

BATTERY-DRIVEN PROPULSION

System design and assessment of maintenance requirements

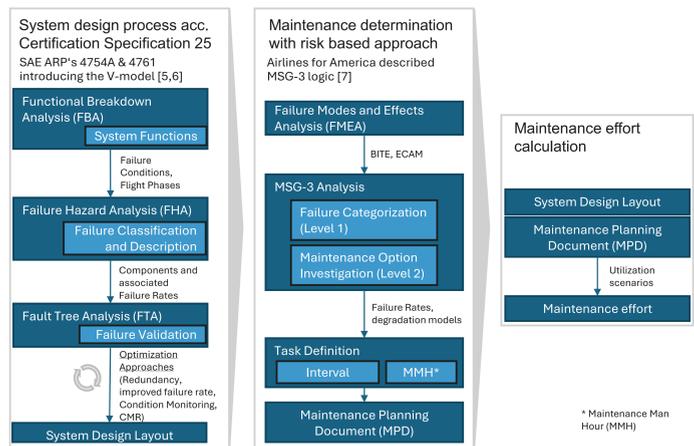
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Methodology

The development of a system architecture marks the basis of which investigations on the resilience of new propulsion technology are carried out. Design of the mentioned system was conducted in line with specific certifications and standards. At the beginning of the analysis, all system functions, their failures with related conditions and causes are identified. Afterwards, depending on the failure probability, the system layout is iteratively improved until all safety requirements are satisfied.

Subsequently, the failures are analyzed in terms of their consequences and necessary maintenance tasks are determined.

Methodology for system development and maintenance estimation



Results

Focus of the examination is the evaluation of the maintenance scope of an Electric Propulsion System (EPS), as well as the comparison of said EPS to a conventional propulsion system.

With the system transition from kerosene-based to a battery-electric propulsion system, the maintenance effort can be expected to be **reduced by about 36%**. Despite the reduction in labour hours (MMH (measured in Maintenance man hours)), an **increase in maintenance task complexity** has been determined for example by additional staff qualification requirements or servicing equipment needed.

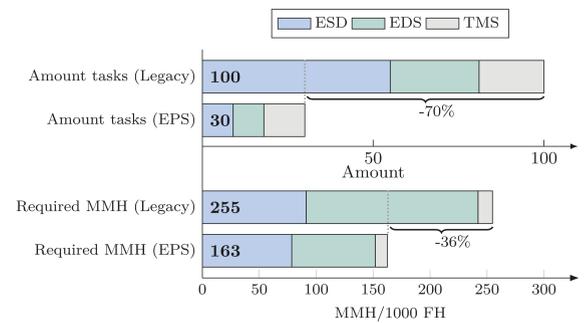
The outcome shows that the subsystems for energy storage and distribution (ESD) and the electric drive system (EDS) contribute about 93% to the total maintenance effort.

With **battery restorations** being the **primary maintenance driver**, their reliability and cycling stability heavily influence any cost saving effects.

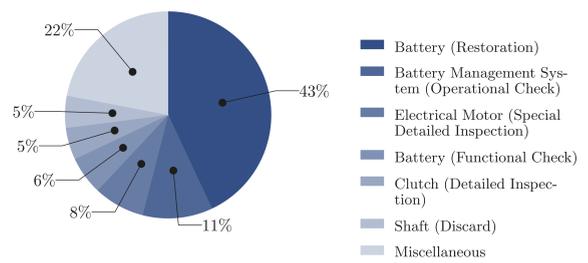
Lastly, the **operating scenario** of the EPS only has **minor impact** on the maintenance effort.

Irrespective of the annual utilization, the required maintenance demand for battery-electric systems is virtually unchanged. However, they seem to be **beneficial** from a maintenance perspective **for comparably long flight segments**.

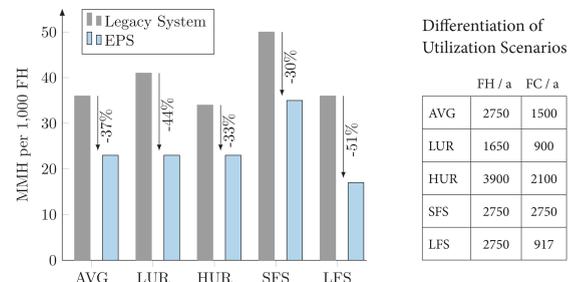
Comparison between conventional and novel electric battery systems show that maintenance costs can be significantly reduced.



Most affording tasks by amount of execution per 1000 FH



Utilization scenarios have little impact on the maintenance efforts of the battery system.



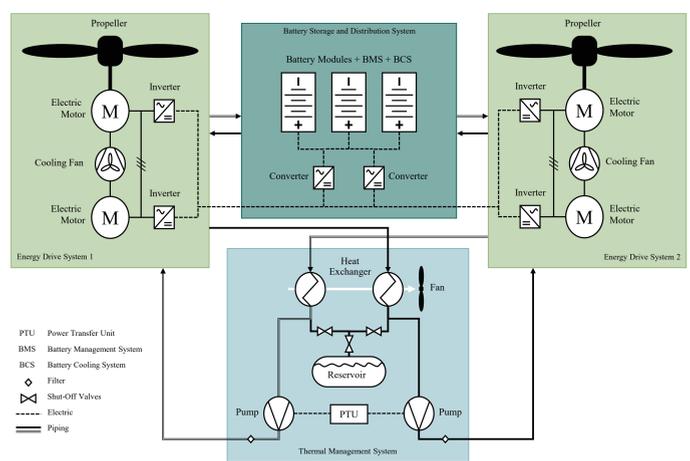
Differentiation of Utilization Scenarios

	FH / a	FC / a
AVG	2750	1500
LUR	1650	900
HUR	3900	2100
SFS	2750	2750
LFS	2750	917

Conclusion

- The overall maintenance effort of the system is highly related to battery technology.
- Utilization scenarios barely influence the maintenance effort in total reduction of required spare parts.
- Increased share of in-shop maintenance demand.
- Reduction of required spare parts.
- Despite maintenance effort decrease, the task complexity is likely to increase.
- Considering maintenance in early design staged benefits the systems reliability.

Improved system-layout for electric propulsion technology.



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