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Title

Liquid Hydrogen in a Flight Test Environment - Developing an Operational Concept for the DLR Electric Flight Demonstrator

Authors

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Abstract

The use of hydrogen as an aviation fuel, in particular in its liquid state, is a key element for achieving climate-neutral flight. Electrical propulsion using air breathing hydrogen fuel cells is therefore a main focus of R&D projects. In this context, the German Aerospace Center (DLR) is currently developing the Electric Flight Demonstrator (EFD) aircraft, to explore the required technologies and tools [1]. The aircraft will be operated from DLR's Oberpfaffenhofen flight test site, where the required hydrogen ground infrastructure will also be established.

Liquid hydrogen (LH2) is characterized by its high energy density but also poses several unique challenges when used in the aviation sector. This concerns aspects of aircraft maintenance, servicing, safety as well as storage, transport and general handling of a cryogenic medium.

Considering these aspects early in the development process is vital in order to guarantee complete coverage of associated requirements, functions, and procedures. Therefore, the development of an operational concept (OpsCon) parallel to the system development is essential [2]. DLR is utilizing a comprehensive approach to investigate all aspects of the EFD aircraft operation, by using a graphical mission model. This model identifies the states that the aircraft can assume during a mission, their interconnecting sequences as well as the associated geographic locations. This allows to correlate operational needs with the required properties and functions to be provided by the aircraft and its systems including the ground support equipment.

While the initial model focuses on a "Standard Mission", the OpsCon can be extended to also consider systemic failures or specific environmental conditions to explore the different effects that these have on operational procedures or aircraft and mission system functions and requirements.

This modelling approach is accompanied by procedures and methods to integrate it into the overall systems engineering process according to ARP4754A to support development and certification activities.

References

- [1] https://www.dlr.de/content/en/articles/news/2021/04/20211124_dlr-takes-delivery-of-its-new-do-228-research-aircraft-d-cefd.html
- [2] Guide to the Preparation of Operational Concept Documents, American National Standard, ANSI/AIAA G043B-2018