

Appendix 1 to AMC 20-20 Guidelines for the Development of a Supplementary Structural Inspection Programme

Provides interpretations, guidelines and acceptable means of compliance for the SSIP actions.

Background

Service experience has demonstrated that there is a need to have continuing updated knowledge concerning the structural integrity of aircraft, especially as they become older. Early fatigue requirements, such as “fail safe” regulations did not provide for timely inspection of an aircraft’s critical structure to ensure that damaged or failed components could be dependably identified and then repaired or replaced before hazardous conditions developed.

One prerequisite for the successful application of the damage tolerance approach for managing fatigue is that crack growth and residual strength can be anticipated with sufficient precision to allow inspections to be established that will detect cracking before it reaches a size that will degrade the strength below a specified level.

When damage is discovered, airworthiness is ensured by repair or revised maintenance action. Evidence to date suggests that when all critical structure is included, fatigue and damage-tolerance based inspections and procedures (including modification and replacement when necessary) provide the best approach to address aircraft fatigue.

Implementation Considerations

Under Part-M requirements it is expected that an operator will automatically incorporate the SSIP into their maintenance program - Compliance with FAR / CS 25.571 requires periodic inspection for potential fatigue damage in areas where it is most likely to occur.

The content of the Airworthiness Limitations Section of the Instructions for Continued Airworthiness is designated by some TCH’s as Airworthiness Limitations Instructions (ALI). Other TCH’s have decided to designate the same items as Airworthiness Limitations Items (ALI).

Supplemental Structural Inspection Program (SSIP)

SSIPs are based on a thorough technical review of the damage-tolerance characteristics of the aircraft structure using the latest techniques and changes in operational usage. They lead to revised or new inspection requirements primarily for structural cracking and replacement or modification of structure where inspection is not practical.

Pre-Amendment 25-45 aeroplanes (Aircraft which were certified before MSG-3 Amendment 2)

- The TCH is expected to initiate development of a SSIP for each aeroplane model.
- Such a programme must be implemented before analysis, test and/or service experience indicate that a significant increase in inspection and or modification is necessary to maintain structural integrity of the aeroplane.
- This should ensure that an acceptable programme is available to the operators when needed.
- The programme should include
 - Procedures for obtaining service information, and

- Assessment of service information, available test data, and new analysis and test data.

Supplemental Structural Inspection Document

The SSID 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 operation for which the SSID is valid.

The review of the SSID by the Agency will include both engineering and maintenance aspects of the proposal. In the event an acceptable SSID cannot be obtained on a timely basis the competent authority may impose service life, operational, or inspection limitations to assure structural integrity

The TCH should check the SSID periodically against current service experience.

This should include an evaluation of current methods and findings. Any unexpected defect occurring should be assessed as part of the continuing assessment of structural integrity to determine a need for revision to the document.

Post-Amendment 25-45 aeroplanes

Aeroplanes certificated to FAR 25.571 Amendment 25-45, and CS-25 or later amendments are damage-tolerant.

To maintain the structural integrity of these aeroplanes it is necessary to follow up the effectiveness of these inspections and procedures.

The DAH should therefore check this information periodically against current service experience. Any unexpected defect occurring should be assessed as part of the continuing assessment of structural integrity to determine a need for revision to this information.

The revised data should be developed in accordance with the same procedures as at type-certification giving consideration to any additional test or service data available and changes to aeroplanes operating patterns.

Guidelines for Development of the Supplemental Structure Inspection Document

It is essential to identify the structural parts and components that contribute significantly to carrying flight, ground, pressure, or control loads, and whose failure could affect the structural integrity necessary for the continued safe operation of the aeroplane.

The damage-tolerance or safe-life characteristics of these parts and components must be established or confirmed.

Analyses made in respect to the continuing assessment of structural integrity should be based on supporting evidence, including test and service data.

An effective method of evaluating the structural condition of older aeroplanes is selective inspection with intensive use of non-destructive techniques, and the inspection of individual aeroplanes, involving partial or complete dismantling (“teardown”) of available structure.

The effect of repairs and modifications approved by the TCH should be considered. In addition, it may be necessary to consider the effect of repairs and operator-approved or other DAH modifications on individual aircraft. The operator has the responsibility for ensuring notification and consideration of any such aspects in conjunction with the DAH.

Damage-tolerant structures

The damage-tolerance assessment of the aircraft structure should be based on the best information available. The assessment should include a review of analysis, test data, operational experience, and any special inspections related to the type design.

A determination should then be made of the site or sites within each structural part or component considered likely to crack, and the time or number of flights at which this might occur.

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

The damage tolerance certification specification of CS 25.571 requires not only fatigue damage to be addressed but also accidental and environmental damage.

Some types of accidental damage (e.g. scribe marks) can not be easily addressed by the MSG process and require specific inspections based on fatigue and damage tolerance analysis and tests.

The minimum size of damage that is practical to detect and the proposed method of inspection should be determined. This determination should take into account the number of flights required for the crack to grow from detectable to the allowable limit, such that the structure has a residual strength corresponding to the conditions stated under CS 25.571.

Note: In determining the proposed method of inspection, consideration should be given to visual inspection, non-destructive testing, and analysis of data from built-in load and defect monitoring devices.

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

- A number of small adjacent cracks, each of which may be less than the typically detectable length, developing suddenly into a long crack;
- Failures or partial failures in other locations following an initial failure due to redistribution of loading causing a more rapid spread of fatigue; and
- Concurrent failure or partial failure of multiple load path elements (e.g., lugs, planks, or crack arrest features) working at similar stress levels.

Information to be included in the assessment

- The current operational statistics of the fleet in terms of hours or flights;
- The typical operational mission or missions assumed in the assessment;
- The structural loading conditions from the chosen missions; and
- Supporting test evidence and relevant service experience.

The following should be included for each critical part or component:

- The basis used for evaluating the damage-tolerance characteristics of the part or component;
- The site or sites within the part or component where damage could affect the structural integrity of the aircraft;
- The recommended inspection methods for the area;

- 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; and
- For damage-tolerant structures, at each damage site the inspection threshold and the damage growth interval between detectable and critical, including any likely interaction effect from the damage sites.

Note: Where re-evaluation 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 or reliability may be in doubt, replacement or modification action may need to be defined.

Inspection programme

The purpose of a continuing airworthiness assessment in its most basic terms is to adjust the current maintenance inspection programme, as required, to assure continued safety of the aircraft type.

The size of damage that 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 limit.

The recommended inspection programme should be determined, giving due consideration to the following:

- Fleet experience, including all of the scheduled maintenance checks;
- Confidence in the proposed inspection technique; and
- 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.

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

- 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.
- For structure with no reported cracking, it may be acceptable, provided sufficient fleet experience is available, to determine the inspection threshold on the basis of analysis of existing fleet data alone. This threshold should be set such as to include the inspection of a sufficient number of high-time aircraft to develop added confidence in the integrity of the structure

The Supplemental Structural Inspection Document

The SSID should contain the recommendations for the inspection procedures and replacement or modification of parts or components necessary for the continued safe operation of the aircraft up to the LOV.

The document should be prefaced by the following information:

- Identification of the variants of the basic aircraft type to which the document relates;
- Reference to documents giving any existing inspections or modifications of parts or components;

- The types of operations for which the inspection programme are considered valid;
- A list of service bulletins (or other service information publication) revised as a result of the structural reassessment undertaken to develop the SSID, including a statement that the operator must account for these service bulletins.
- The type of damage which is being considered (i.e., fatigue, corrosion and/or accidental damage).
- Guidance to the operator on which inspection findings should be reported to the type-certificate holder.

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, including means of access to the part.
- Relevant service experience.
- Likely site(s) of damage.
- Inspection method and procedure, and alternatives.
- Minimum size of damage considered detectable by the method(s) of inspection.
- Service bulletins (or other service information publication) revised or issued as a result of in-service findings resulting from implementation of the SSID (added as revision to the initial SID).
- Initial inspection threshold.
- Repeat inspection interval.
- Reference to any optional modification or replacement of part or component as terminating action to inspection.
- Reference to the mandatory modification or replacement of the part or component at given life, if fail-safety by inspection is impractical; and
- Information related to any variations found necessary to “safe lives” already declared.

The SSID should be compared from time to time against current service experience. Any unexpected defect occurring should be assessed as part of the continuing assessment of structural integrity.