SOC ARC TSO Subcommittee Report 2020
TSO Transformation

1 Executive Summary

The innovation and integration of products and articles within the aviation industry is propelling change at even greater speed than prior eras. In order to maintain safety of the national airspace system and provide trusted building blocks for the products within it, Technical Standard Order (TSO) approvals needs to transform. The SOC ARC TSO Subcommittee consisting of the FAA, international certification authorities, and industry members focused on the following objectives to address this challenge:

1) Incorporate the Safety Continuum into TSOs
2) Streamline Non-TSO Functions (NTF)
3) Enhance TSO responsiveness to technical change
4) TSO continued operational safety

To address these objectives the TSO subcommittee has generated 15 recommendations to transform the TSO authorizations (TSOA) and help maintain the leadership of the Unites States in international aviation and aerospace. The recommendations include: restructuring TSO to have a general subpart for incorporating the safety continuum and general requirements; approving NTF through a Title 14 Code of Federal Regulations (CFR) Part 21.8(d) or Special Project approval; establishing data driven updates to TSOs; publication of TSO deviations on FAA website; clarifying data and review expectations between TSOA and product certification applicants; approving new and novel technology at the article level; and allowing continued manufacturing when no safety issue exists for a TSO noncompliance.

These recommendations have broad support of the TSO article industry. A positive response from the FAA is anticipated. The FAA should report on the status of evaluation of the responses to industry on a regular basis.

2 Objective #1: Incorporate the Safety Continuum into TSOs

The TSO process requires strict adherence to the TSO and applicable performance standards. The applicant, regardless of the significance, must request a deviation and provide the equivalent level of safety (ELOS) when deviating from literal compliance to the TSO requirements. The differing levels of safety needs are difficult to implement when required to follow the current TSOs and performance requirements. In general, TSO performance requirements were developed with limited scalability, focusing on transport category aircraft, leaving the small normal category aircraft unable to efficiently use the TSO process. New policies and guidance are needed to encourage safety continuum concepts.

2.1 Related Regulations and Policy

The TSO SOC-ARC Subcommittee recognized the following regulations, policies and guidance applicable to the incorporation of the Safety Continuum into the Technical Standard Order (TSO) design and production approval process:

2.1.1 Code of Federal Regulations

14 CFR Part 21 – Certification Procedures for Products and Articles

14 CFR 21.8 Amdt. 21-92 *Approval of articles*
21.8(b) *Under a TSO*
14 CFR Part 21 Subpart O Amdt. 21-92 *Technical Standard Order Approvals*

14 CFR Part 23 – Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes

23.1301 Amdt. 23-62 *Function and installation*
23.1306 Amdt. 23-61 *Electrical and electronic system lightning protection*
23.1308 Amdt. 23-57 *High-intensity Radiated Fields (HIRF) protection*
23.1309 Amdt. 23-62 *Equipment, systems, and installations*
23.2500 Amdt. 23-64 *Airplane level system requirements*
23.2505 Amdt. 23-64 *Function and installation*
23.2510 Amdt. 23-64 *Equipment, systems, and installations*
23.2515 Amdt. 23-64 *Electrical and electronic system lightning protection*
23.2520 Amdt. 23-64 *High-intensity Radiated Fields (HIRF) protection*

14 CFR Part 25 – Airworthiness Standards: Transport Category Airplanes

25.1301 Amdt. 25-123 *Function and installation*
25.1309 Amdt. 25-123 *Equipment, systems, and installation*
25.1316 Amdt. 25-134 *Electrical and electronic system lightning protection*
25.1317 Amdt. 25-122 *High-intensity Radiated Fields (HIRF) Protection*

14 CFR Part 27 – Airworthiness Standards: Normal Category Rotorcraft

27.1301 *Function and installation*
27.1309 Amdt. 27-46 *Equipment, systems, and installation*
27.1316 Amdt. 27-46 *Electrical and electronic system lightning protection*
27.1317 Amdt. 27-42 *High-intensity Radiated Fields (HIRF) Protection*

14 CFR Part 29 – Airworthiness Standards: Transport Category Rotorcraft

29.1301 *Function and installation*
29.1309 Amdt. 29-53 *Equipment, systems, and installations*
29.1316 Amdt. 29-53 *Electrical and electronic system lightning protection*
29.1317 Amdt. 29-49 *High-intensity Radiated Fields (HIRF) Protection*

2.1.2 FAA Advisory Circulars

AC 23.1309-1E, *System Safety Analysis and Assessment for Part 23 Airplanes*

2.1.3 FAA Policy

PS-ACE-23-10, *HIRF/Lightning Test Levels and Compliance Methods for 14 CFR Part 23 Class I, II, and III Airplanes*

PS-ACE100-2005-10039 *Standardization and Clarification of Application of 14 CFR Part 23, §§ 23.1301 and 23.1309, Regarding Environmental Qualification*

PS-AIR-21.16-02 Rev. 2, *Establishment of Special Conditions for Aircraft Systems Information Security Protection*

PS-AIR-23-09, *System Level Verification of Electronic Equipment (Software and Airborne Electronic Hardware) for 14 CFR Part 23 Airplanes*

PS-ASW-27-15, *Safety Continuum for Part 27 Normal Category Rotorcraft Systems and Equipment*

PS-ASW-27, 29-10, *Policy Statement Concerning Non-Required Safety Enhancing Equipment (NORSEE) in Rotorcraft*

2.2 Options Considered

The TSO Subcommittee evaluated a number of possible options before arriving at the final recommendations.

1) FAA Order 8150.1D revision to allow TSO Deviations when using identified Safety Continuum policy and Guidance (e.g., Order 8150.1D Section 7-4 e., add PS-AIR-23-09 to list of ACO granted deviation approvals).
2) Revise and update specific TSOs that may have applicable Safety Continuum policy, guidance.
3) Create a FAA document with Subpart A – "General & Technical Conditions", determination of document type (TSO, AC, Policy Memo, FAA Order) will be out of scope of recommendation.
4) Create FAA TSOs with Subpart A and Subpart B requirements.

2.3 Recommendation

1) Implementation of Safety Continuum into the TSO process should utilize a standalone FAA document that provides "Subpart A –General" content.

Subpart A would be similar to TSO "Subpart A –General" from the historical FAA Regulation Part 514 and the current EASA ETSO. Because the administrative burden to revise existing TSOs to use the new Subpart A, the type of FAA document should be selected by the FAA. The FAA should take into consideration the need to be efficient to update, while providing the regulatory or policy coverage necessary to be used with the existing TSOs when determining the form and content of Subpart A. As TSOs are issued or revised, it is expected that they would point to the new Subpart A instead of duplicating its contents.

The applicant would use Subpart A identified safety continuum policy/guidance documents without the need for deviations and an ELOS (e.g., use of PS-AIR-23-09 to replace DO-178 for a TSO product intended only for Part 23 Level 1 & 2 airplanes). In general, the document would facilitate the FAA and industry acceptance to use alternate standards and/or technical requirements for current TSOs, without the need to update the TSOs themselves, and without the need for the applicant to establish an ELOS to the TSO deviation. The removal of the requirement to create an ELOS is especially important since most safety continuum tailoring would not be equivalent to the original TSO requirement.

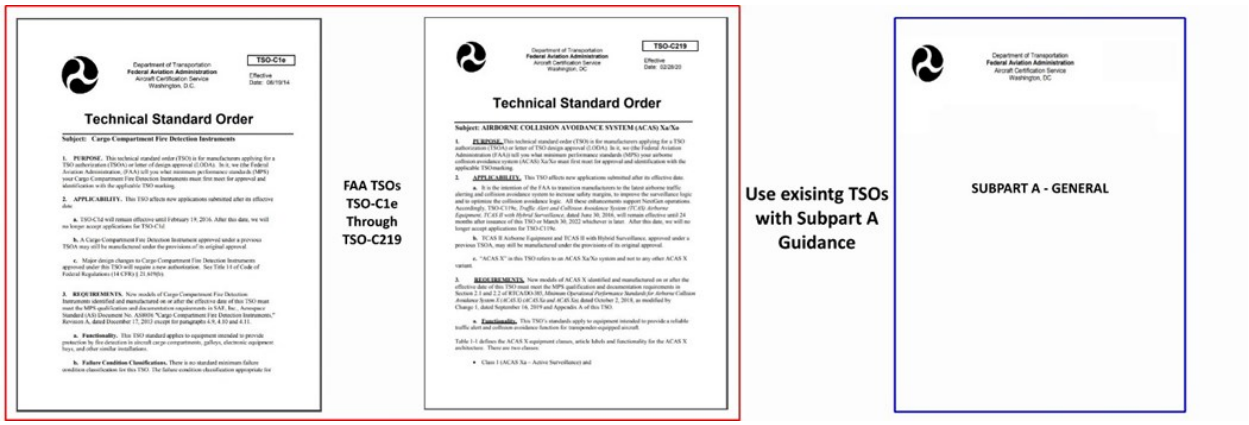

Figure 2-1 TSO Subpart A

The ability to tailor the existing TSO requirements with Subpart A content, where applicable for the TSO project, may be used to replace requirements and standards provided in the current TSO. This tailoring of the TSO may not be used to remove requirements specifically and uniquely defined in the TSO itself. It is recommended that the coordination between the applicant and the FAA utilize a certification plan, such as the example detailed in "The FAA and Industry Guide to Product Certification", Third Edition.

2.3.1 Subpart A

Subpart A covers each technical requirement in common for many TSOs. Applicable requirements are Environmental Standards, Software Standards, Airborne Electronic Hardware Standards, Failure Conditions Classification and Development Assurance Aspects currently included in each individual TSO Requirements section. Included with each technical requirement would provide applicable Safety Continuum policy, guidance that may be used by the applicant.

- Environmental Standards (RTCA/DO-160)
- Software Standards (RTCA/DO-178)
- Airborne Electronic Hardware Standards (RTCA/DO-254)
- Failure Conditions Classification and Development Assurance Aspects

2.3.2 Subpart B

Subpart B references the article specific TSO.

- Subpart B is not required initially, it is recommended to include in the future
- Subpart B would list the current TSOs
- Subpart B does not list the MOPS, each TSO lists the MOPS, and where applicable if Safety Continuum applies then the specific MOPS would be listed in Subpart A.

It is recommended to include a Table in Subpart A to assist the FAA and the applicant in determining the applicability and installation limitations when using the accepted Subpart A safety continuum guidance.

The system will rely on an optional subpart A/B system that will utilize existing TSOs as the basis for subpart B. Initially any TSO published before the issuance of subpart A is eligible to be used as a subpart B. The sections of current TSOs that are not addressed by Subpart A will become subpart B. Once new TSOs are developed/revised it will be in a format of a subpart B that directly references subpart A.

Table 2-1 Applicable Safety Continuum Policy Guidance by Installation

	Part 23				Part 27					Part 25		Part 29	
Policy/Guidance	**I / 1**	**II / 2**	**III / 3**	**IV / 4**	**I**	**II**	**III**	**IV**	**Cat A**	**19 pax**	**>19 pax**	**Cat B**	**Cat A**
AC 23.1309-1E	*A*	*A*	*A*	*A*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
PS-ACE-23-10	*A*	*A*	*A*	*E*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
PS-ACE100-2005-10039	*A*	*A*	*A*	*A*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
PS-AIR-21.16-02	*E*	*E*	*E*	*A*	*E*	*E*	*E*	*A*	*A*	*A*	*A*	*A*	*A*
PS-AIR-23-09	*A*	*A*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
PS-ASW-27-15	*NA*	*NA*	*NA*	*NA*	*A*	*A*	*A*	*A*	*NA*	*NA*	*NA*	*NA*	*NA*
PS-ASW-27, 29-10	*NA*	*NA*	*NA*	*NA*	*A*	*A*	*A*	*A*	*A*	*NA*	*NA*	*A*	*A*
Legend:													
A – Policy/Guidance Applicable to identified Model/Class													
E – Policy/Guidance Exempts the identified Model/Class													
NA – Policy/Guidance No Applicable													

2.4 Expected Outcomes

The expected outcomes of this recommendation is:

1) Promotes implementation of safety continuum
2) Enables scalable requirements that better align with intended application
3) Enhances TSO responsiveness to technical change
4) Reduces deviations

Table 2-2. Objective #1 Recommendation Analysis

OBJECTIVE #1: Incorporate the Safety Continuum into the TSO Process and TSOs					
Recommendation: Implementation of Safety Continuum into the TSO process would utilize a standalone FAA document that provides "Subpart A –General" content. The applicant would use Subpart A identified safety continuum policy/guidance documents without the need for deviations and an ELOS to tailor the current TSO.					
Table Legend:	*Adequately Covers*		*Requires Additional Coverage*		*Not Applicable*
Tasks	**Recommendation(s) provided works inside the TSO Process**	**Recommendation(s) utilize "Tailoring" based on Part 23/25/27/29, Class & Level**	**Recommendation(s) utilize "Tailoring" based on Operational Requirements (such as Part 91 and 135)**	**Recommendation(s) identify and use existing Policy, Guidance "Ready to Use"**	**Recommendation(s) identify and address existing "Holes" in Policy, Guidance**
#1 Recommend how we should reflect the safety continuum in the TSO	*Efficiently pulls existing guidance & policy into the TSO Requirements using the Subpart A tailoring.*	*In the Subpart A, Part 23/25/27/29 installation requirements can be provided to assist the TSO applicant. See example Table 1.*	*In the Subpart A polices or guidance related to Part 91 and 135 operational requirements may also be included.*	*Efficiently pulls existing guidance & policy into the TSO Requirements using the Subpart A tailoring.*	*The allowance to tailor the existing TSO with Subpart A identified policy/guidance without the need for ELOS addresses the Hole.*
#2 Identify standards which do not reflect the safety continuum, and recommend alternatives	*Applicant tailors the current TSO with existing safety continuum policy and guidance. Updates to existing standards is not required.*	*The recommendation provides the safety continuum guidance/policy, and is portable to any existing standard. Updates to existing standards is not required.*	*In the Subpart A polices or guidance related to Part 91 and 135 operational requirements may also be included. Updates to Standards not required.*	*Applicant tailors the current TSO with existing safety continuum policy and guidance. Updates to existing standards is not required.*	*Not Applicable*
#3 Recommend how the FAA should incorporate PS-AIR-23-09 into the TSO program	*Add into the tailoring of Subpart A – for Software.*	*Add into the tailoring of Subpart A – for Software, and utilization of Table 1.*	*Not Applicable*	*Add into the tailoring of Subpart A – for Software, and utilization of Table 1.*	*The allowance to tailor the existing TSO with Subpart A accepted PS-AIR-23-09, without an ELOS addresses "holes".*
#4 Identify alternatives for depicting applicability for installation (e.g. Part 23 vs Part 25)	*In the Subpart A, Part 23/25/27/29 installation requirements can be provided to assist the TSO applicant. See example Table 1.*	*In the Subpart A, Part 23/25/27/29 installation requirements can be provided to assist the TSO applicant. See example Table 1.*	*In the Subpart A, Operational Requirements can be provided in Table 1; Currently only 23/25/27/29 shown.*	*In the Subpart A, requirements can be provided showing "Ready to Use" policy and guidance. See example Table 1.*	*Not Applicable*

3 Objective #2: Streamline Non-TSO Function

Non-TSO Functions (NTFs) are very common in more complex articles. They are standalone functions that do not support the existing TSO functionality. Currently these are accepted by the FAA as part of the TSOA as non-interfering with the TSO functions the article carries. While NTFs are typically developed, by TSO holders, under the same FAA approved quality system and using the same design assurance process used for TSO function, there is no recognition of this, which limits the ability of the installer to take credit for the data generated for NTFs under the TSO process. In addition, because the NTFs are not developed as an industry standard there is a need to provide additional compliance data that covers aircraft level certification. Finally, there needs to be FAA approval of the design and production of the Non-TSO Function (rather than only acceptance of the NTFs as integrated into the TSO article). This includes modification of aircraft certification guidance that informs TC/STC applicants that these approvals can be used for credit during aircraft certifications.

3.1 Related Regulations and Policy

The TSO SOC-ARC Subcommittee recognized the following regulations, policies and guidance applicable to streamlining NTF:

3.1.1 Code of Federal Regulations

14 CFR Part 21 – Certification Procedures for Products and Articles

- 14 CFR 21.8 Amdt. 21-92 *Approval of articles*
  - 21.8(b) *Under a TSO*
  - *21.8(d)* *In any other manner approved by the FAA*
- 14 CFR Part 21 Subpart O Amdt. 21-92 *Technical Standard Order Approvals*
- 14 CFR 21.9 Amdt. 21-100 *Replacement and Modification Articles*

3.1.2 FAA Advisory Circulars

AC 21-46A, *Technical Standard Order Program*

AC 21-50, *Installation of TSOA Articles and LODA Applications*

AC 23-22, *Guidance for Approved Model List (AML) Supplemental Type Certificated (STC) Approval of Part 23 Airplane Avionics Installations*

3.1.3 FAA Policy

PS-ASW-27, 29-10, *Policy Statement Concerning Non-Required Safety Enhancing Equipment (NORSEE) in Rotorcraft*

PS-AIR-21.8-1602, *Approval of Non-Required Safety Enhancing Equipment (NORSEE)*

3.1.4 FAA Orders & Notices

Order 8110.4C Change 3, *Type Certification*

Order 8150.1D, *Technical Standard Order Program*

Order 8110.115, *Certification Project Initiation and Certification Project Notification*

3.2 Options Considered

The TSO Subcommittee evaluated a number of possible options before arriving at the final recommendations.

Table 3-1. Objective #2 Options Considered

Approach	***Pro's***	***Con's***	***Included in Recommendation?***
NORSEE Update	1) Simple modification to an existing policy.	1) The name implies non-required so may not be possible to overcome interface required equipage. Will struggle with that going forward.	No
Generic PMA	1) PMA is well understood by all.	1) The portability idea leveraged from AC 23-22 may not be understood well. PMA and its portability or lack thereof is established/entrenched. 2) Inability to clearly indicate design approval.	No
New 21.8(d) method	1) Can establish the ability to interface required equipage. 2) Approval method supported by the Fars. 3) Could use Order 8110.4C change 3 with minor tweaks. 4) Creates a document that looks very similar to a TSOA. Helps with acceptance. 5) Can use open brackets ( ) for minor change. 6) Accompanied by data that supports aircraft certification. Helps fill the gap for safety aspects.	1) Must overcome lack of understanding and acceptance by everyone. 2) Foreign Acceptance is not established. 3) Requires a TSO for the article.	Yes

Approach	***Pro's***	***Con's***	***Included in Recommendation?***
Special Project	1) Already available. 2) Foreign Acceptance is already established. 3) 8110-3 Statement of Compliance – also very acceptable. 4) Can likely have an agreement with the ACO to make minor changes and have open bracket part number. 5) Need to add language to the CPN Order to help in the understanding that this project can be used at the article level.	1) Must overcome lack of understanding and acceptance by everyone. 2) Requires a TSO for the article.	Yes
Generic TSO		1) Can't be done. The term "standard" is in TSO so unable to use company proprietary MPS	No

3.3 Recommendations

1) Resurrect 8110.4C Change 3 for 14 CFR 21.8(d) approval of NTFs. Ensure language is acceptable to the FAA and Industry.
2) For Non-TSO Functions, the function needs to be treated in a similar method as TSO with new language in AC 21-50. Supported by data from the 14 CFR 21.8(d) or Special Project. AC 21-50 should be expanded to cover this and should be part of the Objective #3 recommendation.
3) Add language to the Certification Project Notification to inform that approved data can be generated at the article level.
4) Incorporate Non-TSO Function examples into the guidance provided by this recommendation. See the following table.

Table 3-2. Non-TSO Function Examples

Item	***Classification of the Function Provided by the Item***	***Explanation***	***Article Type***
Seat Adjustable Features (such as recline, leg rests, and head rests)	TSO Function	The seat TSO discusses adjustable features in seats and the requirement to be able to return the seat to the taxi, takeoff, and landing position.	Seat
Airbags	TSO Function for dynamic seats (TSO-C127)	One of the primary functions of the dynamic seat TSO is to protect the occupant (i.e., head injury criteria (HIC) and lumbar load). For example, airbags can reduce head path or create a protective barrier to soften head strikes. Airbags are one means of achieving acceptable HIC values for TSO compliance. Airbags on static seats are considered a non-TSO function since the seat is evaluated statically where the airbag will not activate.	Seat
	Non-TSO function for static seats (TSO-C39)		Seat
Passenger Convenience Items (such as reading lamps, in-flight entertainment (IFE), and heaters)	Non-TSO Function	The intended function of these types of items does not directly relate to the seat TSO functionality.	Seat
Medical Equipment (such as equipment used for emergency medical operations)	Non-TSO Function	The intended function of these types of items does not directly relate to the seat TSO functionality.	Seat
Additional Data Collection (such as decompression loading, enhanced flammability, or environmental via DO-160)	Neither a TSO Function nor a Non-TSO Function	Substantiation data collection is not considered a function and therefore is not considered a TSO or non-TSO function. Substantiation data required to show compliance to the TSO requirements must be submitted to the FAA. Substantiation data that is not needed to show compliance to the TSO MPS is evaluated separately during the aircraft installation approval.	Seat, Avionics
CAS	Non-TSO Function	No applicable TSO. Does not support or affect other TSOs or NTFs. Can technically be implemented outside the TSO article.	Avionics
Synthetic Vision	Non-TSO Function	No applicable TSO. Does not support or affect other TSOs or NTFs. Can technically be implemented outside the TSO article.	Avionics

Item	***Classification of the Function Provided by the Item***	***Explanation***	***Article Type***
Controller Pilot Data Link Communications (CPDLC)	Non-TSO Function	No applicable TSO. Does not support or affect other TSOs or NTFs. Can technically be implemented outside the TSO article.	Avionics
Aircraft Addressing and Reporting Communications System (ACARS)	Non-TSO Function	No applicable TSO. Does not support or affect other TSOs or NTFs. Can technically be implemented outside the TSO article.	Avionics
Future Air Navigation System (FANS) 1/A(+)	Non-TSO Function	No applicable TSO. Does not support or affect other TSOs or NTFs. Can technically be implemented outside the TSO article.	Avionics
COM Flip Flop	TSO Function	Enhancement to TSO-C169	Avionics
NAV Identification	TSO Function	Enhancement to TSO-C40 and TSO-C36	Avionics
3D Audio	TSO Function	Enhancement to TSO-C139	Avionics
User Defined Holding Pattern	TSO Function	Enhancement to TSO-C146	Avionics
Vertical Profiles	TSO Function	Enhancement to TSO-C165	Avionics

3.4 Expected Outcomes

The expected outcomes of these recommendations are:

1) Non-TSO Functions gain Design and Production Approval as part of a TSO article.
2) Non-TSO Functions are evaluated under the TSO article and at the aircraft level and create compliance data.
3) Non-TSO Function compliance data has reuse/portability for Aircraft Certification.
4) Changes to Non-TSO Functions are evaluated at the article level in the same manner as TSO with allowed minor changes.
5) Non-TSO Function approval has Foreign Certification acceptance.

4 Objective #3 Enhancing TSO Responsiveness to Technical Change

The current TSO structure is slow in responding to technical changes. The current structure has no means (other than existing TSO revision process) to incorporate approved deviations, update overarching requirements, or implement small changes to the standards efficiently and in a timely manner. There are multiple issues preventing TSOs from being responsive. Each of the investigated issues are listed later along with specific recommendations to address the concern.

4.1 Related Regulations and Policy

The TSO SOC-ARC Subcommittee recognized the following regulations, policies and guidance applicable to enhancing TSO responsiveness to technical change:

4.1.1 Code of Federal Regulations

14 CFR Part 21 – Certification Procedures for Products and Articles

14 CFR 21.8 Amdt. 21-92 *Approval of articles*

21.8(b) *Under a TSO*

21.8(d) In any other manner approved by the FAA

14 CFR Part 21 Subpart O Amdt. 21-92 *Technical Standard Order Approvals*

14 CFR 21.9 Amdt. 21-100 *Replacement and Modification Articles*

4.1.2 FAA Advisory Circulars

AC 21-46A, *Technical Standard Order Program*

AC 21-50, *Installation of TSOA Articles and LODA Applications*

AC 23-22, *Guidance for Approved Model List (AML) Supplemental Type Certificated (STC) Approval of Part 23 Airplane Avionics Installations*

4.1.3 FAA Orders & Notices

Order 8110.4C Change 3, *Type Certification*

Order 8150.1D, *Technical Standard Order Program*

4.1.4 FAA Guidance

The FAA and Industry Guide to Product Certification, 3rd Edition

4.2 Issues & Recommendations

Seven issues were identified that contribute towards delays in TSO responsiveness to change. This section identifies each issue and provides corresponding recommendations.

4.2.1.1 Issue 1

Currently, there is no internal time requirements at the FAA to trigger TSO revisions after approved deviations are compiled for a specific TSO.

4.2.1.2 Recommendation

1) Develop a FAA process to review TSOs that have approved deviations. The process should specify both metrics for the number of deviations, over a period of time, and a time period for evaluation. For example 4 similar deviations over 5 years with an evaluation no later than 6 months after the 4th deviation.

It is recommended for FAA to review the TSOs with high number of deviations and review common deviations applicable to multiple TSOs (TSOs released or revised within last 10 years) to verify need for revision. Please refer to Figure 4-1 and the embedded Excel workbook, *TSO Deviation Report.*

TSO Deviations Report.xlsx

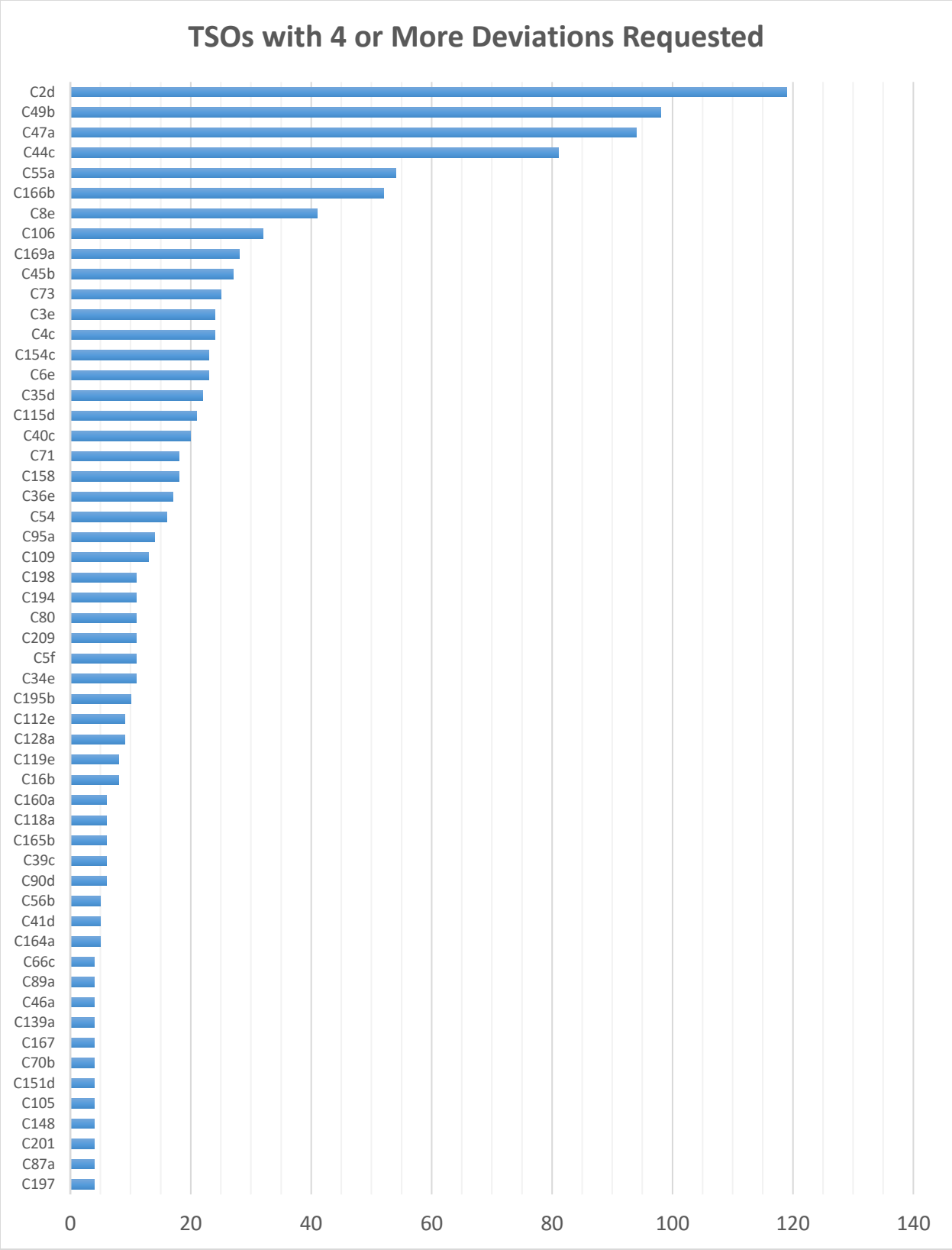

Figure 4-1. Number of TSO deviations requested in last 10 years

4.2.1.3 Issue 2

How to publish and reuse deviations without revising the TSO?

4.2.1.4 Recommendations

1) Provide delegation to TSOA approving ACOs for similar deviations to reduce deviation approval cycle time without revising the FAA Order.
2) Create a public deviation process for TSO. The following recommendations are in order of preference:
   a) Develop a process to create TSO addendum (without deploying full TSO revision process, may be using administrative change process) listing approved deviations (that do not have any proprietary ELOS or IP infringement).
   b) Develop a process to revise TSO (without deploying full TSO revision process) to incorporate approved deviations (that do not have any proprietary ELOS or IP infringement).
   c) Develop a process (similar to EASA) to use public comment process for the first deviation approval then revise TSO incorporating similar deviations without deploying full TSO revision process.

In order to expedite industry relief, an interim FAA policy memo allowing usage of similar deviations without further FAA review and approval should be published.

4.2.1.5 Issue 3

How to avoid separate approvals from FAA for same deviations submitted repeatedly for multiple programs?

4.2.1.6 Recommendations

1) FAA to develop a process to address ability for applicants to reuse previously granted deviations without resubmittal.

Until a process is developed, the FAA should publish a policy memo allowing reuse of previously granted deviations without resubmittal. This will help the industry because policy memo publication should take lesser time than developing a new process by FAA. Additionally, a compliance assurance system should include a process for TSOA applicants and allow reuse of previously approved deviations.

4.2.1.7 Issue 4

Regular overarching requirements updates need to be incorporated into all TSOs.

4.2.1.8 Recommendation

1) Follow recommendations for incorporating safety continuum into TSO in section 2.3.

4.2.1.9 Issue 5

Clarify TSO furnished data submission requirements to installer.

4.2.1.10 Recommendations

1) FAA to issue a policy memo (followed by revision of AC 21-50) emphasizing the following topics:
   a) Memo on behalf of FAA aircraft certification regarding:
      i) Robustness of TSO process and qualifications.
      ii) Data approved under TSO is FAA approved data and could be used for installation compliance (without additional review of TSO data by installer) when airworthiness and TSO requirements are identical.

b) Airworthiness and TSO requirement equivalency may be established at the beginning of a TSO application and may be included in PSCP (Project Specific Certification Plan for TSOA) with upfront agreement between installer and TSO applicant.
c) Utilization of TSOA Installation Manual (IM) and Installation Instructions and Limitations (IIL) (and/or Interface Definition) to extract required information for airworthiness compliance by installer.

2) FAA to revise guidance to emphasize 14 CFR § 21.601(2) that TSO is a design and production approval of an article and clarify to the use of TSO data in installation approvals. Specific areas of change include:
   a) AC 21-50 to be revised addressing topics in item (a) above. Please see Appendix A and Appendix B for proposed changes. Proposed changes are focused on risk reduction to eliminate compliance finding delays during the installation certification process.
   b) Refer to FAA policy memo or revised AC 21-50 in TSO Furnished Data section of the TSO.
   c) Update The FAA and industry guide to product certification (CPG) based on the above recommendations.
   d) Review AC 21-46 to identify need for revision based on above and revise as necessary.

4.2.1.11 Issues 6

Address approval of new and novel technology for TSO articles (e.g. issue papers, project specific memo, special project, specific means of compliance, or something similar.)

4.2.1.12 Recommendations

1) Recommend FAA to open Special Project to approve new and novel design/feature/technology and utilize FAA Form 8110-3 (from applicant) with proper delegation. Revision of existing FAA Deviation Memo AIR600-18-6C0-DM106, Revision 1 (deviation to FAA Orders 8110.4C, 8110.112A and 8100.16) is needed to include approval of new and novel design/feature/technology at the TSO article level rather than at the TC/STC level.

4.2.1.13 Issues 7

Small changes that do not modify the intent of the TSO, quick FAA administrative change or amendment / addendum process is currently NOT available. Current FAA TSO or Order revision process do not have the flexibility to improve the cycle time because of local ACO review, legal review, public comment, etc.

4.2.1.14 Recommendations

1) In order to make the TSO revision process efficient and time sensitive, develop separate criteria for different TSO revision scenarios. As for example:
   a) Administrative changes (e.g., editorial, changes that do not have any impact on technical, legal or proprietary topics, etc.).
   b) Changes to upgrade a TSO based on updated FAA and Industry consensus standards. As for example, if referenced industry standard in a TSO is revised (based on agreement among FAA & industry), the TSO revision process should be expedited without deploying existing TSO revision process.
   c) After the first deviation is approved (without any impact on technical/legal/IP topics) add it to the TSO as an addendum, or other method, to allow all TSO applicants to utilize the approved deviation without applying for deviation approval.

4.3 Expected Outcomes

The expected outcomes of these recommendations are:

1) New and/or revised FAA documents (e.g., process, order, memo, advisory circular, etc.) to simplify and streamline
   a) Timely revision of TSOs due to multiple similar deviations, reuse of deviations, and incorporation of updates and small changes, etc.
   b) Clarification on TSO furnished data and proper utilization of TSO approved data to show compliance with airworthiness requirements.
   c) Approval of new/novel designs at the TSO article level.

5 Objective #4: TSO Continued Operational Safety

The current TSO marking regulation (§ 45.10) does not allow for continued production and delivery when TSO equipment has a design deficiency [TSO noncompliance] that does not result in an unsafe condition. This is inconsistent with TC/STC regulations that allow for continued production and delivery with an FAA-accepted corrective action plan.

The current regulation 14 CFR § 45.10 has the following potential (and realized) negative impacts:

1) Currently, stopping shipments of TSO articles due to discovered TSO non-compliances results in considerably disruptive and costly interruptions, with unplanned development/certification efforts that impact both the TSO holder, the TC/STC holder(s), and Operators.
2) While this is likely to be appropriate in the event that the noncompliance also creates a safety of flight concern, it is less than appropriate in many cases where a noncompliance has no impact on safety of flight and, in some cases, may have no functional impact at the aircraft level at all.
3) Stopping shipment typically results in:
   a) delays in the deployment of a safe technology or a safety improvement into the field,
   b) delayed delivery of aircraft to operators which can impact fleet schedules and cause disruptions to flight operations,
   c) unplanned emergency releases (to allow resumption of shipping) that disrupt planned schedules for improvements that enhance safety,
   d) the prioritization of often less meaningful fixes over more substantive functional updates,
   e) unanticipated/unfunded, non-value-added certification programs, of particular concern during times of economic hardship.

5.1 Related Regulations and Policy

The TSO SOC-ARC Subcommittee recognized the following regulations, policies and guidance applicable to streamlining NTF:

5.1.1 Code of Federal Regulations

14 CFR Part 21 – Certification Procedures for Products and Articles

14 CFR 21.616 Amdt. 21-92 *Responsibility of Holder*

14 CFR Part 45 – Identification and Registration Marking

14 CFR 45.10 Amdt. 45-26 *Marking*

5.2 Recommendation

1) Amend 14 CFR 45.10 and 14 CFR 21.616 to allow for continued production and delivery in accordance with an FAA-accepted corrective action plan for design deficiencies that constitute TSO noncompliance and do not result in an unsafe condition. This would be consistent with how similar TC/STC design approval deficiencies are addressed. See recommended amendments below.

§45.10 Marking.

No person may mark a product or article in accordance with this subpart unless—

(a) That person produced the product or article —
  (1) Under part 21, subpart F, G, K, or O of this chapter; or
  (2) For export to the United States under the provisions of an agreement between the United States and another country or jurisdiction for the acceptance of products and articles; and
(b) That product or article conforms to its approved design, and is in a condition for safe operation~~; and, for a TSO article; that TSO article meets the applicable performance standards.~~

§21.616 Responsibility of holder.

Each holder of a TSO authorization must—

….

(c) Ensure that each manufactured article conforms to its approved design, is in a condition for safe operation, and meets the applicable TSO;

…

(i) Notwithstanding paragraph (c) of this section and §21.3, a holder of a TSO Authorization may, upon discovery of a discrepancy that results in the TSO article not meeting the applicable performance standards, continue to manufacture a TSO article after the following actions have been accomplished:
  (1) The TSO Authorization holder reports the discrepancy to the FAA;
  (2) The FAA determines in writing that the discrepancy does not result in an unsafe condition;
  (3) The TSO Authorization holder submits a corrective action plan to the FAA; and
  (4) The FAA accepts the TSO Authorization holder's corrective action plan.
(j) Subsequent to FAA acceptance of the TSO Authorization holder's corrective action plan per paragraph (i)(4) of this section, the TSO holder may continue manufacturing the TSO article while the following conditions are true:
  (1) The TSO Authorization holder successfully proceeds with implementation of the corrective action plan; and
  (2) The FAA continues to concur that the TSO Authorization holder is making acceptable progress in its implementation of the corrective action plan.

5.3 Expected Outcomes

The expected outcomes of this recommendation is:

1) Modifications to the regulations 14 CFR 45.10 and 14 CFR 21.616 resulting in elimination or reduction of the safety and financial risks for the installation and continued airworthiness of TSO articles.

This will allow TSO holders the ability to continue production and delivery when TSO equipment has a design deficiency [TSO noncompliance] that does not result in an unsafe condition, given timely coordination with FAA to develop and incorporate a corrective action plan.

Appendix A. Propose Changes for AC 21-50

The following table contains a list of inseparable edits recommended for AC 21-50.

Appendix Table A-1. Proposed Edits for AC 21-50

Section	***Current Verbiage***	***Proposed Verbiage***	***Reason***
Section 1.a	Does not exist.	Propose to include after 1st paragraph: The guidance in this AC describing the use of TSOA data by an applicant's compliance showing to the airworthiness requirements are also applicable to articles approved by the FAA using other manners per 14 CFR 21.8(d).	Expand guidance to apply to other methods of article approval. Use of 14 CFR 21.8(d) part of TSO SOC-ARC strategy for Non-Required Safety Enhancing Equipment (NORSEE)
Section 4.a	**Background:** The amount of substantiation and descriptive data an applicant needs depends on several considerations. A TSO defines the minimum performance standard (MPS) for an article. The data developed by a TSOA holder is required to address the MPS defined by the TSO, and might not address all of the applicable airworthiness requirements for its installation in the type design of a product. Therefore, the TSO marking on a TSO article does not indicate that the applicable airworthiness requirements of the product on which it is being installed have been addressed.	**Background:** The amount of substantiation and descriptive data an applicant needs depends on several considerations. A TSO defines the minimum performance standard (MPS) and furnished data for an article. The data developed by a TSOA holder ~~is required to address the MPS defined by the TSO, and~~ might not address all of the applicable airworthiness requirements for its installation in the type design of a product. Therefore, the TSO marking on a TSO article does not necessarily indicate that the applicable airworthiness requirements of the product on which it is being installed have been addressed.	Verbiage modified to emphasize furnished data has a broader use in addition to addressing the TSO MPS.

Section	*Current Verbiage*	*Proposed Verbiage*	*Reason*
Section 4.b	**What an applicant must do:** An applicant must have the descriptive and substantiation data necessary to show that the product on which the TSO article is being installed meets the applicable airworthiness regulations. An applicant may use data approved by the FAA under a TSOA to support showing compliance to the airworthiness requirements applicable to the category of the product on which the TSO article is being installed. If an installer relies on data approved under the TSO approval, they must:	**What an applicant must do:** An applicant must have the descriptive and substantiation data necessary to show that the product on which the TSO article is being installed meets the applicable airworthiness regulations. Applicant may establish equivalency of TSO and airworthiness requirements together with the TSOA applicant (at the beginning of TSOA process) to ensure TSO requirements adequately address the airworthiness requirements. Please refer to Appendix A for detail steps that may be followed from beginning of TSOA process till TSO furnished data is evaluated for airworthiness by applicant. An applicant may use data approved by the FAA under a TSOA to support showing compliance to the airworthiness requirements applicable to the category of the product on which the TSO article is being installed. If an installer relies on data approved under the TSO approval, they must:	Emphasize upfront early coordination between the TSO article installer and TSOA applicant to maximize use of TSO process and reduce risk of discovering gaps in the applicant's showing of compliance after the TSOA is granted.

Section	*Current Verbiage*	*Proposed Verbiage*	*Reason*
Section 4.b (2)	Identify the data approved by the FAA under the TSOA that is applicable to the airworthiness requirements (see section 5 for the types of data you may need to identify). The data, required to be supplied by the TSOA holder under their TSO, has been approved under the TSOA. To the extent that the FAA-approved TSOA data aligns with the applicable airworthiness requirements, the data needs no further substantiation or evaluation by the FAA.	Identify the data approved by the FAA under the TSOA that is applicable to the airworthiness requirements (see section 5 for the types of data you may need to identify). The ~~data, required to be~~ furnished data and the associated methods employed in the generation of such data needs no further substantiation or evaluation by the applicant, as the data supplied by the TSOA holder under their TSO, has been approved under the TSOA. ~~To the extent that the FAA-approved TSOA data aligns with the applicable airworthiness requirements, the data needs no further substantiation or evaluation by the FAA.~~	Verbiage in (b)(3) and the last sentence in (b)(2) were stating the same idea, therefore deleted (b)(3) and added wording to (b)(2). Added data generation methods in addition to the furnished data as not requiring further substantiation by the applicant.
Section 5 Title	**Identifying the Data Approved by the FAA for the TSO article.**	Application of TSO Data to Airworthiness Requirements.	Title modified to better reflect content of section.

Section	***Current Verbiage***	***Proposed Verbiage***	***Reason***
Section 5 1st Paragraph	Identifying the FAA-approved data relative to the TSO MPS will allow an applicant to determine the level of performance provided by the TSO article. To do this, the applicant must thoroughly review and understand the documentation associated with the TSO approval. Look for the following types of data:	The applicant must understand the alignment of the applicable airworthiness requirements and the TSO MPS and furnished data ~~Identifying the FAA-approved data relative to the TSO MPS will allow an applicant~~ to determine the level of performance provided by the TSO article. This alignment between the TSOA and the issuance or change approval to type design is a fundamental part of the application of TSOA data, and should be a key aspect when an applicant begins planning and documenting a certification project. ~~To do this, the applicant must thoroughly review and understand the documentation associated with the TSO approval.~~ Look for the following types of data:	Provide additional details as to what "thoroughly review and understand the documentation associated with the TSO approval". Focus verbiage on applicant's responsibility to understand alignment between the applicable airworthiness requirements and TSO MPS / expected furnished data.

Section	*Current Verbiage*	*Proposed Verbiage*	*Reason*
Section 5.a	**Minimum performance standards of the TSO:** The FAA approves an article relative to the MPS in a specific version of a TSO. Some articles are approved to multiple TSOs. Articles may also be approved by a foreign authority to a standard published by that authority which may have a different MPS than the comparable FAA TSO. The TSOA holder is required to provide the applicant with certain data, typically called FURNISHED DATA in a TSO. Data provided with the TSO article may specify the manner, the environment, or conditions of the installation that are needed to assure compliance with the TSO MPS. The data relative to the TSO MPS has been approved by the FAA and may be used to show compliance with any related aspects of the applicable airworthiness requirements.	**Minimum performance standards of the TSO:** The FAA approves an article relative to the MPS in a specific version of a TSO. Some articles are approved to multiple TSOs. Articles may also be approved by a foreign authority to a standard published by that authority which may have a different MPS than the comparable FAA TSO. ~~The TSOA holder is required to provide the applicant with certain data, typically called FURNISHED DATA in a TSO. Data provided with the TSO article may specify the manner, the environment, or conditions of the installation that are needed to assure compliance with the TSO MPS. The data relative to the TSO MPS has been approved by the FAA and may be used to show compliance with any related aspects of the applicable airworthiness requirements.~~	Verbiage modified to emphasize furnished data has a broader use in addition to addressing the TSO MPS. Create new Section for furnished data (5.b.) using much of the verbiage from 5.a. Added non-TSO function performance as part of furnished data.

Section	*Current Verbiage*	*Proposed Verbiage*	*Reason*
Section 5.b	**Deviations to the TSO:** TSO articles may be approved with deviations, as long as the TSO manufacturer has shown that the article provides an equivalent level of safety to the TSO MPS. The approval of a deviation may include installation or operational conditions that are necessary to ensure the equivalent level of safety. These conditions are reflected in installation or operational instructions. An applicant must consider any TSO deviations and related instructions when establishing compliance to the applicable airworthiness requirements.	Added new section 5.b – Furnished data. Renumbered existing section 5.b to 5.c. Section 5.b: **Furnished data:** The TSOA holder is required to provide the applicant with certain data specified in a TSO. Data provided with the TSO article may specify the manner, the environment, or conditions of the installation that are needed to assure compliance with the TSO MPS or proper performance of non-TSO functions. The data has been approved by the FAA, under TSO, and may be used to show compliance with any related aspects of the applicable airworthiness requirements.	See reason above for Section 5.a.

Section	*Current Verbiage*	*Proposed Verbiage*	*Reason*
Section 7.a	**Changes to the article by the TSOA holder:** This paragraph provides guidance on evaluating changes in type design as they relate to changes in the TSO article. The TSOA holder may make modifications to the design of the article as a minor change under their TSOA. These changes may affect the design approval holder' s compliance to the applicable airworthiness requirements, and might only be indicated by changes to version and not the base part number (for example, a software version; change in the number in brackets; or change in the dash number). The airworthiness approval holder is responsible for evaluating minor changes to TSO articles to determine if the change affects compliance to the airworthiness requirements.	**Changes to the article by the TSOA holder:** This paragraph provides guidance on evaluating changes in type design as they relate to changes in the TSO article. The TSOA holder may make modifications to the design of the article as a minor change under their TSOA. These changes may affect the ~~design approval holder's~~ applicant's compliance to the applicable airworthiness requirements, and might only be indicated by changes to version and not the base part number (for example, a software version; change in the number in brackets; or change in the dash number). The ~~airworthiness approval holder~~ applicant is responsible for defining a change notification process with the TSOA holder to facilitate change management oversight of the TSO article installation and continuation of compliance to airworthiness requirements. This process should define what changes the TSOA holder is required to notify the applicant. The notification criteria may rely on the TSOA holder's minor change process to assess whether the TSO MPS is still met and the TSOA furnished data remain unchanged. The applicant may choose to not be notified of minor changes approved under TSOA holder's minor change process if the minor change does not impact applicant's compliance showing to airworthiness requirements as defined by the criteria in the applicant's change notification process. ~~evaluating minor changes to TSO articles to determine if the change affects compliance to the airworthiness requirements.~~	Verbiage changed for consistency of terms. In Section 1.a. "those seeking a design approval will be referred to as applicants." Emphasize establishment of a change notification process between the TSO article installer and TSOA applicant. Provide additional guidance of what the applicant's responsibility is for evaluating minor changes to a TSO article, including the applicant's option to rely on the TSOA minor change process.

Section	*Current Verbiage*	*Proposed Verbiage*	*Reason*
Section 7.a	The design approval holder should maintain a list of all applicable TSO article versions, for which airworthiness compliance has been established, and provide this data in the installation data for the installer to ensure the correct TSO article version is being installed.	Please clarify the intent and purpose of this sentence. If this sentence is intended to emphasize on change notification from TSOA holder to the applicant to ensure compliance with airworthiness requirements, this sentence could be deleted. Because change notification has been addressed in the above proposed verbiage.	

Appendix B. Proposed Appendix for AC 21-50

Process Steps:

1) Applicant evaluates installation of TSOA article to determine the requirements that need a compliance showing.

2) Applicant develops plan to incorporate TSOA MPS and furnished data (IM, IIL, Non-TSO Function data, etc.) and other applicable data applicable to airworthiness requirements beyond the TSO MPS, into compliance showing.

3) As an outcome of Step #2, the applicant may determine that coordination with the article supplier is necessary to facilitate the use of the article TSOA in the applicant's compliance showing. This may include the applicant providing requirements to the article supplier describing interfaces, performance, environment, etc. expected to be addressed in the TSOA.

4) TSOA Holder provides TSOA furnished data to the applicant.

5) Applicant Evaluates TSO Furnished Data:

   The applicant must review the TSOA letter and furnished data to ensure that:

   a. Part number (either listed or within the bounds of an open bracket part numbering system) in the TSOA matches the part number intended for installation.
   b. The TSOA data is applicable to the intended showing of compliance to airworthiness requirements.
   c. The intended installation of the TSOA article is within the TSOA Installation Instructions and Limitations (IIL) or Installation Manual (IM).

   This evaluation should also look for whether the TSOA is incomplete or has any documented deviations to the TSO MPS. In addition, exemptions to any CFR, if they exist, need to be included. The applicant will need to address incomplete or MPS deviations as discussed in section 5.c and 5.d.

   Based on this evaluation, the applicant and TSOA holder may determine that a revision to the TSOA is advantageous to support the article installation compliance showing.

6) Applicant writes compliance showing for the installation of the TSOA article.

   The following TSO information should be included in the compliance showing:
   a. TSO number
   b. The name of the TSO holder/manufacturer
   c. Description of TSO MPS alignment to installation requirements
   d. Description of TSOA furnished data incorporated into the compliance showing.

7) Applicant makes a compliance finding based on the compliance showing in Step 5.

Appendix C. SOC ARC TSO Subcommittee Membership

- Andy Richards — *Duncan Aviation*
- Ben Morrow — *Genesys Aerosystems*
- Bod Godsy — *Garmin Ltd.*
- Carlos Bergueiro — *Transport Canada Civil Aviation*
- Chuck Wiplinger — *Wipaire, Inc.*
- Dana Krueger — *Collins Aerospace*
- Derrick Pruitt — *The Boeing Company*
- Doug Law — *Federal Aviation Administration*
- Erik Oltheten — *Bell Textron Inc.*
- Fay Trowbridge — *Honeywell Aerospace*
- Jens Lukoschat — *Textron Aviation*
- Joe Harvey — *Collins Aerospace*
- John Waddle (co-chair) — *Astronautics Corporation of America*
- Jonathan Archer — *General Aviation Manufactures Association*
- Kajetan Litwin — *Transport Canada Civil Aviation*
- Kathy Volk — *L3Harris Technologies*
- Mike Chick — *Duncan Aviation*
- Raki Islam — *Safran S. A.*
- Ric Peri — *Aircraft Electronics Association*
- Robert Bouza (co-chair) — *Federal Aviation Administration*
- Rodrigo Valério Magalhães — *Agência Nacional de Aviação Civil*
- Susan McCormick — *Federal Aviation Administration*