

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)  
Heavy Lift Launchers Capabilities and New Missions (8)

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ENABLING AN AFFORDABLE LIQUID ADVANCED BOOSTER FOR THE SPACE LAUNCH  
SYSTEM**Abstract**

For NASA's Space Launch System (SLS) Advanced Booster Engineering Demonstration and/or Risk Reduction (ABEDRR) procurement, Dynetics, Inc. and Pratt Whitney Rocketdyne (PWR) formed a team to offer an affordable booster approach that meets the evolved capabilities of the SLS along with a series of full scale risk mitigation hardware demonstrations. To establish a basis for the risk reduction activities, the Dynetics Team developed a booster design that takes advantage of the flight-proven Apollo-Saturn F-1, still the most powerful U.S. liquid rocket engine ever flown. The F-1 is well suited to the Advanced Booster, providing a combination of high thrust-to-weight and reliability in a low-cost package. PWR brings unique cost and performance lessons from having recently working to modernize another Saturn-era engine, the J-2X. The high thrust of a two-engine, F-1-based booster design delivers significant performance margin well beyond NASA's 130 mT Low Earth Orbit (LEO) payload requirement, which enables a robust approach to structural design. Low-cost tank and skirt designs are friction stir welded at 18-ft diameter, which leverages recent NASA investments in manufacturing tools, facilities, and processes, significantly reducing development and recurring costs. The F-1 offers safety and reliability features demonstrated on thirteen Saturn V flights of 65 engines with no failures. As a liquid engine, the F-1 can be acceptance tested to screen for defects prior to integration and, with the vehicle restrained, can be run on the pad for pre-launch readiness demonstration. During the ABEDRR effort, the Dynetics Team will apply state-of-the-art manufacturing and processing techniques to the heritage F-1, resulting in a low recurring cost engine while retaining the benefits of Apollo-era experience. The booster's Main Propulsion System (MPS) design leverages Saturn, Delta IV, and SLS Upper Stage experience to prepare current suppliers to produce large cryogenic components. ABEDRR will use NASA test facilities to perform a full-scale F-1 powerpack hotfire for risk reduction engine testing. Dynetics will also fabricate and test a tank assembly to verify the structural design.