

this bulkhead and going up to here, we have liquid hydrogen, liquid hydrogen at -423° F. There are about 260,000 gallons of liquid hydrogen. This tank here, which is almost, but not quite, a sphere right under the hydrogen tank, contains 85,000 gallons of liquid oxygen at -297° . There are five engines built by Rocketdyne, called the J-2 engines, which have a nominal thrust of 200,000 pounds each. There is an uprated version, at 230,000 pounds, which we will have on our later vehicles. The stage, after it separates from the S-IC, burns for about 390 seconds, a little over 6 minutes. A measure of how good the engine and propellant system are is called the specific impulse; it's the pounds of thrust per second of propellants burned which gives the value in seconds. At altitude, it's about 436 seconds. The specific impulse on the hydrogen-oxygen stages are characteristically quite high compared to liquid oxygen and kerosene. There are eight solid-propellant ullage motors that attach to the sides for a total thrust of about 23,000 pounds. When we separate from the S-IC, we momentarily go into zero g. These ullage motors are used to resettle all the propellants at the rear end of the tank, so that the engines will have plenty of pressure head. When the main engines are ready to light, we start these solid-propellant ullage motors and burn them for a little over 3 seconds; that moves the propellants to the bottom of the tank, and the main engines can start. After main engine start, we throw the ullage motors away.

The S-II stage lights at about 38 miles altitude, and burns out at about 114 miles. At engine start, it has been boosted by the S-IC to a velocity of 7,700 feet per second. It then gains about 14,000 feet per second, reaching an end velocity of 20,840 feet per second. At this time it shuts off, just before the S-IVB separates and continues the mission. This is somewhat short of orbital velocity, so this stage actually splashes back into the water. It does not go into orbit.

This is one way of getting a quick broad look at the program scope (slide 5). We manufactured three vehicles that for all intents and purposes are like the flight stage but were made for test purposes. One was made for static testing, to test the structural integrity of the stage. This was the S-II-S. It was tested at Seal Beach. Another one we call the S-II-F, "F" standing for facility. It was made to send down to Florida to check out the facility and make sure the stage would interface properly with the S-IC below it and the S-IVB above it, with the launch umbilical tower, the stand, and the other equipment. And then we had what we call the S-II-T, "T" standing for test, which had all the flight systems in it, including the five engines. This is the stage that we sent to Mississippi and fired a number of times to find out if we really had a good design and if it was all working. Test results were fed back into the design of the flight stages.

The Battleship (called that because it's made of boiler plate) is mainly to test out the engines. It is at Santa Susana, up above Canoga Park in the San Fernando Valley. We also had an electro-mechanical mockup which is here behind Building 2. We took the stage and cut it in the middle and put half of it here and set the other half next to it, which made it a little simpler to work with.