Occupant Protection for Legacy Rotorcraft

Presented to: 10th Triennial International Fire & Cabin Safety Research Conference

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Date: 10/20/2022

Federal Aviation Administration

Overview

- **Background of legacy rotorcraft accidents**
- **Goals of this project**
- **Review the sled testing to be conducted at CAMI**
  - Testing Plan
  - Test Equipment
- **NASA interagency testing**
  - Overview of multiple year agreement
  - Legacy Rotorcraft and VTOL systems

Background

- **Rotorcraft have high injury & fatality rate from what should be survivable crashes**
- **New rotorcraft must meet Emergency Landing Dynamic Conditions Rule (Part 27/29.562)**
  - Vertical impact at 30 ft/sec, peak of 30 G, and 30° off vertical.
  - Regulatory limit of 1500 lb compressive load on lumbar spinal column
- **Only 10% of the U.S. fleet are compliant with current rule**
  - These aircraft can't meet the rule due to the rotorcraft structure
  - FAA formed working group for legacy rotorcraft
    - Goal to propose solutions to increase the level of safety

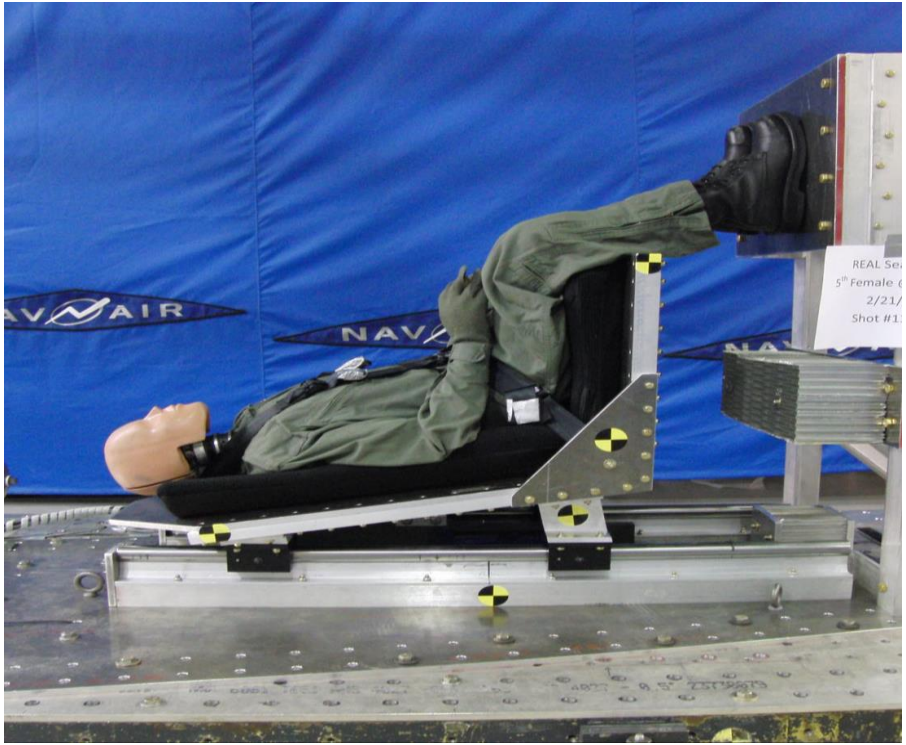
Goals of Project

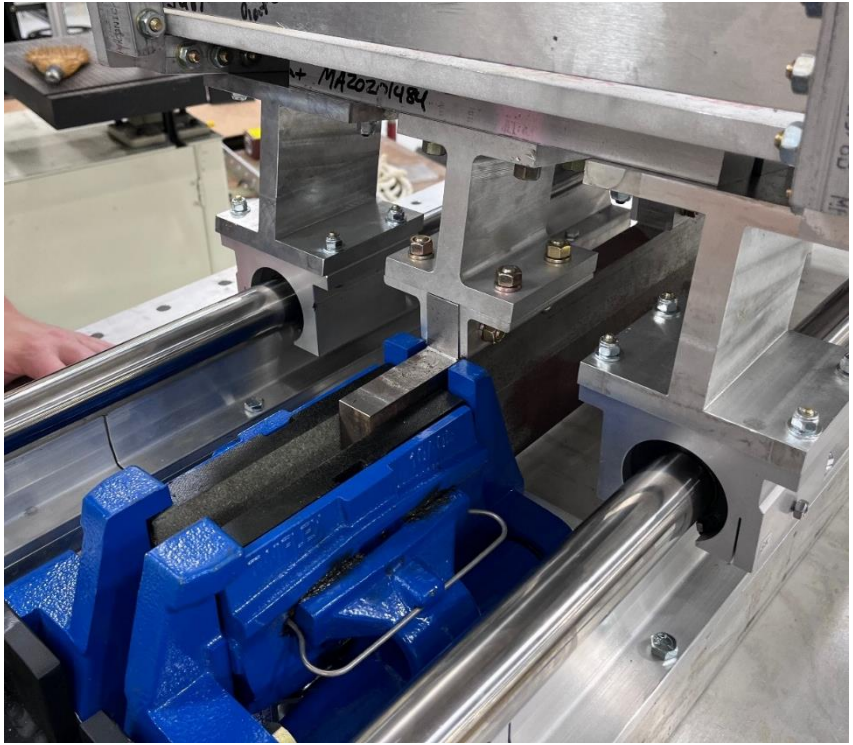
- Evaluate reduced dynamic test pulses and compare to risk of spinal column injury
- Gather data on seat stroke and compare to risk of spinal column injury
- Evaluation of overhead structure interaction with rotorcraft seats and restraints systems
- Identify areas to increase safety
- Propose existing technologies to make legacy aircraft safer

REAL Seat Test Fixture

- **Manufactured a copy the Navy's REAL seat**
- **Rigid seat structure**
  - Rides on two linear rails
  - Mounting points for the brake blade
  - 5 Point Harness
- **Sled mount components**
  - Linear rails
  - Brake accumulator system
  - Structural supports, sled attachment fixtures
  - Emergency load limiter

REAL Seat Test Fixture (cont.)



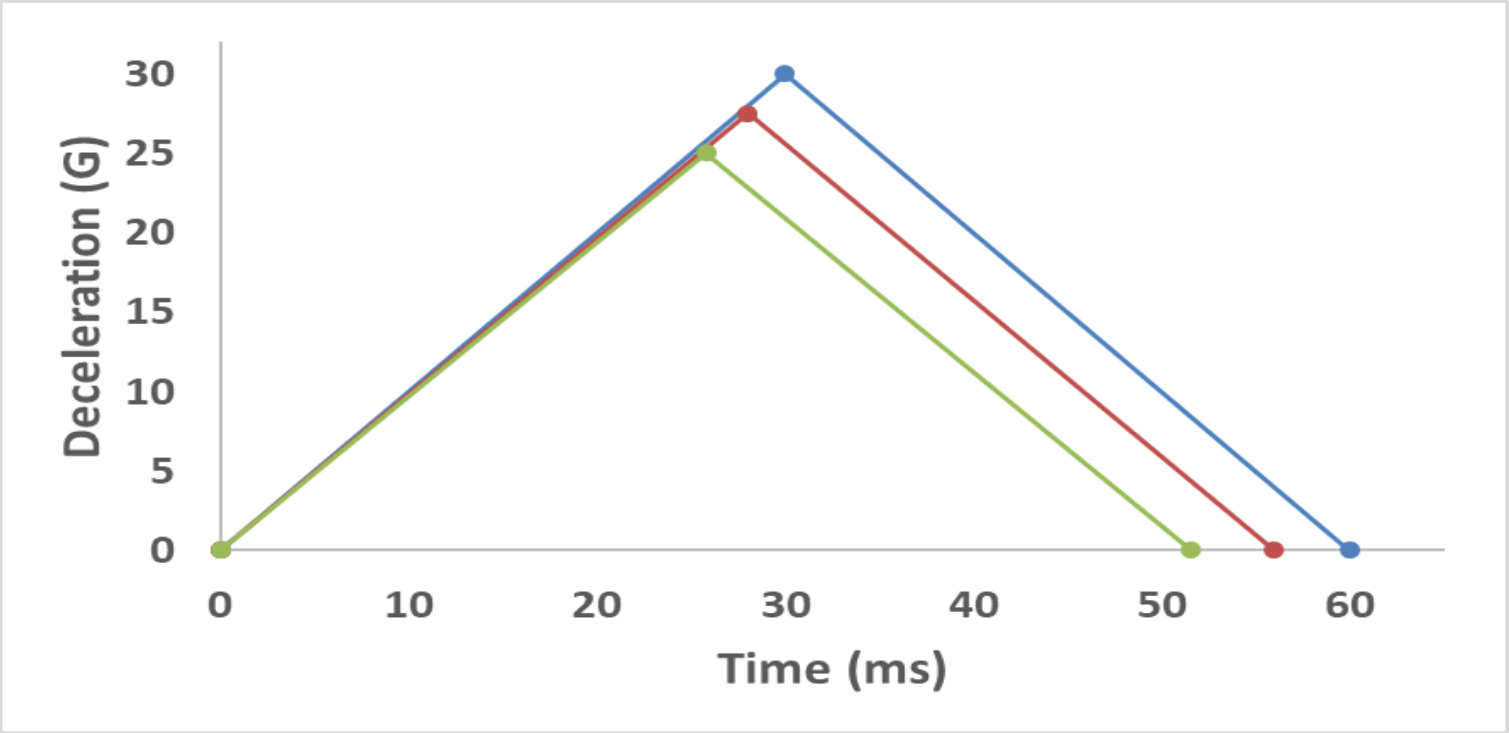


Courtesy of NAVAIR

REAL Seat Operation

- **Brake system integrated to control seat stroke**
- **Seat stroke varies on seat load and brake pressure**
- **Braking system requires brake in period**
- **Develop a chart for load and desired stroke versus brake pressure**
- **The main data to be collected for this series**
  - Change in Lumbar load vs sled pulse and seat stroke
  - Head path vs seat stroke distance

Sled Testing Pulses



Test Matrix

Min Velocity Change (ft/sec)	Min Peak G	Max Rise Time (ms)	Total Duration (ms)	Stroke (inches)					Number of Tests
30.0 ft/sec	30.0	30.0	63.0	2	4	6	8	10	15
25.0 ft/sec	27.5	27.0	57.0	2	4	6	8	10	15
20.8 ft/sec	25.0	25.0	52.0	2	4	6	8	10	15
								Total	45

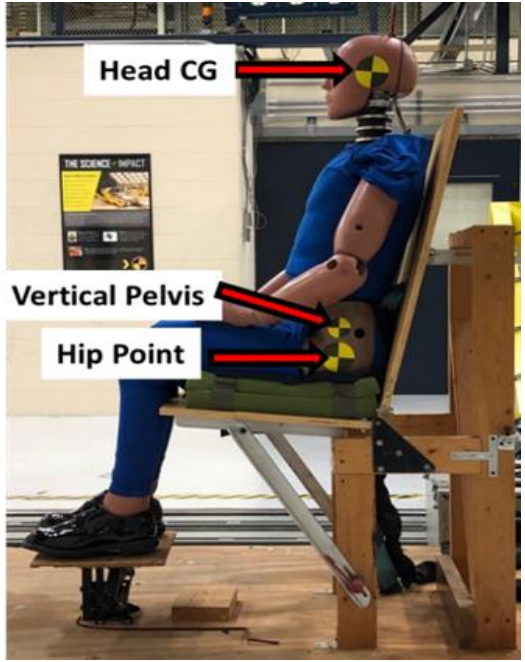
Anthropomorphic Test Device

- **Humanetics FAA Hybrid 3 50% Male**
- **Channels**
  - Minimum channels
  - Additional channels
    - Tibia load & moment
    - T12 load & moment
  - Filter class IAW J211

Description	Units	Filter Class
Head Acceleration (Ax, Ay, Az)	G	1000
Upper Neck Loads (Fx, Fy, Fz)	lb	1000
Upper Neck Moment (Mx, My, Mz)	in-lb	600
Lumbar Force (Fx, Fy, Fz)	lb	600
Lumbar Moment (Mx, My, Mz)	in-lb	600
Spinal Acceleration (Ax, Az)	G	180
Pelvis Acceleration (Ax, Ay, Az)	G	1000

Anthropomorphic Test Device (cont.)

- **Seating procedure**
  - ATD knees up
  - 15 lb of force on the chest
- **1 G seating**
  - CMM to translate ATD position
- **Temperature & humidity limitations**
  - 66 to 78 °F, 10 to 70% relative humidity
- **Limb joint setting/adjustment**
  - 1 G minimum, 2 G maximum



Sled Data Acquisition

- **Minimum channels**
  - Sled acceleration (G)
  - Seat Pan acceleration (G)
  - Pan displacement (in)
- **Possible channels**
  - Belt tension
  - Brake pressure
- **All filter class IAW J211**

Description	Units	Filter Class
Sled Acceleration	G	60
Seat Pan Acceleration	G	60
Pan Displacement	in	180

High Speed Video

- **Minimum of two views**
  - Perpendicular to sled travel
  - Photometric targets to track
    - Analysis of head path
    - seat motion, stroke distance
  - Possible camera angles for 3D motion analysis
    - Overhead
    - Front view
    - 45 degrees from sled path of travel

Interagency Agreement with NASA

- Multiple year agreement between NASA and FAA
- Collect data to support the advanced development and evaluation of overhead structure interaction with rotorcraft seats and restraints systems in vertical takeoff and landing (VTOL).
- Goal to reduce blunt force trauma in legacy rotorcraft and VTOL aircraft
- Evaluate legacy structure and rotorcraft seating technology
  - Use data to support configuration, seat, and restraint systems in VTOL aircraft.
- Evaluation of rotorcraft structures seating system options
  - Vertical drop testing and full scale testing
  - Monitor risk of head and spinal injury to occupants.
- Collect date to support certification efforts eVTOL for dynamic landing conditions.

Interagency Agreement with NASA (cont.)

- Evaluate rotorcraft structures and seats to collect injury data
  - The ATD and load data will be the main data collected from this effort.
- Currently in planning stage
  - Agencies are developing the parameters to meet the research requirements
    - Types of seats
    - Pulse shapes and energy levels
    - Seated configurations of ATDs for eVTOL full-scale tests
    - Requirements for vertical drop testing
    - Advanced instrumented ATDs that could be suitable for testing
- Testing starts in FY25
- Reports and project close out in FY27

Summary

- **Background of legacy rotorcraft accidents**
- **Goals of this project**
- **Reviewed the sled testing to be conducted at CAMI**
  - Testing plan and equipment
  - Testing planning two start within next two months
- **Overview of the NASA interagency testing**
  - Discussed the key points of the multi-year contact
  - Described the objective of the agreement in relation to making Legacy Rotorcraft and VTOL systems safer

Thank you

- **Project Sponsor: Joseph Pellettiere**
- **Stake Holders: Martin Crane, Daniel Moore**
- **CAMI Biodynamics team: David Moorcroft, Jeff Ashmore, Ronnie Minnick, Zak Perkins, & Will Carroll**

This data will be published in an Office of Aerospace Medicine (OAM) technical report

Project Control Number A11J.RS.1

Questions?