Designation: F2930 – 16

Standard Guide for Compliance with Light Sport Aircraft Standards[1]

This standard is issued under the fixed designation F2930; 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 document provides guidance to assist manufacturers in understanding and meeting ASTM standards for light sport aircraft. This guidance material presents philosophies, practices and considerations recommended by industry consensus, but does not present technical or business requirements that must be met.

1.2 It is the intent of this guide to provide processes to be considered by organizations looking to develop or improve objective evidence of compliance for light sport aircraft. It does not attempt to identify all of the standards, regulations or other requirements that may be applicable to a given aircraft, production or testing process.

1.3 *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

F2295 Practice for Continued Operational Safety Monitoring of a Light Sport Aircraft

F2483 Practice for Maintenance and the Development of Maintenance Manuals for Light Sport Aircraft

F2746 Specification for Pilot's Operating Handbook (POH) for Light Sport Airplane

F2839 Practice for Compliance Audits to ASTM Standards on Light Sport Aircraft

F2972 Specification for Light Sport Aircraft Manufacturer's Quality Assurance System

F3035 Practice for Production Acceptance in the Manufacture of a Fixed Wing Light Sport Aircraft

F3060 Terminology for Aircraft

2.2 *FAA Standards:*[3]

FAA Advisory Circular No. 23.629-1B Means of Compliance with Title 14 CFR, Part 23, Section 23.629, Flutter

FAA JASC (Joint Aircraft System/Component) Codes

2.3 *Other References:*

ATA (Air Transport Association) Spec 100, or the newer iSpec 2200—Information Standards for Aviation Maintenance[4]

Metallic Materials Properties Development and Standardization (MMPDS, formerly MIL-HDBK-5)[5]

CMH-17 (formerly MIL-HDBK-17) for composite material properties[5]

CICTT (Commercial Aviation Safety Team/International Civil Aviation Organization Common Taxonomy Team) International Standard for Aircraft Make, Model, and Series Groupings – Business Rules, October 2012 (1.3)[6]

3. Terminology

3.1 The following are a selection of relevant terms. See Terminology F3060 for more definitions and abbreviations.

3.2 *Definitions:*

3.2.1 *compliance package*—a set of documents which provides objective, verifiable evidence for compliance to applicable ASTM standards.

3.2.2 *compliance program*—a set of activities planned for, executed, and for which results are reviewed against ASTM standards for the purpose of declaring compliance to a particular standard.

3.2.2.1 *Discussion*—The program may be short and simple or extensive and comprehensive, depending on the standard or purpose of the program (for example, initial design versus modification).

[1] This guide is under the jurisdiction of ASTM Committee F37 on Light Sport Aircraft and is the direct responsibility of Subcommittee F37.70 on Cross Cutting.

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[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 Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, http://www.faa.gov.

[4] Available from http://www.airlines.org.

[5] Available from http://www.everyspec.com.

[6] Available from http://intlaviationstandards.org.

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3.2.3 *continued compliance activity*—work that is conducted as part of the ongoing support and production of an aircraft following the initial design definition and statement of compliance.

3.2.4 *control drawing*—discloses engineering form, fit, function, and performance requirements for the acquisition of purchased items of existing designs, or of items specially developed by vendors.

3.2.4.1 *Discussion*—A control drawing facilitates accurate procurement of vendor-developed items without disclosing details of designs or divulging proprietary vendor data.

3.2.5 *date of manufacture*—possible dates include, but are not limited to, the date of initial registration in the relevant country of first registry of the individual aircraft, the date of initial airworthiness certification, the date of the signature of a statement of compliance, or other date as defined by the applicable CAA.

3.2.5.1 *Discussion*—It is important for the manufacturer to correctly identify this date as it determines which standards and which revisions thereof are applicable to each individual aircraft.

3.2.6 *declaration of compliance*—the official statement by a manufacturer that an aircraft meets the applicable light sport aircraft standards as specified by the relevant CAA.

3.2.7 *manufacturer*—any entity engaged in the production of a light sport aircraft which is responsible for completing all compliance-related paperwork and assertions of compliance.

3.2.7.1 *Discussion*—The manufacturer is also responsible for identifying each aircraft produced; for stating that each aircraft complies with the applicable requirements, conforms to its own design definition and has performed acceptably on all necessary ground and flight testing; and for continued monitoring and correction of safety-of-flight issues.

3.3 *Acronyms:*

3.3.1 *AMM*—Aircraft Maintenance Manual

3.3.2 *BOM*—Bill of Materials

3.3.3 *CAA*—Civil Aviation Authority

3.3.4 *CAD/CAM*—Computer Aided Design/Computer Aided Manufacturing

3.3.5 *COS/COSM*—Continued Operational Safety/ Monitoring

3.3.6 *COTS*—Commercial Off-The-Shelf

3.3.7 *FTS*—Flight Training Supplement

3.3.8 *IPB*—Illustrated Parts Breakdown (aka IPC, Integrated Parts Catalogue, Illustrated Parts Catalog)

3.3.9 *LSA*—Light Sport Aircraft

3.3.10 *MCCL*—Master Compliance Check List

3.3.11 *MOC*—Means of Compliance

3.3.12 *MTS*—Made to Spec

3.3.13 *NHA*—Next Higher Assembly

3.3.14 *OEM*—Original Equipment Manufacturer

3.3.15 *POH*—Pilot Operating Handbook (aka AFM, Aircraft Flight Manual; aka AOI, Aircraft Operating Instructions)

3.3.16 *QA*—Quality Assurance

3.3.17 *QAM*—Quality Assurance Manual

3.3.18 *QAP*—Quality Assurance Program

3.3.19 *QAR*—Quality Assurance Record

3.3.20 *QC*—Quality Control

3.3.21 *UM*—Unit of Measure

4. Significance and Use

4.1 This guide provides some major themes and examples for consideration related to compliance which are not necessarily captured in any single standard pertinent to light sport aircraft. The outline of this document is intended to loosely reflect the process that an organization would go through in order to reach and maintain production of a light sport aircraft that is demonstrably compliant with the applicable ASTM standards.

4.2 These considerations are applicable to manufacturers which are responsible for conformity to processes and procedures required in ASTM standards for light sport aircraft. Manufacturers are encouraged to think through the contents of this guide, reference the ASTM light sport aircraft standards, establish, document and follow their own procedures.

4.3 Manufacturers are responsible for determining which standards and revisions thereof are part of the regulatory package of any given CAA, along with any other requirements applicable within the agency's jurisdiction.

4.4 Following this guide does not ensure compliance of a particular light sport aircraft; however, following the explanations provided herein should assist manufacturers in avoiding common pitfalls of declaring compliance prematurely, determining shortcomings in current declarations of compliance, and maintaining a body of documentation sufficient to support a declaration of compliance.

5. Key Themes

5.1 The following key concepts are essential to the compliance process and can be seen throughout this guide. Manufacturers are encouraged to keep these themes in mind.

5.2 *Configuration Control*—Over the course of the development or compliance program, or both, the configuration should be captured such that the specifics of the compliant design are characterized, traceable, and documented. This includes elements such as definition, source, specifications, and a system for managing configuration.

5.3 *Change Management*—Changes come about from a variety of sources: changes for improvements to a design, as a result of safety of flight issues, or in response to a change in the standards themselves. All changes must be managed in order to maintain compliance to the applicable standards throughout the product's lifecycle. Failure to manage and track changes will result in non-compliance.

5.4 *Documentation*—The implementation of the consensus standards within a certification process depends on compliance which is not merely declared, but also verifiable and repeatable. If compliance is not documented, it cannot be assumed.

Thorough documentation is essential for providing traceability, supporting compliance and certification activities, and facilitating design control. The manufacturer must be able to fully account for all activity pertaining to the applicable requirements associated with the aircraft. In addition, any assumptions that are relied upon as part of the design or production process should also be thoroughly documented. For parameters that are subject to variation, documentation of the sensitivity of aircraft performance or conformity to those parameters is also highly recommended.

5.5 *Plan, Execute, Evaluate, Record (PEER):*

5.5.1 *Plan*—A systematic plan that covers all elements of compliance, from an overall system for document management and design definition to maintenance and continued operational support, should be established at the beginning of any compliance-related effort. It should include a process for documenting results to be used as a means of checks and balances. The plan should cover all phases of product development, manufacture, and support. Reliance on fleet experience or anecdotal information for an existing design does not generally meet the minimum requirements for this plan. Processes that are capable of providing traceability and support proof of compliance as needed should be implemented within each phase.

5.5.2 *Execute*—Systematic execution to the plan with thorough documentation is essential to future declarations of compliance. If documentation is not sufficient, either from newly conducted design or test exercise, or from potentially relevant fleet experience, the manufacturer may have to redo testing or analysis.

5.5.3 *Evaluate*—Appropriate evaluation of results in light of each individual requirement and use of planned checks and balances is critical. Standards are written in terms of minimum requirements such that failure to comply or a lack of ability to demonstrate compliance on any single item in a standard is non-compliance of the entire aircraft or system.

5.5.4 *Record*—Appropriately document all findings that support the applicable requirements. Documents should be clearly identified and written so that compliance to the requirements can be easily verified. Document control will also support configuration control.

6. Compliance Process Overview

6.1 *Overview*—A schematic overview of the compliance process is shown in Fig. 1. One possible path through the light sport aircraft compliance process is provided in Fig. 2. Following these flowcharts does not ensure compliance, nor does implementing a process that differs from these flowcharts

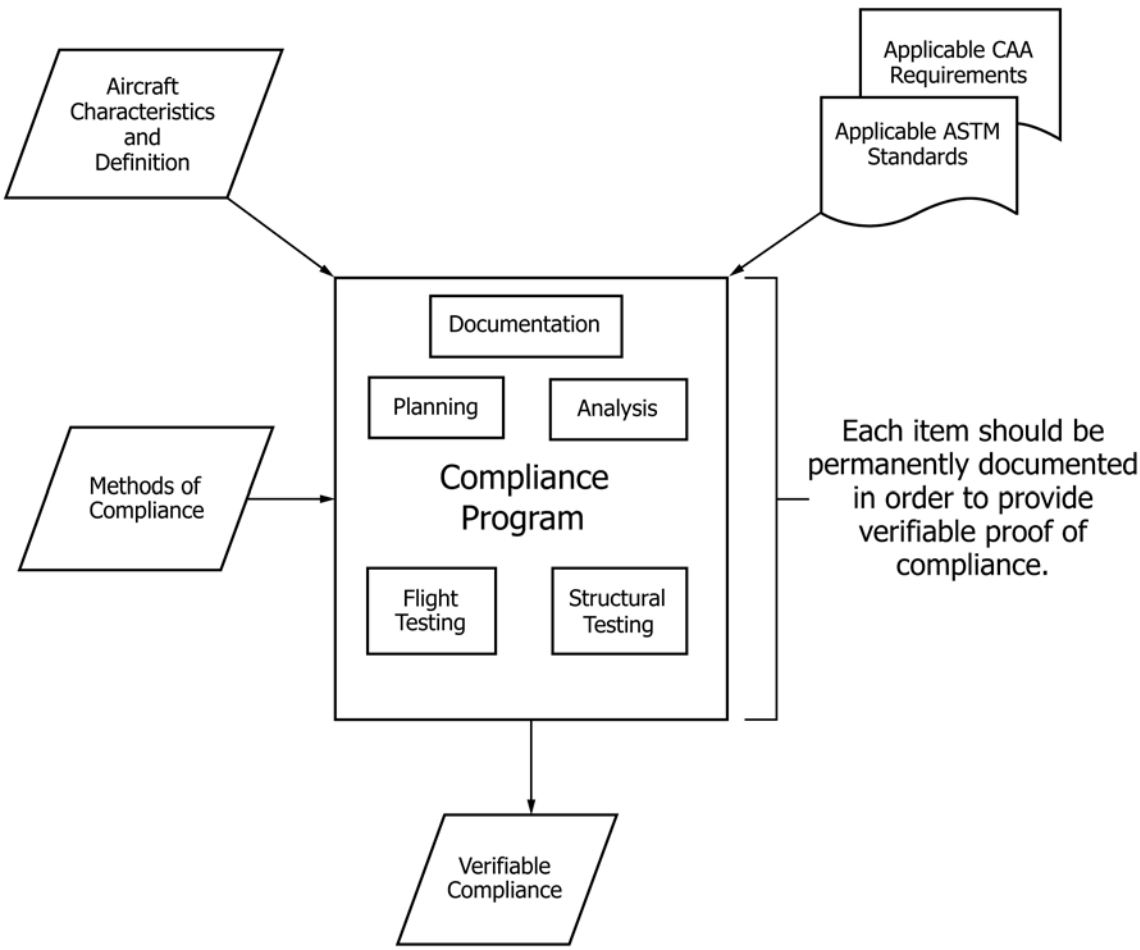

FIG. 1 Compliance Program Schematic Overview

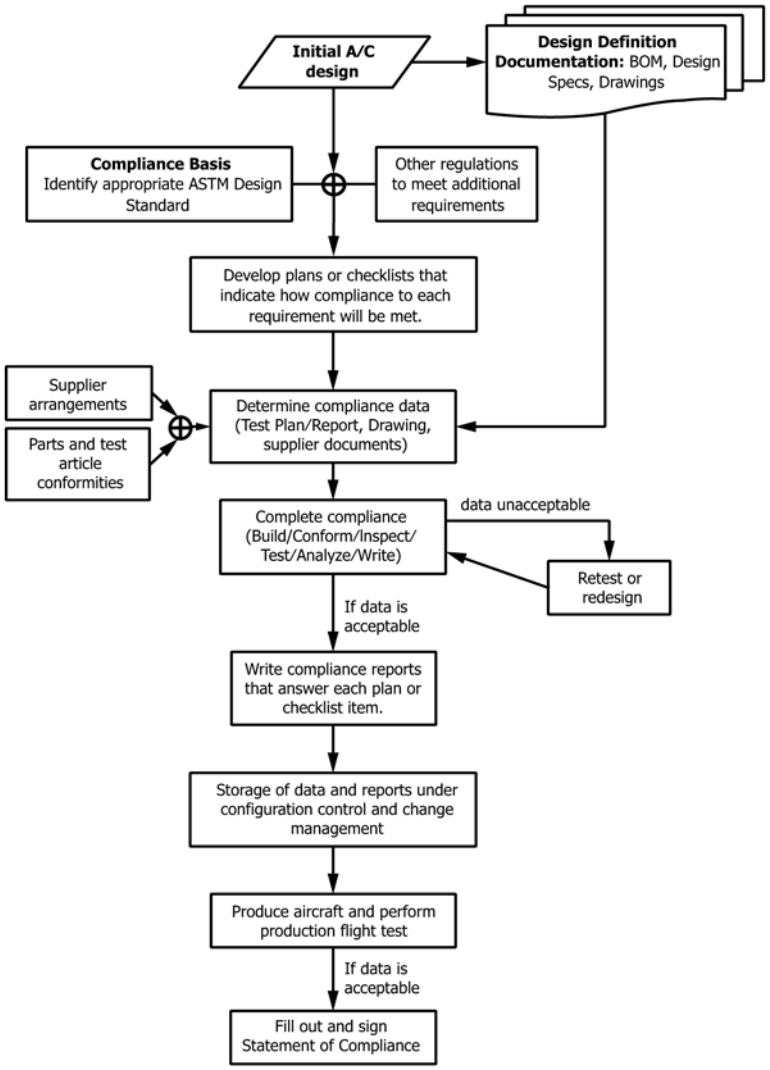

FIG. 2 Example Light Sport Aircraft Certification Process

necessarily mean non-compliance. Manufacturers are responsible for defining, executing and evaluating their own processes for both initial and ongoing compliance.

NOTE 1—While Fig. 2 ends with signing a statement of compliance for a production aircraft, each aircraft produced does require its own statement of compliance and must comply with the set of standards that are currently in effect at the date of manufacture.

6.2 *Personnel Certification*—A key aspect of the compliance process is ensuring that those responsible for determining compliance within the manufacturer's organization are appropriately trained and qualified to do so. This is true regardless of the level of CAA oversight applied to the certification process. While it is not the intent of this Guide to mandate training or a particular training course, Manufacturers should be aware of any such requirements that the relevant Civil Aviation Agency in the county of first registry of the aircraft may, if desired, impose that mandate training or define limitations of validity and requirements for recurrent training. The scope discussed in 6.2.1 is intended to be representative of what one might expect to see in an appropriate training course.

6.2.1 *Training Scope*—The training is intended to verify that graduates are able to understand and determine whether an aircraft design and the manufacturer's operations and processes meet the requirements set forth in the ASTM standards for Light Sport Aircraft as well as the relevant regulatory framework. The training aims to provide education on the relevant standards, how they are used, and best practices to help minimize potential negative actions by the applicable CAA through robust demonstration of compliance. To achieve this, the training provides understanding of:

6.2.1.1 How to assess whether there is adequate substantiation to show compliance to the applicable standards set forth in the ASTM standards for light aircraft;

6.2.1.2 The requirements to obtain LSA certification, inclusive of design, performance, quality, and continued operational safety;

6.2.1.3 The various materials that must be provided with the sale of an ASTM compliant aircraft; and

6.2.1.4 The responsibilities and duties of an ASTM compliant aircraft manufacturer.

6.2.1.5 Additionally, training is desirable to enhance understanding in complying with specific design, production, and continued airworthiness requirements. Study of this guide complements this training, but is not intended to replace it.

6.2.2 *Available Training Programs:*

6.2.2.1 *ASTM Light Aircraft Certificate Program*—ASTM administers the Light Aircraft Personnel Certificate Program. The ASTM Technical and Professional Training (TPT) Department developed a two-day training program on the proper application of ASTM F37 standards and processes to the design, production, and operation of light sport aircraft. The ASTM Light Aircraft Certificate Program was designed to match the above stated scope. More information on the Personnel Certificate Program can be found on the ASTM F37 website.

6.2.3 *Other Training Programs*—Other training programs may also be available. Courses not listed in this document are not assumed to be inappropriate. Manufacturers should compare the curriculum of other courses to the suggested scope discussed in 6.2.1 and work within any applicable CAA requirements to determine the usefulness and acceptability of other courses that may be offered.

7. Product Definition

7.1 *Documentation*—Establishing the actual product definition early in the design process is necessary for success in certification. Setting the aircraft configuration and controlling change to that configuration aids in cost minimization as well. In addition to setting and documenting the intended design, configuration, and processes, confirming that those processes are being applied to consistently produce the intended product is critical to the manufacturer's compliance. Design details that are related to a particular regulatory requirement should be clearly identified and traceable as such, with all associated analysis and testing information clearly referenced/identified.

7.2 *Design Definition*—"Design definition" refers to detailed engineering or machine drawings, or electronic CAD/CAM data of equivalent detail that fully defines in-house, vendor, and internationally recognized standard components and assemblies. Vendor items and internationally recognized standard parts may be sufficiently defined by reference to the governing vendor item or the associated recognized standard. If specification or control drawings are utilized, they should be maintained as part of the design definition package for the aircraft. It is strongly recommended that design documentation be organized under a logical and consistent system that allows for revision and approval tracking. Manufacturers should maintain a complete and current design definition for any product they wish to declare compliant. Manufacturers may find some of the referenced documents (for example, ATA iSpec 2200) useful in defining their item numbering and organization system. All design definition should:

7.2.1 Conform to good drawing practice, including appropriate tolerances;

7.2.2 Include reference to process or material specifications that are key to item characteristics; and

7.2.3 Be part of a revision control history with revision information clearly identified and easily accessible.

7.3 *Specifications, Standards and Other Requirements*—Specifications necessary to define the product are a part of the compliance package. Specifications include items such as material specifications, nationally recognized standards, and manufacturing or assembly processes.

7.4 *Product Structure, Bill of Materials (BOM) or Parts List*—The product structure lists all of the items (components, subassemblies, consumables, vendor parts, etc.) and item quantities required to create an instance of the product. A complete product structure, or master configuration list, including both MTS and COTS components, fasteners, and adhesives for the LSA is an integral part of the product definition. It is recommended that a product structure or BOM be structured in a tiered manner that accounts for parts, sub-assemblies and assemblies within the product. Information such as part number and quantity should be included for each line item in the product structure. It is also a good place to capture any acceptable alternatives for a given component as well as reference documents such as design definitions, specifications, control drawings, consumable materials, bulk materials, and processes either through direct inclusion or by reference. Serial numbers are not included in the product structure, but for items for which a serial number should be recorded in the quality assurance record (QAR), that requirement may be called out in the product structure. (See Specification F2972, Section 5.) More information on the QAR can be found in Section 9. Additionally, the product structure can be a powerful tool to cross-check means of compliance for a product (see Section 8). If listed components include information about which standards were applied in their design, manufacturers can check for compliance from the bottom up (starting with a parts list) as well as from the top down (starting with a requirements list). While this level of thoroughness may not be deemed necessary, it may prove useful for a manufacturer wishing to provide an extra level of rigor to their certification process.

7.5 *Retention and Organization of Design Documentation*—Maintaining an organized and easily accessible design documentation package for each aircraft produced is required (see Specification F2972) to substantiate and support an assertion of compliance, to facilitate maintenance and continued operational support (such as through a functional continued operational safety program) for the aircraft, and to track the configuration and any authorized changes to that aircraft.

8. An Approach to Initial Compliance for an S-LSA Design

8.1 *Applicable Standards and Requirements*—It is the responsibility of the manufacturer to determine which of the ASTM standards, including appropriate revision numbers, are applicable to their aircraft at the time of production or major change/alteration to the aircraft. This guide does not address specific requirements that might be imposed outside of the ASTM standards; manufacturers are responsible for identifying any other requirements or regulations, or both. It should be noted that in addition to requirements dealing directly with the design of the aircraft, requirements addressing the manufacture

and support of the aircraft need to be determined and documented as described in this guide and as required by the relevant CAA(s).

8.2 *Determining Applicable Requirements*—Applicable standards should be selected for compliance for the type of aircraft or system being manufactured. These standards can cover the design, product documentation, quality assurance program, supplemental material, and other operational and continued operational safety aspects of the aircraft's life cycle and are identified by the CAA of the manufacturing state or CAA of import (delivery) state as it applies to that aircraft or system. For each standard identified, manufacturers are strongly encouraged to itemize individual requirements in a consistent manner of their choosing (for example, in a checklist, spreadsheet or database). The method chosen should facilitate traceability to the requirements and organization of proof of compliance and all supporting information in an easily accessible format. For each identified requirement, the manufacturer keeps a record of the means of compliance that will support the final product compliance statement.

8.3 *Documenting Means of Compliance*—Sufficient documentation, including copies of each revision of each standard used, needs to be retained for each applicable requirement such that a third party would be able to verify complete compliance of the manufacturer's aircraft. The manufacturer should also identify individuals within the organization who determine and assure compliance for each requirement, including name, position title and any qualifications deemed relevant by the manufacturer. It also serves as a record of the manufacturer's design and compliance process for future reference as part of an investigation or change control process. Subsection 8.4 includes a list of common means of compliance. Usability and clear identification are important aspects of maintaining compliance-support documentation. Suggestions for identification of supporting documentation include a title, drawing or document number, date, serialization affected, and manufacturer's name on each page of a drawing or document, or both.

8.4 *Means of Compliance*—Manufacturers are encouraged to develop, define and consistently implement their own standard means of compliance. Some common practices are provided in the following examples. Where specific means of compliance are specified within the standard under consideration, they should be used. Special care needs to be taken to ensure that the means of compliance chosen is rational, applicable, and appropriate to the particular use-case.

8.5 *Substantiation of Compliance*—After a means of compliance has been determined for each itemized requirement and an overall compliance plan is in place, the plan-execute-evaluate-record process can be applied to substantiate compliance on an item-by-item basis. These PEER cycles can be seen as nested inside the Execute step of the overarching compliance program. Iterations with this MOC-level work and redesign may be necessary to get to a fully compliant product. Substantiation techniques for a few common means of compliance are discussed in the following sections:

8.5.1 *Substantiation of Compliance by Design*—For all requirements substantiated with compliance by design, the product definition discussed in Section 7 takes on even greater importance. It should be clear how compliance can be verified from the recorded design documentation and should not be assumed to be "obvious" from the aircraft itself. (Items that are clearly compliant based on looking at the aircraft may be substantiated with compliance by inspection, but this basis should be used with care.) Compliance by design should not be declared based solely on the similarity of two components but rather on the specifics of the design, as defined and documented, of the component in question.

8.5.2 *Substantiation of Compliance by Analysis*—Substantiation by analysis uses calculation(s) or modeling, or both, in lieu of testing to show that a design can be expected to meet a requirement with an acceptable margin of safety. Substantiating analytical data, including inputs, assumptions, and methods, should be retained as part of the compliance package.

8.5.2.1 *Load Analysis*—A load analysis is a necessary early component of the substantiation package to prove structural integrity of the design. This analysis establishes the predicted applied loads which the aircraft and its components must withstand (flight, ground, landing, etc.) throughout its operating envelope. These loads are determined from weight, power, and other characteristics of the aircraft using design speeds,

TABLE 1 Industry Example Means of Compliance, Case 1

AMM	Aircraft Maintenance Manual
AN	Analysis
CS	Statement
DE	Design
EX	Exemption
FT	Flight Test
GT	Ground Test
IN	Inspection
IPB	Illustrated Parts Breakdown
N/A	Not Applicable
POH	Pilot Operating Handbook
QAM	Quality Assurance Manual
QAP	Quality Assurance Program
QAR	Quality Assurance Record
SB	Service Bulletin

TABLE 2 Industry Example Means of Compliance, Case 2

Type of Compliance	Means of Compliance		Associated Compliance Documents
Engineering Evaluation	MC0	Compliance Statement	Type Design Documents, Recorded Statements, Compliance by Similarity,
	MC1	Design Review/ Description	Descriptions, Definitions, Drawings
	MC2	Calculation/ Analysis	Substantiation Reports
	MC3	Safety Assessment	Safety Analysis
Tests	MC4	Lab or Bench Test	Test Plans and Test
	MC5	Ground Tests on Aircraft	Results Reports
	MC6	Flight Tests	MC6 Flight Tests indicates compliance will be shown
	MC8	Simulation	based on compliance flight tests.
Inspection	MC7.1	Conformity Inspection	Aircraft or Component Inspection Records
	MC7.2	Inspection	
Equipment Qualification	MC9	Equipment Qualification	May include all of the previous Means of Compliance

load factors, and factors of safety as specified in the compliance requirements. These loads form the foundation of additional testing and subsequent analyses. All data used as part of a load analysis should be retained. Clear indication of units and terminology consistent with the standards is also highly recommended. Extra diligence should be applied to ensure that the full operational envelope is considered, including "worst case" scenarios of both operation and configuration.

8.5.2.2 *Structural Analysis*—"Structural analysis" (a.k.a. "Stress Analysis") describes the substantiating data which establishes mathematically that the appropriate structural strength requirements have been met. The structural analysis draws upon the load analyses and material properties. The source of material properties and allowable stress should be included with the stress analysis in which they are employed. Stress analysis may include static stress analysis, fatigue, fail safe analysis, etc. and must fully define the configuration(s) used in the analysis.

8.5.2.3 *Recorded Data & Applicability of Analytical Methods*—Sufficient documentation on any analysis used for verifiable evidence of compliance shall be retained such that the analysis is repeatable. This information typically includes items such as the inputs and assumptions used in the analysis and the results of the analysis with measurements units (for example, N, kPa, kg, etc.). An interpretation of those results in the context of the standard under consideration may be included with this documentation, either directly or by reference, or maintained separately. If a software package or other computer model is used, the software version and model revision should be noted on the analysis results. It is also recommended that the manufacturer include information on how a particular analysis tool was validated for use in the relevant application or situation being modeled (for example, "industry standard software developed for this purpose", "see software verification and validation documentation XXX", "curve produced from data set YYY", etc.).

8.5.3 *Substantiation of Compliance by Test*—For all tests (flight, ground, bench, etc.), a detailed plan and other supporting documentation is developed, precisely executed, results are evaluated, and the entire process documented to a level that facilitates both repeatability and clear, consistent evaluation of results. For qualitative or pass/fail results, clear definition and consistent application of terms should be employed throughout the testing program. For each test conducted, the manufacturer should document the following: a test plan, any instrumentation and data collection plan, the test article description, conformity, inspection requirements, and all resulting data, in both raw (as collected) and analyzed (that is, processed) formats.

8.5.3.1 *Test Plans*—Prior to conducting any test, a manufacturer typically lays out a test plan that describes the test(s) to be performed, the specific standard(s) that are relevant to the test, the expected or required result of the test, or both, inspections that will be performed before and after the test, what data are to be collected and how that collection is to be accomplished, and any other information relevant to the execution of the test. Test plans are structured in such a way as to demonstrate and facilitate the repeatability of the test result. Manufacturers are encouraged to include recommended safety equipment and risk mitigation plans in their test plan documentation.

8.5.3.2 *Data Collection Techniques*—In the collection of data, manufacturers should consider:

(1) The rigor of the data collection technique employed, and its sufficiency for meeting the requirements and significance of the relevant standard(s) and test plan(s).

(2) The level of precision for the collection. As a rule of thumb, data should be collected to one significant level of precision greater than that used in the specification. As a minimum, data should be collected at the same level of precision as that used in the specification.

(3) The calibration of all tools, instruments and equipment as well as the verification of all data collection methods before use. If a non-standard or subjective data collection technique is employed, an explanation of the method(s) and description(s) of the scale employed should be documented and included in the test report and attached to the data themselves. All units, calibrations, and non-standard conversion or scaling factors used should also be included in the test report and attached to the data.

8.5.3.3 *Data Reduction Techniques*—Wherever possible and appropriate, data should be reduced and analyzed using industry-standard processes. If custom reduction techniques are employed, care shall be taken to ensure that the reduction processes are consistent and do not modify or otherwise bias the data in a manner that cannot be corrected prior to drawing conclusions from the data. The data reduction method(s) employed may be included in the test report, attached to the data themselves, or documented separately and cross-referenced to the data or test report, or both.

8.5.3.4 *Conformity of Test Articles*—Any part, assembly, or aircraft used in testing should conform to the design that is being declared as appropriate for the purpose of the test. The manufacturer is responsible for ensuring and documenting the conformity of test article(s) as relevant to the test(s) being conducted prior to commencing any testing activities. A complete BOM for any article(s) used in the conformity testing process should be retained. Any test article deviations should be documented and approved prior to conducting the test.

8.5.3.5 *Test Reports*—Test reports should be created for each test conducted as part of the compliance process. For a given test, wherever possible the test report should follow the structure and data collection processes laid out in the test plan for that activity. If the actual test differs from the test plan, the test report should follow the actual test, noting the reason for any discrepancies. Test reports should include the date and time frame over which test data were recorded, a test title or description, all relevant environmental information for the test period (that is, wind speeds and direction, temperature, etc.) and results of inspections performed. Data analysis and any conclusion(s) drawn from that analysis as relevant to the standard(s) relevant to the test may be included with the test report or cross-referenced and maintained separately. This information should be retained in a format that is easily retrieved to support the test report. Also included in the test

report, either directly or by reference to another document, is verification of conformity for each test article as discussed in 8.5.3.4.

8.5.3.6 *Disposition of Test Articles*—Before deciding on a disposition, or possible further use for test articles, manufacturers should consider the condition of test articles as it relates to continued service or disposal, based on the particulars of a test. Any use of a test article on a flight article or production aircraft should be done with full conformance to the manufacturer's compliant quality system. It should be noted that damage to parts may not be visible or directly inspectable.

8.6 *Compliance Through Product and Production Documentation*—Documents that accompany the product and guide production, either internally within the organization or to a customer on delivery, are compiled and maintained by the manufacturer as part of the compliance package. Accompanying documents, which include but are not limited to the aircraft maintenance manual, pilot operating handbook and quality assurance record, should be comprehensive, complete and cover each relevant line item of the applicable requirements (for example, Specifications F2245 and F2746). These documents should also include the manufacturing process definition, quality assurance programs and manuals, maintenance manuals, customer support processes, change and revision control processes, operating limitations, handbooks, and any other supporting material necessary for the manufacture, use and support of the product. Manufacturers are responsible for determining the complete accompanying document package as required by the ASTM standards and the relevant CAA. As with all compliance documentation, it is highly desirable, and required by some CAAs that supporting documentation is made available in the English language. A manufacturer should not consider their compliance package complete, nor declare compliance for an aircraft, without every required manual and document being readily available for inspection and use. A flight training supplement, as required, would also be considered product documentation.

8.6.1 *Aircraft Maintenance Manual (AMM)*—While details on the AMM are given in Practice F2483, manufacturers should note that it is critical that the maintenance manual for an aircraft be complete. It is possible that the relevant CAA may restrict repairs and alternations not explicitly covered in the AMM regardless of their perceived level of severity or complexity.

8.6.2 *Pilot's Operating Handbook (POH)*—Details on the POH are given in the ASTM standards relevant to each aircraft type (for example, Specification F2746 for LSA Airplanes). Manufacturers should note that while the POH may include training information in the form of an FTS (flight training supplement), an FTS does not take the place of a POH or vice versa. The FTS is intended to cover any particular skills or handling characteristics endemic or unique to the aircraft, or both, that would not ordinarily be considered part of a generic flight training curriculum. The POH contains all of the specific information needed for a pilot who has successfully the curricula in the FTS to safely operate the aircraft.

8.7 *Evaluation of Compliance*—Once the plan-execute-evaluate-record process has been completed for each requirement line item on the MOC level, the manufacturer returns to the larger framework of the compliance program at the evaluate step. The list of applicable requirements as discussed in 8.1 should be reviewed to confirm that each was met. If a discrepancy or area of incomplete information is discovered, the manufacturer should determine to what point in the compliance process they should return in order to ensure that all items are addressed before making a declaration of compliance. This may result in several iterations before a complete compliance substantiation package is compiled.

8.8 *Record of Compliance*—To facilitate international usability, all data used to demonstrate compliance should be compiled and organized by the manufacturer in English in such a way that it is clear and would be easily understood by an authorized third party. Clear identification of all substantiation reports containing data used to demonstrate compliance would include as a best practice information such as the manufacturer's name, the product identifier, date, document title, number and revision as applicable. Each page of a report should include similar information for easy identification. As mentioned in 7.4, it is good practice to cross-check the MOC records against the product structure. Similarly, manufacturers are encouraged to cross-reference each line-item requirement to the documentation that supports the identified MOC for that requirement, as well as referencing in the MOC documentation which line-item requirement(s) motivated the compliance activity. Two possible ways to capture these links are a master compliance check list (MCCL) and a cross-linked database.

9. Production of Conforming Aircraft

9.1 Once an aircraft design has been determined to be compliant with the applicable standards and requirements, the manufacturer then ensures that all aircraft produced conform to that design and will continue to conform in the case of standards or design changes. This is the intent of quality assurance (QA), production acceptance, and continued airworthiness requirements. While QA duties may in some instances be assigned to outside parties, no manufacturer should produce or declare compliance for aircraft which is not supported by a documented program that provides confidence in its continued compliance.

9.2 *Quality Assurance Program (QAP) Components*—The QAP is the program through which the manufacturer ensures continued conformity of their product to the compliant design. It covers all stages of the quality lifecycle for the aircraft, from plan, through execute and evaluate to record. The QAP is itself documented in the quality assurance manual (QAM) and produces as an end product, among other documents, the quality assurance record (QAR) for each aircraft produced.

9.3 *Planning for Quality Assurance*—The planning phase of the QA activities is closely related to the design of the product and should be considered in parallel with the finalization of the product definition and structure.

9.3.1 *Production Process Definition*—Production processes include manufacturing specifications, process routings, assembly instructions and any special processes or services that are

used in the production of structurally-critical aircraft components. All production processes should be documented within, or clearly referenced by, the quality assurance manual.

9.3.1.1 *Manufacturing Specifications* include key measurable characteristics of the component or product that are critical to conformity and the range of acceptable values for those measurements.

9.3.1.2 *Process Routings* include what work is to be done, in what order, by whom and in what locations.

9.3.1.3 *Assembly Instructions* consist of a step-by-step process for the integration of components into either subassemblies or onto the aircraft and include the proper use of any necessary adhesives or fasteners.

9.3.1.4 *Special Processes* are controlled and relate to the production of components considered by the manufacturer to be critical to the structural integrity of the product (for example, welding, composite construction, and heat treatment). These processes should include any inspection and record-keeping requirements for any tool, equipment, gauge or compound used therein.

9.3.2 *Production Inspections*—While the implementation of controlled processes and known methods of production are the first step in producing compliant hardware, inspections are done to ensure that all components and processes being used in the construction of an LSA conform to all applicable engineering requirements and production processes. Each inspection should have clear pass/fail criteria. Items that have not yet been inspected, that have been inspected and accepted, and items that have been inspected and rejected, should all be separated and clearly identifiable as such. Non-conforming items may be handled as described in 9.4.2. Records of all inspections should be kept in an organized and traceable manner. The manufacturer should determine not only which inspections to do but also any training requirements for those performing the inspections, whether or not an inspection requires the participation of more than one person and whether or not real-time approval during the manufacturing process can be implemented. Manufacturers should also determine what equipment, tooling or gauges are required for each inspection, and what maintenance, calibration and record-keeping needs to be performed on those items to ensure the validity of the inspection results. The timing of an inspection can also be critical to prevent unnecessary rework and facilitate access to the component being inspected.

9.3.3 *Acceptance Testing*—While production inspections and processes are intended to ensure conformity, the goal of the final production acceptance testing is to ensure the compliance of the product. Manufacturers should refer to the applicable QA or production acceptance standards (see Practice F3035), or both, for their aircraft, but in general this suite of testing includes items such as final inspections, weight and balance confirmation, ground checks on systems and flight controls, and taxi and flight testing. If necessary, instruments are calibrated as part of the production acceptance testing for an aircraft. Any discrepancies or anomalies discovered should be resolved by way of a process implemented by the manufacturer for this purpose and any aircraft with discrepancies or anomalies should be clearly tagged as such until they are resolved. To be able to show compliance, manufacturers need to document the production acceptance inspections, checks and tests conducted, as well as their results, for each aircraft. A completed written checklist is an example of an acceptable documentation method.

9.3.4 *Tooling, Equipment and Gage Requirements*—To ensure that accurate results are achieved from any manufacturing or inspection task, the proper tools, equipment and calibrations must be used. For each item used in the production of an LSA (for example, a torque wrench or scale), the manufacturer should define the appropriate settings, tolerances and calibrations that must be performed as well as the interval at which the same is to be verified. Manufacturers might find the exercise of a gauge repeatability and reproducibility (Gauge R&R) study a useful tool in this effort.

9.3.5 *A Note on Quality Assurance versus Quality Control Approaches*—Two approaches to quality are commonly used in manufacturing: quality assurance (QA) and quality control (QC). Quality assurance focuses on process control and the idea that if the same things are done properly every time, the same product will consistently result, thus reducing the need for final inspection. Quality control focuses on inspecting the final product to ensure conformity to intent and reworking as needed. While each can produce conforming product, manufacturers are encouraged to think about and evaluate their differences when crafting their QAP. A successful quality program often incorporates elements of both philosophies.

9.4 *Execution of the Quality Assurance Program (QAP):*

9.4.1 In following good practice, manufacturers should establish and maintain systems to ensure that conforming assembly, subassembly or detail parts, inclusive of purchased items, are incorporated into the aircraft.

9.4.2 *Non-Conformity Processes*—Invariably, articles that do not conform to the design definition will occasionally be produced. Appropriate identification and disposition of these articles is critical to the overall compliance of the product(s) and shall be done in compliance with applicable design and quality standards. Records of these procedures and any dispositions made shall be retained in a clear and accessible form by the manufacturer. Examples of disposition range from discarding the article to repair to conforming design. Any article not discarded should be approved and its use substantiated by an appropriately qualified member of the manufacturer's organization and that approval, along with any accompanying repair procedures, documented as part of the compliance data package.

9.5 *Continued Evaluation of the Quality Assurance Program (QAP)*—The quality assurance program, as documented in the quality assurance manual, should include a mechanism for its own revision as well as controls to ensure that only the most recent version is in use. A record of all revisions of the QAM should be retained within the manufacturer's organization. It is a suggested best practice that the quality assurance record for each aircraft produced should indicate which revision of the QAP was in effect for its production. This allows for ongoing improvement as well as traceability and efficient responsive action in the event that a problem or uncertainty associated with an element of the QAP arises in the future.

9.5.1 *Quality Assurance Audits*—The QAP should include mechanisms by which it can be revised and a means to track those revisions such that only the most current is in use. Quality assurance audits are required to be conducted by a manufacturer on their QAP annually. Thorough records of these audits should be kept, including any findings and resulting corrective actions performed.

9.5.2 *Changes to the Design*—Design changes come from a variety of sources and should be evaluated for effects on compliance. A systematic method for evaluating design changes and whether they are major or minor changes/alterations should be established. A change management process should be implemented to provide the traceability needed to maintain configuration control. This process should evaluate the level of the design change and determine how any planning, implementation and supporting documentation will be effected by the change.

9.5.3 *Changes to the Standards or Requirements*—When ASTM publishes a new revision of any applicable standard, a manufacturer is encouraged to gain familiarity with the new revision and understand what changes to their compliance package(s) would result from the changes to the standard. Individual CAA guidance should be sought as to the regulatory applicability of new ASTM standards. It should be noted that a single aircraft declared as compliant is only compliant to a single set of standards and not a mix of old and new revisions. Copies of the standard(s) to which an aircraft was declared compliant should be maintained as part of that aircraft's compliance documentation.

9.6 *QA Documentation and Record Keeping:*

9.6.1 *The Quality Assurance Manual (QAM)*—In addition to capturing the QAP, the QAM should document the quality assurance administration, or organization within the manufacturer that is responsible for implementing the QAP. In addition to identifying any employees, officials, agents or assigns involved with the QAP, the QAM should include information on the minimum qualifications for those parties, a definition of their specific responsibilities within the QAP, and mechanisms for ongoing evaluation, training and contingency planning as relevant to the roles within the manufacturer's quality assurance administration.

9.6.2 *The Quality Assurance Record (QAR)*—A QAR is generated for each aircraft produced and is the place to document everything that goes into or is done to the aircraft during production and acceptance testing. It is tied to an individual aircraft serial number and should include at minimum an aircraft-specific BOM or parts list with serial numbers, material certifications and the results of inspections for critical components, acceptance testing and full aircraft inspection reports, and the final determination of compliance of the aircraft to the appropriate requirements and standards. The QAR also provides manufacturers with the data necessary to identify which aircraft may be affected by an anomaly that results in a necessary corrective action, thus allowing said correction to be applied only where necessary instead of to the entire fleet. The manufacturer may also find it valuable to include either directly or by reference the following production documentation in the aircraft's QAR.

9.6.3 *Production Documentation*—Regardless of whether it is included with a QAR for an aircraft, production documentation should be revision controlled, with all revisions retained. It may include, but is not limited to, the following: product definition/BOM/parts list, production process definitions, design definitions, the QAM, the POH, the AMM, and any other documentation used in the production of, or accompanying at delivery, an LSA.

9.7 *Conformity of Re-Assembled Aircraft*—Any organization currently declaring that a product is compliant with the applicable ASTM standards takes on full responsibility for being able to demonstrate verifiable compliance in every respect, including but not limited to processes, tools, fixtures and documentation. If the disassembly/reassembly of the aircraft is required for delivery purposes, instructions should be provided for reassembly and any subsequent testing that must be conducted to ensure that the aircraft continues to be fully compliant with the requirements associated with that product.

10. Configuration Control and Change Management

10.1 *Decision Points*—The manufacturer is responsible for making decisions related to changes which would retain compliance for its fleet of aircraft. The following questions are considerations for managing changes to an already compliant aircraft:

10.1.1 What kinds of changes will certainly/possibly affect compliance of this aircraft?

10.1.2 Will this particular change result in a new condition or configuration for which traceability is necessary?

10.1.3 Besides Design Documentation or specification changes, how will the systems in place to produce aircraft need to be updated to maintain compliance?

10.1.4 Is there a system in place to aid consistent decision making that is not tied to the personal opinions of employees?

10.1.5 Do the existing systems rely too heavily on a single individual within the organization?

10.1.6 Do the existing systems provide confidence that changes which are deemed "minor" according to existing processes won't have unforeseen negative future consequences?

10.2 *Major versus Minor Changes*—In addition to the questions above, formally and accurately classifying a change as major or minor can be central to how a manufacturer handles a change internally and to how that change is perceived by the appropriate CAA. A minor change is one that does not have a significant effect on weight, balance, structural strength, reliability, operational characteristics, airworthiness characteristics, power and noise, or emissions. A major change is simply a change that cannot be defined as minor. When determining whether a change is major or minor, all effects of the change should be considered, including those that may be incidental or unintended. Also, it should be noted that several minor changes can have a cumulative effect that is in practice a major change. In the context of a statement of compliance, minor changes may be handled by verifying that the previously existing means of compliance is still applicable while a major

change may require a substantive rework of the means of compliance (for example, repeating a test or recalculating analyses).

10.3 *Change and Revision Control*—As design and compliance documentation evolves, manufacturers should maintain an archive of the revision history of all documents which demonstrate compliance to the appropriate quality assurance standards. This set of documents and their history ensures that any aircraft is traceable to compliant design and production quality systems. This can be facilitated by implementing a document numbering system that allows identification of the revision of a given document. Changes to documentation that is relevant to compliance should be documented, including who in the manufacturer's organization approved the change. Examples of compliance critical documents include but are not limited to drawings, production processes, Pilot's operating handbooks, and maintenance manuals. Care should be taken to ensure that changes are consistent across all related materials. A determination by the manufacturer as to whether a revision is backward compatible, particularly for assemblies or components already in service on existing S-LSAs, should be made for each change. Backwards compatibility is affected by both certification basis and technical considerations. If a change is not backward compatible, the old drawing(s) and data should be maintained unchanged in parallel to the new data in order to support existing aircraft. (Note that all compliance-related design definition and data needs to be archived as part of the compliance package for any previously delivered aircraft regardless of backwards compatibility issues. See 8.8 for more.)

10.4 *New Make and Model Designation*—To help establish some minimum criteria that would necessitate a manufacturer to designate a new model, both make and model have been defined. A major change, as discussed in 10.2, to an existing model's design or style of structure would constitute a new model. It is the manufacturer's responsibility to determine and document what constitutes a new model. The manufacturer must document the methodology used to determine whether or not a change is major or results in the aircraft being a new model, or both.

10.4.1 *Aircraft Make*—Aircraft make is the name assigned to an aircraft by the aircraft manufacturer when each aircraft is produced. In most cases, the aircraft make is the name of the aircraft manufacturer. If the entity that holds rights to an aircraft design permits another organization to build that aircraft, in most cases the aircraft make will be the name assigned by the entity that holds rights to the aircraft design. (See Table 3.)

10.4.2 *Aircraft Model*—Aircraft model is an aircraft manufacturer's or design holder's designation for an aircraft grouping with similar design or style of structure. The aircraft model when joined with the aircraft make must be unique in order to identify that aircraft grouping. (See Table 4.)

10.4.3 *Additional Data Elements*—CICTT business rules define additional data elements other than Make and Model. The complete hierarchy of terms provided includes: Manufacturer – Make – Master Model – Model – Master Series – Series – Popular Name. For some companies it can be helpful to make use of all of these definitions to be able to properly assign Make and Model.

11. Continued Compliance, Conformity and Operational Safety

11.1 The responsibility to ensure compliance and safety does not end with the delivery of a product and associated documentation. Processes compliant with continued airworthiness standards need not be complex, but they should be robust enough to respond appropriately as safety of flight issues are discovered, evaluated, and corrected. Manufacturers continue to have operational and procedural compliance responsibilities as detailed in the applicable standards. Manufacturers should develop, implement and document processes to maintain continued airworthiness of their product.

11.2 *Planning for Continued Operational Safety (COS)*—It is important that manufacturers have adequately considered how they will support aircraft in the field over time and have a COS plan in place before commencing deliveries. A manufacturer already delivering product is encouraged to evaluate their existing COS processes and implement any desired changes. The COS plan should factor prominently into any business planning activities conducted by the manufacturer's organization. Key components of an effective COS plan include:

11.2.1 Owner relationship definitions and agreements.

11.2.2 Mechanisms for supporting aircraft in the field as the configuration changes with time.

11.2.3 Processes for disseminating applicable notifications to owners and service providers, whether they originate with the manufacturer or from a third party.

11.2.4 Organizational structure to provide spare parts and maintenance information.

11.2.5 Processes for handling owner requests outside the scope of typical product support (for example, major repairs and alterations, upgrades, overhauls).

11.2.6 Processes for tracking and responding to owner requests and incident reports.

11.2.7 Risk assessment processes as desired or required, or both.

11.2.8 Any delegations of COS duties and how those third-party relationships will be monitored and maintained.

11.2.9 Contingency plans for discontinued airworthiness support.

TABLE 3 Examples of Aircraft Manufacturer and Make

Aircraft Manufacturer	Aircraft Make
American Legend Aircraft Company	American Legend Aircraft Company
BushCaddy Aircraft Canada	Canadian Light Aircraft Sales & Service
Flight Design GmbH (Germany)	Flight Design GmbH

TABLE 4 Examples of Aircraft Make and Model

Aircraft Make	Aircraft Model
American Legend Aircraft Company	AL3
CubCrafters Inc.	CC11-160
Flight Design GmbH	CTLS

11.3 *Manufacturer Execution of a COS Plan*—In order to maintain the highest level of Continued Operational Safety and owner satisfaction, manufacturers are encouraged to dedicate resources to training COS and support staff on their COS plan so that customer communications are consistent, accurate and timely. Manufacturers may find the following useful considerations when executing a COS plan as outlined in 11.2:

11.3.1 How will the manufacturer facilitate and incentivize owners to stay in touch with the manufacturer and follow proper COS and maintenance procedures? Does a lack of incoming communication from the field really indicate a lack of issues in the field?

11.3.2 How are aircraft configurations tracked with time? Is the QAR for the aircraft in question amended? Are suggested logbook entries provided by the manufacturer as well as tracked internally?

11.3.3 What communication channels are the most effective for the manufacturer's particular group of owners? Is there a desire for a feedback mechanism to verify that critical information was received or acted upon, or both?

11.3.4 How will spare parts production fit into the operations of the manufacturer? How are replacement/alternate parts checked for suitability and compliance?

11.3.5 Who within the manufacturer's organization can approve a maintenance scheme for a major repair or alteration? Do upgrades and overhauls need to be done at the manufacturer's location or by specially trained staff?

11.3.6 How will trends in service issues be uncovered? What corrective actions would such a trend initiate within the manufacturer's organization? What records are kept from each owner communication?

11.3.7 Who within the manufacturer's organization is responsible for performing risk assessment procedures? How are these procedures and their results documented and implemented?

11.3.8 What are the qualifications for a third party designee? How are communications between the manufacturer and any third parties involved in COS facilitated such that issues requiring the attention of the manufacturer are dealt with in a timely fashion?

11.3.9 How will aircraft already in the field be able to get service should the manufacturer no longer be able to provide support?

11.4 *Continued Evaluation of COS Activities*—Manufacturers are required to conduct audits of their processes and compliance practices on a regular and ongoing basis. Practice F2839 is recommended for this purpose. Manufacturers should be ready to support any third party audits that may be required by applicable CAA's or voluntarily implemented. Audit results should be recorded and archived with the same level of permanence as the rest of the compliance documentation package. The final and perhaps most crucial component of any audit process is the opportunity that it presents for improvement in any area found to be lacking by the auditing agency, whether that agency be internal or external to the manufacturer. As part of the audit planning, execution and evaluation process, the manufacturer is encouraged to define internal responsibilities and timelines for accomplishing and verifying any action items uncovered as part of the audit process.

11.5 *COS-related Documentation and Record Keeping*—As with all compliance-related activities, the creation, revision control, and retention of a complete documentation package for the COS and maintenance programs for an aircraft are critical to the overall compliance of that aircraft. Data and documentation relevant to continued airworthiness should be tracked with revision controls in the same fashion as all other compliance and conformity documentation. COS-related data includes, but is not limited to:

11.5.1 *Support and Service Data*—Data from maintenance and customer support activities should be documented and compiled at a level that is sufficient for the identification of trends that may result in the need for a corrective action. Manufacturers should maintain a system of monitoring operational safety of its product(s) that is in compliance with all applicable standards and CAA regulations. This includes retaining a record of all risk assessment procedures, root cause analyses, incident data, and justification for decisions related to continued airworthiness actions or non-actions.

11.5.2 *Aircraft Maintenance Manual*—To comply with applicable standards, maintenance manuals and practices should be developed, kept current, and documented with revision controls in the same fashion as other compliance and conformity documentation.

11.5.3 *Notices*—Once an evaluation is made by the manufacturer that corrective action is needed, or if such a determination is made by a third party for a component of the aircraft, the manufacturer is required to inform the owner/operators of all effected aircraft. Documentation requirements for these notices are provided in Practice F2295, and include effective dates, ways of identifying the aircraft affected, and one of the following designations: "SAFETY ALERT", "SERVICE BULLETIN" OR "NOTIFICATION", depending on the severity and urgency of the information being disseminated. In addition to sending new notifications, manufacturers are required to provide a method by which owner/operators can verify that they have all of the current information for their aircraft. How to obtain this information, as well as any needed information on required inspections, such as annual or condition inspections, for the aircraft should be included in the accompanying documentation for the aircraft (see 8.6 and the applicable standards for more information on accompanying documentation).

11.5.4 *Owner Contact Information*—While this is something that has proven to be difficult in practice, manufacturers should make every effort to maintain current and accurate contact information for the owner of each of its in-service aircraft. This may include, but should not be considered limited to, efforts such as sending periodic requests for contact information verification, maintaining a convenient method for owners to voluntarily update their information, and leveraging service or support interactions as opportunities to confirm the most up-to-date information for an owner.

11.5.5 *Discontinued Aircraft*—Manufacturers should maintain an archive of the entire compliance data package (including product definition, accompanying documentation and all QAP-related information) for each model as well as continue to provide maintenance and continued operational safety support to those aircraft in service. As a precaution against the instance of a manufacturer becoming unwilling or unable to maintain the necessary data or to provide ongoing maintenance support, the compliance data package should be retained in a clear and accessible format in a fashion such that the data would remain accessible and available to the owners and operators of the aircraft in service. In the event of a manufacturer no longer being able to provide support for their aircraft, they should make a timely and diligent effort to contractually transfer the data and responsibility for their aircraft to a viable entity.

12. Concluding Remarks

12.1 This guide is not intended to convince the reader that complex systems commensurate with large bureaucracies are required for success in the LSA market. However, consideration of these topics and a systematic approach to compliance, which is verifiable and repeatable, are required.

13. Keywords

13.1 compliance guidance; conformity; continued operational safety; light sport aircraft; product definition; quality

APPENDIX

(Nonmandatory Information)

X1. FLUTTER MITIGATION GUIDANCE MATERIAL

X1.1 Applicability and Use

X1.1.1 The following resources provide methods for flutter mitigation prevention. All resources listed here must be utilized with care as their applicability to today's light sport aircraft designs may be limited due to differences in structure, design concept, aerodynamics, mass distribution, or other characteristics. In cases where substantive discrepancies are suspected, and particularly for faster aircraft, it is recommended that ground vibration testing (GVT), flutter analysis, and instrumented flight flutter testing be conducted and that any issues found as a result be mitigated. Corrective actions may include addition of control surface mass balances or stiffness improvements, or both.

NOTE X1.1—Applicability of Specification F2245 directed vibrational flight testing (or lack thereof) is not altered by the conduct of GVT or other analytical flutter investigations.

X1.2 Reference 1

X1.2.1 *FAA Report No. 45*[7]—This report is intended to serve as a guide to the small plane designer in the presentation of design criteria for the prevention of such aeroelastic phenomena as flutter, aileron reversal and wing divergence. It should also serve as a guide to recommended, acceptable practices for the design of non-structural, mass balance weights and attachments. The criteria developed in this report include: wing torsional rigidity; aileron, elevator and rudder mass balance; reversible tab and balance weight attachment criteria.

X1.3 Reference 3

X1.3.1 *FAA Advisory Circular No. 23.629-1B*—The complexity of flutter analysis has historically prompted endeavors to find simplified methods of flutter substantiation. Although the advent of electronic computers has de-emphasized the need to make drastic assumptions previously necessary to enable mathematical treatment of the flutter phenomenon, there remains a need to simplify flutter solution as much as possible consistent with safety in order to minimize the cost and effort required to show freedom from flutter. Past experiences gained by the necessity to judiciously choose degrees of freedom, and by the need to make essential parametric studies to establish practical boundaries of the effectiveness of the various physical quantities, has resulted in a generally recognized set of good practices. These good practices form the basis for this advisory circular.

X1.4 Reference 2

X1.4.1 *"Aeroelastic Flutter Prevention in Gliders and Small Aircraft"*[8]—An empirical method is specified which can be used by the manufacturers of gliders and small aircraft to evaluate flutter vulnerability without extensive computational analysis and to take appropriate preventive measures. Suggestions are given on how designers can avert flutter from the very outset of the designing process. This method has been applied by the author in numerous cases and can be considered proven for conventional structures. It is based on the results of a simple vibration test as well as stiffness and friction measurements taken on the control system. Statistically derived design frequencies are given, thus restricting the number of vibration modes which must be considered. Through this method the required mass balance for the control surfaces is derived. Simple formulas for the calculation of the torsion frequency and the critical speed for torsional flutter are given.

[7] Rosenbaum, R., "Simplified Flutter Prevention Criteria for Personal Type Aircraft," *FAA Report No. 45*, Federal Aviation Administration, 1955.

[8] Stender, W. and Kießling, F., "Aeroelastic Flutter Prevention in Gliders and Small Aircraft," *Forschungsanstalt für Luft- und Raumfahrt*, Vol. 91, No. 3, 1991.

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