GOVERNMENT OF INDIA

OFFICE OF THE DIRECTOR GENERAL OF CIVIL AVIATION

TECHNICAL CENTRE, OPP SAFDURJUNG AIRPORT, NEW DELHI

CIVIL AVIATION REQUIREMENTS
SECTION 2 - AIRWORTHINESS
SERIES 'D' PART II
1st JANUARY, 1985 **EFFECTIVE: FORTHWITH**

Subject : Aircraft Maintenance Programme and their approval.

1. APPLICABILITY :

Aircraft Rule 60(2) authorizes DGCA to specify standard of maintenance of aircraft, aircraft component and item of equipment. This series of CAR lays down detailed compliance standard of maintenance. The requirements of CAR are applicable to airlines and non-scheduled operators as well as private operators.

2. DEFINITION :

Airworthiness :

The continuing capability of the aircraft to perform in a satisfactory manner the flight operations for which it was designed.

Maintenance :

The action or a set of actions including inspection,servicing and determination of condition required to achieve a desired out-come which restores an aircraft part, equipment in serviceable condition.

Overhaul:

Overhaul means stripping a unit and restoring it to its original design performance level after replacing/reworking parts to a given standard.

Damage Tolerant :

An item is to be judged damage tolerant if it can sustain damage and the remaining structure can withstand reasonable load without structural failure or excessive structural deformation when the damage is detected. This includes damage due to fatigue, accidental damage and damage due to environmental factors.

Structural Significant item :

A structural detail, structural element or structural assembly is judged significant because of the reduction in aircraft residual strength or loss of structural functions which are subsequent to its failures.

Hard Time:

This is a failure preventive process in which deterioration of an item is limited to an acceptable level by the maintenance actions, which are carried out at periods, related to time in service (e.g. calendar time, number of cycles, number of landings). The prescribed actions normally include servicing and such other actions as overhaul, partial overhaul, replacement in accordance with instructions in the relevant manuals, so that the item concerned (e.g. system, component, portions of structure) is either replaced or restored to such a condition that it can be released for a further specified period.

On Condition:

This is also a failure preventive process but one in which the item is inspected or tested, at specific periods, to an appropriate standard in order to determine whether it can continue in service (such an inspection or test may reveal a need for servicing actions). The fundamental purpose of On-Condition is to remove an item before its failure in service. It is not a philosophy of 'fit' until failure or 'fit and forget it'.

Condition Monitoring:

This is not a preventive process, having neither Hard Time nor On-Condition elements, but one in which information on items gained from operational experience is collected, analyzed and interpreted on a continuing basis as a means of implementing corrective procedure.

3. Purpose:

It is essential for the continued airworthiness of aircraft/aircraft systems that there be an efficient maintenance program applicable to each aircraft. With the change of size, complexity and high performance of aircraft and also with improved design techniques it is essential that a more knowledgeable approach is made to the control of maintenance. The earlier concept of stripping and overhauling of all aircraft components, items of equipment to ensure the airworthiness is no longer justified considering improved design techniques, redundancy in the system, high degree of built-in reliability and cost involved in carrying out overhaul as airlines have to fly aircraft not only safely but also economically.

4. Primary Maintenance Process:

It has been recognized by the various airworthiness authorities that the airworthiness of aircraft and safety of its operation can be very well maintained by three following processes:-

(a) Hard Time Maintenance Process: This process recognizes that the component or the part has got direct relationship between reliability and the age and also its failure on the aircraft may have direct effect on the safety. Failure rate and premature removal could be very well analyzed to establish that the components/parts have been failing after reaching particular hours of operation at which it is most desirable and efficient to remove the component from the aircraft and carry out overhaul rather than let it fail on the aircraft. The process is called the failure preventive maintenance process. This process is suitable for operators with very small fleet of aircraft, low utilization and smaller in size where system redundancy and modern sophistication has not been built in the design stage and the operator may not have a large support organization of Quality Control/record keeping.

(b) On Condition: On condition maintenance concept was later on developed where the components deterioration or determination in reliability could be measured or properly assessed without stripping the component by physical measurement, benchcheck, internal leak rate checks, and the operator has to justify and substantiate necessary data and support either from the manufacturers or from his own operational data analysis with the particular components performance that failure resistance could be detected by in situ maintenance for functional check and establish a performance standard after which the component will be removed and again brought to its original performance level and released for service for specified period.

(c) Condition Monitoring: Condition Monitoring components have no overall control and are operated to failure. No maintenance task is required to evaluate condition, life expectancy or reliability degradation to replace the item before it fails. Neither 'Hard Time' nor 'On Condition' standards can control the reliability or failure rate of CM items. Replacement of CM items is an UNSCHEDULED maintenance action.

Note : Notwithstanding the above, the definitions given by the manufacturer shall prevail over those given in this CAR.

5. Approval of the System :

An operator depending on his capability, staff and other support organization should apply to the Regional Airworthiness Office for approval of his Maintenance Program. He can select either of the above three maintenance programs or a combination of these processes as the primary means of controlling the maintenance activities thereby leading to effective airworthiness control. Manufacturer's recommendation will be the main guiding factor. Multi Cell components can have all the three processes applied to e.g. an engine having a number of components (cells) some of which may be time limited (discs etc.), the others may be depending on the ON Condition for example deterioration of engine power and checked by Condition Run and some on 'On Condition Monitoring' concept.

6. Monitoring of the Approved Maintenance Process :

The maintenance process approved for an operator will have to be monitored continuously for its result and changes implemented arising out of this monitoring. Monitoring is basically based on statistical analysis of various performance parameters.

(1) Pilots' Report :

Occurrence of malfunction in flight are recorded in the Technical Log by the Flight Crew for each flight. Pilots also record various instrument data for monitoring the condition of the engine and airframe. The engine performance can be very well monitored by the inflight crew monitoring of instruments. These monitorings indicate long term trend and are very useful in recognizing impending failure/deterioration. The Pilots' report etc. are calculated as rate per 1000 hours of operation or as a number of per 100 departures. The operator has to establish an Alert level based on experience of initial operation and it can be continuously up-dated by means of what is called Rolling average either quarterly or six monthly.

(2) Engine Inflight Shut-Down :

Engine Inflight Shut-Down may result in removal of the engine for further overhaul or repair. Analysis of the causes and the failure give lot of information on the method of operation and the standard of engine overhaul, the basic design of the engine. Feed-back from strip report will be very much beneficial for enhancing the reliability of Power Plant.

(3) Aircraft Mechanical Delay and cancellation of services.

Performance of the operator or an airlines organization is very well judged by the mechanical delays to scheduled services and also by the cancellations. All delays of more than 15 mts. as per the present approved practice are to be reported and the operator support system (Quality Control System) has to assess cause and take corrective action. The delays are classified and assessed ATA systemwise and dispatch reliability calculated.

(4) Components Unscheduled Removals or Premature Removals:

This is another factor which would help the operator to assess the condition of the component maintenance behaviour after proper investigation of confirmed failures. Such components are to be investigated by the operators reliability control section and necessary corrective action taken.

7. Statistical Reliability Measurement :

The various data collected are reduced to 1000 per hrs. of operation or thousands of flight hours and numerical rate derived. The pilots reports as well as the confirmed failures are to be taken as complementary to each other as sometimes unscheduled removal of components may not be a confirmed failure.

8. Reliability Alert Level :

The Reliability Alert level for the purpose of establishing the performance standard control level or an upper limit may be established based on the operators experience initially over two to three years of operation depending on fleet size and utilization and then to be continuously up-dated on the experience gained and corrective action taken. There are several methods of calculating an alert level and any of the established methods of statistical analysis may be used. Appendix (II) details one such method.

9. The Programme Document :

The operator will have to document the programme for the guidance of all the personnel involved for satisfactory implementation. It will also include the method of establishing alert value, the method of data collection, publishing various documents for the guidance of others bringing out the various charts and graphs to indicate the trend.

The Airworthiness Officers would carry out checks to ensure that the programme is implemented in the spirit. Any deviation observed by them would be brought to the notice of Quality Control Manager for corrective action.

Regular evaluation and assessment by operator's higher authorities of the reliability programme must be done at frequent intervals to detect the fault in the system. The programme will have to be reflected in the Maintenance System Manual of the operator. It will clearly indicate the alert values or upper control limit which require a maintenance action. The operators reliability monitoring unit under the Quality Control Manager will review the various Pilots Reports, premature removed components, investigation reports, confirmed failures, defects noticed by the AMEs on ground and take necessary corrective action after establishing the monthly rate in light of the alert established for the components.

After gaining experience and after demonstrating to the Regional Airworthiness Offices the particular component or item be shifted from one type of programme to the other. The criteria for fixing whether the component would be on Hard Time, On-Condition or Condition Monitoring concept will have to follow the logic decision tree given in the Appendix (ii) to this CAR (MSG 2 Logics). When the operator wishes to change a component from one type of maintenance to another he will produce necessary statistics to demonstrate and justify the same. Manufacturers' recommendation would also be a guide in this regard. The operator will also produce the failure rate removal etc. in graphical form for the purpose of quick assessment. Whenever alert value exceeds, Q.C.M. would initiate necessary corrective action in this connection. However, wherever the failure rate remains below an approved alert level the operator can adjust the life of component. Alert value will be established for each operator by taking the mean failure/defect removal rates and adding to it two or three standard deviations to have a realistic confidence level and scatter.

10. The Structural Inspection Programme :

Pressurised transport aircraft require regular assessment of their structure which degrade in strength due to fatigue, corrosion and accidental damages received during the maintenance. The operator should have a regular programme for assessing the condition of the aircraft structure. The operator has to identify the significant structural items (SSIs) and devise a means of regular inspection of these items. Initially for older aircraft, manufacturers would issue a document called 'Supplemental Structural Inspection Documents'. This document contains significant structural items, method of inspection and required corrective action. The documents when issued for an aircraft will be declared mandatory for continued airworthiness of the aircraft. There should also be a regular corrosion prevention schedule included in the operators' Maintenance System Manual in respect of the particular aircraft mentioning the type of inspection and various prevention methods utilised for the purpose. It may be mentioned that aircraft had been designed and their strength had been assessed without considering impact of corrosion. Corrosion degrades strength considerably to the extent that catastrophic failure may occur.

Particular areas such as wingtanks, lavatory galley, bilge areas, require greater attention. Similarly aircraft used for insecticide spray requires much greater attention in this regard. MSG 2 Decision logic given in Appendix (II) equally applies to structure.

11. Aircraft Engine Analysis Method :

The method of determining contents of the power plants scheduled maintenance programme is similar to the programme of other components. The operator has to identify:

a. The system and their significant items.
b. Their functions, failure modes and failure effects.
c. Define Scheduled Maintenance task having potential
d. maintenance leading to better reliability.
e. Assess the desirability of schedule of those task
f. having potential effectiveness.
g. Determine initial sampling threshold.

11.1 Inflight Shut-down :

Premature removal rate and engine instrument monitoring by crew are the methods which can easily give the condition of the engine operation. Mechanical parameters like engine oil analysis programme, oil consumption etc. are also methods available for the purpose.

12. Programme Document :

Once the maintenance programme is approved, the same shall be reflected in the Operator's Quality Control manual. The details of the programme such as inspection schedule, COSL, special inspection schedules, etc. should be reflected in the Operator's Maintenance System Manual. It shall be the duty of QC Manager to ensure that all concerned personnel are made familiar with the contents of the manuals and ensure its compliance.

CAR Series 'D' Part II Issue III, is hereby canceled.

Sd/-
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Deputy Director General of Civil Aviation
for Director General of Civil Aviation

APPENDIX - 1

1. 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 3).
(d) Is the function hidden from the view point of the flight crew? (See Addendum 3).
(e) Is there an adverse relationship between age and reliability?

2. 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.

3. 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.

4. 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 programme.

5. 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 manufacturers 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 analysis 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 programme or the On Condition maintenance programme.

6. Refer to Addendum 3 for explanation of question (d). If the answer to question (d) is Yes, periodic ground test or shop test 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 can not be considered to have a hidden function which is evident to the flight crew during normal operations. In this case, the answer must be NO.

Note:- Task resulting from a Yes answer to question (d) may be part of either the Hard Time limitation or the On-Condition maintenance programme.

7. 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.

8. 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.

9. 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 analysis 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 Programmes complying with FAA Advisory Circular 120-17.

10. 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 development in the field of nondestructive test technique, built-in test equipment, etc.

11. 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.

12. 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.

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

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

15. For hidden function question, normally at least one task

must be listed for each hidden function having a yes answer to Figure 1, question. If a task is not selected, as permitted by addendum 3, an explanation must be provided.

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

17. 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 configuration of the old and new airplanes are sufficiently similar to conclude that the task will be equally effective for the new airplane.

18. The question "Does failure prevent dispatch?" refers to whether the item will be on the Minimum equipment list (MEL).

19. 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.

20. 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.

ADDENDUM 1

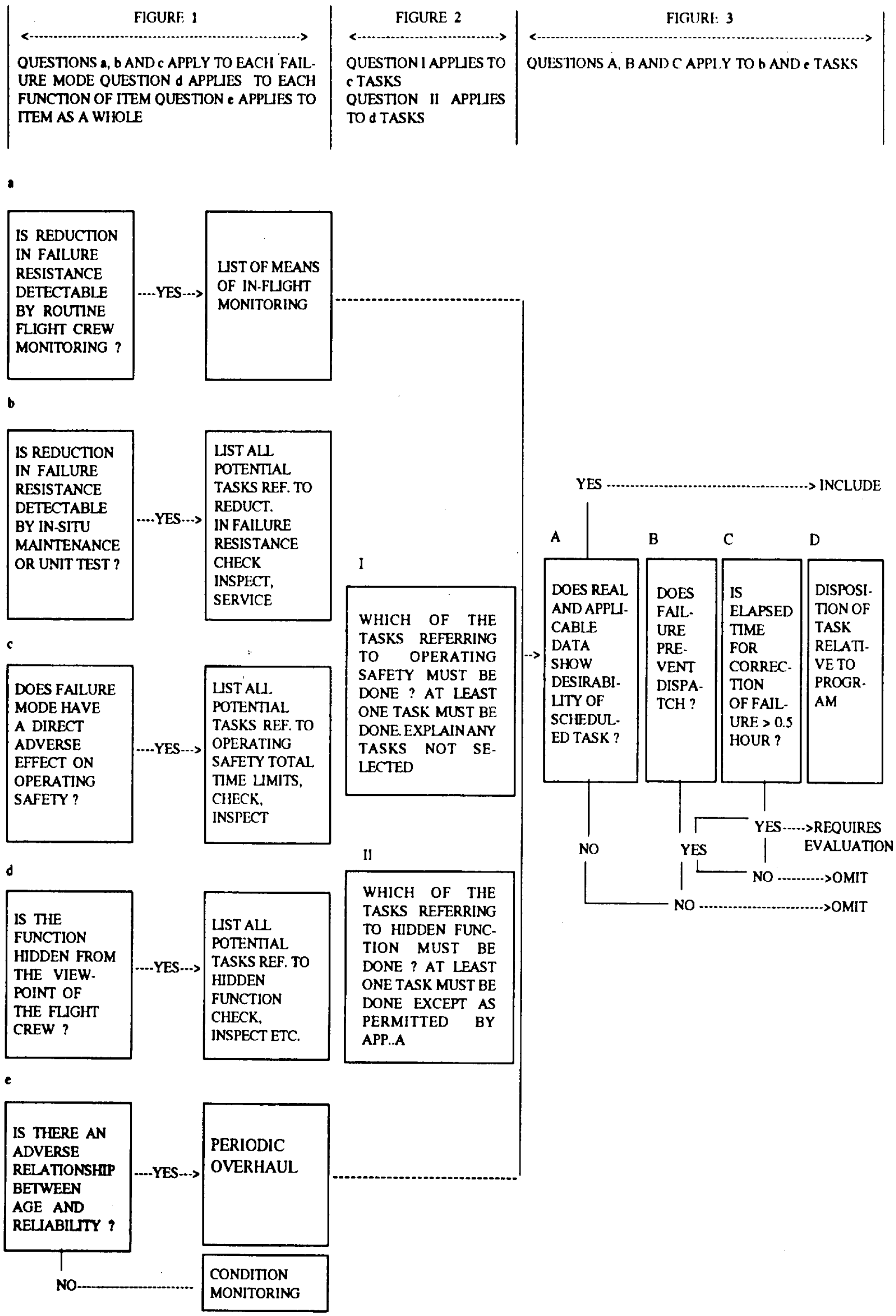
FIGURE 1
QUESTIONS a, b AND c APPLY TO EACH FAILURE MODE QUESTION d APPLIES TO EACH FUNCTION OF ITEM QUESTION e APPLIES TO ITEM AS A WHOLE
FIGURE 2
QUESTION I APPLIES TO c TASKS QUESTION II APPLIES TO d TASKS
FIGURE 3
QUESTIONS A, B AND C APPLY TO b AND c TASKS
a
IS REDUCTION IN FAILURE RESISTANCE DETECTABLE BY ROUTINE FLIGHT CREW MONITORING ?
YES
LIST OF MEANS OF IN-FLIGHT MONITORING
b
IS REDUCTION IN FAILURE RESISTANCE DETECTABLE BY IN-SITU MAINTENANCE OR UNIT TEST ?
YES
LIST ALL POTENTIAL TASKS REF. TO REDUCT. IN FAILURE RESISTANCE CHECK INSPECT, SERVICE
c
DOES FAILURE MODE HAVE A DIRECT ADVERSE EFFECT ON OPERATING SAFETY ?
YES
LIST ALL POTENTIAL TASKS REF. TO OPERATING SAFETY TOTAL TIME LIMITS, CHECK, INSPECT
d
IS THE FUNCTION HIDDEN FROM THE VIEW-POINT OF THE FLIGHT CREW ?
YES
LIST ALL POTENTIAL TASKS REF. TO HIDDEN FUNCTION CHECK, INSPECT ETC.
e
IS THERE AN ADVERSE RELATIONSHIP BETWEEN AGE AND RELIABILITY ?
YES
PERIODIC OVERHAUL
NO
CONDITION MONITORING
I
WHICH OF THE TASKS REFERRING TO OPERATING SAFETY MUST BE DONE ? AT LEAST ONE TASK MUST BE DONE. EXPLAIN ANY TASKS NOT SELECTED
II
WHICH OF THE TASKS REFERRING TO HIDDEN FUNCTION MUST BE DONE ? AT LEAST ONE TASK MUST BE DONE EXCEPT AS PERMITTED BY APP..A
YES
INCLUDE
A
DOES REAL AND APPLICABLE DATA SHOW DESIRABILITY OF SCHEDULED TASK ?
B
DOES FAILURE PREVENT DISPATCH ?
C
IS ELAPSED TIME FOR CORRECTION OF FAILURE > 0.5 HOUR ?
D
DISPOSITION OF TASK RELATIVE TO PROGRAM
YES
REQUIRES EVALUATION
NO
OMIT
NO
YES
NO
OMIT

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 and adverse effect on 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 effect on 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 in active 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 degree F. In addition, there is a pylon shutoff valve which incorporates a secondary temperature control, should the temperature exceed 400 degree F. A duct overheat switch is set to warn the flight crew of a temperature above 480 degree 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 hidden inactive function. For 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 are 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 in to evident ones).

   It is recognised 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 it is used with sufficient frequency to quality 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, than the decision whether to apply maintenance to check the pertinent hidden function becomes an economic decision to the 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 atleast 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.

APPENDIX - 2

ESTABLISHING ALERT LEVELS

(a) Alert Levels should, where possible, be based on the number of events which have occurred during a representative period of safe operation of the aircraft fleet. They should be updated periodically to reflect operating experience, product improvement, changes in procedures, etc.

(b) When establishing Alert Level based on operating experience the normal period of operation taken is between two and three years dependent on fleet size and utilisation. The Alert Levels will usually be so calculated as to be appropriate to events recorded in one-monthly or three-monthly period of operation. Large fleets will generate sufficient significant information much sooner than small fleets.

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

(i) For a new aircraft type during the first two years of operation all malfunctions could be considered significant and should be investigated, and although Alert Levels may not be in use, programme data will still be accumulated for future use.

(ii) To an established aircraft type with a new operator, the experience of other operators may be utilised until the new operator has himself accumulated a sufficient period of his own experience. Alternatively, experience gained from operation of a similar aircraft model may be used.

(iii) A recent concept to be applied in setting Alert Levels for the latest aircraft, aircraft designs, is to use computed values based on the degree of system and components in- service, expected reliability assumed in the design of the aircraft. These computed values are normally quoted in terms of Mean Time Between Unscheduled Removal (MTBUR) of Mean Time Between Failure (MTBF) for both individual components and complete systems. Although these levels tend to be theoretical, they are, of course, based on a considerable amount of testing and environmental engineering and design analysis. Being purely initial predictions they should be replaced when sufficient inservice experience has been accumulated.

(d) There are several recognised methods of calculating Alert Levels, any one of which may be used provided that the method chosen is fully defined in the operator's Programme documentation.

(e) Typical acceptable procedures for establishing Alert Levels are described briefly in paragraphs (i) to (iii) and some detailed examples of the methods of calculation are shown in Appendix B. It will be seen that the resultant Alert Levels can vary according to the method of calculation, but this need not necessarily be considered to be of significance.

(i) Pilots Report (Pireps) :

For the following example calculations, a minimum of twelve months operating data has to be available and the resultant Alert Level per 1,000 hours is:

Calculation 1.

The three-monthly running average Pirep rate per 1,000 hours for each system (or sub-system) as in the Table of Example 1, is averaged over the sample operating period and is known as the Mean; the Mean is multiplied by 1.30 to produce the Level Alert for a given system. This is sometime known as the '1.3 Mean' or '1.3x- method.

Calculation 2.

The mean, as in Calculation 1, plus the Standard deviation of the 'Mean' (as illustrated in Appendix B-Example 1)

Calculation 3.

The mean, as in Calculation 1, plus the Standard deviation of the 'Mean of the Means', plus 3 Standard Deviations of the Mean (as illustrated in Appendix B-Example).

(ii) Component Unscheduled Removals :

For the following example calculations, a minimum period of seven quarters' (21 months') operating data has to be available, and the resultant Alert Level rate for the current quarter may be set in accordance with any one of the following:

Calculation 4.

The mean of the individual quarterly Component Unscheduled Removals' rates for the period of seven quarters, plus 2 standard deviations of the Mean.

Calculation 5.

The maximum acceptable number of 'Expected Component Unscheduled Removals' in a given quarter, as calculated using a statistical process in association with the Poisson

Distribution of Cumulative Probabilities (as illustrated in Appendix 3).

Calculation 6.

The Number of 'predicted Component Unscheduled Removals (or failures)' in a given quarter, as determined by the Weilbull or other suitable statistical method.

(iii) Component confirmed Failure:

The period of operating experience has to be as in (ii) and the resultant Alert Level rate for the current quarter is the 'corrected' means of the individual quarterly Component Confirmed Failure rates for the period, plus 1 Standard Deviation of the Mean (as illustrated in Appendix B, Example 4).

-- END --