Acoustic Noise Prediction of the Amine Swingbed ISS ExPRESS Rack Payload

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Abstract

Acoustics plays a vital role in maintaining the health, safety, and comfort of crew members aboard the International Space Station (ISS). In order to maintain this livable and workable environment, acoustic requirements have been established to ensure that ISS hardware and payload developers account for the acoustic emissions of their equipment and develop acoustic mitigations as necessary. These requirements are verified by an acoustic emissions test of the integrated hardware. The Amine Swingbed ExPRESS (Expedite the PRocessing of ExperimentS to Space) rack payload creates a unique challenge to the developers in that the payload hardware is transported to the ISS in phases, making an acoustic emissions test on the integrated flight hardware impossible. In addition, the payload incorporates a high back pressure fan and a diaphragm vacuum pump, which are recognized as significant and complex noise sources. In order to accurately predict the acoustic emissions of the integrated payload, the individual acoustic noise sources and paths are first characterized. These characterizations are conducted though a series of acoustic emissions tests on the individual payload components. Secondly, the individual acoustic noise sources and paths are incorporated into a virtual model of the integrated hardware. The virtual model is constructed with the use of hybrid method utilizing the Finite Element Acoustic (FEA) and Statistical Energy Analysis (SEA) techniques, which predict the overall acoustic emissions. Finally, the acoustic model is validated though an acoustic characterization test performed on an acoustically similar mock-up of the flight unit. The results of the validated acoustic model are then used to assess the acoustic emissions of the flight unit and define further acoustic mitigation efforts.