



U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: Dynamic Evaluation of Seat
Restraint Systems and Occupant Protection on
Transport Airplanes

Date: D R A F T

AC No: 25.562-1B

Initiated By: AIR-626

Change: 2

1. **PURPOSE.** This change updates methods of compliance for front-row seats under paragraph 5e(5)(d) and Appendix 4, based on studies of forward-facing seats with conventional lap and Y-belt restraints. FAA research report “Comparison of standard and Y-belt aircraft passenger restraints in frontal impacts with PMHS and ATD”¹ found that extreme flail of the upper torso can result in severe injuries, such that the risk management principles used to develop previous methods of compliance to title 14, Code of Federal Regulations (14 CFR) 25.562 and 25.785 for front row seats are no longer justified. Those principles were originally conveyed in Federal Aviation Administration (FAA) Policy Memorandum ANM-115-05-14, *Policy Statement on Acceptable Methods of Compliance with § 25.562(c)(5) for Front Row Passenger Seats*, dated December 14, 2005, and subsequently conveyed in this Advisory Circular (AC) at Revision B, Change 1. The guidance in this AC supersedes Policy Memorandum ANM-115-05-14, *Policy Statement on Acceptable Methods of Compliance with § 25.562(c)(5) for Front Row Passenger Seats*, dated December 14, 2005.

This change also updates Section 13, Pass/Fail Criteria, paragraph 13.a.(2)b, for purposes of eliminating neck injuries associated with occupant interaction with interior features. This change provides additional guidance for seat designs for which dynamic testing shows obvious and unacceptable injurious interactions of the head and neck. The added guidance incorporates neck injury assessment information previously conveyed in FAA Letter ANM-115-17-002, dated March 9, 2017 and Technical Standard Order (TSO)

¹ Report published in proceedings of the 53rd Annual Rocky Mountain Bioengineering Symposium, RMBS 2016 & 53rd International ISA Biomedical Sciences Instrumentation Symposium 2016. Available from the internet at <https://www.proceedings.com/31943.html>. Abstract available on the internet at https://www.fire.tc.faa.gov/2016Conference/files/Crash_Dynamics_III/HummFrontRowOccupant/HummFrontRowOccupantAbs.pdf.

C127c, *Rotocraft, Transport Airplane, and Small Airplane Seating Systems*, Appendix 1, dated August 31, 2020.

2. PRINCIPAL CHANGES. Change 2 updates AC 25.562-1B, Change 1, *Dynamic Evaluation of Seat Restraint Systems and Occupant Protection on Transport Airplanes*, dated September 30, 2015. The FAA has added the change number and date of revision at the top of each changed page and has also marked the changes with a vertical change bar in the margin. Specifically, Change 2 incorporates the following changes.

- a. Revises paragraphs 2.a., 2.b., 2.c. and 2.d.
- b. Adds paragraph 3.b.
- c. Revises the description of front row seats in paragraph 5e(5)(d) to adequately address forward flail conditions.
- d. Revises paragraphs 5e(5)(d)1 and 2 to extend the scope of the defined compliance approach to also address forward flail conditions.
- e. Deletes paragraph 5e(5)(d)3 and its note.
- f. Revises paragraph 13.a.(2)b. to include neck injury assessments.
- g. Revises paragraph 13.a.(2)i. to add the airworthiness standard reference.
- h. Updated the reference to AC 20-146A in paragraph 16.b.
- i. Deletes Appendix 4, paragraph 3.

Page Control Chart

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1. PURPOSE. This advisory circular (AC) provides information and guidance regarding acceptable means of compliance with the requirements of 14 CFR part 25 applicable to dynamic testing of seats. The AC provides background and discussion of the reasoning behind the test procedures. It also describes the test facilities and equipment necessary to conduct the tests.

2. APPLICABILITY.

a. The guidance in this AC is for airplane manufacturers, modifiers, foreign regulatory authorities, Federal Aviation Administration (FAA) transport airplane type certification engineers, and FAA designees.

b. The contents of this AC do not have the force and effect of law, and are not meant to bind the public in any way. This document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies.

c. This AC describes an acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The FAA will consider other means of demonstrating compliance that an applicant may elect to present. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. If, however, the FAA becomes aware of circumstances that convince the FAA that following this AC would not result in compliance with the applicable regulations, the FAA will not be bound by the terms of this AC, and the FAA may require additional substantiation or design changes as a basis for finding compliance.

d. The material contained in this AC does not change or create any additional regulatory requirement, nor does it authorize changes in, or permit deviations from, existing regulatory requirements.

3. CANCELLATION.

a. Advisory Circular 25.562-1A, dated 01/19/96, is canceled.

b. Change 2 of AC 25.562-1B, cancels Policy Memorandum ANM-115-05-14, *Policy Statement on Acceptable Methods of Compliance with § 25.562(c)(5) for Front Row Passenger Seats*, dated December 14, 2005. The effective date of Change 2 is *enter date 2 years from issuance of the change.*

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(d) Front-row seats are those located directly aft of a partition, monument, or any other commodity certificated to 9g. Front-row seats also include any other seat installation that allows for unrestrained forward movement, such as seats installed at a large pitch and seats located directly aft of seat-related furniture such as consoles and walls of pod seats. For front-row seats, these methods intentionally limit the range of occupant evaluation for HIC to that solely covered by the test in § 25.562(b), which utilizes a 50% male ATD:

1 Perform dynamic testing as prescribed in § 25.562(b) with a Hybrid II ATD (49 CFR part 572, subpart B, or equivalent) or FAA Hybrid III ATD where there is no head contact, or there is contact, but with HIC of 1000 or less. A glancing blow resulting in HIC of 1,000 or less is acceptable and would not necessitate additional analysis or testing using a more conservative test setup. However, an unrestrained forward flail of the upper torso (or free flail, where there is no head contact during an emergency landing) is not compliant to § 25.785(b); therefore, unrestrained forward flail of the upper torso must be prevented by some means (such as a 3-point restraint or inflatable restraint system) to limit forward flail; or

2 Perform a dynamic test as described in Appendix 4, paragraph 2, of this AC to determine the head path arc of a Hybrid II ATD (49 CFR part 572, subpart B, or equivalent) or FAA Hybrid III ATD, and install the seat such that no contact by the ATD head would occur. In this case, the FAA would not require more analyses or repositioning of the seat for the purposes of showing compliance to § 25.562(c)(5). However, as noted above, unrestrained forward flail of the upper torso is not compliant to § 25.785(b); therefore, unrestrained forward flail of the upper torso must be prevented by some means (such as a 3-point restraint or inflatable restraint system) to limit forward flail.

f. Deformation for Egress. The seat permanent deformations (see Appendix 2) must be measured in all structural tests. In addition, seat-back permanent deformations

b. If the ATD is exposed to impact with interior features during the test, an HIC of 1,000 is not exceeded. Additionally:

(1) If the test uses a Hybrid II ATD, then

(a) the head does not rotate about its vertical axis, relative to the torso, greater than 105 degrees in either direction from forward facing, or introduce a feature or surface that produces concentrated loading on the neck, and

(b) the head center of gravity does not stop for more than 10 milliseconds from sliding down the seat back while the torso is still moving downward, or

(2) If the test uses an FAA Hybrid III ATD or equivalent, then

(a) the head does not rotate about its vertical axis, relative to the torso, greater than 105 degrees in either direction from forward facing, or introduce a feature or surface that produces concentrated loading on the neck, and

(b) the N_{ij} (calculated in accordance with 49 CFR 571.208) is below 1.0, where $N_{ij} = (F_z/F_{zc}) + (M_{ocy}/M_{yc})$, and N_{ij} critical values are:

- i. $F_{zc} = 1530$ lbf for tension
- ii. $F_{zc} = 1385$ lbf for compression
- iii. $M_{yc} = 229$ lbf ft in flexion
- iv. $M_{yc} = 100$ lbf ft in extension

(c) peak upper neck F_z is below 937 lbf in tension and 899 lbf in compression.

(3) If testing is first conducted with the Hybrid II ATD and the interaction could cause serious human injury if conditions in paragraph (1)(b) are not met, (e.g., chin snagging on a horizontal seat back feature), then subsequent testing may be accomplished with the FAA Hybrid III or equivalent. To show acceptability using the FAA Hybrid III or equivalent:

(a) the ATD is positioned so the chin will strike above the seat feature which caused the unacceptable interaction in the initial Hybrid II ATD test, and

(b) testing demonstrates the same behavior as shown with the Hybrid II ATD in order for the safety demonstration to be valid, and

(c) the loads in (2)(a) and (2)(b) are reported.

(d) If the test demonstrates an acceptable interaction per paragraph (1)(a) and the loads in (2)(a) and (2)(b) are below the limits, no further substantiation is necessary.

(e) Due to differing chin shape and neck stiffness, the chin of the FAA Hybrid III ATD or equivalent may or may not hang up on the seat feature. If the head stops, the stop time may exceed 10ms as long as the loads in (2)(a) and (2)(b) are not exceeded.

c. Where upper torso restraint straps are used, tension loads in individual straps do not exceed 1,750 lbs (7.78 kN). If dual straps are used for restraining the upper torso, the total strap tension load does not exceed 2,000 lbs (8.90 kN).

d. The maximum compressive load measured between the pelvis and the lumbar column of the ATD does not exceed 1,500 lbs (6.67 kN).

e. Where installed, the upper torso restraint straps remain on the ATD's shoulder during impact.

f. The pelvic restraint remains on the ATD's pelvis during impact.

g. Where leg contact with seats or other structure occurs, the axial compressive load in each femur does not exceed 2,250 lbs (10.0 kN).

h. The seat permanent deformations are within the quantitative limits of Appendix 2 of this AC and will not significantly impede an occupant from releasing his restraints, standing, and exiting the seat. In no case should deformation of the seat cause entrapment of the occupant, whether or not the defined limits referenced in Appendix 2 are exceeded.

NOTE: With the exception of seatbacks, it is assumed that the maximum seat structural deformation will result from the structural evaluation (that is, single row Type 1 or 2 test). Once this is accomplished, it would not, therefore, be considered necessary to repeat deformation measurements after the injury criteria (multiple row) tests, unless the structural and injury criteria tests were combined into one test. Maximum deformation to the seatback usually occurs as a result of impact by the occupant to the rear of the seat.

i. To meet § 25.562.(c)(8), all deployable items must remain stowed, unless it can be shown that they do not impede egress or cause serious injury (see Appendices 2 and 5).

14. TEST FAILURES VS. RETEST.

a. As noted in paragraph 13, a variety of failures can result in an unsuccessful test. Failures can range from structural separation of the seat from the tracks to deployment of items that impede egress. All such failures should be addressed and corrective action taken. However, the necessity of repeating tests following corrective action is the same decision process as that used to determine which tests are conducted initially.

b. Failures in any part of the primary load path, including the seat attachment to the track or restraint system attachment to the seat, will almost certainly require a retest. Failures in (secondary) internal structure may be able to be addressed analytically. For example, failures in members for which analytical substantiation is acceptable when making the test article selection (using the procedures outlined elsewhere in this AC), may not require a retest. However, each case should be assessed individually and a determination made that the failure point would not simply be transferred to another part of the load path. In general, members for which the failure mode is not catastrophic (for example, compressive failures in a forward leg as opposed to a tension failure in an aft leg for a 16g forward test) are less likely to warrant retest. The extent to which a secondary load path(s) can carry the load is a factor in determining the pass/fail of a structural test.

c. Special attention to the seat structure prior to the removal of floor warpage is advised. Structural failure can occur as a consequence of removal of floor warpage. If it can be determined

that the damage or seat deformation occurred solely as a result of removing the floor warpage, it is not considered a failure.

d. Similarly, the evaluation of the seat attachment should be made before the seat tracks are straightened (unwarped). The process of straightening the seat tracks may result in a seat attachment becoming detached. This is not a test failure. The assessment for seat attachment should be made after the restraining force on the pitch-and-roll fixture has been released. It is not necessary to return the floor to a flat condition to evaluate the seat attachment. Once the evaluation for seat attachment has been completed, the floor may be returned to a flat state in order to take deformation measurements (if applicable).

e. Cuts or tears in a restraint system may not require a retest if it can be demonstrated that the corrective action will be effective and if all other pass/fail criteria were met on the test in question.

f. Failures of attachments of items on the seat may be addressed analytically, provided that the corrective action does not impact the primary load path of the seat/occupant system or occupant injury criteria. However, the seat must be shown to be able to carry its full weight, including any attached items. Similarly, items that deploy should not require retests if the corrective action does not affect the dynamic behavior of the seat or occupant.

g. If a test exceeds the minimum test conditions and results in a failure, an assessment of the test conditions and the failure mode must be made, and a rational basis for retest without a design change must be presented to allow a retest without modification.

15. TEST DOCUMENTATION.

a. General. The tests should be documented in reports that describe the procedures, limitations, results, and deviations to the tests discussed in this AC. In addition to the specific data requirements specified in paragraph 9 of this AC, the documentation should include the following:

(1) Facility data.

(a) The name and address of the test facility performing the tests.

(b) The name and telephone number of the individual at the test facility responsible for conducting the tests.

(c) A brief description and/or photograph of each test fixture.

(d) A statement confirming that all instrumentation and data collection equipment used in the test meet the facility's internal calibration requirements, that these calibration requirements are documented and available for inspection upon request, that all calibrations are traceable to a national standard, and that the records of current calibration of all instruments used in the test are maintained at the facility.

(e) A statement confirming that the data collection was done in accordance with the recommendations in this AC, or a detailed description of the actual procedure used and technical analysis showing equivalence to the recommendations of this AC.

(f) The manufacturer, governing specification, serial number, and test weight of the ATDs used in the tests, and a description of any modifications or repairs performed on the ATDs that could cause them to deviate from the specification.

(g) A description of the photographic-instrumentation system used in the tests.

(2) Seat restraint system data.

(a) The manufacturer's name and identifying model numbers of the seat restraint system used in the tests with a brief description of the system, including identification and a functional description of all major components and photographs or drawings, as applicable. Qualifying approvals, such as Technical Standard Order (TSO) authorizations, should be included.

(b) For systems that are not symmetrical, an analysis supporting the selection of most critical conditions used in the tests.

b. Test Description. The description of the test should be documented in sufficient detail, so that the tests could be reproduced simply by following the guidance given in the report. The procedures outlined in this AC can be referenced in the report, but should be supplemented by such details as are necessary to describe the unique conditions of the tests. For example:

(1) Pertinent dimensions and other details of the installation that are not included in the drawings of the test items should be provided. This can include footrests, restraint system webbing guides and restraint anchorages, “interior surface” simulations, bulkhead or sidewall attachments for seats or restraints, etc.

(2) The floor deformation procedure, guided by goals of most critical loading for the test articles, should be documented.

(3) The placement and characteristics of electronic and photographic instrumentation chosen for the test beyond that information provided by the facility should be documented. This can include special targets, grids, or marking used for interpretation of photo documentation, transducers, restraint system loads, floor reaction forces, or other measurements beyond those discussed in this AC.

(4) Any unusual or unique activity or event pertinent to conducting the test should be documented. This could include use of special “break away” restraints or support for the ATDs, test items or transducers, operational conditions or activities such as delayed or aborted test procedures, and failures of test fixtures, instrumentation system components, or ATDs.

(5) Any energy-absorbing features that are intended as part of the design and the expected structural behavior that will result should be documented.

16. COMPUTER MODELS.

a. Several computer models have been developed to represent the seat restraint/occupant system in a crash. Some of these models include representation of the vehicle interior as well. Models vary in complexity from simple spring-mass dynamic models to exceedingly complex models that can help design an entire work station. Validation of these models also varies from no validation at all to complex validation efforts based on controlled testing and field experience. The use of these models during the design phase of seat restraint/interior systems for civil airplanes is encouraged. They can be of great assistance in predicting “most critical” conditions, in understanding the performance of systems when used by various sized occupants, in estimating head strike paths and velocities, and for many other uses of interest to the designer.

b. Advisory Circular 20-146A, *Methodology for Dynamic Seat Certification by Analysis for Use in Part 23, 25, 27, and 29 Airplanes and Rotorcraft*, dated June 26, 2018, provides criteria for the use of analytical modeling techniques and guidance on methods of compliance using computer models. The FAA will continue to assess the performance of dynamic computer models and will continue to issue appropriate advisory material as these techniques are found to be useful alternatives to the tests discussed in this AC.

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APPENDIX 4. PROCEDURE FOR DEMONSTRATING COMPLIANCE WITH HIC FOR REPETITIVE SEAT ROWS (CONTINUED)

(3) The test will be conducted with no yaw, no pitch, and no roll. Representative seat track is not required for this test, since structural attachment substantiation is not under consideration (for example, steel tracks may be used on this test).

(4) The head path data of the ATD expected to move the furthest forward due to structural deformation (usually in the most overhung seat place) should be collected. The most overhung seat place is the outer (left or right) seat place with the greatest distance from the centerline of the seat leg to the outer edge of the seat.

NOTE: It is acceptable to conduct additional head path tests of this type on less critical seats or, alternatively, head path data may be collected on more than one ATD on the same seat to collect head path data for specific occupant locations.

NOTE It is also acceptable to install a bulkhead or rigid vertical wall at the minimum design setback from the bulkhead into the test setup for the purpose of showing no ATD head contact during the test. It is not required for the bulkhead used in the test setup or material to be representative of the production airplane interior component. This is because the test is conducted to establish if head contact occurs for a specific setback distance and the location of head contact by a 50th percentile ATD in those cases where it does. It is the responsibility of the seat installer to use this data to demonstrate an acceptable installation. One way to use this data to demonstrate compliance for front-row HIC is to digitize the head path, then use the data to show no head contact for the range of occupants.

(5) Representative mass for baggage, life vests, and literature pocket contents must be installed at each seat place, regardless of seat occupancy. Items of mass on the seat (for example, under-seat IFE boxes) may be replaced by ballast.

(6) Retention of items of mass need not be demonstrated in this test, and items of mass may be restrained for the test.

(7) A representative floor must be included in the test setup for the ATD's feet.