

Aircraft Maintenance - the practical approach

Henk T. Beekelaar

2011



This document describes all necessary ingredients needed to start or optimize an aircraft maintenance organization.

It will discuss :

- the Introduction to aircraft maintenance
- the organization breakdown
- the maintenance program based upon the updated MSG-3 analysis
- the planning of aircraft maintenance
- the Operation center
- the maintenance capacity & capability
- the material management
- the maintenance costs
- the reliability program
- the legislation of the EASA and foreign civil aviation authorities
- the highlights of the EASA Part-145

This document is therefore of interest to students and those who like to know more about the organization of aircraft maintenance

Aircraft Maintenance
the practical approach

Henk T. Beekelaar

© Uitgeverij U2pi BV (www.jouwboek.nl), Voorburg
1e druk maart 2012
1e ebookversie maart 2012

Titel: Aircraft Maintenance, the practical approach
Auteur: Henk T. Beekelaar

ISBN: 978-90-8759-265-3
NUR: 968

Alle rechten voorbehouden. Niets uit deze uitgave mag worden verveelvoudigd, opgeslagen in een geautomatiseerd gegevensbestand, of openbaar gemaakt, in enige vorm of op enige wijze, hetzij elektronisch, mechanisch, door fotokopieën, opnamen, of enige andere manier, zonder voorafgaande toestemming van de uitgever.

All right reserved. No part of this book may be reproduced, scanned, transmitted or distributed in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the publisher.



Table of Contents

Preamble:	7
0. Issue of edition nr.2.....	8
1. Introduction.....	8
1.1 Historical developments;	9
1.2. Maintenance philosophy.	11
1.3 Definitions used for aircraft maintenance.....	12
1.4. Categories in parts.	12
2.0 Airline maintenance organizations.....	15
2.1. Introduction.....	15
2.2 Key Objectives:.....	15
2.3 Organization Principles :.....	16
2.4. The ideal Organization:.....	17
2.5. A breakdown of an Airline Maintenance Organization:.....	18
2.6. Considerations to start a maintenance facility.....	21
3.0 INTRODUCTION	26
3.1. MSG-3 Analysis/ Decision Techniques.....	27
3.1.1 Definition of a failure;	28
3.1.2 Failure Consequences;	28
3.1.3 Quantitative failure description;	29
3.1.4. Inherent reliability characteristics;	30
3.1.5. The basic maintenance tasks;.....	30
3.1.6. Applicability and Effectiveness	31
3.2 The Decision Logic;	31
3.2.1 Introduction;	31
3.2.2. Maintenance Significant Items;	31
3.2.3. Evaluation of failure consequences;	32
3.3. The complete MSG-3 decision diagram;.....	33
3.3.1 Recent developments:.....	37
3.4. Basis of structural maintenance program:.....	39
3.5 Purpose of Structural Programs:	43
3.5.1 Damage Tolerance (Source Boeing).....	44
3.6 MSG-3 Logic Analysis	45
3.6.1 Structural Classification;	45
3.6.2 SSI Selection.....	47



3.7 The MSG-3 Structural Logic Diagram	48
3.7.1 EDR – Environmental Deterioration Rating:	49
3.7.2 Accidental Damage Rating (ADR):	51
3.7.3 Task selection options	53
3.8 Practical example for structure	54
3.9 Zonal analysis	59
3.10 Initial and ongoing Programs	60
3.10.1 Default strategy;	60
3.10.2 Systems/Powerplant and Structure	61
3.10.3.Using the Decision Diagram in the Program Development;	62
3.10.4 Conclusion;	62
4. Introduction:.....	64
4.1. Time factors that affect the planning process:	64
4.2.Maintenance events;.....	65
4.3. Effects on staffing policies and schedules on production planning;	66
4.4. Workpackage(s):	67
4.4.1 Preparing tasks;.....	69
4.4.2. Actual maintenance activities;.....	69
4.4.3 Work packaging considerations;.....	69
4.4.4 Job cards	70
4.4.5 Next step in preparation of an inspection package;	73
4.5 Kitting:	74
4.6. Time control, Tools, Trade-offs;.....	75
4.7. Other planning considerations;	76
4.7.1. Human Factors:.....	76
4.7.2. Schedule Planning:	77
Conclusion;	77
5 Maintenance Operation Center	79
5.1. Introduction	79
5.1.1.Schedule integrity;.....	80
5.2 Operations Centre Description:	80
5.2.1 Technical Control Group:	80
5.2.2 Aircraft routing:	81
5.3 System Control:	81
5.4 Key factors influencing schedules and maintenance:.....	82
5.5 Trouble-Shooting Philosophy;.....	82



6.1.Introduction:.....	93
6.2. Work Generators:.....	93
6.3.Other Features:.....	94
6.3.1. Dock-plan	94
6.3.2. Allowable.....	94
6.3.3. Rotable components	94
6.3.4 Direct cost per flight hour.....	95
6.4. Manpower Capacity:.....	96
6.5. Manpower Control:	97
7.0 Introduction.....	99
7.1 Initial Provisioning:	99
7.2 Rotable component aspects.....	100
7.3 Expendable aspects:	101
7.4 Information Flow Process:.....	101
7.5 Service level;.....	102
7.6 Overstock management;.....	103
7.7 Economic Order Quantity Concept;.....	103
7.8 Stock availability interrelationships;.....	104
7.8.1 ABC Control:.....	105
7.8.2. Pooling of parts;.....	106
7.8.3. Ownership interrelation:	107
7.9 Marginal Gain:	108
7.9.1 Inventory Investment example:	109
7.9.2 Marginal Gain Benefits:	109
7.9.3 Initial Provisioning Model;.....	110
7.10 Modern Spares Support:	111
7.11 Rotable Control System	112
7.11.1 Identification of Rotable components	112
7.12 Inventory Control.....	116
7.13 Traffic Control.....	117
7.13.1 Redistribution	117
7.14 Purposes for Rotable Control.....	117
7.15 Management information.....	118
7.16 Consumable Control;	118
7.16.1 Introduction	118
7.16.2 Order philosophy	119



7.16.3 Financial impact on issue of consumables.....	119
7.17 Bogus parts:	119
8.1. Introduction;.....	123
8.2. Survey:	123
8.3. What are Maintenance Costs ?.....	124
8.3.1. Breakdown of Aircraft Maintenance Costs:.....	124
8.4. Relative value of published maintenance costs:	125
8.5. Value of Cost Prediction Methods:	126
8.5.1. Empirically Determined Mathematical Constants.....	126
8.5.2. Aircraft Empty Weight.....	126
8.5.3. Aircraft delivery Price.....	127
8.5.4. Flight length:.....	127
8.5.5. Maintenance Burden:.....	128
8.6. Parameters to be used for maintenance cost prediction;.....	129
8.7. Consideration;.....	129
9.0 Reliability Program.....	131
9.1. Definitions:	131
9.2. Different types of Reliability Programs;	132
9.2.1. Dispatch reliability;	132
9.2.2. System reliability;.....	133
9.2.3. Component reliability;.....	134
9.2.4. Engine reliability;	135
9.3. Reliability costs;.....	136
9.4. Reliability versus ETOPS (Extended Range Two Engine Operation) operation;.....	136
10. Legislation.....	139
10.1 Introduction.....	139
10.2 ICAO:.....	139
10.2.1 Explanation of the functional diagram:	141
10.3 EASA regulations	142
10.3.1 Definitions:	144
10.3.2 Relationship between Part M, Part 145, Part 147 & Part 66	144
10.4 EASA Part M.....	144
10.4.1 Approvals.....	144
10.4.2 Certifying staff.....	145
10.4.3 Responsibilities.....	145
10.5 EASA Part 145:.....	146



10.6 EASA Part-147.....	147
10.7 EASA Part-66.....	147
10.8 EASA Part 21 subpart "J" Design organization	148
10.9 FAA regulations.....	149
10.10 Latest development in EASA legislation	149
10.10.1 'Part OPS'	149
10.10.2 Authority Requirements (Part AR).....	150
10.10.3 Organization Requirements (Part OR).....	150
10.10.4 Air Operations Requirements (Part AOR).....	151
10.10.5 Part FCL, MED and CC	152
10.10.6 Conclusion	152
11. Highlights part-145 requirements	154
11.1 Continuation training	154
11.2 Human factors.....	155
11.3 Fuel tank safety requirements.....	158
11.4 Occurrence reporting	158



PREAMBLE:

The author has been working for 34 years in aircraft maintenance, of which are 2 years in the military services and the rest in the commercial aviation business.

He was an inspector for the Dutch Aviation Authorities directly involved in the manufacturing of the Fokker aircraft, such as Fokker F-27, F-28.

He was an after sales service engineer at Fokker's, where he was involved in the development of an updated maintenance program for the Fokker F-28 as well as maintenance advices for the operators to perform efficient maintenance and bring back fuel consumption.

He was working in an operators maintenance facility as head of engineering, material management and maintenance planning and for the last 12 years as head of the maintenance training department.

During his work he experienced that there was barley knowledge about why and how aircraft maintenance should be done in the most effective and efficient way. This was the trigger to write such a document, which was sponsored by the Amsterdam Technical Academy, resulting in various guest lecture's for students.

This document, issue 2, is an update for issue 1 of 1995.

So why such a document?

As explained in issue 1 no proper overview is available for the all aspects involved in aircraft maintenance. Of course there is enough information about every detail discussed in this document, but are too profound.

Issue 2 has been created because of new developments and updates in the aircraft maintenance environment.

So this document has been created to provide an inside information for both students and staff within aircraft maintenance organizations.

The author:

H(Henk).T. Beekelaar

Born: March 3, 1947 in Haarlem, the Netherlands

Maried and has two daughters.

Graduated: 1968 Haarlem Technical Academy Aircraft Engineering



0. ISSUE OF EDITION NR.2

The edition nr. 2 was necessary to update the whole document to the present situation and it is therefore that some chapters have been deleted, such as the description of maintenance manuals, because almost every maintenance document is nowadays to be found on the internet at the manufacturer's website or other websites.

Another item of importance in this document is the addition of the specific legislation for this kind of business.

1. INTRODUCTION.

Effective aircraft maintenance has become an issue of vital significance to the smooth running of airline operations. Fleet levels are still exceeding existing in-house capacity at more and more locations and airlines are facing the extra burden of mandatory modifications of older aircraft or extra maintenance tasks ordered by the authorities based on the outcome of accident analyses (e.g. Fuel tank safety). Another worry for the maintenance organizations is the shortage of skilled personnel.

All of these factors are conspiring to place unprecedented demands on engineering divisions worldwide. In order to overcome such problems, operators will have to realistically quantify their capabilities and make decisions on which aircraft should continue to be maintained in-house and which should be sent to third parties.

In order to make a contribution to these subjects we created a document and in this document we will follow a line, describing how an airline maintenance facility is set up and what kind of management tools can be used or have to be used in order to get the aircraft the most efficient maintenance.

We start with some historical developments about why maintenance and in particular preventive maintenance is required.

Chapter 2, will tell us about an example how an airline maintenance organization is set up and which supporting departments are involved.

Chapter 3 explains how an aircraft maintenance program will be established, where one of the most recent and important developments in aircraft maintenance will be discussed called "Aircraft Aging problems".

Chapter 4, an efficient aircraft maintenance cannot be done without proper planning and the relating documents, some examples will be discussed as well.

Chapter 5, a coordination department within the aircraft maintenance is the Maintenance Operations Centre, who will follow all aircraft in the fleet to keep track of the planned inspection times as well as aircraft flying with technical problems or are grounded because of a technical malfunction.

Chapter 6, besides the earlier mentioned aspects for an efficient maintenance it is also of vital importance to have a very good view of the maintenance capacity and the capability.