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CRONUS – SANDWICH COMMON BULKHEAD TANK DEMONSTRATOR

Abstract

In the development of launcher upper stages, cost reduction and light construction normally contradict each other. The Sandwich Common Bulkhead (SCB) upper stage design however combines both cost efficiency as well as lightweight design which enables it to meet high performance requirements.

Within ESA's FLPP 3 framework, MT Aerospace is commissioned with the manufacturing of the Sandwich Common Bulkhead cryogenic upper stage tank demonstrator CRONUS (Cryogenic Optimized New Upper Stage). Focus of CRONUS is the Sandwich Common Bulkhead which represents a compact intertank architecture and provides a strong thermal barrier between both tank compartments. Therefore, a full scale cryogenic upper stage tank design featuring a SCB was derived from Ariane 6 relevant requirements and optimized for improved thermal performance and structural aspects. Based on that, the design was scaled down to a tank diameter of 1.3 m, resulting in the CRONUS tank demonstrator. A design-to-manufacturing approach and cost optimized production methods were applied including latest technologies e.g. friction stir welding and spin forming.

After final assembly of the CRONUS tank demonstrator, a proof pressure test at ambient temperature conditions was performed and confirms the safety requirements and the structural integrity of the SCB. Moreover, a cryogenic test campaign was performed in order to prove the thermal and structural performance of the CRONUS tank demonstrator within a representative load environment. Therefore, the tank compartments were filled with liquid hydrogen and liquid nitrogen and multiple tests were performed, including filling, draining, self-pressurization and active pressurization, applying all dimensioning thermal and mechanical loads to the SCB. With the successful completion of the CRONUS project, the presented SCB technology is successfully matured to TRL 6 as the test objectives have been fulfilled and manufacturing aspects, thermal performance and structural integrity have been validated in a representative environment.

This paper presents the main results of the thermal and structural analyses which led to the unique design of the Sandwich Common Bulkhead. Furthermore, the manufacturing process of the tank demonstrator is outlined. Finally, results of the cryogenic test campaign of the CRONUS tank demonstrator will be presented. An outlook will be given for subsequent activities with regard to the full scale Sandwich Common Bulkhead Flagship Demonstrator SCOUT.