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For a successful space program: Quality and Safety! (1)

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RAMS AND FDIR METHODS IN SUPPORT TO ZERO DEBRIS APPROACH

Abstract

Nowadays, in view of the maturing of satellite technologies, more systems are being designed and launched in Earth orbit with a wide range of objectives such as in-orbit demonstration but also complex and ambitious missions with objectives more difficult to achieve. For the past decades, new space players have emerged, designing missions for which cost is one of the main driving factors. This aspect has brought many improvements in equipment miniaturization and resource optimization. However, this has also led to an increased population of spacecraft in orbit and subsequently, when no deorbiting capabilities are foreseen after their end of life, in debris.

Space debris is defined in the European Space Agency (ESA) Zero Debris (ZD) approach as "all non-functional, human-made objects, including no longer functioning spacecraft or fragments of them, in orbit or reentering Earth's atmosphere". The current population of non-functional satellites in Earth orbit is viewed worldwide as a concern for the present missions, but also for the near future ones. This concern has triggered the urgent action in ESA to ensure the situation is improved and as such, the Zero Debris Policy (ZDP) has been created which has led to the creation of the ESA Space Debris Mitigation Requirements (SDMR) ESSB-ST-U-007, standard that aims at more stringent rules for a clean space.

This paper will present the differences between the ISO 24113-2023 and the ESA ESSB-ST-U-007 with respect to the SDMR, with a focus on Reliability, Availability, Maintainability and Safety (RAMS) or/and Fault Detection Isolation and Recovery (FDIR). The research will also justify what were the motivations behind the stringent requirements in these domains. Moreover, this paper will also highlight how the ESSB-ST-U-007 fits within the frame of the recently developed ESA RAMS map and will clarify what RAMS and FDIR analyses, tools and methods are required to show compliance with the ESA Space Debris Mitigation Standard (ESSBU-ST-U-007).

This work brings to the space community the clarification and step-by step description of methods that need to be followed in order to show and achieve compliance to some of the very important requirements that contribute to the SDMR, such as: probability of successful disposal and passivation, probability of accidental break-up, probability of collision due to on-board failures and lastly but not least, how to decide on life extension or decision for disposal.