

Instructions for Continued Airworthiness (ICA), ETX900-TSO Battery

Revision Log

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B	Incorporate FAA AEG comments.	7/31/2020	R.Nicoson FAA Approved 9/8/2020
C	Generic for all Part 23 Aircraft, Reference to SAFM/AFMS	9/11/2021	R.Nicoson/B.Olsen
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Overview – Purpose

This set of instructions is to provide information per 14 CFR Part 23, Appendix G, to enable maintenance personnel to maintain the ETX900-TSO Battery System (EBS) in a part 23 airplane. Installations of rechargeable lithium batteries defined herein, are expected to meet the requirements of AML STC SA01005DE certified with guidance of AC 20-184 and tested to RTCA DO-311A.

In the spirit of an AML STC, this ICA and accompanying Installation and Maintenance Manual (IMM), EarthX document 180407, is intended for general use and reuse. Additional details on the initial installation of a given Model are contained in the appendices of the IMM. However, this ICA is a standalone document and is all that is required to properly maintain the Battery System (EBS).

The EarthX Lithium battery is designed as a maintenance free replacement for 12-volt lead-acid or lithium starter batteries. The EBS is part of the electrical system as a Secondary function with the Alternator system being the Primary in the aircraft electrical system. The battery system within this electrical system has two sub functions: Starting Battery and Storage battery with associated components defined as the EBS.

Per AC 23.1309-1E and TSO-C179b, the Failure Condition Classification (FCC) for this TSO Battery was initially defined as “Major” during the TSO and AML STC projects. Other installations may deem the analysis lessor or greater, dependent on the function in the particular installation Aircraft.



Although many internal and external safety features have been designed per TSO-C179b and AC 20-184, failure to follow all application use, installation, charging, and storage instructions per the AML STC may result in battery damage and could lead to fire!

Installation Requirements

This article meets the minimum requirements of technical standard order (TSO) C179b. The installation of this battery system requires adherence to the AML STC SA01005DE. The article may be installed only according to 14 CFR part 43 and the applicable airworthiness and STC requirements. Below are the installation specific, in-service requirements, as identified in EarthX’s AML STC process document 18114 and is not part of the TSO Part (LRU) specific certification under TSO-C179b. The installation per STC SA01005DE requires:

- a. The maximum charge rating of 80 amps, so the aircraft alternator rated output must be 80 amps or less.
- b. The maximum voltage output from aircraft charging system shall not exceed 16 volts for a limited time. Thus, an automatic over-voltage protection device (OVPD) or system (OVPS) is required on the aircraft charging system.

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- c. The battery fault/status indicator must be installed and tested.
- d. The battery vent system must be installed and maintained per the aircraft model specific instruction (see the IMM if additional details are desired).
- e. The cranking current demand should not exceed;
 - o A Peak Power (I_{pp}) 800/390 Amps (+23C/-18C), Rated Power (I_{pr}) 600/365 Amps (+23C/-18C). Note: Old CCA spec is I_{pr} at -18C.
- f. The capacity demand (storage requirement) should not exceed:
 - o 31 Amps for 30 Minutes. Timely pilot identification and load shedding expected per normal procedures. An Electrical Load Analysis (ELA) or test is required.
- g. The battery system must be installed in such a manner and location so as to limit radiant and convection heating. The maximum short term (30 minute) environmental temperature of battery location should be less than 65°C. The maximum short term (30 minute) environmental temperature of battery location while the aircraft is on the ground shall not exceed 85°C. The battery's normal operating temperature is -30°C to 60°C.
- h. The battery is to be secured in the existing battery box or battery holder as detailed in the IMM.

For a specific aircraft installation details not required for this ICA, refer to the Installation and Maintenance Manual (IMM), EarthX document 180407.

Airworthiness Limitations

The Airworthiness Limitations section is FAA approved and specifies maintenance required under 43.16 and 91.403 of the Title 14 of the Code of Federal Regulations.

There are no new (or additional) airworthiness limitations associated with this equipment and/or installation.

FAA APPROVAL:

Instructions for Continued Airworthiness (ICA)

The Instructions for Continued Airworthiness (ICA) are required by 14 CFR part 23 for this Article (Part) installed on an Aircraft as a battery system (EBS) per AML STC SA01005DE and compiles with 14 CFR 23.1529.

The Battery Functions are considered Secondary within the electrical system for each of the Classes of Airplanes shown in Figure 2 of AC 23.1309-1E. The alternator charging system is considered Primary for this ICA.

ICA Revisions

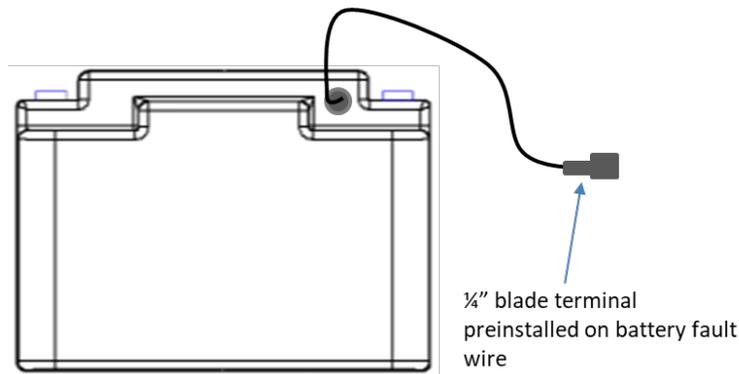
Updates and/or revisions to the ICA will be available from the documentation section of the EarthX Website: www.earthxbatteries.com. Customers will be notified of a change to the ICA via the customer's email of record.

Battery System Maintenance Requirements

The ETX900-TSO battery system contains a maintenance free battery (article) with no internal replaceable components. No inspection or testing is required for the first 24 months after purchase. Thereafter, an annual inspection of the system is required to ensure that the battery functions as designed are maintained, and that it remains installed for safe operation of the aircraft and airworthiness.

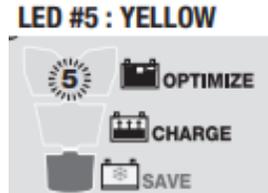
The following inspections/tests of the EBS shall be performed on an annual basis (after the first 24-month period), typically during the annual or 100 hour inspection. Any failure of the following shall result in a repair or replacement of any component in the battery system:

- 1) Visually inspect the battery for signs of damage; plastic case cracks, warped plastic or long side of the battery is swollen. Replace if damaged.
- 2) Verify the battery fault/status LED circuit is operational. To do this, use a wire jumper to connect the battery's fault output wire to battery ground (see figure inset below), and verify that the battery's internal fault LED is lit and that the external fault LED and/or EFIS indicator (on the instrument panel) is lit or indicating. If the panel mount LED is equipped with a "Push to Test" feature, verify it operates as intended as well. Repair or replace for any failures.



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- 3) Ensure the battery is fully charged. Turn off the aircraft master switch and any other battery loads, then measure the voltage at the battery terminals. A fully charged ETX900-TSO battery should be approximately 13.2 volts or greater. If not, connect an Optimate TM291 (5 amp) or TM275 (9.5amp) battery charger (or compatible LiFePO4 type) to the battery and leave the charger “On” until the charge lights indicate per the charger manufacturer indications. Optimate example:



- 4) After fully charging the battery in the previous step, allow the battery to rest overnight (minimum of 12 hours) without any load applied to the battery. Verify the battery is “holding a charge” by confirming the voltage is greater than 13.2 volts. Replace if this charge is not maintained.
- 5) Verify the battery capacity. A battery’s current capacity as compared to its original capacity is an indication of the battery’s remaining service life. A battery with greater than 80% of its original “rated” capacity is consider fit for continued airworthiness or service. If the battery capacity is less than 80%, then it must be replaced. Alternately, if the batteries tested capacity is capable of supporting the aircraft’s emergency load for the required amount of time it is consider fit for continued service. It is recommended that the article be replaced after 6 years of service. To test the battery capacity:
 - a. Fully charge the battery with an appropriate charger.
 - b. Turn on all electrical loads for cruise flight operation and start a timer.
 - c. Measure and record the battery’s discharge amps using a DC clamp-on current meter at the positive terminal of the battery.
 - d. Using the measured amps in the previous step and the battery’s nameplate rated capacity (in Ah), calculate the time to discharge the battery to 80%.

$$\text{Time to discharge 80\% (Hours)} = \frac{\text{Rated Capacity in Ah} * .8}{\text{Measured Discharge Amps}}$$

For Example, (16 Ah Rated Capacity, 5 amp measured discharge rate)

$$\text{Time to discharge 80\%} = \frac{16 * 0.8}{5} = 2.56 \text{ hours}$$

- e. Terminate the test after the number of hours calculated in the previous step has expired or if the battery is over-discharged (shuts off due to discharge current). If the battery is still supplying power at the termination of the test, then the battery’s capacity is greater than 80%. If the battery’s capacity is greater than 80% of it is rated or capable of supporting the aircraft’s

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emergency load for the required amount of time, then the battery has passed the test.

- f. Fully charge the battery with an appropriate charger.
- 6) Verify battery terminals are clean and terminal screws are properly secured (torque to 45in-lbs).
- 7) Visually inspect the vent tubes to ensure they are not blocked (plugged, pinched or kinked). Replace if damaged.
- 8) Verify the battery box and or battery restraint system is in good working order. If a foam insert is supplied to fill the void in the original battery box, verify the foam does not show signs of excessive wear and that the battery movement is less than +/- 1/8” sided to side or front to back (as measured at the bottom of the box).
- 9) Test complete, record in Aircraft Logbook with inspection info or storage log.

Aircraft Charging System Maintenance Requirements

An annual inspection or 100 Hour (check and/or test) is required for the voltage regulator and Over-Voltage Protection Device (OVPD) or System (OVS) of the aircraft charging system for safe operation of the battery and aircraft electrical system. The regulator and OVPD or OVS may physically be separate devices or in a single housing. Follow the regulator and/or OVP manufacturer’s ICA or maintenance instructions for periodic checks.

Battery Charging

If at any time the aircraft will not start, or the battery seems low, or the voltage is less than 13.2 volts, charge it for the recommended time and charge rates shown below and disconnect the charger when charging is complete. The recommended and maximum charge rate is specified on the top label of the battery. NEVER exceed the maximum charging amps for your battery.

This table shows typical charging times for the battery using the Optimate series of chargers. Refer to the manufacturer’s instructions if compatible (LiFePO4) chargers are used:

Model	Charging Amps	Charging Time
ETX900-TSO	5 amp (TM291/TM391)	3 hours
	10 amp (TM275)	1.5 hours

Lithium batteries have a very low self-discharge rate which means the battery, if disconnected from the aircraft, could “hold its charge” for over a year. However, some aircraft may have systems that use a small amount of power with the “Master Switch” off. In those cases, we recommend disconnecting a battery cable, or other means, to isolate the battery during long term storage (greater than 6 months).

Only an approved battery charger shall be used, see EarthX website for compatible chargers. EarthX approves of the following example chargers:

**Optimate TM291 (5 amp) or Optimate TM391 (6 amp)
Optimate TM275 (9.5amp)**

If the battery has been over-discharged and “disconnected”, the voltage at the battery terminal should be near zero volts if the battery still has a load on it. If the battery is disconnected from the load, it will automatically reconnect internally, and the terminal voltage should return to > 9volts (remove the load by removing the positive or negative cables from the battery). In this case, simply connect the battery to a charger to restore charge (charge with 1-10 amps for 20-30 minutes), and then re-check the voltage. If the voltage is 12.8V or greater, and holding a charge, the battery should be serviceable and can be fully charged. If the battery voltage does not return to >9 volt after removing any and all loads; Step 1- connect the Optimate battery cables to the battery (red clamp to positive and black clamp to negative), Step 2- plug the charger power cord into an AC outlet. The charger should startup and go into the “Save” charging mode. If not contact EarthX technical support.

If using a Ground Power Unit (GPU), the current rating or current setting SHALL NOT be more than the max charge rate stated on the battery label or in this manual. It is recommended that a warning label is placed next to the GPU plug stating the max current allowed.



Never jump start from a car size battery or larger!



Never charge a faulty battery (a battery that will not accept a charge or hold a charge).



Never use the de-sulfate setting on your charger. Be sure the charger’s output voltage level does not exceed 15V. If the charger does not display the voltage reading, then use a voltmeter to check the voltage while charging. Use only approved LiFePO4 chargers.



If the battery gets hot while charging, discontinue charging and use.



Do not charge battery in temperatures above 140 degrees F (60C), or in direct sunlight.



When charging a battery, place it on a non-flammable surface, and remove any flammable items nearby.



For maximum battery and starting system life, do not crank an engine for more than 15 seconds within any 1 minute period.

Battery End of Life

The ETX900-TSO battery expected life is 6 years. However, the following conditions indicate battery end-of-life and the battery should be replaced to ensure continued airworthiness:

- Insufficient capacity per annual or 100 hour maintenance requirements above
- Insufficient power to crank engine
- On-going battery fault indication (refer to the “Battery Operation” section of this manual or the “Troubleshooting” section of the IMM)
- Will not hold a charge (>13.2 volts a week after charging the battery to full charge)
- 6 years of in-aircraft service (Recommended)



At battery end-of-life contact EarthX for replacement options.

Batteries can be recycled at any location accepting lithium-ion type batteries. Drain battery and/or cover terminals with electrical insulating tape prior to recycling. For recycling information and where to recycle check this website (www.call2recycle.org/).

Battery Storage and Handling

If the Aircraft is to be put in storage for an extended period of time (> 6 months), disconnect the battery cable to eliminate drain from the Aircraft’s electrical system. A fully charged battery can be put in storage for up to a year without charging, but should be charged and inspected annually.

EarthX batteries can be stored at temperatures between -40°C to +70°C. The batteries have no liquid inside and will not freeze.

Special care must be taken in the handling, shipping, and storage of rechargeable lithium batteries. As a result, installers, end users, and personnel involved in the maintenance, and disposal of rechargeable lithium batteries requires training in the special characteristics related to rechargeable lithium battery safety. Leaving battery output terminals or leads exposed may result in external short-circuiting of the battery during shipping, handling, testing and installation. Terminals of batteries shall be covered with non-conductive protective devices to avoid any possibility of shorting during handling, shipping, and storage.



Do not incinerate or expose to open flames!



The MSDS is available on EarthX’s website.



Always follow the manufacturers recommended safety precautions and procedures.

Battery Operation

Under normal operating conditions the battery performs as any lead acid battery, storing energy from the charging system and supplying it when the charging system is off.

There are no new or special pilot operating procedures for this battery beyond the existing aircraft PoH or AFM instructions. An in-flight loss of battery functions is indicated by aircraft current and/or voltage meters and is augmented by a battery fault/status light.

Terminology

The following table describes the battery terminology used in this document.

Ah	Amp-Hour is a unit of measure of charge that can be stored in a battery.
BMS	The Battery Management System refers to the collection of electronics responsible for monitoring and controlling the cell charge level, providing over charge protection and over discharge protection.
Cell	A single encased electrochemical unit (one positive and one negative electrode) which exhibits a voltage differential across two terminals.
EBS	ETX900-TSO Battery System
OEM	Original Equipment Manufacturer
OVPD/S	Over-Voltage Protection Device/System

Reference Documents

14 CFR part 23	AIRWORTHINESS STANDARDS: NORMAL, UTILITY, ACROBATIC, AND COMMUTER CATEGORY AIRPLANES	Dated 1/31/2001 Subpart G – 14 CFR 23.1529
AC 20-184	Guidance on Testing and Installation of Rechargeable Lithium Battery and Battery on Aircraft	Dated 10/15/15 (or latest revision)
AC 23-22	Guidance for approved model list (AML) supplemental type certificate (STC) approval for part 23 Airplane avionics installations	Dated January 27, 2005 (or latest revision)
AC 23.1309-1E	System Safety Analysis and assessment for part 23 Airplanes	Dated 11/17/2011
AC 43.13-1A CHG 1	ACCEPTABLE METHODS, TECHNIQUES, AND PRACTICES AIRCRAFT INSPECTION AND REPAIR	Dated 09/27/2001
TSO-C179b	Rechargeable Lithium Batteries and Battery Systems	Dated 3/23/18

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