IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Interactive Presentations - IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (IPB)

Author: Ms. Maryam Ozair
Pakistan Space and Upper Atmosphere Research Commission (SUPARCO), Pakistan

PREDICTION OF ACOUSTIC NOISE INDUCED BY THE LAUNCH OF SPACE VEHICLES

Abstract

During lift-off, space vehicles produce high-intensity sound waves that can induce vibrations capable of damaging the vehicles themselves, their payloads and nearby launch pad structures. Furthermore, launch noise propagates longer distances and can negatively affect the farfield community, wildlife and natural environment. Due to increase in the number of space launches and launch facilities globally, it has been extremely important to predict farfield noise to estimate the impact of these noise exposures on the communities and ecology surrounding the launch site. Estimation of farfield noise is also necessary to determine acoustic protection requirements for on-facility personnel, structures and equipment. Experiments and numerical simulations to determine farfield noise environment are very costly and time-consuming. Empirical models are also available, but either they are not very accurate or suitable only for certain types of space vehicles.

Therefore, the purpose of this paper is to develop an accurate noise prediction method based on experimental data and analytical concepts to predict farfield noise from the launch of various types of space vehicles ranging from heavy-lift to small-lift vehicles. In this method, to model launch noise, various aspects of noise source's characteristics such as acoustic power, directivity, forward flight effects and Doppler frequency shift are considered. To account for noise attenuation due to propagation, the effects of geometric spreading, atmospheric absorption and ground interference are included. The received noise at ground locations is estimated by combining the noise source characteristics and propagation effects.

In this paper, we have predicted farfield noise for the launches of various heavy-, medium- and small-lift space vehicles including Saturn V, Saturn SA-6, Falcon 9 and Scout. For each of these vehicles, we have computed overall sound pressure levels (OASPLs) and octave band sound pressure spectra for different ground locations (ranging between 183 m to 19.5 km from the launch pad) during early launch period. The predicted results are validated with the data measured during actual flights. The predicted OASPLs, octave band sound pressure spectra and peak frequencies in the maximum radiation direction are found to be in a very good agreement with the measurement results. Hence, this indicates that the method developed in this work makes accurate and reliable estimations of farfield noise for heavy-lift, medium-lift and small-lift space vehicles.