Detached Eddy Simulation Analysis of a Transonic Rocket Booster for Steady & Unsteady Buffet Loads

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TLG Aerospace was tasked by a customer to provide unsteady buffet loads on a rocket with 'hammer-head' configuration at transonic Mach numbers. Accurately capturing the physics of time-unsteady bluff body shedding, recirculation and reattachment required a large scale application of the STAR-CCM+ DES flow solver.

As part of the customer analysis, validation work was done against NASA wind tunnel data on a similar geometry. The NASA report published rocket geometry, steady state (time averaged) pressures and unsteady pressures in the form of RMS ?CP . The steady state (RANS) correlation was very good, including in the detached region. The unsteady DES results were clearly capturing the vorticity shedding in the detached region, but over-predicted the maximum magnitude of RMS ?CP.

From published experimental work on DES applications to bluff body shedding, this over-prediction is an indication of insufficiently resolved mesh. However, the actual locations of the peak RMS ?CP values from the DES solution agreed quite well with experimental data. While computationally costly, the DES solver offers capability to provide unsteady buffet loads previously only available with an (even more costly) wind tunnel test.

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