Ares I-X Material Testing

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Abstract

An independent assessment was conducted to determine the critical initial flaw size (CIFS) for the flange-to-skin weld in the Ares I-X Upper Stage Simulator (USS). The skin and flange are made of normalized A516 Grade 70 steel and the flange-to-skin weld was initially performed using a pulse MIG process, but the process was changed to a flux-cored welding process for the final production of the USS. Tests were conducted to evaluate the material behavior of the A516 steel with particular attention to the material behavior that could be influenced by the weld process.

The welded plates for testing were created by either a flux-core or pulse MIG welding process that joined a ½ inch thick plate to a 1-inch thick plate. The 1-inch thick plate was intended to simulate the flange and the ½ inch thick plate simulated the skin. Unlike the actual structure, the flange was rotated 90 degrees to allow sufficient material for manufacture of the specimens, as shown in Figure 1. The flange material was machined to a thickness of ½ inch after the weld was completed to allow for testing with standard specimen configurations. The weld consisted of a single bevel on the skin side and was straight on the flange side, as illustrated in the edge etch shown in Figure 2.

Several types of tests that were conducted to characterize the material. These include fatigue crack growth rate in lab air and in a salt-water environment, Charpy impact tests, and fracture tests. Parent A516 material was used for the fatigue crack growth rate tests and plates of welded material were used for the Charpy impact (flux-cored process) and fracture (both flux cored and pulse MIG processes) tests. This paper describes these tests.

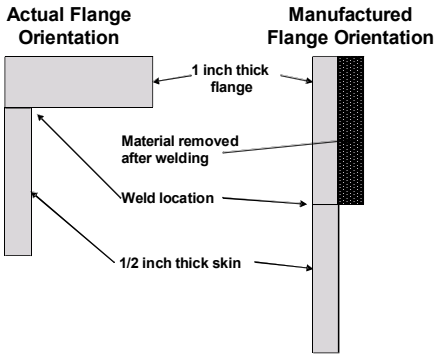

Figure 1. Schematic of weld configuration.

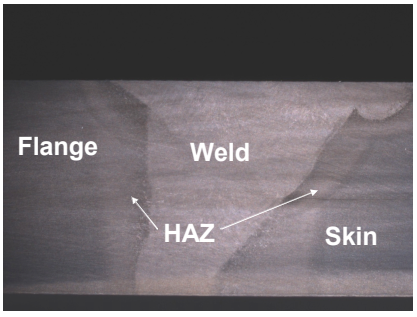

Figure 2. Photograph of a weld edge etch.