

Installation & Maintenance Manual (IMM), ETX900- TSO Battery

Revision Log

Rev	Description	Date
New	Created New	4/07/2018
A	Update to limitations, DO-311A	8/30/2018
B	Updated elect.& mech. Installation sections; Incorporate FAA AEG comments.	11/24/2020
C	Updated Appendix for PA-28, M20, PA-18, Husky Installs	1/23/2022
D	Updated for AFM inclusion error. Removed references	5/13/2022
E	Add Appendix for Mooney M20	8/16/2022
E1	Changed Revision Log column width; Page Header text change to ETX900-TSO; Specs Table changes (removed Charge Cycle Life and text change “Life” to “Rated Life”); text “ETX Hundred” and “ETX” changed to ETX-Hundred; Added TM391 charger to Charging Section; removed Alt from Min Cruise Load in Appendix IV	9/9/2022
F	Add Appendix for Aviat	9/10/2022

FAA ACTION	
DENVER AIRCRAFT CERTIFICATION OFFICE	
<input type="checkbox"/> APPROVED:	<input type="checkbox"/> Concur:
<input checked="" type="checkbox"/> Accepts: EarthX, Installation & Maintenance Manual (IMM), ETX900-TSO Battery, 180407 Rev F	<input type="checkbox"/> Reject:
FAA Project Number: SP07753DE-A	
Comments: ACO Acceptance of revisions to document necessary to allow installation on the Aviat A-1 Series models.	
FAA Safety Engineer Signature	Date



I C O N K E Y	
	Valuable information
	Caution

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Overview

EarthX Lithium batteries are designed as a maintenance free replacement for the 12-volt lead-acid or lithium starter batteries. For this manual, the battery performs two functions within the airplane electrical system; 1- The Starting Battery (Function) and 2- The Storage Battery (Function) in the electrical system for Category I and II, part 23 Aircraft. The alternator charging system is considered the primary source of electrical power during flight with the battery being secondary. Per 14 CFR 23.1309-1E and TSO-C179b, the Failure Condition Classification (FCC) for this TSO Battery is “Major” - unless other installations deem the analysis lessor or greater, dependent on the function(s) in the particular installation.

This manual covers the TSO Article (Part) installation aspects for the battery. This manual is an accompanying manual to the Instructions for Continued Airworthiness (ICA) manual.



Failure to follow all application use, installation, charging, and storage instructions may result in battery damage and/or fire! Never disassemble the battery or disable the built-in Battery Management System (BMS).

Technology Inside

Battery Cells

Our batteries use cells made of Lithium Iron Phosphate (LiFePO_4). This chemistry is one of the highest performance types, and the safest on the market today.

Lithium batteries are fundamentally different than lead-acid batteries. A lithium battery voltage remains relatively constant while discharging, while voltage for a lead-acid battery steadily decreases. As such, a 16Ah lithium battery has the equivalent “useable” capacity of a 22Ah lead-acid battery. Also, a lithium battery’s cranking power is stronger, for the voltage while cranking is generally higher.



LiFePO_4 cells by the nature of their chemistry are 3.3 volt. 12V lithium batteries are created by using 4 cells in series (technically it is a 13.2-volt battery, but nominally full charge voltage is $>13.3\text{V}$). Lead-acid batteries are made with 6 cells in series. Another difference is that lithium cells are a dry cell technology, where the cells are packaged individually. As such, the individual cell’s charge level will diverge with repeated charge/discharge cycles and age. This condition would reduce the performance of the battery (reduces capacity) without a Battery Management System to monitor, control and protect the cells.

BMS

EarthX’s integrated Battery Management System (BMS), part number BMS_DR, monitors each cell’s voltage as part of the cell balancing and over-charge protection. If the voltage of a cell exceeds the others, the BMS circuits will work to reduce that cell’s charge level. This ensures that the charge level of all the cells remains equal, even with the high discharge ($>100\text{Amps}$) and charge current ($>10\text{Amps}$) of your aircraft.

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The ETX900-TSO BMS has the following features: over-charge protection, over-discharged protection (completely draining the battery), excessive cranking protection, high temperature protection and short-circuit protection. **The BMS was designed to Design Assurance Level (DAL), C (major).**

The BMS disconnects the battery from the load if it is drained to less than 5% of remaining charge (an over-discharge condition). An over-discharged battery typically has a voltage less than 11.5V. If the BMS disconnects the battery, the voltage reading of the battery will be zero volts. Excessive cranking protection logic includes temperature monitoring to limit “high current use” (engine cranking) to 10 -30 seconds in any 60 second period. If the battery terminals are “shorted” (or a low impedance load is connected across terminals), which causes the battery volts to instantaneously drop to a very low level, the battery will disconnect from the load to protect the cells and BMS from damage (short circuit protection). If the BMS disconnects due to excessive cranking protection or short circuit protection, the BMS will automatically reconnect after a cooldown period (typically 1-3 minutes). The BMS is designed for short circuit protection > 1000 Amps.

All components associated with the main electronic battery disconnect are redundant. The built-in redundancy ensures that no single point of failure results in the battery unintentionally disconnecting. The battery also includes a thermal run-away containment system. The design aligns with the requirements for a FAA approved lithium battery per RTCA performance specification DO-311A and DO-160G.

In the event of a charging system failure where the voltage increases above 16V, the charging current is blocked. The time delay for this feature is approximately 2 seconds to allow the aircraft alternators over voltage protection to activate first (typically less than 100ms). This design offers charge voltage protection greater than 100V. The discharge current (current out of battery) is unaffected in this situation. EarthX requires that an aircraft have a redundant (external of the battery) automatic over-voltage protection device or system (crowbar or other means of shutoff) for alternator type charging systems.

The battery’s micro-controller (BMS) monitors all failure modes, and reports failures with a built-in LED indicator and discrete output. The discrete output for external fault monitoring is a single wire connection with a ¼” quick connect terminal. The output is a “current sinking” (Active Low) type circuit (see diagram below) that can sink 100mA (connects the discrete output to battery ground if a fault is present). This output can be connected to an external 12V LED or general-purpose discrete input of an EFIS. The fault output has three states: fast flashing (2 seconds on/2 seconds off), slow flashing (5 seconds on/5 seconds off) or solid. The fast-flashing fault is an indication of high temperature; temperature exceeding the normal operating or storage limits of the battery (>75C). The slow flashing fault can indicate an improper state of charge or a problem with the cells internal to the battery. The solid (LED steady on) fault indicates a BMS hardware failure.

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 requirements (such as an STC). Refer to AC 20-184 for full Aircraft installation guidance and requirements not the subject of this manual. Below are the installation specific, in-service requirements as identified in EarthX’s AML STC process document 18114-03 and is not part of the TSO Part (LRU) specific certification under TSO-C179b:

- The maximum charge rating is 80 amps, so the aircraft alternator rated output must be 80 amps or less.
- The maximum voltage output from aircraft charging system shall not exceed 16 volts. Thus, an automatic over-voltage protection device (OVPD) is required on the aircraft charging system.
- The battery fault/status monitoring indicator must be installed and tested.
- The battery vent system must be installed (see installation section of this manual).
- The cranking current demand should not exceed those listed in the Specification section below. Note: Old CCA spec is Ipr at -18C.
- The capacity demand (storage requirement) should not exceed 31 Amps for 30 Minutes. Timely pilot identification and load shedding assumed per normal procedures. An Electrical Load Analysis (ELA) or measurements is/are required.
- 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.
- The battery should be secured in the existing battery box or battery holder as detailed in this manual or aircraft manufacturer’s manual.

The maintenance must comply with the requirements of the Instructions for Continued Airworthiness (ICA), a separate document.

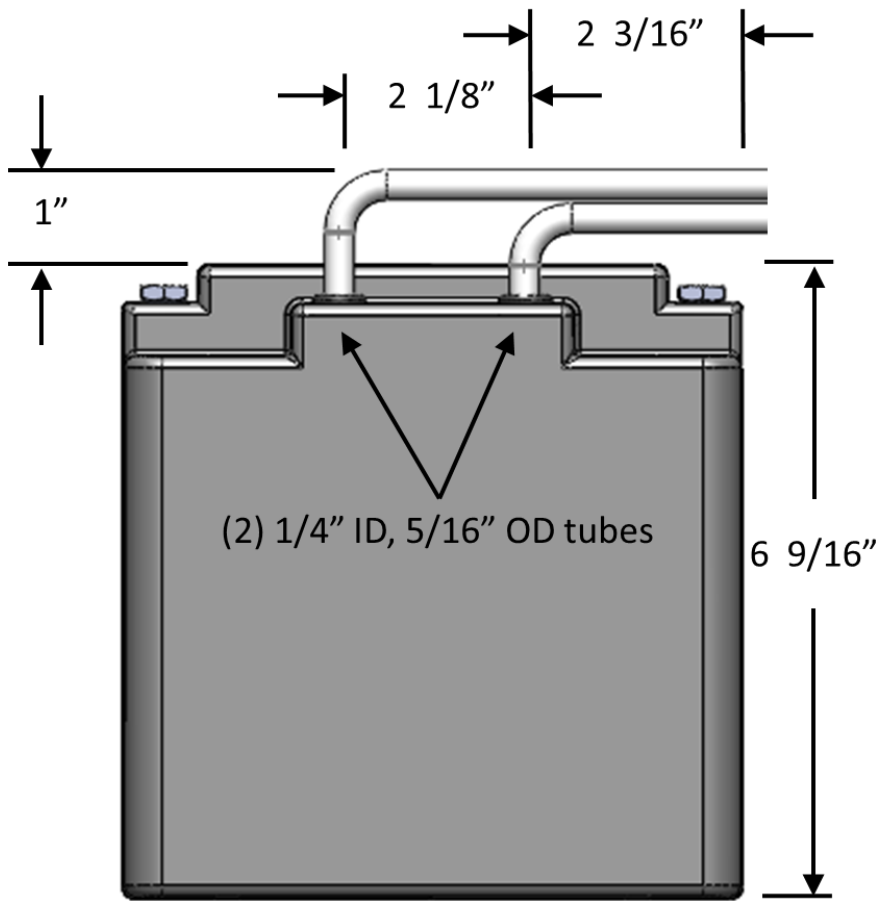
Specifications

Model: ETX900-TSO

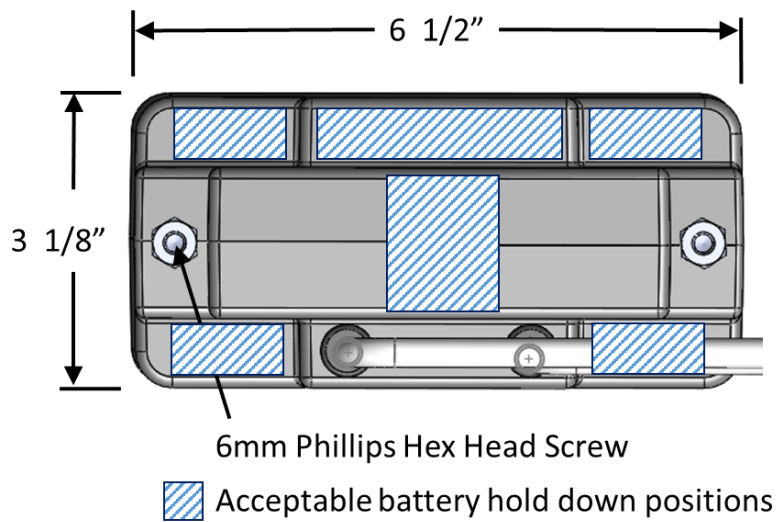
Voltage	13.2 V
Capacity (1C, 1hour rate at 23 °C)	15.6Ah @ 1C rate (See below)
Capacity vs Temperature	25 °C = 15.6Ah 0°C = 15.3Ah -30°C = 15.0Ah
Self-Discharge Rate	<3%/month @ 25°C
Peak Power (Ipp), 23/-18 °C	800 / 390 amps
Rated Power (Ipr), 23/-18 °C	600 / 365 amps
Max Continuous Discharge Amps (Discharging 100% of capacity)	31A
Standard Charge Voltage	13.9 - 14.6 V
Recommended Charger/Maintainer Amps	.8 - 20A
Max Charge Amps	80A (from aircraft charging system)
Rated Life (recommended replacement time)	6 Years
Weight	5.4lb
Dimensions	6.5in (L) x 3.1in (W) x 6.6in (H) 166mm(L)x79mm(W)x168mm(H)
Environmental Rating (resistance to water intrusion)	IP 66 (wash down with a high-pressure washer)
Operating Temperature (short term)	-30 °C to +60 °C (+65 °C)
Storage & Ground Survival Temp	-40 °C to +70 °C
Short Term Ground Survival Temp	85 °C (30 minutes)
Maximum Altitude	25,000 Ft
Shelf Life	1 year (without charging)
FAA Standard Order	TSO-C179b
Design Assurance Level (DAL)	C (major)
Flammability Rating (case and vent tube)	14CFR 25.853 (a)

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Back View



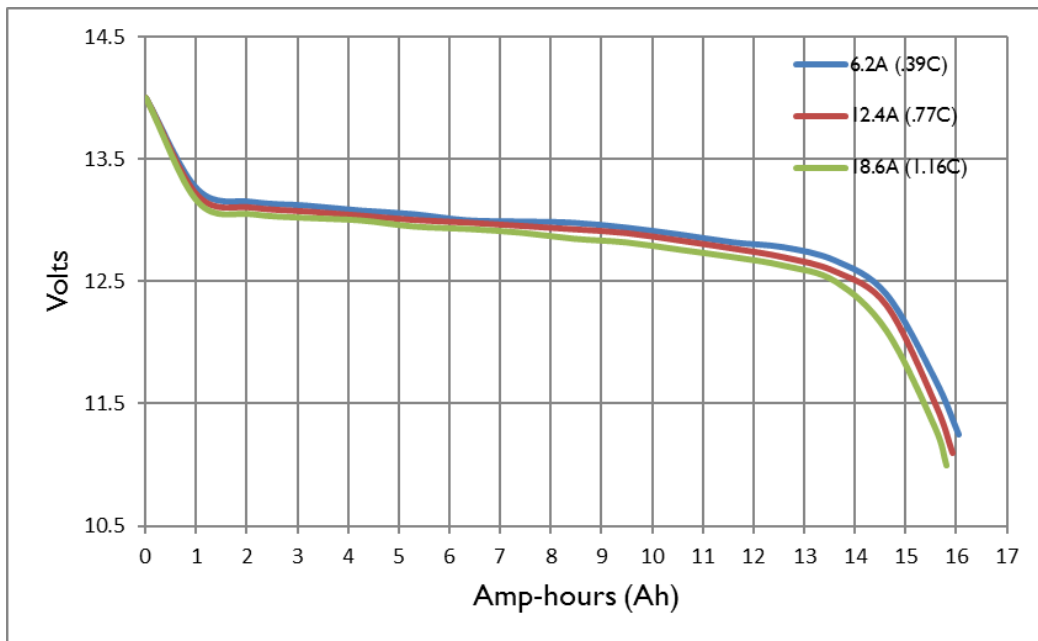
Top View



Discharge Curves

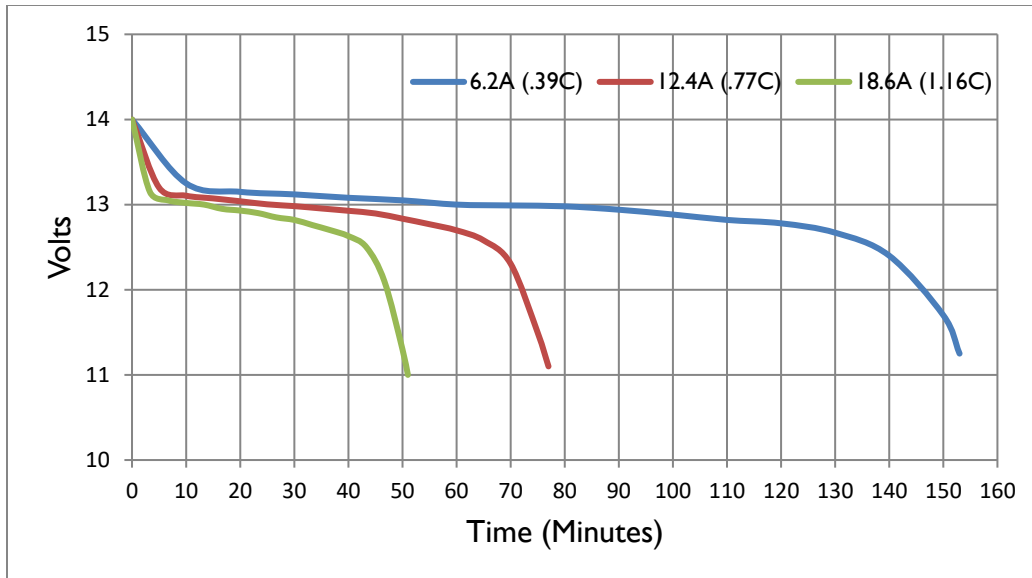
The first graph below shows the state-of-charge versus voltage (various discharge rates). Typically, lithium batteries require advanced methods like current counting to track the charge level. As seen from the graph, the voltage only varies .4V for nearly 80% of the discharge cycle at 25 Deg C. 13.4V is a good indication of full charge, while 12.7V is an indication of a discharged battery at 25 Deg C.

The graph below also illustrates that usable Ah is nearly the same regardless of the discharge rate (discharge graph lines are nearly on top of each other), with the voltage remaining above 11.5V for most of the discharge cycle.



Discharge Capacity

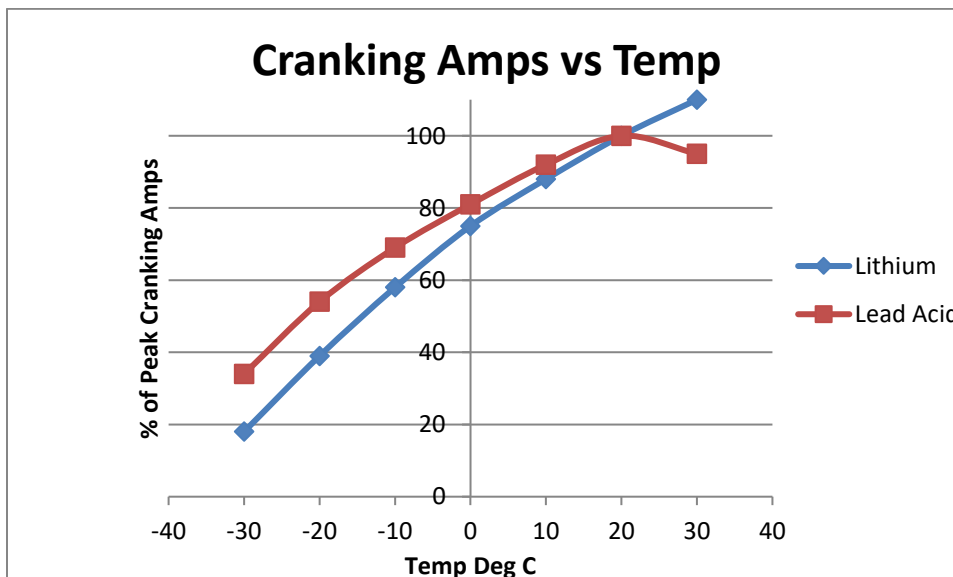
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Discharge Time

Discharge Versus Temperature

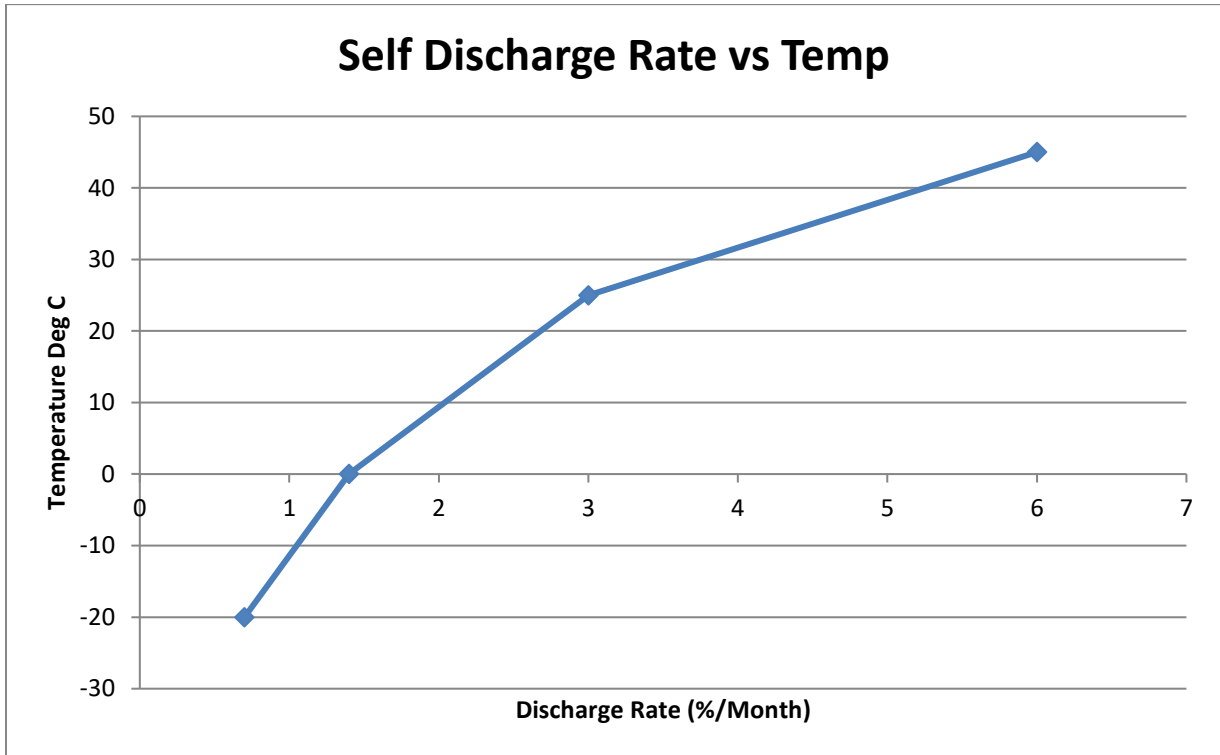
Aircraft batteries use a similar Cold Cranking Amp test standard as the lead acid battery manufacturers (SAE test performed at 0°F, but 15 second discharge time vs 30 second). As such, our battery with a similar CCA rating as a lead acid battery should provide the same cranking performance at 0°F. But, below 0°F an equivalent lead acid battery will outperform a lithium battery (see the graph below).



Like lead acid batteries, lithium batteries' discharge performance is lower as the temperature decreases, meaning the voltages and the Ah are lower. Note: there can be as much as a 15% decrease in Ah and discharge voltage at -30°C as compared to 25 °C.

Self-discharge Rates

The self-discharge rate is dependent on temperature. At high temperatures ($>25^{\circ}\text{C}$), the cell internal resistance decreases so the self-discharge rate increases. See the graph below for self-discharge rates (in % per month) versus temperature.



Installation

The instruction given in this section are generic. For a specific aircraft, refer to the documentation listed in this manual appendix and/or aircraft manufacturer's manual.



Remove all metal objects from your person before handling the battery and use insulated tools for installation.



The power terminals are ALWAYS live. Do not short across the terminals. Use caution when handling the battery inside the aircraft around metallic structures.

Battery Installation Location

The battery is designed to be mounted in a variety of locations within the aircraft including the engine compartment, baggage compartment or cabin, as long as the environmental condition in those locations do not exceed the battery's specifications (see the specifications section and environmental qualification section of this manual). The battery can be mounted in any position, such as upright or on its side. Refer to specific AML STC documentation for approved installations.

In the extremely improbable event of a battery thermal runaway the external surfaces of the battery may reach 250°F and the vent gas tubing may reach 300°F. The battery and vent tube shall not be located near or touching aircraft structures that could be damaged by such temperatures.

Battery Installation

It is recommended you check the battery voltage before installing. If the voltage is below 13.2V, charge the battery before installing. Follow these steps to properly, and safely, install your new battery. Qualified personnel should inspect the box, connections, and venting provisions in accordance with AC 43.13-1B Section 2. STORAGE BATTERIES (refer to 11-19). BATTERY MAINTENANCE (including d. Mechanical Integrity).

1. Remove the old battery, while paying attention to the routing and placement of wires, cables, and protective covers.
2. Check the battery cables and connectors for corrosion or damage. Pay special attention to the positive battery cable (red cable), checking for cuts or wear marks in the insulation. Clean and or replace the battery cables as required.
3. Mount the battery in the existing battery box with the approved spacer (see Appendix for specific instructions).
4. Connect the positive (red) cable first. Make sure the Phillips screw is securely fastened (45in-lbs), but do not over-tighten. Next, connect the negative (black) cable and tighten screw to 45in-lbs. Do not connect the battery in reverse polarity (positive to negative or negative to positive).
5. Re-install the battery holder or strap and tighten securely. Re-secure all the wires and cables.

Battery Vent Installation

The ETX900-TSO includes a thermal run-away containment system. The containment system includes vent tubes designed to carry vapor or smoke to the exterior of the aircraft in the event of a thermal run-away condition. There are no emissions during normal operation. Both tubes exiting the battery are for outflow, and both are required. For specific installation instructions based on a specific model aircraft and or battery mounting location, see the Appendix. Follow the below guidelines for properly installing the vent tubes:

- Route the vent tubes to the outside of the aircraft or a compartment sealed-off from the passenger cabin that is vented to the outside. Be sure emitted gases will not be directed to cabin air intakes. Vent tubes should use existing battery drain fittings on exterior of the aircraft if available.
- Routing of vent tubes should include a 6" vertical section after exiting the battery and a downward slope so condensate drains to the outside of the aircraft.
- Secure the vent tubes within 12" of the battery and within 12" of the aircraft exit
- Be careful not to crush or restrict flow through the tubing.
- The minimum bend radius is 3"; tighter bends could cause the tubing to kink.
- The two 1/4" ID tubing can be connected to a wye fitting with 3/8" outlet tubing that leads to the outside of the aircraft.
- Only EarthX supplied tubing should be used. The tubing is chemical resistant and rated for 400°F (1/4" ID or 3/8" ID Teflon tubing).
- To install tubing to barbed fittings it is helpful to heat the tubing to a couple hundred degrees F.
- Be sure the entire barbed part of the elbow is completely inserted into the tubing.

The supplied stainless-steel elbows allow the vent tubes to be routed to the left or right side of the battery with minimal headroom requirements (1" above the battery height). The tube stubs on the battery can be cut to different lengths so the tubing can be routed one on top of the other. Additional barbed fittings may be used if they do not restrict flow. Fittings must be brass, stainless, Teflon or other material with at least a 400 °F temperature rating (i.e. nylon). Barbed fittings must not restrict flow.



Installation of the battery in the cockpit requires the battery is properly vented over-board.

Fault Monitoring Installation

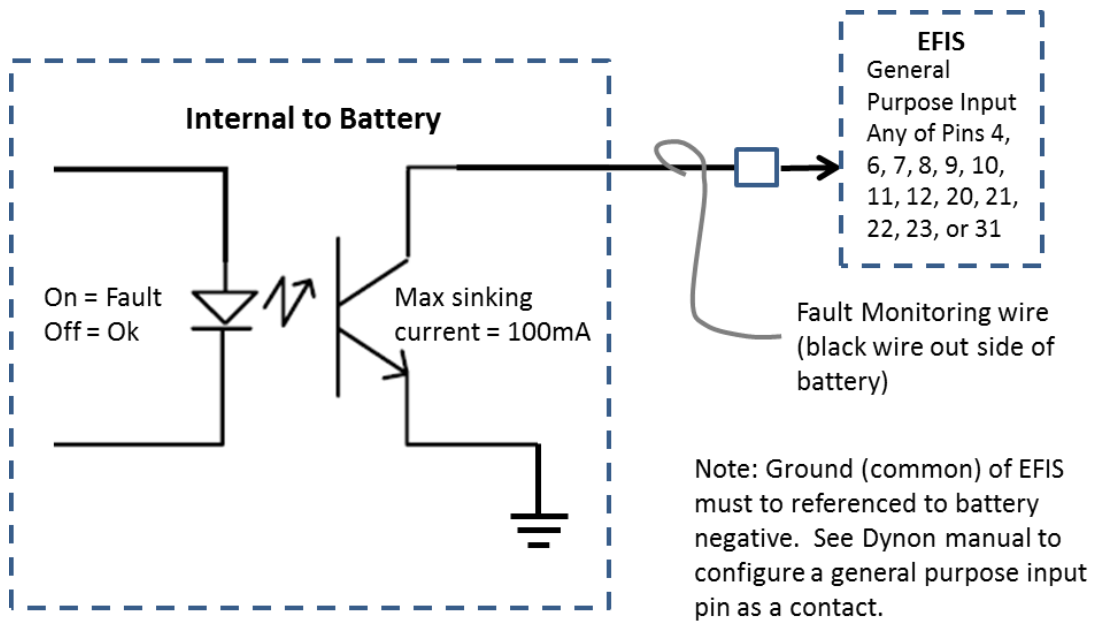
The ETX-Hundred Series batteries have a discrete output that can be connected to many aircraft Electronic Flight Instrument System (EFIS) electronics or to a remote mounted LED. The diagrams below detail the required connections for both type installations.

The discrete output for external fault monitoring is a single wire with 1/4" quick connect terminal. The 1/4" quick connect terminal is an insulated "female" type and should be compatible with most other manufacturers male 1/4" quick connect terminals. The following two examples detail how to

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connect the fault monitoring output to an EFIS general purpose discrete input. The EFIS DC source negative must be referenced to the battery negative (this is the standard configuration).

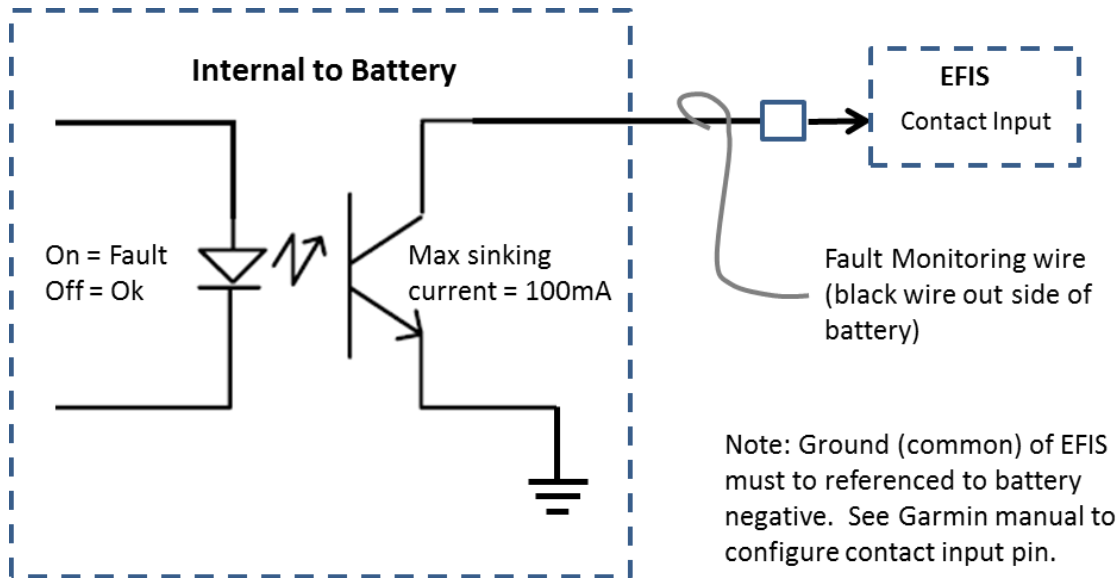
Fault Monitoring Connection to Dynon Avionics



Configure the input as “active low”, “alarm” type. Note; when Dynon power is off the LED inside battery may be dimly lit (less than 120uA, too small to drain the battery).

Fault Monitoring Connection to Garmin EFIS

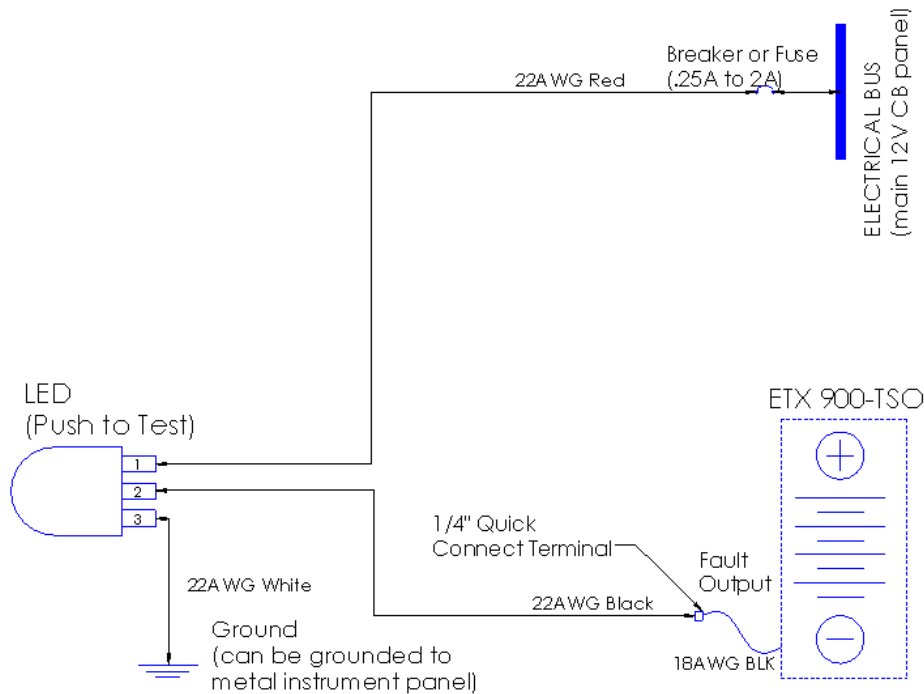
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Configure the digital input (contact input) as “active low”, “user defined alert” type.

Fault/Status Connection to 12V LED

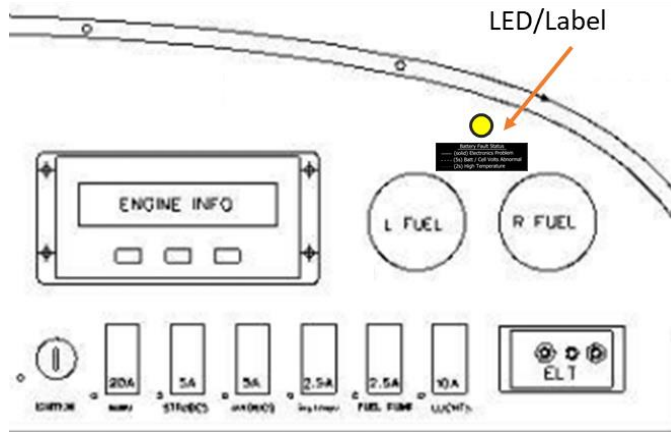
Connect the LED’s red wire to a spare or existing fuse or breaker off the electrical bus. Use any .25 Amp to 2 Amp fuse or breaker. Connect the LED’s white wire to aircraft ground. The black wire is to be connected to the battery’s fault output (black wire), using a male 1/4” quick connect terminal.



Fault/Status Indicator (LED) Install Procedure

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A suitable location for the Fault/Status Indicator will be determined by the installer. One example is shown below, but aircraft will vary. Find an open area that will not interfere with other equipment and in plain view of the pilot. LED must be visible in all operating conditions. Follow shop best practice and/or AC 43.13 guidance.



1. Removed trim panel - drill a 7/16" hole in the panel.
2. Remove one panel nut from the LED housing and feed the LED housing thru the hole from the back side of the panel.
3. Secure the LED in place with the panel nut removed in the previous step.
4. Secure the LED Placard (1" x 3") to the trim panel in close proximity to the LED.
5. Route the black wire from the LED to the battery box through main wire bundle, secure in place with zip ties. Follow shop best practices and AC 43.13 guidance. **See Appendix for wiring and routing diagrams.**
6. Cut the black signal wire to length leaving a few inches of service loop at the battery.
7. Attach the "male" quick connect to the black wire. Then plug the male spade connector into the battery's female spade connector.
8. Behind the instrument panel, route the red wire (with inline fuse) to the instrument (or lights) circuit breaker (10A Typical); crimp (supplied) #6 ring lug to wire and secure to breaker.
9. Route the white wire to an adequate or available ground stud, crimp on (supplied) #6 ring lug and secure in place.

Return to Service Checks (Tests)

Follow these steps to check the battery operation prior to returning to or putting in service:

1. Verify the vent tube protruding for the aircraft can NOT be pushed up and into the interior of the aircraft with the force of an index finger.
2. Apply power to the aircraft via master switch, observe proper voltage, greater than 13.1V.
3. Verify the battery Fault/Status LED is off.
4. Press the LED "push-to-test lens" and observe the LED illuminates.
5. At the battery, jumper the fault/status discrete output to battery negative terminal using a test clip and verify BOTH the panel LED and battery LED are lit.

6. Configure the aircraft for typical cruise loads and verify it is less than 31 amps. Also, configure aircraft for minimum cruise load (load shed condition) and verify it is less than 16 amps. If either exceeds these values, conduct a complete Electrical Load and Capacity Analysis as detailed in the Appendix.
7. Verify engine starts as normal.

Aircraft Voltage Monitoring Equipment (if applicable)

The table below shows the recommended user alerts based on voltages when in flight. This pertains to existing aircraft equipment and is not applicable if existing low or high voltage alerts do not exist or are not adjustable.

The low charge level is very different from a lead acid battery, for a lithium battery is completely drained at approximately 11.5V, and the normal resting voltage is 13.3V.

Note: this table pertains to existing voltage level warning equipment and is **NOT** associated with the Fault monitoring LED.

Voltage	User Alert
>15V	High voltage warning
<13.5V	Alternator off-line alert
<12.8V	Low charge level warning

Replaceable Parts

There are no replaceable parts.

Operating Instruction

While in flight the battery fault/status indicator should be monitored. The indicator can be monitored either by an LED or input to an EFIS where approved. The fault codes are considered cautionary or advisory only.

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.

Normal 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. Under normal operation the LED is OFF.

Abnormal Operation

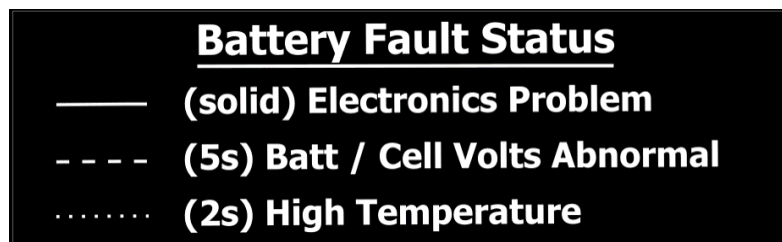
A battery fault in flight is categorized as ABNORMAL and the following conditions and actions then apply.

The table below is a summary of the battery's fault/status codes (discrete output).

LED Light	Airplane Voltage/Current	Battery Possible Cause	Recommended Action
Slow Flashing (5s on/5s off)	12.8-14.6V or current indicating normal charge or discharge	Cell to cell charge level imbalance. May come on briefly (less than 60 minutes) during or following periods of high current charging	No pilot action is required in flight. The pilot should report a battery problem to maintenance personnel when back on the ground. Do not dispatch aircraft.
Slow Flashing (5s on/5s off)	Less than 12.8V/ amp meter shows discharge / or alternator warning light on	Charging system is not functioning (battery is being discharged or at a low state of charge)	Pilot to follow POH procedure for faulty alternator. Do not dispatch aircraft.
Solid Light	Any voltage or current	BMS electronics problem	No pilot action is required in flight. Continue to monitor aircraft bus voltage and or current. The pilot should report battery problem to maintenance personnel when back on the ground. Do not dispatch aircraft.
Short Flashing (2s on/2s off)	Any voltage or current	High battery temperature ($> 75^{\circ}\text{C}$ / 167°F)	No pilot action is required in flight. The pilot should report battery problem to maintenance personnel when back on the ground. Do not dispatch aircraft until battery has cooled and fault cleared.

Placard

A placard (P/N: 200208) is provided, and installed, adjacent to the Fault/Status Indicator LED (see image below).



A sustained fault can indicate a serious issue with the battery or aircraft charging system that requires attention. Discontinue use until the issue is resolved and the battery no longer indicates a fault.

Continued use of a faulty battery can result in a cell rupture, and the release of flammable vapors, and or smoke (through vent system and to outside the aircraft).

Maintenance

The ETX900 battery is a maintenance free battery with no internal replaceable components. Charging is only required on an as needed basis (see charging section in this manual).

Inspection and testing are required annually. For more details, see the ICA.

Weight and Balance

A lithium battery is generally 25-30% of the equivalent lead acid battery weight, so weight and balance must be considered (see Appendix for more details).

Charging



Failure to follow these instructions may result in damage to the battery!



Never jump start from a car size battery or larger!

If the battery fault/status indicator LED slowly cycles 5 second on then 5 seconds off and/or the aircraft bus voltage is less than 12.8 volts, or the aircraft will not start, or the battery seems low, 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
ETX900-TSO	5 amp (TM291/TM391 Charger)	3 hour
	10 amp (TM275)	1.5 hour

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 LiFePO4 type battery charger shall be used; Optimate TM291 (5 amp), TM391 (6amp) or TM275 (9.5amp). Call the factory for more information or additional approved models.

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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 connected. If the battery is disconnected from the load, it will automatically reconnect, and the terminal voltage will 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 ok and can be fully charged. If the battery voltage does not return to >9 volt after removing any and all of the loads, 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 be placed next to the GPU plug stating the max current allowed. Call EarthX for a label, when required.



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.



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.

Storage

If the Aircraft is to be put in storage for an extended period (> 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.

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



Do not incinerate or expose to open flames!

Warranty

EarthX Inc. (Manufacturer) warrants its ETX-Hundred Series lithium batteries (hereafter referred to as Battery or Batteries) to be free of defects in material and workmanship for a period of two years. A dealer is not authorized to issue a replacement battery without prior authorization from EarthX.

The applicable Warranty period begins from the date of purchase with original receipt or, if no receipt is available, from the manufacturing date on the battery. The warranty is non-transferable and is for the original purchaser only. Batteries determined to meet the conditions of this warranty will be replaced free of charge, one time. For warranty replacement consideration, fill out the online warranty submission form located on the EarthX website. EarthX's acceptance of any items shipped to EarthX for warranty replacement shall not be deemed an admission that the item(s) are defective. For international warranty returns, customer will pay the shipping expenses. Batteries replaced under the warranty provisions will carry only the remainder of the original applicable Warranty period.

See our website at www.earthxbatteries.com for details.

Troubleshooting

The table below is a summary of the battery's three fault modes of operation: solid on, slow on/off cycling or fast on/off cycling with possible causes:

LED Light	Voltage	Possible Cause	Recommended Action
Slow Flashing (5s on/5s off)	Less than 12.8V	Battery over-discharged due to faulty charging system (alternator) not charging the battery.	Charge the battery. Verify aircraft charging system is functioning.
Slow Flashing (5s on/5s off) (> 1 hour)	12.8-14.6V	Weak or failing cell	Charge the battery with an approved charger and observe fault LED. If LED persists, charge the battery a second time with approved charger. If the LED fault persists, the battery should be replaced.
Slow Flashing (5s on/5s off)	Greater than 15.2V	Over-charging (due to faulty charging system regulator)	Verify aircraft charging system is functioning properly; could be

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			faulty voltage regulator and or over-voltage protection device.
Slow Flashing (5s on/5s off) (< 1 hour)	13.2V – 14.6V	Cell to cell charge levels are not equal. The battery's BMS cell balancing circuitry needs time to re-balance the cell charge level.	Charge the battery with an approved charger and observe fault LED. If LED persists, charge the battery a second time with approved charger. If the LED fault persists, the battery should be replaced.
Solid Light	Any voltage	BMS electronics issue	Isolate the battery from the aircraft (disconnect positive or negative cable). Disconnect the battery's fault wire from the aircraft's LED or EFIS. If the fault LED on the battery is not extinguished, the battery should be replaced.
Solid Light that turns off after 3 minutes	Any voltage	Short Circuit protection was activated	Verify normal voltage (13.2 to 14.5 volt) at the battery terminals. Battery can be returned to service.
Short Flashing (2s on/2s off)	Any voltage	Battery temperature very high (> 85°C / 185°F) due to environment or excessive discharge.	If due to excessive discharge amperage, let the battery cool down prior to cranking or charging. If environmental temperature is too high, engineer means to cool battery when in service.

The ETX-Hundred Series Lithium battery is an extremely reliable battery with a longer useful life than comparable lead-acid batteries.

Despite the high reliability, you may encounter situations where the battery does not operate as expected. Go to www.earthxbatteries.com and review the FAQ section for the most up to date comprehensive troubleshooting information.

Regulations / Standards

The ETX-Hundred Series (ETX900-TSO), is designed and tested to the following safety regulations and guidance as outlined in:

- FAA Technical Standard Order – TSO-C179b
- RTCA DO-311A, RTCA DO-160G, DO-254
- IEC 62133-2
- CE — EU consumer safety, health, and environmental regulations.
- UN 38.3
- AC 20-184 Rechargeable Lithium Batteries

These standards set the level of safety required for lithium batteries. The standard addresses normal and abnormal operating conditions.

Lithium batteries have special requirements for transportation (shipping) per UN 38.3 and Title (part) 49 of the Code of Federal Regulations or CFR's. Title 49 CFR Sections 100-185 of the U.S. Hazardous Materials Regulations (HMR).

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.
AML	Approved Model List
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.
EFIS	Electronic Flight Instrumentation System
IEC	International Electro-Technical Commission on safety standards.
ICA	Instructions for Continued Airworthiness
LED	Light Emitting Diode
STC	Supplemental Type Certificate

Appendix I DO-311A and DO-160G Testing

DO-311A Test Summary

Test Description	Section	Reportable Information
Physical Examination	2.4.4.1	Passed functional performance per DO-311A, Section 2.2.1.1
ATP	2.4.4.2	Passed functional performance per DO-311A, Section 2.2.1.2
Insulation Resistance	2.4.4.3	N/R - Plastic non-conductive case, no heaters
Handle Strength	2.4.4.4	N/R, no handle on battery
Capacity	2.4.4.5	Passed functional performance per DO-311A, Section 2.2.1.5
Capacity at Low & High Temperatures	2.4.4.6	Passed functional performance per DO-311A, Section 2.2.1.6
Constant Voltage Discharge for High Rate Batteries	2.4.4.7	Passed functional performance per DO-311A, Section 2.2.1.7
Charge Acceptance	2.4.4.8	Passed functional performance per DO-311A, Section 2.2.1.8
Charge Retention	2.4.4.9	N/R - EUT is energy category 3, test only required on category 4
Cycle Test for High Rate Batteries	2.4.4.10	N/R, -EUT is energy category 3, test only required on category 4
Rapid Discharge at Short Time Operating High Temperature	2.4.4.11	Passed functional performance per DO-311A, Section 2.2.1.11
Short Circuit with Protection Enabled	2.4.4.12	Passed functional performance per DO-311A, Section 2.2.1.12
Overdischarge	2.4.4.13	Passed functional performance per DO-311A, Section 2.2.1.13
Overcharge	2.4.4.14	Passed functional performance per DO-311A, Section 2.2.1.14
Short Circuit of a Cell	2.4.5.1	Passed functional performance per DO-311A, Section 2.2.2.1
Short Circuit without Protection	2.4.5.2	Passed functional performance per DO-311A, Section 2.2.2.1
Over discharge without Protection	2.4.5.3	Passed functional performance per DO-311A, Section 2.2.2.2
Single Cell Thermal Runaway Containment	2.4.5.4	N/R, this test is not required when thermal runaway containment testing is done with two or more cells in thermal runaway
Battery Thermal Runaway Containment	2.4.5.5	Passed functional performance per DO-311A, Section 2.2.2.4
Explosion Containment	2.4.5.6	Passed functional performance per DO-311A, Section 2.2.2.5
Drop Impact Test	2.4.5.7	N/R, this battery is not for a portable device
Remarks There is no deviation to the test requirements. If test is marked N/R, it is not required due to the battery construction or battery energy category.		

ETX900-TSO LITHIUM BATTERY**DO-160G Environmental Qualification Form**

The following table is the DO-160G testing Environmental Qualification form.

Nomenclature: Rechargeable Lithium Battery System

Model: ETX900-TSO

Manufacturer's Specification: N/A

Manufacturer: EarthX

TSO Number: TSO-C179b

Revision & Change Number of DO-160: G, Dec8, 2010

Date Tested: Dec 22, 2017

Conditions	Section	Description of Tests Conducted
Temperature and Altitude	4.0	Equipment tested to Categories B3, A3
Low Temperature	4.5.1	Equipment identified as Category X, no auxiliary cooling Equipment tested to Cat. B3 Equipment tested to Cat. A3, 50,000ft Equipment tested to Cat. A3, -15,000ft
High Temperature	4.5.2&4.5.3	
Loss of Cooling		
Altitude	4.6.1	
Decompression	4.6.2	
Overpressure	4.6.3	
Temperature Variation	5	Equipment tested to Categories B
Humidity	6	Equipment tested to Categories B
Operational Shock and Crash Safety	7	Equipment tested to Categories B
Vibration	8	Equipment tested to Category R,S, and U aircraft zone 1 and 2 for fixed wing turbojet engine aircraft, fixed wing unducted turbofan engine aircraft, helicopters, and fixed wing reciprocating/turbojet engine aircraft (multi or single engine) less than 5,700kg using vibration test curves B,B1,C,C1,G,G1,L,M,R and F
Explosive Atmosphere	9	Equipment identified as Category X, no test performed
Waterproofness	10	Equipment tested to Categories R
Fluid Susceptibility	11	Equipment tested to Categories F Equipment spray tested
Sand and Dust	12	Equipment identified as Category X, no test performed
Fungus	13	Equipment identified as Category X, no test performed
Salt Fog	14	Equipment tested to Categories S
Magnetic Effect	15	Equipment tested to Categories X, no test performed
Power Input	16	Equipment tested to Categories B(RX), loss of power or low voltage tests not applicable for the equipment is a power source
Voltage Spike	17	Equipment tested to Categories A

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Audio Frequency Conducted Susceptibility	18	Equipment tested to Categories B
Induced Signal Susceptibility	19	Equipment tested to Categories B(CX)
Radio Frequency Susceptibility	20	Equipment tested for conducted susceptibility to Categories R and for radiated susceptibility to Category R
Radio Frequency Emission	21	Equipment tested to Categories M
Lightning Induced Transient Susceptibility	22	Equipment tested to pin test waveform set A, level 2. Cable bundle test Category XXXX, no test performed
Lightning Direct Effects	23	Equipment identified as Category X, no test performed
Icing	24	Equipment identified as Category X, no test performed
Electrostatic Discharge	25	Equipment tested to Categories A
Fire Flammability	26	Equipment identified as Category X, no test performed
Other Tests: Flammable Material		Fire resistance tests were conducted in accordance with FAA regulations Part 25, Appendix F
Remarks - A critical frequency was identified at 49-55 Hz (Y axis, battery in upright position), and was consistent throughout testing with no change. -Fluid susceptibility test was conducted with the following fluids: piston engine fuel, synthetic hydraulic fluid, mineral based lubricating oil, isopropyl alcohol solvent, ethylene glycol, and insecticide.		

Appendix II: Typical Installation and Wiring Diagram

Wiring Diagram

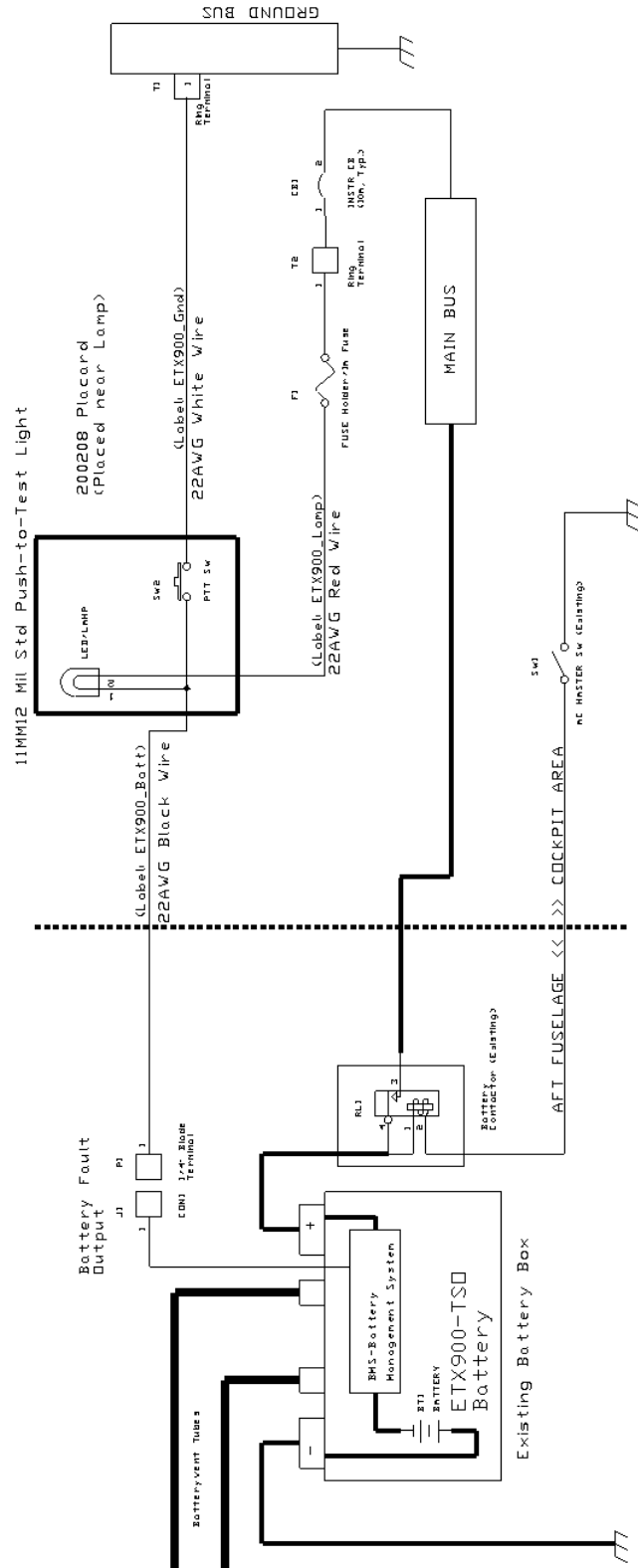
Definitions:

CB=Circuit Breaker

AWG=American Wire Gauge

AR=As Required

EA=Each



Appendix III: Model Evaluation Checklist (MEC)

This Model Evaluation Checklist is to document the applicability of AML STC SA01005DE to a specific aircraft.

✓ 1. Identify the proposed Model for Installation Eligibility per AML STC SA01005DE:

- ☐ Obtain the FAA Registry for the target Airplane at: registry.faa.gov/aircraftinquiry/NNum_Inquiry.aspx
- ☐ Retain the information: Make, model and serial number for evaluation.
- ☐ APPLICABILITY: Is the installation candidate Model on the AML of the STC?
- ☐ YES, proceed using AML STC data, installation is eligible.
- ☐ NO, but do you want to add the Model?
- ☐ Yes, contact EarthX, Inc. for additional update request, END this process.
- ☐ NO, end this process checklist, Model not currently eligible.
- ☐ APPLICABILITY: Airplane certification level.
- ☐ Certification Level: Level 1 - airplanes with a max seating configuration of 0 to 1 passengers.
or Level 2 - for airplanes with a maximum seating configuration of 2 to 6 passengers.
- ☐ FUNCTION: Will this installation be for STARTING and STORAGE battery intended functions in the current electrical system?
- ☐ YES, proceed. It is a replacement for the current battery using new technology.
- ☐ No, incompatible, STOP. The installation may require further analysis and certification.
- ☐ LOCATION: Is the current battery installation AFT of the firewall?
- ☐ YES, proceed
- ☐ NO, STOP, contact EarthX for further information and/or other STCs.

✓ 2. Evaluate the proposed Model serial number for addition:

- ☐ Using Qualified personnel, does the target airplane meet the min requirements for Required Systems & Equipment?
- A. Primary Electrical System - Alternator less than or equal to 80 Amps?
- ☐ YES, proceed
- ☐ NO, STOP -Airplane not eligible if it exceeds 80 Amps. I.E. - such as a 95 Amp alternator by STC.
- B. Does the airplane electrical system have Over Voltage Protection?
- ☐ YES, proceed
- ☐ NO, STOP - Airplane not eligible, or evaluate installation of an OVPD or OVPS.
- Is there an existing approval to install the required equipment?
- ☐ YES, proceed to install equipment per approved data.
- Are the installation Instructions adequate for the new equipment?
- ☐ YES, proceed with process.
- ☐ NO, contact EarthX for an update to IMM and/or ICA (if required).
- ☐ YES, Install OVPD or OVPS per FAA Approved data. Proceed.

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☐ NO, STOP - Model serial number not eligible.

C. Using qualified personnel, i.e. such as an A&P, DER or informed AET, evaluate the airplane Model for EBS requirements.

☐ ENVIRONMENT: Operating Temperature -30C to +60C (+65C, short term).

☐ STARTING: Peak Power (Ipp): 800/390 Amps (+23C/-18C), Rated Power (Ipr): 600/365 Amps (+23C/-18C).

☐ STORAGE*: 31 Amps for 30 Minutes. Timely pilot identification and load shedding assumed per normal procedures.

* Either through Electrical Load Analysis (ELA) or Test, essential loads must be evaluated by qualified personnel.

☐ CHARGE: 80 Amps maximum charging system.

☐ WEIGHT: 5.4 Lbs. As the weight change is significant, a Weight & Balance Report (WBR) is required. 14 CFR 91.103(b)(2).

☐ LIFE: 6 Years, replacement per ICA test fail or 6 years (recommended) whichever comes first.

☐ If yes to all, proceed. Else, further analysis and/or certification approval may be required. Contact EarthX.

✓ 3. Evaluate the certification basis for proposed Model:

☐ Does the installation CONTINUE to meet the requirements of the applicable rules, modifications and guidance?

A. Original AML STC remains applicable?

☐ YES, listed on the AML STC - meets the current regulations - Proceed.

☐ NO, STOP. Process END.

B. Are there any Model serial specific issues that would preclude the installation of the proposed equipment?

☐ NO, proceed. See list below.

☐ YES, evaluate the following:

Inadequate location for Fault/Status indicator Light.

Battery box not adequate for installing battery inside due to modifications.

Other installation aspects or issues discovered that could affect functions or safety.

C. Does the installation manual still provide adequate detail to complete the installation?

☐ YES,
proceed

☐ NO, contact EarthX, Inc. for further guidance on IMM updates or request improvements.

✓ 4. Issues

Model specific issues and ELOS

☐ ADs: Using qualified personnel, are current Airworthiness Directives complied with?

☐ YES,
proceed

☐ NO STOP - Airplane is not eligible.

☐ STCs: Are currently installed STCs compatible with this installation?

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- ☐ YES,
proceed.
- ☐ NO, incompatible, STOP. Further analysis and certification may be required.

- ☐ COMPLEXITY: Does the installation remain simple? Installed into an existing location with no major modifications?
- ☐ YES,
proceed.
- ☐ NO, contact EarthX, Inc. for further guidance.

Appendix IV: Typical Electrical Load and Capacity Analysis (ELCA)

Load Definitions

Normal Cruise Load, Pre-Load Shed (5 Minute):

- Engine monitoring Instruments ON (Master ON)
- ALT ON – Alternator working per Ammeter
- Avionics ON
- Transponder and GPS ON
- Com/Nav 1, 2 and 3 ON (if so equipped)
- Autopilot ON
- Panel Lights ON
- Strobes ON
- NAV Lights ON
- Pitot heat ON
- Flood Lights OFF
- Landing Lights OFF

Minimum Cruise Load (30 Minute):

- Engine monitoring Instruments ON (Master ON)
- Avionics ON
- Transponder and GPS ON
- Com/Nav 1 Intermittent
- Nav 2 and 3 OFF
- Autopilot OFF
- Panel Lights ON
- Strobes ON last 10 minute only
- NAV Lights OFF
- Pitot heat ON last 10 minutes only
- Flood Lights OFF
- Landing Lights ON last 3 minutes only
- Non-essential Lights OFF

Battery Duration /Capacity Analysis

A conservative capacity for the battery is 75% of nameplate (.75x15.6Ah=11.7Ah). The A-min (amp x minutes) of this battery is (11.7Ah x 60min=**702A-min**). The calculated Capacity Used A-min in the table below must be equal or less than 702 A-min.

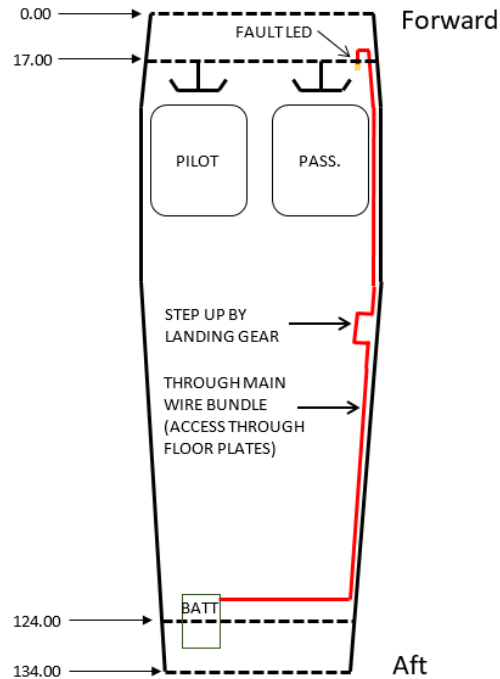
Measurement is an acceptable method of establishing loads for part 23 airplanes.

ASTM F2490 – 20 Capacity Calculation				
Load	Min	A	A-min	Notes:
Normal Cruise, Preload Shed	5			Measure the total amps, and put number in A column; calculate A-min by multiplying minutes and amp and put in A-min column
Minimum Cruise				
20 Min (prior to approach/landing)	20			Measure the total amps, and put number in A column; calculate A-min by multiplying minutes and amp and put in A-min
10 Min (approach)	10			Measure the amps for strobes and pitot heat only, and put number in A column; calculate A-min by multiplying minutes and amp and put in A-min
3 Min (landing)	3			Measure the amps of landing lights only, and put number in A column; calculate A-min by multiplying minutes and amp and put in A-min
Capacity Used (A-min):				Take sum of A-min for all rows and put in the A-min column

Appendix A: Cessna 182 Install

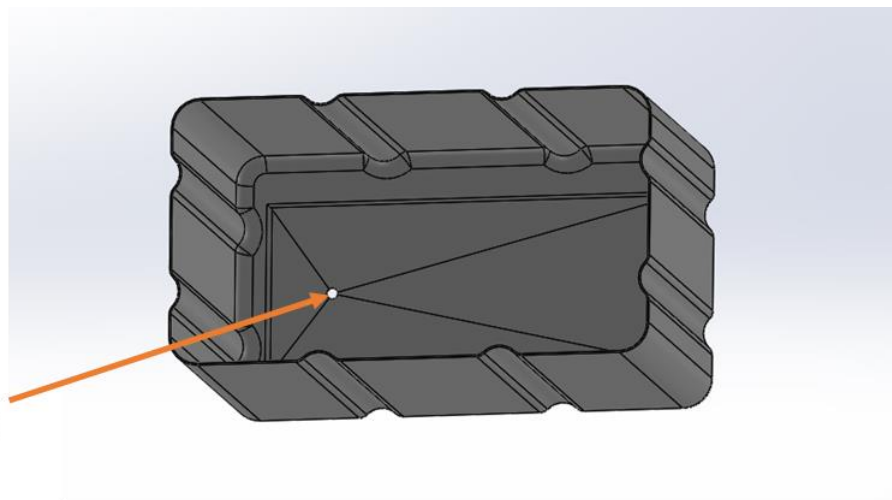
Install Parts Kit:
ETX900-TSO-35-KIT

Typical Wire Routing



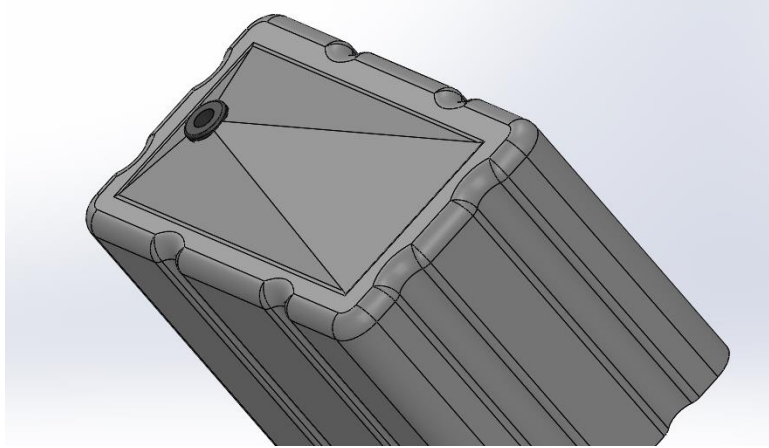
Battery and Vent Tubing

1. Drill a 9/16" hole in the bottom of the existing Cessna plastic battery box at the current drain hole. Follow guidelines of AC 43.13-2B, 11-19 and 11-22 (Installation Practices/Ventilating Systems). Install 9/16" grommet for 1/8" panel thickness at drain hole.

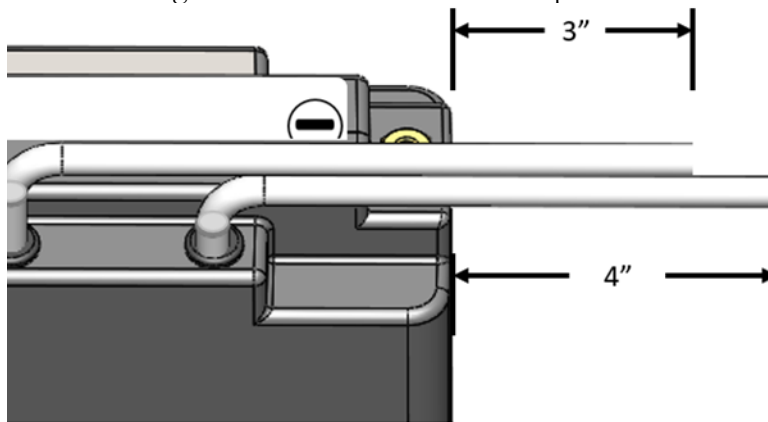


Drill out existing
drain hole with
9/16" bit

ETX900-TSO LITHIUM BATTERY

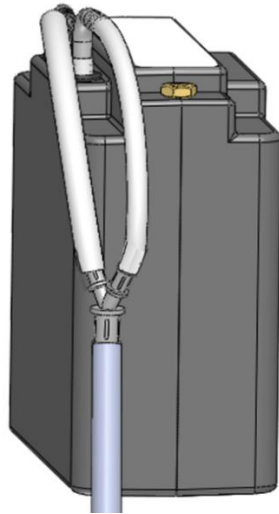


2. Install the supplied stainless-steel elbows to the battery vent tube stubs. It is helpful to heat the tubing to a couple hundred degrees F before pressing them into the tubes. Be sure the entire barbed part of the elbow is completely inserted into the tubing.
3. Connect the supplied $\frac{1}{4}$ " ID tubing to the stainless elbows. Next, cut the $\frac{1}{4}$ " tubes to a length of 3" and 4". Attach these pieces of $\frac{1}{4}$ " tubing to elbows.

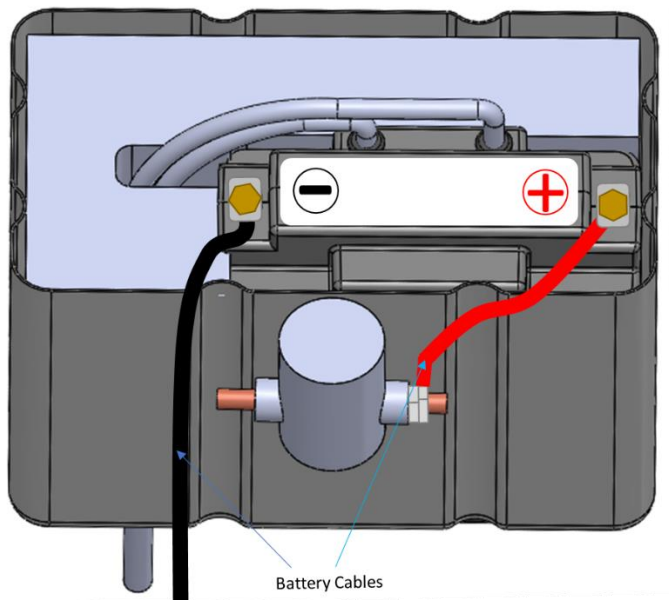


4. Connect the $\frac{3}{8}$ " wye fitting to the $\frac{3}{8}$ " tube supplied and then to $\frac{1}{4}$ " tube from battery (do not kink the tubes). Next heat the $\frac{1}{4}$ " tubes while bending them to create a 90-degree swiping bend with a 3" radius. (See image below).

ETX900-TSO LITHIUM BATTERY

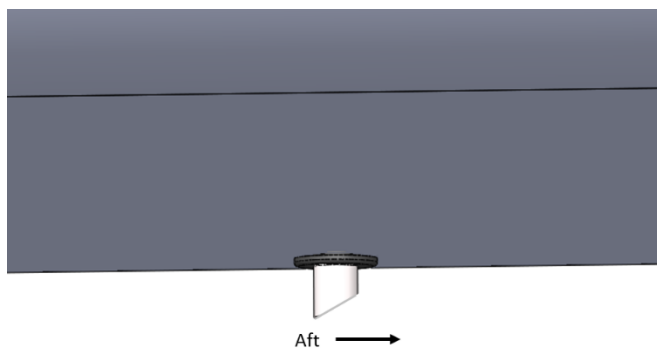


5. Feed the 3/8" exhaust tube straight down and out the aircraft's existing battery box drain hole, then thru the drain hole of the aircraft (do not cut tube length at this time).
6. Install another 9/16" grommet for 1/16" panel thickness at the aircraft exit hole. Silicon can be used around the grommet and or tubing to seal and secure it in place.
7. Insert L-Shaped foam insert (190531) into the 35Ah box around the battery. Make sure that the slot in the spacer is located over the drain hole and around the vent tubes. The foam insert (spacer) is used to hold the battery in a corner on the opposite end of the box from drain hole (up to +1/8" of battery movement side to side or front to back is ok). The battery should be positioned on the side of the box closest to the battery cables.



8. With the battery box cover installed, push the vent tube up into the aircraft, then cut exhaust tubes to length; at least 9/16" should be exposed on the outside of the aircraft. Cut the tube at an angle towards the aft of the aircraft.

ETX900-TSO LITHIUM BATTERY

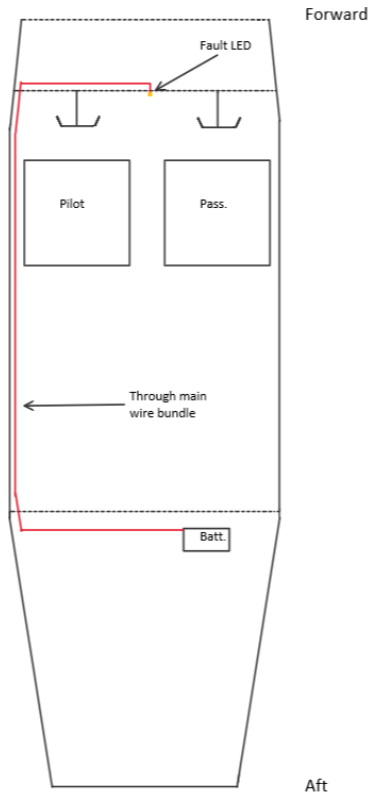


Appendix B: Piper PA-28 Install

Install Parts Kit:

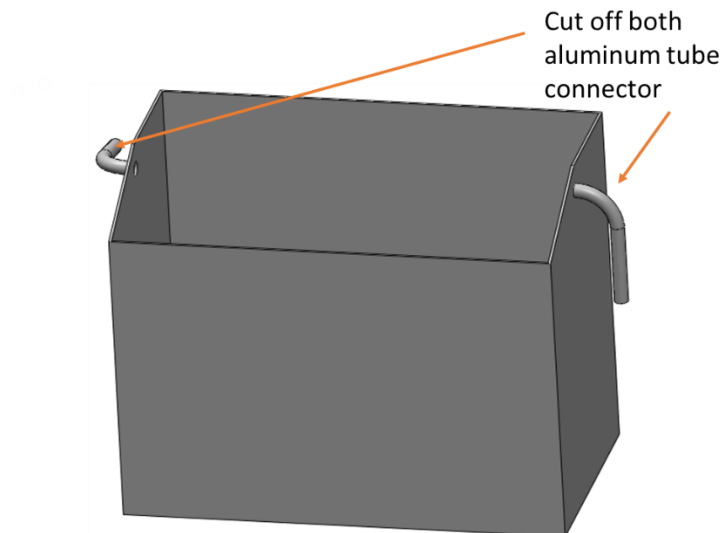
ETX900-TSO-35-PA-KIT

Typical Wire Routing



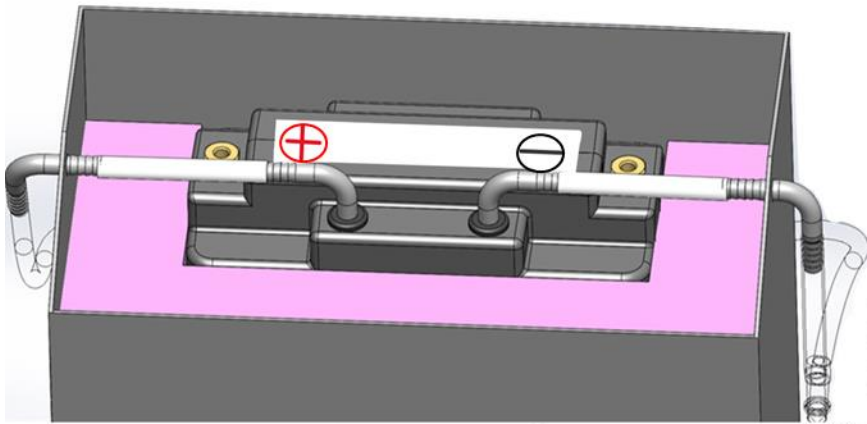
Battery and Vent Tubing

1. Remove aluminum vent tube connections from the top edge of the existing battery box (cut then drilled out). Drill out vent tube penetration hole to 5/16".

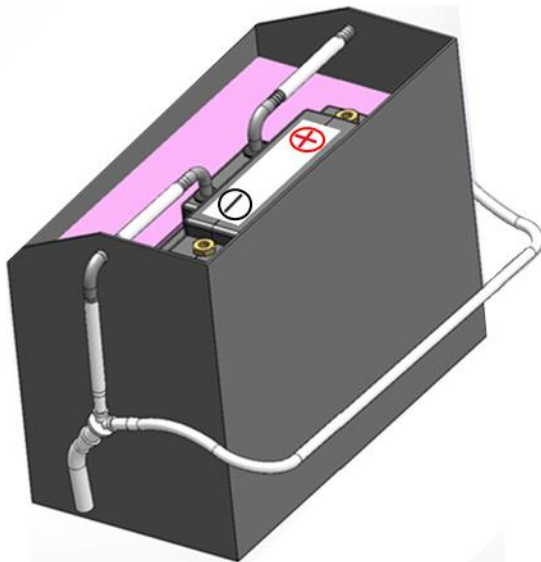


ETX900-TSO LITHIUM BATTERY

2. The tubing from the bottom drain hole can be left as is.
3. Install the supplied stainless-steel elbows to the battery vent tube stubs. It is helpful to heat the tubing to a couple hundred degrees F before pressing them into the tubes. Be sure the entire barbed part of the elbow is completely inserted into the tubing.
4. Cut two pieces of the supplied $\frac{1}{4}$ " ID tubing to a length of 3.5 inches. Then, connect to each of the stainless elbows already installed on the battery.
5. Insert U-Shaped foam insert (210608) into the 35Ah box with the battery cutout closest to the battery cables.
6. Place the ETX900-TSO EarthX battery into the foam cutout. Ensure the battery is on the side of the battery box closest to the battery cables (see figure below).
7. Connect $\frac{1}{4}$ " stainless elbows (one each side) through the battery box vent tube holes to the tubing already installed.



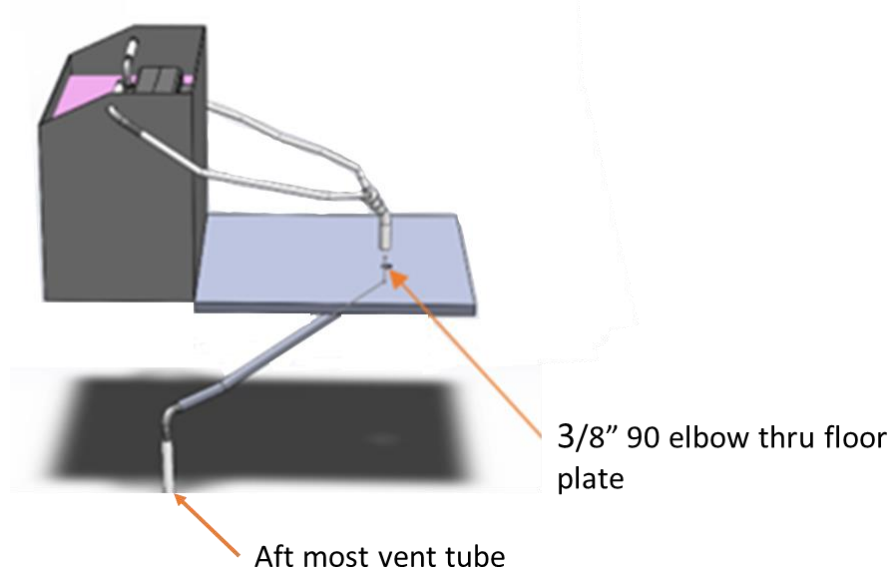
8. Use additional $\frac{1}{4}$ " ID tubing to connect the stainless elbows to the $\frac{3}{8}$ " wye fitting as shown below. Wrap the positive side of the battery's $\frac{1}{4}$ " ID tube around the battery box as to not interfere with the battery cables.



ETX900-TSO LITHIUM BATTERY

9. Cut a piece of 3/8" tube to connect the 3/8" wye fitting to the existing ventilation port on the belly of the aircraft. The 3/8" tube should be connected to the aft most port of the two ventilation ports. Secure tube with spring clamp.

Note: for under the rear seat installs, use supplied 3/8" elbows to make right angle bends under the subfloor (see figure below).

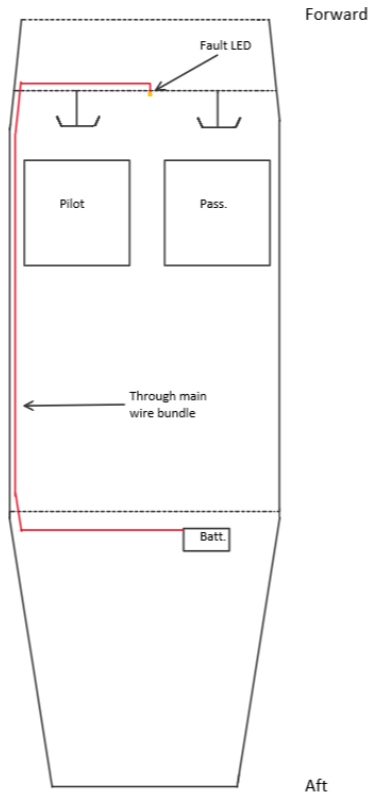


Appendix C: Mooney M20 Install

Install Parts Kit:

ETX900-TSO-35-M20-KIT

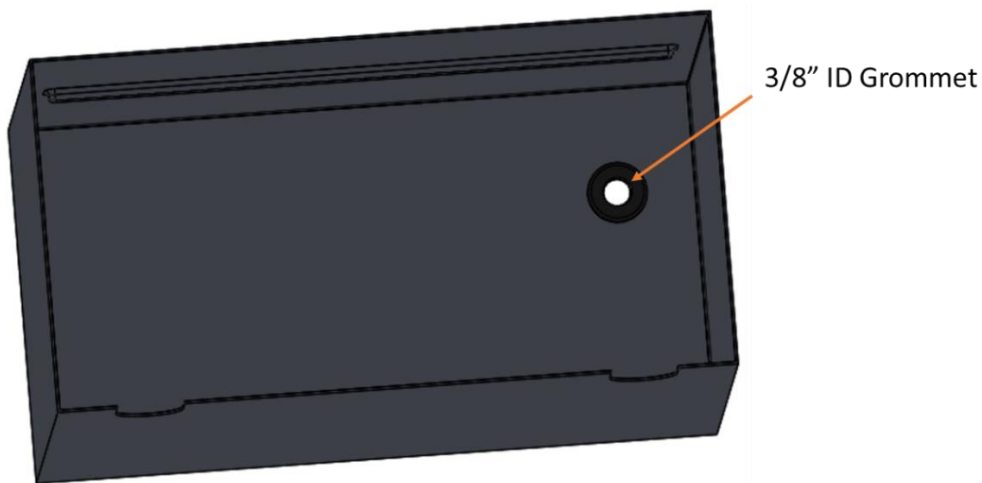
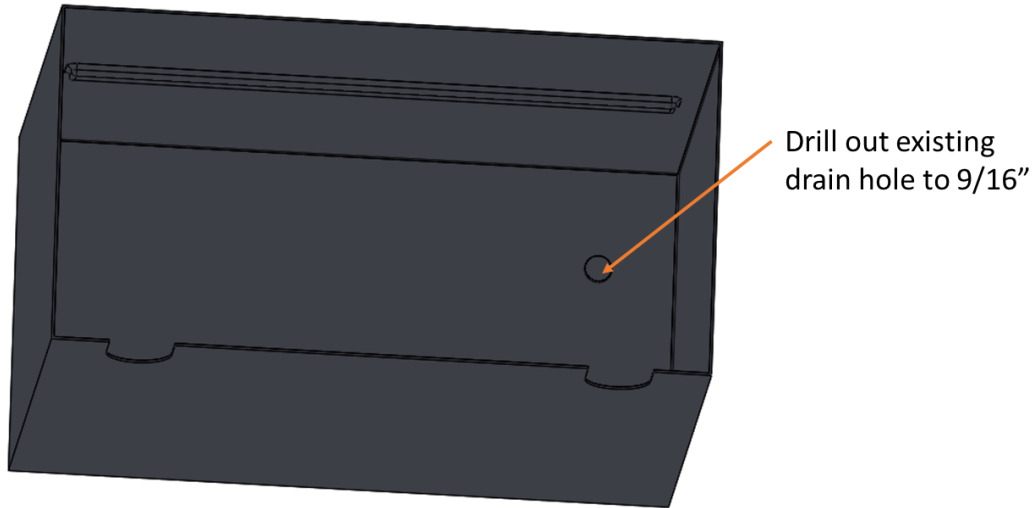
Typical Wire Routing



Battery and Vent Tubing

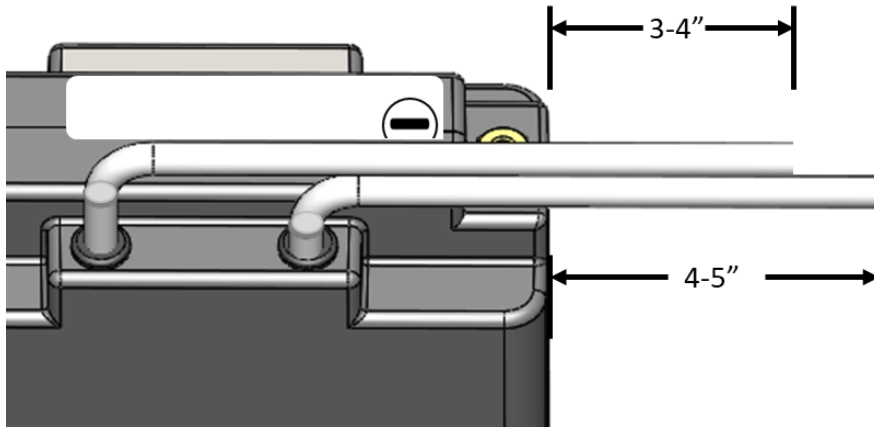
1. Drill a 9/16" hole in the bottom of the existing battery box at the current drain hole. Follow guidelines of AC 43.13-2B, 11-19 and 11-22 (Installation Practices/Ventilating Systems). Install 9/16" grommet for 1/16" panel thickness at drain hole.

ETX900-TSO LITHIUM BATTERY

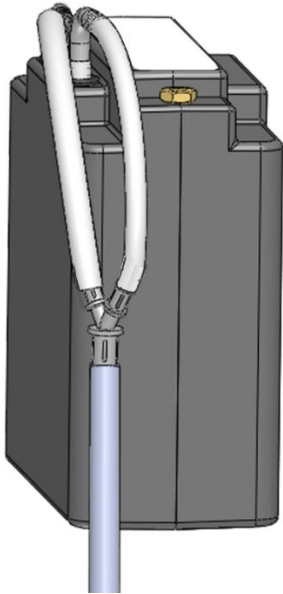


2. Install the supplied stainless-steel elbows to the battery vent tube stubs. It is helpful to heat the tubing to a couple hundred degrees F before pressing them into the tubes. Be sure the entire barbed part of the elbow is completely inserted into the tubing.
3. Connect the supplied 1/4" ID tubing to the stainless elbows. Next, cut the 1/4" tubes to a length of 3" and 4". Attach these pieces of 1/4" tubing to elbows.

ETX900-TSO LITHIUM BATTERY

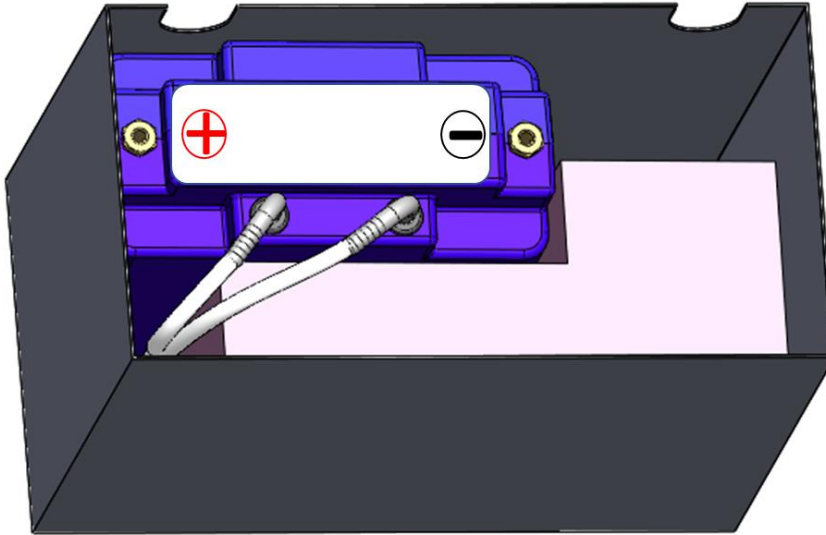


4. Connect the $\frac{3}{8}$ " wye fitting to the $\frac{3}{8}$ " tube supplied and then to $\frac{1}{4}$ " tube from battery (do not kink the tubes). Next heat the $\frac{1}{4}$ " tubes while bending them to create a 90-degree swiping bend with a 3" radius. (See image below).

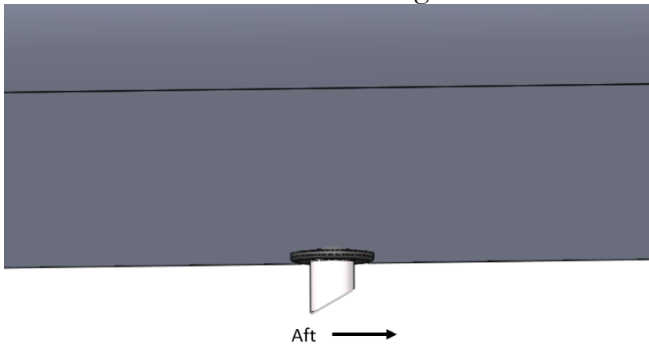


5. Feed the $\frac{3}{8}$ " exhaust tube straight down and out the aircraft's existing battery box drain hole, then thru the drain hole of the aircraft (do not cut tube length at this time).
6. Install another $\frac{9}{16}$ " grommet for $\frac{1}{16}$ " panel thickness at the aircraft exit hole. Silicon can be used around the grommet and or tubing to seal and secure it in place.
7. Insert L-Shaped foam insert into the 35Ah box around the battery. Make sure that the spacer is located at the end of the box away from the vent tubes. The foam insert (spacer) is used to hold the battery in a corner on the same end of the box as the drain hole (up to $\pm \frac{1}{8}$ " of battery movement side to side or front to back is ok). The battery should be positioned on the side of the box closest to the battery cables. **Note: some boxes may have the drain hole on the opposite side shown below.**

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8. With the battery box cover installed, push the vent tube up into the aircraft. Then cut exhaust tubes to length; at least 9/16" should be exposed on the outside of the aircraft. Cut the tube at an angle towards the aft of the aircraft.



9. Lastly, replace battery negative cable with the one provided

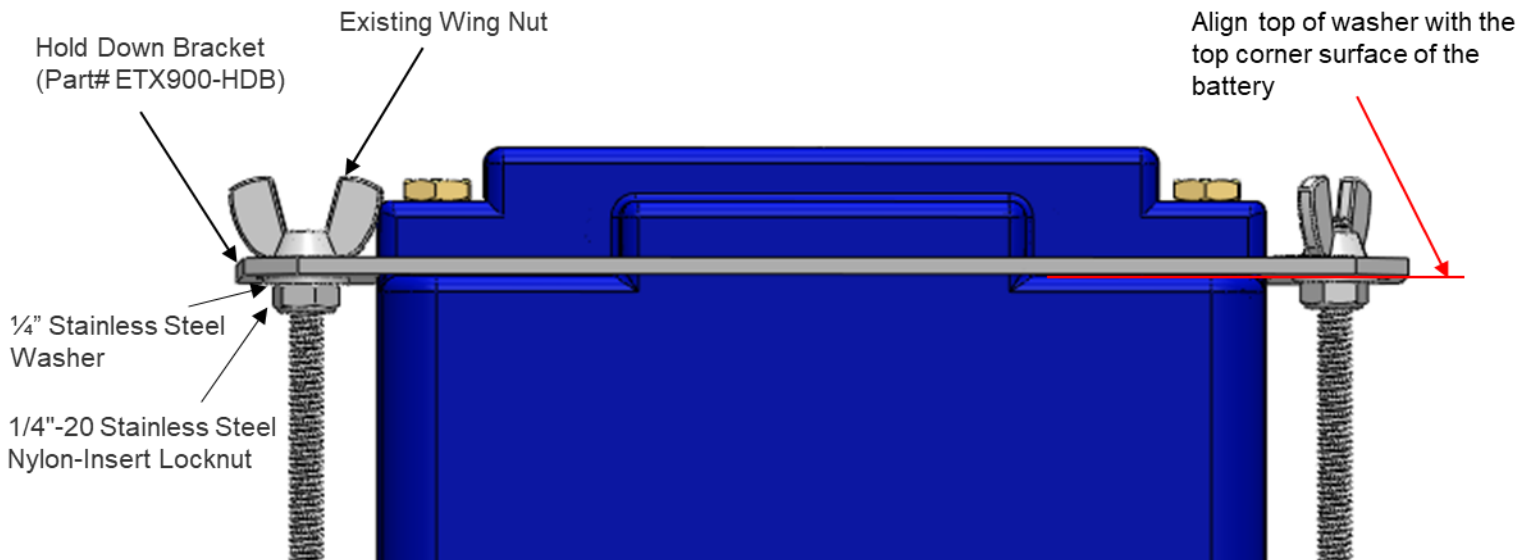
Appendix D: Aviat Install

Install Parts Kit:

ETX900-TSO-AVIAT-KIT

Battery and Vent Tubing

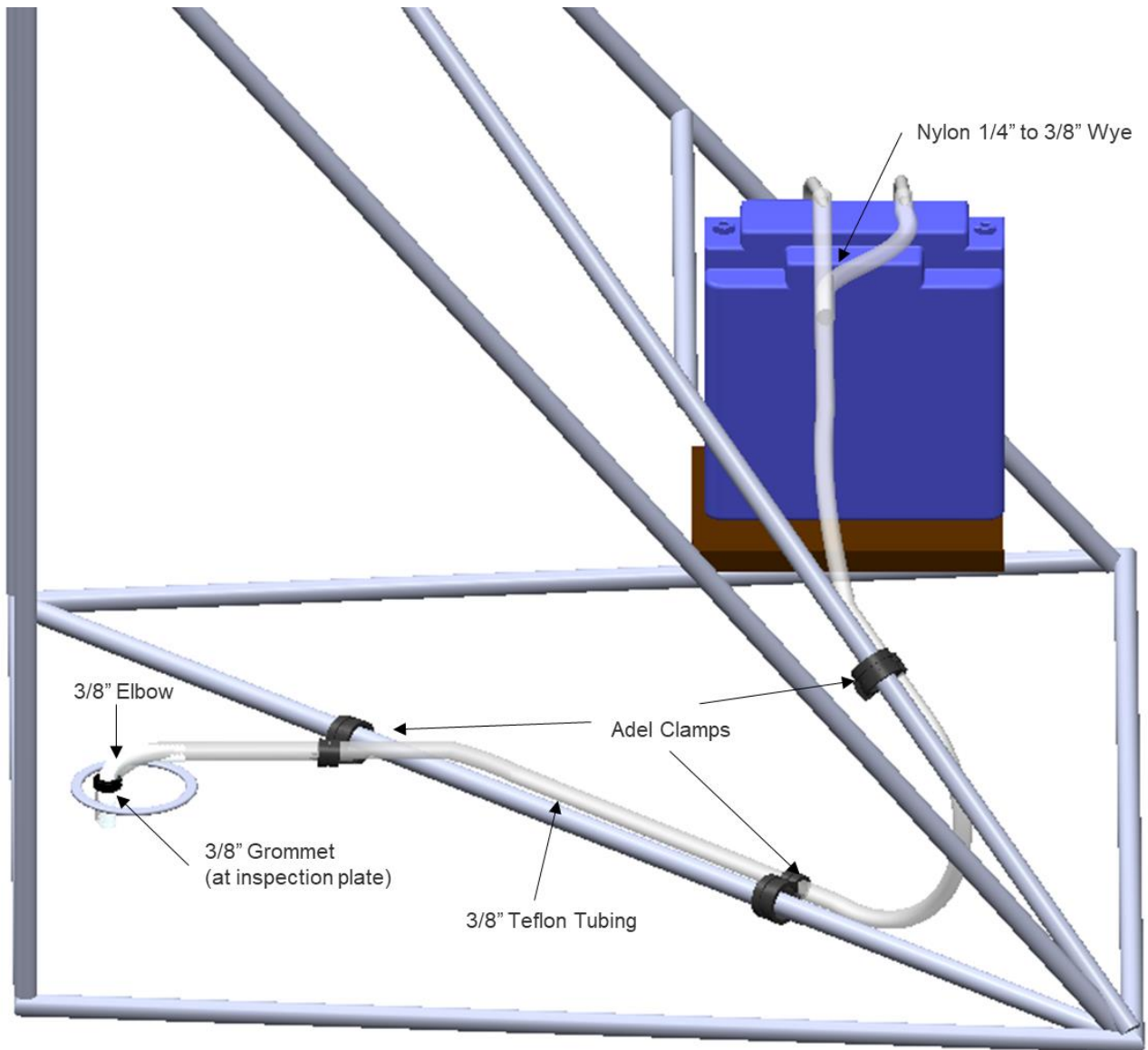
1. Thread lock nut onto exiting 1/4"-20 rod and then place a washer on top of the nut.
Note, the lock nut is installed up-side-down (nylon lock side down).
2. Set the battery on the battery tray and place the hold down bracket on top of the battery feeding the threaded rod thru the 1/4" holes in the bracket.
3. Using a straight edge, align the top of the washer with the top of the battery outside corners (pull the threaded rod upward while aligning, see figure below).
4. Install the wing nuts and hand tighten ensuring the threaded rod is perpendicular to the battery tray.



5. Verify the hold down bracket is firmly holding the battery (can't slide side to side). If not, tighten the lock nut another 1/2 turn. The wing nuts should not be overly tight as to bend (flex) the hold down bracket.
6. Install safety wire from hold down bracket to the wing nut.
7. Install the supplied stainless-steel elbows to the battery vent tube stubs. It is helpful to heat the tubing to a couple hundred degrees F before pressing them into the tubes. Be sure the entire barbed part of the elbow is completely inserted into the tubing.
8. Cut two pieces of the supplied 1/4" ID tubing to a length of 6 inches. Then, connect to each of the stainless elbows already installed on the battery.
9. Attach each of the two loose ends of the 1/4" ID tubing to the supplied 3/8" wye fitting.

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10. Connect the 3/8" tubing to the wye fitting and route to the round inspection plate in the belly of the aircraft aft of the battery (see recommended routing below). The 3/8" tubing will run from the battery down the vertical tube frame (5/8" Adel clamp here) with the other wiring bundles to the horizontal frame tube to the aft of the aircraft inspection plate. The 3/8" tubing will be secured to the frame tubing with Adel clamps at three locations (see example install below).



11. Drill a 9/16" hole through the center of the inspection plate in the belly of the tail section. Install a 9/16" grommet in the plate. Install a 3/8" elbow onto the vent tubing at the inspection plate hole location. Then connect a short piece of 3/8" tubing to the elbow which will feed down thru the grommet to outside the aircraft (see figure above). Use RTV Silicon to secure tube at the inspection plate grommet if required. Then cut the exhaust tubes to length; at least 9/16" should be exposed on the outside of the aircraft. Cut the tube at an angle towards the aft of the aircraft.