

**International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper (IP)**

Initial Date: 28/Apr/2017
IP Number: IP171
Revision / Date: R0 / 28/Apr/2017

Title: Scope of FD Analysis in MSG-3

Submitter: SWG

Applies To:	
MSG-3 Vol 1	X
MSG-3 Vol 2	X
IMPS	X

Issue:

Current structure analysis section of MSG-3 document does not provide clear guidance for handling of the Fatigue Damage (FD) assessment within the MSG-3 process.

Problem:

Unclear wording within the MSG-3 document has created a lack of consistency between the TCHs, Operators and Regulating Authorities in how they apply processes used to identify and incorporate FD tasks into the MRB R.

The following were identified as deficiencies in the document:

- There is currently not a clear distinction between the MSG-3 FD process scope and the stress engineering FD evaluations, potentially generating a non-efficient maintenance program and/or a non-efficient MRB process.
- From the flow-chart 2-4-4.1 one could understand that the FD MSG-3 analysis results could be regarded as inputs for the Airworthiness Limitations, while the Airworthiness Limitations are generated purely according to the 25.571 process.
- Damage tolerance wording use implies the MSG-3 process has an active role in identifying the tasks for compliance to 25.571; while those are addressed in the Airworthiness Limitations and hence out of the scope of the MSG-3 process.
- The roles of the manufacturer and of the SWG in selecting the FD MRB R tasks are not enough detailed.

Recommendation (including Implementation):

It is Industry agreement that the MSG-3 process alone provides no tools to identify the need for FD tasks for non-PSE SSIs (or non-PSE portions of the SSI). It is however the scope of the MSG-3 process to assess the feasibility and accessibility aspects of a task identified by the manufacturer stress engineering for non-PSE SSIs (or non-PSE portions of the SSI).

It is known that:

- All structure is assessed as per 25.571 in which PSEs are identified.
- The FD evaluation for PSE's is covered by 25.571. PSEs include FCS (fatigue critical structure). Full scale fatigue test is performed and fatigue issues are addressed.

As a result, neither the MSG-3 FD analysis is required for the PSE's nor the FD evaluation on PSEs shall be described in MSG-3. This applies to both safe-life and damage tolerant structure and leads to the deletion of the associated boxes in the structure logic diagrams.

All the SSI's, damage tolerant or safe-life, will continue to be evaluated for AD and ED regardless of whether they contain PSEs or not.

International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper (IP)

Initial Date: 28/Apr/2017

IP Number: IP171

Revision / Date: R0 / 28/Apr/2017

Only non-PSE SSIs (or non-PSE portions of SSI) for which the manufacturer engineering stress office will have identified the need for a task are subject to FD assessment in the MRB process. This assessment is limited to the feasibility and accessibility aspects of the identified task.

If the manufacturer stress engineering confirms that no FD task is identified for non-PSE SSIs (or non-PSE portions of SSI), no further FD MSG-3 assessment is needed. This confirmation could be documented in the PPH or at individual SSI level.

Changes required in the ATA MSG-3:

- Section 2-4 Aircraft Structural Analysis Procedure

This section contains guidelines for developing scheduled maintenance tasks for aircraft structure **as part of the MRB process**. These are designed to relate the scheduled maintenance tasks to the consequences of structural damage remaining undetected. Each structural item is assessed in terms of its significance to continuing airworthiness, susceptibility to any form of damage, and the degree of difficulty involved in detecting such damage. Once this is established, scheduled structural maintenance can be developed which can be shown to be effective in detecting and preventing ~~structural degradation due to fatigue,~~ **accidental damage**, environmental deterioration, ~~or accidental damage and in some cases structural degradation due to fatigue,~~ throughout the operational life of the aircraft. The structural maintenance task(s) developed as part of the scheduled structural maintenance are used to satisfy aircraft type certification and MRB requirements.

Mandatory replacement times for structural safe-life parts **and mandatory inspection requirements for damage tolerant parts** are included in the Airworthiness Limitations, required by the regulatory authorities as part of the Instructions for Continued Airworthiness, **hence they are not part of the MSG-3 scope**. ~~Some of the items requiring fatigue related inspections may also be included, as well as specific Corrosion Prevention and Control Program (CPCP) tasks which subsequently warrant inclusion, based on the in-service experience of the operators.~~

- Section 2-4-1 Aircraft Structure Defined

1. Significant and Other Structure

Structure can be subdivided into items according to the consequences of their failure to aircraft safety as follows:

a. A Structural Significant Item (SSI) is any detail, element or assembly, which contributes significantly to carrying flight, ground, pressure or control loads, and whose failure could affect the structural integrity necessary for the safety of the aircraft.

SSIs must not be confused with Principal Structural Elements, PSE (Section 571 of the applicable certification standard); however, all PSEs must be addressed by the SSIs.

International Maintenance Review Board Policy Board (IMRBPB)
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An SSI can be damage tolerant or safe-life or a combination of both.

b. Other Structure is that which is judged not to be a Structural Significant Item. It is defined both externally and internally within zonal boundaries.

- Section 2-4-2 Scheduled Structural Maintenance

AD and ED analysis is done by means of an assessment based on a rating system, as described in 2-4-5. ~~FD analysis (as part of the MRB process) is an accessibility and feasibility evaluation of the damage tolerant assessment, as described in Figure 2-4-4-6.~~ **FD assessment within the MSG-3 is limited to the accessibility and feasibility evaluation of a task, if such a task is recommended by the stress office engineering for non-PSE SSIs (or non-PSE portions of the SSI), as illustrated in Figures 2-4-4-1 and 2-4-4-5.** This evaluation can be done based on a rating system as described in 2-4-5, or as stipulated in the PPH.

~~Inspections related to FD detection in metals are applicable after a threshold, which is established during the aircraft type certification process. At the time the fatigue related inspections are implemented, sampling can be used, where it is applicable and effective. The fatigue related inspections are based on the manufacturer's approved damage tolerance evaluations and changes or adjustments by the operators require use of an approved procedure.~~

2. Inspection Thresholds

c. **Fatigue Damage** - ~~Inspections directly related to fatigue damage detection will occur after a threshold(s) to be established by the manufacturer and approved by the appropriate regulatory authority. Thresholds are normally established as part of the damage tolerance certification requirements.~~ **When applicable, the initial inspection threshold will be defined by the manufacturer stress engineering.** ~~These are~~ This is subject to change as service experience, additional testing, or analysis work is obtained.

3. Repeat Inspection Intervals

c. **Fatigue Damage** - ~~The repeat intervals for fatigue related inspections are based on the damage tolerance evaluations. These are used to demonstrate that applicable and effective inspections provide sufficient probability of detecting fatigue damage for each SSI.~~ **When applicable, the repeat intervals for fatigue related inspections will be defined by the manufacturer stress engineering. This is subject to change as service experience, additional testing, or analysis work is obtained.**

- Section 2-4-3 Damage Sources and Inspection Requirements

2. Inspection Requirements

c. ~~Detectable size fatigue cracking is not normally anticipated in primary airframe structure until the fleet has matured. Thereafter, scheduled structural maintenance may~~

International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper (IP)

Initial Date: 28/Apr/2017

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Revision / Date: R0 / 28/Apr/2017

~~require revision. For Fatigue Damage (FD), manufacturer stress engineering may determine FD tasks to be added to non-PSE SSIs (or non-PSE portions of the SSI). For most transport aircraft structure, aircraft with the highest number of flight cycles are more susceptible to initial fatigue cracking in the fleet and are suitable candidates for a fatigue related sampling, should this be applicable and effective.~~

- Section 2-4-4 Scheduled Structural Maintenance Development

The scheduled structural maintenance tasks and intervals are based on an assessment of structural design information, fatigue ~~and damage tolerance~~ evaluations, service experience with similar structure and pertinent test results.

- c. The consequences of structural deterioration to continuing airworthiness

1. Effect on aircraft (e.g. loss of function or reduction of residual strength).
2. Multiple ~~site or multiple element fatigue~~ damage **occurrences**.
3. The effect on aircraft flight or response characteristics caused by the interaction of structural damage or failure with systems or powerplant items.
4. In-flight loss of structural items.

- 1. Procedure

- d. Items categorized as Structural Significant Item (SSI) (P3) are listed as SSIs. They are ~~to be categorized as safe life or damage tolerant (D5), and are additionally~~ subjected to AD/ED/CPCP analysis (either as metallic or non-metallic structure).

- e. Items categorized as Other Structure (P4) are compared to similar items on existing aircraft (D2). Maintenance recommendations are developed by the Structures Working Group (SWG) for items which are similar and by the manufacturer for those which are not, e. g., new materials or design concepts (P5). All tasks selected by the SWG (P6) are evaluated for zonal transfer (~~D9-D6~~) and will either become zonal inspection candidate (~~P20b P17~~) or will be included in the scheduled structural maintenance (~~P20a P18~~).

- o. All tasks resulting from AD/ED analysis ([Figure 2-4-4.3] and/or [Figure 2-4-4.4]), including SSHM tasks selected by the SWG, are evaluated for zonal transfer (~~D9 D6~~) and will either become zonal inspection candidate (~~P20b P17~~) or will be included in the structural maintenance (~~P20a P18~~).

~~p. The manufacturer categorizes each SSI as damage tolerant or safe life (D5).~~

~~q. For each item categorized as safe life, the manufacturer determines the safe life limit (P15) which is included in the aircraft Airworthiness Limitations (P19). No fatigue related inspection is required to assure continuing airworthiness. However, AD/ED/CPCP tasks selected (P20) might be required to ensure that the item will reach its safe life limit.~~

~~r. All remaining SSIs are damage tolerant and the manufacturer determines if timely detection of fatigue damage is dependent on scheduled inspections (P16). Scheduled~~

International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper (IP)

Initial Date: 28/Apr/2017

IP Number: IP171

Revision / Date: R0 / 28/Apr/2017

~~fatigue related inspection may not be required for SSIs designed to carry the required load with damage that will be readily detectable during routine operation of the aircraft (D6).~~

p. The manufacturer Stress Engineering determines need for FD task for non-PSE SSIs (or non-PSE portions of the SSI) (P15). This can be documented in the PPH or the individual SSI and will be determined by each TCH.

~~sq. Details of the these fatigue related task requirements based on the manufacturer's damage tolerance evaluations, including validated S-SHM application(s), are presented to the SWG (or equivalent body) who determines if they are acceptable (D7 D5).~~

tr. Improved task requirement (e.g. change in task type inspection levels - visual inspections, non-destructive inspections, S-SHM, interval, and/or access, and/or procedure) may be proposed to the manufacturer (P16). and/or redesign of the SSI may be required (D8/P17). If this is not feasible for the manufacturer, the SSI must be categorized as safe life (P17). If the manufacturer stress engineering confirms that no FD task is identified for non-PSE SSIs (or non-PSE portions of SSI), no further FD MSG-3 assessment is needed. This confirmation could be documented in the PPH or at individual SSI level.

~~u. Fatigue related task requirements are listed (P18).~~

~~v. To support Type Certification, selected FD requirements associated with PSEs (D5) should be listed in the Airworthiness Limitations document.~~

ws. Tasks from AD, ED, FD (other than Airworthiness Limitations), and other structure analyses are evaluated for zonal transfer (D9 D6) and will either become zonal inspection candidate (P20a P18) or will be included in the scheduled structural maintenance (P20b P17).

xt. The resulting maintenance requirements for all structure from step “w s” are submitted to the ISC for approval and inclusion in the MRB report proposal.

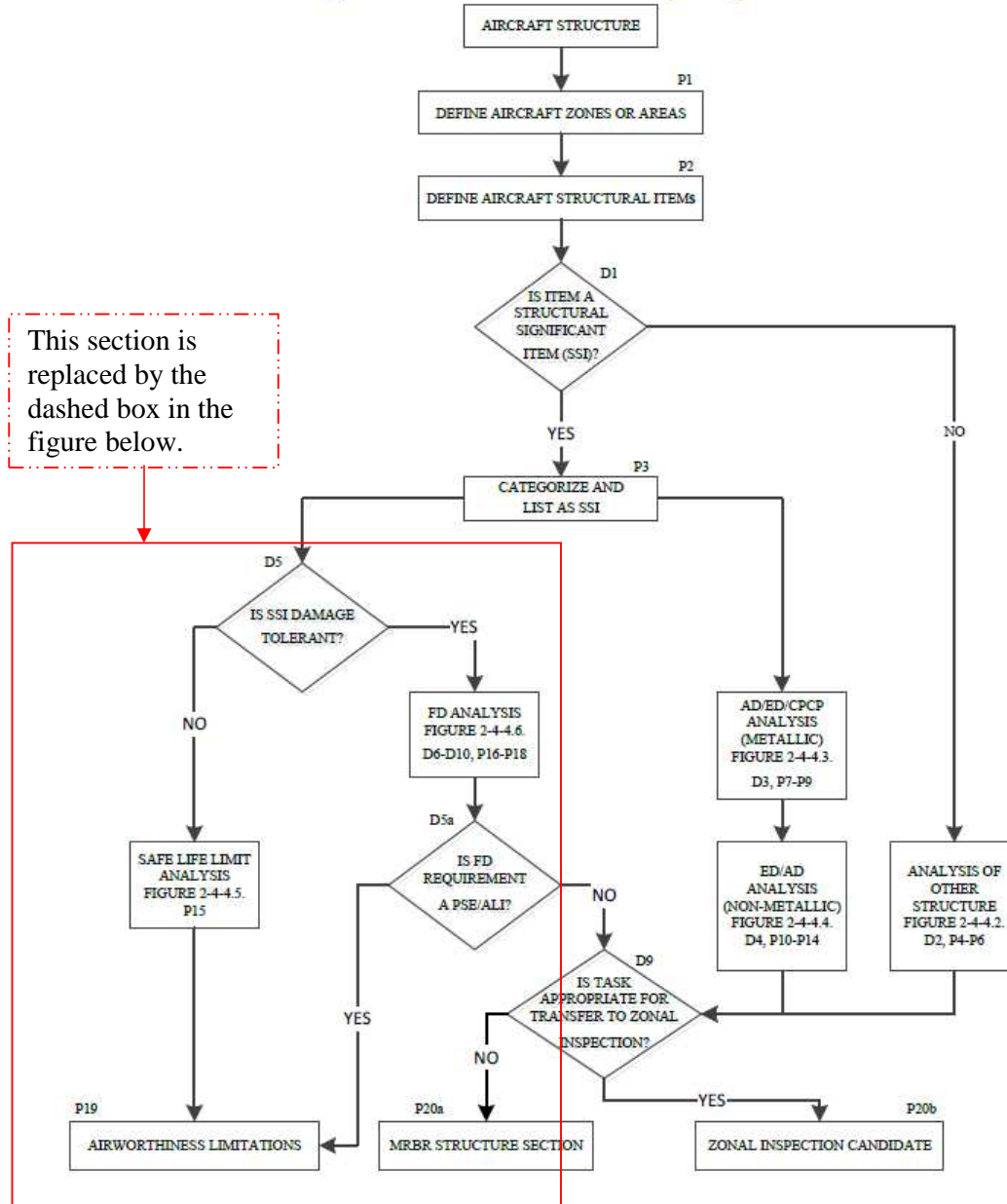
~~y. The structural maintenance portion of the Airworthiness Limitations should be included in a separate document and submitted to the appropriate Regulatory Authority (certification) for approval.~~

**International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper (IP)**

Initial Date: 28/Apr/2017
IP Number: IP171
Revision / Date: R0 / 28/Apr/2017

Figure 2-4-4.1 (Revision 2015.1 version)

Figure 2-4-4.1. Structure MSG-3 Logic Diagram



**International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper (IP)**

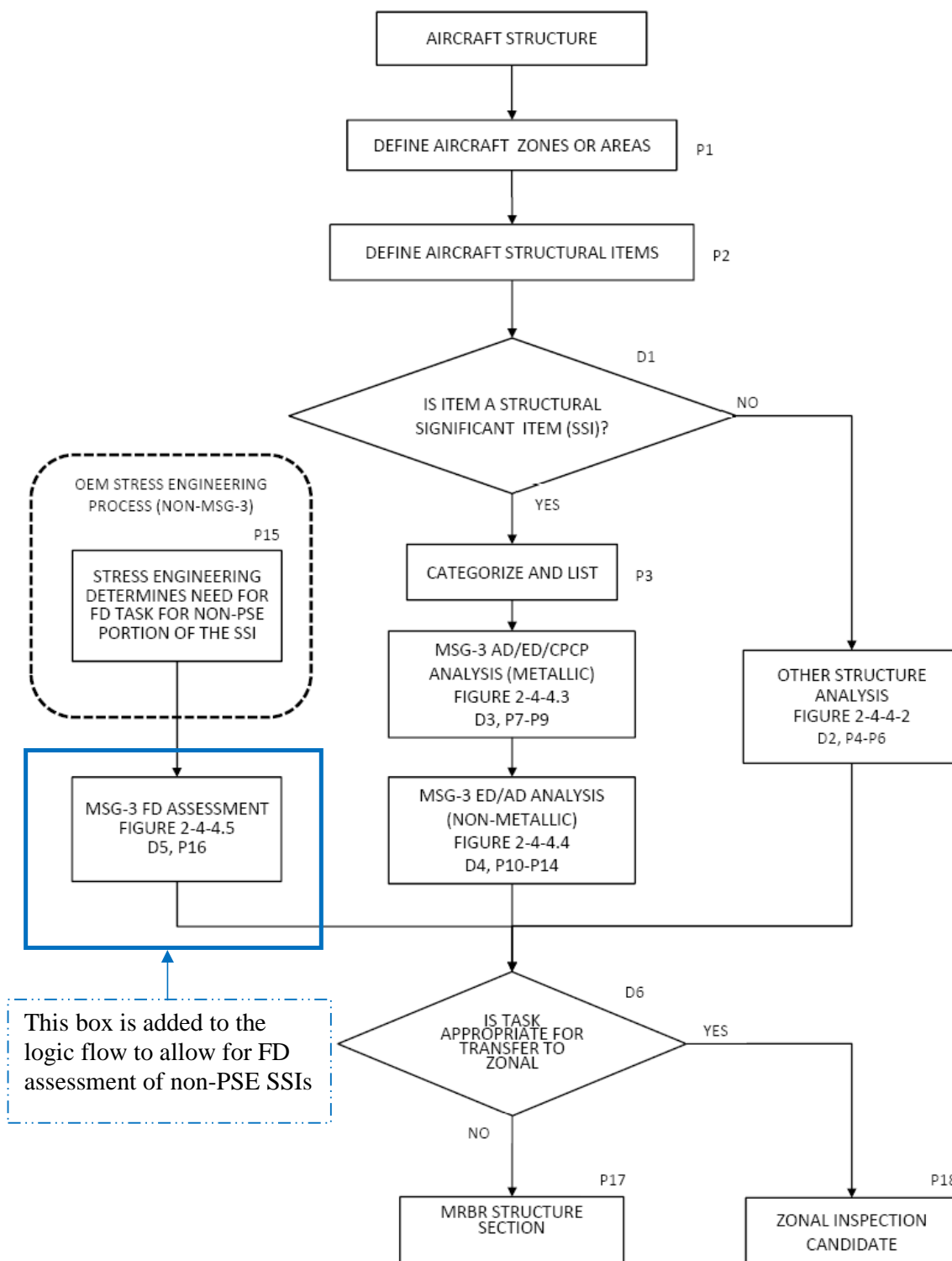
Initial Date: 28/Apr/2017

IP Number: IP171

Revision / Date: R0 / 28/Apr/2017

- Revised Figure 2-4-4-1. This figure replaces the figure noted above.

Figure 2-4-4-1. Structure MSG3 Logic Diagram



**International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper (IP)**

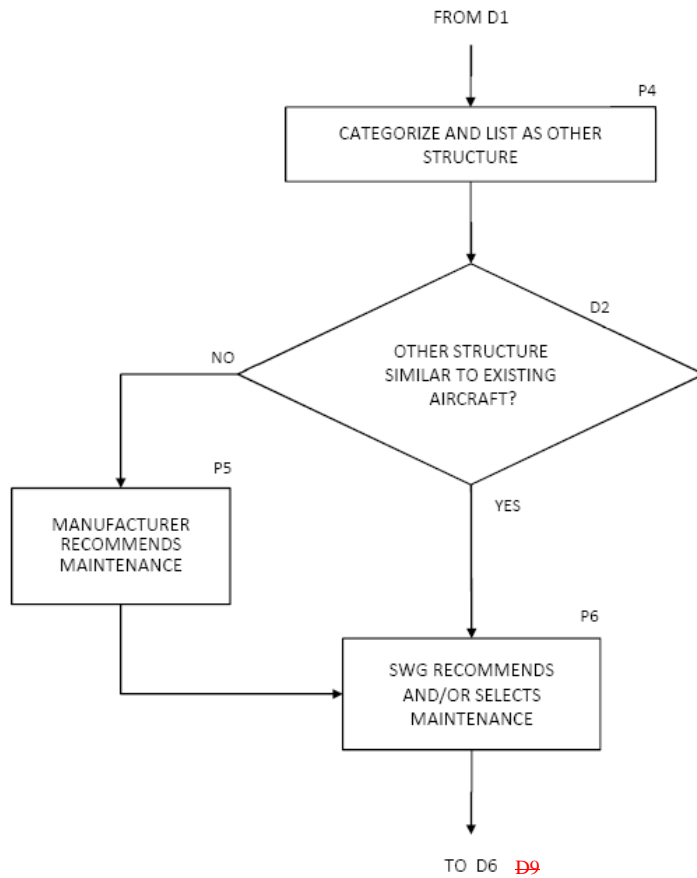
Initial Date: 28/Apr/2017

IP Number: IP171

Revision / Date: R0 / 28/Apr/2017

- Revised Figure 2-4-4-2.

Figure 2-4-4.2. Other Structure Logic Diagram



**International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper (IP)**

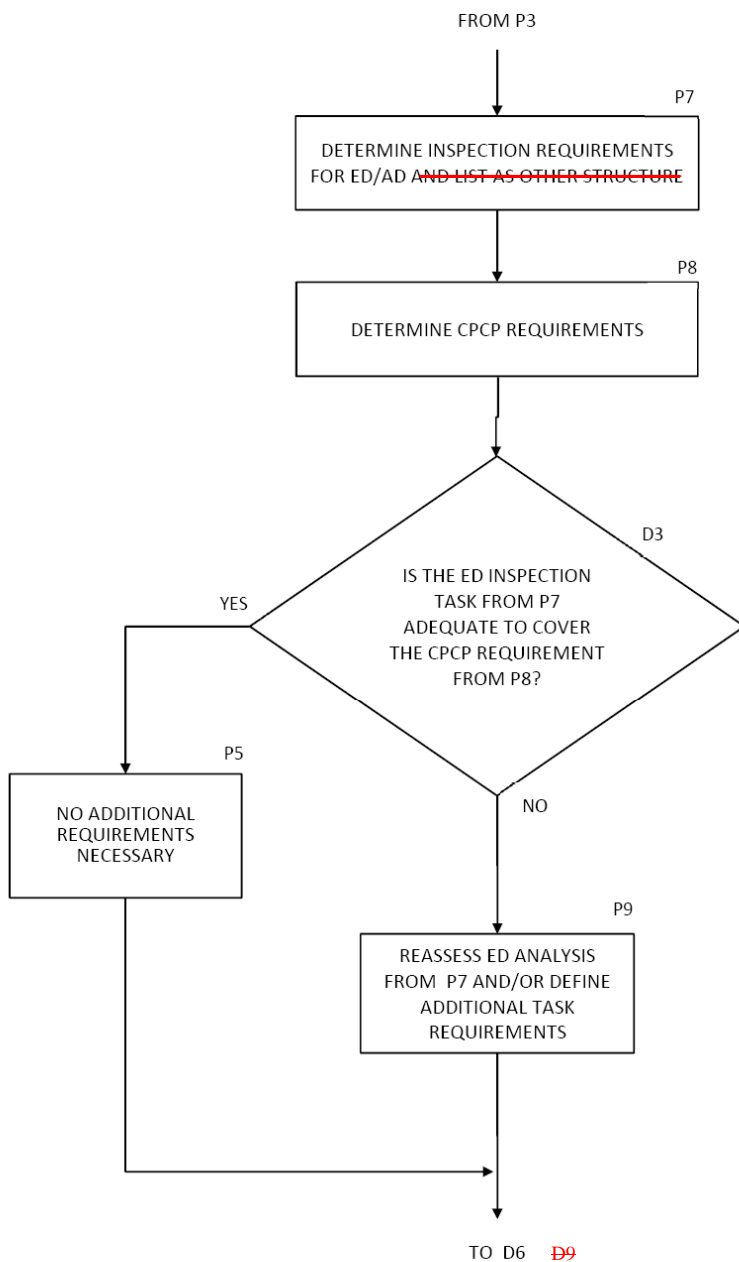
Initial Date: 28/Apr/2017

IP Number: IP171

Revision / Date: R0 / 28/Apr/2017

- Revised Figure 2-4-4-3.

Figure 2-4-4.3. Accidental Damage and Environmental Deterioration (Metallic) Logic Diagram



**International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper (IP)**

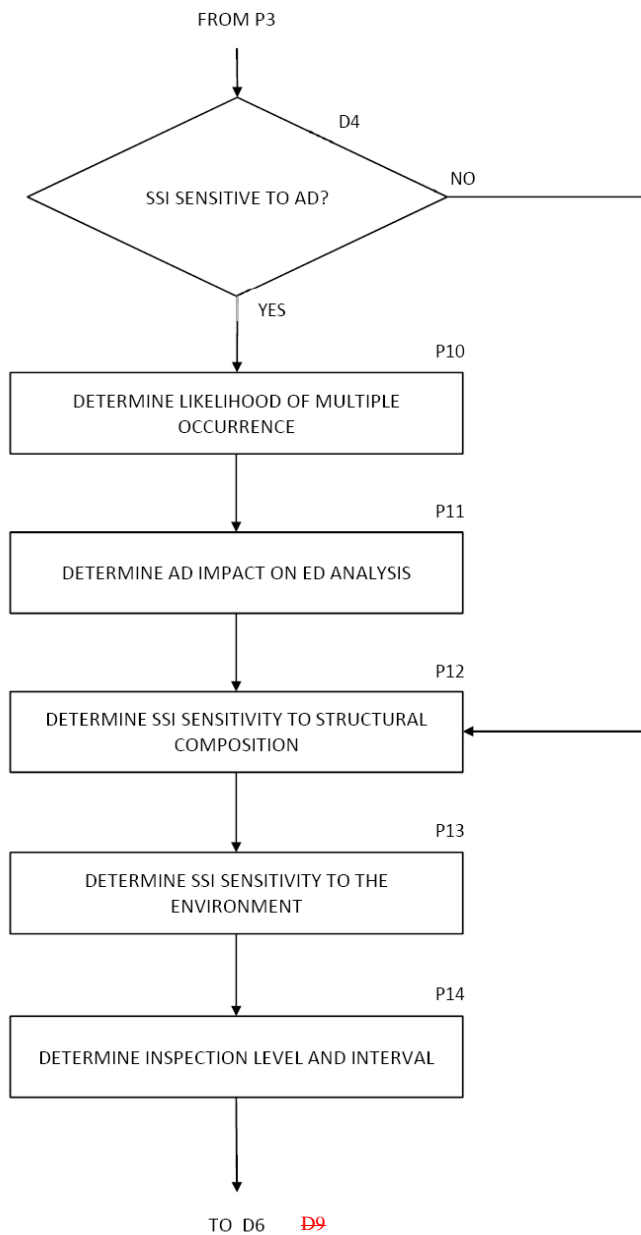
Initial Date: 28/Apr/2017

IP Number: IP171

Revision / Date: R0 / 28/Apr/2017

- Revised Figure 2-4-4.4.

Figure 2-4-4.4. Accidental Damage and Environmental Deterioration (Non-Metallic) Logic Diagram

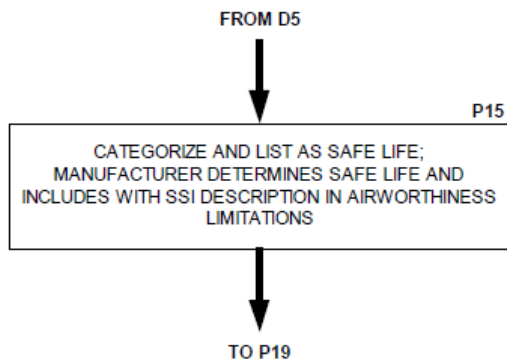


**International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper (IP)**

Initial Date: 28/Apr/2017
IP Number: IP171
Revision / Date: R0 / 28/Apr/2017

- Deleted Figure 2-4-4-5 Safe Life Limit Analysis Logic Diagram.

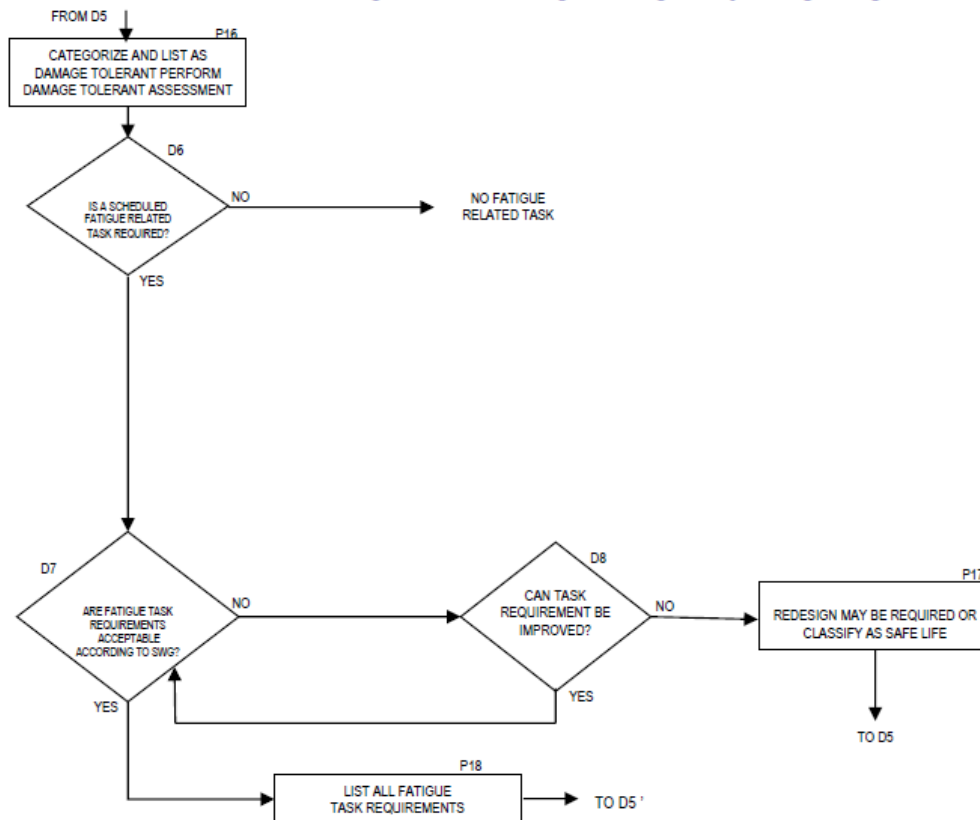
Figure 2-4-4.5. **Safelife Limit Analysis Logic Diagram**



- Revised and renumbered Figure 2-4-4-6 to Figure 2-4-4-5.

Figure 2-4-4.6 Original Version (Revision 2015.1)
This figure does not fit in the revised logic diagram and is deleted.

Figure 2-4-4.6. **Fatigue Damage Analysis Logic Diagram**

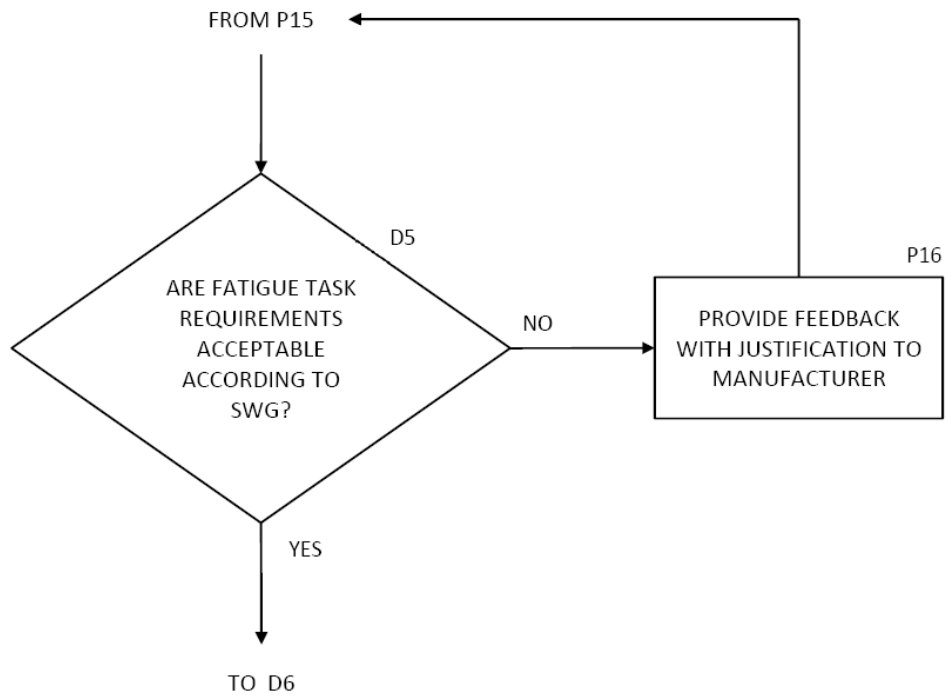


**International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper (IP)**

**Initial Date: 28/Apr/2017
IP Number: IP171
Revision / Date: R0 / 28/Apr/2017**

Revised and renumbered Figure 2-4-4.5

Figure 2-4-4.5. Fatigue Damage Analysis Logic Diagram



**International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper (IP)**

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IP Number: IP171

Revision / Date: R0 / 28/Apr/2017

- Section 2-4-5. Rating Systems for Structural Significant Items

If rating systems for FD of metals are used, they should evaluate only the detectability of damage. The FD susceptibility should be only evaluated by the manufacturer stress office engineering.

4. Rating Fatigue Damage

If a rating system to assess the detectability of the fatigue damage and feasibility of the inspection is used, it should consider the different inspection levels and methods, accessibility conditions, expected inspection conditions (e.g., sealant obscuring the damage location).

NOTE: Estimated detectable crack lengths can be used for the fatigue damage detection evaluations required as part of aircraft type certification.

Changes required to IMPS document:

Appendix 1, Section 4.6

Update Section 4.6 as follows;

4.6 Fatigue Damage (FD) Analysis Process

4.6.1 ~~Type Certification Interface~~ Stress Engineering Interface (*FD for non-PSE portion of SSIs*)

~~4.6.1.1 Airworthiness Limitation Items (ALI)~~

4.6.2 ~~Crack Growth Rate~~ FD within MSG-3 (*FD for non-PSE portion of SSIs*)

4.6.2.1 Feasibility and Applicability of FD Tasks

4.6.2.2 FD Inspection Threshold

4.6.2.3 Selection of Inspection Intervals

4.6.2.4 Feasibility of an FD Sampling Program

~~4.6.3 Residual Strength~~

~~4.6.4 Crack Detectability~~

~~4.6.5 FD Inspection Threshold~~

~~4.6.6 Feasibility of an FD Sampling Program~~

~~4.6.7 Selecting Inspection Intervals for FD~~

International Maintenance Review Board Policy Board (IMRBPB)
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Position: IMRBPB agrees to CIP IND-2015-07 with the changes implemented at the IMRBPB Meeting 2017, which becomes IP171

Date:

Position:

Status of Issue Paper and date:

Active 28/Apr/2017

Recommendation for implementation:

IP171 will be included into the next revisions of the MSG-3 and IMPS documents

Retroactive: NO

Important Note: The IMRBPB IPs are not policy. An IP only becomes policy when the IP is adopted into the processes of the appropriate National Aviation Authority. However, before formal adoption, the IP content may be incorporated by the MRB applicant on a voluntary basis with the agreement of all parties as detailed in the program PPH.