1. Placeholder
2. Development of Scheduled Maintenance
3. 1. Placeholder
   2. Placeholder
   3. Placeholder
   4. Placeholder
   5. Placeholder
   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 items of critical systems and structure in order to maintain the inherent safety and reliability levels of the aircraft.

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

* 1. 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.

* 1. 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. Lightning/HIRF Protection Assurance Plan

The Protection Assurance Plan (or equivalent validation program) should include direct measurements on a defined set of L/HIRF protection components, which are determined by the OEM through a process acceptable to the certifying authority.

If the Protection Assurance Plan (or equivalent validation program) includes verification of the adequacy of the maintenance program, the MSG-3 analyst shall assist engineering during the definition of the Plan.

* + 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. If a Protection Assurance Plan (or equivilant program) is in place to verify the maintenance program, additional dedicated L/HIRF maintenance may not be required.
5. 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.
   * + 1. 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.

* + - 1. L/HIRF Protection Analysis Methodology and Logic Diagram (see Figure 2-6-1.3)

**Step 1: Identify L/HIRF Aircraft Protection by location**

OEM Engineering will provide a list of L/HIRF protection components for critical systems and structures, which are determined through a process acceptable to the certifying authority. This list will contain 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 collection of similar components to form the boundaries of each LHSI at the highest manageable level 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 the right level for the analysis has been chosen and may recommend changes to the ISC.

**Step 3: Identify and list each LHSI protection component**

For each LHSI a list and description of the L/HIRF protection components will be provided for WG review. This will include a general description of the installation that may include material and finish. A process specification may be used to support the component installation description.

**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**

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 in-service experience 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 in-service experience is accomplished. The Data sources for in-service experience can include Assurance Plans or comparable maintenance program results. Data also must consider the component installation needs to be within a location with similar ED/AD threats. Criteria for determining favorable in-service performance will be developed by the OEM and utilized by the WG to determine if a dedicated L/HIRF task is required.

**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.

**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. Such mitigation within the installed environment may eliminate requirement for dedicated maintenance.

**Step 9: Is there the potential for degradation?**

If component is susceptible to 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 an effective task 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 Block 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 assurance plan 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 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 assurance plan 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. The possibility for a redesign is assessed by the OEM and results are provided to the Working Group.

**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 a Protection Assurance Plan (or equivalent validation program)?**

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

**Step 17: Does a Protection Assurance Plan (or equivalent validation program) task sufficiently cover the intent of the dedicated task?**

OEM must provide details in the Protection Assurance Plan to satisfy the working group that the degradation concern is sufficiently covered. If need for task is based on unfavorable in-service experience it is not a candidate for coverage by the Protection 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 Protection Assurance Plan (or equivalent validation program)**

OEM must ensure traceability of all dedicated tasks covered by the Protection 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 Protection 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.

Figure 2-6-1.3 L/HIRF Analysis Methodology Logic Diagram





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. |
| 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. |
| 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. |
| Corrosion Level 1 | Corrosion damage that does not require structural reinforcement or replacement.  Or  Corrosion occurring between successive inspections exceeds allowable limit but is local and can be attributed to an event not typical of operator usage of other aircraft in the same fleet (e.g. Mercury spill). |
| 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 during which passengers and crew are on board for the purpose of 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) | An electrical connection between two or more points including the associated terminal devices (e.g., connectors, terminal blocks, splices) and the necessary means for its installation and identification. |
| Environmental Deterioration (ED) | Physical deterioration of an item's strength or resistance to failure as a result of chemical 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. |
| Inspection - Detailed (DET) | An intensive examination of a specific item, installation or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses, etc. 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. |
| Inspection - Special Detailed (SDI) | An intensive examination of a specific item, installation, or assembly to detect damage, failure or irregularity. The examination is likely to make extensive use of specialized Inspection Techniques and/or equipment. Intricate cleaning and substantial access or disassembly procedure may be required. |
| 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 Protection Components | Any self-contained part, combination of parts, subassemblies, units, or structures that perform a distinctive function necessary to provide L/HIRF protection. |
| L/HIRF Protection Systems | Systems comprised of components that avoid, eliminate, or reduce the consequences of an L/HIRF event. |
| Lightning/HIRF Significant Item | A Lightning/HIRF Significant Item (LHSI) consists of aircraft system or structural Lightning/HIRF protection components or group of components in an installed environment identified at the highest manageable level. Components that make up LHSIs are selected using engineering judgement based on the anticipated consequences of the protection component degradation.  The LHSI list includes the aircraft critical system or structural L/HIRF protection components provided by the OEM Design Engineering team and any additional protection components added by the MSG-3 analyst. The LHSI list is analyzed through the MSG-3 logic process to determine initial L/HIRF scheduled maintenance requirements. |
| Protection Assurance Plan | A Protection Assurance Plan validates that the L/HIRF protection performance assumptions are utilized in developing the scheduled maintenance. This plan can be used to confirm that the maintenance tasks and intervals are appropriate, and identify unanticipated protection degradation that is not detected in the maintenance program. Results from this plan may be used to justify changes to the maintenance program. |
| 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 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. |
| 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 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. |
| 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) | Theact 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. |
| Visual Check | A visual check is an observation to determine that an item is fulfilling its intended purpose. Does not require quantitative tolerances. This is a failure finding task. |
| Wear Damage | Physical deterioration of the surface of an item due to relative motion between two parts in contact. |