Reliability Factors

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ABSTRACT

There are two ways of exploitation of an aircraft. The first one is called Hard Time exploitation, the second one is called On Condition exploitation. The only difference is what we have to do after in specified advance time. In first case you have to replace old part by a new one. It doesn't matter if the old one is still working, if it looks nice, it also doesn't matter if you can see any wear. You just have to replace it. Reliability analysis is analysing observed factors to predict maintenance before aircraft defect appear in the air, but depending on statistics which are continuously updated by every operator. The analysis of this statistics use some factors which answer questions important for operator, maintenance department, crew department and so on. The answers comes from statistics based simulation. After one simulates when some component will failed, one can replace the component by new one before failure.

INTRODUCTION

Reliability engineering and maintenance are the source of safety. They are one of the most important aims in modern aviation. The modern reliability engineering is also the way of seeing safety as exploitation costs reduction. Following good written reliability programs airplanes earning money as long as possible, as often as possible. They are not spending time waiting for parts, which were unexpectedly broken, they are reaching destinations on time. The customers are glad because of accuracy and reliability. How to reach this aim?

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PROBLEM FORMULATION

There are two ways of exploitation of an aircraft. The first one is called Hard Time exploitation, the second one is called On Condition exploitation. The only difference is what we have to do after in specified advance time. In first case you have to replace old part by new one. It doesn't matter if the old one is still working, if it looks nice, it also doesn't matter if you can see any wear. You just have to replace it. Reliability analysis is analysing observed factors to predict maintenance before aircraft defect appear in the air, but depending on statistics which are continuously updated by every operator. The analysis of this statistics use some factors which answer questions important for operator, maintenance department, crew department and so on. The answers comes from statistics based simulation. After one simulates when some component will failed, one can replace the component by new one before failure.
Those questions are not only important for economic reasons, but also - or first - for safety reason, that is why it results from reliability analysis. The Reliability Report is expected by aviation authorities from every operator. For European countries authority is the EASA (European Aviation Safety Agency) and for USA it is the FAA (Federal Aviation Agency). Reports in most cases reach authorities every month, for every aircraft, from every operator. Reports differ between each other depending on type of aircraft, number of aircrafts operated in company, number

of hours flown, tape of missions and so on. What form and kind of data will appear in report is written in Reliability Programs accepted by aviation authorities and created by operators, but in every report there are such data as hours flown by each aircraft, number of landings, number of defects and accidents.

THE ATA 100

All of reported defects have to be divided using ATA code. The Ata code is the Component Code Table DEVELOPED by The Air Transport Association of America (ATA), and called Specification 100 code. Now it is used By FAA and accepted by EASA. Such fragmentation is useful when you want to know what part of the airplane, what system or what component most common makes problems, where you have to look more often. The main system is as follows:

21 Air conditioning
22 Auto Flight
23 Communications
24 Electrical Power
25 Equipment Furnishing
26 Fire Protection
27 Flight Controls
28 Fuel
29 Hydraulic Power
30 Ice & Rain
31 Indicating & Record
32 Landing Gear
33 Lights
34 Navigation
35 Oxygen
36 Pneumatic
37 Vacuum
38 Water / Waste
45 Central Maintenance
49 Auxiliary Power
51 Structures
52 Doors
53 Fuselage
54 Nacelles / Pylons
55 Stabilizers
56 Windows
57 Wings
71 Power plant
73 Engine Fuel Control
74 Ignition
76 Engine Controls
78 Exhaust
79 Oil
80 Starting

As it can be seen there are only some chosen chapters, and in every chapter there are also subchapters. The system is independent on aircraft type so if some operator frequently have to change parts in its different type of aircraft's, so with different Part Numbers it is simple to check if, for instance there is permanent problem with landing gear system. Then one can ask if it is a maintenance problem or exploitation or conditions problem. But this question is to answer using system other then ATA 100.

RELIABILITY FACTORS

The reliability factors can be divided in 3 groups. The first group contains factors describing whole aircraft and people who are somehow connected with the aircraft, pilots, management, and maintenance. In this group one can find such factors as:

- <u>PRR (*Pilot's Reports Rate*) Factor</u>

This factor shows how many defects or problems were reported/found by pilots. Some of defects appeared during the flight but there is also group of cases, where the problems were found by pilots because they were not found by mechanics. The parameter is given as cases for 1000 flights.

- <u>PRMR (*Pilot's Reports/Maintenance Report*) Factor</u>

This factor show how many defects or problems were reported/found by pilots in compare to defects found by maintenance departments.

- <u>DR (*Dispatch Reliability*) Factor</u>

This factor analyses technical reason influence on dispatch delays/cancelations compare to all delays/cancelations.

- <u>SR (*Shop Rate*) Factor</u>

Factor shows amount of time when aircraft spend on unplanned maintenance every 100 flight hours.

- <u>TF (*Technical Functionality*) Factor</u>

The TF Factor is number of hours flown with accepted defects and flight limitations (Flight with Minimum Equipment List Regulation, and Hold Item List Document usage) for every 100 flight hours.

- <u>TI (*Technical Incidents*) Factor</u>

This factor is calculated for 1000 flights. The deference is because of calculated case. It is a serious defect with influence on flight safety, which should be report in separate report to authorities.

The second group contains factors, which more precisely describe aircraft and its components. Every of factor below is calculated separately for each ATA 100 chapter or, in case of number of defects/removals/shop time even subchapters. In this group one can find following factors:

- RR (*Removals Rate*) Factor

The RR factor show number of removals of exact component from an aircraft, independently of reason for this removal for every 1000 cycles or working hours.

- FR (*Failure Rate*) Factor

The FR factor shows number of removals of exact component from an aircraft, because of failure for every 1000 cycles or working hours

- MTBR (*Mean Time Between Removals*) Factor

The MTBR factor, as the name says show average time between removals of exact component from an aircraft for every 1000 cycles or working hours.

- MTBF (*Mean Time Between Failure*) Factor

The MTBR factor, as the name says show average time between removals of exact component from an aircraft, because of failure for every 1000 cycles or working hours

- MTBUR (*Mean Time Between Unscheduled Removals*) Factor

The MTBR factor, as the name says show average time between unplanned removals of exact component from an aircraft for every 1000 cycles or working hours.

The third group of factors is the group of factors combined with power plants. Those very important aircrafts components have separate factors.

- IFSD (*In-Flight Shut Down Rate*) Factor

Factor describing number of In flight shut down of engines or other serious problems with engines during flight. Because the case is not very common the factor is calculated for 1000 flight hours.

- URR (*Unscheduled Removals Rate*) Factor

This factor is unscheduled engines removals from an aircraft rate. The factor differs from previous one, because removal can be made also after defect find on ground. The factor is calculated for 1000 flight hours.

- SVR (*Shop Visit Rate*) Factor

This is a parameter showing number of engine repairs in a shop for 1000 flight hours.

CONCLUSIONS

Lot of the presented factors is similar and the choice which is more useful for an operator or airlines depends on operator its self and authorities which have to accept the Reliability Program. Factors can also be created especially for operators needs or problems they think are more common. But the most important thing is to analyze the changes of calculated factors during time, after each probe and compare it to reliability levels predicted by previous years of flying on analyzed aircraft and results for rest aircraft the same type which are flying all over the world, whole manufactured fleet. The simulation is as proper as large is the number of cases the statistics data used for this simulation is based on.

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4. Reliability Programs of deferent Airlines and Aircraft Operators.

5. Appendix 1 (part M) to implementing Rules EC 2042/2003 dated November 20/2003

BIOGRAPHY

Jan Amborski born in 1972 received his M.Sc. in Engineering in 1999 from Warsaw University of Technology, Faculty of Power and Aeronautical Engineering and 2006 PhD from Warsaw University of Technology, Faculty of Automotive and Construction Machinery Engineering. Now he is working at Warsaw Institute of Aviation.