



## CHAPTER 15

### Reliability Programme Approval

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## 1.0 PURPOSE

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This Chapter is issued to provide guidance and information to airworthiness inspectors for evaluating and approving reliability programmes.

## 2.0 REFERENCES

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- 2.1 Regulation [9.4.1.13](#) of the Nigeria Civil Aviation Regulations
- 2.2 The Authority Advisory Circular No. [NCAA-AC-AWS0015](#) (Maintenance Control by Reliability Methods)
- 2.3 The Authority Advisory Circular No. [NCAA-AC-GEN002](#) (Approval of Technical Manuals)
- 2.4 Federal Aviation Administration AC 120-17A as revised (Maintenance Control by Reliability Methods).
- 2.5 The Airline/Manufacturer Maintenance Program Planning Document, Maintenance Steering Group (MSG)-2/3
- 2.6 CHECKLIST: [CL: O-AWS015](#)

## 3.0 GUIDANCE

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### 3.1 General

- 3.1.1 The Airworthiness inspector performs this task, which needs to be closely coordinated between both the mechanical and avionics specialties. Approving a reliability program is one of the most complex duties of an Airworthiness inspector, who must give special attention to every element of the proposed program.
- 3.1.2 Reliability programs establish the time limitations or standards for determining intervals between overhauls, inspections, and checks of airframes, engines, propellers, appliances, and emergency equipment.
- 3.1.3 It is important that the Airworthiness inspector explains all of the program requirements to the operator/applicant.



## 3.2 Primary Maintenance Processes

### 3.2.1 MSG-2, Primary Maintenance Processes Definitions

- a) **Hard-Time (HT), Overhaul Time Limit, or Part Life-Limit:** This is a preventive primary maintenance process that requires a system, component, or appliance to be either overhauled periodically (time limits) or removed from service (life limit). Time limits may only be adjusted based on operating experience or tests, in accordance with (IAW) procedures in the operator 's approved reliability program.
- b) **On-Condition (OC):** This is also a preventive primary maintenance process that requires a system, component, or appliance be inspected periodically or checked against some appropriate physical standard to determine if it can continue in service. The standard ensures that the unit is removed from service before failure during normal operation. These standards may be adjusted based on operating experience or tests, as appropriate, (IAW) air operator 's approved reliability program or maintenance manual.
- c) **Condition Monitoring (CM):** MSG-2 introduced condition monitoring. This process is for systems, components, or appliances that have neither HT nor OC maintenance as their primary maintenance process. It is accomplished by appropriate means available to an operator for finding and solving problem areas. The user must control the reliability of systems or equipment based on knowledge gained through analysis of failures or other indications of deteriorations.

### 3.2.2 MSG-3, Maintenance Task Definitions

- a) **Lubrication/Service (LU/SV):** Any act of lubrication or servicing for the purpose of maintaining inherent design capabilities. The replenishment of the consumable must reduce the rate of functional deterioration.
- b) **Operational/Visual Check (OP/VC):** Hidden functional failure categories. An operational check is a task to determine if an item is fulfilling its intended purpose. The check does not require quantitative tolerances, but is a failure-finding task. A visual check is an observation to determine that an item is fulfilling its intended purpose and does not require quantitative tolerances. This is a failure-finding task that ensures an adequate availability of the hidden function to reduce the risk of a multiple safety failures and to avoid economic effects of multiple failures and be cost-effective.
- c) **Inspection/Functional Check (IN/FC), All Categories:**
  - (i) **Inspections**
    - (aa) **Detailed inspection:** An intensive visual examination of a specific structural area, system, 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 by the Airworthiness inspector. Inspection aids such as mirrors or magnifying lenses may be used. Surface cleaning and elaborate access procedures may be required.



- (bb) General visual (surveillance) inspection: 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 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.
- (cc) Special detailed inspection: An intensive examination of a specific item(s), 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 procedures may be required.
- (dd) Functional Check: A quantitative check to determine if one or more functions of an item perform within specified limits. Reduced resistance to failure must be detectable, and there must be a reasonably consistent interval between a deterioration condition and functional failure.
- (ii) Restoration (RS), All Categories: That work necessary to return an item to a specific standard. Since restoration may vary from cleaning or replacement of single parts to a complete overhaul, the scope of each assigned restoration task has to be specified.
- (iii) Discard (DS), All Categories: The removal from service of an item at a specified life limit. Discard tasks are normally applied to so-called single-celled parts, such as:
  - (aa) Cartridges,
  - (bb) Canisters,
  - (cc) Cylinders,
  - (dd) Engine disks, or
  - (ee) Safe-life structural members.

**3.3 New Aircraft:** The lack of real experience with new aircraft requires a careful, detailed study of their characteristics to determine which components or systems would probably benefit from scheduled maintenance (HT or OC).

3.3.1 Special teams of industry and Federal Aviation Administration (FAA) personnel developed the initial maintenance programs for the B-747, DC-10, and L-1011 aircraft. Using the MSG-2 decision analysis, these teams identified potential maintenance tasks and determined which of these tasks must be performed to ensure operating safety or determine essential hidden function protection. The remaining tasks were evaluated to determine if they were economically useful.

3.3.2 This evaluation provided a systematic review of the aircraft design so that, in the absence of real experience, the best maintenance process could be employed for each component or system. The B-747, DC-10, and L-1011 aircraft operating experience confirmed the effectiveness of these procedures.



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### 3.4 Data Collection System

3.4.1 Typical sources of data collection include:

- a) Unscheduled removals,
- b) Confirmed failures,
- c) Pilot reports,
- d) Sampling inspections,
- e) Shop findings,
- f) Functional checks,
- g) Bench checks,
- h) Service difficulty reports,
- i) Mechanical Interruption Summaries, and
- j) Other sources the operator considers appropriate.

3.4.2 Not all of these sources may be covered in each and every program. However, the availability of additional information provides the operator with an invaluable source of operating history for determining success or failure in meeting program goals.

3.4.3 Data collected must be accurate and factual to support a high degree of confidence for any derived conclusion. It must be obtained from units functioning under operational conditions and must relate directly to the established levels of performance.

**3.5 Data Analysis and the Application to Maintenance Controls:** The objective of data analysis is to recognize the need for corrective action, establish what corrective action is needed, and determine the effectiveness of that action.

3.5.1 Data Analysis Systems: Data analysis is the process of evaluating mechanical performance data to identify characteristics indicating a need for program adjustment, revising maintenance practices, improving (modifying) hardware, etc. The first step in analysis is to compare or measure data against acceptable performance levels. The standard may be a running average, tabulation of removal rates for past periods, graphs, charts, or any other means of depicting a norm.

3.5.2 Programs Incorporating Statistical Performance Standards (-Alert) Programs)

- a) Reliability programs developed under NCAA-AC-AWS010, current edition, and earlier criteria use parameters for reliability analysis such as delays per 100 departures for an aircraft system. They incorporate performance standards as described in paragraph 3.2.2.b). (i). These



standards define acceptable performance.

- b) System performance data usually is reinforced by component removal or confirmed failure data. The condition-monitored process can be readily accommodated by this type of program.

3.5.3 Programs Using Other Analysis Standards (-Non-Alert) Programs): Data compiled to assist in the day-to-day operation of the maintenance program may be used effectively as a basis for continuous mechanical performance analysis.

- a) The following are examples of the types of information suitable for this monitoring method:
  - (i) Mechanical interruption summaries
  - (ii) Flight record review,
  - (iii) Engine monitoring reports,
  - (iv) Incident reports, and
  - (v) Engine and component analysis reports.
- b) The number and range of inputs must be sufficient to provide a basis for analysis equivalent to the statistical programs' standards.
- c) Actuarial analysis should be conducted periodically to ensure that the current process classifications are correct.

### 3.6 Performance Standards

3.6.1 The following factors are acceptable for establishing or revising a reliability program 's performance standards:

- a) Past and present individual operator and industry experience. If industry experience is used, the program must include a provision for reviewing the standards after the operator has gained one year of operating experience;
- b) Performance analysis of similar equipment currently in service;
- c) Aircraft or equipment manufacturers 'reliability engineering analysis; or
- d) History of experience where reliability standards were acceptable to the airline industry.

3.6.2 If the program does not incorporate statistical performance standards or significantly deviates from the instructions in NCAA-AC-AWS010 -

- a) Performance measurements expressed numerically in terms of:
  - (i) System or component failure,
  - (ii) Pilot reports,
  - (iii) Delays,
  - (iv) A/C operating hours,
  - (v) Number of landings,
  - (vi) Cycles, or
  - (vii) Other.



- b) Standards adjusted to:
  - (i) Operator 's experience,
  - (ii) Seasonal, and/or
  - (iii) Environmental.
- c) Procedures for periodic review:
  - (i) Upward adjustment, and
  - (ii) Downward adjustment.
- d) Monitoring procedure:
  - (i) New aircraft, and
  - (ii) Computing performance standards.
- e) No statistical performance standards: Do not approve program.
- f) Also, any significant deviation from the current NCAA-AC-AWS010.

### **3.7 Evaluating Program Displays and Status of Corrective Action Programs and Reporting.**

3.7.1 Corrective Action System. Corrective action should be positive enough to restore performance effectively to an acceptable level within a reasonable time. The corrective action system must include provisions for the following:

- a) Notifying the organization responsible for taking the action.
- b) Obtaining periodic feedback until performance reaches an acceptable level.
- c) Encompassing methods that have been established for the overall maintenance program, such as:
  - (i) Work orders,
  - (ii) Special inspection procedures,
  - (iii) Engineering Orders, and
  - (iv) Technical standards.
- d) Critical failures in which loss of function or the secondary effects of failure could affect the airworthiness of the aircraft.

3.7.2 Statistical Performance Standards System.

- a) A performance measurement expressed numerically in terms of system or component failure, pilot report, delay, etc. (bracketed by hours of aircraft operation, number of landing, operating cycles, or other exposure measurement) serves as the basis for the standard. Control limits or alert values are usually based on accepted statistical methods, such as standard deviations or the Poisson distribution.
- b) Some applications use an average or baseline method. The standard should be adjustable a n d



should reflect the operator 's experience during seasonal and environmental condition changes and variations.

- c) The program should include procedures for periodic review and adjusting the program as appropriate.
- d) The program should include procedures for monitoring new aircraft until sufficient operating experience is available to compute performance standards, normally one year.
- e) **The program should include procedures for imposing operational restrictions and what level of restrictions is appropriate should there be degraded level of safety below acceptable standards**

### 3.7.3 Data Display and Reporting System

- a) Operators with programs incorporating statistical performance standards (-alert programs) should develop a monthly report, with appropriate data displays summarizing the previous month 's activity. This report should include the following:
  - (i) All aircraft systems controlled by the program in sufficient depth to enable the Authority and other recipients to evaluate the effectiveness of the total maintenance program;
    - a. Systems that exceeded the established performance standards and discussion of what action has been taken or planned;
  - (ii) An explanation of changes that have been made or are planned in the aircraft maintenance program, including changes in maintenance and inspection intervals and changes from one maintenance process/task to another;
  - (iii) A discussion of continuing over-alert conditions carried forward from previous reports;  
and
  - (iv) The progress of corrective action programs.
- b) Programs using other analytical standards (-non-alert programs) should consolidate or summarize significant reports used in controlling their program to provide for evaluating program effectiveness. These reports may be computer printouts, summaries, or other forms. A typical program of this type reports the following information:
  - (i) Mechanical Interruption Summary (MIS) reports,
  - (ii) Maintenance process/task and interval assignments (master specification),
  - (iii) Weekly update to the maintenance process and interval assignments,
  - (iv) Daily repetitive item listing by aircraft,
  - (v) Monthly component premature removal report, including removal rate,
  - (vi) Monthly engine shutdown and removal report,
  - (vii) Quarterly engine reliability analysis report,
  - (viii) Engine threshold adjustment report, and
  - (ix) Worksheets for maintenance process/task and interval changes (not provided to the Authority, but the Authority approves the process/task changes).





- c) Program Review System. The program should include a procedure for revision which is compatible with Authority approvals. The procedures should identify organizational elements involved in the revision process and the authority. The program areas requiring formal Authority

approval include any changes to the program that involve the following:

- (i) Procedures relating to reliability measurement/performance standards,
- (ii) Data collection,
- (iii) Data analysis methods and application to the total maintenance program,
- (iv) Process/task changes,
- (v) Adding or deleting components/systems,
- (vi) Adding or deleting aircraft types, or
- (vii) Procedural and organizational changes concerning administration of the program.

### 3.8 Interval Adjustments, Process, and/or Task Changes.

- 3.8.1 Maintenance Interval Adjustment, Process Category, and/or Task Change System. Reliability programs provide an operator with a method of adjusting maintenance, inspection, and overhaul intervals without prior Authority approval. This does not relieve the operator or the Authority of their responsibilities regarding the effects of the program on safety.

**NOTE:** *If the AIRWORTHINESS INSPECTOR has any doubt as to the soundness of a requested maintenance interval adjustment or task change, the inspector should coordinate the request with the appropriate State of Design.*

- 3.8.2 Procedures: Procedures for adjusting maintenance intervals must be included in the program. Maintenance interval adjustments should not interfere with ongoing corrective actions. There should be special procedures for escalating systems or components whose current performance exceeds control limits.

- a) Typical considerations for adjusting HT or OC intervals include the following:
  - (i) Sampling,
  - (ii) Actuarial studies,
  - (iii) Unit performance,
  - (iv) Inspector or maintenance findings, and
  - (v) Pilot reports.
- b) Methods for adjusting aircraft/engine check intervals should be included if the program controls these intervals. Sampling criteria should be specified.

- 3.8.3 Classifying the Maintenance Processes and/or Tasks. The program should include procedures for the classification and assignment of maintenance processes and/or tasks and for changing from one process and/or task to another. Refer to MSG-2 for maintenance processes and MSG-3 for maintenance tasks. It should include the authority and procedures for changing maintenance specifications and the related documents to reflect the interval adjustments or process and/or task change.

### 3.9 Prerequisites and Coordination Requirements



- 3.9.1 Prerequisites: Previous experience with the type of equipment the operator/applicant proposes to include in the program.
- 3.9.2 Coordination: This task requires coordination between the Airworthiness Inspectors, both mechanical and avionics.

### 3.10 Procedures.

- a) Meet with Operator/Applicant. In addition to providing NCAA-AC-AWS010, current edition, inform the operator/applicant of the following program requirements:
- (i) Program application,
  - (ii) Organizational structure,
  - (iii) Data collection system,
  - (iv) Methods of data analysis and application to maintenance control,
  - (v) Procedures for establishing and revising performance standards,
  - (vi) Definition of significant terms,
  - (vii) Program displays and status of corrective action programs,
  - (viii) Procedures for program revision, and
  - (ix) Procedures for maintenance control changes.
- b) Evaluate the Program Application Procedures. When the applicant submits a formal program, ensure that the program document defines the following:
- (i) Components, systems, or complete aircraft controlled by the program. Individual systems and/or components are identified by Air Transport Association of America (ATA) Specification 100. A list of all components controlled by the program must be included as an appendix to the program document or included by reference (e.g., time limits, manuals, or computer report).
  - (ii) The portion of the maintenance program controlled by the reliability program (e.g., overhaul and/or inspection, check periods).
- c) Evaluate Organizational Structure. The structure must be described adequately and address committee membership, **if appropriate, and reliability meeting frequency which must include NCAA attending such reliability meetings periodically and some cases, unannounced as a form of surveillance.** Ensure that the reliability program includes an organizational chart that shows the following:
- (i) The relationships among organizational elements responsible for administering the program.
  - (ii) The two organizational elements responsible for approving changes to maintenance controls and specifying the duties and responsibilities for initiating maintenance program revisions.

**NOTE:** One of the two organizational elements must have inspection or quality control responsibility or have overall program responsibility.

- d) Evaluate the Organizational Responsibilities.



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- (i) Determine if the reliability program document addresses the following:
    - aa) The method of exchanging information among organizational elements. This may be displayed in a diagram.
    - bb) Activities and responsibilities of each organizational element and/or reliability control committee for enforcing policy and ensuring corrective action.
  - (ii) Ensure that authority is delegated to each organizational element to enforce policy.
- e) Evaluate the Data Collection System.
- (i) Ensure that the reliability document fully describes the data collection system for the aircraft, component, and/or systems to be controlled. The following must be addressed:
    - a) Flow of information,
    - b) Identification of sources of information,
    - c) Steps of data development from source to analysis, and
    - d) Organizational responsibilities for each step of data development.
  - (ii) Ensure that the document includes samples of data to be collected, such as:
    - a) Powerplant disassembly and inspection reports,
    - b) Component condition reports,
    - c) Mechanical delay and cancellation reports,
    - d) Flight record reports,
    - e) Premature removal reports,
    - f) In-flight shutdowns,
    - g) Confirmed failure reports,
    - h) Internal leakage reports, and
    - i) Engine shutdown reports.
  - (iii) Ensure that the reliability document includes a graphic portrayal of program operations. It must be a closed loop and show source data, data collection, and analysis.
- f) Evaluate the Methods of Data Analysis and Application to Maintenance Controls. Ensure that the data analysis system includes the following:
- (i) One or more of the types of action appropriate to the trend or level of reliability experienced, including:
    - aa) Actuarial or engineering studies employed to determine a need for maintenance program changes;
    - bb) Maintenance program changes involving inspection frequency and content, functional checks, overhaul procedures, and time limits;
    - cc) Aircraft, aircraft system, or component modification or repair; and/or
    - dd) Changes in operating procedures and techniques.
  - (ii) The effects on maintenance controls such as overhaul time, inspection and check periods, and overhaul and/or inspection procedures.
  - (iii) Procedures for evaluating critical failures as they occur.
  - (iv) Documentation used to support and initiate changes to the maintenance program,



- including modifications, special inspections, or fleet campaigns. The program must reference the operator 's manual procedures for handling these documents.
- (v) A corrective action program that shows the results of corrective actions in a reasonable period of time. Depending on the effect on safety, a reasonable period of time can vary from immediate to an overhaul cycle period. Each corrective action plan or program must be made a matter of record and include a planned completion date. Samples of forms used to implement these actions must be included in the program document.
  - (vi) A description of statistical techniques used to determine operating reliability levels.
- g) Evaluate the Procedures for Establishing and Revising Performance Standards.
- (i) Ensure that each program includes one of the following for each aircraft system and/or component controlled by the program:
    - aa) Initial performance standards defining the area of acceptable reliability; or
    - bb) Methods, data, and a schedule to establish the performance standard.
  - (ii) Ensure that the performance standard is responsive and sensitive to the level of reliability experienced and is stable without being fixed. The standard should not be so high that abnormal variations would not cause an alert or so low that it is constantly exceeded in spite of the best-known corrective action measures.
  - (iii) Ensure that the procedures specify the organizational elements responsible for monitoring and revising the performance standard, as well as when and how to revise the standard.
- h) Evaluate Definitions. Verify that each program clearly defines all significant terms used in the program. Definitions must reflect their intended use in the program and will therefore vary from program to program. Acronyms and abbreviations unique to the program must also be defined.
- i) Evaluate Program Displays and Status of Corrective Action Programs and Reporting.
- i) Ensure that the program describes reports, charts, and graphs used to document operating experience. Responsibilities for these reports must be established and the reporting elements must be clearly identified and described.
  - ii) Ensure that the program displays containing the essential information for each aircraft, aircraft system, and component controlled by the program are addressed. Each system and component must be identified by the appropriate ATA Specification 100 system code number.
  - iii) Ensure that the program includes displays showing:
    - aa) Performance trends,
    - bb) The current month 's performance,
    - cc) A minimum of 12 months 'experience, and





- dd) Reliability performance standards (-alert) values).
- iv) The program must include the status of corrective action programs. This includes all corrective action programs implemented since the last reporting period.
- j) Evaluate the Interval Adjustments and Process and/or Task Changes System.
  - aa) Review the change system procedures. Ensure that there are special procedures for escalating systems or components whose current performance exceeds control limits.
  - bb) Ensure that the program does not allow for the maintenance interval adjustment of any Certification Maintenance Requirements (CMR) items. CMRs are part of the certification basis. No CMR item may be escalated through the operator maintenance/reliability program. CMRs are the responsibility of the Authority as far as approval and escalation.

**NOTE:** *The operator may not use its reliability program as a basis for adjusting the repeat interval for its corrosion prevention and control program; however, the operator may use the reliability program for recording data for later submission to the Authority to help substantiate repeat interval changes.*

- cc) Ensure that the program includes provisions for notifying the Authority when changes are made.
- k) Evaluate the Procedures for Program Revisions. The reliability document must accomplish the following:
  - (i) Identify and isolate areas which require the Authority approval for program revision, including the following:
    - aa) Reliability measurement;
    - bb) Changes involving performance standards, including instructions relating to the development of these standards;
    - cc) Data collection system;
    - dd) Data analysis methods and application to maintenance program; and
    - eel) Any procedural or organizational change concerning program administration.
  - (ii) If the operator proposes that the Authority approve all revisions to the program document, isolation of those areas requiring Authority approval is not required. However, the document must recognize each of the above requirements and must contain procedures for adequately administering and implementing changes required by these actions.
  - (iii) Identify the organizational element responsible for approving amendments to the program.
  - (iv) Provide a periodic review to determine that the established performance standard is still realistic.
  - (v) Provide procedures for distributing approved revisions.
  - (vi) Reference the operator 's manual and provide the overhaul and inspection periods, work



content, and other maintenance program activities controlled by the program.

- l) Evaluate the Procedures for Maintenance Control Changes. Ensure that the reliability program document addresses the following:
  - (i) Procedures for maintenance control changes to the reliability program.
  - (ii) The organizational elements responsible for preparing substantiation reports to justify maintenance control changes. At least two separate organizational elements are required, one of which exercises inspection or quality control responsibility for the operator.
  - (iii) Processes used to specify maintenance control changes (e.g., sampling, functional checks, bench checks, decision tree analysis, and unscheduled removal).
  - (iv) Procedures covering all maintenance program activities controlled by the program.
  - (v) Procedures for amending OpSpecs, as required.
  - (vi) Procedures to ensure maintenance interval adjustments are not interfering with ongoing corrective actions.
  - (vii) Critical failures and procedures for taking corrective action.
  - (viii) Procedures for notifying the Authority, when increased time limit adjustments or other program adjustments are addressed.
- m) Analyze Reliability Program
  - (i) After the review is completed the Inspector will meet with the applicant or operator to discuss needed programme changes and recommendations to resolve discrepancies. This should be followed by a written notification.
  - (ii) If discrepancies are found the notification will list specific discrepancies found and recommendations, outlining what will be required to correct the discrepancies;
  - (iii) When the inspector satisfied that he reliability programme meets the requirements:
  - (iv) Return the original approved reliability programme to the applicant or operator accompanied by a letter of approval;

## **4.0 CONCLUSION**

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- 4.1 Successful completion of this task will result in the approval of the operator/applicant 's reliability program and OpSpecs
- 4.2 Keep a copy of the reliability programme on the operator 's file.
- 4.3 The same procedures will be followed when a revision to the original or approved reliability programme is received from the air operator.



## **5.0 FUTURE ACTIVITIES**

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### **5.1 Normal surveillance**