# APPENDIX 4: ENVIRONMENTAL REQUIREMENTS

## 1 SCOPE

This appendix provides the environmental and qualification requirements and criteria for the active components and subsystems on the X-43C Demonstrator Vehicle (DV) and the Adapter. The goal is to ensure that all of these elements are capable of surviving the ground and flight operations environment, specifically in regard to the pressure, temperature, vibration, shock, and acceleration imposed by the captive carry, boost, and flight environment.

An active component is defined as any pneumatic, hydraulic, electronic, electrical, electro-optical, or electromechanical component used in the DV and Adapter.

## 2 DEFINITIONS

The following definitions of terms are used with this appendix:

### 2.1 Acceptance Test

An Acceptance Test is one that is used to verify that specific items conform to acceptable standards for operational use. Acceptance testing is never designed to be destructive. Acceptance Tests serve as a quality control screen to detect deficiencies in manufacturing.

### 2.2 Qualification Test

Qualification Tests are intended to demonstrate that the test item will function within performance specifications under simulated environments more severe than those expected from ground handling and flight operations. Their purpose is to uncover deficiencies in design and method of manufacture. They are not intended to exceed design safety margins or to introduce unrealistic modes of failure.

### 2.3 Flight Hardware

Flight Hardware is intended to be used operationally in flight. It includes the following subsets:

- Protoflight Hardware: Flight hardware of a new design. It is subjected to a test program that combines elements of qualification and flight acceptance verification; that is, the application of design qualification test levels and flight acceptance test durations.
- Follow-On Hardware: Flight hardware built in accordance with a design that has been previously qualified either as prototype or as protoflight hardware. Follow-on hardware is subjected to flight acceptance criteria.

- Spare Hardware: Hardware the design of which has been proven in a design qualification test program. It is subjected to a flight acceptance test program and is used to replace flight hardware that is no longer acceptable for flight.
- Reflight Hardware: Flight hardware that has been used operationally in flight and is to be reused in the same way. The verification program to which it is subjected depends on its past performance, current status, and the upcoming mission.

# 3 GENERAL REQUIREMENTS

3.1 All active component and subsystem designs shall be qualified to the X-43C operational environment specified herein. This shall be accomplished in one of three (3) ways;

- Qualification testing
- Protoflight testing
- Design similarity

3.2 Acceptance criteria shall be applied to all active components and subsystems with the exception of protoflight hardware that has been subjected to protoflight testing. The Contractor shall develop acceptance criteria.

3.3 The Contractor shall develop a qualification test program for unqualified hardware.

3.4 Qualification-tested items shall not be used in flight vehicles.

3.5 Qualification, Protoflight, & Acceptance testing shall be in accordance with the following table:

| Test | Qualification | Protoflight* | Acceptance |
|---|---|---|---|
| Structural Loads Test Level | See section 3.3 | 1.25 x Limit Load | See section 3.2 |
| Random Vibration | See section 3.3 | Limit Level +3dB | See section 3.2 |
| Mechanical Shock | See section 3.3 | 1.4 x Limit Level | See section 3.2 |

*From General Environmental Verification Guidelines for STS & ELS Payloads, Subsystems, and Components, NASA Langley Research Center, July 1992, Revision A.

3.6 For hardware designs previously qualified to other requirements, the Government will grant its use provided the qualification test meets the requirements of this Appendix. Documentation shall be provided that the items intended for use are of the same design and materials, and they were manufactured in accordance with the same processes and quality requirements as the qualification-tested item.

3.7 Accelerometers shall be exempt from the vibration requirements of this specification.

3.8 If the components and subsystems will be subjected to conditions more severe than the environmental levels stated herein, the test procedures shall be modified accordingly.

3.9 Where feasible, the unit undergoing test shall be operated during the complete test cycle and a concurrent performance evaluation made with suitable readout devices. Where not feasible, both pre- and post-testing operational checks shall be conducted and a comparison made for any sign of performance degradation.

# 4 OPERATIONAL ENVIRONMENT

4.1 Altitude

The components and subsystems shall be capable of operating to an altitude from sea-level to 120,000 feet.

4.2 Temperature

4.2.1 The active components and subsystems installed within the DV and Adapter shall be capable of operating in an external ambient environment when temperatures are between minus 40 degrees Fahrenheit and plus 120 degrees Fahrenheit during Ground Operations and Captive Carry Phases.

4.2.2 The Contractor shall determine the internal DV & Adapter temperatures for qualification of active components and subsystems considering the following factors, during all mission phases:

a) Proximity to fluid systems.
b) Effects of aerodynamic heating.
c) Protective devices (heaters, insulators, etc.)
d) Proximity of heat-generating devices within the vehicle (exhaust ducts, gas generators, etc.).
e) Temperature extremes encountered during Ground Operations and Captive Carry Phases including prolonged parking on the ramp, hangar operations, and the extreme cold encountered at high altitudes.

4.3 Vibration

4.3.1 The active components and subsystems installed within the DV and Adapter shall be capable of operating in the external environment under vibration (i.e. acoustic, random, shock) during Captive Carry through Engine Test Phases. The qualification test profile for the external random vibration environment for the mission is defined in Figure 1.

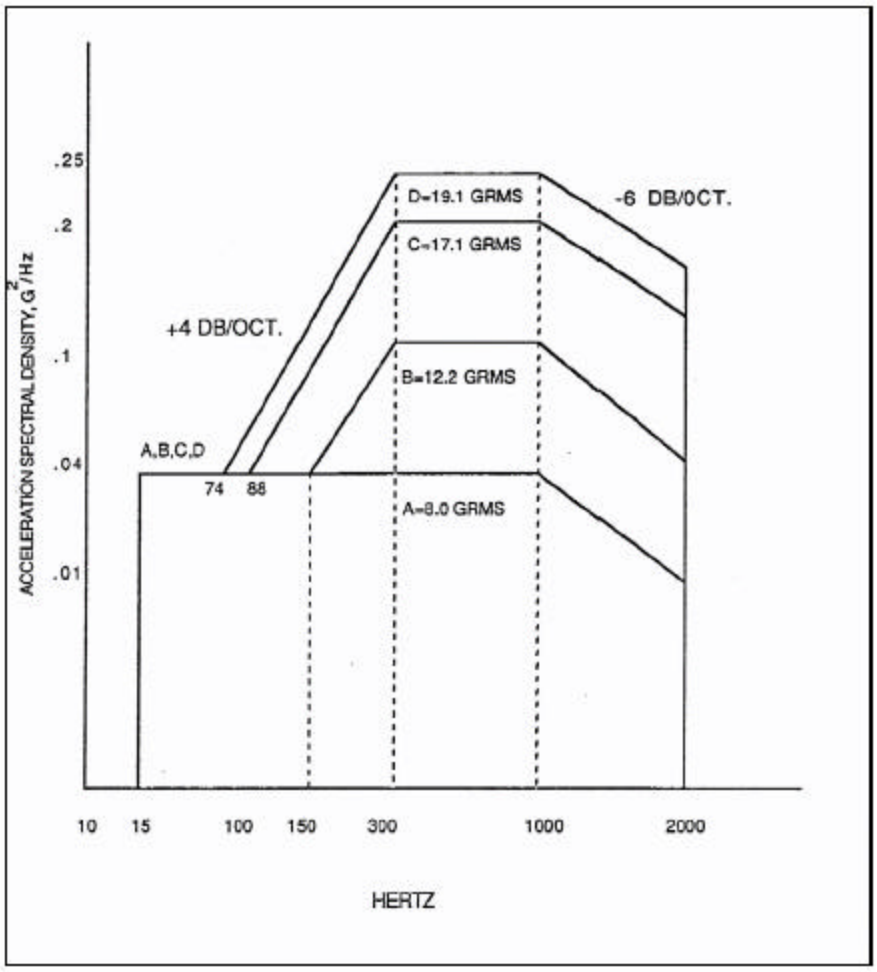


**Figure 1: Random Vibration Qualification Test Curves**

Curve selection Notes:

A: Use for test unit normally installed on vibration isolator but tested with rigid mounting, due to unavailability of isolator.

B: Use for test unit mounted in the DV, Adapter, or the CAC fuselage (if Curve "A" isn't otherwise applicable).

C: Use for test unit mounted in the CAC wings.

Note: This diagram is from the reference document DCP-O-018. Curve D is not applicable to the X-43C Program.

4.3.2 The test unit shall be tested with random vibration for a minimum of twenty minutes in each of its perpendicularly-mutual axes.

4.3.3 For test units that weigh over 80 pounds, the Contractor shall use the vibration level reduced by a factor as shown in Figure 2.

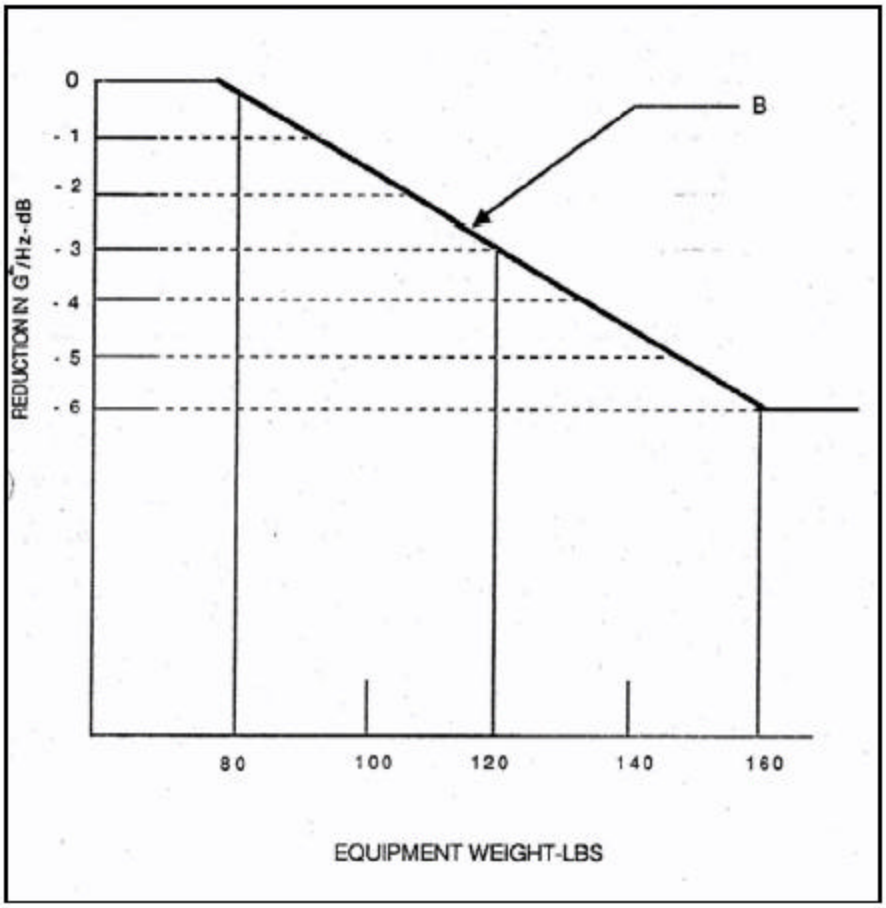


**Figure 2: Random Vibration Testing Reduction Factor for Mass Loading**

4.3.4 If the test unit is to be mounted in the DV or Adapter on vibration isolators, it shall be so mounted for the vibration test wherever possible. Where not possible, the test unit shall be tested in accordance with curve A of Fig. 1.

4.4 Shock

4.4.1 The shock load requirement for components and subsystems on the DV and Adapter shall include consideration for separation system shock effects and booster launch environment.

4.4.2 The booster launch environment is shown in Figure 3.

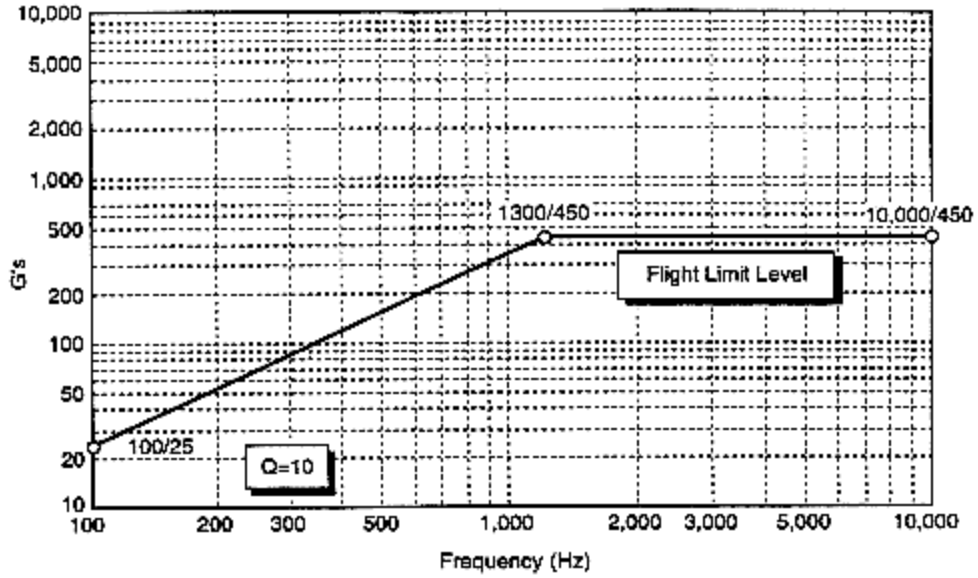


**Figure 3: Booster Launch Environment**
(Shock at the Payload interface excluding shock due to the Payload Separation System)

4.5 Steady-state Acceleration

4.5.1 The active components and subsystems installed within the DV and Adapter shall be capable of operating in an external ambient environment under steady-state load conditions encountered during Captive Carry through Engine Test Phases.

4.5.2 The Contractor shall determine the steady-state acceleration environment during Captive Carry through Engine Test Phases.

4.6 Electromagnetic Radiation

The DV and Adapter electrical systems shall be Electromagnetic Compatible (EMC) per MIL-STD-461 or equivalent.