

## DOCUMENT COMMENT LOG Comments from Boeing Commercial Airplanes

Originating Office:	Document Description:	Project Lead/Reviewer	Reviewing Office:	Date of Review:
ALR-120	TSO-C179A – Permanently Installed Rechargeable Lithium Cells, Batteries and Battery Systems			

#	Page & Paragraph	Comment	Reason for Comment	Suggested Change	Comment Resolution (For FAA use only)
<b>1 of 8</b>	Page 1, Section 1. PURPOSE	We request that this section clearly state that this TSO is only applicable to <u>large</u> rechargeable lithium cell batteries and battery systems	RTCA/DO-311, which this proposed TSO references for the requirements, was written for large rechargeable lithium batteries, and the intent of TSO-179a, therefore, is to apply to <u>large</u> rechargeable lithium batteries. Therefore, it would be appropriate for the TSO to clearly specify this in order to avoid any confusion for the applicants, suppliers, and installers.	Change the text in Section 1 to state: "This Technical Standard Order (TSO) is for manufactures and designers of permanently installed <b>large</b> rechargeable lithium cells, batteries, and battery systems ...."	Good suggestion but the intent of this TSO was not to restrict to one size of battery. If an applicant would like to use this for any size they are most welcome to use this. I agree that in practice this TSO would be usable for Large lithium battery and battery systems.

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2 of 8	Page 1, Section 2. APPLICABILITY	We request that this section clearly state that this TSO is only applicable to <u>large</u> rechargeable lithium cell, batteries and battery systems	See our comment # 1	Change the text in Section 2 to state: " ... Major design changes to permanently installed <b>large</b> rechargeable lithium cells, batteries, and battery systems approved under this TSO will require a new authorization. ... "	Same response as item 1.
3 of 8	Page 1, Section 3. REQUIREMENTS	We suggest adding a requirement that defines what size of battery will be classified as "large rechargeable lithium cell, batteries and battery systems."	This information is necessary in order to allow manufacturers and designers to correctly apply the TSO's MPS to their batteries types.	Add a subparagraph to Section 3 that defines the battery size, such as: <b>"Battery size 'large' is defined as a battery that has Lithium content of LI &gt; 25g"</b>	Same response as item 1. In addition the size of the battery is expected to be defined by RTCA SC 225 committee. After that effort we intend to issue a TSO to capture small and medium lithium battery and battery systems utilizing the new or updated DO document.

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4 of 8	Page 1, Section 3. REQUIREMENTS	This proposed TSO-C179a has removed the ability to use UL 1642, and has added RTCA DO-311 as the requirement. Some of the test requirements in DO-311 cannot be achieved due to the design and construction of the battery cell. In light of this, we suggest that the TSO provide an alternative means to show compliance.	Since some of the test requirements in DO-311 cannot be achieved due to the design and construction of the battery cell, applicants should be able to show compliance by a defined alternative means.	We suggest adding the following text under paragraph 3.d.:  <b><i>"When performing the DO-311 3.3.3 test, if overcharging does not create a thermal runaway, then analysis per §25.1309 may be performed in lieu of the DO-311 tests, provided that the analysis shows the occurrence of specific tested events to be extremely improbable."</i></b>	Good suggestion again. This was brought up in our SC225 meeting and is expected to be addressed in the update to DO-311.
5 of 8	Page 1, Para 3.b.	Proposed paragraph 3.b. states: <i>"Failure of the function defined in paragraphs 3 and 3a of this TSO is a major failure condition."</i> However, it is not clear what the "function" is as used in that sentence. Paragraph 3 is just a reference to the RTCA DO-311 requirements, and paragraph 3.a. is just an applicability statement for the TSO. There is no definition of the "function" referred to in paragraph 3.b.	Clarity is needed.	In order to better understand and comply with the intent and the requirements of this TSO, a definition for the term "function," as used in paragraph 3.b., should be added.	Disagree. This is common terminology in TSO. This pertains to the intended function of the article.

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6 of 8	Page 1, Para 3.b.	Proposed paragraph 3.b. states: <i>"Failure of the function defined in paragraphs 3 and 3a of this TSO is a major failure condition."</i>  The term "major" failure condition, as used in that sentence, is not clear.	It is unclear whether the word "major" refers to a failure category as defined in 14 CFR §25.1309 or as defined elsewhere.	Clarify the term "major" as used in paragraph 3.b..	This major pertains to the article and not installation requirement under 25.1309.
7 of 8	Page 2 Para 3.d.	We note that the TSO does not require testing for electrical/EME qualification.	Only the Environmental Qualification, Section 3 of DO-311, is referenced in the proposed TSO. We recommend that the TSO include the requirements of Section 2 of DO-311, which addresses Electrical/EME Qualification.	We suggest adding the following new subparagraph:  <b><u>"xx. Electrical / EME Qualification. Test the equipment according to Section 2 of RTCA/DO-311."</u></b>	Agreed. Section 2 has been added to the requirement.
8 of 8	Page 2, Para 3.d.	Some of the test requirements in DO-311 cannot be achieved due to the design and construction of the battery cell. In light of this, we suggest that an alternative means to show compliance with this testing be provided in the TSO..	Some of the test requirements in DO-311 cannot be achieved due to the design and construction of the battery cell. Applicants should have an alternative method to show compliance.	We suggest adding the following under paragraph 3.d.:  <b><i>"When performing the DO-311 3.3.3 test, if overcharging does not create a thermal runaway, then analysis per §25.1309 may be performed in lieu of the DO-311 tests, provided that the analysis shows the occurrence of specific tested events to be extremely improbable."</i></b>	Same comment as 4 of 8.

**Clearance Record  
DOCUMENT COMMENT LOG (AIRBUS comments)**

<b>Originating Office:</b> AIR-120	<b>Document Description:</b> TSO-C179A - Permanently Installed Rechargeable Lithium Cells, Batteries and Battery Systems	<b>Project Lead/Reviewer</b>	<b>Reviewing Office:</b>	<b>Date of Review:</b>
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AIRBUS	General	This TSO does not make distinction between small, medium and large lithium battery/cells as defined in FAA ANM-113-10-004 (ANM still in draft)	Depending on the battery size, applicable requirements should differ as detailed in ANM-113-10-004	FAA to clarify the TSO perimeter: large, or large and medium or large, medium and small The definition of battery size is to be also provided (or a reference to ANM-113-10-004)	Agree with the principle of the comment.  The intent of this updated TSO is for large lithium batteries. The size is not stated since there is an effort by an RTCA SC225 group trying to define that size boundary. Once that is defined maybe we can define that. In the mean time anyone who wants to get a TSO for permanently installed lithium battery and battery system regardless of size can use this TSO. The intent also was not to restrict anyone from using this TSO if they so chooses.
AIRBUS	Page 1, §3b	The sentence "failure of the function defined in paragraphs 3 and 3a of this TSO is a major failure condition" is ambiguous.	This sentence could lead to different interpretations as for example: 1- Any Lithium cell/battery can lead to only major failure condition 2- This TSO is applicable only to Lithium battery which failure is major	The following sentence is proposed:  "the lithium battery/cell failure classification has to be done in accordance with ED-79/ARPA754 §5.4 criteria or equivalent "	Disagree. The TSO does not evaluate the installation provision of the article. Here the failure classification is for the article only. Based on what we know of these types of battery and battery systems their failure is major. There may be other considerations during installation approval of these articles and the installer will have to comply with all applicable airworthiness

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					regulations at that stage.
AIRBUS	Page2, §3d	The sentence "Test the equipment according to sections of RTCA/DO-311" is not exhaustive	The environmental qualification should also cover the EMC/HIRF/lightning requirements.	The following sentence is proposed: "Test the equipment according to section 2.3.20; 2.3.21; 2.4 and 3 of RTCA/DO-311"	Agreed. The TSO has been updated by prior comments also to include sections 2 and 3.
AIRBUS	Page2, §3e	The paragraph related to SW is redundant with §2.5.1 of DO311	Any redundancy is to be avoided.	The following sentence is proposed: "If the article... must be developed according to RTCA/DO-178B as required in DO311 §2.5.1"	Agreed. Removed redundant statement.
AIRBUS	Page 2, §3f	In recent AIRBUS programs (like A350), FAA has considered that the AC20-152 and DO254 requirements have to be amended as clarifications are required as well as omissions. (See for example A350 IP SH-1)	There is no reason that the complex electronic of a lithium battery/cell is not qualified to the latest agreed standard.	To add a reference to latest means of compliance for complex electronic HW.	Disagree. Some later DO documents may be different. The date and revision of the document is added to specify the configuration at this time.

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Garmin	Page 1, Paragraph 3b  Failure Condition Classification. Failure of the function defined in paragraphs 3 and 3a of this TSO is a major failure condition. You must develop lithium cells, batteries, and battery systems to, at least, the design assurance level equal to this failure condition classification.	This statement implies the failure condition classification of an appliance is determined by the TSO regardless of mitigations employed to meet aircraft level safety requirements such as redundant appliances/systems. Unless the DAL cannot be affected by the installation, the aircraft System Safety Assessment should determine the failure classification and by extension, the design assurance level (DAL) requirement. The aircraft FHA/SSA ultimately determines the DAL requirement for a particular installation. Specifying the DAL at the appliance level without the benefit of the specific aircraft level FHA/SSA means that in some cases the DAL will undoubtedly be higher and more costly than necessary. This will have a chilling effect on the installation of new, safety enhancing technologies since the cost will be greater than necessary. It is possible to build and certify a TSOA appliance that cannot be approved for installation in one or more aircraft types because it does not have the required DAL. Similarly, just because the appliance meets a TSO DAL does not mean it can be approved for installation. We recommend that no failure classification/DAL requirement be included in a TSO when the installation can affect or mitigate the hazard level and therefore consideration should be given to revising paragraph 3b in this TSO to the following general guidance in the suggested	Under most circumstances DAL should not be determined by TSO  EASA released the following wording in their latest (CS-ETSO/6 December 2010) ETSOs Subpart A – GENERAL 2.4 Failure condition classification paragraph:  Develop the system to, at least, the design assurance level equal to the failure condition classifications provided in the ETSO.  Development to a lower Design Assurance Level may be justified for certain cases and accepted during the ETSO process but will lead to installation restrictions.	"Develop each system to at least the design assurance level required by the anticipated installation for the function defined in Paragraph 3a."	Disagree.  The manufacturer of the TSO does not know all the mitigating factors and aircraft level safety requirements at design or production of the TSO article. This design assurance level has always been at the article level. The installer has to evaluate this design assurance level with respect to the aircraft level safety requirement at the time of installation.

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		change. (Note that TSO-C112c is an example where a classification/DAL may be appropriate as a transponder output is used by the national airspace system and the installation has no ability to mitigate the safety risk.)			
Garmin	RTCA DO-311, Page 22, section 2.3.9 Storage Test	Running the storage test, as written, would add an excessive amount of time to product development.	Batteries are improving in capacity and safety at a steady pace, the current document would lead to a minimum 3 year development cycle. This would greatly curtail on-going improvements in safety.	The TSO should be modified to supersede the MOPs and allow battery cell manufacturer data and any initial storage information to be used at first. Monitor a product in storage after TSO is finished and update information if it diverges from manufacturer specification.	Good suggestion but this needs to be addressed by the RTCA SC225 committee. This TSO could be used for large main battery and battery system of aircraft. These types of battery and battery system require this test. The point is well taken and will be presented to the RTCA SC 225 committee to update the DO-311 to include other battery and battery system that may not require this 3 year cycle.
Garmin	RTCA DO-311, Page 23, section 2.3.10 Float Life Test	The testing period called for would take 2 years after the product has been otherwise built and certified.	Batteries are improving in capacity and safety at a steady pace, the current document would lead to a minimum 3 year development cycle (1 year to build and 2 years to test). This would greatly curtail on-going improvements in safety.	The TSO should be modified to supersede the MOPs and allow battery cell manufacturer data and any initial testing (perhaps a few months worth) to be used initially. Monitor a product after completion and update the relevant information if it diverges from the expected performance.	Same response as above item.

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L-3 Avionics Systems	Page 1, Section 3	DO-311 is referenced by TSO-C179 A with MOPPS form section 2 and 3. Not all tests of sections 2 and 3 will apply to all applications of Li Ion battery systems. Will any tests of section 2 or 3 that are not applicable or not doable be considered a deviation to the TSO?	Some of the tests of DO-311 sections 2 and 3 are not applicable to a small integral stand-by battery. Prior to TSO-C179 an FAA issue paper defined which tests of DO-311 are to be run. The TSO states the tests are to be based on the intended application defined in the TSO installation manual which is usually only preliminary at the time the TSO test plan is submitted for approval.	... defined in the TSO installation manual and/or TSO Test Plan...	Agreed. The TSO is for a wide variety of battery and battery systems. It is not feasible to list individual test requirements of section 2 or 3. The manufacturer will have to discuss with the applicable ACO to determine which tests are applicable and which are not based on the intended function of the article. In most cases the manufacturer picks the worst case scenario of intended function. No change to document.
	Page 3, Section 5.f	This description is an ICA, not a CMM and should be stated as such to eliminate confusion with actual CMM requirements		TSO C195 for example in 5.f says "CMM or IM, as appropriate". This is the way it should be written	Disagree The installation manual is provided in section 5 b of this TSO. The manufacturer should provide all information required under section 5f for CMM and this is usually varied for different manufactures.
	Page 4, Section 7	The data in sections 5a-g must be provided to anyone receiving an article. Again, we do not provide CMM's to everyone, much less one with each article.		TSO-C195 for example in 5.f says "CMM or IM, as appropriate". This is a better way for the requirement to be written.	Disagree Same response as above for CMM or IM question. The data in section 5 a - g is required to be furnished with all articles of this TSO. Please see section 7 of this TSO.

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J.J. Machon	Page 2 para 5 Page 3 para 6	The TSO does not identify any requirements for carriage as spares, while undoubtedly the TSO approved cells and batteries will have to be carried as such aboard aircraft for resupply.	Carriage of uninstalled Lithium cells and batteries of both Li-metal and Li-ion varieties is known to be a major potential hazard for aircraft, unless stringent packaging requirements are applied in agreement with 49CFR or ICAO Instructions for the Safe Transport of Dangerous Goods by Air.	Consider possible addition as a TSO requirement, in para 5, Application Data Requirements, or para 6, Manufacturer Data Requirements, of classification testing results and determination of packaging requirements for transport as spares, in accordance with 49CFR or ICAO Instructions for the Safe Transport of Dangerous Goods by Air.	Disagree. The regulations for batteries that are carried on as spares are covered by DOT This can be found at: <a href="http://safety.dot.gov/">http://safety.dot.gov/</a> . This TSO only deals with the Minimum Operating Performance standards of permanently installed Lithium batteries on aircraft. Spares and carry on batteries are out of scope of this document.

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Sam Carswell	General	<p>The FAA has studied many incidences involving thermal runaway of rechargeable lithium batteries and the root causes vary: manufacturing quality control, charger design defects, physical damage, age, etc. In some cases the cause may never be determined. TSO-C179A institutes design, test and maintenance procedures to reduce the causes and mitigate the affect for lithium battery thermal runaway.</p> <p>Rechargeable lithium batteries pack tremendous energy into a small light package and hence there are important commercial and environmental reasons to promote their safe use in aircraft. TSO-C179A will lessen the probability of failure but it cannot eliminate all instances, therefore the TSO should specify where the battery may be installed.</p> <p>A rechargeable lithium battery pack in thermal runaway rapidly releases each cell's energy as heat, fire, smoke, noxious gas and noise. A dramatic event that bombards all five senses for an extended period of time does not belong in the cockpit where there may be no time to react and recover. A rechargeable lithium battery enclosure that would fully contain the effects of thermal runaway would be heavy and expensive thus offsetting the rationale for using a battery with Li-ion chemistry.</p> <p>Therefore the TSO-C179A be updated to specifically ban the cockpit installation of equipment using rechargeable lithium batteries. There are safer cost effective alternatives in the cockpit:</p> <ol style="list-style-type: none"> <li>1. Redundant power busses</li> </ol>	Safety	Ban installed equipment using rechargeable lithium batteries from the cockpit	This is a great solution to the issue at hand, but is not a practical solution. As long as there is a benefit of using Lithium battery as source of power on electronic equipment lithium battery will be an item that we have to deal with. We are trying to mitigate the risk by testing and validating these types of power source so that they do not create the very conditions you present on aircraft.

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		<p>2. Non-lithium batteries for 30-minute emergency backup of EFBS</p> <p>3. COTS laptops can be fitted with safe battery packs designed to emulate the COTS lithium battery pack's interface but which actually contain safer 30-minute batteries such as NiMH.</p> <p>The ban eliminates the unintended consequence of FAA tacitly condoning operational approval for cockpit use of rechargeable lithium battery PEDs. Banning cockpit rechargeable lithium batteries also removes the need for a subjective case-by-case field determination a rechargeable lithium system's safety sufficiency when installed in the cockpit.</p>			

