Transport Canada Transports Canada

Advisory Circular

Subject: **Reliability Methods for Maintenance Schedule Amendment**

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1.0 INTRODUCTION

(1) This Advisory Circular (AC) is provided for information and guidance purposes. It describes an example of an acceptable means, but not the only means, of demonstrating compliance with regulations and standards. This AC on its own does not change, create, amend or permit deviations from regulatory requirements, nor does it establish minimum standards.

1.1 Purpose

(1) The purpose of this document is to provide guidance to the aviation industry with respect to the means by which air operators can assess the continued effectiveness of their approved maintenance schedules and to demonstrate how reliability control methods can be used to justify maintenance schedule amendments. It describes the basic elements of a reliability program, which provides an acceptable means that may be used by an air operator to develop a Maintenance Monitoring Program described in paragraph 625.86(11)(b) of the *Canadian Aviation Regulations* (CARs).

1.2 Applicability

(1) This AC is available to the aviation industry for information purposes.

1.3 Description of Changes

(1) Not applicable.

2.0 REFERENCES AND REQUIREMENTS

2.1 Reference Documents

(1) It is intended that the following reference materials be used in conjunction with this document:

(a) *Aeronautics Act* (R.S., 1985, c. A-2)*;*

(b) Part I, Subpart 1 of the *Canadian Aviation Regulations* (CARs)— *Interpretation*;

(c) Part VI, Subpart 5 of the CARs— *Aircraft Requirements*;

(d) Transport Canada Publication, TP 13850— *Scheduled Maintenance Instruction Development Processes*;

(e) TP 13094— Maintenance *Schedule Approval Policy and Procedures Manual*;

(f) Specification 100, *Air Transport Association of America* (ATA)— *Manufacturer's Technical Data*; and

(g) Maintenance Steering Group (MSG)-3, ATA— *Operator/Manufacturer Scheduled Maintenance Development*.

2.2 Cancelled Documents

(1) Not applicable.

(2) By default, it is understood that the publication of a new issue of a document automatically renders any earlier issues of the same document null and void.

2.3 Definitions and Abbreviations

(1) The following **definitions** are used in this document:

(a) **Airworthiness Limitation**: a limitation applicable to an aeronautical product, in the form of a life limit or a maintenance task that is mandatory as a condition of the type certificate;

(b) **Condition Monitoring (CM)**: the use of a maintenance analysis process in order to determine equipment condition and potentially predict failure in order to determine if allocation of technical resources is required. CM is not a preventive maintenance

process; it allows failures to occur and relies upon analysis of operating experience information to indicate the need for appropriate action;

(c) **Confirmed Failure**: when shop findings confirm a defect or failure, which substantiates the reason for removal;

(d) **Green Aircraft**: a term used to describe a newly manufactured type certificated aircraft, in conformity with its certification basis and issued its first permanent flight authority but with additional and optional equipment and systems not yet installed. This would include optional avionic systems, emergency and survival equipment, cabin comfort and entertainment systems, interior furnishing and completions and exterior paint coatings that are required by the intended aircraft operational environment or specified by the customer;

(e) **Hard Time Maintenance (HT)**: a maintenance process under which a part is removed from service or over-hauled at fixed intervals defined in operating hours, operating cycles, or calendar time;

(f) **Interval**: the period (in flying hours, operating cycles or calendar time) which is permitted to elapse before a particular maintenance task is required, or between repeats of a task;

(g) **Life Limited Parts**: a part that, as a condition of the type certificate, may not exceed a specified time or number of operating cycles in service;

(h) **Maintenance Monitoring Program (MMP)**: a process described and approved in an air operator Maintenance Control Manual to allow the deviation from an approved maintenance schedule as described in Subsection 605.86(3) of the *Canada Aviation Regulations* (CARs), without the Ministers approval, when such deviation is supported by the operators reliability program;

(i) **Maintenance Planning Document**: a manufacturer's recommendation on the maintenance of his product in advance of, or concurrent with, the MRB report, and usually based on the same analyses which are submitted to the program development group, to enable prospective operators to establish maintenance schedules prior to the introduction of a new type into service.

(j) **Maintenance Process**: a classification of the manner in which a particular item is maintained;

(k) **Maintenance Review Board (MRB)**: the section of an airworthiness authority with responsibility for the approval of recommendations made by industry on the maintenance requirements of new aircraft types;

(l) **Maintenance Review Board Report (MRBR)**: the recommendations of a program development group, which are submitted to the airworthiness authority's MRB for approval, and thereafter form an approved basis on which a new operator may establish a maintenance schedule;

(m) **Maintenance Schedule**: a program for the scheduled maintenance of aircraft for a given fleet developed by an air operator and approved by Transport Canada, Civil Aviation (TCCA);

(n) **Maintenance Significant Items**: those maintenance items that are judged by the manufacturer to be relatively the most important from a safety or reliability standpoint or from an economic standpoint;

(o) **Mean Time Between Failures (MTBF)**: a performance figure calculated by dividing the total unit flying hours accrued in a period by the number of unit failures in that period;

$$\text{MTBF} = \frac{\text{Total unit hours this period}}{\text{Number of units failed this period}}$$

Note: *MTBF does not account for unit hours flown in other periods, scheduled unit removals, or units still operating*

(p) **Mean Time Between Removals (MTBR)**: a performance figure calculated by dividing the total unit flying hours accrued in a period by the total unit removals (both scheduled and unscheduled) in that period;

$$\text{MTBR} = \frac{\text{Total unit hours this period}}{\text{Number of units removed this period}}$$

Note: *MTBR does not account for unit hours flown in other periods or for units still operating*

(q) **Mean Time Between Unscheduled Removal (MTBUR)**: A performance figure calculated by dividing the total unit flying hours accrued in a period by the total unit unscheduled removals in that period;

(r) **Mean Time To Failure (MTTF)**: a performance figure calculated by computing the average of the cumulative operating hours for each unit at failure;

$$\text{MTTF} = \frac{\text{Total unit hours accrued by all failed units}}{\text{Total number of units failed}}$$

Note: *MTTF accounts for the average life of failed units only. Scheduled removals are not included*

(s) **Mean Time To Removal (MTTR)**: a performance figure calculated by computing the average of the total unit operating hours at removal for both scheduled and unscheduled removals;

$$\text{MTTR} = \frac{\text{Total unit hours accrued by all removed units}}{\text{Total number of units removed}}$$

Note: *MTTR is the most accurate performance figure for the average "life" realized for all components*

(t) **Minimum Equipment List (MEL)**: an approved list of items, which may be inoperative for flight under specified conditions;

(u) **MSG-1/2/3**: logic systems developed by the maintenance steering group of the Air Transport Association of America, for use by program development groups in the analysis of an aircraft's maintenance requirements;

(v) **On-Condition Maintenance (OC)**: a maintenance process having repetitive inspections or tests to determine the condition of units, systems or portions of structure;

(w) **Operational Reliability**: the ability to perform the required functions within acceptable operational standards for the time period specified;

(x) **Primary Maintenance Process**: the process primarily depended upon to ensure that inherent design reliability is maintained;

(y) **Sampling Program**: a program applied to major items of equipment, which are expected to be subject to progressive deterioration in service, and for which there is insufficient service experience to determine appropriate tasks and intervals. The purpose of the program is to collect data, which will enable the identification of the appropriate tasks and intervals, and indicate the need for product improvements;

(z) **Shop Findings**: detailed information concerning a component following repair, overhaul, bench test or sampling inspection. Information usually includes: confirmation of failure, details of failure modes/causes, parts replaced, condition of item, action taken, item disposition and recommendations concerning Time between Overhaul (TBO), preventive maintenance, etc;

(aa) **Task**: an action or set of actions intended to restore an item to, or maintain it in, an airworthy condition, including inspection to determine if the item is airworthy; and

(bb) **Time Between Overhaul (TBO)**: the overhaul interval approved by TCCA for a specified product, when used by a particular operator. Operator's TBO's are specified in the operator's maintenance schedule, approved pursuant to Section 605.86 of the CARs.

(2) The following **abbreviations** are used in this document:

(a) **PIREP**: A condition or event that has been reported by the Pilot; and

(b) **PMI**: Principal Maintenance Inspector.

3.0 BACKGROUND

(1) The first generation of formal air carrier maintenance programs was based on the belief that each part of an aircraft required periodic overhaul.

(2) Times between component overhaul were strictly controlled, and the entire aircraft was periodically disassembled, overhauled, and reassembled, in an effort to maintain the highest level of safety. This was the origin of the process referred to as "hard time maintenance."

(3) As experience was gained, it became apparent that some components did not require overhaul on a fixed time basis. Consequently, a second process evolved, referred to as "on-condition". This designation was assigned to components, the condition of which could be determined by visual inspection, measurement, testing or other means, which did not involve disassembly or overhaul.

(4) New methods of maintenance control were developed, which were oriented towards the assessment of mechanical performance rather than the prediction of failure. These methods were collectively known as "reliability control" because their major emphasis was upon maintaining failure rates below a predetermined value; i.e., the achievement of an acceptable level of reliability. The analytical nature of reliability control also disclosed the existence of aircraft components and systems that did not fit either the hard time or on-condition maintenance process categories. This led to the recognition of a third process category in which no maintenance tasks needed to be specified; instead, current performance was monitored and analyzed to indicate the need for a maintenance program amendment. This process, entitled "condition monitoring", was first recognized in the decision logic of the initial maintenance steering group document MSG-1 and was applied to Boeing 747 aircraft.

(5) The experience gained with MSG-1 was used to update its decision logic and create a more universal document for application to other aircraft or power plants. This document was designated MSG-2. When applied to a particular aircraft type, the MSG-2 logic results in a list of maintenance significant items each of which is assigned to one or more of the three process categories described above.

(6) After more than a decade of MSG-2 use, experience indicated that a further update was appropriate. As a result, a new industry task force developed MSG-3, which uses the basic philosophies of MSG-1 and MSG-2, but prescribes a different approach in the assignment of maintenance requirements. In lieu of process categories, MSG-3 identifies maintenance tasks. The development of this task oriented decision logic came about, partly in response to the misunderstanding which had been experienced with the terms on-condition and condition monitoring, and partly due to the realization that the reliability monitoring (on a unit basis) of items having only benign failure modes was an economic, rather than a safety requirement. Detailed

explanations of MSG-3 analysis methods may be found in Transport Canada Publication (TP) 13850.

(7) The processes, tasks and intervals arrived at by the use of MSG-1, -2 or -3, or, in the case of earlier aircraft, by the manufacturers' subjective analyses, are used by the operator as the basis of the development of their initial maintenance schedule. Subsequent amendments to that schedule must be consistent with the initial logic used, and will be based upon the operator's experience with the aircraft type. The means by which that experience is analyzed, quantified, and used to indicate required changes, are collectively known as the operator's "reliability program". Over a period of time the changes implemented as a result of a reliability program can be significant.

4.0 INITIAL ESTABLISHMENT OF A MAINTENANCE SCHEDULE

4.1 Maintenance Review Board Report

(1) Maintenance Review Board Reports (MRBRs) are usually available for modern transport category aircraft. They are often supported by a Maintenance Planning Document, which is based on the same analyses as the Maintenance Review Board (MRB). A maintenance schedule based on an MRBR must include all the tasks listed in the report, plus any additional tasks arising from the role in which the aircraft is to be employed or the environment in which the aircraft is to be operated.

(2) MRBRs usually address only the "green" aircraft and must therefore be supplemented by additional tasks to ensure the serviceability of optional equipment, including avionics, galley and passenger service equipment, life jackets, medical kits, etc.

(3) The intervals between tasks specified in the MRBR should be regarded as the maximum intervals for the operator's initial program, and should be reduced if the operation is in any way non-standard. For example, an unusually short haul route structure will mean a greater proportion of the flying hours spent with the flaps extended, and more frequent inspection of the flap tracks, and supporting structure may be indicated. Operation in areas of heavy atmospheric pollution may require frequent corrosion inspection and compressor washing. Susceptibility to fatigue and corrosion increases with age, so that structural inspection intervals may have to be reduced in the case of older aircraft.

4.2 Manufacturer's Recommendations

(1) Although manufacturer's recommendations are not formally approved, they are assessed by TCCA to determine their acceptability. Maintenance schedules based upon manufacturer's recommendations therefore, will generally be approved after a minimum of review, provided that all necessary additional items resulting from the operator's role, environment and optional equipment are also included.

5.0 RELIABILITY PROGRAM FORMAT

(1) An air operator reliability program should be tailored to meet the special requirements of the particular operator, and should take into account the operational and environmental circumstances, organizational structure, record keeping system, etc. The scope of an operator's reliability program will be defined in their maintenance control manual. All or part of an operator's maintenance schedule may be controlled by use of reliability methods, and a typical reliability program may include segments devoted to systems, components, powerplants and structures. All segments of the reliability program may use identical methods, or each may be handled individually. A reliability program may encompass a select group of items without affecting other controls for the remaining items.

(2) Statistical type reliability programs may be used wherever the frequency of events being monitored is sufficient. This type of program enables the use of alert rates, which may be shown on graphic charts (or equivalent displays) to identify areas where responsive action may be

needed. Where the frequency of events is too low to provide valid statistical data, sampling inspection and defect analysis may be used to assess the relationship between operating time and the failure resistance of components. These types of programs are respectively known as "alert" and "non-alert" programs. In practice most reliability programs include elements of both techniques. The description of a program as an "alert" or "non-alert" type generally indicates the predominant method used.

6.0 PROCESS CATEGORIES AND TASKS

(1) The basis of an operator's maintenance schedule is a list of items, together with the processes or tasks assigned to those items, and the intervals at which action is required. MSG-3 tasks are categorized as inspections, functional checks, operational checks, servicing/lubrication, restoration, discard, operating crew monitoring and "non-scheduled" tasks. Each inspection program should include specific definitions of the process categories and/or tasks it uses, and how they are applied.

(2) There is no hierarchy of processes or tasks, and complex (multi-cell) units may be subject to control by one or more of them. It should be noted, however, that some tasks might be included to meet a safety requirement, while others may have a primarily economic purpose. Before amending the inspection program, it may be necessary to refer to the initial analysis to determine which of these purposes applies. Information that is unknown to the operator may be obtained from the manufacturer. Engineers or engineering organizations may need to be consulted to obtain information necessary to allow for a safe change to an inspection program.

7.0 RELIABILITY PROGRAM ELEMENTS

(1) Both alert and non-alert type programs will usually include the following elements:

(a) data collection;

(b) analysis;

(c) display and reporting;

(d) responsive action; and

(e) program amendment procedures.

(2) The intent of the following paragraphs is not to provide rigid specifications, but rather to explain the purpose of each of these elements, which the operator may incorporate in this particular program.

7.1 Data Collection

(1) The data collection system should provide a specific flow of information from identified sources, and procedures for transmission of data, including the use of forms, computer printouts, etc. Responsibilities within the operator's organization must be established for each source of data collection. Typical sources of performance information are described below; however, it is not implied that all of these sources need to be included in the program, or that this listing prohibits the use of others.

7.1.1 Pilot Reports

(1) Pilot reports, more commonly known as “PIREPs”, are reports of occurrences and malfunctions entered in the aircraft journey log by the flight crew. PIREPs are among the most significant sources of information, since they are a direct indication of aircraft reliability as experienced by the crew. Usually the journey log entries are routed to the organization’s reliability section at the end of each day, or at some other agreed interval, whereupon each entry is extracted and recorded as a count against the appropriate system. Engine performance (trend) monitoring can also be covered by the PIREP system, and may be used as a source of data in the same way as

reports on system malfunctions. However, it should be kept in mind that this form of monitoring is primarily intended as a part of the “on-condition maintenance” process.

7.1.2 Mechanical Interruptions/Delays

(1) The operator’s line maintenance personnel normally report aircraft delays, and cancellations resulting from mechanical defects daily. Each report gives the cause of delay and clearly identifies the system or component in which the defect occurred. The details of any responsive action taken and the severity (period) of the delay are also included. The delays are usually listed in ATA 100 chapter sequence.

7.1.3 Engine In Flight Shutdowns

(1) Flight crew reports of engine shutdowns usually include details of the indications and symptoms prior to shutdown. When analyzed, these reports provide an overall measure of propulsion system reliability, particularly when coupled with the results of the subsequent investigations and with the records of unscheduled engine removals.

7.1.4 Unscheduled Removals

(1) Component unscheduled removals are reported, together with the following information:

(a) Identification of component;

(b) Precise reason for removal;

(c) Aircraft registration and component location;

(d) Date and airframe hours at removal; and

(e) Component hours since new/repair/overhaul/calibration.

7.1.5 Confirmed Failures

(1) With the exception of self-evident cases, each unscheduled removal report is followed up by a workshop report in which the reported defect is confirmed or denied. This report is routed to the reliability section. Workshops reports may be compiled from an operator's own "in-house" findings and/or from details supplied by component repair/overhaul contractors.

(2) Where a reported malfunction is confirmed, the workshop report will normally include details of the cause of the defect, the responsive action taken and, where relevant, a list of replacement items. Many programs utilize the same type of report to highlight structural and general aircraft defects found during routine maintenance checks.

7.1.6 Miscellaneous Reports

(1) Dependent upon the formation of individual programs, a variety of additional reports may be produced on a routine or ad hoc basis. Such reports could range from formal minutes of reliability meetings to reports on the sample stripping of components, and also include special reports, which have been requested during the investigation of any item, which has been highlighted by the program, such as service difficulty reports.

7.2 Data Analysis

(1) Data analysis is the process of evaluating mechanical performance data to identify characteristics, which indicate a need for program adjustment, revision of maintenance practices or hardware improvement (modification). The initial step in analysis is the comparison of the data to a predetermined standard of performance. This comparison may involve statistical calculations (alert type programs) or other methods (non-alert type programs).

(2) With both alert and non-alert type programs, the objectives of data analysis are to verify acceptable levels of performance, to identify trends which may need responsive action, and to indicate those tasks and intervals which may be safely eliminated, modified or extended.

7.2.1 Alert Type Programs

(1) Programs incorporating statistical performance standards use parameters such as the total number of delays, PIREPs per 1,000 departures or component removals/failures per 1,000 hours, for each aircraft system, or total number of delays/cancellations per 100 departures for the entire aircraft. The choice of units of measurement is not critical provided that they are constant throughout the operation of the program and are appropriate to the type and frequency of the events being recorded.

(2) When prepared as a running graphical or tabular display of current performance, these data depict trends as well as show out-of-limits conditions. The system performance data is usually reinforced by reports of component removals or confirmed failures.

(3) The data are then compared with a reliability alert level (or equivalent title, e.g. performance standard, control level, reliability index, upper limit, hereinafter referred to as an "alert level") which, when exceeded, indicates that there has been an apparent deterioration in the normal behavior pattern of the system or component with which it is associated. When an alert level is exceeded, appropriate responsive action must be taken. It should be recognized that alert levels are not minimum acceptable airworthiness levels. Rather, they are a means of identifying those increases in failure rate, which fall outside the bounds of normal distribution and therefore warrant further investigation.

(4) Alert levels can range from zero (for critical components, and for those where failures in service have been extremely rare) to perhaps as many as 100 PIREPs per 1,000 hours on a systems basis, for less critical systems, such as ATA Chapter 25 (equipment/ furnishings). Wherever possible, they should be based on the number of events, which have occurred during a representative period of safe operation of the aircraft fleet. Alert levels should be revised periodically to reflect operating experience.

(5) When establishing alert levels based on operating experience, the normal period of operation taken is between two and three years, dependent upon fleet size and utilization. The levels will usually be so calculated as to be appropriate to the numbers of events recorded in one-month or three-month periods of operation. Large fleets will generate sufficient information much sooner than small fleets.

(6) Where there is insufficient operating experience, or when a program for a new aircraft type is being established, the following approaches may be used:

(a) For a new aircraft type during the first two years of operation all malfunctions may be considered significant (i.e. alert level zero) while data is accumulated for future use.

(b) Alternatively, levels may be established based on the degree of system and component in-service reliability assumed in the design of the aircraft. These estimated values are normally quoted in terms of Mean Time Between Unscheduled Removal **(**MTBUR) or Mean Time Between Failures (MTBF) for both individual components and complete systems. These initial predictions should be replaced by actual reliability figures when sufficient in-service experience has been accumulated.

(c) For an established aircraft type with a new operator, the alert levels of other operators may be utilized until the new operator has accumulated sufficient experience.

(d) Alternatively, experience gained from operation of a similar aircraft model may be used.

(7) Both the method used for establishing an alert level, and the associated qualifying period, apply also when the level is recalculated to reflect current operating experience. However, if during the period between recalculations of an alert level, a significant change in the reliability of an item is experienced, which can be related to some known action (e.g. modification, change in maintenance or operating procedure) then the alert level applicable to the item should be re-assessed, based upon the data subsequent to the change. The procedures, periods and conditions for recalculation of alert levels must be defined in the program document and approved by TCCA.

7.2.2 Non-Alert Type Programs

(1) Programs that do not depend upon statistics for their operation (non-alert type programs) may be used by any size of organization and applied to any size of fleet. If the programs are to be as effective as the statistically based programs then the number and range of inputs must be equivalent to those of the statistical programs. The operator's organization must have the capability of analyzing the data to arrive at meaningful conclusions. This may involve the establishment of a dedicated section for the purpose. Less comprehensive non-alert type programs, which are applied to a limited number of components at any given time, may be handled by existing organizational elements, or even by a single individual.

(2) Much of the information that is compiled to assist in the day-to-day operation of the operator's maintenance program may be effectively used as a basis for this type of continuous mechanical performance analysis. Mechanical interruption summaries, flight log reviews, powerplant monitoring reports, incident reports, powerplant and component analysis reports are examples of the types of information suitable for this monitoring method. Non-alert type programs also include many elements of maintenance management, which are often not considered under the heading of "reliability". Examples include trial programs for different (though previously approved) lubricants, the documented use of different suppliers or overhaulers, and sampling (time trial) programs, whereby the escalation of times between overhaul of engines or other components is based upon satisfactory strip reports following successive trial extensions.

7.2.3 Changes in Inspection Program Basis

(1) Both types of program must include provision for the analysis of changes in the basis of the inspection program. Such changes may take the form of MRBR amendments, or changes in the maintenance planning document, or other manufacturers' recommendations, transmitted by manual amendments, service bulletins or other means. Each change must be evaluated to assess its applicability to the operator's program.

7.3 Data Display and Reporting

(1) All programs will require some means of displaying and reporting the collected data, and should include a periodic reporting system with appropriate data displays, summarizing the activity of the previous period. The reports should cover all aircraft systems controlled by the program, in sufficient depth to enable TCCA and other recipients to evaluate the effectiveness of the affected segments of the maintenance program. The reports should highlight systems which have fallen short of the established performance standards and discuss any action which has been taken, or is planned, including changes in maintenance and inspection intervals and changes from one process category and/or task to another. Continuing over-alert conditions carried forward from previous reports should be listed, together with details of the progress of any responsive action taken.

7.4 Responsive Action

(1) The actions to be taken in response to the data analysis should be positive enough to achieve the desired level of performance within a reasonable time. The system must include procedures to ensure TCCA approval for any proposed changes in the maintenance schedule, and for notification of the organizational element(s) responsible for taking the action. The system should also provide periodic feedback until such time as performance has reached an acceptable level. The procedures of the responsive action system may include work forms, special inspection procedures, engineering orders, etc. Special provision should be made for the control of critical items, the failure of which could impair the airworthiness of the aircraft.

(2) Action taken in response to the findings of the reliability program can include changes in operational procedures or fault finding techniques, changes in fuels or lubricants, variation of storage conditions, the use of different sources of supply and the improvement of training standards, etc. The major advantage of reliability control programs however, is that they afford the operator a formal means of substantiating applications for approval to amend the existing maintenance schedules. The program document should include a description of how applications will be made.

(3) The volume of data required to substantiate the extension of a maintenance interval, or the change or deletion of a maintenance task, will depend both on the frequency of the task, and on the reason for its inclusion in the initial program. The minimum level of experience would normally be approximately one year, or one complete interval between the events in question, whichever is the greater. Thus, high frequency events, such as "A" check items, will require a relatively high volume of data, in the order of 25-50 events or more, while infrequent events, such as "C" check items, will usually require the operator to demonstrate satisfactory completion of at least one complete interval between the tasks under review. Similarly, changes to tasks introduced for safety reasons (e.g. in response to route 5 or 8 tasks of MSG-3) will require significantly more substantiating data than those included primarily for economic or operational efficiency reasons. A demonstration that the amendment to the safety related task will not expose the aircraft or system to an unsafe condition will be required. This may involve additional documentation from engineering. This documentation may include analysis and calculations considering the original design philosophy. It will be necessary to refer to the original MRBR to determine the reason for each task.

(4) Changes that involve the deletion of a task, or a change in the primary maintenance process (e.g. from on-condition to hard time, or vice versa), must be subjected to the same analysis that was used to establish the initial program basis. This is sometimes referred to as the internal MRB procedure.

(5) Changes to tasks designated as airworthiness limitations, life limits, etc., may NOT be made on the basis of an operator's reliability program.

7.5 Reliability Program Amendment

(1) The program should include a description of the procedures for its own revision. The description should identify the organizational elements involved in the revision process and their authority. TCCA approval will be required for any revision affecting:

(a) Data collection systems;

(b) Data analysis methods;

(c) Performance standards;

(d) Addition or deletion of aircraft types; and

(e) Procedural and organizational changes concerning the administration of the program.

8.0 ADMINISTRATION OF PROGRAMS

(1) Participants in the reliability program should be drawn from appropriate elements of the organization and should be authorized to act on behalf of those elements. The Principal Maintenance Inspector (PMI) assigned to the carrier, or any other TCCA representative may participate in the administration of the program as an observer, but such participation will have no bearing on the approval or rejection of any changes proposed.

(2) The makeup of the administration group may vary considerably from one operator to another. It may consist of a technical board that analyzes performance trends and shop findings to make recommendations. This board type of administration should have meetings scheduled at some specified interval, and should provide for the ad hoc assembly of the board at any time a decision is needed.

(3) Alternatively, operators with sufficient organizational capability may administer their program by assigning appropriate responsibilities to each organizational element. With this type of arrangement, responsibility for operation of the program should be assigned to a specific element of the operator's organization.

(4) The procedures used for controlling each of the elements of the reliability program should be incorporated in appropriate sections of the operator's maintenance control manual. This will

provide each organizational element and individuals therein with instructions regarding their part in the program. Pre-printed forms should be used to document recurring actions that involve several organizational elements, such as the analysis of substandard systems or components, shop analysis of components for purposes of task interval adjustment, and reports relating to the amendment of aircraft inspection/check content.

9.0 PROGRAM DOCUMENT

(1) Reference is made in this AC to a reliability program document. In practice this document will most likely take the form of a section of the operator's maintenance control manual, and should include at least the following:

(a) General description of the program;

(b) Organizational structure, duties and responsibilities;

(c) Description of the individual systems;

(d) Derivation of performance standards;

(e) Method of controlling changes to the program;

(f) Copy and explanation of all forms particular to the system; and

(g) Revision control system.

(2) The document should describe the workings of all systems in sufficient detail to provide for proper operation of the program. It should describe any reports relative to the program, and include samples of any forms used with instructions for their use. The organizational element(s) responsible for publishing reports should be identified and the distribution should be stated.

(3) The document should also include definitions of significant terms used in the program, with particular emphasis on definition of the process categories and/or tasks.

10.0 PROGRAM APPROVAL

(1) Private operators may implement a reliability program without prior TCCA approval. The program will, however, be subject to review prior to the approval of any inspection program changes, which may be based upon it.

(2) An air operator’s or flight training unit’s reliability program will be reviewed, and where appropriate, approved by TCCA, as a part of the operator’s overall maintenance schedule. Approval of revisions to an air operator’s or flight training unit’s program will be by approval of the associated maintenance control manual amendment.

11.0 MAINTENANCE SCHEDULE AMENDMENT

(1) In accordance with Subparts 406 and 706 of the CARs air operator and flight training unit quality programs must include means to assess the effectiveness of their maintenance schedules. This may be accomplished by the use of a reliability program. The nature of the reliability program will depend upon the type and size of the operation, but it should be sufficiently comprehensive to identify any need for changes to the maintenance schedule.

(2) Changes to the maintenance schedule will consist essentially of three types:

(a) Addition of tasks or reduction of intervals, to ensure that acceptable levels of safety and reliability are obtained;

(b) Deletion of tasks or extension of intervals, to achieve reductions in operating costs; and

(c) Re-arrangement of existing tasks and intervals into different check packages, to cater for changes in route structure or timetables, or to obtain improved equipment availability.

(3) The approval of changes which consist solely of rearranging existing tasks and intervals is a simple matter, and will consist primarily of ensuring that skilled personnel are available to perform the work, and that the operating schedule allows for sufficient down-time to enable rectification of likely defects which may be detected during the checks.

(4) Air Operator initiated changes for reasons of economics will require the demonstration not only of an acceptable level of reliability (in the form of numbers of failures) but also an assessment of the hardware, in the form of satisfactory applicable workshop reports or inspection findings. Increases in the Time Between Overhaul (TBO) on major items such as engines and propellers will usually be by means of a trial program.

12.0 TRIAL PROGRAMS

(1) Before commencing a trial program for the extension of a TBO, the air operator must demonstrate acceptable performance at the existing interval. Normally, this demonstration will consist of the production of satisfactory strip reports on a number of units that have been successfully operated to the full TBO. To allow operational flexibility, units removed prior to the full TBO; may be acceptable as samples if at least 95% of the existing TBO has been achieved. Where the sample units include sub-assemblies (such as magnetos, generators) the sub-assemblies should be units which have been installed for the full interval, or which have completed a comparable amount of time in service. If this requirement cannot be met, the trial will be valid for the core unit only, necessitating a separate trial for the sub-assemblies if the desire is to increase the TBO also.

(2) The number of samples required will normally be between 10% and 25% of the total unit population, varying inversely with fleet size. Thus, an operator of two, twin engine aircraft would be required to produce a single sample of a propeller or engine (25% of the population), while an operator with a fleet of ten, four engine aircraft, would be required to provide four samples (10% of the population).

(3) If strip reports of the sample units are satisfactory, a deviation may be granted in accordance with Subsection 605.86(3) of the CARs, allowing the operator to exceed the approved TBO for the purposes of the trial. This deviation will usually apply to specified sample units only. It is in the operator's own interest to ensure that enough "stagger" is arranged between units to allow the sample units to complete the trial period, and be evaluated, before the remainder of the fleet reaches the normal TBO. The length of the trial period will normally not be more than 10% of the actual TBO, and the number of units sampled will be the same as the number sampled at the basic TBO.

(4) Upon completion of the trial period the sample units are overhauled, and if the resulting strip reports are satisfactory, approval will be granted for an amendment to the operator's program. This allows the operation of the fleet to the new interval. At this time, application may be made for a new trial with samples being run to the next level. This process may continue until either the strip reports indicate that further increases are inadvisable, or the reliability data indicates problems.

(5) Some manufacturers have developed their own life development program that differ from the above procedure, and in these cases TCCA will usually approve a trial based upon the manufacturer's recommended program.

13.0 DELETION OF TASKS

(1) The procedure to be followed for the deletion of a task from a maintenance schedule will depend upon the basis used to establish the initial program. If the program is based upon an MRB report, the operator must demonstrate that the circumstances of the operation are such as to make the

task irrelevant in their particular case. Typically, these tasks would only be effective from an operational or economic perspective, as MRB report safety tasks should never be deleted from an operator's maintenance schedule. MRBR rules need to be considered when making changes to tasks.

14.0 JOINT RELIABILITY PROGRAMS

(1) A fleet size of 5 or more aircraft is usually considered necessary to generate sufficient data for the operation of an effective statistically based reliability program. To accommodate the needs of smaller operators, participation in joint programs may be approved. Such programs fall into two main categories, those primarily intended for the use of another operator, and those managed by a third party (usually either the aircraft manufacturer, or a supplier of computer services). Each of these types of program differs significantly from the other, as shown below.

14.1 Participation in a Reliability Program of Another Operator

(1) Participation in the reliability program of another operator will require the approval of the PMI, or equivalent airworthiness authority representative, of each operator. The applicants will be required to demonstrate sufficient commonality of aircraft configuration, operating environment, utilization and route structure, to maintain the integrity of the program.

(2) Responsibility for program management for each of the participating fleets must be clearly defined, and the integration of data must be arranged so as to enable termination of the joint program without loss of applicable data. Data collection and analysis systems must include provision to detect significant differences in the participating fleets.

14.2 Third Party Programs

(1) This type of reliability program is most applicable to those aircraft types, such as business jets, where there may be no single large fleet operator. They may be regarded as data collection and analysis services, rather than complete programs. Multi participant programs of this type are of most value in the provision of operating data to the MRB to enable revision of the MRB report.

(2) Nevertheless, such programs may meet the Condition Monitoring (CM) requirements of MSG-2, and may be used by individual operators to demonstrate significant differences between their own and the global fleet, in support of changes to their own inspection programs

(3) Third party programs are not approved as such. Instead, individual operators must apply to TCCA for approval for their participation in the program. This is usually considered part of the approval of the operator's inspection program.

15.0 MAINTENANCE MONITORING PROGRAM

(1) TCCA must first approve initial maintenance schedules. Similarly, all amendments to schedules must also be approved; unless the operator's approved Maintenance Control Manual (MCM) includes Maintenance Monitoring Program (MMP). An MMP will contain procedures for incorporating amendments to the maintenance schedule solely on the basis of the operator's own analysis of reliability data that has been developed from the Air Operators operating experience.

(2) The MMP may be in addition to an existing reliability program approved for use by the operator or it may be a stand-alone program of reliability and analysis. In either case the program must be approved in the MCM.

(3) In addition to reliability data collection and analysis methods, the program must contain a process to monitor the effect of any changes made to a maintenance schedule that were a result of the MMP. The program must also describe a method for timely advising of Transport Canada of changes made to a maintenance schedule and must provide details of the changes made.

(4) Record keeping methods must be developed and described. Records relating to the MMP to record reliability data collected and data analysis that were completed must be kept. Records of reviews of maintenance schedule changes resulting from the MMP that were completed and records of any MMP decisions made must also be kept. All records must be made available to Transport Canada upon request.

16.0 INFORMATION MANAGEMENT

(1) Not applicable.

17.0 DOCUMENT HISTORY

(1) Not applicable.

18.0 CONTACT OFFICE

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[original signed by Arlo Speer for]

Jacqueline Booth
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Civil Aviation
Transport Canada

Transport Canada documents or intranet pages mentioned in this document are available upon request.