



U.S. Department  
of Transportation  
**Federal Aviation  
Administration**

# Advisory Circular

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**Subject:** HOW TO PREPARE  
RELIABILITY ASSESSMENT PLANS  
FOR AIRCRAFT SYSTEMS AND  
EQUIPMENT

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**Date:** 1/19/07  
**Initiated by:** AIR-120

**AC No:** 20-157

## 1. WHAT IS THE PURPOSE OF THIS ADVISORY CIRCULAR?

**a.** This advisory circular (AC) shows you how to develop and use a reliability assessment plan. An assessment plan documents the controlled, repeatable processes for assessing the reliability of aircraft and engine electronic and electrical systems, including their electromechanical elements and equipment.

**b.** We encourage manufacturers of aircraft systems, engines, and equipment to develop and use an assessment plan. Each manufacturer who prepares a plan becomes the plan owner, and the plan may be unique to the plan owner. Plan owners may apply for certification through one of the following processes:

- Type certificate (Title 14 of the Code of Federal Regulation (14 CFR)) part 21, Subparts B and F,
- Supplemental type certificate (14 CFR part 21, Subpart E),
- Amended supplemental type certificate (14 CFR part 21, Subpart D),
- Technical standard order authorization (14 CFR part 21, Subpart O), or
- Parts manufacturer approval (14 CFR part 21, Subpart N).

**c.** This AC is not mandatory and does not constitute a regulation. However, if you use the means described herein, you should follow it in all important respects. This AC describes an acceptable means, though it is not the only means, for manufacturers to use reliability assessment plans to assess the reliability of aircraft and engine electronic and electrical systems, including their electromechanical elements and equipment. This AC doesn't apply to other systems and equipment, such as mechanical or fluid systems. Those systems and equipment may involve very different approaches to reliability.

## **2. WHAT ARE THE USES AND BENEFITS OF A RELIABILITY ASSESSMENT PLAN?**

**a.** A plan is used to assess the reliability of aircraft and engine electronic and electrical systems, including their electromechanical elements, and equipment during their design and operational life. You can use the results of a plan as a part of the following:

- Reliability program planning and monitoring,
- Safety assessments and analyses,
- Certification analyses,
- Equipment design decisions,
- System architecture selection, and
- Continued airworthiness assessments.

**b.** The advantages to using a plan are:

(1) It encourages you, as an equipment manufacturer and plan owner, to consider all relevant information regarding equipment reliability (including the effects of design, manufacturing process, and component selection). This is different from more traditional methods that focus on component reliability as the most significant contributor to equipment reliability.

(2) A plan encourages you to define and use the processes most effective for your equipment.

(3) A plan gives you a “toolbox” of complementary assessment methods based on several current practices. In this AC we don't recommend a particular set of acceptable data, algorithms, methods, or equations to use in a plan. A plan describes applicable means and methods of performing the reliability assessment that the plan owner may choose to use.

(4) A plan may define the range of equipment designed or manufactured by the plan owner and the plan applicability date, to which the plan applies. A plan allows you to update assessments as more information becomes available during the equipment life cycle. You can use this information to improve both equipment reliability and the effectiveness of the assessment process.

**c.** A plan should list all the documents referred to in it (including industry and government documents), plus the plan owner's internal documents, and their roles and responsibilities.

### 3. WHAT GUIDANCE WILL HELP ME DEVELOP A PLAN?

**a.** You may use SAE International's Aerospace Recommended Practice (ARP) 5890, *Guidelines for Preparing Reliability Assessment Plans for Electronic Engine Controls*, dated November 2002, as a framework to prepare a plan. Due to the decline both in the availability of mil-spec parts and the use of military specifications and handbooks, ARP 5890 was produced to illustrate alternative reliability assessment methods. Additional supporting references to prepare a plan include:

- SAE M-102/95, *Reliability, Maintainability, and Supportability Guidebook*, dated September 1995,
- SAE JA 1000, *Reliability Program Standard*, dated June 1998, and
- SAE JA 1000/1, *Reliability Program Standard Implementation Guide*, dated March 1999.

**b.** Reliability assessment depends on correctly understanding the reliability requirements. Conduct the assessment according to a documented, controlled, and repeatable process. Using SAE ARP 5890 as a model, you can develop a plan that combines data and methods suitable for the product type and its life-cycle stages (such as design, qualification, and in-service).

### 4. HOW CAN THE PLAN AND ITS RESULTS BE USED?

**a.** Reliability assessment results should be viewed as numerical estimates that the proposed design satisfies the product reliability requirements and goals. To achieve this objective, conduct reliability assessments in accordance with the plan, and use the assessment results as inputs to the system safety assessment and system architecture selection. SAE ARP 4761, *Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment*, dated December 1996, shows how to determine system safety assessment and system development.

**b.** Reliability assessment results are important inputs to many safety assessment tasks, including fault trees, failure modes and effects analysis, and other tasks in SAE ARP 4761. If a numerical safety assessment relies on reliability assessment approaches, then that portion of the safety assessment must be consistent with reliability practices. The reliability assessment provides an excellent opportunity to revisit and validate ground rules and assumptions used in safety analysis.

**c.** SAE Aerospace Information Report (AIR) 5022, *Reliability and Safety Process Integration*, dated July 1996, describes how to integrate the reliability and safety assessment processes, and describes several of the commonly performed reliability and safety analysis tasks, emphasizing their inter-relationships and common data elements.

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**d.** For highly integrated systems that perform complex and interrelated functions, include validation and verification processes and activities in your plan. You can use SAE ARP 4754, *Certification Considerations for Highly-Integrated or Complex Aircraft Systems*, dated November 1996, as a guide for safety assessment validation and verification processes and activities.

**e.** When selecting a particular reliability assessment method for a specific application, review the accuracy and limitations of that method. Justify, within the plan, your use of that method. Include in your justification the approaches for dealing with uncertainty in assessment data and assumptions.

**f.** SAE ARP 5890 offers reliability assessment methods and tools. MIL-HDBK-217F CHG Notice 2, *Reliability Prediction of Electronic Equipment*, dated February 1995, and Institute of Electrical and Electronics Engineers (IEEE) 1413, *Standard Methodology for Reliability Prediction and Assessment for Electronic Systems and Equipment*, dated December 1998, and IEEE 1413.1, *Guide for Selecting and Using Reliability Predictions Based on IEEE 1413*, dated September 2002, provide acceptable methods to predict a given electronic component's reliability. You can use the Reliability Analysis Center's *Nonelectronic Parts Reliability Data (NPRD)-95*, dated January 1995, Section 2, Part Summary, to determine mechanical parts failure rates. All of these methods can accurately estimate expected systems and equipment reliability before starting production.

**g.** Use SAE ARP 5150, *Safety Assessment of Transport Airplanes in Commercial Service*, dated November 2003, to understand how to relate the reliability assessment and continued airworthiness safety assessment processes. ARP 5150 also describes the important elements involved in a safety analysis and the need to justify or validate the associated assumptions using service experience data.

**h.** You can use reliability assessment results as inputs to continued airworthiness assessment tasks. As an example, see FAA advisory circular (AC) 39-8, *Continued Airworthiness Assessments of Powerplant and Auxiliary Power Unit Installations of Transport Category Airplanes*, for guidance on continued airworthiness tasks, such as assessment of component failure rate.

**i.** You can use reliability assessment results to establish certification maintenance requirements and provide input to the reliability centered maintenance processes and MSG-3 application. AC 25-19, *Certification Maintenance Requirements*, provides guidance for certification maintenance requirements. The Air Transport Association of America's Maintenance Suppliers Guide (MSG)-3, *Operator/Manufacturer Scheduled Maintenance Development*, dated May 2005, guides airline/manufacturer maintenance program planning. SAE JA 1011, *Evaluation Criteria for Reliability-Centered Maintenance Processes*, dated August 1999, provides guidance for evaluation criteria for reliability-centered maintenance processes.

**NOTE:** See appendix 2 for a consolidated list of applicable documents and where to get copies.

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## **5. HOW DO I START A PLAN AND CONTINUE AS AN OWNER?**

**a.** Prepare and implement a plan for your systems and equipment using the guidelines of SAE ARP 5890.

**b.** Establish a procedure using the framework of SAE ARP 5890 to ensure that the plan is reviewed and updated as needed.

David W. Hempe  
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## APPENDIX 1. DEFINITIONS

**Assessment.** An evaluation based on engineering judgment.

**Continued airworthiness.** Ongoing activities to ensure a product provides an acceptable level of safety throughout its operating life.

**Equipment.** An end item, sub-assembly, line-replaceable unit, engine, shop replaceable unit, or system, designed by the plan owner.

**Manufacturer.** A person who manufactures a system, equipment, component, part, or appliance thereof. Includes the equipment manufacturer, supplemental type certificate holder, parts manufacturer approval holder, or technical standard order authorization holder.

**Product.** An aircraft, aircraft engine, propeller, or appliance.

**Reliability.** Determination that a system, subsystem, unit, or part will perform its intended function for a specified interval under certain operational and environmental conditions.

**Reliability Assessment Plan.** A document recording the controlled, repeatable processes for assessing the reliability of aircraft and engine electronic and electrical systems, including their electromechanical elements and equipment

**System.** Combination of components, parts, and elements that are interconnected to perform one or more functions. In this AC, “system” applies to electronic, electrical, electromechanical, mechanical, hydraulic, pneumatic, or engine systems.

**Validation.** Determination that the requirements for a product are sufficiently correct and complete.

**Verification.** Evaluation of implementing the requirements, to determine they were met.

## APPENDIX 2. RELATED DOCUMENTS

**1. Code of Federal Regulations.** Order 14 CFR parts 21, 23, 25, 27, 29, 33, and 35 from the Superintendent of Documents, Government Printing Office, P.O. Box 37154, Pittsburgh, PA 15250-7954. Telephone (202) 512-1800, fax (202) 512-2104. You can also order online at [www.access.gpo.gov](http://www.access.gpo.gov). You can also access the latest 14 CFRs on the FAA internet website Regulatory and Guidance Library (RGL) at <http://www.airweb.faa.gov/rgl>.

**2. FAA Advisory Circulars (AC).** Order ACs from the U.S. Department of Transportation, Subsequent Distribution Office, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785. Telephone (301) 322-4477, fax (301) 386-5394. You can also view copies from the FAA's Regulatory and Guidance Library (RGL) at [www.airweb.faa.gov/rgl](http://www.airweb.faa.gov/rgl). On the RGL webpage, select "Advisory Circulars." The following ACs are relevant to this AC:

- AC 23-1309-1, *Equipment, Systems, and Installations in Part 23 Airplanes.*
- AC 25-19, *Certification Maintenance Requirements.*
- AC 25-1309-1, *System Design and Analysis.*
- AC 27-1, Change 2, *Certification of Normal Category Rotorcraft.*
- AC 29-2, Change 2, *Certification of Transport Category Rotorcraft.*
- AC 33.75-1, *Guidance Material for 14 CFR 33.75 Safety Analysis.*
- AC 39-8, *Continued Airworthiness Assessments of Powerplant and Auxiliary Power Unit Installations of Transport Category Airplanes.*

**3. SAE Documents.** Order SAE documents from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001. Telephone (724) 776-4970, fax (724) 776-0790. You can also order copies online at [www.sae.org](http://www.sae.org). We referred to the following SAE documents in this AC:

- ARP 5890, *Guidelines for Preparing Reliability Assessment Plans for Electronic Engine Controls*, dated November 2002.
- ARP 4761, *Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment*, dated December 1996.
- ARP 4754, *Certification Considerations for Highly Integrated or Complex Aircraft Systems*, dated November 1996.

## APPENDIX 2. RELATED DOCUMENTS (CONTINUED)

- ARP 5150, *Safety Assessment of Transport Airplanes in Commercial Service*, dated November 2003.
- AIR 5022, *Reliability and Safety Process Integration*, dated July 1996.
- JA 1000, *Reliability Program Standard*, dated June 1998.
- JA 1000/1, *Reliability Program Standard Implementation Guide*, dated March 1999.
- JA 1011, *Evaluation Criteria for Reliability-Centered Maintenance (RCM) Processes*, dated August 1999.
- SAE M-102/95, *Reliability, Maintainability, and Supportability Guidebook*, dated September 1995.

### 5. Other Documents.

**a. Institute of Electrical and Electronics Engineers (IEEE) Association documents.** Order IEEE documents from IEEE, 346 East 47th Street, New York, NY 10017. Telephone (732) 981-0060, fax (732) 562-6380. You can also order copies online at [www.ieee.org](http://www.ieee.org). We referred to the following documents in this AC:

- IEEE 1413, *Standard Methodology for Reliability Prediction and Assessment for Electronic Systems and Equipment*, dated December 1998.
- IEEE 1413.1, *Guide for Selecting and Using Reliability Predictions Based on IEEE 1413*, dated September 2002.

**b. U.S. Military Documents.** Order copies of military standards and handbooks from the Department of Defense Single Stock Point, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5098. Telephone (215) 697-2179, fax (215) 697-1462. You can also order copies online at <http://dodssp.daps.dla.mil/>. We referred to the following document in this AC:

- MIL-HDBK-217F CHG Notice 2, *Reliability Prediction of Electronic Equipment*, dated February 1995.



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**APPENDIX 2. RELATED DOCUMENTS (CONTINUED)**

**c. Air Transport Association of America documents.** Order MSG-3, *Operator/Manufacturer Scheduled Maintenance Development*, dated May 2005, from the Air Transport Association of America Distribution Center, P.O. Box 511, Annapolis Junction, MD 20701. Telephone (301) 490-7951, fax (301) 206-9789. You can also order copies online at [www.air-transport.org](http://www.air-transport.org).

**d. Reliability Analysis Center documents.** Order NPRD-95, *Nonelectronic Parts Reliability Data*, dated January 1995, from the Reliability Analysis Center, 201 Mill Street, Rome, NY 13440. Telephone (315) 337-0900, fax (315) 337-9932. You can also order copies online at <http://rac.alionscience.com/>.