USAARL-CNPA-BC--2025-38

UNITED STATES ARMY AEROMEDICAL RESEARCH LABORATORY

Critical Review of Civilian and Military Crashworthy Aircraft Seat Performance Requirements (Reprint)

Danielle Rhodes, B. Joseph McEntire, Joseph F. Willett, & Valeta Carol Chancey

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14. ABSTRACT

U.S. Army rotary-wing seating system specifications, MIL-S-58095A (AV) (pilot and co-pilot) and MIL-S-85510 (AS) (crew and passenger) provide rigorous safety metrics with the goal of proper occupant protection. Although MIL-S-58095A (AV) has been canceled and MIL-S-85510 (AS) rendered inactive, they are still referenced by the active MIL-STD-1290A. Civilian standards provide an appealing alternative due to less rigorous testing conditions and off-the-shelf, mass-produced materiel for seating systems. Future Vertical Lift (FVL) designers are considering adopting civilian rotary-wing crew seat performance requirements due to a lack of adequate and active specifications requirements. Static and dynamic requirements of the seating system of the U.S. Army's pilot, crew, and troop seat and system requirements/guidance specified in MIL-S-85510, MIL-S-58095A, and JSSG-2010-7 were compared to those of the civilian requirements in SAE AS8049D and SAE AS8049/1 Rev. B.

15. SUBJECT TERMS

Rotary-wing, rotorcraft seating systems, MIL-S-58095A, MIL-S-85510, SAE AS8049D, SAE AS8049/1 rev. B, crashworthiness, civilian crash standards, military crash standards

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13. Supplementary Notes (continued)

Rhodes, D., McEntire, B. J., Willet, J. F., & Chancey, V. C. (2025, 1-6 June). C*ritical review of civilian and military crashworthy aircraft seat performance requirements* [Oral presentation]. Aerospace Medical Association Annual Scientific Meeting, Altanta, GA.

14. Abstract (continued)

Researchers found that the testing conditions and performance metrics defined by the civilian rotary-wing seating standards are less rigorous than the legacy military seating specifications and, as such, will not replicate the exposures experienced in military operational environments and will likely result in increased occupant injury and mortality rates in severe but otherwise survivable military rotary-wing mishaps. As the rotary-wing seating system is the occupant's last line of defense against crash-induced injury, it is imperative that the military rotary-wing aircraft seating and occupant restraint systems be designed for and tested against stringent, military-relevant, performance and test standards.

Civilian Versus Military Rotorcraft Crashworthy Seat Standards for Crash Protection

Danielle Rhodes[1,2], B. Joseph McEntire[1], Joseph Willett[1,2], Valeta Carol Chancey[1]

[1]U.S. Army Aeromedical Research Laboratory (USAARL), Fort Rucker, AL
[2]Chenega Corporation, Anchorage, AK

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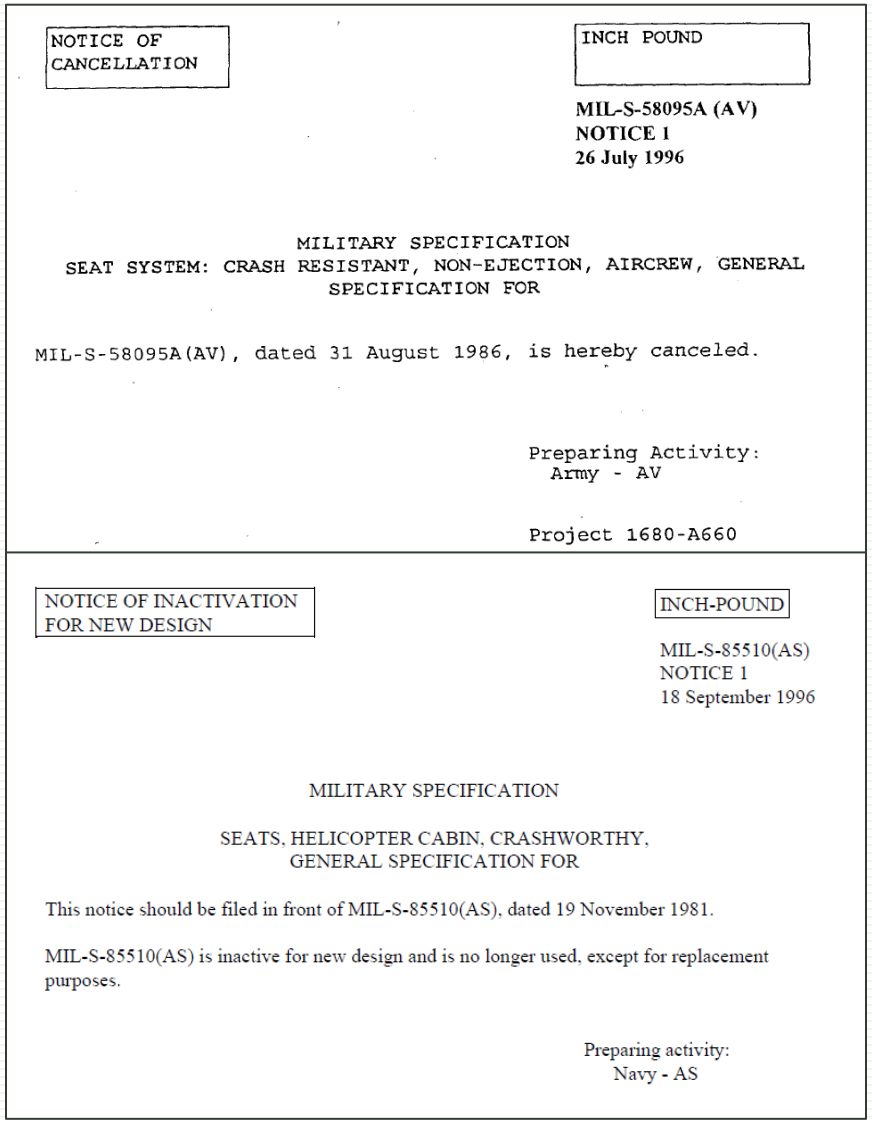
Introduction

- Since the 1960s, the U.S. Army has been investigating U.S. Army helicopter mishaps and resulting injuries while also researching means to reduce aviation mishap morbidity and mortality.
- Many of the findings and results were incorporated into the U.S. Army Aircraft Crash Survival Design Guide [ACSDG].
- Information from the ACSDG was leveraged in the military standards and specifications.

Introduction

- Performance requirements and testing conditions differ depending on the function of the seat (i.e., pilot/co-pilot, crew/passenger) and the aviation environment for which the seating system is designed.
  - MIL-S-58095A (AV) – Pilot and co-pilot seating systems
  - MIL-S-85510 (AS) – Crew and passenger seating systems

- MIL-S-58095A and MIL-S-85510 were canceled and rendered inactive, respectively, in 1996; however, they are referenced in MIL-STD-1290A, which is still active.



NOTICE OF CANCELLATION

INCH POUND

MIL-S-58095A (AV)
NOTICE 1
26 July 1996

MILITARY SPECIFICATION
SEAT SYSTEM: CRASH RESISTANT, NON-EJECTION, AIRCREW, GENERAL SPECIFICATION FOR

MIL-S-58095A(AV), dated 31 August 1986, is hereby canceled.

Preparing Activity:
Army - AV

Project 1680-A660

NOTICE OF INACTIVATION FOR NEW DESIGN

INCH-POUND

MIL-S-85510(AS)
NOTICE 1
18 September 1996

MILITARY SPECIFICATION

SEATS, HELICOPTER CABIN, CRASHWORTHY, GENERAL SPECIFICATION FOR

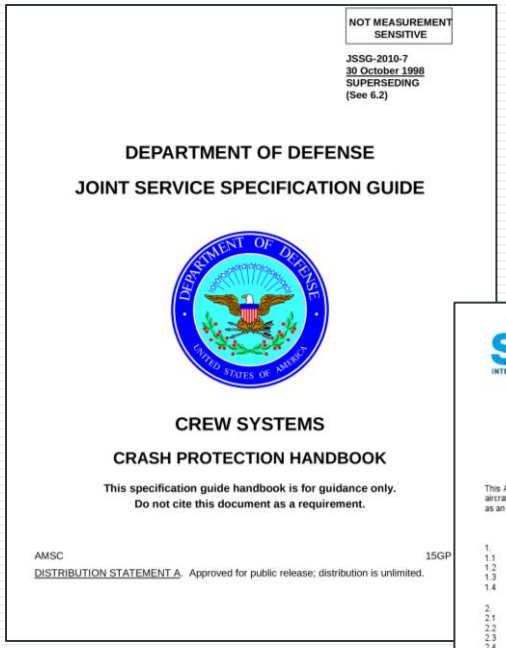
This notice should be filed in front of MIL-S-85510(AS), dated 19 November 1981.

MIL-S-85510(AS) is inactive for new design and is no longer used, except for replacement purposes.

Preparing activity:
Navy - AS

Introduction

- As a result, Army Program Managers are forced to consider other military guides that define seat performance standards for new aircraft and seat development efforts.
  - Joint Service Specification Guide (JSSG)-2010-7
  - Civilian standards like the SAE International AS8049™D
- Future Vertical Lift (FVL) designers are considering adopting civilian standards as seat performance requirements in lieu of active military specifications.



NOT MEASUREMENT SENSITIVE

JSSG-2010-7
30 October 1998
SUPERSEDING
(See 6.2)

DEPARTMENT OF DEFENSE

JOINT SERVICE SPECIFICATION GUIDE

CREW SYSTEMS

CRASH PROTECTION HANDBOOK

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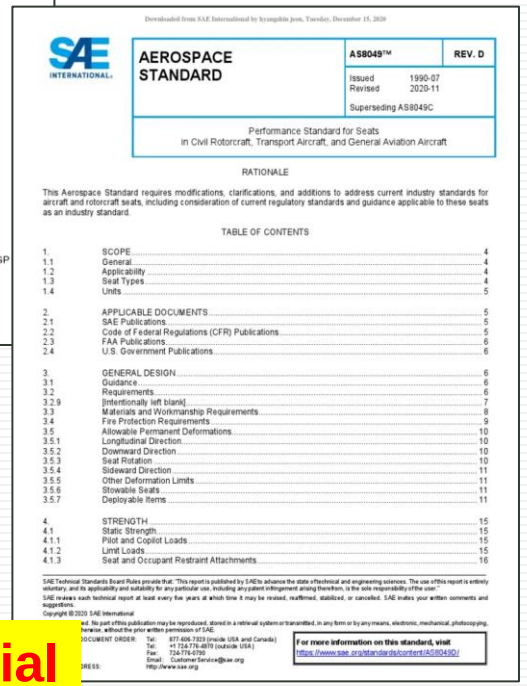

SAE INTERNATIONAL

AEROSPACE STANDARD

AS8049™ REV. D

Issued 1990-07
Revised 2020-11

Superseding AS8049C

Performance Standard for Seats in Civil Rotorcraft, Transport Aircraft, and General Aviation Aircraft

RATIONALE

This Aerospace Standard requires modifications, clarifications, and additions to address current industry standards for aircraft and rotorcraft seats, including consideration of current regulatory standards and guidance applicable to these seats as an industry standard.

TABLE OF CONTENTS

While civilian seat standards provide an alternative for off-the-shelf commercial seating systems, their performance requirements are less rigorous.

Methods

Static and dynamic test requirements for military and civilian energy attenuating rotary-wing seating systems were reviewed for static strength requirements, dynamic test conditions (peak acceleration, velocity change, etc.), and the corresponding pass/fail criteria to include anthropomorphic test device (ATD) response measures*:

U.S. Army seat performance standards

- **MIL-S-58095A (AV) (1986)** - Pilot and Co-pilot seating system specification for U.S. Army rotorcraft
  - Canceled in 1996
- **MIL-S-85510 (AS) (1981)** - Crew and passenger seating system specification for U.S. Army rotorcraft
  - Rendered inactive for new design in 1996

Guidance and Civilian seat performance standards

- **JSSG-2010-7 (1998)** - Crew systems crash protection handbook for U.S. military (Guidance)
- **SAE AS8049TMD (2020)** - Crew and passenger seating system standard for civilian rotorcraft
- **SAE AS8049TM/1B (2023)** - Amendment to AS8049TMD to accommodate sideward facing seats

*Reviewed specification and standards were chosen for relevance to helicopter aircrew seat crashworthiness and are not inclusive of all military and civilian specifications and standards.

Standards vs. Real World

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Representative Occupant Weight Specifications Compared to Updated Soldier Anthropometry

Occupant Representative Size	MIL-S-58095A	JSSG-2010-7	MIL-S-85510	SAE AS8049™D		Gordon et al., 2014	Gordon et al., 2016
	Seat Occupant Weight Requirements (pounds [lb])					Soldier Weight (lb)	Pilot Weight (lb)
5th Male	140	133.4	126.3	*NS*		142	152.3
50th Male	*NS*	170.5	156.3	170		186.5	192.2
95th Male	250*	211.7	201.9	*NS*		244.1	244.1
5th Female	*NS*	102.8	*NS*	*NS*		113.1	115.5
50th Female	*NS*	131.4	*NS*	*NS*		147.3	146.8
95th Female	*NS*	164.3	*NS*	*NS*		192	185.6

Notes. NS = Not Specified

*The 250 lb referenced in MIL-S-58095A is an encumbered weight representing the 95th percentile male with equipment.

Static Loading Requirements

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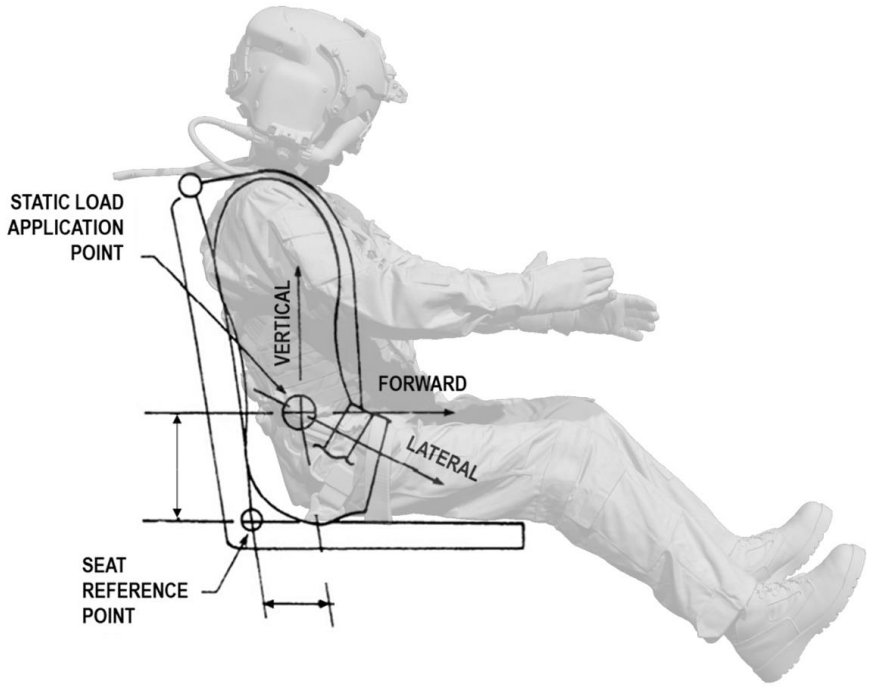
Body and Equipment Weight Requirements

Loading Direction	MIL-S-58095A/ JSSG-2010-7		MIL-S-85510		SAE AS8049TMD	
	Body Weight for Load Determination (lb)	Equipment Weight (lb)	Body Weight for Load Determination* (lb)	Equipment Weight (lb)	Body Weight for Load Determination (lb)	Equipment Weight (lb)
Forward	250	Combat gear weight included in body weight determination	242	Combat gear weight included in body weight determination	170	No Gear Required by Civilian Standard
Aftward	250		242			
Lateral	250		242			
Downward	200+		196.6^			
Upward	250		242			

*Body block weight is inclusive of the 95th percentile male Soldier with 40.3 lb of equipment.
+Effective weight (80%) of a 250 lb occupant.
^Downward loading in MIL-S-85510 is representative of the 50th percentile male Soldier with 40.3 lb of equipment.

Static Testing Parameters (Load Factors)



Loading Direction	MIL-S-58095A JSSG-2010-7	MIL-S-85510	SAE AS8049TMD
Forward	35	30	16
Aftward	12	12	1.5
Lateral	20	20	8
Downward	25	14.5	20
Upward	8	8	4
Combined			
Forward	25	30	NA
Lateral	9	9	NA
Downward	*a*	14.5	NA

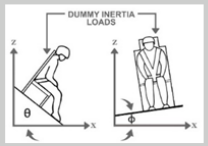
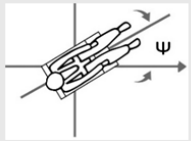
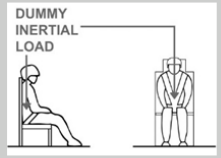
A civilian seat exposed to loads expected in military rotary-wing mishaps will likely fail.

Combined loading ensures the seat's design and construction is sufficient to withstand the combined forward and lateral loads without degrading the seat's capability to absorb vertical impact conditions.

Note. NA = Not Applicable
a. Static load factor as necessary to meet dynamic test criteria, Table III, MIL-S-58095A.

Dynamic Loading Requirements

Seated Occupant Requirements

Test Condition		MIL-S-58095A JSSG-2010-7	MIL-S-85510	SAE AS8049™D	SAE AS8049™/1B
1		95th Male ATD	50th Male ATD	50th Male HII, HIII, FAA HIII, or equivalent	50th Male HII or equivalent
2		95th Male ATD	95th Male ATD	50th Male HII, HIII, FAA HIII, or equivalent	ES-2 re EuroSID-2 rib extension
3		5th Male ATD	Not Required	Not Required	Not Required
4		95th Male ATD			

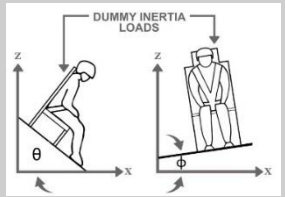
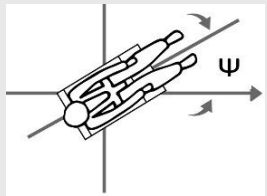
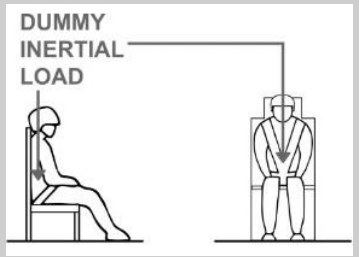
Note: The 5th male ATD referenced in MIL-S-58095A and JSSG-2010-7 is a 50th male ATD with arms removed to represent a 5th male weight.

Testing with a 95th percentile male vs. a 50th percentile male requires the seat to have a more robust construction.

Dynamic Loading Requirements

Specified Angles
Θ = pitch, Φ = roll, Ψ = yaw

- Condition 1 represents a 30° pitch, nose down, impact condition; however, all three military documents include a 10° roll angle while the SAE AS8049D has no roll (Φ)
- Condition 2 that represents an offset frontal impact, all three military documents require a 30° yaw condition while only a 10° yaw is specified in SAE AS8049D
- Conditions 3 and 4 (vertical loading) are required by MIL-S-58095A and JSSG-2010-7, but they are not required in the other documents

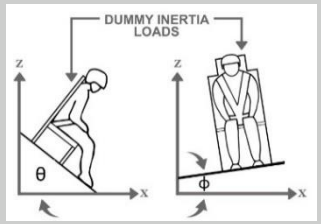
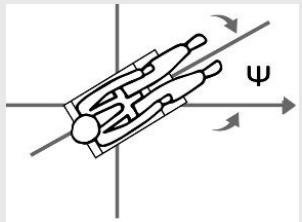
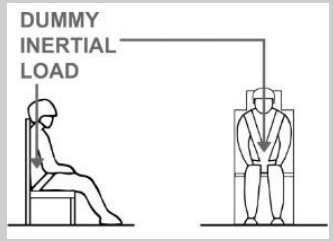
Test Condition		MIL-S-58095A JSSG-2010-7	MIL-S-85510	SAE AS8049™D
1		Θ = 30 Φ = 10 Ψ = 0	Θ = 30 Φ = 10 Ψ = 0	Θ = 30 Φ = 0 Ψ = 0
2		Θ = 0 Φ = 0 Ψ = 30	Θ = 0 Φ = 0 Ψ = 30	Θ = 0 Φ = 0 Ψ = 10
3 & 4		Θ = 0 Φ = 0 Ψ = 0 Conditions 3 & 4 differ only by simulated occupant weight.	Θ = 0 Φ = 0 Ψ = 0 Vertical loading condition is an additional requirement if substituted for a static test.	Not Required

Dynamic Loading Requirements

Peak Minimum Acceleration

$$\Delta = \frac{(peak\ accel_{alt.standard} - peak\ accel_{MIL-S-58095A})}{peak\ accel_{MIL-S-58095A}}$$

- The acceleration parameters specified in MIL-S-58095A (and JSSG-2010-7) are the most rigorous and were used to calculate the percent change for the MIL-S-85510 and SAE AS8049TMD
- Both MIL-S-85510 (AS) and SAE AS8049D showed reductions in G minimum, SAE AS8049TMD showed the greatest reduction at 34% for conditions 1 and 2 parameters

Test Condition		MIL-S-58095A JSSG-2010-7	MIL-S-85510	SAE AS8049TMD
1		46 G	32 G *Δ -30%*	30 G *Δ -35%*
2		28 G	22 G *Δ -21%*	18.4 G *Δ -34%*
3 & 4		46 G*	32 G** *Δ -30%*	Not Required

*Conditions 3 & 4 differ only by simulated occupant weight.
**Vertical loading condition is an additional requirement if substituted for a static test.

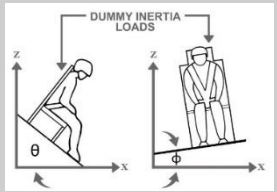
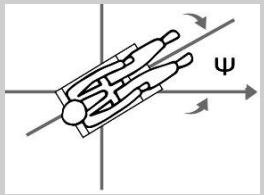
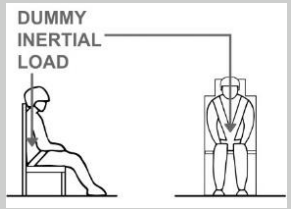
Dynamic Loading Requirements

Change in Velocity (Δv = area under the acceleration pulse)

Normalized Energy = Change in Velocity Squared (Δv^2)

$$\Delta = \frac{(\Delta v^2_{alt.standard} - \Delta v^2_{MIL-S-58095A})}{\Delta v^2_{MIL-S-58095A}}$$

- Calculating the "normalized energy" using the change in velocity squared allows for comparison between standards regardless of the size of the ATD

Test Condition		Parameter	MIL-S-58095A JSSG-2010-7	MIL-S-85510	SAE AS8049™ D
1		Δv (ft/s)	50	50	30
		Normalized Energy (ft^2/s^2)	2500	2500	900 *Δ -64%*
2		Δv (ft/s)	50	50	42
		Normalized Energy (ft^2/s^2)	2500	2500	1764 *Δ -29%*
3&4		Δv (ft/s)	42	42	Not Required
		Normalized Energy (ft^2/s^2)	1764	1764	

Conditions 3 & 4 differ only by simulated occupant weight.

Vertical loading condition is an additional requirement if substituted for a static test.

Minimum Instrumentation

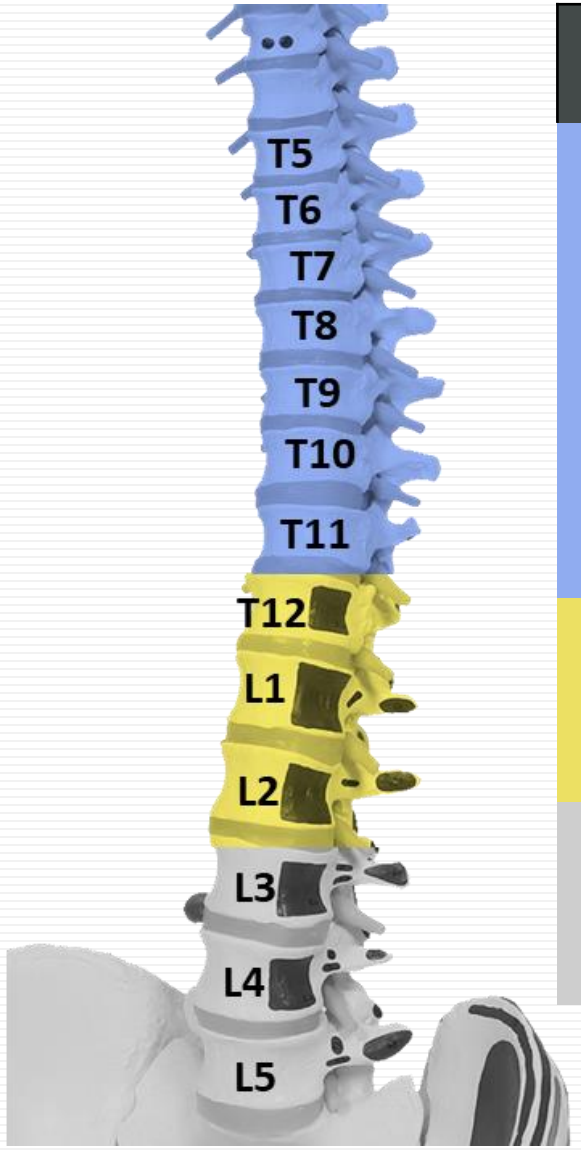
- MIL-S-58095A
  - Only required on structure; no instrumentation on surrogate
  - Accelerometer fixed to the lower seat pan (5.5 inches forward of the seat reference point [SRP] for dynamic test Conditions 3 and 4)
  - No requirements to assess injury risk
- JSSG-2010-7
  - No instrumentation requirements
  - Document used for guidance only
  - No requirements to assess injury risk
- MIL-S-85510
  - No instrumentation requirements
  - Contractor must document and provide instrumentation details in test plan
  - No requirements to assess injury risk
- SAE 8049^{TM}D and 8049^{TM}/1B
  - ATD head accelerations, femur forces, pelvic/lumbar column force, neck forces and moments, and chest accelerations are collected via data channels that could potentially assess injury risk.
  - Sled and drop tower acceleration data and restraint system/seat attachment point loads
  - Photo and video documentation (for ATD kinematics)

Discussion

- **When military rotorcraft seating specifications are canceled or rendered inactive, confusion is created when these specifications are referenced in active standards (MIL-STD-1290A)**
- Seats developed according to, or conforming to, civilian standards provide an alternative over military specifications.
  - Off-the-shelf availability
  - Mass-produced materials
  - Less rigorous requirements
  - Exposure requirements are not representative of the military environment, to the detriment of occupant safety
- Military seat specifications should be updated and re-activated to ensure Soldier safety in training and operational environments.
  - Specifications should be updated to reflect and accommodate revised male and female Soldier anthropometric measurements, including combat duty kit weights.
  - The load application point for static testing should be updated to reflect updated seat and equipment dimensions and Soldier anthropometry.
  - Expand dynamic testing requirements and update to accommodate different occupant sizes (i.e., 5F, 50M, and 95M) with equipment weight to evaluate seat performance.
  - MIL-S-58095A dynamic testing parameters should be used for seat evaluation performance for all seat systems including aircrew and troops.
  - Military seating standards should consider injury assessment reference values recommended by Rhodes, Flath, et al. (2022) and Rhodes, Willet, et al. (2022) for ATDs to assess injury risk to the occupant.

Discussion

- Aviators are still experiencing spinal injuries in mishaps with rotary-wing seats designed to MIL-S-58095A and MIL-S-85510.
- Brozoski et al. (2020) reported that Army aviators were still at risk for thoracolumbar injuries in potentially survivable mishaps between January 1990 and December 2014.
- While military standards were sufficient at first, Soldier anthropometry and equipment weights have increased over the last 30 years (Rhodes et al., 2021).
- Losing pilots and crewmembers due to spinal injuries reduces unit readiness and could cost more than $9 million per pilot (General Accounting Office, 1999).
- USAARL is currently using ATDs to investigate thoracolumbar injury tolerance in potentially survivable mishaps to assess injury risk.



Number of Injuries
2
2
7
3
0
5
7
17
32
21
7
11
1

Take Aways

Military aircraft seats are the Soldier's last defense in a crash.

- Rotary-wing crashworthy seat test conditions that are less rigorous than the legacy military requirements reduce occupant protection and increase injury risks.
- Opportunity should be taken to update and improve military seat crashworthiness standards.
- Full Technical Report: McEntire, B. J., Willett, J., Rhodes, D., Chancey, V. C. (2024). *Critical review of civilian and military crashworthy aircraft seat performance requirements* (USAARL-TECH-FR--2025-02). U.S. Army Aeromedical Research Laboratory.

References

Brozoski, F., Chancey, V. C., Licina, J., & McEntire, B. J. (2020). *Retrospective review of spinal injuries in U.S. Army rotary-wing mishaps: January 1990 – December 2014* (USAARL-TECH-FR--2020-024). U.S. Army Aeromedical Research Laboratory.

Coltman, J., Ingen, C., Johnson, N., & Zimmerman, R. (1989). Aircraft crash survival design guide - Volume II - Aircraft design crash impact conditions and human tolerance (USAAVSCOM TR 89-D-22B). Aviation Applied Technology Directorate & U.S. Army Aviation Research & Technology Activity.

Department of Defense [DoD]. *Seats, helicopter cabin, crashworthy, general specification for* (MIL-S-85510). Washington D.C.: U.S. Department of Defense, November 19, 1981.

DoD. *Seat system: Crashworthy, non-ejection, aircrew, general specification for* (MIL-STD-58095A). Washington D.C.: U.S. Department of Defense, August 27, 1986.

DoD. *Light fixed and rotary-wing aircraft crash resistance* (MIL-STD-1290A). Washington D.C.: U.S. Department of Defense, September 27, 1988.

DoD. *Joint Service Specification Guide: Crew Systems Crash Protection Handbook* (JSSG-2010-7). Washington D.C.: U.S. Department of Defense, October 30, 1998.

Desjardins, S. P., Zimmerman, R. E., Bolukbasi, A. O., & Merritt, N. A., (1989). Aircraft crash survival design guide- Volume IV - Aircraft seats, restraints, litters, and cockpit/cabin delethalization (USAAVSCOM TR 89-D-22D). Aviation Applied Technology Directorate & U.S. Army Aviation Research & Technology Activity.

General Accounting Office (GAO). (1999). Military personnel: Actions needed to better define pilot requirements and promote retention (GAO/NSIAD-99-211). GAO.

Gordon, C. C., Blackwell, C. L., Bradtmiller, B., Parham, J. L., Barrientos, P., Paquette, S. P., Corner, B. D., Carson, J. M., Venezia, J. C., & Kristensen, S. (2016). *2012 anthropometric survey of U.S. Army pilot personnel: Methods and summary statistics* (NATICK/TR-16/013). U.S. Army Natick Soldier Research Development and Engineering Center.

Rhodes, D., McEntire, B. J., Ballard, M., & Chancey, V. C. (2021). *Implications of updated Soldier anthropometry and gear weights on future and enduring seating based on the UH-60 Crew Chief/Gunner and Medic seat retention strength* (USAARL-TECH-TR--2021-052). U.S. Army Aeromedical Research Laboratory.

Rhodes, D., Flath, N. L., Brown, B. A., Ballard, M. T., Williams, S. T., Robinette, A. M., Lafferty, E. L., Chancey, V. C., & McEntire, B. J. (2022). Critical review of injury assessment reference values for application in the military environment: Volume I (Report No. USAARL-TECH-FR--2022-45). U.S. Army Aeromedical Research Laboratory.

Rhodes, D., Willett, J. F., & McEntire, B. J. (2022). Critical review of injury assessment reference values for application in the military environment: Volume II (Report No. USAARL-TECH-FR--2022-46). U.S. Army Aeromedical Laboratory.

SAE International, Inc. (2023). *Performance standards for side facing seats in civil rotorcraft, transport aircraft, and general aviation aircraft* (SAE AS8049™/1B). SAE International, Inc.

SAE International, Inc. (2020). *Performance standard for seats in civil rotorcraft, transport aircraft, and general aviation aircraft* (SAE AS8049™D). SAE International, Inc.

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