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Abstract

Airworthiness is a very broad subject, covering not only the engineering safety of the aircraft, but also its operation, its protection as an asset and the economics of its use. These are all established as a standard during its development by a combination of inputs from the manufacturers, the potential operators and the regulatory authorities. However, what happens when the aircraft has entered service tends to be ignored by the industry as a whole, being left to the individual operator in association with his regulatory authority. This paper attempts to describe how the industry has set about establishing a standard for maintaining the airworthiness of its fleet of aircraft, so that everyone can work to a common approach. This effort will maybe help those operators, particularly the airlines from the emerging countries, to keep abreast of their larger colleagues and competitors.

Introduction

"A safe aircraft is one that never flies".

A simple statement which conversely argues that an aircraft that flies is inherently unsafe. Managing the level of safety which gives an economic return on the operation and a beneficial service to the customer is an industry responsibility from which no one - manufacturer, operator, or regulatory authority - can be excused.

Aircraft are designed and manufactured to a common set of standards. However, once in operation differing airworthiness standards are specified and maintained by individual regulatory authorities and operators worldwide.

Definition of Airworthiness

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

This is based on the expectation that flight operations will be performed with acceptable reliability in respect of flight crew workloads, flight handling characteristics, flight performance/envelope availability, safety margins, welfare of occupants, punctuality and economics.

RESPONSIBILITIES FOR MANAGING AIRWORTHINESS

Regulatory Authority

No civil aircraft on the British register can fly unless it holds either a valid Certificate of Airworthiness (C of A) or a permit issued by the Civil Aviation Authority (CAA).

Before issuing a C of A, the Authority is required by the legislation to be satisfied that the aircraft is fit to fly. This involves taking into account not only the engineering aspects but also the flying characteristics of the aircraft. The Authority's duty therefore, is to ensure as far as possible that the aircraft is mechanically sound and fit to fly, and remains so throughout its operating life.

British Civil Airworthiness Requirements

These seemingly simple objectives are met by first setting the standards. These are published as British Civil Airworthiness Requirements (BCARs). Having set the standards, the Authority then monitors the work of approved organisations to see that the BCARs are properly applied in practice. This is achieved by, amongst other things, the approval of the constructors who design and manufacture aircraft to ensure that their products conform with the set standards, as well as licensing the engineers who maintain the aircraft to see that they are properly trained and otherwise suitable. The CAA is also involved in making sure that there is sufficient data available for all concerned, by way of manuals and maintenance schedules for the continued safe operation of the aircraft.

Airline

The operator must satisfy the CAA, through its Airworthiness Division, that the Engineering support arrangements (i.e., the personnel, accommodation, equipment and facilities, organisation, procedures and documentation) provided

for the engineering support of the aircraft covered by the Air Operator Certificate (AOC) are to a satisfactory standard.

Organisations/Airlines approved by the CAA in accordance with BCARs (A8-3/13) must incorporate management systems designed to ensure overall control of the continuing airworthiness of the aircraft including:-

- (a) The quality control and assurance necessary to achieve satisfactory standards of continuing airworthiness (including compliance with all relevant mandatory modifications and inspections).
- (b) Efficient work planning and progress.

In accordance with the Air Navigation Order (Article 9), and as detailed in BCAR A6-4, public transport aircraft must not fly unless they are maintained to an Approved Maintenance Schedule which means the Schedule together with any associated Condition Monitoring/Reliability programmes.

EVOLUTION OF COMMON STANDARDS

The Civil Aviation Authorities of certain European countries have agreed common comprehensive and detailed airworthiness requirements - referred to as the Joint Airworthiness Requirements (JAR) - with a view to minimising Type Certification problems on joint ventures, and also to facilitate the export and import of aviation products.

An existing airworthiness code (FAR, Part 25 of the Federal Aviation Administration of the United States of America) has been selected to form the basis of the JAR for large aeroplanes, and is referred to as basic code.

These legal requirements go a long way to ensuring that the aircraft are designed and certificated to a common standard, which should be reflected in the manufacturers Maintenance Planning Guide and the MRB documents which are produced utilising manufacturer/airline experience in a logical manner as detailed in MSG3.

The MRB document provides the minimum requirement on day one, for any operator of a new aircraft type. These requirements can be deleted or supplemented by the individual operators as time progresses by negotiation with their regulatory authorities.

"In this sometimes cut-throat de-regulated Industry, great pressure is put upon the individual airlines to ensure they achieve the optimum maintenance programme".

The initial requirements, whether evolved from the MRB/MSG process or not, are developed initially utilising the experience and information available at the time. Therefore, with operating experience, airlines are required to add maintenance tasks to the programme for various reasons which become apparent, and in some instances delete tasks which have been proven to be ineffective or replace them with more effective ones.

The various airlines throughout the world employ different methods to monitor the effectiveness of their Maintenance Programmes. Hence the subsequent amendment processes differ and the Maintenance Schedules become more customised, with the work content and degree of maintenance becoming significantly different amongst the world's airlines. In general however, the amendments are dependent upon individuals (ie systems specialists, etc.), being made aware of inadequacies or unnecessary tasks by chance or operational effects and not as a result of periodic reviews.

Following proposals by BA at an EMAC Workshop meeting held in Zurich on January 1985, it was decided that an EMAC working group should be set up with the following terms of reference:-

'To develop a simplified logic analysis based on MSG3 principles for regular, systematic analysis of maintenance tasks, with a view to deleting those which are unjustified and establishing optimum frequencies for those remaining'.

It is envisaged that the logic which has been developed by the working group will be accepted by the regulatory authorities and hence provide a consistent basis by which the various airlines will be able to periodically review their maintenance programme, utilising their own experience to provide greater optimisation of their resources.

OPTIMISATION OF MAINTENANCE PROGRAMMES

Working Group

The Working group which includes representatives from British Airways, Lufthansa, Air Canada, Swiss Air, KLM, South African Airways and Alitalia has met twice to date.

Progress

A document entitled Maintenance Programme Optimisation 1 (MPO 1, Part 1), covering all the tasks relating to systems and powerplant requirements has been prepared and submitted to EMAC for approval.

Additional requirements for the structures tasks are still being considered and will form Part II when completed.

The MPO 1, Part I document, basically consists of logic diagrams with explanatory notes and a glossary covering specific terms and recommendations.

It was agreed that the logic should be capable of being applied to all aircraft types, whether the existing Maintenance Programmes were developed from MSG/MRB procedures or not. It should also cover all maintenance tasks whether systems or structure related, either accomplished on or off the aircraft.

As with any universal document which is formulated by individuals from different airlines and countries, although written in English it has to be understood and interpreted properly by all users with common objectives.

Objectives

(i) Maintenance Programmes

It was agreed that a Maintenance Programme should produce a safe and efficient operation of the aircraft.

(ii) MPO Logic

The objective of the proposed logic was to provide a consistent method by which all airlines may obtain greater optimisation of their Maintenance Programme.

If the logic is established and recognised by the various regulatory authorities as an approved method for reviewing maintenance task effectiveness it will surely aid in the justification and approval of any proposed amendments resulting from the 'Review Committee' of each airline utilising it.

Interpretation

To ensure that the document was interpreted correctly, a glossary containing agreed terms and definitions was included.

FORMAT

The logic has two levels:-

- (a) Task Category Logic diagram.
- (b) Task effectiveness logic diagrams.

1. Task Category Logic

The logic is applicable to all tasks under review. The route through the logic is dependent upon a 'Yes' or 'No' answer to each question.

The resultant is that each task analysed will fall into one of five categories as listed below:-

- (i) Airworthiness Authority Requirement.
- (ii) Appearance/Customer Standard.
- (iii) Operating Safety.
- (iv) Operating Capability.
- (v) Non Operating Economic.

The category should identify the reasons/intent for carrying out the tasks.

2. Task Effectiveness Logic

Once categorised, the effectiveness of the tasks and interval under review is analysed using the Effectiveness Logic diagram developed for each category.

Progression through this logic is again dependent upon a 'Yes' or 'No' answer to each of the questions using the judgement of the Review Committee.

This judgement is based on airline experience achieved from reviewing operating data and applicable current technical information.

The resultant is that the tasks and the intervals are either revised, deleted or retained. In the case of an Airworthiness Authority Requirement, any proposed change to the task/interval will require prior consultation with the airworthiness authority concerned.

Application

The logic is intended to be used for periodic reviews of existing maintenance tasks. It forms a base - judgements must be made by the individual airlines utilising their own experience and that learnt from others to meet the airline standards and the requirements of the authorities concerned.

It is envisaged that the logic will be used by a Review Committee made up of technical personnel employed by the individual airlines who are knowledgeable of the aircraft, systems and components applicable to the tasks under review.

SUPPORT AND FEEDBACK SYSTEMS

With an established disciplined approach to reviewing the Maintenance Programme requirements, this will undoubtedly encourage the airlines to take a closer look at the feedback and communication systems, not only within their own organisation but also with other airlines, manufacturers and the authorities.

In order to determine the effectiveness of any maintenance task in achieving the continuing airworthiness and economic maintenance of the aircraft, reliable feedback and adequate communications is essential.

The Maintenance Schedule should only include effective maintenance tasks which respond to the maintenance needs of the aircraft. Non-effective tasks need to be identified and eliminated to prevent limited resources being misdirected.

Ineffective maintenance is manifested by operational problems from various sources. The introduction of computers has allowed the operation of the aircraft to be monitored very closely, by providing the ability to quickly record and store large amounts of data, which can be retrieved in various formats.

Utilising these facilities and the application of established maintenance philosophies which are known generally by the air transport industry as Condition Monitored Maintenance and Reliability Programmes, airlines and manufacturers should have sufficient data available to make accurate decisions relating to the maintenance requirements.

Many airlines have developed sophisticated computer systems which have been proven to work well. What needs to be improved is the flow and availability of the information to an agreed format between the various airlines and manufacturers, accompanied by quicker and more positive reaction to significant problems.

IMPROVED TECHNOLOGY

The continuing advancements in design and maintenance techniques, not only enhances the airworthiness standards but reduces the cost and number of maintenance tasks. When reviewing existing maintenance tasks, the awareness of the application of new techniques is crucial to ensure the most effective and economic methods are being used.

CONCLUSION

A safe aircraft is one which is correctly designed and properly maintained to fly. The continuing airworthiness of an aircraft with good design can be managed efficiently if the resources and facilities of the airlines and maintenance organisation, are put to optimum use.