



SPACE SHUTTLE SUPER LIGHTWEIGHT EXTERNAL TANK

The Space Shuttle's major components are the Orbiter, two Solid Rocket Boosters and the External Tank (ET). The largest of these elements is the ET, which has a dual role during the first 8½ minutes of each shuttle launch. The ET feeds liquid propellants (liquid hydrogen and liquid oxygen) to the Orbiter's three main engines, and the ET absorbs most of the seven million pounds of thrust exerted by the Solid Rocket Boosters and the main engines. Lockheed Martin Space Systems – Michoud Operations manufactures the ET at the NASA Michoud Assembly Facility in New Orleans.

The original version of the ET used on the first shuttle launches in the early 1980s weighed some 76,000 pounds. A program to redesign the ET yielded a 10,000-pound weight savings. The resulting Lightweight Tank, introduced on the sixth mission (STS-6) in 1983, made possible substantial improvements in shuttle performance. Each pound removed from the structure of the ET means an extra pound of payload in the Orbiter's cargo bay or the ability to go to a higher orbit and/or into an orbit more highly inclined to the Earth's equator.

The Super Lightweight Tank, a new redesign of the ET, has improved shuttle performance even more. NASA authorized the use of a new aluminum-lithium alloy in order to reduce the ET's weight an additional 7,500 pounds. That weight savings, in turn, made possible the first shuttle flight on December 4, 1998, that placed International Space Station components in high-inclination orbits.

Aluminum alloy 2219 is the material previously used for the pressurized portions of the ET structure. In 1986, the Lockheed Martin Laboratories in Baltimore undertook the challenge to develop a high strength, low density replacement for the 2219 alloy -- while retaining that alloy's excellent weldability, fracture toughness and cryogenic properties. The result was a family of aluminum-lithium alloys called Weldalite®, from which the 2195 alloy was selected as the optimum replacement for the 2219 alloy on the ET.

The 2195 aluminum-lithium alloy is weldable, 30% stronger and 5% less dense than the 2219 alloy and has excellent fracture toughness at cryogenic temperatures down to -423°F, the temperature at which liquid hydrogen is maintained on board the ET. The nominal chemistry for the 2195 alloy is 1% lithium, 4% copper, 0.4% silver, 0.4% magnesium, with the remainder aluminum. Alcan, located in Ravenswood, WVA, provides Lockheed Martin with aluminum-lithium for material for Super Lightweight Tank production.

Some 7,500 pounds have been saved by using the stronger, lighter aluminum-lithium alloy and incorporating weight-saving design changes, such as replacing machined longitudinal tee stiffeners in the liquid hydrogen tank barrels by an orthogonal waffle grid design. Additional weight savings are achieved by fine-tuning controls for the thickness of the spray-on thermal protection coating, machining this sprayed-on coating and optimizing tank structure not undergoing material change.

The first Super Lightweight Tank lifted off June 2, 1998, with shuttle flight STS-91.