HeliSafe® TA
Improving Occupant Protection in Case of Helicopter Crash
Vienna, 20 June 2006
Statistics of Helicopter Accidents

**Accident Rates of Helicopters in Germany**

- **Fatalities per 100 helicopters**
- **Accidents per 100 helicopters**

**Civil Aircraft Accidents per Year**

- **Avion**
- **Glisseur**
- **Ballon**
- **ULM + autogire + autre**

Source: BFU - German Federal Bureau of Aircraft Accidents Investigation - Annual Report 2004

Source: BEA - French Bureau d’Enquêtes et d’Analyses pour la Sécurité de l’Aviation Civile

## Examples for helicopter crashes

### Bell UH1-D
- Flight path: 8°
- Roll: 0°
- Pitch: 10° (nose up)
- Vx: ≈ 30 m/s
- Vz: ≈ 4 m/s
- Crew members: 4
  - Fatal injuries: 1 (Pilot)
  - Minor injuries: 3

**Injuries**
- Head, neck and spine injuries to the pilot.
- Contact to doorframe, skin-abrasion

### Super Puma AS 332L
- Flight path: 20°
- Roll: -3°
- Pitch: 2°
- Vx: ≈ 20 m/s
- Vz: ≈ 7 m/s
- Crewmembers: 17
  - Fatal injuries: 11
  - Major injuries: 1
  - Minor injuries: 5

**Injuries**
- all killed crewmembers are drowned because of unconsciousness

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Progress

Steps of Safety Technology

Harness
Restraint System
Advanced Restraint System
Occupant protection system
Active Aircraft Safety Accident prevention

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Occupant protection in helicopters
(State-of-the-art)

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Side-Airbag
Door, Seat
Aircraft Structure

Crash Sensor
Cyclic Stick
Knee protection

Crash Sensor
Cyclic Stick
Knee protection

Seat
Airbag

Seat
Airbag

Seat
Airbag

Safety Belt

Safety Belt

Safety Belt

Safety Belt

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Co-ordinator

Autoflug - Aeronautic Safety Equipment Manufacturer (Restraints, Seats, etc.)

Partner

CIDAUT - Specialist of Crashworthiness and Occupant Safety in the Automotive Area
CIRA - Research & Simulation concerning Crashworthiness in the Aeronautic Area, Large Crash Facility
DLR - Crashworthiness and Impact Behaviour, Composite Structures
Eurocopter-SAS - Helicopter Structure Technology, Implementation of Safety Systems
ECD - Helicopter Airworthiness and Flight Safety
PTM - Research & Simulation on Energy Absorbing Mechanism
PZL - Helicopter and Fixed Wing Manufacture, Technology Transfer
SRS - Research, Development and Pre-Design of Airbags, Sensors, Adaptive Safety Elements
TNO - Provides Automotive Safety Solutions, Developer of Dummy Hard- and Software, MADYMO provider
Coventry University - Simulation Specialist (ADAMS, MADYMO), Research on Adaptive Car Structures
TU Delft - Specialist of Bio-mechanics, Injury Criteria

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HeliSafe TA - Helicopter Occupant Safety Technology Application

The main objective is to save lives and to mitigate the consequences of survivable helicopter accidents by systematic application of advanced safety features.

Key action: Aeronautics & Space
Budget: 4,800,000 Euro
Duration: 36 Months
Start: 1st March 2004
Main Objectives:

Carry out a full-scale drop test
- to improve the knowledge of the overall crash behaviour
- to define real world crash loads (structure & occupant)
- to develop appropriate prediction tools which covers the total airframe structure
- to analyse the correlation of the dummy motion and contacts

Investigations on:
- supplemental passive/active safety components to protect occupants independent of weight, size and seat position
- reliability on crash sensor systems during critical flight manoeuvres
- integration of additional inflatable features (side-, knee-, cushion-, carpet-airbags, etc.)
- Side facing seats, stretcher and out-of-position
- new and/or unconventional harness systems
- feasibility of a pre-crash detection concept
Reference Scenario:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_X$</td>
<td>+42 ft/s</td>
<td>12.8 m/s</td>
</tr>
<tr>
<td>$V_Y$</td>
<td>0</td>
<td>nil</td>
</tr>
<tr>
<td>$V_Z$</td>
<td>-26 ft/s</td>
<td>-7.9 m/s</td>
</tr>
<tr>
<td>Pitch</td>
<td>+8°</td>
<td>Nose up</td>
</tr>
<tr>
<td>Yaw</td>
<td>0°</td>
<td>nil</td>
</tr>
<tr>
<td>Roll</td>
<td>0°</td>
<td>nil</td>
</tr>
</tbody>
</table>
Looking for a suitable Test Article:
\[ V_x = 12.8 \text{ m/s} \]

\[ V_{Z} = 7.9 \text{ m/s} \]
Simulation of Reference Scenario: $V_x=12.8\text{m/s}; V_z=7.9\text{m/s}; \Theta=8^\circ$

- Time = 40 ms
- Time = 120 ms
- Time = 80 ms
- Time = 160 ms

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KRASH simulation of ref. scenario $V_x=12.8$, $V_z=7.9$ m/s, $\Theta=8$ deg.

UH010

Acceleration [g]

-24
-20
-16
-12
-8
-4
0

Time [s]

0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16

C.G. X-Acceleration
C.G. Z-Acceleration

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KRASH simulation of ref. scenario $V_x=12.8$, $V_z=7.9 \text{ m/s}$, $\Theta=8 \text{ deg.}$

UH010 Mass Z-Acceleration Filtered - Cockpit Floor
LISA Test Facility at CIRA
Test Preparation - Cabin seats

Bell UH-1D with original seats

For the drop test replaced by crashworthy seat (state-of-the-art)
Test Preparation - Pilot seat
Status & Outlook

WP 1
Specification

- Reference Scenario Definition
- Full Scale Drop Test
- Crash Pulse Definition
- Human Body Model Assessment

WP 2
Development / Research

- Helicopter Interior Definition
- Motion Analysis

WP 3
Analysis / Innovation

- ECU/Sensors Definition
- Harness Definition
- Aero-Dummy Adaptation
- Adaptive/Passive Components

WP 4
Testing

- Sensor-network Validation
- Parameter Studies
- Seat & Stretcher Layout

WP 5
Assessment

- Mock-up
- Full Scale Drop Tests
- Assessment & Evaluation

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Next major steps

- Definition of a crash pulse able to be carried out on sled facilities
- Adaptation of generic cockpit and cabin mock-up
- Set-up of a simulation models
- Performing baseline sled tests
- Validation of the simulation models
- Parameter studies
- Prototyping of new safety features
- Performing final sled tests
- Post-test simulation of sled tests
- Performing the final full-scale drop test
- Definition of airworthiness recommendations
- Technology transfer to fixed wing aircraft
thank you!