Designation: ~~F2840 – 11~~ F2840 – 14

Standard Practice for Design and Manufacture of Electric Propulsion Units for Light Sport Aircraft[1]

This standard is issued under the fixed designation F2840; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This ~~specification~~practice covers minimum requirements for the design and manufacture of Electric Propulsion Units (EPU) for light sport aircraft, VFR use. The EPU shall as a minimum consist of the electric motor, associated controllers, disconnects and wiring, an Energy Storage Device (ESD) such as a battery or capacitor, or both, and EPU monitoring gauges and meters. Optional onboard charging devices, in-flight charging devices or other technology may be included.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F2245 Specification for Design and Performance of a Light Sport Airplane

~~F2279~~F2972 ~~Practice for Quality Assurance in the Manufacture of Fixed Wing Light Sport Aircraft~~Specification for Light Sport Aircraft Manufacturer's Quality Assurance System ~~(Withdrawn 2014)~~

2.2 *Other Standards:*

EASA CRI F-58 Lithium Battery Installations[3]

SAE J2344 Guidelines for Electric Vehicle Safety[4]

3. Significance and Use

3.1 This specification provides designers and manufacturers of electric propulsion for light sport aircraft design references and criteria to use in designing and manufacturing EPUs.

3.2 Declaration of compliance is based on testing and documentation during the design, ground testing and flight testing of the EPU by the manufacturer or under the manufacturers' guidance.

3.3 Manufacturers of the EPUs are encouraged to review and incorporate appropriate standards and lessons learned from ground based systems as documented in SAE J2344 and EASA CRI F-58 (see Appendix X2).

3.4 Electric aircraft may contain potentially hazardous level of electrical voltage or current. It is important to protect persons from exposure to this hazard. Under normal operating conditions, adequate electrical isolation is achieved through physical separation means such as the use of insulated wire, enclosures, or other barriers to direct contact. There are conditions or events that can occur outside normal operation that can cause this protection to be degraded. Some means should be provided to detect degraded isolation or ground fault. In addition, processes or hardware, or both, should be provided to allow for controlled access to the high voltage system for maintenance or repair. A number of alternative means may be used to achieve these electrical safety goals including automatic hazardous voltage disconnects, manual disconnects, interlock systems, special tools and grounding. The intention of all these means is either to prevent inadvertent contact with hazardous voltages or to prevent damage or injury from the uncontrolled release of electric energy. Lightning strikes are not addressed in this Standard Practice because LSA aircraft are limited to VMC flight only.

[1] This practice is under the jurisdiction of ASTM Committee F37 on Light Sport Aircraft and is the direct responsibility of Subcommittee F37.20 on Airplane.

Current edition approved ~~March 1, 2011~~Nov. 1, 2014. Published ~~April 2011~~December 2014. Originally approved in 2011. Last previous edition approved in 2011 as F2840 – 11. DOI: ~~10.1520/F2840-11.~~10.1520/F2840-14.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from European Aviation Safety Agency (EASA), Postfach 10 12 53, D-50452 Koeln, Germany, http://easa.europa.eu/home.php.

[4] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

4. Electric Propulsion Unit (EPU) Model Designation

4.1 *Electric Propulsion Parts List*—A detailed parts list is required for each electric propulsion unit qualified in accordance with this specification.

4.2 *New Electric Propulsion Unit Model Designations:*

4.2.1 Each new EPU must be qualified in accordance with this practice.

4.2.2 Design or configuration changes that impact the installation interface, performance, or operability of the EPU require a new EPU model designation.

4.3 *Design Changes of Parts*—Each design change of a part or component of an EPU model qualified to this specification shall be evaluated to the requirements of this specification.

5. Data Requirements

5.1 *Retained Data*—The following data and information shall be retained on file at the manufacturer's facility or alternative business entity for a minimum of 18 years after production is discontinued.

5.1.1 Drawings, reference specifications and other technical data that define the EPU configuration.

5.1.2 Primary material and process (M&P) specifications in effect at the time of Declaration of Compliance and referenced in the parts drawings. Second tier, flow down M&P documents are not required to be retained.

5.1.3 Engineering analyses and test data prepared for qualification with this specification.

5.2 *Delivered Data*—The following data shall be delivered to the airplane manufacturer to support design and operation of the applicable airplane.

5.2.1 An EPU performance specification that defines the system performance under all anticipated operating environments.

5.2.2 An installation manual that defines all functional and physical interface requirements of the EPU. This should include an EPU installation drawing.

5.2.3 Detailed specifications for any caution or warnings that must be placed on the aircraft. The warnings shall ensure that operators, maintenance crews, and emergency crews understand potential hazards with the electric propulsion system.

5.2.4 An operating manual that defines normal and abnormal operating procedures and any applicable operating limitations, including EPU and any aircraft limitations.

5.2.5 A maintenance manual that defines periodic installed maintenance, major inspections, replacement or overhaul intervals, and any other maintenance limitations including limited life components requiring replacement between overhaul intervals. Maintenance requirements for the continued airworthiness of the EPU shall be specified. This manual shall identify any special equipment or testing required to ensure the electric propulsion system is safe for continued operation.

5.2.6 An overhaul manual that provides instructions for disassembling, replacing or overhauling components identified in the manual for such, in order to return the EPU to airworthy condition that is safe for operation until the next major overhaul.

6. Design Criteria

6.1 *Materials*—The materials and components used in the EPU must be adequate for the intended design conditions of the system.

6.2 *Fire and Electric Shock Prevention*—The design and construction of the EPU shall minimize the probability of the occurrence and spread of fire and electric shock. The design shall incorporate electrical isolation-insulation materials capable of shielding the occupants and ground personnel from electrical shock in the event of an in flight or ground based emergency. Wire insulation subject to arc tracking, such as Kapton™, shall not be used. Isolation means the electrical resistance between the battery high voltage system and any airframe conductive structure. A value greater than or equal to 500 ohms/volt at the maximum working voltage is defined as isolated. As a minimum, the system shall:

6.2.1 Incorporate a non-resettable fuse as part of the energy storage device which protects the main power lead wires from an over-temperature or over-current condition. A warning or indication device to alert the pilot shall be incorporated.

6.2.2 Incorporate a pilot/mechanic operated main shutoff of the energy storage device from the remainder of the EPU system. This shutoff shall not rely on any processor or software actions to provide electrical isolation of the energy storage device.

6.2.3 Incorporate an ESD which is electrically isolated from the airframe.

6.2.4 Consider incorporation of a ground fault detection system that provides the pilot or ground personnel a warning if the airframe is no longer fully electrically isolated from the energy storage device.

6.2.5 Be designed for flight in (or flight subsequent to exposure to) heavy rain without risk to occupants or ground personnel.

6.2.6 Incorporate warnings, cautions or placards on components and on the airframe exterior conveying the potential high voltage hazards.

6.2.7 Develop maintenance procedures enabling continuous airworthiness with minimal risk to mechanics or ground personnel.

6.3 *Electrical Arcing*—The EPU shall be designed to eliminate the possibility of high voltage electrical arcing (or corona effect) at altitudes up to those specified as the maximum in the operating manual (see 5.2.4).