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Acoustic and Random Vibration Testing for Low-Cost Missions

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Abstract

The traditional approach for environmental testing of NASA's interplanetary spacecraft is to perform a full set of environmental qualification tests on the engineering model of each component and acceptance tests on each flight component. (If an engineering model is not made, the component is tested to protoflight levels.) The assembled spacecraft is then subjected to system level environmental tests. The environmental testing philosophy has been to perform every test that is relevant to each component and to the entire spacecraft. This philosophy is no longer justifiable in the cost-constrained and Faster, Better, Cheaper environment. Projects are now willing to accept more calculated risk if substantial cost and schedule savings can be made.

Acoustic and random vibration tests are an integral part of environmental testing. Current test programs generally involve performing both acoustic and random vibration tests at the spacecraft level, and usually one of the vibration tests at the component level. Depending on the surface area, mass, and geometry of the test object, one vibration test is normally more severe than the other. Therefore, in most cases, one test is more effective in screening for potential failure modes, without the need to perform both tests. This paper describes a method of optimizing the acoustic and random vibration tests to reduce cost and schedule. The methodology developed herein determines their relative effectiveness by calculating the overall response of the test object under vibration. Examples will be given on how this methodology applies to some typical test objects with calculation of their responses. Optimizing the acoustic and random vibration test programs is different at component and spacecraft levels. This paper provides guidance for determining the most appropriate vibration test at both levels.