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AC 91-56

DATE May 6, 1981

# ADVISORY CIRCULAR

With Change 2 (up to date, 4/15/83)

DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
Washington, D.C.

FAR GUIDANCE MATERIAL

*Subject:* SUPPLEMENTAL STRUCTURAL INSPECTION PROGRAM FOR LARGE TRANSPORT CATEGORY AIRPLANES

1. PURPOSE: This Advisory Circular (AC) provides guidance material to manufacturers and operators for use in developing a continuing structural integrity program to ensure safe operation of older airplanes throughout their operational life. This guidance material applies to large transport airplanes which were certified under the fail-safe or damage tolerance structural requirements of Civil Air Regulations 4b or Federal Aviation Regulations (FAR) Part 25 and which have a maximum gross weight greater than 75,000 pounds. Guidance material on this subject for other transports will be provided at a later date. The procedures set forth by this AC are applicable to the large transport category airplanes operated under Subpart D of FAR 91 and FAR 121, 123, 125, and 135.

2. BACKGROUND: Service experience has demonstrated that there is a need to have continuing updated knowledge concerning the structural integrity of transport airplanes, especially as they become older. The structural integrity of these airplanes is of concern since such factors as fatigue cracking and corrosion are time dependent and knowledge concerning them can best be assessed on the basis of real time operational experience and the use of the most modern tools of analysis and testing.

a. The FAA, manufacturers, and operators have continually worked to maintain the structural integrity of older airplanes. Traditionally, this has been accomplished through an exchange of field service information and subsequent changes to inspection programs, and by the development and installation of modifications on particular aircraft. However, increased utilization, longer operational lives, and the high safety demands imposed on currently operating transports have indicated that there is a need for a program to assure a high level of structural integrity for all airplanes in the transport fleet. Accordingly the program outlined in this advisory circular is intended to assure a continuing structural integrity assessment by each airplane manufacturer on a timely basis and the adaptation of the results of each assessment into the maintenance program of each operator, also on a timely basis.

b. The assessment by the manufacturer should use all of the modern technologies which add to the reliability of the assessment. The details of the

assessment process were developed during a long-term discussion between the FAA and industry. The results of the assessment will be incorporated into the maintenance program of each operator.

3. DEVELOPMENT OF SUPPLEMENTAL INSPECTION PROGRAMS: The manufacturer, in conjunction with operators, is expected to initiate development of the supplemental inspection program for each model on a timely basis to ensure that an acceptable program is available to the operators when needed. As noted above, such a program should be initiated when analysis, tests, and/or service experience indicates that a significant increase in inspection and/or modification is necessary to maintain structural integrity. The program should include procedures for obtaining service information, and assessment of service information, available test data, and new analysis and test data. A Supplemental Inspection Document (SID) should be developed, as outlined in Appendix I, from this body of data.

a. Present transports were not certificated under current FAR 25.571, which emphasizes damage tolerant design. However, the structure to be evaluated, the type of damage considered (fatigue, corrosion, service, and production damage), and the inspection and/or modification criteria should, to the extent practicable, be in accordance with the damage tolerance principles of the current FAR 25.571 standards.

b. The recommended supplemental inspection program, along with the criteria used and the basis for the criteria, should be submitted to the certificating region for review and approval. The supplemental program should be adequately defined in the SID and presented in a manner that is effective. The SID should include: the type of damage being considered, and likely sites; inspection access, threshold, interval, method and procedures; applicable modification status and/or life limitation; and types of operations for which SID is valid.

c. The FAA review of the SID will include both engineering and maintenance aspects of the proposal. Portions of the SID found to be both applicable to all operators and of safety concern, as a result of a demonstrated safety problem, will be made mandatory under the existing Airworthiness Directive (AD) system. In addition, any service bulletin or other service information publications found to be essential for safety during the initial SID assessment process should be implemented by AD action. Service bulletins or other service information publications revised or issued as a result of inservice findings resulting from implementation of the SID should be added to the SID or implemented by AD action, as appropriate.

d. In the event an acceptable SID cannot be obtained on a timely basis, the FAA may impose service life, operational, or inspection limitations to assure structural integrity.

e. The manufacturer should revise the SID whenever additional information shows a need. Revisions to the SID should be submitted to the operators and the FAA for review. The original SID will normally be based on predictions or assumptions (from analyses, tests and/or service experience) of failure modes, time to initial damage, frequency of damage, typically detectable damage and the damage growth period. Consequently, a change in these factors sufficient to justify a revision would have to be substantiated by test data or additional service information. Any revision to SID criteria and the basis for these revisions should be submitted to the FAA for review and approval of both engineering and maintenance aspects. The FAA will advise operators when a SID has been approved.

f. All currently published SID's are listed in Appendix II to this AC. The Appendix will be updated as additional SID's become available.

5. IMPLEMENTATION: The SID program will be applied to the operators through the appropriate FAR's as follows:

a. Once a SID is issued, operators will be in a position to amend their current structural inspection programs to comply with and account for the applicable SID. Structural inspection programs approved in accordance with FAR 121.25 and 121.45, FARs 123.31, 125, 135, and Subpart D of FAR 91, will require an amendment to the presently approved structural inspection program. Affected certificate holders should submit their proposed amendment for the areas covered by the SID to the FAA for approval. It should be recognized that each operator must make its own determination, subject to FAA approval, as to how the data in the SID should be incorporated in its maintenance program due to the differences in the various operators' maintenance programs, operating environment, and fleet modification status. Each amendment will be evaluated on an individual basis. To accomplish the evaluation, the FAA will establish a team of maintenance and engineering specialists. This will be accomplished prior to the PMI's approval of the amendment. Once the amendment related to implementation of the SID is approved, changes to specific maintenance procedures, time limitations (except for mandatory retirement times), inspection levels, and repetitive inspection intervals will be made in accordance with operations specifications approved by the Administrator under FARs 121, 125, and 123 or an inspection program approved under FAR 91.217(e). These changes must either be kept within the guidelines established by the SID or additional analysis must be accomplished to justify the change to the certificating region.

b. It is the FAA's intent that all operators incorporate the SID into their operations specifications. In cases where the operator does not submit an amended structural inspection plan to comply with the applicable SID, the FAA will obtain compliance under the established operations specifications amendment procedures.

M. C. BEARD
Director of Airworthiness

# APPENDIX 1

## GUIDELINES FOR DEVELOPMENT OF SUPPLEMENTAL INSPECTION DOCUMENT

### 1. General

1.1 The first essential is to identify the structural parts and components which contribute significantly to carrying flight, ground, pressure or control loads and whose failure could affect the structural integrity necessary for the safety of the airplane, and whose damage tolerance or safe-life characteristics it is necessary, therefore, to establish or confirm.

1.2 Analyses made in respect to the continuing assessment of structural integrity should be based on supporting evidence including test and service data. This supporting evidence should include a proper appreciation of the operating loading spectra, structural loading distributions, and material behavior. An appropriate allowance should be made for the scatter in life to crack initiation and rate of crack propagation, in establishing inspection threshold, inspection frequency and, where appropriate, retirement life. Alternatively, an inspection threshold may be based solely on a statistical assessment of fleet experience provided that it can be shown that equal confidence can be placed in such an approach.

1.3 Some manufacturers find that an effective method of evaluating the structural condition of older airplanes is selective inspection with intensive use of nondestructive techniques and the inspection of individual airplanes involving partial or complete dismantling ("tear-down") of available structures.

1.4 The effect of repairs and modifications approved by the manufacturer should also be taken into account. In addition, it may be necessary to consider the effect of repairs and operator-approved modifications on individual airplanes. The operator has the responsibility for ensuring notification and consideration of any such aspects.

1.5 The Supplemental Inspection Document should be checked from time to time against current service experience. Any unexpected defect occurring should be assessed as part of the continuing assessment of structural integrity to determine the need for revision of the document. Future structural service bulletins should state their effect on the SID.

### 2. Damage tolerant structures

2.1 Damage tolerance characteristics should be based on the best information available, including analysis, test, and operational experience, including special

inspections which can be related to the type. From this should be judged the site or sites of likely cracking within each structural part or component and the time or number of flights at which this might occur.

2.2 The growth characteristics of damage and interactive effects on adjacent parts in promoting more rapid or extensive damage should be determined. This study should include those sites which may be subject to the possibility of crack initiation due to fatigue, corrosion, stress corrosion, disbonding, accidental damage, or manufacturing defects in those areas which service experience or design judgment has shown to be vulnerable.

2.3 The minimum size of damage that it is practical to detect and the proposed method of inspection should be determined along with the number of flights required for the crack to grow from detectable to the allowable final size of damage, such that the structure has a residual strength corresponding to the conditions stated for fail-safe qualification under the current FAR 25.571. For aircraft not certificated under the current damage tolerance (fail-safe) requirements of FAR 25.571(b), where the damage is readily detectable within a relatively short period, a lower residual strength may be accepted if justified by a probability assessment.

Note: In determining the proposed method of inspection, consideration should be given to:

- visual inspection;

- nondestructive testing;

- analysis of data from built-in load and defect monitoring devices.

2.4 The continuing assessment of structural integrity may involve more extensive damage than might have been considered in the original fail-safe evaluation of the airplane, such as:

a) A number of small adjacent cracks, each of which may be less than the typically detectable length, developing suddenly into a long crack;

b) failures or partial failures in other locations following an initial failure due to redistribution of loading causing a more rapid spread of fatigue; and

c) concurrent failure or partial failure of multiple load path elements (e.g., lugs, planks or crack arrest features) working at similar stress levels.

3. Information to be included in the assessment

3.1 The continuing assessment of structural integrity for the particular airplane type should be based on the principles outlined in 2.1 to 2.4 above. The following information should be included in the assessment and kept by the manufacturer in a form available for reference:

a) the current operational statistics of the fleet in terms of hours or flights:

b) The typical operational mission, or missions, assumed in the assessment;

c) the structural loading conditions from the chosen missions;

d) supporting test evidence and relevant service experience.

3.2 In addition to the information specified in 3.1, the following should be included for each critical part or component:

a) the basis employed for evaluating the damage tolerance characteristics of the part or component;

b) the site or sites within the part or component where damage could affect the structural integrity of the airplane;

c) the recommended inspection methods for the area;

d) for damage tolerant structures, the maximum damage size at which the residual strength capability can be demonstrated and the critical design loading case for the latter;

e) for damage tolerant structures, at each damage site the inspection threshold and the damage growth interval between detectable and critical including any likely interaction effects from other damage sites.

Note: Where reevaluation of fail-safety or damage tolerance of certain parts or components indicates that these qualities cannot be achieved or can only be demonstrated using an inspection procedure whose practicability may be in doubt, then replacement or modification action may need to be defined.

4. Inspection program

4.1 The purpose of a continuing airworthiness assessment in its most basic terms is to adjust the current inspection program as required to assure continued safety of the airplane type.

4.1.1 In accordance with paragraphs 1. and 2. an allowable final size of damage should be determined for each site such that the structure has a residual strength for the load conditions contained in the current FAR § 25.571 except as defined in 2.3. The size of damage that it is practical to detect by the proposed method of inspection should be determined along with the number of flights required for the crack to grow from detectable to the allowable final size of damage defined above.

4.2 The recommended inspection program should be determined from the data described in 4.1.1 giving due consideration to the following:

a) Fleet experience including all of the scheduled maintenance checks;

b) confidence in the proposed inspection technique;

c) the joint probability of reaching the load levels described above and the final size of damage in those instances where probabilistic methods can be used with acceptable confidence.

4.3 For aircraft not certificated under the current damage tolerance (fail-safe) requirements of FAR 25.571(b) and where damage is in-flight or ground evident or readily detectable within a few flights, the low exposure to operation with the damage present provides the qualitative rationale for selecting a reduced residual strength level. This reduced strength level should provide the same level of safety as that associated with the residual strength level specified for the case of damage which is not as readily detectable.

4.4 Inspection thresholds for supplemental inspections should be established. These inspections would be supplemental to the normal inspections including the detailed internal inspections.

4.4.1 For structure with reported cracking, the threshold for inspection should be determined by analysis of the service data and available test data for each individual case.

4.4.2 For structures with no reported cracking it may be acceptable, if sufficient fleet experience is available, to determine the inspection threshold on the basis of analysis of existing fleet data alone. This threshold should be such as to include sufficient high-time airplanes in the inspection to develop added confidence in the integrity of the structure (see also 1.2). Thereafter, if no cracks are found, the

inspection threshold may be increased progressively by successive inspection intervals until cracks are found. In the latter event paragraph 4.4.1 would apply.

5. The Supplemental Inspection Document

5.1 The Supplemental Inspection Document should contain the recommendations for the inspection procedures and replacement or modification of parts or components necessary for the continued safe operation of the airplane. The document should be prefaced by the following information:

a) identification of the variants of the basic airplane type to which the document relates;

b) the operational statistics of the fleet in terms of hours and flights should be summarized. The typical mission, or missions, should be described;

c) reference to documents giving any existing inspections, or modifications of parts or components;

d) the types of operations for which the inspection program is considered valid should be stated; and

e) a list of service bulletins (or other service information publication) revised as a result of the structural reassessment undertaken to develop the SID. The SID should have a statement indicating that the operator must account for these service bulletins.

5.2 The document should contain at least the following information for each critical part or component:

a) description of the part or component and any relevant adjacent structure. Means of access to the part should be given;

b) type of damage which is being considered (i.e., fatigue, corrosion, accidental damage);

c) any service experience which may be relevant;

d) the likely site(s) of damage;

e) recommended inspection method and procedure and alternatives;

f) minimum size of damage considered detectable by the method(s) of inspection;

g) service bulletins (or other service information publication) revised or issued as a result of inservice findings resulting from implementation of the SID (added as revision to the initial SID);

h) guidance to the operator on which inspection findings should be reported to the manufacturer;

i) recommended initial inspection threshold;

j) recommended repeat inspection interval;

k) reference to any optional modification or replacement of part or component as terminating action to inspection;

l) reference to the mandatory modification or replacement of the part or component at given life if fail safety by inspection is impractical; and

m) information related to any variations found necessary to safe lives already declared.

AC 91-56

CHANGE 1

DATE 12/4/81

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DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
Washington, D.C.

FAR GUIDANCE MATERIAL

*Subject:* SUPPLEMENTAL STRUCTURAL INSPECTION PROGRAM FOR LARGE TRANSPORT CATEGORY AIRPLANES

PURPOSE. This change is to advise Boeing Model 727 operators that a Supplemental Inspection Document has been issued for the Boeing Model 727 aircraft and should be incorporated into their operations specifications.

PAGE CONTROL CHART

| Remove pages | dated | Insert pages | dated |
|---|---|---|---|
| Appendix 2<br>Page 1 | 5/6/81 | Appendix 2<br>Page 1 | 12/4/81 |

Jerold M. Chavkin
Acting Director of Airworthiness

Suggest filing this transmittal at the back of the AC. It will provide a reference authority for changes, a method of determining that all Changes have been received, and a check for determining if the AC contains the proper pages.

Initiated by: AWS-120

APPENDIX 2

LISTING OF PUBLISHED SUPPLEMENTAL STRUCTURAL INSPECTION DOCUMENTS

1. Boeing Model 707-720 Aircraft.

"Supplemental Structural Inspection Document for High Time Model 707-720 Aircraft," Boeing Aircraft Company Document D6-44860, Revision D, dated June 30, 1980, or later revisions.

2. Boeing Model 727 Aircraft.

"Supplemental Structural Inspection Document for B-727 aircraft," Boeing Aircraft Company Document D6-48040-B-727 dated January 15, 1981, or later revisions.

* 3. British Aerospace Model BAC 1-11 200, 300, and 400 Series Aircraft Which Have Accumulated Less Than 85,000 Landings.

The following items contain the inspections required to fulfill the intent of this AC:

a. British Aerospace Maintenance Planning Guide (MPG) for 200, 300, and 400 series aircraft, Revision 162, dated September 11, 1981, or a subsequent revision.

b. All Alert Service Bulletins and Service News Letters not contained in the most current copy of the Maintenance Planning Guide but scheduled for incorporation in future revisions of the Maintenance Planning Guide.

c. BAC 1-11 Alert Service Bulletin 51-A-PM5830 No. 1 dated December 24, 1981, or a subsequent revision. *

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