Designation: ~~F3153 – 15~~ F3153 – 22

Standard Specification for
Verification of ~~Avionics~~Aircraft Systems and Equipment[1]

This standard is issued under the fixed designation F3153; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification provides a process ~~by which the intended function and compliance with safety objectives of avionics systems may be verified by system-level testing.~~for performing system level verification of aircraft systems and equipment. It provides a means of compliance that can be used for systems and equipment with software and Airborne Electronic Hardware (AEH) that have not been addressed by traditional development assurance methods.

1.2 This process can be used to show compliance to regulations that require a demonstration that functionality was implemented as intended, including safety mitigations that address failure conditions for software and AEH aspects for aircraft systems and equipment.

1.3 While this specification was developed with systems and equipment installed on aircraft certification level 1 and 2 (or class I and II in accordance with Advisory Circular (AC) 23.1309-1) normal category aeroplanes in mind, the content may be more broadly applicable. It is the responsibility of the Applicant to substantiate broader applicability as a specific means of compliance and obtain concurrence for its use from the applicable Civil Aviation Authority (CAA).

1.4 ~~Software and hardware development assurance are not in the scope of this specification and this specification should not be used if a development assurance process is required.~~When using this specification, regulations that govern system safety requirements applicable to the aircraft still apply. In complying with those regulations, additional architectural mitigations such as redundancy, independence, separation, system monitors, etc., may be required in addition to the verification process specified in this specification.

1.5 The ~~specification intentionally does not attempt to define its own applicability with regard to the type, category, class of aircraft, or criticality of function to which avionics systems verified by the specification may be applied as doing so could ultimately place~~ system level verification activities expected by this specification increase as the severity of the failure conditions applicable to or affected by the function increase. Those functions, which have hazardous and catastrophic failure conditions, receive additional activities through this process to provide detailed scrutiny. For normal category aircraft, refer to Practice F3309, Practice F3230~~the language of the specification in conflict with external requirements and guidance. Aircraft applicability, intended use, and limitations must ultimately be determined by the designer, installer, and recognizing body.~~, or AC 23.1309-1 for more information on the identification and classification of system failure conditions. Involvement of the applicable CAA personnel or their designees in this system verification process should be discussed early in the project.

1.6 This verification process specifically addresses definition, identification, and verification of system functions. Processes

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conducted under this specification may not satisfy all applicable external requirements; additional review on the part of the system developer, integrator, or installer may be required to meet specific requirements or the specified mission of the aircraft, or both.

1.7 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.8 *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~~ safety, health, and ~~health~~ environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]
F3060 Terminology for Aircraft
F3061/F3061M Specification for Systems and Equipment in Aircraft
F3230 Practice for Safety Assessment of Systems and Equipment in Small Aircraft
F3309 Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft
2.2 *Aeronautical Radio, Inc. (ARINC) Standard:*[3]
ARINC Mark 33 Digital Information Transfer System (DITS), Specification 429, Parts 1–15, November 2012
2.3 *Federal Aviation Administration (FAA) Advisory Circular:*[4]
AC 23.1309-1E System Safety Analysis and Assessment for Part 23 Airplanes
2.4 *RTCA Standards:*[5]
DO-178( ) Software Consideration in Airborne Systems and Equipment Certification
DO-254( ) Design Assurance Guidance for Airborne Electronic Hardware

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 *defect, n*—an unexpected or improper behavior.

3.2.2 *intended function, n*—a capability the system is designed to provide when installed on an aircraft.

3.2.3 *system, n*—a combination of components, parts, and elements that are interconnected to perform one or more functions.

3.2.4 *test ~~scenario,~~ case, n*—a set of inputs, pre-conditions, execution steps, expected results, and pass/fail crtieria defined by the manufacturer to verify proper function. Test ~~scenarios~~ cases are derived from the intended functions established for the system.

3.2.5 *verification, n*—confirmation, through the collection and review of objective evidence, that specified requirements have been fulfilled.

4. Process Overview

4.1 Fig. 1 provides an overview of the system verification process defined by this specification.

5. ~~Organizational Requirements~~ Configuration Management

5.1 An organization complying with this specification ~~shall manage under configuration control all life cycle data which are~~

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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~~ standard's Document Summary page on the ASTM website.

[3] Available from ARINC Industry Activities, SAE ITC, 16701 Melford Blvd, Suite 120, Bowie, MD 20715, https://www.aviation-ia.com/product-categories/arinc.

[4] Available from FAA's Dynamic Regulatory System, Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, https://drs-uat.faa.gov/browse.

[5] Available from RTCA, 1150 18th NW, Suite 910, Washington, D.C. 20036, https://www.rtca.org.
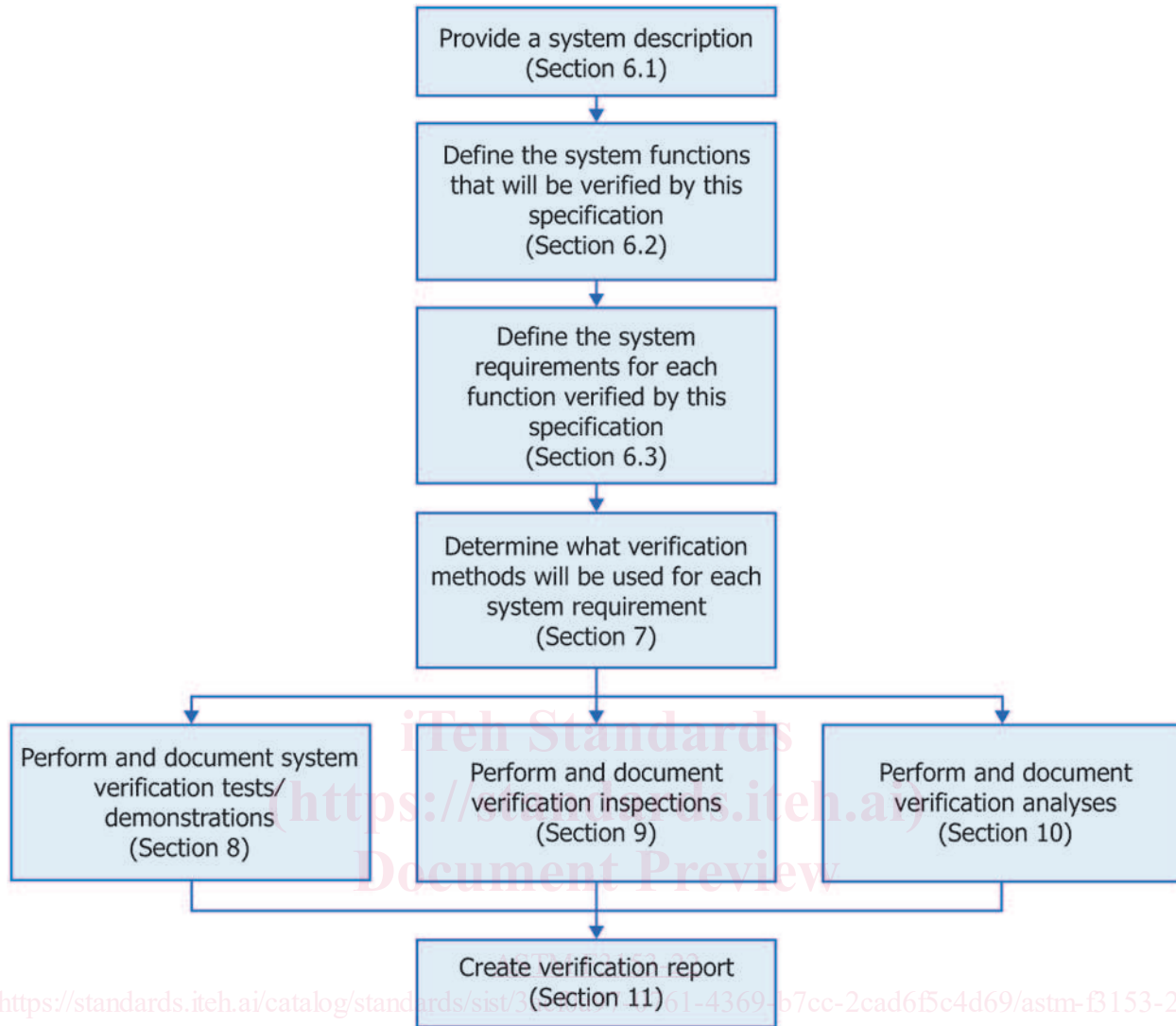
FIG. 1 System Verification Process Overview

~~generated by applying this specification.~~must have a documented engineering configuration management process that is used for any system whose function is verified by this process.

5.2 ~~The organization shall keep a record of the documentation used to show compliance of each approved system configuration produced to all applicable consensus specifications and regulatory requirements in effect at the time of manufacture.~~At a minimum, this engineering configuration management process shall:

5.2.1 Uniquely identify and control the configuration of all system artifacts and data generated under this process.

5.2.2 Keep a record of the documentation used to show compliance of each approved system configuration produced to all applicable consensus specifications and regulatory requirements in effect at the time of manufacture up to system retirement.

5.2.3 Ensure that changes to the system and documentation affecting compliance are tracked and the change process for developing, reviewing, and incorporating revisions to compliance documentation is controlled.

5.2.4 Ensure that the most recent and appropriate revision of data, or the revision documented in the plans, is used during each verification activity.

5.2.5 Establish a problem-reporting process to capture, document, communicate, and track system defects to their resolutions and closure. A summary of the problem reports should be made available to the certifying authorities.

5.2.5.1 Problem reports are required to track any defects and their impact on the system.

5.2.5.2 Problem reports must be used for tracking resolution and closure of system defects.

5.2.5.3 When justifying the deferral of an open (that is, unresolved) problem report to a future system revision, it must be shown that the system is safe and compliant with the applicable regulations.

~~4.3 Revisions to documentation affecting compliance shall be tracked and the change process for developing, reviewing, and incorporating revisions to compliance documentation shall be controlled.~~

~~4.4 The organization must ensure and verify the use of the proper revision of any compliance document.~~

6. Product Definition ~~Process~~Phase

6.1 *Function Identification:System Description:*

6.1.1 ~~Document the intended function(s)~~Provide a thorough description of the system. This description should include information such as:

6.1.1.1 Textual description of the system operation.

6.1.1.2 List of all inputs and output parameters at the system level.

6.1.1.3 Block diagrams.

6.1.1.4 System schematics.

6.2 *Function Classification:Intended Function:*

6.2.1 Identify and document the intended functions performed by the system.

6.2.2 For each function identified ~~under~~in ~~5.1~~6.2.1, determine and document ~~whether it is to~~those functions that will be verified under this ~~specification or by other means.~~specification. Identify which functions shall be verified through other means,

~~Note 1—Other means of verification may be proprietary or may be based on other standards, as best suits the developer's objectives with regard to safety, marketability, and compliance concerns.~~ and reference the process to be used.

6.2.3 For each function identified in 6.2.2:

6.2.3.1 Identify the failure conditions applicable for each function.

Note 1—This information is typically generated as part of the system safety assessment process. It is not expected that the applicant recreate the failure condition analysis for this specification, but to utilize the information from the Functional Hazard Assessment (or equivalent) that would be generated as part of the system safety assessment process. For normal category aircraft, refer to Practice F3230, Practice F3309, or AC 23.1309 for more information on the identification and classification of system failure conditions.

Note 2—The system verification should include the range of failure conditions expected in the inputs/outputs and computation/communication aspects of the various functions in the system. This would include hard failures (open circuits, short circuits, out-of-range input/output (IO) devices and interfaces); and soft failures (drifts, offsets, in-range erratic behavior, repetitive intermittence).

6.2.3.2 Define and document the environmental and operating conditions to be supported by the system. While it is beyond the scope of this specification to address environmental qualification of the system hardware, this action will provide a clear understanding of the intended system functionality and performance under expected operating and environmental conditions. For example, a primary display may be intended for installation on aircraft that support operation in Instrument Flight Rules (IFR) into known icing conditions up to 26 000 ft. The requirements and subsequent verification performed in this specification should be appropriate to support functionality of the system through the range of expected conditions.

6.3 ~~Function Specification:~~ Define System Level Requirements:

6.3.1 For each function identified ~~for verification under this specification~~ in ~~5.2~~6.2.2, ~~document the specifications of the function, including:~~specify the system level requirements that define the following:

6.3.1.1 ~~A description of the function,~~The proper operation and performance of the system when performing its intended function.

6.3.1.2 ~~An explanation of the intended use of the function, and~~The system mitigations that protect against failure conditions (such as monitors, annunciations, redundancy, independence, etc.).

NOTE 3—If the mitigation is provided by another system that is not verified under this specification, such as Technical Standard Order Authorization (TSOA) appliance, then this step is not required.

6.3.1.3 ~~Operating parameters or limitations that apply to the function.~~The expected system behavior given abnormal system inputs or

NOTE 2—~~The requirements of 5.1 and 5.3 may be met by a suitably annotated copy of the system's user or installation manual or by means of reference to a third-party specification (such as a TSO minimum performance standard).~~ operating conditions.

NOTE 4—The depth of the system requirements needed to adequately define the function will depend on the criticality of the functions provided by the system. For example, the music radio function of a datalink entertainment system could likely be defined by a very simple set of high-level requirements. Whereas a function that provides primary flight information would require a more detailed set of requirements to define its intended function and proper operation.

NOTE 5—The requirements of 6.1 and 6.3 may be met by a suitably annotated copy of the system's user or installation manual or by means of reference to a third-party specification (such as a Technical Standard Order (TSO) minimum performance standard). Refer to Appendix X2 of this specification for more guidance on ACs and Minimum Performance Standards (MPS).

7. Verification Methods

7.1 Verification of system level requirements established in accordance with 6.3 can be accomplished by one or more of the following verification methods:

7.1.1 *System Level Verification Testing and Demonstration:*

7.1.1.1 The "Test" verification method is the verification of a system using a controlled and predefined series of inputs, data, or stimuli to ensure that the system will produce a very specific and predefined output as specified by the requirements. When a system model is used to generate inputs, data, or stimuli for a verification test, the predictive properties and limitations as compared to the physical system should be assessed and documented.

7.1.1.2 Demonstration is the manipulation of the system as it is intended to be used to verify that the results are as expected.

7.1.1.3 For purposes of this specification, testing and demonstration methods should be considered and documented in the same way.

7.1.1.4 Verification of system requirements by test or demonstration shall be accomplished using Section 8.

7.1.2 *Inspection:*

7.1.2.1 Inspection is the nondestructive examination of a system using one or more senses (for example, visual, auditory, tactile, etc.). It may include but is not limited to simple physical manipulation and measurements.

7.1.2.2 Verification of system requirements by inspection shall be accomplished using Section 9.

7.1.3 *Analysis:*

7.1.3.1 Analysis is the verification of a system using models, calculations, or testing equipment, or combinations thereof. Analysis allows someone to make predictive statements about the expected system performance based on extrapolation of known data and assumptions.

7.1.3.2 Verification of system requirements by analysis shall be accomplished using Section 10.

7.2 For each function and associated system level requirements, the applicant shall identify which verification method will be used. It is expected that most of these requirements will be addressed by system level verification testing. However, some requirements may be more appropriately addressed by one or more of the other verification methods listed in 7.1.

8. Verification ~~Process~~Tests/Demonstration

8.1 *~~Functional Verification~~ Test Planning:*

~~6.1.1 Document the system test plan.~~

8.1.1 For each ~~function identified for verification under this specification in~~system level requirement identified as requiring verification by test/demonstration, the applicant ~~5.2:~~shall document the system verification test plan(s) that define one or more test cases and pass/fail criteria.

8.1.1.1 ~~Define a series of test scenarios and pass/fail criteria that trace to the functional requirement and that verify the function's correct operation within the set limits. In~~ When developing the test ~~scenarios,~~ cases, the applicant should consider known failures in similar systems or components, or both.

8.1.1.2 Testing may be conducted using bench tests, aircraft ground and flight tests, or a combination thereof, as appropriate for the function being evaluated.

8.1.1.3 ~~The test scenario should include failure conditions when appropriate and important to the system level function.~~These tests plans shall include test cases needed to verify proper function of the system under normal

~~Note 3—Where applicable, make use of a functional, non-functional, ground, and flight tests, providing direct reference to the specifications documented in 5.3 that make this specific test necessary.~~ and abnormal conditions. Appendix X1 provides guidance on the types of normal and abnormal conditions that should be considered when developing this test plan.

8.1.2 Test plans/procedures must:

8.1.2.1 Be performed on test articles that are representative of the final system configurations that will be approved. To accomplish this, the following should be included:
 (1) Include the definition of the test article(s) and test setup(s) on which testing is to be performed.
 (2) Identification (for example, part number and revision) of test article(s).
 (3) Document the test equipment required, including models or simulations if used, to generate inputs, data, or stimuli, and calibration requirements.

8.1.2.2 Provide a trace between the test cases and the system requirements that they verify.

8.1.3 A review of the test plan shall be conducted to ensure that the test plan fully represents the system requirements, verifies interactions between requirements and functions, and performs robustness testing for normal operations and failure conditions.

Note 6—Applicants may choose to document their test plans as one or more documents. Some CAAs may want participation by their specialists or their designee in some aspects of this testing. Consideration should be given to packaging those aspects in their own test plan(s). It is the responsibility of the applicant to establish participation expectations with the CAA early in the program.

6.2 *~~Testing:~~*

~~6.2.1 Execute the previously defined test scenarios.~~

~~6.2.2 Review test results and document pass/fail for each test scenario.~~

8.2 ~~Test Failure Resolution:~~ Conducting System Level Verification Tests:

8.2.1 Establish test article(s) and test setup(s) required by 8.1.2.1.

NOTE 7—Some CAAs may require some of these tests to be conducted as formal certification tests. As such, the test articles and test setups may be subject to additional conformity inspection requirements prior to formally conducting the test. It is the responsibility of the applicant to establish these requirements with their CAA early in the program.

8.2.2 Execute the test plan(s) documented in 8.1.

8.2.3 Review test results and document pass/fail for each test case using the pass/fail criteria defined in the test plan(s).

8.2.4 While performing testing in accordance with 8.2.2, test failures or other anomalous system behavior may be observed. These may fall into one of the following categories:

8.2.4.1 Test failures where the result of the test does not meet the pass/fail criteria established in the test plan.

8.2.4.2 Failures or anomalous behavior not directly related to the test procedure. These may be defects observed with the specific system under test or with other systems.

8.2.5 Determine and document the technical cause of each failure or anomalous behavior.

NOTE 8—For failures or anomalies in systems other than the system under test, the investigation may be limited to proving that the issue could not have been caused by the system being certified. If there is no way that the system under test could have caused the observed issue in the unrelated system, no further investigation is required.

8.2.6 Resolve all test failures ~~via~~ or observed anomalies by means of one or more of the following means:

8.2.6.1 Repeat the failed test procedure without revision to the system, specification, test set up or test plan.

NOTE 9—Repeat of the failed test procedure without changes to the system design, the test plan steps, or test setup would only be valid if the cause of the failure was determined to be the technique used by the tester.

8.2.6.2 Revision to the ~~system or its specifications,~~ system, its specifications, the test case, or the test plan and repeating the test.

8.2.6.3 ~~Revision of the system test plan,~~ Correcting a defect in the test setup or test equipment and repeating the test.

8.2.6.4 ~~Justification for deferral~~ Justify deferral of the open issue to a future system revision.

NOTE 10—When justifying the deferral of an open problem report to a future system revision, it must be shown that the system is safe and compliant with the applicable regulations with the open problem report present. In order to show this, there may be a need for mitigations such as flight manual limitations or procedures. Other open problem reports related to system features may not warrant any mitigations and can be safely deferred.

~~6.3.2 Identify the test(s) to be re-executed to verify the revised version of the system.~~

8.3 System Level Verification Test Reports:

8.3.1 Test reports should include:

8.3.1.1 Summary of pass/fail results.

8.3.1.2 Disposition of each observed failure or anomalous behavior, including the technical cause and corrective action taken.

8.3.1.3 Raw data files such as test notes, working copy of the test plan (including redlines).