



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

Advisory Circular

Subject: Approval of Modified Seating Systems Initially Approved Under a Technical Standard Order

Date: 01/11/2016

AC No: 21-25B

Initiated By: AIR-100

1 **PURPOSE.**

1.1 This advisory circular (AC) provides information, clarification, and procedural guidance for the approval and installation of modified technical standard order (TSO) approved seating systems in U.S. type-certificated aircraft. In this AC, we address modifications that result from design changes, repairs, and alterations pursuant to Title 14 of the Code of Federal Regulations (14 CFR) parts 21 and 43.

1.2 This AC is not mandatory and does not constitute a regulation. This AC describes an acceptable means, but not the only means, to modify TSO seating systems. However, if you use the means described in this AC, you must follow it in all important respects.

2 **AUDIENCE.**

This AC affects persons and organizations seeking to modify TSO seating systems.

3 **CANCELLATION.**

As of its effective date, this AC cancels AC 21-25A, *Approval of Modified Seating Systems Initially Approved Under a Technical Standard Order*, dated 6/3/97.

4 **EFFECTIVE DATE.**

This AC is effective January 11th, 2016.

5 **CHANGES.**

The purpose of this revision is to update references in accordance with amendment 21-92 to 14 CFR part 21 and to further clarify requirements for modifying seats originally approved under a TSO.

6 **RELATED REGULATIONS.**

- 14 CFR part 21, §§ 21.8, 21.9, 21.101, 21.301, 21.601, 21.616, and 21.619.
- 14 CFR part 23, §§ 23.561, 23.562, 23.785 (former Civil Air Regulation (CAR) 3.390), and 23.853.
- 14 CFR part 25, §§ 25.561, 25.562, 25.785 (former CAR 4b.358), and 25.853, and appendix F, parts I and II.
- 14 CFR part 27, §§ 27.561, 27.562, 27.785, and 27.853.
- 14 CFR part 29, §§ 29.561, 29.562, 29.785, and 29.853.
- 14 CFR part 43, § 43.13.
- 14 CFR part 45, § 45.15.

7 **BACKGROUND.**

A modification to a TSO article is a change to the approved design and may be accomplished through Federal Aviation Administration (FAA) design approvals or through alterations and repairs. This AC supplements the general guidance for TSO articles in AC 21-46, *Technical Standard Order Program*, and AC 21-50, *Installation of TSOA Articles and LODA Appliances*. This AC is intended to be used in conjunction with the general guidance contained in AC 21-46 and AC 21-50 to clarify the general guidance specifically to modifications of TSO seating systems.

7.1 **TSO Seating Systems.**

- 7.1.1 Seating systems produced by a manufacturer holding a TSO authorization (TSOA) or letter of design approval (LODA) must meet the minimum performance standards (MPS) described in the applicable version of TSO-C39 or TSO-C127.
- 7.1.2 Seating systems commonly integrate other TSO-approved articles into the design of the article. For example, restraints produced by a manufacturer holding a TSOA must have met the MPS described in TSO-C22 or TSO-C114, and flotation cushions produced under a TSOA must meet the MPS described in TSO-C72.

7.1.3 Non-TSO functions (NTF) are typically integrated into the seating system. These non-TSO functions are provided by components such as in-flight entertainment (IFE) systems, floor proximity lighting, and reading lights. Additional guidance for NTF in seats is provided in FAA Policy Statement, PS-AIR-21-130-03-01, *Clarification for Non-TSO Functions in Seats*.

7.2 **Modifications Approved Pursuant to 14 CFR Part 21.**

Pursuant to § 21.8, the design approval to modify the seating system must be obtained:

- Under a parts manufacturer approval (PMA);
- Under a TSO;
- Under type certification procedures (in an original type certificate (TC), by supplemental type certificate (STC), or by amended type certificate (ATC)); or
- In any other manner approved by the FAA Administrator.

7.3 **Modifications Approved Pursuant to 14 CFR part 43.**

Pursuant to § 43.13, maintenance, preventive maintenance, and alterations performed on a seating system shall result in a product that is at least equal to its original or properly altered condition with respect to all qualities affecting airworthiness. The local FAA Flight Standards District Office (FSDO) and, as required, Aircraft Certification Office (ACO) may be contacted regarding the article modification and the approval basis. The following provide further guidance on alterations and repairs:

- AC 21-47, *Submittal of Data to an ACO, a DER or an ODA for a Major Repair or a Major Alteration*, provides guidance to create a complete data package for a major repair or alteration.
- AC 43-210, *Standardized Procedures for Requesting Field Approval of Data, Major Alterations, and Repairs*, and AC 120-77, *Maintenance and Alteration Data*, provide guidance on how to repair and alter certificated products.
- FAA Order 8300.16, *Major Repair and Alteration Data Approval*, provides considerations that must be addressed in the development of technical data to substantiate major repairs or alterations.
- FAA Order 8110.37, *Designated Engineering Representative (DER) Handbook*, contains requirements for DER approval of data associated with alterations and repairs.

7.4 **Dynamic Seat Considerations.**

- 7.4.1 Historically, seat certification and subsequent modifications have only involved static structural requirements. In the late 1980s, the FAA issued a series of regulations aimed at improving the survivability of aircraft crashes. These regulations (14 CFR 23.562, 25.562, 27.562 and 29.562; hereafter referred to as “§§ 2X.562”), introduced new dynamic loading criteria and occupant injury criteria.
- 7.4.2 Although §§ 2X.562 are applicable to new type-certificated aircraft, an operational rule change pursuant to 14 CFR 121.311(j) in 2005 significantly accelerated the conversion to dynamic seats. This change requires most new seats on transport aircraft that operate under 14 CFR part 121 and were produced after 2009 to be compliant with § 25.562. Pursuant to § 121.311(j), transport aircraft that were not required to meet § 25.562 as part of the original type design are now required to meet the new § 25.562 requirement for any new aircraft produced.
- 7.4.3 The new §§ 2X.562 requirements took distinct parts of the seats that were typically approved separately, such as TSO seat belts and flotation cushions, and created an integrated seating system evaluation method by levying requirements on the seating system as a whole. Modifications affecting the strength or stiffness of a seat part may affect the seating system, and thus may affect the dynamic loading of the structure and the loads transferred to the occupant. Therefore, a modification to a part either in the direct load path or within striking distance of the occupant will typically require a dynamic assessment. For this reason, any changes to common components such as seatbelts, cushions, IFE system hardware, seat back tray tables, and any other item added or removed from the seat, an assessment must be conducted to verify that the seating system structural integrity and occupant injury performance is maintained.

8 **DISCUSSION.**

8.1 **Approval Considerations.**

8.1.1 Applicable Regulations.

All modifications must be substantiated by test and/or analysis to show that the applicable requirements are met. Each applicant seeking approval to install a modified TSO article in an aircraft must show that the modification meets the applicable aircraft airworthiness requirements as specified in § 21.101 or pursuant to § 43.13. If the applicant is the article manufacturer who holds the TSOA, and is electing to show that the modified article still meets the TSO standards, then 14 CFR 21.619 (a) or (b) applies. If the design change is being made by someone other than the manufacturer holding the TSOA, then the provisions of 21.619 (c) apply.

8.1.2 Installation vs. Article Approval.

A seat or berth article approved as part of an aircraft type design (under a TC, ATC or STC), or parts of a TSO seating system approved under a PMA, are approved for installation in an aircraft with an associated approved interior arrangement. However, an article initially approved under a TSO is approved only for design and production of the article, and a separate approval is required for aircraft installation. Therefore, the use of a TSO approved seat, berth, flotation cushion or restraint does not guarantee a compliant aircraft installation. The installer should be aware that TSO articles may be used on multiple aircraft models with varying certification basis, special conditions, and airworthiness directives; therefore, the data required for installation may differ from model to model. AC 21-50, *Installation of TSOA Articles and LODA Appliances*, provides additional guidance on the acceptable use of TSO data for installation approval. Similarly, alterations and repairs must be substantiated relative to the certification standards for the aircraft; therefore, repairs and alterations based solely on compliance to TSO article requirements are not sufficient.

8.1.3 Major vs. Minor Design Change, Repair, or Alteration.

The determination of a major or minor design change, repair, or alteration varies, and depends on which FAA approval is being affected. That is, changes are classified differently within their specific regulatory basis if the FAA approval is a TSOA, STC, repair, or alteration. A minor change under a TSOA may be a major change for other types of FAA approval and vice versa. Regardless of how a modification is classified, all modifications must be substantiated relative to the applicable requirements.

Note: The FAA has published guidance to assist with classifying major vs. minor changes by the TSO seat manufacturer in policy memorandum PS-AIR100-9/8/2003, *Classification of Design Changes to TSO-C39b, TSO-C127, and TSO-C127a Articles*, dated September 8, 2003.

8.1.4 Design Control.

Pursuant to § 21.601, it is the TSOA/LODA holder's responsibility to control the design relative to the applicable TSO requirements, including all parts, processes, or services procured from an outside source. Similarly, it is the TC/STC holder's responsibility to ensure design changes made to TSO articles continue to meet the applicable airworthiness requirements of the aircraft.

8.1.4.1 It is common for TSO-approved seats to include other TSO-approved articles (such as restraints and flotation cushions) in their design. These TSO articles are in turn incorporated into the approved TSO design of the seating system. For example, a seatbelt that has been modified by the TSO-C22 manufacturer with a minor design change and that continues to meet the requirements of TSO-C22, may or may not continue to be acceptable for use on a TSO-C127 seat and/or for installation in an aircraft. This scenario creates a situation in which there are multiple

levels of FAA approvals and requires a clear understanding for the design change responsibility. In this example, the TSO-C22 seatbelt manufacturer can make a minor design change pursuant to 21.619, as long as the design change meets the requirements for a minor change and continues to meet the requirements of TSO-C22. Although the minor seatbelt design change continues to meet the requirements of TSO-C22, this minor seatbelt design change is also considered a design change to the overall dynamic seating system (refer to § 21.619) given that the seatbelt is a subcomponent to the seat assembly. As a result, this seatbelt design change may affect compliance to the requirements of TSO-C127. Therefore, it is the seat manufacturer's responsibility to control the seat design relative to TSO-C127, including substantiating design changes to supplier subcomponents that also have a TSOA/LODA. Similarly, it is the TC/STC holder's responsibility to ensure the design changes to the seating system still comply with the applicable airworthiness requirements of the aircraft.

- 8.1.4.2 Seats are often integrated with electronic components. Some types of changes do not affect compliance to the TSO MPS, but may affect compliance to the installation airworthiness requirements. Furthermore, other types of changes to the electronic components may affect compliance to the TSO MPS. AC 21-49, *Gaining Approval of Seats with Integrated Electronic Components*, provides guidance for the design control of electronic components in seats.

8.2 **Technical Compliance Considerations.**

This section describes common modifications to seating systems and how those changes may affect continued compliance to the TSO and/or airworthiness requirements. This section is intended to highlight some common examples; however, it does not provide a comprehensive list of considerations that must be addressed for any particular modification.

8.2.1 Structural Tests.

For each seating system previously produced, tested, and certified to the static, dynamic, and/or occupant injury performance standards, the modification's effect on the validity of those tests must be addressed.

- 8.2.1.1 Static Strength. All seating systems must be approved to meet the applicable static strength load factors. Design changes affecting the weight, center of gravity, structural strength, and deformation must be substantiated to the applicable requirements.
- 8.2.1.1.1 Although TSO seating systems require certain minimum required static load factors, load factors for specific installations may exceed the TSO

required loading and therefore need to be substantiated during the installation approval process.

- 8.2.1.1.2 Modifications to the article that are not part of the primary seat structure also need to be assessed for their potential impact on the article meeting the static test requirements. For example, in TSO-C39b (National Aircraft Standard 809, subparagraph 4.3.1, governing the static testing of seats and berths), use of the dimensions specified for the application points of the side loads and up loads requires the seat bottom and back cushion systems be in place and a seat cushion compression of 2 inches. If a cushion is removed for the test, or if a seat cushion compression varies from 2 inches, the location for applying the loads must be changed accordingly. Modification of a cushion system will necessitate an analysis to verify the specifications are met. If the specifications are not met, additional tests or analyses will be required.
- 8.2.1.2 Dynamic Strength and Occupant Injury Protection. Structural modifications that may be acceptable for static seats may not be acceptable for dynamic seats. Dynamic seats require demonstration of the protection of the occupant (such as head injury criterion (HIC), lumbar load, femur load, and restraint loading) subjected to dynamic emergency landing conditions, whereby the structural capability and permanent deformation of the seat is assessed. Paragraphs 8.2.1.2.1, 8.2.1.2.2, and 8.2.1.2.3 of this AC provide some common examples of modifications requiring substantiation and usually require re-testing to verify continued compliance with the dynamic requirements of §§ 2X.562 and/or TSO-C127. As an alternate to testing for compliance to 2X.562, analysis may be used in accordance with the guidance defined in AC 20-146, *Methodology for Dynamic Seat Certification by Analysis for Use in Part 23, 25, 27, and 29 Airplanes and Rotorcraft*.
- 8.2.1.2.1 Seat cushions and covers composed of modified materials (e.g., material changes, manufacturing process changes, additions to or modifications of padded dress covers, or modified buildups of identical materials) require substantiation because of the possible increase on pelvic and lumbar column compressive loading or belt loading under the downward and forward combined loading test, and the potential to cause submarining of the occupant. Changes to the seat reference point (SRP) should also be evaluated for acceptability. In some cases, simplified procedures such as those identified in ANM-115-05-005, *Policy Statement on Acceptance of a Component Test Method to Demonstrate Compliance with §25.562(c)(2) for Replacement Seat Bottom Cushions*, may be used to evaluate changes.
- 8.2.1.2.2 Restraints approved according to TSO-C22 or TSO-C114 are only evaluated relative to static structural requirements and are not independently certified to meet dynamic seating system requirements.

Restraints are substantiated dynamically as part of the dynamic tests for the seating system. Therefore, restraint changes to the webbing material, manufacturing process, stitching, or hardware must be substantiated due to the potential impact to the occupant response and structural loading. For example, changing the weave pattern of identical webbing material may alter the stiffness, strength and dynamic performance of the seating system, which in turn may impact compliance to requirements such as HIC, occupant restraint load limits, and retention of the occupant. In some cases, simplified procedures such as those identified in ANM-115-05-10, *Policy Statement on an Acceptable Method of Compliance with § 25.562 for Replacing Restraint Systems on Forward and Aft Facing Seats*, may be used to evaluate changes.

- 8.2.1.2.3 Modifications to passenger entertainment system components and/or to the meal tray assembly must be substantiated to determine their effect on the dynamic performance of the seating system and whether the modified system still meets the HIC. For example, changes to these parts that alter the stiffness may affect the ability to absorb impact loads during HIC testing and changes to the meal tray latch may affect the ability of the meal tray to remain stowed.

8.2.2 Fire and Flammability Tests.

The modified seating system must be shown to meet the applicable flammability requirements. The TSO flammability requirements vary depending on both the TSO revision and on the classification of the seating system (i.e., transport airplane, normal rotorcraft, commuter, etc.). Furthermore, the flammability requirements vary dependent upon the aircraft airworthiness requirements and the amendment level.

- 8.2.2.1 An example of a common modification for transport aircraft TSO-C127 aircraft seats are modifications to the cushion. Transport aircraft seats typically require an oil burner test on a set of representative production seat cushion test specimens. A change to the seat cushion system design might affect the flammability characteristics of the system. Thus, a new configuration or combination of foam, fire blocking layer, and dress cover will require additional testing and approval to establish compliance with the flammability standards. However, changes to dress covers may be qualified by similarity. AC 25.853-1, *Flammability Requirements for Aircraft Seat Cushions*, provides additional information on the approval of seat cushion dress covers on the basis of similarity. If there is a question as to whether a design change to a cushion system is significant enough to require retesting, the local FAA ACO should be consulted.

- 8.2.2.2 The requirements for general aviation aircraft seats vary depending on the TSO seat classification and aircraft category. For example, per TSO-C127b *Type C - Normal, Utility and Acrobatic* category aircraft seats must have flame resistant properties. FAA AC 23-2A, *Flammability Tests*,

provides a test procedure for flame resistant testing. TSO-C127b also requires *Type C - Commuter* category seats to be self-extinguishing and tested pursuant to 14 CFR part 23, Appendix F, Part I.

- 8.2.2.3 There may be circumstances where the testing required by the TSO for flammability is insufficient for installation compliance. For example, some transport airplane require seats with large non-metallic panels to meet heat release and smoke emission requirements pursuant to 14 CFR, part 25, Appendix F – part IV and part V. Compliance to the heat release and smoke emission is not required under the TSO; therefore, in this scenario the installer of the modified seat must ensure the heat release and smoke emission requirements continue to be met.

8.2.3 Installation and Maintenance Instructions:

- 8.2.3.1 Installation Instructions and Limitations (IIL). Modifications to TSO seating systems may affect the original TSO IIL; therefore, modifications should address the potential impact the modification has to the TSO IIL. It is important to distinguish that the TSO IIL are intended to give instructions to the installer for how to install the TSO article such that it continues to meet the requirements of the TSO. The TSO IIL does not ensure compliance to all of the applicable aircraft installation airworthiness requirements. The TSO IIL document is revised only when the modification is performed by the TSOA/LODA holder.

Note: Some changes to the seating system have no effect on the continued compliance to the applicable TSO standard, but may affect compliance to airworthiness requirements for a particular installation. For example, a change in the recline angle of the seat may affect compliance to emergency exit row requirements.

- 8.2.3.2 Maintenance Instructions. Modifications to TSO seating systems may affect the TSO maintenance instructions, as well as instructions for continued airworthiness (ICA) for the aircraft; therefore, modifications should address any applicable changes to the TSO maintenance instructions and/or ICA.

Note: For example, TSO-C127 requires that maintenance instructions include guidance on the limits of wear and damage permissible to the seat cushions and restraint system webbing material that would warrant replacement. In this case, the maintenance instructions provided by the TSO-C22 or TSO-C114 restraint manufacturer may not be sufficient to adequately address the continued adherence to the TSO-C127 dynamic MPS. Therefore, modifications to the TSO-C127 seating system that include changes to the seatbelt or cushion should also address any required changes to the maintenance instructions and/or ICA.

8.2.4 Marking.

A modified seating system needs to be appropriately marked. A TSOA/LODA seat manufacturer who receives a new TSOA/LODA resulting from a TSO major design change shall mark the seat in accordance with the applicable TSO requirements. Seat modifications accomplished under part 43 or under the applicable airworthiness regulations must mark the modified article with sufficient data to identify that it has been modified. This may be accomplished by providing a reference to a design approval (e.g., STC number), the modifier's name and address, or reference to other documentation describing the modification. If the modifier cannot substantiate that the article continues to meet the applicable TSO(s), the modifier must permanently obliterate the TSO marking while retaining all other identifying data.

Note: For example, a basic seat cushion (not approved to TSO-C72) that is subsequently approved via PMA identity would not invalidate compliance to the seat TSO requirements. Therefore, the TSO marking may remain on the seat along with a modification placard identifying that the PMA was the design approval to modify the cushion, and by virtue the seating system. Conversely, a PMA on a basic seat cushion may be obtained via test reports and computations to show compliance to the airworthiness requirements for the applicable aircraft configuration(s). In this scenario, if the seat TSO requirements continue to be met, then the seat must be marked with a modification placard identifying that the PMA was the design approval to modify the cushion, and by virtue the seating system. If the seat TSO requirements are no longer met, then the seat TSO marking must be obliterated.

9 **CONCLUSION.**

After successfully showing compliance with the applicable regulations, the modifier should seek approval from the FAA pursuant to § 21.8 or § 43.13.

10 **WHERE TO FIND THIS AC.**

10.1 You may find this AC at http://www.faa.gov/regulations_policies/advisory_circulars/.

- 10.2 If you have any suggestions for improvements or changes, you may use the template provided at the end of this AC.



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Appendix A. Advisory Circular Feedback Form

If you find an error in this AC, have recommendations for improving it, or have suggestions for new items/subjects to be added, you may let us know by (1) emailing this form to 9-AWA-AVS-AIR500-Coord@faa.gov or (2) faxing it to the attention of the AIR Directives Management Officer at 202-267-3983.

Subject: _____

Date: _____

Please check all appropriate line items:

An error (procedural or typographical) has been noted in paragraph _____ on page _____.

Recommend paragraph _____ on page _____ be changed as follows:

In a future change to this AC, please cover the following subject:
(Briefly describe what you want added.)

Other comments:

I would like to discuss the above. Please contact me.

Submitted by: _____ Date: _____