U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: INSTRUCTIONS FOR CONTINUED AIRWORTHINESS OF STRUCTURAL REPAIRS ON TRANSPORT AIRPLANES

Date: 8/1/91
Initiated by: ANM-110

AC No: 25.1529-1
Change:

1. PURPOSE. This Advisory Circular (AC) provides instructions to ensure continued airworthiness of structural repairs on transport category airplanes. It addresses the approval procedures to follow when making structural repairs to structure certificated under the damage tolerance requirements of § 25.571 of the Federal Aviation Regulations (FAR), Amendment 25-45, and to type designs with Supplemental Inspection Documents (SIDs) which were based on these criteria. The methods provided herein are not the only means acceptable for showing compliance with the applicable portions of § 25.1529 and Appendix H of Part 25. The Federal Aviation Administration (FAA) will consider other methods of compliance the applicant may elect to present.

2. RELATED FAR SECTIONS. Sections 1.1, 21.31(c), 21.50, 25.571, 25.1529, and 43.16 of the FAR. Appendix H of Part 25. Appendix A of Part 43.

3. BACKGROUND. The current industry procedure for repairing structural elements is to first classify the repair as either major or minor in accordance with the definitions set forth in § 1.1 and Appendix A of Part 43. The FAA-approval procedures depend on the classification of the repair. The structure is then restored to the original certification status; either safe-life, fail-safe, or damage tolerant and approved in accordance with established procedures. The definitions of major and minor have historically been subject to widely varying application by maintenance and inspection personnel. In order to standardize the application of the term major repair, the FAA published a list of parts and types of repairs considered major in Civil Aeronautics Manual (CAM) 18 in 1953. This was later adopted as Appendix A of Part 43. This standardized list of major repairs has in some cases resulted in the classification of minor repairs as major simply because the list has not been updated to include evolving airplane design and construction techniques and it is not practical to tailor the list to individual airplane models. There is no attempt in this AC to redefine the terms major or minor as defined in Parts 1 and 43 of the FAR. Rather, the intent of this AC is to ensure damage tolerant structure will remain damage tolerant after it has been repaired.

The advent of damage tolerant design in modern transport category airplanes further complicated the approval procedures for repairs by introducing the need for additional testing and/or analysis in order to assess the long term effects of repairs on damage tolerant structure. Although the repairs may be structurally sound and airworthy when completed, it is not practical in many instances to complete the damage tolerance evaluation for long term airworthiness prior to returning the airplane to service. This

necessitates an interim repair approval where the repair is found to be structurally sound relative to static strength but has not been analyzed for long term airworthiness effects. The final approval of the repair is made shortly thereafter and before long term fatigue effects are manifested. This AC provides guidance to airplane manufacturers and to those authorized to repair structures, in cases where this two-phase approval process is necessary.

4. DEFINITION OF TERMS.

a. Damage tolerance means that the structure has been evaluated to ensure that should serious fatigue, corrosion, or accidental damage occur within the operational life of the airplane, the remaining structure can withstand reasonable loads without failure or excessive structural deformation until the damage is detected.

b. Fail-safe means the structure has been evaluated to assure that catastrophic failure is not probable after fatigue failure or obvious partial failure of a single, principal structural element.

c. Safe-life means that the structure has been evaluated to be able to withstand the repeated loads of variable magnitude expected during its service life without detectable cracks.

d. Primary structure is structure that significantly contributes to the carrying of flight, ground, or pressure loads. It is also known as a structurally significant item (SSI).

e. Principal structural elements (PSE) are those elements of primary structure which contribute significantly to carrying flight, ground, and pressurization loads, and whose failure could result in catastrophic failure of the airplane.

f. Single load path is where the applied loads are eventually distributed through a single member, the failure of which would result in the loss of the structural capability to carry the applied loads.

g. Multiple load path is identified with redundant structures in which, (with the failure of individual elements) the applied loads would be safely distributed to other load-carrying members.

5. GUIDANCE. Appendix H of Part 25 specifies the general requirements for the preparation of instructions for continued airworthiness as required by § 25.1529. The following guidance is to be used in conjunction with Appendix H and other related regulations.

a. Structural Repair Manual. The applicant should include in the maintenance instructions required by Appendix H, paragraph H25.3(b), a structural repair manual (SRM) which describes the types of structural repairs anticipated in service. This SRM should be reviewed and approved by the FAA.

b. Principal Structural Elements. The SRM should identify all PSE's and primary structure requiring approved repair data. Examples of PSE's may be found in Advisory Circular 25.571-1A, Damage Tolerance and Fatigue Evaluation of Structure, dated 3/5/86.

c. Repair Documentation. Any repair to a PSE or primary structure, including the removal of cracks and corrosion, requires some form of approval whether deemed "major" or "minor" under the definition of Part 1 and the provisions of Part 43. The SRM should provide criteria for determining if the repair warrants FAA engineering approval. In general, repair to a PSE or primary structure requires FAA engineering approval. Such approval is usually accomplished by the FAA, a designated engineering representative, or a Special Federal Aviation Regulations (SFAR) 36 authorized staff.

d. Substantiating Repairs. Additionally, the SRM should provide guidance to repairers as to what substantiating data is necessary to show that the repair complies with certification requirements. This guidance should address repairs to PSE's and primary structure for which no FAA-approved or acceptable data currently exists. It should identify the applicable certification requirements and describe acceptable methods for demonstrating compliance. The SRM must tell the repairer that FAA approval is required for such repairs.

e. Basis for Inspection Program. The basis for an inspection program for repairs certified herein will be contained in a future revision to AC 25.571-1A.

f. Two Stage Structural Evaluation.

(1) Applicants may elect to allow two-stage repair approval in which the basic structural evaluation shows that the repair will meet immediate and short term strength requirements (ultimate strength) but a more extensive investigation is required to show long-term strength requirements. If the applicant elects this option he must schedule the completion of the evaluation such that the airplane is not subjected to the risk of structural failure due to fatigue in the interim. For example, a two-stage evaluation may be recommended where;

(i) A static structural strength evaluation is made prior to release of the airplane into service with a stated time for completion of the damage tolerance evaluation, and

(ii) A damage tolerance evaluation of the repair is made within the prescribed time period after this interim release. The final evaluation must reflect any changes in the related inspection program, including threshold, interval, and inspection procedure.

(2) Final repair approval should not be made until a damage tolerance evaluation has been completed and has shown that the repair is adequate to assure continued airworthiness. The time period established for completion of the approval should be based on technical, logistic and recordkeeping considerations. Due to the logistics and recordkeeping requirements and the ability of the operator to realistically track follow-on

technical approval programs, a time period for completion of the approval process that does not exceed 12 months is generally adequate for most structural repairs. This time period is justified based on the assumed inherent crack free performance of structure designed to maintain its initial strength level for the lifetime of the structure.

(3) Procedures must be established by the operator as agreed upon by the manufacturer, with approval from the cognizant Aircraft Certification Office, which would assure timely completion of the approval process. These procedures should also provide for audits to ensure that interim repairs are finalized as scheduled.

g. Special Qualifications. Guidance should be provided with regard to the qualifications of persons evaluating and approving repairs made to certain PSE's which have special design considerations. For example, a particular design may include certain PSE's having damage tolerant structure requiring a person who has comprehensive knowledge of the specific design philosophy, loading spectrum, and fracture mechanics techniques used in that particular design. Due to these qualifications of the specialist, responsibility for the assessment may be restricted to staff members of the airframe manufacturer, certain designated engineering representatives, the FAA, or certain SFAR 36 engineering staff personnel. The FAA Aircraft Certification Offices should provide guidance in regard to qualifications of personnel.

h. Logic Diagram. The logic diagram in Figure 1 is provided to assist in the determination of when FAA Engineering approval is required for a repair to damage tolerant structure. The decision process begins when it has been determined that structural damage has occurred to a PSE.

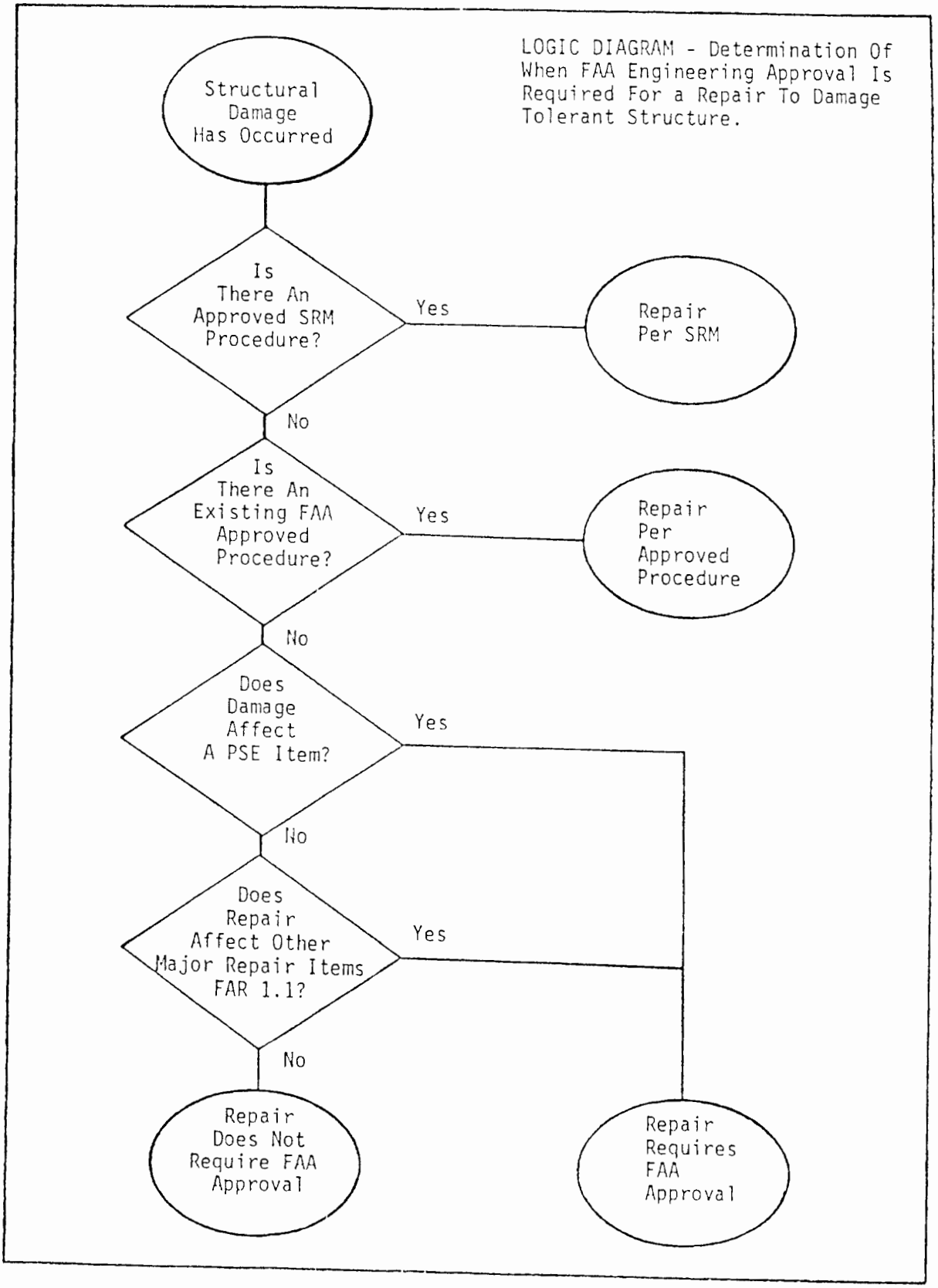
LOGIC DIAGRAM - Determination Of When FAA Engineering Approval Is Required For a Repair To Damage Tolerant Structure.
Structural Damage Has Occurred
Is There An Approved SRM Procedure?
Yes
Repair Per SRM
No
Is There An Existing FAA Approved Procedure?
Yes
Repair Per Approved Procedure
No
Does Damage Affect A PSE Item?
Yes
No
Does Repair Affect Other Major Repair Items FAR 1.1?
Yes
No
Repair Does Not Require FAA Approval
Repair Requires FAA Approval

Figure 1

The following guidance is offered for use with the logic diagram:

(1) Determine if the repair can be accomplished using standard methods defined in the SRM for the particular airplane. These standard repair methods may be simple or complex; for example:

(i) Blend out - local.
(ii) Replacement with identical part.
(iii) Oversize attachment.
(iv) Reduction of edge distance.

(2) For damage not covered by an SRM procedure determine if an FAA approved repair exists or if other means of repair acceptable to the FAA exists; for example:

(i) FAA approved repair.
(ii) Service Bulletin (FAA or DER approved).
(iii) All operators letter (FAA or DER approved).
(iv) FAR 36 repair previously approved.

(3) Once it has been determined that the damage or repair does not affect primary structure (PSE) then it must be determined whether it affects other criteria in the major repair definition of § 1.1; i.e., systems, weight and balance, aerodynamics, or airplane performance.

(4) If it has been determined that a repair must be submitted for FAA approval, and cannot be shown to have prior approval or other acceptable data, it may be approved by the FAA, a designated engineering representative, or an SFAR 36 authority.

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U.S. Department
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