Stress Analyses of an ARES I-X Upper Stage Simulator Common Segment for a Critical Initial Flaw Size Assessment

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Abstract

The ARES I-X Upper Stage Simulator (USS) is a mass simulator element for the ARES I system. The USS is comprised of seven similar cylindrical shell segments, referred to as "tuna-can segments", and interface structures. Several tuna-can segments are identical in their design and are referred to as the common segments. Each tuna-can shell segment has a flange welded to each end allowing the different segments to be bolted together. Finite element models of a 10°-wedge repeating unit were developed for two adjacent tuna-can segments. These models are referred to as the two segment 10°-wedge models.

This paper summarizes the stress analyses performed supporting a critical initial flaw size assessment of the ARES I-X USS common tuna-can segments. Stress analyses of two segment 10°-wedge finite element models were performed to examine the stress state in the vicinity of the shell-to-flange weld. Elasto-plastic, large-deformation simulations were performed.

Stress levels were well below the material yield stress for the bounding axial tensile design load derived from all aspects of a typical mission profile. Fit-up stresses due to flange-surface mismatch during assembly were also examined. Flange-surface mismatch was shown to have a significant effect on the maximum axial tensile stress at the top of the fillet weld for the CIFS analyses. These stress levels were used in the fatigue crack growth assessment.