U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: EQUIPMENT, SYSTEMS, AND INSTALLATIONS IN PART 23 AIRPLANES	**Date:** 8/5/92 **Initiated by:** ACE-100	**AC No:** 23.1309-1A	**Change:** Change 1

1. PURPOSE. This change transmits revised pages for the subject advisory circular (AC).

2. EXPLANATION OF CHANGE. This change has been initiated to incorporate editorial corrections. The asterisks (*) in the right and left margins indicate the beginning and end of the change.

3. DISPOSITION OF TRANSMITTAL. After filing the revised page, this change transmittal should be retained.

PAGE CONTROL CHART

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* operational life of any single airplane of a specific type. This may be determined on the basis of past service experience with similar components in comparable airplane applications. For quantitative assessments, this term describes a probability on the order of greater than 1×10^{-5}. *

v. Qualitative. Those analytical processes that assess system and airplane safety in a subjective, non-numerical manner.

w. Quantitative. Those analytical processes that apply mathematical methods to assess system and airplane safety.

x. Redundancy. The existence of more than one independent means for accomplishing a given function. Each means of accomplishing the function need not necessarily be identical.

y. Reliability. The determination that a system, subsystem, unit, or part will perform its intended function for a specified interval under stated operational and environmental conditions.

z. Similarity. The process of claiming that the equipment type, form, function, design, and installation are nearly identical to already approved equipment. The reliability and operational characteristics and other qualities affecting the airworthiness of the installation has no appreciable effects.

7. APPLICATION OF § 23.1309 AS ADOPTED BY AMENDMENT 23-14.

a. The airworthiness standards in § 23.1309(a) as amended by amendment 23-41 were originally adopted by amendment 23-14, and they are based on single-fault or fail-safe concepts and experience based on service-proven designs and engineering judgment. Paragraphs (a), (a)(1), (a)(2), and (a)(3) of § 23.1309, as amended by amendment 23-41, are derived from paragraphs (a), (b), and (c) of § 23.1309, as amended by amendment 23-14. The requirements in § 23.1309(a), are generally used for equipment systems and installation that are not complex and/or whose failure conditions are not classified as catastrophic or severe-major. Section 23.1309(a) is appropriate for systems used for airplanes approved to fly VFR and/or IFR, and for systems where analysis by single-fault or fail-safe concepts and experienced based on service-proven designs and engineering judgments. A design safety assessment is not necessary, but it may be used.

b. In order to show compliance with the requirements of § 23.1309(a) (amendment 23-41), it will be necessary to verify that the installed systems and equipment will cause no unacceptable adverse effects and also verify that the airplane is adequately protected against any hazards that could result from probable malfunctions or failures. A probable malfunction or failure is any single malfunction or failure that is considered probable on the basis of past service experience and/or analysis with similar components in comparable airplane applications. Multiple malfunctions or failures should be considered probable when the first malfunction or failure would not be detected during normal operation of the system, including preflight checks, or if the first malfunction or failure would inevitably lead to other malfunctions or failures. Equipment, systems, and installations should be analyzed, inspected, and tested to ensure compliance with the requirements of § 23.1309. A step-by-step diagram to comply with § 23.1309(a) is shown in figure 1 and these steps are listed below:

(1) Evaluate all airplane systems and equipment in order to determine whether they are:

(i) Essential to safe operation; or

(ii) Not essential to safe operation.

(2) Determine that operation of installed equipment has no unacceptable adverse effects. This can be verified by applicable flight or ground checks as follows:

(i) If it can be determined that the operation of the installed equipment will not adversely affect equipment essential to safe operation, the requirements of § 23.1309(a)(1)(i) have been satisfied.

(ii) If it is determined that the operation of the installed equipment has an adverse effect on equipment not essential to safe operation and a means exists to inform the pilot of the effect, the requirements of § 23.1309(a)(1)(ii) have been met. An acceptable means to inform the pilot would include any visual or aural method (flags, lights, horns, loss of display, etc.) that will indicate to the pilot that the affected system is not performing properly.

(3) Determine that failure or malfunction of the installed equipment could not result in unacceptable hazards.

(i) All equipment should be evaluated for general installation hazards. These types of hazards would normally include those hazards that would directly compromise the safety of the airplane or its occupants, such as fire, smoke, explosion, toxic gases, depressurization, etc. A hazard could also result from loss of essential equipment or systems when minimum required functions are lost. Individual failure of redundant equipment would not necessarily be considered a hazard. For example, the single failure of either communication transceiver or a navigation *

(2) An assessment to identify and classify failure conditions is generally qualitative. On the other hand, an assessment of the probability of a failure condition may be either qualitative or quantitative. An analysis may range from a simple report that interprets test results or compares two similar systems to a detailed analysis that may (or may not) include estimated numerical probabilities. The depth and scope of an analysis depends on the types of functions performed by the system, the severities of system failure conditions, and whether or not the system is complex. Failure conditions should be classified according to their severities as minor, major, or catastrophic as defined in paragraph 6.

(i) The classification of failure conditions does not depend on whether or not a system or function is required by any specific regulation. Some systems required by specific regulations, such as transponders, position lights, and public
* address systems, may have the potential for only minor failure
conditions. Conversely, other systems not required by any specific *
regulation, such as flight management systems and automatic landing systems, may have the potential for major or catastrophic failure conditions.

(ii) The classification of failure conditions should consider all relevant factors. Examples of factors would include the nature of the failure modes, system degradation, flight crew actions, flight crew workload, performance degradation, reduced operational capability, effects on airframe, etc. It is particularly important to consider factors that would alleviate or intensify the severity of a failure condition. An example of an alleviating factor would be the continued performance of identical or operationally-similar functions by other systems not affected by a failure condition. Examples of intensifying factors would include unrelated conditions that would reduce the ability of the crew to cope with a failure condition, such as weather or other adverse operational or environmental conditions, or failures of other unrelated systems or functions.

(iii) Analysis of Minor Failure Conditions. Minor failure conditions may be probable. An analysis should consider the effects of system failures on other systems or their functions. The analysis is complete if it shows that system failures would cause only minor failure conditions. In general, the system does not perform airworthiness-related functions, and the common design practice provides physical and functional isolation from airworthiness-related components.

(iv) Analysis of Major Failure Conditions. Major failure conditions should be shown to be improbable.

(A) An assessment using experienced engineering and operational judgment is often sufficient. Compliance may also be shown by qualitative analysis. A quantitative analysis is sometimes used to support experienced judgment and to supplement qualitative analysis for the more severe-major failure conditions.

(B) If the installation is not complex but similar in its relevant attributes, a design and installation appraisal with satisfactory service experience will usually be acceptable for showing compliance. If the installation is not complex and similar, but the system is conventional in its relevant attributes, compliance may be shown by a qualitative assessment.

(C) An analysis of a redundant system is usually complete if it shows isolation between redundant system channels and satisfactory reliability for each channel. For complex systems, a failure modes and effects analysis or a fault tree analysis is often used to show that isolation actually exists (i.e., that any single failure would not cause the failure of a function in more than one redundant system channel) and to show that the failure modes of the system do not have any adverse effects on safety-related functions performed by other systems.

(v) Analysis of Catastrophic Failure Conditions. Catastrophic failure conditions should be shown to be extremely improbable. A very thorough safety assessment is necessary.

(A) The assessment usually consists of an appropriate combination of qualitative and quantitative analyses.

(B) In limited cases, using experienced engineering and operational judgment could be sufficient for conventional systems that have similar attributes and are not complex when service experience data shows no potentially catastrophic failure.

(C) In general, a failure condition resulting from a single failure mode of a device cannot be accepted as being extremely improbable. In very unusual cases, however, experienced engineering judgment may enable an assessment that such a failure mode is not a practical possibility. The assessment's logic and rationale should be so straightforward and obvious that the failure mode simply would not occur unless it is associated with an unrelated failure condition that would itself be catastrophic.

(3) Methods for qualitatively assessing the causes, severities, and likelihood of potential failure conditions are available to support experienced engineering and operational