200408

Instructions for Continued Airworthiness (ICA) ETX680-24-TSO Battery

Revision Log

Rev	Description	Date	Approved By:
Draft	Draft	7/12/2020	R.Nicoson

Table of Contents

Overview – Purpose

This manual covers the TSO Article (Part) installation aspects for the ETX680-24-TSO Battery to be installed on 14 CFR part 23 Aircraft. Installations of rechargeable lithium batteries defined herein, are expected to meet the guidance of AC 20-184. This TSO Battery meets the applicable TSO-C179b and is targeted for installation in 14 CFR part 23 airplanes. Refer to AC 20-184 for full Aircraft installation guidance and requirements not the subject of this manual.

In the spirit of an AML STC, this ICA is intended for general use and reuse with specifics contained in the appendices for a specific model. Additional models using the Model Qualification Process (MQP) will be added to the AML-STC.

The EarthX Lithium battery is designed as a maintenance free replacement for 24-volt lead-acid or lithium starter batteries. The ETX680-24-TSO battery is part of the electrical system as a Secondary function with the Alternator system being Primary in the aircraft electrical system. The battery within this system has two sub functions: Starting Battery and Storage battery.

Per 14 CFR 23.1309-1E and TSO-C179b, the Failure Condition Classification (FCC) for this TSO Battery was initially defined as "Major" during the TSO project. Other installations may deem the analysis lessor or greater, dependent on the function in the particular installation Aircraft. Operation in an over-voltage condition (greater than 32 volts) may potentially result in a dangerous battery failure. Additionally, the safety of the aircraft may be compromised, if the battery is not properly sized to provide adequate emergency power, according to the aircraft essential system design load and duration.

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 may result in battery damage and could lead to fire!

Installation Requirements

"This article meets the minimum requirements of technical standard order (TSO) C179b. Installation of this article requires separate approval." The article may be installed only according to 14 CFR part 43 and the applicable airworthiness or STC requirements. Below are the installation specific, in-service requirements and is not part of the TSO Part (LRU) specific certification under TSO-C179b:

a. The maximum charge rating is 70 amps, so the aircraft alternator rated output must be 70 amps or less or the appropriate aircraft controls in place to limit peak recharge current to 70 amps or less.

b. The maximum voltage output from aircraft charging system shall not exceed 32 volts. Thus, an automatic over-voltage protection device (OVPD) is required on the aircraft charging system.

c. The battery fault monitoring indicator must be installed and tested.

d. The battery vent system must be installed per the IMM or aircraft model specific TC/STC Installation and Wiring Diagram (IWD) instruction.

e. The cranking current demand should not exceed; a Peak Power (Ipp) 850/400 Amps (+23C/-18C), Rated Power (Ipr) 500/250 Amps (+23C/-18C). Note: Old CCA spec is Ipr at -18C.

f. The capacity demand (storage requirement) should exceed 30 minutes, plus 5 minutes for pilot identification. Timely pilot identification and load shedding assumed per normal procedures. An Electrical Load Analysis (ELA) is required.

g. The battery must be installed in such a manner and or location 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 should be secured in the existing battery box or battery holder as detailed in this manual and aircraft model specific TC/STC instructions.

For a specific aircraft installation, refer to the documentation listed in the Appendix of this manual.

Airworthiness Limitations

The conditions and tests for TSO approval of this article are minimum performance standards. Those installing this article, on or in a specific type and class of aircraft, must determine that the aircraft installation conditions are within the TSO standards. The article may be installed according to 14 CFR part 43 or the applicable airworthiness requirements. 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 supplemental Instructions for Continued Airworthiness (ICA) are required by 14 CFR part 23 for this Article (Part) installed on Aircraft (14 CFR 23.1529 for this application and TSO).

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. Per AC 23.1309-1E and reference TSO-C179b, the Failure Condition Classification (FCC) for this TSO Battery is "Major". For this ICA and Battery there is no complex hardware or software. However, other installations may deem the analysis lessor or greater, dependent on the function in the particular installation Aircraft.

ICA Revisions

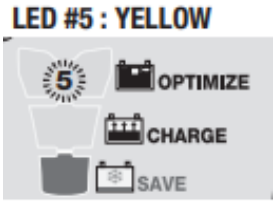
Updates and/or revisions to the ICA will be available from the documentation section of the EarthX Website: www.earthxbatteries.com. Customers will be notified of a change to the ICA via the customer's email of record.

Battery Maintenance Requirements

The ETX680-24-TSO battery is a maintenance free battery with no internal replaceable components. No inspection or testing is required for the first 24 months after purchase. Thereafter, an annual inspection is required to ensure that the battery functions as designed and installed for safe operation of the aircraft.

The following inspections/tests shall be performed on an annual basis (after first 24-month period), typically during the annual inspection:

1) Visually inspect the battery for signs of damage; plastic case cracks, warped plastic or long side of the battery is swollen.
2) Verify the battery fault monitoring LED circuit is operational (not required for digital communications). 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. Alternately, if the panel mount LED is equipped with a "Push to Test" feature, it can be used in lieu of the wire jumper method described above.
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 battery should be 26.6 volts or greater. If not connect an Optimate TM281 (5 amp) battery charger to the battery and leave the charger "On" until the charge lights (Save, Charge and Optimize LEDs in the center of the charger) are extinguished.



4) After fully charging the battery in the previous step, allow the battery rest over-night (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 26.6 volt.
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 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 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%.

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

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

$$\text{Time to discharge 80\%} = \frac{16 * .8}{5} = 2.56 \text{ hours}$$

    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 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 rated or capable of supporting the aircraft's 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).
8) Verify the battery box and or battery restraint system is in good working order.
9) Test complete, record in Aircraft Logbook with inspection info or storage log.

Aircraft Charging System Maintenance Requirements

An annual inspection (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 OVP manufacturer's ICA or maintenance instructions for annual checks and or tests.

Battery Charging

If at any time the aircraft will not start, or the battery seems low, or the voltage is less than 26.4 volt, 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:

Model	Charging Amps	Charging Time
ETX680-24-TSO	5 amp (TM281 Charger)	3 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 from the battery during long term storage (greater than 6 months).

Only an approved battery charger shall be used:

Optimate TM281 (5 amp)

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 and the terminal voltage 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 25.6V or greater and holding a charge, the battery should be ok and can be fully charged. If the battery voltage does not return to >20 volt after removing any and all load. Then (step 1) connect the Optimate battery cables to the battery (red clamp to positive and black clamp to negative), next (step 2) plug the charger power cord into 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 30V. If the charger does not display the voltage reading, then use a voltmeter to check the voltage while charging.

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

- Insufficient capacity per annual 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 Installation and Maintenance Manual (IMM), 200407
- Will not hold a charge (>26.4 volts a week after charging the battery to full charge)
- 6 years of in-aircraft service

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.

Our batteries can be stored at temperatures between -40°C to +70°C. Our 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.**

Terminology

The following table describes the 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.
OEM	Original Equipment Manufacturer
IEC	International Electro-Technical Commission on safety standards.

Reference Documents

AC 20-184 Dated 10/15/15 (or latest rev)	Guidance on Testing and Installation of Rechargeable Lithium Battery and Battery on Aircraft
AC 43.13-1B CNG1 Dated 9/8/98 (or latest rev)	ACCEPTABLE METHODS, TECHNIQUES, AND PRACTICES - AIRCRAFT INSPECTION AND REPAIR