



U.S. Department  
of Transportation  
**Federal Aviation  
Administration**

# Advisory Circular

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**Subject:** ESTABLISHING AND  
IMPLEMENTING LIMIT OF VALIDITY TO  
PREVENT WIDESPREAD FATIGUE  
DAMAGE

**Date:** 01/10/11  
**Initiated By:** ANM-100  
and AFS-300

**AC No:** 120-104

**1. PURPOSE.** This advisory circular (AC) offers guidance on compliance with Title 14 Code of Federal Regulations (14 CFR) 26.21, 26.23, 121.1115, and 129.115. It tells design approval holders of transport category airplanes how to establish a limit of validity of the engineering data that supports the structural maintenance program (hereafter referred to as LOV) for those airplanes. It also tells design approval holders how to address maintenance actions that have been determined necessary to support an LOV. It tells operators of those airplanes how to incorporate the LOV into their Continued Airworthiness Maintenance Programs. Finally, this AC provides guidance to anyone wishing to extend an LOV. Guidance for establishing an LOV for airplanes whose type certificate was applied for after January 14, 2011, is contained in AC 25.571-1D. Guidance for extending an LOV approved under § 25.571, § 26.21, or § 26.23 can be found here. The actions described in this AC are meant to prevent widespread fatigue damage (WFD) in the transport airplane fleet up to the LOV.

## **2. APPLICABILITY.**

**a.** The regulatory basis for this AC is defined in Appendix 1. This guidance is for design approval holders—holders of type certificates, supplemental type certificates, and amended type certificates, as defined in Appendix 2—as well as applicants for those certificates. It is also intended for airplane manufacturers, operators, foreign civil aviation authorities, and Federal Aviation Administration (FAA) transport category airplane type certification engineers and their designees, as well as FAA Flight Standards inspectors.

**b.** This guidance applies to metallic structure on:

**(1)** Turbine-powered transport category airplanes, existing at the effective date of the rule (January 14, 2011), that are operated under part 121 or 129 and have a type certificate issued after January 1, 1958, and a maximum takeoff gross weight greater than 75,000 pounds as approved by the original type certificate or an amended or supplemental type certificate.

(2) Transport category airplanes that have had the maximum takeoff gross weight reduced from greater than 75,000 pounds to 75,000 pounds or less if the application for that change was made after January 14, 2011.

(3) All transport category airplanes with a current LOV, when that LOV is being extended. This would include LOVs approved under § 25.571, 26.21, or 26.23.

c. Like all AC material, this AC is not, in itself, mandatory, and does not constitute a regulation. It describes an acceptable means, but not the only means, for showing compliance with the applicable regulations. The FAA will consider other means of showing compliance that an applicant may elect to present. We derived these guidelines from extensive FAA and industry experience in showing compliance with the relevant regulations. On the other hand, if we become aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC. We may require additional substantiation or design changes as a basis for finding compliance.

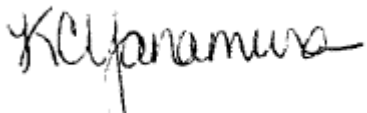
d. This material does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements. The regulatory basis for this AC is contained in Appendix 1.

e. The term “must” in this AC is used only in the sense of ensuring applicability of this particular means of compliance when the acceptable means of compliance described herein is used.

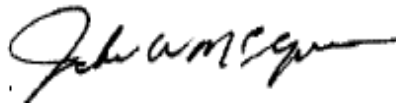
**3. WHY DO YOU NEED AN LOV?** If you properly maintain an airplane, theoretically you could operate it indefinitely. But structural maintenance tasks for an airplane are not constant with time. Tasks are typically added to the maintenance program as the airplane ages. It is reasonable to expect, then, that the current structural maintenance tasks may not, at some future point, be sufficient for continued operation. Maintenance tasks for a particular airplane can only be determined based on what is known about that airplane model at any given time—from analyses, tests, service experience, and teardown inspections. To ensure that an airplane is free from WFD up to this point, a design approval holder would evaluate WFD-susceptible structure and establish an LOV.

**4. DOCUMENT ORGANIZATION.** This AC has four chapters. Chapter 1 provides an overview for establishing an LOV. Chapter 2 addresses compliance information for design approval holders. Chapter 3 addresses extended LOV. Chapter 4 gives compliance information for operators. Finally, the appendices contain useful information such as related regulations and documents (Appendix 1), definitions (Appendix 2), acronyms (Appendix 3), background to the rule (Appendix 4), examples of structure susceptible to WFD (Appendix 5), details of a WFD

evaluation (Appendix 6), an example of how to establish an LOV (Appendix 7), and a sample compliance plan (Appendix 8).



Dorenda D. Baker  
Director, Aircraft Certification Service



John M. Allen  
Director, Flight Standards Service

## TABLE OF CONTENTS

1. PURPOSE	I
2. APPLICABILITY	I
3. WHY DO YOU NEED AN LOV?	II
4. DOCUMENT ORGANIZATION	II
CHAPTER 1—OVERVIEW OF THE PROCESS FOR ESTABLISHING A LIMIT OF VALIDITY	3
100. GENERAL INFORMATION ABOUT CHAPTER 1	3
101. WIDESPREAD FATIGUE DAMAG.E	3
102. LIMIT OF VALIDITY	3
103. CONTINUED AIRWORTHINESS FOR AGING AIRPLANES	4
104. MAINTENANCE ACTIONS AND AIRWORTHINESS DIRECTIVES	4
105. DESIGN APPROVAL HOLDER AND OPERATOR TASKS	5
CHAPTER 2—§ 26.21 COMPLIANCE INFORMATION FOR DESIGN APPROVAL HOLDERS	6
200. GENERAL INFORMATION ABOUT CHAPTER 2	6
201. COMPLIANCE PLAN	6
202. RECOMMENDED ADDITIONAL COMPLIANCE PLAN ITEMS	7
203. AIRPLANE STRUCTURAL CONFIGURATION	8
204. ESTABLISHING AN LOV	8
205. MAINTENANCE ACTIONS AND SERVICE INFORMATION	11
206. REQUIREMENT FOR AIRWORTHINESS LIMITATIONS SECTION	12
207. SUPPORTING DATA	12
208. FAA OVERSIGHT OFFICE APPROVAL	13
209. MAKING LOV DATA AVAILABLE	13
210. DESIGN APPROVAL HOLDER REPORTING	13
CHAPTER 3—§ 26.23 EXTENDED LOVS	15
300. GENERAL INFORMATION ABOUT CHAPTER 3	15
301. APPLICATION FOR EXTENDED LOV	15
302. AIRPLANE STRUCTURAL CONFIGURATION FOR AN EXTENDED LOV	16
303. ESTABLISHING AN EXTENDED LOV AND SUPPORTING DATA	16
304. AIRWORTHINESS LIMITATIONS SECTION	16
305. FAA APPROVALS FOR EXTENDED LOVS	16
CHAPTER 4—COMPLIANCE INFORMATION FOR OPERATORS	17
400. GENERAL INFORMATION FOR OPERATORS	17
401. AIRWORTHINESS LIMITATIONS SECTION	17
402. AIRPLANES WITHOUT LOVS	18
403. ADDING AN AIRPLANE TO AN OPERATOR'S FLEET AFTER THE COMPLIANCE DATE HAS PASSED	18
404. EXTENDED LOVS	18
405. PMI APPROVAL	19
406. OPERATOR REPORTING	19
APPENDIX 1—RELATED REGULATIONS AND DOCUMENTS	
APPENDIX 2—DEFINITIONS	
APPENDIX 3—ACRONYMS USED IN THIS AC	
APPENDIX 4—BACKGROUND	
APPENDIX 5—EXAMPLES OF STRUCTURE SUSCEPTIBLE TO WFD	

APPENDIX 6—WIDESPREAD FATIGUE DAMAGE EVALUATION

APPENDIX 7—EXAMPLE OF HOW TO ESTABLISH AN LOV

APPENDIX 8—SAMPLE COMPLIANCE PLAN

## CHAPTER 1—OVERVIEW OF THE PROCESS FOR ESTABLISHING A LIMIT OF VALIDITY

**100. GENERAL INFORMATION ABOUT CHAPTER 1.** This chapter gives an overview of widespread fatigue damage and the various aspects of establishing a limit of validity of the engineering data that supports the structural maintenance program (LOV). It explains the relationship of the widespread fatigue damage rule (Amendment Nos. 25-132, 26-5, 121-351, and 129-48) to other programs that have been established to address structural integrity of airplanes as they age. It also includes design approval holder and operator tasks and deliverables.

**101. WIDESPREAD FATIGUE DAMAGE.** Structural fatigue damage is progressive. It begins as minute cracks, and those cracks grow under the action of repeated stresses. This can happen because of normal operational conditions and design attributes or because of isolated situations or incidents, such as material defects, poor fabrication quality, or corrosion pits, dings, or scratches. Fatigue damage can occur locally, in small areas or structural design details, or globally. Global fatigue damage is general degradation of large areas of structure with similar structural details and stress levels. Global damage may occur in a large structural element such as a single rivet line of a lap splice joining two large skin panels (multiple site damage). Or it may be found in multiple elements, such as adjacent frames or stringers (multiple element damage). Multiple site damage and multiple element damage cracks are typically too small initially to be reliably detected with normal inspection methods. Without intervention, these cracks will grow, and eventually compromise the structural integrity of the airplane, in a condition known as widespread fatigue damage. Widespread fatigue damage, hereafter referred to as WFD, is increasingly likely as the airplane ages, and is certain if the airplane is operated long enough without any intervention.

**102. LIMIT OF VALIDITY.** The LOV is the period of time (in flight cycles, flight hours, or both), up to which it has been demonstrated that WFD is unlikely to occur in an airplane's structure by virtue of its inherent design characteristics and any required maintenance actions. An airplane may not operate beyond the LOV, unless an extended LOV is approved. To support establishment of the LOV, the design approval holder must demonstrate by test evidence and analysis at a minimum and, if available, service experience or service experience and teardown inspection results of high-time airplanes, that WFD will not occur in that airplane up to the LOV. An LOV applies to an airplane structural configuration common to a fleet, as described in § 26.21. Any reference in this AC to the LOV for an airplane refers to the LOV for all the airplanes with that structural configuration. When establishing an LOV under § 26.21, or an extended LOV under § 26.23, you are not required to evaluate repairs and design changes for WFD, except for modifications and replacements mandated by airworthiness directives.

For airplanes with an LOV, the Changed Product Rule, 14 CFR 21.101, would require applicants for significant design changes to include the latest amendment of § 25.571 in the design change certification basis. Guidance for evaluating repairs and design changes according to the latest requirements of § 25.571 is included in AC 25.571-1D.

**103. CONTINUED AIRWORTHINESS FOR AGING AIRPLANES.** The requirement to establish an LOV is the last element of a series of initiatives meant to ensure the continued airworthiness of aging airplane structure. The following programs for existing airplanes, or their equivalent for new airplanes, have already been established—

- The Supplemental Structural Inspection Program. This AD-mandated program made damage-tolerance-based inspections on certain airplane models a requirement.
- The Mandatory Modification Program. This AD-mandated program was a review of service bulletins in order to decide whether inspections are sufficient or whether terminating actions should be made mandatory.
- The Repair Assessment Program. This is an operational rule that mandated evaluations of certain repairs to determine whether inspections or terminating actions are necessary.
- The Corrosion Prevention and Control Program. This AD-mandated program made inspections for corrosion on certain airplane models a requirement.
- The Aging Airplane Safety Rule (which addresses repairs, alterations, and modifications). This is an operational rule that mandates development of damage-tolerance-based inspections for fatigue critical structure.

For further guidance on the elements involved in ensuring continuing structural integrity for airplanes see AC 91-56B and AC 120-93.

**104. MAINTENANCE ACTIONS AND AIRWORTHINESS DIRECTIVES.** If you are a design approval holder complying with § 26.21, you are not required to identify and develop maintenance actions if you can show that such actions are not necessary to prevent WFD before the airplane reaches the LOV. If you establish an LOV that does rely on maintenance actions, you must identify them. Service information, which is typically issued in service bulletins, includes a description of the maintenance actions and the procedures for accomplishing them. Some of the maintenance actions required for the LOV may have already been issued in a service bulletin and mandated by airworthiness directive. For the rest, airworthiness directives will need to be issued.

**105. DESIGN APPROVAL HOLDER AND OPERATOR TASKS.** The following table displays an overview of the tasks necessary for establishing an LOV and incorporating it into the maintenance program. These tasks are further developed in Chapter 2 of this AC. They are necessary for establishing a point in time up to which affected airplanes will remain free of WFD. These design approval tasks will support the operator tasks necessary for compliance with §§ 121.1115 and 129.115.

**Table 1**

**Required Tasks for Design Approval Holders and Operators**

Design Approval Holders	Operators
Develop and submit compliance plan [§ 26.21(d)]	Obtain approved revised ALS or new ALS containing the LOV from DAH [§ 121.1115(b) or § 129.115(b)] or use the default LOV from Table 1 of § 121.1115(f) or § 129.115(f)
Identify the airplane structural configuration for affected airplane model/models [§ 26.21(b)(1)]	Submit revised maintenance program with revised or new ALS incorporating the LOV to the PMI [§ 121.1115(e) or § 129.115(e)]
Establish the LOV and demonstrate that WFD will not occur in the airplane up to the LOV [§ 26.21(b)(1)]	Stop operating the airplane if the LOV is not incorporated by compliance date. [§ 121.1115(b) or § 129.115(b)]
Submit list of any maintenance actions needed to support the LOV if service information has been issued but not mandated by AD [§ 26.21(b)(2)(i)]	Stop operating the airplane if the airplane reaches the LOV. [§ 121.1115(d) or § 129.115(d)]
Submit a list of any needed maintenance actions for which service information has not been issued, and a binding schedule for when it will be available [§ 26.21(b)(2)(ii)]	
Create an ALS of the ICA if one does not exist [§ 26.21(b)(3)]	
Incorporate the LOV into the ALS and submit it (and supporting data) [§ 26.21(b)(4)]	

AD—Airworthiness Directive

ALS—Airworthiness Limitations section

DAH—Design Approval Holder

ICA—Instructions for Continued Airworthiness

PMI—Principal Maintenance Inspector



## CHAPTER 2—§ 26.21 COMPLIANCE INFORMATION FOR DESIGN APPROVAL HOLDERS

**200. GENERAL INFORMATION ABOUT CHAPTER 2.** Table 1, in the previous chapter, listed required tasks for design approval holders and operators. This chapter gives details for the design approval holder tasks. (Although this chapter uses the term “design approval holder,” some applicants for design approvals must complete the same tasks.) If you are a design approval holder who must comply with § 26.21, this chapter tells you how to establish an LOV for affected existing airplanes. It tells you how to establish an LOV for those airplanes with a type certificate, amended type certificate, or supplemental type certificate that is pending approval as of the effective date of § 26.21 or those airplanes with an amended type certificate or supplemental type certificate that will be approved in the future. It explains the role of maintenance actions in complying with these requirements and how they are identified, approved, and implemented. This chapter also tells you how to create or revise the Airworthiness Limitations section of the Instructions for Continued Airworthiness.

**201. COMPLIANCE PLAN.** One requirement of § 26.21 is that affected persons provide compliance plans to the FAA Oversight Office<sup>1</sup> (as defined in § 26.3) for review and approval. The compliance plan serves to give the aircraft certification office or Transport Airplane Directorate engineer a clear idea of what the design approval holder is going to do to comply with the WFD rule, including processes and dates. The compliance plan is meant to ensure that the design approval holder and the FAA have a common understanding and agreement about what is necessary to achieve compliance. Specific details of the acceptable contents of a compliance plan, and procedures for submission to the FAA, are described in AC 26-1, “Part 26, Continued Airworthiness and Safety Improvements.” Compliance plans must contain elements that describe compliance status and any proposed differences in means of compliance from those described in this AC. Any deviation from the means of compliance described in this AC may require an issue paper. Integral to the compliance plan will be the inclusion of procedures to allow the FAA to monitor progress toward compliance. A compliance plan must include:

**a.** A project schedule identifying all major milestones for meeting the compliance dates. This schedule should include, but is not limited to—

**(1)** A schedule for submission of an LOV.

**(2)** Establishment of a structures task group<sup>2</sup> schedule (if applicable).

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<sup>1</sup> The FAA Oversight Office is the aircraft certification office or office of the Transport Airplane Directorate with oversight responsibility for the relevant type certificate, supplemental type certificate, or manufacturer, as determined by the Administrator.

<sup>2</sup> A structures task group is a group formed of manufacturers and operators to discuss maintenance procedures for specific models.

- b.** A proposed means of compliance with the requirements, such as methods and procedures for—
  - (1)** Identifying the airplane structural configuration to be evaluated.
  - (2)** Identifying WFD-susceptible structure. (See Appendix 5 for further guidance.)
  - (3)** Identifying the source of engineering data that will be used to perform the required evaluations.
  - (4)** Evaluating structure for WFD. (See Appendix 6 for further guidance.)
  - (5)** Establishing an LOV. (See Appendix 7 for further guidance.)
  - (6)** Identifying and developing maintenance actions, if any.
- c.** A plan for submitting a draft of all required compliance items for review by the FAA Oversight Office not less than 60 days before the applicable compliance date.
- d.** Plans for distribution of the approved LOV.

If you are the design approval holder, the process for completing all of the above will require ongoing communication with personnel from the FAA Oversight Office. You have the option of developing a single LOV to apply to all the models on the type certificate data sheet, a separate LOV for each model, or an LOV for different groups of airplanes within the type certificate. If you have not yet decided on the airplane model grouping at the time the compliance plan is submitted, or if you have not yet identified WFD-susceptible structures, we would expect you to communicate that information as soon as possible. The compliance plan should include a schedule for when that information will be made available. We also expect that the compliance plan would specify milestone dates for transmitting any information not yet known. Appendix 8 of this AC includes a sample compliance plan.

**202. RECOMMENDED ADDITIONAL COMPLIANCE PLAN ITEMS.** In addition to the required elements, we recommend you include the following elements in your compliance plan:

- a. A Proposed Communication and Coordination Plan.** This plan should identify the design approval holder personnel who will be the contacts for the FAA Oversight Office. Conversely, although not part of the communication and coordination plan, the FAA Oversight Office should make sure the design approval holder knows who to contact within the FAA. The plan should also include the frequency of and mechanism for status updates and the sharing of other information.
- b. A Proposed Delegation Plan.** If a design approval holder asks for delegated authority for approving compliance with these regulations on behalf of the FAA, then that

delegation plan must first be approved by the FAA. Except for the WFD evaluation methodology, we may delegate to our designees the review and approval of supporting data (see paragraph 207 of this AC) used for the establishment of an LOV or any maintenance actions. However, just as we do not delegate approval of certification plans, we will not delegate review and approval of this rule's compliance plan, binding schedule, and LOV to designees.

**203. AIRPLANE STRUCTURAL CONFIGURATION.** You must identify the airplane structural configuration for each airplane model you are evaluating for WFD. Under § 26.21(c)(3) or (4), if you amend the type certificate in the future, this requirement would also apply to any configuration change. For existing and pending airplanes, the airplane structural configuration must consist of all model variations and derivatives approved under the type certificate, and include any structural modifications or replacements mandated by AD as of January 14, 2011. You may then develop a single LOV to be applied to all those model variations and derivatives collectively, or you may develop separate LOVs for each model variation and derivative. Similarly, if a new model is added to the type certificate, the configuration of that new model must be identified and evaluated for WFD as well. The result of that evaluation may be that the LOV for the originally certificated model can also be applied to the new one. Alternatively, the WFD evaluation may result in a new LOV being established because the configuration of the new model is different enough from the originally type-certificated model that the WFD behavior will be different as well.

**204. ESTABLISHING AN LOV.** The process for establishing an LOV involves four steps—

- (a) Identifying a “candidate LOV.”
- (b) Identifying WFD-susceptible structure.
- (c) Performing a WFD evaluation of all susceptible structure.
- (d) Finalizing the LOV.

Appendix 7 provides an example of how to establish an LOV using the process summarized below.

**a. Step 1—Candidate LOV.** An LOV is applicable to an airplane model with a defined structural configuration. The LOV will be dependent on the fatigue knowledge available for the airplane structural configuration at the time the LOV is established. It may also depend on maintenance actions considered necessary to preclude WFD in susceptible areas. There is no single “valid” LOV. For existing younger airplane models with many years of operation remaining between the time on the high-time airplane of that model and its design service goal, the LOV may be approximately equal to the design service goal with few, if any, required maintenance actions. For airplane models with high-time airplanes

approaching or exceeding the design service goal, the LOV may be significantly greater than the design service goal and dependent on a large number of maintenance actions. Conceptually, any LOV can be valid as long as it is demonstrated that the airplane model will be free from WFD up to the LOV based on the airplane's inherent fatigue characteristics and any required maintenance actions. An established LOV can always be extended in accordance with § 26.23 as discussed in Chapter 3.

Early in the WFD evaluation process, design approval holders may have an LOV in mind as a likely candidate for compliance with § 26.21. This "candidate LOV" will be based on high-level technical considerations, such as the age and service experience of the fleet, and results of previously accomplished fatigue tests and analyses. It may also be based on economic considerations. Subsequently, as susceptible areas are evaluated in detail, the LOV may be adjusted up or down based on the impact of the proposed maintenance actions

**b. Step 2—Identification of WFD-Susceptible Structure.** If you are developing an LOV, you must identify the structure that is susceptible to WFD. Appendix 5 provides examples and illustrations of structure where multiple site damage or multiple element damage has been documented. This list is not meant to be inclusive of all structure that might be susceptible on any given airplane model, and it should only be used for general guidance. It should not be used to exclude any particular structure. When developing the list of structure susceptible to WFD you should:

- (1) Consider the list of fatigue-critical baseline structures identified under § 26.43, the Damage Tolerance Data for Repairs and Alterations rule.
- (2) Develop rationale for including and excluding structure. This should be part of your compliance data.
- (3) Establish criteria that could be used for identifying what structure is susceptible to WFD based on the definitions of multiple site damage, multiple element damage, and WFD. For example, structural details and elements that are repeated over large areas and operate at the same stress levels are obvious candidates. This should be part of your compliance data.

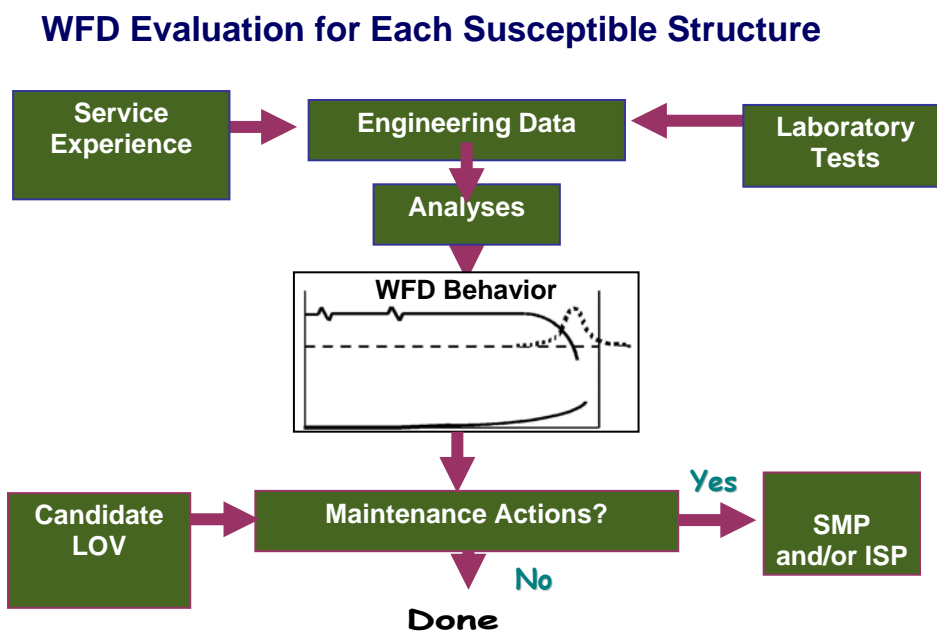
**c. Step 3—WFD Evaluation of Susceptible Structure.** Each susceptible structure must be evaluated to some degree. For some structures, you may have data such as fatigue tests, analysis, and service experience that demonstrates that WFD will not occur before an airplane reaches its LOV. In that case, you would not have to go through the process of quantifying the point in time when, without intervention, 50% of the fleet is expected to have developed WFD. That point in time is referred to as the "WFD average behavior" for that structure. For other structures, you will have to do an evaluation. Figure 2 shows the evaluation process. Engineering data from service experience or laboratory tests or both must be available to support the evaluation. Based on the data available, a time period is determined for WFD<sub>(average behavior)</sub> and is then compared to the candidate LOV. It may be

found that maintenance actions are needed before the airplane reaches the candidate LOV to preclude WFD in that airplane. When that is the case, additional work may be required to—

- Assess multiple site damage/multiple element damage inspection reliability and practicality (e.g., detectable size of cracks and probability of detection).
- Determine when inspections should start (this is the inspection start point—ISP).
- Determine inspection intervals.
- Determine when modifications or replacements should occur (this is the structural modification point—SMP).

This process will determine the maintenance actions necessary for the airplane to reach the LOV. The additional work required to complete the service information is discussed in paragraph 205. The WFD evaluation process is discussed in detail in Appendix 6.

**Figure 1**



SMP – Structural Modification Point

ISP – Inspection Start Point

**d. Step 4—Finalize LOV.** Once all susceptible structures have been evaluated, the final step is to determine where to establish the LOV that you will propose for compliance. Based on the WFD evaluation under Step 3, you may decide to establish the final LOV by increasing or decreasing the candidate LOV identified in Step 1. This may result in fewer

maintenance actions, or more of them. See Appendix 7 for an example of establishing an LOV with the process described in this chapter. In addition to the technical considerations, the LOV may be based on several other factors, including—

- Fleet demographics.
- Maintenance considerations.
- Operator input.
- Economics.

**205. MAINTENANCE ACTIONS AND SERVICE INFORMATION.** Based on the evaluation described above, the design approval holder will establish an LOV. The LOV may depend on maintenance actions and, if so, you must identify them. Maintenance actions could be inspections, modifications, or replacements.

**a.** For each required inspection, you should include—

- The structure to be inspected.
- The method of inspection.
- The inspection start point (the point in time at which to begin inspections).
- The repeat interval.

**b.** For required modifications or replacements, you should include—

- The structure to be modified or replaced.
- The method of modification or replacement.
- The structural modification point (the point in time to begin the modification).

The service information for these maintenance actions must include all the information above plus the procedures for accomplishing them. See Appendix 6 for further information on inspection start point and modification start point.

**c.** The maintenance actions required to support the LOV, if any, fall into one or more of the following categories—

**(1) Mandatory Maintenance Actions Supporting the LOV.** Design approval holders may decide to use only existing type design data and maintenance actions for which service information has been mandated by an AD. Modifications and replacements mandated by AD would be identified with the airplane structural configuration to be evaluated, and thus would be already included in the LOV. If an inspection previously mandated by AD to address WFD will be used to support the LOV, it should be identified and included with the LOV.

**(2) Maintenance Actions Identified and Already Issued.** Design approval holders may choose to use previously published service information to establish the LOV. A list of such maintenance actions must be submitted to the FAA Oversight Office. The FAA will then issue ADs to ensure that operators perform these maintenance actions to support the LOV.

**(3) Maintenance Actions Identified, but Not Issued.** Design approval holders may propose to support an LOV farther out in time by using new maintenance actions—maintenance actions for which service information has not yet been published. In this case, the design approval holder must submit to the FAA Oversight Office a list identifying each of those maintenance actions and a binding schedule for when they will be made available. This schedule should allow for the time required by the FAA AD rulemaking process, as well as for the time required for operators to incorporate those maintenance actions into their maintenance programs and carry out those maintenance tasks. This is to ensure that high-time airplanes do not pass the threshold for beginning inspections or modifications before those inspections or modifications have been made mandatory.

**206. REQUIREMENT FOR AIRWORTHINESS LIMITATIONS SECTION.** The Airworthiness Limitations section of the Instructions for Continued Airworthiness is required by part 25, Amendment 25-54 (September 11, 1980) and later. Airplanes certificated to Amendment 25-54 and later will have an Airworthiness Limitations section specifying those items with mandatory replacement or inspection times and related structural inspection procedures approved under § 25.571. Before 1980 those airworthiness limitations had been contained in chapter 5 of the airplane maintenance manual. Under § 26.21, a design approval holder with airplanes that do not have an Airworthiness Limitations section must create one and include the LOV. If an airplane does have an Airworthiness Limitations section, the design approval holder must revise it to include the LOV. Any new Airworthiness Limitations section and any Airworthiness Limitations section revision must be submitted to the FAA Oversight Office for review and approval.

**207. SUPPORTING DATA.** Supporting data for the LOV must include:

- a. Identification of the airplane structural configurations that were evaluated.

- b.** Summary of the operational statistics of the fleet, including accumulated flight cycles and flight hours.
- c.** Assumptions made about operational loading.
- d.** Identification and description of the structure susceptible to WFD.
- e.** Identification and description of the analytical methods used in the WFD evaluation.
- f.** Results of the WFD evaluations.
- g.** Guidance on reporting inspection findings (see paragraph 210 and Chapter 4 of this AC for further information).

**208. FAA OVERSIGHT OFFICE APPROVAL.** The items that require FAA approval are:

- a.** The compliance plan.
- b.** An Airworthiness Limitations section with the LOV incorporated (and supporting data).
- c.** The list of any required maintenance actions not mandated by airworthiness directives.
- d.** A binding schedule for publishing any required service information not yet published.

The time it takes for FAA approval of compliance data will be determined by the quality of design approval holders' submissions and the responsiveness of design approval holders to issues raised by the FAA.

**209. MAKING LOV DATA AVAILABLE.** Once the initial LOV is approved by the FAA Oversight Office, you must make the LOV available to operators of affected airplanes. This could be by normal business procedures, such as through the existing revision distribution processes, by website access, by e-mail, or by U.S. mail.

**210. DESIGN APPROVAL HOLDER REPORTING.** Reporting requirements for design approval holders remain the same. However, when reporting structural defects in compliance with existing rules, design approval holders should include the following information:

- a.** Description (with a sketch) of the damage, including crack length, orientation, location, flight cycles/hours, and condition of structure.
- b.** Results of follow-up inspections by operators that identify similar problems on other airplanes in the fleet.



- c.** Findings from inspections performed during repair, modification, or replacement that identify additional similar damage sites.
- d.** Description of adjacent repairs within the same structure.

## CHAPTER 3—§ 26.23 EXTENDED LOVS

**300. GENERAL INFORMATION ABOUT CHAPTER 3.** This chapter gives guidance for extending an LOV approved under § 25.571, § 26.21, or § 26.23. The requirements for extending an LOV are the same as those for establishing the initial LOV except for the differences noted in Table 2 below. This chapter explains the process involved, the documentation required, and the deliverables.

**Table 2**

### Differences between LOV and Extended LOV

	§ 26.21 (Initial LOV— required)	§ 25.571 (Initial LOV—required)	§ 26.23 (Extended LOV— <i>optional</i> )
<b>Who Establishes the LOV?</b>	DAH	Applicant	Any Person (STC required if not DAH)
<b>What Airplanes Are Affected?</b>	Airplanes > 75,000 lbs MTGW	All Transport Category Airplanes	Airplanes with an LOV per §§ 25.571, 26.21, 26.23
<b>What Configuration is Considered?</b>	Configuration at Effective Rule Date	Configuration of production airplane	Configuration at Approval Date of Extended LOV
<b>How are Maintenance Actions Mandated?</b>	Airworthiness Directive	Placement in Airworthiness Limitations section	Placement in Airworthiness Limitations Section
<b>When is Unpublished Service Information Due?</b>	By Date Indicated in the Binding Schedule	By Date of TC Approval or Delivery of the First Airplane or Issuance of a Standard Certificate of Airworthiness or Date of LOV Approval, Whichever Occurs Latest	By Date of Approval of the Extension
<b>Is Compliance Plan Required?</b>	Yes per § 26.21(d)	Not Required by § 25.571 but Recommended as Part of the Normal Certification Process per Part 21	Not Required by § 26.23 but Recommended as Part of the Normal Certification Process Per part 21

**301. APPLICATION FOR EXTENDED LOV.** Any person may apply to extend an existing LOV established under § 25.571, § 26.21, or § 26.23. The applicant must demonstrate that WFD will not occur in the airplane up to the proposed extended LOV. The applicant should consider the age (flight cycles or flight hours or both) of high-time airplanes relative to the existing LOV to determine when to begin developing data to extend it. Because the data is likely to include additional full-scale fatigue testing, the applicant should allow sufficient time (e.g., four years) to

complete such testing and to submit the compliance data for approval. An extended LOV is a major change to the type design of an airplane. Thus any person applying for an extended LOV must use the processes for an amended type certificate (ATC) (subpart D of 14 CFR part 21) or supplemental type certificate (STC) (subpart E of part 21). An extended LOV may also include specified maintenance actions, which would be part of the new LOV approval. Extended LOVs, along with any required maintenance actions for the extended LOV, would be incorporated into the Airworthiness Limitations section.

**302. AIRPLANE STRUCTURAL CONFIGURATION FOR AN EXTENDED LOV.** Persons seeking approval of an extended LOV must identify the airplane structural configuration for each airplane model they are evaluating for WFD and perform that evaluation. The applicant need not extend the LOV for the entire group of airplanes for which the existing LOV was established and instead may extend the LOV for only a subset of those airplanes. The structural configuration considered must be the configuration evaluated for the existing LOV plus any additional modifications and replacements mandated by airworthiness directive up to the approval date of the extended LOV.

**303. ESTABLISHING AN EXTENDED LOV AND SUPPORTING DATA.** The process for establishing an extended LOV, and the documentation required, is the same as that for an initial LOV. Depending on where in the life of the airplane the initial LOV was established, this may mean that full scale fatigue tests are necessary to substantiate the extended LOV. See AC 25.571-1D for guidance on performing full-scale fatigue tests.

**304. AIRWORTHINESS LIMITATIONS SECTION.** Only design approval holders may revise the Airworthiness Limitations section of the Instructions for Continued Airworthiness for their airplanes. Anyone else adding limitations must do so in the form of a supplement. The extended LOV, along with any service information that supports it, must be incorporated into the Airworthiness Limitations section. Type certificate holders would do this in the form of a revision, and other persons would add a supplement. Service information documented in the Airworthiness Limitations section or any supplement to it becomes airworthiness limitation items.

**305. FAA APPROVALS FOR EXTENDED LOVS.** For approval of an extended LOV the applicant and the FAA would follow the same procedures they use during approval of amended type certificates or supplemental type certificates. For an extended LOV, the Airworthiness Limitations section, with the LOV and any required service information incorporated (and supporting data), requires FAA approval.

## CHAPTER 4—COMPLIANCE INFORMATION FOR OPERATORS

**400. GENERAL INFORMATION FOR OPERATORS.** This chapter tells operators how to incorporate an LOV approved by the FAA Oversight Office into their maintenance programs. It applies to 14 CFR part 121 operators of transport category airplanes and to foreign air carriers or foreign persons operating U.S.-registered transport category airplanes under 14 CFR part 129. Under § 121.1115 and § 129.115, no one may operate an affected airplane unless it has an Airworthiness Limitations section with an LOV approved under Appendix H to part 25 or § 26.21. Under § 91.403(c), an operator must comply with any Airworthiness Limitations section referenced in operations specifications issued to it under part 121 or 129. This chapter describes the process for incorporating the Airworthiness Limitations section with the LOV into the maintenance program and the procedure for approval of the maintenance program revisions by the principal maintenance inspector (PMI). If a design approval holder develops maintenance actions to support the LOV under § 26.21, those maintenance actions would be mandated by AD. This chapter also provides guidance to operators who choose to incorporate an extended LOV. If there are any maintenance actions developed to support the extended LOV, they will be included in the Airworthiness Limitations section.

**401. AIRWORTHINESS LIMITATIONS SECTION.** Depending on the airplane's certification basis, a design approval holder would have either revised an Airworthiness Limitations section or established a new one to include the LOV for affected airplanes. The design approval holder must make the Airworthiness Limitations section available to operators (see paragraph 209) for incorporation into their maintenance programs.

**a. Airplanes Subject to § 26.21.** For any existing airplane that does not have an Airworthiness Limitations section, the design approval holder must create one under § 26.21 to include an LOV. If an existing airplane does have an Airworthiness Limitations section, the design approval holder would revise it under § 26.21 to include an LOV.

**b. Airplanes with Type Certificates Applied for After January 14, 2011, Subject to § 25.571.** Unlike § 26.21, § 25.571 applies to all transport category airplanes, regardless of the rule under which they are operated. Under § 25.571, the FAA may issue a design approval for an airplane model before full-scale fatigue testing has been completed. The design approval holder would establish the LOV after completion of this testing, in accordance with an FAA-approved schedule. Operators may operate such airplanes while the design approval holder is performing the fatigue testing. To do this, they must incorporate into their maintenance program the Airworthiness Limitations section with a number of cycles equal to  $\frac{1}{2}$  the number of cycles accumulated on the fatigue test article. Under § 91.403(c), operators may not fly these airplanes beyond that limitation. The number of cycles in the Airworthiness Limitations section may be revised by the design approval holder as additional cycles are accumulated on the test article. Although it is not required, operators may then revise their maintenance program to reflect

the new number. Once fatigue testing is complete and the LOV is established and approved, operators may revise their maintenance program to include the LOV. If they do not, the previously described number of cycles entered into the Airworthiness Limitations section will serve as the LOV. The LOV is an airworthiness limitation, and no airplane may be operated beyond the LOV stated in the Airworthiness Limitations section.

**402. AIRPLANES WITHOUT LOVs.** Operators may be faced with a situation where an LOV for a certain model airplane is not available for compliance with the operating rule. This may happen because the design approval holder has not provided an LOV, or it can happen because the operator wants to operate an airplane on the excluded list for § 26.21 and the design approval holder wasn't required to develop one.

- If the design approval holder has not provided an LOV on an airplane for which it was required, the operator may use the default LOV published in Table 1 of § 121.1115 or § 129.115.
- If an operator intends to operate an airplane on the exclusion list of § 26.21, that operator may develop its own LOV or use the default LOV published in Table 2 of § 121.1115 or § 129.115.

Because these default LOVs are part of §§ 121.1115 and 129.115, there is no further need for FAA Oversight Office approval. However, the operator must still receive principal maintenance inspector approval to incorporate the default LOV into its maintenance program.

**403. ADDING AN AIRPLANE TO AN OPERATOR'S FLEET AFTER THE COMPLIANCE DATE HAS PASSED.** Before an air carrier adds an airplane to its operations specifications, the following applies:

- a.** If the airplane was previously operated under an FAA-approved maintenance program, the new operator must ensure that the applicable LOV is incorporated into its maintenance program.
- b.** If the airplane was not previously operated under an FAA-approved maintenance program, the operator must incorporate the applicable LOV.
- c.** If the airplane is U.S.-registered, and will be in use in operations under 14 CFR part 129, the foreign owner or operator must incorporate the ALS containing the LOV into the maintenance program.

**404. EXTENDED LOVS.** Any person may apply for an extended LOV. Section 26.23 defines an extended LOV as a major change to the type design of an airplane. An applicant must use the amended type certificate or supplemental type certificate process when applying for an extended LOV. See Chapter 3 of this AC for further guidance. To operate an airplane to its extended

LOV, operators may need to perform maintenance actions to prevent WFD from occurring. Those maintenance actions must be specified as airworthiness limitation items in the Airworthiness Limitations section of the Instructions for Continued Airworthiness. If an extended LOV is approved for an airplane, operators are not required to incorporate it unless they want to operate the airplane beyond the current LOV (initial or previously-approved extended LOV) in effect. The person with the approved extended LOV is not required to make it available to all operators of airplanes for which it is applicable.

**405. PMI APPROVAL.** Operators must submit maintenance program revisions, containing the Airworthiness Limitations section with the LOV, to the principal maintenance inspector or Flight Standards International Field Office for review and approval. After the principal maintenance inspector or Flight Standards International Field Office has found these changes acceptable, they would approve the revision through the existing approval processes for time limitations. Any subsequent revision to this limit will follow the same approval process. The Airworthiness Limitations section must be clearly distinguishable within the maintenance program.

**406. OPERATOR REPORTING.** Reporting requirements for operators remain the same. However, when reporting fatigue-related structural defects in compliance with existing rules, operators should include the following information:

- Description (with a sketch) of the damage, including crack length, orientation, location, flight cycles/hours, and condition of structure.
- Results of follow-up inspections by operators that identify similar problems on other airplanes in the fleet.
- Findings from inspections performed during repair, modification, or replacement that identify additional similar damage sites.
- Description of adjacent repairs within the same structure.

Operators should also report the items above, and all suspected cases of multiple site damage/multiple element damage, to design approval holders and, if possible, provide them with the damaged structure for examination and further assessment.

## **APPENDIX 1**

### **RELATED REGULATIONS AND DOCUMENTS**

The regulatory basis of this AC is comprised of the following parts of 14 CFR:

- Part 21, Certification Procedures for Products and Parts.
- Part 25, Airworthiness Standards.
- Part 26, Continued Airworthiness and Safety Improvements: Transport Category Airplanes.
- Part 43, Maintenance, Preventive Maintenance, Rebuilding, and Alteration.
- Part 119, Certification: Air Carriers and Commercial Operators.
- Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations.
- Part 121, Subpart AA, Continued Airworthiness and Safety Improvements.
- Part 129, Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged in Common Carriage, Subpart B, Continued Airworthiness and safety Improvements.

You can download an electronic copy of 14 CFR from the Internet at <http://www.gpoaccess.gov/cfr/>. A paper copy may be ordered by sending a request to the U.S. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402-0001, or by calling telephone number (202) 512-1800; or by sending a request by facsimile to (202) 512-2250. Below are the specific regulations pertinent to this AC:

- a.** § 21.3, Reporting of failures, malfunctions, and defects.
- b.** § 21.50, Instructions for continued airworthiness and manufacturer's maintenance manuals having airworthiness limitations sections.
- c.** § 21.101, Designation of applicable regulations.
- d.** § 25.571, Damage-tolerance and fatigue evaluation of structure.
- e.** § 25.1529, Instructions for continued airworthiness.
- f.** Appendix H to part 25, Instructions for Continued Airworthiness.

- g.** § 26.21, Limit of validity.
- h.** § 26.23, Extended limit of validity.
- i.** § 43.13, Performance rules (general).
- j.** § 43.16, Airworthiness limitations.
- k.** § 91.403, General (under Maintenance, Preventive Maintenance, and Alterations).
- l.** § 121.703, Service difficulty reports.
- m.** § 121.1115, Limit of Validity.
- n.** § 129.115, Limit of Validity.

**REFERENCES.** The following list of related documents is provided for information purposes and are not necessarily directly referenced in this AC.

**a. Advisory Circulars.** Electronic copies of the following ACs can be downloaded from the Internet at <http://www.faa.gov/rgl>. Paper copies may be ordered from the U.S. Department of Transportation, Subsequent Distribution Office, M-30, Ardmore East Business Center, 3341 Q 75<sup>th</sup> Avenue, Landover, MD 20785.

- (1)** AC 20-107B, “Composite Aircraft Structure.”
- (2)** AC 21.101-1, “Establishing the Certification Basis of Changed Aeronautical Products.”
- (4)** AC 26-1, “Part 26, Continued Airworthiness and Safety Improvements.”
- (5)** AC 25.571-1D, “Damage Tolerance and Fatigue Evaluation of Structure.”
- (6)** AC 25.1529-1A, “Instructions for Continued Airworthiness of Structural Repairs on Transport Airplanes.”
- (7)** AC 91-56B, “Continuing Structural Integrity Program for Airplanes.”
- (8)** AC 91-82, “Fatigue Management Programs for Airplanes with Demonstrated Risk of Catastrophic Failure Due to Fatigue.”
- (9)** AC 120-16E, “Air Carrier Maintenance Programs.”



(10) AC 120-73, “Damage Tolerance Assessment of Repairs to Pressurized Fuselages.”

(11) AC 120-93 “Damage Tolerance Inspections for Repairs and Alterations.”

**b. FAA Policy.** An electronic copy of the following policy statement can be downloaded from the Internet at <http://www.faa.gov/rgl>. A paper copy may be ordered from the Federal Aviation Administration, Transport Airplane Directorate, Transport Standards Staff, Standardization Branch, ANM-113, 1601 Lind Avenue SW., Renton, WA 98055-4056.

- PS-ANM110-7-12-2005, Policy Statement, “Safety – A Shared Responsibility - New Direction for Addressing Airworthiness Issues for Transport Airplanes,” issued July 6, 2005, effective July 12, 2005.

**c. FAA Orders.** Electronic copies of the following Orders can be downloaded from the Internet at <http://www.faa.gov/rgl>. Paper copies may be ordered from the U.S. Department of Transportation, Subsequent Distribution Office, M-30, Ardmore East Business Center, 3341 Q 75<sup>th</sup> Avenue, Landover, MD 20785.

(1) Order 8110.54, “Instructions for Continued Airworthiness Responsibilities, Requirements, and Contents.”

(2) Order 8900.1, “Flight Standards Information Management System (FSIMS).”

(3) Order 8110.104, “Responsibilities and Requirements for Implementing Part 26 Safety Initiatives.”

**d. Related Documents.** Electronic copies of the following reports can be downloaded from the Internet at <http://www.faa.gov>.

(1) “Recommendations for Regulatory Action to Prevent Widespread Fatigue Damage in the Commercial Airplane Fleet,” Revision A, dated June 29, 1999 (A report of the Airworthiness Assurance Working Group for the Aviation Rulemaking Advisory Committee Transport Aircraft and Engine Issues).

(2) “Widespread Fatigue Damage Bridging Task Multiple Element Damage,” dated July 23, 2003 (A report of the Airworthiness Assurance Working Group for the Aviation Rulemaking Advisory Committee’s Transport Aircraft and Engine Issues Group).

(3) Final Report of the AAWG – Continued Airworthiness of Structural Repairs, September 12, 1996.

(4) A Report of the AAWG – Recommendations for Regulatory Action to Prevent Widespread Fatigue Damage in the Commercial Airplane Fleet, March 11, 1999.

**(5)** A Report of the AAWG - Recommendations For Regulatory Action To Enhance Continued Airworthiness Of Supplemental Type Certificates, Final Report, January 21, 2003.

**(6)** ATA Report 51-93-01 - Structural Maintenance Program Guidelines For Continuing Airworthiness.\*

**(7)** A Report to the AAWG - Structures Task Group Guidelines Document, June 1996.

**(8)** A Report to the AAWG – Recommendations Concerning ARAC Tasking FR Doc. 04-10816, Re: Aging Airplane Safety Final Rule, 14 CFR 121.370a and 129.16, Task 3 Final Report, March 22, 2007, Revised April 11, 2007.

\*For a copy of this report, please contact the ATA: Air Transport Association of America, Inc., 1301 Pennsylvania Avenue., NW, Suite 1100, Washington, DC 20004-1707; telephone (202) 626-4000.

## APPENDIX 2

### DEFINITIONS

For purposes of this AC, the following definitions apply:

**Airplane structural configuration**—The approved type certificate design, which includes the original design, any model variations or derivatives, and alterations or replacements mandated by AD.

**Airworthiness limitation item (ALI)**—A maintenance action item identified in the Airworthiness Limitation section of a design approval holder's Instructions for Continued Airworthiness. These items may contain mandatory modification or replacement times, mandatory inspection times, or inspection procedures.

**Airworthiness Limitations section (ALS)**—A collection of mandatory maintenance actions required for an airplane's structure and fuel tank systems. The Airworthiness Limitations section is part of an airplane's Instructions for Continued Airworthiness. For structural maintenance actions, the ALS includes structural modification times, replacement times, structural inspection thresholds and intervals, and related structural inspection procedures.

**Alteration or modification**—A design change made to an airplane. Within the context of this AC, the two terms are synonymous.

**Amended type certificate (ATC)**—An approved change to an airplane's original type certificate made by the type certificate holder. Only the holder of the type certificate may apply for an amended type certificate.

**Baseline structure**—The structure that is designed under the original type certificate or amended type certificate for that airplane model.

**Damage tolerance** —The attribute of a structure that permits it to retain its required residual strength without detrimental structural deformation for a period of use after the structure has sustained a given level of fatigue, corrosion, or accidental or discrete source damage.

**Design approval holder**—The term applied to the holder of any design approval, including type certificate, amended type certificate, supplemental type certificate, amended supplemental type certificate, parts manufacturer approval, TSO authorization, letter of TSO design approval, and field approval (FAA Form 337).

**Design service goal (DSG)**—The period of time (in flight cycles or flight hours, or both) established at design and/or certification during which the principal structure of an airplane will be reasonably free from significant cracking.

**Fatigue-critical baseline structure**—The part of the baseline structure of an airplane that is classified as fatigue-critical.

**Fatigue critical structure**—Structure of an airplane that is susceptible to fatigue cracking that could lead to a catastrophic failure of the airplane. For the purposes of this AC, fatigue-critical structure refers to the same class of structure as the structure that would need to be assessed for compliance with § 25.571(a) at Amendment 25-45 or later. The term fatigue-critical structure may refer to fatigue-critical baseline structure, fatigue-critical alteration structure, or both.

**FAA Oversight Office**—The aircraft certification office or office of the Transport Airplane Directorate having oversight responsibility for the relevant type certificate or supplemental type certificate, as determined by the Administrator.

**Flight Standards Service Offices**—Offices located in FAA headquarters responsible for developing guidance and policy applicable to transport category airplanes for Aircraft Evaluation Group personnel and Flight Standards Service field personnel (maintenance, avionics, and operations Aviation Safety Inspectors) in the conduct of their responsibilities.

**Inspection start point (ISP)**—The point in time when special inspections of the fleet are initiated because of a specific probability of having a multiple site damage/multiple element damage condition.

**Instructions for Continued Airworthiness (ICA)**—Maintenance actions developed by the TC or STC holder in accordance with 14 CFR 25.1529 and delivered with the airplane in accordance with 14 CFR 21.50. Instructions for continued airworthiness are documentation that set forth instructions and requirements for the maintenance that is essential to the continued airworthiness of an aircraft, engine, or propeller.

**Limit of validity (of the engineering data that supports the structural maintenance program)**—The period of time (in flight cycles, flight hours, or both), up to which it has been demonstrated by test evidence, analysis and, if available, service experience and teardown inspection results of high-time airplanes, that widespread fatigue damage will not occur in the airplane structure.

**Maintenance actions**—Inspections, modifications, replacements, or any combination of these.

**Multiple site damage (MSD)**—A source of widespread fatigue damage characterized by the simultaneous presence of fatigue cracks in the same structural elements.

**Multiple element damage (MED)**—A source of widespread fatigue damage characterized by the simultaneous presence of fatigue cracks in similar adjacent structural elements.

**Structural modification point (SMP)**—The point in time when a structural area must be modified to preclude WFD.

**Scatter factor**—A life reduction factor used in the interpretation of fatigue analysis and fatigue test results.

**Structures Task Group**—A model-specific airplane industry group that consists of type certificate holders and operators responsible for developing aging airplane model-specific programs. Such a group also includes regulatory authorities who approve and monitor those programs.

**Supplemental Structural Inspection Program**—A damage-tolerance-based inspection program. Structural inspection programs only address the structure identified by the type certificate holder using the guidance contained in AC 91-56.

**Teardown Inspection**—The term used for the process of disassembling structure and using destructive inspection techniques or visual (e.g., magnifying glass and dye penetrant) or other non-destructive (e.g., eddy current, ultrasound) inspection techniques to identify the extent of damage within a structure caused by fatigue, corrosion, and accidental damage.

**Test-to-structure factors**—A series of factors used to adjust test results to full-scale structure. These factors could include, but are not limited to, differences in—

- Stress spectrum,
- Boundary conditions,
- Specimen configuration,
- Material differences,
- Geometric considerations, and
- Environmental effects.

**Type design**—The engineering definition of a particular product. The type design consists of the following (see 14 CFR § 21.31):

- Drawings and specifications,
- Dimensions, materials, and processes,
- Airworthiness limitations,
- (for primary category aircraft, if desired) A special inspection and preventive maintenance program designed to be accomplished by an appropriately rated and trained pilot/owner, and
- Other data to describe the product design and to determine the airworthiness, noise characteristics, fuel venting, and exhaust emissions (where applicable).

**WFD<sub>(average behavior)</sub>**—The point in time when, without intervention, 50% of the fleet is expected to develop WFD for a particular structure.

**Widespread fatigue damage (WFD)**—The simultaneous presence of cracks at multiple structural locations that are of sufficient size and density that the structure will no longer meet the residual strength requirements of § 25.571(b).

## APPENDIX 3

### ACRONYMS USED IN THIS AC

AAWG	Airworthiness Assurance Working Group
AC	Advisory Circular
AD	Airworthiness Directive
ALS	Airworthiness Limitations section
ARAC	Aviation Rulemaking Advisory Committee
ATC	Amended Type Certificate
DAH	Design Approval Holder
FAA	Federal Aviation Administration
ICA	Instructions for Continued Airworthiness
LOV	Limit of Validity of the Engineering Data that Supports the Structural Maintenance Program
ISP	Inspection Start Point
MED	Multiple Element Damage
MSD	Multiple Site Damage
MSG	Maintenance Steering Group
PMI	Principal Maintenance Inspector
SMP	Structural Modification Point
SSID	Supplemental Structural Inspection Document
SSIP	Supplemental Structural Inspection Program
STC	Supplemental Type Certificate
TC	Type Certificate
WFD	Widespread Fatigue Damage

## **APPENDIX 4**

### **BACKGROUND**

Structural fatigue is the degradation of a material subjected to repeated structural loads. Fatigue of metallic structure is recognized as a significant threat to the continued airworthiness of airplanes. This is because even small fatigue cracks can significantly reduce the strength of airplane structure. For over 50 years, the airworthiness standards for certification of new transport category airplanes have addressed fatigue. These airworthiness standards are meant to prevent catastrophic failures due to fatigue throughout the anticipated operational life of the airplane. These standards have evolved over the years and have changed as the relevant knowledge base has increased. This knowledge includes service experience, specific incidents and accidents, and technological advances in design, analysis, testing, manufacturing, and inspection of airplanes.

One of the first significant changes in the airworthiness standards occurred in March 1956, with the revision of the fatigue evaluation requirements contained in Civil Air Regulations (CAR) 4b.270. This revision added “fail-safe strength” as an option to the “fatigue strength” approach for addressing fatigue. Motivation for this change was the realization that precluding the occurrence of fatigue cracking might not always be possible and, therefore, as an option, the structure may be designed to survive cracking. The fatigue strength approach aims for a design where fatigue cracking is not probable within the operational life of the airplane. The fail-safe approach assumes that cracking could occur, but that a specified minimum strength could be maintained after a “fatigue failure or obvious partial failure.” The efficacy of the fail-safe approach was not only dependent on the structure keeping the specified minimum strength with the fatigue damage present, but also on finding the damage during normal maintenance. As applied, the fail-safe approach emphasizes redundancy as opposed to fatigue performance, and inspectability is assumed and not quantified. The fail-safe option was the predominant approach chosen for most large transport category airplanes certified in the 1960s and 1970s.

Another significant change in the airworthiness standards for fatigue occurred in October 1978 with Amendment 25-45, when § 25.571 was revised and § 25.573 was deleted. This change involved removing the fail-safe option entirely and establishing a new requirement to develop damage-tolerance-based inspections wherever practical. The fatigue strength approach, as a default option, is used only if the damage-tolerance approach is impractical. The motivation for the 1978 change was the recognition, based on mounting evidence, that the fail-safe approach that had been applied up to that point was not reliable and would not achieve the desired level of safety. Specific areas of concern with the fail-safe approach included loss of “fail-safety” with age. This was because of the increased probability of cracking in the structure adjacent to the fatigue failure, or obvious partial failure, and the lack of directed inspections and quantification of residual life with the assumed damage present. It was agreed at the time that more emphasis was needed on where and how fatigue cracking could occur in the structure, and on quantifying crack growth and residual strength characteristics. Such an approach includes knowledge of damage tolerance characteristics and development of effective inspection protocols, such as



where, when, how, and how often to inspect. The 1978 changes achieved this for certification of new transport category airplanes.

The same events and reasoning that drove the changes to airworthiness standards for new airplanes also influenced the strategy adopted to ensure continued airworthiness of the existing fleet. There was increasing concern about existing older airplanes that had been certified according to the fail-safe requirements of CAR 4b.270. Eleven large transport models were specifically identified as needing the most attention. The FAA determined a need to develop damage-tolerance-based inspection programs. These inspections supplemented existing maintenance inspections, so they were referred to as Supplemental Structural Inspection Programs (SSIPs). The inspection requirements for these programs were documented in supplemental structural inspection documents (SSIDs). It was also agreed that SSIDs would be developed by the original equipment manufacturers on a voluntary basis and then mandated by airworthiness directives. The Civil Aviation Authority for the United Kingdom published guidance for developing the SSIPs in Airworthiness Notice No. 89, *Continuing Structural Integrity of Transport Aeroplanes*, dated August 23, 1978, and the FAA published guidance for developing the SSIPs on May 6, 1981 in AC No. 91-56, *Supplemental Structural Inspection Program for Large Transport Category Airplanes*. SSIPs were subsequently developed and documented in SSIDs and mandated by airworthiness directives for the eleven aging model airplanes.

In April 1988, one of the eleven aging model airplanes suffered major structural damage to its pressurized fuselage because of undetected fatigue cracking of the baseline primary structure. Although that airplane had an SSIP that was mandated by an airworthiness directive, there were no special directed inspections for fatigue cracks at multiple structural locations. This was because it was believed that the link-up of multiple fatigue cracks in one skin frame bay would result in safe decompression by skin flapping.<sup>3</sup> It was thought that the damage to the fuselage skin would be obvious by inspection or by the inability to pressurize the fuselage. The accident was attributed, in part, to the aging of the airplane involved. This aging included the simultaneous presence of small fatigue cracks at multiple locations in the fuselage skin lap splice. Instead of being obvious, those cracks grew undetected. Then they linked up quickly to cause catastrophic failure of a large section of the fuselage.

That accident precipitated actions that culminated in regulations aimed at avoiding catastrophic failures from fatigue in existing and future airplanes. In response to the April 1988 accident, the FAA sponsored a conference on aging airplanes and established a task force representing the interests of the airplane operators, airplane manufacturers, regulatory authorities, and other aviation representatives. This task force was later renamed the Airworthiness Assurance Working Group (AAWG). They specifically recommended establishment of an Aging Aircraft Program to address long-term airworthiness issues in airplane structure that result from aging. The AAWG also recommended that the program include an element for addressing fatigue cracking at multiple structural locations. The National Transportation Safety Board recommended that design approval holders discontinue classifying fuselage skin as “malfunction evident” or “damage obvious” in SSIDs.

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<sup>3</sup> Flapping is a phenomenon that occurs in cracks in fuselage skin subjected to cabin pressure. When the two tips of the crack meet stiffened structure, they change direction and turn away from the stiffened structure.

The April 1988 accident also precipitated Congressional legislation. In October 1991, Congress enacted Title IV of Public Law 102-143, the *Aging Airplane Safety Act of 1991* (AASA). The AASA had two key elements:

- (1)** It required “the Administrator to make such inspections and conduct such reviews of maintenance and other records of each airplane used by an operator to provide air transportation as may be necessary to determine that such is in a safe condition and is properly maintained for operation in air transportation.”
- (2)** It specified that an operator must be able to demonstrate, as part of that inspection, “that maintenance of the airplane’s structure, skin, and other age sensitive parts and components have been adequate and timely enough to ensure the highest level of safety.”

The SSIPs were revised to remove the methodology for classifying certain fatigue cracking in structures as “malfunction evident” or “damage obvious” and to include damage-tolerance-based inspections for those structures. The FAA issued airworthiness directives to mandate those changes. The supplemental structural inspection program is one element of the overall Aging Aircraft Program for structures. We also adopted changes to operating rules and issued airworthiness directives to mandate, in part, other elements of the Aging Aircraft Program, including:

- The Mandatory Modification Program.
- The Repair Assessment Program.
- The Corrosion Prevention and Control Program.

For further discussion on the Aging Aircraft Program for structures, see AC 91-56B. In response to the AASA, in part, the FAA issued the Aging Airplane Safety Final Rule,<sup>4</sup> and the Damage Tolerance Data Rule,<sup>5</sup> and guidance material. The Damage Tolerance Data Rule is the design-approval-holder component that facilitates operator compliance with the Aging Airplane Safety Final Rule. For further background information and discussion on these rules, see AC 120-93.

In 1998, the FAA amended § 25.571 (Amendment 25-96<sup>6</sup>) of the aircraft certification requirements for transport category airplanes. Under this amendment, we introduced the term widespread fatigue damage (WFD) into § 25.571. Widespread fatigue damage is a condition that occurs when there is simultaneous presence of fatigue cracks at multiple structural locations that are of sufficient size and density that the structure will no longer meet the residual strength requirements of § 25.571(b). As part of the certification process, § 25.571 requires full-scale fatigue test evidence to demonstrate that WFD will not occur before an airplane reaches its design service goal.

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<sup>4</sup> Aging Airplane Safety: 70 FR 5518; February 2, 2005

<sup>5</sup> Damage Tolerance Data for Repairs and Alterations: 72 FR 70486; December 12, 2007

<sup>6</sup> Damage-Tolerance and Fatigue Evaluation of Structure: 63 FR 15707; March 31, 1998

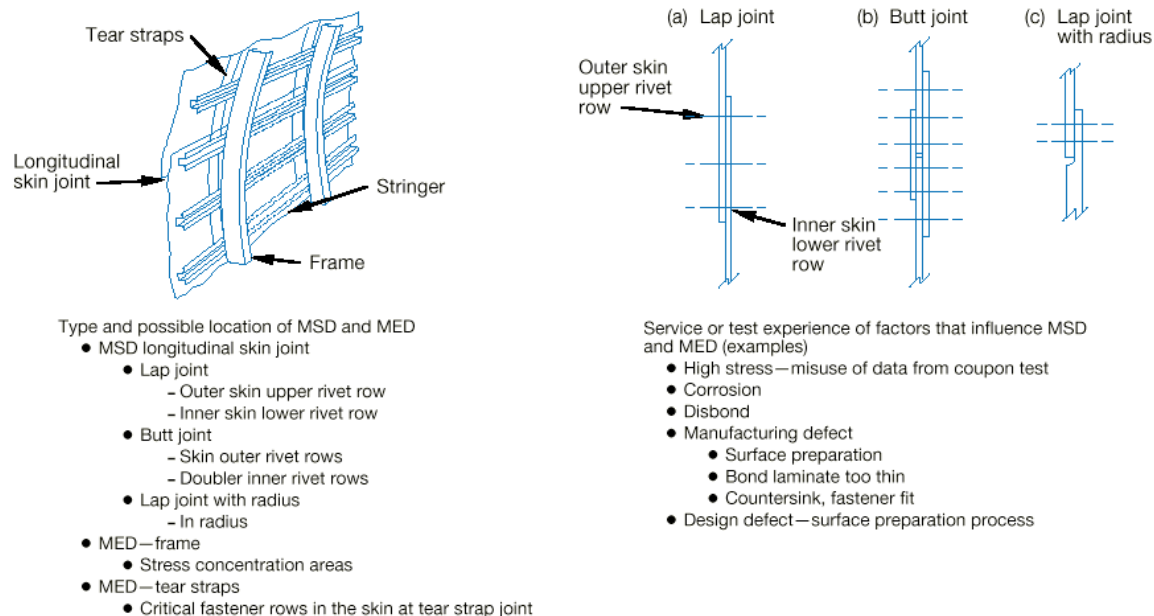
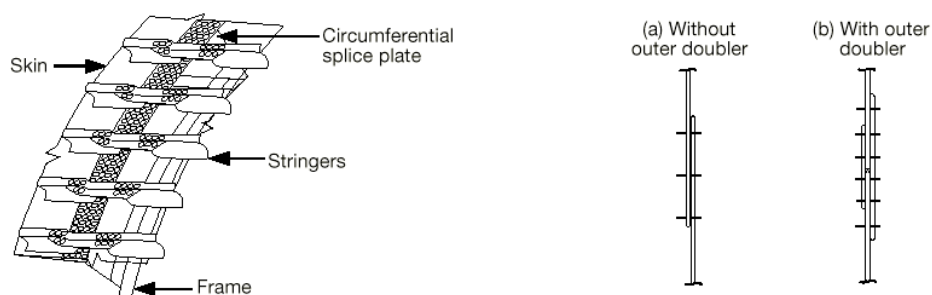
Another significant change in the airworthiness standards for fatigue occurred in November 2010 with the issuance of Amendment Nos. 25-132 and 26-5<sup>7</sup> when the FAA revised § 25.571 and added §§ 26.21 and 26.23. We determined that this change was necessary because the structural fatigue characteristics of airplanes are understood only up to the point where analyses and testing of the structure are valid. Until Amendment Nos. 25-132 and 26-5,, there were no requirements to limit the operation of airplanes based on existing engineering data to prevent catastrophic failures from WFD. We adopted these amendments to require that design approval holders establish a limit of validity of the engineering data that supports the structural maintenance program (LOV) and demonstrate that WFD will not occur in the airplane before it reaches LOV. Under this change, we also added §§ 121.1115 and 129.115 in Amendment Nos. 121-351 and 129-48, to prohibit operation of an airplane beyond its LOV. Section 26.23 provides an option for any person to extend the LOV and to develop the maintenance actions that support the extended limit. Thereafter, to operate an airplane beyond the existing LOV, an operator must incorporate the extended LOV and associated maintenance actions into its maintenance program. The airplane may not be operated beyond the extended LOV. These amendments, which specifically addresses WFD, is intended to be the last element of the overall Aging Aircraft Program for structures.

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<sup>7</sup> Aging Aircraft Program: Widespread Fatigue Damage: 75 FR 69746, November 15, 2010.

**APPENDIX 5****EXAMPLES OF STRUCTURE SUSCEPTIBLE TO WFD**

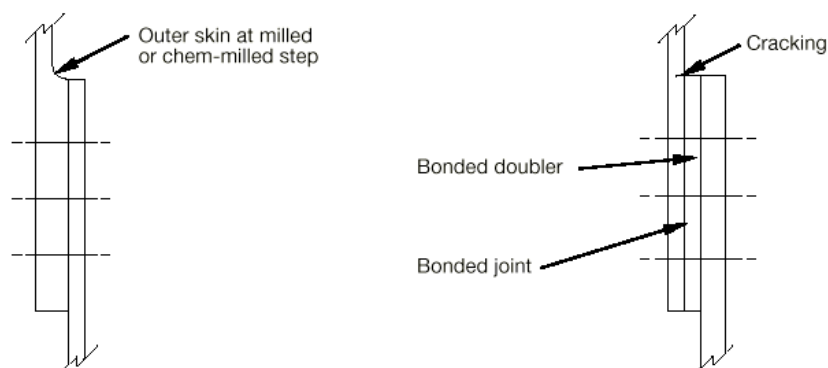
STRUCTURAL AREA	SEE FIGURE
Longitudinal Skin Joints, Frames, and Tear Straps (MSD/MED)	5-1
Circumferential Joints and Stringers (MSD/MED)	5-2
Lap Joints with Milled, Chem-milled or Bonded Radius (MSD)	5-3
Fuselage Frames (MED)	5-4
Stringer to Frame Attachments (MED)	5-5
Shear Clip End Fasteners on Shear Tied Fuselage Frames (MSD/MED)	5-6
Aft Pressure Dome Outer Ring and Dome Web Splices (MSD/MED)	5-7
Skin Splice at Aft Pressure Bulkhead (MSD)	5-8
Abrupt Changes in Web or Skin Thickness — Pressurized or Unpressurized Structure (MSD/MED)	5-9
Window Surround Structure (MSD, MED)	5-10
Over-Wing Fuselage Attachments (MED)	5-11
Latches and Hinges of Non-plug Doors (MSD/MED)	5-12
Skin at Runout of Large Doubler (MSD)—Fuselage, Wing or Empennage	5-13
Wing or Empennage Chordwise Splices (MSD/MED)	5-14
Rib-to-Skin Attachments (MSD/MED)	5-15
Typical Wing and Empennage Construction (MSD/MED)	5-16

**Figure 5-1 Longitudinal Skin Joints, Frames, and Tear Straps (MSD/MED)****Figure 5-2 Circumferential Joints and Stringers (MSD/MED)****Type and possible location of MSD/MED**

- MSD—circumferential joint
  - Without outer doubler
    - Splice plate—between and/or at the inner two rivet rows
    - Skin—forward and aft rivet row of splice plate
    - Skin—at first fastener of stringer coupling
  - With outer doubler
    - Skin—outer rivet rows
    - Splice plate/outer doubler—inner rivet rows
- MED—stringer/stringer couplings
  - Stringer—at first fastener of stringer coupling
  - Stringer coupling—in splice plate area

**Service or test experience of factors that influence MSD and/or MED (examples)**

- High secondary bending
- High stress level in splice plate and joining stringers (misuse of data from coupon test)
- Poor design (wrong material)
- Underdesign (over-estimation of interference fit fasteners)

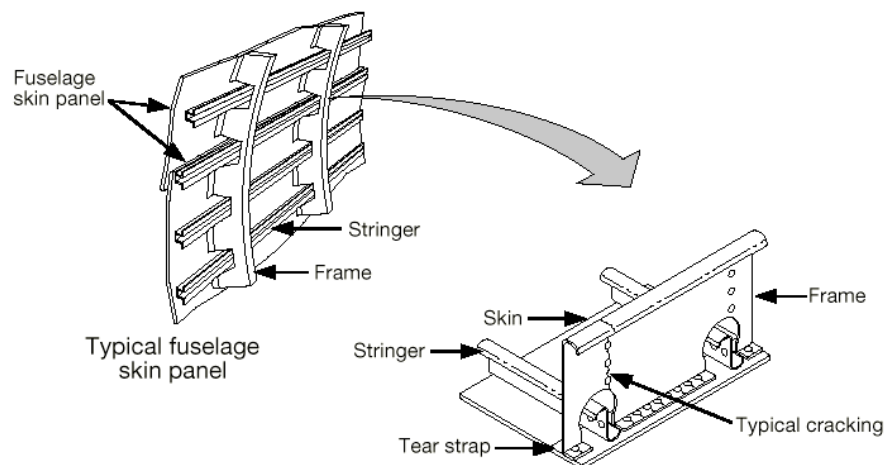
**Figure 5-3 Lap joints with Milled, Chem-milled or Bonded Radius (MSD)**

Type and possible location of MSD and MED

- MSD—abrupt cross section change
- Milled radius
- Chem-milled radius
- Bonded doubler runout

Service or test experience of factors that influence MSD and MED (examples)

- High bending stresses due to eccentricity

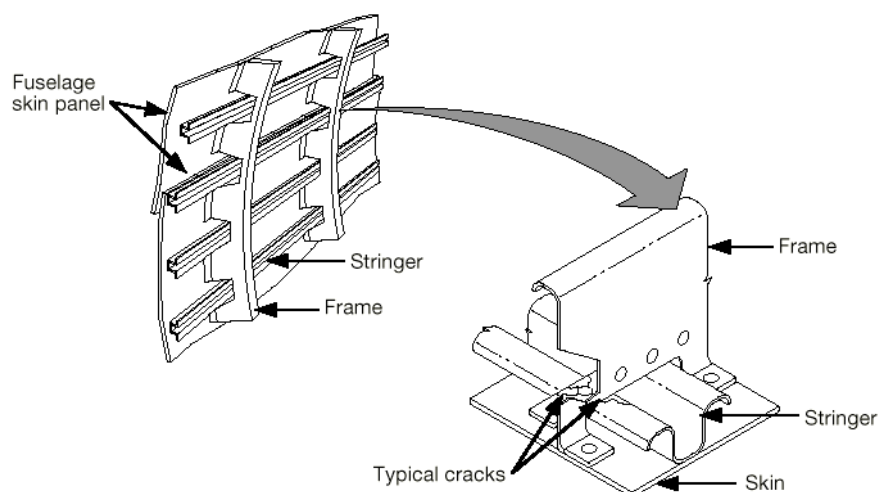
**Figure 5-4 Fuselage Frames (MED)**

Type and possible location of MSD/MED

- MED—the cracking of frames at stringer cutouts at successive longitudinal locations in the fuselage. The primary concern is for those areas where noncircular frames exist in the fuselage structure. Fractures in those areas would result in panel instability.

Service or test experience of factors that influence MSD and/or MED (examples)

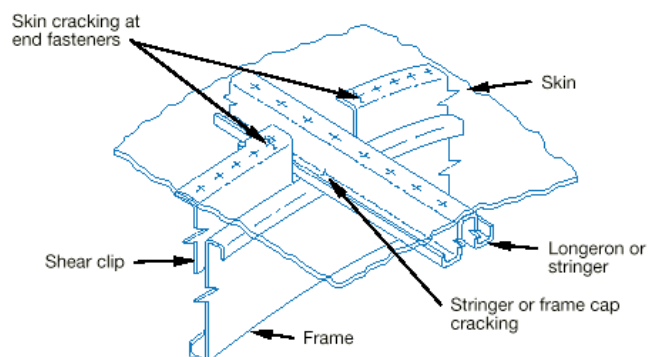
- High bending—noncircular frames
- Local stress concentrations
  - Cutouts
  - Shear attachments

**Figure 5-5 Stringer-to-Frame Attachments (MED)****Type and possible location of MED**

- MED—any combination of fracture of frames, clips, or stringers, including the attachments, resulting in the loss of the shear tie between the frame and stringer. This condition may occur at either circumferential or longitudinal locations at fuselage frame/stringer intersection.

**Service or test experience of factors that influence MSD and/or MED (examples)**

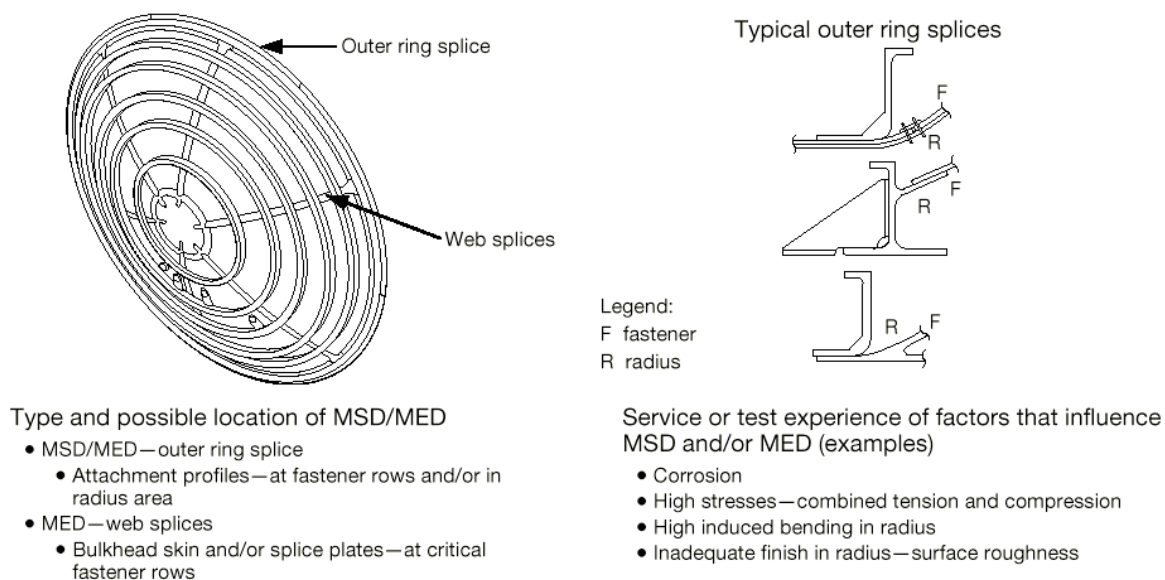
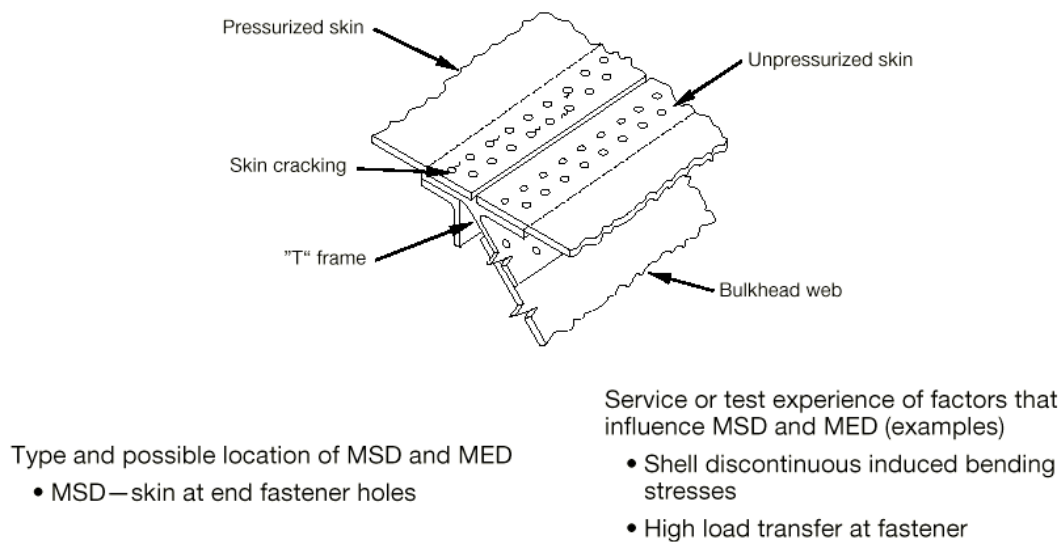
- Poor load path connection

**Figure 5-6 Shear Clip End Fasteners on Shear-Tied Fuselage Frame (MSD/MED)****Type and possible location of MSD and MED**

- MSD—skin at end fastener of shear clip
- MED—cracking in stringer or longeron at frame attachment
- MED—cracking in frame at stringer or longeron attachment

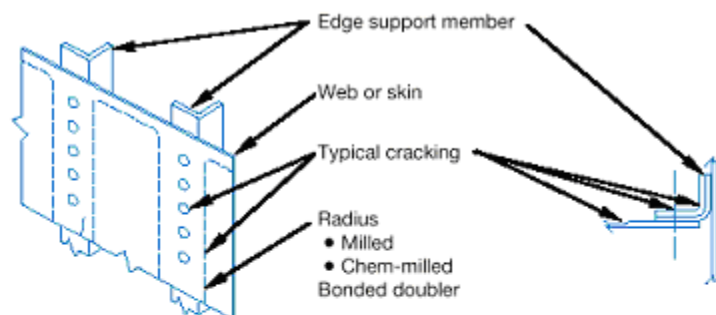
**Service or test experience of factors that influence MSD and MED (examples)**

- Preload
- Localized bending due to pressure
- Discontinuous load path

**Figure 5-7 Aft Pressure Dome Outer Ring and Dome Web Splices (MSD/MED)****Figure 5-8 Skin Splice at Aft Pressure Bulkhead (MSD)**



**Figure 5-9 Abrupt Changes in Web or Skin Thickness — Pressurized or Unpressurized Structure (MSD/MED)**



**Type and possible location of MSD and MED**

**Abrupt change in stiffness**

- Milled radius
- Chem-milled radius
- Bonded doubler
- Fastener row at edge support members

**Edge member support structure**

- Edge member - in radius areas

**Service or test experience of factors that influence MSD and MED**

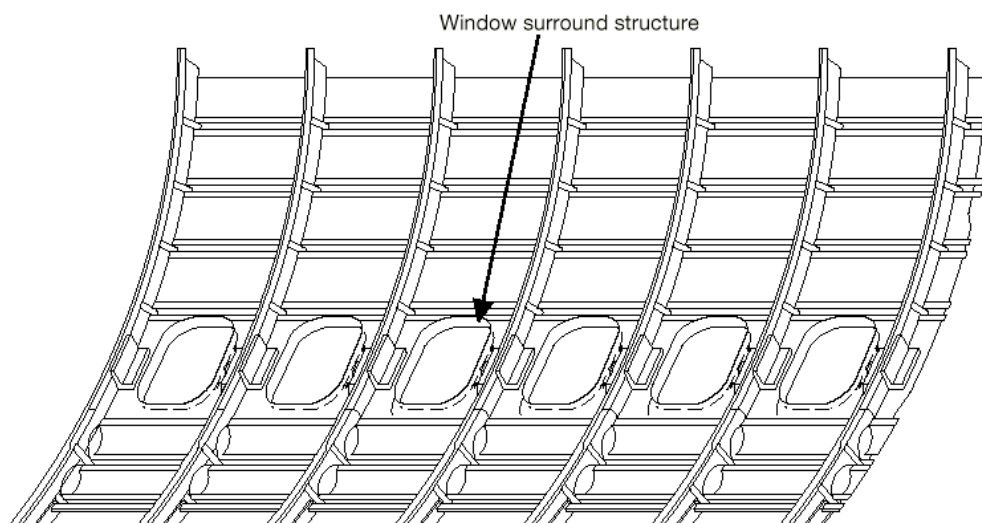
**Pressure structure**

- High bending stresses at edge support due to pressure

**Non-pressure structure**

- Structural deflections cause high stresses at edge supports

**Figure 5-10 Window Surround Structure (MSD, MED)**

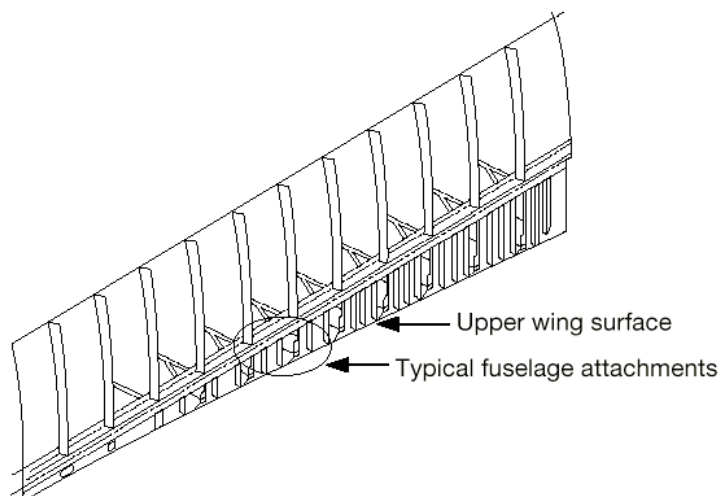


**Type and possible location of MSD/MED**

- MSD—skin at attachment to window surround structure
- MED—repeated details in reinforcement of window cutouts or in window corners

**Service or test experience of factors that influence MSD and/or MED (examples)**

- High load transfer

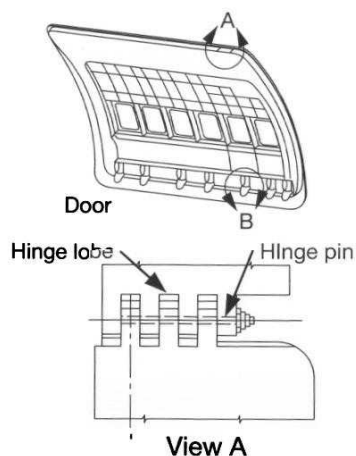
**Figure 5-11 Over Wing Fuselage Attachments (MED)**

Type and possible location of MSD/MED

- MED—repeated details in overwing fuselage attachments

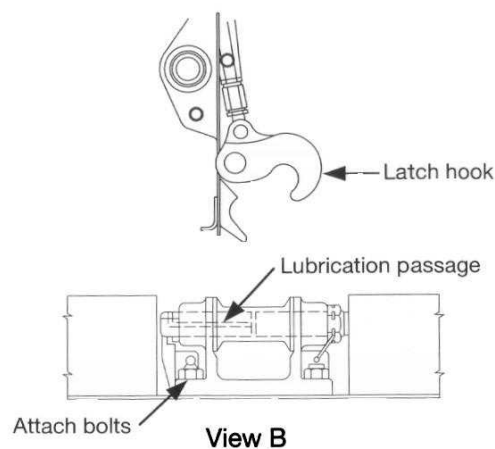
Service or test experience of factors that influence MSD and/or MED (examples)

- Manufacturing defect—prestress
- Induced deflections

**Figure 5-12 Latches and Hinges of Non-plug Doors (MSD/MED)**

Type and possible location of MSD/MED

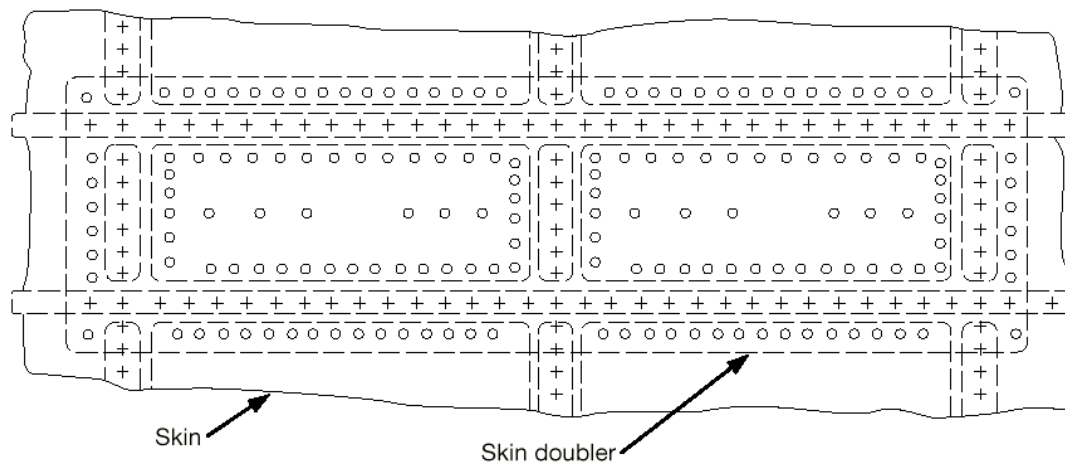
- MSD—piano hinge
  - At hinge fastener attachment row
  - In fillet radius
  - Emanating from hole in lobes
- MED—latches
  - In multiple latch hooks
  - At lube channel of latch spool
  - At spool bracket attach bolts (also corrosion)



Service or test experience of factors that influence MSD and/or MED (examples)

- Bending stresses due to fuselage elongation
- High local stress
- Fretting

**Figure 5-13 Skin at Runout of Large Doubler (MSD) —  
Fuselage, Wing, or Empennage**



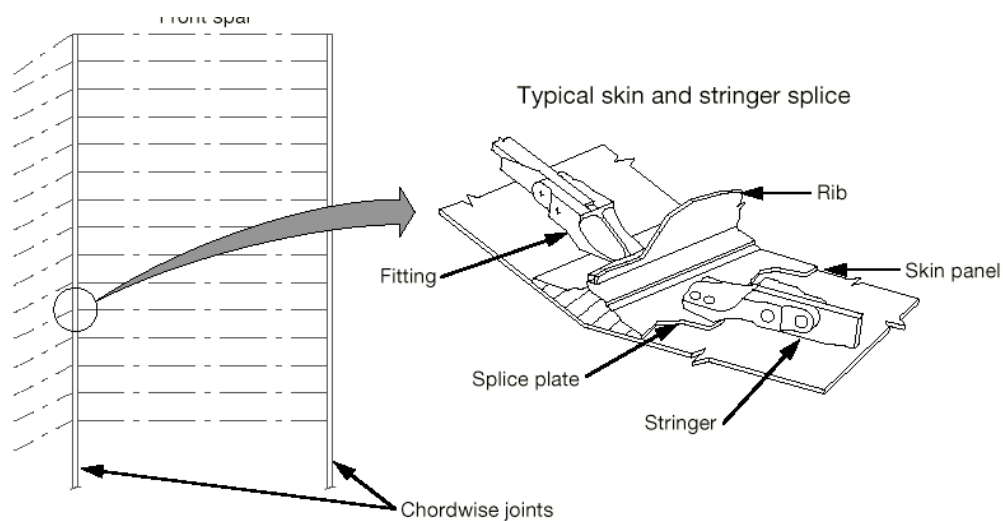
**Type and possible location of MSD/MED**

- MSD—cracks initiated at multiple critical fastener holes in skin at runout of doubler

**Service or test experience of factors that influence MSD and/or MED (examples)**

- High load transfer—high local stress

**Figure 5-14 Wing or Empennage Chordwise Splices (MSD/MED)**

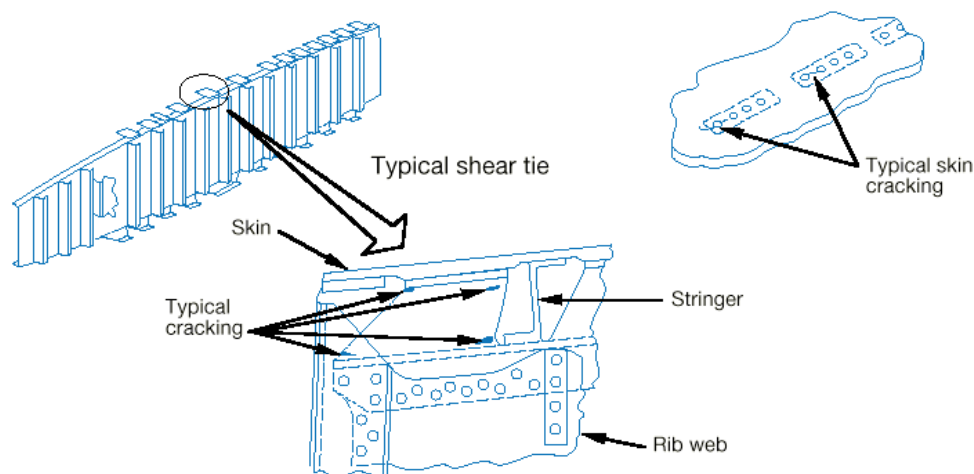


**Type and possible location of MSD/MED**

- MSD—skin and/or splice plate
  - Chordwise critical fastener rows
- MED—stringer runout of fitting
  - Fatigue-critical fastener holes at stringer and/or fitting

**Service or test experience of factors that influence MSD and/or MED (examples)**

- High load transfer
- Local bending

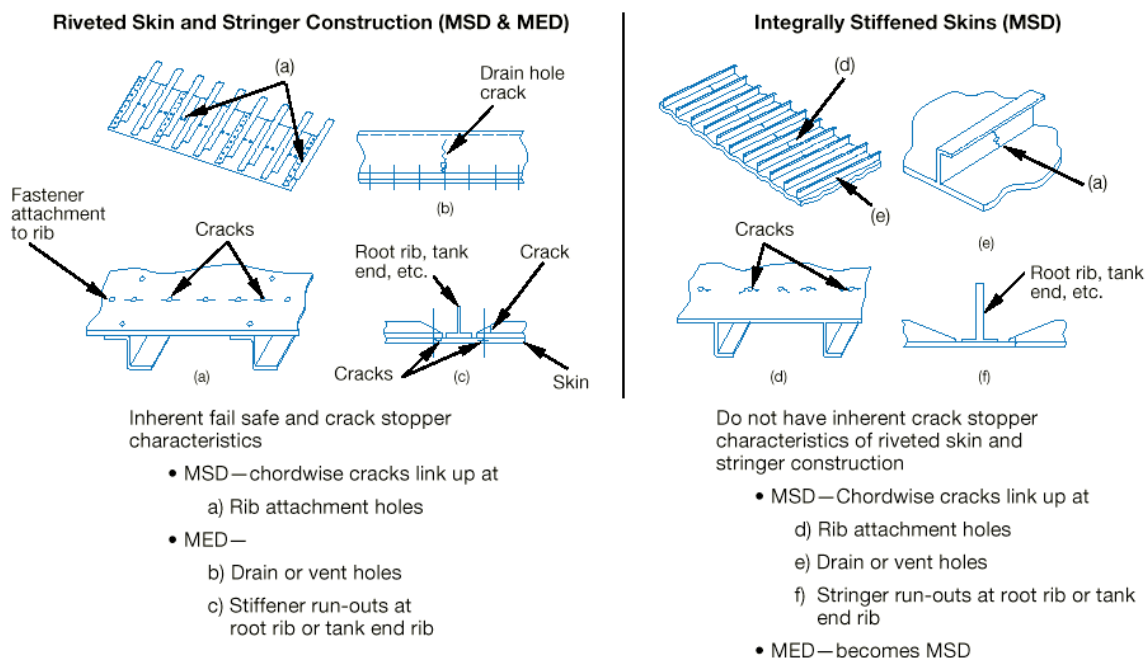
**Figure 5-15 Rib-to-Skin Attachments (MSD/MED)**

Type and possible location of MSD and MED

- MSD—critical fasteners in skin along rib attachments
- MED—critical rib feet in multiple stringer bays (particularly for empennage under sonic fatigue)

Service or test experience of factors that influence MSD and MED (examples)

- Manufacturing defect—prestress due to assembly sequence
- Sonic fatigue (empennage)

**Figure 5-16 Typical Wing and Empennage Construction (MSD/MED)**

## APPENDIX 6

### WIDESPREAD FATIGUE DAMAGE EVALUATION

This appendix tells you how to perform a WFD evaluation as part of the overall process for establishing an LOV. The WFD evaluation may be simple or very complex. The situation will vary from model to model and area to area on any given airplane structural configuration. The evaluation of the identified WFD-susceptible structure has two objectives—

- To predict when WFD is likely to occur.
- To establish additional maintenance actions, as necessary, to ensure continued safe operation of the airplane.

The information contained in this appendix was derived in part from the 1999 and 2003 ARAC Working Group reports referenced in Appendix 1.

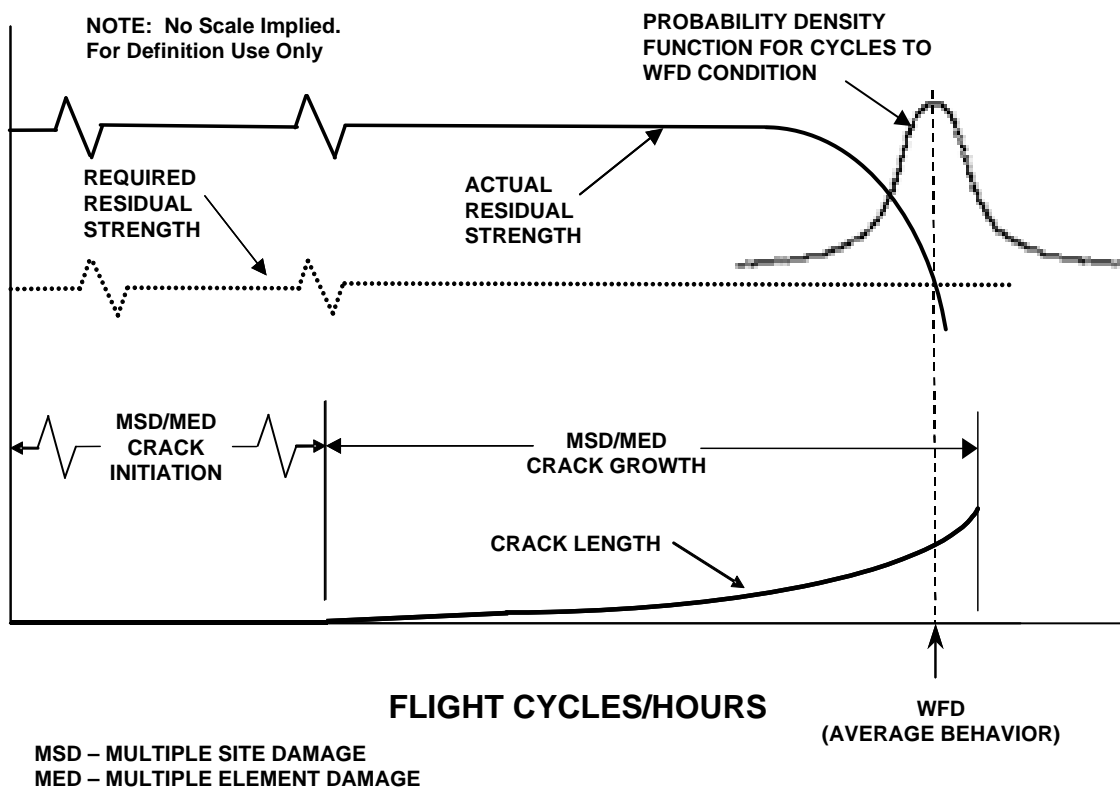
### THE EVALUATION

The WFD evaluation of susceptible structure is a process for determining when WFD is likely to occur in the structure, what maintenance actions might be necessary to prevent it from occurring before the LOV, and when those maintenance actions should be begun. This evaluation should be based on service history, test data, fatigue analyses, damage-tolerance analyses, teardown inspections of high-usage airplanes, or any combination of these.

#### 1. Predicting When WFD is Likely to Occur.

**a. Characterization of Events Leading to WFD.** The fatigue process that leads to WFD is shown in Figure 6-1. This figure is applicable both to damage that occurs in multiple sites (multiple site damage) and damage that occurs in similar structure at more than one location (multiple element damage). For any susceptible structural area, it is not a question of *whether* WFD will occur—but *when* it will occur. In Figure 6-1, the “when” is illustrated by the line titled “WFD (average behavior),” which is the point when, without intervention, 50 % of the airplanes in a fleet would have experienced WFD in the considered area. (Note that the probability density function for flight cycles or flight hours to WFD has been depicted for reference.) The WFD process includes this phase of crack initiation and a crack growth phase. During the crack initiation phase, which generally spans a long period of time, there is little or no change in the basic strength capability of the structure. The actual residual strength curve depicted in Figure 6-1 is flat, and equal to the strength of the structure in its pristine state. However, at some time after the first small cracks start to grow, residual strength begins to degrade. Crack growth continues until the capability of the structure degrades to the point of the minimum strength required by § 25.571(b). In this context, the line in Figure 6-1 called WFD<sub>(average behavior)</sub> represents a point when, without intervention, 50 % of the airplanes in a fleet fall below the minimum strength requirements of § 25.571(b).

**Figure 6-1**  
**MSD/MED Residual Strength Curve**



**b. Widespread Fatigue Damage (average behavior).** WFD average behavior should be estimated for each susceptible structural area. Such an estimate may be based on full-scale fatigue test evidence and analyses at a minimum, and if available, in-service history. In making this estimate, consider the following:

- (1) A complete review of the in-service history of the susceptible areas (including loads, mission profiles, environment, and operational statistics of the fleet, stated as a number of accumulated flight cycles or flight hours).
- (2) Significant production variants (material, design, assembly method, and any other change that might affect the fatigue performance of the detail).
- (3) Relevant full-scale and component fatigue test data. (See Appendix 1 of AC 25.571-1D for guidelines on full-scale fatigue test evidence, including addressing cracks found during testing.)
- (4) Relevant data from teardown inspections of full-scale and component fatigue test data, including teardown inspections of high-time airplanes.
- (5) Any fractographic analysis available.

The evaluation of test results for the reliable prediction of the time when WFD might occur in each susceptible area should include appropriate test-to-structure factors (See definition in Appendix 2 of this AC). The WFD evaluation may be analytically determined, supported by test or in-service information.

**c. Cracking Pattern.** Regardless of whether the assessment of WFD average behavior is based on in-service data, full-scale fatigue test evidence, analyses; or a combination of any of these, the following should be considered:

- (1) **Initial cracking scenario.** This is the size and extent of multiple location cracking expected at the initiation of multiple site damage or multiple element damage. To determine the time to multiple site damage or multiple element damage initiation you will need empirical data or an assumption of the crack locations and sequence, plus a fatigue evaluation. Alternatively, analysis can be based on either:
  - (a) The distribution of equivalent initial flaws as determined from the regression to zero cycles of flaws found during fatigue testing, teardown inspections, or both.
  - (b) The distribution of fatigue cracking determined from relevant fatigue testing or service experience, or both.
- (2) **Final cracking scenario.** This is an estimate of the size and extent of multiple location cracking that could cause residual strength to fall to the minimum required

level (WFD condition), as shown in Figure 6-1. There are techniques for 3-D elastic-plastic analysis of such problems; but there are also several alternative test and analysis approaches that provide acceptable estimates. One such approach is to define the final cracking scenario as not yet critical—a point in time before the cracking has developed into the WFD condition. An example of a multiple site damage problem would be the occurrence of the first crack link-up in a row of fastener holes. An example of a multiple element damage problem would be simultaneous cracking of two or three adjacent structural elements. Using a sub-critical scenario reduces the complexity of the analysis and, in many cases, will not greatly reduce the estimate of the total time to WFD<sub>(average behavior)</sub> because the majority of the total time is generally associated with crack initiation.

**(3) Crack growth.** Progression of the crack distributions from the initial cracking scenario to the final cracking scenario should be developed. You can develop crack growth predictions in two ways—

- (a) Analytically:** typically based on linear elastic fracture mechanics; or
- (b) Empirically:** from test or service fractographic data.

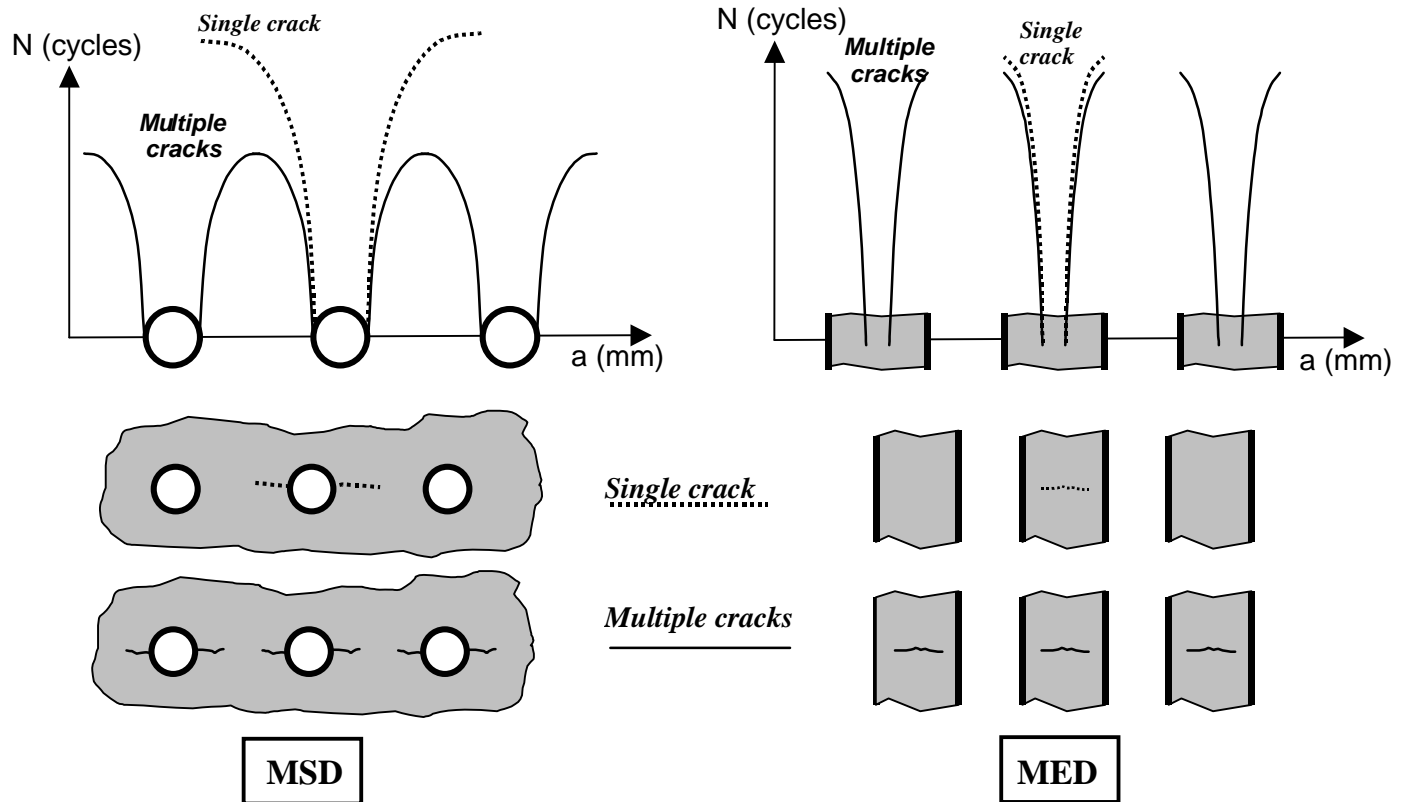
**(4) Differences between multiple site damage and multiple element damage.** We expect details of the approach used to characterize events leading up to WFD to be different. The differences will depend on whether you are considering multiple site damage or multiple element damage. This is especially true for crack interaction.

- (a) Crack Interaction.** Multiple site damage has the potential for strong crack interaction, and the effect of multiple cracks on each other needs to be addressed. Multiple element damage, in most cases, does not have the same potential for strong crack interaction. The differences between interaction effects for multiple site damage and multiple element damage are illustrated in Figure 6-2.



Figure 6-2

## Difference between MSD and MED Interaction Effects



**(b) Multiple Site Damage and multiple element damage interaction.**

Some areas of an airplane are potentially susceptible to both multiple site damage and multiple element damage. Simultaneous occurrence of multiple site damage and multiple element damage is possible, even though it's not common. A comparison of inspection start points or modification start points might indicate the possibility of this occurring. If so, your evaluation should consider interaction between multiple site damage and multiple element damage.

**(5) Multiple Site Damage.** When you are assessing multiple site damage, certain assumptions or methods may have a greater impact than others on the final outcome of the WFD evaluation.<sup>8</sup> The following items were found to have such an impact:

- (a) The flaw sizes assumed at initiation of the crack growth phase of analysis.
- (b) Material properties used (static, fatigue, fracture mechanics).
- (c) Ligament<sup>9</sup> failure criteria.
- (d) Crack growth equations used.
- (e) Statistics used to evaluate fatigue behavior of the structure (e.g., time to crack initiation).
- (f) Methods of determining the structural modification point (SMP).
- (g) Detectable flaw size assumed.
- (h) Initial distribution of flaws.
- (i) Factors used to determine lower-bound behavior as opposed to mean behavior.

**(6) Multiple Element Damage.** When considering multiple element damage in your evaluation, you need not consider interaction between cracks in different elements. You should consider the following:

- (a) There is not a high probability that, after a crack initiates in an element, a second crack will initiate in an element right next to it. If this does happen, however, the consequences to the overall structure may be severe. This is because having two structural members fail right next to each other can completely negate any ability of the structure to tolerate additional damage.

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<sup>8</sup> "Recommendations for Regulatory Action to Prevent Widespread Fatigue Damage in the Commercial Airplane Fleet," Revision A, dated June 29, 1999 (a report of the Airworthiness Assurance Working Group for the Aviation Rulemaking Advisory Committee's Transport Aircraft and Engine Issues Group).

<sup>9</sup> Ligament is the material between discontinuities in a given structure. Types of discontinuities include holes, cutouts, or cracks.

Consequently, when performing your evaluation, you should make conservative assumptions and assume failures to be adjacent to each other.

**(b)** When an element fails completely, the load that has to be redistributed onto the non-failed structure can be large and can have a significant impact on evaluation results. You should therefore consider the effects of load redistribution and include it in your evaluation.

## 2. Establishing Maintenance Actions.

**a. Structural Modification Point and Inspection Start Point.** Fatigue damage is the gradual deterioration of a material subjected to repeated loads. This gradual deterioration is a function of use and can be statistically quantified. The term widespread fatigue damage is used, and can be statistically quantified, at the end of the deterioration process—when the structure is no longer able to carry the residual strength loads. As depicted in Figure 6-1, WFD can never be absolutely precluded because there is always some probability, no matter how small, that it will occur. Therefore, modifying or replacing structure at a pre-determined, analytically-derived time stated in flight cycles or flight hours, minimizes the probability of having WFD in the fleet. Modification or replacement is the most reliable method for precluding WFD. The point at which a modification is undertaken is referred to as the “structural modification point” (SMP) and it is illustrated in Figure 6-3. The SMP is generally a fraction of the number representing the point in time when  $WFD_{(average\ behavior)}$  will occur, and should result in the same reliability as a successful two-lifetime fatigue test. This level of reliability for setting the SMP is acceptable if inspections for multiple site damage or multiple element damage are shown to be effective in detecting cracks. If the inspections are effective, they must be implemented before the SMP. The implementation times for these inspections are known as the “inspection start points.” Repeat inspections are usually necessary to maintain this effectiveness in detecting cracks. If inspections for multiple site damage or multiple element damage are not effective in detecting cracks, then SMP should be set at the time of inspection start point. For the purposes of this AC, an inspection is effective if, when performed by properly trained maintenance personnel, it will readily detect the damage in question.<sup>10</sup> The SMP should minimize the extent of cracking in the susceptible structural area in a fleet of affected airplanes. In fact, if this point is appropriately determined, a high percentage of airplanes would not have any multiple site damage or multiple element damage by the time the SMP is reached.

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<sup>10</sup> The cracking identified in airworthiness directive (AD) 2002-07-09 is an example of the type of cracking that MSD inspections are effective in detecting. These cracks grow from the fastener holes in the lower row of the lower skin panel in such a way that the cracking is readily detectable using non-destructive inspection methods. The cracking identified in AD 2002-07-08 is an example of places where MSD inspections are not effective. These cracks grow in the outer surface and between the fastener holes in the lower row of the lower skin panel in such a way that the cracking is not readily detectable using non-destructive inspection methods. Modification is the only option to address this type of cracking.

**(1) Structural modification point.** The SMP should be established as a point in time when structure should be modified or replaced to prevent WFD from occurring. This is typically established by—

- Calculating when WFD would first occur in the structure (predicted using the  $WFD_{(\text{average behavior})}$ ).
- Setting a time before the predicted occurrence of WFD to perform modifications or replacements that will prevent it.

**(a)** As an example, the SMP may be determined by dividing the number representing the timing of when  $WFD_{(\text{average behavior})}$  will occur by a factor of 2 if there are effective inspections, or by a factor of 3 if inspections are not effective.

**(b)** A design approval holder may find that the SMP for a particular structural area has been exceeded by one or more airplanes in the fleet. In that case, the design approval holder should evaluate those high-time airplanes to determine their structural condition and notify the airworthiness authorities and propose appropriate maintenance actions specific to those airplanes.

**(2) Inspection start point.** If an inspection is determined to be effective, you will need to establish when those inspections should start. This point is illustrated in Figure 6-1. The start point is determined through a statistical analysis of crack initiation based on fatigue testing, teardown, or in-service experience of similar structure. The inspection start point is assumed to be equivalent to a lower-bound value with a specific probability in the statistical distribution of cracking events. Alternatively, you may establish an inspection start point by applying appropriate factors (e.g., dividing by a factor of 3) to the number representing WFD average behavior.

**(3) Inspection interval.** The interval between inspections depends on the detectable crack size and the probability that it will be detected with the specific inspection method.

**(4) Adjustment of SMP.** The SMP may be extended or reduced, based on the following:

**(a) Extension of SMP.** You can extend the SMP if you can show freedom from WFD up to the new SMP. The tasks required to extend the SMP may include any or all of the following:

- 1** Additional fatigue or residual strength tests, or both, on a full-scale airplane structure or a full-scale component followed by detailed inspections and analyses.

**2** Fatigue tests of new structure or structure from in-service airplanes on a smaller scale than full component tests (i.e., sub-component or panel tests, or both). If a sub-component test is used, the SMP would be extended only for that sub-component.

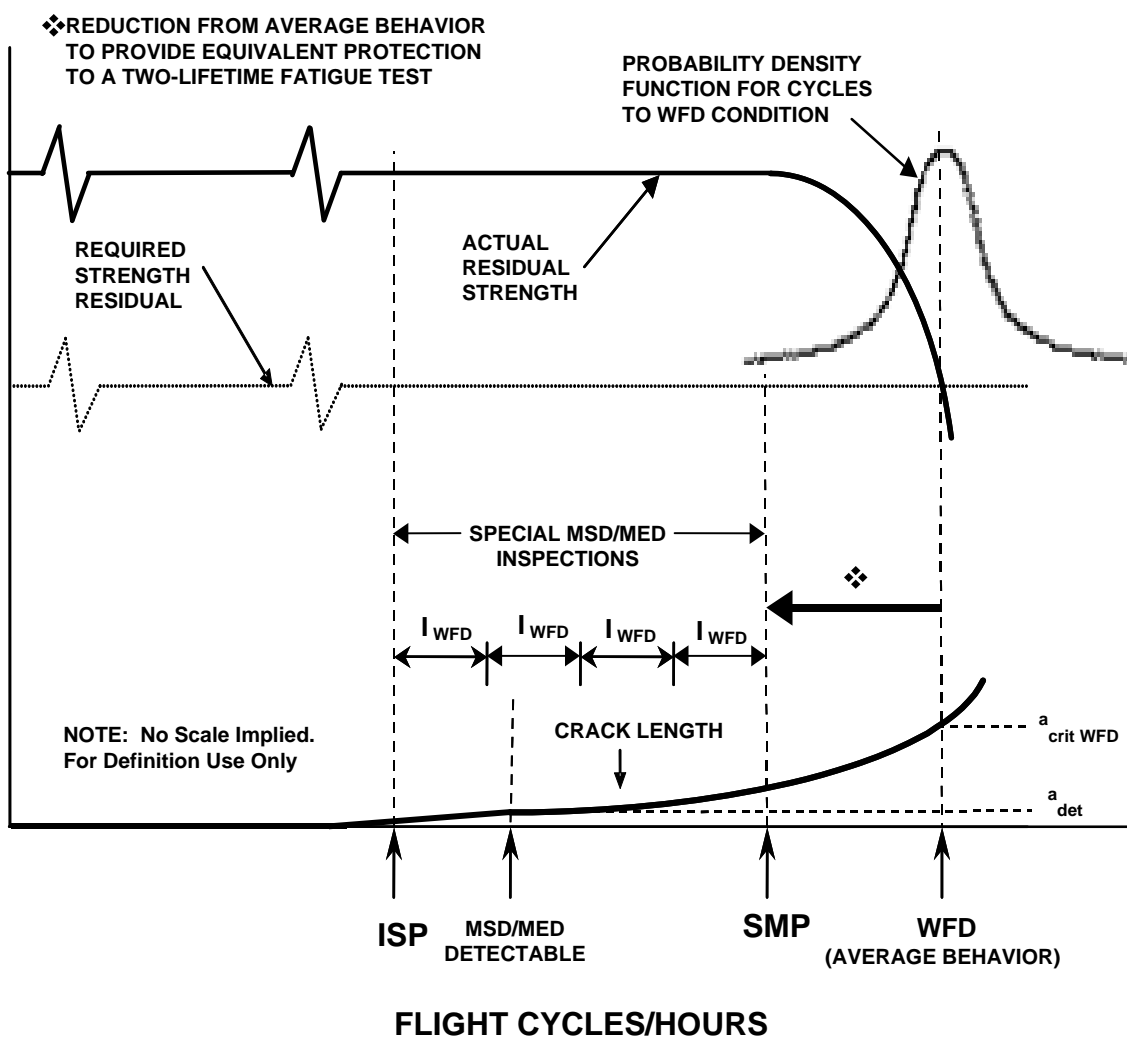
**3** Teardown inspections (destructive) on structural components that have been removed from service.

**4** Teardown inspections (non-destructive) accomplished by selected, limited disassembly and subsequent reassembly of specific areas of high-time airplanes.

**5** Analysis of in-service data (e.g., inspections) from a statistically significant number of airplanes.

**(b) Reduction of SMP.** If an inspection program for WFD is in place, and if cracks are found in the structure during an inspection (or during a modification or replacement), the SMP should be reevaluated to determine if it provides sufficient freedom from WFD. If it does not, the point in the life of the airplane at which it is accomplished should be shortened, and you should revise the existing service information accordingly.

**Figure 6-3**  
**MSD/MED Residual Strength Curve**  
**(Including WFD Inspections)**



## APPENDIX 7

### EXAMPLE OF HOW TO ESTABLISH AN LOV

This appendix provides a simplified example of how to establish an LOV for a specified airplane structural configuration. The process for establishing an LOV involves four steps—

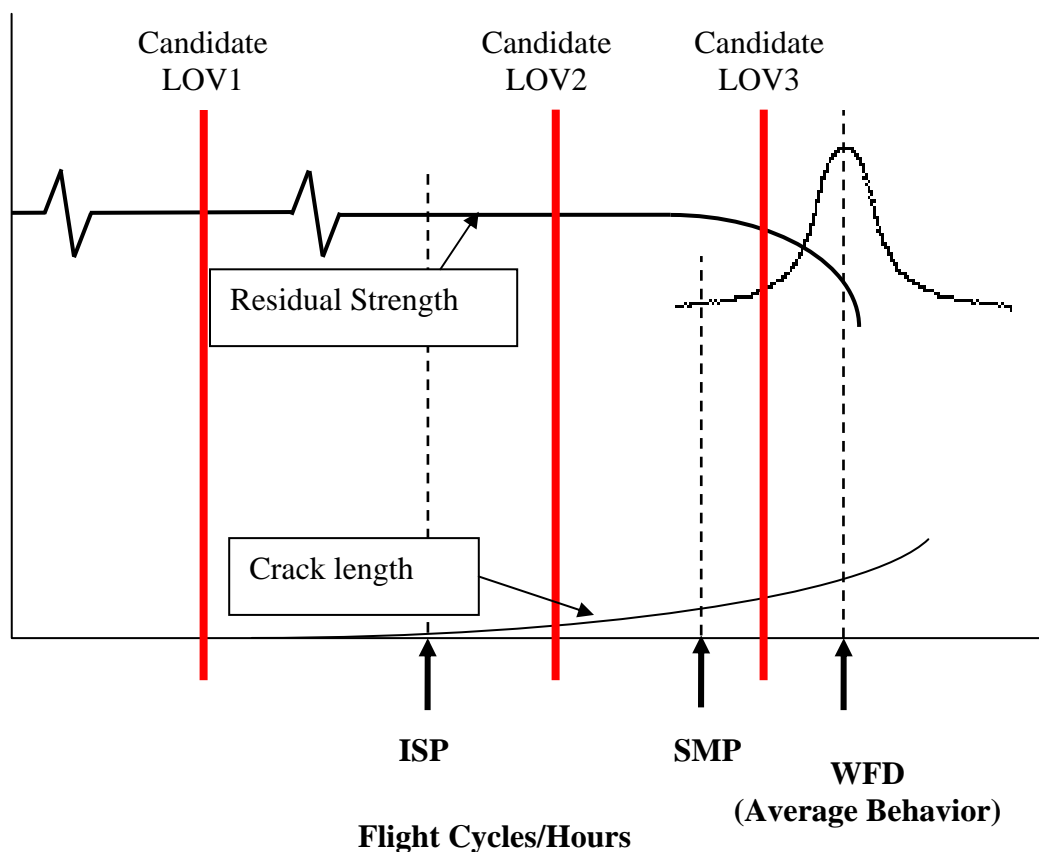
**Step 1.** Identifying a candidate LOV (204.a. of this AC) for the airplane structural configuration (203).

**Step 2.** Identifying WFD-susceptible structure (204.b.). For this evaluation example, it was determined that the airplane structural configuration had six areas with WFD-susceptible structure.

**Step 3.** Performing a WFD evaluation of each of the six areas of WFD-susceptible structure (204.c. and Appendix 6) to determine whether there are inspection start points and structural modification points for the candidate LOV identified. This allows evaluation of the candidate LOV.

Figure 7-1, shown below, shows the WFD behavior for one WFD-susceptible area. The figure also shows three different candidate LOVs. Candidate LOV1 is at a point that occurs significantly before the  $WFD_{(average\ behavior)}$  line. This LOV won't require any maintenance actions. Candidate LOV2 occurs before the  $WFD_{(average\ behavior)}$  line, but closer to it. As a result, inspection will need to start before the LOV. Although candidate LOV3 occurs before the  $WFD_{(average\ behavior)}$  line, with this LOV the probability of WFD in the fleet is unacceptable and an inspection and subsequent modification or replacement is required before the airplane reaches LOV3. Note that for LOV2 and LOV3, if inspections were determined to be unreliable, then the SMP would occur at the point on the chart where the ISP is. Using this example, this decision process needs to be repeated for all six WFD-susceptible areas.

Evaluate candidate LOVs and results of WFD evaluations for each susceptible area.

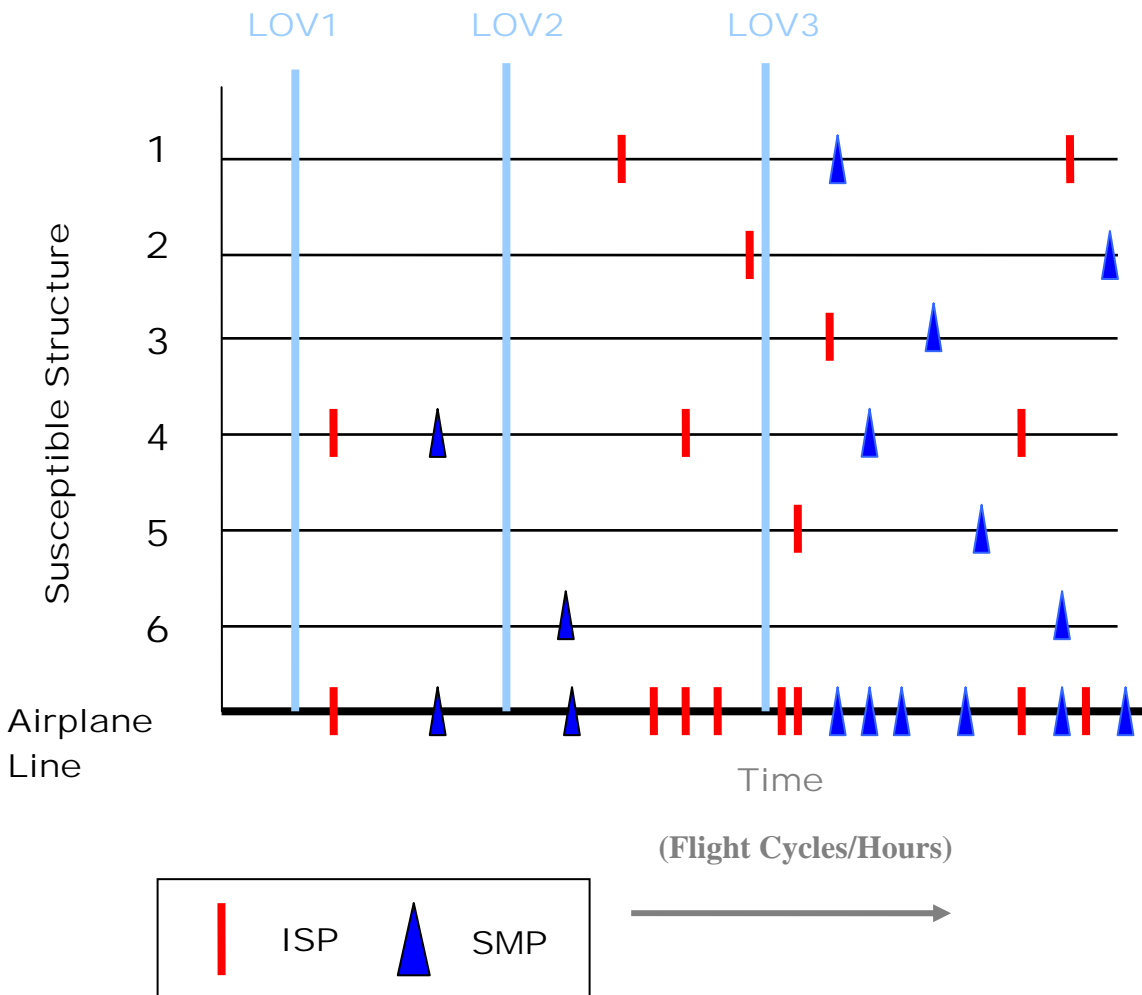
**Figure 7-1****Comparison of WFD-Susceptible Structure to Airplane LOV**

**Step 4.** Finalizing the LOV. Once all susceptible areas have been evaluated, the final step is to determine where to establish the LOV that you will propose for compliance (204.d.). Figure 7-2 shows the results of the WFD evaluation of the six WFD-susceptible areas. As shown, there are inspections and modifications or replacements that must be performed over time to preclude WFD. Any LOV can be valid as long as it is demonstrated that, based on its inherent fatigue characteristics and any required maintenance actions, the airplane model will be free from WFD up to the LOV. The example in Figure 7-2 includes three LOVs that could be proposed for compliance.

- LOV1: Maintenance actions are not required to address WFD.
- LOV2: Inspection and modification or replacement of area four are required to address WFD.



- **LOV3:** The design approval holder may propose an LOV that is greater than LOV2. However, as shown in Figure 7-2, that would result in more maintenance actions than identified for LOV2. Operators would be required to perform maintenance actions in four out of the six WFD-susceptible areas. Areas 1, 2, and 4 would have to be inspected prior to the LOV. Areas 3 and 5 would be free from WFD maintenance actions. Area 4 would be required to be inspected and modified, and then the modification would be required to be inspected prior to the LOV. Area 6 would require only modification prior to reaching the LOV because it was determined that inspections in this area would not be reliable. Some of the maintenance actions required for the LOV may have already been issued in a service bulletin and mandated by airworthiness directive. For the rest, airworthiness directives would need to be issued.

**Figure 7-2****Airplane Maintenance Actions**

## **APPENDIX 8—SAMPLE COMPLIANCE PLAN**

This appendix provides an example of what the compliance plan required by § 26.21(d) might look like. It tracks the steps necessary to develop a compliance plan and shows how the AAC Airplane Company prepares the compliance plan for its AAC1 airplanes. Design approval holders are not required to use the same format as the one used in this example.

References to compliance/completion/meeting dates are tied to the effective date of the rule, and some may differ based on the design approval holder's schedules.

Limit of Validity  
Widespread Fatigue Damage

14 CFR Part 26  
Compliance Plan

Document No. AAC1-26.21-CP-01  
AAC Airplane Company  
Airplane Model: AAC1

REVISION X  
(DATE)

## Table of Contents

I.	Design Approval Holder: AAC Airplane Company .....
II.	Airplane Model Applicability [§ 26.21(a)].....
	a. Airplane Model: AAC1 .....
	b. Airplane Model Description.....
	c. Certification Basis (amendment level for § 25.571) .....
III.	Applicable Part 26 Requirements .....
IV.	Airplane Structural Configurations [§ 26.21(b)(1)(i) &(ii)] .....
V.	Establishing Limit of Validity [§ 26.21(b)(1)].....
	a. Candidate LOV .....
	b. Widespread-Fatigue-Damage-Susceptible Structure .....
	c. WFD Evaluation of Susceptible Structure .....
	d. Finalizing LOV for compliance .....
VI.	Maintenance Actions and Service Information [§ 26.21(b)(2)] .....
VII.	Airworthiness Limitations Section [§ 26.21(b)(3) &(4)] .....
VIII.	Certification Compliance Matrix .....
IX.	Deviations to Guidance Material.....
X.	Compliance Documents and Supporting Data .....
XI.	Schedule.....
XII.	Model AAC1 Part 26 Compliance Team .....
XIII.	Communication and Coordination Plan .....
XIV.	Delegation Plan .....
XV.	Operators' Involvement.....

## List of Tables

Table 1 - List of Applicable Part 26 Regulations .....	
Table 2 - Certification Compliance Matrix .....	
Table 3 - Compliance Document Summary .....	
Table 4 - Certification Compliance Team Matrix .....	

## I. Design Approval Holder.

If you are preparing the compliance plan for § 26.21 on behalf of a design approval holder, you must first identify the design approval holder and provide a brief description of the company's background as it relates to the certification of transport category airplane structure.

**Example:** *The AAC Airplane Company (AAC) is a well-established airplane manufacturer that has been designing and manufacturing airplane model AAC1 and its derivatives since 1965. We have a long history of optimizing the structural design features of our aircraft. We have developed the capability and expertise to use state-of-the-art structural analysis tools and techniques and we have extensive experience in structural analysis, structural validation testing, and in-service evaluations. We have performed partial teardown of our oldest, retired airplanes to support structural validation work. We have also developed numerous repairs and modifications/alterations for our airplanes.*

*AAC employs a staff of 357 structures engineers responsible for new designs and continued operational safety for our existing fleet, as well as customer requests. Thirty-two of these engineers are FAA Designated Engineering Representatives (DER). Internal company oversight of our DERs is provided by our Regulatory and Government Affairs organization, AAC-001.*

## II. Airplane Model Applicability [§ 26.21(a)].

**a. Airplane Model**—Reference the type certificate data sheet.

**b. Airplane Model Description**—Provide a brief description of all model types.

[At a minimum, provide sufficient information about the product to show part 26 applicability (i.e., maximum takeoff gross weight, date certificated). A sketch of the model, with different views, may be a way to further describe it.]

**Example:** *The Model AAC1 is a turbine-powered transport category airplane with two wing-mounted turbine powered engines. The Model AAC1 has a metallic airframe, constructed with aluminum skin and stringer and frame construction. The Model AAC1 also uses aluminum floor beams. The wing, the vertical fin, and the horizontal stabilizer all use an aluminum rib spar configuration.*

*Only Models AAC1-P2 and AAC1-C are affected by § 26.21. Those two models fit the rule criteria and are not included in the exception list contained in § 26.21(g). Model AAC1-P1 is not affected by § 26.21 because of its maximum takeoff gross weight. A summary of all three models is listed for reference.*

**AAC1-P1:** *Type certificate approved February 8, 1968. This passenger airplane model has two variations –*

*(1) A single-class seating configuration with a capacity of 70 passengers and maximum takeoff gross weight of 72,500 lbs.*

*(2) A three-class seating configuration with a capacity of 60 passengers and a maximum takeoff gross weight of 68,000 lbs.*

**AAC1-P2:** *Type certificate approved July 12, 1974. This passenger airplane model has a three-class seating configuration with a capacity of 100 passengers. The maximum takeoff gross weight is 80,000 lbs.*

**AAC1-C:** *Type certificate approved October 4, 1984. This cargo model has a maximum takeoff gross weight of 95,000 lbs.*

- c. Certification Basis (amendment level for § 25.571)—**identify the certification basis of the airplane model for § 25.571.

[It may be necessary to provide certification basis information by airplane model, airplane serial numbers, and by sections of the airplane where appropriate. Some manufacturers have modified portions of an airplane model on amended type certification programs, and have different parts of the airplane certified to different amendment levels of § 25.571 (reference § 21.101 Designation of Applicable Regulations).]

**Example:** *The Model AAC1 has the following certification basis for § 25.571:*

- ***AAC1-P2—Amendment 25-0.*** *There is a supplemental structural inspection document for the airplane (Document No. AAC1-P2-SSID) which identifies damage-tolerance-based inspections. These inspections are based on the guidance in AC 91-56 and mandated by Airworthiness Directive 88-xx-yy.*
- ***AAC1-C—Amendment 25-54,*** *except Amendment 25-0 for the fuselage from the forward pressure bulkhead to the aft pressure bulkhead. There is a supplemental structural inspection document (Document No. AAC1-C-SSID) for the fuselage, which identifies damage-tolerance-based inspections for that structure. These inspections are based on AC 91-56 guidance and mandated by Airworthiness Directive 98-xy-zz.*

### **III. Applicable Part 26 Requirements.**

Identify the applicable part 26 requirements.



**Example**

**Table 1**  
**Relevant Part 26 Requirements**

<i>PART 26—CONTINUED AIRWORTHINESS AND SAFETY IMPROVEMENTS FOR TRANSPORT CATEGORY AIRPLANES</i>	
<b>Regulation</b>	<b>Requirement</b>
26.21	<i>Limit of Validity</i>
26.21(a)	<i>Applicability</i>
26.21(b)	<i>Limit of validity</i>
26.21(c)	<i>Persons who must comply and compliance dates</i>
26.21(d)	<i>Compliance plan</i>
26.21(e)	<i>Compliance dates for compliance plans</i>
26.21(f)	<i>Compliance plan implementation</i>

#### **IV. Airplane Structural Configurations [§ 26.21(b)(1)(i) and (ii)].**

Describe the proposed means for defining the airplane structural configurations for each model's LOV. The configuration comprises all model variations and derivatives approved under the type certificate, and any structural modifications or replacements mandated by airworthiness directives (ADs) as of [insert effective date of the final rule].

**Example:** AAC proposes to establish a separate LOV for each model variation (passenger model AAC1-P2 and cargo model AAC1-C). AAC will follow the guidance in AC 120-104 to identify the structural configurations of each model airplane. The configuration will include the basic model (including all variations) and all structural modifications and replacements mandated by AD for that model.

*For the airplane structural configuration section of AAC1-P2-WFD and AAC1-C-WFD documents, AAC will include the following information:*

- *Overall picture of the airplane with dimensions (span, length, etc.).*
- *View of each airplane section—wing, fuselage sections, horizontal stabilizer, vertical stabilizer, etc.—with a description of relevant details. These figures will also include a definition or identification of airplane sections, airplane zones, details, dimensions, etc. as necessary to define the locations of structure susceptible to WFD and such identifiers as body/wing stations, frame/stringer locations, and door numbers/locations.*

- *Identification of airplane structural configurations (by model and dash numbers) and rationale for grouping airplane models, as applicable, for which the LOV will apply.*
- *List of all structural modifications and replacements mandated by airworthiness directive.*

**v. Establishing the Limit of Validity [§ 26.21(b)(1)].**

Describe the proposed means of compliance for establishing an LOV.

[Once you have defined the airplane structural configuration, you can assess its fatigue characteristics to determine the LOV for that configuration. The process for establishing an LOV typically involves four steps—

- (1)** Identifying a “candidate LOV.”
- (2)** Identifying WFD-susceptible structure.
- (3)** Performing a WFD evaluation of all susceptible structure.
- (4)** Finalizing the LOV.]

**Example:** *AAC proposes to establish one LOV for the passenger model AAC1-P2 and one for the cargo model AAC1-C. AAC will provide compliance documents AAC1-P2-WFD and AAC1-C-WFD for the passenger and cargo models respectively. The document for each model will follow the format of the Model AAC1 maintenance planning data and include—*

- *An LOV.*
- *The airplane structural configurations.*
- *The substantiation data.*
- *A list of all WFD maintenance actions that support the LOV.*
- *A proposed binding schedule for developing any service information that has not yet been issued.*

*The substantiation data will include—*

- *A pictorial definition of each airplane model.*
- *A list of structure susceptible to WFD.*
- *The engineering data and analyses used to determine the WFD behavior of structure.*
- *Inspection start points and structural modification points.*

*For each affected model, AAC proposes to use the AC 120-104 guidance for establishing the LOV and developing substantiation data. The proposed means of compliance for identifying and establishing maintenance actions are further described in section VI of this compliance plan.*

- a. Candidate LOV [§ 26.21(b)(1)]**—Identify the LOV that is likely to be proposed for compliance with § 26.21.

[At the beginning of the compliance process, you may have an LOV that is a likely candidate for a specific airplane model. This candidate LOV may or may not be the LOV you finally submit to the FAA for approval. Although the rule does not require that the compliance plan include a candidate LOV, you may elect to include that information in your compliance plan. The candidate LOV should be based on high-level technical considerations such as the age and service experience of the fleet as well as results of previously accomplished fatigue tests and analyses. It may also be based on economic considerations.]

**Example:** *Candidate LOVs*

- **AAC1-P2:** *35,000 flight cycles and 100,000 flight hours.*
- **AAC1-C:** *30,000 flight cycles and 80,000 flight hours.*

- b. WFD-Susceptible Structure [§ 26.21(b)(1)]**—Describe how you will determine WFD-susceptible structure and identify that structure.

[You must identify WFD-susceptible structure. Accomplishing this will require screening of all structural components—both baseline structure and structural modifications and replacements mandated by airworthiness directive. The list of WFD-susceptible structure will be a subset of the list of fatigue-critical structure developed for § 26.43.]

***Example:*** AAC will use the guidance in AC 120-104, Appendix 5, to identify structure susceptible to WFD. AAC will use the list of fatigue-critical structure identified for § 26.43 as part of this process. Additionally, AAC will identify WFD-susceptible structure based on structural details and elements that are repeated over large areas and operated at the same stress levels [structure susceptible to multiple site damage (MSD) or multiple element damage (MED)]. AAC will cull out AD-mandated modifications, replacements, and baseline structure that do not need to be evaluated. The method for culling out structure will be identified in each model's compliance documents. AAC will obtain FAA concurrence of this method early in the compliance process.

*For the WFD-susceptible structure section of the AAC1-P2-WFD and AAC1-C-WFD documents, AAC will include the following information—*

- *Method for screening structure (including modifications and replacements mandated by AD) susceptible to WFD.*
- *Identification of structure susceptible to WFD. AAC will identify susceptible structure by:*
  - 1. Including sketches of the structure with dimensions and details to describe the structure and identify its location.*
  - 2. Summarizing the WFD-susceptible structure in a tabular format by—*
    - *Assigning an identifier to the affected fatigue-critical structure.*
    - *Describing the structure, parts, or element included in that structure.*
    - *Identifying which airplanes or models this information applies to and the location where WFD would most likely occur.*

*See Section VI of this compliance plan, Maintenance Actions and Service Information, for further information on identifying structural details that must be inspected, modified, or replaced to support the LOV.*

*The following is an example of the format that AAC will use for identifying WFD-susceptible structure.*

<i><b>Fatigue-Critical Structure</b></i>	<i><b>Part Name or Description</b></i>	<i><b>Applicability</b></i>	<i><b>Location</b></i>
<i>Part No. 1</i>	<i>Wing – Fuselage Attachment</i>	<i>AAC1-all</i>	<i>Section 44, Zone xxxx</i>
<i>Part No. 2</i> <i>Part No. 3</i>	<i>Fuselage Skin Lap Joint xxxx modified per AD xxxxxxxx</i>	<i>AAC1-all</i> <i>AD X modifies SN 1 – 250</i>	<i>Zone yyyy or Body Station xx - yy</i>
<i>Part No. 4a</i>	<i>Aft Pressure Dome – Lap Splice</i>	<i>AAC1-all</i>	<i>Section 48, Zone aaaa</i>
<i>Part No. 4b</i>	<i>Aft Pressure Dome – Y Chord</i>	<i>AAC1-all</i>	<i>Section 48, Zone bbbb</i>
<i>Part No. N – NN</i>	<i>Main Deck Cargo Door Frames ...</i>	<i>AAC1-C</i>	<i>Section 43, Body Station xx – yy</i>

- c. WFD Evaluation of Susceptible Structure [§ 26.21(b)(1)]**—Describe how you will evaluate structure for WFD susceptibility and determine the average behavior of WFD for that structure, as applicable.

[The design approval holder must establish an LOV that corresponds to the period of time, stated as a number of total accumulated flight cycles or flight hours or both, during which it is demonstrated that widespread fatigue damage will not occur in the airplane. This demonstration must include an evaluation of airplane structural configurations and be supported by test evidence and analysis at a minimum and, if available, service experience, or service experience and teardown inspection results, of high-time airplanes of similar structural design, accounting for differences in operating conditions and procedures.

You must evaluate each susceptible structure to some degree. For some structures, you may have data such as fatigue tests, analysis, and service experience that demonstrates that WFD will not occur before an airplane reaches its LOV. If that is the case, you may not have to go through the process of quantifying the WFD average behavior for that structure. For other structures, for which you do not have sufficient data, you will have to do an evaluation.]

**Example:** AAC will establish an LOV based on AC 120-104 guidance. AAC's Document AAC1-26-LOV describes that method, including the engineering data AAC will use to evaluate susceptible structure and quantify the  $WFD_{(average\ behavior)}$  of that structure.

## **Engineering Data**

**Laboratory fatigue tests.** AAC conducted a full-scale fatigue test on the Model AAC1-P1 produced from 1967 to 1970. The fuselage, empennage, landing gear, and wing structure were tested. AAC has also conducted component-level testing of certain structural elements and testing of the fuselage for Model AAC1-P2. To support certification of Model AAC1-C to the damage tolerance requirements of § 25.571, Amendment 25-54, AAC had also previously conducted additional testing and teardown of some portions of the original test article and the Model AAC1-P2 fuselage produced from 1981 to 1982. AAC will use all that data now to determine the WFD average behavior for each susceptible structure, as necessary. AAC will provide document AAC1-26-TPR, which describes the test procedures and results.

**Service Experience.** AAC reviewed the in-service history of Model AAC1 structure (all three models) susceptible to WFD. This review included the evaluation of both positive and negative findings, and consideration of loads, mission profiles, environmental factors, and fleet operational statistics. AAC has conducted teardown inspections of certain WFD-susceptible structure on a high-time Model AAC1-P2 airplane. Some inspections included fractographic examination of the structure. AAC combined the service history results with test and analysis data to determine the WFD behavior of structure.

## **Analysis of Engineering Data**

AAC used an analysis approach, based on test and service experience, to determine fatigue, crack growth rates, and residual strengths of structures and to develop the Model AAC1 continued airworthiness structure inspection/maintenance requirements. AAC used AC 25.571-1D and AC 91-56 as guidance for developing damage-tolerance inspections. AAC's crack growth analysis method is based on linear elastic fracture mechanics using tools such as NASGRO or AFGROW software to determine the time (measured in flight cycles or flight hours) between a detectable crack size and the critical crack size for each structure evaluated. AAC will use this information, as well as the guidance in AC 120-104, to evaluate structure susceptible to WFD to determine if additional maintenance actions are required in order for airplanes to reach the LOV. The operating loads and loads spectra for these evaluations are defined in documents AAC1-P2-Loads and AAC1-C-Loads for the passenger and cargo airplanes respectively.

AAC will conduct additional fatigue and crack growth analyses to fully determine the WFD behavior of the structure. AAC will use existing and proposed fatigue test results as well as service experience (both positive and negative findings) to make this determination. The data will be contained in AAC1-26-TPR. AAC will also use statistical analyses to further evaluate the WFD behavior of the WFD susceptible structure.

## Safety Factors

*AAC will apply safety factors to the analyses results to account for any uncertainties in the analyses and scatter in the data. The safety factors will also reflect AAC's confidence level in the engineering data used. AAC will be using extensive service experience in conjunction with fatigue tests. Early in the compliance process, AAC will obtain FAA Oversight Office concurrence with the safety factors before applying them to the analyses results. AAC will apply appropriate safety factors to the analysis to determine what the WFD average behavior is for a structural component for the airplane model fleet. Based on the results of this task, AAC will identify inspection start points and structural modification points for the airplane model fleet.*

## Comparison of WFD-Susceptible Structure to a Candidate LOV

*Based on the data available, AAC will determine the time period representing the WFD average behavior for each structure susceptible to WFD and compare it to the candidate LOV. It may be found that maintenance actions are required before the airplane reaches the candidate LOV in order to preclude WFD. When AAC determines that maintenance actions are required, it will—*

- (1) Assess multiple site damage/multiple element damage inspection reliability and practicality in relation to detectable size of cracks and probability of detection.*
- (2) Determine when inspections should start.*
- (3) Determine inspection intervals.*
- (4) Determine when modifications or replacements should occur. This process will determine the maintenance actions necessary for affected airplanes to reach the LOV. AAC will follow AC 120-104 guidance for setting inspection start points and structural modification points.*

**d. Finalizing LOV for compliance [§ 26.21(b)(1)]**—Identify factors for consideration in finalizing the LOV.

*[The LOV may be based on factors such as economics or input from operators in addition to the technical considerations. The design approval holder should identify those factors being considered.]*

**Example:** *Once all susceptible structures have been evaluated and compared to the candidate LOV, AAC will determine where in the life of the airplane to establish the LOV it will submit for compliance. AAC will hold meetings—referred to as “Structural Task Group Meetings—with industry and the authorities to discuss its findings, conclusions, and proposals for compliance*

*with § 26.21. AAC will provide the FAA with the meeting schedule early in the compliance process.*

## **VI. Maintenance Actions and Service Information [§ 26.21(b)(2)].**

Describe the proposed method for identifying and developing WFD maintenance actions, if any.

[If the design approval holder establishes an LOV that relies on maintenance actions, those maintenance actions must be identified. Service information, which is typically issued in service bulletins, includes a description of the maintenance actions and the procedures for accomplishing them. Some of the maintenance actions required for the LOV may have already been published in a service bulletin and mandated by airworthiness directive as of January 14, 2011. If an inspection previously mandated by an AD to address WFD will be used to support the LOV, it should be identified as necessary to meet the LOV. For the rest, airworthiness directives will need to be issued.]

**Example:** *AAC will use the AC 120-104 guidance, in conjunction with results from an evaluation of the WFD- susceptible structure, to determine whether maintenance actions (inspections, modifications, and replacements) are required in order for affected airplanes to reach the LOV. If maintenance actions are required, AAC will identify them in documents AAC1-P2-WFD and AAC1-C-WFD. This will include identifying—*

- *All WFD maintenance actions.*
  - *The structure to be inspected, modified, or replaced. For example, if the aft pressure dome is identified as WFD-susceptible structure (reference Appendix 5, Figure 5-7), AAC will identify the structural details of the outer ring splice and the web splices so that maintenance action can be performed properly.*
  - *The method of inspection, modification, or replacement.*
  - *The inspection start point (the point in time at which to begin inspections) and/or the structural modification point (the point in time to begin the modification).*
  - *The repeat interval.*
- *All WFD maintenance actions for which service information has been issued, but ADs have not been issued.*
- *All WFD maintenance actions for which service information has not been issued and a proposed binding schedule for providing the necessary service information to the FAA for those actions in a timely manner so that ADs can be issued.*



## **VII. Airworthiness Limitations Section [§ 26.21(b)(3) & (4)].**

Describe the means of compliance for revising or creating an Airworthiness Limitations section in the airplane's instructions for continued airworthiness, as applicable.

[If an Airworthiness Limitations section does not exist for the airplane model being considered, the design approval holder must establish one. When you submit the LOV for compliance with (b)(4), the FAA will be reviewing and approving the revision or creation of the Airworthiness Limitations section in addition to the LOV, and all substantiation data.]

**Example:** *AAC has an Airworthiness Limitations section in the instructions for continued airworthiness for Model AAC1-C, as required by part 25, Amendment 25-54 or later. The Airworthiness Limitations Section includes reference to the fuselage structure inspections contained in the supplemental structural inspection document (AAC1-C-SSID) mandated by airworthiness directive 98-xy-zz. AAC will develop an Airworthiness Limitations section for Model AAC1-P2, which was originally certified before Amendment 25-54 and therefore does not have an Airworthiness Limitations section. AAC will also reference in the Airworthiness Limitations section the supplemental structural inspection document AAC1-P2-SSID mandated by airworthiness directive 88-xx-yy. The Airworthiness Limitations section for each model will contain a section that will include the FAA-approved LOV.*

*In service bulletins, AAC will define the WFD maintenance actions needed to support the LOV. Although not required, AAC will revise the ALS for each model to include a reference to those maintenance actions when they are available to be included.*

## **VIII. Certification Compliance Matrix.**

Providing a certification compliance matrix would be one way to streamline the review process. Such a matrix would include each regulation number (paragraph by paragraph), what it requires, a means of compliance description, and the name of the compliance document.

**Example:** [The following example shows only a few of the paragraphs from § 26.21 that a design approval holder would include in its certification compliance matrix.]

**Table 2**  
**Certification Compliance Matrix**

<b>26.21—Limit of Validity (LOV)</b>			
<b>Regulation</b>	<b>Requirement</b>	<b>Means of Compliance(MOC) Description</b>	<b>Compliance Document</b>
26.21(a)	<i>Applicability. Except as provided in paragraph (g) of this section, this section applies to transport category, turbine-powered airplanes with a maximum takeoff gross weight greater than 75,000 pounds and a type certificate issued after January 1, 1958, regardless of whether the maximum takeoff gross weight is a result of an original type certificate or a later design change. This section also applies to transport category, turbine-powered airplanes with a type certificate issued after January 1, 1958, if a design change approval for which application is made after January 14, 2011, has the effect of reducing the maximum takeoff gross weight from greater than 75,000 pounds to 75,000 pounds or less.</i>	<p>AAC Airplane Company has provided a statement of applicability in Section II of this compliance plan.</p> <p>AAC Airplane Company is not a holder or applicant for any STCs or ATCs for which this rule is applicable.</p>	<i>Compliance Plan Document No. AAC1-26.21-CP-01</i>
26.21(b)	<i>Limit of validity. Each person identified in paragraph (c) of this section must comply with the following requirements:</i>	<i>AAC Airplane company will follow the MOC provided in AC 120-104. Ref Section V of this document. See following for 26.21(b).</i>	<i>Documents AAC1-P2-WFD, AAC1-C-WFD</i>
26.21(b)(1)	<i>Establish a limit of validity of the engineering data that</i>	<i>AAC Airplane company will follow the MOC</i>	<i>Documents AAC1-P2-WFD, AAC1-C-WFD,</i>

	<p><i>supports the structural maintenance program (hereafter referred to as LOV) that corresponds to the period of time, stated as a number of total accumulated flight cycles or flight hours or both, during which it is demonstrated that widespread fatigue damage will not occur in the airplane. This demonstration must include an evaluation of airplane structural configurations and be supported by test evidence and analysis at a minimum and, if available, service experience, or service experience and teardown inspection results, of high-time airplanes of similar structural design, accounting for differences in operating conditions and procedures. The airplane structural configurations to be evaluated include—</i></p>	<p><i>provided in AC 120-104. Ref Section V of this document.</i></p>	<p><i>AAC1-26-LOV, AAC1-26-TPR</i></p>
26.21(b)(1)(i))	<p><i>All model variations and derivatives approved under the type certificate; and</i></p>	<p><i>AAC Airplane company will follow the MOC provided in AC 120-104. Ref Section IV of this document.</i></p>	<p><i>DocumentsAAC1-P-WFD, AAC1-C-WFD</i></p>
26.21(b)(1)(ii)	<p><i>All structural modifications and replacements to the airplane structural configurations specified in paragraph (b)(1)(i), mandated by airworthiness directives as of January 14, 2011.</i></p>	<p><i>AAC Airplane company will follow the MOC provided in AC 120-104. Ref Section IV of this document.</i></p>	<p><i>DocumentsAAC1-P-WFD, AAC1-C-WFD</i></p>

**IX. Deviations to Guidance Material.**

Describe any proposed deviations from any applicable guidance material. The description should include the proposed alternative means of compliance and rationale.

***Example:*** AAC does not plan on deviating from the guidance provided in AC 120-104. However, if AAC determines that it may be necessary or appropriate to deviate from this guidance, AAC will notify the FAA Oversight Office of the deviation, and work with that office to determine the appropriate course of action.

**X. Compliance Documents and Supporting Data.**

Identify and summarize the compliance documents and any supporting data. The items that require FAA approval include—

- (1) The compliance plan.
- (2) An Airworthiness Limitations section with the LOV incorporated (and supporting data).
- (3) The list of any required maintenance actions not mandated by airworthiness directives.
- (4) A binding schedule for publishing any required service information not yet published.

***Example:*** AAC will provide the following data/documents to the FAA Oversight Office for review and approval.

**Table 3**  
**Compliance Document Summary**

<i>Document Number</i>	<i>Document Title</i>	<i>Document Overview</i>	<i>Submittal Date to [FAA Oversight Office]</i>
<i>AAC1-26.21-CP-01</i>	<i>AAC Models AAC1-P2 and -C: 14 CFR 26.21(d) Certification Compliance Plan</i>	<i>Document contains details of how AAC intends to show compliance with the applicable section 26.21 requirements.</i>	<i>90 days after effective date of the final rule</i>
<i>Document No. AAC1-26-LOV</i>	<i>WFD Evaluation and LOV Methodology</i>	<i>Document describes the method for determining WFD average behavior, demonstrating that WFD will not occur before the LOV, establishing maintenance actions (if applicable), and establishing the LOV.</i>	<i>120 days after effective date of the final rule</i>
<i>Document No. AAC1-2P-Loads, AAC1-C-Loads</i>	<i>Passenger Model and Cargo Model Loads Document</i>	<i>Documents contain operating loads, loads spectra, and assumptions about operational loading. Documents provide the loads used in analyses and tests.</i>	<i>18 months after the effective date of the final rule</i>  <i>Draft document – 60 days before the 18-month compliance date</i>
<i>Document No. AAC1-26-TPR</i>	<i>Fatigue Test Procedures and Reports, and Service Information</i>	<i>Document contains fatigue test procedures and reports of the test results, including any analysis of the test data. The fatigue tests will be used either to show freedom from WFD for specific structure or to validate analysis methods. The document also contains data from service experience, including analysis of that data.</i>	<i>18 months after the effective date of the final rule</i>  <i>Draft document – 60 days before the 18-month compliance date</i>

<i>Document Number</i>	<i>Document Title</i>	<i>Document Overview</i>	<i>Submittal Date to [FAA Oversight Office]</i>
<i>Document No. AAC1-P2-WFD, AAC1-C-WFD,</i>	<i>AAC Models AAC1-P2, -C: LOV - WFD Document</i>	<p><i>Documents contain:</i></p> <ul style="list-style-type: none"> <li>○ <i>LOV</i></li> <li>○ <i>Airplane structural configurations</i></li> <li>○ <i>List of all structural modifications and replacements mandated by AD</i></li> <li>○ <i>List of all inspections mandated by AD to address WFD</i></li> <li>○ <i>Identification of structure susceptible to WFD</i></li> <li>○ <i>WFD evaluation of WFD-susceptible structure, including</i> <ul style="list-style-type: none"> <li>▪ <i>Identification of engineering data used in the WFD evaluation</i></li> <li>▪ <i>WFD average behavior for each WFD-susceptible area or demonstration that WFD will not occur before the proposed LOV</i></li> <li>▪ <i>Identification of structural modification points and inspection start points, if applicable</i></li> </ul> </li> <li>○ <i>Identification and summary of any maintenance actions necessary to support the proposed LOV</i></li> <li>○ <i>Proposed binding schedule for completion of service information, if necessary</i></li> </ul>	<p><i>18 months after the effective date of the final rule</i></p> <p><i>Draft document – 60 days before the 18-month compliance date</i></p>
<i>Document No. AAC1-P2-ALS, AAC1-C-ALS,</i>	<i>AAC Models AAC1-P2, -C: Airworthiness Limitations section of the instructions for continued airworthiness</i>	<p><i>Documents contain the LOV. For areas certified to Amendment 25-54 or later, the ALS also contains other Instructions for Continued Airworthiness of the airplane.</i></p> <p><i>AAC will update the document to reference service information (AAC service bulletins) that describe the WFD maintenance actions that support the LOV. These actions have been mandated by AD.</i></p>	<i>18 months after the effective date of the final rule</i>

<i>Document Number</i>	<i>Document Title</i>	<i>Document Overview</i>	<i>Submittal Date to [FAA Oversight Office]</i>
<i>AAC1-M1 thru Mxx</i>	<i>AAC Models AAC1-P2, -C: Maintenance Documents for xxxxxxxx</i>	<i>These various documents contain maintenance instructions for the airplane. They will reference the applicable LOV and WFD maintenance actions (AAC service bulletins) as necessary.</i>	<i>18 months after the effective date of the final rule</i>
<i>AAC1-WFD-DIST-02</i>	<i>AAC Models AAC1-P2, -C: Distribution Method for Instructions for Continued Airworthiness</i>	<i>This document provides details on how AAC intends to make the LOV and WFD maintenance actions (AAC service bulletins) available to owners/operators.</i>	<i>90 days after effective date of the final rule</i>

ALS- Airworthiness Limitations Section

## **XI. Schedule.**

Identify all major milestones, including the schedule for submitting the LOV, the schedule for meeting compliance dates, and a schedule for structures task group meetings if applicable.

### **Example:**

**Project Milestones:** AAC proposes the following schedule based on FAA AC 26-1 and Order 8110.104:

- 1. Project kick-off meeting and familiarization briefing: 14 days after effective date.*
- 2. Compliance plan: 90 days after effective date.*
- 3. Meeting to discuss delegation plan: 10 days after compliance plan submittal.*
- 4. Compliance plan approval: 4 weeks after AAC submittal to the FAA.*
- 5. Coordination and technical meeting to discuss AAC WFD evaluation methodology and operator involvement through structures task group meetings: 100 days after effective date.*
- 6. Submittal of WFD evaluation methodology: 120 days after rule effective date.*
- 7. Coordination and technical meeting to review application of WFD evaluation methodology: 150 days after rule effective date.*

8. *Coordination and technical meeting to provide project status update: 6 months after rule effective date, and every 2 to 4 weeks thereafter, as necessary.*
9. *Coordination and technical meeting to brief the FAA on draft compliance documents: 90 days prior to 18 months after effective date.*
10. *Submittal of draft documents with LOV and substantiation data: 60 days prior to the 18-month compliance date.*
11. *FAA review of and comments on draft documents: 5 weeks after AAC submittal of draft documents to FAA.*
12. *Coordination and technical meeting to discuss with FAA the draft documents: 6 weeks after AAC submittal of draft documents to the FAA.*
13. *Submittal of documents for FAA approval: 18 months after rule effective date.*

## **XII. Model AAC1 Part 26 Compliance Team.**

Identify the name, organization, position, and roles/responsibilities of part 26 compliance team members.

### **Example:**

**Table 4**

***Certification Compliance Team Matrix***

<i>Name</i>	<i>Organization</i>	<i>Position</i>	<i>Role/Responsibility</i>
<i>Name 1</i>	<i>Regulatory and Government Affairs AAC-001</i>	<i>Regulatory Liaison</i>	<i>Focal for communication with FAA Oversight Office. e.g., oversees correspondence, acts as meeting coordinator, ensures AAC compliance with applicable part 26 requirements</i>
<i>Name 2</i>	<i>Engineering – Commercial Airplanes AAC-101</i>	<i>Engineering Lead</i>	<i>Technical focal for development of structural ICA</i>
<i>Name 3</i>	<i>Engineering – Commercial Airplanes AAC-101</i>	<i>Structures Design Engineer</i>	<i>Technical focal for design of Models AAC1-P2 and AAC1-C</i>
<i>Name 4</i>	<i>Engineering – Commercial Airplanes AAC-101</i>	<i>Structures Maintenance Engineer</i>	<i>Technical focal for structures engineering support to maintenance department</i>
<i>Name 5</i>	<i>Maintenance – Commercial Airplanes AAC-201</i>	<i>Structures Maintenance Program Coordinator</i>	<i>Maintenance planning department focal for development of Models AAC1-P2 and AAC1-C maintenance programs (including structural maintenance)</i>



<i>Name 6</i>	<i>Maintenance – Commercial Airplanes AAC-201</i>	<i>Maintenance Program Customer Liaison</i>	<i>Maintenance department focal for ECA/Customer Relations</i>
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### XIII. Communication and Coordination Plan.

Describe proposed communication and coordination plan.

**Example:** Reference AC 26-1 and Order 8110.104. AAC proposes monthly status meetings or more frequently, if required, with [FAA Oversight Office]. The point of contact for scheduling these meetings is **Name xx**, who can be reached at 555-555-5555, or via e-mail at *name.xx@abc.com*.

### XIV. Delegation Plan.

Describe proposed delegation plan and identify the name, organization, and delegation of each designee.

**Example:** AAC is working to obtain authorization for its DERs with delegated functions A3 (Fatigue Analysis) and A12 (Damage Tolerance Evaluations) to support compliance findings with the applicable Part 26 regulations. We will submit a more detailed delegation plan in the near future. Our Regulatory Liaison, **Name xx**, will contact the FAA Oversight Office within 10 business days after submittal of this plan to request a preliminary meeting regarding our delegation plan.

<i>Name</i>	<i>Organization</i>	<i>Delegation</i>
<i>Name 1</i>	<i>Engineering – Commercial Airplanes, AAC-101</i>	<i>Structures DER (Design)</i>
<i>Name 2</i>	<i>Engineering – Commercial Airplanes, AAC-101</i>	<i>Structures DER (Analysis)</i>
<i>Name 3</i>	<i>Engineering – Commercial Airplanes, AAC-101</i>	<i>Structures DER (Installations)</i>
<i>Name 4</i>	<i>Maintenance – Commercial Airplanes, AAC-201</i>	<i>Structures DER (Maintenance)</i>

### XV. Operators' Involvement.

Describe the plan to facilitate operator involvement in the design approval holder's part 26 compliance process.

**Example:** AAC will work with operators of Model AAC1 aircraft during the collection of in-service data as well as the coordination and review of data that AAC will be developing to support operator compliance with 121.1115 and 129.115. AAC will establish Structures Task Groups to facilitate operator and regulatory authority comments. These meetings will be in addition to those identified in Section XI of this document. AAC will provide the schedule for the STG meetings at the coordination and technical meeting, which is scheduled for [insert appropriate date].