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<th>2. REPORT TYPE</th>
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<td>5b. GRANT NUMBER</td>
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<td>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</td>
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</tr>
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<td></td>
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<td>17. LIMITATION OF ABSTRACT</td>
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<td>18. NUMBER OF PAGES</td>
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Statement of Accountability

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Cleared for public release by ASC Public Affairs.
Disposition Date: 3 May 2007
Document Number: AFRL-WS 07-1099
This study describes all 207 U.S. Army Class A-B Rotary Wing Mishaps ascribed to ‘Non - Human Factors’ (NHF) from FY 85 to 05.

This data is based on a study of data archived in the mishap files of the USA Combat Readiness Center at Fort Rucker, Alabama.

This data is the third part of a study that will include all rotary wing aircraft in the DoD.

- The first part ‘USAF Helicopter Mishap Data’ was publicly released on 18 Sep 2006.
- The second part ‘USA Human Factor Helicopter Mishap Data’ was publicly released on 29 Mar 2007.
Method

• Obtained all U.S. Army Rotary Wing Aircraft Class A & B Mishaps ascribed to ‘Non-Human Factors’ from FY 85 to FY 05 inclusive from the U.S. Army Combat Readiness Center

• Reviewed all 207 mishap reports

• Created a data base for initial analysis

• Major injuries resulted in approximately four weeks or more of lost duty time or permanent disability

• Minor injuries resulted in approximately less than four weeks of lost duty time
## Definitions

Aircraft were placed in 7 groups for the analysis:

<table>
<thead>
<tr>
<th>AH-1</th>
<th>AH-1E/F/G/S</th>
<th>H-47</th>
<th>CH-47C/D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FAH-1S, JPAH-1S</td>
<td></td>
<td>MH-47D/E</td>
</tr>
<tr>
<td>UH-1</td>
<td>UH-1H/V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>JUH-1H</td>
<td>OH-58</td>
<td>OH-58A/C/D/DR</td>
</tr>
<tr>
<td>H-6</td>
<td>AH-6C/G/J</td>
<td>H-60</td>
<td>EH-60A</td>
</tr>
<tr>
<td></td>
<td>MH-6B/E/H/J</td>
<td></td>
<td>MH-60A/K/L</td>
</tr>
<tr>
<td></td>
<td>OH-6A</td>
<td></td>
<td>UH-60A/L</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AH-64</td>
<td>AH-64A/D</td>
</tr>
</tbody>
</table>
Overview

• Definitions
• Mishap Characterization
• Phase of Flight Data
• Fatality & Injury Data
• Summary & Recommendations
Definitions

Non-Human Factor Definition:

• Any mishap where the proximal cause was not due to a human factor in accordance with the Department of Defense Human Factors Analysis and Classification System

• Generally speaking: mechanical failures and weather

• Weather cases are those where severe weather was encountered but was not forecast
Non-Human Factor Mishap Character
9% of Inventory, FY 85 – 05, Involved in Class A or B NHF Mishaps

- UH-1 (34)
- AH-1 (19)
- H-6 (14)
- H-47 (20)
- OH-58 (49)
- H-60 (33)
- AH-64 (38)

N = 207
NHF Mishaps by MDS

- AH-64 (38)
- UH-1 (34)
- AH-1 (19)
- H-60 (33)
- H-6 (14)
- OH-58 (49)
- H-47 (20)

N = 207
NHF Mishap Rates/100KHrs by MDS

- UH-1 (34)
- AH-1 (19)
- H-6 (14)
- CH-47 (20)
- OH-58 (49)
- H-60 (33)
- AH-64 (38)
Non-Human Factor Mishap Character
Phase of Flight
NHF Mishap by Phase of Flight
FY 85-05

- T/O
- Cruise
- Hover/Taxi
- Landing
- Ground

N = 207

61%
NHF Fatalities & Injuries by Phase of Flight - Overview

- Cruise: 300 (Major: 100, Fatal: 200)
- Landing: Minor
- Hover & Taxi: Minor
- Take-off: Minor
- Ground: Minor
All NHF Mishaps Malfunction Categories

- Engine Failure: 78
- WX: 15
- Fuel System: 17
- Tail Rotor: 18
- Airframe: 15
- Flight Controls: 29
- Fire: 15
- Electrical: 17
- Main Rotor: 18
- Transmission: 29
- Weapons: 15
- FOD: 17
- Hydraulics: 82%

N = 207
NHF Cruise Mishaps Malfunction Categories

- Engine Failure: 54
- WX: 20
- Tail Rotor: 11
- Fuel Systems: 9
- Flight Controls: 6
- Electrical: 6
- Main Rotor: 11
- Hydraulics: 6
- Weapons: 9
- Fire: 6
- FOD: 6

N = 126
NHF Cruise Fatalities & Injuries by Malfunction Category

Engine Failure
WX
Electrical
Flight Controls
Tail Rotor
Main Rotor
Fuel Systems
Airframe
Fire
Weapons
Hydraulics
Transmission

Minor
Major
Fatal

N = 437

19
NHF Landing Mishaps Malfunction Categories

- Engine Failure: 7
- WX: 6
- Tail Rotor: 4
- Fuel Systems / Starvation: 3
- Main Rotor: 2
- Flight Controls: 6
- FOD: 2

N = 24
NHF Landing Mishaps
Fatalities & Injuries

N = 99

- Uninjured: 35
- Minor: 35
- Major: 8
- Fatal: 21
NHF Landing Fatalities & Injuries by Malfunction Category

Fuel System
- Minor
- Major
- Fatal

Tail Rotor
- Minor
- Major
- Fatal

WX
- Minor
- Major
- Fatal

Main Rotor
- Minor
- Major
- Fatal

Engine Failure
- Minor
- Major
- Fatal

FOD
- Minor
- Major
- Fatal

N = 64
NHF Hover/Taxi Mishaps Malfunction Categories

- Engine: 8
- Airframe: 6
- Tail Rotor: 4
- Electrical: 2
- Flight Controls: 2
- Fuel: 2
- Hydraulics: 2
- Transmission: 2
- Weapons: 2
- WX: 2

N = 30
NHF Hover/Taxi Mishaps
Fatalities & Injuries

- Uninjured: 67
- Minor: 16
- Major: 5
- Fatal: 5

N = 93
NHF Hover/Taxi Fatalities & Injuries by Malfunction Category

N = 26
NHF Take-Off Mishaps
Malfunction Categories

- Engine
- Flight Controls
- Fuel Systems
- WX

N = 13
NHF Take-Off Mishaps
Injuries

No Fatalities

- Uninjured: 32
- Minor: 17
- Major: 2

N = 51
NHF Take-Off Fatalities & Injuries by Malfunction Category

- Engine Failure
  - Minor
  - Major
  \( N = 19 \)

- Fuel Systems
  - Minor

- Flight Controls
  - Minor
NHF Ground Mishaps
Malfunction Categories

- Airframe
- Flight Controls
- Fire
- Engine Failure
- FOD
- Main Rotor
- Transmission
- WX

N = 14
NHF Ground Mishap Fatalities & Injuries

- Uninjured: 41
- Minor: 3
- Fatal: 1

N = 45
Non-Human Factor Deaths & Injuries
NHF Fatality Rates/100K Hours
Adjusted for average personnel on board
NHF Injury Rates/100K Hours by MDS

- UH-1
- AH-1
- H-6
- H-47
- OH-58
- H-60
- AH-64

Categories: Minor - Major
NHF Injury Rates/100K Hours
Adjusted for average personnel on board

[Diagram showing NHF injury rates for different helicopters, with bars for minor and major injuries.]
NHF Fatalities & Major Injuries by MDS

Fatal

Major
NHF Fatality & Injury Rates by MDS/100K Hours

Fatal

Major
NHF Fatality & Injury Rates by MDS/100K Hours - Adjusted

- Fatal
- Major
Percent Survivable Mishaps

- AH-1
- UH-1
- H-6
- H-47
- OH-58
- H-60
- AH-64

Legend:
- Uncategorized
- Non-Survivable
- Partially Survivable
- Survivable
Percent Injuries in Survivable Mishaps
Army Rotary Wing Non-Human Factor Mishap Fatalities & Injuries

- Major (n=44)
- Fatal (n=164)

- Head
- Chest
- Spine
- Lower Ext
- Abdomen
- Pelvis
- Upper Ext
- Burns
- Drown

- Drown: 0
- Burns: 40
- Upper Ext: 50
- Pelvis: 70
- Abdomen: 100
- Lower Ext: 120
- Spine: 130
- Chest: 140
- Head: 150

0 50 100 150
Pilot injuries were most often to the head, lower extremity, and spine in NHF mishaps.
# Pilot Fatality and Injury Location

<table>
<thead>
<tr>
<th>PILOTS (N = 409)</th>
<th>Fatal (N=69)</th>
<th>Non-Fatal (N=340)</th>
<th>Percent Fatal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>60 (87.0%)</td>
<td>53</td>
<td>53.1%</td>
</tr>
<tr>
<td>Chest</td>
<td>60 (87.0%)</td>
<td>18</td>
<td>76.9%</td>
</tr>
<tr>
<td>Abdomen</td>
<td>43 (62.3%)</td>
<td>5</td>
<td>89.6%</td>
</tr>
<tr>
<td>Pelvis</td>
<td>36 (52.2%)</td>
<td>6</td>
<td>85.7%</td>
</tr>
<tr>
<td>Upper Ext.</td>
<td>35 (50.7%)</td>
<td>31</td>
<td>53.0%</td>
</tr>
<tr>
<td>Lower Ext.</td>
<td>41 (59.4%)</td>
<td>61</td>
<td>40.2%</td>
</tr>
<tr>
<td>Spine</td>
<td>45 (65.2%)</td>
<td>52</td>
<td>46.4%</td>
</tr>
</tbody>
</table>

Percent of pilots with a given injury location who died
Non-Pilot injuries were most often to the head, lower extremity, chest, and spine in NHF mishaps.

<table>
<thead>
<tr>
<th>Non-PILOT Injuries n=315</th>
<th>Fatal</th>
<th>Major</th>
<th>Minor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>63</td>
<td>11</td>
<td>17</td>
<td>91 (28.9%)</td>
</tr>
<tr>
<td>Chest</td>
<td>62</td>
<td>8</td>
<td>5</td>
<td>75 (23.8%)</td>
</tr>
<tr>
<td>Abdomen</td>
<td>43</td>
<td>2</td>
<td>0</td>
<td>45 (14.3%)</td>
</tr>
<tr>
<td>Pelvis</td>
<td>45</td>
<td>5</td>
<td>5</td>
<td>55 (17.5%)</td>
</tr>
<tr>
<td>Upper Ext</td>
<td>37</td>
<td>4</td>
<td>13</td>
<td>54 (17.1%)</td>
</tr>
<tr>
<td>Lower Ext</td>
<td>46</td>
<td>10</td>
<td>20</td>
<td>76 (24.1%)</td>
</tr>
<tr>
<td>Spine</td>
<td>50</td>
<td>4</td>
<td>19</td>
<td>73 (23.2%)</td>
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## Non-pilot Fatality and Injury Patterns, by Location

<table>
<thead>
<tr>
<th>Crew &amp; PAX</th>
<th>Fatal (N=95)</th>
<th>Non-Fatal (N=220)</th>
<th>Percent Fatal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>63 (66.3%)</td>
<td>28</td>
<td>69.2%</td>
</tr>
<tr>
<td>Chest</td>
<td>62 (65.3%)</td>
<td>13</td>
<td>82.7%</td>
</tr>
<tr>
<td>Abdomen</td>
<td>43 (45.3%)</td>
<td>2</td>
<td>95.6%</td>
</tr>
<tr>
<td>Pelvis</td>
<td>45 (47.4%)</td>
<td>10</td>
<td>81.8%</td>
</tr>
<tr>
<td>Upper Ext.</td>
<td>37 (38.9%)</td>
<td>17</td>
<td>68.5%</td>
</tr>
<tr>
<td>Lower Ext.</td>
<td>46 (48.4%)</td>
<td>30</td>
<td>60.5%</td>
</tr>
<tr>
<td>Spine</td>
<td>50 (52.6%)</td>
<td>23</td>
<td>68.5%</td>
</tr>
<tr>
<td>MISHAPS N = 207</td>
<td>PILOTS N = 409</td>
<td>PAX &amp; CREW N = 315</td>
<td>Δ%</td>
</tr>
<tr>
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<td>------------</td>
</tr>
<tr>
<td></td>
<td>#</td>
<td>%</td>
<td>#</td>
</tr>
<tr>
<td>NOT INJURED</td>
<td>218</td>
<td>53.3</td>
<td>132</td>
</tr>
<tr>
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<td></td>
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<td>409</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MINOR INJURY</td>
<td>99</td>
<td>24.2</td>
<td>67</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>409</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAJOR INJURY</td>
<td>23</td>
<td>5.6</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>409</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FATAL</td>
<td>69</td>
<td>16.9</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>409</td>
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</table>
## Emergency Locator Transmitters
### U.S. Army Rotary Wing Non-Human Factor Mishaps

<table>
<thead>
<tr>
<th>MISHAPS N = 207</th>
<th>Fatal Mishap N = 49</th>
<th>Non-Fatal Mishap N = 158</th>
</tr>
</thead>
<tbody>
<tr>
<td>No ELT Installed or ELT not armed</td>
<td>#</td>
<td>%</td>
</tr>
<tr>
<td>8</td>
<td>25.6</td>
<td>4</td>
</tr>
<tr>
<td>ELT Installed</td>
<td>41</td>
<td>74.4</td>
</tr>
</tbody>
</table>
Summary & Recommendations
• NHF mishaps affect all MDS approximately equally
• Most NHF mishaps, injuries, and fatalities occur during cruise flight (High $V^2$)
• Most NHF cruise mishaps are due to engine failure or weather
• Engine failure is common to all phases of flight but is uniquely NOT the greatest problem with regards to injury during landing
• Head injury is associated with the greatest risk of fatality
• Non-pilot crew members and passengers have greater frequencies of more severe injuries than pilots
• Lack of an installed and armed ELT is highly associated with fatal mishaps
Safety Technology Recommendations

• Require all personnel aboard helicopters to wear helmets at all times
• Provide real time, satellite datalink weather to all helicopter pilots
• Improve crashworthiness, flail and Gz protection of non-pilot seating to mitigate disproportionately high injury and death rates compared to pilots
• Improve the ability of rear compartment crew to remain in crashworthy seating below ETL
• Eliminate the need to use harnesses in place of crashworthy seating
• Emergency Locator Transmitters should be installed and armed on all aircraft
• Design emergency procedures to minimize V²