



AEROSPACE RECOMMENDED PRACTICE

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SHOCK AND VIBRATION EVALUATION OF PACKAGING

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1. FOREWORD

The ultimate test of a good package is the reliability of the package in delivering undamaged equipment consistently to its destination under normal handling conditions. If all the variables in package design were completely predictable, a package could be designed on the board and need never be tested. However, when cushioning characteristics are not completely identified under dynamic conditions, it becomes necessary to test packages for dynamic effectiveness.

2. PRELIMINARY TEST

Package testing, considered as a development test, may be conducted on a prototype basis in conjunction with shock and vibration development tests of the equipment to be packaged. The fragility rating of the equipment to be packaged should be determined in terms of shock and vibration to achieve an accurate description of the capabilities of the equipment regarding natural periods and response to vibration and to shock pulses.

3. RECOMMENDED PACKAGE TEST EQUIPMENT

3.1 Determinations of Frequency and Amplitude Amplification: Use Electro-Dynamic Shaker or other machine capable of imparting the desired frequency and amplitude inputs to the package.

3.2 Shock Exposure:

3.2.1 Electro Dynamic Shaker: If the packaged equipment weight is compatible with the shock required and the force rating of the shaker.

3.2.2 Drop Tester: May be either of two types. It may consist of a hammer assembly that drops upon a test item, or it may be a device by means of which the test item can be dropped in a prescribed manner onto a suitable surface.

3.2.3 Rigid Platform: If correlation of package experience indicates a specific "drop height" criterion and duplication of package treatment is not required in terms of pulse shape, magnitude, and pulse time.

4. TESTS ON MOCK-UP EQUIPMENT

4.1 Construct mock-up of equipment, duplicating dimensions, weight, center of gravity, and the three principal moments of inertia, as nearly as possible and making provision for rigidly mounting accelerometers in the three principal axes. Internal equipment features should also be duplicated in the mock-up when these features are considered sensitive to shock and vibration.

4.2 Construct one or more prototype packages to accept the mock-up equipment.

4.3 Package mock-up equipment and accelerometers, with the pickups connected to a suitable recording system.

4.4 Conduct package tests in accordance with conditions prescribed in packaging specifications or actual handling data, if known.

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5. ANALYSIS OF TESTS

- 5.1 Frequencies: Compare package natural frequency data to equipment natural frequency data for coincidence. Package design should avoid natural frequency coupling with equipment during vibration and shock exposure. If coupling is unavoidable, verify the effects to be tolerable to the equipment by comparison of response loads to equipment fragility.
- 5.2 Response to Vibration: Measure the response loads on the equipment due to the input loading of 4.4, or responses may be calculated as the input loads multiplied by the corresponding amplification factors across the package to the equipment. Compare the responses to the equipment fragility data for assessment of package design adequacy.

5.3 Response to Shock:

- 5.3.1 The shock spectrum should be determined for the shock record applicable to the package. The shock spectrum reveals the maximum response of the given package to the given shock at the fundamental package natural frequency, provided the system behaves as a single degree of freedom dynamic system. Direct response analysis should be used for multi-degree of freedom systems.
- 5.3.2 Shock spectra for common pulses such as half sine and terminal peak sawtooth are readily available in published literature, and spectra for more complex shocks may be determined from available computer programs.
- 5.3.3 Use the shock spectrum with the natural periods of the package for an assessment of damage potential from the shock.

- 5.4 Evaluate all records for indications of cushion bottoming - actual as well as virtual.

6. TEST ON ACTUAL EQUIPMENT

- 6.1 Determine possible finalized package per Section 4 basis of mock-up tests.
- 6.2 Package actual equipment using packaging of 6.1 and rerun test of 4.4.
- 6.3 Compare results of 4.4 and 6.2 in accordance with Section 5 and check actual equipment for proper functioning. Revise packaging as required until a safe design is achieved.

7. FINAL PACKAGE DESIGN

- 7.1 Determine, on the basis of the record evaluation, over design or optimum design of the package and the economic feasibility of adjusting a safe design to obtain optimum packaging.
- 7.2 Prepare packaging details for production use.

8. NOTES

- 8.1 Marginal Indicia: The phi (ϕ) symbol is used to indicate technical changes from the previous issue of this recommended practice.

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