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DESIGN, VERIFICATION AND GROUND QUALIFICATION APPROACH FOR THE STRUCTURE OF THE EUROPEAN SERVICE MODULE OF THE ORION MULTI-PURPOSE CREW VEHICLE

Abstract

This paper presents an overview of the design and verification approach for the structure of the European Service Module of the "Orion" Multi-Purpose Crew Vehicle, currently undergoing development and qualification test activities. Under an agreement between NASA and ESA, the new NASA Multi-Purpose Crew Vehicle (MPCV) for human space exploration missions will be powered by a European Service Module (ESM), based on the design and experience of the ATV (Automated Transfer Vehicle). The development and qualification of the European Service Module (ESM) is managed and implemented by ESA. The ESM prime contractor and system design responsible is Airbus Defence and Space, while Thales Alenia Space Italia is responsible for the design and integration of the ESM Structure and Micro-Meteoroids and Orbital Debris (MMOD) protection, the Thermal Control System and the Consumable Storage System. The Multi-Purpose Crew Vehicle (MPCV) is a pressurized, crewed capsule that transports up to four crew members from the Earth's surface to a nearby destination or staging point, and brings the crew members safely back to the Earth's surface at the end of a mission. The MPCV provides all services necessary to support the crew members while on-board for short duration missions (up to 21 days) or until they are transferred to another element. The European Service Module supports the crew module from launch through separation prior to re-entry. It provides in-space propulsion capability for orbital transfer, attitude control, and high altitude ascent aborts. It provides the water and oxygen needed for a habitable environment, generates and stores electrical power, and maintains the temperature of the vehicle's systems and components.

The structure of the ESM is composed of various structural parts. The main elements are: the 6 longerons, that transfer the loads from the Crew Module Adapter to the Spacecraft Adapter, and thus are the main contributor in the primary load path; the central core made of a composite sandwich web assembly; the tank bulkhead at the top of the ESM; the lower platform; the Micrometeorite and Debris Protection System (MDPS).

The ESM structure qualification logic at structure assembly level includes mainly the static stiffness test, acoustic tests, sine vibration tests, shock tests and the ultimate static test performed in Turin and Plum Brook Ohio, whilst the MDPS testing involves an extensive Hyper Velocity Impact (HVI) test campaign performed at NASA's White Sands test range.