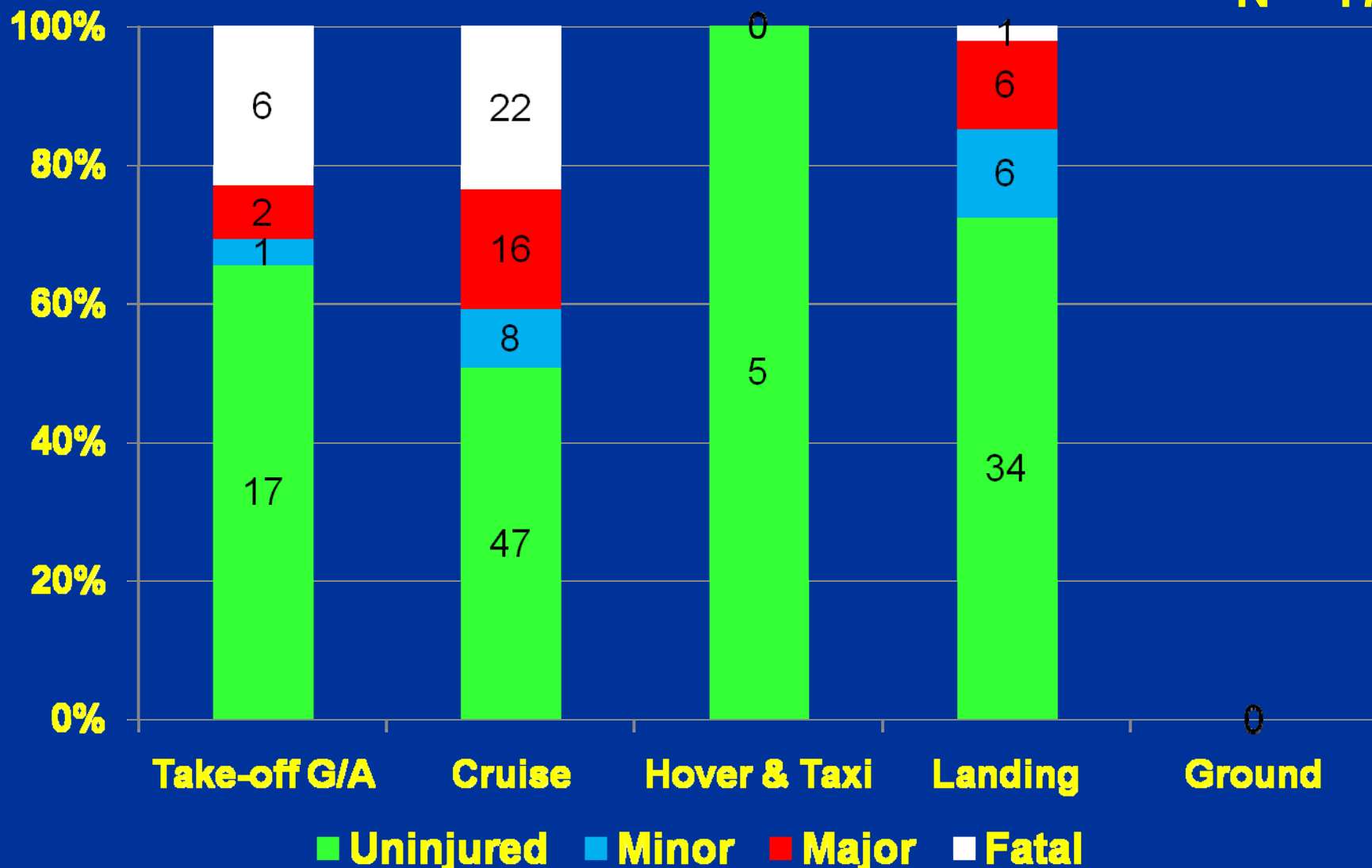
DoN H-60 Occupant Outcome by Mishap Cause





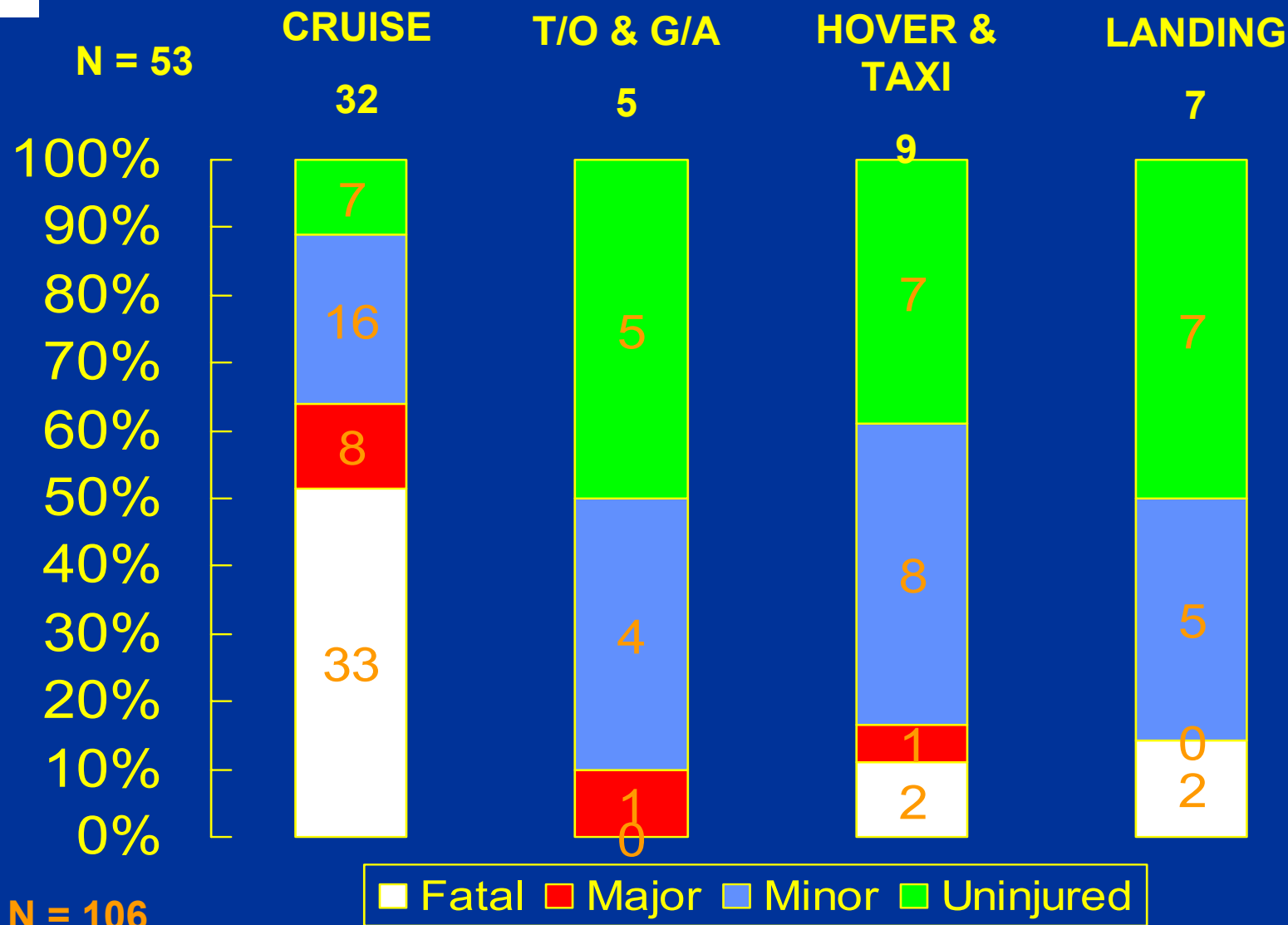
DoN H-60 Occupant Outcome by Phase of Flight

N = 171



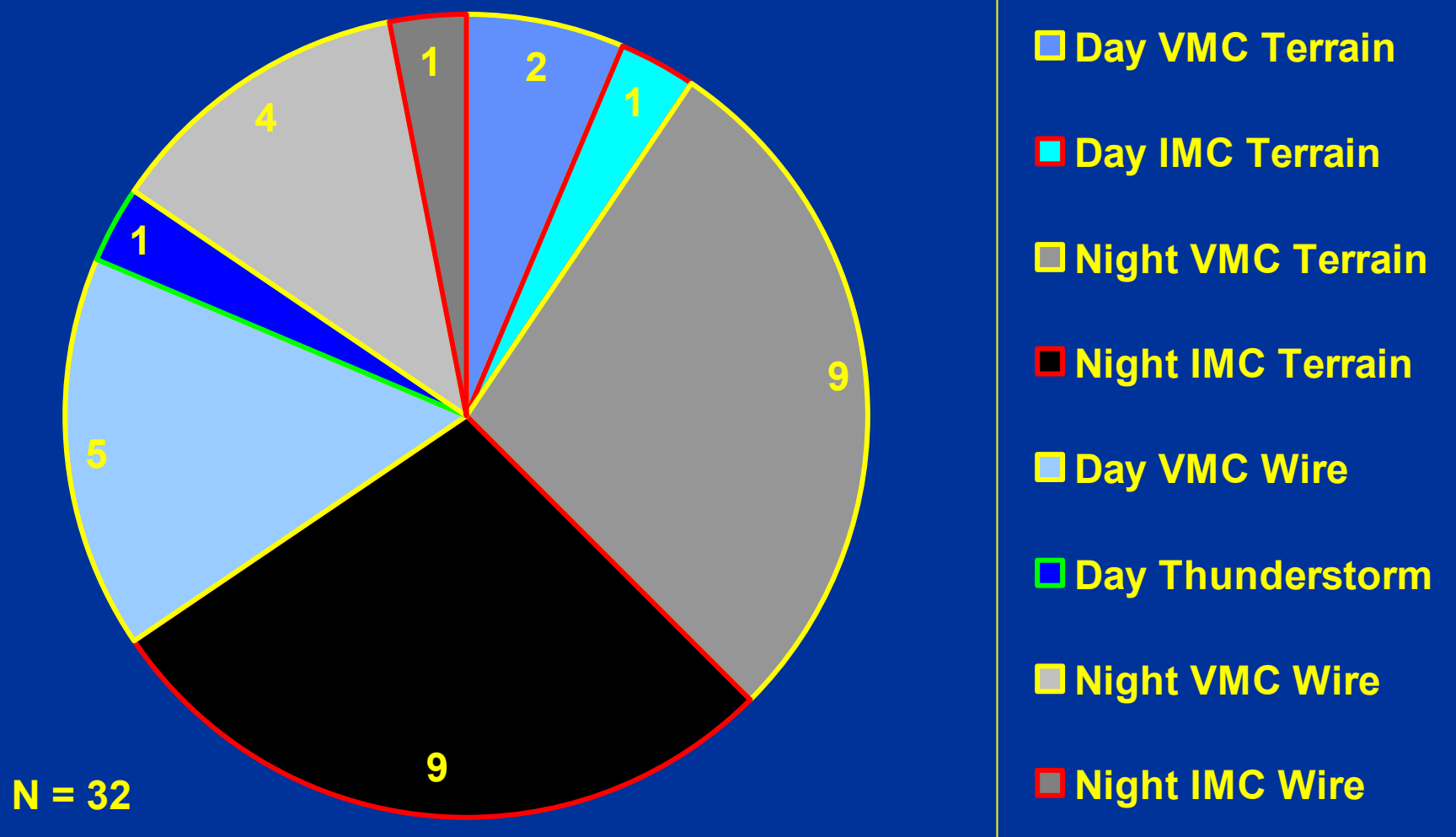


Army HF Kiowa Warrior CFIT



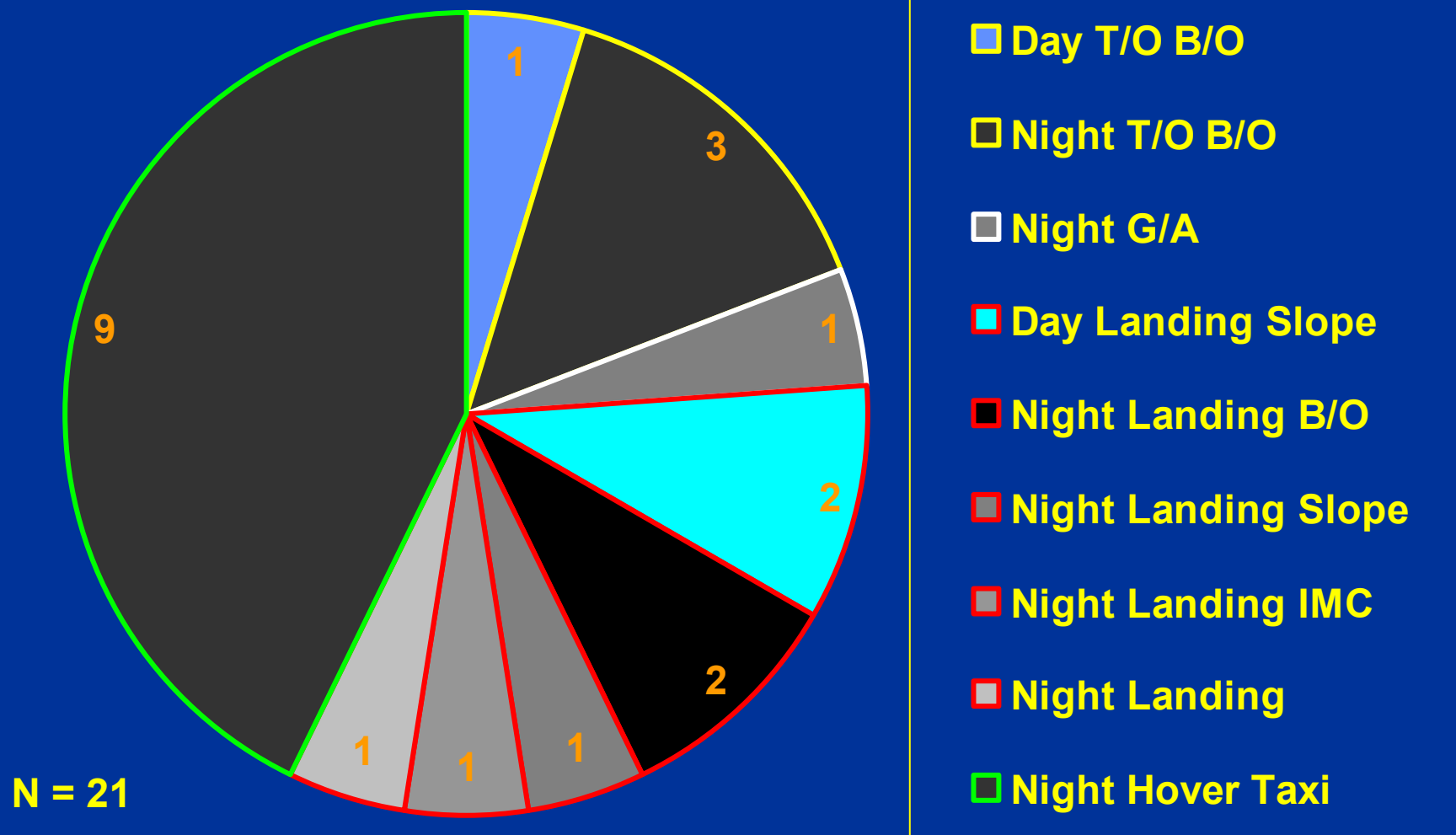


Army HF Kiowa Warrior Cruise CFIT





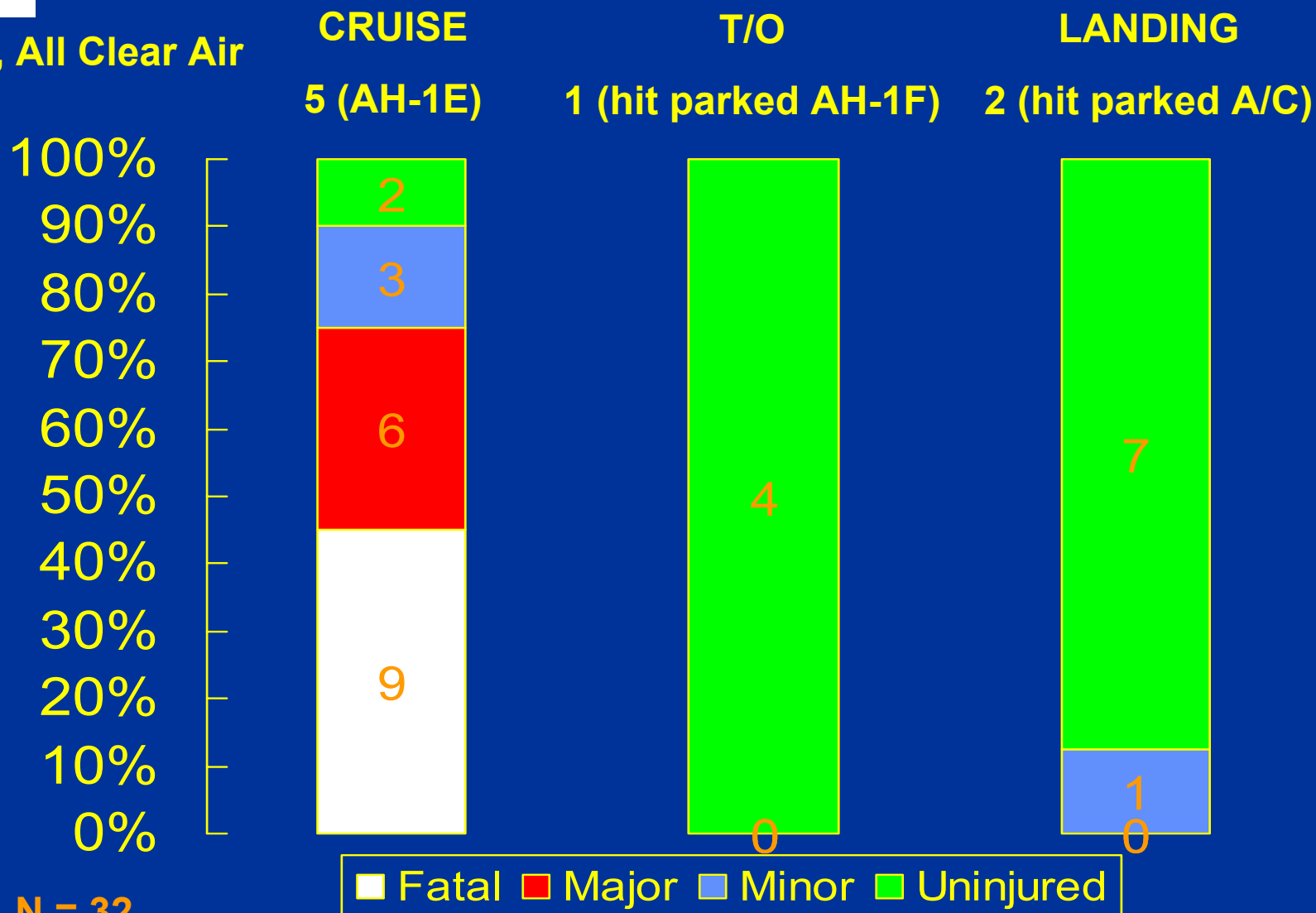
Army HF Kiowa Warrior Slow CFIT





Army HF Kiowa Warrior MIDAIR

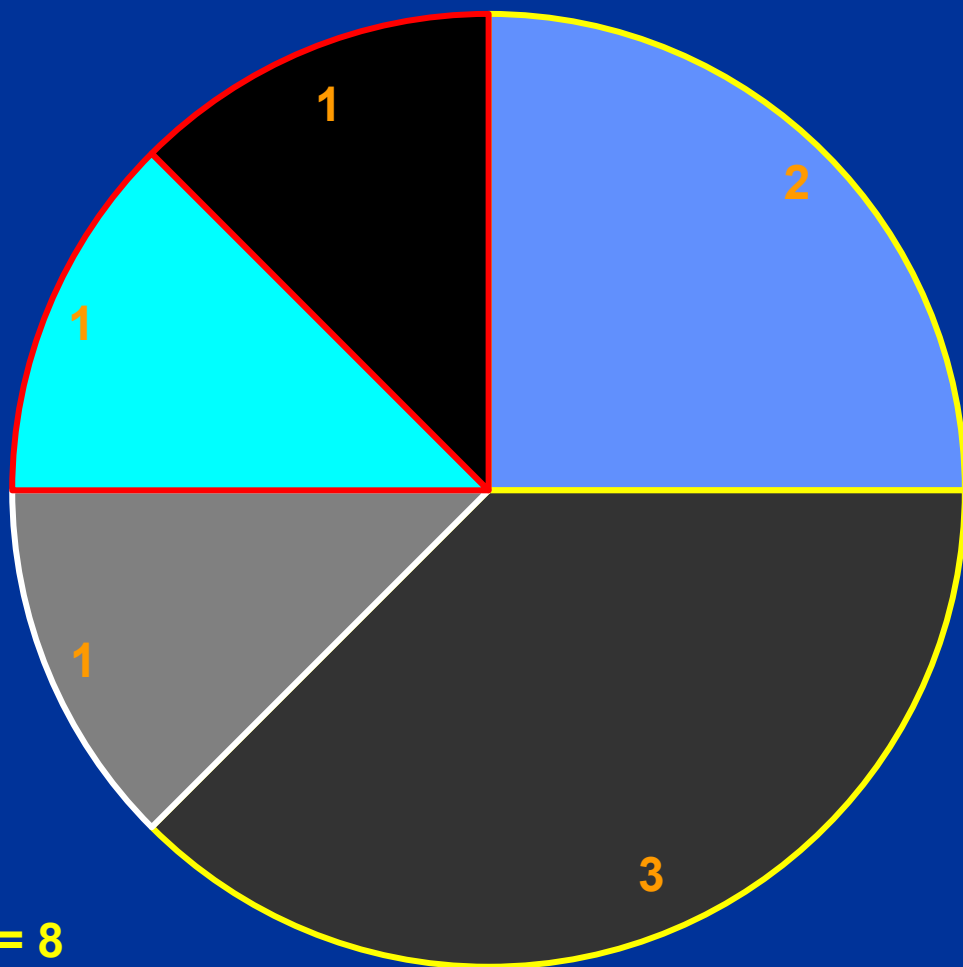
N = 8, All Clear Air





Army HF Kiowa Warrior MIDAIR

ALL CLEAR AIR



□ Day Cruise

□ Night Cruise

□ Night T/O

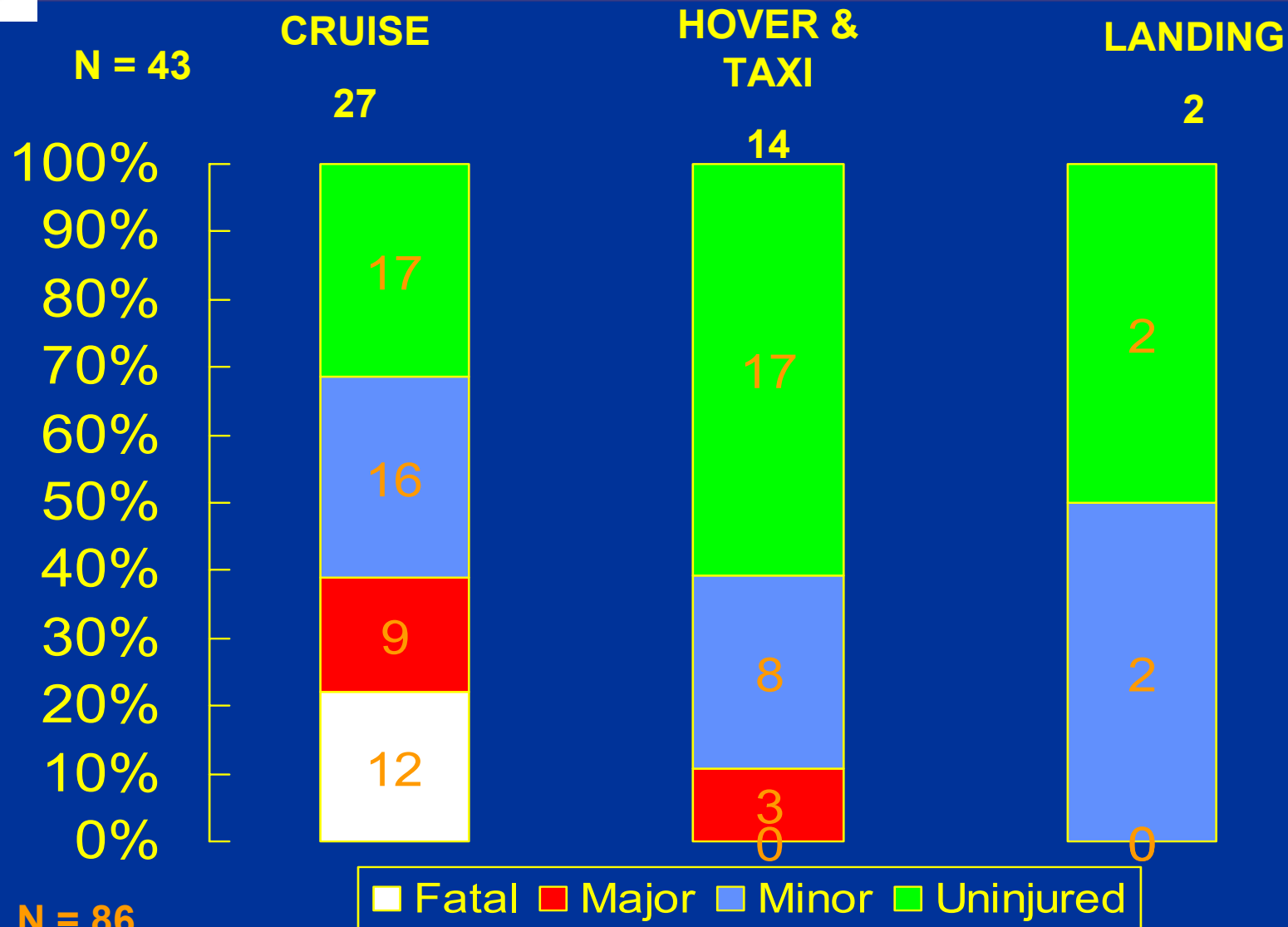
□ Day Landing

□ Night Landing

N = 8

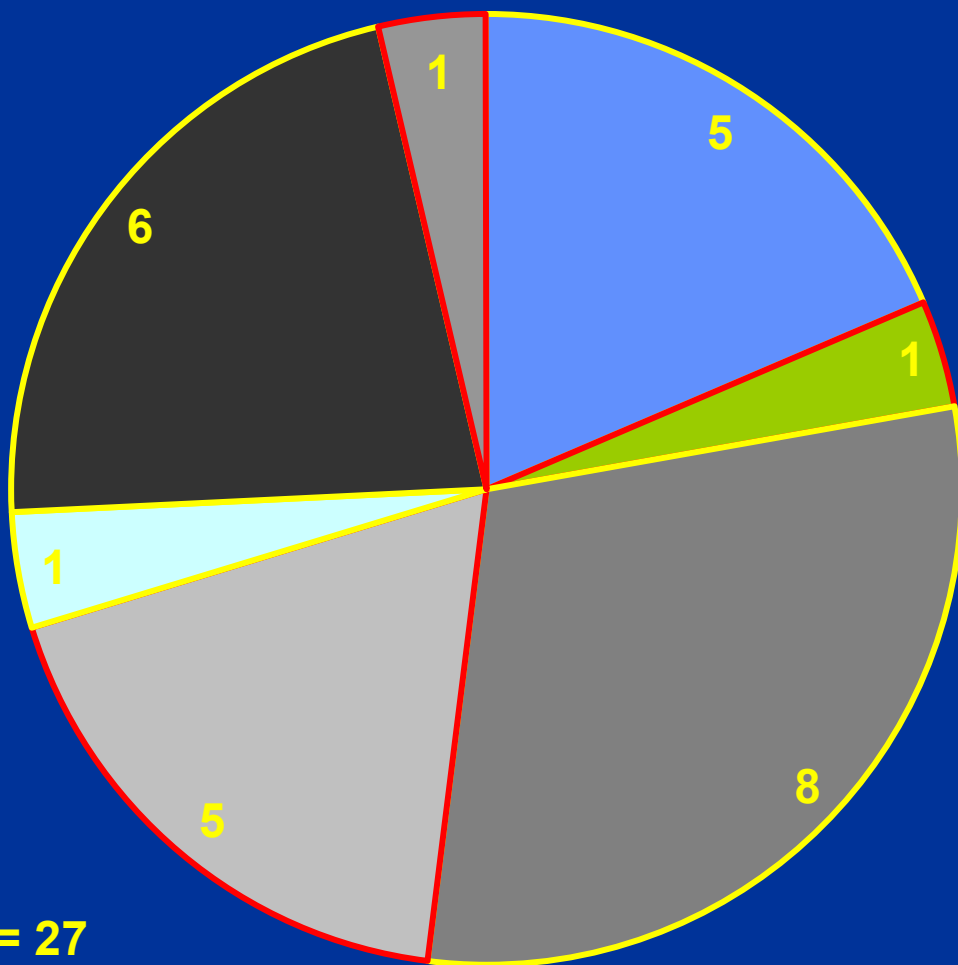


Army HF Apache CFIT





Army HF Apache Cruise CFIT



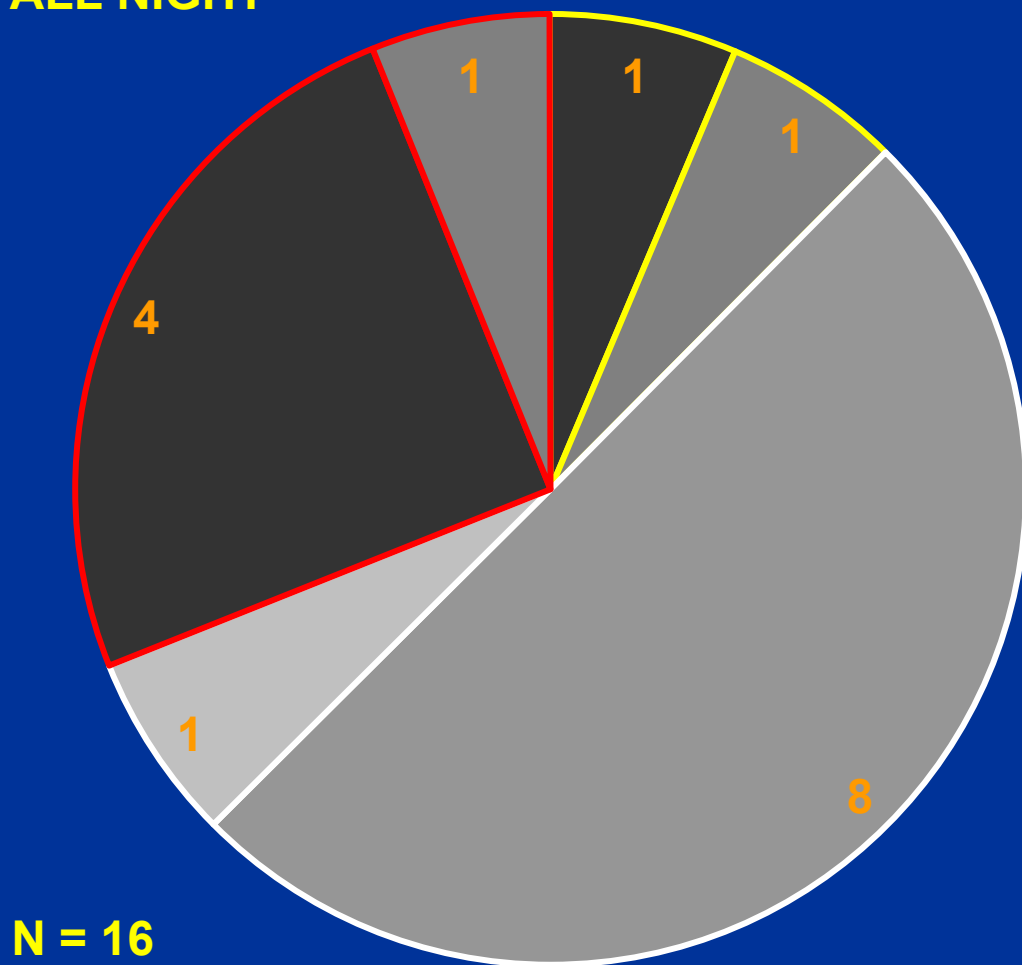
N = 27

- Day VMC Terrain
- Twilight IMC
- Night VMC Terrain
- Night IMC Terrain
- Day VMC Wire
- Night VMC Wire
- Night IMC Wire



Army HF Apache Slow CFIT

ALL NIGHT



- ☐ Landing B/O
- ☐ Landing
- ☐ Hover
- ☐ Hover IMC
- ☐ Hover TR VMC
- ☐ Hover TR IMC



Army HF Apache MIDAIR

N = 9

CRUISE

HOVER/TAXI

T/O & G/A

LANDING

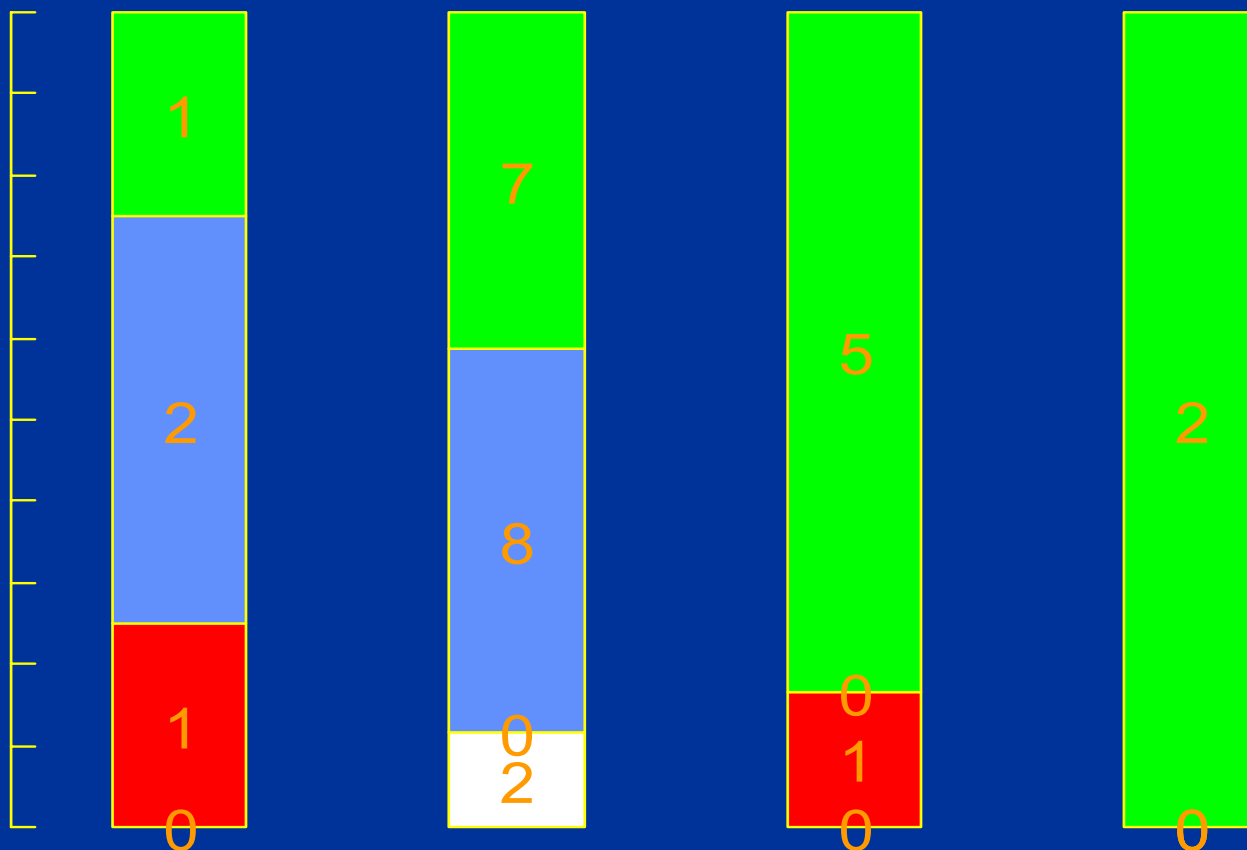
1

4 (UH-60)

3

1

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

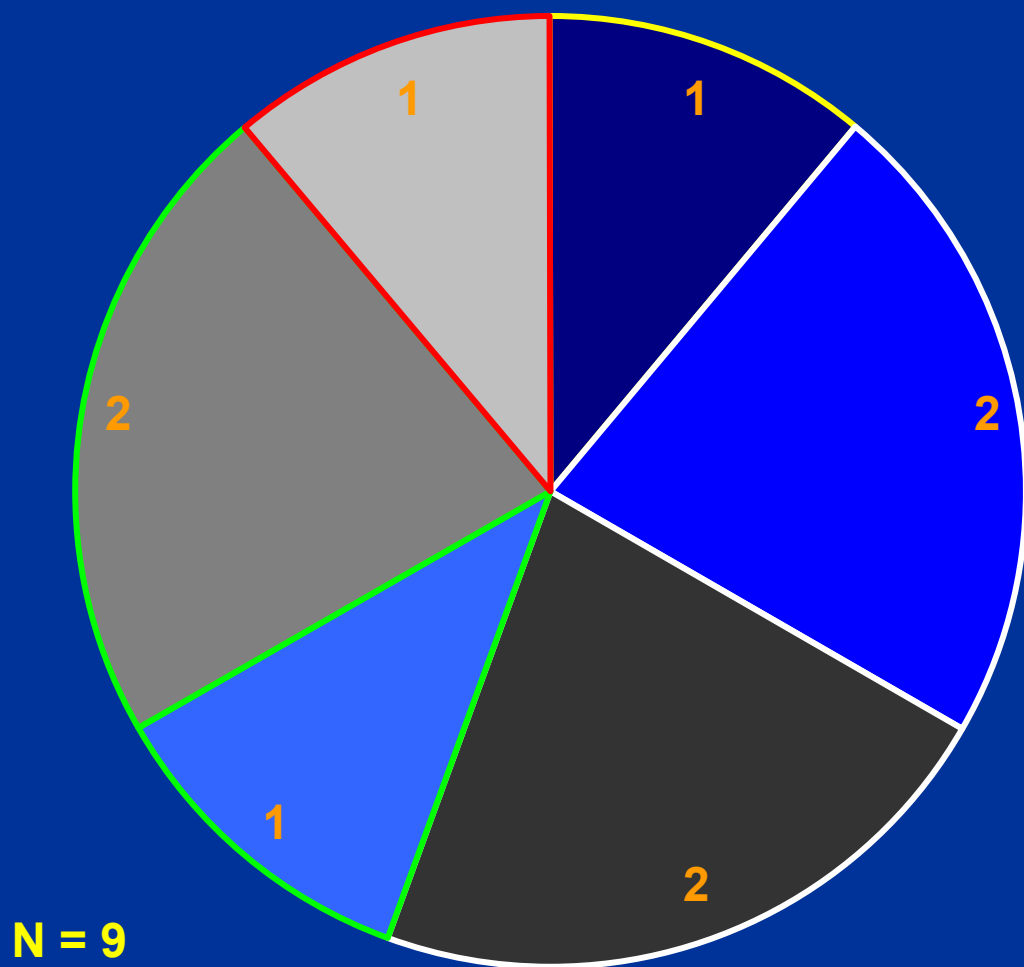


N = 29

■ Fatal ■ Major ■ Minor ■ Uninjured



Army HF Apache MIDAIR



□ Day Cruise

□ Day Hover & Taxi (1B/O)

□ Night Hover & Taxi (1B/O)

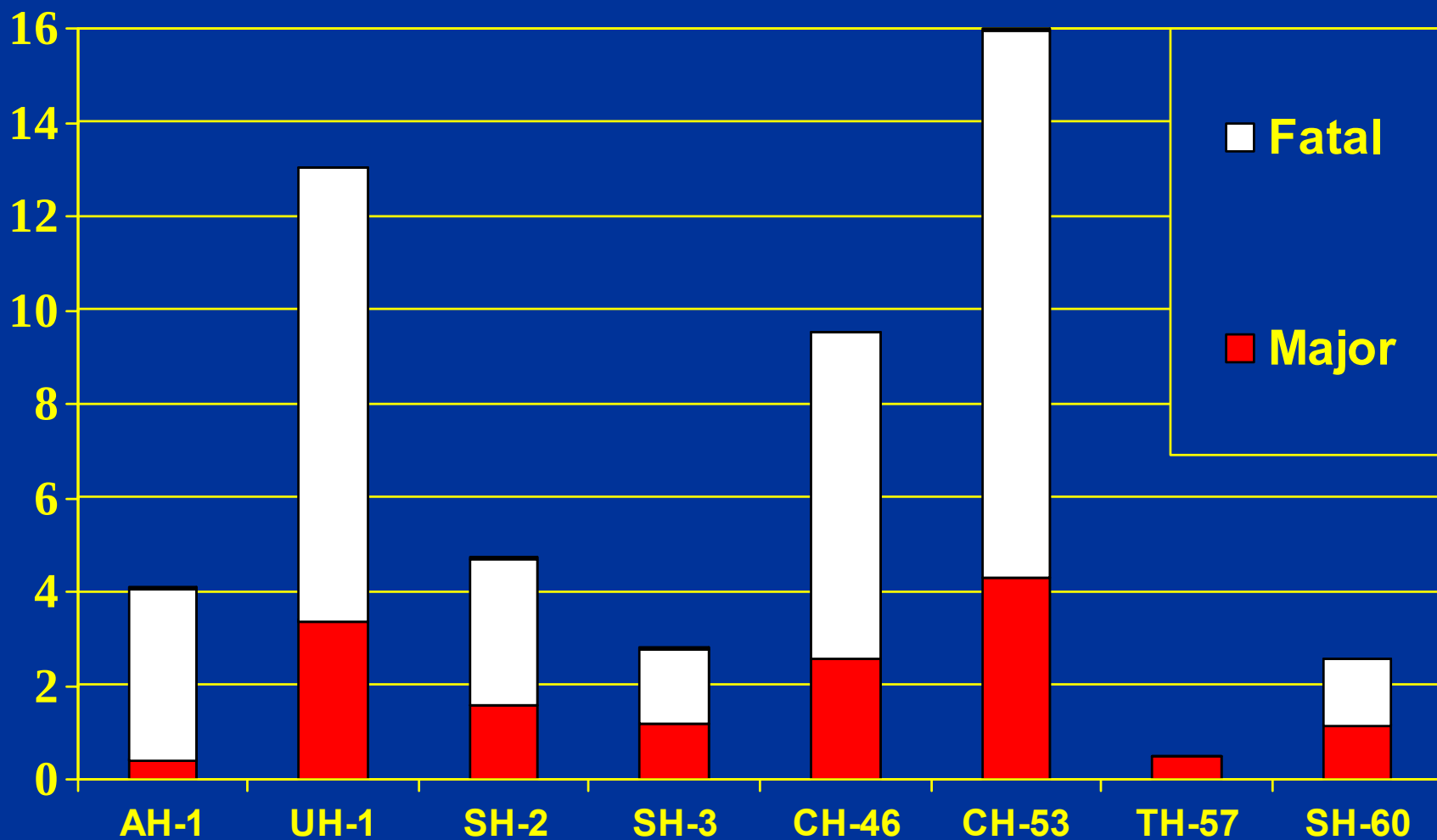
□ Day T/O & G/A (B/O)

□ Night T/O & G/A (B/O)

□ Night Landing (B/O)

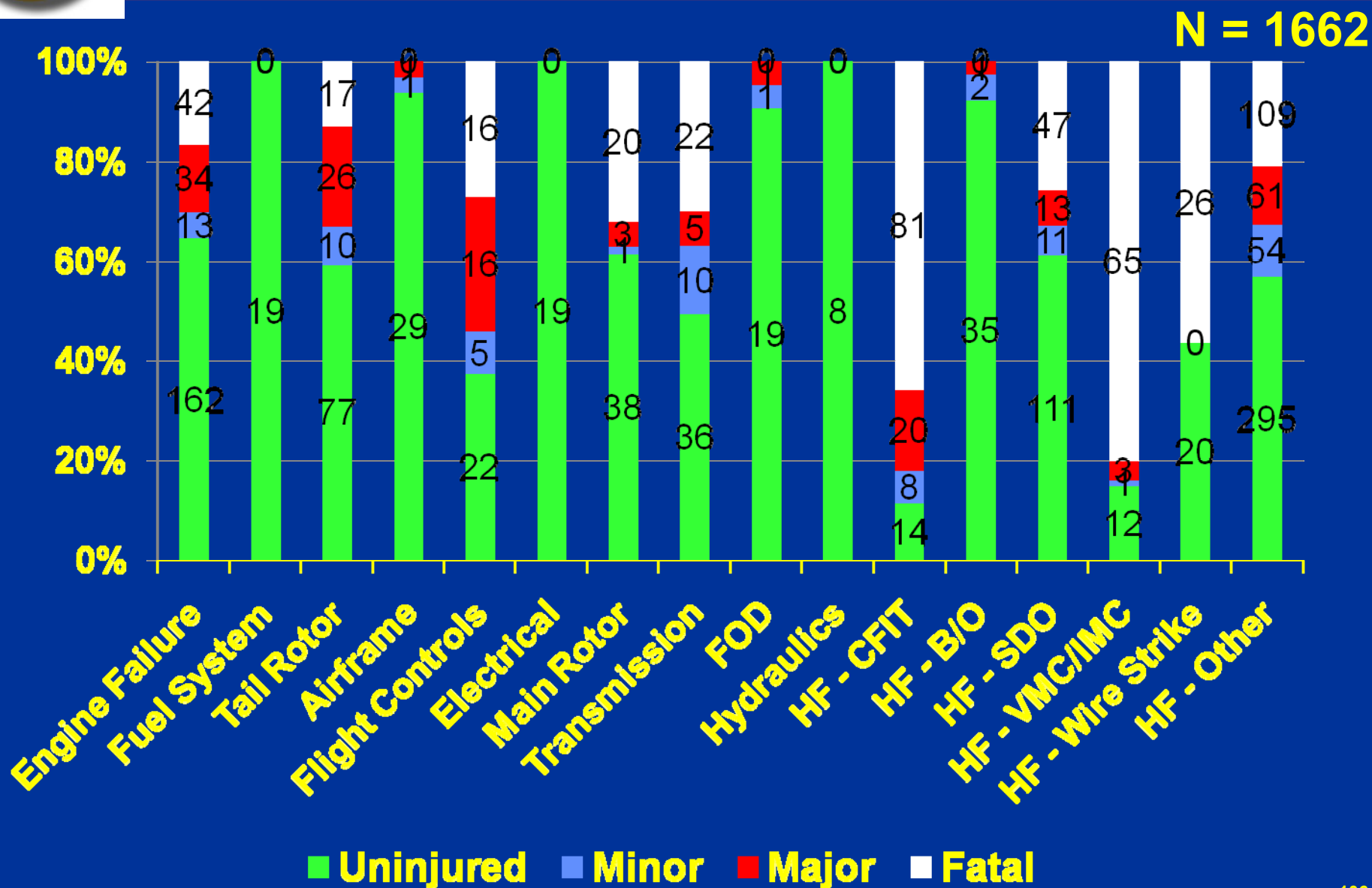


DoN Fatalities & Major Injury Rates per 100,000 Flying Hours by Type



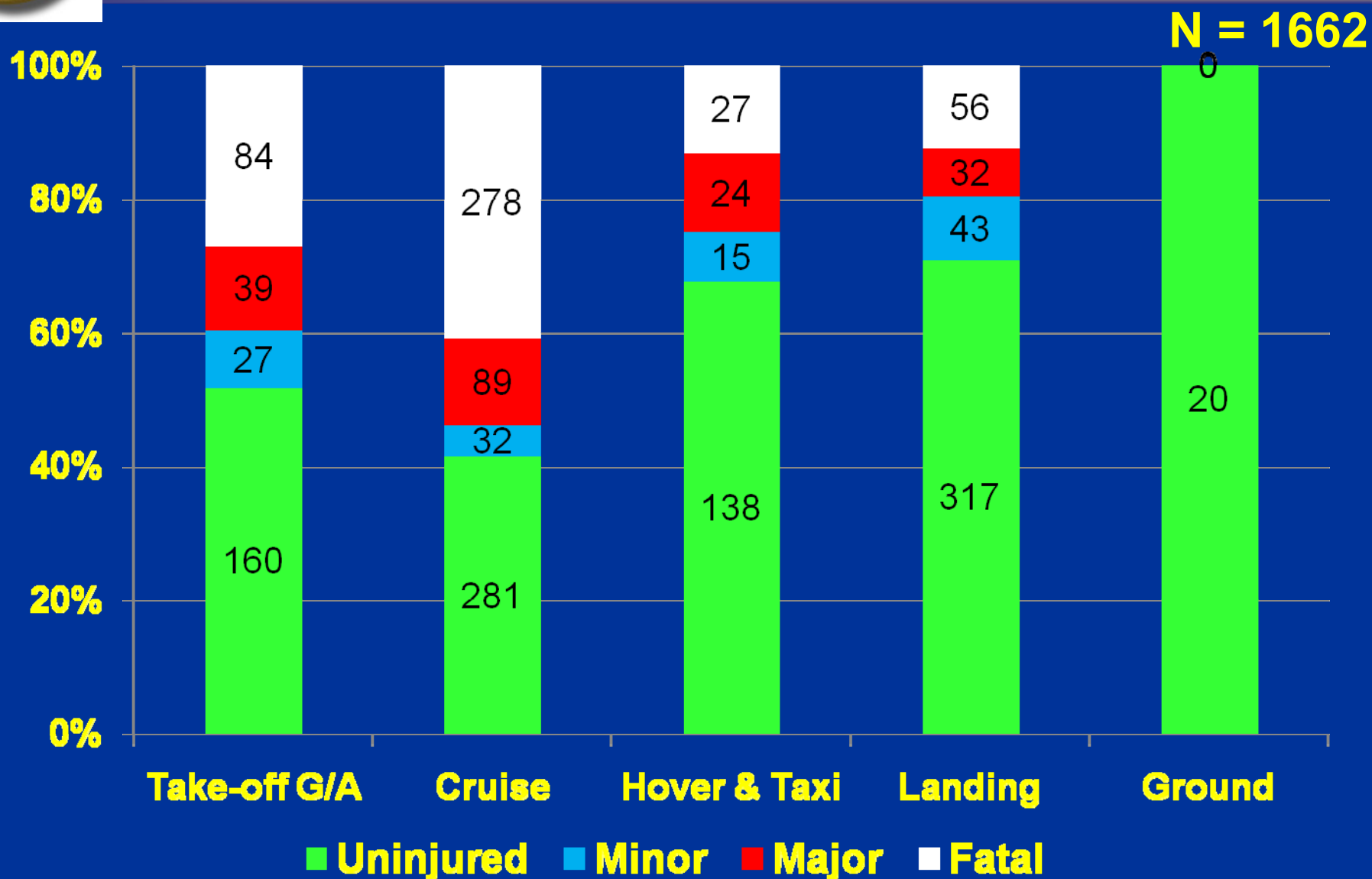


DoN ALL ROTARY WING Occupant Outcome by Mishap Cause





DoN ALL ROTARY WING Occupant Outcome by Phase of Flight





Comparison of USA HF Class A & B Mishaps by Threats & Type

MDS	CFIT	MIDAIR	B/O	TR	Night (Associated)	Cause Lost Lives
UH-1	X		X		X	
AH-1	X	X	X		XXX	A/C
H-6	X				X	#1 X
H-47	X		X		X	#2 X
OH-58 A-C = D	X	X		X	XXX	#3 X
H-60	X	X	X		XX	
AH-64	X		X	X	X	



Pilot vs. Passenger & Crew DoN Injuries & Fatalities CH-53

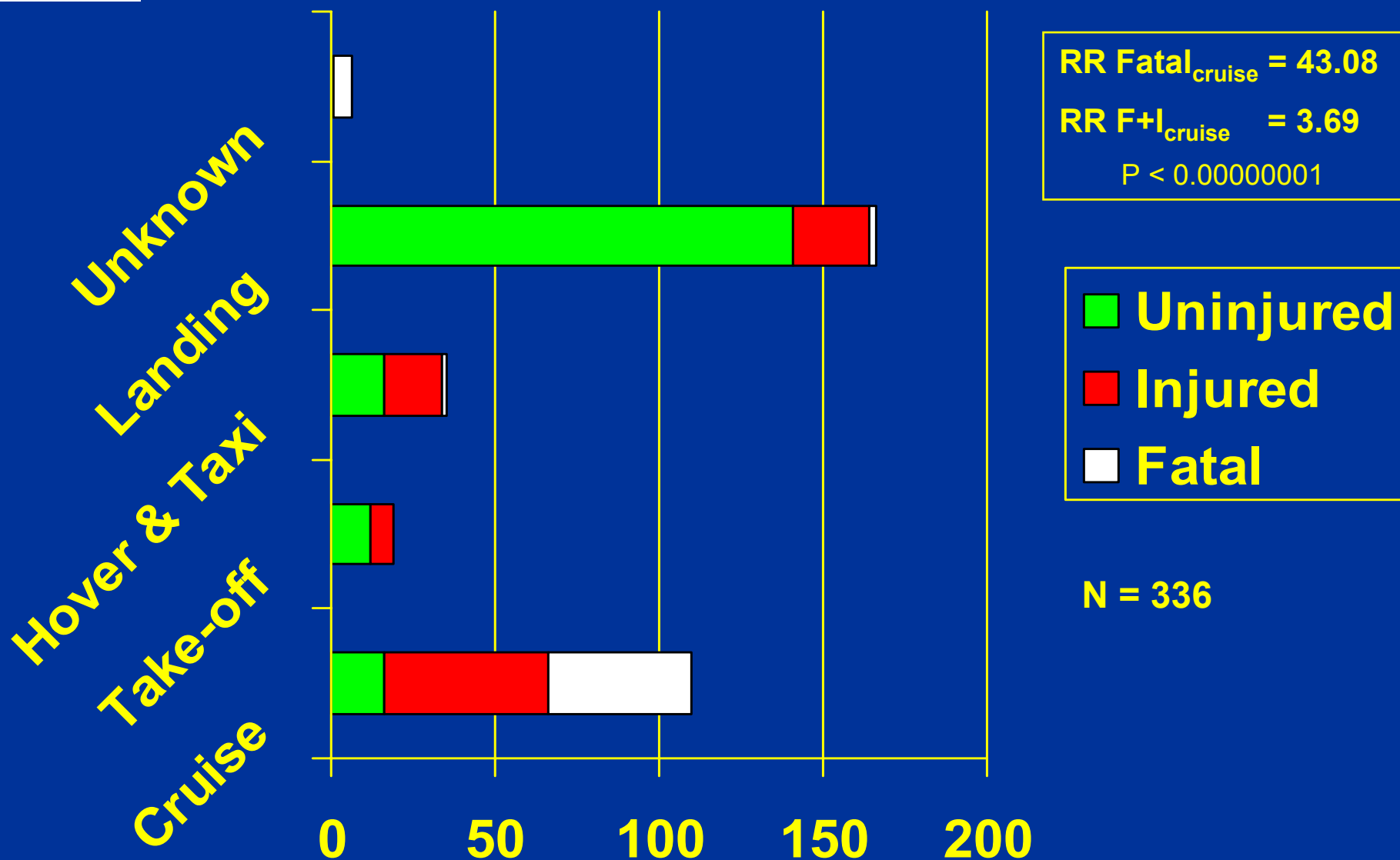
MISHAPS N = 60	PILOTS N = 110		PAX & CREW N = 269		$\Delta\%$
	Count	Percent	Count	Percent	
NOT INJURED	59	53.6	101	37.5	+16.1 R = 1.43 (p = 0.004)
MINOR INJURY	5	4.5	17	6.3	-1.8 R = 0.72 (p = 0.502)
MAJOR INJURY	13	11.8	40	14.9	-3.1 RR = 0.79 (p = 0.437)
FATAL	33	30.0	111	41.3	-11.3 RR = 0.73 (p = 0.04)



Mishaps & Injuries By Phase Of Flight



USAF HF Fatalities & Injuries by Phase of Flight





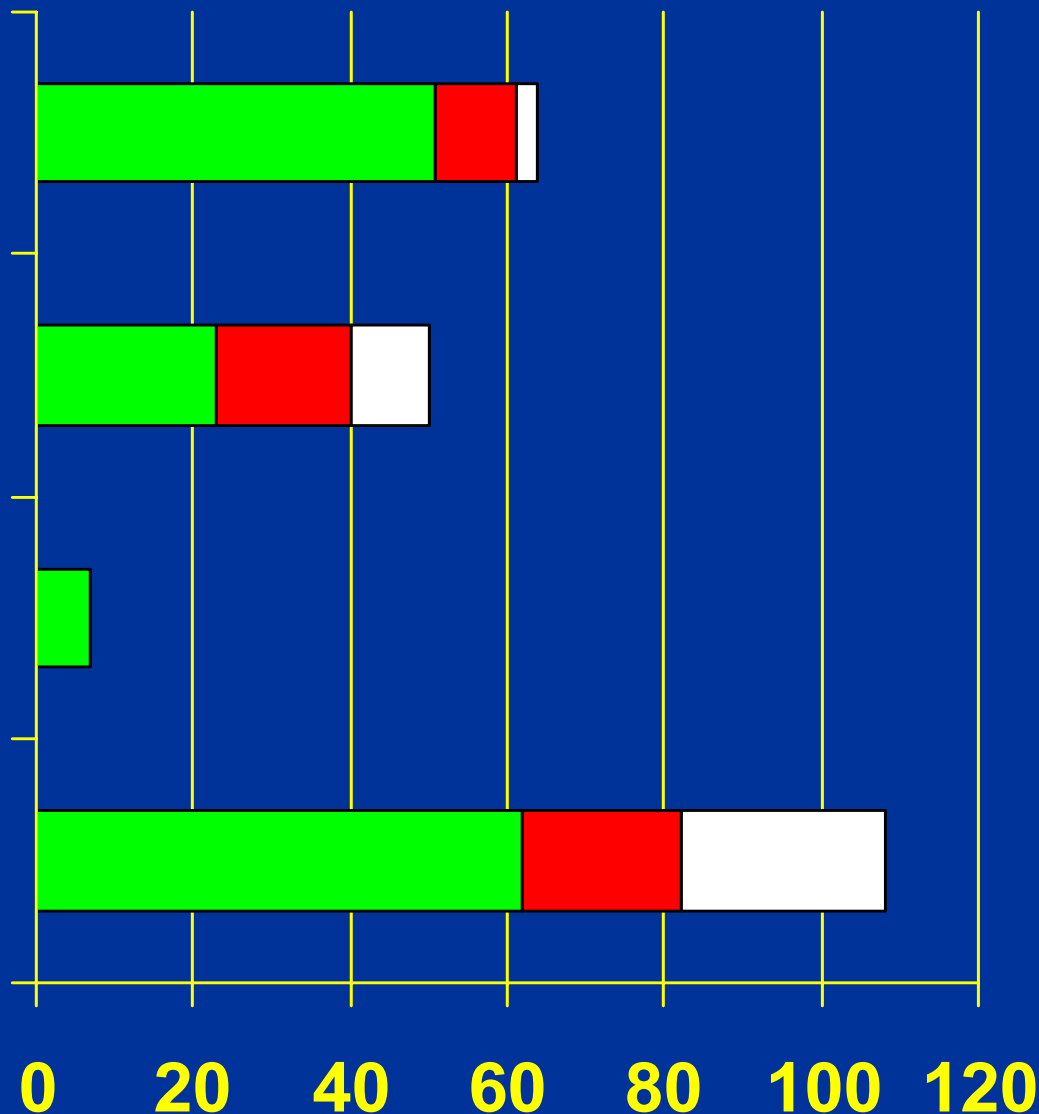
USAF NHF Fatalities & Injuries by Phase of Flight

Landing

Hover &
Taxi

T/O &
G/A

Cruise



$$RR \text{ Fatal}_{\text{cruise}} = 2.24$$

$$RR \text{ F+I}_{\text{cruise}} = 1.29$$

$$P = .0074; .137$$

Uninjured

Injured

Fatal

N = 229



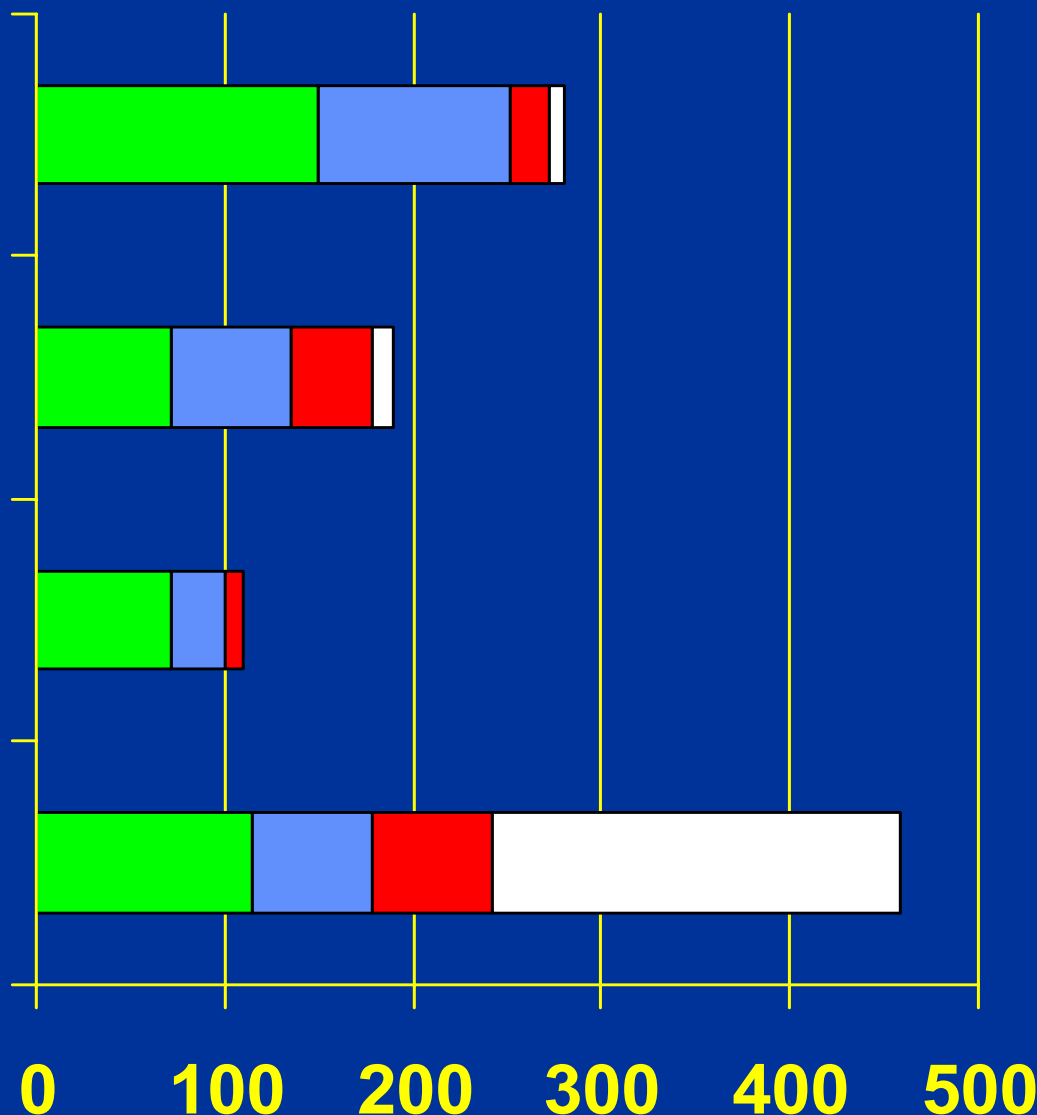
USA HF Fatalities & Injuries by Phase OF Flight

Landing

Hover &
Taxi

T/O &
G/A

Cruise



$RR\ Fatal_{cruise} = 14.24$

$RR\ F+I_{cruise} = 1.42$

$P < 0.00000001$

Uninjured

Minor

Major

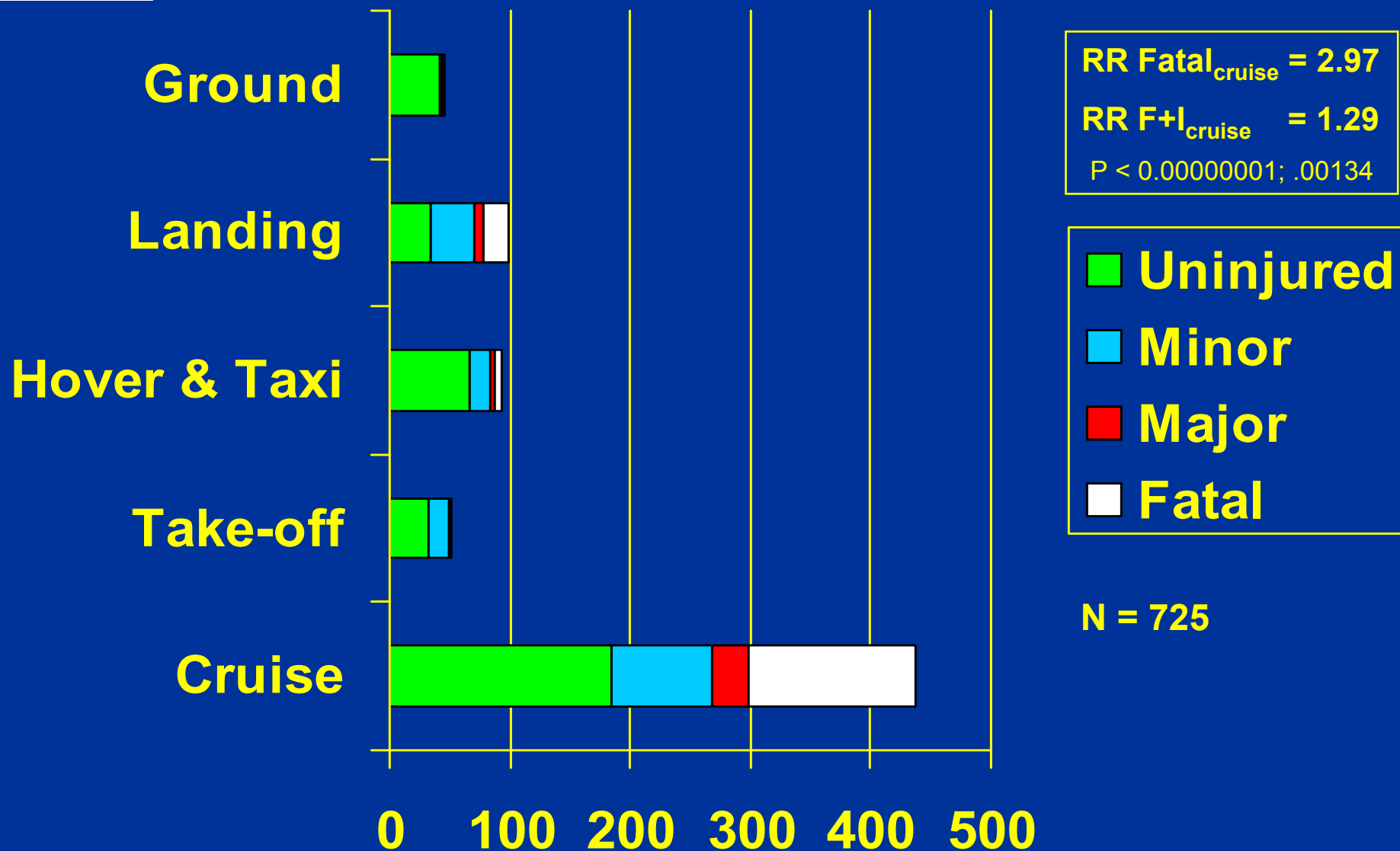
Fatal

$N = 740$

of 974+

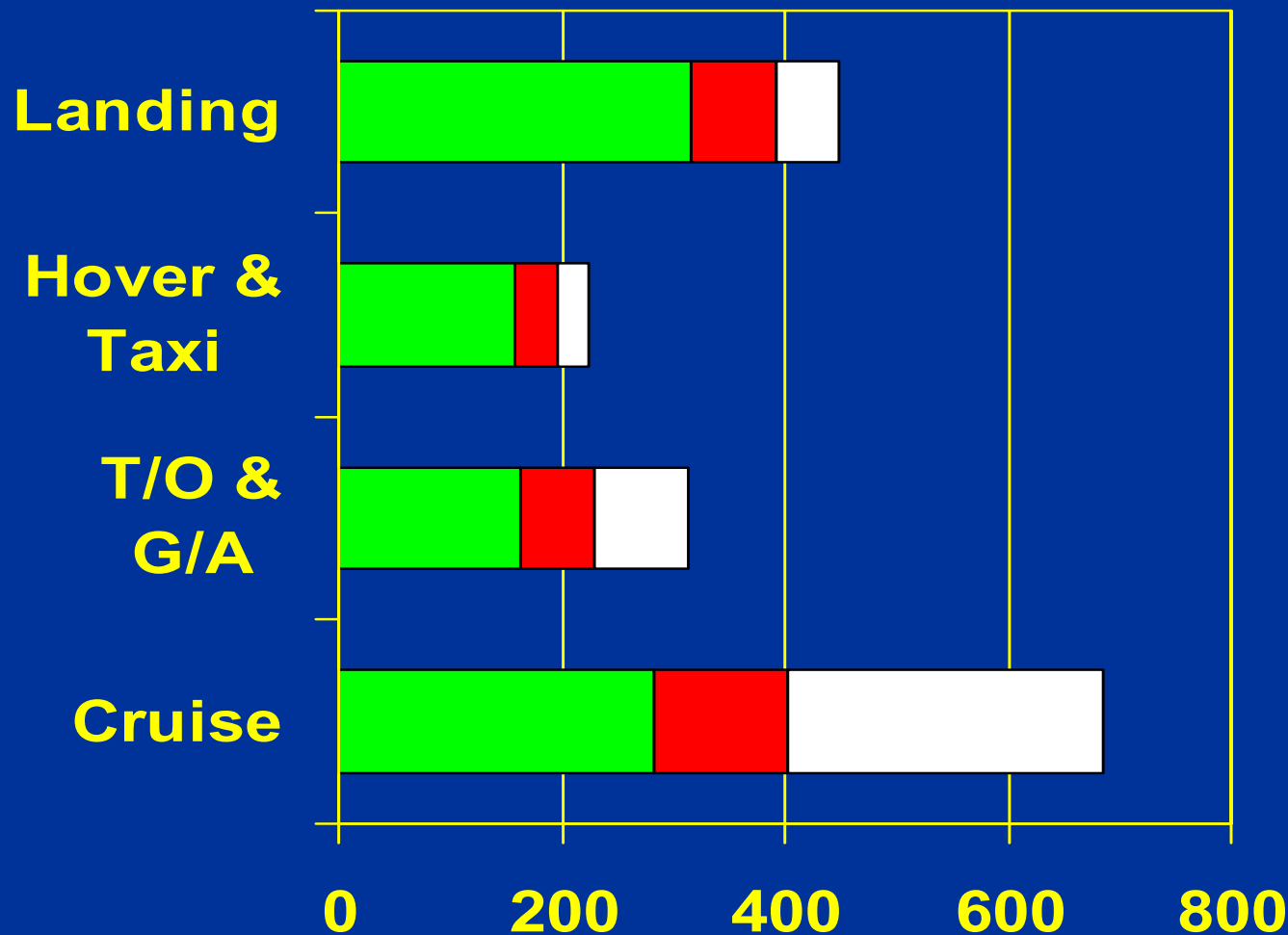


USA NHF Fatalities & Injuries by Phase of Flight





DoN Helicopter Exposed Population by Outcome & Phase Of Flight



$RR\ Fatal_{cruise} = 2.43$

$RR\ F+I_{cruise} = 1.67$

$P < 0.00000001$

■ Uninjured

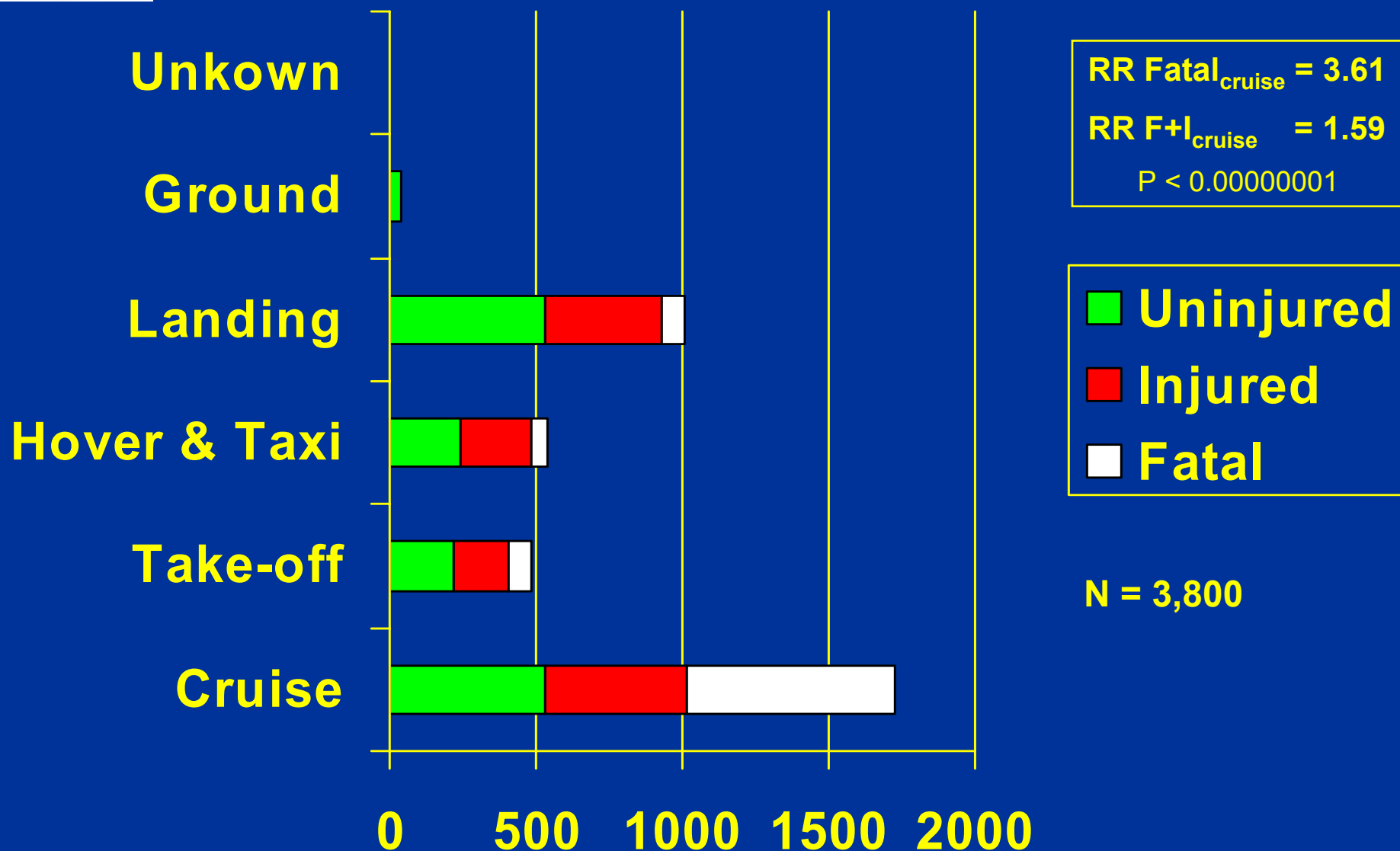
■ Injured

■ Fatal

$N = 1,666$

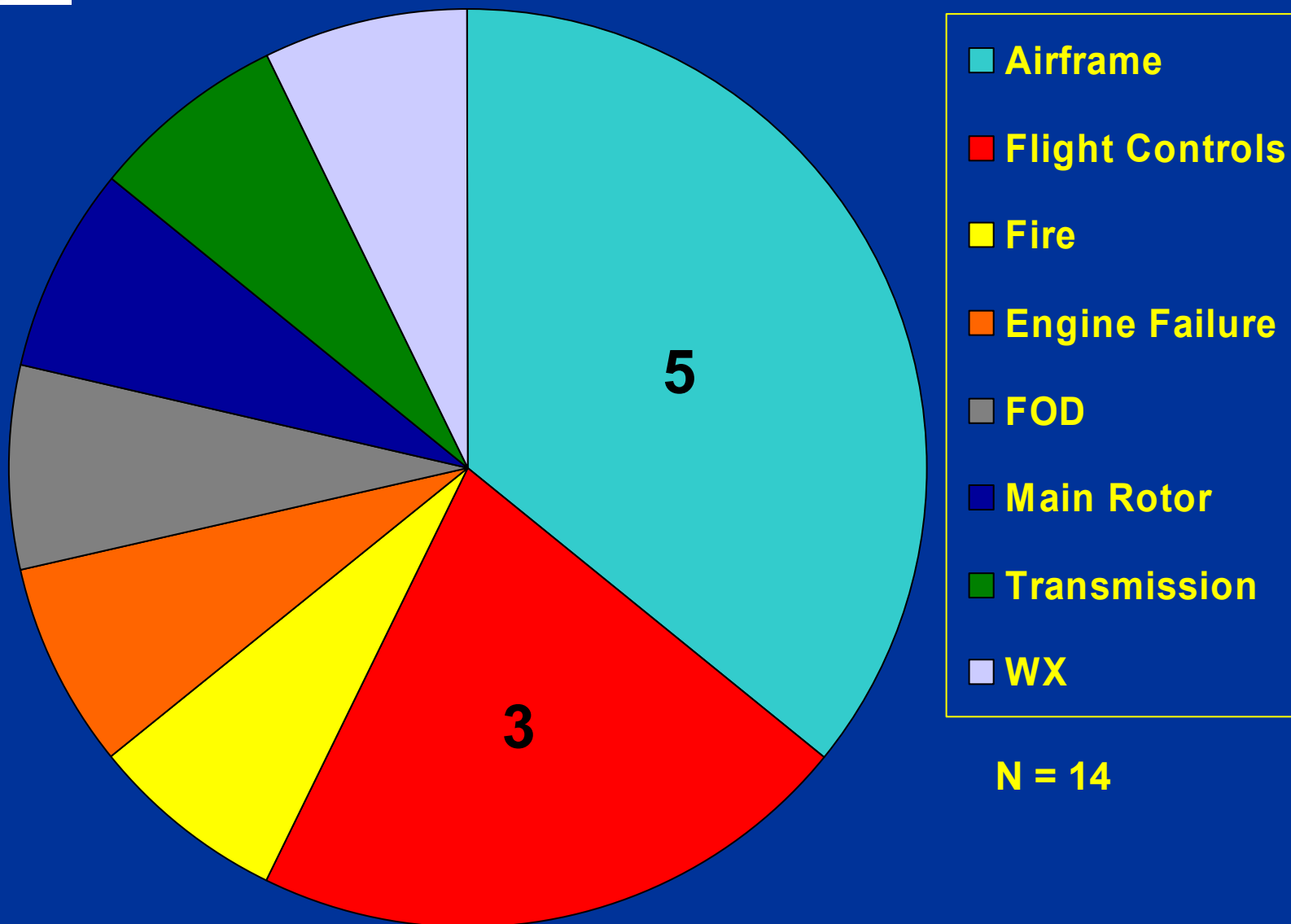


DoD Fatalities & Injuries by Phase of Flight



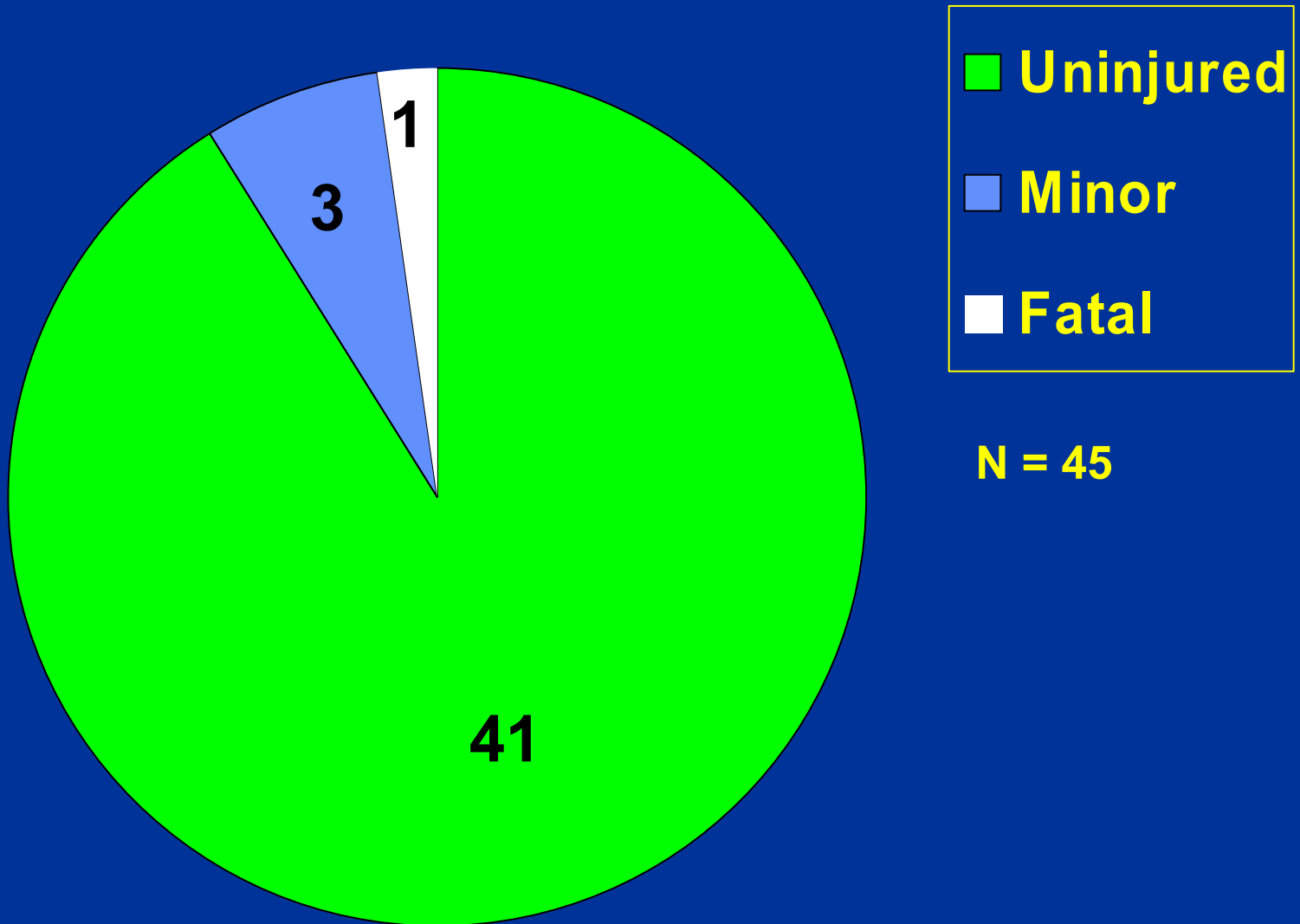


USA NHF Ground Mishaps Malfunction Categories



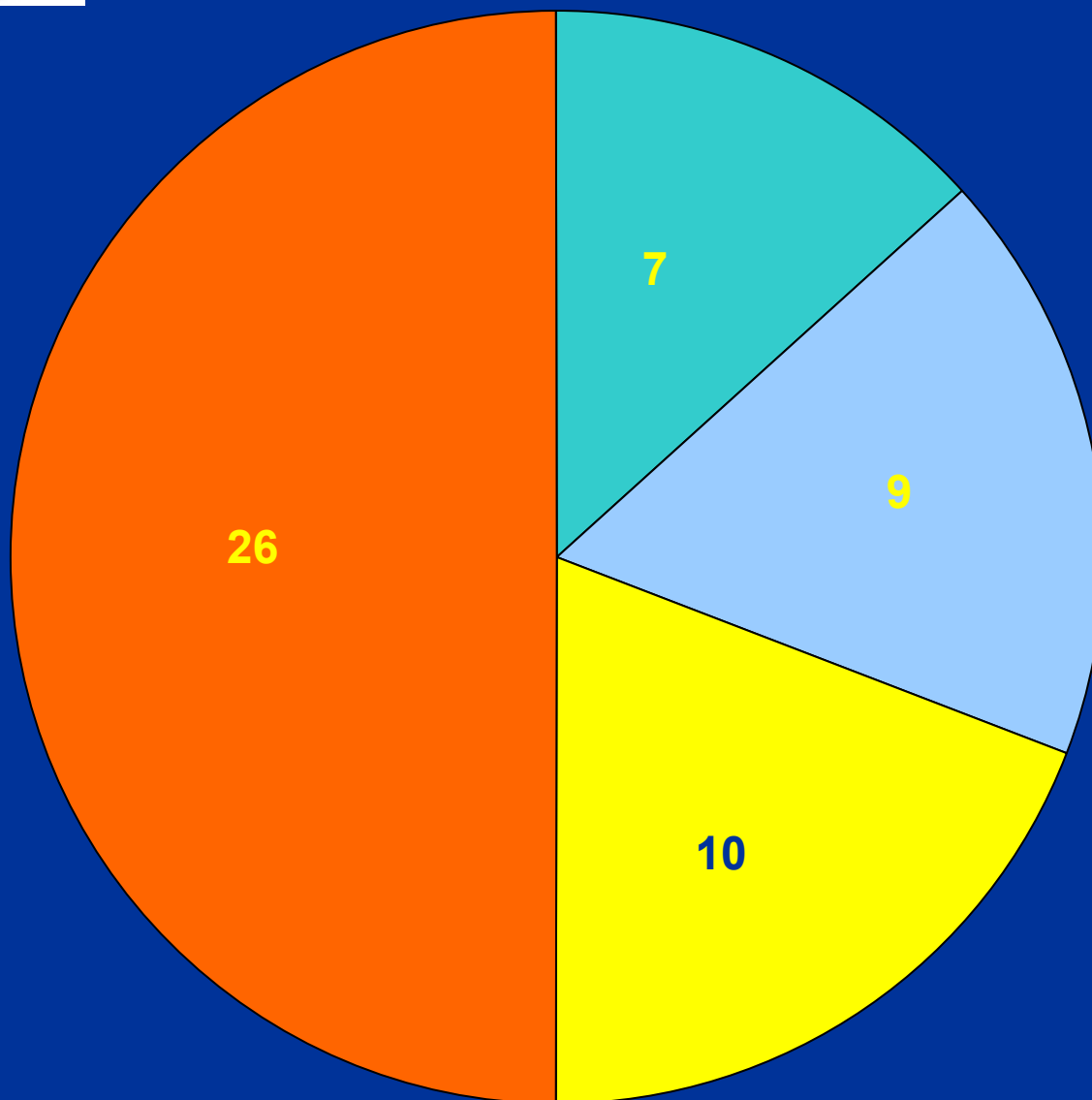


USA NHF Ground Mishap Fatalities & Injuries





USA HF Landing Mishaps



■ Day

■ Day - Low Vis.

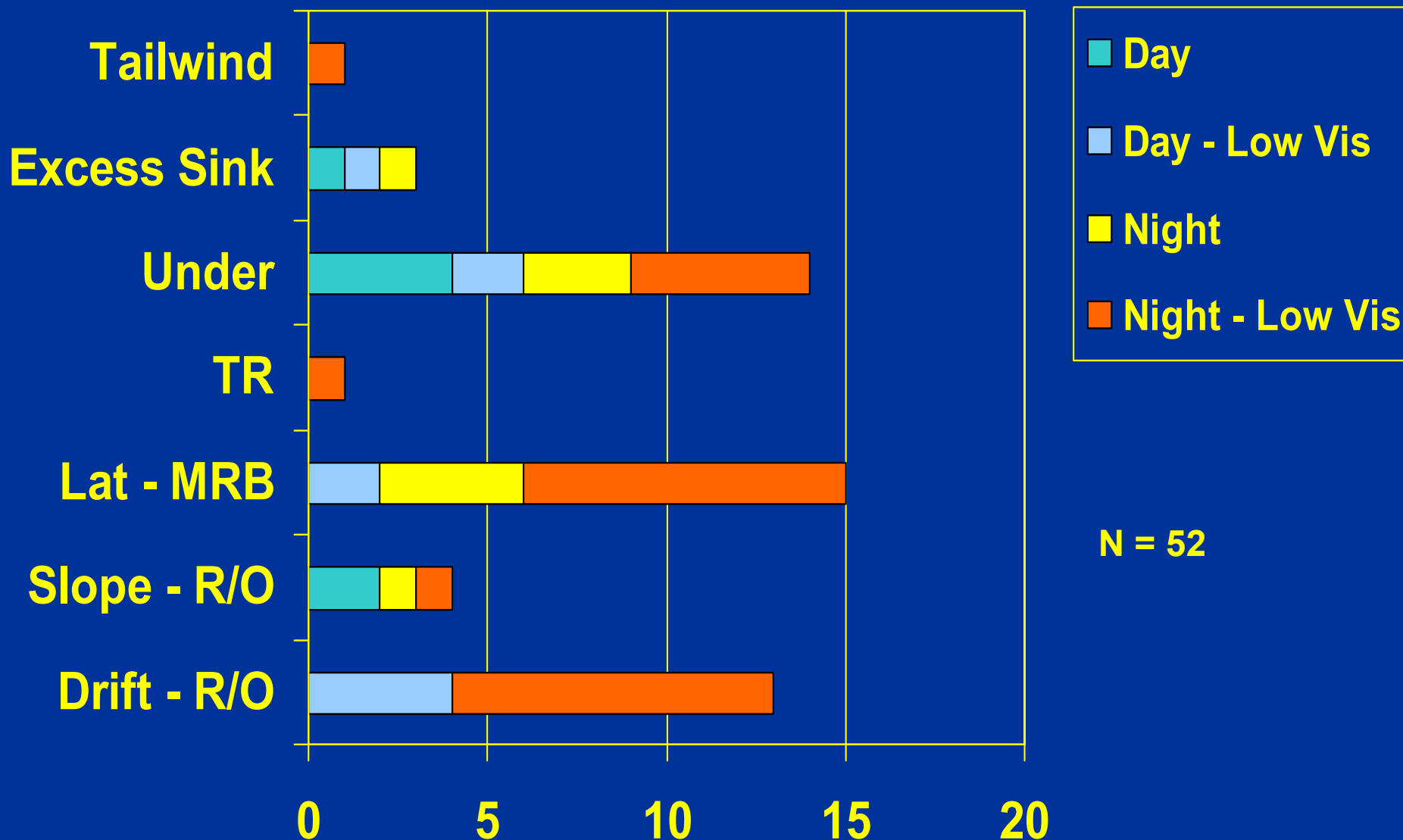
■ Night

■ Night - Low Vis.

N = 52



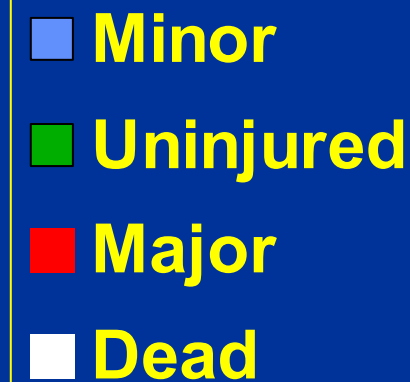
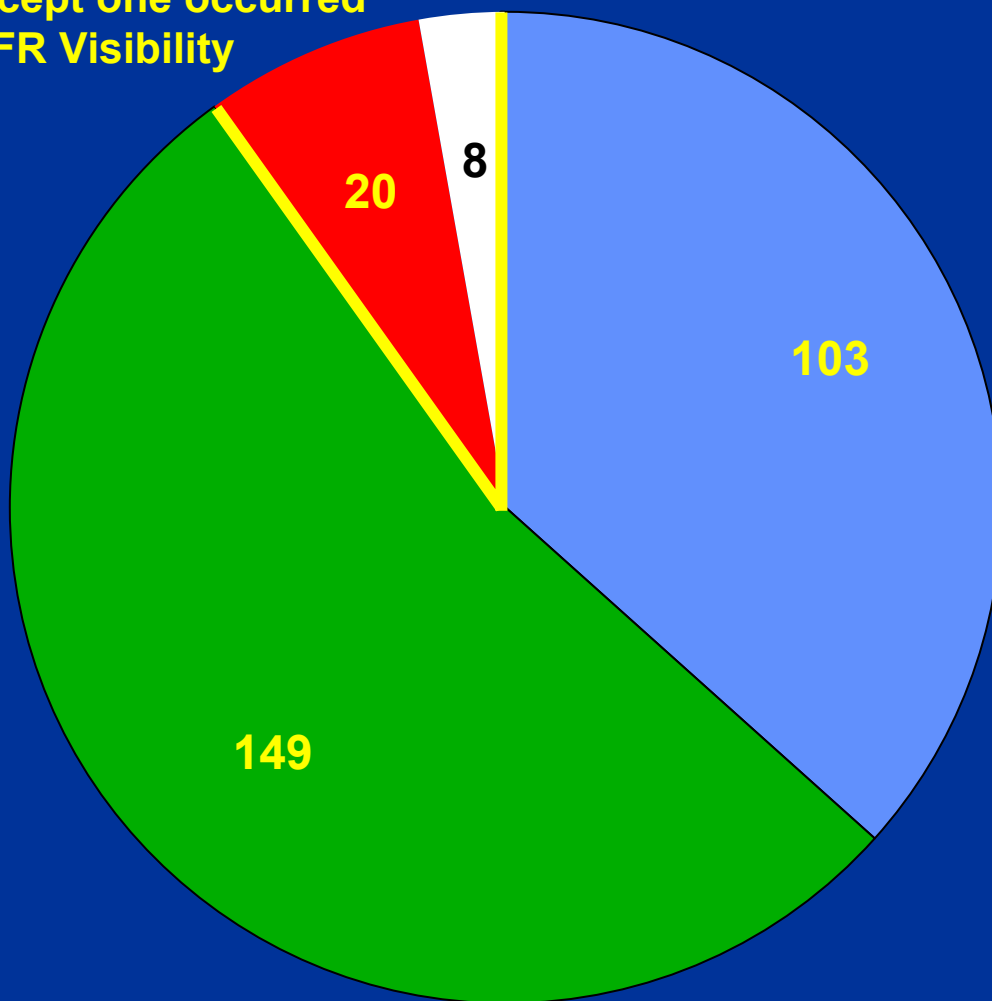
USA HF Landing Mishaps





USA HF Landing Fatalities & Injuries

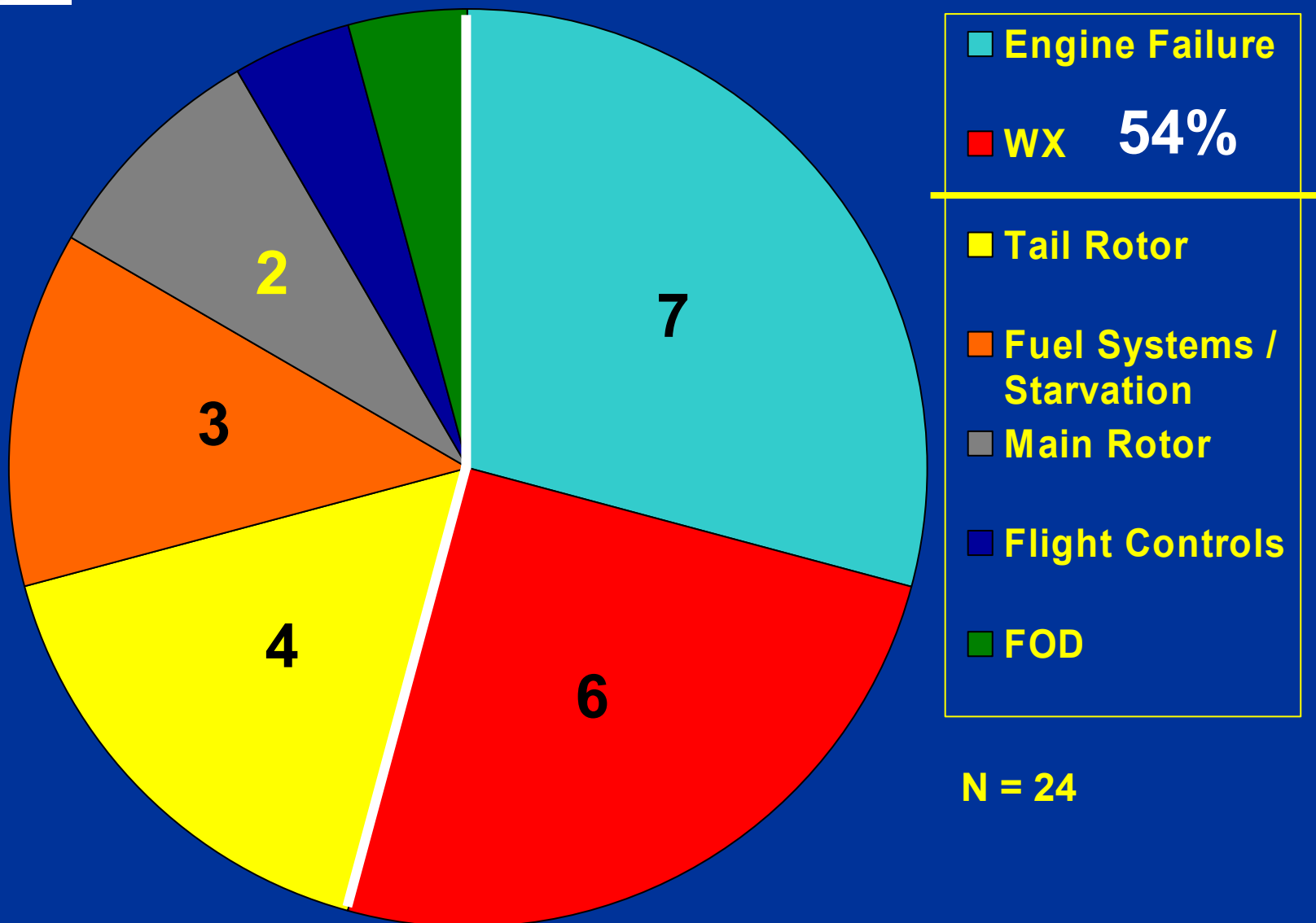
All Fatalities and all major injuries except one occurred in B/O or IFR Visibility



N = 280

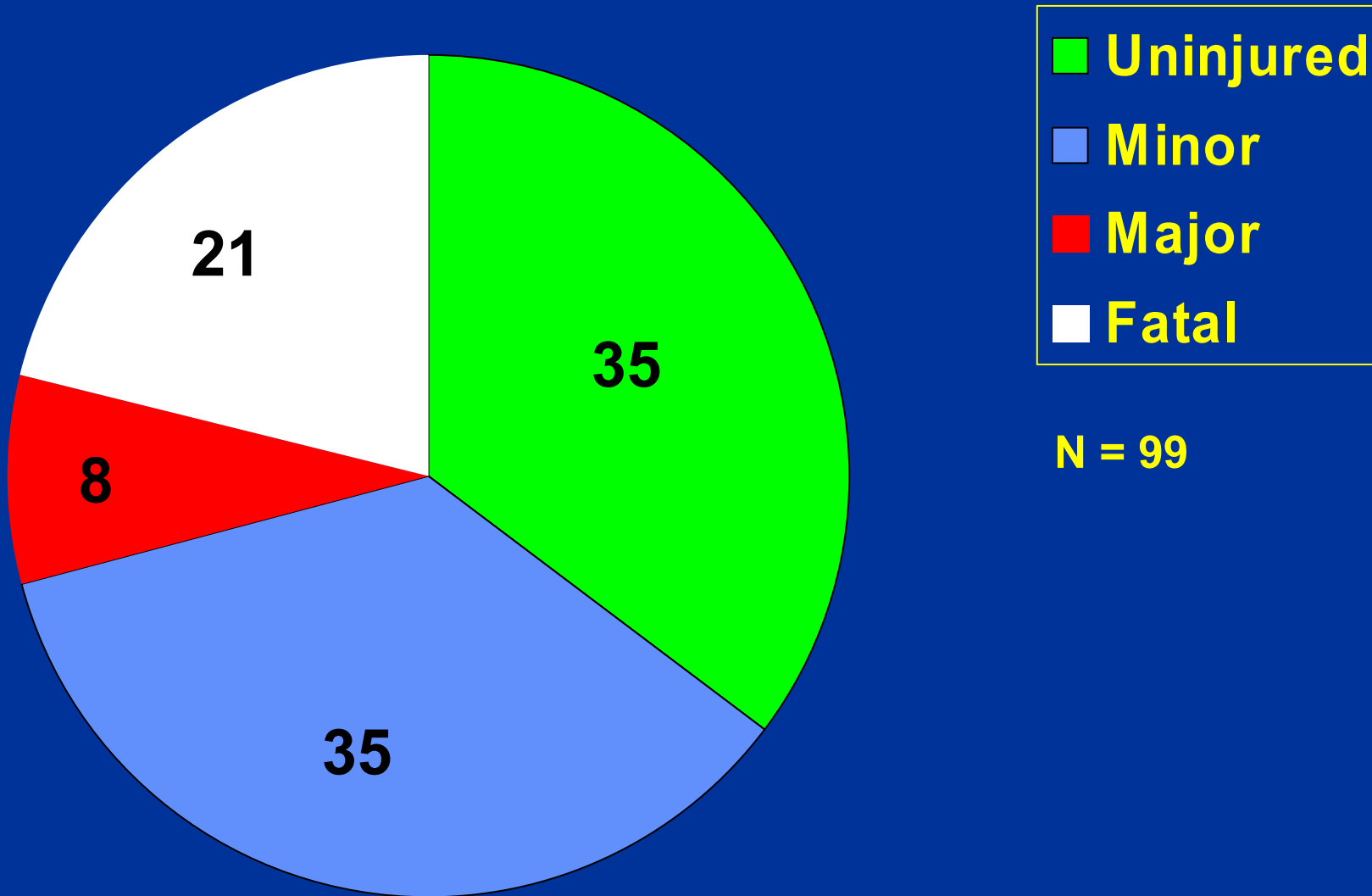


USA NHF Landing Mishaps Malfunction Categories



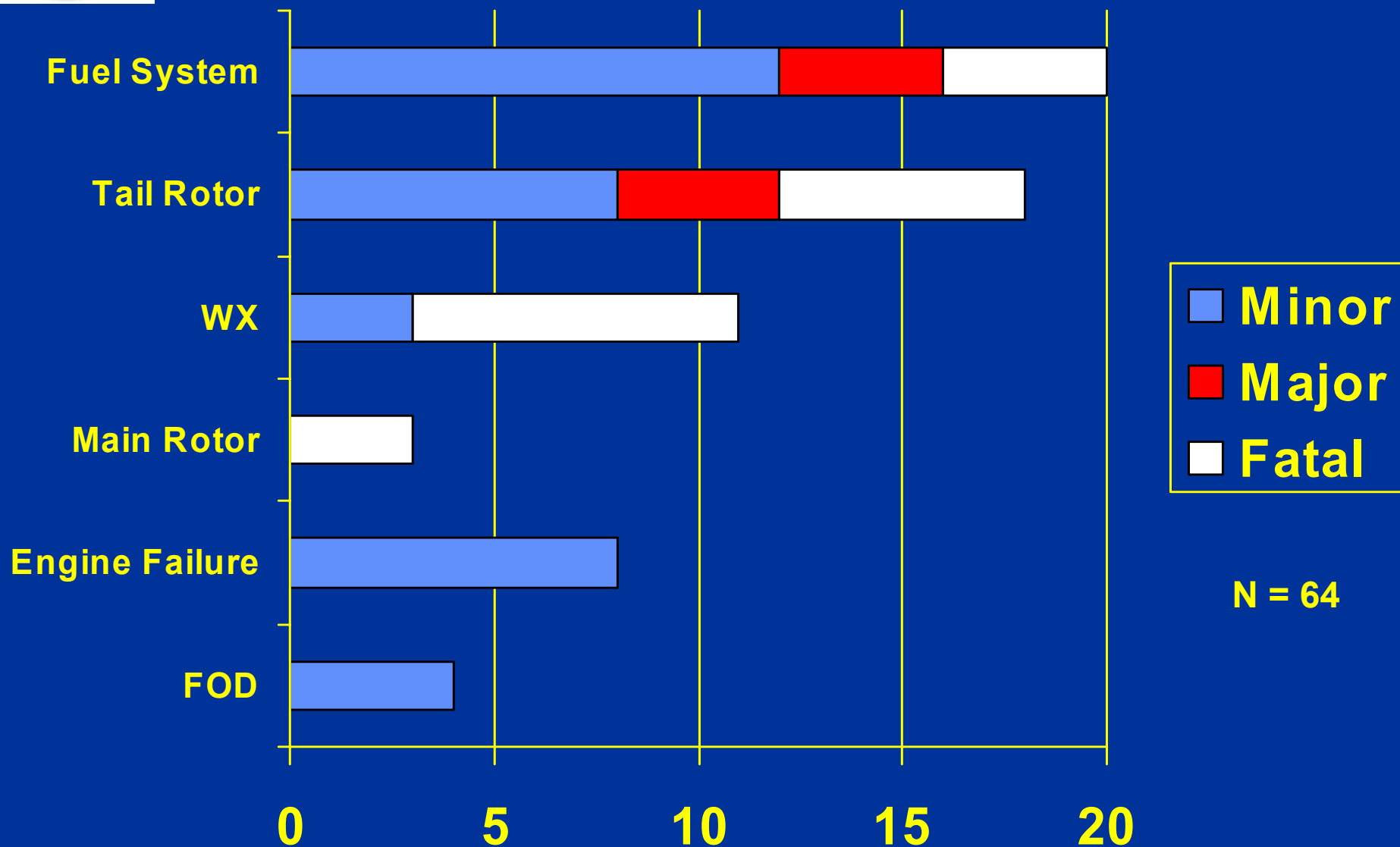


USA NHF Landing Mishaps Fatalities & Injuries



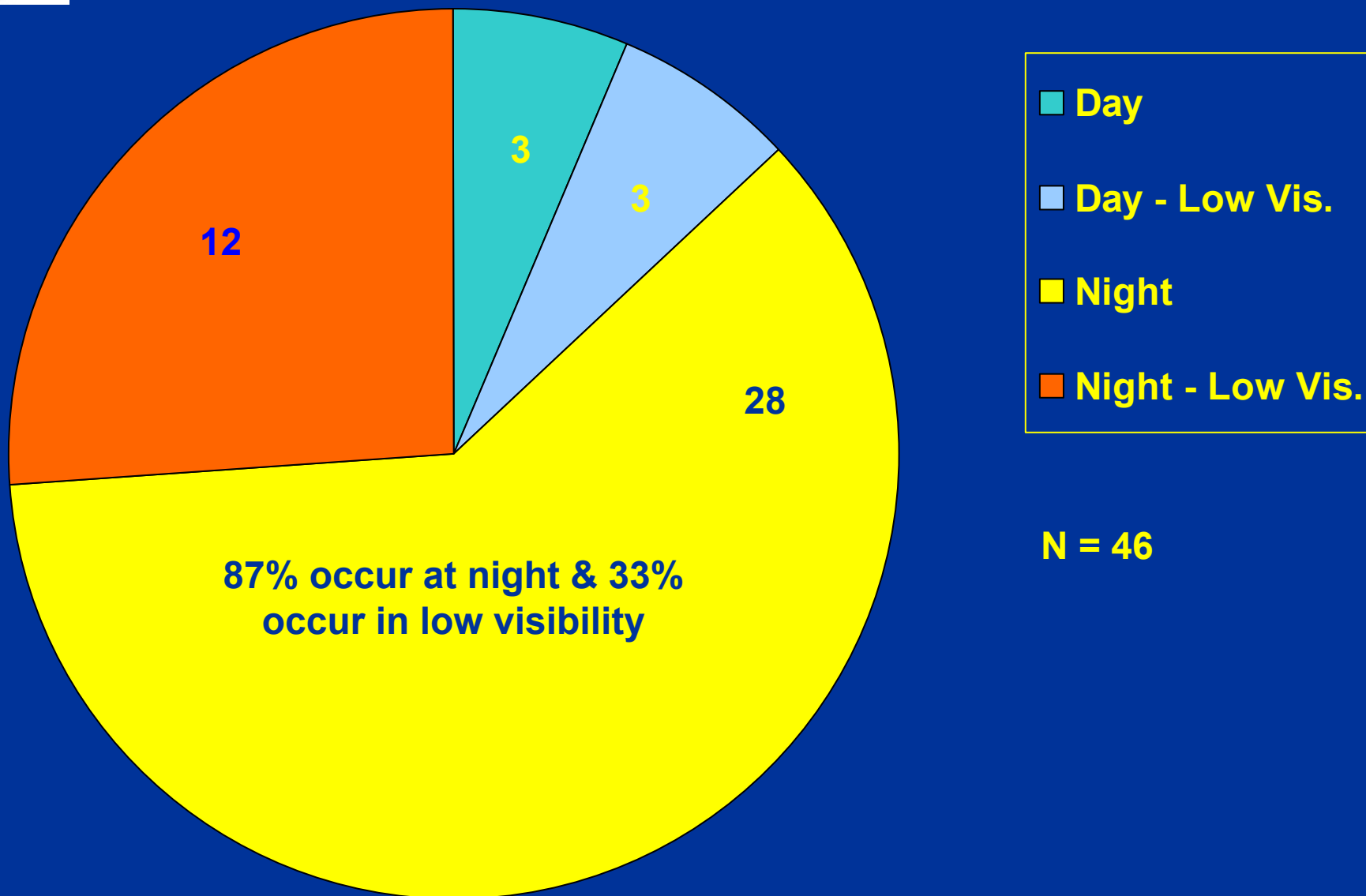


USA NHF Landing Fatalities & Injuries by Malfunction Category





USA HF Hover/Taxi Mishaps





USA HF Hover/Taxi Mishaps

Lateral (MRB)

TR

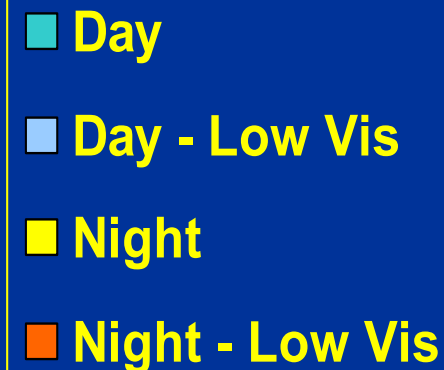
Aero - Power

Excess Sink

Hit A/C

Drift - R/O

Not Spec.

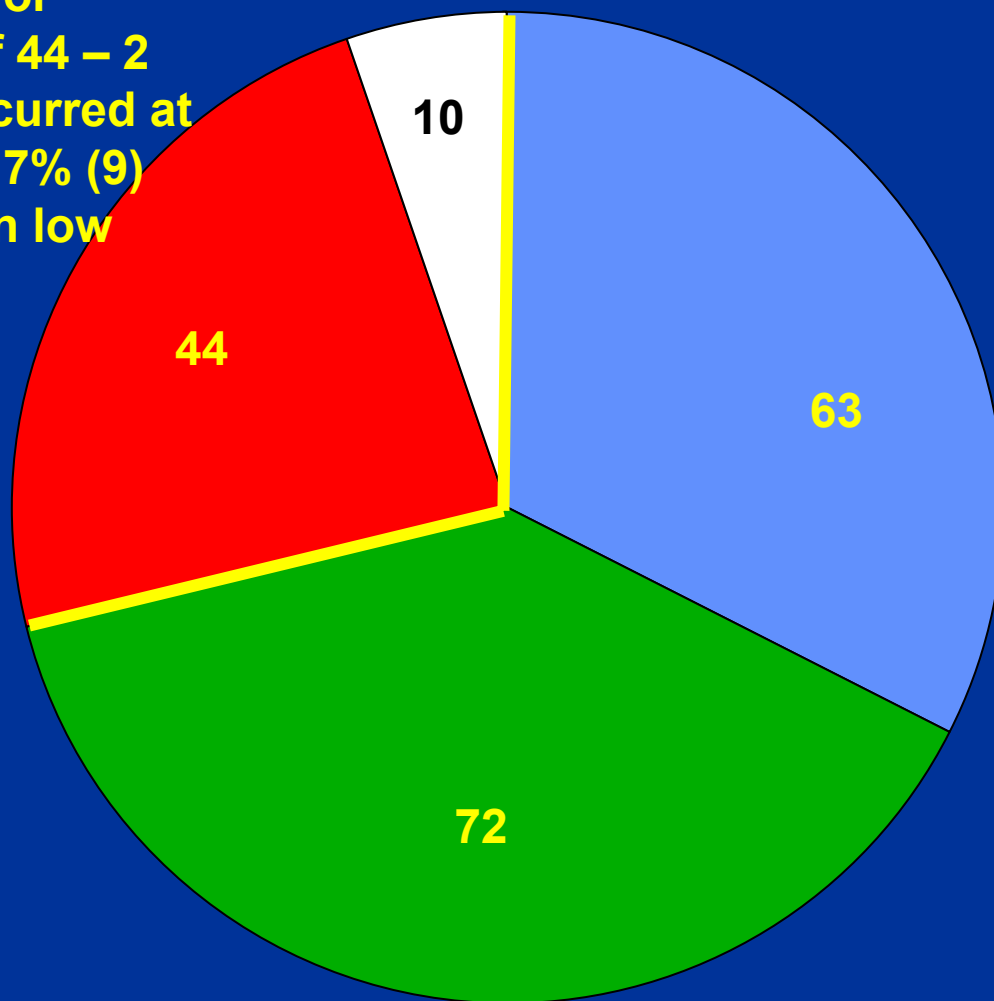


N = 46



USA HF Hover/Taxi Fatalities & Injuries

All Fatalities (10)
and 42 Major
Injuries (of 44 – 2
undet.) occurred at
night & 16.7% (9)
occurred in low
visibility



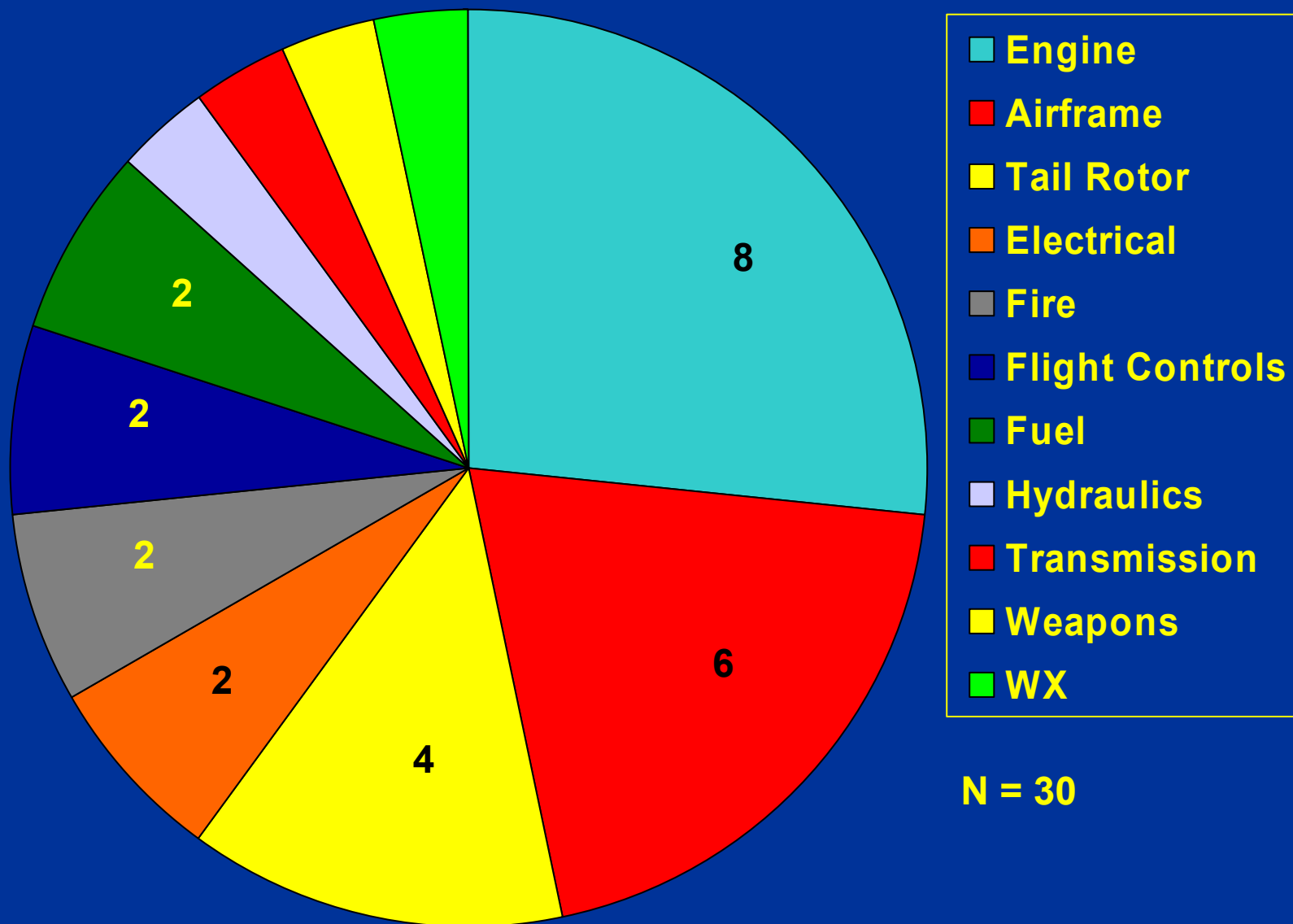
■ Minor
■ Uninjured
■ Major
■ Dead

N = 189

Of those uninjured
or with minor
injuries, 6 were
day (3 low vis) and
129 were night (3
low vis)

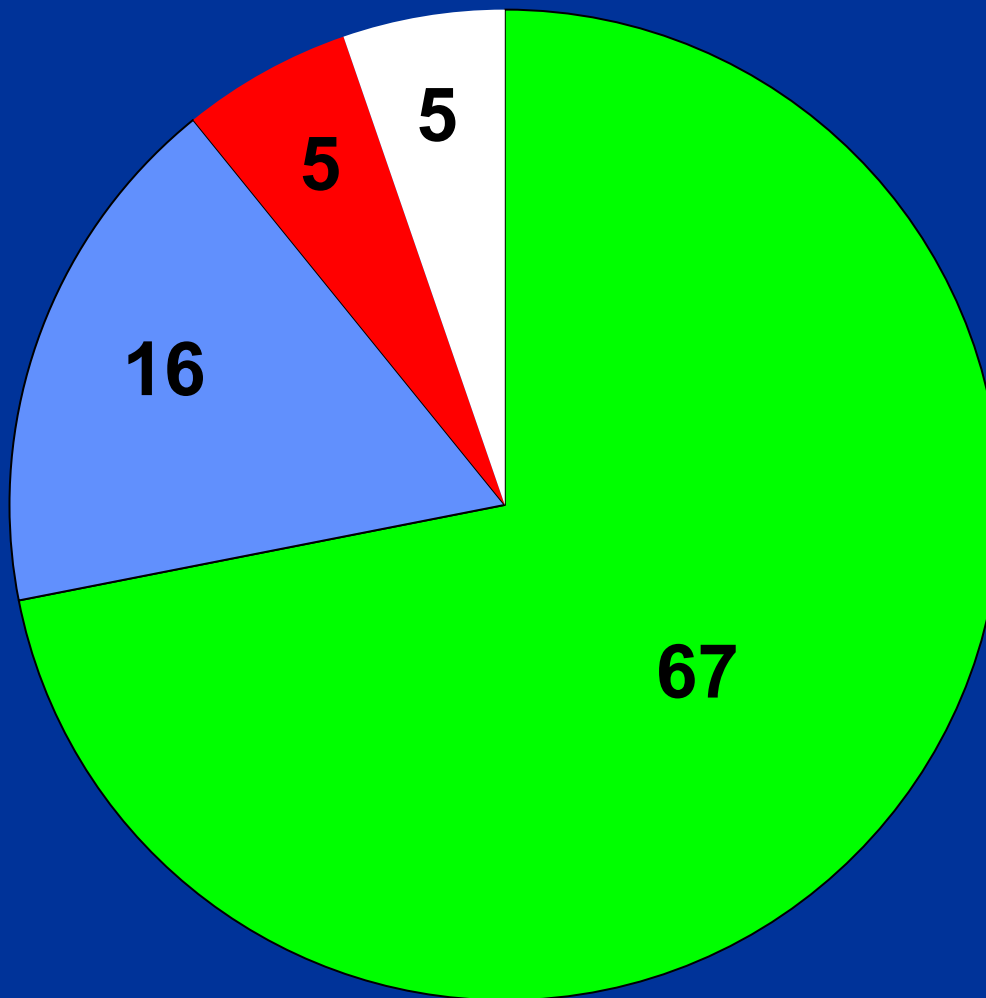


USA NHF Hover/Taxi Mishaps Malfunction Categories





USA NHF Hover/Taxi Mishaps Fatalities & Injuries



Uninjured

Minor

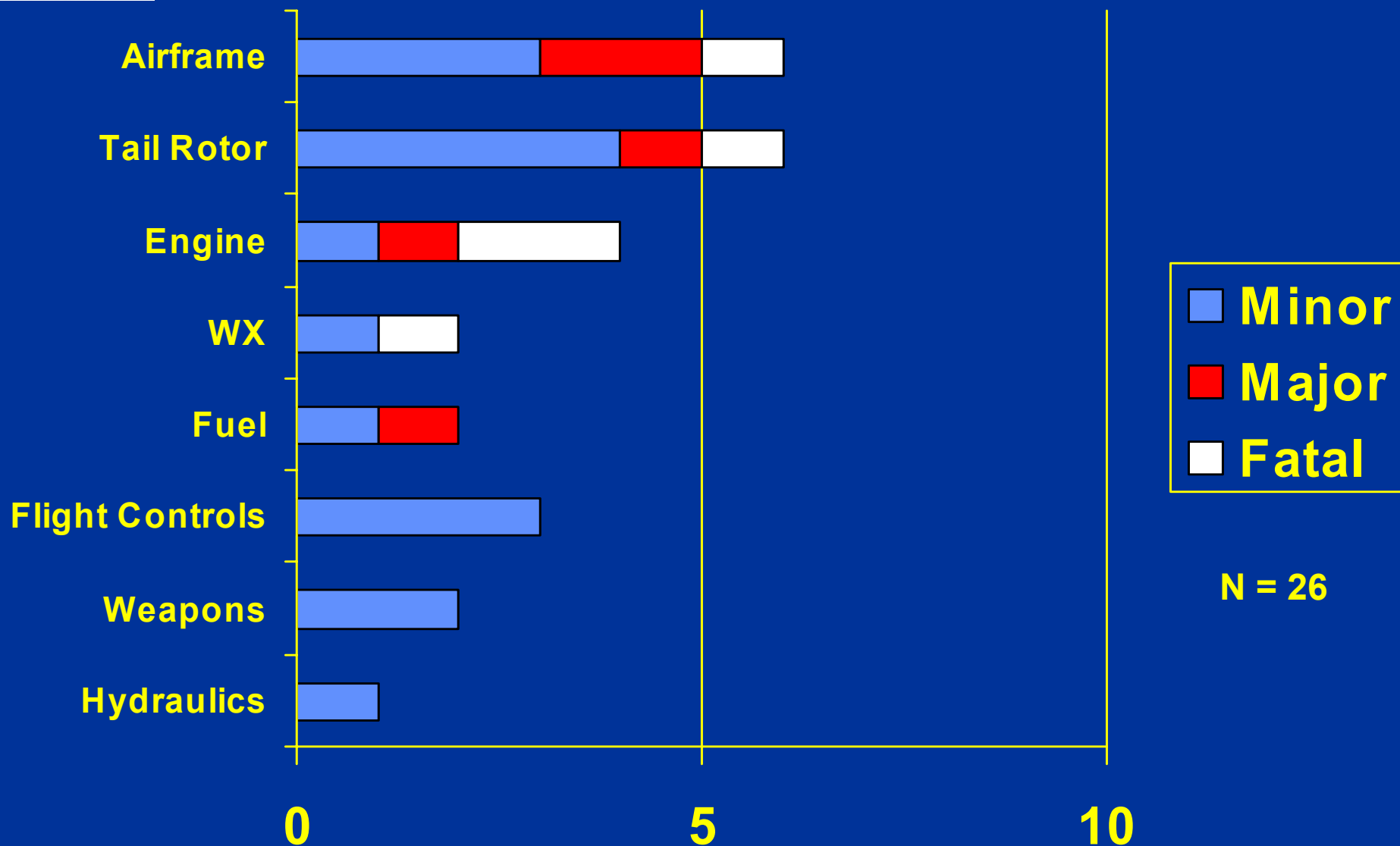
Major

Fatal

N = 93

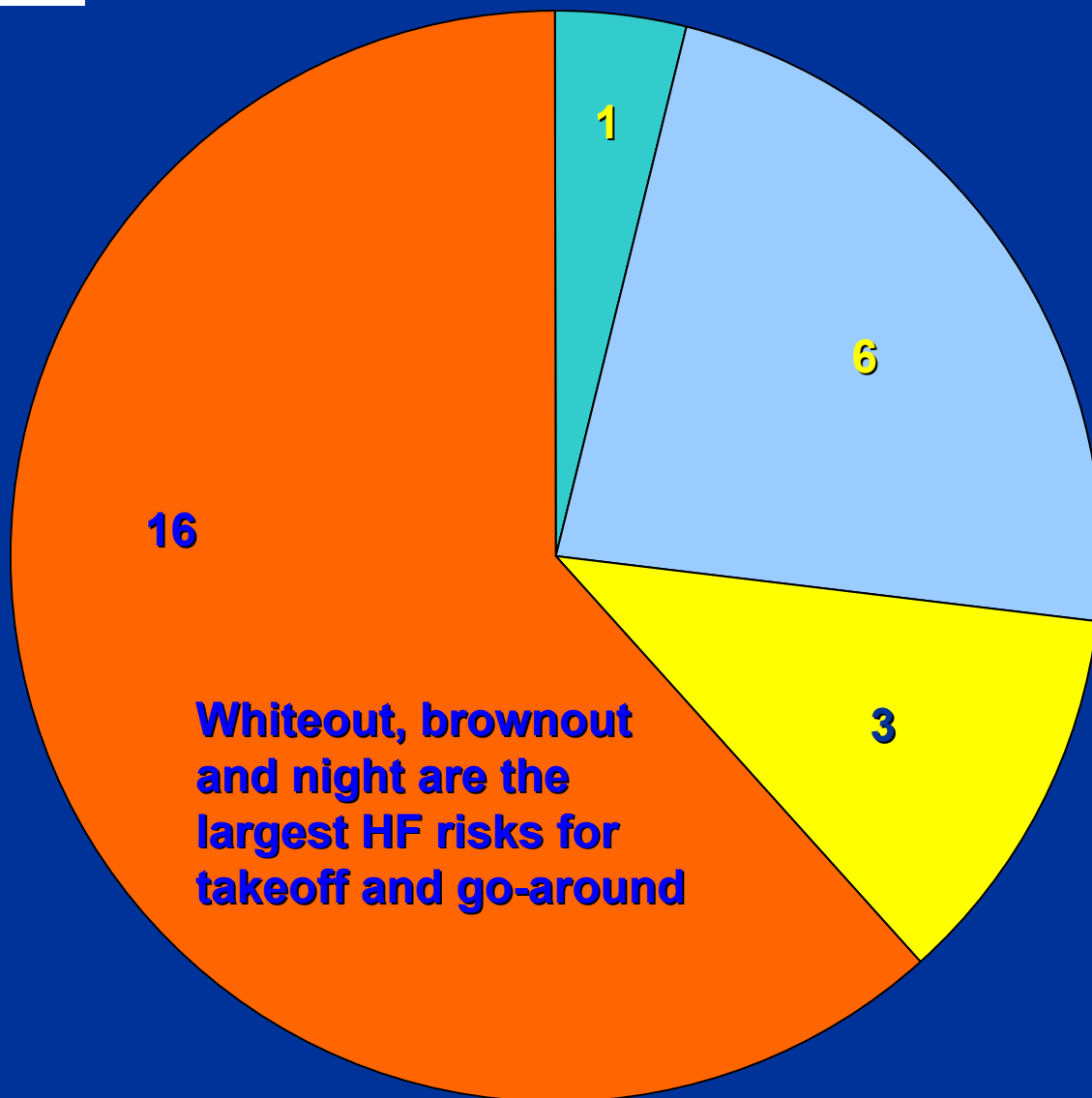


USA NHF Hover/Taxi Fatalities & Injuries by Malfunction Category





USA HF T/O & G/A Mishaps



- Day
- Day - Low Vis.
- Night
- Night - Low Vis.

N = 26

Whiteout, brownout
and night are the
largest HF risks for
takeoff and go-around



USA HF T/O & G/A Mishaps

Aero - PWR

Lat - A/C

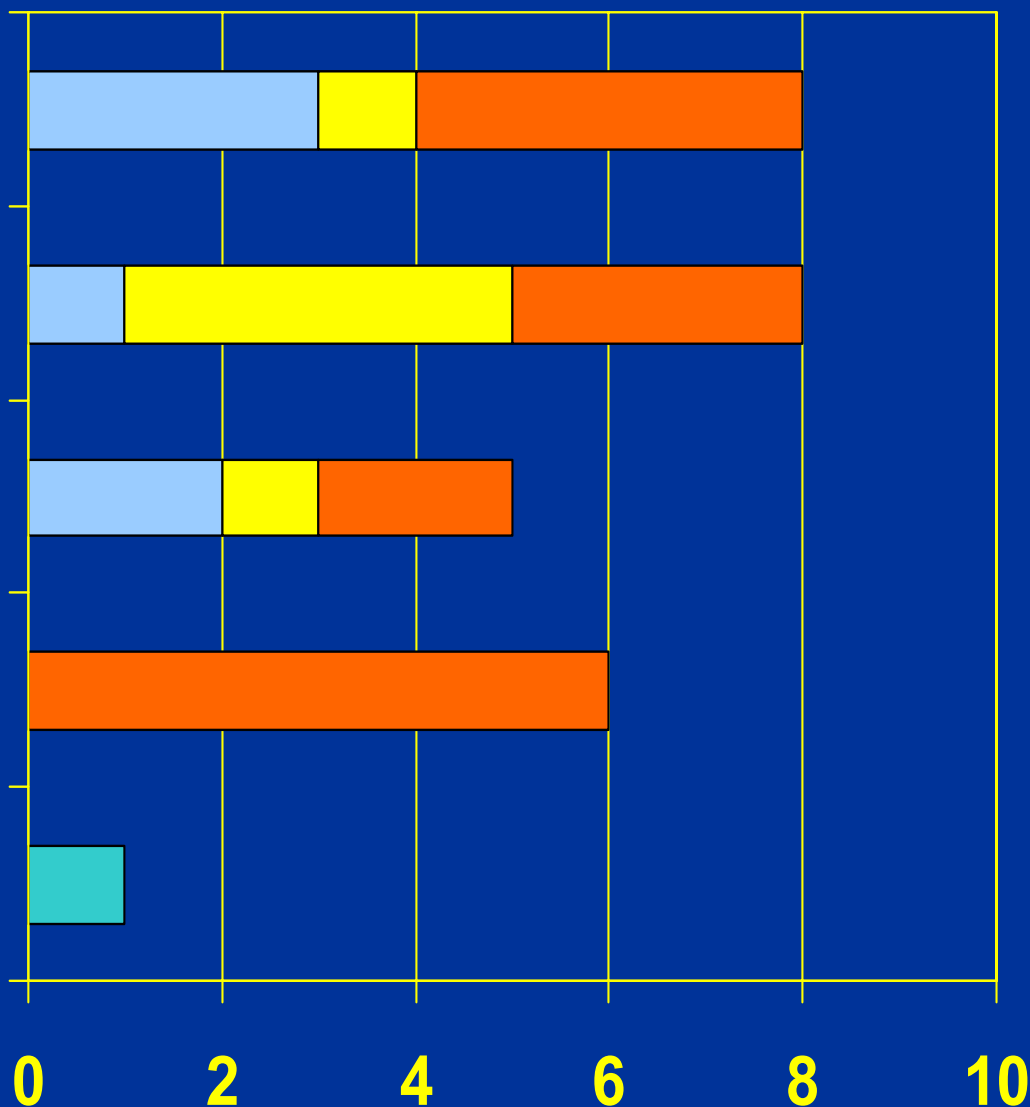
Lat - MRB

Drift - R/O

Wire



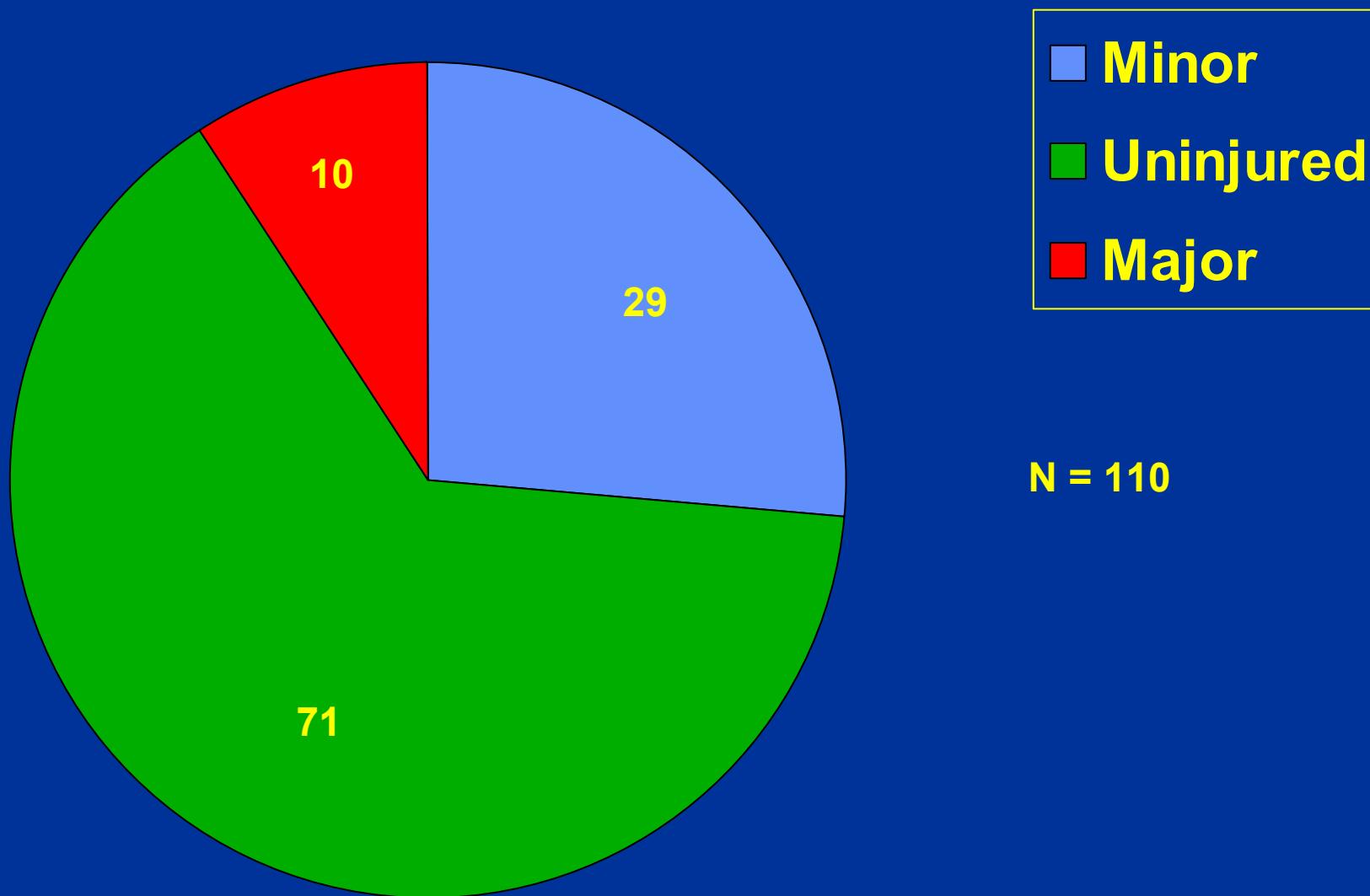
N = 26





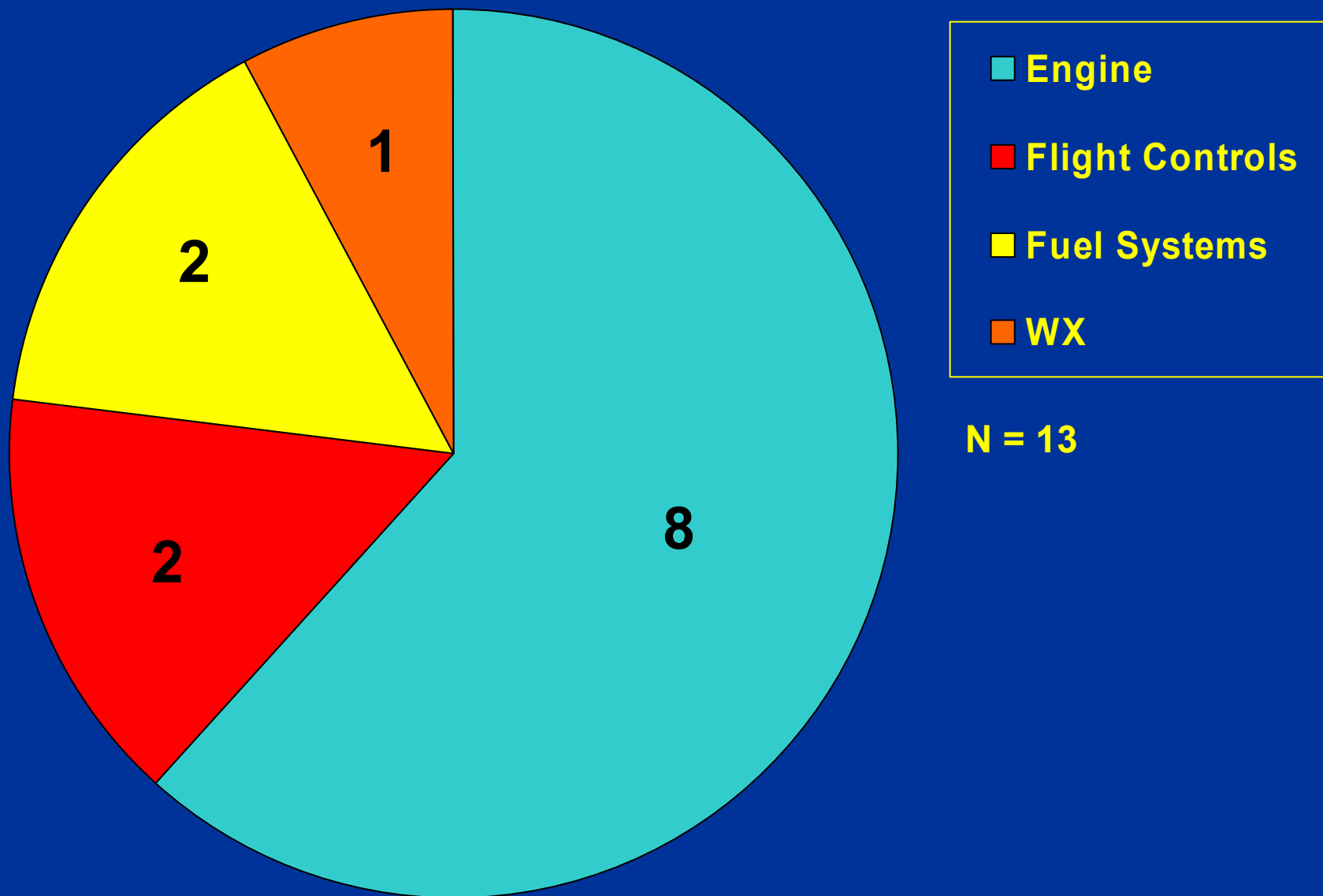
USA HF T/O & G/A Mishaps

(NO HF FATALITIES OCCURRED DURING T/O & G/A)





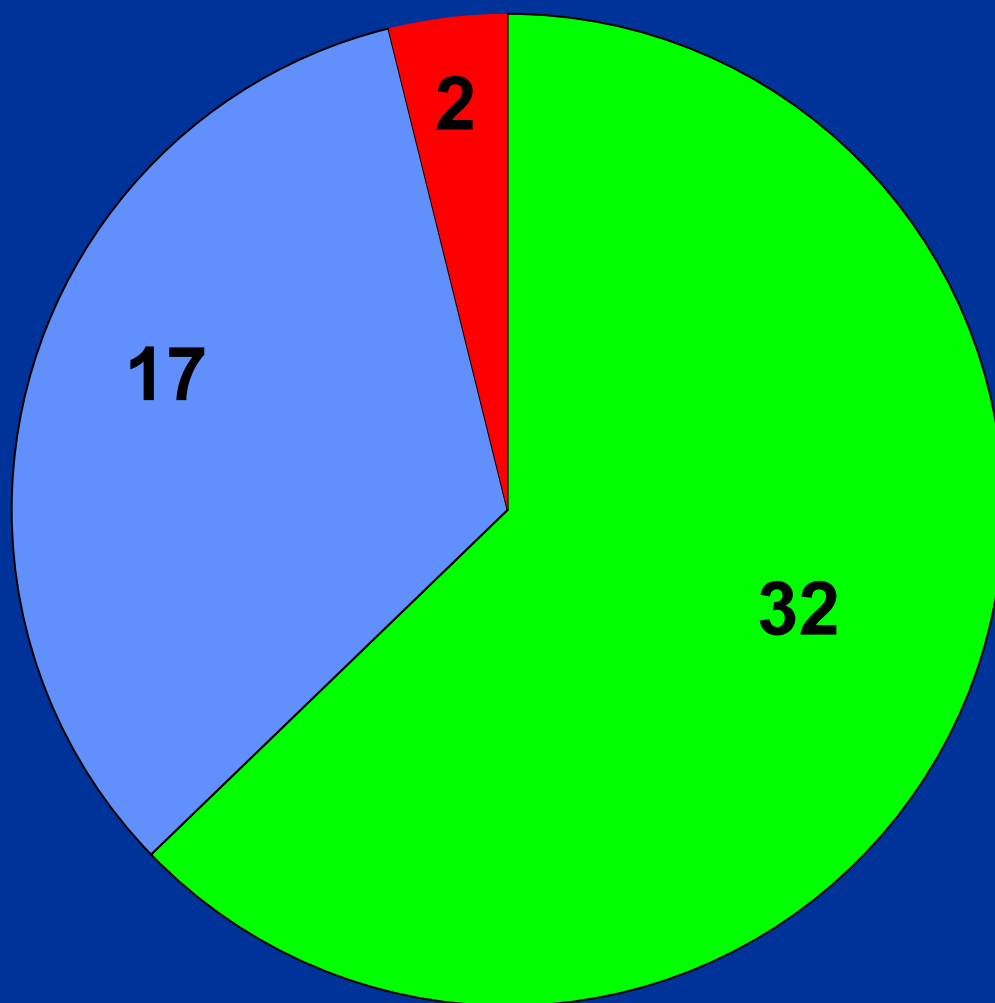
USA NHF Take-Off Mishaps Malfunction Categories





USA NHF Take-Off Mishaps *Injuries*

No Fatalities



Uninjured

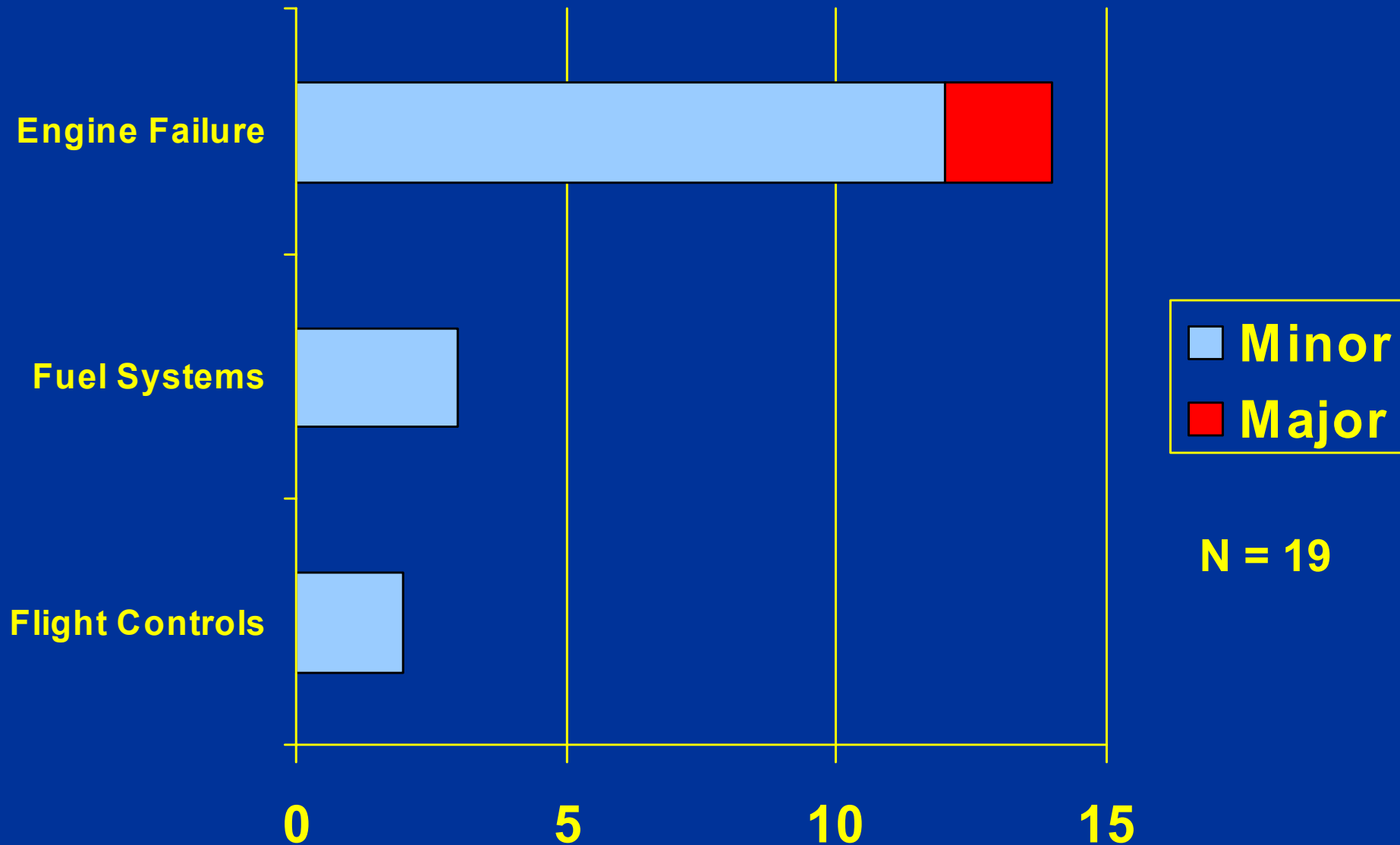
Minor

Major

N = 51

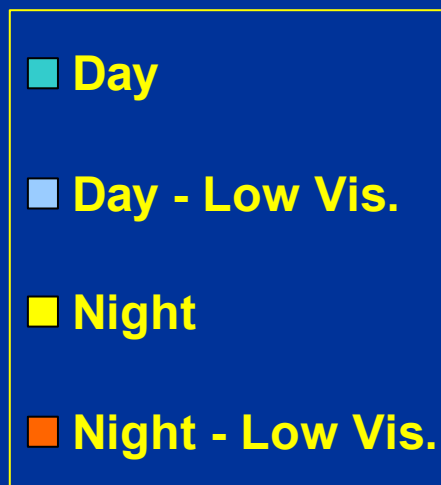
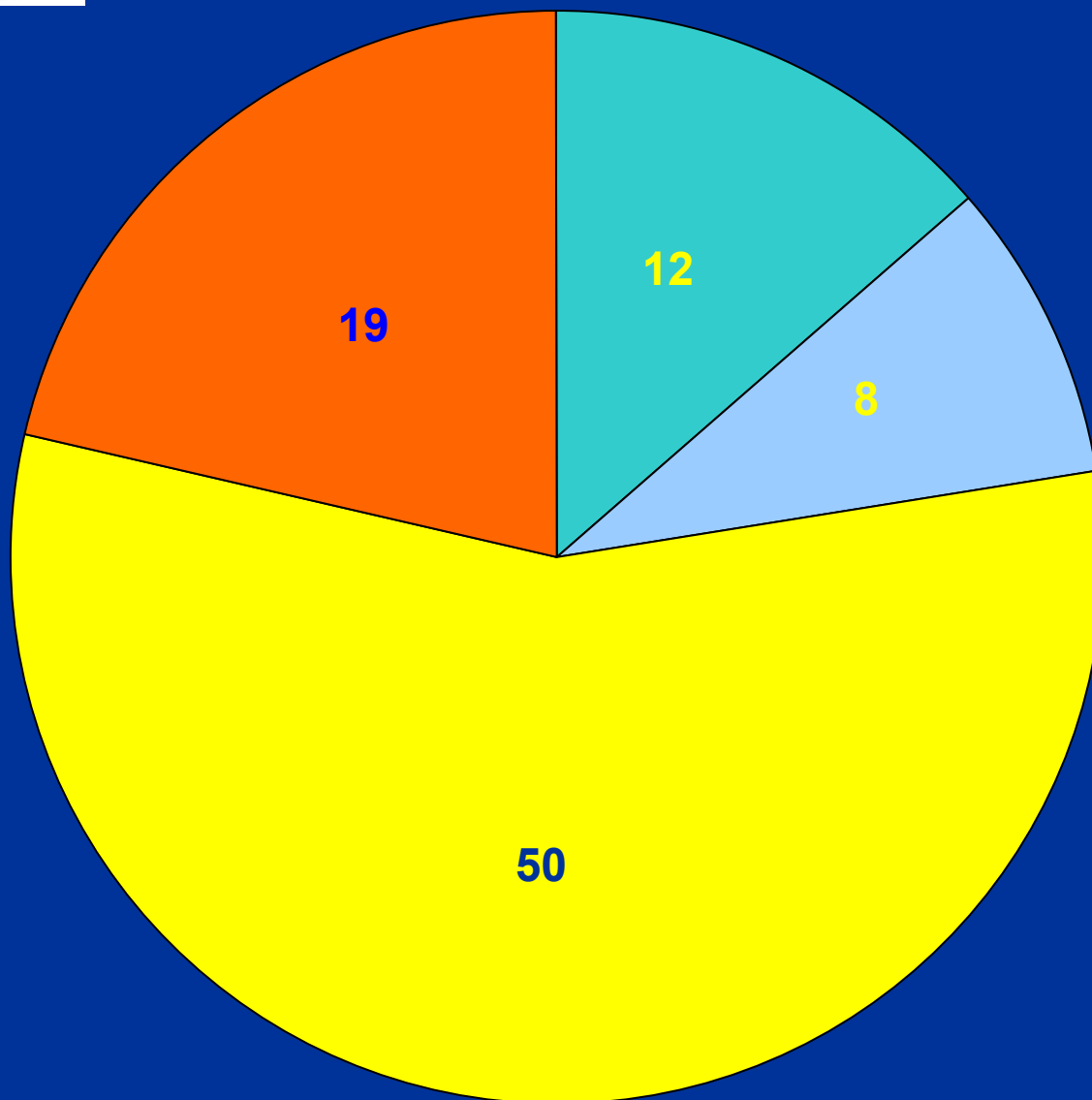


USA NHF Take-Off Fatalities & Injuries by Malfunction Category





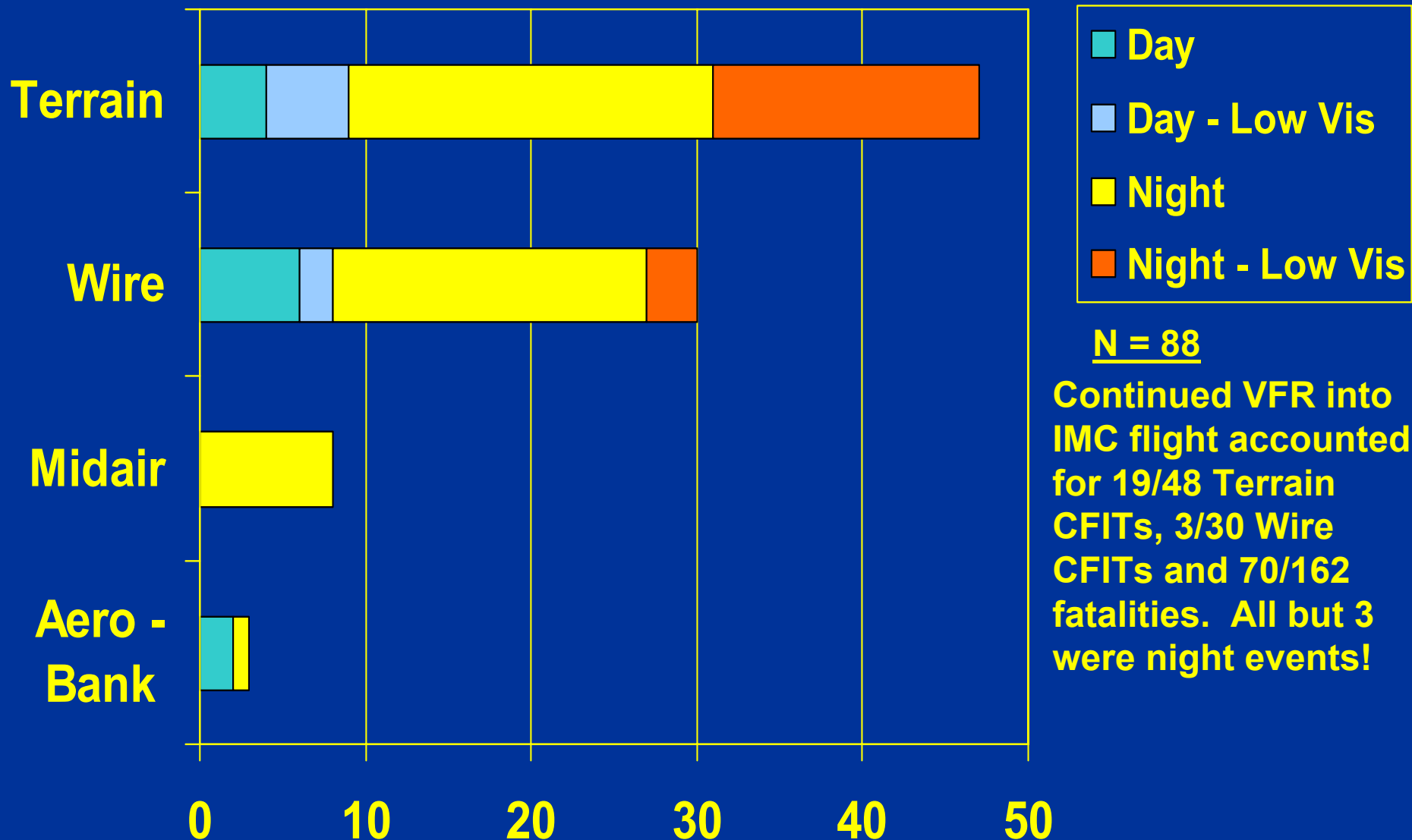
USA HF Cruise Mishaps



N = 88



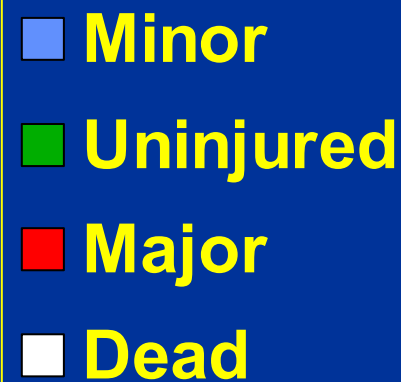
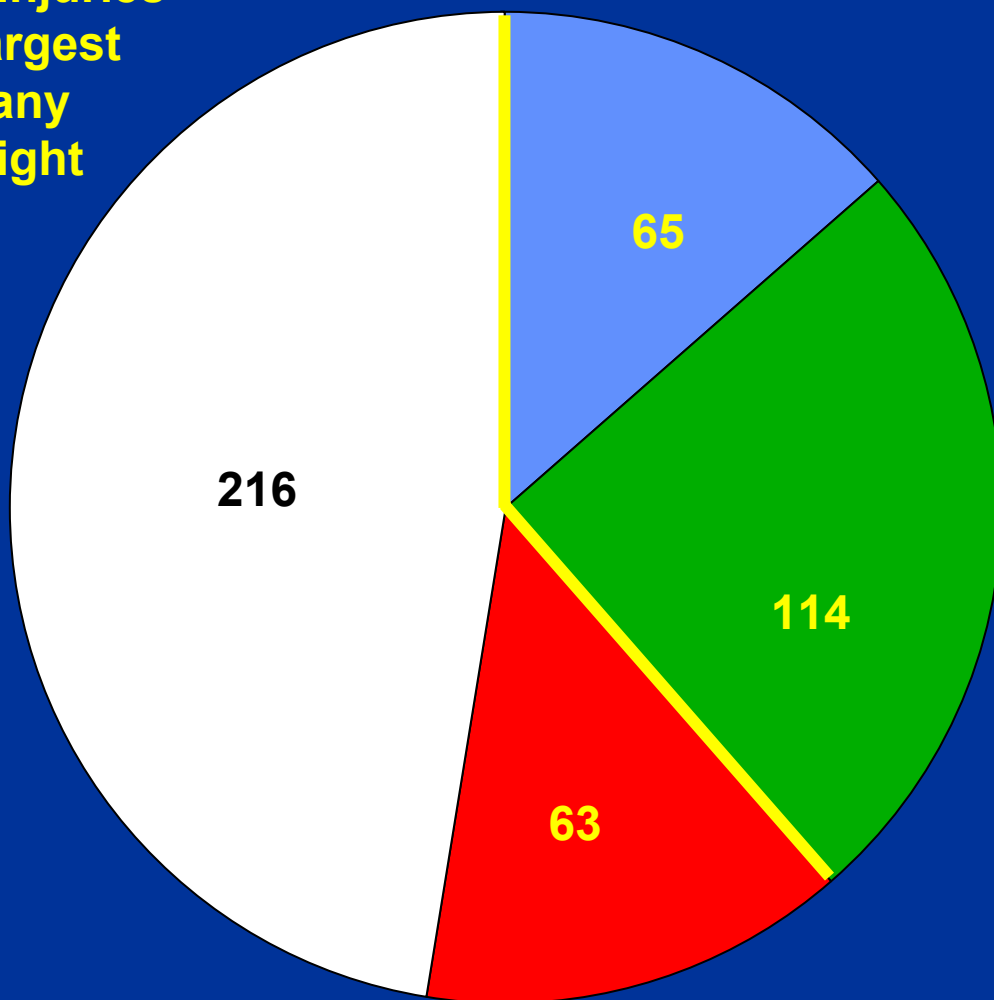
USA HF Cruise Mishaps





USA HF Cruise Fatalities & Injuries

Cruise Fatalities and Major Injuries were the largest groups in any phase of flight



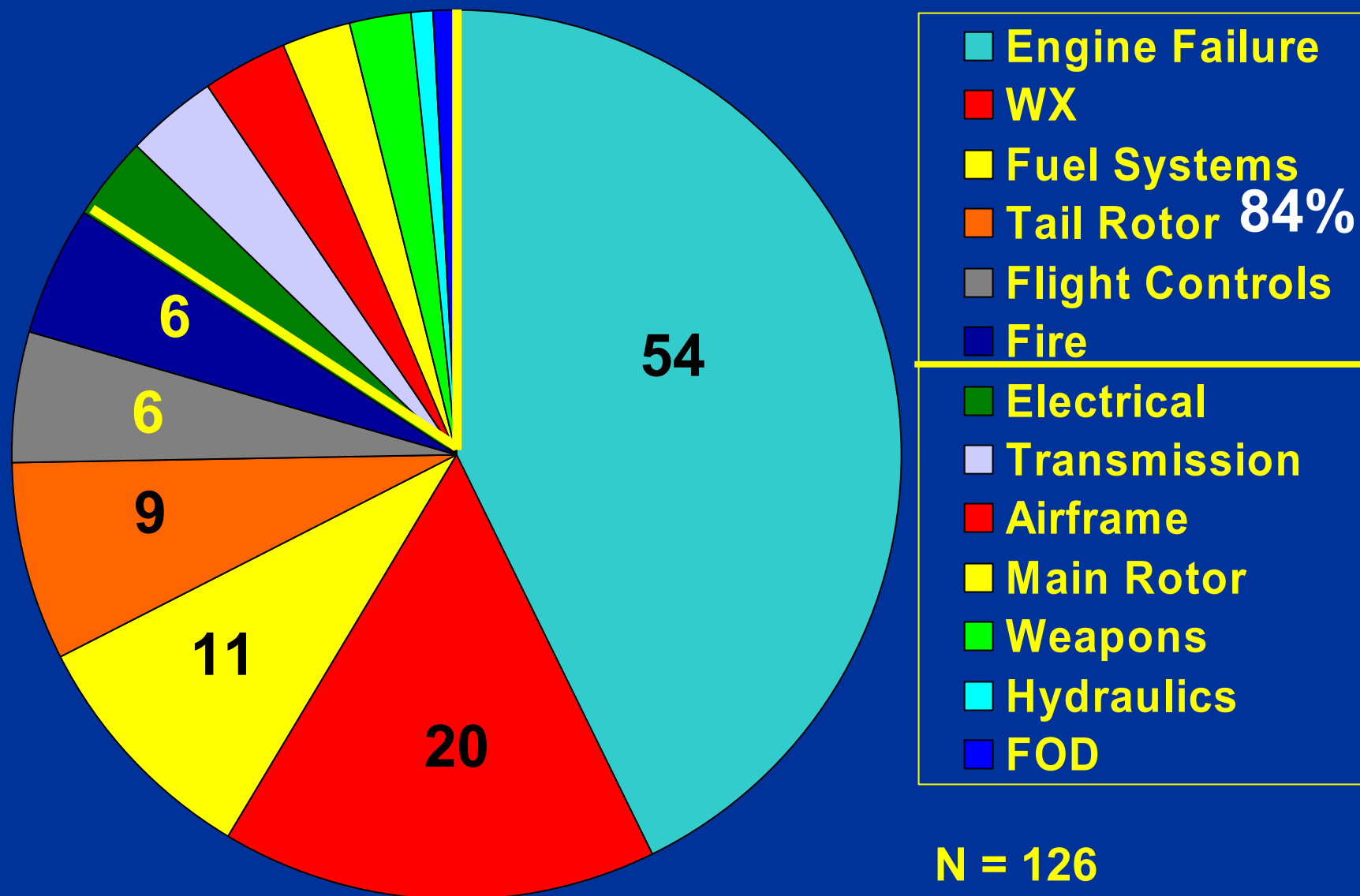
N = 458

Wire strikes accounted for 42/216 cruise fatalities and 22/63 major injuries

Midair collisions accounted for 50/216 cruise fatalities and 10/63 major injuries

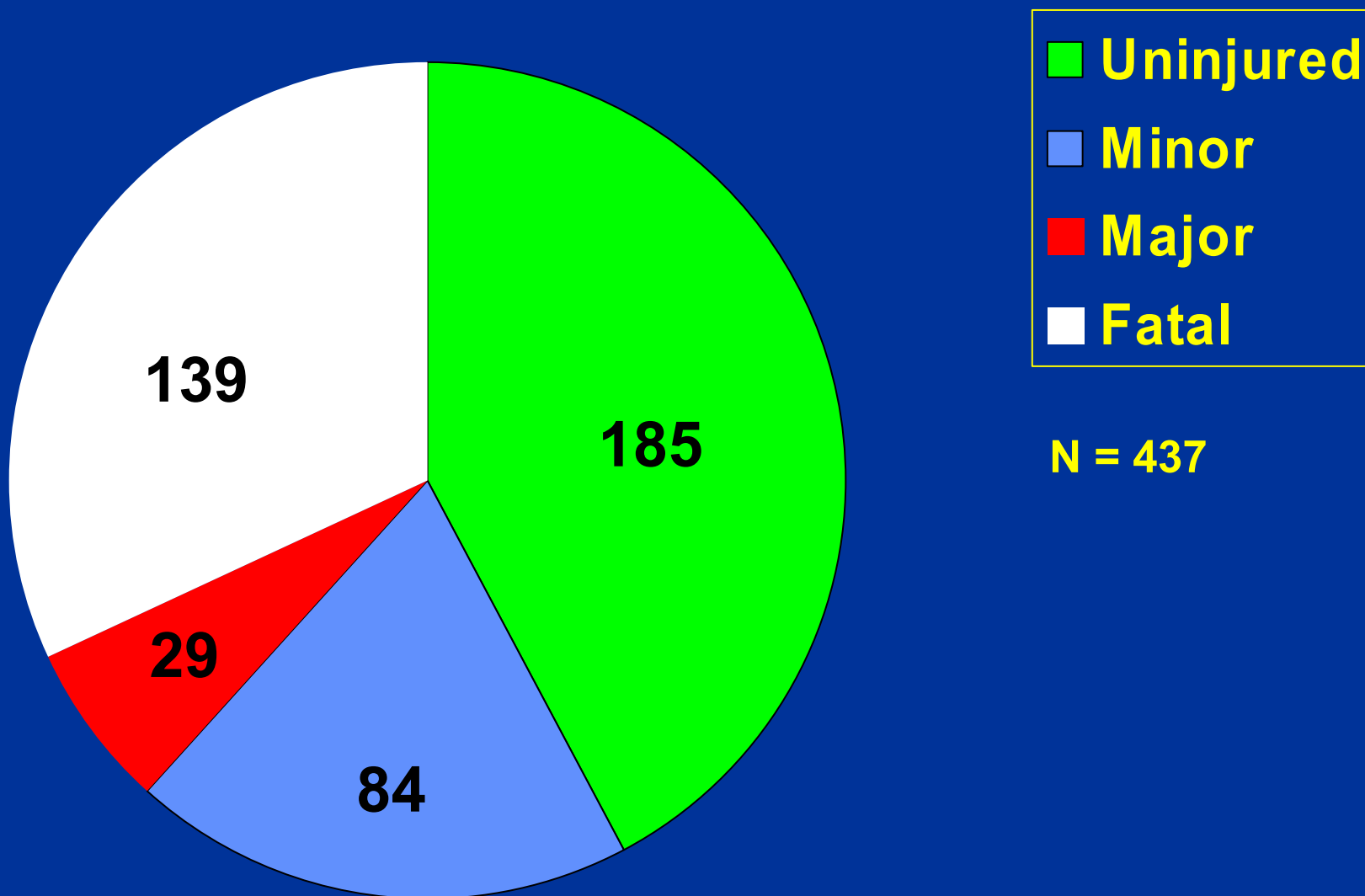


USA NHF Cruise Mishaps Malfunction Categories



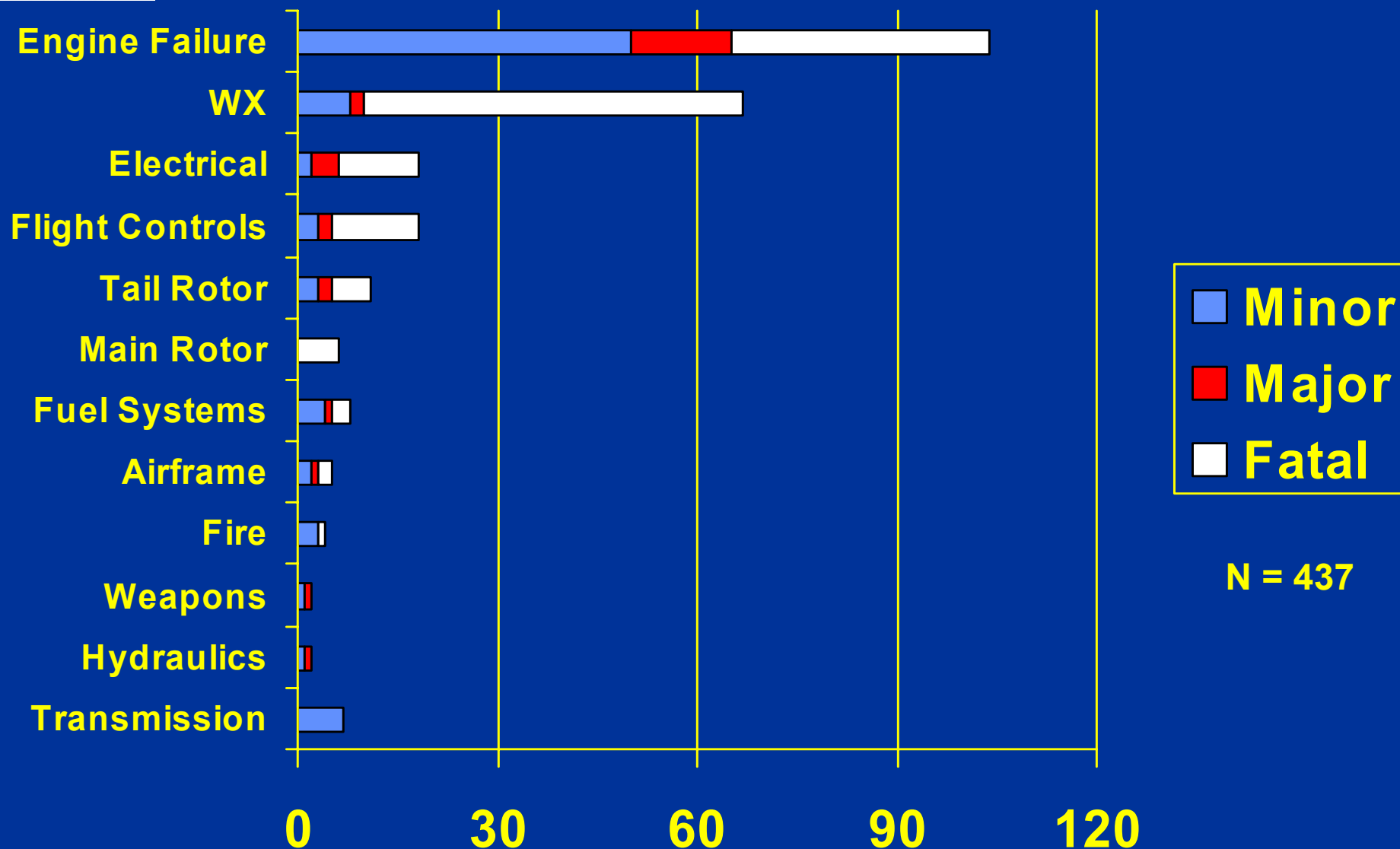


USA NHF Cruise Mishaps Fatalities & Injuries





USA NHF Cruise Fatalities & Injuries by Malfunction Category





Findings



Army Findings

- Cruise flight (CFIT) is the most lethal and injurious
- Twin rotor aircraft & attack helicopters appear to be the most survivable
- The training pilots receive to deal with NHF mishaps improves protection factor by roughly 20%
- Cargo compartment crew are more likely to receive major injuries and die than pilots
- IMC is associated with the highest risk of mishap fatality
- Unforecast adverse weather accounts for 1/6 of NHF mishaps, engine failure is the leading NHF mishap cause
- Whiteout/brownout was the most common risk factor in mishaps below ETL
- Tail rotor strikes were common in AH & OH helicopters



DoN Findings

- The risk of fatality in cruise is 2.43 times greater than in flight below effective translational lift given an accident
- DoN has cut mishap fatalities and injuries in half since the period from FY 85 to 94
- Mandatory cranial use yields lower head fatality/injury ratio (2.8:1) compared to the Army (4.97:1)
- Pilots are more likely to be uninjured than cargo compartment occupants
- Twin rotor design & IP on TH-57 increased HF survivability
- DoN has greater likelihood of over water mishap yet water fatalities have been dramatically reduced



USAF Findings

- Class C USAF mishaps do not foretell Class A or B
- H-60 use in CSAR produces a high fatality rate not seen on the use of the H-60 by other services
- The H-53 & H-60 experience high mortality and morbidity compared to other services and the H-1
- Cruise CFIT was the most lethal and injurious phase of flight
- The wire strike and the midair were 100% lethal
- All brownouts and all but one IMC mishap occurred at night
- IMC imposed 20 to 30 times the risk of a mishap
- Mishaps are likely with low time aircraft commanders



Recommendations



Technology Recommendations (Life Saving - Requirements)

- USA & USAF Helicopters would benefit from a system similar to TAWS (HTAWS)
 - Militarize a COTS item to provide this for legacy aircraft
 - Modify Navy TAWS to see obstructions
- Bring datalink weather data into all helicopter cockpits
- Provide COTS traffic warning technology to prevent midairs
 - TCAD (lightest weight, lowest cost option)
 - TCAS (heavier, more expensive)
 - ADSB (less practical due to coverage limits)
- All helicopters need wire detection technology
- Wire cutters should be installed on all helicopters
- USAF H-60 CSAR mission needs new or Δ 'd vehicle
- Develop extensive simulator training for HF Scenarios



Technology Recommendations (Life Saving - Crashworthiness)

- Occupants of mishap helicopters above ETL cannot be protected, the only protection is mishap prevention through increased situational awareness (HTAWS, Sat. Wx, TCAD)
- Injuries and deaths in low speed mishaps can be mitigated:
 - All occupants should use lap and shoulder restraints
 - Airbag installation should be encouraged
 - Stroking seats should be standard for all occupants
 - Head protection use should be required of all occupants
- Crew positions should be designed to eliminate (minimize) the need for any crewmember to be out of a crashworthy seat below ETL
- Maximize use and acquisition of twin rotor designs
 - Move pilots out in front of forward rotor head
- Prevent occupancy beneath heavy components



Technology Recommendations (Aircraft Saving)

- All helicopters need technology permitting safe flight and the maintenance of situational awareness in brownout/whiteout conditions, particularly at night:
 - Automated hover with instant availability
 - Automated landing systems
 - Sensor based systems (See through/See & remember)
- All helicopters without rearward visibility (AH & OH) should be equipped with technology to prevent tail rotor strikes:
 - Warning systems that notify the pilot when an object is in the proximity of the tail rotor.
 - Automated systems permitting hover in a fixed position without drift.



Policy Recommendations

- Require all occupants of operating helicopters to wear a helmet at all times
- Require all passengers to remain strapped in position when operating below ETL until landing or in a stabilized hover has been achieved
- VFR training should cease in IMC for all pilots
 - High Risk Mission, approve at O-6+ level
 - Supervisors should actively recall or direct the landing of any assets airborne on VFR missions if weather is forecast to fall below VMC or does
 - Capable aircraft/pilots should use IFR clearances
- Emphasize (Do Not Waive) IMC proficiency



DoN Recommendations

- Improve head protection for all crew members
- Continue to improve rear compartment seating
- Communicate effectiveness of water safety improvements to other branches of service and civil aviation
- Record type and details of helmet and restraint information into existing DoN safety database
- Improvement in numerator and denominator collection is required at the DoN Safety Center
 - Original reports should be kept
 - Populate all variables in the current database format
 - DoN needs to integrate denominator feeds to Center (A/C & Aircrew hours, night, IMC, # A/C, etc)



Initiatives

- Occupant Protection
 - DON SBIR on crashworthy passenger seating
 - USA Airbags in OH-58 (No stroking seat)
 - STWG white paper commissioned
 - USAF
 - *SBIR on localizing crew functions in back
 - SBIR on crashworthy crew seating
 - SBIR on crashworthy passenger seating
- Terrain, weather & traffic awareness
 - DSOC Dem/Val program with GPS based data
 - Applies to USAF and USA Legacy Aircraft

* = unfunded



Needed

- Radar or Optical Wire Detection
- Tail Warning and/or automated hover for OH & AH aircraft (no rear visibility)
- Wireless Intercom for aft compartment crew (Navy)
- Collection of adequate data for analysis by all services
 - Flight hours by year & aircraft type
 - For Aircraft - Total, Instrument, Night, NVD, Overwater
 - For Aircrew - Total, Recency, Night, Nvd & Instrument
 - Phase of flight exposure data (MFOQA)
 - Time in various altitudes & flight regimes
 - Man years of exposure
 - Mishap data (Incorporate MFOQA into Board Reports)
 - Recommend Joint Analysis Center (USUHS, OSD, JCS)



The material in this presentation represents the opinion of the author and should not be construed to represent the position of the United States Air Force, the Department of Defense or any other organization.

Questions?

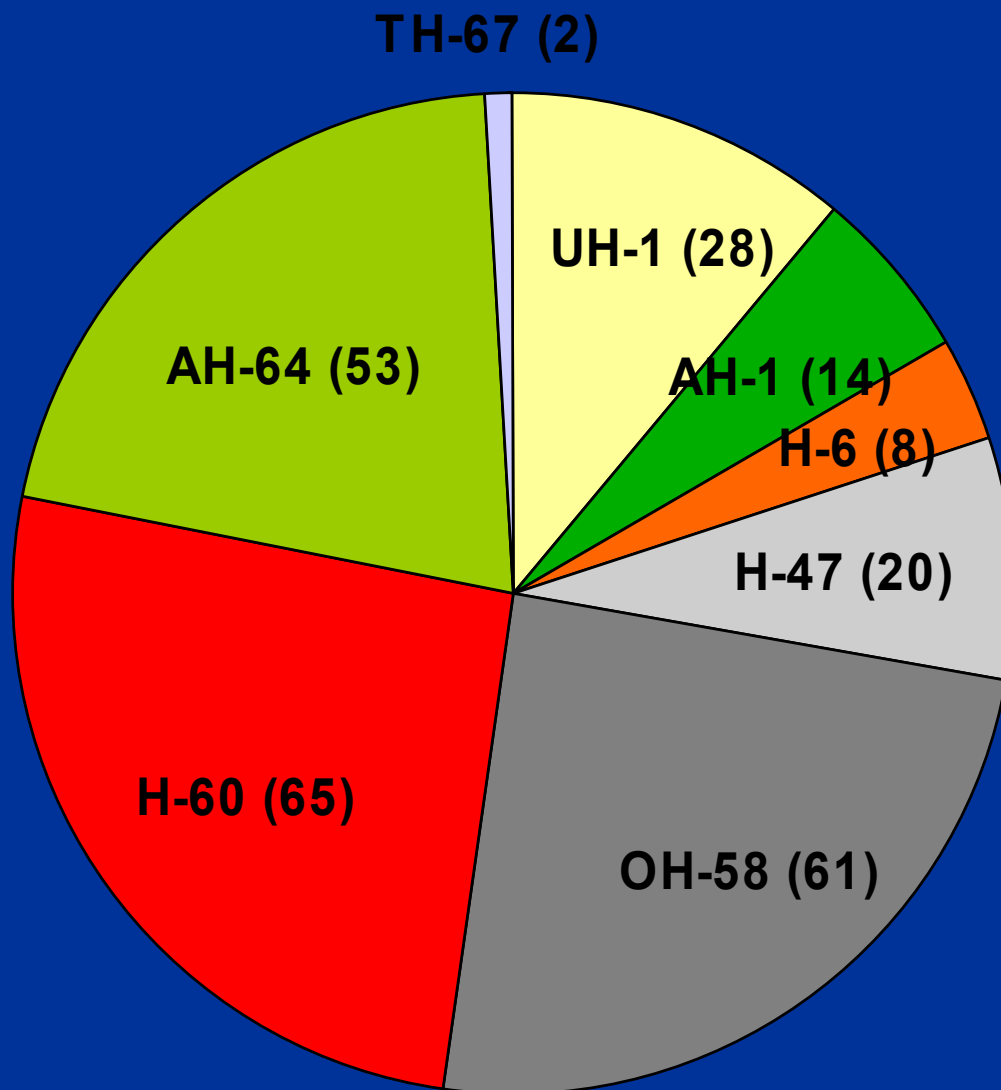
Colonel Pete Mapes
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Backup Slides



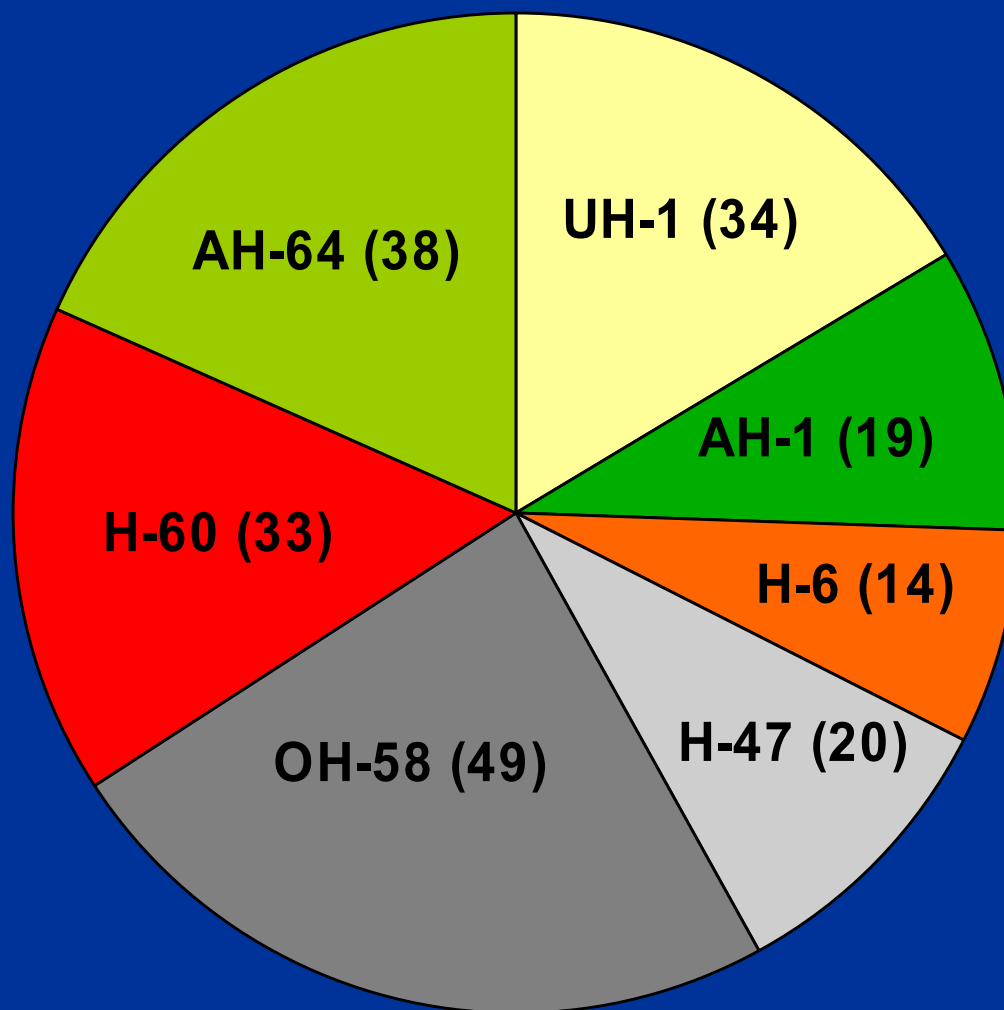
USA HF Mishaps by MDS



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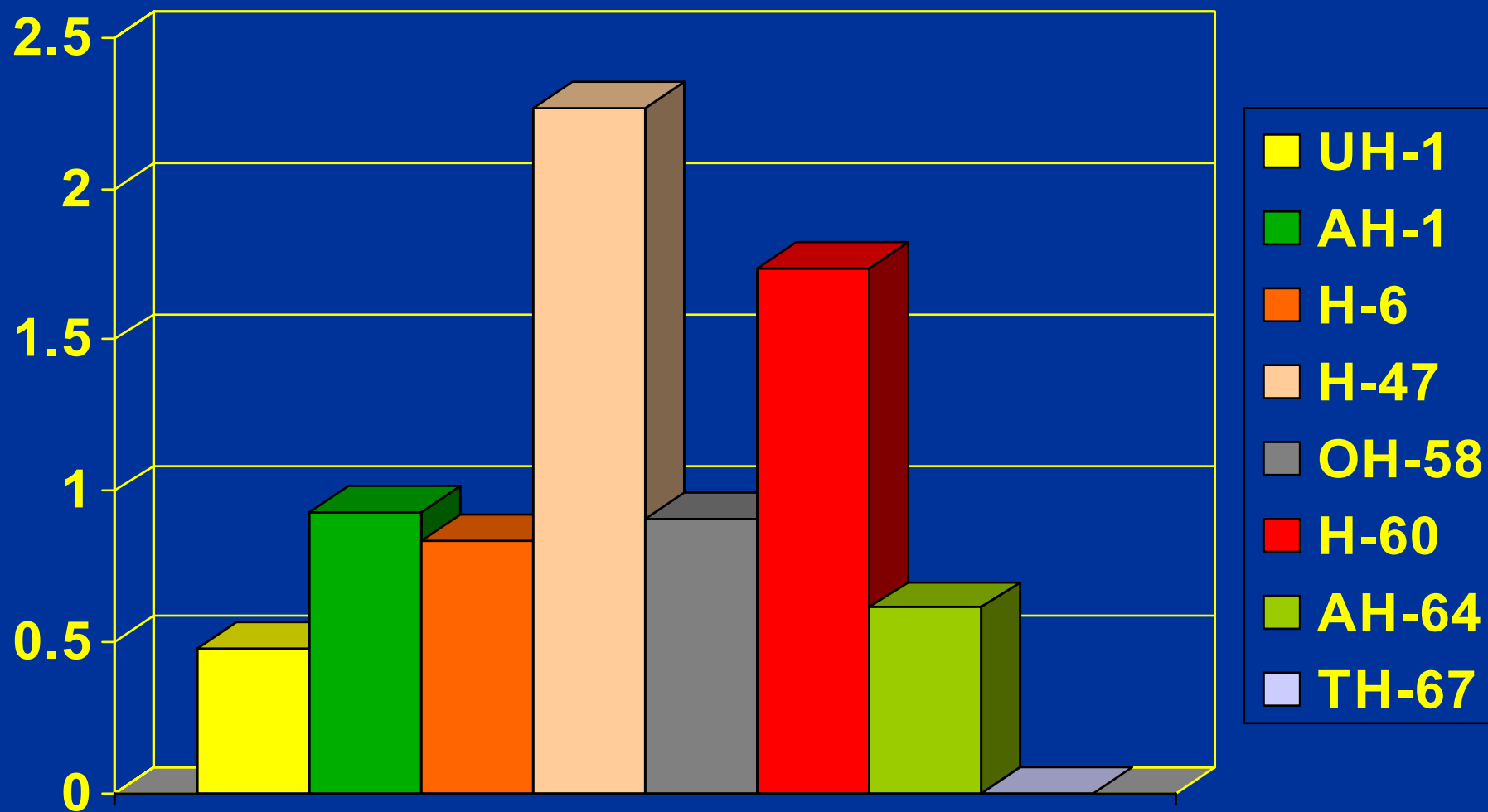
USA NHF Mishaps by MDS



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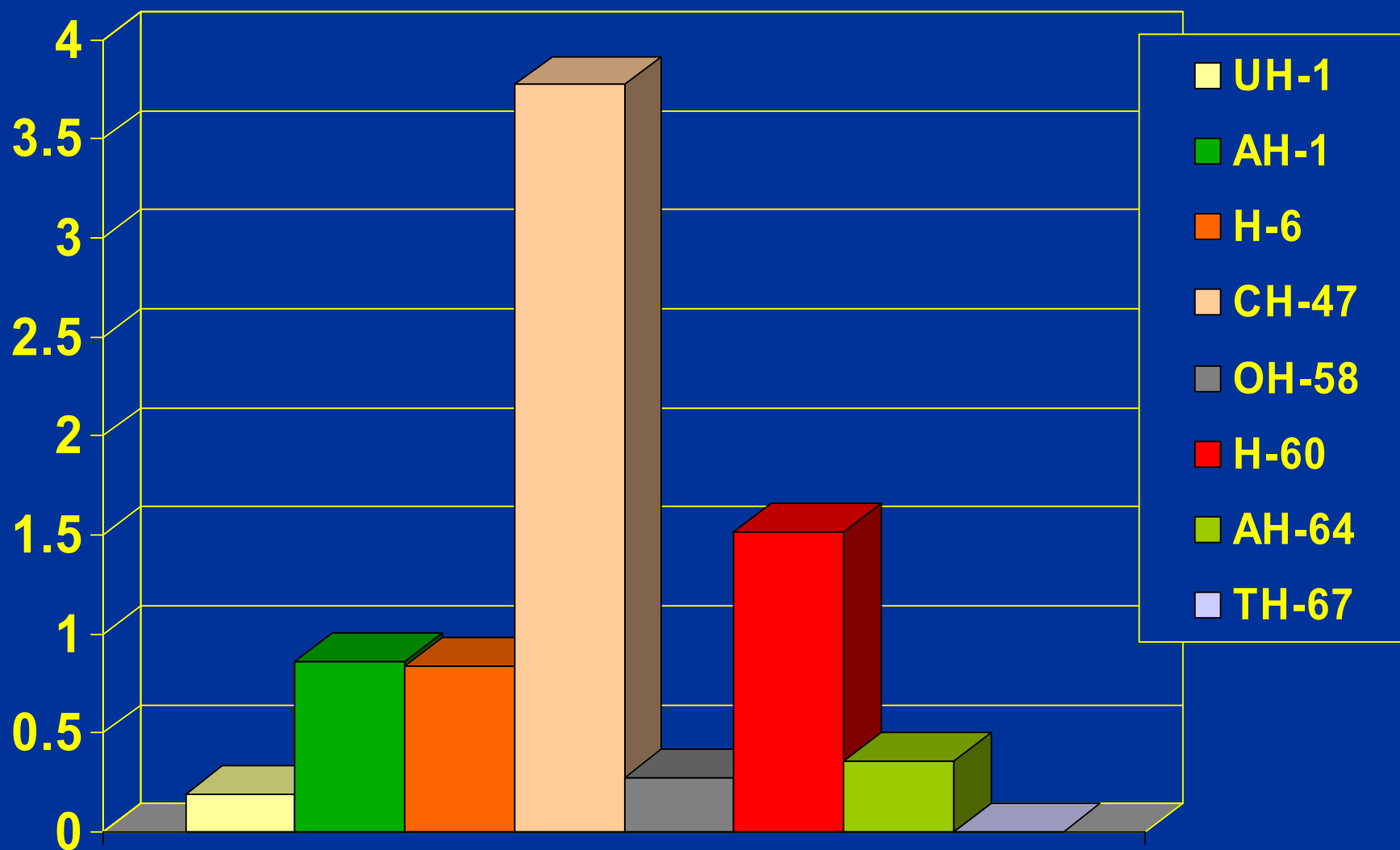


USA HF Fatality Rates/100K Hours BY MDS



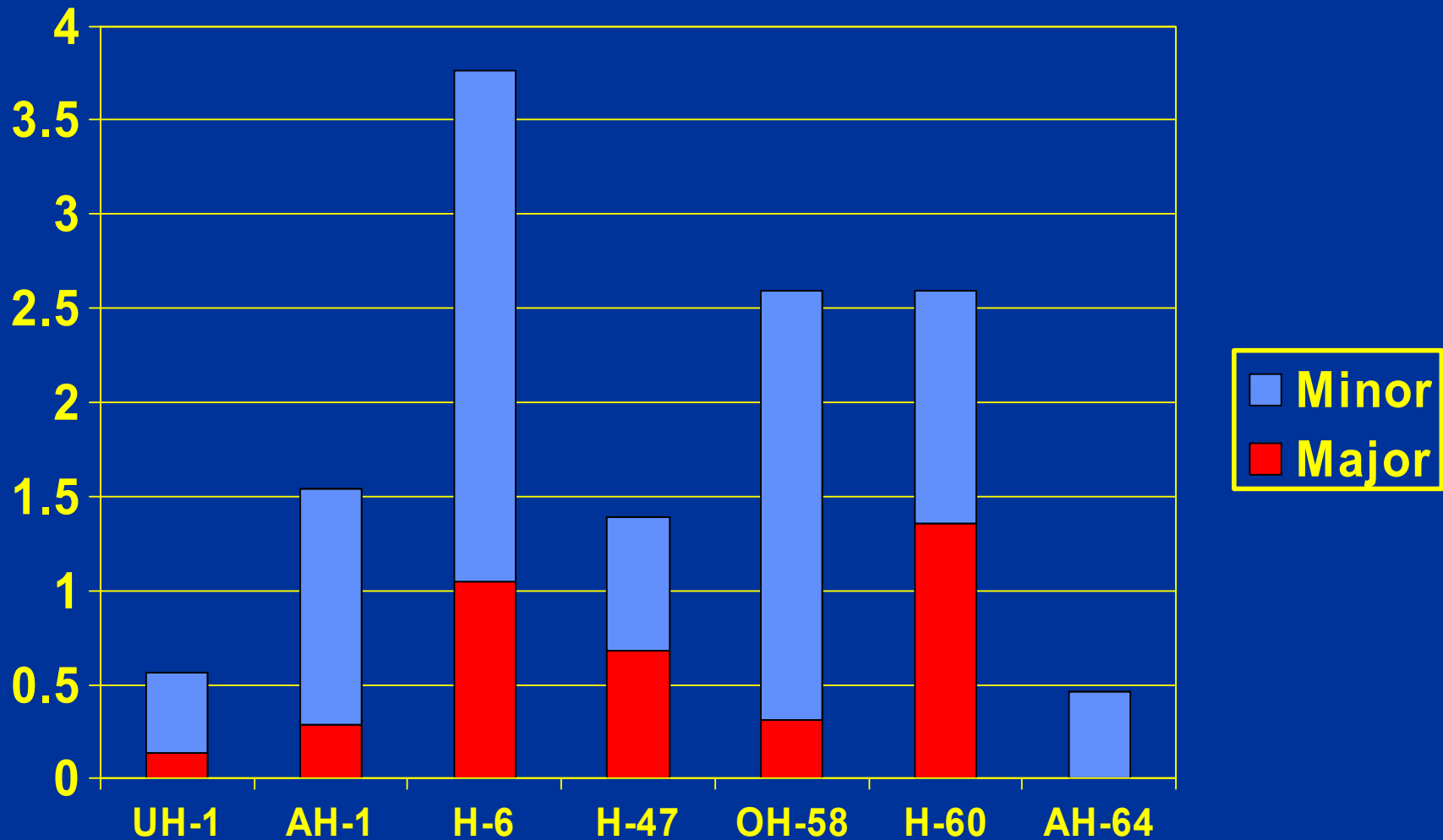


USA NHF Fatality Rates/100KHrs by MDS



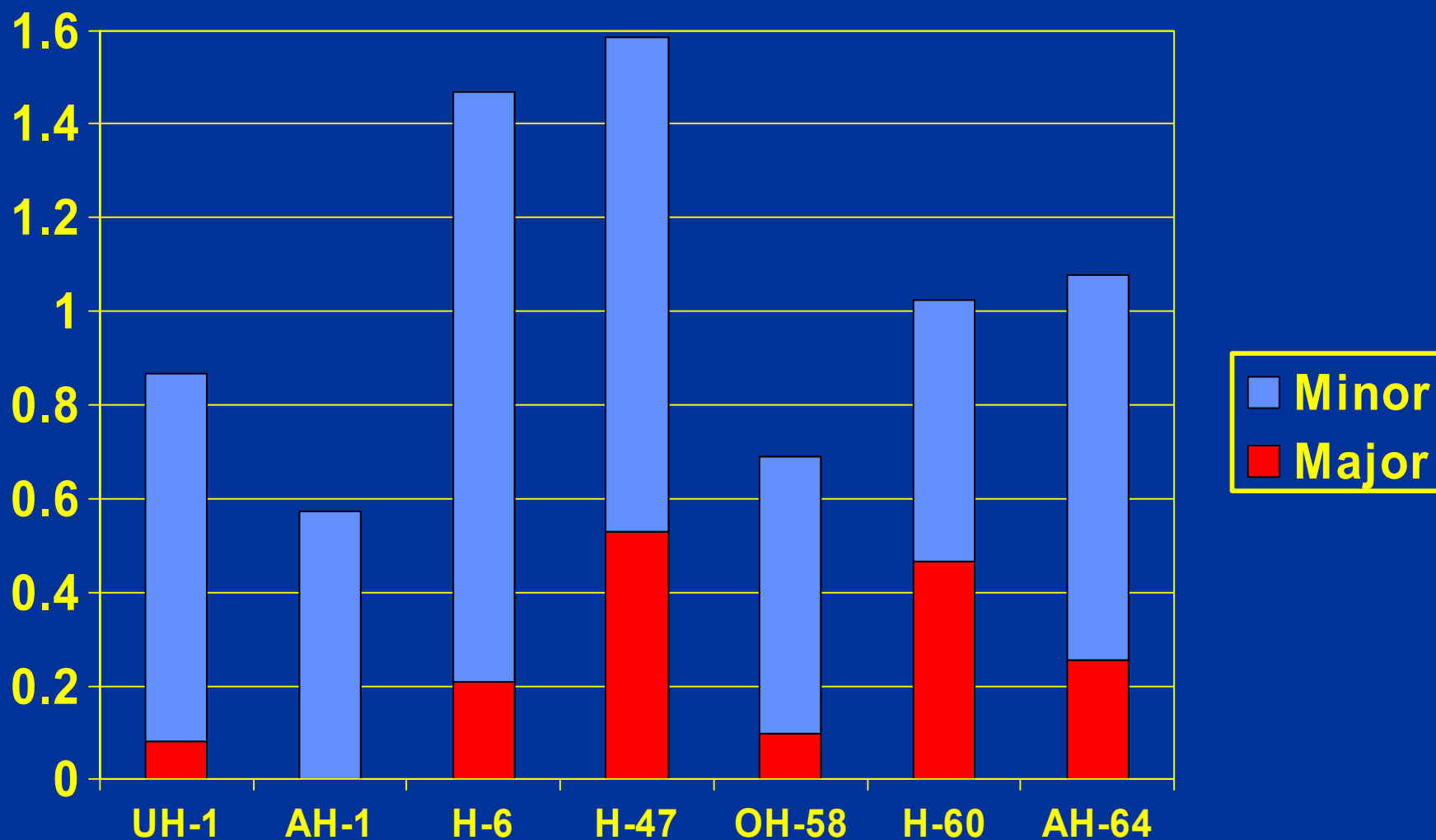


USA HF Injury Rates/100K Hours By MDS



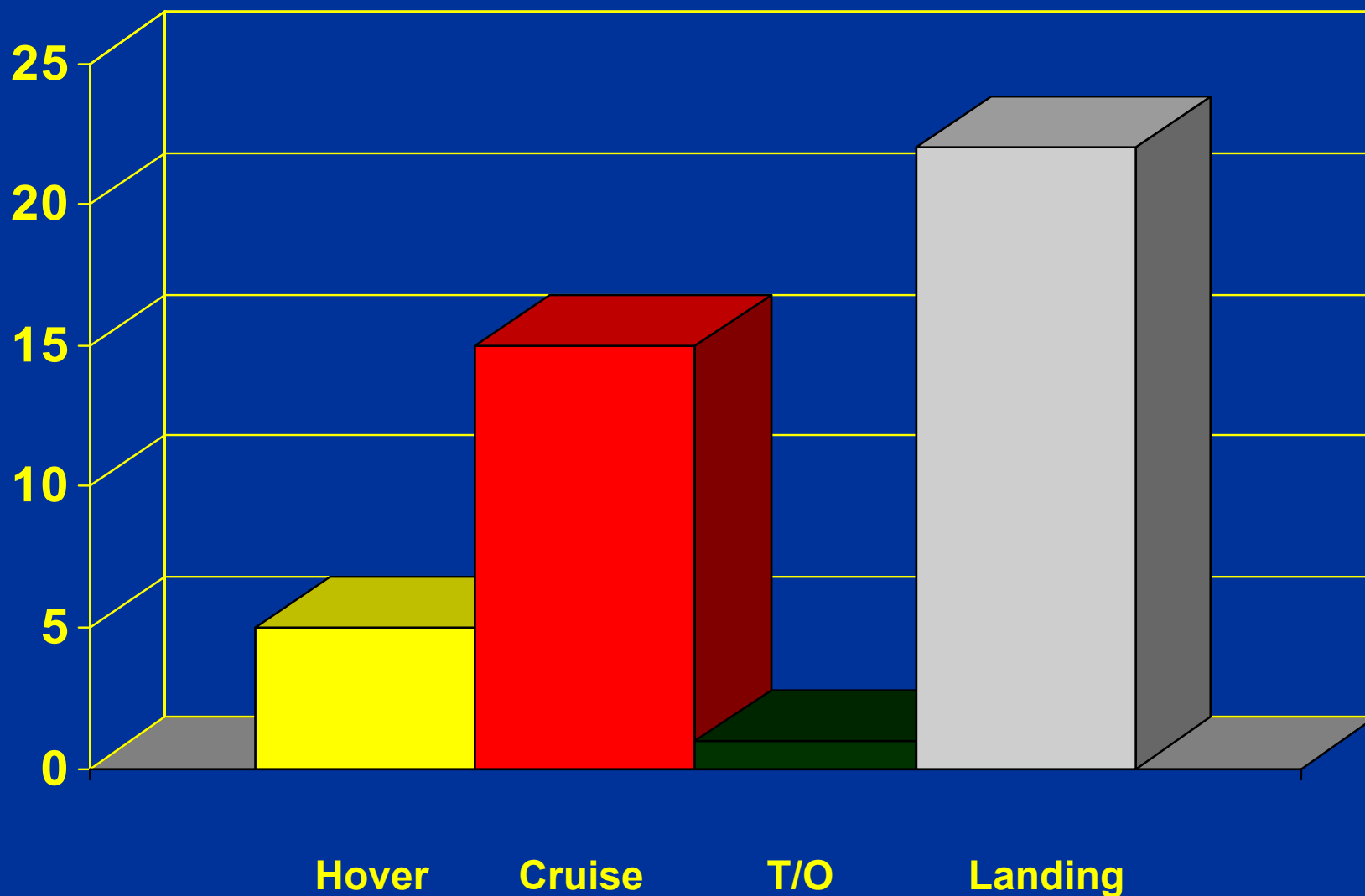


USA NHF Injury Rates/100K Hours by MDS



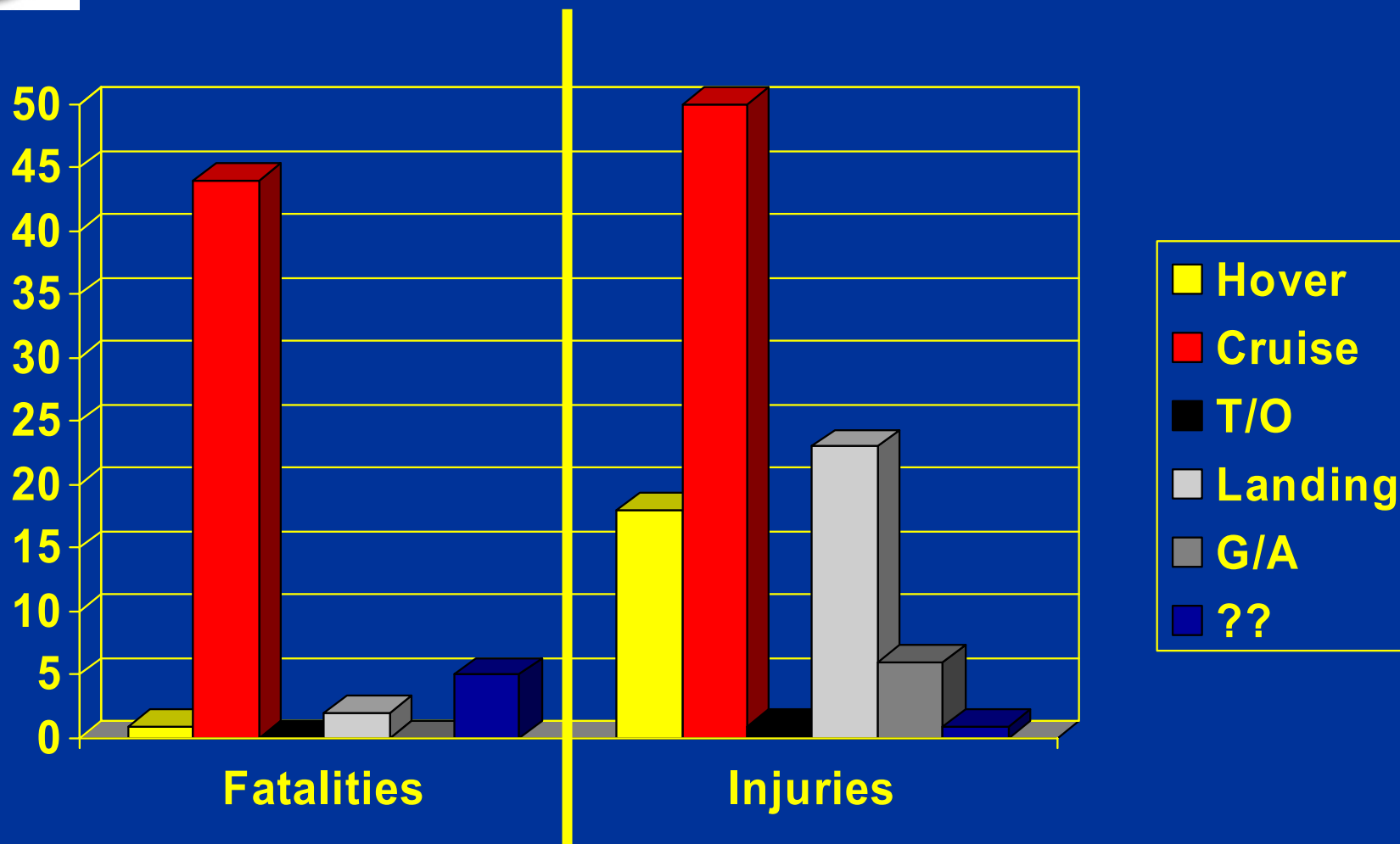


USAF Rotary Wing CFIT Mishaps FY 85-05, By Phase of Flight





USAF Rotary Wing # CFIT Fatalities & Injuries, FY 85-05, By Type





DoN Rotary Wing Airframe Types

Aircraft Category	Common Name	Mission	Models Included	Mishap Numbers	Mishap Rate /100,000 Hours
AH-1	Cobra	Attack	AH-1J/T/W	22	3.52
UH-1	Huey	Utility Rescue	UH-1N; HH-1N	48	6.63
SH-2	Seasprite	Anti-submarine Utility	SH-2F	28	6.27
SH-3	Sea King	Anti-submarine Utility, Rescue	SH-3G/H; UH-3H; HH-3A; VH-3D	32	3.42
CH-46	Sea Knight	Cargo Rescue	CH-46A/D/E; HH-46A/D; UH-46D	76	3.80
CH-53	Sea Stallion	Cargo Rescue	CH-53A/D/E; MH-53E/J; RH-53D	60	4.87
TH-57	Sea Ranger	Training	TH-57B/C	17	1.18
SH-60	Sea Hawk	Utility Rescue	SH-60B/F; HH-60H; UH-60A; VH-60N	40	2.28

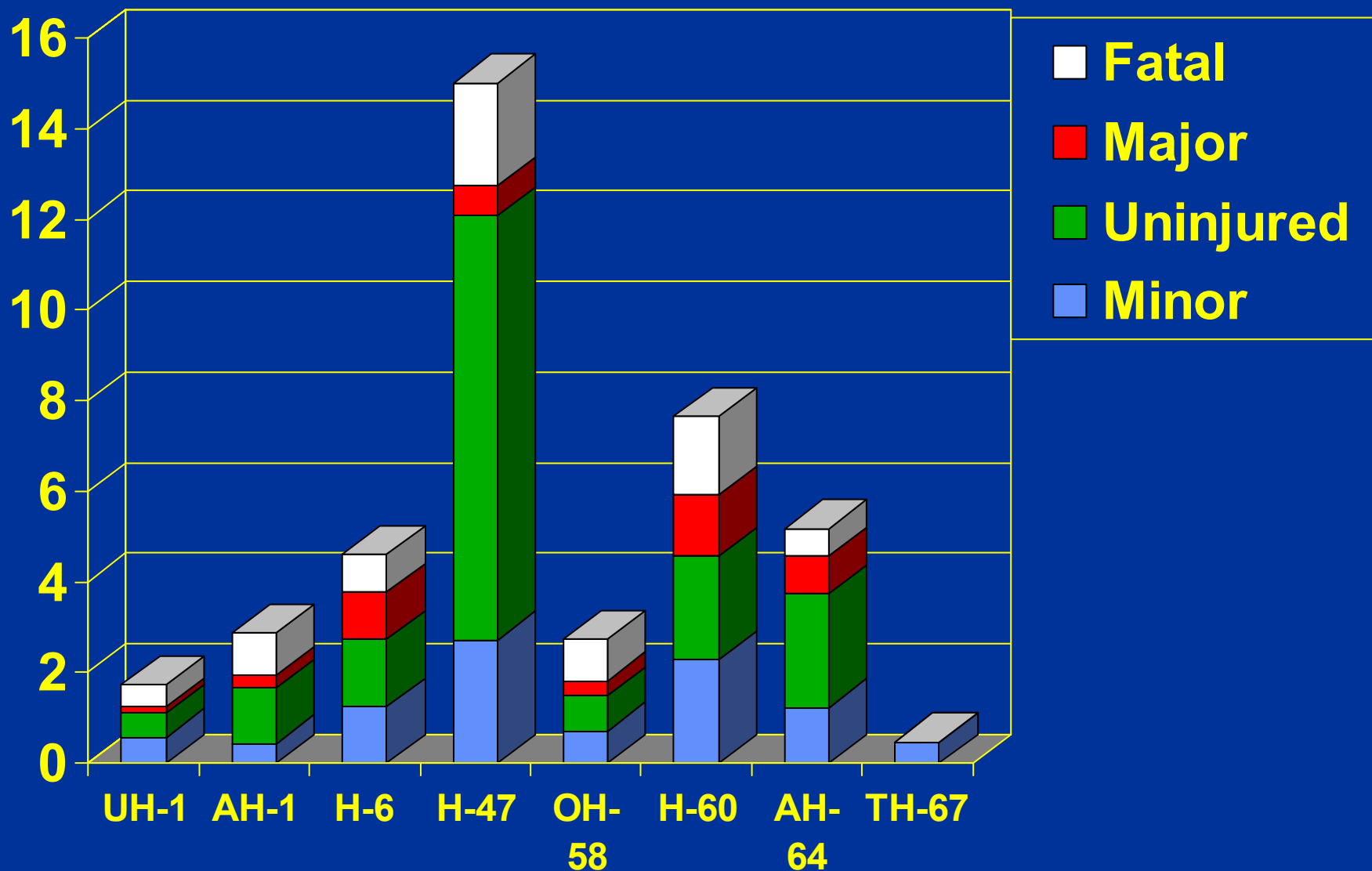


Pilot vs. Passenger & Crew DoN Injuries & Fatalities SH-60

MISHAPS N = 40	PILOTS N = 80		PAX & CREW N = 89		$\Delta\%$
	Count	Percent	Count	Percent	
NOT INJURED	49	61.3	53	59.6	+1.7 RR = 0.91 (p = 0.49)
MINOR INJURY	3	3.8	11	12.4	-8.6 RR = 0.3 (p = 0.043)
MAJOR INJURY	13	16.3	11	12.4	+3.9 RR = 1.31 (p = 0.469)
FATAL	15	18.8	14	15.7	+3.1 RR = 1.19 (p = 0.603)



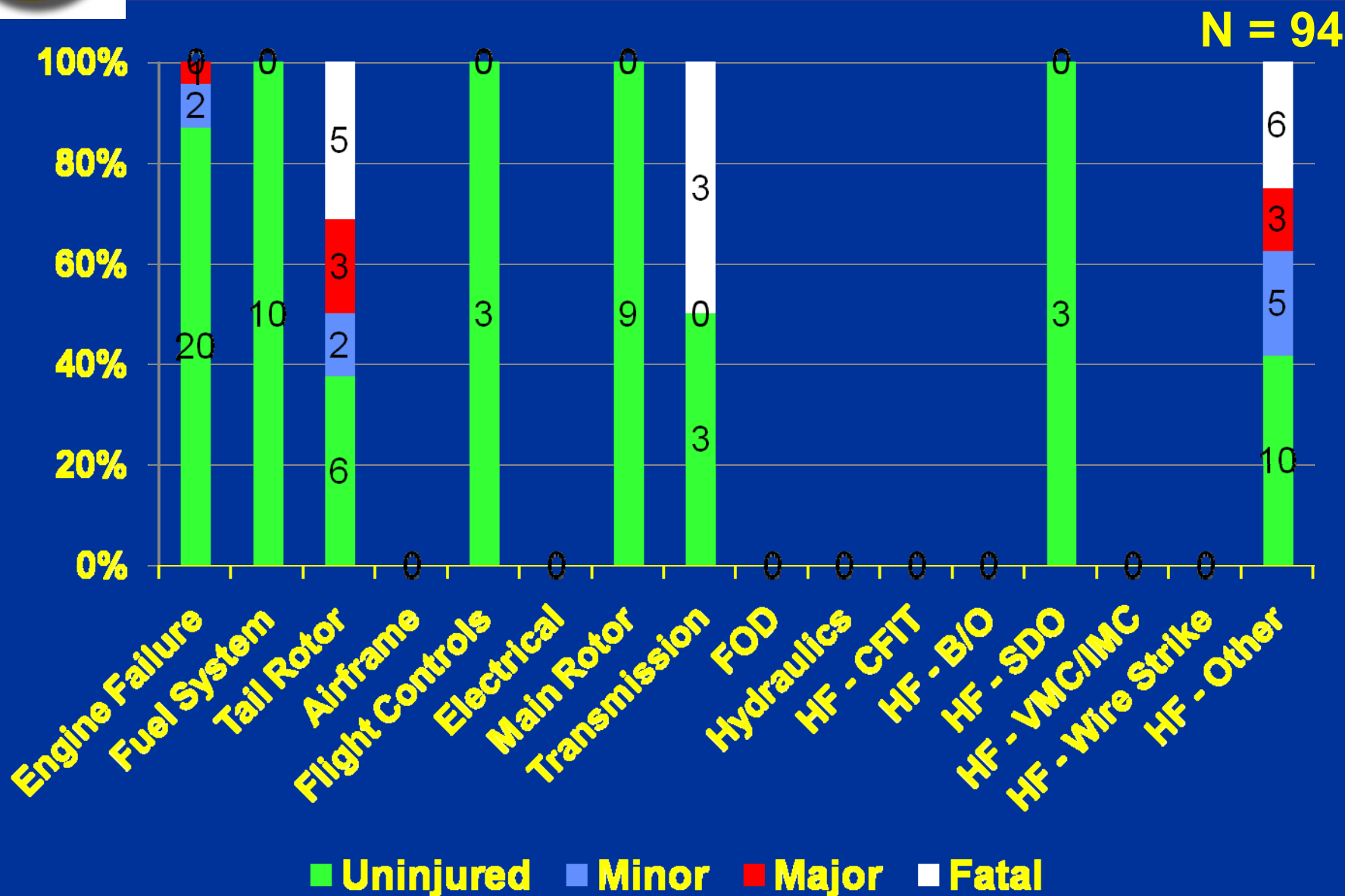
USA HF Fatality & Injury Rates by MDS/100K Hours - Overview





DoN SH-2

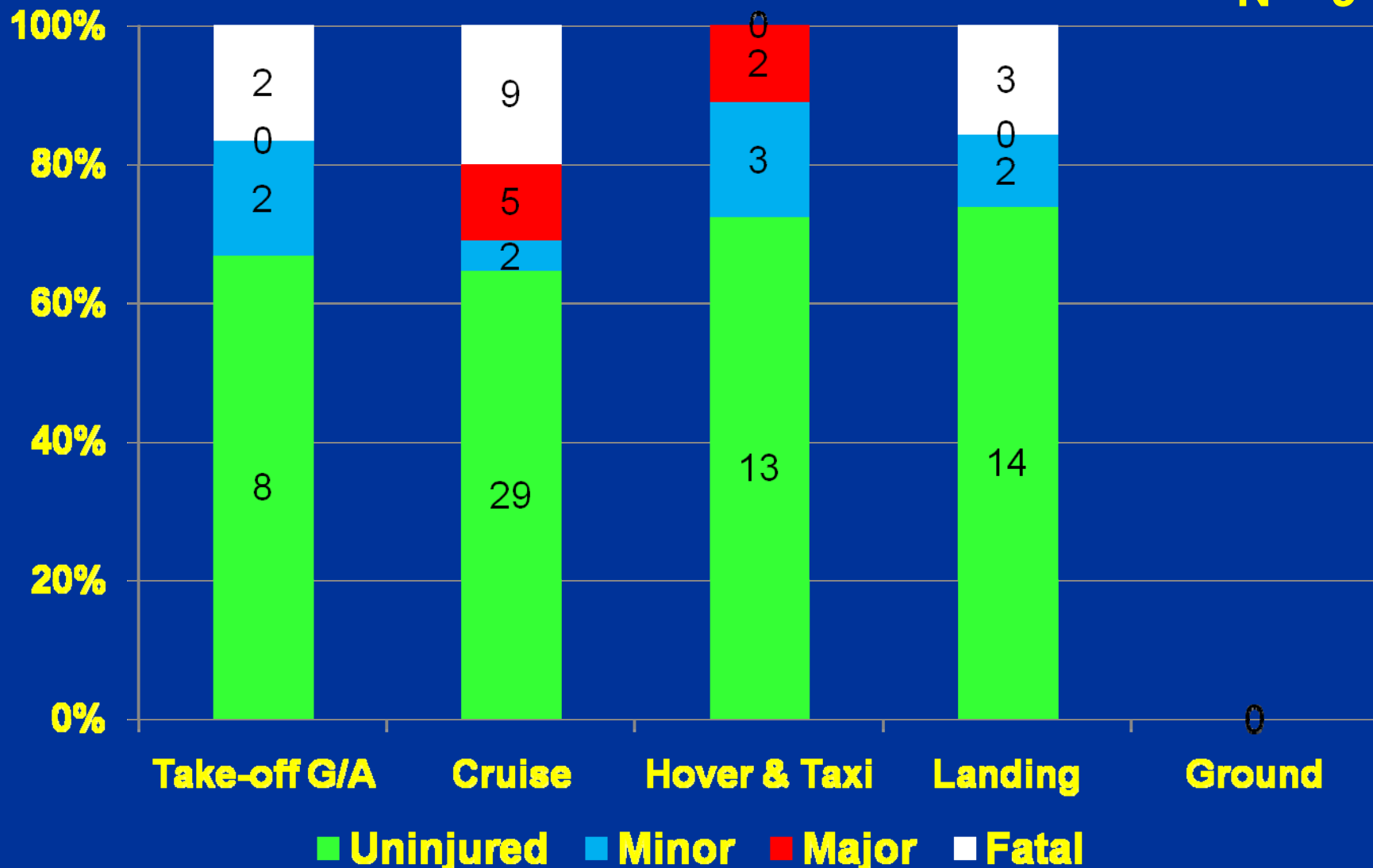
Occupant Outcome by Mishap Cause





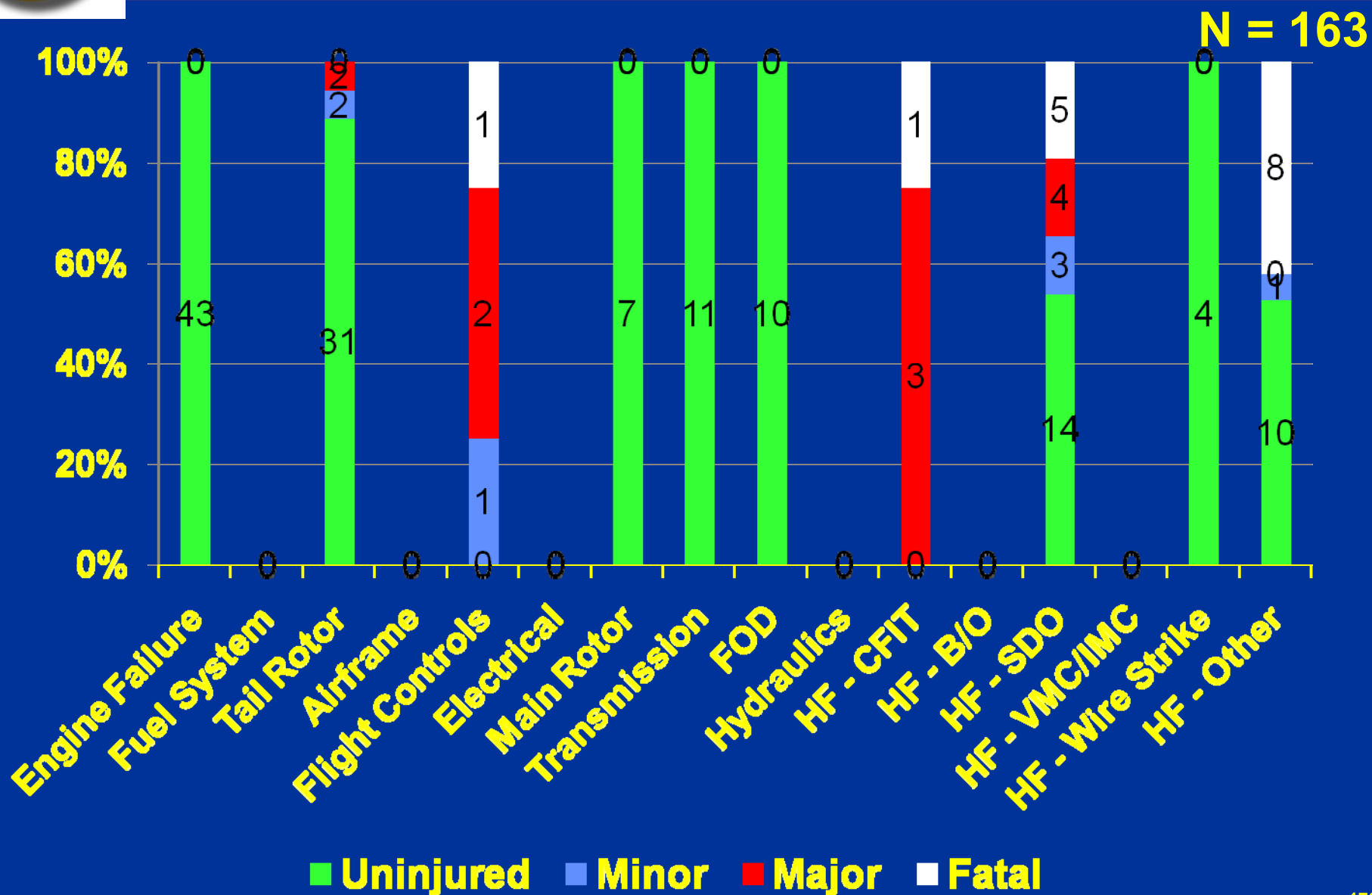
DoN SH-2 Occupant Outcome by Phase of Flight

N = 94



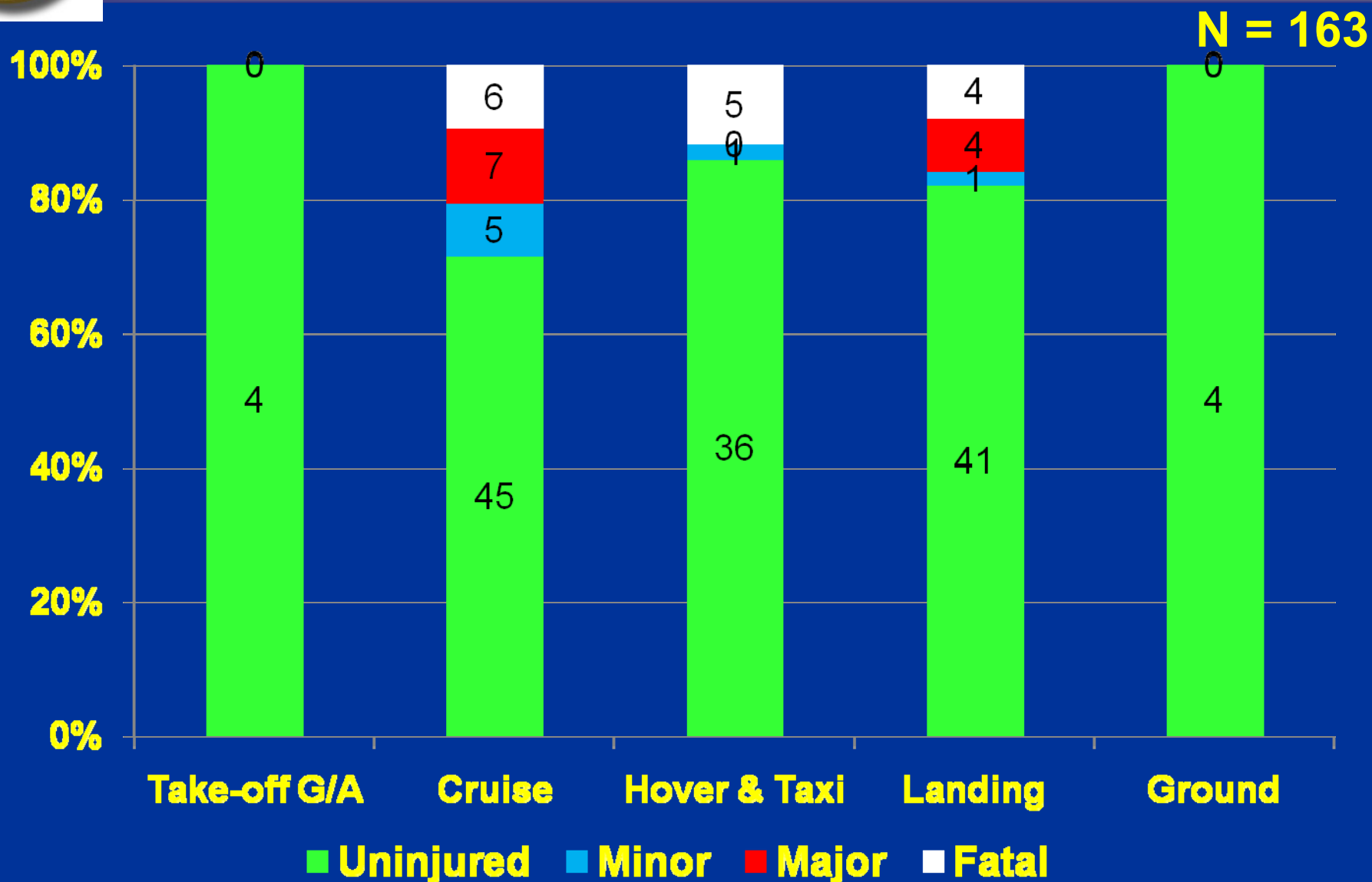


DoN SH-3 Occupant Outcome by Mishap Cause





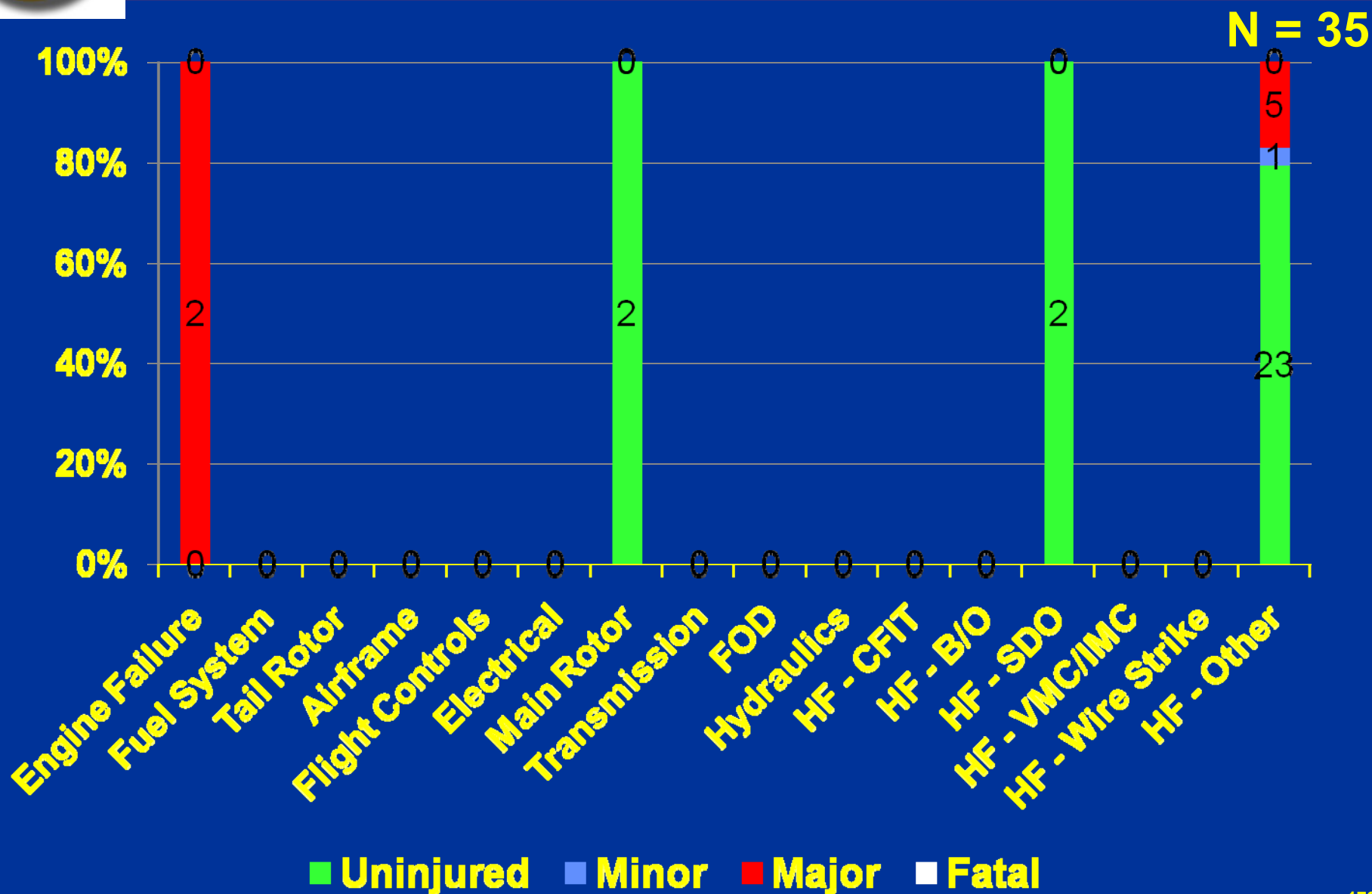
DoN SH-3 Occupant Outcome by Phase of Flight





DoN TH-57

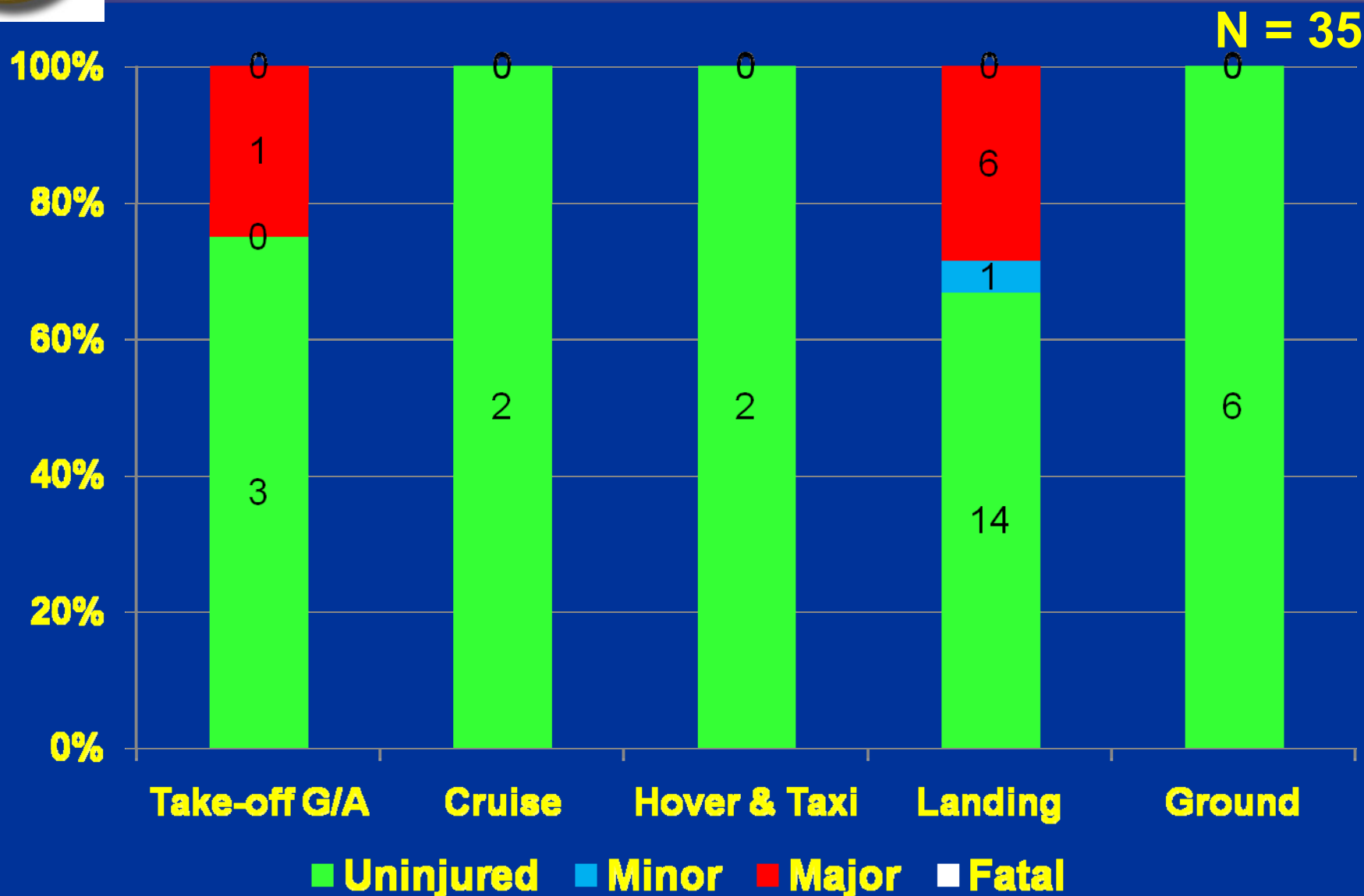
Occupant Outcome by Mishap Cause





DoN TH-57

Occupant Outcome by Phase of Flight





Pilot vs. Passenger & Crew

USN Injuries & Fatalities – CH-46

- **Complicated interactions in CH-46 injuries were found when stratified for the two time periods examined**
- **Minor injuries: In the second decade pilots were for 4 times more likely than passengers to sustain MINOR injuries. ($p_{FE}=0.049$)**
- **Major injuries: Pilots were half as likely to sustain MAJOR injuries in the first decade. ($p=0.056$)**
- **Fatalities:**
 - **After subtracting drowning and lost at sea fatalities from the first decade, pilots were found to be twice as likely as passengers to die. ($p=0.0174$)**
 - **Pilots were half as likely as passengers to die in the second decade. ($p=0.03$) This difference was not affected by drowning and lost at sea data.**