U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: DAMAGE TOLERANCE ASSESSMENT OF REPAIRS TO PRESSURIZED FUSELAGES	**Date:** 12/14/00	**AC No: 120-73**
	Initiated By: ANM-100	**Change:**

1. PURPOSE. This advisory circular (AC) is applicable to operators of large transport category aging airplane models, as identified in this document. It provides guidance on incorporating FAA-approved "repair assessment guidelines" in air carrier maintenance or inspection programs subject to Title 14, Code of Federal Regulations (14 CFR) part 121. The guidance can be used by operators operating under 14 CFR parts 91, 125, and 129. The means of compliance described in this document is intended to supplement the engineering and operational judgment that must form the basis of any compliance findings relative to repair assessments for pressurized fuselages.

a. The guidance provided in this AC is directed to operators, airplane model type certificate holders, and airframe modifiers. It may be used by foreign regulatory authorities and Federal Aviation Administration (FAA) type certification engineers and their designees.

b. Like all AC material, this AC is not, in itself, mandatory, and does not constitute a regulation. This AC does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements. It is issued to describe an acceptable means, but not the only means, for demonstrating compliance with the requirements for transport category airplanes. Terms such as "shall" and "must" are used only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance described in this document is used.

2. RELATED DOCUMENTS.

a. Title 14, Code of Federal Regulations (14 CFR):

§ 25.571	Damage-tolerance and fatigue evaluation of structure
§ 25.1529	Instructions for Continued Airworthiness
§ 91.410	Repair assessment for pressurized fuselages
§ 121.370	Repair assessment for pressurized fuselages
§ 125.248	Repair assessment for pressurized fuselages
§ 129.32	Repair assessment for pressurized fuselages

b. FAA Advisory Circulars (AC). You can obtain a copy of any of the AC's listed below by sending a request to the U.S. Department of Transportation, Subsequent Distribution Center, SVC-121.23, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, Maryland 20785.

AC 25.571-1C "Damage-Tolerance and Fatigue Evaluation of Structure," dated 4/29/98.

AC 25.1529-1 "Instructions for Continued Airworthiness of Structural Repairs on Transport Airplanes," dated 8/1/91.

c. Other Documents. You can get a copy of the report by requesting it from the FAA's Office of the Chief Counsel, Attn: Rules Docket (AGC-200), Docket No. 29104, 800 Independence Avenue SW., Washington, D.C. 20591.

"Continued Airworthiness of Structural Repairs," a report of the Airworthiness Assurance Working Group (AAWG) for the Aviation Rulemaking Advisory Committee (ARAC):

3. DISCUSSION.

a. Parts 91, 121, 125, and 129 include requirements for a structural integrity assessment of repairs to the fuselage pressure boundary (which includes the fuselage skin, door skin, and bulkhead webs) on certain model transport category airplanes. The specific airplane models subject to the requirements of those rules are:

- Airbus Model A300 (excluding the -600 series), including the Model B2, Model B4-100 (including Model B4-2C), and Model B4-200
- British Aerospace Model BAC 1-11: all models
- Boeing Model 707: all models
- Boeing Model 720: all models
- Boeing Model 727: all models
- Boeing Model 737: all models
- Boeing Model 747: all models
- Fokker Model F-28 Mark 1000, 2000, 3000, and 4000
- Lockheed Model L-1011: all models
- McDonnell Douglas Model DC-8: all models
- McDonnell Douglas Model DC-9/MD-80: all models
- McDonnell Douglas Model DC-10: all models

b. Those rules require the incorporation of FAA-approved repair assessment guidelines for the fuselage pressure boundary into the FAA-approved maintenance or inspection program of each operator of these airplane models.

c. The type certificate holders have developed model-specific repair assessment guidelines to evaluate existing and new repairs using damage-tolerance principles. This AC provides guidance on how those model-specific repair assessment guidelines may be incorporated into an operator's maintenance or inspection program. Model-specific repair assessment guidelines for the affected airplanes may be obtained from the type certificate holder.

4. BACKGROUND.

a. In June 1988, the FAA sponsored a conference on aging airplanes. As a result of that conference, the Airworthiness Assurance Task Force (AATF), representing the interests of the aircraft operators and type certificate holders, regulatory authorities, and other aviation representatives, was established in August 1988. The Task Force set forth five major elements of a program, for each airplane model in the aging transport fleet, for keeping the aging fleet safe. These elements were:

(1) Select service bulletins describing modifications and inspections necessary to maintain structural integrity;

(2) Develop inspection and prevention programs to address corrosion;

(3) Develop generic structural maintenance program guidelines for aging airplanes;

(4) Review and update the Supplemental Structural Inspection Documents (SSID) which describe inspection programs to detect fatigue cracking; and

(5) Assess damage-tolerance of structural repairs.

b. The requirements to incorporate repair assessment guidelines into the maintenance or inspection programs for certain large transport airplanes address the fifth element.

5. REPAIR ASSESSMENT PROCESS. There are two principal techniques that may be used to accomplish the assessment of repairs to the fuselage pressure boundary using the "repair assessment guidelines" developed by the type certificate holder:

a. The first technique involves a three-stage procedure to evaluate repairs to fuselage pressure boundary. This technique would be well-suited for operators of small fleets.

(1) **Stage 1: Data Collection**.

(a) This stage specifies what structure should be assessed for repairs and collects data for further analysis. Since older airplanes may have a large number of structural repairs without accompanying documentation, locating the repairs necessitates a survey of the structure of each airplane. If a repair is on a structure in an area of concern, the analysis continues; otherwise, the repair does not require classification in accordance wit this program.

(b) The repair assessment guidelines for each model will provide a list of structure for which repair assessments are required. Some type certificate holders have reduced this list by determining the inspection requirements for critical details. If the requirements are equal to normal maintenance checks, such as the Baseline Zonal Inspection (BZI) (typical maintenance inspection intervals assumed by the type certificate holders to be performed by most operators), those details were excluded from this list. Additionally, some manufacturers have excluded items from the list if, through any other inspection program, the repaired structure was previously found to be damage-tolerant.

(c) The type certificate holders have developed a survey form that may be used to record key repair design features needed to accomplish a repair assessment. Air carrier or air operator personnel not trained as damage-tolerance specialists can use the form to document the configuration of each observed repair.

(d) Repair details are collected for further analysis in Stage 2. Repairs found during data collection that do not meet the static strength requirements or are in a poor condition are immediately identified and corrective action must be taken before further flight.

(2) **Stage 2: Repair Classification**. Using the information gathered during Stage 1 , it is possible to classify repairs into one of 3 categories:

(a) *Category A*: A permanent repair for which the BZI is adequate to ensure continued airworthiness (inspectability) equal to the unrepaired surrounding structure. The operator's approved maintenance or inspection program must be at least as rigorous as the BZI.

(b) *Category B*: A permanent repair that requires supplemental inspections to ensure continued airworthiness.

(c) *Category C*: A temporary (time-limited) repair that will need to be reworked or replaced prior to an established time limit. Supplemental inspections may be necessary to ensure continued airworthiness prior to this limit.

(3) **Stage 3: Determination of Structural Maintenance Requirements.**

(a) The supplemental inspection and/or replacement requirements for Category B and C repairs are determined in this stage. Inspection requirements for the repair are determined by calculation or by using predetermined values provided by the type certificate holder, or other values obtained using an FAA-approved method.

(b) In evaluating the first supplemental inspection, Stage 3 will define the inspection threshold in flight cycles measured from the time of repair installation. If the time of installation of the repair is unknown and the airplane has exceeded the assessment implementation times (refer to paragraph 6.f. of this AC) or has exceeded the time for first inspection, the first inspection should occur by the next C-check interval or equivalent cycle limit after the repair data is gathered (Stage 1).

(c) An operator may choose to accomplish all three stages at once, or just Stage 1. In the latter case, the operator would be required to adhere to the schedule specified in the FAA-approved model-specific repair assessment guidelines for completion of Stages 2 and 3.

(d) Incorporating the maintenance requirements for Category B and Category C repairs into an operator's individual airplane maintenance or inspection program completes the repair assessment process for the first technique.

b. The second technique involves the incorporation of the repair assessment guidelines as part of an operator's routine maintenance program. This approach would be well-suited for operators of large fleets and would entail evaluating repairs at predetermined planned maintenance visits as part of the maintenance program. This technique would require the operator to choose an inspection method and interval in accordance with the FAA-approved repair assessment guidelines. The repairs where inspection requirements are fulfilled by the chosen inspection method and interval would be inspected in accordance with the regular FAA-approved maintenance or inspection program. Any repair that is not permanent, or where inspection requirements are not fulfilled by the chosen inspection method and interval, would either be upgraded to allow utilization of the chosen inspection method and interval, or individually tracked to account for the repair's unique inspection method and interval requirements. This process is then repeated at each inspection interval.

(1) Repairs added between the predetermined maintenance visits, including interim repairs installed at remote locations, would be required either to have a threshold greater than the length of the predetermined maintenance visit or to be tracked individually to account for the repair's unique inspection method and interval requirements. This would ensure the airworthiness of the structure until the next predetermined maintenance visit, at which time the repair would be evaluated as part of the repair maintenance program.

(2) Whichever technique is used, there may be some repairs that cannot easily be upgraded to Category A for cost, downtime, or technical reasons. Such repairs will require supplemental inspections, and each operator should make provisions for this when incorporating the repair assessment guidelines into its maintenance or inspection program.

> **NOTE**: The repair assessment guidelines provided by the manufacturer do not generally apply to repairs to structure modified by a Supplemental Type Certificate (STC). The operator, however, is still responsible for evaluating the entire fuselage pressure boundary in accordance with the program objectives. This means that the operator should develop, submit, and gain FAA approval of guidelines to evaluate repairs to such structure. (See paragraph 7 of this AC, below.)

c. Type certificate holders and operators may develop other techniques, which would be acceptable as long as they fulfill the objectives of the rules and are approved by the FAA.

6. IMPLEMENTATION. The means by which the repair assessment guidelines are incorporated into a certificate holder's FAA-approved maintenance or inspection program is subject to approval by the certificate holder's Principal Maintenance Inspector (PMI) or other cognizant airworthiness inspector. When the PMI/cognizant airworthiness inspector having oversight responsibilities for the operator is satisfied that the operator's continued airworthiness, maintenance, or inspection program contains all the elements of the FAA-approved manufacturer's repair assessment guidelines, the inspector can approve an operation specification(s) or inspection program revision. However, the following guidance should be considered when implementing the program:

a. Revisions of Repair Assessment Guidelines: If the proposed maintenance or inspection program revises any of the FAA-approved repair assessment guidelines, the proposal must be submitted to the FAA Aircraft Certification Office (ACO) having cognizance over the type certificate for the affected airplane.

b. Existing Repairs**.**

(1) The repair assessment process should be completed in accordance with the schedule in the FAA-approved model-specific repair assessment guidelines for each of the affected airplanes. Any necessary actions (revised inspection programs, etc.) to be taken as a result of the assessment would be incorporated into the FAA-approved maintenance or inspection program.

(2) Structural repairs mandated by Airworthiness Directive (AD) do not always contain instructions for future supplemental inspection requirements. If the repair assessment establishes a supplemental inspection requirement where one does not exist in the AD, the operator is not required to obtain an Alternative Method of Compliance (AMOC) to conduct those inspections. The operator would, however, be required to obtain an AMOC if the repair is modified.

c. New Repairs. Unless new repairs are accomplished according to Structural Repair Manuals, or another equivalent method that incorporates damage-tolerance methods of design and evaluation, the operator should establish a means within the maintenance or inspection program to assess new repairs using FAA-approved repair assessment guidelines. A two-stage structural evaluation and FAA approval process, described in AC 25.1529-1 ("Instructions for Continued Airworthiness of Structural Repairs on Transport Airplanes"), is an acceptable means of assessing the damage-tolerance requirements of new repairs.

d. Reporting Requirements. There are no added reporting requirements associated with the repair assessment guidelines. However, the FAA encourages operators to report significant findings to the type certificate holders to ensure that prompt fleet action be taken. Existing reporting requirements under 14 CFR § 121.703 still apply.

e. Recordkeeping Requirements. There are no added recordkeeping requirements associated with the repair assessment guidelines. However, as with all maintenance, existing regulations already impose recordkeeping requirements that apply to the actions required by the rules. When incorporating the repair assessment guidelines into its approved maintenance or inspection program, each operator should address how it will comply with these requirements. The means of compliance, along with the remainder of the program, is subject to approval by the PMI.

f. Implementation Time. The implementation time for assessments of existing repairs is based on the findings of repair assessment surveys and fatigue damage considerations. Implementation times generally can be defined as 75% of the design service goal (DSG), established for an airplane model by the manufacturer, in terms of flight cycles. The implementation times for incorporation of the repair assessment guidelines into an airplane's maintenance or inspection program are specified in 14 CFR §§ 91.410, 121.370, 125.248, and 129.32.

g. Beginning of the Assessment Process. After the guidelines are incorporated into the maintenance or inspection program, operators must begin the assessment process for existing fuselage repairs within the flight cycle limit specified in the FAA-approved model-specific repair assessment guidelines. There are three deadlines for beginning the repair assessment process, depending on the cycle age of the airplane on the effective date of the rule:

(1) *Airplane Cycle Age Equal to or Less Than Implementation Time on May 25, 2000 (the effective date of the associated rule).* The operator must incorporate the repair assessment guidelines into its maintenance or inspection program by the flight cycle implementation time, or May 25, 2001, whichever occurs later. The assessment process would begin (e.g., accomplishment of Stage 1) on or before the cycle limit specified in the repair assessment guidelines (generally equivalent to a D-check), not to exceed the cycle limit computed by adding the DSG to the cycle limit equivalent to a C-check (specified in the repair assessment guidelines) after the incorporation of the guidelines.

(2) *Airplane Cycle Age Greater than the Implementation Time but Less Than the DSG on May 25, 2000*. The operator must incorporate the repair assessment guidelines into its maintenance or inspection program by May 25, 2001. The assessment process would begin (e.g., accomplishment of Stage 1) on or before the cycle limit specified in the repair assessment guidelines (generally equivalent to a D-check), not to exceed the cycle limit computed by adding the DSG to the cycle limit equivalent of a C-check interval (specified in the repair assessment guidelines), after incorporation of the guidelines.

(3) *Airplane Cycle Age Greater Than the DSG on May 25, 2000*. The operator must incorporate the repair assessment guidelines into its maintenance or inspection program by May 25, 2001. The assessment process would begin (e.g., accomplishment of Stage 1) on or before the next cycle limit specified in the repair assessment guidelines (equivalent to a C-check) after incorporation of the guidelines.

h. Maintenance Program Changes. When a maintenance or inspection program interval is revised, the operator must evaluate the impact of the change on the repair assessment program. If the revised maintenance or inspection program intervals are greater than those in the BZI, the previous classification of Category A repairs may become invalid. The operator may need to obtain approval of an alternative inspection method, upgrade the repair to allow utilization of the chosen inspection method and interval, or re-categorize some repairs and establish unique supplemental inspection methods and intervals for specific repairs. Operators using the "second technique" of conducting repetitive repair assessments at predetermined maintenance visits would evaluate whether the change to the predetermined maintenance visit continues to fulfill the repair inspection requirements in accordance with the guidance provided in paragraph 5b of this AC.

i. Sale and Transfer of Airplanes. Before an airplane is added to an air carrier's operations specifications, or operators fleet, a program for accomplishment of the repair assessment should be established in accordance with the following:

(1) *For airplanes that previously have been operated under an FAA-approved maintenance program*, the new operator should begin the repair assessment process in accordance with either the previous operator's schedule or the new operator's schedule, whichever would result in an earlier accomplishment date for the assessment.

(2) *For airplanes that previously have not been operated under an FAA-approved maintenance program*, the operator should begin the repair assessment in accordance with paragraph 6g of this AC. If the airplane's DSG and compliance times have been exceeded, the repair assessment should be accomplished prior to the airplane being added to the air carrier's operations specifications, or in accordance with a schedule approved by the PMI.

j. Operation of Leased Foreign-Owned Airplanes. Acquisition of a leased foreign-owned airplane for use in operations under parts 91, 121, 125, or 129 will require that the certificate holder determine the status of the airplane relative to the model-specific implementation times. If the airplane has exceeded or is within one year of exceeding the implementation time, the operator should implement the

repair assessment program into the airplane's maintenance or inspection program. Implementation of the repair assessment programs then would occur per the model-specific repair assessment guidelines. Airplanes below the implementation time would implement the assessment program by the time the airplane has reached the model-specific implementation time.

7. REPAIRS TO STRUCTURAL MODIFICATIONS CERTIFIED BY A SUPPLEMENTAL TYPE CERTIFICATE (STC).

a. The operator will need to establish a program for repairs of structure modified by an STC. Those repairs that can be evaluated using the manufacturer's model-specific repair assessment guidelines should be documented and submitted to the operator's PMI. The PMI may approve the program subject to the guidance in paragraph 6 of this AC. For all other repairs, a separate program will need to be developed.

b. It is recognized that the operators may not have the resources to determine a DSG or to develop repair assessment guidelines for structure approved under STC's. Furthermore, a repair may be of a type or size that excludes it from being treated like a repair in the Structural Repair Manual (SRM), model-specific repair assessment documents, or other FAA approved source. In this case, the operator may have to work with the STC holder to develop repair assessment guidelines, or to determine a DSG. If the STC holder is unable to provide this assistance, the operator may need to seek the necessary expertise to develop and gain approval of repair assessment guidelines and the associated DSG.

c. The difficulty of developing guidelines for modified structure may be less than that for the basic airplane structure for three reasons.

(1) *First*, the only modifications made by persons other than the type certificate holder that are of concern are those that affect the fuselage pressure boundary. Of those that do affect this structure, many are small enough to qualify as Category A repairs under the repair assessment guidelines, based solely on their size.

(2) *Second*, if the modified structure is identical, or very similar, to the type certificate holder's original structure, then repairs made to the structure modified by an STC are probably covered by referencing the type certificate holder's guidelines and the SRM.

(3) *Third*, the modification may have been made so recently that no repair assessment guidelines would be needed for many years. Compliance with the rules could be shown by establishing the DSG for the new modified structure, calculating an implementation time that is equal to three quarters of that DSG, and then adding a statement to the operations specifications that repair assessment guidelines would be incorporated into the maintenance program by that time. No guidelines would be needed until 75 percent of the new DSG is reached.

8. ALTERNATIVE METHODS. As specified previously, this AC provides one means, but not the only means, of compliance with the associated rules. If an operator wishes to develop its own repair assessment guidelines and submit such guidelines for FAA approval, it may do so. The proposed repair assessment guidelines must ascertain the "damage-tolerance" of the repairs to the extent necessary to establish what supplemental maintenance actions, if any, are necessary to assure that fatigue damage will be detected before the damage degrades the load-carrying capability of the structure below certification levels. The proposed guidelines should be submitted jointly to the operator's PMI and the FAA Aircraft Certification Office (ACO) having cognizance over the type certificate of the affected airplane.

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