CIVIL AVIATION AUTHORITY
OF VIETNAM

ADVISORY CIRCULAR
AC 04-006

MAINTENANCE CONTROL BY RELIABILITY METHODS

SECTION 1 POLICY & GENERAL INFORMATION

1.1 PURPOSE

A. This advisory circular outlines practices acceptable to CAAV with regard to development, management and approval of aircraft maintenance reliabilty control programs using the aircraft manufacturer's maintenance planning document which establish the criteria for classifying maintenance processes.

B. It also provides information and guidance which may be used to design or develop a maintenance program that utilizes reliability control methods.

The aircraft maintenance reliability program is a subsection of an approved aircraft maintenance program.

1.2 STATUS OF THIS AC

This AC is an original issuance.

1.3 BACKGROUND

1.3.1 HARD-TIME

A. The first generation of formal air operator maintenance programs was based on the belief that each functional part of a transport aircraft needed periodic disassembly inspection.

B. Time limitations were established for servicing, checks and inspections, and the entire aircraft was periodically disassembled, overhauled, and reassembled in an effort to maintain the highest level of safety.

- This is the origin of the first primary maintenance process discussed in this publication and referred to as "Hard-Time."

1.3.2 ON-CONDITION

A. As the industry grew, matured, and adopted more complex aircraft, literal application of the "Hard-Time" primary maintenance process became obsolete.

- The industry came to realize that each component and part did not require scheduled overhaul on a fixed time basis, and a second primary maintenance process evolved, referred to as "On-Condition."

- Advisory Circulars are intended to priovide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.
- Where an AC is referred to in a 'Note' below the regulation, the AC remains as guidance material,
- ACs should always be read in conjunction with the referenced regulations.

B. This concept is assigned to components on which a determination of continued airworthiness can be made by visual inspections, measurements, tests or other means without disassembly, inspection or overhaul.

1.3.3 RELIABILITY CONTROL

Control of these programs was previously accomplished by individual approval of the hard- time or on-condition check periods for the aircraft, engines, and components.

- The procedures used to adjust these periods were awkward and burdensome, often inhibiting logical adjustment.
- This method of control was oriented toward mechanical performance rather than to predicting failure wear out points, as was the case in the previous methods.
- The new method was entitled "reliability control" because its major emphasis was toward maintaining failure rates below a predetermined value; i.e., an acceptable level of reliability.

1.3.4 CONDITION MONITORING

A. The analytical nature of reliability control disclosed and emphasized the existence of components and systems that did not respond to the hard-time or on-condition processes.

B. This led to a third process whereby no services or inspections are scheduled to determine integrity or serviceability.

- In this process, the mechanical performance is monitored and analyzed, but limits or mandatory action are not prescribed. This process is entitled "Condition-Monitoring."

1.4 APPLICABILITY

The guidance provided in this advisory circular is applicable to operators of aircraft that are required to be maintained under an maintenance program approved by CAAV.

This AC is also applicable to the personnel and organizations that are involved in the implementation and administration of the maintenance program.

1.5 RELATED REGULATIONS

This advisory circular provides guidance regarding airworthiness reliability that is applicable to compliance with—

- Part 4, Continuing Airworthiness.
- Part 5, Approved Airworthiness Organizations
- Part 12, AOC Certification and Administration

1.6 RELATED PUBLICATIONS

The following publications also contain pertinent technical background regarding reliability programs—

- CAAV Airworthiness Inspector Manual
- Maintenance Control by Reliability Methods, AC 120-17, United States Federal Aviation Administration

The CAAV airworthiness inspectorates can provide access to these reference documents.

1.7 ACRONYMS & DEFINITIONS

1.7.1 ACRONYMS & ABBREVIATIONS

The following acronyms and abbreviations are used in this document.

1) **CM** = Condition Monitoring
2) **HT** = Hard Time
3) **MPD** = Maintenance Planning Document
4) **MSG** = Maintenance Steering Guide
5) **MRB** = Maintenance Review Board
6) **OC** = On-Condition

1.7.2 DEFINITIONS

The following definitions are used in this document—

1) **Operator.** An airline with maintenance programme controlled by a reliability programme.
2) **Service Provider.** An operator contracting out an approved maintenance programme controlled by a reliability programme to another operator.

SECTION 2 GENERAL INFORMATION & GUIDANCE

2.1 ACCEPTABLE LEVEL OF RELIABILITY

A. The Reliability Control Program focuses on maintaining failure rates below a predetermined value; i.e., an acceptable level of reliability.

B. The maintenance philosophy, consideration of operational and environmental factors, record keeping systems, the extent and scope of the operator's application of reliability control, are reflected and defined in his own reliability program document.

2.2 COMPONENTS OF A MAINTENANCE PROGRAM

A. There are four general categories of an operator's maintenance program—

1) Systems and components;
2) Propulsion systems and components;
3) Aircraft and propulsion system checks and inspections; and
4) Structural inspection and/or /overhaul.

All four categories may be controlled by a composite program, or each may be handled individually.

B. The program can encompass a select group of items from a category without affecting other controls for the remaining items of that category.

- For example, the basic engine might be maintained by a program that does not include its accessories. The accessories could be on another program or they could be under traditional operations specifications control

2.3 STATISTICAL ANALSIS

A. Statistical analysis is most effective in its application to systems and components because the occurrence of failures can be readily reduced to meaningful statistics.

- Alert rates used in the analysis, graphic charts (or equivalent displays) show areas in need of corrective action.
- Conversely, statistical analysis of inspection findings or other abnormalities related to aircraft/ engine check and inspection periods requires judgmental analysis.

B. Programs encompassing aircraft/engine check or inspection intervals might consider numerical indicators, but sampling inspection and discrepancy analysis would be of more benefit.

SECTION 3 PRIMARY MAINTENANCE PROCESSES

3.1 GENERAL

A. The three primary maintenance processes utilized by maintenance programs are—

1) Hard-time;

2) On-condition; and

3) Condition-monitoring.

B. Each program should include specific definitions of the processes it uses and how they are applied.

> The detailed requirements for the condition-monitoring process are included in the aircraft manufacturer's maintenance planning document (for example, MSG-2).

3.1.1 HARD-TIME (HT)

A. This is a preventive primary maintenance process.

B. It requires that an appliance or part be periodically overhauled in accordance with the AOC holder's maintenance manual or that it be removed from service.

3.1.2 ON-CONDITION (OC)

A. This is a preventive primary maintenance process.

B. It requires that an appliance or part be periodically inspected or checked against some appropriate physical standard to determine whether it can continue in service.

C. The purpose of the standard is to remove the unit from service before failure during normal operation occurs.

3.1.3 CONDITION-MONITORING (CM)

A. This is a maintenance process for items that have neither "Hard-Time" nor "On-Condition" maintenance as their primary maintenance process.

B. CM is accomplished by appropriate means available to an operator for finding and solving problem areas.

> The detailed requirements for the condition-monitoring process are included in the aircraft nanufacturer's MPD (MSG-2 and MSG-3)

C. Complex (multicell) units may be subject to control by two or even all three of the primary processes.

D. The predominant process will determine its classification.

- For example, the B-747 Modular Package - Stabilizer Control has CM assigned as its primary maintenance process by the MRB report, but a leakage check, which is a conventional OC task, is also specified.

3.2 EXAMPLE COMBINING ALL THREE PROCESSES

A. The basic engine has characteristics that involve all three primary maintenance processes.

B. Programs that control engine major overhaul intervals consider the engine as a hard-time unit.

> The overhaul standards are specified by overhaul manuals or other publications that do not identify individual processes as such.

C. Programs controlling shop maintenance to a "conditional" standard (restoration, etc.,) may classify the engine as on-condition or as condition-monitoring depending on the characteristics of the program.

D. The applicable maintenance processes and their intervals should be designated in (or referenced by) the program document, MSG-2 and -3,. discusses the analysis method for assigning maintenance processes.

E. This method was used in the MRB activity for the engines of the wide-bodied jets.

This analytical method, in conjunction with service experience, can be applied to earlier engines.

SECTION 4 RELIABILITY CONTROL SYSTEMS

A. The maintenance reliability program must reflect the application of the following control systems—

1) Data collection;

2) Data analysis;

3) Corrective action;

4) Performance standards;

5) Data display and report;

6) Maintenance interval adjustment and process change; and

7) Program revision.

B. These systems explain the framework which the operator can use to develop his particular reliability program.

4.1 DATA COLLECTION SYSTEM

A. This system should include—

- A specific flow of information;
- Identification of data sources; and
- Procedures for transmission of data, such as the use of forms and computer runs.

B. Responsibilities within the operator's organization must be established for each step of data development and processing.

C. Typical sources of performance information includes—

1) Pilot reports;

2) In-flight engine performance data;

3) Mechanical interruptions/delays;

4) Engine shutdowns;

5) Unscheduled removals;

6) Confirmed failures;

7) Functional checks;

8) Bench checks;

9) Shop findings;

- All of these sources do not need be included in the program
- This listing does not prohibit the use of other sources of information.

10) Sampling inspections;

11) Inspection writeups; and

12) Service difficulty reports

4.2 DATA ANALYSIS SYSTEM

A. Data analysis is the process of evaluating mechanical performance data to identify characteristics indicating a need for—

- Program adjustmen;
- Revision of maintenance practices;
- Hardware improvement (modification)

B. The initial step in analysis is the comparison of the data to a standard representing acceptable performance.

- The standard may be a running average, tabulations of removal rates for past periods, graphs, charts, or any means of depicting a "norm."

4.2.1 PROGRAMS INCORPORATING STATISTICAL PERFORMANCE STANDARDS

A. These programs are generally known at “alert type programs.”

B. Reliability programs previously developed, utilize parameters for reliability analysis such as delays per 100 departures for an aircraft system.

These programs incorporate performance standards which define acceptable performance.

- When compared with a running graphical or tabular display of current performance these programs depict trends as well as show out-of-limits conditions.

C. The system performance data is usually reinforced by component removal or confirmed failure data.

- The condition-monitoring process can be readily accommodated by this type of program.

4.2.2 PROGRAMS USING OTHER ANALYSIS STANDARDS

A. These programs are generally known as “non-alert type programs.”

B. Data that is compiled to assist in the day-to-day operation of the maintenance program may be effectively used as a basis for continuous mechanical performance analysis.

- Mechanical interruption summaries, flight log review, engine monitoring reports, incident reports, engine and component analysis reports are examples of the types of information suitable for this monitoring method.
- For this arrangement to be effective, the number and range of inputs must be sufficient to provide a basis for analysis equivalent to the statistical standard programs.

C. The operator's organization must have the capability of summarizing the data to arrive at meaningful conclusions.

Actuarial analysis should be periodically conducted to ensure that current process classifications are correct.

SECTION 5 CORRECTIVE ACTION

The objective of data analysis is to—

1) Recognize the need for corrective action;

2) Establish what corrective action is needed; and

3) Determine the effectiveness of that action.

5.1 CORRECTIVE ACTION SYSTEM

A. The actions to be taken are a reflection of the analysis and should be positive enough to effectively restore performance to an acceptable level within a reasonable time.

- The system must include notification to the organizational element responsible for taking the action.
- The system should provide periodic feedback until such time as performance has reached an acceptable level.

B. The mechanics of the corrective action system normally encompass methods that have been established for the overall maintenance program such as—

- Work forms
- Special inspection procedures
- Engineering orders
- Technical standards

C. Special provisions should be included for critical failures; such as failures in which loss of the function or secondary effects of the failure impair the airworthiness of the aircraft.

5.2 STATISTICAL PERFORMANCE STANDARDS SYSTEM

A. The basis for the statistical standard is a performance measurement expressed numerically in terms of—

1) System or component failures;

2) Pilot reports;

3) Delays or some other event (bracketed by hours of aircraft operation, number of landings, operating cycles; or

4) Other exposure measurement..

B. The development of control limits or alert values is usually based on accepted statistical methods such as standard deviation or the poisson distribution.

Some applications use the average or base line method.

C. The standard should be adjustable with reference to the operator's experience and should reflect seasonal and environmental considerations.

D. The program should include procedures for periodic review of, and either upward or downward adjustment of, the standards as indicated.

The program should also include monitoring procedures for new aircraft until sufficient operating experience is available for computing performance standards.

SECTION 6 DATA DISPLAY & REPORT SYSTEM

6.1 REPORTS FOR ALERT TYPE PROGRAM

A. Programs incorporating statistical performance standards (alert type programs) should develop a monthly report, with appropriate data displays, summarizing the previous month's activity.

B. The report should—

1) Cover all aircraft systems controlled by the program in sufficient depth to enable the CAAV and other recipients of the report to evaluate the effectiveness of the total maintenance program;

2) Highlight systems which have exceeded the established performance standards and discuss what action has been taken or planned;

3) Explain changes which have been made or are planned in the aircraft maintenance program, including changes—

   (a) In maintenance and inspection intervals; and

   (b) From one maintenance process to another.

4) Discuss continuing over-alert conditions carried forward from previous reports; and

5) Report the progress of corrective action programs.

6.2 REPORTS FOR NON-ALERT TYPE PROGRAM

A. Programs using other analytical standards should consolidate or summarize significant reports used in controlling their program to provide for evaluation of its effectiveness.

These reports may be in the form of computer printouts, summaries, or any intelligible form.

B. A typical program of this type reports the following information—

1) Mechanical Interruption Summary (MIS);

2) Mechanical Reliability Reports (MRR);

3) Listing of all maintenance processes and interval assignments (Master specifications);

4) Weekly updates;

5) Daily Repetitive Item Listing (by aircraft);

6) Monthly Component Premature Removal Report (includes removal rate);

7) Monthly Engine Shutdown and Removal Report;

8) Quarterly Engine Reliability Analysis Report;

9) Engine Threshold Adjustment Report;

10) Worksheets for maintenance process and interval changes;

11) Maintenance interval adjustment and process change system.

SECTION 7 ADJUSTMENTS & REVISIONS

7.1 MAINTENANCE INTERVAL ADJUSTMENTS

A. Maintenance interval adjustments should not interfere with ongoing corrective actions.

Special procedures for escalating systems or components whose current performance exceeds control limits should be provided.

B. Typical considerations for adjusting hard-time and on-condition intervals include—

1) Sampling;

2) Actuarial studies;

All the factors listed here do not have to be considered for each case

3) Unit performance;

4) Inspector or shop findings;

5) Pilot reports.

C. Methods for adjusting aircraft/engine check intervals should be included if the program controls these intervals and sampling criteria should be specified.

D. The system should include—

1) Procedures for initial classification of maintenance processes (HT-OC-CM) and for changes from one process to another;

2) Authority and procedures for changing maintenance specifications; and

3) Related documents to reflect the interval adjustment or primary process change.

7.2 PROGRAM REVISION SYSTEM

A. The program should include a procedure for revision which is compatible with CAAV approvals.

This revision procedure should identify organizational elements involved in the revision process and their authority.

B. The program areas requiring formal CAAV approval include any changes to the program that involve—

1) Any of the program control systems;

2) Adding or deleting components/systems;

3) Adding or deleting aircraft types;

4) All procedural and organizational changes concerning administration of the program.

7.3 PROGRAM ADMINISTRATION

A. Administration of reliability programs (as discussed in this circular) requires a specific organizational structure within the operator's maintenance organization.

- Participants of the reliability program andministration team should be drawn from appropriate elements of the organization and should be authorized to act on behalf of their elements.
- The highest maintenance official or his designee should participate in the administration of the program. He should serve as the final authority for major activities and for the program.

B. The reliability program administration team may vary from one operator to another.

C. It may have a technical board that analyses performance deteriorations and shop findings to make determinations that may be acted on by an administrative board.

- The two boards can be combined if this better serves the needs of the particular operator.
- The board type of administration should entail meetings scheduled for some specified interval and should provide for assembling a board at any time a decision is needed.

D. In the absence of a formal administration team, operators with sufficient organizational capability should include a strong engineering function to administer their program by assigning appropriate responsibilities to specific elements of the operator's organization.

E. It is important to know that the effective management of the established procedures of operating each system is essential to the success of the program.

These procedures should be incorporated in appropriate sections of the operator's manual system.

F. Forms should be used, as necessary, to facilitate and document recurring transactions that involve several elements such as—

1) Changes from one maintenance process to another;

2) Analysis of substandard system or component mechanical performance;

3) Shop disassembly analysis for condition-monitoring purposes or overhaul frequency adjustment.; and

4) Sampling inspection for aircraft check or inspection adjustment.

SECTION 8 RELIABILITY PROGRAM DOCUMENT

A. The operator should develop a document describing the application of reliability control methods.

B. This document should include at least the following—

1) General description of the program;

2) Organizational structure, duties and responsibilities;

3) Description of the individual systems;

4) Derivation of performance standards (if used);

5) Changes to the program including designation of changes requiring CAAV approval;

6) Copy and explanation of all forms peculiar to the system; and

7) Revision control and certification of revisions to the document.

C. The document should—

1) Describe the workings of all systems in sufficient detail to provide for proper operation of the program.

2) The details for how the three maintenance processes are applied.

3) Describe the monthly report and any other reports relative to the program, and include samples of these reports with instructions for their use;

4) Identify the organizational element(s) responsible for publishing reports and the distribution of those reports; and

Copies of pertinent reports shall be provided to CAAV.

5) Include definitions of significant terms used in the program with particular emphasis on definitions of the three maintenance processes.

SECTION 9 PROGRAM APPROVAL

9.1 INITIAL APPROVAL

A. The program document and related data should be submitted to CAAV with a formal cover letter.

B. CAAV approval will be specified in the operations specifications issued to the operator.

9.2 REVISION APPROVAL

A. Amendments to the reliability program shall be subjected to a review, evaluation and approval process before incorporation.

B. It is important to take in consideration the impact of the proposed amendments on the overall organization manual system.

End of Advisory Circular

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