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FRICITION STIR WELD APPLICATION AND TOOLING DESIGN FOR THE MULTI-PURPOSE
CREW VEHICLE STAGE ADAPTER

Abstract

The Multi-Purpose Crew Vehicle (MPCV), commonly known as the Orion capsule, is planned to be the United States' next manned spacecraft for missions beyond low earth orbit. Following the cancellation of the Constellation program and creation of SLS (Space Launch System), the need arose for the MPCV to utilize the Delta IV Heavy rocket for a test launch scheduled for September 2014 instead of the previously planned Ares I rocket. As a result, an adapter called the MPCV Stage Adapter (MSA) will be used in conjunction with the MPCV to account for the variation in diameter of the launch vehicles. Prior to article fabrication, a pathfinder was fabricated to fine tune the associated manufacturing processes. The adapter consists of an aluminum frustum (partial cone) with circumferential rings on each end. The frustum was fabricated by friction stir welding (FSW) three individual panels together on a Vertical Weld Tool (VWT) at NASA Marshall Space Flight Center. Subsequently, each circumferential ring was friction stir welded to the frustum using a Robotic Weld Tool (RWT). The irregular geometry and manufacturing process loads of the MSA required that extensive tooling preparation be put into support structures for the friction stir weld. The tooling on the VWT consisted of an anvil with pneumatic clamps and a set of conveyors mounted on pre-existing stanchions so that the MSA had the ability to be rotated after each of the three friction stir welds. The tooling requirements to friction stir weld the rings with the RWT were somewhat more demanding. To support the mass of the MSA and resist the load of the weld tool, a system of mandrels were mounted to stanchions and assembled in a circle. The goal of the paper will be to explain the design, fabrication, and assembly of the tooling, to explain the use of friction stir welding on the MSA pathfinder, and also to discuss the lessons learned and modifications made for flight article fabrication in support of the September 2014 launch of the Orion MPCV.