# MAP VEM Damping Treatments
# Characterization of Damping/Stiffness Properties
# Test Plan

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## 1.0 Scope

Damping treatments have been added to the MAP spacecraft to reduce high acceleration levels measured during acoustic testing. The damping treatments consist of a visco-elastic material (VEM) with a constraint layer that has been bonded to the MAP spacecraft. These damping treatments will be subjected to thermal vacuum testing prior to launch. During thermal vacuum testing, the areas in which the damping treatments are located will experience temperatures of -76° C (predicted temperature). There is concern that cold temperatures during thermal-vac testing could cause a reduction in the damping capability of the damping treatment. This reduction could be due to a material property change or a disbond due to thermal stresses. There is currently limited data on how these damping treatments will perform after being subjected to cold temperatures to address this concern. The testing outlined in this plan will address this issue by measuring the mechanical properties of coupons representing the damping treatments applied to the MAP spacecraft before and after being subjected to cold temperatures which replicate the thermal-vac environment.

## 2.0 Test Objective

The objective of this testing effort is to determine if the damping treatments applied to the MAP spacecraft will experience a reduction in damping capability after being subjected to cold temperatures during spacecraft level thermal-vac testing. This will be accomplished by measuring the mechanical properties of test coupons before and after being subjected to cold temperatures. The data from this test will be used to assess whether thermal-vac testing would cause a change in the damping capability of the damping treatments applied to the spacecraft and to quantify the amount of that change.

## 3.0 Test Facility/Personnel

The testing will be conducted in the Code 541 test facilities located in Building 30. Test personnel include:

| | | |
|---|---|---|
| Test Conductor | Son Ngo/543 | x6-5504 |
| MAP Test Analyst | Scott Gordon/542 | x6-9940 |
| Test Facility Engineer | Mike Veins/541 | x6-2049 |
| MAP Quality Assurance (QA) Manager | Mike Jones/300 | x6-3198 |

## 4.0 Test Items

Two different damping treatments have been used on the MAP spacecraft. Therefore, two different coupon types will be utilized during this testing effort. A total of 12 coupons consisting of 6 test specimens of each type of damping treatment will be tested. Each type of damping coupon is described below.

### 4.1 Scotchdamp Coupons

There will be 6 coupons that replicate the damping treatments using the 3-M Scotchdamp material (ISD-242). Each of these coupons will be 6” long x 1” wide with an overall thickness of 0.244”. The coupon consists of two facesheets which are 0.12” thick made from M55J/934 material with a .004” core layer of the Scotchdamp material. The Scotchdamp coupon configuration is shown in Figure 1.

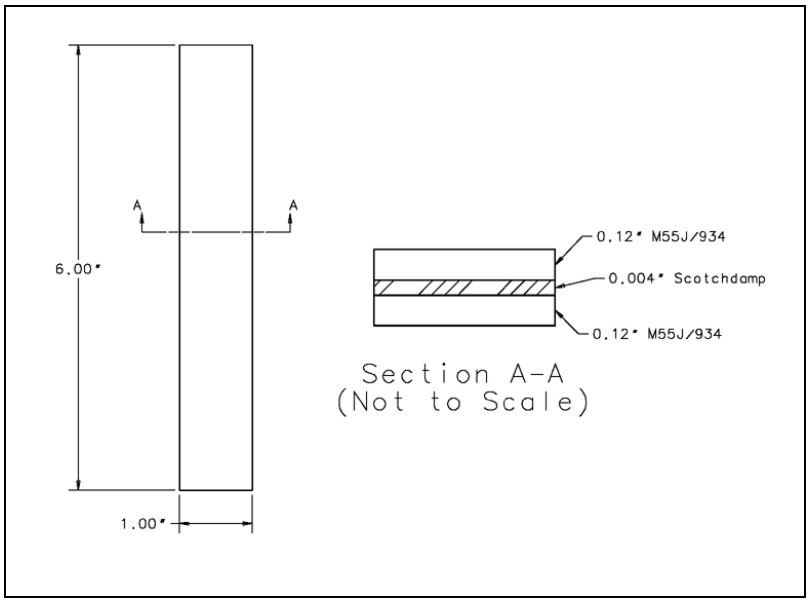


**Figure 1. Scotchdamp Coupon**

### 4.2 SMRD Coupons

There will be 6 coupons that replicate the damping treatments using the Lockheed-Martin SMRD material (100F-90). Each of these coupons will be 17" long and 1" wide with an overall thickness of 1.68". The coupon consists of a 1.28" thick constraint layer of honeycomb construction, a 0.4" SMRD layer, and a .015" SMRD facesheet layer. The SMRD coupon configuration is shown in Figure 2.

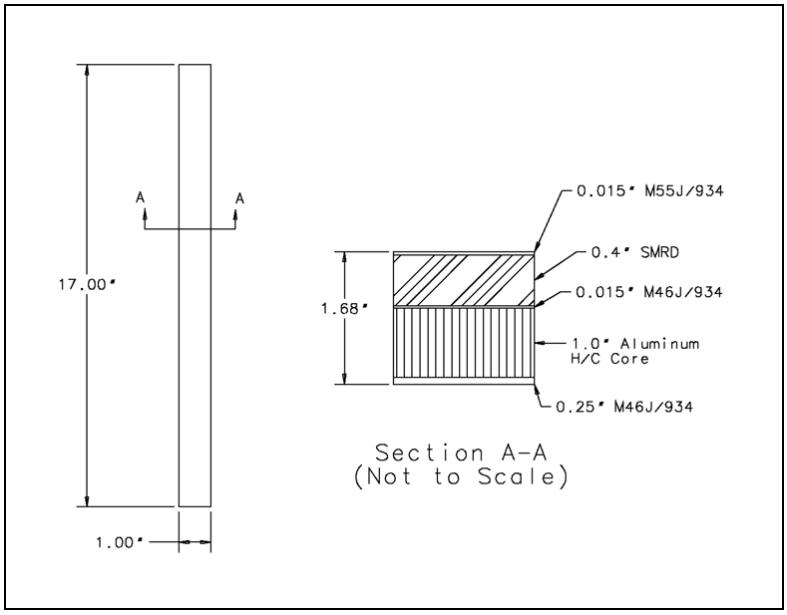


**Figure 2. SMRD Coupon**

## 5.0 Test Configuration

During the test, all of the test coupons will be subjected to a 3-point bend test to measure overall stiffness of the coupon. In addition, the Scotchdamp coupons will be subjected to a dynamic resonance test in which one end of the coupon is driven which the tip deflection is measured at the other end. This data will be used to measure the resonant frequency and damping factor of the Scotchdamp beam coupons. Each of the tests shown below will be performed before and after being subjected to a temperature of -86° C.

### 5.1 3-Point Bend Testing

Each of the beam specimens shall be installed into a 3-point bend fixture for testing. The testing will be performed using the Instron 1125 Universal Testing Machine. A load shall be applied to the top center of the coupon and the corresponding vertical deflection on the under-side of the coupon shall be measured by an LVDT. During testing, the force and deflection measurements shall be recorded at each load increment.

The bend test configuration for the SMRD coupons is different from the bend test configuration for the Scotchdamp coupons. Each test configuration has been optimized to produce a deflection that exceeds the curvature predicted for the flight damping treatments subjected to proto-flight loads but is well within the strength allowable for the test article. The details of each of the test configurations are provided in Table 1. Loading shall be applied to the test article to achieve the minimum deflection but shall not exceed either the maximum deflection or load specified in the table. The rate at which the load is applied shall not exceed 1 Hz.

**Table 1. 3-Point Bend Test Configurations**

| Coupon | Span Length (in) | Min Deflection (in) | Max Deflection (in) | Max Load (lbs) |
|---|---|---|---|---|
| SMRD | 16 | 0.0093 | 0.04 | 100 |
| | | | | |
| Scotchdamp | 4 | $5.79 \times 10^{-4}$ | 0.015 | 100 |

### 5.2 Scotchdamp Vibration Testing

In addition to the 3-point bend testing specified in the previous section, the Scotchdamp coupons will be subjected to a resonant vibration test. This testing will be performed on the Acoustic Spectrometer. The Scotchdamp coupon will be suspended in the test equipment and subjected to a frequency sweep until the fundamental resonance has been measured. The displacement of the coupon will be measured and recorded. The predicted fundamental resonance of the 6” Scotchdamp beam coupons in a free-free configuration is 1520 Hz.

## 6.0 Test Flow

The following sequence shall be followed during testing of the damping coupons:

1. Install SMRD coupon into 3-point bend test fixture using the span length specified in Table 1.

2. Apply load to coupon to achieve minimum center deflection as specified in Table 1.
3. Increase load until either maximum deflection or load has been achieved. Record force and deflection data.
4. Repeat procedure for remaining five (5) SMRD coupons
5. Install Scotchdamp coupon into 3-point bend test fixture using the span length specified in Table 1.
6. Apply load to coupon to achieve minimum center deflection as specified in Table 1.
7. Increase load until either maximum deflection or load has been achieved. Record force and deflection data.
8. Repeat procedure for remaining five (5) Scotchdamp coupons.
9. Install Scotchdamp coupon into the Acoustic Spectrometer.
10. Apply dynamic input as specified in Section 5.2. Record deflection and frequency data.
11. Repeat procedure for remaining five (5) Scotchdamp coupons.
12. Place coupons into Thermal Chamber and cool to a temperature of -86° C for a duration of 24 hours.
13. Repeat procedures 1 thru 11.

**7.0 Test Data**

Code 541 will record all data mentioned in this plan in order to verify the mechanical properties of the test coupons. The following data shall be provided by Code 541 after completion of the test:

1. Force vs. deflection curves for all 3-point bend tests.
2. Deflection vs. frequency plots for all vibration tests.
3. Resonant frequency and damping factor for each Scotchdamp coupon as measured before and after thermal cycling.

The above data shall be supplied in both hardcopy and electronic formats (ASCII data).

**8.0 Cleanliness**

An acceptable laboratory environment is sufficient.

**9.0 Test Safety**

All tests shall be conducted in accordance with the test facility's standard safety and environmental procedures with no undue risks or hazards to personnel or test item.