-Testing and Evaluation of Systems Reliability (II/II)-

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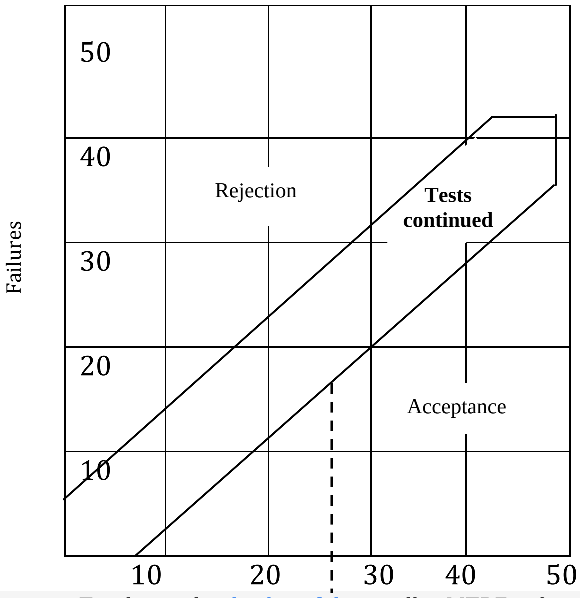
Continuing the matter started at MSC 27, we will now present an example taken from MIL-STD-781 about reliability tests, with didactic adaptations.

In this case, the MTBF for the system is expected to be 400h. The maximum test time is thus 10 x 400 = 4.000h. When the system fails, it is repaired and comes back to the aircraft for the test continuation. Every failure is analyzed from the point of view of "what has failed and what was the cause." These considerations are additional data from the tests which can used for the design improvement.

Let us now plot the graph of Figure 1.



Total time (multiples of the smaller MTBF: θ_1)
Figure 2 - Graph for the Reliability Assessment.

Assuming that the risk decision, α and β, are both 10% (0.1) and taking into account that θ_0 = 400h and the rate of discrimination θ_0/θ_1 = 3/2, it follows that θ_1 = 270h .

With these values, we use the expressions (1) and (2) from the MSC 27 and draw the lines of rejection and acceptance.

As we are working with 10 expected MTBF (4.000h) it results that the minimum point of decision is 10 x θ_1 = 2.700h. . This point is marked in Fig 1.

The following table shows the correspondence between the expected values of failures and the corresponding values of acceptance and rejection.

Tabela 1 – Pontos de plotagem para o gráfico da Fig. 1

Nº falhas	Rejeição (= ou <)	Aceitação (= ou >)	Nº falhas	Rejeição (= ou <)	Aceitação (= ou >)
0	N/A	6,60	21	18,92	32,15
1	N/A	7,82	22	20,13	33,36
2	N/A	9,03	23	21,35	34,58
3	N/A	10,25	24	22,56	35,79
4	N/A	11,46	25	23,78	37,01
5	N/Á	12,68	26	24,99	38,22
6	0,68	13,91	27	26,21	39,44
7	1,89	15,12	28	27,44	40,67
8	3,11	16,34	29	28,65	41,68
9	4,32	17,55	30	29,85	43,10
10	5,54	18,77	31	31,08	44,31
11	6,75	19,98	32	32,30	45,53
12	7,97	21,20	33	33,51	46,74
13	9,18	22,41	34	34,73	47,96
14	10,40	23,63	35	35,94	49,17
15	11,61	24,84	36	37,16	49,50
16	12,83	26,06	37	38,37	49,50
17	14,06	27,29	38	39,59	49,50
18	15,27	28,50	39	40,82	49,50
19	16,49	29,72	40	42,03	49,50
20	17,70	30,93	41	49,50	N/A

Having said that, the tests began. 2700 hours would be the minimum point of decision, but we repeat: the minimum time. In this interval, there were eight (8) failures, with all of them in the region of continuity of the tests. So we had 2700/8 = 332h, a value above the minimum 270h. The test, however, has continued until 3.200h without any new failure has occurred.

Thus, in 3.200h, just was made the division was 3200/8 = 400. Just a coincidence.

Obviously, from the point of view of the MTBF parameter, the system (aircraft) was accepted.

But let us go to the final considerations. If all the failures had been plotted in the acceptance region, the test would have stopped at the minimum point of decision. If however an appreciable number of failures had been plotted in the rejection region, the system probably would not have been accepted, nor until 3200h, and it would have been necessary to take a decision to continue or not the tests, taken jointly by program managers of customer and producer.

As we can see, from that context, it is not always possible to take a decision with high confidence level, because, as we said, they are Probabilistic approaches. However, this at least gives us an idea of the behavior and trend of the system.

In fact, the system will be really improved in the operational phase. In the AM-X Program, there was an activity, in that phase, called Reliability Enhancement, based on the so-called Method of Duane. It was an activity that in fact helped to improve the Reliability.

Well, we could continue this discussion, but we think that the character of "flash" of a MSC, probably we have achieved our goal.

We stop here.

See you.

References:

(1) MIL-STD-781C - **Reliability Design Qualification and Production Acceptance Tests: Exponential Distribution**. USA: DoD.1977.

(2) Blanchard, B. S.; W. J. Fabrick**. Systems Engineering and Analysis,** 4th. Ed. Prentice Hall. Upper Saddle River, NJ, USA. 2006.