Research Topics Related to Naval Aviation Crashworthy Systems

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Presented to: FAA eVTOL Crashworthiness Workshop #3

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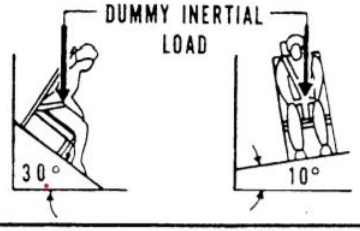
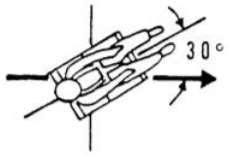
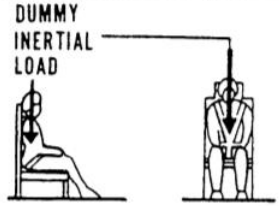
Organizational Background

- Crashworthy and Escape Systems Branch primarily focused on seating systems (rotary wing and fast jet), restraint systems, and other crash protection technologies.
- Crashworthy Seating Systems: Ensure that seating systems provide protection to occupants during a mishap event and also support successful mission tasking and long-term health of aircrew.
- Two Research Categories:
  - Addressing injury risk of long-term exposure to operational environment
  - **Improving Mishap Survivability**

Qualification Process

- Navy utilizes its own airworthiness process
- Seating Systems typically qualified to tailored versions of seating system Mil-Specs
  - MIL-S-85510 (Cabin/Troop Seats)
  - MIL-S-85095 (Cockpit/Crew Seats)
- Tailoring Considerations:
  - Legacy platform capability
  - Dynamic Performance Requirements (Occupant size, crash pulse/orientations)

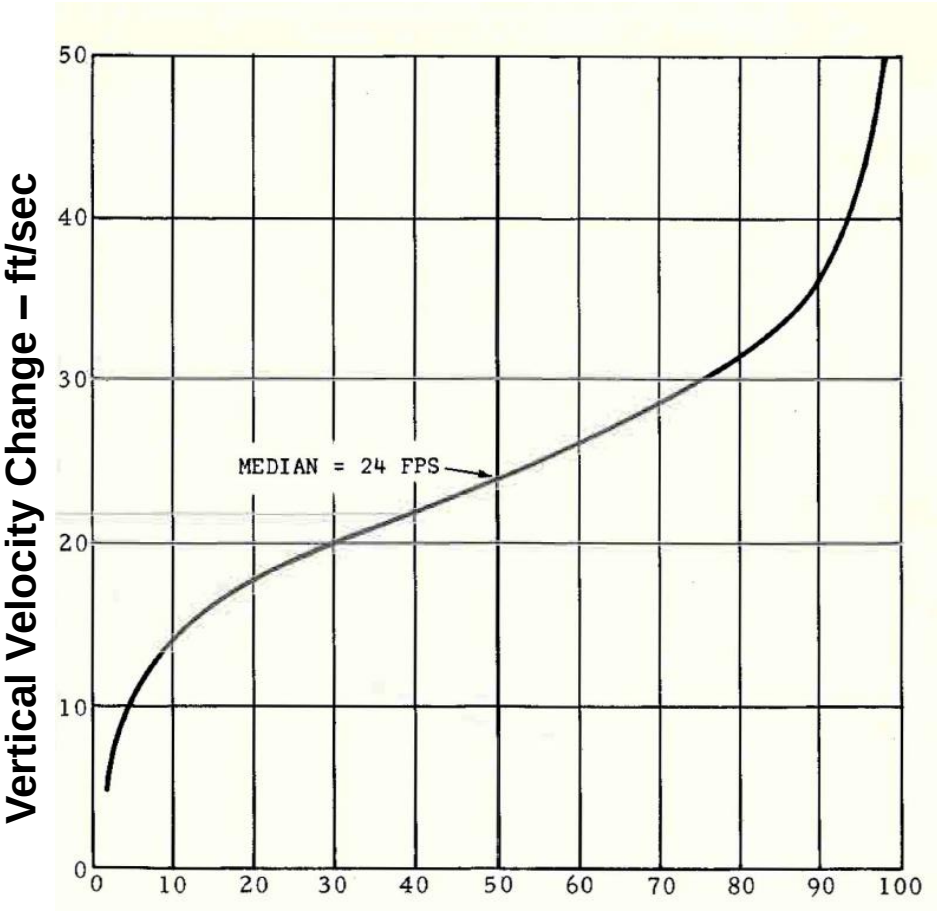
TABLE III. Dynamic Test Requirements

TEST	CONFIGURATION	PARAMETER	LIMITS
1		t_1 SEC t_2 SEC G MIN G MAX △ V MIN, FT/SEC (M/SEC)	0.043 0.061 46 51 50 (15.2)
2		t_1 SEC t_2 SEC G MIN G MAX △ V MIN, FT/SEC (M/SEC)	0.066 0.100 28 33 50 (15.2)
3 & 4		t_1 SEC t_2 SEC G MIN G MAX △ V MIN, FT/SEC (M/SEC)	0.036 0.051 46 51 42 (12.8)

Source: MIL-S-85095A

Characterizing the Mishap Environment

- Current characterization of rotary wing mishap environment
  - Based on studies conducted decades ago
  - Based on previous generation of rotorcraft
  - Data based on subjective reconstructions, using limited available quantitative data
- Specifications for Crashworthy technologies based primarily on aforementioned studies
- Existing definition has enabled significant improvements in crash survivability; gaps remain



Source: Crash Survival Design Guide (1969)

Mishap Characterization

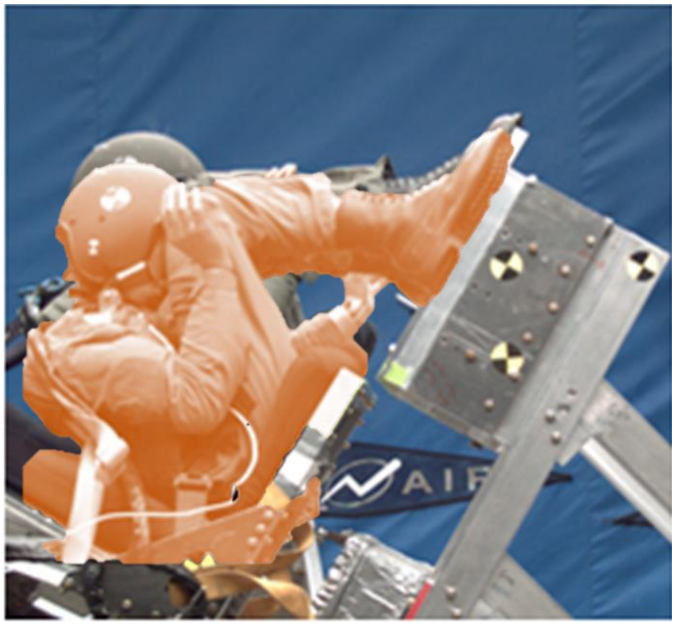
- Evaluating the utility of Crash Sensing Systems in legacy platforms
- Currently investigating the potential for low-power, high sample rate, event recorders (accelerometers and angular rate sensors) to be deployed throughout the fleet
- Goals:
  - Better reconstruct individual mishaps, with a focus on identifying potential injury mechanisms
  - Build a library of mishap data that enables improved mishap characterization and updated performance specifications for crashworthy seating and other safety systems
  - Enable the application of next-generation crash protective technology

Evaluating Concepts for Improving Occupant Survivability

- In-house Horizontal Accelerator System can produce acceleration pulses representative of mishap
- Used to evaluate and qualify crashworthy seating systems
- Reusable Energy Absorbing Laboratory (REAL) Seat Test Fixture, available at NAS Patuxent River, MD is used to economically evaluate impact of safety improvements
  - Pretensioning Systems
  - Cushion Modifications
  - Novel Restraint Concepts
  - Airbag Systems

Additional Areas of Research

- Restraint Systems
  - Additional survivability gains can be made by improving seat restraint systems
  - Restraint systems currently rely on user to properly adjust belts and to achieve optimal fit
  - Evaluating approaches to minimize workload of seat occupant and accommodate non-ideal restraint adjustment/placement
  - Ensure that ability to safely egress aircraft is not negatively impacted



Pretensioner flail shown in orange; Baseline in true color

Summary

- Primary Research Focus Areas:
  - Mitigating pain and musculoskeletal injury associated with long-duration exposure to the operational environment
  - **Improved occupant protection during mishaps**
- Crash Protection
  - Modern characterization of the mishap environment
  - Improved restraint systems
  - Minimizing workload impacts to seat occupants
  - Maintain ability to quickly egress aircraft in the event of a mishap

Questions?

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