

Reducing the Effect of Transducer Mount Induced Noise on Aeroacoustic Wind Tunnel Testing Data with a New Transducer Mount Design

A.J. Herron¹, D.K. Reed¹, D.K. Nance¹

¹NASA/Marshall Space Flight Center, Huntsville, Alabama, USA

Characterization of launch vehicle unsteady aerodynamics is a field best studied through experimentation, which is often carried out in the form of large scale wind tunnel testing. Measurement of the fluctuating pressures induced by the boundary layer noise is customarily made with miniature pressure transducers installed into a model of the vehicle of interest. Literature shows that noise level increases between two to five decibels (dB referenced to 20 μ Pa) can be induced when the transducer surface is not mounted perfectly flush with the model outer surface. To reduce this artificially induced noise, special transducer holders have been used for aeroacoustic wind tunnel testing by NASA. This holder is a sleeve into which the transducer fits, with a cap that allows it to be mounted in a recessed hole in the model. A single hole in the holder allows the transport of the tunnel medium so the transducer can discriminate the fluctuating pressure due to the turbulent boundary layer noise. The holder is first dry fitted into the model and any difference in height between the holder and the model surface can be sanded flush. The holder is then removed from the model, the transducer glued inside the holder, and the holder replaced in the model, secured also with glue, thus eliminating the problem of noise level increases due to lack of flushness. In order to work with this holder design, special transducers have been ordered with their standard screen removed and the diaphragm moved as close to the top of the casing as possible to minimize any cavity volume.

Although this greatly reduces induced noise due to the transducers being out of flush, the holders can also induce a cavity resonance that is usually at a very high frequency. This noise is termed transducer mount induced noise (XMIN). The peak of the mode can vary with the cavity depth, boundary layer noise that can excite the mode, tunnel flow medium, and the build of the transducers.

Because the boundary layer flow interaction with the microphone holder seems to have some effect on the cavity resonance response, the NASA/Marshall Space Flight Center (MSFC) aeroacoustic team postulated that changing the design of the holder might reduce the cavity resonance response. An experiment was performed at the MSFC Trisonic Wind Tunnel comparing a new holder design with the traditional MSFC holder. The new holder design is intended to mimic the Kulite Semiconductors, Inc. B-screen, where the single hole of the traditional MSFC holder is replaced by a series of ten 0.007 inch diameter holes. This particular design serves to protect the transducer diaphragm as in the manufacturer's B-screen, but also increases the frequency of the XMIN such that it is not apparent in the data collected from aeroacoustic wind tunnel tests.

MSFC compared the two holder designs by installing two transducers in standard holders on one side of a ten inch long ten degree cone, and two transducers in B-screen holders on the opposite side for a series of runs at different conditions. Over 11-13 February, 2013, the model was run at Mach numbers between 0.80 and 1.96 at angles of attack at 0°, $\pm 1^\circ$, $\pm 2^\circ$, $\pm 4^\circ$, and $\pm 8^\circ$. Model roll attitudes at 0°, 90°, and 180° were tested to isolate potential tunnel bias. This paper presents results from the test showing that the proposed holder design significantly reduces the influence of XMIN on measured fluctuating pressure levels.