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Cassini Spacecraft and Instrument Force Limited Vibration Testing

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During the past three years, force limiting has been used in the vibration tests of most of the instruments and major equipment on the CASSINI spacecraft, as well as in the axial random vibration test of the complete flight spacecraft in November of 1996. Over a hundred acceleration responses were monitored in the spacecraft vibration test, but only the total axial force was used in the control loop to notch the input acceleration. The force limit specified in the spacecraft vibration test plan was used without any modifications, and many of the major equipment items on the spacecraft reached their flight limit load in the vibration test.

The force limits for the Cassini instruments and for the complete spacecraft vibration tests were developed using a simple, semi-empirical method which requires only the acceleration specification and data from a low level pre-test to determine the apparent mass of the test item. This semi-empirical method of predicting force limits was validated by comparisons with two-degree-of-freedom analytical models and with interface force data measured at the instrument/spacecraft interface in acoustic tests of the Cassini spacecraft DTM structure. The instrument force limits derived with the semi-empirical method were generally equal to or less than those derived with the two-degree-of-freedom method, but were still conservative with respect to the interface force data measured in the acoustic test.