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# December 2011 MSS/LPS/SPS Joint Subcommittee Meeting
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## ABSTRACT INFORMATION

Title: CFD Simulations of Supersonic Highly Swirling Flow Exiting a Turbine Vane Row Compared with Experimental Observations

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## MANAGEMENT APPROVAL

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**December 2011 MSS/LPS/SPS Joint Subcommittee Meeting**

# ABSTRACT SUBMITTAL FORM

## Unclassified Abstract

*(250-300 words; do not include figures or tables)*

Marshall Space Flight Center (MSFC) has been heavily involved in developing the J2-X engine. The Center has been testing a Work Horse Gas Generator (WHGG) to supply gas products to J2-X turbine components at realistic flight-like operating conditions. Three-dimensional time accurate CFD simulations and analytical fluid analysis have been performed to support WHGG tests at MSFC. The general purpose CFD program LOCI/Chem was utilized to simulate flow of products from the WHGG through a turbine manifold, a stationary row of turbine vanes, into a Can and orifice assembly used to control the back pressure at the turbine vane row and finally through an aspirator plate and flame bucket. Simulations showed that supersonic swirling flow downstream of the turbine imparted a much higher pressure on the Can wall than expected for a non-swirling flow. This result was verified by developing an analytical model that predicts wall pressure due to swirling flow. The CFD simulations predicted that the higher downstream pressure would cause the pressure drop across the nozzle row to be approximately half the value of the test objective. With CFD support, a redesign of the Can orifice and aspirator plate was performed. WHGG experimental results and observations compared well with pre-test and post-test CFD simulations. CFD simulations for both quasi-static and transient test conditions correctly predicted the pressure environment downstream of the turbine row and the behavior of the gas generator product plume as it exited the WHGG test article, impacted the flame bucket and interacted with the external environment.