



AEROSPACE RECOMMENDED PRACTICE

ARP5757™**REV. B**Issued 2008-03
Revised 2025-11

Superseding ARP5757A

(R) Guidelines for Engine Component Tests

RATIONALE

ARP5757B is based on the previously issued ARP5757A to provide guidance on the methodology to conduct engine component tests. This revision reflects input received as part of the Five-Year Review process, which includes field learnings and a subsequent further understanding of environmental threats.

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) provides guidance for substantiating the airworthiness of aircraft engine components. Generally, these components are associated with the engine control system, the system or systems that allow the engine to provide thrust or power as demanded by the pilot of the aircraft while also ensuring the engine operates within acceptable operating limits. But these components may also include hardware and systems associated with engine lubrication, engine or aircraft hydraulic or electrical systems, aircraft environmental control systems, thrust reverser control, or similar aircraft or engine propulsion system functions.

This paper develops the concept of using a standardized 26-item checklist of environmental conditions for evaluating aircraft engine component airworthiness. This approach is compatible with current practices used in the industry and has been accepted by engine certification authorities in conjunction with other guidance as described in FAA AC 33.91-1 and EASA AMC 80 as part of engine certification programs.

1.1 Purpose

The purpose of this document is to provide guidance on demonstrating compliance with aircraft engine certification authority requirements for engine components. Many complete engine tests are done as part of the overall engine substantiation and certification process. But often during the engine testing process, it is not practical to exercise all of the components of the engine to the extreme environmental limits each will encounter during operation in service. A simple example is during on the ground engine demonstrations the various components may not be exposed to the range of ambient temperature that will exist in the aircraft application. Additional tests or analysis may be required to demonstrate that the component will operate successfully throughout the range of ambient temperature conditions. There are a number of other environmental conditions and combinations of conditions that can best be evaluated at the engine component or subsystem level. The determination of specifically what these environmental conditions are is an engine system level activity comprised of component requirement derivation and decomposition. It is important that the combination of component, subsystem, or engine tests verify the system and component capabilities for the combination of environmental conditions expected in service. The correct and substantiated validation supporting these component requirements are critical to the success of any engine or engine component certification process and, moreover, a prerequisite of this ARP. Special consideration should be given to new components or technologies when utilized in an engine architecture including conditions resulting from non-normal operation.

This ARP is written to address the engine components associated with a new engine program certification. But the guidance may also be used for validating design changes to previously certified engines. However, when using this ARP for substantiating design changes, all test parameter levels, times, and pass/fail criteria should be reviewed to make sure they are adequate for the engine application with potential test parameter updates based on service experience.

1.2 Field of Application

This document applies to the components of civil certified engines. The components discussed by this ARP may vary from application to application. For this ARP, they are defined to include the parts of the engine control and accessory system that are maintained as line replaceable units (LRUs) and are not part of the actual thrust or power generation part of the turbomachinery of the engine. The control system includes all those components that are part of the speed, power, or thrust control system, fuel delivery and metering system, the engine airflow control system including turbomachinery variable geometry and air bleed systems, starting and ignition, and any other components associated with fault detection and accommodation of the control systems. The accessory system includes all the components that are part of the engine lubrication delivery and metering system and any other components associated with fault detection and accommodation of those systems. Depending on the specific application, other engine accessory systems and components of the thrust reverser and aircraft environmental control systems may be included.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE, FAA, and EASA publications shall apply. The applicable issue of other publications shall be as noted in this document. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. However, nothing in this document supersedes applicable laws and regulations unless a specific exemption has been obtained. All plans developed from the guidance in this document should be reviewed with the applicable airworthiness authority for their acceptance.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 1-877-606-7323 (U.S. and Canada only) or 1-724-776-4970 (outside U.S. and Canada), www.sae.org.

AIR1639	Safety Criteria for Pneumatic Starting Systems
AIR4023	Aircraft Turbine Fuel Contamination History and Endurance Test Requirements
AIR4246	Contaminants for Aircraft Turbine Engine Fuel System Component Testing
AIR6108	Engine Electronic Unit Fire and Overheat Design Guide
ARP1401	Aircraft Fuel System and Component Icing Test
AS4273A	Fire Testing of Fluid Handling Components for Aircraft Engines and Aircraft Engine Installations
MAP749	Aircraft Turbine Engine Fuel System Component Endurance Test Procedure (Room Temperature Contaminated Fuel)

2.1.2 Code of Federal Regulations (CFR) Publications

Copies of these documents are available online at www.ecfr.gov.

14 CFR Part 33 Airworthiness Standards: Aircraft Engines

2.1.3 EASA Publications

Available from European Union Aviation Safety Agency, Konrad-Adenauer-Ufer 3, D-50668 Cologne, Germany, Tel: +49 221 8999 000, www.easa.europa.eu.

CS-E Certification Specification for Engines

2.1.4 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

AC 20-135	Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards and Criteria (issued February 6, 1990)
AC 20-147A	Turbojet, Turboprop, and Turbofan Engine Induction System Icing and Ice Ingestion (issued October 22, 2014)
AC 21-16G	RTCA Document DO-160 versions D, E, F, and G, "Environmental Conditions and Test Procedures for Airborne Equipment" (issued June 22, 2011)

AC 33.17-1A	Fire Prevention (issued August 3, 2009)
AC 33.28-3	Guidance Material for 14 CFR § 33.28, Engine Control Systems (issued May 23, 2014)
AC 33.63-1	Turbine Engine Vibration (issued July 25, 2007)
AC 33.67-1	Engine Fuel Systems (issued May 20, 2024)
AC 33.91-1	Engine System and Component Tests (issued December 9, 2010)

2.1.5 ISO Publications

Available from International Organization for Standardization, ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, Tel: +41 22 749 01 11, www.iso.org/store.

ISO 12103-1:2016 Road vehicles — Test contaminants for filter evaluation — Part 1: Arizona test dust

ISO 12103-2:1997 Road Vehicles — Test Dust for Filter Evaluation — Part 2: Aluminium Oxide Test Dust

ISO 2669:1995 Environmental tests for aircraft equipment — Steady-state acceleration

2.1.6 RTCA Publications

Available from RTCA, Inc., 1150 18th Street NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

RTCA DO-160G Environmental Conditions and Test Procedures for Airborne Equipment (issued December 8, 2010)

2.1.7 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

MIL-E-5007E General Specification for Engines, Aircraft, Turbojet and Turbofan
(This specification is inactive for new designs and should be used for reference only)

MIL-E-8593A Engines, Aircraft, Turboshaft and Turboprop, General Specification For
(This specification is inactive for new designs and should be used for reference only)

MIL-STD-810H Environmental Test Methods

2.2 Acronyms and Terminology

AC	Advisory Circular (FAA nomenclature)
AIR	SAE Aerospace Information Report
AMC	Acceptable Means of Compliance
ARP	SAE Aerospace Recommended Practice
ATP	Acceptance Test Procedure
°C	Degrees Centigrade
CFR	Code of Federal Regulations
CRI	Certification Review Items
CS-E	Certification Specification Engine (EASA nomenclature)

EASA	European Union Aviation Safety Authority
EEC	Electronic Engine Control
EMI	Electromagnetic Interference
EUROCAE	European Organisation for Civil Aviation Equipment
°F	Degrees Fahrenheit
FZ	Fire Zone
FAA	Federal Aviation Administration (or Authority)
FADEC	Full Authority Digital Engine Control
FFLZ	Flammable Fluid Leakage Zone
FMEA	Failure Modes and Effects Analysis
HIRF	High-Intensity Radiated Field
ICA	Instructions for Continued Airworthiness
LRU	Line Replaceable Unit
JAA	Joint Airworthiness Authorities (of Europe)
JAR	Joint Airworthiness Requirement
LVDT	Linear Variable Differential Transformer
MAP	Aerospace Recommended Practice
RTCA	Entity formerly known as Radio Technical Commission for Aeronautics

NOTE 1: “Component” is used interchangeably with “equipment” as used in CS-E 80. Unless stated otherwise, it includes all controls and accessories of the engine.

NOTE 2: “Containing” or “conveying” is used to describe any component where fluid enters the component or the component is part of a pressure vessel containing the fluid.

NOTE 3: Type Design is the component as identified by the engine Type Certificate

3. APPLICABILITY

The applicability of these guidelines is intended primarily for engines certifying to 14 Code of Federal Regulations (CFR) Part 33 or equivalent regulations. The approaches contained herein have been accepted in previous approvals for engines certified to the provisions of 14 CFR § 33.91. This approach is usually coordinated with an effort to show compliance with 14 CFR § 33.28 since the substantiation for engine component tests and engine control systems is interdependent. The approaches are also intended to fulfill the requirements imposed by EASA under Certification Specification - Engine (CS-E) regulations. The acceptability of these approaches should be coordinated with the appropriate certification agency during any new certification effort.

As defined in Section 1 of this ARP, the enclosed guidelines are limited to those parts of the engine associated with engine controls and accessories. However, the guidance may be extended to other parts of the engine or aircraft systems that include similar hardware. When that is done, the guidance in this ARP may require tailoring for the specific function or application and should be coordinated with the appropriate certification agency.

4. HISTORICAL PERSPECTIVE

In the United States, law under the Code of Federal Regulations (CFR) defines the requirements for certification of aircraft engines. Within that Code, Title 14 is applicable to aeronautics and space, Subchapter C deals with aircraft, and Part 33 provides the Airworthiness Standards for Aircraft Engines. Compliance with the paragraphs of Part 33 is required for certification of aircraft engines.

Many certification tests are conducted on the complete engine assembly. But testing the complete engine assembly may not always expose all parts of the engine to the extreme conditions encountered in service. For this reason, 14 CFR Part 33 regulations make allowance for testing some of the engine hardware off of the engine; or, in other words, requires individual component or engine subsystem testing. Section 33.91 defines this requirement.

With the advent of Full Authority Digital Engine Controls (FADECs), additional requirements were added to 14 CFR as § 33.28. When 14 CFR § 33.28 became effective in August 1993 (Amendment 15), some of the testing that was traditionally done to address compliance with § 33.91 became more appropriate as compliance with § 33.28. The FAA has issued Advisory Circulars (ACs) with guidance for compliance with § 33.28. With the transition of some substantiation from § 33.91 to § 33.28 for items unique to electronics, the various tests needed to show compliance with § 33.91 were reduced and the checklists changed accordingly. Although most of the electromagnetic interference (EMI)/high-intensity radiated field (HIRF)/lightning environmental substantiation for electrical systems is substantiated under 14 CFR § 33.28, the verification that the individual components of the system are not damaged due to the electrical currents generated within the electrical system during a lightning strike is done on an individual component test basis as part of compliance with 14 CFR § 33.91. That requirement is defined as Pin Injection.

Amendment 26 of 14 CFR § 33.28 was published on August 19, 2008, and is the latest revision of § 33.28 at the issuance of this ARP. In addition to Pin Injection mentioned above, some component tests identified in this document such as Power Input and Overheat are also utilized to show compliance to both §§ 33.28 and 33.91.

The FAA published AC No. 33.91-1 (Subject: Engine System and Component Tests) on December 9, 2010. This AC recognizes ARP5757 as an acceptable test procedure for some of the 26 test categories identified.

European Union Aviation Safety Agency (EASA) regulations have similar requirements defined in CS-E 50, CS-E 80, and CS-E 170. EASA CS-E 80 applies to "equipment" and is similar to the requirements of 14 CFR § 33.91. The acceptable means of compliance (AMC) to CS-E 80 provides a 24-item test matrix which is similar to that contained in the FAA Advisory Circular for § 33.91 and this ARP.

The list of items required for compliance with 14 CFR § 33.91 as recommended by this ARP is summarized in Table 1. The suggested methods of compliance for each item will be developed in Section 5 of this ARP. Table 2 contains a brief summary of the changes to the list for compliance with 14 CFR § 33.91 that occurred with the introduction of 14 CFR § 33.28.

This ARP utilizes the guidance material available from the FAA and EASA and incorporates industry experience to define a method that can be used by most engine manufacturers for most aircraft engine applications to demonstrate compliance with FAA regulation 14 CFR § 33.91 and EASA regulation CS-E 80.

5. APPROACH

The approach followed by this ARP is to identify the test requirements and the certification agency source of the requirement, define the intent of each requirement, and suggest a method of testing or analysis for demonstrating compliance with the requirement. The result is a recommended approach for demonstrating compliance with FAA regulation 14 CFR § 33.91 and EASA regulation CS-E 80. Note that 14 CFR § 33.91 subparagraph (d) is not addressed in this ARP. Subparagraph (d) addresses supersonic aircraft which is not a common occurrence in today's civil aviation industry. Therefore, this ARP provides no guidance for it and does not include it in the compliance requirement checklist for all components. The majority of the tests listed below are recommended by AC 33.28-3 and/or AMC CS-E 80.

Many of the tests recommended by this ARP have procedures that are adequately defined in existing documents. The most common source of those procedures is "Environmental Conditions and Test Procedures for Airborne Equipment," which is also known as DO-160, published by RTCA. Revision G, issued December 8, 2010, is currently applicable. The FAA recognizes DO-160 in AC 21-16. DO-160 was also concurred with by the European Organization for Civil Aviation Equipment (EUROCAE) and is also known as RTCA DO-160G/EUROCAE ED-14G. Where no acceptable procedure exists, this ARP provides information on how to develop an acceptable procedure.

Unless otherwise noted in the guidance that follows, the test should be structured so the component is operating, providing its normal function, and configured in an installation representative manner as it would be in its intended application. Then each of the environmental conditions is varied one by one until performance has been successfully demonstrated at the maximum (or minimum) required environmental limits.

Each of the items is defined as a test to be passed. Often, it may be shown by analysis that the component would pass the test if it were to be tested. That may be the case when a similar part has already successfully completed the test. For this kind of comparison to be accepted by the certifying agency, the analysis must show that the new and previously tested components are equivalent in design, installation, materials, and construction methods; that the function or operation of the components is similar; and that the data confirms the previous component successfully met the requirements for the new application. This ARP does not discuss specific methods of how that comparative analysis may be performed, but it does encourage the applicant to review those methods with the certifying agency.

This ARP also provides guidance on the selection of appropriate pass/fail criteria for each item. At times, those criteria are completely defined. But in most cases, the user must evaluate the function of the component being tested and the implications of that function on engine operation to complete the definition of the pass/fail requirements.

The pass/fail criteria usually are divided into two parts: the performance of the part during or after exposure to the test environment and post-test inspection to confirm the component was not damaged during the test. The component specified performance should be met during most tests conducted within the expected environmental and engine operating conditions. For thrust loss pass/fail criteria, if specific requirements are identified in the following sections or if application specific requirements are available, they should be used. If neither is available, the guidelines of AC 33.28-3 may be followed.

A few of the tests are to show acceptable component performance at extreme conditions or to show that the component will perform reliably for an extended period of time. In those cases, the pass/fail criteria as defined for each item may allow for some level of degraded performance of the component. In a few cases, the only pass/fail criteria involve post-test inspection of the component to verify no damage occurred during the test.

Often, the pass/fail criteria will refer to passing an Acceptance Test Procedure (ATP) or selected parts of the ATP. That reference is made when the component is expected to totally comply with its specified performance. In those cases, all acceptance test parameters that may have been impacted by the environmental test exposure should be included. However, the functions normally verified in the ATP that were not exercised during the test may not need to be included in the post-test ATP, e.g., things like weight, tests at extreme temperatures, etc. Sometimes, there may be an ATP defined with acceptable new part production limits and another ATP for acceptable field service limits (if allowed by the component's system requirements). The field service limits may be used for all pass/fail criteria specified within this ARP. However, any significant performance changes within limits should be evaluated for the impact on continuing successful operation of the component. In some cases, an equivalent functional test may be substituted for the ATP. To be acceptable, a functional test should provide the same level of verification as would the ATP. As each item is developed, the individual check list item discussions provide more definitive guidance on the pass/fail criteria to be used.

Although 26 different test criteria are discussed, some criteria are not applicable to every component. This ARP defines when the requirement is applicable. And by definition of the intent of the 14 CFR § 33.91 requirement, the tests are only required when the engine level testing does not expose the component to the extreme environmental conditions required by the engine application.

General guidance for the conduct of tests and test accuracies can be found in DO-160 Section 3. It should be specifically pointed out that guidance previously supplied in older versions of DO-160 pertaining to cumulative sequencing of Temperature, Altitude, Vibration, and Humidity on the same test unit has been deleted in DO-160F and onward. The DO-160 committee stated it was never their intent to force cumulative testing on the same unit, and indeed they were trying to *prevent* the effects of one test from contaminating the results of a subsequent test performed on the same unit. New wording in DO-160F and G provides guidance that each test result should stand alone and any requirement for cumulative testing must come from the equipment specifications and not DO-160.

Although each test item is discussed individually in this ARP, at times it may be appropriate to combine various tests. When that is done, consideration should be given to ensuring that all of the individual test requirements and pass/fail criteria are incorporated into the combined test. DO-160 provides guidance on acceptable combinations of some of the tests. It should be noted that combining tests for component level certification is strictly optional, as it is acceptable to perform each individual test on a separate and distinct component.

5.1 High Temperature

The High Temperature demonstration is to verify that the component can function properly in its maximum temperature environment and to identify any damage caused by exposure to maximum temperature that could lead to component failure. Historical guidelines for the High Temperature test are available in MIL-E-5007 paragraph 4.6.2.2.5 and MIL-STD 810 Method 501. Those requirements may be used to derive an acceptable test procedure. However, the temperatures for the test may be tailored to the unique requirements of the specific application. This tailoring should consider impacts due to engine-to-engine manufacturing variation, installation and ambient variation, service degradation, and accuracy of instrumentation used in measuring power and parameters involved in the Ratings and Limitations (e.g., speed, voltage, current, torque, temperatures, pressures, vibration, etc.). The rationale used to derive the test temperature should be documented in the test plan or other design record. If the component has a different temperature limit for operation than that for nonoperating conditions or has a time limit at the highest temperature limit, the provisions of DO-160 paragraphs 4.5.3 and 4.5.4 should be incorporated into the test cycle.

The testing should evaluate both the maximum ambient and internal fluid temperature conditions. Often, the maximum ambient and fluid temperatures do not occur at the same operating conditions. In those cases, an analysis may be done to define the worst-case conditions to be used during testing; or also acceptable is to subject the component to the maximum ambient and the maximum internal fluid temperatures individually. If testing to the maximum temperatures in separate tests, the non-maximized fluid temperature may be set at a temperature that is more representative of the test condition.

For a fluid system component (e.g., oil, fuel, or hydraulic fluid), consideration should be given to using a fluid that has the most aggressive effect on nonmetallic parts such as gaskets and O-rings.

All input variables should be cycled during the test. The test cycle should simulate the functions performed by the component during a typical engine mission cycle or at least the extremes of the functional requirements of a typical engine mission cycle; it should also include demonstration of all other component functions required for engine compliance with 14 CFR Part 33 requirements (such as engine protection or limiting) at least once every ten cycles.

Total test time should be at least 100 hours.

Pass/fail criteria should include operation of the component within its specified limits at the tested conditions, successful completion of those parts of a production acceptance test that may be impacted by component operation at high temperature, and inspection to confirm that no damage has occurred that could lead to failure.

The maximum temperature capability substantiated by this test should be consistent with the declared environment for the engine. Usually, that means that the maximum temperature demonstrated during this test is included in the engine installation manual and validated in the installation as part of aircraft certification.