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PREFERRED DESIGN OF A NEW CRYOGENIC UPPER STAGE FOR VEGA EVOLUTION

Abstract

In preparation for German contribution to development of the European VEGA launcher through the VECEP programme, MT Aerospace has performed a trade-off and design study for a new cryogenic upper stage. The project was carried out in cooperation with ELV and AVIO, and with financial contribution from DLR. The current preferred design choice for VEGA-Evolution is a 10 tonne-class LOx-methane upper stage powered with a MIRA engine. This would be the first operational LOx-methane stage in Europe and indeed worldwide, consequently the design challenges and design space are not fully understood.

This paper will present design trade-offs for different Vega-Evolution upper stage configurations with the focus on insulated tanks, avionics bay and engine bay. The result of these trade-offs was a preferred design with a sandwich common bulkhead separating the oxygen and methane propellant tanks. This design was analysed in more detail, with detailed lay-out studies, structural design and analysis, thermal analysis including boil-off estimations and dynamic analysis. Throughout the study, a design-to-manufacturing approach has been applied extensively. At each design step, starting from preliminary configurations, applicable manufacturing technologies and concepts have been considered and will be presented here. In many instances, the manufacturing aspects have been the design driver.

As an integral element of the design approach, dedicated cost engineering with respect to both non-recurring and recurring cost has been applied for concept assessment and optimisation. This has enabled an identification of cost drivers and the definition of cost reducing steps. Inclusion of reliable cost and manufacturing engineering early in the design process enables a high confidence in the selected design. The estimated development and production costs for the selected design are included in this paper, along with the identified cost-drivers.

Finally, a preliminary development and qualification plan was outlined with special emphasis on new technologies such a sandwich common bulkheads and friction stir welding. This work has been fed into other national and international cryogenic development technology development programmes currently being undertaken at MT Aerospace.