

## 2014 NSMMS ABSTRACT

### Development of Aluminum-Lithium 2195 Gores by the Stretch Forming Process

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#### Abstract

Aluminum-Lithium alloy 2195 exhibits higher mechanical properties and lower density than aluminum alloy 2219, which is the current baseline material for Space Launch System (SLS) cryogenic tank components. Replacement of Al 2219 with Al-Li 2195 would result in substantial weight savings, as was the case when this replacement was made on the shuttle external tank. A key component of cryogenic tanks are the gores, which are welded together to make the rounded ends of the tanks. The required thicknesses of these gores depend on the specific SLS configuration and may exceed the current experience base in the manufacture of such gores by the stretch forming process. Here we describe the steps taken to enhance the formability of Al-Li 2195 by optimizing the heat treatment and stretch forming processes for gore thicknesses up to 0.75", which envelopes the maximum expected gore thicknesses for SLS tanks. An annealing treatment, developed at Marshall Space Flight Center, increased the forming range and strain hardening exponent of Al-Li 2195 plates. Using this annealing treatment, one 0.525" thick and two 0.75" thick gores were manufactured by the stretch forming process. The annealing treatment enabled the stretch forming of the largest ever cross sectional area (thickness x width) of an Al-Li 2195 plate achieved by the manufacturer. Mechanical testing of the gores showed greater than expected ultimate tensile strength, yield strength, modulus, and elongation values. The gores also exhibited acceptable fracture toughness at room and LN<sub>2</sub> temperatures. All of the measured data indicate that the stretch formed gores have sufficient material properties to be used in flight domes.