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STATUS REPORT PROMETHEUS L-PBF TURBINE PROGRAM

Abstract

The Prometheus program aims at breaking new ground for turbine design and manufacturing. The use of additive manufacturing (AM) is identified as a key technology and will for the first time be used to manufacture a European turbine to be run in a hot fire engine test. The Prometheus engine, developed by ArianeGroup, is a new ultra low cost engine of gas generator type driven by liquid methane (CH₄) as fuel and with liquid oxygen (LOX) as oxidizer. The turbine and pumps are all mounted on one shaft in a vertical configuration. To achieve the ultra low cost objectives, the benefits of AM have been utilized to design the turbine to consist of only two parts, an inlet manifold and a rotor, both manufactured with a laser powder bed fusion (L-PBF) process. The Prometheus program also includes technology activities run in parallel supported in part by ESA program, and also in part by the Swedish National Space Agency, aiming at preparing the technology step needed for competitive future launchers. The paper aims to show the experience gained up until spring 2019 within the Prometheus turbine demonstrator development program for future European launcher applications. The paper will report on the following activities: (i) challenges in design and manufacturing of the first L-PBF turbine parts, (ii) experiences with design using AM as manufacturing method, (iii) results of development and test campaigns performed to date, and (iv) achievements in cost reduction. The experience of AM parts in manufacturing is discussed with regard to which degree the manufacturing has been simplified, and what challenges that were discovered when using AM as the manufacturing method. Results from testing of materials, components and post-AM processes (e.g. surface treatment and inspection) performed to date provide insights into how these tests have impacted the design and what lessons that have been learned regarding post-process activities that will be part of a future manufacturing process chain. Finally, the cost impact of using AM will be discussed in general terms to draw conclusions on the feasibility of Prometheus as an ultra low cost program.