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USE OF ADDITIVE MANUFACTURING TECHNOLOGY AND QUALIFICATION APPROACH IN HEPD-02 INSTRUMENT

Abstract

This paper outlines the strategy for verifying and ensuring product quality while addressing risks associated with the utilization of Polymeric Additive manufacturing, a non-qualified process, in the frame of CSES/Limadou space programme for the second China Seismo-Electromagnetic Satellite (CSES-02) that is currently under final integration and test phase and its launch is expected at the end of 2023.

Additive manufacturing, or 3D printing, is extensively used in the aerospace sector for its capability to produce complex and lightweight components, but given the critical nature of ALM (Additive Layer Manufacturing) processes and the potential influence of multiple factors on the final product's properties, the quality assurance approach for qualification is crucial to guarantee the survival of the parts and thus the success of the mission. However, the currently available standards do not provide a specific qualification procedure offering only a general approach to polymeric materials and relevant processing technologies. This paper provides insights into the design of the HEPD-02 (High Energy Particle Detector) instrument, highlighting the use of 3D-printed polymeric components that facilitate rapid and on-demand production of tertiary structures. The component is produced from a high-performance thermoplastic, namely PEEK (polyether-ether-ketone), using Fused Filament Fabrication (FFF, also known as FDM). The adoption of PEEK via FFF aims to accelerate production by creating support structures, such as wire holder supports. This has ensured the production of tertiary structure and some spare parts with minimal lead time, allowing for minor design adjustments to better align with the intended purpose and geometry of the structural support, all readily available on demand. Nevertheless, an early definition phase, a thorough review of the design, analysis, and qualification process was crucial to ensuring the final product's quality and compliance with the demands of the space environment. A two-step approach was employed at the instrument level: initially, a set of requirements, along with associated analysis and verification methods, was established with regard to specific technology constraints, such as sharp edges and minimum width. The second step focused on validating production quality through testing and inspection. The qualification results at the instrument level have been subsequently documented.

The study results offer valuable insights into the verification and product assurance strategy implemented within the Limadou-02 program. This approach ensures instrument integrity and product quality while incorporating novel materials and technologies for space applications.