ATA MSG-3

Operator/Manufacturer Scheduled Maintenance Volume 1 - Fixed Wing Aircraft

Revision 2022.1

MSG-3

Airlines for America
We Connect the World

Airlines for America
1275 Pennsylvania Avenue, NW - Suite 1300
Washington, DC 20004-1707
USA

http://www.airlines.org/

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Acceptance Letter

International Maintenance Review Board Policy Board (IMRBPB)

International MRB Policy Board

ENDORSEMENTS:

19 April 2023

Mr. Kevin Berger

Director, Technical Operations
Airlines for America

1275 Pennsylvania Ave NW
Washington, DC 20004

Dear Mr. Berger,

The International Maintenance Review Board Policy Board (IMRBPB) has reviewed the changes proposed to the Air Transport Association (ATA) Maintenance Steering Group – 3 (MSG-3) Report “Operator/Manufacturer Scheduled Maintenance Development”, Volumes 1 and 2, Revision 2022.1.

The ten signatory agencies of the IMRBPB hereby accept ATA MSG-3 2022.1, Volume 1 and 2, for use as a guidance document in the development of future Maintenance Review Board Reports (or equivalent reports) within our respective regulatory structures.

Sincerely,

William A. Heliker

William A. Heliker, Chairperson, IMRBPB

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Digitally signed by Dale R Hawkins for Rebecca S Hoover
Date: 2023.02.28 11:52:21 -05'00'

Dale R Hawkins for Rebecca S Hoover

Rebecca HOOVER	Date
Division Manager (Acting)	
Aircraft Maintenance Division AFS-300	
Federal Aviation Administration (FAA)	

18 April 2023

Jeffrey PHIPPS	Date
Chief, Operational Airworthiness (AARTM)	
Standards Branch	
Transport Canada, Civil Aviation (TCCA)	

24/02/2023

Raffaele IOVINELLA	Date
Aircraft Maintenance Section Manager	
Maintenance and Production Department / Flight Standards Directorate	
European Union Aviation Safety Agency (EASA)	

7 March 2023

Jimmy LEUNG	Date
Senior Airworthiness Officer	
Flight Standards and Airworthiness Division	
Hong Kong Civil Aviation Department (HKCAD)	

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Mar 3 /2023

Nelson Eisaku NAGAMINE — Date

Manager, Continuing Airworthiness Technical Branch

Department of Airworthiness

National Civil Aviation Agency – Brazil (ANAC)

28 March 2023

Gerald POH Hock Guan — Date

Senior Manager (Airworthiness Engineering)

Airworthiness Certification & UAS Division

Civil Aviation Authority of Singapore (CAAS)

Yasushi Yamashita

08-Mar-2023

Yasushi YAMASHITA — Date

Deputy Director

Flight Standard Division

Japan Civil Aviation Bureau (JCAB)

2023/3/29

XUE Shi Jun — Date

Deputy Director General

Flight Standards Department

Civil Aviation Administration of China (CAAC)

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28 February 2023

David PUNSHON Date

Manager Continued Operational Safety

Airworthiness & Engineering Branch / National Operations & Standards Division

Civil Aviation Safety Authority of Australia (CASA)

02 March 2023

Hatem DIBIAN Date

Senior Manager Air Operators and CAMO

Aviation Safety Affairs

General Civil Aviation Authority (GCAA)

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Highlights

Release History

- Revision 2022.1 (December 2022)
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- Revision 2013.1 (October 2013)
- Revision 2011.1 (September 2011)
- Revision 2009.1 (December 2009)
- Revision 2007.1 (April 2007)
- Revision 2005.1 (March, 2005)
- Revision 2003.1 (March, 2003)
- Revision 2002.1 (March, 2002)
- Revision 2001.1 (February, 2001)
- Revision 2000.1 (March 2000, reformatted into an electronic document)
- Revision 2 (September 12, 1993)
- Revision 1 (March 31, 1988)
- Original Issue (September 30, 1980)

Revision 2022.1 (Revised December 2022)

Location	Description of Change
All	See the Preface section for a complete description.

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Contents

Acceptance Letter ... v
International Maintenance Review Board Policy Board (IMRBPB) ... v
Highlights ... ix
Release History ... ix
Revision 2022.1 (Revised December 2022) ... ix
Contents ... x
Preface ... 1
MSG-3, Original Revision ... 1
MSG-3, Revision 1 ... 3
MSG-3, Revision 2 ... 4
MSG-3, Revision 2001 ... 5
MSG-3, Revision 2002 ... 5
MSG-3, Revision 2003 ... 6
MSG-3, Revision 2005 ... 6
MSG-3, Revision 2007 ... 7
MSG-3, Revision 2009.1 ... 7
MSG-3, Revision 2011.1 ... 8
MSG-3, Revision 2013.1 ... 8
MSG-3, Revision 2015.1 ... 9
MSG-3, Revision 2018.1 ... 10
MSG-3, Revision 2022.1 ... 11
Chapter 1. General ... 12
1-1. Objective ... 12
1-2. Scope ... 12
1-3. Organization ... 12
1-3-1. Industry Steering Committee ... 12
1-3-2. Working Groups ... 13
Chapter 2. Development of Scheduled Maintenance ... 14
2-1. General ... 14
2-1-1. Purpose ... 14
2-1-2. Approach ... 14
1. Scheduled Maintenance Objectives ... 14
2. Scheduled Maintenance Content ... 15
3. Method for Scheduled Maintenance Development ... 15
2-2. Divisions of MSG-3 Document ... 16
2-3. Aircraft Systems/Powerplant Analysis Procedure ... 19
2-3-1. MSI Selection ... 19
1. Step 1. ... 19
2. Step 2. ... 19
3. Step 3 ... 20
4. Step 4 ... 20
5. Step 5 ... 20
6. Step 6 ... 20
2-3-2. Analysis Procedure ... 21
2-3-3. Logic Diagram ... 22

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1. Levels of Analysis....22
2-3-4. Procedure....23
2-3-5. Consequences of Failure (First Level)....24
1. Evident or Hidden Functional Failure....24
2. Direct Adverse Effect on Safety....25
3. Hidden Functional Failure Safety Effect....25
4. Operational Effect....26
2-3-6. Failure Effect Categories (First Level)....27
1. Evident Safety Effects (Category 5)....27
2. Evident Operational Effects (Category 6)....28
3. Evident Economic Effects (Category 7)....30
4. Hidden Function Safety Effects (Category 8)....31
5. Hidden Function Non-Safety Effects (Category 9)....32
2-3-7. Task Development (Second Level)....35
1. Lubrication/Servicing (All Categories)....35
2. Operational Check (Hidden Functional Failure Categories Only)....35
3. Visual Check (Hidden Functional Failure Categories Only)....36
4. Inspection/Functional Check (All Categories)....36
5. Restoration (All Categories)....37
6. Discard (All Categories)....37
7. Combination (Safety Categories Only)....38
8. Task Selection Criteria....39
9. Task Consolidation....40
2-3-8. Systems/Powerplant Classic Task Interval Determination....40
1. General....40
2. Sources of Information....40
3. Task Interval Parameters....41
4. Task Interval Selection Criteria....42
5. "Access-Defined" Inspection Intervals....42
2-3-9. AHM Candidate Analysis (Third level)....43
1. General....43
2. Step 1....44
3. Step 2....46
4. Step 3....46
5. Sources of Information....47
6. AHM timing / frequencies....47
2-4. Aircraft Structural Analysis Procedure....48
2-4-1. Aircraft Structure Defined....48
1. Significant and Other Structure....48
2-4-2. Scheduled Structural Maintenance....49
1. Structural Maintenance Tasks....50
2. Inspection Thresholds....50
3. Repeat Inspection Intervals....51
4. Fatigue Related Sampling Inspections....51
5. Corrosion Prevention and Control Programs (CPCP)....51
6. Age Exploration Program....52

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7. Zonal Inspections 52
8. Inspection Results 52
2-4-3. Damage Sources and Inspection Requirements 52
1. Damage Sources 52
2. Inspection Requirements 53
2-4-4. Scheduled Structural Maintenance Development 54
1. Procedure 54
2-4-5. Rating Systems for Structural Significant Items 62
1. Rating Accidental Damage 62
2. Rating Environmental Deterioration (metals) 63
3. Rating Environmental Deterioration (non-metals) 63
4. Rating Fatigue Damage 64
2-5. Zonal Analysis Procedure 64
2-5-1. Procedure 64
2-5-2. Zonal Inspection Task Intervals 68
2-6. Lightning/High Intensity Radiated Field (L/HIRF) Analysis Procedure 69
2-6-1. L/HIRF Maintenance 70
1. L/HIRF Protection Analysis Concepts 70
2. LHSI Selection 70
3. L/HIRF Protection Analysis Methodology and Logic Diagram (see Figure 2-6-1.3) 70
Analysis Approval 77
Appendix A. Glossary 78
Annex 1. References 86

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Preface

Airline and manufacturer experience in developing scheduled maintenance for new aircraft has shown that more efficient programs can be developed through the use of logical decision processes.

In July, 1968, representatives of various airlines developed Handbook MSG-1, "Maintenance Evaluation and Program Development," which included decision logic and inter-airline/manufacturer procedures for developing scheduled maintenance for the new Boeing 747 aircraft.

Subsequently, it was decided that experience gained on this project should be applied to update the decision logic and to delete certain 747 detailed procedural information so that a universal document could be made applicable for later new type aircraft. This was done and resulted in the document, entitled, "Airline/ Manufacturer Maintenance Program Planning Document," MSG-2. MSG-2 decision logic was used to develop scheduled maintenance for the aircraft of the 1970's.

In 1979, a decade after the publication of MSG-2, experience and events indicated that an update of MSG procedures was both timely and opportune in order for the document to be used to develop maintenance for new aircraft, systems or powerplants.

An ATA Task Force reviewed MSG-2 and identified various areas that were likely candidates for improvement. Some of these areas were the rigor of the decision logic, the clarity of the distinction between economics and safety, and the adequacy of treatment of hidden functional failures. Additionally

A. The development of new generation aircraft provided a focus, as well as motivation, for an evolutionary advancement in the development of the MSG concept.

B. New regulations which had an effect on maintenance programs had been adopted and therefore needed to be reflected in MSG procedures. Among those were new damage tolerance rules for structures and the Supplemental Structural Inspection program for high time aircraft.

C. The high price of fuel and the increasing cost of materials created trade-off evaluations which had great influences on maintenance program development. As a result, maintenance programs required careful analysis to ensure that only those tasks were selected which provided genuine retention of the inherent designed level of safety and reliability or provided economic benefit.

MSG-3, Original Revision

Against this background, ATA airlines decided that a revision to existing MSG-2 procedures was both timely and appropriate. The active participation and combined efforts of the FAA, CAA/UK, AEA, U.S. and European aircraft and engine manufacturers, U.S. and foreign airlines, and the U.S. Navy generated the document, MSG-3. As a result there were a number of differences between MSG-2 and MSG-3, which appeared both in the organization/presentation of the material and in the detailed procedural content. However, MSG-3 did not constitute a fundamental departure from the previous version but was built upon the existing framework of MSG-2 which had been validated by ten years of reliable aircraft operation using maintenance based thereon.

The following reflects some of the major improvements and enhancements generated by MSG-3 as compared to MSG-2.

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1. Systems/Powerplant Treatment:

   MSG-3 adjusted the decision logic flow paths to provide a more rational procedure for task definition and a more straightforward and linear progression through the decision logic.

   MSG-3 logic took a "from the top down" or consequence of failure approach. At the outset, the functional failure was assessed for consequence of failure and was assigned one of two basic categories:

   A. SAFETY

   B. ECONOMIC

   Further classification determined sub-categories based on whether the failure was evident to or hidden from the operating crew. (For structures, category designation was "significant" or "other" structure, and all functional failures were considered safety consequence items).

   With the consequence category established for systems/powerplants, only those task selection questions pertinent to the category needed to be asked. This eliminated unnecessary assessments and expedited the analysis. A definite applicability and effectiveness criteria was developed to provide more rigorous selection of tasks. In addition, this approach helped to eliminate items from the analytical procedure whose failures had no significant consequence.

   Task selection questions were arranged in a sequence such that the most preferred, most easily accomplished task, was considered first. In the absence of a positive indication concerning the applicability and effectiveness of a task, the next task in sequence was considered, down to and including possible redesign.

2. Structures Treatment:

   Structures logic evolved into a form which more directly assessed the possibility of structural deterioration processes. Considerations of fatigue, corrosion, accidental damage, age exploration and others, were incorporated into the logic diagram and were routinely considered.

3. MSG-3 recognized the new damage tolerance rules and the supplemental inspection programs, and provided a method by which their intent could be adapted to the **Maintenance Review Board (MRB)** process instead of relying on type data certificate restraints. Concepts such as multiple failures, effect of failure on adjacent structure, crack growth from detectable to critical length, and threshold exploration for potential failure, were covered in the decision logic of the procedural material.

4. The MSG-3 logic was task-oriented and not maintenance process oriented (MSG-2). This eliminated the confusion associated with the various interpretations of **Condition Monitoring (CM)**, **On-Condition (OC)**, **Hardtime (HT)** and the difficulties encountered when attempting to determine what maintenance was being accomplished on an item that carried one of the process labels.

   By using the task-oriented concept, one would be able to view the MRB document and see the initial scheduled maintenance reflected for a given item (e.g., an item might show a lubrication task at the "A" frequency, and inspection/functional check at the "C" frequency and a restoration task at the "D" frequency).

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5. Servicing/Lubrication was included as part of the logic diagram to ensure that this important category of task was considered each time an item was analyzed.

6. The selection of maintenance tasks, as output from the decision logic, was enhanced by a clearer and more specific delineation of the task possibilities contained in the logic.

7. The logic provided a distinct separation between tasks applicable to either hidden or evident functional failures; therefore, treatment of hidden functional failures was more thorough than that of MSG-2.

8. The effect of concurrent or multiple failure was considered. Sequential failure concepts were used as part of the hidden functional failure assessment (Systems/Powerplant), and multiple failure was considered in structural evaluation (Structures).

9. There was a clear separation between tasks that were economically desirable and those that were required for safe operation.

10. The structures decision logic no longer contained a specific numerical rating system. The responsibility for developing rating systems was assigned to the appropriate manufacturer with approval of the Industry Steering Committee.

MSG-3, Revision 1

In 1987, after using MSG-3 procedures on a number of new aircraft and powerplants in the first half of the 1980's, it was decided that the benefits of the experience so gained should be used to improve the document for future application; thus, Revision 1 was undertaken.

This revised document includes changes developed by American and European airframe manufacturers, American and European airworthiness authorities, supplemented and agreed to by the Air Transport Association of America and other airline representatives.

The major improvements and enhancements reflected in items one through nine above were basically unchanged and remain applicable to this revised document.

The following are some of the more noteworthy revisions that have been incorporated:

1. Table of Contents and a List of Effective Pages: ADDED.

2. Clarification that MSG-3 is used to develop an "initial scheduled maintenance program."

3. The task - "Operating Crew Monitoring": DELETED.

4. Section addressing "Threshold Sample": REVISED.

5. Section addressing "Program Development Administration": DELETED.

6. “Top-down approach" - explanation of process: ADDED.

7. "Visual Check" added to "Operational Check" task.

8. System/Powerplant and Structures logic diagrams: REVISED.

9. Task selection criteria table: ADDED.

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10. Inspections:

    Detailed Inspection - REVISED.

    Directed Inspection - DELETED.

    External Surveillance Inspection - DELETED.

    General Visual Inspection - REVISED.

    Internal Surveillance Inspection - DELETED.

    Special Detailed Inspection - UNCHANGED.

    Walk Around Check Inspection - DELETED.

11. Clarification of hidden functional failure: "one additional failure."
12. Inspection/Functional Check task question revised.
13. Reference to a "User's Guide" for procedures related to administration and forms added.
14. Reference to "off-aircraft" deleted.
15. Operating Crew Normal Duties - "Normal Duties" revised to delete pre-flight and post-flight check list; added "on a daily basis" for frequency of usage with respect to normal crew duties.
16. Added that procedures for handling composite of other new materials may have to be developed.
17. Reference to specific U.S. Federal Air Regulations: DELETED.
18. Definition of "Operating": REVISED.
19. Defined logic for failures which may affect dispatch capability or involve the use of abnormal or emergency procedures. Failure-effect Category 6 is now identified as "Operational - Evident".
20. Noted that each MSI and SSI should be recorded for tracking purposes whether or not a task was derived therefrom.

MSG-3, Revision 2

In 1993, MSG-3 Revision 2 was incorporated. The most significant changes introduced were:

21. To adapt MSG-3 logic procedures to assure development of tasks/intervals associated with the aircraft's certificated operating capabilities.
22. To provide guidelines which ensure that a consistent approach be taken with respect to tasks/intervals required to maintain compliance with Type Certification requirements.
23. To provide guidelines on the development of Corrosion Prevention and Control Programs.
24. To introduce procedures to determine the appropriate scheduled maintenance requirements for composite structure.

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25. To revise inspection task definitions.

MSG-3 [Section 2-4] and its respective logic diagrams have been revised to add an evaluation process to insure the **Corrosion Prevention and Control Program (CPCP)** is considered in the evaluation of each **Structural Significant Item (SSI)** and every zone.

Damage Sources [Heading 2-4-3.1] now includes a discussion of non-metallic materials (composites).

Procedures [Heading 2-4-4.1] has been revised to add Procedure and Decision blocks for the CPCP evaluation and edited to produce a more ordered flow of the Procedure and Decision block numbers.

The Glossary - [Appendix A] Inspection Level Definitions have been revised to apply to Systems, Powerplants and Structures, and definitions related to CPCP have been added.

It is suggested, in order to fully comprehend the MSG-3 concept, that the entire MSG-3 document be reviewed and considered prior to accepting or modifying its approaches to maintenance development. A User's Guide or Policies and Procedures Handbook may be adopted with guidance and approval of the Industry Steering Committee.

MSG-3, Revision 2001

In 2001, MSG-3 Revision 2001 was incorporated. The most significant changes introduced were:

1. Added distance requirement and use of a mirror to definition of General Visual Inspection (GVI).
2. Deleted "visual" from definition of Detailed Inspection, and substituted the term "used" for the word "necessary."
3. Corrected terminology throughout the document to change the product of MSG-3 from a "maintenance program" to simply "maintenance."
4. Guidance was added to [Heading 2-3-5.1]. to cover acceptable assumptions as to the flight crew "normal duties" in determining whether or not a functional failure is evident.
5. Expanded the wording on hidden functions of safety/emergency systems or equipment [Heading 2-3-5.3].
6. Deletion of the requirement to forward FEC 6 items without task to the ISC/MRB for review...
7. Significantly expanded the wording on "Interval Determination" [Subject 2-3-8].
8. Rewrote [Section 2-5] to incorporate enhanced zonal analysis.
9. Added a section [Section 2-6] on analysis for Lightning/High Intensity Radiated Field (L/HIRF).
10. Added many more terms to the Glossary.

MSG-3, Revision 2002

In 2002, MSG-3 Revision 2002 was incorporated. The most significant changes introduced were:

1. Added wording emphasizing the importance of recording any and all assumptions made during analysis.

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2. Added wording emphasizing the importance of fully considering all available Vendor Recommendations during MWG discussions.
3. Rewrote the MSI Selection Process to expand and clarify.
4. Added a new [Subject 2-3-2], "Analysis Procedure" in order to separate its paragraphs from the MSI Selection Process.
5. Procedure added for Fault-Tolerant Systems Analysis.
6. Explanation provided for use of MMEL in answering Systems Analysis Level 1 Question 4.
7. General Visual Inspection (GVI) definition was clarified.
8. Structural Maintenance Task Development expanded to address analysis of non-metallic structures.
9. Glossary additions - "Fault" and "Redundant Functional Elements."

MSG-3, Revision 2003

In 2003, MSG-3 Revision 2003 was incorporated. The most significant changes introduced were:

1. Added 3-letter task abbreviations to the 2-letter task abbreviations of [Heading 2-1-2.2]
2. Rewrote the procedural [Subject 2-3-4]. for "Fault-Tolerant Systems" as per FAA request.
3. Added a definition for "Fault-Tolerant System" to the Appendix A, Glossary.
4. Divided existing definition in Appendix A, Glossary, for "Safety/Emergency Systems or Equipment" into bullet points to clarify.

MSG-3, Revision 2005

The changes introduced in 2005 were:

1. Added a NOTE in the MSI Selection [Subject 2-3-1]. Step 2 to identify design features that may result in development of ignition sources in the fuel tank system.
2. Corrected [Heading 2-3-5.1] referencing the Airplane Flight Manual (AFM).
3. In [Heading 2-4-1.1], rewrote the paragraph differentiating Structural Significant Items (SSI) and Principal Structural Elements (PSE).
4. Corrected wording relating to Fatigue Damage (FD) detection in non-metals; [Subject 2-4-2].
5. Corrected a typo in the first box in [Figure 2-4-4.6].
6. Enhanced the Zonal Analysis Procedure, [Subject 2-5-1], paragraphs "e" and "f," added paragraph "l," enhanced both [Figure 2-5-1.1] and [Figure 2-5-1.2] to incorporate the most current recommendations from the FAA's Aging Transport Systems Rulemaking Advisory Committee (ATSRAC) on aging wiring.
7. Added a definition for "Electrical Wiring Interconnection System (EWIS)" to the Appendix A, Glossary.

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MSG-3, Revision 2007

The changes introduced in 2007 were:

1. Expanded text to better define/consider structural wear damage. Changes were made to the note under step 1 of the MSI Selection procedure [Section 2-3-1.1], Aircraft Structure Defined [Section 2-4-1.], and Scheduled Structural Maintenance [Section 2-4-2.].
2. Expanded text and added a flowchart to better explain the CMR versus MRB task and interval determination procedure. Changes were made to Certification Maintenance Requirements (CMRs) [Section 2-3-8.6.].
3. Expanded text and revised two flowcharts to clarify the Fatigue Damage (FD) logic. Changes were made to Scheduled Structural Maintenance Development Procedure [Section 2-4-4.1.] and [Figure 2-4-4.1.] and [Figure 2-4-4.6.].
4. Major rewrite of Lightning/High Intensity Radiated Field (L/HIRF) Analysis [Section 2-6.], and added L/HIRF Protection Systems, L/HIRF Protection Components, and L/HIRF Characteristics to Glossary [Appendix A].

MSG-3, Revision 2009.1

The changes introduced in 2009 were:

1. Addition of Structural Health Monitoring (SHM) and Scheduled Structural Health Monitoring (S-SHM) definitions to the Glossary [Appendix A].
2. Added SHM and S-SHM concepts and revised Fatigue Damage (FD) analysis in:

   [Section 2-1-2] Scheduled Maintenance Content

   [Section 2-4-2] Scheduled Structural Maintenance

   [Section 2-4-4] Scheduled Structural Maintenance Development

   [Figure 2-4-4.6] Fatigue Damage Analysis Logic Diagram

   [Section 2-4-5] Rating Systems for Structural Significant Items
3. Added a definition of Wear Damage to the Glossary [Appendix A]
4. Added discussion of wear [Section 2-4-2]
5. Clarified in [Section 1-2] and [Section 2-3-3] that the analysis process accounts for all the aircraft's certificated operating capabilities.
6. Added note to clarify the need to consider all elements of assemblies defined as SSIs [Section 2-4-1]
7. Added note [Section 2.3.7] to require GVI's developed from Category 5 or Category 8 logic be retained as System/Powerplant tasks and not to become covered by zonal inspections; requirement also referenced in [Section 2.5.1]
8. Revised handling of hidden functions of safety/emergency systems or equipment to allow credit for

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redundancies within these systems or equipment in order to develop an FEC 9 task [Section 2-3-5]

MSG-3, Revision 2011.1

The changes introduced in 2011 were:

1. Clarified status of system parts that meet SSI definition [Section 2-3-1] (IP 96)
2. Clarified status of structure that meet MSI definition [Section 2-3-1] (IP 96)
3. Clarify analysis of ED/AD due to system failure effects [Section 2-3-2] (IP 96)
4. Updated the definition of Fault Tolerant system [Section 2-3-4, Appendix A] (IP 112)
5. Clarified that normal flight crew duties are described in the "approved section" of the AFM [Section 2-3-5]
6. Clarified analysis of structural degradation of MSI [Section 2-3-7] (IP 96)
7. Deleted current wording that incorrectly suggests that the requirement for the aircraft manufacturer to work with the LRU manufacturer constitutes an alternative to application of MSG-3 in cases of LRU internal L/HIRF protection. [Section 2-6] (IP 113)
8. Updated the L/HIRF Protection Analysis Process and Flowchart to remove duplications and address misunderstandings. [Section 2-6-1] (IP 114)

MSG-3, Revision 2013.1

The changes introduced in this revision are:

1. Clarified the treatment of fluid spill and the corresponding structure consequences [2-4-3] [2-4-5] [Appendix A Glossary] (IP 97)
2. Updated the definition of Corrosion Level 1. [Appendix A Glossary] (IP 119)
3. Added a note to Second Level Task Development to prevent transfer of safety (FEC8) Visual Check to zonal [2-3-7.2] (IP 121)
4. Updated the definitions for "General Visual (GVI)", "Detailed (DET)", and "Special Detailed (SDI)" Inspections [2-3-7.4] [Appendix A Glossary] (IP 122)
5. Clarified handling of emergency and back-up equipment whose failure is evident. [2-3-5.2] (IP 124)
6. Designated this document as MSG-3 Volume 1 (Fixed Wing Aircraft) based on creation of new MSG-3 Volume 2 for Rotorcraft (IP 125)
7. Added a new definition to the Glossary for "Vendor Recommendations (VR) to highlight that they may be contained in TSOs" [Appendix A Glossary] (IP 126)
8. Clarified requirements for Certification Maintenance Requirements (CMRs) and changed the term "System Safety Assessment (SSA)" to "Safety Analyses (SA)" [0] (IP 128)
9. Revised the L/HIRF logic diagram and supporting text [2-6]. Added new definition to the glossary for "Lightning/HIRF Significant Item" [Appendix A Glossary] (IP 129)

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10. Updated the structural analysis logic in MSG3 to clarify the intent of the Zonal transfer of structural maintenance requirements [2-4-4.1] (IP 130)

11. Updated the text relating to redesign for Failure Effect Category 8 [2-3-6.4] (IP 131)

12. Clarified that FEC8 consideration for safety/emergency systems or equipment is limited to the safety/emergency functions only [2-3-5.3]. Added new definition in the Glossary for "Safety/Emergency Function" [Appendix A Glossary] (IP 132)

13. Updated the Zonal Analysis Procedure to reflect AC 25-27A and clarify the relationship between the "Standard" and "Enhanced" zonal analysis processes [2-5]. Modified the Glossary definition of "Electrical Wiring Interconnection System (EWIS)" and added new definition for "Enhanced Zonal Analysis Procedure (EZAP)" [Appendix A Glossary] (IP 133)

14. Updated the Zonal Analysis Procedure to clarify when zonal analysis should be conducted at multiple levels of access [2-5] (IP 135)

MSG-3, Revision 2015.1

The changes introduced in 2015 are:

1. Updated the definition of Corrosion Level 1 in accordance with the recommendation from the Airworthiness Assurance Working Group [Appendix A Glossary] (IP 119 Rev 2_210415).

2. Removed statement in the Zonal Analysis Procedure regarding Zonal Transfer Guidance of GVI's determined by L/HIRF Analysis [2-5-1] (IP 137).

3. Deleted the Glossary term for L/HIRF Protection Systems as that term is no longer used in MSG-3 [Appendix A Glossary] (IP 138).

4. Clarified that surface protection ratings should evolve over time [2-4-5] (IP 139).

5. Provided guidance to help in answering question 3 of level 1 Systems analysis for protective functions, in particular which combination of failures should be considered [2-3-5.3] (IP 140).

6. Provided additional guidance on handling of safe life items that might be affected by corrosion and subsequent premature failure [2-4-2.5],[2-4-2.6], [2-4-4.1] (IP 141).

7. Updated logic diagram titles for consistency [Figure_2-2.1], [Figure_2-4-4.1], [Figure_2-5-1.1], [Figure_2-6-1.3] (IP 142).

8. Clarified the distinction between Visual Check and Operational Check [2-3-7.2], [2-3-7.8], [Appendix A Glossary] (IP 143).

9. Provided clarification of the policy permitting consolidation of tasks [2-3-7.7], [2-3-7.9], [Appendix A Glossary] (IP 144).

10. Removed references to FAA 14 CFR §25.571 to allow recognition of the equivalent requirement in other regulatory systems [2-4-1.1] (IP 149).

11. Provided clarification that the MRB Report should contain tasks only arising from the MSG-3 logic process [1-1] (IP 150).

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12. Revised the Glossary definition of "Lightning/HIRF Significant Item" to clarify which L/HIRF structural components should be addressed as LHSIs [Appendix A Glossary] (IP 151).

13. Provided clarification on which Effectiveness criteria should be considered for each Failure Effect Category. Also provided guidance on what is meant by "cost-effective" and "multiple failure" [2-3-6.3], [2-3-6.5], [2-3-7.1], [2-3-7.2], [2-3-7.3], [2-3-7.4], [2-3-7.5], [2-3-7.6], [2-3-7.8], [Appendix A Glossary] (IP 152).

14. Clarified the meaning of "unacceptable degradation" for L/HIRF protection [2-6-1.3], [Appendix A Glossary] (IP 155).

MSG-3, Revision 2018.1

The changes introduced in 2018 are:

1. Updated document acceptance (letter) page to replace the EASA, FAA and TCCA acceptance letters with one International Maintenance Review Board Policy Board (IMRBPB) letter.

2. Provided guidance on need to identify power-down assumptions when considering faults found during tests performed automatically at power up [2-3-5], [2-3-6] (IP156)

3. Clarified L/HIRF analysis methodology with wording to ensure attention is given to assessment of L/HIRF protection provided to all systems and structural components required to maintain the inherent safety of the aircraft [2-6], [2-6-1.3] (IP157)

4. Removed references to non-scheduled and non-routine maintenance to eliminate confusion with MSG-3 Objective [1-1], [2-1-2.2], [2-1-2.3] (IP158)

5. Clarified that sampling programs are not to be used to select initial tasks intervals larger than those that can be substantiated with available data [2-3-8.7] (IP162)

6. Clarified the structural analysis for landing gears including the need to add CPCP identifiers on tasks looking for corrosion irrespective of the Section in which they are placed [1-3-2], [2-4-2.5] (IP164)

7. Added statement that scheduled maintenance development shall not be unduly influenced by National Requirements [2-1-2.3] (IP169)

8. Updated Structure logic to introduce significant changes. Fatigue Damage on PSE structure no longer part of MSG-3 logic. MSG-3 FD assessment limited to accessibility and feasibility evaluation in cases where stress office recommend a task for non-PSE structure [2-4], [2-4-1, 2, 3, 4], [Figures 2-4-4-1, 2, 3, 4, 5, 6] (IP171)

9. Added the need for the identification and recording of information to support task selection and to provide traceability of task requirements [2-1-2.3] (IP176)

10. Clarified that in both Systems and Structure logic application, a Special Detailed Inspection may be selected to detect wear damage within specified limits using a measuring tool [2-3-7], [2-4-2] (IP179)

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11. Added a statement to require that traceability is recorded of individual tasks that are subsequently consolidated [2-3-7-9] (IP182)

12. Added text to drive a harmonised approach to assessment of pressurised cylinder failures and the consideration of the effectiveness of hydrostatic tests for the satisfaction of MSG-3 logic [2-3-4] (IP185)

MSG-3, Revision 2022.1

The changes introduced in 2022 are:

1. Added a method to integrate AHM capability within the MSG-3 process by introducing new language and new decision tree logic (Systems/Powerplant Analysis Level 3) (IP180)

2. Updated the definition of “Operating” to align it to ICAO definition of “Operation of an aircraft” (IP 186)

3. Clarified that “Operators” and not only “Airlines” are involved to develop scheduled maintenance (IP 188)

4. Clarified that tasks selected through EZAP to reduce the likelihood of accumulation of combustible materials is only for zone containing EWIS (IP 189)

5. Clarified that Failure Causes should describe specifically why and how a function fails (IP 190)

6. Provided guidance on need to consider in the SSI selection any structure that, if failed or detached in flight could, through secondary damage, compromise continued safe flight and landing (IP 192)

7. Provided guidance on the need to provide detailed information about how much deterioration of an LHSI / L/HIRF protection component is acceptable and how it can be detected (IP 193)

8. Clarified that “Sampling” is not only applicable to “Systems/Powerplant” (IP 194)

9. Removed duplicated information from paragraph [2-3-7] (IP 195)

10. Adjusted the Zonal procedure scope to adequately address “Other Structure” (IP 196)

11. Clarified that the references to and use of Aircraft Health Monitoring (AHM) requires the certification of associated on-aircraft system features (IP 197)

12. Added the definition of the "Intent” of an MSI Classic Task (IP 200)

13. Provided guidance on the management of AFM Assumptions (IP 201)

14. Added supplementary factors to be considered in the definition of the CPCP task (IP 202)

15. Removed the references to the CCMR/CMCC process from paragraph [2-3-8] (IP 204)

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Chapter 1. General

1-1. Objective

It is the objective of this document to present a means for developing the scheduled maintenance tasks and intervals which will be acceptable to the regulatory authorities, the operators, and the manufacturers. The scheduled maintenance task and interval details will be developed by coordination with specialists from the operators, manufacturers, and the Regulatory Authority of the country of manufacture. Specifically, this document outlines the general organization and decision processes for determining scheduled maintenance requirements initially projected for the life of the aircraft and/or powerplant.

Initial scheduled maintenance tasks and intervals are specified in **Maintenance Review Board (MRB)** Reports. MSG-3 is intended to facilitate the development of initial scheduled maintenance.

This document addresses the development of scheduled maintenance using the MSG-3 analysis procedure. The MRB Report should only contain tasks arising from the MSG-3 logic process. National requirements not derived from MSG-3 logic are not part of the MRB Report. Other non-MSG-3 tasks may be submitted to the Industry Steering Committee for consideration for inclusion in the MRB Report only when justification can be provided.

1-2. Scope

For the purpose of developing an MRB Report, MSG-3 is to be used to determine initial scheduled maintenance requirements.

The analysis process allows scheduled tasks and intervals required to support all certificated operating capabilities of the aircraft (including specific operations such as Extended Twin OPerationS / ExTended OPerationS (ETOPS), Reduced Vertical Separation Minima (RVSM), Category (Cat) III to be identified.

1-3. Organization

The organization to carry out the scheduled maintenance development for a specific type aircraft shall be staffed by representatives of the operators purchasing the equipment, the prime manufacturers of the airframe and powerplant, and the Regulatory Authority.

1-3-1. Industry Steering Committee

The management of the scheduled maintenance development activities shall be accomplished by an **Industry Steering Committee** composed of members from a representative number of operators and representatives of the prime airframe and engine manufacturers. It shall be the responsibility of this committee to establish policy, decide on AHM consideration, set initial goals for scheduled maintenance check intervals, direct the activities of working groups or other working activity, carry out liaison with the manufacturer and other operators, prepare the final recommendations and represent the operators in contacts with the Regulatory Authority. The ISC should see that the MSG-3 process identifies 100% accountability for all **Maintenance Significant Items (MSI's)** and **Structural Significant Items (SSI's)**, whether or not a task has been derived from the analysis.

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The ISC should advise Maintenance Working Groups (MWG) to fully consider available Vendor Recommendations (VR) and accept them only if they are applicable and effective according to MSG-3 criteria.

1-3-2. Working Groups

One or more Working Groups, consisting of specialist representatives from the participating operators, the prime manufacturer, and the Regulatory Authority, may be constituted. The Industry Steering Committee, alternatively, may arrange some other means for obtaining the detailed technical information necessary to develop recommendations for scheduled maintenance in each area. Irrespective of the organization of the working activity, written technical data must be provided that supports its recommendations to the Industry Steering Committee. After approval by the Industry Steering Committee, these analyses and recommendations shall be consolidated into a final report for presentation to the Regulatory Authority.

> NOTE: If separate Working Groups are constituted, means of cooperation need to be established to assess items that fall into both SSI and MSI definitions (landing gear, doors, etc.) If similar tasks are developed in the separate working groups, coordination between the working groups must occur to avoid task duplication (e.g., a reference to the other working group's task can be inserted in the analysis). However, when assessing the duplication of tasks, the intent of the tasks should be carefully considered in order to ensure that the expected degradations will be detected in a timely manner and that the monitoring and reporting of in-service issues is properly addressed.

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Chapter 2. Development of Scheduled Maintenance

2-1. General

It is necessary to develop scheduled maintenance for each new type of aircraft prior to its introduction into service.

2-1-1. Purpose

The primary purpose of this document is to develop a proposal to assist the Regulatory Authority in establishing initial scheduled maintenance tasks and intervals for new types of aircraft and/or powerplant. The intent is to maintain the inherent safety and reliability levels of the aircraft. These tasks and intervals become the basis for the first issue of each operator's maintenance requirements to govern its initial maintenance policy. Initial adjustments may be necessary to address operational and/or environmental conditions unique to the operator. As operating experience is accumulated, additional adjustments may be made by the operator to maintain efficient scheduled maintenance.

2-1-2. Approach

It is desirable, therefore, to define in some detail

a) The objectives of efficient scheduled maintenance.

b) The content of efficient scheduled maintenance.

c) The method by which efficient scheduled maintenance can be developed.

1. Scheduled Maintenance Objectives

The objectives of efficient aircraft scheduled maintenance are

a) To ensure realization of the inherent safety and reliability levels of the aircraft.

b) To restore safety and reliability to their inherent levels when deterioration has occurred.

c) To obtain the information necessary for design improvement of those items whose inherent reliability proves inadequate.

d) To accomplish these goals at a minimum total cost, including maintenance costs and the costs of resulting failures.

These objectives recognize that scheduled maintenance, as such, cannot correct deficiencies in the inherent safety and reliability levels of the aircraft. The scheduled maintenance can only prevent deterioration of such inherent levels. If the inherent levels are found to be unsatisfactory, design modification is necessary to obtain improvement.

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2. Scheduled Maintenance Content

The content of the scheduled maintenance itself consists of two parts with the objective to identify failures and to prevent deterioration of the inherent safety and reliability levels of the aircraft:

a) A group of scheduled tasks to be accomplished at specified intervals. The tasks in scheduled maintenance may include:

   (1) Lubrication/Servicing (LU/SV or LUB/SVC)

   (2) Operational/Visual Check (OP/VC or OPC/VCK)

   (3) Inspection/Functional Check (IN*/FC or */FNC)

   * General Visual Inspection (GV or GVI)

   * Detailed Inspection (DI or DET)

   * Special Detailed Inspection (SI or SDI)

   * Scheduled Structural Health Monitoring (S-SHM)

   (4) Restoration (RS or RST)

   (5) Discard (DS or DIS)

and

b) A group of alternative procedures and/or actions and/or tasks, as related to above (1) to (5), which make use of AHM capability.

An efficient program is one which schedules only those tasks necessary to meet the stated objectives. It does not schedule additional tasks which will increase maintenance costs without a corresponding increase in reliability protection.

3. Method for Scheduled Maintenance Development

This document describes the method for developing the scheduled maintenance.

Scheduled maintenance will be developed via use of a guided logic approach and will result in a task-oriented program. The logic's flow of analysis is failure-effect oriented.

The development shall not be unduly influenced by National Requirements.

As part of the Scheduled maintenance development procedures, maintenance requirements will only be selected if they meet the applicability and effectiveness criteria as defined in this document. The ISC will define the information to be presented to the working group to support their task selection decision and to provide traceability of task requirements in the development of the supporting ICA. This information (e.g. task purpose, accesses, tools/GSE, main steps of the procedure, estimated elapsed time/labor hour, pass/fail criteria ...) will be recorded in the MSG-3 analysis or referenced supporting documentation for tracking purposes.

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Items that, after analysis, have no scheduled task specified, may be monitored by an operator's reliability program and/or optionally make use of AHM.

Sampling may be established for items defined in any MSG-3 Analysis Procedures when novel technology is used, or items which the expected degradation is not fully experienced by the equipment manufacturer for the application operational environment. In order to select applicable and effective Sampling, its selection needs to be supported by the manufacturers and ISC participants.

Sampling is an examination of a specific number of items at defined intervals in order to validate that there are no unexpected degradation characteristics. Sampling programs should not be used as a means to select initial task intervals larger than those that can be substantiated with available data (such as in service and/or design data). Non-sampled items may continue in service until sampling results highlight the need for adjustment.

Assumptions made during the analysis, that can result in a change to the analysis, are to be recorded.

- Assumptions applying to the program as a whole, and not only to an individual MSG-3 analysis, are to be documented in the appropriate "Policy and Procedures Handbook" or "User's Guide." As a minimum, this applies to statements concerning anticipated average annual utilization, the environments to be considered, and the operating capabilities to which the aircraft/powerplant is certificated.
- If an analysis is (partially or as a whole) based on design solutions not completely frozen, this should be recorded in the analysis.

2-2. Divisions of MSG-3 Document

The working portions of MSG-3 are contained in the next four (4) sections. Systems/Powerplant, including components and APU's, are considered in [Section 2-3]. Aircraft Structures is considered in [Section 2-4], Zonal Inspections in [Section 2-5] and L/HIRF is considered in [Section 2-6]. Each section contains its own explanatory material and decision logic diagram (as appropriate); therefore, it may be used independently of other MSG-3 sections.

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Figure 2-2.1. Systems/Powerplant MSG-3 Logic Diagram (Part 1 of 2)

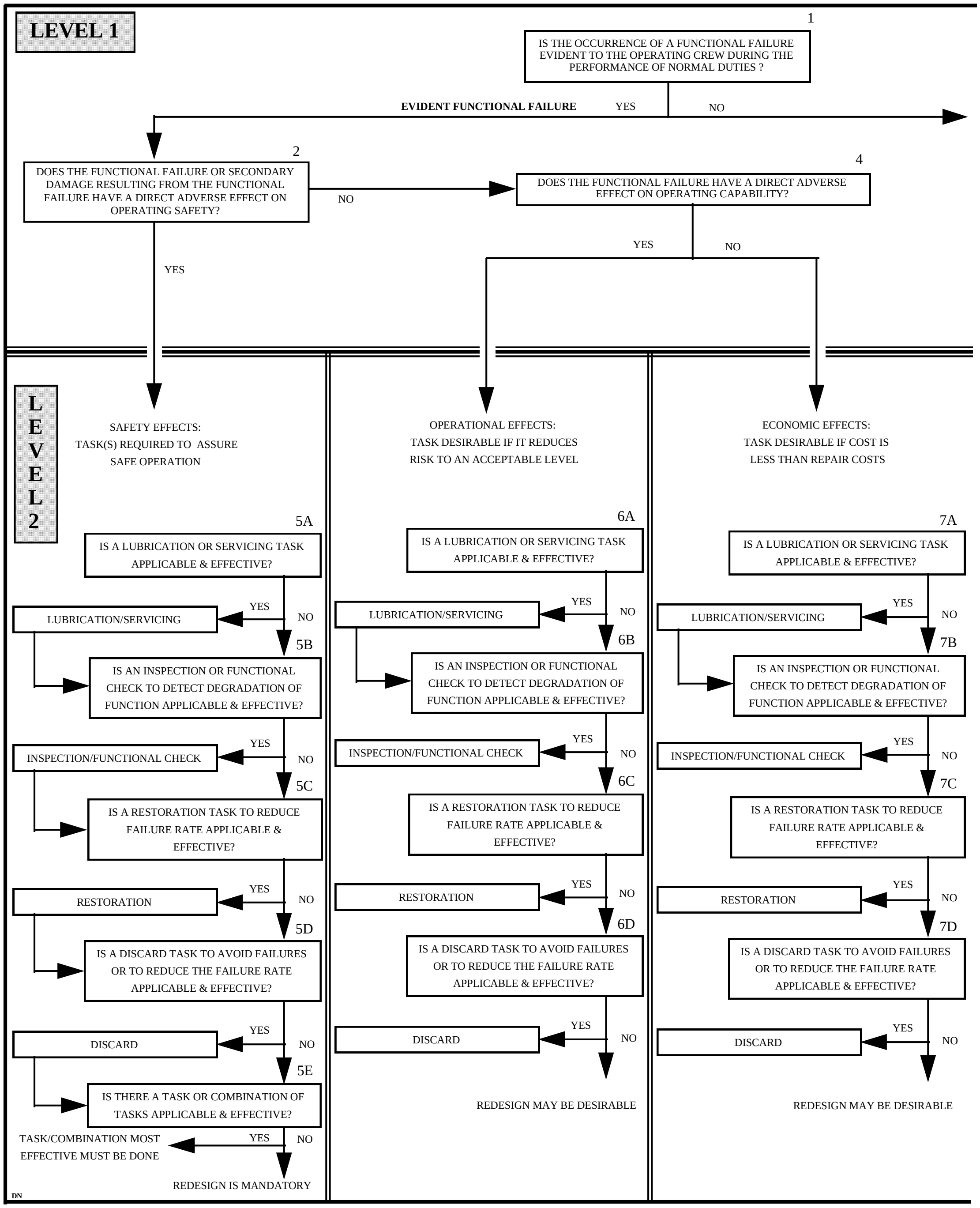

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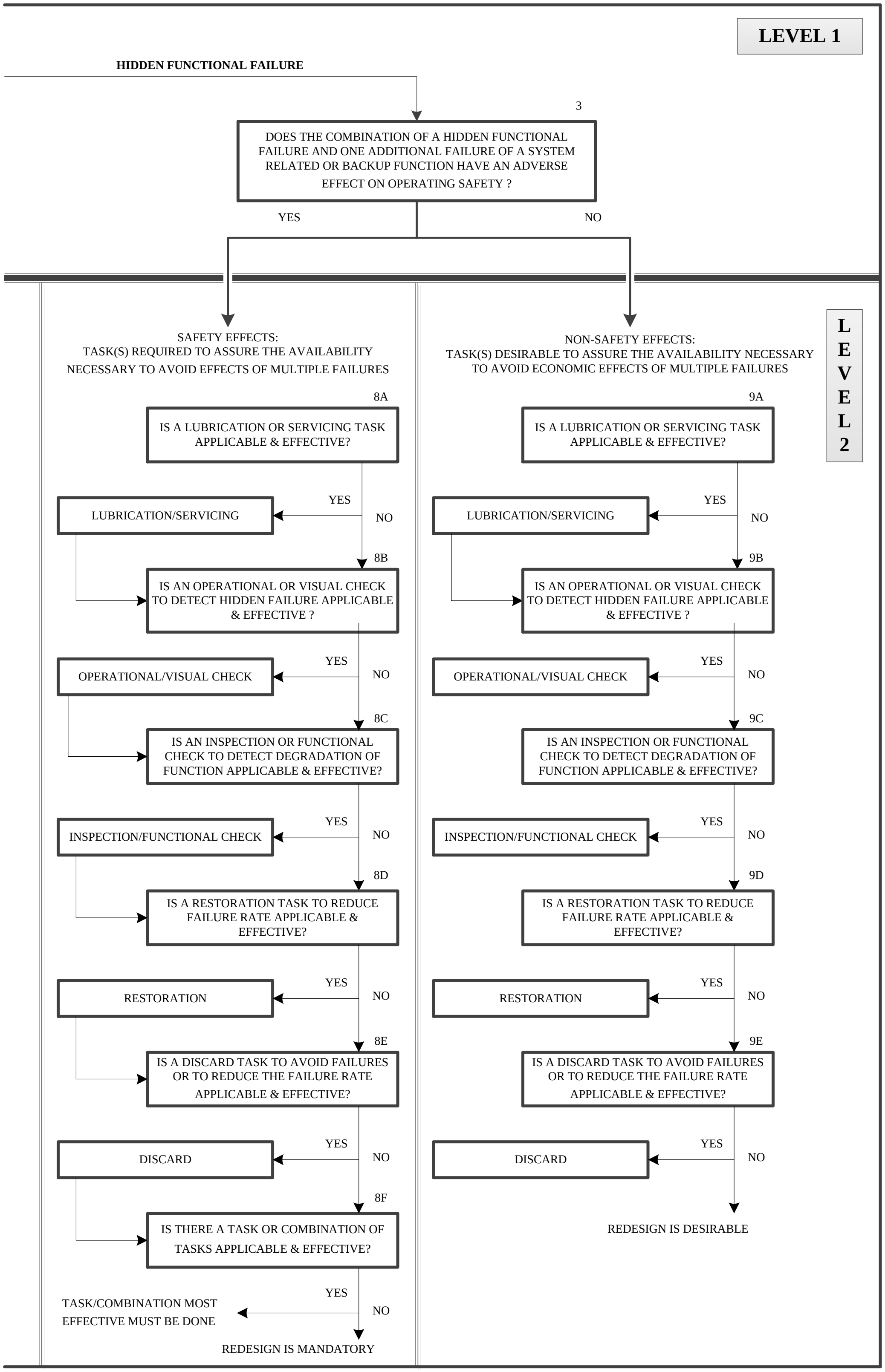
Figure 2-2.1. **Systems/Powerplant MSG-3 Logic Diagram (Part 2 of 2)**



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2-3. Aircraft Systems/Powerplant Analysis Procedure

The method for determining the scheduled maintenance tasks and intervals for systems/powerplant, including components and APU's, uses a progressive logic diagram. A glossary of terms and definitions used in the logic diagram is listed in Appendix A. This logic is the basis of an evaluation technique applied to each maintenance significant item (system, sub-system, module, component, accessory, unit, part, etc.), using the technical data available. Principally, the evaluations are based on the item's functional failures and Failure Causes.

The references to and use of AHM throughout this section requires the certification of the associated on-aircraft system features by the type certification staff of the Regulatory Authority. The use of AHM is limited to non-safety tasks provided the tasks are not covering CCMRs.

2-3-1. MSI Selection

Before the actual MSG-3 logic can be applied to an item, the aircraft's significant systems and components must be identified. The identification process shall not be influenced by National Requirements.

Maintenance Significant Items (MSIs) are items fulfilling defined selection criteria (see Step 3 below) for which MSI analyses are established at the highest manageable level.

This process of identifying Maintenance Significant Items is a conservative process (using engineering judgment) based on the anticipated consequences of failure. The top-down approach is a process of identifying the significant items on the aircraft at the highest manageable level.

The MSI selection process is outlined below:

1. Step 1.

The manufacturer partitions the aircraft into major functional areas; ATA Systems and Subsystems. This process continues until all on-aircraft replaceable components have been identified.

NOTE:	1. Structural items, whether designated as SSI or Other Structure, having system related functionality (e.g. firewalls, shields, integral fuel tank boundaries, flight control hinge bearings, drains, door hinges) need to be addressed in the MSI selection through coordination between Systems and Structures Working Groups in accordance with established transfer policies and procedures. 2. System components that contribute significantly to carrying flight, ground, pressure or control loads and whose failure could affect the structural integrity necessary for the safety of the aircraft should be analyzed in consultation with the Structures Working Group in accordance with established transfer policies and procedures 3. All safety/emergency systems or equipment should also be included.

2. Step 2.

Using a top-down approach, the manufacturer establishes the list of items to which the MSI selection questions will be applied.

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NOTE:	Regulatory policy developed for fuel tank system safety Instructions for Continued Airworthiness (ICA), requires the identification of design features that may result in development of ignition sources in the fuel tank systems; e.g., the bonding subsystem to carry electrical current generated in the event of lightning, and the wire harnesses in an around fuel tanks that maintain separation to prevent wire contact/chafing. These design features are to be included in MSI selection and analysis.

3. Step 3

The manufacturer applies the following questions to the list of items identified in Step 2:

a) Could failure be undetectable or not likely to be detected by the operating crew during normal duties?

b) Could failure affect safety (on ground or in flight), including safety/emergency systems or equipment?

c) Could failure have significant operational impact?

d) Could failure have significant economic impact?

4. Step 4

a) For those items for which at least one of the four questions is answered with a "YES," MSG-3 analysis is required, and the highest manageable level must be confirmed (see Step 2, above). Consideration should be given to selecting a higher manageable level that includes this item as part of that higher-level system.

   An MSI is usually a system or sub-system, and is, in most cases, one level above the lowest (on-aircraft) level identified in Step 1. This level is considered the highest manageable level; i.e., one which is high enough to avoid unnecessary analysis, but low enough to be properly analyzed and ensure that all functions, functional failures and Failure Causes are covered.

b) For those items for which all four questions are answered with a "NO," MSG-3 analysis is not required and further MSI selection analysis is not necessary at lower levels. Additionally, the lower-level items should be listed to identify those that will not be further assessed. This list must be presented by the manufacturer to the ISC for review and approval.

5. Step 5

Once the highest manageable level is confirmed per Step 4, the resulting list of items is now considered the "Candidate MSI List," and is presented by the manufacturer to the ISC. The ISC, in turn, reviews and approves this list for subsequent distribution to the Working Groups.

6. Step 6

The Working Groups will review the Candidate MSI List, and through application of MSG-3 analysis, validate the selected highest manageable level or (if required) propose modification of the MSI list to the ISC. The primary aim of the Working Group review is to verify that no significant item has been overlooked, and that the right level for the analysis has been chosen.

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> NOTE: Although an item may be selected as an MSI and will be analyzed, this does not imply that a task will necessarily result from the analysis.

2-3-2. Analysis Procedure

After the MSI's have been selected, the following must be identified for each MSI:

a) Function(s) - the normal characteristic actions of an item

b) Functional Failure(s) - Failure of an item to perform its intended function within specified limits

c) Failure Effect(s) - what is the result of a functional failure

d) Failure Cause(s) - why the functional failure occurs

Defining some functional failures may require a detailed understanding of the system and its design principles. For example, for system components having single element dual load path features, such as concentric tubes or back-to-back plates, the function of both paths should be analyzed individually. The degradation and/or failure of one path may not be evident.

Failure Causes should describe specifically why and how a function fails i.e. which component is causing the failure and by which behavior (For Example: check valve stuck open, gland seal leaking, filter clogged, membrane ruptured) to aid in maintenance task and interval determination as well as for Failure Cause transfers among MSIs.

When listing functions, functional failures, failure effects, and Failure Causes, care should be taken to identify the functions of all protective devices. These include devices with the following functions:

a) to draw the attention of the operating crew to abnormal conditions

b) to shut down equipment in the event of a failure

c) to eliminate or relieve abnormal conditions which follow a failure

d) to take over from a function that has failed

Protective function statements should describe the protective function itself, and should also include the words "if" or "in the event of" followed by a brief description of the events or circumstances that would activate or require activation of the protection. For example, "To open the relief valve to atmosphere in the event of system X pressure exceeding 300 psi."

For systems providing AHM capability, all related functions of the corresponding MSIs and candidate MSIs have to be identified if they are intended to be used. After the Level 3 analysis exercise is completed, information is to be provided to the ISC in order to show that all systems/sub-systems providing AHM functionality were accounted for and its analyses has been checked for completeness.

Tasks and intervals required in the scheduled maintenance are identified using the procedures set forth herein. Both the economic and safety related tasks are included so as to produce initial scheduled maintenance tasks/intervals.

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All available Vendor Recommendations (VR) should be fully considered, discussed in the MWG meetings, and accepted only if they are applicable and effective according to MSG-3 criteria.

Prior to applying the MSG-3 logic diagram to an item, a preliminary work sheet will be completed that clearly defines the MSI, its function(s), functional failure(s), failure effect(s), Failure Cause(s) and any additional data pertinent to the item; e.g., ATA chapter reference, fleet applicability, manufacturer's part number, a brief description of the item, expected failure rate, hidden functions, need to be on M.E.L., redundancy (may be unit, system or system management), AHM capability (including certification considerations), parameters and outputs (data generated), etc. This work sheet is to be designed to meet the user's requirements and will be included as part of the total MSG-3 documentation for the item.

If system failure may affect structural integrity then details relating to the failure should be passed to the Structures Working Group (or equivalent body) for consideration in accordance with established transfer policies and procedures. Examples could include, but are not limited to, failure of load limiting devices, hydraulic leaks and bleed air leaks.

The approach taken in the following procedure is to provide a logic path for each functional failure. Each functional failure and Failure Cause must be processed through the logic so that a judgment will be made as to the necessity of a task. The resultant tasks and intervals will form the initial scheduled maintenance.

2-3-3. Logic Diagram

The decision logic diagrams are used for analysis of systems/powerplant items. The logic flow is designed whereby the user begins the analysis at the top of the diagram, and answers to the "YES" or "NO" questions will dictate direction of the analysis flow.

1. Levels of Analysis

The decision logic has two levels (Level 1 and 2) enabling the development of Classic tasks (Ref. [Figure 2-2.1]) and a third level (Level 3) enabling the use of AHM (Ref. [Figure 2-3-9.1]):

a) Level 1 (questions 1, 2, 3 and 4) requires the evaluation of each FUNCTIONAL FAILURE for determination of the Failure Effect Category; i.e., safety, operational, economic, hidden safety or hidden non-safety.

The response to these questions shall take into consideration all certificated operating capabilities of the aircraft (e.g., Extended Twin OPerationS / ExTended OPerationS (ETOPS), Reduced Vertical Separation Minima (RVSM), Category (Cat) III).

b) Level 2 (questions 5, 6, 7, 8 and 9, "A" through "F", as applicable) then takes the FAILURE CAUSE(S) for each functional failure into account for selecting the specific type of task(s).

At level 2, the task selection section, paralleling and default logic have been introduced. Regardless of the answer to the first question regarding "Lubrication/Servicing", the next task selection question must be asked in all cases. When following the hidden or evident safety effects path, all subsequent questions must be asked. In the remaining categories, subsequent

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to the first question, a "YES" answer will allow exiting the logic.

NOTE:	At the user's option, advancement to subsequent questions after deriving a "YES" answer is allowable, but only until the cost of the task is equal to the cost of the failure prevented.

Default logic is reflected in paths outside the safety effects areas by the arrangement of the task selection logic. In the absence of adequate information to answer "YES" or "NO" to questions in the second level, default logic dictates a "NO" answer be given and the subsequent question be asked. As "NO" answers are generated the only choice available is the next question, which in most cases provides a more conservative, stringent and/or costly task.

c) Level 3 - If the system offers AHM capability, a third level decision logic (i.e. Level 3) may be applied. This level enables working groups to assess Failure Causes covered by AHM capability associated with lubrication and servicing, detecting degradation, and detecting hidden failure.

2-3-4. Procedure

This procedure requires consideration of the functional failures, Failure Causes, and the applicability/ effectiveness of each task. Each functional failure processed through the logic will be directed into one of five Failure Effect categories [Subject 2-3-6].

Fault-Tolerant Systems

By definition, the implementation of fault-tolerant system design by the manufacturer may be required to achieve necessary safety and reliability levels of the aircraft and/or to enhance the in-service system availability.

In Fault Tolerant Systems, after a Function has been defined as redundant, a failure of one element is often not a valid Failure Cause, since it has another level of redundancy built in on a sub level. It is up to the WG to decide if it is practical and effective to consider a sub level failure, which is actually a Fault (see a Glossary definition). A Functional Failure in this case is a degradation of redundancy.

Tasks may be selected in cases where the identification of faults within a fault tolerant system is considered effective to support inherent safety and reliability levels. In the case of reliability, the task shall only be selected if it is considered of operational or economic benefit to the operator in maintaining the required reliability levels.

Tasks with the sole intent to enhance in-service availability i.e. tasks to support dispatch guarantees that go beyond maintaining inherent reliability levels, do not form part of the minimum set of tasks required for an operators initial maintenance program and thus shall not be included in the MRB Report.

Pressurized Cylinders

Historical data has shown that the performance of a Hydrostatic Test has no correlation to the high level of safety of the pressurized cylinders and is deemed as not applicable and effective. The same data highlights that only isolated cases of sudden rupture of cylinders in flight have been reported over the last thirty years of operation of cylinders on commercial aircraft.

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To drive a harmonized approach in the consideration of pressure cylinders, the MSG-3 analyst should observe the following:

a) A sudden rupture of a cylinder shall be considered as unrealistic and thus does not need to be identified as a Failure Cause. This limits the effect of failures to the system in which the cylinder is installed.

b) The Hydrostatic Test typically recommended by the cylinder vendor (and possibly also the subject of National Requirements) is not considered an effective task to satisfy MSG-3 logic.

In determining appropriate tasks and intervals, consideration shall be given to the use of the cylinder with particular attention being given to cylinders that are regularly refilled in service to address normal usage (e.g. oxygen), these being more likely to experience degradation caused through more frequent handling and being more susceptible to the introduction of moisture or other contaminants.

2-3-5. Consequences of Failure (First Level)

The decision logic diagram (Ref. [Figure 2-2.1]) facilitates the identification of the tasks required. There are four first level questions.

1. Evident or Hidden Functional Failure

QUESTION 1:	**IS THE OCCURRENCE OF A FUNCTIONAL FAILURE EVIDENT TO THE OPERATING CREW DURING THE PERFORMANCE OF NORMAL DUTIES?**

This question asks if the operating crew will be aware of the loss (failure) of the function during performance of normal operating duties. Question 1 must be asked for each functional failure of the item being analyzed. The intent is to segregate the evident and hidden functional failures. The operating crew consists of qualified flight compartment and cabin attendant personnel who are on duty. Normal duties are those duties associated with the routine operation of the aircraft on a daily basis.

System failures which are indicated to the operating crew when performing their normal duties shall be considered as evident.

If there is uncertainty about the frequency of use of certain systems, and assumptions are to be made, then the assumptions made must be recorded in the analysis for later verification. This applies equally to assumptions made concerning tests that are performed automatically by electronic equipment.

NOTE: In order to take credit for tests that are performed automatically by electronic equipment at power up of a system, any assumption that this system is de-powered on a daily basis is to be formalized in the MRB Report Program/Operating rules.Ground crew is not part of the operating crew.

Flight crew "normal duties" are described (in part) in the approved section of the Airplane Flight Manual (AFM) and must be accomplished by the flight crew. Working groups may consider these flight crew checks as part of the operating crew's "normal duties" for the purpose of categorizing failures as evident in the MSG-3 Level 1 analysis. It should be documented in the analysis whenever credit is taken for such flight crew checks.

Since the AFM is not available during the initial MSG-3 analysis, the manufacturer shall propose an appropriate method documented in the "Policy and Procedures Handbook" to adequately cover AFM assumptions and

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coordinate the follow-up of the AFM modifications with the ISC and MRB until its approval. Once the AFM is approved, all Level 1 analyses based on such assumptions must be verified to ensure that these checks are included in the AFM. This verification activity shall be finalized prior to the entry into service of the aircraft. Level 1 analysis must be redone for any assumed flight crew check not included in the approved section of the AFM. Any change affecting the MSG-3 analysis with a direct impact on the MRBR content should be reflected as soon as possible prior to the entry into service of the aircraft.

A "YES" answer indicates the functional failure is evident; proceed to Question 2 (Ref. [Heading 2-3-5.2]).

A "NO" answer indicates the functional failure is hidden; proceed to Question 3 (Ref. [Heading 2-3-5.3]).

2. Direct Adverse Effect on Safety

QUESTION 2:	**DOES THE FUNCTIONAL FAILURE OR SECONDARY DAMAGE RESULTING FROM THE FUNCTIONAL FAILURE HAVE A DIRECT ADVERSE EFFECT ON OPERATING SAFETY?**

For a "YES" answer the functional failure must have a direct adverse effect on operating safety.

NOTE:	Contrary to the guidance in Para 2-3-5.3 that requires selection of FEC 8 in specific circumstances, FEC 5 is only selected if the Failure Cause has a direct adverse effect on safety; no additional failure/event needs to be considered.

<u>Direct:</u> To be direct the functional failure or resulting secondary damage must achieve its effect by itself, not in combination with other functional failures (no redundancy exists and it is a primary dispatch item).

<u>Adverse Effect on Safety:</u> Safety shall be considered as adversely affected if the consequences of the failure condition would prevent the continued safe flight and landing of the aircraft and/or might cause serious or fatal injury to human occupants.

<u>Operating:</u> This is defined as the time interval between any person boarding the aircraft with the intention of flight and the last person disembarking the aircraft following that flight.

A "YES" answer indicates that this functional failure must be treated within the Safety Effects category and task(s) must be developed in accordance with [Heading 2-3-6.1].

A "NO" answer indicates the effect is either operational or economic and Question 4 (Ref. [Heading 2-3-5.4]) must be asked.

3. Hidden Functional Failure Safety Effect

QUESTION 3:	**DOES THE COMBINATION OF A HIDDEN FUNCTIONAL FAILURE AND ONE ADDITIONAL FAILURE OF A SYSTEM RELATED OR BACK-UP FUNCTION HAVE AN ADVERSE EFFECT ON OPERATING SAFETY?**

This question is asked of each hidden functional failure which has been identified in Question 1.

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The question takes into account failures in which the loss of the one hidden function (whose failure is unknown to the operating crew) does not of itself affect safety; however, in combination with an additional functional failure (system related or intended to serve as a back-up) has an adverse effect on operating safety.

For hidden functional failures of protective devices that could prevent the protective function, the additional failure is the event for which this function of the system or equipment is designed.

For hidden functional failures of safety/emergency systems or equipment (see Glossary) that could prevent the safety/emergency function, the additional failure is the event for which this function of the system or equipment is designed, and in these cases, where the system has no redundancies, a FEC 8 is to be selected. For redundant systems, if the system failure remains hidden after the failure of the first redundancy, a FEC 8 is also to be selected. This applies irrespective of whether the function is required by regulation or is carried as an operator option.

If a "YES" answer is determined, there is a safety effect and task development must proceed in accordance with [Heading 2-3-6.4].

A "NO" answer indicates that there is a non-safety effect and will be handled in accordance with [Heading 2-3-6.5].

4. Operational Effect

QUESTION 4:	**DOES THE FUNCTIONAL FAILURE HAVE A DIRECT ADVERSE EFFECT ON OPERATING CAPABILITY?**

This question asks if the functional failure could have an adverse effect on operating capability:

a) requiring either the imposition of operating restrictions or correction prior to further dispatch; or

b) requiring flight crew use of abnormal or emergency procedures.

This question is asked of each evident functional failure not having a direct adverse effect on safety. The answer may depend on the type of operation.

The assessment of whether or not a failure has an effect on operating capability may require consultation of the MMEL and/or other documentation with operational procedures. As the documents necessary to assess the effect on operating capability are normally not available during the initial MSG-3 analysis, working groups should document all Level 1 failure analyses based on assumptions regarding question 4. Once the affected documents become available, all Level 1 analyses based on such assumptions must be verified.

If the answer to this question is "YES", the effect of the functional failure has an adverse effect on operating capability, and task selection will be handled in accordance with [Heading 2-3-6.2].

A "NO" answer indicates that there is an economic effect and should be handled in accordance with [Heading 2-3-6.3].

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2-3-6. Failure Effect Categories (First Level)

Once the analysts have answered the applicable first level questions, they are directed to one of the five Effect Categories

a) Evident Safety (Category 5)

b) Evident Operational (Category 6)

c) Evident Economic (Category 7)

d) Hidden Safety (Category 8)

e) Hidden Non-Safety (Category 9)

1. Evident Safety Effects (Category 5)

The Evident Safety Effect category must be approached with the understanding that a task is required to assure safe operation. All questions in this category must be asked. If no effective task(s) results from this category analysis, then redesign is mandatory. The following is the logic progression for functional failures that have Evident Safety Effects.

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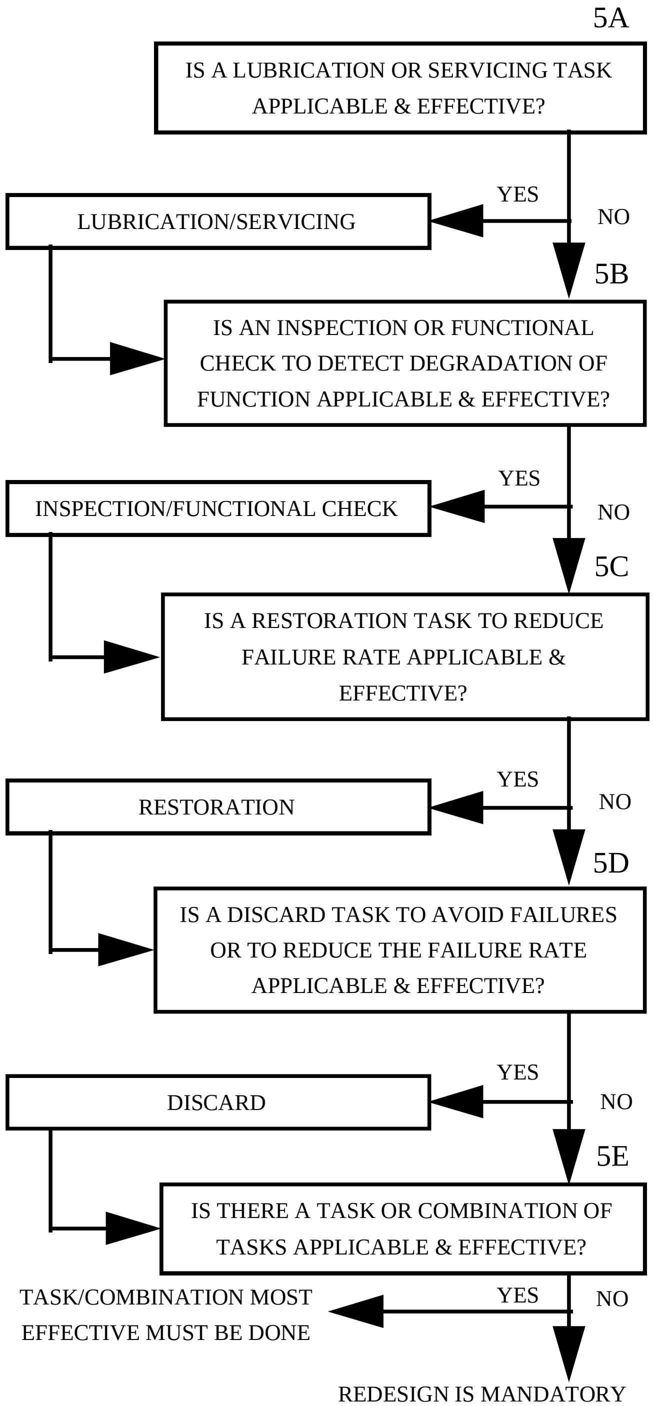
Figure 2-3-6.1. Functional Failures that have Evident Safety Effects



2. Evident Operational Effects (Category 6)

A task(s) is desirable if it reduces the risk of failure to an acceptable level. Analysis of the Failure Causes through the logic requires the first question (Lubrication/Servicing) to be answered. Either a "YES" or "NO" answer of question "A" still requires movement to the next level; from this point on, a "YES" answer will complete the analysis and the resultant task(s) will satisfy the requirements. If all answers are "NO", then no

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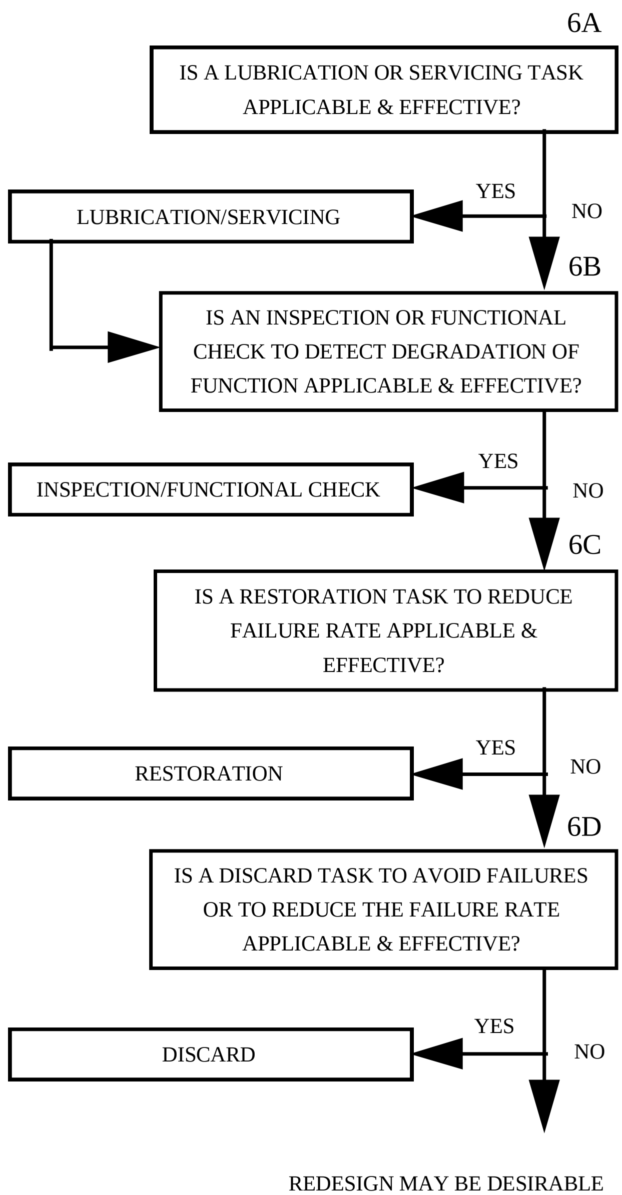
task has been generated. If operational penalties are severe, a redesign may be desirable. The following is the logic progression for functional failures that have Evident Operational Effects.

Figure 2-3-6.2. Functional Failures that have Evident Operational Effects



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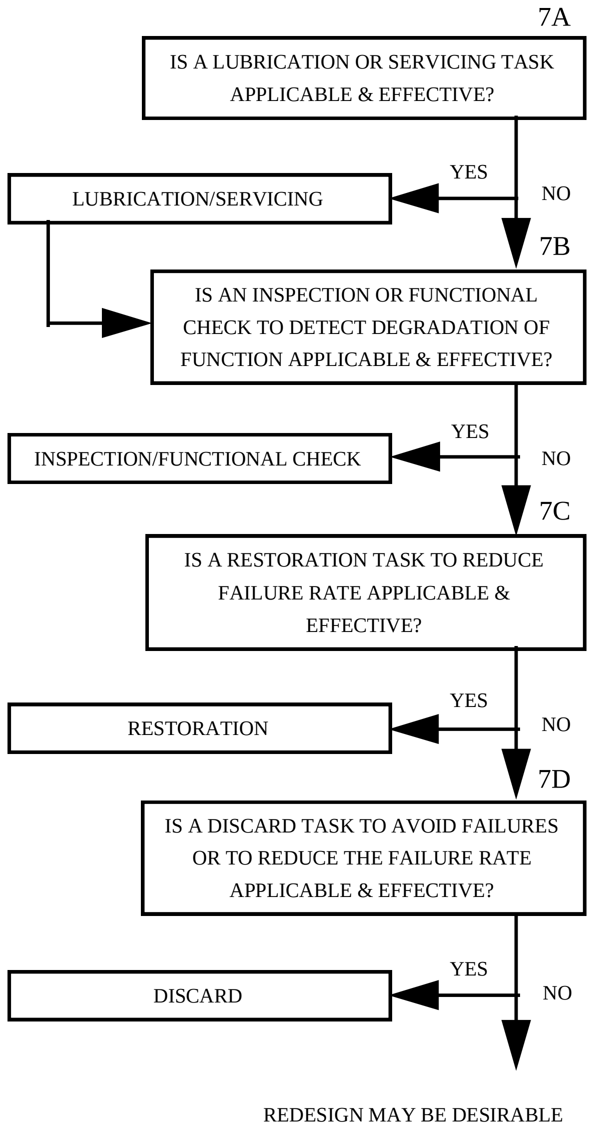
3. Evident Economic Effects (Category 7)

A task(s) is desirable if the cost of repeatedly performing the task on one aircraft is less than the cost of potentially recurring repair. The determination of task effectiveness should be made for one typical aircraft over its full life considering repetitive task performance and potentially repetitive failure and repair.

Analysis of the Failure Causes through the logic requires the first question (Lubrication/Servicing) to be answered. Either a "YES" or "NO" answer to question "A" still requires movement to the next level; from this point on, a "YES" answer will complete the analysis and the resultant task(s) will satisfy the requirements. If all answers are "NO", no task has been generated. If economic penalties are severe, a redesign may be desirable. The following is the logic progression for functional failures that have Evident Economic Effects.

Figure 2-3-6.3. Functional Failures that have Evident Economic Effects



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4. Hidden Function Safety Effects (Category 8)

The **Hidden Function Safety Effect** requires a task(s) to assure the availability necessary to avoid the safety effect of multiple failures. All questions must be asked. If there are no tasks found effective, then redesign is mandatory unless it can be justified in the analysis that no task selection is acceptable based on the design philosophy (e.g. existence of an auto-initiated test). The use of this design philosophy must provide the timely detection for the failure. In addition, the function of the detection capability must be analyzed within the appropriate MSI. The following is the logic progression for functional failures that have Hidden Function Safety Effects.

NOTE:	In order to take credit for tests that are performed automatically by electronic equipment at power up of a system, the assumption that this system is de-powered frequently enough to provide the timely detection of the failure is to be justified prior to the MRB Report approval, and the assumed maximum period between power-downs shall be formalized in the MRB Report Program/Operating rules.

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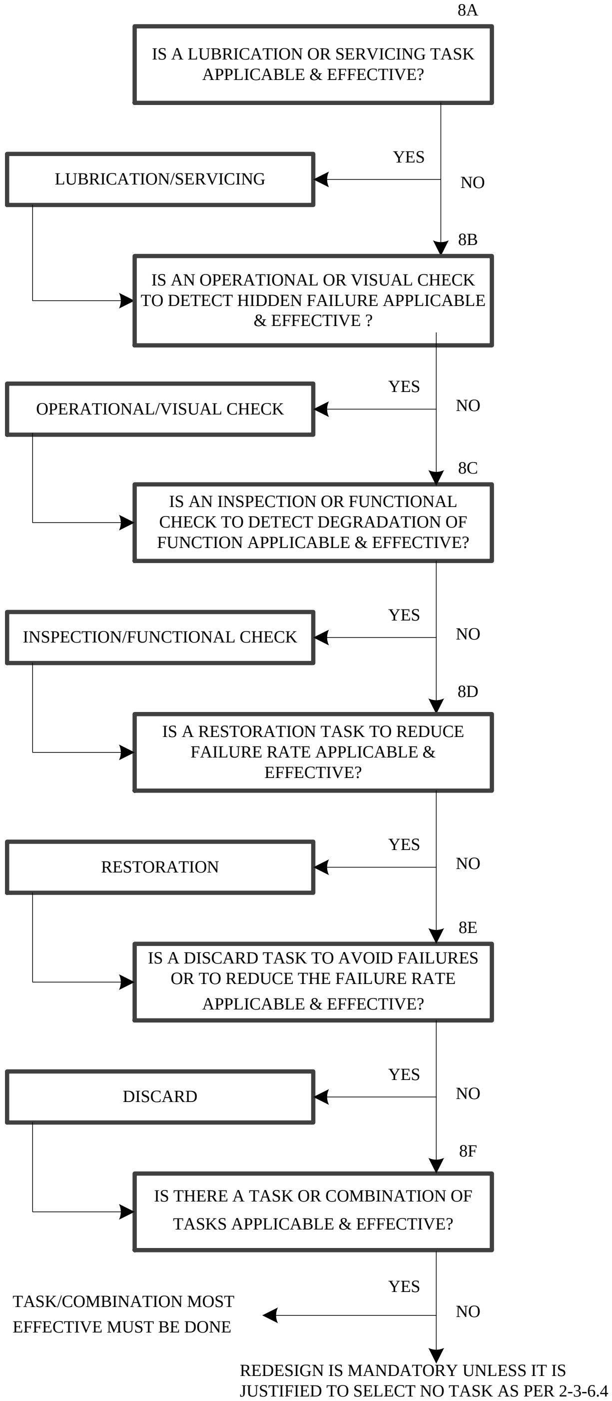
Figure 2-3-6.4. Functional Failures that have Hidden Function Safety Effects



5. Hidden Function Non-Safety Effects (Category 9)

The Hidden Function Non-Safety Effect category indicates that a task(s) may be desirable to assure the availability necessary to avoid the operational or economic effects of multiple failures. Task selection will take into account both operational and economic (cost) effectiveness.

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- The operational consideration shall be limited to the immediate consequences on the operation of the aircraft experiencing the double failure during certificated operations, e.g. cancellation of flight, aborted take-off, return-to-base, diversion. No consideration shall be given to:
    - the consequence on the infrastructure in which the aircraft operates, e.g. the impact of disruptions to the airport and airspace,
    - the subsequent disruption to the schedule, e.g. the impact of rescheduling or accommodating passengers overnight
    - a specific type of operation e.g. perishable goods as cargo,
    - the availability of repair capability or impact of sending parts and workforce to a remote airport (unless otherwise specified in the applicable Policy and Procedures Handbook or User's Guide).
- The economic consideration shall be limited to an assessment of whether the cost of repeatedly performing the task on one aircraft is less than the cost of the potentially recurring functional failure (i.e. loss of a function) or failure effect (e.g. increased fuel consumption) prevented on that aircraft. The assessment will qualitatively compare the cost to perform the task (limited to material and labour cost) with the cost of the failure effect and the cost of having to repair or replace a component whose failure could have been avoided by scheduled maintenance.

The determination of task effectiveness should be made for one typical aircraft over its full life considering repetitive task performance and potentially repetitive failure.

Movement of the Failure Causes through the logic requires the first question (Lubrication/Servicing) to be answered. Either a "YES" or "NO" answer still requires movement to the next level; from this point on, a "YES" answer will complete the analysis and the resultant task(s) will satisfy the requirements. If all answers are "NO", no task has been generated. If operational or economic penalties are severe, a redesign may be desirable.

The following is the logic progression for functional failures that have Hidden Function Non-Safety Effects.

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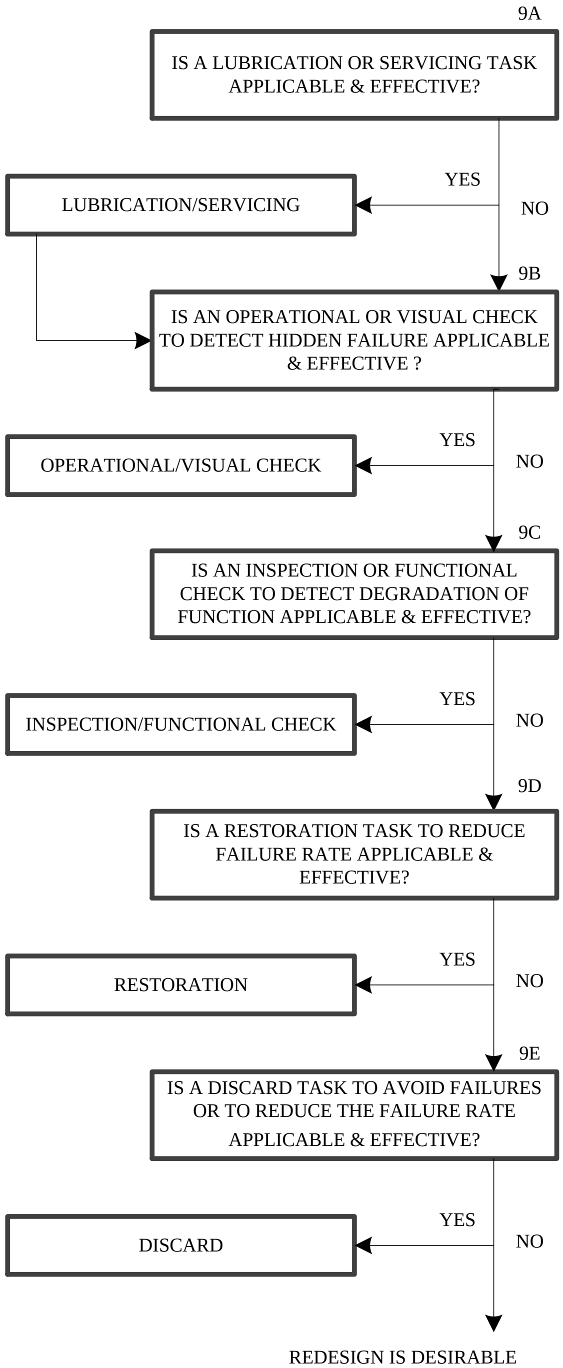
Figure 2-3-6.5. Functional Failures that have Hidden Function Non-Safety Effects



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2-3-7. Task Development (Second Level)

Task development is handled in a similar manner for each of the five Effect categories. For task determination, it is necessary to apply the Failure Causes for the functional failure to the second level of the logic diagram. Definition of Task types can be found at Appendix A. Glossary. There are seven possible task resultant questions in the Effect categories as follows

1. Lubrication/Servicing (All Categories)

QUESTION 5A, 6A, 7A, 8A, 9A:	**IS A LUBRICATION OR SERVICING TASK APPLICABLE AND EFFECTIVE?**

1.1. Applicability Criteria

The replenishment of the consumable must reduce the rate of functional deterioration.

1.2. Effectiveness Criteria - Safety

The task must reduce the risk of failure to assure safe operation.

1.3. Effectiveness Criteria - Operational

The task must reduce the risk of failure to an acceptable level.

1.4. Effectiveness Criteria - Economic

The task must be cost-effective.

2. Operational Check (Hidden Functional Failure Categories Only)

QUESTION 8B & 9B.	**IS AN OPERATIONAL OR VISUAL CHECK TO DETECT HIDDEN FAILURE APPLICABLE AND EFFECTIVE?**

2.1. Applicability Criteria

Confirmation that an item is fulfilling its intended purpose must be possible.

2.2. Effectiveness Criteria - Safety

The task must ensure adequate availability of the hidden function to reduce the risk of multiple failures.

2.3. Effectiveness Criteria - Operational

The task must ensure adequate availability of the hidden function in order to avoid operational effects of multiple failures.

2.4. Effectiveness Criteria - Economic

The task must ensure adequate availability of the hidden function in order to avoid economic effects of multiple failures and must be cost-effective.

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3. Visual Check (Hidden Functional Failure Categories Only)

QUESTION 8B & 9B.	**IS AN OPERATIONAL OR VISUAL CHECK TO DETECT HIDDEN FAILURE APPLICABLE AND EFFECTIVE?**

NOTE: A Visual Check identified through application of Systems/Powerplant logic may not subsequently be considered as covered by a zonal inspection as described in paragraph 2-5-1(j) if it is derived from a Category 8 analysis. At the level of the originating document, such a task must be retained as a standalone Visual Check task within the MSI from which it was identified.

3.1. Applicability Criteria

Visual identification of pass / fail state must be possible.

3.2. Effectiveness Criteria - Safety

The task must confirm the state of a component which indicates that a function required for safe operation is available and reduces the risk of multiple failures.

3.3. Effectiveness Criteria – Operational

The task must confirm a state of a component which indicates availability of the hidden function in order to avoid operational effects of multiple failures.

3.4. Effectiveness Criteria – Economic

The task must confirm a state of a component which indicates availability of the hidden function in order to avoid economic effects of multiple failures and must be cost effective.

4. Inspection/Functional Check (All Categories)

QUESTION 5B, 6B, 7B, 8C & 9C.	**IS AN INSPECTION OR FUNCTIONAL CHECK TO DETECT DEGRADATION OF FUNCTION APPLICABLE AND EFFECTIVE?**

An Inspection can be a General Visual Inspection (GVI), Detailed Inspection (DET), Special Detailed Inspection (SDI). A Functional Check (FNC) can also be selected.

NOTE 1: A GVI identified through application of Systems/Powerplant logic may not subsequently be considered as covered by a zonal inspection as described in paragraph 2-5-1(h) if it is derived from either a Category 5 or 8 analysis. At the level of the originating document, such a task must be retained as a standalone GVI task within the MSI from which it was identified.

NOTE 2: A Special Detailed Inspection identified through application of Systems/Powerplant logic can be used to detect wear damage within specified limits using a measuring tool.

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4.1. Applicability Criteria

Reduced resistance to failure must be detectable, and there exists a reasonably consistent interval between a deterioration condition and functional failure.

NOTE:	If the deterioration identified is of a structural nature (e.g. corrosion) the Structures Working Group could be consulted to help determine an applicable inspection task and interval in accordance with established transfer policies and procedures.

4.2. Effectiveness Criteria - Safety

The task must reduce the risk of failure to assure safe operation.

4.3. Effectiveness Criteria - Operational

The task must reduce the risk of failure to an acceptable level.

4.4. Effectiveness Criteria - Economic

The task must be cost-effective.

5. Restoration (All Categories)

QUESTION 5C, 6C, 7C, 8D, & 9D.	**IS A RESTORATION TASK TO REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?**

Since Restoration may vary from cleaning or replacement of single parts up to a complete overhaul, the scope of each assigned restoration task has to be specified.

5.1. Applicability Criteria

The item must show functional degradation characteristics at an identifiable age and a large proportion of units must survive to that age. It must be possible to restore the item to a specific standard of failure resistance.

5.2. Effectiveness Criteria - Safety

The task must reduce the risk of failure to assure safe operation.

5.3. Effectiveness Criteria - Operational

The task must reduce the risk of failure to an acceptable level.

5.4. Effectiveness Criteria - Economic

The task must be cost-effective.

6. Discard (All Categories)

QUESTION 5D, 6D, 7D, 8E, 9E	**IS A DISCARD TASK TO AVOID FAILURES OR TO REDUCE THE FAILURE RATE APPLICABLE AND EFFECTIVE?**

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Discard tasks are normally applied to so-called single celled parts such as cartridges, canisters, cylinders, engine disks, safe-life structural members, etc.

6.1. Applicability Criteria

The item must show functional degradation characteristics at an identifiable age and a large proportion of units must survive to that age.

6.2. Effectiveness Criteria - Safety

A task must reduce the risk of failure to assure safe operation.

6.3. Effectiveness Criteria - Operational

The task must reduce the risk of failure to an acceptable level.

6.4. Effectiveness Criteria - Economic

The task must be cost-effective.

7. Combination (Safety Categories Only)

QUESTION 5E, 8F.	**IS THERE A TASK OR COMBINATION OF TASKS APPLICABLE AND EFFECTIVE?**

Since this is a safety category question and a task is required, all possible avenues must be analyzed. To do this, a review of the task(s) that are applicable is necessary. From this review the most effective task(s) must be selected. If multiple tasks are selected these may only be consolidated in accordance with Para 2-3-7.9.

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8. Task Selection Criteria

Table 2-3-7.1. Criteria for Task Selection

TASK	APPLICABILITY CRITERIA	EFFECTIVENESS CRITERIA					
		SAFETY		NON - SAFETY			
				OPERATIONAL		ECONOMIC	
		FEC 5	FEC 8	FEC 6	FEC 9	FEC 7	FEC 9
LUBRICATION OR SERVICING	The replenishment of the consumable must reduce the rate of functional deterioration.	The task must reduce the risk of failure to assure safe operation.		The task must reduce the risk of failure to an acceptable level.		The task must be cost effective,	
OPERATIONAL CHECK	Confirmation that an item is fulfilling its intended purpose must be possible *Note: not applicable for an evident failure.*	Not applicable to FEC 5.	The task must ensure adequate availability of the hidden function to reduce the risk of multiple failures	Not applicable to FEC 6	The task must ensure adequate availability of the hidden function in order to avoid operational effects of multiple failures	Not applicable to FEC 7.	The task must ensure adequate availability of the hidden function in order to avoid economic effects of multiple failures and must be cost effective.
VISUAL CHECK	Visual identification of pass / fail state must be possible *Note: not applicable for an evident failure.*	Not applicable to FEC 5.	The task must confirm a state of a component which indicates that a function required for safe operation is available and reduces the risk of multiple failures	Not applicable to FEC 6	The task must confirm a state of a component which indicates availability of the hidden function in order to avoid operational effects of multiple failures.	Not applicable to FEC 7	The task must confirm a state of a component which indicates availability of the hidden function in order to avoid economic effects of multiple failures and must be cost effective.
INSPECTION OR FUNCTIONAL CHECK	Reduced resistance to failure must be detectable and there exists a reasonably consistent interval between a deterioration condition and functional failure.	The task must reduce the risk of failure to assure safe operation		The task must reduce the risk of failure to an acceptable level.		The task must be cost effective.	
RESTORATION	The item must show functional degradation characteristics at an identifiable age, and a large proportion of units must survive to that age. It must be possible to restore the item to a specific standard of failure resistance.	The task must reduce the risk of failure to assure safe operation		The task must reduce the risk of failure to an acceptable level.		The task must be cost effective.	
DISCARD	The item must show functional degradation characteristics at an identifiable age and a large proportion of units must survive to that age.	The task must reduce the risk of failure to assure safe operation.		The task must reduce the risk of failure to an acceptable level.		The task must be cost effective.	

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9. Task Consolidation

Task consolidation is normally not acceptable when establishing the initial scheduled maintenance tasks and intervals. If considered appropriate, it shall be limited to:

- failure finding tasks (OP/OPC and VC/VCK)
- tasks having the same two/three letter code.

If, for technical reasons, tasks of different types (other than OP/OPC and VC/VCK) are required to be performed during the same maintenance event then they shall be linked by a note to this effect against the tasks rather than being consolidated into a single task.

Consolidated tasks may contain tasks derived from one or more analysis dossiers.

In this case, consolidation rules are applicable and appropriate traceability must be implemented.

This paragraph applies to on-aircraft tasks only. Descriptions for off-aircraft restoration tasks may identify different task types.

2-3-8. Systems/Powerplant Classic Task Interval Determination

1. General

As part of the MSG-3 Logic-Analysis, the Maintenance Working Group (MWG) determines the interval of each scheduled maintenance task that satisfies both the applicability & effectiveness criteria. The MWGs should select the most appropriate interval for each maintenance task based on available data and good engineering judgment. In the absence of specific data on failure rates & characteristics, intervals for systems tasks are largely determined based on service experience with similar systems/components.

The information needed to determine optimum intervals is ordinarily not available until after the equipment enters service. In many cases previous experience with the same or a similar item serves as a guide. The difficulty of establishing "correct" intervals for maintenance tasks is essentially an information problem and one that continues throughout the operating life of the equipment.

A task should not be done more often than experience or other data suggests simply because it is easily accomplished (doing tasks more often than necessary increases the chance for maintenance-induced errors and may have an adverse effect on reliability and safety).

2. Sources of Information

The MWG should consider the following in determining the most appropriate task interval:

- manufacturer's tests and technical analysis
- manufacturer's data and/or vendor recommendations
- customer requirements

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- service experience gained with comparable or identical components and subsystems
- 'best engineering estimates'

In order to arrive at the 'best initial' maintenance interval for each task, each MWG must assess the interval based on all relevant data that is available. As part of this assessment, the MWG should consider answering the following questions in order to determine the most appropriate interval:

- What service experience is available for common/similar parts/components/systems on other aircraft that defines an effective task interval?
- What design improvements have been incorporated that warrant a longer interval between checks?
- What task interval is recommended by the vendor/manufacturer based on test data or failure analysis?

3. Task Interval Parameters

Task intervals are established in terms of the measure of exposure to the conditions that cause the failure at which the task is directed. The most widely used usage parameters are:

- calendar time
- flight hours
- flight cycles
- Engine/APU hours/cycles.

Task interval determination consists of identifying the correct usage parameter and its associated numerical interval or the appropriate letter check. Both intervals expressed in usage parameters and/or letter checks are acceptable and may be used in line with specific procedures established for a given program. If an interval is to be expressed in a usage parameter, interval determination consists of the following steps:

- The first step is to define the predominant (governing) usage parameter(s). For many Systems/Powerplant tasks, flight hours is the predominant usage parameter; however, for some tasks, flight cycles or calendar time may be the predominant usage parameter. Intervals may also be expressed in terms of more than one usage parameter.
- The second step is to determine the interval in terms of the selected usage parameter subject to the criteria discussed below.

As a matter of convenience, usage of letter checks for individual tasks and the establishment of a check interval framework may be considered by the ISC; e.g., if no predominant usage parameter can be identified.

For some tasks, it may be appropriate for the MWG to consider specifying an initial interval that is different from the repeat interval.

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4. Task Interval Selection Criteria

In addition to the general guidelines included in [Heading 2-3-8.1], the following detailed recommendations should be considered:

Lubrication/Servicing (failure prevention):

- The interval should be based on the consumable's usage rate, the amount of consumable in the storage container (if applicable) and the deterioration characteristics.
- Typical operating environments and climatic conditions are to be considered when assessing the deterioration characteristics.

Operational Checks & Visual Checks (failure-finding):

- Consider the length of potential exposure time to a hidden failure and the potential consequences if the hidden function is unavailable.
- Task intervals should be based on the need to reduce the probability of the associated multiple failure to a level considered tolerable by the MWG.
- The failure-finding task and associated interval selection process should take into account any probability that the task itself might leave the hidden function in a failed state.

Inspections & Functional checks (potential failure finding):

- There should exist a clearly defined potential failure condition.
- The task interval should be less than the shortest likely interval between the point at which a potential failure becomes detectable and the point at which it degrades into a functional failure. (If the specific failure data is available, this interval may be referred to as the P to F interval.)
- It should be practical to do the task at this interval.
- The shortest time between the discovery of a potential failure and the occurrence of the functional failure should be long enough for an appropriate action to be taken to avoid, eliminate or minimize the consequences of the failure mode.

Restoration and Discard (failure avoidance):

- Intervals should be based on the "identifiable age" when significant degradation begins and where the conditional probability of failure increases significantly.
- Vendor recommendations based on in-service experience of similar parts should also be taken into consideration.
- A sufficiently large proportion of the occurrences of this failure should occur after this age to reduce the probability of premature failure to a level that is tolerable.

5. "Access-Defined" Inspection Intervals

Occasionally, it is impossible to accomplish a task until a component/system is removed/displaced; the interval of such a task should be coordinated with the removal/displacement of that component/system.

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If the component/system is removed/displaced at intervals shorter than what is required for the task, then the task interval should be defined by the MWG as the removal/displacement interval (scheduled or unscheduled). If the task interval is shorter than the removal/displacement interval, then an access-defined interval is not appropriate.

NOTE:	If the MWG selects an access-defined interval, consideration should be given to defining a minimum interval between tasks. For example, if "Engine Change" is the access-defined interval, and the engine is removed soon after the last engine change due to an unscheduled event, the task should not be repeated unless a minimum number of hours have elapsed.

2-3-9. AHM Candidate Analysis (Third level)

1. General

The AHM Candidate category consists of the Failure Causes for which AHM capability exists and for which a Classic task was selected following the Level 2 analysis (see definition). All AHM candidates are processed through the logic diagram of Level 3 analysis. There are three steps associated with the logic diagram. Each step begins with an opening question intended to assess the applicability to the AHM candidate.

Each Failure Cause covered by AHM capability is assessed for:

- Need for lubrication and/or servicing (step 1)
- Detecting degradation (step 2)
- Detecting hidden failure (step 3 - for FEC 8 and 9 only)

The methodology assesses:

- AHM applicability to the Failure Cause(s)
- Time margin between AHM notification and the respective AHM procedure / action
- AHM effectiveness related to the Failure Cause(s)
- Whether AHM presents a full or partial alternative to a Classic task

Three possible outcomes may result from the AHM candidate analysis (per Figure 2-3-9.1)

1. No AHM
2. AHM Alternative(s)
3. AHM Hybrid(s)

AHM alternative(s) and AHM hybrid(s) (i.e. above 2. and 3.) may be used instead of the Classic task. The manufacturer must provide traceability to the Classic task (two way). The PPH will define how these are published in the MRBR and how traceability and the link to detailed procedure documents will be ensured. Except for an AHM applicability note, the Classic task remains unchanged and available. The Classic task, AHM alternative and AHM hybrid each fulfil the minimum requirements and may be individually selected by the operator. The manufacturer will provide provisions which allow the operator to switch between the Level 2 and Level 3 outcome

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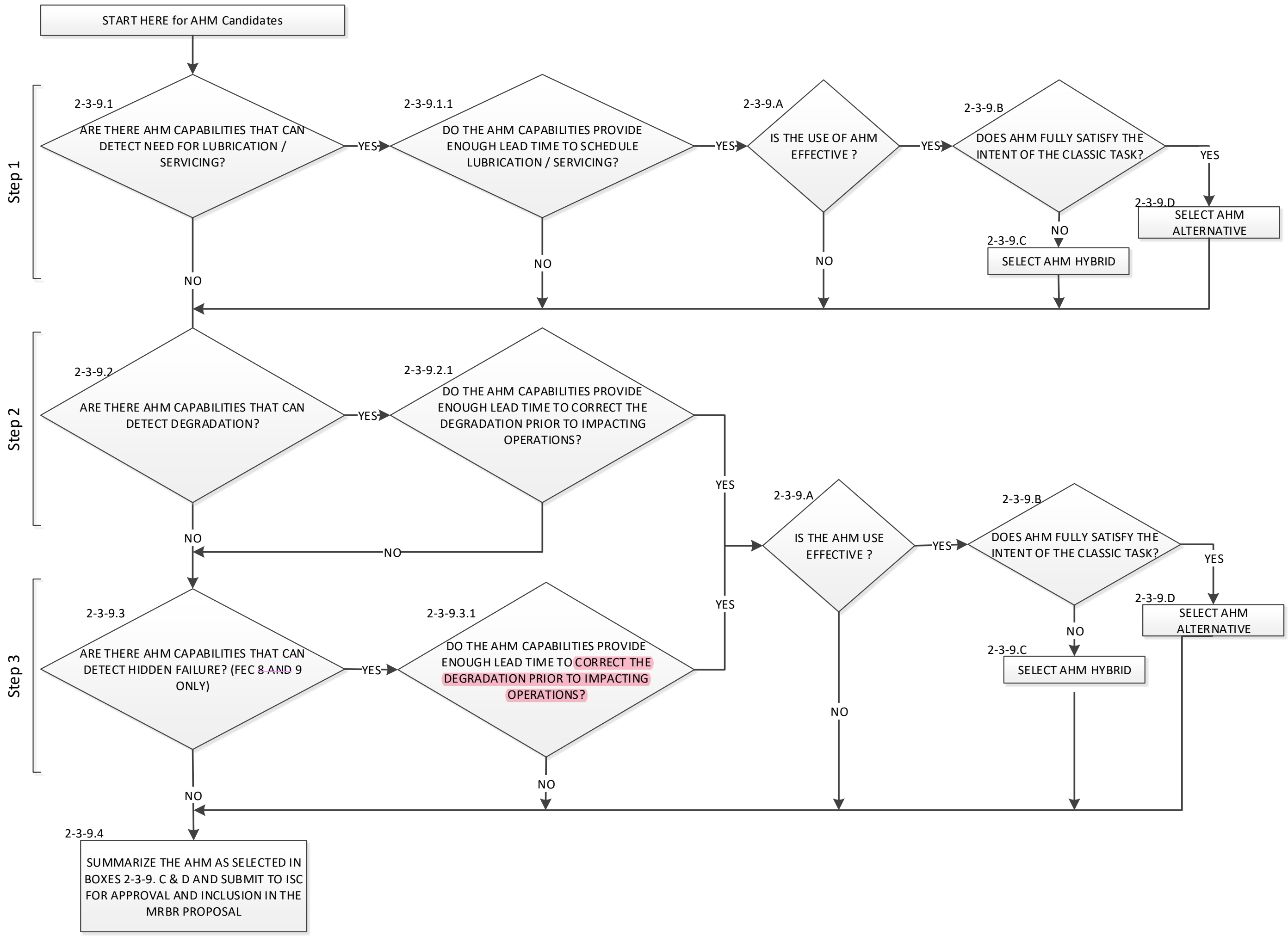
throughout the service life of the aircraft.

The Original Equipment Manufacturer (OEM) must clearly identify AHM system configuration (e.g. Mod No., Option No., dash-Number) and respective AHM functionality within the AHM analysis worksheet in sufficient detail to allow the working groups to answer all questions associated with the logic flow.

Figure 2-3-9.1. Systems/Powerplant MSG-3 Logic Diagram – Level 3 Analysis



2. Step 1

Box 2-3-9.1: ARE THERE AHM CAPABILITIES THAT CAN DETECT NEED FOR LUBRICATION / SERVICING?
Parameter(s) indicating (directly or indirectly) the need for lubrication / servicing must be available to AHM.

Box 2-3-9.1.1: DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO SCHEDULE LUBRICATION / SERVICING?
The AHM must provide timely awareness to the operator before the loss of the function in order to allow the LUB/SVC task to be scheduled at the next convenient opportunity.

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In answering the question, consideration should be given to the ease in which corrective action can be applied and the time required for preparation (e.g. accomplished at an outstation/line maintenance or in a hangar, availability of parts).

Box 2-3-9.A: (as applicable to all three steps) IS THE AHM USE EFFECTIVE?
The same criteria as in Level 2 are used in determining the effectiveness of AHM.

The AHM must be as effective as or more effective than the Classic task(s) selected in Level 2 analysis according to the FEC. In assessing the AHM effectiveness, the following criteria must be satisfied by AHM, as applicable, for:

- FEC 8: it reduces the risk of failure to assure safe operations
- FEC 6&9: it reduces the risk of failure to an acceptable level
- FEC 7&9: the cost of AHM is less than the cost of potentially recurring failure

Box 2-3-9.B: (as applicable to all three steps) DOES AHM FULLY SATISFY THE INTENT OF THE CLASSIC TASK?
AHM must address all Failure Causes covered by the Classic task.

<u>NOTE</u>**:**	In assessing the question consideration should include AHM capability beyond those associated with Failure Cause (e.g. functional failure). The way AHM mitigates the Failure Cause does not necessarily have to be the same as the Classic task, for example a Failure Cause covered by a classic qualitative visual check (failure finding task) may be fully covered by quantitative AHM monitoring (potential failure finding).

Box 2-3-9.C: (as applicable to all three steps) SELECT AHM HYBRID
This is a Classic task supplemented by AHM which may change scope, interval or procedure. In this case the AHM does not fully satisfy the intent of the Classic task – not all Failure Causes are covered by AHM.

Examples of combination could be (but are not limited to):

- AHM paired with modified Classic task at different interval (e.g. for partial – not all Failure Causes)
- Classic task scheduled by parameters from AHM (e.g. for delta P – a restore task converted to FC at a reduced interval)
- AHM data applied for scheduled checks (e.g. for Air Cycle Machine – temp records of operational environments allow for a different interval for ACM maintenance)
- AHM may provide usage parameter to aid in task interval definition

The AHM Hybrid is published within the MRBR.

Box 2-3-9.D: (as applicable to all three steps) SELECT THE AHM ALTERNATIVE
This outcome is a fully equivalent AHM alternative to the Classic task. The AHM Alternative is published within the MRBR.

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3. Step 2

Box 2-3-9.2: ARE THERE AHM CAPABILITIES THAT CAN DETECT DEGRADATION?
Parameter(s) indicating (directly or indirectly) functional degradation or deterioration of components must be present.

Box 2-3-9.2.1: DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO CORRECT THE DEGRADATION PRIOR TO IMPACTING OPERATIONS?
In answering the question consideration should be given to the ease in which corrective action can be applied and the time required for preparation (e.g. accomplished at an out-station/line maintenance or in a hangar, availability of parts).

The AHM must provide timely awareness to the operator before the loss of the function in order to allow the corrective action to be scheduled at the next convenient opportunity. The working group must have a satisfactory understanding of the deterioration characteristics (e.g. P to F curve).

4. Step 3

Box 2-3-9.3: ARE THERE AHM CAPABILITIES THAT CAN DETECT HIDDEN FAILURE? (FEC 8 AND 9 ONLY)
This question is only applicable to Category 8 and 9 functional failures and only if no AHM capability to detect degradation has been identified. Parameter(s) indicating (directly or indirectly) functional failure must be present.

Box 2-3-9.3.1: DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO SCHEDULE CORRECTIVE ACTION?
The AHM must allow the operator to identify the loss of the hidden function in order to prevent a safety, operational or economic impact in combination with a second failure (including back-up). Appropriate lead time will depend on affected function and level of redundancy. Consideration should be similar to those used in determining the interval of a failure finding tasks in level 2 analysis (e.g. consider the length of exposure time to a hidden failure and the potential consequences if the hidden function is unavailable.)

In answering the question consideration should be given to the AHM procedure which must provide detailed instructions about the mitigation action to be launched in case an alert has been triggered. This action can range from a one-time inspection up to a component replacement and needs to be followed by the operator as defined.

In answering the question consideration should be given to the ease in which corrective action can be applied and the time required for preparation (e.g. accomplished at an out-station/line maintenance or in a hangar, availability of parts).

Documentation and active management of the failure must be addressed by the operator.

Box 2-3-9.4: SUMMARIZE THE AHM AS SELECTED IN BOXES 2.3.9 C & D AND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR PROPOSAL.

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This means that all results produced by the Level 3 analysis, following the logic of boxes C and D per any of the three steps (i.e. Step 1 to 3), should be processed as detailed in the PPH.

5. Sources of Information

The following information related to AHM capability, such as but not limited to, should be available when evaluating an AHM candidate:

- All AHM parameters and messages associated with the MSI Failure Cause(s)
- How these parameters are expressed to the operator (Maintenance Message, Operation Center monitoring, etc.)
- The frequency the parameters are checked either by automatic (non-human intervention) or manual (human intervention) means
- Vendor/manufacturer test data or related analysis associated with any limitations (e.g. filter contamination, brake wear)
- AHM messaging informing when parameters are unavailable to support the level 3 AHM options.

6. AHM timing / frequencies

AHM allows operators to identify the need for planning and scheduling maintenance action in order to avoid costly unscheduled maintenance or AOG situations.

Timing associated with the AHM will be contained within the AHM analysis worksheet. Consideration should be given to:

- Message transmittal frequencies,
- Read out frequencies,
- Timing for action, and
- Thresholds or limits associated with a parameter.

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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 accidental damage, environmental deterioration, 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.

Requirements for detecting **Accidental Damage (AD)**, **Environmental Deterioration (ED)**, **Fatigue Damage (FD)**, and procedures for preventing and/or controlling corrosion form the basis for the MRB structural maintenance. However, all FD inspection requirements may not be available when the aircraft enters service. In such cases the manufacturer shall propose, prior to the entry of the aircraft into service, an appropriate time frame for completing the FD inspection requirements.

If the need arises, procedures should be developed for any new material (e.g., new composite material) whose damage characteristics do not follow those procedures described in this document.

2-4-1. Aircraft Structure Defined

Aircraft structure consists of all load carrying members including wings, fuselage, empennage, engine mountings, landing gear, flight control surfaces and related points of attachment. The actuating portions of items such as landing gear, flight controls, doors, etc. will be treated as systems components and will be analyzed as described in [Section 2-3]. The attachment fittings of the actuators to the airframe will be treated as structure, while the dynamic components such as hinge bearings will be treated as System components. Structure-to-structure attach points, not otherwise associated with an aircraft system (e.g., pylon attach fittings and diagonal braces) that feature bearings will be treated as structure. However, since the Structural Analysis Procedure may not provide appropriate tasking for maintaining such attach points, this information should be coordinated with the appropriate Systems Working Group in accordance with established transfer policy and procedures.

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.

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Consideration should be given to any structure that, if failed or detached in flight could, through secondary damage, compromise continued safe flight and landing. The selection of such structure items as SSI should be based on inputs from the design office through simulations, safety hazard analysis, fatigue test results, and in-service experience with similar designs.

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.

An SSI can be damage tolerant or safe-life or a combination of both.

NOTE:	When assemblies are selected to be SSI, those elements that form the assembly and comply with the SSI definition need to be included (e.g., single bolt attaching a pylon diagonal brace).

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.

2-4-2. Scheduled Structural Maintenance

The primary objective of the scheduled structural maintenance is to maintain the inherent airworthiness throughout the operational life of the aircraft in an economical manner. To achieve this, the inspections must meet the detection requirements from each of the AD, ED and FD assessments. Where applicable, other sources of damage/deterioration, such as wear are to be considered when establishing scheduled maintenance requirements. Full account may be taken of all applicable inspections occurring in the fleet.

Wear is typically found in/at bushings, bearings, stops, latches, locks, tracks, guides, cams, rollers, cables, pulleys or floors. Wear can influence loads and strength, lead to inaccurate positioning and adverse free play or change resistance to environmental deterioration. Wear can be systematic for parts intended to be in contact, or random for parts that should normally not come in contact or should not be subjected to relative motion.

NOTE: A Special Detailed Inspection identified through application of Structures logic can be used to detect wear damage within specified limits using a measuring tool. AD and ED analysis is done by means of an assessment based on a rating system, as described in 2-4-5. 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 detection of AD/ED are applicable to all aircraft when they first enter service. Changes or adjustments can be made to these inspections based on individual operator experience, when approved by their local regulatory authority.

Additional maintenance tasks (related to ED in metallics) to control corrosion to Level 1 or better are applicable at a threshold which is established during the aircraft type certification process. These are based on manufacturer and operator experience with similar aircraft structure, taking into consideration differences in

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relevant design features e.g. choice of material, assembly process, corrosion protection systems, galley and toilet design etc. See also [Heading 2-4-2.5] entitled Corrosion Prevention and Control Program.

Non-metallic structure is susceptible to damage and/or deterioration (e.g., disbonding and delamination). Such structure that is classified as an SSI will require inspections to ensure adequate strength throughout its operational life. Susceptibility to long term deterioration is assessed with regard to the operating environment. Areas such as major attachments, joints with metallic parts and areas of high stress levels are suggested as likely candidates for inspection.

Inspections related to FD detection in non-metals should not be required if their design is based on a "no-damage growth" design philosophy and substantiated by testing.

Where no service experience exists with similar structure, the structural maintenance requirements shall be based on manufacturer's recommendations.

Proposed initial scheduled maintenance tasks, to be used as the basis for the structural maintenance, are established for each aircraft type by the Industry Steering Committee on the basis of:

a. Operator experience
b. Manufacturer's proposals
c. Considerations of systems analysis requirements

1. Structural Maintenance Tasks

As part of the structural maintenance development procedure, applicable and effective structural maintenance tasks are selected for each deterioration process of the SSI. To assure a direct correlation between the structural damage tolerance evaluations and the structural maintenance, it is necessary to describe each task.

To all extents possible, the inspection methods specified in the tasks should use the standard set of definitions included in the MSG-3 glossary. Changes and/or additions to the inspection methods and definitions must be approved by the Industry Steering Committee.

Emerging technology, such as SHM may be an option to check or watch for Accidental Damage (AD), Environmental Deterioration (ED) and /or Fatigue Damage (FD) where demonstrated to be applicable and effective. For the time being, MSG-3 only takes into account Scheduled SHM (S-SHM). Dedicated analysis procedures need to be developed and approved/accepted at the level of the PPH for such technology.

2. Inspection Thresholds

The inspection threshold for each SSI inspection task is a function of the source of damage as follows:

a. **Accidental Damage** - The first inspection (threshold) for accidental damage normally corresponds to a period equal to the defined repeat inspection interval, from the time of first entry into service.

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b. **Environmental Deterioration** - The initial inspection thresholds for all levels of inspection are based on existing relevant service experience, manufacturer's recommendations, and/or a conservative age exploration process.

c. **Fatigue Damage** - When applicable, the initial inspection threshold will be defined by the manufacturer stress engineering. This is subject to change as service experience, additional testing, or analysis work is obtained.

3. Repeat Inspection Intervals

After each inspection has been conducted, the repeat interval sets the period until the next inspection:

a. **Accidental Damage** - The repeat interval should be based on operator and manufacturer experience with similar structure. Selected intervals will normally correspond to single or multiple levels of the scheduled maintenance check intervals.

b. **Environmental Deterioration** - The repeat interval for detection/prevention/control of ED (corrosion, stress corrosion, delamination, disbonding, etc.) should be based on existing relevant service experience and/or manufacturers recommendations.

c. **Fatigue Damage** - 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.

4. Fatigue Related Sampling Inspections

Transport aircraft with the highest number of flight cycles are most susceptible to initial fatigue cracking in the fleet. This means that adequate inspections on such aircraft will provide the greatest benefits for timely detection of fatigue damage. Such sampling inspections are developed on the basis of appropriate statistical variables, including:

a. The number of aircraft inspected.

b. The inspection methods and repeat intervals.

c. The number of flight cycles completed.

A list of SSIs that are suitable for a fatigue related sampling inspections will be established by the Structures Working Group and submitted to the Industry Steering Committee for approval and inclusion in the MRB report proposal. Full details of the fatigue related sampling inspections will be established by a joint operator/ manufacturer task force, based on the manufacturer's technical evaluations, prior to aircraft exceeding the fatigue damage threshold(s).

5. Corrosion Prevention and Control Programs (CPCP)

A Corrosion Prevention and Control Program should be established to maintain the aircraft structure's resistance to corrosion as a result of systematic (e.g. age related) deterioration through chemical and/or environmental interaction. This Program applies to damage tolerant and safe-life structure defined as SSI.

The program is expected to allow control of the corrosion on the aircraft to **Corrosion Level 1** or better. The CPCP should be based on the ED analysis, assuming an aircraft operated in a typical environment and, if available, operator experience and in-service data with similar design, materials and surface protection. If

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corrosion is found to exceed Level 1 at any inspection time, the corrosion control program for the affected area must be reviewed by the operator with the objective to ensure Corrosion Level 1 or better.

Special care should be taken to ensure that tasks which cover CPCP requirements are properly identified in the MRB Report, including those transferred or consolidated in a different section than the Structure Section.

6. Age Exploration Program

An age exploration program may be desirable to verify the aircraft's resistance to corrosion deterioration before the Corrosion Prevention and Control Program Task Thresholds.

For Safe-Life items with a life limit below the CPCP Threshold, an age exploration program may be necessary to verify that no premature crack initiation due to corrosion prevents the items to reach their safe-life limit.

To improve on the specific task intervals for non-metallic significant structure, an age exploration program may be desirable to verify the rate of structural deterioration.

Guidelines for age exploration should be established by the Structures Working Group and submitted to the Industry Steering Committee for approval and inclusion in the scheduled structural maintenance tasks and intervals.

7. Zonal Inspections

Some parts of the inspection requirements for SSIs and most of the items categorized as Other Structure can be provided by the zonal inspections (Ref. [Section 2-5]).

Tasks and intervals included in the zonal inspections should be based on operator and manufacturer experience with similar structure. For structure containing new materials and/or construction concepts, tasks and intervals may be established based on assessment of the manufacturer's recommendations.

8. Inspection Results

The type certificate holder (manufacturer) and the operators will implement a satisfactory system for the effective collection and dissemination of service experience from the scheduled structural maintenance.

This process will supplement the system which is required by existing regulations for reporting occurrences of failures, malfunctions or defects (e.g. Service Difficulty Reports).

2-4-3. Damage Sources and Inspection Requirements

This section describes the damage sources and inspection requirements to be considered when developing the scheduled structural maintenance.

1. Damage Sources

The assessment of structure for the selection of maintenance tasks should consider the following damage sources

a. **Accidental Damage (AD)**, which is characterized by the occurrence of a random discrete event which may reduce the inherent level of residual strength. Sources of such damage include ground

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and cargo handling equipment, foreign objects, erosion from rain, hail, lightning, runway debris, discrete spillage events, etc., and those resulting from human error during aircraft manufacture, operation or maintenance that are not included in other damage sources.

The same sources of accidental damage as those considered for metallic materials are to be considered for non-metallic material such as composites. The sensitivity to certain AD sources may differ, depending on the material used. The consequence of damage may not be readily apparent and may include internal damage, e.g., disbonding or delamination.

Large size accidental damage, such as that caused by engine disintegration, bird strike or major collision with ground equipment, will be readily detectable and no maintenance task assessment is required.

b. **Environmental Deterioration (ED),** which is characterized by structural deterioration as a result of an interaction with its climate or environment. Assessments are required to cover corrosion, including stress corrosion, and deterioration of non-metallic materials. Corrosion may or may not be time/usage dependent. For example, deterioration resulting from a breakdown in surface protection is more probable as the calendar age increases. Frequently occurring fluid spillage, like galley spillage, that occur several times during typical inspection intervals should be taken into account when assessing the operational environment. Conversely, corrosion due to rare events, like battery acid spillage should be assessed as a randomly occurring discrete event.

Stress corrosion cracking in a given environment is directly dependent upon the level of sustained tensile stress which may result from heat treatment, forming, fit-up, or misalignment.

In contrast to the environmental deterioration process of metallic structures, non-metallic structures such as composites are not normally susceptible to chemical interaction with the environment, but may be adversely affected by moisture, heat or radiation. The effect of long-term aging in an operating environment has to be taken into consideration when developing the structural maintenance. Pressure/temperature cycling effects should be taken into account due to the potential for fluid ingress during the service life

When evaluating inspection requirements, attention should be paid to the design of the drainage system, as environmental deterioration is directly dependent on the time the structure is exposed to fluids.

c. **Fatigue Damage (FD),** which is characterized by the initiation of a crack or cracks due to cyclic loading and subsequent propagation. It is a cumulative process with respect to aircraft usage (flight cycles or flight hours).

2. Inspection Requirements

Inspection requirements in relation to the damage sources are as follows:

a. **Accidental Damage (AD),** stress corrosion and some other forms of corrosion are random in nature and can occur any time during the aircraft service life. In such cases, inspection requirements apply to all aircraft in the fleet throughout their operational lives.

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b. Most forms of corrosion are time/usage dependent and more likely to occur as the fleet ages. In such cases, operator and manufacturer experience on similar structure can be used to establish appropriate maintenance tasks (including CPCP tasks) for the control of environmental deterioration.

   The deterioration of non-metallic structures such as composites has to be taken into consideration when establishing maintenance tasks. Appropriate inspection levels and frequencies should be based on existing relevant service experience and manufacturer's recommendations.

c. 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).

2-4-4. Scheduled Structural Maintenance Development

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

The assessment of structure for selection of maintenance tasks should include the following

a. The sources of structural deterioration:
   1. Accidental Damage
   2. Environmental Deterioration
   3. Fatigue Damage
b. The susceptibility of the structure to each source of deterioration.
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 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.
d. The applicability and effectiveness of various methods of preventing, controlling or detecting structural deterioration, taking into account inspection thresholds and repeat intervals.
e. Details of any SHM applications proposed by the manufacturer.

1. Procedure

The procedure for developing structural maintenance tasks is shown in the logic diagram (Ref. [Figure 2-4-4.1]) and described by a series of process steps (P1, P2, P3, etc.) and decision steps (D1, D2, D3, etc.) as follows:

a. The structural maintenance analysis is to be applied to all aircraft structure which is divided into zones or areas (P1) and structural items (P2) by the manufacturer.

b. The manufacturer categorizes each item as structurally significant (SSI) or Other Structure, on the

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basis of the consequences to aircraft safety of item failure or malfunction (D1).

c. The same procedure is repeated until all structural items have been categorized.

d. Items categorized as Structural Significant Item (SSI) (P3) are listed as SSI's. They are 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 (D6) and will either become zonal inspection candidate (P17) or will be included in the scheduled structural maintenance (P18).

f. The manufacturer must consider two types of AD/ED analysis; for metallic structure (P7-P9) and for non-metallic structure (P10-P14). Each SSI may consist of one or the other, or both.

g. Task requirements for timely detection of Accidental Damage (AD) and Environmental Deterioration (ED) are determined for all metallic SSIs (P7). These can be determined for individual SSIs or groups of SSIs which are suitable for comparative assessments on the basis of their location, boundaries, inspection access, analysis breakdown, etc. The manufacturer's rating systems (Ref. [Subject 2-4-5]) are used to determine these requirements. The manufacturer may propose a validated S-SHM application(s) as long as it satisfies the detection requirement(s).

h. For each SSI containing metallic structure (damage tolerant or safe-life), the maintenance requirements are determined (P8) such that the expectations of the CPCP (Ref. [Heading 2-4-2.5]) are fulfilled.

i. The inspection requirement of the ED analysis is compared with the requirement of the CPCP (D3). If they are similar or identical, the ED task will cover the CPCP requirement. If the CPCP task requirement is not met, the ED task has to be reviewed and/or additional and separate CPCP tasks have to be determined (P9).

j. The process (P7, P8, P9) is repeated until all metallic SSIs are examined.

k. Each SSI containing non-metallic structure is assessed as to its sensitivity to Accidental Damage (AD) or not (D4), on the basis of SSI location, frequency of exposure to the damage source, and location of damage site.

l. SSIs containing non-metallic structure classified as sensitive to Accidental Damage (AD), are assessed for frequency of exposure to each likely damage source and the likelihood of multiple occurrence (P10), and its impact on the Environmental Deterioration (ED) analysis (P11).

m. When applicable, AD impact on the ED analysis is considered when the SSI is assessed for sensitivity to structural composition (P12) and sensitivity to the environment (P13), considering the material type.

n. Task requirements for timely detection of damage (e.g., delamination and disbonding) are determined for all SSIs containing non-metallic structure (P14). The manufacturer's rating systems (Ref.[Subject 2-4-5]) are used to determine these requirements. The manufacturer may propose a validated S-SHM application(s) as long as it satisfies the detection requirement(s).

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

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.

q. Details of these fatigue related task requirements, including validated S-SHM application(s), are presented to the SWG (or equivalent body) who determines if they are acceptable (D5).

r. Improved task requirement (e.g. change in inspection levels – visual inspections, nondestructive inspections, S-SHM, interval, access, procedure) may be proposed to the manufacturer (P16). 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.

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

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

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

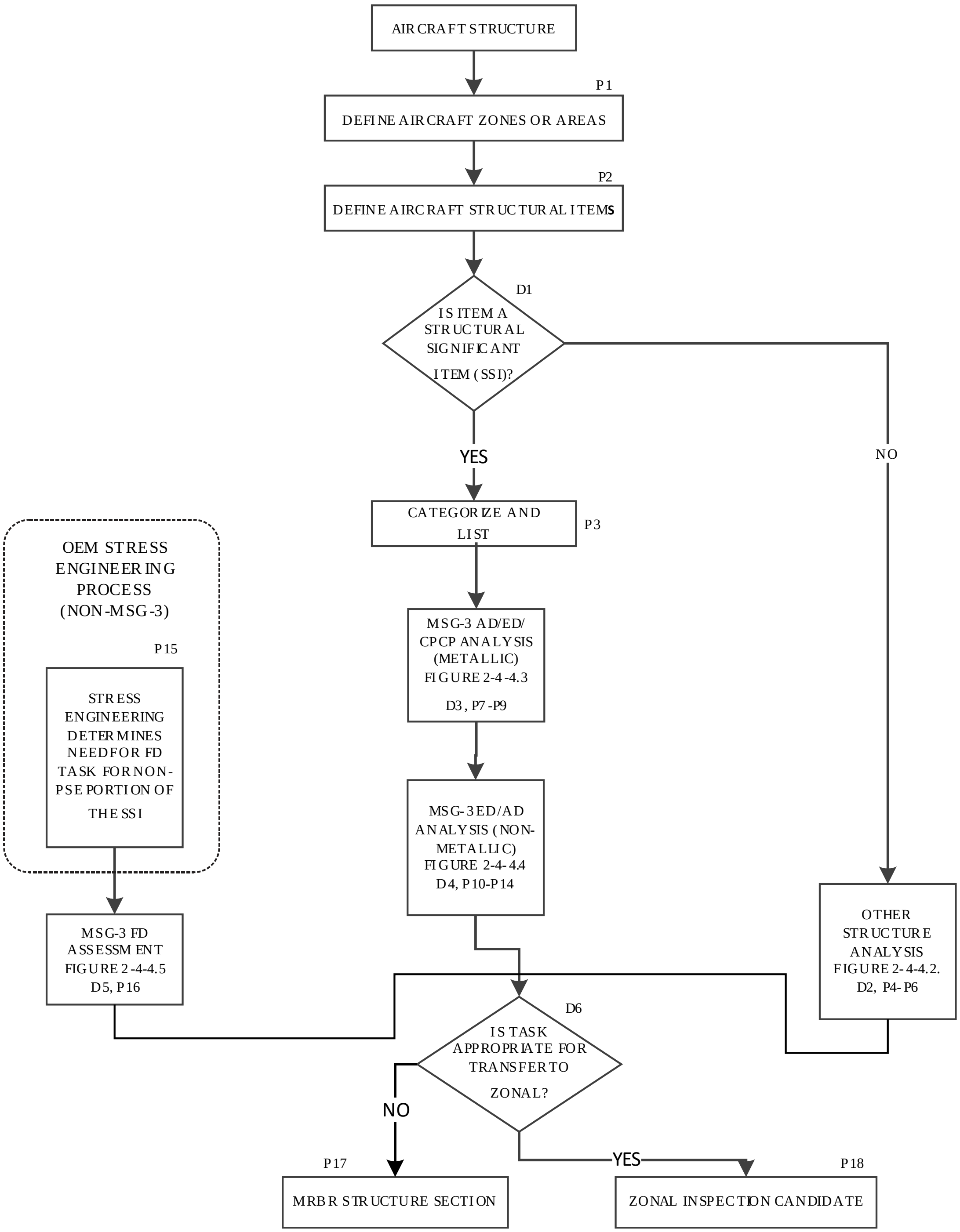

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Figure 2-4-4.2. **Other Structure Logic Diagram**

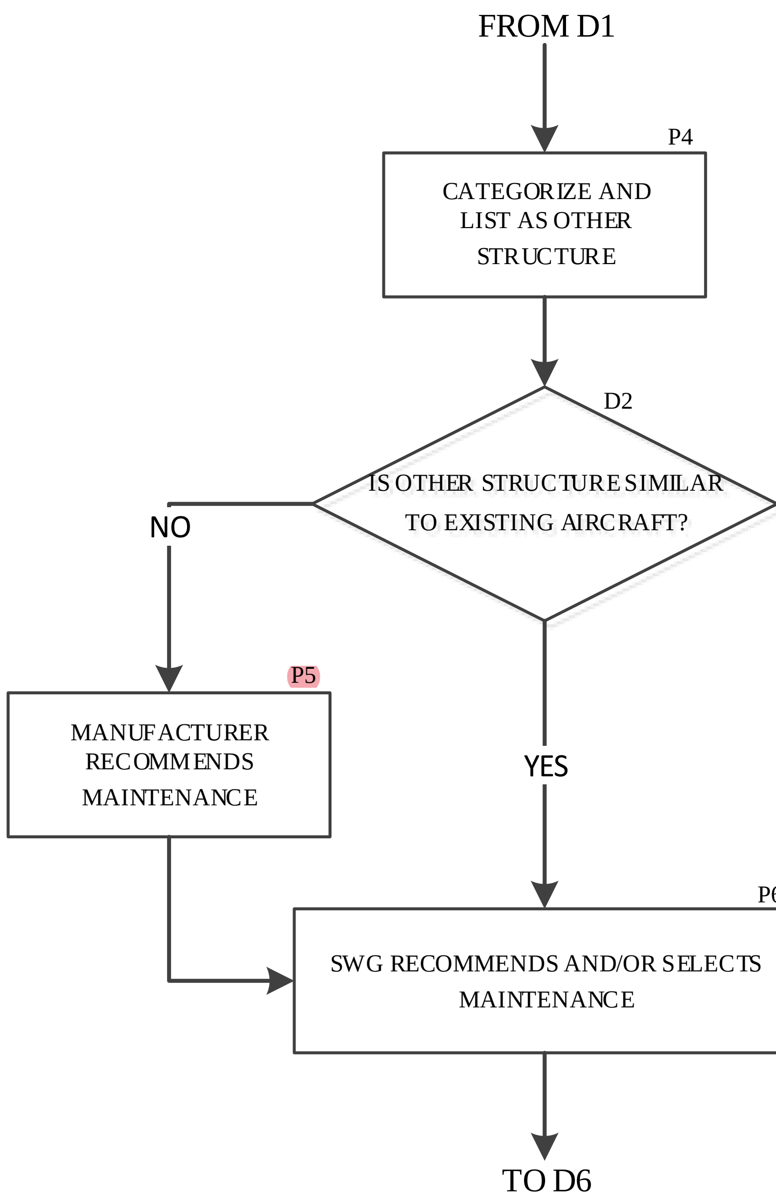

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Figure 2-4-4.3. **Accidental Damage and Environmental Deterioration (Metallic) Logic Diagram**

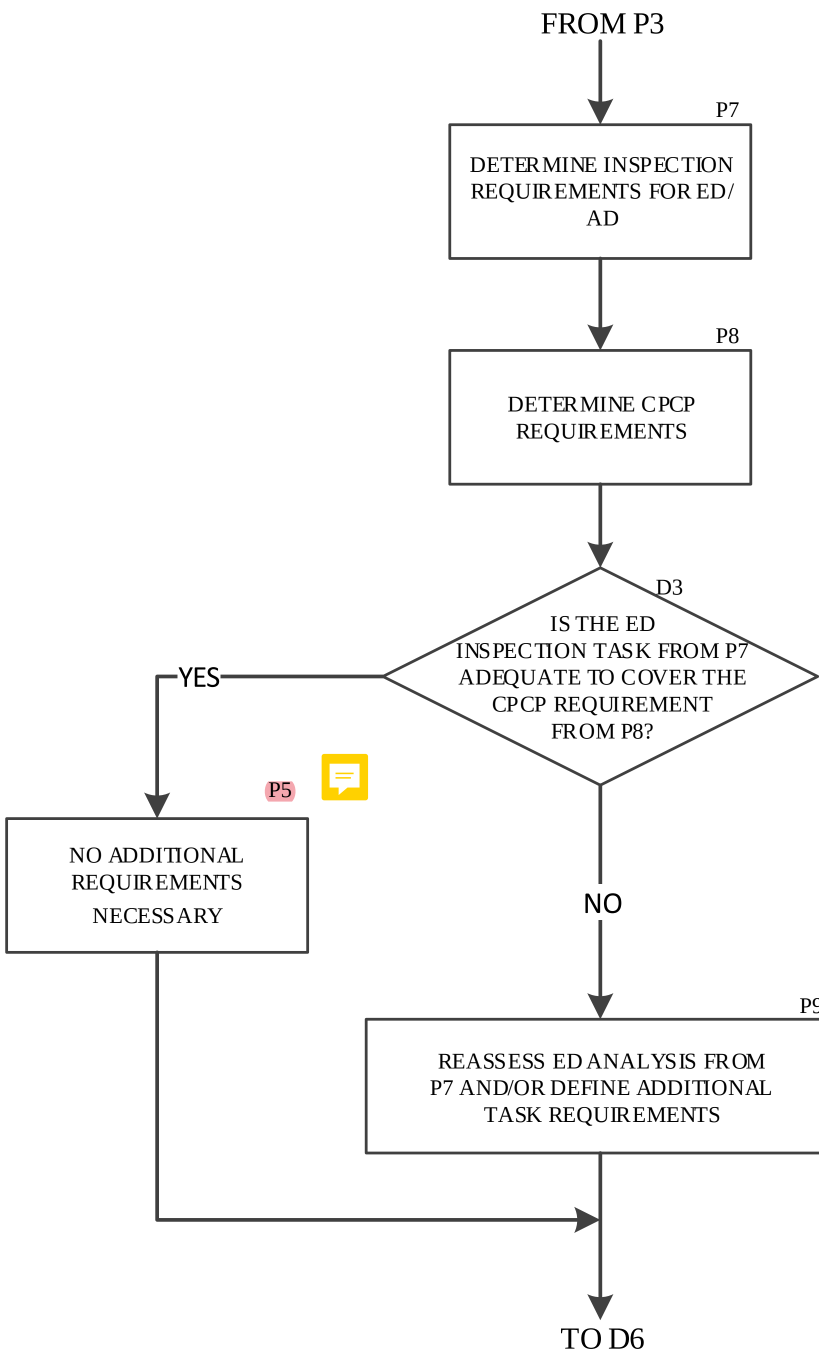

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Figure 2-4-4.4. **Accidental Damage and Environmental Deterioration (Non-Metallic) Logic Diagram**

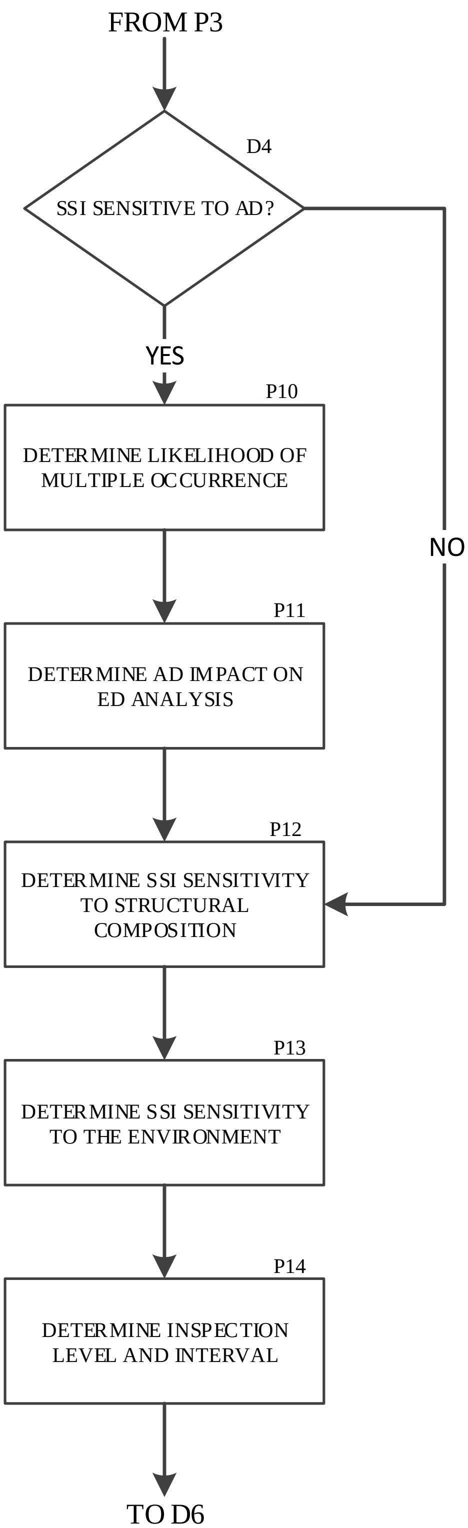

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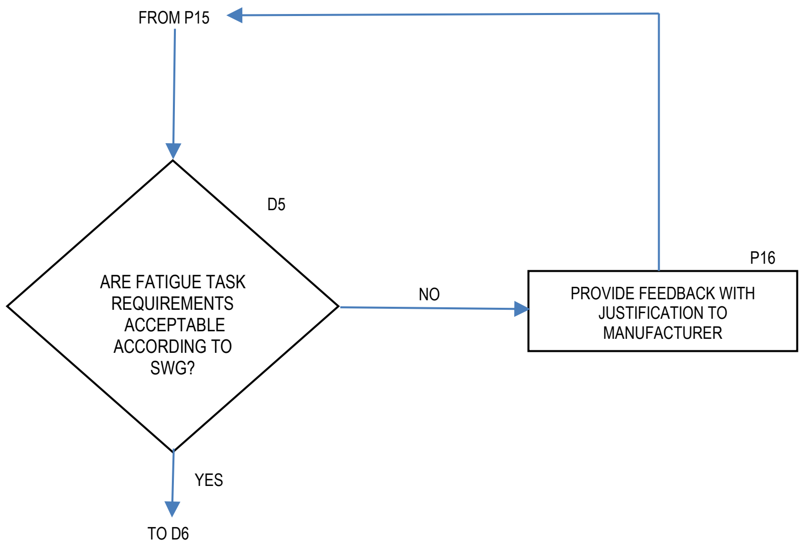
Figure 2-4-4.5. **Fatigue Damage Analysis Logic Diagram**



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

As part of the scheduled structural maintenance development, it is necessary to rate each Structural Significant Item in terms of susceptibility (likelihood of damage) and detectability (timely detection of damage). This section provides guidelines to assist manufacturers in the development of suitable rating systems. The rating system should account for the susceptibility of the SSI to the likely source of damage and the likely type of deterioration of the SSI due to the damage source. Differences between metallic and non-metallic portions of the SSI's must be taken into account.

The scheduled structural maintenance tasks and intervals are developed on the basis of requirements to assure timely detection of Accidental Damage, Environmental Deterioration, and Fatigue Damage. Rating systems for AD and ED should be compatible to allow comparative assessments for each group of SSIs. Emphasis is placed on rating each SSI in relation to other SSIs in the same inspection area, leading to increased inspection emphasis for the most critical SSIs. Manufacturer and operator experience is a key ingredient for these evaluations.

Ratings are established to rank the importance of a particular condition or influence as it affects each SSI. As a general guideline, a sufficient number of rating values should be assigned to provide the relative gradations desired. Each rating system should be established to adequately cover all different SSI.

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 Damage Tolerant Analysis. Where required, rating systems for FD of non-metals should incorporate results from manufacturer's approved tests. The applicability and effectiveness of various inspection methods, detectable damage sizes and access requirements are key ingredients for these evaluations.

1. Rating Accidental Damage

Accidental damage rating systems should include evaluations of the following

a. Susceptibility to minor (not obvious) accidental damage based on frequency of exposure to and the location of damage from one or more sources, including:

   1. Ground handling equipment
   2. Cargo handling equipment
   3. Those resulting from human error during manufacture, maintenance, and/or operation of the aircraft that are not included in other damage sources.
   4. Rain, hail, etc.
   5. Runway debris
   6. Lightning strike
   7. Discrete spillage events

b. Residual strength after accidental damage, normally based on the likely size of damage relative to the critical damage size for the SSI.

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c. Timely detection of damage, based on the relative rate of growth after damage is sustained and visibility of the SSI for inspection. Assessments should take into account damage growth associated with non-chemical interaction with an environment, such as disbond or delamination growth associated with a freeze/thaw cycle.

Rating values should be assigned to groups of SSIs in the same inspection area on the basis of comparative assessments within the group.

2. Rating Environmental Deterioration (metals)

Environmental deterioration rating systems should allow for evaluations of susceptibility to and timely detection of corrosion and stress corrosion.

Susceptibility to corrosion is assessed on the basis of probable exposure to an adverse environment and adequacy of the protective system. For example:

a. Exposure to a deteriorating environment such as cabin condensation, galley spillage, toilet spillage, cleaning fluids, etc.

b. Contact between dissimilar materials (potential for galvanic activity).

c. Breakdown of surface protection systems; for example, deterioration of paint, primer, bonding, sealant, corrosion inhibiting compounds and cladding systems with the resulting corrosion of metallic materials.

Material characteristics, coupled with the likelihood of sustained tensile stress, are used to assess susceptibility to stress corrosion.

Timely detection is determined by sensitivity to relative size of damage and visibility of the SSI for inspection.

NOTE:	Rating system evaluations should be made taking into account the requirement for each operator to control the aircraft structure at corrosion Level 1 or better.

3. Rating Environmental Deterioration (non-metals)

Environmental deterioration rating systems should allow for evaluations of susceptibility to, and timely detection of, structural deterioration (e.g., delamination and disbonding).

Susceptibility to deterioration (e.g., loss of stiffness) is assessed on the basis of materials subjected to environmental sources and the adequacy of the protective system. For example:

a. Aramind Fiber Reinforced Plastic (AFRP, also known as Kevlar) is sensitive to Ultra-Violet (UV) light, moisture and other fluids, when directly exposed.

b. Glass Fiber Reinforced Plastic (GFRP) may undergo long term degradation when directly exposed to UV light, but otherwise has low sensitivity to the environment.

c. Carbon Fiber Reinforced Plastic (CFRP) has low sensitivity to the environment.

- Susceptibility to delamination and disbonding or to fluid ingress into permeable materials is assessed on the basis of material type, adequacy of the protective system, and structural composition (e.g.,

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sandwich or monolithic laminate), coupled with the likelihood of AD, and exposure to certain environmental conditions.

4. Rating Fatigue Damage

If a rating system to determine 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).

2-5. Zonal Analysis Procedure

Zonal inspections may be developed from application of the Zonal Analysis Procedure. This requires a summary review of each zone on the aircraft and normally occurs as the MSG-3 analyses of structures, systems, and powerplants are being concluded. These inspections may subsequently be included in the Zonal Inspections.

This Zonal Analysis Procedure permits appropriate attention to be given to Electrical Wiring Interconnection Systems (EWIS). Thus, as well as determining zonal inspections, the logic provides a means to identify applicable and effective tasks to minimize contamination and to address significant EWIS installation discrepancies that may not be reliably detected through zonal inspection. These dedicated tasks may subsequently be included in the Systems and Powerplant tasks.

In top down analyses conducted under MSG-3, many support items such as plumbing, ducting, EWIS, other structure, etc., may be evaluated for possible contribution to functional failure. In cases where a general visual inspection is required to assess degradation, the zonal inspection is an appropriate method.

2-5-1. Procedure

The following procedures may be used

a. Divide the aircraft externally and internally into zones as defined in [ATA iSpec 2200], (formerly ATA Spec 100).

> NOTE: As the zoning of the aircraft is required for any analysis (systems/powerplant, structures and L/HIRF) and later changes will have an impact on those, this step should be performed as early in the process as possible and agreed by the ISC.

b. Develop rating tables to determine the repeat interval for a zonal inspection. Rating tables will permit the likelihood of accidental damage, environmental deterioration and the density of equipment in the zone to be taken into account.

c. For each zone, prepare a work sheet that identifies data such as: zone location, zone boundaries, access (e.g. doors, panels, linings, insulation blankets), approximate size (volume), structures (including other structure), systems and components installed, typical power levels in any wiring bundles, features specific to L/HIRF protection, etc. In addition, assess potential for the presence of combustible material, either through contamination (e.g., dust and lint) or occurring by design (e.g., fuel vapor). This assessment shall be made in operational condition with all systems, components, interior, linings, insulation blankets etc. installed.

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d. For all aircraft zones containing systems installations, perform a standard zonal analysis using the rating tables from paragraph (c.) to define the extent and interval of zonal inspection tasks. Multiple zonal inspections may be identified for each zone with those requiring increased access typically resulting in less frequent inspection intervals due to the better ratings (e.g. less accidental damage risk, better visibility).

NOTE:	Zonal Analysis is not required if the zone only contains SSI structure or if the zone contains SSI and Other Structure but the access does not allow for a GVI. In the latter case, the zonal WG to advise Structure WG that any need to inspect the Other Structure must be covered by a task in the structures section.

e. Identify zones that both contain EWIS and have potential for combustible material being present. Any area and item within a zone needs to be considered including items removed for access (e.g. EWIS attached to cabin interior panels, combustible material being present on top of galleys, lavatories).For those zones, perform an enhanced zonal analysis that permits the identification of stand-alone inspection tasks that allow appropriate attention to be given to deterioration of installed EWIS, in particular for EWIS in close proximity (i.e., within 2 inches or 50 mm) to both primary and back-up hydraulic, mechanical, or electrical flight controls, and tasks that minimize contamination by combustible materials, if applicable and effective. Credit may be taken for cleaning during scheduled and/or unscheduled maintenance tasks following a "clean as you go" policy. Rating tables addressing the potential effects of fire caused by a wiring/EWIS failure on adjacent wiring and systems (e.g., the risk to aircraft controllability), the size of the zone and the density of installed equipment may be used to determine the inspection level. General Visual Inspections may be found effective for the complete zone. Detailed Inspections may be found applicable and effective for specific items in a zone. Interval determination may be accomplished using rating tables that consider accidental damage and environment.

f. Detailed Inspections, stand-alone GVIs, and tasks to minimize contamination, arising from paragraph "e" should be included in the Systems and Powerplant tasks. Since these tasks are not specific to the routine ATA-defined systems and do not have a Failure Effect Category, introduction in a dedicated section is suggested, for example, under ATA 20.

g. General Visual Inspections arising from the enhanced zonal analysis (paragraph e.) may be compared with the Zonal Inspections determined from the standard zonal analysis (paragraph d.). The former may be considered fully covered by the zonal inspection if the access requirement is the same and the proposed interval is at least as frequent. Otherwise, a stand-alone GVI should be included with the tasks identified in paragraph (f.).

h. Except as noted in paragraph 2-3-7.4, General Visual Inspections arising from the systems, powerplants and structures may be compared with the Zonal Inspections determined from the standard zonal analysis (paragraph d.). Work sheets should record the interval proposed in the originating analysis. These GVIs may be considered fully covered by the zonal inspection if the access requirement is the same and the proposed interval is at least as frequent. Otherwise, a stand-alone GVI should be included within the MSI or SSI from which it was identified.

i. Visual Checks may be considered covered by the Zonal Inspections provided that the Systems Working Group that identified them consider that the failure would be noted and addressed during a zonal inspection. Otherwise, the task should remain in the Systems and Powerplants tasks where specific attention can be drawn to the item.

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j. All tasks developed through application of the standard zonal analysis (paragraph d.) should be included in the Zonal Inspections. For accountability purposes, any General Visual Inspection or Visual Check originating from application of systems, powerplant or structures analyses should be referenced in the MRB Report zonal task. To avoid giving unjustified attention to these items, this should not be indicated on task/work cards.

k. All Enhanced Zonal Analysis Procedure (EZAP) -derived stand-alone tasks (GVI or DET) should be uniquely identified in the data documentation for traceability during future changes. This is intended to prevent the inadvertent deletion or escalation of an EZAP-derived stand-alone task without proper consideration of the risk basis for the task and its interval.

A typical logic diagram is depicted in [Figure 2-5-1.1] and [Figure 2-5-1.2]. This is provided as a guide and may be customized to reflect individual company policies and procedures

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Figure 2-5-1.1. Zonal MSG-3 Logic Diagram

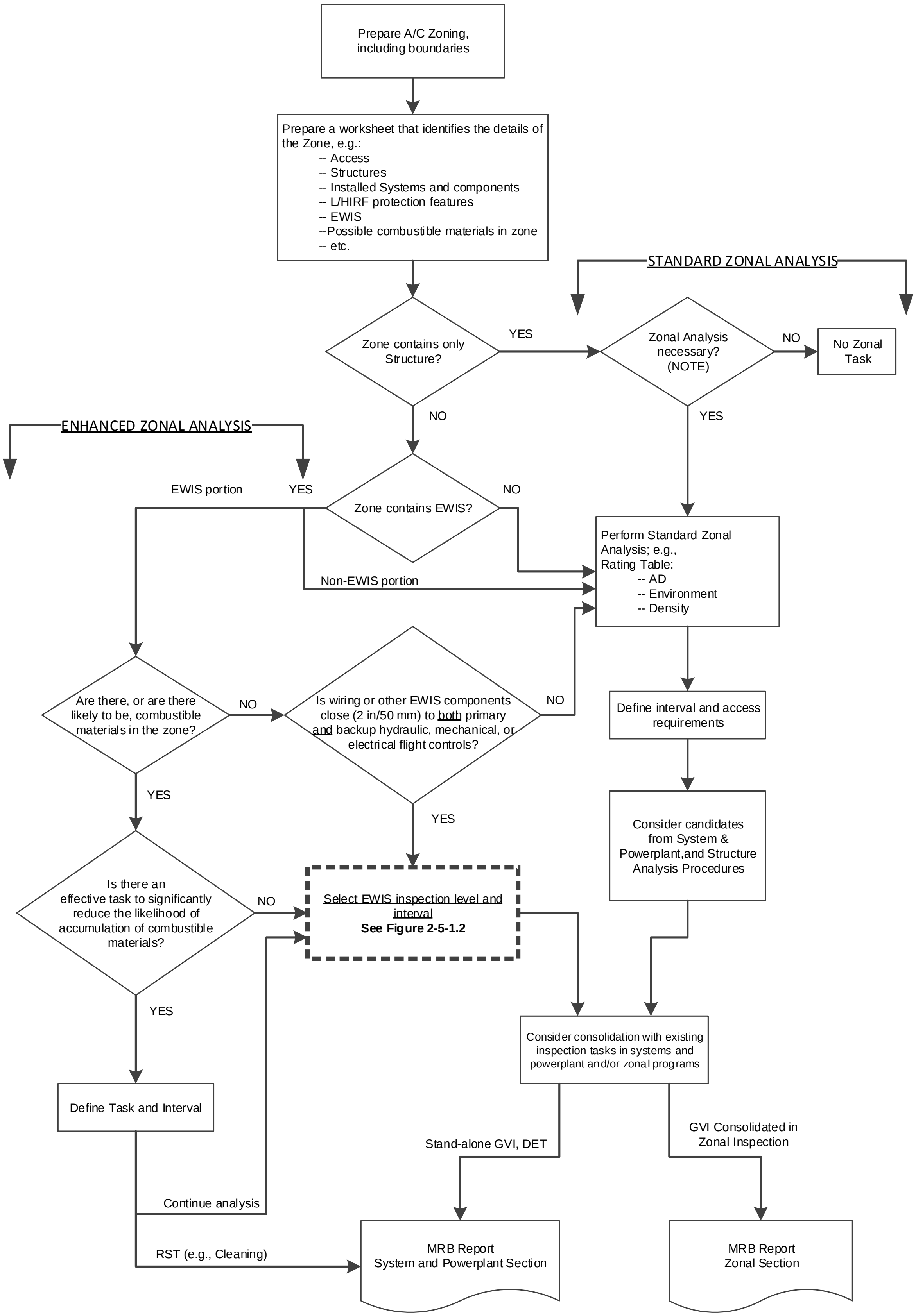

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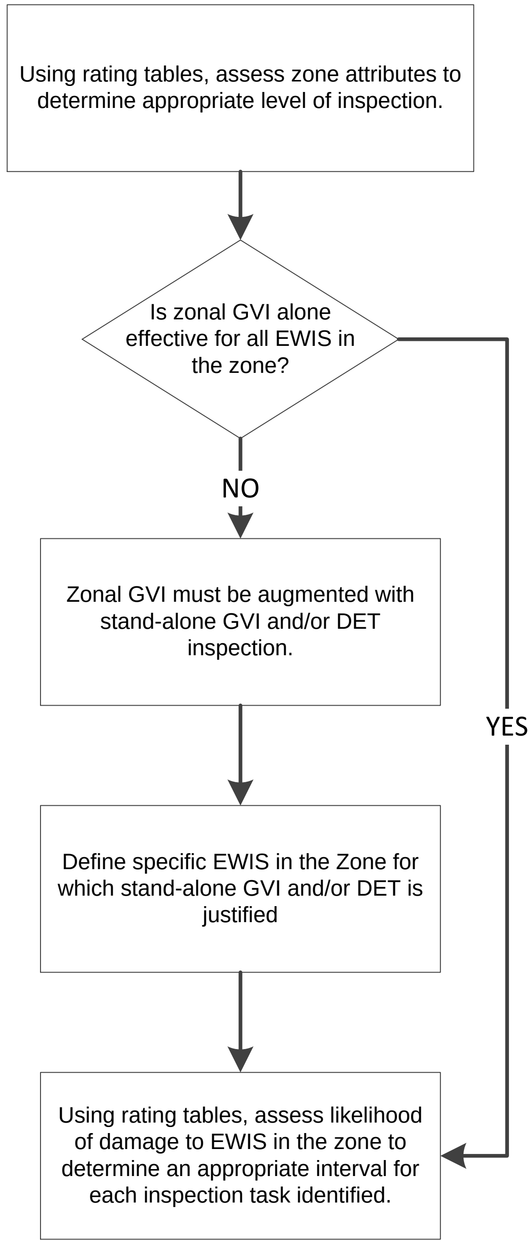
Figure 2-5-1.2. EWIS Inspection Task Determination



2-5-2. Zonal Inspection Task Intervals

Accomplishment intervals are based on hardware susceptibility to damage, the amount of activity in the zone, and operator and manufacturer experience with similar systems, powerplants and structures. When possible, intervals should correspond to those selected for targeted scheduled maintenance checks.

For a given zone, more than one task may be identified. In this case, the frequency of inspection will normally be inversely proportional to the amount of access required; i.e., the more access required, the less the longer the inspection interval.

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2-6. Lightning/High Intensity Radiated Field (L/HIRF) Analysis Procedure

This section contains guidelines for determining the dedicated scheduled maintenance tasks and intervals for L/HIRF protection using a progressive logic diagram. A glossary of terms and definitions used in the logic diagram is listed in Appendix A. This logic is the basis of an evaluation technique applied to each L/HIRF Significant Item (LHSI), using the data available and associated environments (ED/AD). Principally, the evaluations are based on the LHSI susceptibility to degradation. The L/HIRF analysis is a collaborative effort between the OEM Design and Maintenance Engineering groups, which reviews the L/HIRF protection LHSIs in order to maintain the inherent safety and reliability levels of the aircraft.

1. L/HIRF protection relies on both external and internal L/HIRF protection components.

   a. Line Replaceable Unit (LRU) Internal L/HIRF Protection Components

      L/HIRF protection features are incorporated inside the LRU. Protection devices such as filter pin connectors, discrete filter capacitors and transient protection devices (tranzorbs) are installed within LRUs on one or more of the LRU interface circuits.

      Application of MSG-3 logic for LRU internal protection features is not required. For LRUs whose failure could have an adverse effect on safety, the aircraft manufacturer will work with the LRU manufacturer to confirm that the LRU manufacturer's maintenance philosophy will ensure the continued effectiveness of L/HIRF protective features. This maintenance philosophy could include specific LRU CMM procedures or other data acceptable to regulatory authorities to conclude that the L/HIRF protection devices continue to perform their intended functions.

   b. External On Aircraft L/HIRF Protection Components

      L/HIRF protection (any protection not within an LRU) identified as or as part of an LHSI (Lightning/HIRF Significant Item) must be analyzed. Typical examples may include items such as shielded wires, raceways, bonding jumpers, connectors, composite fairings with conductive mesh, and the inherent conductivity of the structure, but may include aircraft specific devices, e.g., RF Gaskets.

2. Use of Lightning/HIRF Assurance Plan Philosophy

   L/HIRF Assurance Plans, regardless of source, can be used to validate L/HIRF protection performance and/or maintenance program effectiveness.

   After a task is proposed through the MSG-3 analysis process and where an L/HIRF Assurance Plan (or equivalent validation program) exists, the philosophy used in the L/HIRF MSG-3 logic is to either retain the proposed task or use the L/HIRF Assurance Plan (or equivalent validation program) to cover the intent of the MSG-3 task. For example, in cases where there is little data and the potential for degradation is low, an LHSI may be more effectively covered by the L/HIRF Assurance Plan.

3. Good Performance Philosophy

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OEMs may prepare a list of LHSIs that have demonstrated good performance that can be excluded from further MSG-3 analysis provided adequate justification data is collected, documented and presented to the WG for acceptance.

In order to show good performance, data demonstrating that the LHSI will remain effective in a similar environment will be provided (examples such as IP44 data, reliability data, in-service experience, validation, or testing results can be used).

2-6-1. L/HIRF Maintenance

Visual detection of obvious deterioration of L/HIRF protection is included in the Zonal Inspections; additional dedicated L/HIRF maintenance may not be required.

1. L/HIRF Protection Analysis Concepts

The following concepts are accepted to support justification of no dedicated L/HIRF task:

1. Visible L/HIRF protection (e.g., wires, shields, connectors, bonding straps, or raceways between connectors or termination points) is addressed by the Zonal Inspections.
2. L/HIRF protection within conduit or heatshrink, is addressed by the Zonal Inspections by confirming integrity of the protective covering.
3. Maintenance of the inherent conductivity of the metallic aircraft structure is addressed by the Zonal Inspections. Corrosion concerns are addressed by the Structural Inspections.
4. L/HIRF protection components with proven good in-service performance in a similar location and environment do not require detailed component assessment and no dedicated L/HIRF maintenance task is required.

2. LHSI Selection

Before the actual MSG-3 logic can be applied, the aircraft's significant L/HIRF protection must be identified. A detailed explanation of the LHSI selection process is provided in the logic diagram and L/HIRF protection analysis methodology.

3. L/HIRF Protection Analysis Methodology and Logic Diagram (see Figure 2-6-1.3)

Step 1: Identify L/HIRF Aircraft Protection by location

Using a process acceptable to the certifying authority, OEM Design Engineering specialists will identify and list L/HIRF protection components relating to all systems and structural components required to maintain the inherent safety of the aircraft. Additional protection components can be added to the list at the discretion of the MSG-3 analyst. The aircraft protection components shall be identified by location on the aircraft.

Step 2: Establish list of LHSIs

The MSG-3 analyst will select candidate LHSIs (see definition in the Glossary) from the list provided in Step 1. The L/HIRF protection components will be grouped by area, component type, bonding path or any logical

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collection of similar components to form the boundaries of each LHSI as determined by the MSG-3 analyst. The candidate LHSI list will be submitted to the ISC for approval. As part of the MSG-3 analysis process, the Working Group will ensure that the right level for the analysis has been chosen and may recommend changes to the ISC.

Step 3: Identify, list and describe each LHSI protection component

For each LHSI, a list and description of the L/HIRF protection components will be provided by OEM engineering for WG review. This should include:

- A general description of the installation that may include material and finish.
- The type(s) of protection the L/HIRF protection components do provide (e.g. shielding).
- The mechanism(s) by which the L/HIRF protection components do provide protection (e.g. by providing a low resistance conductivity path).
- The type(s) of deterioration the L/HIRF protection components can experience (e.g. chafing of braids, corrosion of contact areas).

A process specification may be used to support the component installation description. Component specifications may be used to describe their performance characteristics.

Step 4: Identify Environmental Deterioration / Accidental Damage (ED/AD) threats for each location

The ED/AD threats are determined in each location where LHSIs are installed. The ED/AD threats can be derived from a standalone process or the assessment from the Zonal analysis is acceptable.

Step 5: Perform a susceptibility assessment

For each LHSI, a process will be developed and utilized by the working group to determine a rating of the susceptibility of the protection components to degradation due to ED/AD.

Step 6: Is there data for listed or similar components with similar ED/AD threats that eliminates need for dedicated maintenance?

For all components listed in Step 3, a review of available data is accomplished. This data also must consider the component installation needs to be within a location with similar ED/AD threats. Criteria for determining favorable data will be developed by the OEM and utilized by the WG to determine if a dedicated L/HIRF task is necessary.

Step 7: No dedicated L/HIRF task

Self-explanatory.

NOTE:	All visible components, including L/HIRF protection components, are inspected as part of the Zonal inspections.

NOTE:	Justification of good performance shall be recorded for traceability.

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Step 8: Assess component degradation modes and mitigations

An assessment process will be developed by the OEM and utilized by the working group to determine if there is a potential for unacceptable degradation of the protection components (including mitigation) due to ED/AD.

The following should be assessed as minimum:

• The way deterioration can be detected (directly or indirectly)

• The type / amount of deterioration that is critical / needs to be detected

Mitigations within the installed environment may eliminate requirement for dedicated maintenance.

Step 9: Is there the potential for degradation?

If component is expected to experience unacceptable degradation within the installed location, proceed to Step 11.

~~**Step 10: No dedicated L/HIRF Task**~~

~~Self-explanatory.~~

~~NOTE:~~	~~All visible components, including L/HIRF protection components, are inspected as part of the Zonal inspections.~~

Step 11: Is degradation detectible with a Zonal Inspection?

The L/HIRF WG will perform an assessment using access, visibility or other means to determine if degradation is detectible by a Zonal Inspection.

Step 12: Can an applicable and effective task be accomplished without disassembly be selected? If so, select a task.

Determine if the potential degradation is detectable by a maintenance task without disassembly. If disassembly is required in order to detect identified potential degradation, then proceed to Step 13. If potential degradation is detectable without disassembly, then select appropriate level task that is most applicable and effective in detecting potential degradation from the following:

1. GVI
2. DET
3. FNC
4. SDI

NOTE:	If there is an L/HIRF Assurance Plan (or equivalent validation program) in place, more credit can be given to detect protection degradation through applicable and effective visual inspections.

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NOTE:	At the WG discretion, a combination of tasks may be selected. In the case of multiple task selection, the Working Group should consider the cost of the task compared to the effectiveness of the combined tasks taking into consideration the cost of the protection degradation prevented. Consideration of interval to be selected in Step 15 can be used for the evaluation.

Step 13: Could disassembly significantly degrade the installation or impede ability to detect degradation? If not, select a task.

Accomplish an assessment of the effects of disassembly and compare the installation's probability for degradation, versus the effect of the disassembly. Also, consider if disassembly would negatively affect the ability to detect the protection degradation.

If this assessment shows a task is applicable and effective with disassembly, then select from the following and proceed to Step 15:

1. GVI
2. DET
3. FNC
4. SDI
5. RST
6. DIS

If assessment shows that the negative effects of disassembly outweigh the benefits of maintenance proceed to Step 14.

NOTE:	If there is an L/HIRF Assurance Plan (or equivalent validation program) in place, more credit can be given to detect protection degradation through applicable and effective visual inspections.

NOTE:	At the WG discretion, a combination of tasks may be selected. In the case of multiple task selection, the Working Group should consider the cost of the task taking into consideration the effectiveness of the combined tasks compared to the cost of the protection degradation prevented. Consideration of interval to be selected in Step 15 can be used for the evaluation.

Step 14: Consider redesign or justify no task selected.

Consideration by the working group of the risks associated with disassembly results in redesign or no task selected. Use of disassembly to determine effectiveness of the L/HIRF protection can result in unexpected additional deterioration or induce damage into the LHSI. An example may be removal of structural bonds that require special techniques or procedures that can cause damage or introduce human error. The possibility for a redesign is assessed by the OEM and results are provided to the Working Group. If redesign is not possible and

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disassembly is determined to be detrimental to the design, then an additional assessment should be made to justify no task being selected.

Step 15: For all tasks selected, identify the interval applicable for detecting potential degradation

To determine the maintenance task interval, the Working Group considers the impact of the ED/AD threat on the protection characteristics using best judgment and available information of expected degradation.

Step 16: Is there an L/HIRF Assurance Plan (or equivalent validation program)?

OEM to provide details to the Working Group that may include summary of anticipated test methodologies, sample size details, and general information on type and number of test points.

Step 17: Does an L/HIRF Assurance Plan (or equivalent validation program) task sufficiently cover the intent of the dedicated task?

OEM must provide details in the L/HIRF Assurance Plan to satisfy the working group that the degradation concern is sufficiently covered. If the need for a task is based on unfavorable in-service experience, it is not a candidate for coverage by the L/HIRF Assurance Plan.

Step 18: Submit standalone task determined for inclusion in MRBR.

All L/HIRF-derived stand-alone tasks should be uniquely identified in the MRBR for traceability during future changes.

Once the analysis is completed, the resulting maintenance tasks and intervals for all L/HIRF systems are submitted to the ISC for approval and inclusion in the MRB Report proposal.

Step 19: No standalone task required, monitor with an L/HIRF Assurance Plan (or equivalent validation program)

OEM must ensure traceability of all dedicated tasks covered by the L/HIRF Assurance Plan, until Engineering and the ISC have agreed sufficient data has been collected to determine permanent disposition of the recommended dedicated task.

NOTE:	If an L/HIRF Assurance Plan is discontinued, OEM has responsibility to either use the collected data to support "No dedicated task required" or to institute the original dedicated task into the maintenance program.

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Figure 2-6-1.3 L/HIRF Protection MSG-3 Logic Diagram (part 1)

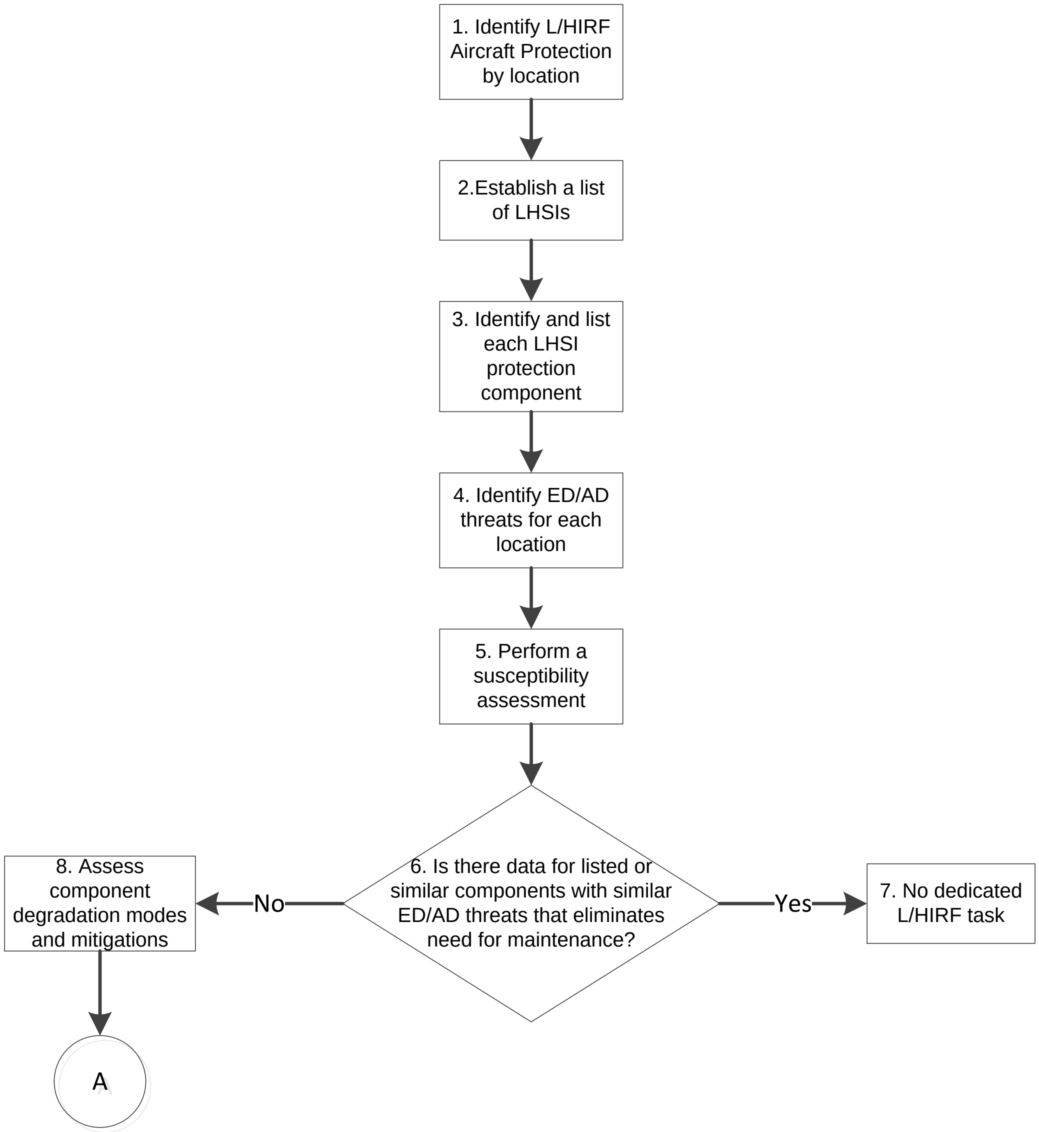

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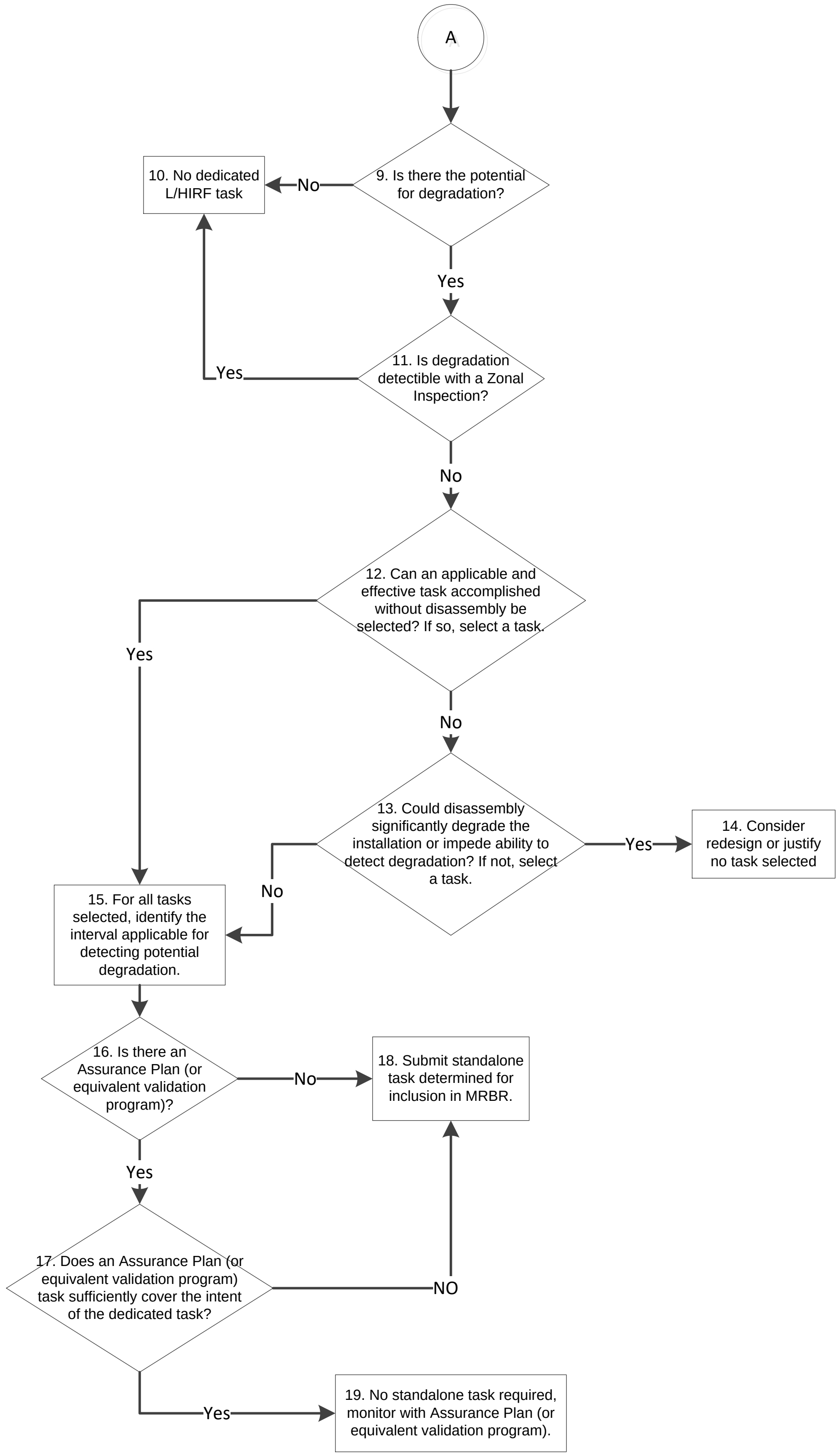
Figure 2-6-1.3 L/HIRF Protection MSG-3 Logic Diagram (part 2)



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Analysis Approval

Once the analysis is completed, the resulting maintenance tasks and intervals for all L/HIRF systems are submitted to the ISC for approval and inclusion in the MRB Report proposal.

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Appendix A. Glossary

Accidental Damage (AD)
: Physical deterioration of an item caused by contact or impact with an object or influence which is not a part of the aircraft, or by human error during manufacturing, operation of the aircraft, or maintenance practices.

Age Exploration
: A systematic evaluation of an item based on analysis of collected information from in-service experience. It verifies the item's resistance to a deterioration process with respect to increasing age.

Aircraft Health Monitoring (AHM)
: Aircraft Health Monitoring (AHM) is the use of data generated from specific aircraft systems to determine condition, reduced resistance to failure or degradation of function for the purpose of timely scheduling maintenance actions (the use typically includes Sensing, Acquisition, Transfer, Analysis and Action "SATAA").

AHM Alternative
: AHM that mitigates all Failure Cause(s) covered by a Classic task.

AHM Candidate
: Failure Cause(s) for which AHM capability exists and for which a CFlassic task exists.

AHM Hybrid
: A combination of AHM and a task resulting in a scheduled action.

Airworthiness Limitations
: A section of the Instructions for Continued Airworthiness that contains each mandatory replacement time, structural inspection interval, and related structural inspection task. This section may also be used to define a threshold for the fatigue related inspections and the need to control corrosion to Level 1 or better. The information contained in the Airworthiness Limitations section may be changed to reflect service and/or test experience or new analysis methods.

Classic Task (MSI)
: A task that results from Level 2 analysis

Classic Task (MSI) - Intent
: The reason or summary of reasons for which the task has been selected in the source Level 2 analysis:

1) to prevent or avoid a functional failure due to a specific Failure Cause, and/or

2) to detect functional degradation characteristics due to a specific Failure Cause, and/or

3) to detect a hidden functional failure, and/or

4) to confirm the availability of a function.

Combination
: The identification of multiple standalone tasks to address a single functional failure.

Conditional Probability of Failure
: The probability that a failure will occur in a specific period provided that the item concerned has survived to the beginning of that period.

Consolidation
: The amalgamation of one or more tasks into a single task.

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Corrosion Level 1

Damage occurring between successive inspections that is within allowable damage limits;

or

Damage occurring between successive inspections that does not require structural reinforcement, replacement or new damage tolerance based inspections;

or

Corrosion occurring between successive inspections that exceeds allowable limits but can be attributed to an event not typical of operator usage of other aircraft in the same fleet;

or

Light corrosion occurring repeatedly between inspections that eventually requires structural reinforcement, replacement or new damage tolerance based inspections.

Corrosion Prevention and Control Program (CPCP)

A program of maintenance tasks implemented at a threshold designed to control an aircraft structure to Corrosion Level 1 or better.

Damage Tolerant

A qualification standard for aircraft structure. An item is judged to be damage tolerant if it can sustain damage and the remaining structure can withstand reasonable loads without structural failure or excessive structural deformation until the damage is detected.

Delamination/Disbond

Structural separation or cracking that occurs at or in the bond plane of a structural element, within a structural assembly, caused by in service accidental damage, environmental effects and/or cyclic loading.

Direct Adverse Effect on Operating Safety

Direct

To be direct, the functional failure or resulting secondary damage must achieve its effect by itself, not in combination with other functional failures (no redundancy exists and it is a primary dispatch item).

Adverse Effect on Safety

Safety shall be considered as adversely affected if the consequences of the failure condition would prevent the continued safe flight and landing of the aircraft and/or might cause serious or fatal injury to human occupants.

Operating

This is defined as the time interval between any person boarding the aircraft with the intention of flight and the last person disembarking the aircraft following that flight.

Discard

The removal from service of an item at a specified life limit.

Economic Effects

Failure effects which do not prevent aircraft operation, but are economically undesirable due to added labor and material cost for aircraft or shop repair.

Electrical Wiring Interconnection System (EWIS)

Any wire, wiring device, or combination of these, including termination devices, installed in any area of the aircraft for the

purpose of transmitting electrical energy between two or more intended termination points. Refer to governing regulations for a specific definition.

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Enhanced Zonal Analysis Procedure (EZAP)
A logical procedure applicable to zones containing EWIS to identify tasks to (1) minimize accumulation of combustible materials, (2) detect EWIS component defects, and (3) detect EWIS installation discrepancies that may not be reliably detected by standard zonal inspections.

Environmental Deterioration (ED)
Physical deterioration of an item's strength or resistance to failure as a result of interaction with its climate or environment.

Failure
The inability of an item to perform within previously specified limits.

Failure Cause
Why the functional failure occurs.

Failure Condition
The effect on the aircraft and its occupants, both direct and consequential, caused or contributed to by one or more failures, considering relevant adverse operational or environmental conditions.

Failure Effect
What is the result of a functional failure?

Fatigue Damage (FD)
The initiation of a crack or cracks due to cyclic loading and subsequent propagation.

Fatigue Related Sampling Inspection
Inspections on specific aircraft selected from those which have the highest operating age/usage in order to identify the first evidence of deterioration in their condition caused by fatigue damage.

Fault
An identifiable condition in which one element of a redundant system has failed (no longer available) without impact on the required function output of the system (MSI). At the system level, a fault is not considered a functional failure.

Fault-Tolerant System
A system that is designed with redundant elements that can fail without impact on safety or operating capability. Redundant elements of the system may fail (fault), but the system itself has not failed. Individually, and in some combinations, these faults may not be annunciated to the operating crew, but by design the aircraft may be operated indefinitely with the fault(s) while still satisfying all certification and airworthiness requirements.

Function
The normal characteristic actions of an item.

Functional Check
A quantitative check to determine if one or more functions of an item performs within specified limits.

Functional Failure
Failure of an item to perform its intended function within specified limits.

Hidden Function
1. A function which is normally active and whose cessation will not be evident to the operating crew during performance of normal duties.

2. A function which is normally inactive and whose readiness to perform, prior to it being needed, will not be evident to the operating crew during performance of normal duties.

Inherent Level of Reliability and Safety
That level which is built into the unit and, therefore, inherent in its design. This is the highest level of reliability and safety that can be expected from a unit, system, or aircraft if it receives effective maintenance to achieve higher levels of reliability generally requires modification or redesign.

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Inspection - Detailed (DET)
An intensive examination of a specific item, installation or assembly to detect damage, failure or irregularity. This could include tactile assessment in which a component or assembly can be checked for tightness/security. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors and magnifying lenses may be necessary. Surface cleaning and elaborate access procedures may be required.

Inspection - General Visual (GVI)
A visual examination of an interior or exterior area, installation or assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or drop-light and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked. Basic cleaning may be required to ensure appropriate visibility.

Inspection - General Visual (GVI) – Stand-Alone
A general visual inspection that is not performed as part of a zonal inspection. Even in cases where the interval coincides with the zonal inspection, the stand-alone GVI remains an independent step on the work card.

Inspection - Special Detailed (SDI)
An examination of a specific item, installation, or assembly making use of specialized inspection techniques such as Nondestructive Testing (NDT) and/or equipment (e.g. boroscope, videoscope, tap test) to detect damage, failure or irregularity. Intricate cleaning and substantial access or disassembly procedures may be required. Classification of a task as an SDI does not define the required qualifications for the person performing the task.

Inspection - Zonal
A collective term comprising selected general visual inspections and visual checks that is applied to each zone, defined by access and area, to check system and powerplant installations and structure for security and general condition.

Interval (Initial - Repeat)
Initial Interval - Interval between the start of service-life and the first task accomplishment.

Repeat Interval - The interval (after the initial interval) between successive accomplishments of a specific maintenance task.

Item
Any level of hardware assembly (i.e., system, sub-system, module, accessory, component, unit, part, etc.).

Letter Checks
Letter checks are named collections of tasks (e.g., A-Check, C-Check, etc.) assigned the same interval.

L/HIRF
Lightning/High Intensity Radiated Field

L/HIRF Characteristics
Those properties of L/HIRF protection components that are necessary to perform their intended L/HIRF protection function(s).

L/HIRF Component Unacceptable Degradation
A deterioration of an L/HIRF protection component during the lifetime of the aircraft that may lead to its inability to continue to provide the necessary L/HIRF protection capability.

L/HIRF Protection Components
Any self-contained part, combination of parts, subassemblies, units, or structures that perform a distinctive function necessary to provide L/HIRF protection.

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L/HIRF Significant Item

Lightning/HIRF Significant Items (LHSIs) address L/HIRF protection components determined by the OEM Design Engineering specialists as those that protect systems / structure whose failure would affect the inherent safety levels of the aircraft. The scope of each LHSI is defined by the MSG-3 analyst. LHSIs may also address operational or economic considerations determined significant by the MSG-3 analyst.

LHSIs will include all of these significant aircraft system or structural Lightning/HIRF protection components or groups of components in an installed environment. Components that make up LHSIs are selected using engineering judgement based on the anticipated consequences of the protection component degradation. Typical protection components may include bonding jumpers, connectors, and embedded mesh in structural panels.

NOTE:

All L/HIRF protection components that protect systems/ structures as identified by OEM Design Engineering must be addressed in an LHSI. Other L/HIRF protection components may be included by the MSG-3 analyst as desired and accepted by the ISC.

Lubrication and Servicing

Any act of lubricating or servicing for the purpose of maintaining inherent design capabilities.

Maintenance Significant Item - (MSI)

Items identified by the manufacturer whose failure

a. could affect safety (on ground or in flight), and/or

b. is undetectable during operations, and/or

c. could have significant operational impact, and/or

d. could have significant economic impact

Multiple Element Fatigue Damage

The simultaneous cracking of multiple load path discrete elements working at similar stress levels.

Multiple Failure

At least two failures occurring independently which in combination have an effect on the aircraft.

Not to be confused with repeatedly occurring failure or with failure occurring as secondary damage directly caused by the first failure.

Multiple Site Fatigue Damage

The presence of a number of adjacent, small cracks that might coalesce to form a single long crack.

Non-metallics

Any structural material made from fibrous or laminated components bonded together by a medium. Materials such as graphite epoxy, boron epoxy, fiber glass, kevlar epoxy, acrylics and the like are non-metallics. Non-metallics include adhesives used to join other metallic or non-metallic structural materials.

Operating Crew Normal Duties

Operating Crew

Qualified flight compartment and cabin attendant personnel who are on duty.

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Normal Duties

a. Procedures and checks performed during aircraft operation in accordance with the Aircraft Flight Manual.

b. Recognition of abnormalities or failures by the operating crew through the use of normal physical senses (e.g., odor, noise, vibration, temperature, visual observation of damage or failure, changes in physical input force requirements, etc.).

Operational Check

An operational check is a task to determine that an item is fulfilling its intended purpose. Does not require quantitative tolerances. This is a failure finding task.

Operational Effects

Failure effects which interfere with the completion of the aircraft mission. These failures cause delays, cancellations, ground or flight interruptions, high drag coefficients, altitude restrictions, etc.

Other Structure

Structure which is judged not to be a Structural Significant Item.

"Other Structure" is defined both externally and internally within zonal boundaries.

Potential Failure

A defined identifiable condition that indicates that a degradation process is taking place that will lead to a functional failure.

Protective Device

Any device or system that has a function to avoid, eliminate or reduce the consequences of an event or the failure of some other function.

P to F Interval

Interval between the point at which a potential failure becomes detectable and the point at which it degrades into a functional failure.

Redundant Functional Elements

Two or more independent physical elements of a system/item providing the same function.

Residual Strength

The strength of a damaged structure.

Restoration

That work necessary to return the item to a specific standard. Restoration may vary from cleaning or replacement of single parts up to a complete overhaul.

Safe Life Structure

Structure which is not practical to design or qualify as damage tolerant. Its reliability is protected by discard limits which remove items from service before fatigue cracking is expected.

Safety (adverse effect)

Safety shall be considered as adversely affected if the consequences of the failure condition would prevent the continued safe flight and landing of the aircraft and/or might cause serious or fatal injury to human occupants.

Safety/Emergency Function

The function of the safety/emergency equipment that provides the means to address the safety/emergency related event for which it has been included in the aircraft design.

Safety/Emergency Systems or Equipment

A device or system that:

1) enhances the evacuation of the aircraft in an emergency or,

2) if it does not function when required, results in a Failure Condition that might have an adverse effect on safety.

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Scheduled Maintenance Check

Any of the maintenance opportunities which are prepackaged and are accomplished on a regular basis.

Structural Significant Item - (SSI)

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.

Scheduled Structural Health Monitoring (S-SHM)

The act to use/run/read-out a SHM device at an interval set at a fixed schedule

Structural Assembly

One or more structural elements which together provide a basic structural function.

Structural Detail

The lowest functional level in an aircraft structure. A discrete region or area of a structural element, or a boundary intersection of two or more elements.

Structural Element

Two or more structural details which together form an identified manufacturer's assembly part.

Structural Function

The mode of action of aircraft structure. It includes acceptance and transfer of specified loads in items (details /elements /assemblies) and provides consistently adequate aircraft response and flight characteristics.

Structural Health Monitoring (SHM)

The concept of checking or watching a specific structural item, detail, installation or assembly using on board mechanical, optical or electronic devices specifically designed for the application used. SHM does not name any specific method or technology

Task Applicability

A set of conditions that leads to the identification of a task type when a specific set of characteristics of the Failure Cause being analyzed would be discovered and/or corrected as a result of the task being accomplished.

Task Effectiveness

A specific set of conditions that leads to the selection of a task already identified to be applicable. Avoids, eliminates, or reduces the negative consequences of the failure to an extent that justifies doing the task at the selected interval.

Tasks - Maintenance

An action or set of actions required to achieve a desired outcome which restores an item to or maintains an item in serviceable condition, including inspection and determination of condition.

Threshold

See "Interval - Initial".

Threshold Period

A period during which no occurrences of the failure can reasonably be expected to occur after the item enters into service.

Vendor Recommendation (VR)

Maintenance instructions, including supporting data, provided by the OEM of materials, parts, appliances or components. VR may include for example recommended inspection intervals, periodic maintenance, calibration and testing procedures, installation instructions, or service life. VRs may be contained in various types of source documents such as TSOs and CMMs.

Visual Check

A visual check is an observation to determine that an item is in its intended state. Does not require quantitative tolerances. This is a failure finding task with obvious pass/fail criteria.

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Wear Damage Physical deterioration of the surface of an item due to relative motion between two parts in contact.

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Annex 1. References

[ATA iSpec 2200] *ATA Specification 2200. Information Standards for Aviation Maintenance.* Air Transport Association (http://www.airlines.org), Washington, DC.

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