U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Gaining Approval of Seats with Integrated Electronic Components

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AC No: 21-49
Change:

1. Purpose of This Advisory Circular (AC).

a. This AC explains how to gain approval of aircraft seats with integrated electronic components and installed on aircraft. In it, we focus primarily on seats approved to a technical standard order (TSO). This AC applies to electronic components integrated into aircraft seats only. We don't cover electronic components installed independent of the seat.

b. This AC is not mandatory and does not constitute a regulation. In it, we describe an acceptable means, though it is not the only means, to gain approval to install electronic components integrated in seats on aircraft. However, if you use the means described in the AC, you must follow it in all respects.

2. Applicability. We've written this AC for anyone who:

a. Installs on an aircraft a seat with electronic components, or
b. Is involved with integrating the electronic components into the aircraft seat.

3. Where to Find This AC. You can find this AC at the FAA's regulatory and guidance library website at http://rgl.faa.gov.

4. Explanation of Policy Changes. This AC incorporates, expands and supersedes policy published on this subject in 1998. (See paragraph 13 of this AC for more information.)

5. Examples of Integrated Systems. Integrated electronic components include those mounted in or on seats or attached to seats. Seats often have phones, powered footrests, reading lights, in-flight entertainment (IFE) systems, and other features comprised partly or completely of electronic components. For example, an IFE system could be made of electronic components including video monitors, wiring, user control units, power units, central processing units, and related components.

6. FAA Requirements for Seats with Electronic Components. Approving electronic components in aircraft when the electronic components are integrated in the seat has been a challenge for both the FAA and the aviation industry. In order to integrate electronic components into seats, we need to know that:

a. The combined electronic component and seat design meet the appropriate airworthiness standards for the aircraft it will be installed on,

b. If the seat was approved to a TSO, the seat meets the TSO before and after the electronic component is integrated, and

c. The way the electronic component is integrated in the seat meets the appropriate production requirements.

7. How the FAA Approve Seats with Electronic Components. We approve a seat with electronic components for aircraft installation by one of three ways:

a. Type certification without using a TSO-approved seat. A "TSO-approved" seat means a seat that we approved under a TSO authorization (TSOA) or letter of TSO design approval (LODA). We can approve the seat and electronic components under the aircraft type certification process without a TSO approval for the seat. This is done by issuing a type certificate (TC), amended type certificate (ATC), or supplemental type certificate (STC) that defines a seat (not approved to a TSO) and the electronic components as part of the type design of the aircraft. The TC/ATC/STC applicant/holder is responsible for meeting all the applicable airworthiness standards for the seat and electronic components combination installed on the aircraft.

b. Type certification using a TSO-approved seat with electronic components defined in TSO design. We approve the seat to either TSO-C39c, *9g Transport Airplane Seats Certified by Static Testing* or the latest revision of TSO-C127, *Rotorcraft, Transport Airplane, And Normal And Utility Airplane Seating Systems* with the electronic components defined as part of the TSO article design. The TSO approval applicant/holder must list the electronic components on the TSO drawings because they control the design and manufacturing quality of the seat **and** the electronic components for all aspects affecting compliance to the TSO. The TSO approval covers the electronic components for all the items in Table 1 of this AC. We still require a design approval to the applicable airworthiness standards (TC, ATC, or STC) for the seat with electronic components for aircraft installation. See paragraph 9 of this AC for issues that you must address under the installation approval, and not under the TSO approval.

c. Type certification using TSO-approved seat with electronic components *not* defined in TSO design.

(1) We approve the seat to either TSO-C39 or -C127. The TSO approval applicant/holder doesn't define the electronic components as part of the TSO article design because they don't control the design and manufacturing quality of the electronic components for the items listed in Table 1. So they must not list electronic components on the TSO drawings or any other documents in the TSO approval except when the electronic components are used as a test article and are strictly defined. The drawings and documents for the test article's electronic components must include the revision level to isolate the configuration of the tested components from future design changes. See Frequently Asked Question (FAQ) 9 in appendix 2 of this AC.

After we issue the TSO approval to the seat manufacturer, typically someone other than the seat manufacturer changes the seat design to include electronic components.

(2) We require anyone who wants to change the design of the TSO-approved seat (including electronic components) to get a separate design approval to the applicable airworthiness standards (TC, ATC, or STC) for the seat with the electronic components for aircraft installation. See paragraph 9 for issues that you must address under the installation approval and not under the TSO approval. The person seeking to change the TSO article must show that the seat (with design changes to include the electronic components) continues to meet the TSO, so that the original TSO approval remains valid (see FAQ 8). It is acceptable for the person seeking to change the TSO article to employ the original TSOA holder to help make this determination. See figure 1 of appendix 1 for a flow chart showing one example of this process.

8. TSO Performance Requirements for Electronic Components in Seats. When electronic components are defined in the TSO seat design, we approve some attributes of the electronic components with the TSO approval. Table 1 below shows items (only the ones marked "YES") that we approve for the electronic components under the seat TSOs.

Table 1

Electronic Components Attributes Approved Under the TSO *If Defined* in the Seat Design		
Item	**TSO-C39**	**TSO-C127**
Strength of attachment of electronic components to seat	Yes	Yes
Mass, location, and center of gravity (cg) of electronic components on seat under static loading	Yes	Yes
Sharp edges (delethalization)	Yes	Yes
Flammability*	Yes	Yes
Mass, location, and cg of electronic components on seat under dynamic loading	N/A	Yes
Effect on head injury criteria (HIC) for electronic components mounted in seat backs or arm rests	N/A	Yes
Effect on lumbar loads for electronic components mounted under the seat	N/A	Yes

* See specific TSO for flammability requirements. Each seat TSO is different.

9. Type Certification Requirements for Electronic Components in Seats.

a. TSO-C39 and C127 performance criteria are not adequate to address installation of seat-mounted electronic components into an aircraft. We can't approve items not listed in Table 1 for the electronic components under the TSO approval. Those items must be approved for the aircraft using the type certification process (TC, ATC or STC). Examples of items that require these kinds of approvals for the electronic components include:

- System safety assessment
- Electrical loads analysis
- Electromagnetic Interference (EMI)
- Electromagnetic susceptibility of electrical component or wiring
- Electrical requirements such as electrical and equipment installation, circuit protection/electrical fault protection, and electronic protection
- Power harmonics from the electrical component
- Heat load generated by the electrical component
- Internal structural integrity of the electrical component
- Wire routing
- Equipment environmental conditions (such as RTCA, Inc. document RTCA/DO-160 *Environmental Conditions and Test Procedures for Airborne Equipment*)
- Software considerations (see RTCA/DO-178, *Software Considerations in Airborne Systems and Equipment Certification*)

b. See paragraph 13 for a list of current policy documents on type certification.

10. Manufacturing Seats when Electronic Components are Not Defined in the TSO Design. When seeking approval of the seat with electronic components when the electronic components are not defined in the TSO design per the method in paragraph 7.c (electronic components not defined in TSO design) of this AC:

a. A Production Certificate (PC) or Parts Manufacturer Approval (PMA) is required to produce the seat modified with electronic components. For a U.S. manufacturer, a PC or PMA are the only production approvals that we can issue when the electronic components are installed on a TSO-approved seat, but not defined in the TSO-approved design. We also call the

PC or PMA holder the "seat modifier" (as shown in Figure 1) because we authorize them to manufacture the seat modified to include the electronic component. The PC or PMA holder can assemble the electronic components into the seat, or contract this out to a supplier. Often the supplier to the PC/PMA holder who assembles the electronic components into the seat is the seat TSO-approval holder. Non-U.S. manufacturers must have a production organization approval or approved production system as specified in the applicable bilateral agreements (see FAQ 1).

b. The seat must conform to the design approved under the TSO approval before the TSO approval holder can mark the seat as meeting the TSO. If the type design of the seat approved under the TSO approval doesn't include the electronic components, then the TSO approval holder can't include the electronic components in the TSO manufacturing process. The electronic components can only be assembled into the seat after conformity of the TSO-approved seat has been met. If you're a seat manufacturer, this will require you to build up the complete seat without the electronic components and then disassemble it to install the electronic components.

c. The TSO-approval holder for the seat can assemble electronic components into their seat if they are a supplier to the PC or PMA holder. The PC or PMA holder can contract the TSO approval holder for the seat or other supplier to do the physical work of assembling the electronic components into the seat. When the seat manufacturer works in this capacity, they must first build the seat to conform to the TSO-approved design as explained in paragraph 10.b of this AC. Also when the seat manufacturer works in this capacity, they are working outside their TSO approval (for design and production). The seat manufacturer must be covered under the PC or PMA holder's quality control system (like any other supplier to the production approval holder (PAH)) to assemble the electronic components into the seat. It is the responsibility of the PC/PMA holder to ensure the assembler (the TSO-approval holder in this case) produces an article that conforms to the approved design (generally an STC). We call the seat manufacturer the electronic components *assembler* when they work in this role (see Figure 1 in appendix 1).

d. Only the PC or PMA holder has authority to ship the seat modified with electronic components, because they are the PAH. The PC or PMA holder can extend direct ship authority to one of their suppliers when done according to their FAA approved quality manual or fabrication inspection system (FIS). The seat manufacturer can ship the seat with electronic components directly from their facility only when the PC or PMA holder has so authorized them.

11. Required Markings On The Seat. When you use the method in paragraph 7.c (electronic components not defined in TSO design) of this AC, attach the following markings permanently and clearly to the seat:

a. If you are the TSOA/LODA holder:

(1) TSO label for the seat, per Title 14 of the Code of Federal Regulations (14 CFR) § 21.607(d).

(2) Any markings required by the applicable TSO.

b. If you are the PAH for the seat with electronic components:

(1) A modification placard attached near the TSO label listing:

(a) Name of the modifier (PC or PMA holder).

(b) Means of design approval (TC, ATC, or STC number).

(c) Date of manufacture of the seat modified with electronic components under the PC or PMA.

(2) Any markings required by 14 CFR part 45.

12. Using the Method Described in Paragraph 7.b. in a Common Business Model. A common business model in the world of seat-mounted electronic components (e.g., IFE) involves several entities. Each has different roles and responsibilities toward a common goal. Some of the responsibilities are regulatory in nature and come with the specific design approval held. Other responsibilities are not regulatory, but come from the business relationship of being a supplier to a design approval holder or being a design approval holder and over-seeing a supplier. From the FAA perspective, we only enforce the regulatory responsibilities. However, we have listed best business practices to help ensure that regulatory responsibilities will be met. Table 2 below shows those roles and responsibilities for each of the entities when working under the method described in paragraph 7.b of this AC. Figure 1 shows one concept of a compliant and practical business model.

Table 2: Stakeholder Roles and Responsibilities per the Method in Paragraph 7.b

Stakeholder	Role	Regulatory Responsibilities	Best Business Practices
IFE manufacturer	Produces the IFE		
	Supplier to TSOA holder		Communicating to TSOA holder any design change to IFE that might affect compliance to TSO
	Supplier to IFE STC holder		Communicating to IFE STC holder any design changes to IFE that might affect compliance to paragraph 9 issues
TSO approval holder	Holds design and production approval of the seat (with IFE) to meeting the TSO	Showing seat meets TSO	
		Showing seat with IFE meets TSO wrt Table 1 attributes	
		Controlling IFE manufacturer to meeting Table 1 attributes	Communicating to the IFE supplier types of design changes that might affect compliance to the TSO
Interiors STC holder	Holds design approval of the seat (with IFE) installed in the aircraft.	Showing compliance of seat with IFE to cabin safety issues like effect on emergency evacuation, head injury criteria (HIC) when required, non-interference with exits, etc.	
IFE STC holder	Holds design approval of the IFE installed in the aircraft.	Controlling IFE manufacturer to meeting paragraph 9 issues	Communicating to the IFE supplier types of design changes that might affect compliance to the paragraph 9 issues

13. Earlier Policies Superseded and Updated. After an FAA-industry conference in Atlanta, GA in 1998 we issued PS-ANM100-1998-00126 *Policy and Guidance on the Approval of Electronic Components on Aircraft Seating Systems.* This AC supersedes that policy and answers many questions that the 1998 policy didn't.

14. Current Policy and Guidance on FAA Website. You'll find current policy and guidance on aircraft installation issues on the FAA website at http://rgl.faa.gov. (Select "Policy" for items a. though d. below. Select "Advisory Circular" for item e. below.) Review the list below before seeking approval of seats that include electronic components:

a. PS-01-115-38, *Further Information with respect to use of Industry Standards in Seat Certification*, dated September 12, 2001.

b. PS-ANM100-02-115-21, *Stowage, Retention, and Breakaway of Deployable Individual Video Systems (IVS) Installed in Transport Airplane Seats*, dated November 21, 2002.

c. PS-ANM-01-111-165, *Policy Statement on Certification of Power Supply Systems for Portable Electronic Devices on Part 25 Airplanes*, dated March 18, 2005.

d. ANM-113-04-032, *Certification of In-seat Video Systems (IVS)*, dated August 12, 2005.

e. AC 25-10, *Guidance for Installation of Miscellaneous, Nonrequired Electrical Equipment*, dated March 6, 1987.

15. Frequently Asked Questions on Approvals of Seats with Electronic Components. See appendix 2 of this AC.

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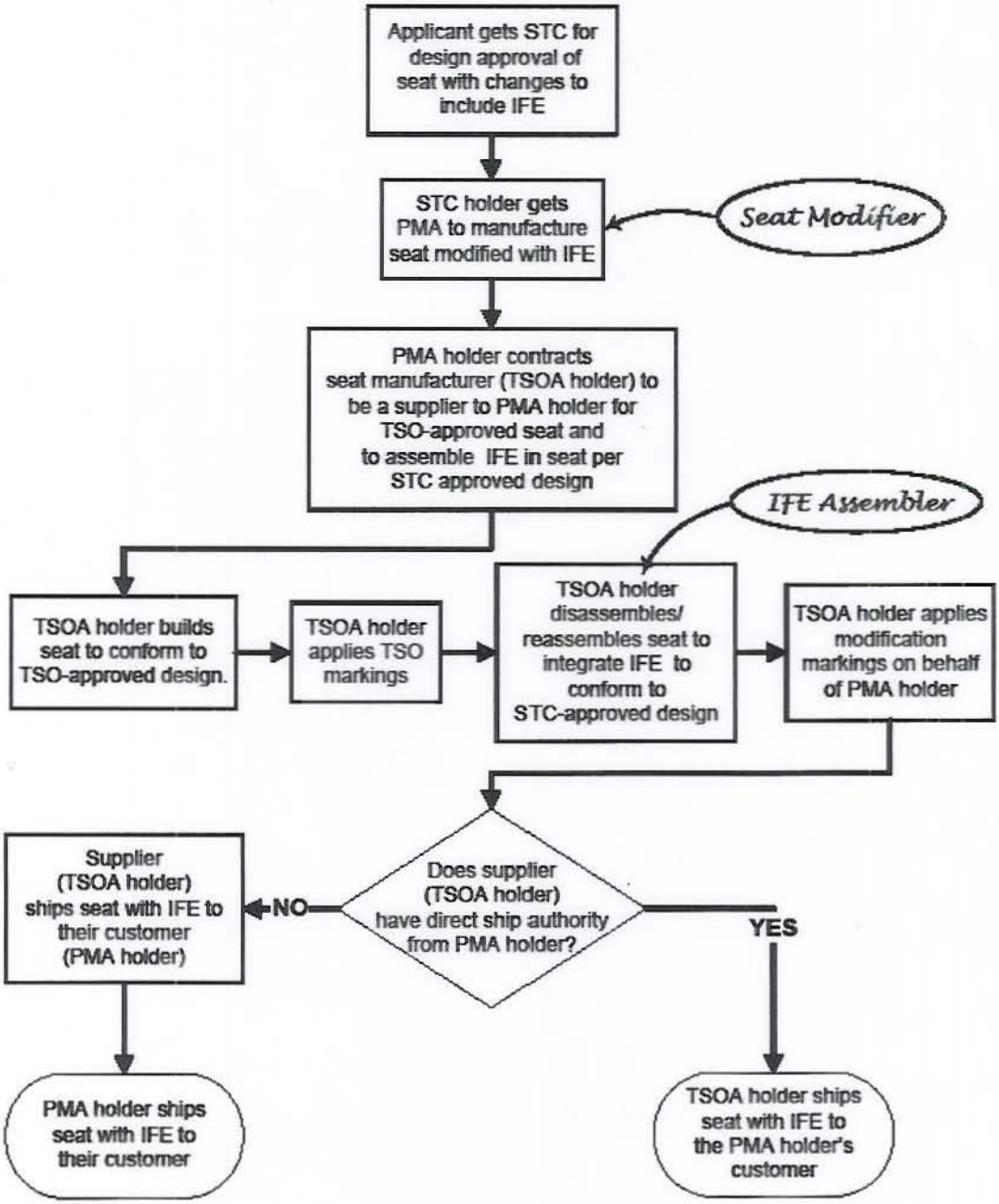
Figure 1. One Process for Integrating Electronic Components in Seats Previously Approved Under TSO
(for example IFE in a TSOA seat)



Note: Although this example shows an article approved via a TSOA, it would also work for an appliance approved under a LODA except for using a PMA. For non-U.S. manufacturers, a PMA can't be issued. An appropriate production approval per the bilaterals for the modified seat must be obtained (see FAQ 1).

FREQUENTLY ASKED QUESTIONS

1. How do I get a design approval and production approval if I am a non-U.S. manufacturer of a seat or electronic component?

a. Design approval. Wherever this AC uses the term "TSO approved seat" it applies to seats manufactured in the U.S. and approved to a TSOA, and to seats manufactured outside the U.S. and approved to a LODA. In either case, the seats can be changed to include electronic components under the U.S. type certification process or under a non-U.S. certification process that is then validated by us in accordance with the applicable bilateral agreement.

b. Production approval. The production approval of the seat, individual electronic components, and seat with electronic components must be obtained in accordance with the applicable bilateral agreement. Typically the bilateral agreement will specify that the civil aviation authority of the country of manufacture will approve and oversee a production quality control system that ensures the exported parts will conform to an approved design and are in a condition for safe operation. The use of the term production approval holder (PAH) in this document includes non-U.S. manufacturers in that they must have an approved production quality control system per the bilateral. Use of the specific terms production certificate (PC) and parts manufacturer approval (PMA) apply to U.S. manufacturers only.

2. Who can change the TSO-approved seat design to include an electronic component?

a. Either the TSO-approval holder or another person, per 14 CFR § 21.611. The TSO approval holder can change the seat design to include electronic components, if they control the design and manufacturing quality of the entire article, including the electronic components to the extent of meeting the TSO requirements as generally outlined in Table 1. See paragraph 7.b (electronic components defined in TSO design) of this AC.

b. According to 14 CFR § 21.611(c), a person other than a manufacturer can change the seat design to include an electronic component by obtaining a TC, ATC, or STC for the electronic components approval.

3. Who is the seat modifier? This is the entity that we approved to *produce* the seat with the design changes that include the electronic components. Often the modifier is the same entity to whom we granted the approval for the design change. Other times, the modifier may be using a previous design approval (using the approved data by a licensing agreement) that we issued to someone else to gain a production approval for the seat with electronic components.

Example: *We issued an STC to Expert Engineering to install an IFE system (integrated in a TSO-approved Welbilt Seat) into a Boeing 767-300. Expert Engineering licenses their STC and associated data to Precision Interiors, who in turn obtains a PMA to produce the seat with IFE. Precision Interiors contracts Welbilt Seats, in a supplier capacity, to assemble the IFE into the seat. Precision Interiors is the modifier because they hold the production approval. The design and installation approval is the STC issued to Expert Engineering.*

4. What are the seat modifier's responsibilities? The seat modifier is responsible to manufacture the seat with electronic components conforming to an approved design of the seat and electronic components. They must ensure all their suppliers are controlled under the seat modifier's approved quality control system or FIS. They must ensure the seat with electronic components is properly marked with a modification placard.

5. When is a modification placard required? The method in paragraph 7.c (electronic components not defined in TSO design) of this AC requires a modification placard. We require a modification placard any time a TSO-approved article is changed by someone other than the TSO approval holder. The method in paragraph 7.a (seat approved under TC but not TSO approved) of this AC doesn't require a modification placard. The method in paragraph 7.b (electronic components defined in TSO design) of this AC doesn't require a modification placard unless a person other than the TSO approval holder makes a change to the seat after it has left the TSO holder's quality control system.

6. What must be listed on the modification placard? See paragraph 11 of this AC for marking requirements.

> ***Example:*** *In FAQ 3 above, the modification placard should list Precision Interiors as the modifier, and list the STC number issued to Expert Engineering as the means of design approval. Precision Interiors is the modifier even when Welbilt Seats holds a TSO approval for the original seat without electronics, and Precision Interiors has contracted Welbilt to install the IFE into the TSO-approved seats. This is because Precision Interiors holds the production approval for the seat with the IFE.*

7. What does it mean to "...control the design and/or quality of the electronic component"? When *controlling* the design, the approval holder directs every aspect of the electronic component that can affect compliance to the applicable requirements, and that can affect conformity. Further, the holder ensures that the electronic component is in a condition for safe operation. *Control* includes all changes to those aspects as well. Approval holders are responsible to make sure that all the parts, components, subassemblies and assembly services they get from suppliers comply with applicable requirements.

> ***Example:*** *A seat manufacturer, Perfection Seats, includes the IFE in their TSO design as explained in paragraph 7.b (electronic components defined in TSO design) of this AC. Perfection Seats contracts Ultimate Video Concepts to provide IFE for integration in their seats, for which Perfection Seats is getting TSO approval. The IFE must meet the TSO performance standards for the items listed in paragraph 8 of this AC. Flammability is one example. Perfection Seats is responsible for ensuring the original design of Ultimate Video Concepts' IFE meets the flammability requirements in the TSO. Perfection Seats is also responsible for ensuring all design changes made by Ultimate Video Concepts to the IFE continue to meet the flammability requirements in the TSO. From our perspective, we issue the approval to*

Perfection Seats, not Ultimate Video Concepts. Perfection Seats is responsible for ensuring the IFE meets the TSO.

8. Does the electronic component design approval affect the seat TSO approval? Sometimes. It's important that the person seeking approval of the electronic component design determines that the seat with the electronic component continues to meet the seat TSO. This person must also ensure that the associated installation limitations remain valid or are properly evaluated and revised. If this isn't done, the TSO approval is no longer valid and they must obliterate the TSO number listed on the TSO label. It also means that if the basis for installing the seat was the fact it was TSO-approved, and this is no longer true, then the applicant for installation approval will now have to reevaluate the basis for showing compliance to 14 CFR.

9. If I'm a seat TSO approval applicant/holder, can I list the electronic component on my seat TSO drawings?

a. Yes, but only if you control the design and manufacturing quality (production) of the electronic components as explained in paragraph 7.b (electronic components defined in TSO design) of this AC. When the TSO approval applicant/holder doesn't control the electronic component, it can't be listed except when the electronic component is used as a test article and strictly defined. This can be accomplished by listing the drawing number including revision level of the electronic component. Because design changes made to the electronic component *after* the revision level were not evaluated during original TSO testing, they are not approved and require additional evaluation and a separate approval. Everything listed on a TSO drawing is the responsibility of the TSO approval applicant/holder to control for design and production to meet the TSO. This is true for all TSO articles (not just seats) that have extra functions or features not required by the TSO. An electronic component is no different.

b. Per Table 1, it is also possible for a seat TSO approval holder to control some electronic components like footrest actuator motors, reading lights, and control units to meeting the TSO and not control other electronic components like IFE to meeting the TSO. In this case, the footrest motor, reading light and control unit are listed on the TSO approved drawings, but the IFE is not listed on the TSO approved drawings.

10. Do the seats have to have a TSO approval? No. As explained in paragraph 7.a (seat approved under TC but not TSO approved) of this AC, a TSO-approved seat is not mandatory.

11. How are statically-tested seats (e.g., TSO-C39 9g seats) affected by adding electronic components?

a. Adding an electronic component to a seat approved to TSO-C39 primarily affects its strength and flammability. The entity seeking electronic component design approval must evaluate the seat for the addition of the electronic component to determine how the seat reacts to the higher load, the change in center of gravity (cg), and so forth.

b. These factors pertain only to how adding the electronic components should be evaluated for its effect on meeting the TSO for a previously TSO-approved seat. The evaluation must also cover the approval for installation into the aircraft.

12. How are dynamically-tested seats (e.g, TSO-C127 16g seats) affected by adding electronic components? In addition to the structural concerns for statically tested seats, adding electronic components to a dynamically tested seat can also affect the seat's response to the dynamic test pulse. Changes to the mass and cg of the seat from adding electronic components are difficult to predict and typically require dynamic testing to evaluate. Adding electronic components will also affect the results of a HIC test, if a head strike on the electronic components occurs. Lumbar loads can be affected by addition of an electronic component below the seat. For seats with electronic components that were successfully dynamically tested for HIC, small changes to component stiffness or mass can have big effects on HIC results. This is one example why it is important for electronic component approval holders to control all changes made by their suppliers.

13. Can a seat TSOA applicant/holder use the non-TSO functions policy with electronic components? No. Our current policy does not allow the method for accepting data for non-TSO functions for seat TSOs. We expect that future internal FAA policy will clarify and expand how we view the use of non-TSO functions data acceptance for all TSOs. Until then we adhere to current policy.

Note: In general, the Non-TSO function policy does not apply to, and can't be used by, LODA applicants/holders unless specifically allowed per the applicable bilateral. Review the bilateral agreement of the country of the foreign manufacturer for more information.

14. Can an air carrier buy a seat modified with electronic components directly from a seat manufacturer? The air carrier can only buy the seat modified with the electronic components from the PAH of the modified seat. The seat may be shipped from a supplier to the customer if the supplier has been granted direct ship authority from the PAH of the modified seat.

a. For the methods described in paragraphs 7.a (seat approved under TC but not TSO approved) or 7.c (electronic components not defined in TSO design) of this AC, the PAH is the PC or PMA holder.

b. For the method described in paragraph 7.b (electronic components defined in TSO design) of this AC, the PAH is the TSO approval holder. However, it must be understood that the seat manufacturer has only a regulatory responsibility to ensure that the seat with the IFE meets the TSO, not the STC that approved the IFE for installation into the aircraft.

15. What's the difference between the "seat modifier" and the "electronic components assembler"? The *seat modifier* holds the approval to produce the seat modified with electronic components. They have total responsibility for production control of the seat with electronic components. The *electronic components assembler* performs the physical work of installing the electronic components into the seat. Sometimes the modifier and assembler are the same. Other times the modifier contracts the physical installation of electronic components to a supplier

(electronic components assembler). In the example in FAQ 3 above, Precision Interiors is the seat modifier and Welbilt Seats is the electronic components assembler.

16. Why does this AC supersede previous policy?

a. In previous policies, we stated that electronic components could be listed on the TSO drawings or supporting documents, like the installation instructions and limitations, even when the TSO applicant/holder did not control the design and manufacture of the electronic components.

b. As we explain in paragraph 7.c (electronic components not defined in TSO design), when the TSO applicant/holder does not control the electronic components, they must not list electronic components on the TSO drawings or any other documents that are part of the TSO approval except as provided for test article components.