04-302

Acoustic Emission Analysis of Shuttle Thermal Protection System

John Lane, Jeffery Hooker, and Christopher Immer
ASRC Aerospace
Kennedy Space Center, FL

James Walker
NASA
Marshall Space Flight Center, AL

Acoustic emission (AE) signals generated from projectile impacts on reinforced and advanced carbon/carbon (RCC and ACC) panels, fired from a compressed-gas gun, identify the type and severity of damage sustained by the target. This type of testing is vital in providing the required "return to flight" (RTF) data needed to ensure continued and safe operation of NASA's Space Shuttle fleet. The gas gun at Kennedy Space Center is capable of propelling 12-inch by 3-inch cylinders of external tank (ET) foam at exit velocities exceeding 1,000 feet per second. Conventional AE analysis techniques require time domain processing of impulse data, along with amplitude distribution analysis. It is well known that identical source excitations can produce a wide range of AE signals amplitudes. In order to satisfy RTF goals, it is necessary to identify impact energy levels above and below damage thresholds. Spectral analysis techniques involving joint time frequency analysis (JTFA) are used to reinforce time domain AE analysis. JTFA analysis of the AE signals consists of short-time Fourier transforms (STFT) and the Huang-Hilbert transform (HHT). The HHT provides a very good measure of the instantaneous frequency of impulse events dominated by a single component. Identifying failure modes and cracking of fibers from flexural and/or extensional mode acoustic signals will help support in-flight as well as postflight impact analysis.