Designation: F2930 – 12

StandardGuide 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

F2279 Practice for Quality Assurance in the Manufacture of Fixed Wing Light Sport Aircraft

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

F2626 Terminology 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

2.2 *Other References:*

ATA (Air Transport Association) Spec 100, or the newer iSpec 2200—Information Standards for Aviation Maintenance[3]

FAA JASC (Joint Aircraft System/Component) Codes[4]

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

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

3. Terminology

3.1 The following are a selection of relevant terms. See Terminology F2626 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).

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.

[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 http://www.airlines.org.

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

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

3.2.5 *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.

3.2.6 *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.

3.2.6.1 *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 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 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 time.

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,

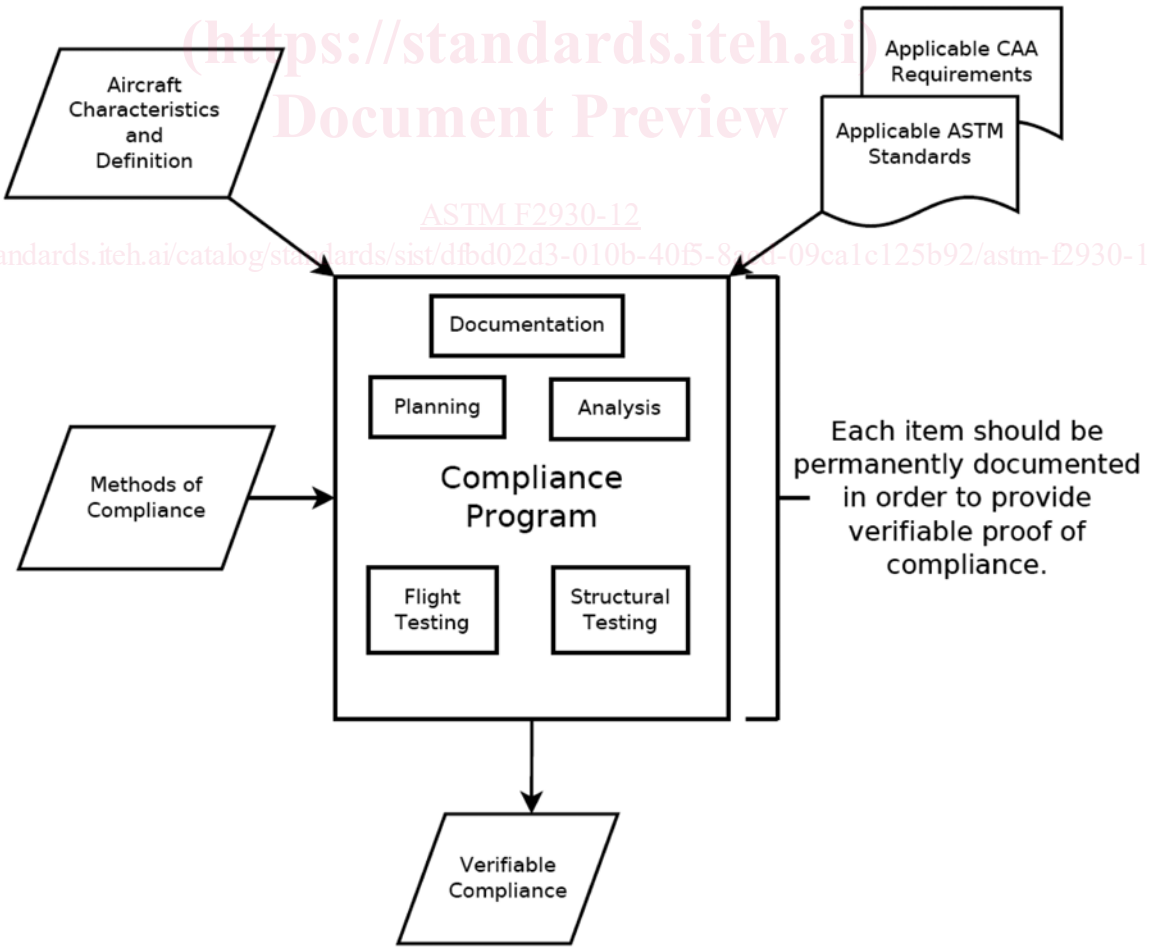

FIG. 1 Compliance Program Schematic Overview

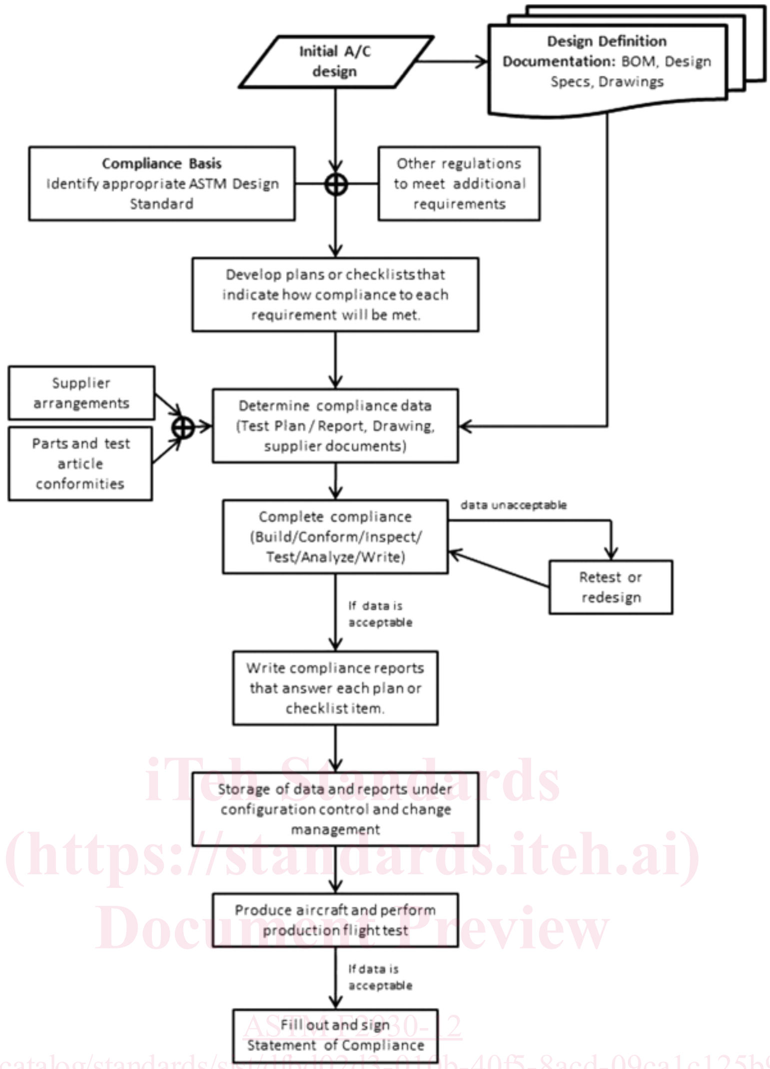

FIG. 2 Example Light Sport Aircraft Certification Process

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 Practice F2279, 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 Practice F2279) 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

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, Descriptions, Definitions, Drawings
	MC1	Design Review/ Description	
	MC2	Calculation/ Analysis	Substantiation Reports
	MC3	Safety Assessment	Safety Analysis
Tests	MC4	Lab or Bench Test	Test Plans and Test Results Reports MC6 Flight Tests indicates compliance will be shown based on compliance flight tests.
	MC5	Ground Tests on Aircraft	
	MC6	Flight Tests	
	MC8	Simulation	
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

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, 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)