

CM-2 Environmental/Modal Testing of SPACEHAB Racks

Combined environmental/modal vibration testing has been implemented at the NASA Glenn Research Center's Structural Dynamics Laboratory. The benefits of combined vibration testing are that it facilitates test article modal characterization and vibration qualification testing.

The Combustion Module-2 (CM-2) is a space experiment that will launch on shuttle mission STS-107 in the SPACEHAB Research Double Module. The CM-2 flight hardware is integrated into a SPACEHAB single and double rack. CM-2 rack-level combined vibration testing was recently completed on a shaker table to characterize the structure's modal response and verify the random vibration response. Control accelerometers and limit force gauges, located between the fixture and rack interface, were used to verify the input excitation. Results of the testing were used to verify the loads and environments for flight on the shuttles.

The CM-2 is a combustion science experiment consisting of eight packages that are integrated into SPACEHAB single and double racks (see the photograph). The CM-2 hardware is a reflight of CM-1 hardware, which was designed and environmentally qualified for SpaceLab and flew on STS-83 (April 4, 1997) and STS-94 (July 1, 1997). The CM-2 design loads and vibration environments for SPACEHAB are higher than for CM-1, requiring requalification of the CM-2 hardware for mission assurance.

The application of combined environmental/modal testing for the CM-2 flight program was a cost-effective way to reduce the design load factors and verify the package environments for mission assurance. The advantage of rack-level testing is it provides flight boundary conditions to the package. Performing rack-level testing instead of individual package level tests saved the program one-half the testing time. Furthermore, the one-fourth flight rack tests reduced the fatigue exposure to the CM-2 commercial, vibration-sensitive electronic hardware. Integrated rack-level testing provided the inertial effect of mass attenuation, reducing the package interface random vibration response. By reducing the CM-2 package loads and vibration environments, the CM-2 program saved the cost of hardware requalification and redesign. This research was presented at the 7th International Congress on Sound and Vibration in Garmisch-Partenkirchen, Germany, July 5, 2000 (ref. 1). More information about CM-2 is available in references 2 and 3.



CM-2 double-rack verification testing.

References

1. McNelis, Mark E.; Goodnight, Thomas W.; and Farkas, Michael A.: CM-2 Environmental/Modal Testing of SPACEHAB Racks. Proceedings of the 7th International Congress on Sound and Vibration, Garmisch-Partenkirchen, Germany, July 4-7, 2000.
2. Combustion Module-2 (CM-2): SPACEHAB Double Rack With Protoflight Packages Sinusoidal Resonance Survey and 1/4 Flight Level Vibration Characterization Test Report. Structural Dynamics Laboratory Test Report SDL-TR 99-34, NASA Glenn Research Center, Dec. 7, 1999.
3. Combustion Module-2 (CM-2): SPACEHAB Single Rack With Protoflight Packages Sinusoidal Resonance Survey and 1/4 Flight Level Vibration Characterization Test Report Structural Dynamics Laboratory Test Report SDL-TR 99-29, NASA Glenn Research Center, Dec. 30, 1999.

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