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ADVISORY CIRCULAR

MAINTENANCE REVIEW BOARD (MRB)

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Initiated by: AFS-230

AC NO: 121-22
DATE: 1/12/77

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: MAINTENANCE REVIEW BOARD (MRB)

1. PURPOSE. This advisory circular provides guidelines for establishing and conducting a Maintenance Review Board on newly manufactured aircraft, powerplant or appliance to be used in air carrier service.

2. REFERENCE. This document is appropriate for guidance of personnel who will participate in MRB proceedings in establishing the initial inspection and maintenance requirements as provided for in Title VI of the Federal Aviation Act of 1958.

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J. A. FERRARESE
Acting Director, Flight Standards Service

Initiated by: AFS-230

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CHAPTER 1. INTRODUCTION

1. PURPOSE. This advisory circular sets forth guidelines to be used in the development and approval of initial maintenance/inspection requirements for air carrier transport category aircraft. These are applicable to newly type certificated aircraft and aircraft powerplants being introduced into service for the first time. Approval of proposed initial maintenance/inspection requirements will be accomplished by a board of FAA specialists, Maintenance Review Board (MRB). All revisions for updating the initial maintenance/inspection requirements will be submitted by an airline/manufacturer committee to the FAA for approval.

2. BACKGROUND. The development of maintenance programs has a long history dating back to Aeronautical Bulletin 7E of May 15, 1930. The process of developing maintenance programs for new type aircraft has evolved from one in which each operator proposed his unique program, to one in which the Federal Aviation Administration (FAA) and industry worked together to formulate initial maintenance/inspection requirements for newly manufactured aircraft, aircraft engine, propellers and appliances. The culmination of these Maintenance Review Board (MRB) proceedings was the issuance of an MRB report. The net product has been a report that serves as a guideline for establishing initial maintenance/inspection requirements for new operators' maintenance programs.

3-10. RESERVED.

CHAPTER 2. APPLICATION

11. GENERAL. An industry proposal or a report containing the initial maintenance/inspection requirements which has been developed in accordance with these guidelines is not to be confused with or thought of as a maintenance program. The requirements when developed and approved become a base or a framework on or around which each operator develops his own individual maintenance program. Although maintenance programs vary widely from one operator to another, the initial requirements will be the same for all. An operator's total maintenance program (the means by which he implements these requirements) will be approved by the assigned Principal Maintenance/Avionics Inspectors (PMI/PAI).

12. MRB MANAGEMENT. When a transport type (air carrier) project is undertaken by a manufacturer, the Factory Maintenance Specialist (FMS) in the controlling region will assume the MRB chairmanship. The MRB membership will vary according to the magnitude of the project. MRB members will be selected by the MRB chairman. The MRB will be composed of knowledgeable personnel who do not necessarily have to be PMI/PAI's of a proposed operator. MRB members will be assigned by the MRB chairman to the various industry working groups as observers. The program developed by industry is submitted by the industry Steering Committee to the MRB chairman. Proposed revisions to the program may be submitted to the MRB chairman at the discretion of the airline/manufacturer committee after the aircraft has accumulated service experience. The MRB policy board is located at FAA Washington Headquarters (AFS-200) to provide a single Flight Standards position concerning MRB policy and responsibilities.

13-20. RESERVED.

CHAPTER 3. INDUSTRY PARTICIPATION

21. GENERAL. This advisory circular is designed around the maintenance program development concepts embodied in Airline/Manufacturer Maintenance Program Planning Document - (MSG-2). While other arrangements may be made by industry for organizing working groups, and other methods may be developed for establishing significant item lists, sampling densities, essential tasks, etc., adherence to these guidelines will facilitate FAA acceptance of industry's proposal. To accomplish this task in an orderly manner, industry may establish and conduct a steering committee and working groups in the following manner.

22. STEERING COMMITTEE. The steering committee should notify the FMS of the type controlling region of their intention to start developing an industry proposal for establishing initial maintenance/inspection requirements for a newly manufactured/certificated aircraft. Industry activities should be coordinated with the FMS by the steering committee which should be composed of members from a representative number of operators and airframe and engine manufacturers. The steering committee establishes policy, directs the activities of the working groups or other working activities, prepares the final proposal, and represents the operators with the FAA. It is also the function and responsibility of the steering committee to:

   a. Determine the number and type of working groups that will be necessary and organize same.

   b. Provide the region FMS with a list of the various types of working groups to be established and the names and affiliation of each working group member.

   c. Make provisions for development of zonal (area) inspection requirements.

   d. Arrange for necessary technical and maintenance program development training of all steering committee and working group members and observers.

   e. When the steering committee has reviewed and revised, as necessary, all working group proposals, they should document the entire package and present it to the MRB chairman for review and approval or denial. The document should be accompanied by supporting technical data.

23. WORKING GROUPS. Working groups are composed of the manufacturer and purchaser/operator representatives and should be chaired by a person appointed by the steering committee. Working groups are responsible for developing the initial maintenance/inspection requirements for their

area of responsibility in utilizing the provisions of MSG-2 or subsequent acceptable methods. Working groups will be established to cover the propulsion, structures, systems and components and avionics areas.

24. MANUFACTURER. The manufacturers are the most knowledgeable people concerning their product and therefore will be relied upon to make available the following information:

a. Provide general familiarization training for the steering committee, working groups, and observers.

b. Provide the steering committee with an initial list of Maintenance Significant Items (MSIs) and Structural Significant Items (SSIs).

c. Provide steering committee and working groups with data to support the analysis of MSIs/SSIs.

d. Provide steering committee and working groups with potential tasks as required by the analysis of paragraph 24.c.

e. Participate in steering committee and working groups' activities.

25. MANUFACTURER'S TEST DATA. Manufacturer's full scale fatigue test data may be used to develop or revise an MRB document. Emphasis should be placed on assuring that the manufacturer sets forth his intended fatigue test programs to interested FAA representatives in the early stages of the type certification process. When applying manufacturer's full scale fatigue test data it is important to ascertain:

a. The validity of the tests. The test program to which a full scale article is subjected should reflect the following criteria:

(1) Test Specimen - The full scale fatigue test article should be representative of the production aircraft. The full scale test article may be tested as a single unit or in major segments.

(2) Test Spectrum - A route analysis should be conducted to establish the expected usage of the aircraft including training and revenue flights. The usage should be represented by appropriate flight profiles which include such items as gross weight, speed, altitude and range. The typical loading spectrum thus developed should be used in conducting the tests. This spectrum should include loads which represent items such as takeoff, flight gusts, maneuvers, landing and ground handling conditions. Specific attention should be given to the ground-air-ground cycle and cabin pressurization.

b. The manufacturer should certify in writing to FAA that his test program meets the above criteria. The manufacturer should make available for inspection by FAA, on his premises and on written request, technical data pertaining to the fatigue test program including the witnessing of actual tests. The latter will be at the manufacturer's convenience as dictated by his test program schedule.

(1) Test Results - A life reduction factor should be applied and substantiated to all full scale fatigue test results. Based on the test program the manufacturer should provide:

(a) Findings of test article inspection including location, time, threshold and description of pertinent discrepancies and also indication of what corrective action is required.

(b) An analysis of the significance of pertinent discrepancies.

(c) Recommendations for inspection intervals for pertinent significant discrepancies.

(d) Recommendations of any changes to existing inspection intervals for nondiscrepant items.

c. The appropriateness of the revision to an MRB document - In applying the test results to the MRB document, judgment must be exercised and operating experience considered. These test results can be used to establish or modify industry sample size and frequency for operators lacking operating experience. All structurally significant items should be reviewed in the light of fatigue test results to determine those which might be changed. Hard and fast rules cannot be stated for application of fatigue test data to the MRB report. This does not mean that the proposed limits must be conservative in comparison with current limits, but they must be appropriate for the time at which they will become effective. The manufacturers' recommendations based on the test results are not considered either a floor or ceiling to inspection intervals but must be considered a baseline from which the actual intervals are determined. Limits based on fatigue tests will be considered inappropriate if they exceed the limits that should be applied for other factors such as corrosion, wear, etc.

d. A decision to disapprove a proposed revision will be accompanied by reasons and, where available, proposed changes which would make the revisions acceptable.

26-35. RESERVED.

CHAPTER 4. FAA PARTICIPATION

36. GENERAL. Approval of proposed initial maintenance/inspection requirements will be accomplished by a group of FAA specialists (MRB), consisting of the MRB chairman, field office and regional maintenance/avionics specialists as assigned, and a representative of the type certificating region's Engineering and Manufacturing Branch. The MRB chairman will be the Factory Maintenance Specialist (FMS), assigned by his respective region, to a specific aircraft or aircraft engine manufacturer. The function and responsibilities of the MRB chairman will be to:

a. Coordinate all MRB activities associated with his assigned manufacturer's product.

b. Offer guidance and assistance to the industry steering committee or working groups when appropriate.

c. Attend steering committee meetings as an observer when invited.

d. Review reports of FAA observers assigned to the industry working groups.

37. FAA OBSERVERS. FAA observers assigned to the industry working groups will be selected by the MRB chairman (FMS). Throughout the proceedings, all FAA observers shall provide the chairman with regular progress reports. Early awareness of potential controversial items will enable development of a timely solution.

38-45. RESERVED.

CHAPTER 5. MRB PROGRAM APPROVAL

46. MAINTENANCE/INSPECTION REQUIREMENT APPROVALS. When all issues have been resolved, the material developed by the MRB proceedings relating to the initial or revised report will be recorded and approved by the MRB chairman. This approved manuscript will be the criteria for evaluating proposed maintenance programs submitted to the assigned inspector.

a. New operators of the aircraft type should implement the MRB report or revisions thereto in accordance with normal approval procedures. Operators who have acquired experience with the aircraft type may adopt all or portions of a revised MRB report in accordance with normal approval procedures.

b. A decision to disapprove the original or revisions to the MRB report by the MRB chairman will be accompanied by reasons for disapproval and, where available, proposed changes which would be acceptable.

47-55. RESERVED.

CHAPTER 6. MRB PROGRAM REVISION

56. MAINTENANCE/INSPECTION REQUIREMENT REVISION. To maintain the initial maintenance/inspection requirements consistent with the management techniques and technological changes brought about as a result of operating experience, periodic revisions will be necessary.

a. After the accumulation of service experience, industry or the MRB chairman may request changes to the initial approved maintenance/inspection requirements. Such requests are handled by an industry airline/manufacturer committee, composed of the manufacturer and representative operators. Requests for changes should be accompanied by supporting data.

b. Revisions to the MRB report will be based on operator experience and/or manufacturer's test data. In analyzing the proposed revisions, the guidelines below should be used. This revision procedure applies to all wide body turbine-powered aircraft whose initial maintenance/inspection requirements were developed under MSG-1/2 or subsequent acceptable methods. (See Appendix 1)

c. This revision procedure may be used for other inservice aircraft based on MSG-2 analysis of maintenance/inspection requirements to establish a baseline or based on an analysis of operator experience, aircraft modification status, and maintenance content for a representative group of operators.

d. Operator Experience. Operator experience is the experience of individual operators in revising their own programs, or the collective experience of all of the operators that provide sufficient evidence for revising the basic program for all operators.

e. When individual operator's maintenance program revisions are used as a basis to revise an MRB report, it is important to determine that these revisions can be universally applied. A revision to an operator's program is insufficient basis for revision to an MRB report if that operator is unique in respect to some important aspect of his operations; e.g., an unusually beneficient environment, or if his revision was made as the result of other related revisions that are not being incorporated in the MRB report.

f. When the collective experience of all of the operators is used to revise an MRB report it is likewise important to determine that this experience can be universally applied. For example, if one or two operators contribute the majority of experience, their operation must be representative of other operators.

g. In either case (e. or f. above), a revision will include a provision for additional scheduled maintenance for operators in unusual environments if appropriate.

h. The MRB report will be revised accordingly to reflect any adverse or positive findings from the operator's experience.

i. Existing operators may adopt all or portions of the provisions of the revised MRB report in accordance with normal approval procedures.

57. MAINTENANCE/INSPECTION REQUIREMENTS PUBLICATIONS. The MRB report is a part of the technical support document provided by the manufacturer to the operators. Technical support documents comprising the maintenance manual, supplied by the manufacturer, should contain a note advising the operator that data contained in the MRB reports comply with the requirements of FARs 25.1529(h) or 29.1529.

AIRLINE/MANUFACTURER MAINTENANCE PROGRAM PLANNING DOCUMENT - MSG-2
(Prepared by: R & M Subcommittee, Air Transport Association)
(Date: March 25, 1970)

1.0 GENERAL

1.1 Introduction. Airline and manufacturer experience in developing scheduled maintenance programs for new aircraft has shown that more efficient programs can be developed through the use of logical decision processes. In July, 1968 representatives of various airlines developed Handbook #MSG-1, "Maintenance Evaluation and Program Development," which included decision logic and interairline/manufacturer procedures for developing a maintenance program for the new Boeing 747 airplane. Subsequently, it was decided that experience gained on this project should be applied to update the decision logic and to delete certain 747 detail procedural information so that a universal document could be made applicable for later new type aircraft. This has been done and has resulted in this document, #MSG-2.

1.2 Objective. It is the objective of this document to present a means for developing a maintenance program which will be acceptable to the Regulatory Authorities, the Operators, and the Manufacturers. The maintenance program data will be developed by coordination with specialists from the operators, manufacturers, and when feasible, the regulatory authority of the country of manufacture. Specifically it is the objective of this document to outline the general organization and decision processes for determining the essential scheduled maintenance requirements for new airplanes.

Historically, the initial scheduled maintenance program has been specified in Maintenance Review Board Documents. This document is intended to facilitate the development of initial scheduled maintenance programs. The remaining maintenance, that is non-scheduled or nonroutine maintenance, is directed by the findings of the scheduled maintenance program and the normal operation of the aircraft. The remaining maintenance consists of maintenance actions to correct discrepancies noted during scheduled maintenance tasks, nonscheduled maintenance, normal operation, or condition monitoring.

1.3 Scope. The scope of this document shall encompass the maintenance program for the entire airplane.

1.4 Organization. The organization to carry out the maintenance program development pertinent to a specific type aircraft shall be staffed by representatives of the Airline Operators purchasing the equipment, the Prime Manufacturers of the airframe and powerplant and when feasible the Regulatory Authority.

1.4.1 The management of the maintenance program development activities shall be accomplished by a Steering Group composed of members from a representative number of Operators and a representative of the Prime Airframe and Engine Manufacturers. It shall be the responsibility of this group to establish policy, direct the activities of Working Groups or other working activity, carry out liaison with the manufacturer and other operators, prepare the final program recommendations and represent the operators in contacts with the Regulatory Authority.

1.4.2 A number of Working Groups, consisting of specialist representatives from the participating Operators, the Prime Manufacturer, and when feasible the Regulatory Authority, may be constituted. The Steering Group, alternatively, may arrange some other means for obtaining the detailed technical information necessary to develop recommendations for maintenance programs in each area. Irrespective of the organization of the working activity, it must provide written technical data that support its recommendations to the Steering Group. After approval by the Steering Group, these analyses and recommendations shall be consolidated into a final report for presentation to the Regulatory Authority.

2.0 DEVELOPMENT OF MAINTENANCE PROGRAMS

2.1 <u>Program Requirement</u>. It is necessary to develop a maintenance program for each new type of airplane prior to its introduction into airline service.

2.1.1 The primary purpose of this document is to develop a proposal to assist the Regulatory Authority to establish an initial maintenance program for new types of airplanes. The purpose of this program is to maintain the inherent design levels of operating safety.* This program becomes the basis for the first issue of each airline's Operations Specifications-Maintenance to govern its initial maintenance policy. These are subject, upon application by individual airlines, to revisions which may be unique to those airlines as operating experience is accumulated.

2.1.2 It is desirable, therefore, to define in some detail:

(a) The objectives of an efficient maintenance program,

(b) The content of an efficient maintenance program, and

(c) The process by which an efficient maintenance program can be developed.

* See Glossary.

2.1.3 The Objectives of an efficient airline maintenance program are:

(a) To prevent deterioration of the inherent design levels of reliability and operating safety of the aircraft, and

(b) To accomplish this protection at the minimum practical costs.

2.1.4 These objectives recognize that maintenance programs, as such, cannot correct deficiencies in the inherent design levels of flight equipment reliability. The maintenance program can only prevent deterioration of such inherent levels. If the inherent levels are found to be unsatisfactory, engineering action is necessary to obtain improvement.

2.1.5 The maintenance program itself consists of two types of tasks:

(a) A group of scheduled tasks to be accomplished at specified intervals. The objective of these tasks is to prevent deterioration of the inherent design levels of aircraft reliability, and

(b) A group of nonscheduled tasks which results from:

(i) The scheduled tasks accomplished at specified intervals,

(ii) Reports of malfunctions (usually originated by the flight crew), or

(iii) Condition Monitoring.

The objective of these nonscheduled tasks is to restore the equipment to its inherent level of reliability.

2.1.5.1 This document describes procedures for developing the scheduled maintenance program. Nonscheduled maintenance results from scheduled tasks, normal operation or condition monitoring.

2.1.6 Maintenance programs generally include one or more of the following primary maintenance processes:

Hard Time Limit: A maximum interval for performing maintenance tasks. These intervals usually apply to overhaul, but also apply to total life of parts or units.

On Condition: Repetitive inspections, or tests to determine the condition of units or systems or portions of structure (Ref.: FAA Advisory Circular 121-1).

Condition Monitoring: For items that have neither hard time limits nor on condition maintenance as their primary maintenance process. Condition monitoring is accomplished by appropriate means available to an operator for finding and resolving problem areas. These means range from notices of unusual problems to special analysis of unit performance. No specific monitoring system is implied for any given unit (Ref.: FAA Procedures 8310.4, paragraph 3033).

This document results in scheduled tasks that fit the hard time limit or on condition maintenance programs or, where no tasks are specified, the item is included in condition monitoring.

2.2 Scheduled Maintenance Program Content

The tasks in a scheduled maintenance program may include:

(a) Servicing

(b) Inspection

(c) Testing

(d) Calibration

(e) Replacement

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

2.2.2 The development of a scheduled maintenance program requires a very large number of decisions pertaining to:

(a) Which individual tasks are necessary,

(b) How frequently these tasks should be scheduled,

(c) What facilities are required to enable these tasks to be accomplished,

(d) Where these facilities should be located, and

(e) Which tasks should be accomplished concurrently in the interests of economy.

2.3 Aircraft System/Component Analysis Method. The method for determining the content of the scheduled maintenance program for systems and components (parts a and b of Paragraph 2.2.2) uses decision diagrams. These diagrams are the basis of an evaluatory process applied to each system and its significant items using technical data provided (Ref. 2.7). Principally, the evaluations are based on the systems' and items' functions and failure modes. The purpose is to:

(a) Identify the systems and their significant items*.

(b) Identify their functions*, failure modes*, and failure reliability*.

(c) Define scheduled maintenance tasks having potential effectiveness* relative to the control of operational reliability*.

(d) Assess the desirability of scheduling those tasks having potential effectiveness.

2.3.1 It should be noted that there is a difference between "Potential" effectiveness of a task versus the "desirability" of including this task in the scheduled maintenance program. The approach taken in the following procedure is to plot a path whereby a final judgment can be made as to whether those potentially effective tasks are worthy of inclusion in an initial maintenance program for a new airplane.

2.3.3 There are three decision diagrams provided (Addendum I, Figures 1 through 3). Figure 1 is used to determine scheduled maintenance tasks having potential effectiveness relative to the control of operational reliability. This determines tasks which can be done.

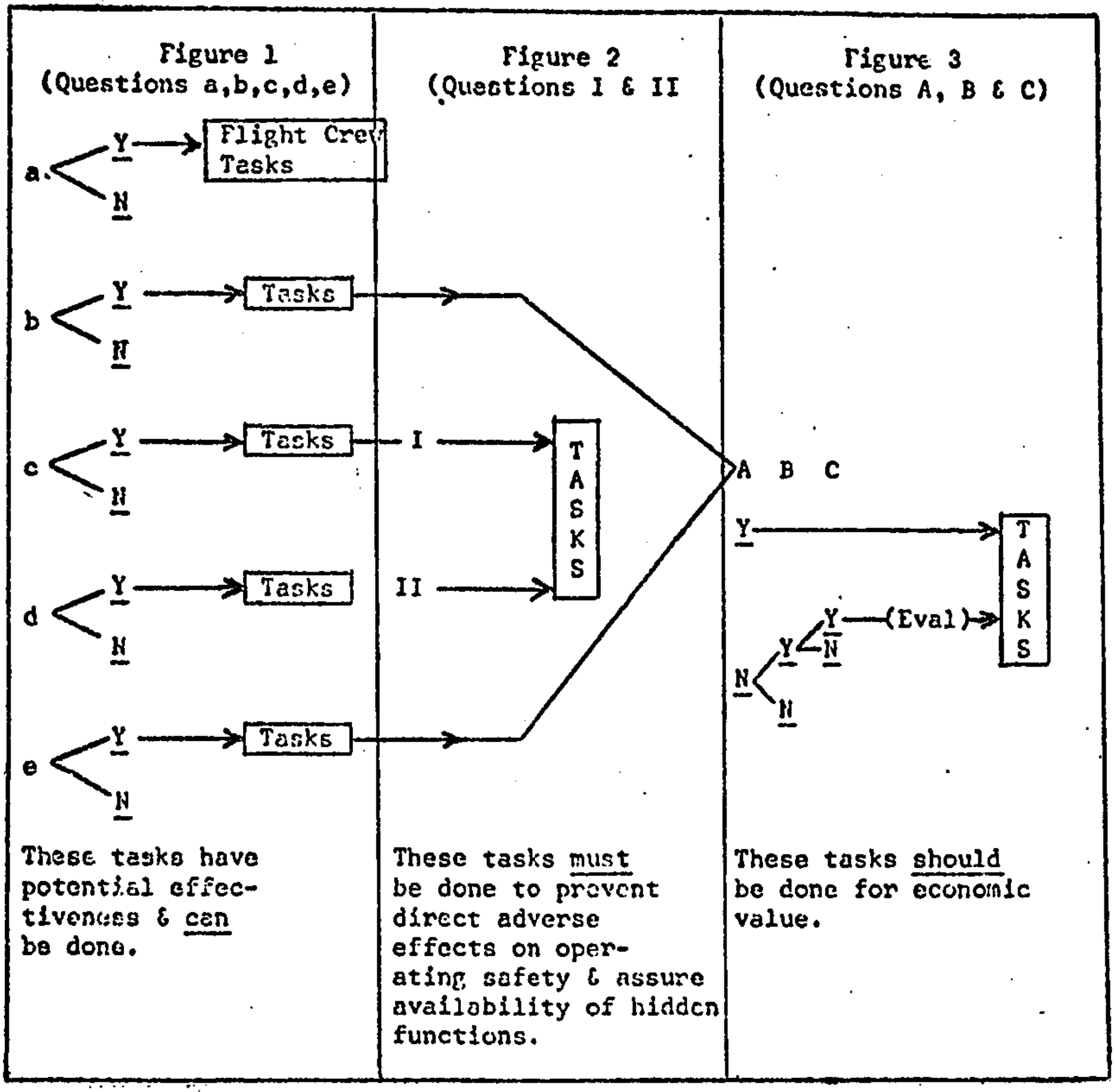
Figures 2 and 3 are used to assess the desirability of scheduling those tasks having potential effectiveness.

Figure 2 tasks must be done to prevent direct adverse effects on operating safety and to assure availability of hidden functions.

Figure 3 tasks should be done for economic value.

* See Glossary.

2.3.3 The total analysis process is shown diagramatically below. See Addendum I for details.



2.3.4 The following guidelines encourage consideration of failure consequences and the potential effectiveness of scheduled maintenance tasks. In those cases where failure consequences are purely economic, the guidelines lead to consideration of both the cost of the scheduled maintenance and the value of the benefits which will result from the task.

2.3.5 A decision tree diagram (Figure 1 of Addendum 1) facilitates the definition of scheduled maintenance tasks having potential effectiveness. There are five key questions.

Note: Questions (a), (b), and (c) must be answered for each failure mode, question (d) for each function, and question (e) for the item as a whole.

(a) Is reduction in failure resistance* detectable by routine flight crew monitoring*?

(b) Is reduction in failure resistance detectable by in situ maintenance or unit test?

(c) Does failure mode have a direct adverse effect upon operating safety? (See Addendum 2.)

(d) Is the function hidden from the viewpoint of the flight crew? (See Addendum 3.)

(e) Is there an adverse relationship between age and reliability?

2.3.6 Each question should be answered in isolation, e.g., in question (c) all tasks which prevent direct adverse effects on operating safety must be listed. This may result in the same task being listed for more than one question.

2.3.7 If the answer to question (a) is Yes, this means there are methods available through monitoring of the normal in-flight instrumentation to detect incipient conditions before undesirable system effects occur. A Yes answer does not require a maintenance task. If the answer is No, there is no in-flight monitoring which can detect reduction in failure resistance. This question is meant to refer to the flight crews' ability to detect deteriorating calibration or systems operation before a failure occurs. NOTE: Tasks resulting from in-flight monitoring are part of nonscheduled maintenance.

2.3.8 If the answer to question (b) is Yes, it means there is a maintenance task, not requiring item disassembly, that has potential effectiveness in detecting incipient conditions* before undesirable system effects occur. Tasks may include inspection, servicing, testing, etc. NOTE: Tasks resulting from a Yes answer to question (b) are part of the On Condition maintenance program.

* See Glossary.

2.3.9 If the answer to question (c) is Yes, this failure mode has a direct, adverse effect on operating safety. It is necessary to examine the mechanism of failure and identify the single cells or simple assemblies where the failure initiates. Specific total time, total flight cycle, time since overhaul and cycle since overhaul limitations may be assigned these single cells or simple assemblies and the probability of operational failures will be minimized. Examples of these actions are turbine engine disc limits, airplane flap link life limits, etc. In many cases, these limits must be based upon manufacturer's development testing. Fortunately, there is only a small number of failure modes which have a direct, adverse effect on operating safety. This results from the fact that failure mode analyses are conducted throughout the process of flight equipment design. In most cases, it is possible after identification of such a failure mode to make design changes (redundancy, incorporation of protective devices, etc.) which eliminate its direct adverse effect upon operating safety. If no potentially effective task exists, then the deficiency in design must be referred back to the manufacturer. The term "direct adverse effect upon operating safety" is explained in Addendum 2. NOTE: Tasks resulting from a Yes answer to question (c) are part of either the Hard Time limitation maintenance program or the On Condition maintenance program.

2.3.10 Refer to Addendum 3 for explanation of question (d). If the answer to question (d) is Yes, periodic ground test or shop tests may be required if there is no other way of ensuring that there is a high probability of the hidden function being available when required. The frequencies of these tests are associated with failure consequences and anticipated failure probability. A component cannot be considered to have a hidden function if failure of that function results in a system malfunction which is evident to the flight crew during normal operations. In this case, the answer must be No. NOTE: Tasks resulting from a Yes answer to question (d) may be part of either the Hard Time limitation or the On Condition maintenance program.

2.3.11 If the answer to question (e) is Yes, periodic overhaul may be an effective way of controlling reliability. Whether or not a fixed overhaul time limit will indeed be effective can be determined only by actuarial analysis of operating experience. NOTE: Tasks resulting from a Yes answer to question (e) are part of the Hard Time limitation maintenance program.

2.3.12 It has been found that overall measures of reliability of complex components, such as the premature removal rate, usually are not functions of the age of these components. In most cases, therefore, the answer to question (e) is No. In this event, scheduled overhaul cannot improve operating reliability. Engineering action is the only means of improving reliability. These components should be operated, therefore, without scheduled overhaul. NOTE: Systems or items which require no scheduled tasks are included in Condition Monitoring.

2.3.13 The preceding paragraph is contrary to the common belief that each component has an unique requirement for scheduled maintenance in order to protect its inherent level of reliability. The validity of this belief was first challenged by actuarial analyses of the life histories of various components. More recently, the correctness of the preceding paragraph has been overwhelmingly demonstrated by the massive operational experience of many airlines with many different types of components covered by Reliability Programs complying with FAA Advisory Circular 120-17.

2.3.14 It is possible to change the answers to the five questions in the decision diagram by improved technology. It is hoped that Aircraft Integrated Data Systems (AIDS), for example, will reliably indicate reduced resistance to various modes of failure of many components during normal airline operations. If this is determined to be possible, many "No" answers to questions (a) and (b) will become "Yes" answers. Answers may also be changed by various developments in the field of nondestructive test techniques, built-in test equipment, etc.

2.3.15 The questions in Figure 1 are intended to determine maintenance tasks having potential effectiveness for possible inclusion in a scheduled maintenance program. However, it is probable that many of these "potentially" beneficial scheduled tasks would not be "desirable" even though such tasks could improve reliability. This might be true when operating safety is not affected by failure or the cost of the scheduled maintenance task is greater than the value of such resulting benefits as reduced incidence of component premature removal, reduced incidence of departure delays, etc. Additional diagrams are used to assess the "desirability" of those scheduled maintenance actions which have potential effectiveness. This is accomplished by Figures 2 and 3 of Addendum 1.

2.3.16 Figure 2 selects those tasks which must be done because of operating safety or hidden function considerations. Figure 3 selects those tasks which should be done because of economic considerations.

2.3.17 Figure 2 assesses tasks listed against the Yes answers of questions c and d in Figure 1, and selects those tasks which must be done.

2.3.18 For the operating safety question, at least one task must be listed for each failure mode having a Yes answer to question c of Figure 1. An explanation should be given for any question c tasks not selected.

2.3.19 For the hidden function question, normally at least one task must be listed for each hidden function having a Yes answer to Figure 1, question d. If a task is not selected, as permitted by Addendum 3, an explanation must be provided.

2.3.20 Figure 3 assesses tasks listed against the Yes answers in Figure 1, questions b and e and select those tasks which should be done because of economic considerations.

2.3.21 A key question in Figure 3 is the first, "Does real and applicable data* show desirability of scheduled task?" a "Yes" answer is appropriate if there is:

(1) Prior knowledge from other aircraft that the scheduled maintenance tasks had substantial evidence of being truly effective and economically worthwhile, and

(2) The system/component configurations of the old and new airplanes are sufficiently similar to conclude that the task will be equally effective for the new airplane.

2.3.22 The question "Does failure prevent dispatch" refers to whether the item will be on the Minimum Equipment List (MEL).

2.3.23 The question "Is elapsed time for correction of failure > 0.5 Hr." refers to whether corrective action can be accomplished without a delay during a normal transit stop.

2.3.24 When a task "requires evaluation" it is important that the frequency of the failure and the cost of carrying out the task are taken into consideration.

* See Glossary.

2.4 Aircraft Structure Analysis Method. The method for determining the content of the scheduled maintenance program for structure is:

(a) Identify the significant structural items.*

(b) Identify their failure modes and failure effects.

(c) Assess the potential effectiveness of scheduled inspections of structure.

(d) Assess the desirability of those inspections of structure which do have potential effectiveness.

2.4.1 The static structure will be treated as hereafter described. Additionally, the mechanical elements of structural components, such as doors, emergency exits, and flight control surfaces will be treated individually by the processes described in Section 2.3.

2.4.2 The decision tree diagram, Figure 1 of Addendum 1, facilitates the definition of scheduled inspections of structure having potential effectiveness. There are five key questions.

(a) Is reduction in failure resistance detectable by routine flight crew monitoring?

(b) Is reduction in failure resistance detectable by in situ maintenance or unit test?

(c) Does failure mode have a direct adverse effect upon operating safety?

(d) Is the function hidden from the viewpoint of the flight crew?

(e) Is there an adverse relationship between age and reliability?

2.4.3 The answer to question (a) is normally No. However, if in-flight instrumentation is developed which permits detection of incipient structural failures then the answer could be Yes.

2.4.4 If the answer to question (b) is Yes, there are methods available to detect incipient conditions before undesirable conditions occur. It would be expected that all redundant external and internal structure would be in this category. NOTE: Tasks resulting from a Yes answer to question (b) are part of the Structural Inspection program. This program is an On Condition program.

2.5.2 The decision tree diagram, Figure 1 of Addendum 1, facilitates the definition of scheduled inspections having potential effectiveness. There are five key questions.

NOTE: Questions (a), (b), and (c) must be answered for each failure mode, question (d) for each function, and question (e) for the item as a whole.

(a) Is reduction in failure resistance detectable by routine flight crew monitoring?

(b) Is reduction in failure resistance detectable by in situ maintenance or unit test?

(c) Does failure mode have a direct adverse effect upon operating safety?

(d) Is the function hidden from the viewpoint of the flight crew?

(e) Is there an adverse relationship between age and reliability?

2.5.3 If the answer to question (a) is Yes, there are methods available through monitoring the normal in-flight instrumentation (including computerized Flight Log Monitoring) to detect incipient conditions before undesirable system effects occur. A Yes answer does not require a maintenance task. If the answer is No, there is no in-flight monitoring which can detect reduction in failure resistance. NOTE: Tasks resulting from in-flight monitoring are part of nonscheduled maintenance.

2.5.4 If the answer to question (b) is Yes, there is a maintenance task, not requiring engine disassembly, that has potential effectiveness in detecting incipient conditions before undesirable system effects occur. Tasks may include inspection, servicing, testing, etc. NOTE: Tasks resulting from Yes answers to question (b) are part of the On Condition maintenance program.

2.5.5 If the answer to question (c) is Yes, this engine component has a failure mode with direct, adverse effect on operating safety. It is necessary to examine the mechanism of failure and identify the single cells or simple assemblies where the failure initiated. Specific total time, or total flight cycle, limitations may be assigned these components to minimize the probability of operational failures, NOTE: Tasks resulting from a Yes answer to question (c) are part of either the Hard Time limitation maintenance program or the On Condition maintenance program.

2.4 Aircraft Structure Analysis Method. The method for determining the content of the scheduled maintenance program for structure is:

(a) Identify the significant structural items.*

(b) Identify their failure modes and failure effects.

(c) Assess the potential effectiveness of scheduled inspections of structure.

(d) Assess the desirability of those inspections of structure which do have potential effectiveness.

2.4.1 The static structure will be treated as hereafter described. Additionally, the mechanical elements of structural components, such as doors, emergency exits, and flight control surfaces will be treated individually by the processes described in Section 2.3.

2.4.2 The decision tree diagram, Figure 1 of Addendum 1, facilitates the definition of scheduled inspections of structure having potential effectiveness. There are five key questions.

(a) Is reduction in failure resistance detectable by routine flight crew monitoring?

(b) Is reduction in failure resistance detectable by in situ maintenance or unit test?

(c) Does failure mode have a direct adverse effect upon operating safety?

(d) Is the function hidden from the viewpoint of the flight crew?

(e) Is there an adverse relationship between age and reliability?

2.4.3 The answer to question (a) is normally No. However, if in-flight instrumentation is developed which permits detection of incipient structural failures then the answer could be Yes.

2.4.4 If the answer to question (b) is Yes, there are methods available to detect incipient conditions before undesirable conditions occur. It would be expected that all redundant external and internal structure would be in this category. NOTE: Tasks resulting from a Yes answer to question (b) are part of the Structural Inspection program. This program is an On Condition program.

2.4.5 If the answer to question (c) is Yes, there is a failure mode which has a direct, adverse effect on operating safety for which there is no effective incipient failure detection method. It would be expected that nonredundant primary structure would be in this category. See Addendum 2 for explanation of "direct adverse effect on operating safety." NOTE: Tasks resulting from a Yes answer to question (c) are part of the Hard Time limitation (usually total time or total cycle limits) maintenance program.

2.4.6 If the answer to question (d) is Yes, there is a function required of this element of structure that is not regularly used during normal flight operations. Some inspection or test is therefore necessary to ensure that this function has a high probability of being available when required. Tail bumper structure and structure provided for wheels-up landing are typical structural examples. NOTE: Tasks resulting from a Yes answer to question (d) are part of the Structural Inspection program.

2.4.7 Structures would be expected to have a Yes answer to question (e) but only in a very long total time envelope. The tasks performed as a result of Yes answers to the other questions are capable of detecting deterioration prior to failure of these items.

2.4.8 It is probable that some of these "potentially" beneficial scheduled inspections would not be desirable, even if such tasks would improve reliability. This might be true when airworthiness is not affected by failure and the cost of the scheduled inspection is greater than the value of the resulting benefits. Therefore, additional diagrams are used to assess the desirability of those scheduled tasks which have potential effectiveness. This is accomplished by Figures 2, 4, and 5 of Addendum 1. A No answer to all questions is unlikely for structure. If it occurs, the item is included in Condition Monitoring.

2.4.9 Figure 2 selects those tasks that must be done because of operating safety or hidden function considerations.

2.4.10 Figures 4 and 5 of Addendum 1 establish internal and external class numbers for structural items. The class numbers take into account vulnerability to failure, consequences of failure. The class numbers are to be used as guides for setting internal and external inspection frequencies.

2.4.11 The items to be evaluated by Figures 4 and 5 are those termed "structurally significant."

2.4.12 Each item is first rated for each of five characteristics per Figure 4 (fatigue resistance, corrosion resistance, crack propagation resistance, degree of redundancy and fatigue test rating).

2.4.13 Each item is then given an overall rating (R No.) per Figure 4 which considers all of the above ratings and combines them by judgment into a single overall rating (R No.) representing a relative level of structural integrity of the item. In general, the overall R No. for an item is equal to or less than the fatigue resistance or corrosion resistance rating for the item, whichever is lesser.

2.4.14 The internal and external class numbers for each item are then determined by reference to Figure 5. Note that some items have both internal and external class numbers. This occurs for those internal items which have some probability of the internal item's condition being evident by some external condition. In these cases the item as described is visible internally and the "internal" inspection specified refers to the item as described. The "external" inspection of this item refers to that portion of the external structure which is adjacent to the internal item and which may yield some indication of the internal item's condition. Therefore, when an external inspection is specified for an internal item, it refers to the adjacent external structure and not the internal item itself.

2.5 Aircraft Engine Analysis Method. The method for determining the content of the scheduled engine maintenance program is:

(a) Identify the systems and their significant items.

(b) Identify their functions, failure modes, and failure effects.

(c) Define scheduled maintenance tasks having potential effectiveness relative to the control of operational reliability.

(d) Assess the desirability of scheduling those tasks having potential effectiveness.

(e) Determine initial sampling thresholds where appropriate.

2.5.1 The engine as a whole and each significant engine item will be treated as described below.

2.5.2 The decision tree diagram, Figure 1 of Addendum 1, facilitates the definition of scheduled inspections having potential effectiveness. There are five key questions.

NOTE: Questions (a), (b), and (c) must be answered for each failure mode, question (d) for each function, and question (e) for the item as a whole.

(a) Is reduction in failure resistance detectable by routine flight crew monitoring?

(b) Is reduction in failure resistance detectable by in situ maintenance or unit test?

(c) Does failure mode have a direct adverse effect upon operating safety?

(d) Is the function hidden from the viewpoint of the flight crew?

(e) Is there an adverse relationship between age and reliability?

2.5.3 If the answer to question (a) is Yes, there are methods available through monitoring the normal in-flight instrumentation (including computerized Flight Log Monitoring) to detect incipient conditions <u>before</u> undesirable system effects occur. A Yes answer does not require a maintenance task. If the answer is No, there is no in-flight monitoring which can detect reduction in failure resistance. NOTE: Tasks resulting from in-flight monitoring are part of nonscheduled maintenance.

2.5.4 If the answer to question (b) is Yes, there is a maintenance task, not requiring engine disassembly, that has potential effectiveness in detecting incipient conditions <u>before</u> undesirable system effects occur. Tasks may include inspection, servicing, testing, etc. NOTE: Tasks resulting from Yes answers to question (b) are part of the On Condition maintenance program.

2.5.5 If the answer to question (c) is Yes, this engine component has a failure mode with direct, adverse effect on operating safety. It is necessary to examine the mechanism of failure and identify the single cells or simple assemblies where the failure initiated. Specific total time, or total flight cycle, limitations may be assigned these components to minimize the probability of operational failures, NOTE: Tasks resulting from a Yes answer to question (c) are part of either the Hard Time limitation maintenance program or the On Condition maintenance program.

2.5.6 If the answer to question (d) is Yes, there is a function required of this engine component that is not evident to the flight crew when the component fails. Some scheduled task may be necessary to assure a reasonably high probability that this function is available when required. NOTE: Tasks resulting from a Yes answer to question (d) may be part of either the Hard Time limitation or the On Condition maintenance program.

2.5.7 It is expected that the answer to question (e) is always Yes for structural engine components, but that their expected life is very long relative to the usual engine inspection periods. If tasks defined by questions (a) through (d) are inadequate to control wear or deterioration of engine components, additional tasks should be listed here. NOTE: Tasks resulting from a Yes answer to question (e) are part of either the Hard Time limitation or the On Condition maintenance program.

2.5.8 Engine components for which no scheduled tasks are selected are included in Gondition Monitoring.

2.5.9 The questions in Figure 1 are intended to determine maintenance tasks having potential effectiveness for possible inclusion in a scheduled maintenance program. However, it is probable that many of these "potentially" beneficial scheduled tasks would not be "desirable" even though such tasks could improve reliability. This might be true when operating safety is not affected by failure or the cost of the scheduled maintenance task is greater than the value of such resulting benefits as reduced incidence of component premature removal, reduced incidence of departure delays, etc. Additional diagrams are used to assess the "desirability" of those scheduled maintenance actions which have potential effectiveness. This is accomplished by Figures 2 and 3 of Addendum 1.

2.5.10 Figure 2 selects those tasks which <u>must</u> be done because of operating safety or hidden function considerations. Figure 3 selects those tasks which <u>should</u> be done because of economic considerations.

2.5.11 Figure 2 assesses tasks listed against the Yes answers of questions c and d in Figure 1, and selects those tasks which must be done.

2.5.12 For the operating safety question, at least one task must be listed for each failure mode having a Yes answer to question c of Figure 1. An explanation should be given for any question c tasks not selected.

2.5.13 For the hidden function question, normally at least one task must be listed for each hidden function having a Yes answer to Figure 1, question d. If a task is not selected, as permitted by Addendum 3, an explanation must be provided.

2.5.14 Figure 3 assesses tasks listed against the Yes answers in Figure 1, questions (b) and (e) and selects those tasks which should be done because of economic considerations.

2.5.15 A key question in Figure 3 is the first, "Does real and applicable data show desirability of scheduled task?"

A "Yes" answer is appropriate if there is:

(1) Prior knowledge from other aircraft that the scheduled maintenance tasks had substantial evidence of being truly effective and economically worthwhile, and

(2) The system/component configurations of the old and new airplanes are sufficiently similar to conclude that the task will be equally effective for the new airplane.

2.5.16 The question "Does failure prevent dispatch" refers to whether the item will be on the Minimum Equipment List (MEL). The answer to question (b) is expected to always be Yes for engine components that cause engine failure.

2.5.17 The question "Is elapsed time for correction of failure $>$ 0.5 Hr." refers to whether corrective action can be accomplished without a delay during a normal transit stop.

2.5.18 When a task "requires evaluation" it is important that the frequency of the failure and the cost of carrying out the task are taken into consideration.

2.5.19 Engine tasks are included in the Threshold Sampling maintenance program. This program is described below.

2.5.20 The Threshold Sampling maintenance program is intended to recognize the On Condition design characteristics of modern Turbo-Jet engines, while sampling to control reliability. This program uses repetitive sampling to determine:

(1) The condition of engine components.

(2) The advisability for continued operation to the next sampling limit, and

(3) The next sampling limit, threshold, or sampling band.

2.5.21 Initial sampling thresholds are based on:

(1) The design of the engine under study, the results of developmental testing, and prior service experience.

(2) The results of previous engine programs.

(3) The fact that samples are available from engines removed for all causes at virtually all ages. This means that knowledge of the condition of engines is available over the complete continuum of time from start of operation to the highest time experienced, and

(4) The fact that most engine design problems become apparent and can be controlled well within any established limits or thresholds.

2.5.22 The Threshold Sampling program establishes the initial sampling threshold. Operators are subsequently responsible for:

(1) Evaluating the samples obtained from the initial threshold.

(2) Determining the next sampling threshold, and

(3) Determining the number to be sampled at the next threshold.

2.5.23 Threshold Sampling is normally accomplished by inspecting the parts or systems of engines that are removed and accessible in the shop. These engines provide samples over a full range of ages without waiting for the threshold to be reached. The results of inspecting these samples are used to determine the future program. When samples are not available from engines that are in the shop, scheduled samples or in situ inspections may be required.

2.6 Program Development Administration. Regulatory Authority participation is encouraged as early and as thoroughly as possible in all phases of working group activity. It is recognized that the Regulatory Authority will later be asked to approve the proposed program resulting from these efforts. Therefore, the Regulatory Authority participation must necessarily be restricted to technical participation, contributing their own knowledge, and observing the activities of the working group. Regulatory Authority approval of working group recommendations is not implied by the participation of Regulatory Authority members in working group sessions. The following activity phases will apply.

Phase I. Steering Group general familiarization training.

Phase II. (a) Working Group or Working Activity Training.

*(b) Preparation of first draft Significant Items List. (Ref. 2.7.1)

*(c) Establish functions and failure modes applicable to the Significant Items.

(d) Preparation of Figures 1 thru 5 decision diagram replies and supporting data for each system and significant item.

Phase III. (a) Evaluation of manufacturer's technical data and recommended tasks by the Working Groups' airline personnel and meeting with manufacturer to make necessary revisions and prepare task recommendations.

(b) Development of task frequency recommendations. (This phase is meant to follow Phase III. a).

NOTE: A Steering Group member should participate in all Phase III activity.

Phase IV. Presentation to Steering Group (meeting with each Working Group or Activity Chariman).

Phase V. Preparation and presentation of the Steering Group's proposal to the Regulatory Authority.

2.7 Supporting Technical Data. The following supporting technical data will be provided in printed form, together with adequate cross-references on the records of replies to the decision diagrams.

2.7.1 Maintenance Significant Items List. This list will include by ATA System, the name, quantity per airplane, prime manufacturer part number, vendor name and part number for each item considered by the Working Group/Activity to require individual analysis.

2.7.2 Significant Items Data.

(a) Description of each significant item and its function(s).

(b) Listing of its failure mode(s) and effects.

* Steering Committee audits are required for these steps before proceeding.

(c) Expected failure rate.

(d) Hidden functions.

(e) Need to be on M.E.L.

(f) Redundancy (may be unit, system or system management).

(g) Potential indications of reduced failure resistance.

2.7.3 System Data.

(a) Description of each system and its function(s).

(b) Listing of any failure modes and effects not considered in item data.

(c) Hidden functions not considered in item data.

GLOSSARY

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

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.

Structural Significant Items - Those local areas of primary structure which are judged by the manufacturer to be relatively the most important from a fatigue or corrosion vulnerability standpoint or from a failure effects standpoint.

Operational Reliability - The ability to perform the required functions within acceptable operational standards for the time period specified.

Effective Incipient Failure Detection - That maintenance action which will reliably detect incipient failures if they exist. That is, detect the pending failure of a unit or system before that system fails. For example, detection of turbine blade cracks prior to blade failure.

Real and Applicable Data - Those data about real, operating hardware that is similar enough to the hardware under discussion to be applicable to the design of maintenance programs for the current hardware.

Reduction in Failure Resistance - The deterioration of inherent (design) levels of reliability. As failure resistance reduces, failures increase; resulting in lower reliability. If reduction in failure can be detected, maintenance can be performed prior to the point where reliability is adversely affected.

Function - The characteristic actions of units, systems and aircraft.

Failure Modes - The ways in which units, systems and aircraft deteriorate can be considered to have failed.

Potential Effectiveness - Capable of being effective (maintenance action) to some degree.

Routine Flight Crew Monitoring - That monitoring that is inherent in normally operating the aircraft. For example, the pre-flight check list, or the normal operation of the aircraft and its components. Does not include monitoring of "back-up" equipment that is normally not tested as a part of a normal flight.

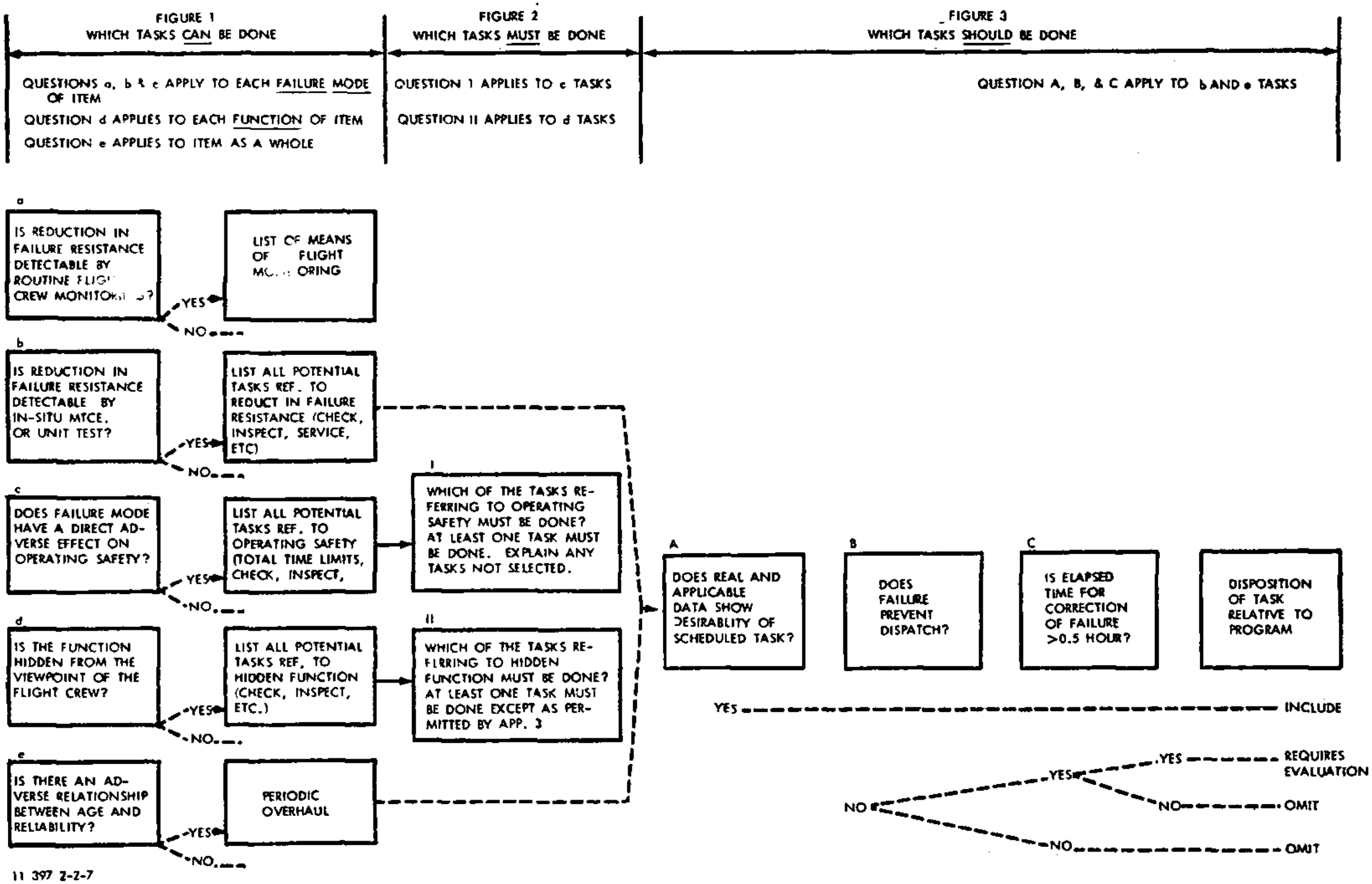
Failure Effects - The consequence of failure.

ADDENDUM 1

FIGURES 1, 2, AND 3. MSG 2 DECISION DIAGRAM

AIRLINE MAINTENANCE PROGRAM DEVELOPMENT

MSG 2 DECISION DIAGRAM



ADDENDUM 1

FIGURE 4. STRUCTURE ANALYSIS METHOD

AIRLINE MAINTENANCE PROGRAM DEVELOPMENT

STRUCTURE ANALYSIS METHOD

		1	2	3	4
FATIGUE RESTANCE	AN INDICATION OF THE FATIGUE RESISTANCE OF THE ITEM RELATIVE TO THE FATIGUE DESIGN GOAL FOR THE OVERALL AIRPLANE	SMALL MARGIN ABOVE DESIGN GOAL	FAIR MARGIN ABOVE DESIGN GOAL	CONSIDERABLE MARGIN ABOVE DESIGN GOAL	HIGH MARGIN ABOVE DESIGN GOAL
CORROSION RESISTANCE (INCL. STRESS CORROSION)	AND INDICATION OF THE RELATIVE CORROSION RESISTANCE OF THE ITEM. CONSIDERING BOTH EXPOSURE AND PROTECTION.	LEAST MARGIN OF RESISTANCE	FAIR MARGIN OF RESISTANCE	CONSIDERABLE MARGIN OF RESISTANCE	HIGHEST MARGIN OF RESISTANCE
CRACK PROPAGATION RESISTANCE	AND INDICATION OF THE RELATIVE ABILITY OF THE MATERIAL USED TO RESIST PROPAGATION OF CRACKS.	LEAST MARGIN OF RESISTANCE (HI HEAT TREAT STEEL)	FAIR MARGIN OF RESISTANCE (7000 SERIES ALUM)	CONSIDERABLE MARGIN OF RESISTANCE (TITANIUM)	HIGHEST MARGIN OF RESISTANCE (2000 SERIES ALUM.)
DEGREE OF REDUNDANCY	AN INIDCATION OF THE DEGREE TO WHICH THE ITEM IS BACKED UP BY REDUNDANT STRUCTURE.	SMALL	—	—	HIGH
FATIGUE TEST RATING	WILL THE LOADS APPLIED TO THE ITEM IN THE FULL SCALE FATIGUE TEST PROPERLY REPRESENT LOADS PREDICTED FOR SERVICE USAGE?	NO	—	—	YES
OVERALL RATING NUMBER (R)	A RATING WHICH CONSIDERS ALL THE ABOVE RATINGS AND COMBINES THEM BY JUDGEMENT INTO A SINGLE OVERALL RATING WHICH REPRESENTS A RELATIVE LEVEL OF THE STRUCTURAL INTEGRITY OF THE ITEM.	1	2	3	4

THIS PORTION OF CHART TO BE EXECUTED FOR EACH ITEM WHICH HAS BEEN DESIGNATED AS "STRUCTURALLY SIGNIFICANT" (applies to the first five rows)

THIS RATING NO. IS ASSIGNED TO ALL OTHER PRIMARY AND SECONDARY STRUCTURE WHICH IS NOT STRUCTURALLY SIGNIFICANT (applies to the Overall Rating Number row)

ADDENDUM 1

AIRLINE MAINTENANCE PROGRAM DEVELOPMENT

STRUCTURE DETECTABILITY EVALUATION

THIS CHART CONVERTS OVERALL RATING (R) TO INTERNAL & EXTERNAL CLASS NUMBERS

	A INTERNAL CLASS NO.	B EX. CLASS NO. IF>10 ABOVE GROUND IN NON FUEL AREA	C EX. CLASS NO. IF<10 ABOVE GROUND OR IN FUEL AREA
STRUCTURALLY SIGNIFICANT ITEMS			
(EX) EXTERNAL ITEMS	NONE	R	R+1
(IN) INTERNAL ITEMS :			
• HIGH PROBABILITY OF EXTERNAL DETECTABILITY OF ITEM'S CONDITION BY FEUL LEAK OR VISUAL CONDITION OF ADJACENT EXTERNAL ITEM	R+1	R	R+1
• LOW PROBABILITY OF DITTO	R	R+1	R+1
• NO EXTERNAL DETECTABILITY OF ITEM'S CONDITION SINCE NO ADJACENT ITEMS ARE VISIBLE EXTERNALLY	R	NONE	NONE
ALL OTHER PRIMARY OR SECONDARY STRUCTURAL ITEMS WHICH ARE NOT STRUCT. SIGNIFICANT			
(EX) EXTERNAL ITEMS	NONE	5	5
(IN) INTERNAL ITEMS	5	NONE	NONE

EXTERNAL MEANS THERE IS VISUAL ACCESSIBILITY WITHOUT DETACHING ANY PARTS (INCL. ACCESS PANELS) FROM THE AIRPLANE, AND INCLUDES CONTROL SURFACE DEFLECTION AS REQUIRED

INTERNAL MEANS THERE IS VISUAL ACCESSIBILITY ONLY BY DETACHING REMOVABLE PARTS OR BY RADIOGRAPHIC MEANS

▶ WHERE VISUAL ACCESSIBILITY EXISTS SIMPLY BY REMOVAL OF AN ACCESS PLATE AND NO ADDITIONAL DETACHMENT OF PARTS IS NECESSARY TO GAIN VISUAL ACCESS

FIGURE 5. STRUCTURE DETECTABILITY EVALUATION

ADDENDUM 2

The following elaborates on the term "direct and adverse effect on operating safety."

During the design process considerable attention is given to system and component failure effect analysis to ensure that failures that result in loss of function do not immediately jeopardize operating safety. In many cases, redundancy can cause the consequences of a first failure to be benign. In other cases, protective devices serve this purpose. Although it may not be possible to continue to dispatch the airplane without correcting the failure and although it may indeed be desirable to make an unscheduled landing after failure, the failure cannot be considered to have an immediate adverse effect upon operating safety. The inclusion of the word direct in the phrase "direct adverse effect upon operating safety" means an effect which results from a specific failure mode occurring by itself and not in combination with other possible failure modes.

Certification requirements ensure that a transport category aircraft has very few failure modes which have a direct adverse effect upon operating safety.

ADDENDUM 3

EXPLANATION OF HIDDEN FUNCTIONS

A component is considered to have a "hidden function" if either of the following exists:

1. The component has a function which is normally active whenever the system is used, but there is no indication to the flight crew when that function ceases to perform.

2. The component has a function which is normally inactive and there is no prior indication to the flight crew that the function will not perform when called upon. The demand for active performance will usually follow another failure and the demand may be activated automatically or manually.

Examples of components possessing hidden functions exist in a bleed air system. A bleed air temperature controller normally controls the bleed air temperature to a maximum of 400°F. In addition, there is a pylon shutoff valve which incorporates a secondary temperature control, should the temperature exceed 400°F. A duct overheat switch is set to warn the flight crew of a temperature above 480°F, in which event they can shut off the air supply from the engine by actuating the pylon shutoff valve switch. There is no duct temperature indicator.

The bleed air temperature controller has a hidden active function of controlling the air temperature. Since there is a secondary temperature control in the pylon valve and since there is no duct temperature indicator, the flight crew has no indication of when the temperature control function ceases to be performed by the temperature controller. Also, the flight crew has no indication prior to its being called into use that the secondary temperature control function of the pylon valve will perform. Therefore, the pylon valve has a hidden inactive function. For a similar reason, the duct overheat warning system has a hidden inactive function. And the pylon valve has a hidden inactive function (manual shutoff) since at no time in normal use does the flight crew have to manually close the valve.

The hidden function definition includes reference to "no indications to the flight crew" of performance of that function. If there <u>are</u> indications to the flight crew, the function is evident (unhidden). However, to qualify as an evident function, these indications must be obvious to the flight crew during their normal duties, without special monitoring (bear in mind, however, that special monitoring is encouraged as a part of the maintenance program to make hidden functions into evident ones).

It is recognized that, in the performance of their normal duties, the flight crews operate some systems full time, others once or twice per flight, and others less frequently. All of these duties, providing they are done at some reasonable frequency, qualify as "normal." It means, for example, that although an anti-icing system is not used every flight is is used with sufficient frequency to qualify as a "normal" duty. Therefore, the anti-icing system can be said to have an evident (unhidden) function from a flight crew's standpoint. On the other hand, certain "emergency" operations which are done at very infrequent periods (less than once per month) such as emergency gear extension, fuel dump actuation, etc., cannot be considered to be sufficiently frequent to warrant classification as evident (unhidden) functions.

The analysis method requires that all hidden functions have some form of scheduled maintenance applied to them. However, in those cases where it may be difficult to check the operation of hidden functions, it is acceptable to assess the operating safety effects of combined failures of the hidden function with a second failure which brings the hidden function failure to the attention of the flight crew. In the event the combined failures do not produce a direct adverse effect on operating safety, then the decision whether to apply maintenance to check the pertinent hidden function becomes an economic decision to be considered by Figure 3 of Addendum 1.

Note also, in some cases, it is acceptable to accomplish hidden function checks of removable components during unscheduled shop visits, providing the component has at least one other function which when failed is known to the flight crew and which causes the unit to be sent to the shop. Also, the hidden function failure mode should have an estimated reliability well in excess of the total reliability of the other functions that are evident to the flight crew.

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