Predicting the Acoustic Environment Induced by the Launch of the Ares I Vehicle

Decision/Data Models and Analysis

The exhaust plumes of launch vehicles impose severe heating rates, pressures, and vibroacoustic loads on ground support equipment (GSE) on the Mobile Launcher (ML), as well as on the vehicle itself. The vibroacoustic environment must be predicted before the criteria for the acceptance and qualification testing of GSE components and their installations can be determined.

Near-field launch noise levels are traditionally computed as described in NASA SP-8072, "Acoustic Loads Generated by the Propulsion System," published in 1971. Figure 1 illustrates the method for determining the noise load on the vehicle. The rocket exhaust plume is a distribution of acoustic sources, each of which propagates to a point on the vehicle. The report contains empirical models for determining the strength and distribution of the noise and includes simple factors for various types of deflectors (Figure 1).

Since SP-8072 was published, there has been considerable research in jet and rocket noise modeling and sound propagation. For example, the overall sound power model in SP-8072 was based on a simple acoustic efficiency factor and is not consistent with Lighthill's well-established jet noise theory. Consistent rocket noise models, more recent research on source distributions and characteristics, and a much better understanding of the shielding of noise by parts of the launcher itself are now available.

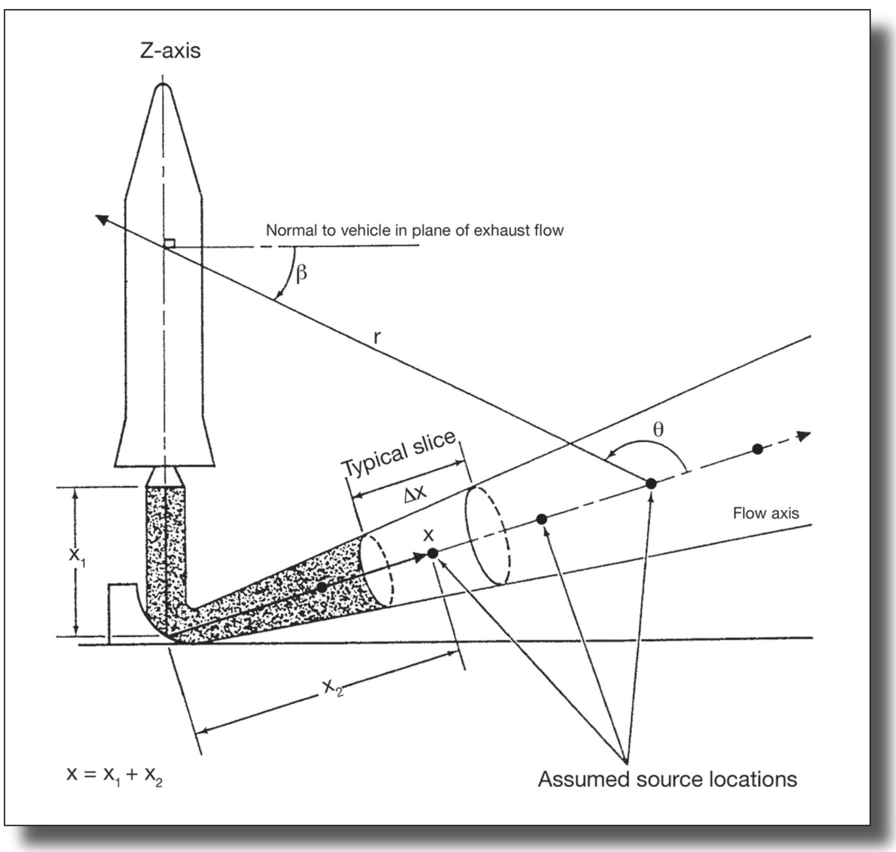

Figure 1. Noise modeling sketch from NASA SP-8072 shows the predominant angle of maximum noise generation.

The sketch in Figure 2 shows a launcher deck and general location of the receivers along the launch tower. Figure 3 shows the vehicle rising past the tower. Various propagation paths are indicated, including those in areas where the launcher deck provides shielding.

This project updates launch noise modeling in the following ways:

- It provides the overall sound power emission of the rocket with the Lighthill-consistent method developed by Sutherland.
- It updates distributions of noise along the plume with the empirical work of Sutherland, McInerny, et al., and by the recent theoretical and laboratory work of Harper-Bourne and others.
- It computes the shielding of propagation paths by the launcher deck via Maekawa's thin screen diffraction model.
- It uses the modern ground impedance model of Chien and Soroka to address how ground reflection affects propagation, and it uses current ANSI/ISO standards to determine the effects of absorption by air.

Key accomplishments were reviewing SP-8072 methodology and identifying components requiring update, generalizing the methodology for off-vehicle locations (in particular, locations on the launch tower), and identifying current technology to be used in updating predictions.

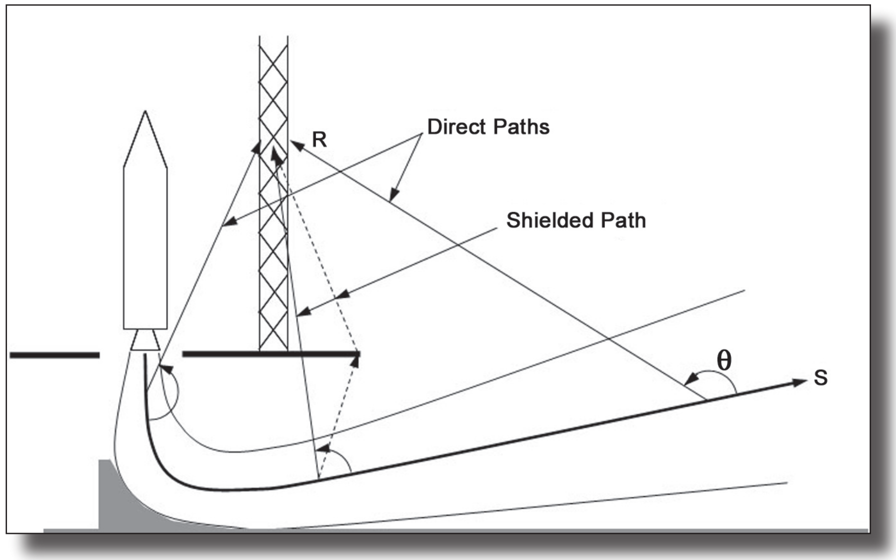

Figure 2. Noise modeling is shown for a mobile launcher with a rocket on the pad.

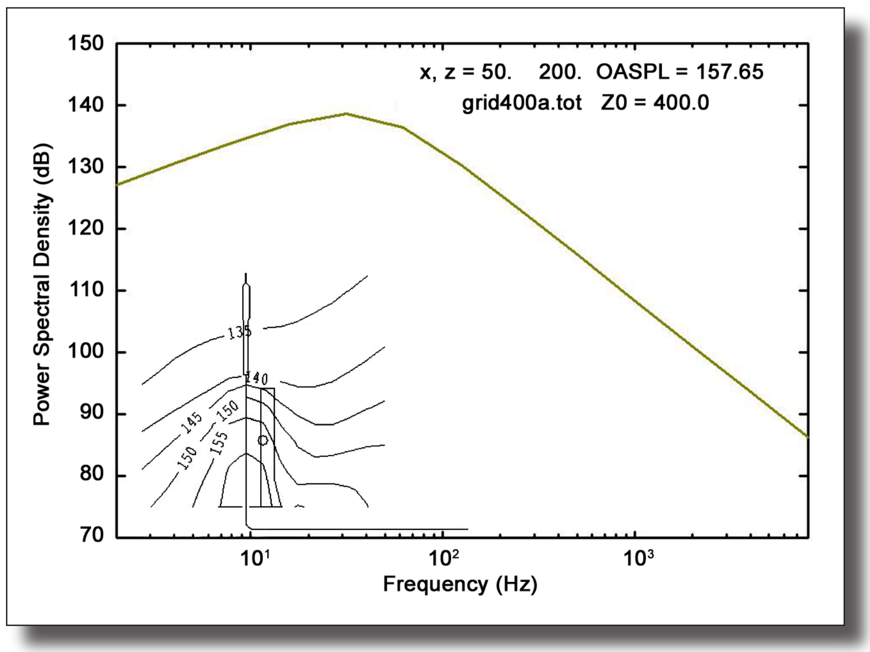

Figure 3. Noise contours and spectrum shown for a mobile launcher with a vehicle rising past the tower.

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