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HEAT TRANSFER AND PRESSURE MEASUREMENTS FOR THE
SSME FUEL TURBINE

Michael G. Dunn and Jungho Kim
Calspan - UB Research Center
Buffalo, New York 14225

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ABSTRACT

A measurement program is currently underway at the Calspan-UB Research Center (CUBRC) using the Rocketdyne two-stage Space Shuttle Main Engine (SSME) fuel turbine. The measurements utilize a very large shock tunnel to produce a short-duration source of heated and pressurized gas which is subsequently passed through the turbine. Within this environment, the turbine is operated at the design values of flow function, stage pressure ratio, stage temperature ratio, and corrected speed. The first-stage vane row and the first-stage blade row are instrumented in both the spanwise and the chordwise directions with pressure transducers and heat-flux gages. The second-stage vane row is instrumented at midspan with heat-flux gages. There are no pressure transducers on the second vane row. The second-stage blade row contains neither pressure nor heat-flux gages at the present time. The specific measurements to be taken include time-averaged surface-pressure and heat-flux distributions on the vane and blade, flow passage static pressure, flow passage total pressure and total temperature distributions, and phase resolved surface pressure and heat flux on the blade.

This paper will provide a current status of the measurement program. Examples of results obtained to date will be presented. Reference ¹

* Paper Submitted for Presentation at the SSME Durability Conference to be Held at NASA Lewis Research Center, May 14-15, 1991

¹ Dunn, M.G., "Heat Transfer and Pressure Measurements for the SSME Fuel-Side Turbopump," paper presented at the 1990 Earth-to-Orbit Conference, Marshall Space Flight Center, May 15-17, 1990.

presented a description of the hardware, the instrumentation, and the measurements being performed on the turbine components and along the flowpath. Table 1 presents a description of flow conditions for which measurements are being obtained.

Table 1

Test Conditions for SSME Fuel Turbine Measurements

T_o , °R	P_o , psia	Flow Function	Re_{chord}	Total to Total Press. Ratio	Rotor Speed rpm
1000	260	2.27	9.9×10^5	1.47	9292
1000	150	2.27	5.7×10^5	1.47	9292
1000	100	2.27	3.8×10^5	1.47	9292
1000	50	2.27	1.9×10^5	1.47	9292
1000	600	2.27	2.3×10^6	1.47	9292

The data point at 100 psia inlet pressure corresponds to the run condition recently completed at the NASA Marshall Space Flight Center for a companion SSME fuel turbine. The Marshall measurement program produced turbine efficiency results for a number of operating points, time averaged surface pressure distributions as a function of chord and span for the first vane row, and time averaged surface pressure distributions along midspan for the second vane row. The first vane pressure results obtained at MSFC will be directly comparable to the CUBRC pressure results. Pressure measurements were not performed on the rotor for the MSFC experiments. No heat-flux measurements were performed for the Marshall configuration.