

## Validation of a Computational Model for the SLS Core Stage Oxygen Tank Diffuser Concept and the Low Profile Diffuser - An Advanced Development Design for the SLS

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The Low Profile Diffuser (LPD) project originated as an award from the Marshall Space Flight Center (MSFC) Advanced Development (ADO) office to the Main Propulsion Systems Branch (ER22). The task was created to develop and test an LPD concept that could produce comparable performance to a larger, traditionally designed, ullage gas diffuser while occupying a smaller volume envelope. Historically, ullage gas diffusers have been large, bulky devices that occupy a significant portion of the propellant tank, decreasing the tank volume available for propellant. Ullage pressurization of spacecraft propellant tanks is required to prevent boil-off of cryogenic propellants and to provide a positive pressure for propellant extraction. To achieve this, ullage gas diffusers must slow hot, high-pressure gas entering a propellant tank from supersonic speeds to only a few meters per second. Decreasing the incoming gas velocity is typically accomplished through expansion to larger areas within the diffuser which has traditionally led to large diffuser lengths. The Fluid Dynamics Branch (ER42) developed and applied advanced Computational Fluid Dynamics (CFD) analysis methods in order to mature the LPD design from an initial concept to an optimized test prototype and to provide extremely accurate pre-test predictions of diffuser performance. Additionally, the diffuser concept for the Core Stage of the Space Launch System (SLS) was analyzed in a short amount of time to guide test data collection efforts of the qualification of the device. CFD analysis of the SLS diffuser design provided new insights into the functioning of the device and was qualitatively validated against hot wire anemometry of the exterior flow field. Rigorous data analysis of the measurements was performed on static and dynamic pressure data, data from two microphones, accelerometers and hot wire anemometry with automated traverse. Feasibility of the LPD concept and validation of the computational model were demonstrated by the test data.