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NASA Engineering and Safety Center (NESC) Enhanced Melamine (ML) Foam Acoustic Test (NEMFAT)

Anne M. McNelis, William O. Hughes, and Mark E. McNelis
Glenn Research Center, Cleveland, Ohio

February 2014

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Acknowledgments

The NEMFAT team would like to thank the following contributors for their support:

- Dr. Curtis E. Larsen/Johnson Space Center (JSC), of the NESC, for funding and support of the NEMFAT task.
- Mr. Joseph M. Roche/GRC of the SLS Payload Fairing project for funding the final pretest preparation of the ML foam, and for his overall support.
- Mr. Thomas Pellegrino/Advanced Resources Inc., Mr. Thomas Burns/Soundcoat Company, and Ms. Carrie Cadd/Soundcoat Company for their advice on the selection and procurement of the ML foam material.
- The management and staff of the Riverbank Acoustical Laboratories (RAL) for their excellent test services and customer support, especially Mr. Eric Wolfram, Mr. Dean A. Victor, Mr. Marc P. Sciaky, and Ms. Kimberly A. Scarano.
- Mr. Noah H. Schiller/Langley Research Center (LaRC) for suggesting the use of the DuPont™ LoWave™ blanket material for future testing.
- Mr. Thomas M. Krivanek/GRC, Ms. Dawn C. Emerson/GRC, Mr. Noah H. Schiller/ LaRC, Mr. Steven J. Gentz/Marshall Space Flight Center (MSFC), and Mr. Timothy K. Brady/Kennedy Space Center (KSC) for their peer review of this report.

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December 12, 2013

Report Approval and Revision History

NOTE: This document was approved at the December 12, 2013, NRB. This document was submitted to the NESC Director on January 10, 2014, for configuration control.

Approved: *Original Signature on File* 1/13/14

NESC Director Date

Version	Description of Revision	Office of Primary Responsibility	Effective Date
1.0	Initial Release	Dr. Curtis E. Larsen, NASA Technical Fellow for Loads and Dynamics	12/12/13

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Technical Assessment Report

1.0 Notification and Authorization

Ms. Anne M. McNelis, Mr. William O. Hughes, and Mr. Mark E. McNelis of the NASA Glenn Research Center (GRC) requested NASA Engineering and Safety Center (NESC) funding and support to plan and perform an acoustic characterization test program of melamine (ML) foam. This request was made due to the increasing use of ML foam for payload fairing acoustic attenuation by the commercial launch vehicle industry and NASA's lack of available relevant acoustic test data for ML foam. Additionally, it was proposed to test enhanced (with voids) ML foam that had been analytically predicted to provide additional acoustic attenuation at low frequencies.

The motivation for the overall request was an identified need to reduce the acoustic interior levels for the Space Launch System (SLS) Payload Fairing. The proposed SLS configuration is predicted to be the most powerful launch vehicle ever flown, resulting in a need to attenuate the resulting extremely harsh acoustic environment.

The request was made to the NESC Loads and Dynamics Technical Discipline Team on December 21, 2012. Dr. Curtis E. Larsen, NASA Technical Fellow for Loads and Dynamics, agreed to fund the proposal on January 10, 2013, at the estimated cost of 0.25 full-time equivalent (FTE) and $15,000 for procurement. The original proposal is provided in Appendix A, and a breakdown of the expenditure costs is provided in Appendix B. The period of performance for this work was January through September 2013. The key stakeholders for this testing were the SLS Payload Fairing project and the NASA vibro-acoustic community.

The GRC engineers performing this task adopted the acronym NEMFAT (NESC Enhanced Melamine Foam Acoustic Test) for this work.

2.0 Signature Page

Submitted by:

Team Signature Page on File - 1/16/14

Mr. William O. Hughes Date

Significant Contributors:

Ms. Anne M. McNelis Date

Mr. Mark E. McNelis Date

Signatories declare the findings, observations, and NESC recommendations compiled in the report are factually based from data extracted from program/project documents, contractor reports, and open literature, and/or generated from independently conducted tests, analyses, and inspections.

3.0 Team List

Name	Discipline	Organization
Core Team		
Anne McNelis	Team Lead/Structural Dynamics	GRC
William Hughes	Structural Dynamics	GRC
Mark McNelis	Structural Dynamics	GRC
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Jonay Campbell	Technical Writer	LaRC/NG
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Evan Pineda	Structural Modeling	GRC
Richard Minter	Foam Sizing and Preparation	GRC
Randy Clapper	Design Drawings	GRC

3.1 Acknowledgements

The NEMFAT team would like to thank the following contributors for their support:

- Dr. Curtis E. Larsen/Johnson Space Center (JSC), of the NESC, for funding and support of the NEMFAT task.
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4.0 Executive Summary

Providing an acceptable acoustic environment to avoid damaging a payload during launch is critical to the success of the payload's mission. Acoustic attenuation systems normally are utilized within the payload fairing to aid in the attenuation of acoustic noise. In the past, attenuation systems consisting of fiberglass blankets have been utilized for this purpose. More recently, the launch vehicle industry is adopting the use of foam, particularly melamine (ML) foam, for this purpose.

The NASA Engineering and Safety Center (NESC) funded a proposal to achieve initial basic acoustic characterization of ML foam, which could serve as a starting point for a future, more comprehensive acoustic test program for ML foam. A project plan was developed and implemented to obtain acoustic test data for both normal and enhanced ML foam. This project became known as the NESC Enhanced Melamine Foam Acoustic Test (NEMFAT).

Because the NEMFAT project was limited to a budget of $15,000, consideration had to be given to balancing the cost of the foam materials with the cost of testing. Additional thought was given to balancing the simplicity of the foam configurations and interpretation of the test data versus testing a realistic flight-like acoustic attenuation system configuration.

The decision was ultimately made to purchase seven sheets of ML foam from the Soundcoat Company. Each sheet was 4 ft × 8 ft × 2 in. in dimension. Five sheets were "standard" density (0.562 lb/ft^3) gray melamine (ML) foam. One sheet was yellow ML "ultralight" (UL) foam, which has a lighter density (0.375 lb/ft^3) than the standard ML foam. One sheet was the "standard" density gray ML foam with an internal Sonic 5666 mass barrier (60 oz./yd^2) placed midway in the thickness. A representative fiber-reinforced foam (FRF) panel was utilized as the mounting base panel.

Enhancements were also made to two of the gray ML foam sheets. Voids and mass inclusions were investigated with these enhancements. These enhancement ideas were based in part on previous work [refs. 1 and 2] within the aerospace industry.

Acoustic testing was conducted at the Riverbank Acoustical Laboratories (RAL), located in Geneva, IL. RAL performed three absorption tests per the American Society for Testing and Materials (ASTM) C423 [ref. 3] and six transmission loss (TL) tests per ASTM E90 [ref. 4] for the NEMFAT project. The tests actually performed exceeded the test matrix scope laid out in the original proposal. The testing at RAL was performed on July 9–10, 2013.

The results of these tests are summarized in Section 7.0. Every individual ML foam sheet was 2 in. thick. The thicker 4-in. and 8-in. test configurations were assembled by layering the appropriate number and type of 2-in.-thick ML foam and ML UL foam sheets.

The absorption coefficients for both the 2-in. and the 4-in. thicknesses of ML foam were measured; the data showed that ML foam has a higher absorption over a broader and higher frequency range relative to previously tested 3-in.-thick fiberglass blankets. However, it should be noted that, unlike the fiberglass blanket, the ML foam test article did not include a cover sheet material, which could affect these absorption results. These results also showed that the absorption at low frequencies is improved by increasing the thickness of the ML foam.

The TLs were measured for (a) the 4-in. ML foam, (b) the 4-in. ML foam with a mass barrier, and (c) the 8-in. ML UL foam/ML foam combination with a mass barrier. It was found that ML foam augmented the TL of the baseline panel above 200 Hertz (Hz). The addition of the mass barrier provided additional TL performance, again above 200 Hz. Of the six NEMFAT test configurations, the 8-in.-thick combination of ML UL foam and ML foam with a mass barrier provided the greatest TL performance.

Limited testing was also performed by enhancing the ML foam using voids (for both the absorption and the TL tests) and mass inclusions (for the TL tests only). The acoustic performances of the enhanced ML foam and the normal ML foam were similar for the three enhanced configurations tested.

The NEMFAT project was successful in that it established an initial database of acoustic properties of ML foam. This database can be used as the baseline for future, more elaborate testing of ML foam. It is recommended that ML foam be considered in the development of acoustic attenuation systems for the Space Launch System (SLS) Payload Fairing project due to its improved acoustic performance and lighter mass relative to fiberglass blankets.

5.0 Assessment Plan

The NEMFAT task was performed according to the original task proposal, as defined in Appendix A. The exceptions to this plan were:

a) An absorption test of the bare panel was not performed due to lack of materials. The necessary surface area of the bare panel material was not available to properly conduct this test.
b) Additional tests were performed beyond those called out in the original task proposal. The original proposal called for three absorption tests and three TL tests. A total of three absorption tests and six TL tests were actually performed, providing additional test data and value beyond the scope of the original proposal.
c) Not all of the $15,000 of procurement money was needed for the NEMFAT testing. With the permission of Dr. Curtis Larsen, additional materials were purchased post-testing. The LoWave™ blanket materials purchased will be assessed in future testing. LoWave™ is a DuPont Company product that utilizes mass inclusions to tune an acoustic blanket for improvements in TL at specific frequencies.

6.0 Problem Description and Background

The SLS Payload Fairing is currently being developed at the Glenn Research Center (GRC). The fairing is expected to be exposed to an unprecedented high external acoustic environment during its liftoff phase due to the increased propulsion capability of the SLS, which has expanded beyond a typical launch vehicle design. Of particular concern for SLS are the predicted high acoustic levels occurring at low frequencies internal to the fairing.

Expendable launch vehicle (ELV) fairings typically utilize acoustic treatments (e.g., foam blankets, fiberglass blankets, and passive Helmholtz resonator devices) to reduce the acoustic energy that transmits through the fairing wall and into the payload region. The typical acoustic blanket treatments applied to launch vehicle fairings are effective in reducing the transmission of noise in the 400 Hz and higher frequency range. Something beyond the traditional and current state-of-the-art acoustic reduction methodologies will be required for SLS noise reduction, especially at lower frequencies (<400 Hz).

A similar situation occurred in the 1990's for the Cassini mission to Saturn, which required specialized acoustic treatments to address a radioisotope thermoelectric generator (RTG) vibration concern at 250 and 315 Hz. From an extensive and successful acoustic blanket development program performed for the Titan IV/Cassini mission, NASA accumulated a wealth of knowledge and acoustic characterization data on fiberglass blankets [refs. 5–7]. The Titan IV/Cassini Program evaluated 19 different fiberglass configurations of varying blanket thicknesses, blanket densities, and internal mass barriers with varying placement locations and densities, for a series of flat panel acoustic testing at the RAL in March and April 1994. The data were used to select the two most promising new blanket designs for full-scale acoustic testing at the Lockheed-Martin (Denver) reverberant acoustic chamber in January and

February 1995. As a result, a new fiberglass barrier blanket, denoted "V5," was chosen for implementation on the Titan IV/Cassini mission and flew in October 1997. This V5 fiberglass barrier blanket successfully reduced the acoustic environment to the Cassini spacecraft as needed [ref. 8].

Given the trend in industry today to use ML foam, it was deemed prudent to assemble a database of acoustic performance test data for ML foam, similar (albeit smaller) to what was achieved for the fiberglass blankets for the Titan IV/Cassini mission. The initial step for obtaining this database was the NEMFAT series of acoustic tests.

The technical objective of this NESC-funded NEMFAT task was to obtain relevant acoustic test data characterizing the acoustic performance of ML foam, both normal and enhanced. The data could then be used as a starting point for future acoustic test programs and to help baseline predictions for potential use of these systems.

7.0 Data Analysis

The NEMFAT test program consisted of three absorption tests and six TL tests performed at RAL on July 9–10, 2013. The Vibro-Acoustics (VA One) analysis software, sold by the ESI Group, was used by the GRC engineers to make pretest TL predictions. A summary of the weights and dimensions of the various test configurations as measured at RAL is given in Table 7.0-1.

The complete RAL test reports are provided in Appendices C and D for the absorption and the TL testing, respectively. RAL is accredited to perform sound absorption coefficient measurements and sound TL measurements for the one-third octave bands in the frequency range of 100 to 5,000 Hz. Additional unofficial representative test data are provided as a service to their customers at several extra one-third octave band frequencies, both at lower (40–80 Hz) and higher (6,300–10,000 Hz) frequencies than the ASTM standard frequencies.

Table 7.0-1. Weight Summary of Test Configurations

RAL Test Report #	Test Configuration Description	Panel Weight, lb	Treatment Weight, lb	Total Weight, lb	Overall Dimensions, in. (W × H × T)
Absorption Test					
A13-173	2-in. ML foam	No panel	6.0	6.0	96 × 96 × 2
A13-174	2-in. ML foam with voids	No panel	6.0	6.0	96 × 96 × 2
A13-175	4-in. ML foam	No panel	12.0	12.00	96 × 96 × 4
TL Test					
TL13-139	FRF panel	39.5	No treatment	39.5	47.75 × 95.75 × 1.08
TL13-140	FRF panel with 4-in. ML foam	39.5	6.0	45.5	47.75 × 95.75 × 5.08
TL13-141	FRF panel with 4-in. ML foam with voids	39.5	6.0	45.5	47.75 × 95.75 × 5.08
TL13-142	FRF panel with 4-in. ML foam with mass inclusions (in voids)	39.5	7.8 with mass inclusions	47.3	47.75 × 95.75 × 5.08
TL13-143	FRF panel with 4-in. ML foam with mass barrier	39.5	20.0 with mass barrier	59.5	47.75 × 95.75 × 5.08
TL13-144	FRF panel with 8-in. ML UL foam and ML foam combination with mass barrier	39.5	24.8 with mass barrier	64.3	47.75 × 95.75 × 8.08

The following sections describe the testing and data analysis performed for NEMFAT.

7.1 Absorption Testing

The choices for the absorption test configurations were based on the test concepts stated in the original proposal, as well as material limitations. For absorption testing, ATSM C423 recommends that the area of the test specimen be at least 60 ft^2 and recommends 72 ft^2. Since the foam sheets were each 4 ft × 8 ft (32 ft^2), an area of 64 ft^2 was achievable by placing two foam sheets next to each other. However, lack of sufficient physical materials prevented this from being possible in all cases; for example, a total of only 32 ft^2 was available for the ML UL foam, the ML foam with a mass barrier, and for the FRF base panel. Therefore, no absorption testing could be performed for these items. What was achievable and actually tested were the following three foam configurations, as illustrated in Figure 7.1-1.

- A13-173 – 2-in. ML foam
- A13-174 – 2-in. ML foam with voids
- A13-175 – 4-in. ML foam

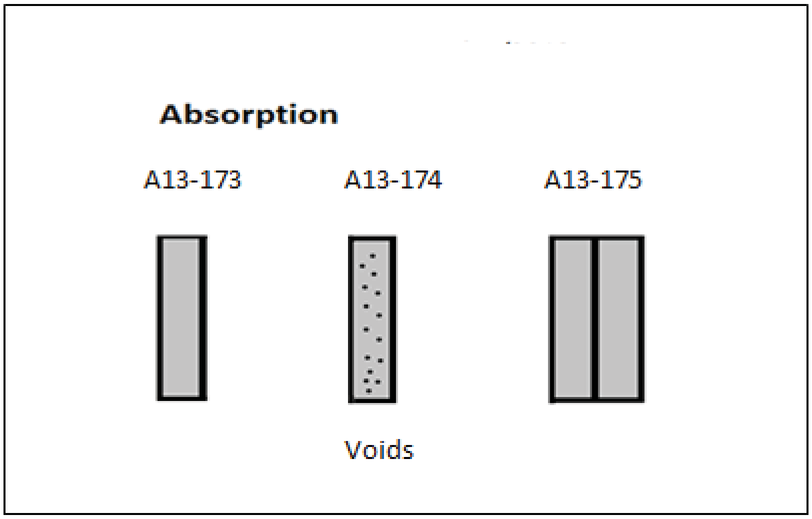

Figure 7.1-1. Cross-sectional Views of NEMFAT Absorption Test Configurations

This testing allowed an analysis of the effect of thickness on absorption (i.e., a comparison of 2-in. versus 4-in.-thick ML foam), and also allowed a comparison of ML foam with and without the voids. A typical absorption test setup at RAL is shown in Figure 7.1-2. The actual absorption test reports from RAL are provided in Appendix C.

In Figure 7.1-3, a plot of the measured absorption coefficient (Sabine absorption) is shown versus frequency for the three configurations tested. The thicker foam (4 in.; A13-175) is a much more effective absorber at lower frequencies compared with the thinner foam (2 in.; A13-173). This trend is expected from theory and also agrees with previous test data obtained from the Cassini fiberglass blanket testing. Note that the Sabine absorption coefficient can exceed a value of 1.0 due to edge diffraction effects and to the Sabine formulation itself [ref. 9].

An enhancement was made to two of the gray ML foam sheets. The enhancement was to introduce 18 voids (or holes), each with a 0.25-in. diameter, through the foam thickness direction, in a random pattern for each sheet. It can also be seen in Figure 7.1-3 that the presence of the voids in the ML foam (A13-174) had no significant effect on the absorption of the ML foam compared with the unaltered ML foam (A13-173) of the same thickness. Further study is needed to reach any firm conclusion since only one enhanced void variation was tested.

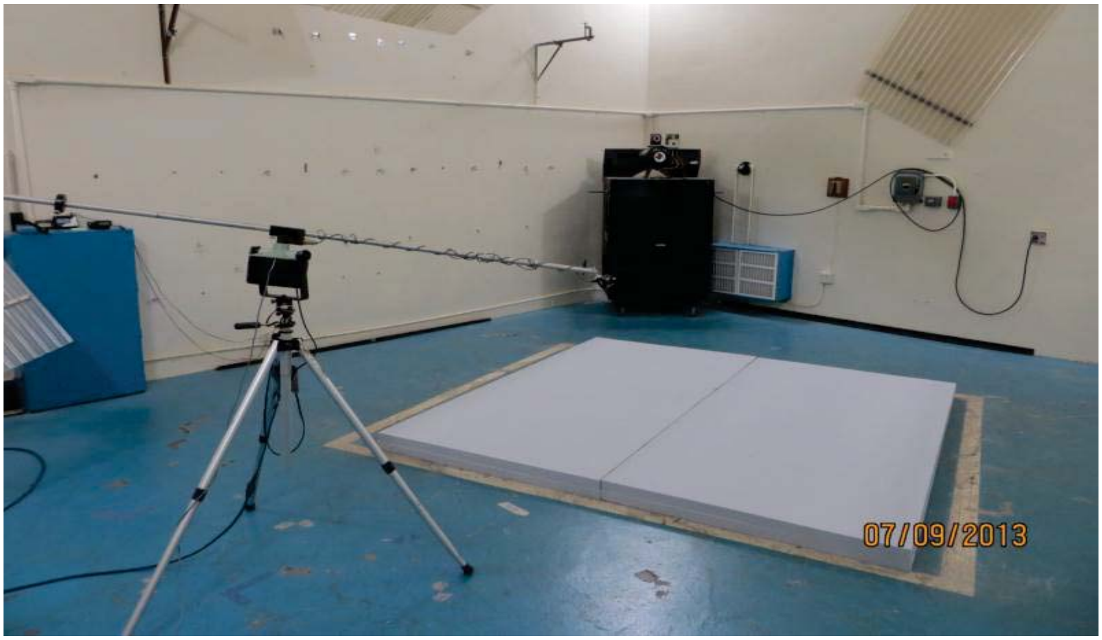

Figure 7.1-2. RAL's Absorption Test Setup
(4-in.-thick ML foam, ASTM-C423 Reverberation Room Method)

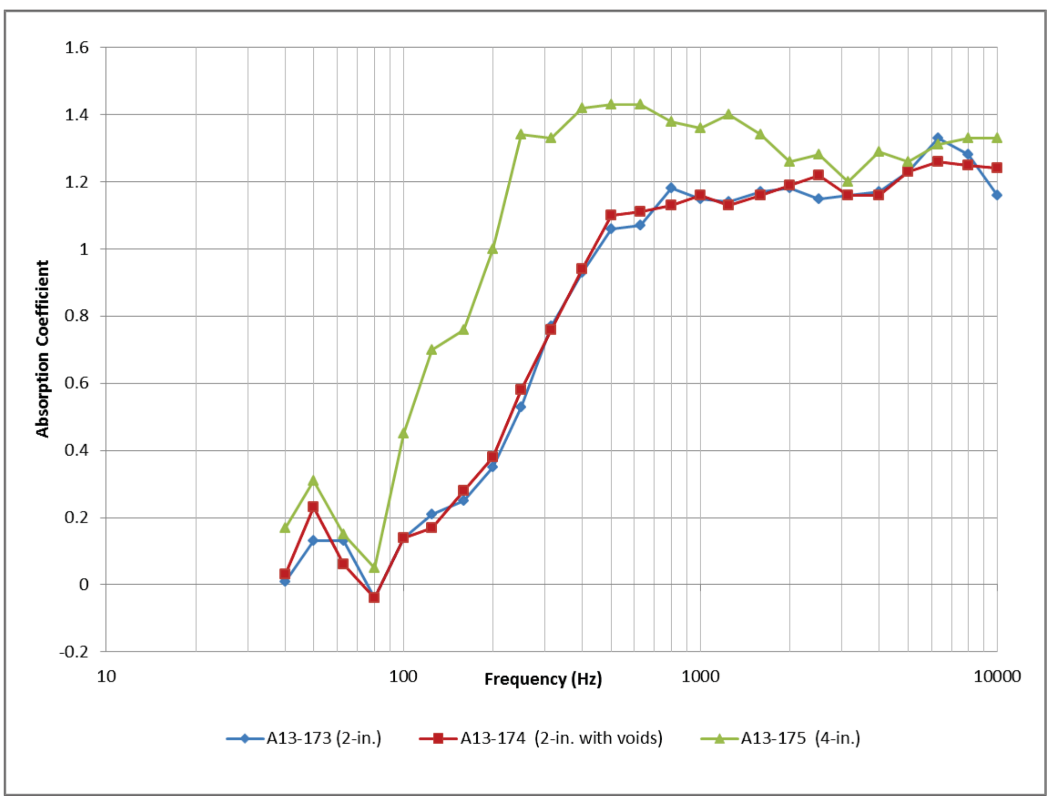

Figure 7.1-3. NEMFAT Absorption Test Results

The 2-in. (A13-173) and 4-in. (A13-175) thick ML foam absorption data are compared in Figure 7.1-4 with the absorption data from the 3-in.-thick fiberglass "baseline" blanket (from the 1994 Titan IV/Cassini testing; A94-72). From this comparison, it appears that the ML foam has a higher peak magnitude of absorption relative to the fiberglass blanket and that the ML foam has a much greater frequency range of effectiveness relative to the fiberglass. However, note that the ML foam tests had no cover sheet material for the NEMFAT testing, whereas the fiberglass blanket was encased in a Mylar bag, which could be the cause of the decline in absorption after reaching the peak absorption value. Further testing of ML foam with a cover sheet is required to determine those effects.

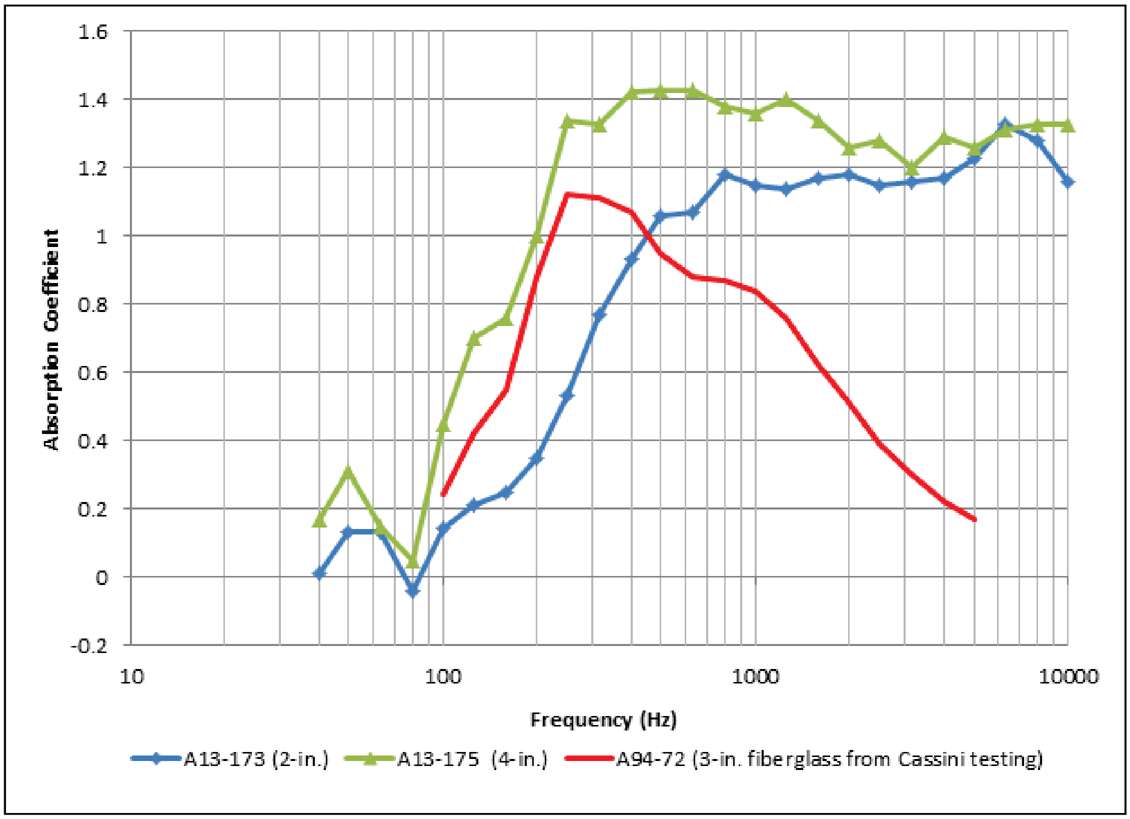

Figure 7.1-4. Comparison of Absorption Coefficients for Melamine Foam versus Fiberglass (Note: the tested ML foam treatments did not have cover sheets)

7.2 Transmission Loss Testing

The choice for the TL test configurations was based first on the test concepts stated in the original proposal and secondly on obtaining additional relevant knowledge. Since the RAL test specimen window between the source and receiver rooms was 8 ft × 4 ft, only one foam sheet of that size was needed for testing. This allowed TL testing of both the ML foam with the mass barrier, and a complex, thicker buildup of materials combining the ML UL foam, the ML foam, and the ML foam with the barrier. The six TL tests performed, as shown in Figure 7.2-1, were as follows:

- TL13-139 – FRF panel
- TL13-140 – FRF panel with 4-in. ML foam
- TL13-141 – FRF panel with 4-in. ML foam with voids
- TL13-142 – FRF panel with 4-in. ML foam with mass inclusions (in voids)
- TL13-143 – FRF panel with 4-in. ML foam with a mass barrier
- TL13-144 – FRF panel with 8-in. total foam thickness: ML UL foam (2 in.) and ML foam (6 in.) combination with a mass barrier

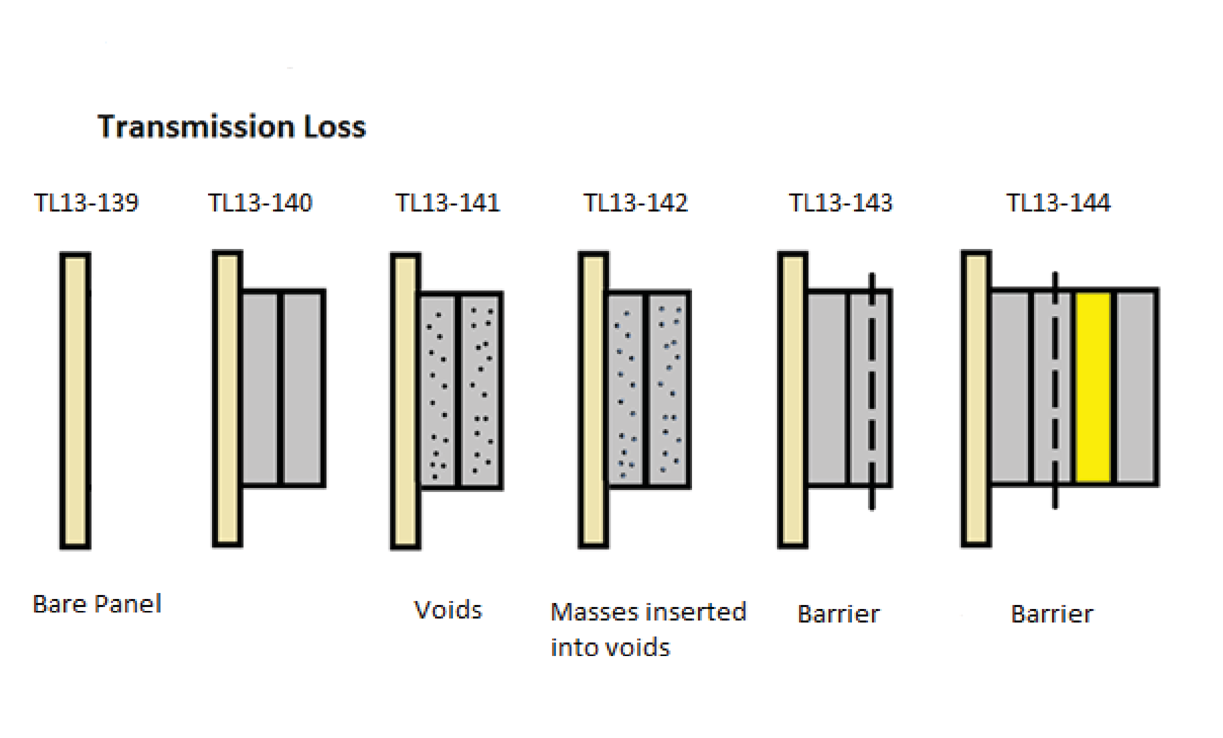

Figure 7.2-1. Cross-sectional Views of NEMFAT TL Test Configurations

These test configurations allowed for multiple acoustic TL performance comparisons, including (a) bare panel versus treated panel, (b) normal ML foam versus enhanced (i.e., voids and mass inclusions) ML foam, (c) the effect of the Sonic 5666 mass barrier (<0.06 in. thickness), and (d) the effect of complex buildup of materials.

A typical TL test setup at RAL is shown in Figure 7.2-2. The actual TL test reports from RAL are provided in Appendix D.

Left, Transmission Loss Receiver Room (4-in. ML foam with mass inclusions shown in test window)

Right, Transmission Loss Source Room (FRF panel shown in test window)

Figure 7.2-2. RAL's TL Test Setup for TL13-142 (ASTM E-90 Airborne Sound TL for Building Partitions and Elements Method)

The TL plots for the six NEMFAT test configurations are shown in Figure 7.2-3. The bare untreated FRF panel (TL13-139), with a weight of 39.5 lb, provides a nominal TL reduction, reaching a peak of 28 decibels (dB) at 4,000 Hz (and at 3,150 Hz). The addition of 4 in. of ML foam (by using two 2-in. ML foam sheets) to the FRF panel (a total weight of 45.5 lb for panel and treatment) substantially increases the TL (TL13-140), reaching 51 dB, respectively, at 4,000 Hz. This 23-dB improvement in TL at 4,000 Hz is significantly greater than the 1–2 dB that could be attributed to the TL increase due only to the mass law.

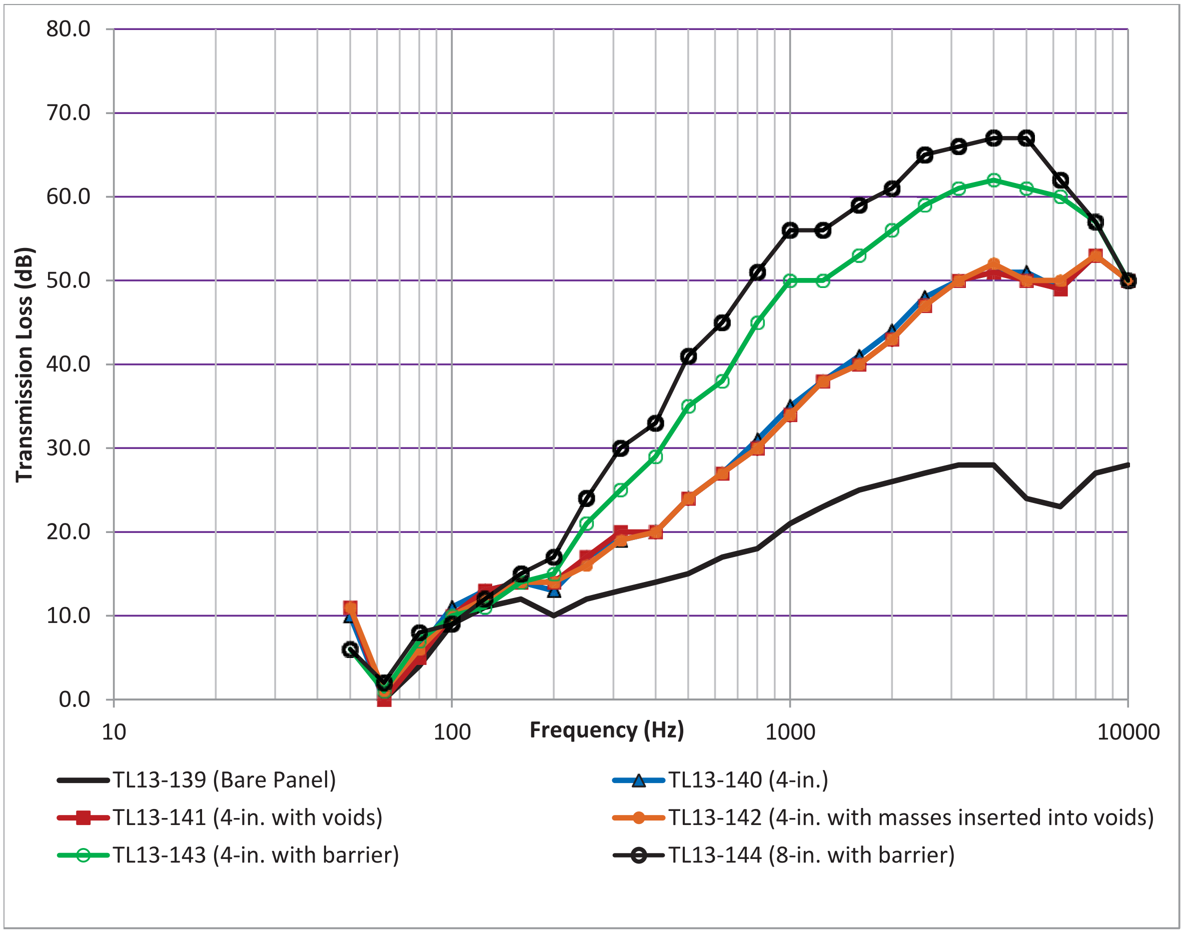

Figure 7.2-3. NEMFAT TL Test Results

Enhancements were made to two of the gray ML foam sheets. The enhancement was to introduce 18 voids (or holes), each with a 0.25-in. diameter, through the foam thickness direction, in a random pattern for each sheet. The second enhancement was to later fill these voids with serrated hex flange bolts representing mass inclusions. The added weight of the 36 bolts was 1.8 lb.

There was no measured improvement (or worsening) in the TL due to the voids and the mass inclusion enhancements. This is shown by the overlapping of the TL data measurements for the tests of the 4-in. ML foam (TL13-140), the 4-in. ML foam with voids (TL13-141), and the 4-in. ML foam with mass inclusions (TL13-142) configurations. This observation was disappointing in that both the literature [refs. 1 and 2] and the pretest VA One TL analysis with voids enhancement predicted an observable increase in TL for the enhanced ML foam. Further efforts are necessary to understand the controlling parameters to physically realize this possible improvement. The NEMFAT task funding did not allow for testing of multiple enhancements with varying parameters, such as void size and number of voids.

The next TL test (TL13-143) added a mass barrier to 4 in. of ML foam (total weight of 59.5 lb, including both panel and treatment). This configuration was a 2-in. ML foam sheet layered with another 2-in. ML foam sheet with the mass barrier in its center, as shown in Figure 7.2-4. Compared with the normal 4-in. ML foam (TL13-140), the foam/mass barrier configuration was significantly better in resisting sound transmission. For example, at 4,000 Hz the TL was 61 dB, a 10-dB improvement over the same ML foam thickness without the mass barrier, and an improvement of 33 dB over the bare FRF panel.

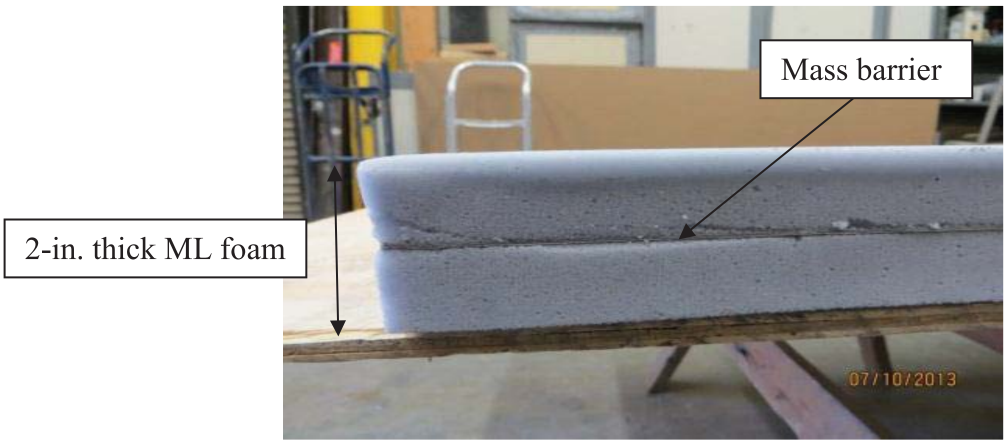

Figure 7.2-4. 2-in.-thick ML Foam Sheet with Mass Barrier at its Center

With one remaining TL test to be performed, it was decided to test a complex foam treatment configuration (TL13-144). This configuration started with the previously described 4-in. ML foam sheet with mass barrier configuration and then added a 2-in.-thick sheet of ML UL foam and a 2-in.-thick sheet of ML foam. This resulted in an 8-in.-thick treatment (with a total weight of 64.3 lb for both the panel and the treatment), as shown in Figure 7.2-5. Not surprisingly, this treatment provided the best TL of the NEMFAT treatment configurations tested. At 4,000 Hz, the TL was 67 dB, a 6-dB improvement over the 4-in. with the mass barrier treatment (TL13-143) and a 39-dB improvement over the bare FRF panel (TL13-139).

As can be seen in Figure 7.2-3, the improvements in TL for each of the foam treatments are most evident above 200 Hz. Below 100 Hz, the measured TL test data seemed to converge for all configurations tested.

Figure 7.2-5. 8-in.-thick Combination Foam Treatment (TL13-144) (top to bottom layers: FRF panel, 2-in. ML foam, 2-in. ML foam with center mass barrier, 2-in. ML UL foam, 2-in. ML foam)

In Figure 7.2-6, a comparison is shown of pretest analytical predictions of TL for (a) 4-in. ML foam with mass barrier and (b) the 8-in. complex foam treatment with the associated RAL TL test data (TL13-143 and TL13-144, respectively). For both cases, the VA One prediction is quite good up to 1,000 Hz. Above this frequency, the predicted TL continues to increase, whereas the measured TL data tend to plateau. Understanding why the analysis does not predict better and improving the comparison above 1,000 Hz will be areas of further study.

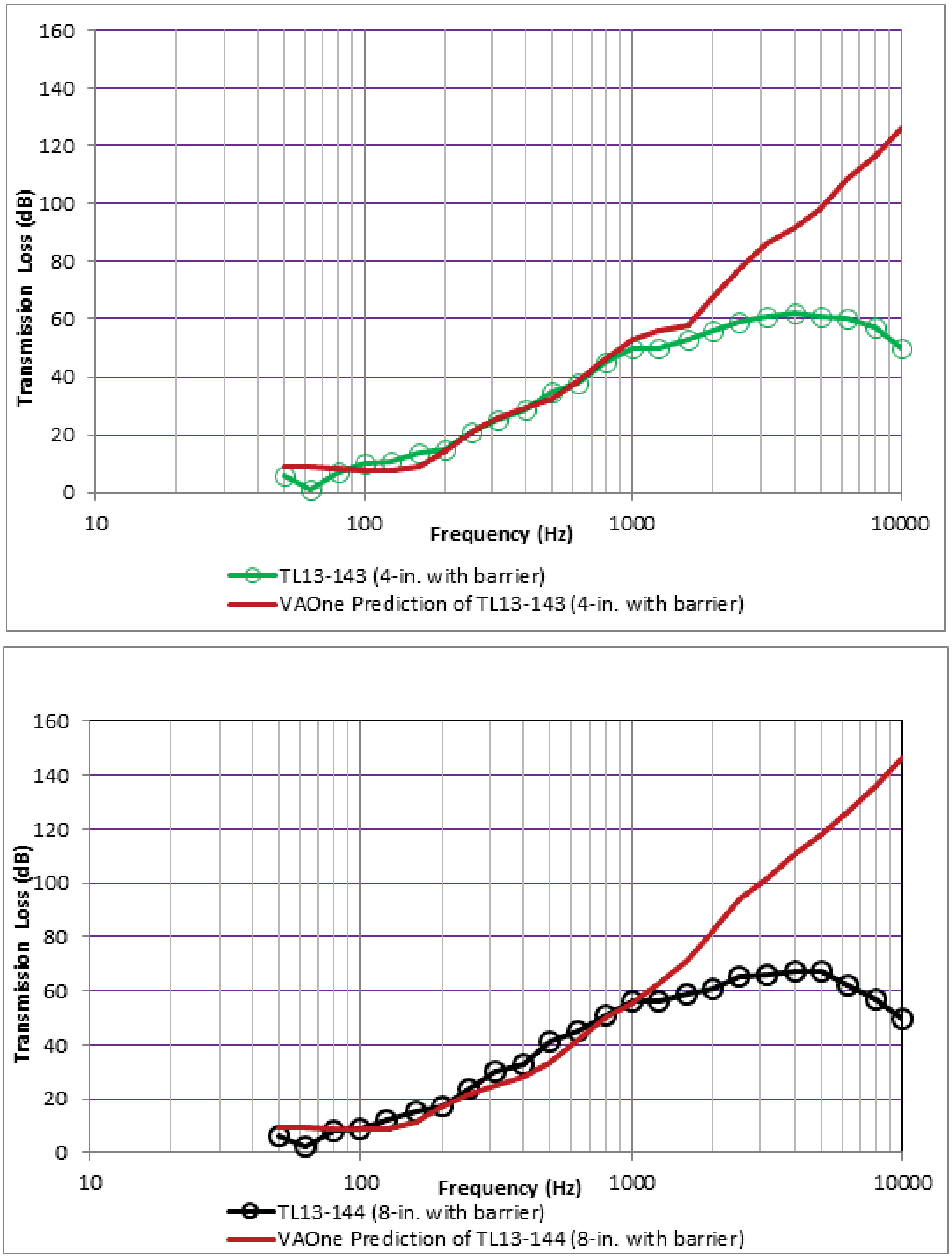

Figure 7.2-6. TL Comparison of RAL Test Data and VA One Pretest Predictions (top: 4-in. ML foam with mass barrier (TL13-143); bottom: 8-in. combination foam treatment (TL13-144))

8.0 Findings, Observations, and NESC Recommendations

8.1 Findings

The following findings were identified:

Absorption

F-1. The acoustic absorption of ML foam (without a cover sheet) is superior relative to the fiberglass (with a cover sheet) absorption because it offers a higher absorption coefficient over a wider frequency range.

F-2. The effective frequency range for absorption of ML foam (without a cover sheet) is shifted to lower frequencies by increasing the thickness of ML foam.

F-3. The peak magnitude absorption value for ML foam (without a cover sheet) is greater than the Titan IV fiberglass blanket (with a cover sheet).

F-4. The absorption of ML foam (without a cover sheet) did not fall off above 300 Hz, unlike the absorption of the Titan IV fiberglass blanket (with a cover sheet).

F-5. The enhancements (i.e., addition of voids) to the ML foam that were tested did not improve or worsen the absorption characteristics of the ML foam.

Transmission Loss

F-6. The TL for the ML foam on the panel was significantly greater than the TL of the bare panel.

F-7. The addition of a mass barrier to the ML foam treatment further increased the TL.

F-8. The TL for a thicker ML foam treatment with a mass barrier was greater than the TL for thinner ML foam with the same mass barrier.

F-9. Of the six configurations tested for TL, the best TL performance was for the combination 8-in. foam treatment (6-in.-thick ML foam and 2-in.-thick ML UL foam combined with a mass barrier).

F-10. The pretest VA One analytical predictions for TL matched well with test data up to 1,000 Hz; however, the analytical predictions diverge and overpredict TL above 1,000 Hz.

F-11. The enhancements (i.e., the addition of voids and the addition of mass inclusions) to the ML foam test configurations did not improve or worsen the TL characteristics.

8.2 Observations

The following observations were noted:

O-1. The RAL test facility is fully capable to properly perform the required testing per the ASTM standards (ASTM C423 for absorption and ASTM E90 for TL).

O-2. In order to "test like you fly," it was necessary to reverse the source and receiver rooms at RAL from their normal room configuration. This was done without any technical impact.

O-3. The ML foam acoustic treatments tested were lighter in weight than traditional acoustic fiberglass blankets.

O-4. The mass barriers tested with the ML foam acoustic treatments were similar in weight to mass barriers utilized for acoustic fiberglass barrier blankets.

O-5. The inability to accurately model, in VA One, the TL beyond 1,000 Hz is an area of concern for modeling of the composite FRF panel with foam acoustic treatments.

O-6. Acoustic testing of a representative panel with acoustic treatments can be useful in identifying leading candidates of acoustic treatments.

8.3 NESC Recommendations

The following NESC recommendations are directed to the SLS Payload Fairing project:

R-1. Consider utilization of ML foam in the development of acoustic attenuation systems for the SLS Payload Fairing project due to the ML foam's improved acoustic performance and lighter mass relative to fiberglass blankets. ***(F-1, F-2, F-3, F-6, O-3)***

R-2. Conduct a more comprehensive acoustic test program, to include investigation of the effects of cover sheets and attachment methods, thickness, density, mass barrier location and density, voids and mass inclusions, standoffs, and percent blanket coverage. ***(F-4, F-5, F-7, F-8, F-9, F-11)***

R-3. Evaluate the acoustic characteristics of the DuPont™ LoWave™ acoustic blanket. ***(F-5, F-11)***

R-4. Investigate the VA One modeling concerns of composite panels with foam acoustic treatments for TL predictions greater than 1,000 Hz. ***(F-10, O-5)***

R-5. Conduct full-scale cylindrical acoustic testing of representative SLS Payload Fairing configurations using the best acoustic treatment candidate(s) from the NEMFAT and from future panel testing. Panel test configurations do not account for the cylinder's structural stiffness or its acoustic cavity. ***(F-1, F-6, O-3, O-6)***

R-6. Investigate the potential structural issues or other concerns that need to be resolved before implementing proposed thicker and/or heavier acoustic treatments for the SLS Payload Fairing project. ***(F-9, O-6)***

9.0 Alternate Viewpoint

There were no alternate viewpoints identified during the course of this assessment by the NESC team or the NRB quorum.

10.0 Other Deliverables

The test data, models, and report generated from this NEMFAT work were electronically transferred to the GRC SLS Payload Fairing project in support of future SLS Payload Fairing acoustic attenuation system designs and analyses.

11.0 Lessons Learned

No applicable lessons learned were identified for entry into the NASA Lessons Learned Information System (LLIS) as a result of this assessment.

12.0 Recommendations for NASA Standards and Specifications

No recommendations for NASA standards and specifications were identified as a result of this assessment.

13.0 Definition of Terms

Absorption	The loss of acoustical energy by a sound wave while traveling through a fluid or solid medium.
Absorption Coefficient	The dimensionless ratio of sound energy absorbed by a given surface to that incident upon the surface, often denoted as α.
Barrier	A material inserted internally in an acoustic treatment whose purpose is to block the direct path of sound energy.
Corrective Actions	Changes to design processes, work instructions, workmanship practices, training, inspections, tests, procedures, specifications, drawings, tools, equipment, facilities, resources, or material that result in preventing, minimizing, or limiting the potential for recurrence of a problem.
Decibel	Dimensionless unit (abbreviated as dB) that expresses the ratio of two powers, such as acoustical power. The number of decibels is 10 times the logarithm to the base 10 of the power ratio.
Finding	A relevant factual conclusion and/or issue that is within the assessment scope and that the team has rigorously based on data from their independent analyses, tests, inspections, and/or reviews of technical documentation.
Hertz	Unit of frequency, defined as number of cycles per second of a periodic waveform (abbreviated as Hz).
Lessons Learned	Knowledge, understanding, or conclusive insight gained by experience that may benefit other current or future NASA programs and projects. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure.

Mass Law	An approximate relationship that describes the sound TL of a solid panel in terms of mass density and frequency. For normal incidence, the mass law predicts a 6-dB increase in TL for every doubling of the panel weight (or for every doubling of frequency) up to a plateau frequency.
Observation	A noteworthy fact, issue, and/or risk, which may not be directly within the assessment scope, but could generate a separate issue or concern if not addressed. Alternatively, an observation can be a positive acknowledgement of a Center/Program/Project/Organization's operational structure, tools, and/or support provided.
One-Third Octave Band (OTOB)	Frequency band where the ratio of the frequency of the upper band limit to the frequency of the lower band limit is $2^{1/3}$ (1.26). There are three OTOBs in one octave band.
Panel	The baseline or core material wall on which further acoustic treatments may be mounted. The panel may represent the payload fairing wall structure for example.
Problem	The subject of the independent technical assessment.
Proximate Cause	The event(s) that occurred, including any condition(s) that existed immediately before the undesired outcome, directly resulted in its occurrence and, if eliminated or modified, would have prevented the undesired outcome.
Recommendation	A proposed measurable stakeholder action directly supported by specific Finding(s) and/or Observation(s) that will correct or mitigate an identified issue or risk.
Reverberation Room	A room designed so that the sound field closely approximates a diffuse sound field. Typically, the room's surfaces are highly reflective, resulting in a long reverberation time.
Root Cause	One of multiple factors (events, conditions, or organizational factors) that contributed to or created the proximate cause and subsequent undesired outcome and, if eliminated or modified, would have prevented the undesired outcome. Typically, multiple root causes contribute to an undesired outcome.

Sound Pressure Level	The logarithmic ratio, abbreviated as SPL and expressed in dB, of the mean square sound pressure (p) to the reference mean square pressure (p_{ref}). By convention, the reference pressure (p_{ref}) is often selected as the threshold of hearing, or 20 µ Pascals (rms). $SPL = 10\ \log_{10}\left(\frac{p}{p_{ref}}\right)^2 = 20\ \log_{10}\left(\frac{p}{p_{ref}}\right)$
Transmission Loss	The logarithmic ratio, abbreviated as TL and expressed in decibels, of the sound power incident (W_i) on the surface of a partition to the sound power transmitted (W_T) on the other side. $TL = 10\ \log_{10}\left(\frac{W_i}{W_T}\right)$
VA One	Vibro-acoustics modeling and analysis software sold by ESI Group.

14.0 Acronym List

ASTM	American Society for Testing and Materials
dB	decibel
ELV	Expendable Launch Vehicle
FRF	Fiber Reinforced Foam
FTE	Full Time Equivalent
GRC	Glenn Research Center
Hz	Hertz (unit of frequency)
JSC	Johnson Space Center
KSC	Kennedy Space Center
LaRC	Langley Research Center
ML	Melamine (foam)
MSFC	Marshall Space Flight Center
NEMFAT	NESC Enhanced Melamine Foam Acoustic Testing
NG	Northrop Grumman Corporation
NESC	NASA Engineering and Safety Center
OTOB	One-Third Octave Band
RAL	Riverbank Acoustical Laboratories
RTG	Radioisotope Thermoelectric Generators
SGT	Stinger Ghaffarian Technologies, Inc.
SLS	Space Launch System
SPL	Sound Pressure Level
TL	Transmission Loss
UL	Ultralight (melamine foam)
VA One	Vibro-Acoustics One

15.0 References

1. Gardner, B., Burkewitz, B., Bremner, P., Fuller, C., and Atalla, N., "Advanced Acoustic Blanket Concepts for Payload Fairings," Spacecraft and Launch Vehicle Dynamic Environments Workshop, June 2002.
2. Kidner, M., Fuller, C., and Gardner, B., "Increase in Transmission Loss of Single Panels by Addition of Mass Inclusions to a Poro-elastic Layer: Experimental Investigation," March 2005.
3. American Society for Testing and Materials, "Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method," ASTM C423-09a, October 15, 2009.
4. American Society for Testing and Materials, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements," ASTM E90-09, July 1, 2009.
5. Hughes, W. O. and McNelis, A. M., "Cassini/Titan IV Acoustic Blanket Development and Testing," NASA-TM-107266, July 1996.
6. Hughes, W. O. and McNelis, A. M., "Acoustic Testing of the Cassini Spacecraft and Titan IV Payload Fairing, Part 1 – Introduction and Test Configuration," NASA-TM-107474, July 1997.
7. Hughes, W. O. and McNelis, A. M., "Acoustic Testing of the Cassini Spacecraft and Titan IV Payload Fairing, Part 1 – Results," NASA-TM-107475, July 1997.
8. Hughes, W. O., McNelis, A. M., and Himelblau, H., "Investigation of Acoustic Fields for the Cassini Spacecraft: Reverberant Versus Launch Environments," NASA-TM-2000-209387, September 2000.
9. Cox, T. J. and D'Antonio, P., *Acoustic Absorbers and Diffusers,* Taylor & Francis, New York, 2004.

16.0 Appendices

Appendix A. Proposal for NESC Discipline Enhancing Work
Appendix B. Expenditure Cost Breakdown
Appendix C. RAL Absorption Test Reports
Appendix D. RAL TL Test Reports

Appendix A. Proposal for NESC Discipline Enhancing Work

Title: Acoustic Test of an Enhanced Melamine Foam Acoustic Treatment

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William Hughes/NASA GRC DEV/216-433-2597/William.O.Hughes@nasa.gov
Mark E. McNelis/NASA GRC DEV/216-433-8395/ Mark.E.McNelis@nasa.gov

Background: The Space Launch System (SLS) vehicle has an unprecedented high external acoustic liftoff level. This in turn produces an internal fairing acoustic noise level detrimental to payload development especially in the 20 Hz – 400 Hz frequency range. Typically an acoustic blanket without special design consideration is not effective in this lower frequency range.

When compared to the typical Expendable Launch Vehicle (ELV) internal overall sound pressure level, the SLS fairing internal acoustic level may be as much as 10 dB higher. This acoustic problem has been studied for various vehicle fairing acoustic analyses. Previously flown flight blankets (barrier/fiberglass design acoustic blankets used for the Titan IV/Cassini mission) have been analytically used to lower the predicted internal noise level.

A newly defined acoustic treatment design, with enhanced melamine foam, has recently been analyzed using the VA ONE acoustic software. Preliminary assessment of this work shows potential for increased acoustic noise reduction in the 20 Hz – 400 Hz frequency range compared with traditional acoustic blanket designs. Furthermore this melamine foam is simple to implement, and is estimated to be 1/3 of the weight and ½ the cost of the Titan IV/Cassini acoustic blanket.

Task Description: It is proposed that this enhanced melamine foam acoustic treatment design be analytically optimized, and assembled and tested at a transmission loss (TL) and absorption acoustic facility to determine its noise lowering benefits for possible use in the SLS fairing.

The (approximate 4 ft x 8 ft) melamine foam treatments could be assembled at the NASA Glenn Research Center (GRC) with purchased materials. Pretest analysis, testing and post-test correlation would be performed and documented. Preferably an SLS Fairing Project-provided composite panel would be utilized as the baseline for this testing, with the backup plan being a previously tested composite panel from GRC. It is proposed that three (3) configurations be tested for both TL and absorption to assess the performance of the acoustic treatment. These three configurations are bare panel (no treatment), melamine foam with panel, and enhanced melamine foam with panel. The TL and absorption data acquired will provide data verifying the acoustic performance of the acoustic treatments, and can be compared with similar data from traditional and enhanced (Titan IV/Cassini) acoustic blankets. This data would also provide parameters for acoustic model correlation thereby advancing the SLS Fairing's structural acoustic optimization.

It is recommended that testing be performed at an accredited two-reverberant-room sound facility capable of performing both ASTM E-90 (transmission loss) and ASTM-C423 (absorption) testing. GRC has had good acoustic test experiences with both the Riverbank Acoustical Laboratories (Geneva, IL) and Owens Corning's Acoustic Laboratory (Granville, OH).

Deliverables: An official NASA report will be written that documents the testing performed, and the resulting TL and absorption test data from the three test panel configurations. This report will also contain the VA ONE acoustic models for the tested panels and the comparison of the VA ONE predictions with the panel test data. A summary of the highlights of this work could also be presented at a NESC webinar (or meeting if travel costs are provided).

Required Resources: In order to analyze, test and document the results of the performance of the melamine foam acoustic treatments the following resources are required:

0.25 FTE: Includes pretest analysis, optimization of enhanced melamine foam blanket treatment, procurement and assembly of test hardware, support of test, post–test correlation, and report documentation.

$15K of Procurement Costs: Includes test costs ($7.5K), material costs ($2.5K), shipping ($1K), travel ($2.5 K), miscellaneous/material assembly ($1.5K).

Appendix B. Expenditure Cost Breakdown

Original cost budget = $15,000.00
Expenditures = $14,922.57
(99.5% of budget was spent)

Materials		$
	Melamine Foam	1886.06
	Miscellaneous Materials	159.86
	LoWave™ Blankets (purchased after NEMFAT testing)	2440.00
	Materials Total	4,485.92
Testing		
	Test Services	7655.00
	Material Shipment to/from test site	1070.00
	Travel Expenses	1391.75
	Use of Government Car (mileage)	319.90
	Testing Total	10,436.65
Total		14,922.57

Appendix C. RAL Absorption Test Reports

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Alion Science and Technology

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TEST REPORT

FOR: NASA Glenn Research Center
Cleveland, OH

Sound Absorption
RAL™-A13-173

CONDUCTED: 9 July 2013

Page 1 of 6

ON: 2" Soundcoat Soundfoam® ML (Gray Melamine Foam)

TEST METHOD

The test method conformed explicitly with the requirements of the ASTM Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method: ASTM C423-09a and E795-05. Riverbank Acoustical Laboratories has been accredited by the U.S. Department of Commerce, National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP) for this test procedure (NVLAP Lab Code: 100227-0). A description of the measuring procedure and room qualifications is available separately.

DESCRIPTION OF THE SPECIMEN

The test specimen was designated by the manufacturer as 2" Soundcoat Soundfoam® ML (Gray Melamine Foam). A visual inspection by Riverbank staff verified the manufacturer's description. See the attached "Technical Data Sheet" for a detailed material specification.

The specimen consisted of 2 pieces laid out as a single rectangular patch. Each piece was 2.44 m (96 in.) long by 1.22 m (48 in.) wide and 50.8 mm (2 in.) thick. The overall dimensions of the specimen as measured were 2.44 m (96.00 in.) wide by 2.44 m (96.00 in.) long and 50.80 mm (2.00 in.) thick. The area used in the calculations was 5.95 m^2 (64.00 ft^2). The weight of the entire specimen as measured was 2.72 kg (6.00 lbs), an average of 0.44 kg/m^2 (0.09 lbs/ft^2).

The specimen was tested in the laboratory's 292.0 m^3 (10,311.0 ft^3) test chamber. The room temperature at the time of the test was 21±0°C (71±1°F) and 63±0% relative humidity. The barometric pressure was 741 mm of mercury.

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Figure 1 - Test specimen in chamber

Figure 2 - Test specimen in chamber

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MOUNTING A

The test specimen was laid directly against the test surface. Perimeter edges were unsealed.

TEST RESULTS

1/3 Octave Center Frequency (Hz)	Absorption Coefficient	Total Absorption In Sabins
100	0.14	9.13
** 125	0.21	13.55
160	0.25	15.78
200	0.35	22.51
** 250	0.53	34.06
315	0.77	49.35
400	0.93	59.75
** 500	1.06	67.89
630	1.07	68.38
800	1.18	75.73
** 1000	1.15	73.58
1250	1.14	72.94
1600	1.17	74.86
** 2000	1.18	75.37
2500	1.15	73.37
3150	1.16	74.06
** 4000	1.17	74.72
5000	1.23	78.75

SAA = 0.97
NRC = 1.00

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TEST RESULTS (Continued)

The sound absorption average (SAA) is defined as a single number rating, the average, rounded to the nearest 0.01, of the sound absorption coefficient of a material for the twelve one-third octave bands from 200 through 2500 Hz, inclusive.

The noise reduction coefficient (NRC) is defined from previous versions of this same test method as the average of the coefficients at 250, 500, 1000, and 2000 Hz, expressed to the nearest integral multiple of 0.05.

Digitally signed by Eric Wolfram
DN: cn=Eric Wolfram, o=Alion Science and Technology, ou=Riverbank Acoustical Laboratories, email=ewolfram@alionscience.com, c=US
Date: 2013.07.17 10:38:21 -05'00'

Tested by ______ Approved by ______

Marc Sciaky
Experimentalist

Eric P. Wolfram
Laboratory Manager

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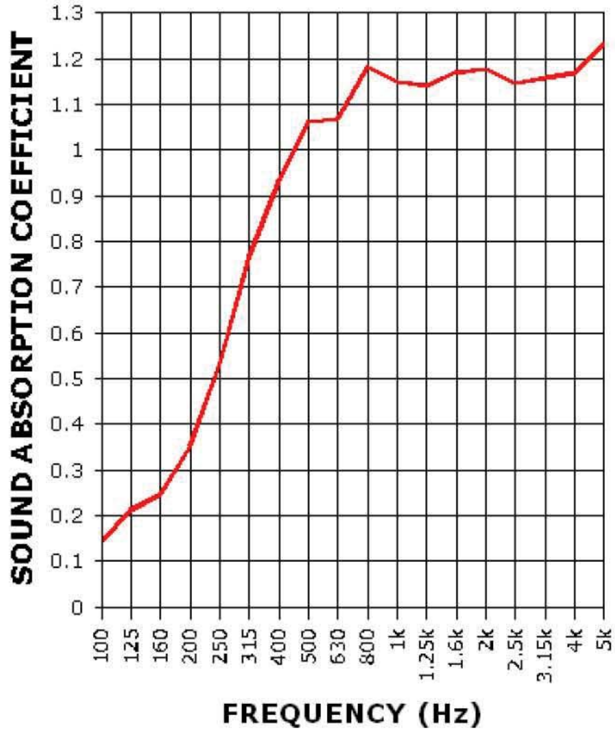
SOUND ABSORPTION REPORT

2" Soundcoat Soundfoam® ML (Gray Melamine Foam)



SAA = 0.97
NRC = 1.00

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TEST REPORT

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Appendix to ASTM C423 Sound Absorption Test
Extended Frequency Range Data

Product Description: 2" Soundcoat Soundfoam® ML (Gray Melamine Foam) (See Full Report)

Riverbank Acoustical Laboratories is accredited to perform sound absorption coefficient measurements for the frequency range of 100Hz to 5,000Hz. However, we calculate sound absorption values at additional test frequencies as a service to our clients.

Although these measurements were made in accordance with the procedures described in ASTM C423-09a, they do not qualify as part of the standard. Since the results are representative of the test environment only, they are unofficial and intended for research and development guidelines rather than for commercial purposes. The sound absorption values at additional frequencies were as follows:

RAL-A13-173

1/3 Octave Center Frequency (Hz)	**Absorption Coefficient**	**Total Absorption** (Sabins)
40	0.01	0.70
50	0.13	8.24
63	0.13	8.26
80	-0.04	-2.46
6300	1.33	84.92
8000	1.28	81.95
10000	1.16	74.18

*Headquarters: 1 Burt Drive, Deer Park, NY 11729 * Tel. 800-394-8913 * Fax: 631-242-2246*
West Coast: 16901 Armstrong Avenue, Irvine, CA 92606 Tel. 949-955-9202 * Fax: 949-222-0834*

SOUNDCOAT

Technical Data Sheet

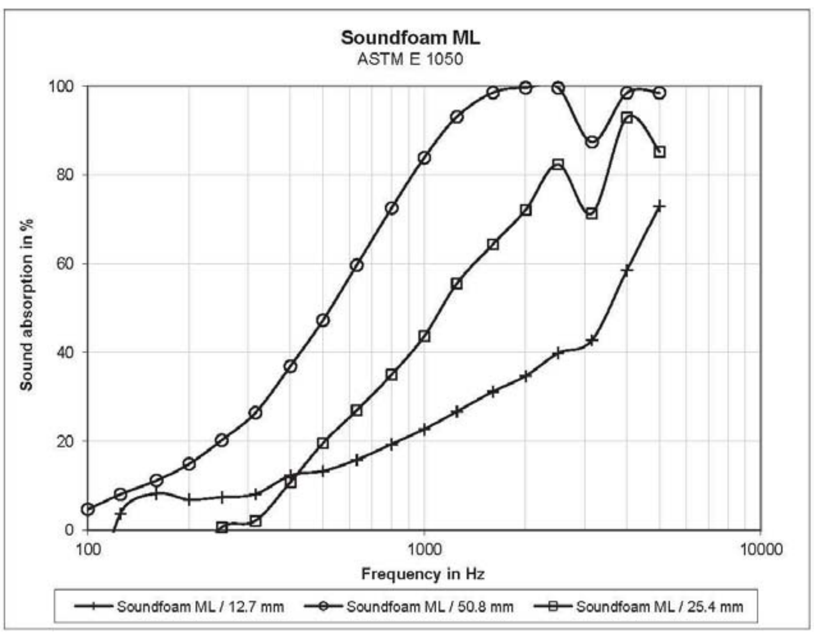
SOUNDFOAM® - ML

Product Description (w/ Features & Benefits):

SOUNDFOAM ML is a lightweight, flexible, open-cell, melamine based acoustic quality foam having excellent flame* and heat resistance. It exhibits a very low degree of flammability, does not drip upon ignition, ceases to burn after removal of ignition source, and produces a minimum amount of smoke. Compared with some glass-fiber based acoustical products, **SOUNDFOAM ML** has better strength, lower compression set, and higher resiliency. It is recommended for use as acoustic or thermal insulation in aerospace, marine, or ground units, etc., where light weight, heat resistance, and fire safety are of the utmost concern. It is available plain or with decorative and protective surface finishes of reinforced aluminized polyester film, Tedlar®, Nomex®, etc. For customer convenience, the foam is supplied with one of several high performance pressure-sensitive adhesives for ease of installation. Soundfoam ML is available in standard sheet sizes or in custom sheet sizes or as custom cut parts.

How It Works:

The sound absorption performance of elastic porous materials is determined mainly by the porosity and airflow resistance (air permeability) of the materials. Sound absorption data for various surface finishes are available upon request. Following are typical sound absorption curves.



Physical Properties:

Chemical Type:	Flexible Melamine Foam
Color:	Grey
Thickness, mm (in.):	Std. 6.4 (0.25), 12.7 (0.5), 19.0 (0.75), 25.4 (1), and 50.8 (2)
Sheet Size, mm (in.):	Std. 1219 x 610 (48 x 24) or 2438 x 1219 (96 x 48)
Density, kg/m^3 (lb/ft^3):	9 (0.562) per ASTM D 3574-77 Test A
Tensile Strength, kPa (psi):	120 (18) per ASTM D 3574-77 Test E
Elongation, %:	20 per ASTM D 3574-77 Test E
Tear Strength, N/m (lb/in)	87 (0.5) per ASTM D 3574-77 Test F
CLD (25%), N/mm^2 (psi):	0.01 (1.4) per ASTM D 3574-77 Test C
Compression Set (50%), %	30 per ASTM D 3574-77 Test D
Thermal Conductivity, $kcal.m/hr.m^2.°C$ ($BTU.in/hr.ft^2.°F$):	46 (0.25) per ASTM C 117 at 24°C (75°F)
Service Temperature:	-43° to 200°C (-45° to 392°F)

Flame Resistance*:	• FAR 25.853 (b) Vertical Burn Test
	  ○ Burn Length: 2.54 cm (1.0 in.)
	  ○ Post Burn Time: 0 s, no dripping
	• FAR 25.856(a)
	  ○ Pass
	• UL-94
	  ○ Meets HF-1 and V-0 classification requirements
	• ASTM E 84 Tunnel Test
	  ○ Flame Spread: 2.5
	  ○ Smoke Developed: 16.9
	• ASTM E 162
	  ○ <25
	• ASTM E 662
	  ○ <100

Airflow Resistivity:	13410 Rayls/m

Typical Sound Absorption Performance:

Sound absorption coefficients measured per ASTM C 384:

Thickness \ Frequency	125	250	500	1000	2000	4000
6.4 mm (0.25 in)	0.05	0.05	0.10	0.20	0.39	0.81
12.7 mm (0.5 in)	0.13	0.15	0.26	0.43	0.76	0.93
25.4 (1.0 in)	0.18	0.25	0.50	0.82	0.97	1.00

For further information regarding this product, please contact our Technical Support Department at 1-800-394-8913, ext. 147.

Visit us on the web at www.soundcoat.com to see our complete line of absorption, damping, and barrier materials for the OEM marketplace.

Rev 3/13

SOUNDCOAT .... *Keeping it Quiet for 40 years*

* This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions. The Federal Trade Commission consider that there are no existing test methods or standards regarding flammability that are accurate indicators of the performance of cellular plastic materials under actual fire conditions. Any result of existing methods, such as ASTM D 1692 and UL-94, are intended only as a measurement of the performance of such materials under specific, controlled conditions.

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TEST REPORT

FOR: NASA Glenn Research Center
Cleveland, OH

Sound Absorption
RAL™-A13-174

CONDUCTED: 9 July 2013

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ON: 2" Soundcoat Soundfoam® ML (Gray Melamine Foam) with 1/4" Holes

TEST METHOD

The test method conformed explicitly with the requirements of the ASTM Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method: ASTM C423-09a and E795-05. Riverbank Acoustical Laboratories has been accredited by the U.S. Department of Commerce, National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP) for this test procedure (NVLAP Lab Code: 100227-0). A description of the measuring procedure and room qualifications is available separately.

DESCRIPTION OF THE SPECIMEN

The test specimen was designated by the manufacturer as 2" Soundcoat Soundfoam® ML (Gray Melamine Foam) with ¼" holes. A visual inspection by Riverbank staff verified the manufacturer's description. See the attached "Technical Data Sheet" for a detailed material specification. Each foam panel was perforated with 18 randomly placed penetrations with a range of approx. 7 mm to 10 mm in diameter. All holes penetrated through the entire panel.

The specimen consisted of 2 pieces laid out as a single rectangular patch. Each piece was 2.44 m (96 in.) long by 1.22 m (48 in.) wide and 50.8 mm (2 in.) thick. The overall dimensions of the specimen as measured were 2.44 m (96.00 in.) wide by 2.44 m (96.00 in.) long and 50.80 mm (2.00 in.) thick. The area used in the calculations was 5.95 m^2 (64.00 ft^2). The weight of the entire specimen as measured was 2.72 kg (6.00 lbs), an average of 0.44 kg/m^2 (0.09 lbs/ft^2).

The specimen was tested in the laboratory's 292.0 m^3 (10,311.0 ft^3) test chamber. The room temperature at the time of the test was 22±1°C (71±1°F) and 63±1% relative humidity. The barometric pressure was 741 mm of mercury.

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TEST REPORT

NASA Glenn Research Center
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Figure 1 - Test specimen with randomly placed penetrations.

Figure 2 - Test specimen in reverberation room.

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TEST REPORT

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MOUNTING A

The test specimen was laid directly against the test surface. Perimeter edges were unsealed.

TEST RESULTS

1/3 Octave Center Frequency (Hz)	Absorption Coefficient	Total Absorption In Sabins
100	0.14	8.75
** 125	0.17	10.82
160	0.28	17.79
200	0.38	24.35
** 250	0.58	37.04
315	0.76	48.93
400	0.94	60.09
** 500	1.10	70.10
630	1.11	70.86
800	1.13	72.10
** 1000	1.16	74.26
1250	1.13	72.14
1600	1.16	74.45
** 2000	1.19	75.84
2500	1.22	78.31
3150	1.16	74.44
** 4000	1.16	74.39
5000	1.23	78.54

SAA = 0.99
NRC = 1.00

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TEST RESULTS (Continued)

The sound absorption average (SAA) is defined as a single number rating, the average, rounded to the nearest 0.01, of the sound absorption coefficient of a material for the twelve one-third octave bands from 200 through 2500 Hz, inclusive.

The noise reduction coefficient (NRC) is defined from previous versions of this same test method as the average of the coefficients at 250, 500, 1000, and 2000 Hz, expressed to the nearest integral multiple of 0.05.

Tested by ______ Marc Sciaky, *Experimentalist*

Approved by ______ Eric P. Wolfram, *Laboratory Manager*

Digitally signed by Eric Wolfram
DN: cn=Eric Wolfram, o=Alion Science and Technology, ou=Riverbank Acoustical Laboratories, email=ewolfram@alionscience.com, c=US
Date: 2013.07.17 10:41:16 -05'00'

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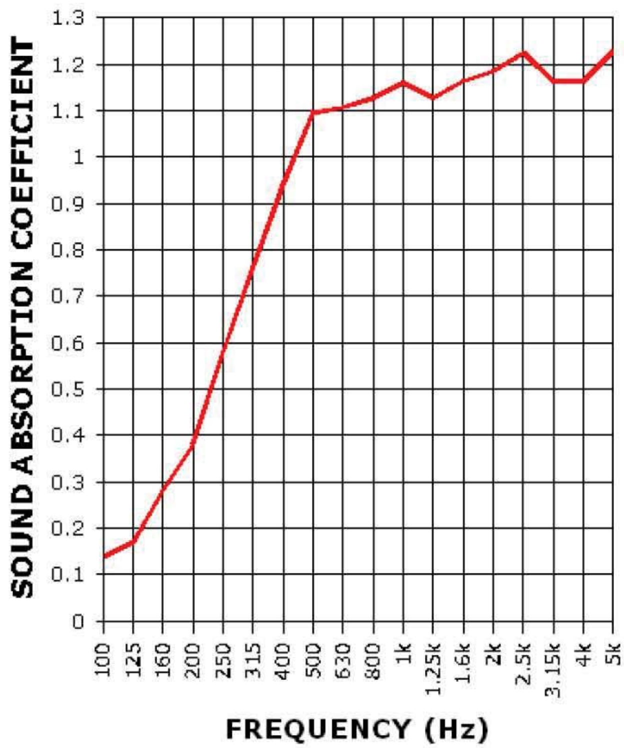
SOUND ABSORPTION REPORT

2" Soundcoat Soundfoam® ML (Gray Melamine Foam) with 1/4" Holes



SAA = 0.99
NRC = 1.00

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Appendix to ASTM C423 Sound Absorption Test
Extended Frequency Range Data

Product Description: 2" Soundcoat Soundfoam® ML (Gray Melamine Foam) with 1/4" Holes (See Full Report)

Riverbank Acoustical Laboratories is accredited to perform sound absorption coefficient measurements for the frequency range of 100Hz to 5,000Hz. However, we calculate sound absorption values at additional test frequencies as a service to our clients.

Although these measurements were made in accordance with the procedures described in ASTM C423-09a, they do not qualify as part of the standard. Since the results are representative of the test environment only, they are unofficial and intended for research and development guidelines rather than for commercial purposes. The sound absorption values at additional frequencies were as follows:

RAL-A13-174

1/3 Octave Center Frequency (Hz)	Absorption Coefficient	Total Absorption (Sabins)
40	0.03	1.89
50	0.23	15.00
63	0.06	3.68
80	-0.04	-2.58
6300	1.26	80.56
8000	1.25	79.88
10000	1.24	79.42

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West Coast: 16901 Armstrong Avenue, Irvine, CA 92606 Tel. 949-955-9202 * Fax: 949-222-0834*

SOUNDCOAT *Technical Data Sheet*

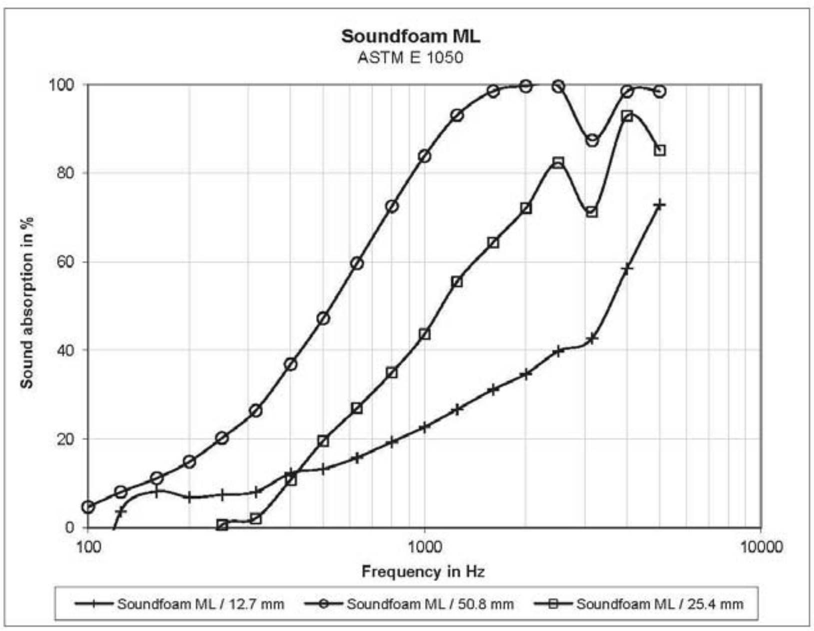
SOUNDFOAM® - ML

Product Description (w/ Features & Benefits):

SOUNDFOAM ML is a lightweight, flexible, open-cell, melamine based acoustic quality foam having excellent flame* and heat resistance. It exhibits a very low degree of flammability, does not drip upon ignition, ceases to burn after removal of ignition source, and produces a minimum amount of smoke. Compared with some glass-fiber based acoustical products, **SOUNDFOAM ML** has better strength, lower compression set, and higher resiliency. It is recommended for use as acoustic or thermal insulation in aerospace, marine, or ground units, etc., where light weight, heat resistance, and fire safety are of the utmost concern. It is available plain or with decorative and protective surface finishes of reinforced aluminized polyester film, Tedlar®, Nomex®, etc. For customer convenience, the foam is supplied with one of several high performance pressure-sensitive adhesives for ease of installation. Soundfoam ML is available in standard sheet sizes or in custom sheet sizes or as custom cut parts.

How It Works:

The sound absorption performance of elastic porous materials is determined mainly by the porosity and airflow resistance (air permeability) of the materials. Sound absorption data for various surface finishes are available upon request. Following are typical sound absorption curves.



Physical Properties:

Chemical Type:	Flexible Melamine Foam
Color:	Grey
Thickness, mm (in.):	Std. 6.4 (0.25), 12.7 (0.5), 19.0 (0.75), 25.4 (1), and 50.8 (2)
Sheet Size, mm (in.):	Std. 1219 x 610 (48 x 24) or 2438 x 1219 (96 x 48)
Density, kg/m^3 (lb/ft^3):	9 (0.562) per ASTM D 3574-77 Test A
Tensile Strength, kPa (psi):	120 (18) per ASTM D 3574-77 Test E
Elongation, %:	20 per ASTM D 3574-77 Test E
Tear Strength, N/m (lb/in)	87 (0.5) per ASTM D 3574-77 Test F
CLD (25%), N/mm^2 (psi):	0.01 (1.4) per ASTM D 3574-77 Test C
Compression Set (50%), %	30 per ASTM D 3574-77 Test D
Thermal Conductivity, kcal.m/hr.m^2.°C (BTU.in/hr.ft^2.°F):	46 (0.25) per ASTM C 117 at 24°C (75°F)
Service Temperature:	-43° to 200°C (-45° to 392°F)
Flame Resistance*:	• FAR 25.853 (b) Vertical Burn Test ○ Burn Length: 2.54 cm (1.0 in.) ○ Post Burn Time: 0 s, no dripping • FAR 25.856(a) ○ Pass • UL-94 ○ Meets HF-1 and V-0 classification requirements • ASTM E 84 Tunnel Test ○ Flame Spread: 2.5 ○ Smoke Developed: 16.9 • ASTM E 162 ○ <25 • ASTM E 662 ○ <100
Airflow Resistivity:	13410 Rayls/m

Typical Sound Absorption Performance:

Sound absorption coefficients measured per ASTM C 384:

Thickness \ Frequency	125	250	500	1000	2000	4000
6.4 mm (0.25 in)	0.05	0.05	0.10	0.20	0.39	0.81
12.7 mm (0.5 in)	0.13	0.15	0.26	0.43	0.76	0.93
25.4 (1.0 in)	0.18	0.25	0.50	0.82	0.97	1.00

For further information regarding this product, please contact our Technical Support Department at 1-800-394-8913, ext. 147.

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* This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions. The Federal Trade Commission consider that there are no existing test methods or standards regarding flammability that are accurate indicators of the performance of cellular plastic materials under actual fire conditions. Any result of existing methods, such as ASTM D 1692 and UL-94, are intended only as a measurement of the performance of such materials under specific, controlled conditions.

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TEST REPORT

FOR: NASA Glenn Research Center
Cleveland, OH

Sound Absorption
RAL™-A13-175

CONDUCTED: 9 July 2013

ON: 4" Soundcoat Soundfoam® ML (Gray Melamine Foam)

TEST METHOD

The test method conformed explicitly with the requirements of the ASTM Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method: ASTM C423-09a and E795-05. Riverbank Acoustical Laboratories has been accredited by the U.S. Department of Commerce, National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP) for this test procedure (NVLAP Lab Code: 100227-0). A description of the measuring procedure and room qualifications is available separately.

DESCRIPTION OF THE SPECIMEN

The test specimen was designated by the manufacturer as 4" Soundcoat Soundfoam® ML (Gray Melamine Foam). The specimen consisted of two layers of 50.8 mm (2 in.) thick panels. A visual inspection by Riverbank staff verified the manufacturer's description. See the attached "Technical Data Sheet" for a detailed material specification.

The specimen consisted of four pieces laid out as a single rectangular patch. Each piece was 2.44 m (96 in.) long by 1.22 m (48 in.) wide and 50.8 mm (2 in.) thick. The overall dimensions of the specimen as measured were 2.44 m (96.00 in.) wide by 2.44 m (96.00 in.) long and 101.60 mm (4.00 in.) thick. The area used in the calculations was 5.95 m^2 (64.00 ft^2). The weight of the entire specimen as measured was 5.44 kg (12.00 lbs), an average of 0.91 kg/m^2 (0.18 lbs/ft^2).

The specimen was tested in the laboratory's 292.0 m^3 (10,311.0 ft^3) test chamber. The room temperature at the time of the test was 21±0°C (70±0°F) and 63±0% relative humidity. The barometric pressure was 741 mm of mercury.

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TEST REPORT

NASA Glenn Research Center
9 July 2013

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Figure 1 – The test specimen mounted in reverberation chamber.

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TEST REPORT

NASA Glenn Research Center
9 July 2013

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MOUNTING A

The test specimen was laid directly against the test surface. Perimeter edges were unsealed.

TEST RESULTS

1/3 Octave Center Frequency (Hz)	Absorption Coefficient	Total Absorption In Sabins
100	0.45	28.92
** 125	0.70	44.83
160	0.76	48.65
200	1.00	64.03
** 250	1.34	85.71
315	1.33	84.83
400	1.42	90.91
** 500	1.43	91.58
630	1.43	91.67
800	1.38	88.60
** 1000	1.36	87.17
1250	1.40	89.49
1600	1.34	85.84
** 2000	1.26	80.76
2500	1.28	81.80
3150	1.20	76.56
** 4000	1.29	82.68
5000	1.26	80.61

SAA = 1.33
NRC = 1.35

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TEST RESULTS (Continued)

The sound absorption average (SAA) is defined as a single number rating, the average, rounded to the nearest 0.01, of the sound absorption coefficient of a material for the twelve one-third octave bands from 200 through 2500 Hz, inclusive.

The noise reduction coefficient (NRC) is defined from previous versions of this same test method as the average of the coefficients at 250, 500, 1000, and 2000 Hz, expressed to the nearest integral multiple of 0.05.

Digitally signed by Eric Wolfram
DN: cn=Eric Wolfram, o=Alion Science and Technology, ou=Riverbank Acoustical Laboratories, email=ewolfram@alionscience.com, c=US
Date: 2013.07.17 10:45:08 -05'00'

Tested by______________________ Approved by______________________

Dean Victor
Senior Experimentalist

Eric P. Wolfram
Laboratory Manager

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NASA Glenn Research Center
9 July 2013

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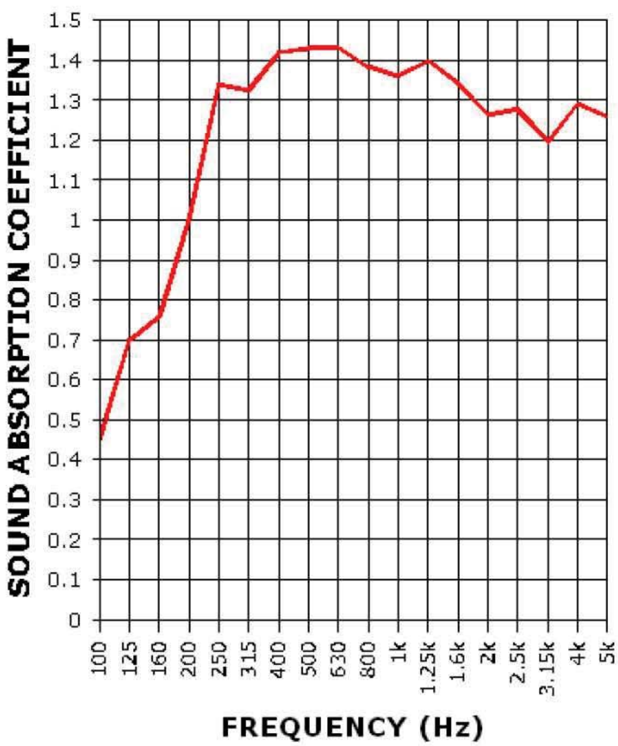
SOUND ABSORPTION REPORT
4" Soundcoat Soundfoam® ML (Gray Melamine Foam)



SAA = 1.33
NRC = 1.35

NVLAP Lab Code 100227-0

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TEST REPORT

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Appendix to ASTM C423 Sound Absorption Test
Extended Frequency Range Data

Product Description: 4" Soundcoat Soundfoam® ML (Gray Melamine Foam) (See Full Report)

Riverbank Acoustical Laboratories is accredited to perform sound absorption coefficient measurements for the frequency range of 100Hz to 5,000Hz. However, we calculate sound absorption values at additional test frequencies as a service to our clients.

Although these measurements were made in accordance with the procedures described in ASTM C423-09a, they do not qualify as part of the standard. Since the results are representative of the test environment only, they are unofficial and intended for research and development guidelines rather than for commercial purposes. The sound absorption values at additional frequencies were as follows:

RAL-A13-175

1/3 Octave Center Frequency (Hz)	**Absorption Coefficient**	**Total Absorption** (Sabins)
40	0.17	10.84
50	0.31	20.02
63	0.15	9.91
80	0.05	3.21
6300	1.31	83.77
8000	1.33	85.07
10000	1.33	85.26

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West Coast: 16901 Armstrong Avenue, Irvine, CA 92606 Tel. 949-955-9202 * Fax: 949-222-0834*

SOUNDCOAT *Technical Data Sheet*

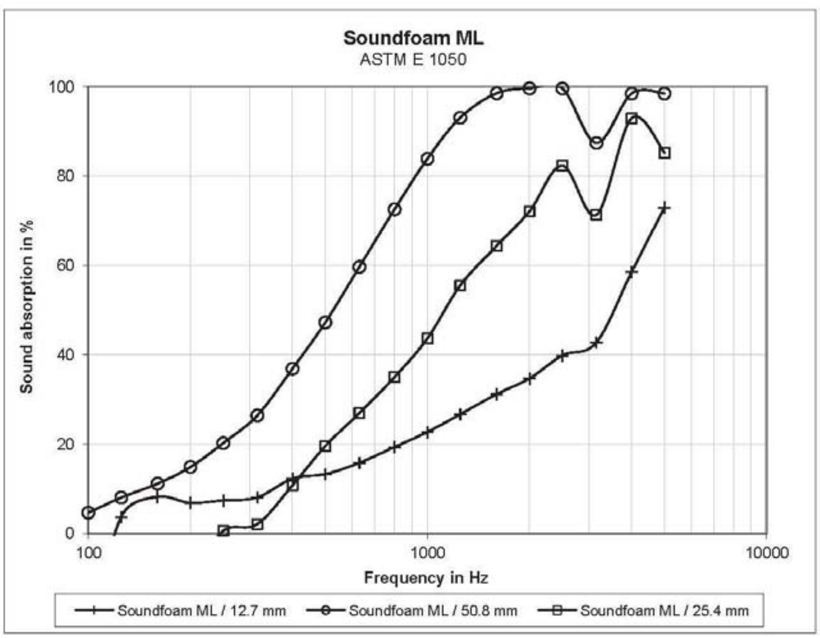
SOUNDFOAM® - ML

Product Description (w/ Features & Benefits):

SOUNDFOAM ML is a lightweight, flexible, open-cell, melamine based acoustic quality foam having excellent flame* and heat resistance. It exhibits a very low degree of flammability, does not drip upon ignition, ceases to burn after removal of ignition source, and produces a minimum amount of smoke. Compared with some glass-fiber based acoustical products, **SOUNDFOAM ML** has better strength, lower compression set, and higher resiliency. It is recommended for use as acoustic or thermal insulation in aerospace, marine, or ground units, etc., where light weight, heat resistance, and fire safety are of the utmost concern. It is available plain or with decorative and protective surface finishes of reinforced aluminized polyester film, Tedlar®, Nomex®, etc. For customer convenience, the foam is supplied with one of several high performance pressure-sensitive adhesives for ease of installation. Soundfoam ML is available in standard sheet sizes or in custom sheet sizes or as custom cut parts.

How It Works:

The sound absorption performance of elastic porous materials is determined mainly by the porosity and airflow resistance (air permeability) of the materials. Sound absorption data for various surface finishes are available upon request. Following are typical sound absorption curves.



Physical Properties:

Chemical Type:	Flexible Melamine Foam
Color:	Grey
Thickness, mm (in.):	Std. 6.4 (0.25), 12.7 (0.5), 19.0 (0.75), 25.4 (1), and 50.8 (2)
Sheet Size, mm (in.):	Std. 1219 x 610 (48 x 24) or 2438 x 1219 (96 x 48)
Density, kg/m^3 (lb/ft^3):	9 (0.562) per ASTM D 3574-77 Test A
Tensile Strength, kPa (psi):	120 (18) per ASTM D 3574-77 Test E
Elongation, %:	20 per ASTM D 3574-77 Test E
Tear Strength, N/m (lb/in)	87 (0.5) per ASTM D 3574-77 Test F
CLD (25%), N/mm^2 (psi):	0.01 (1.4) per ASTM D 3574-77 Test C
Compression Set (50%), %	30 per ASTM D 3574-77 Test D
Thermal Conductivity, kcal.m/hr.m^2.°C (BTU.in/hr.ft^2.°F):	46 (0.25) per ASTM C 117 at 24°C (75°F)
Service Temperature:	-43° to 200°C (-45° to 392°F)
Flame Resistance*:	• FAR 25.853 (b) Vertical Burn Test ○ Burn Length: 2.54 cm (1.0 in.) ○ Post Burn Time: 0 s, no dripping • FAR 25.856(a) ○ Pass • UL-94 ○ Meets HF-1 and V-0 classification requirements • ASTM E 84 Tunnel Test ○ Flame Spread: 2.5 ○ Smoke Developed: 16.9 • ASTM E 162 ○ <25 • ASTM E 662 ○ <100
Airflow Resistivity:	13410 Rayls/m

Typical Sound Absorption Performance:

Sound absorption coefficients measured per ASTM C 384:

Thickness \ Frequency	125	250	500	1000	2000	4000
6.4 mm (0.25 in)	0.05	0.05	0.10	0.20	0.39	0.81
12.7 mm (0.5 in)	0.13	0.15	0.26	0.43	0.76	0.93
25.4 (1.0 in)	0.18	0.25	0.50	0.82	0.97	1.00

For further information regarding this product, please contact our Technical Support Department at 1-800-394-8913, ext. 147.

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Appendix D. RAL TL Test Reports

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TEST REPORT

FOR: **NASA Glenn Research Center**
Cleveland, OH

Sound Transmission Loss
RAL™-TL13-139

CONDUCTED: 9 July 2013

Page 1 of 5

ON: FRF Panel

TEST METHOD

Unless otherwise designated, the measurements reported below were made with all facilities and procedures in explicit conformity with the ASTM Designations E90-09 and E413-10, as well as other pertinent standards. Riverbank Acoustical Laboratories has been accredited by the U.S. Department of Commerce, National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP) for this test procedure (NVLAP Lab Code: 100227-0). A description of the measuring technique is available separately.

DESCRIPTION OF THE SPECIMEN

The manufacturer's description of the specimen was as follows: NASA Standard Fiber-Reinforced Foam Panel (FRF Panel). A visual inspection by Riverbank staff verified the manufacturer's description of the specimen.

The overall dimensions of the specimen as measured were 1.21 m (47.75 in.) wide by 2.43 m (95.75 in.) high and 27.43 mm (1.08 in.) thick. The measured weight of the entire specimen was 17.9 kg (39.5 lbs.), an average of 6.0 kg/m^2 (1.2 lbs/ft^2). The specimen was placed directly in the laboratory's 1.22 m (4 ft) by 2.44 m (8 ft) test opening and sealed on the periphery (both sides) with dense mastic. For this test, Room 3 served as the source room and Room 2 served as the receive room.

The source room temperature at the time of the test was 23±1°C (73±1°F) and 49±1% relative humidity. The receiving room temperature at the time of the test was 23±1°C (74±1°F) and 51±2% relative humidity. The source and receive reverberation room volumes were 140 m^3 (4,929 ft^3) and 178 m^3 (6,298 ft^3), respectively. The transmission area used in the calculations was 3.0 m^2 (32 ft^2).

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TEST REPORT

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9 July 2013

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Figure 1 - The mounted FRF Panel as seen from the source room.

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TEST REPORT

NASA Glenn Research Center — **RAL™-TL13-139**
9 July 2013 — Page 3 of 5

TEST RESULTS

Sound transmission loss values are tabulated at the eighteen standard frequencies. A graphic presentation of the data and additional information appear on the following pages. The precision of the TL test data is within the limits set by the ASTM Standard E90-09.

FREQ.	T.L.	C.L.	DEF.	FREQ.	T.L.	C.L.	DEF.
100	9	0.57		800	18	0.13	4
125	11	0.58		1000	21	0.11	2
160	12	0.38		1250	23	0.13	1
200	10	0.42		1600	25	0.09	
250	12	0.28	1	2000	26	0.07	
315	13	0.21	3	2500	27	0.11	
400	14	0.19	5	3150	28	0.10	
500	15	0.23	5	4000	28	0.07	
630	17	0.23	4	5000	24	0.06	

STC=20

ABBREVIATION INDEX

FREQ. = FREQUENCY, HERTZ, (cps)
T.L. = TRANSMISSION LOSS, dB
C.L. = UNCERTAINTY IN dB, FOR A 95% CONFIDENCE LIMIT
DEF. = DEFICIENCIES, dB<STC CONTOUR (SUM OF DEF = 25)
STC = SOUND TRANSMISSION CLASS

Digitally signed by Eric Wolfram
DN: cn=Eric Wolfram, o=Alion Science and Technology, ou=Riverbank Acoustical Laboratories, email=ewolfram@alionscience.com, c=US
Date: 2013.07.17 10:47:36 -05'00'

Tested by Marc Sciaky — Approved by Eric P. Wolfram

Marc Sciaky
Experimentalist

Eric P. Wolfram
Laboratory Manager

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TEST REPORT

NASA Glenn Research Center
9 July 2013

RAL™-TL13-139
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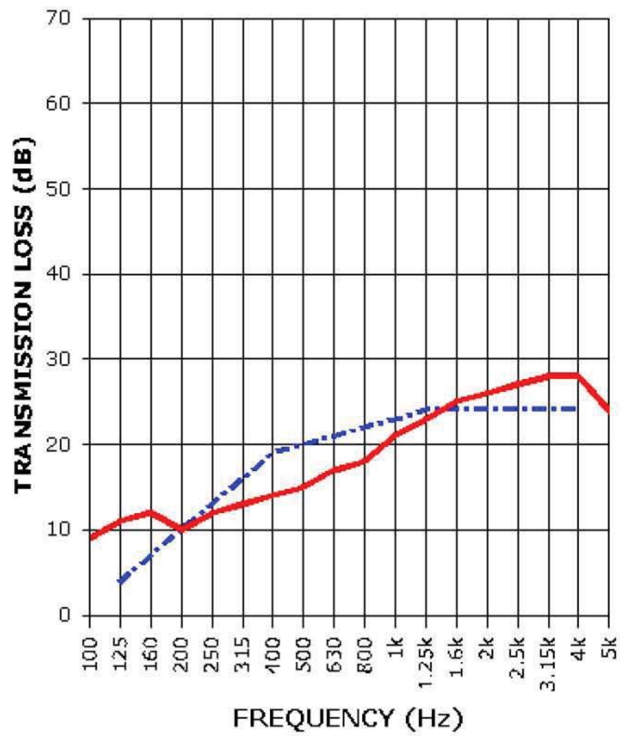
SOUND TRANSMISSION REPORT
FRF Panel



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TRANSMISSION LOSS
SOUND TRANSMISSION LOSS CONTOUR

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Alion Science and Technology

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TEST REPORT

NASA Glenn Research Center — **RAL™-TL13-139**
9 July 2013 — Page 5 of 5

Appendix to ASTM E90 Sound Transmission Loss Test
Extended Frequency Range Data

Product Description: FRF Panel (See Full Report)

As requested by the client, transmission loss (TL) values were calculated at additional test frequencies. Although the measurements were made in accordance with the procedures described in ASTM E90-09, they do not qualify as part of the standard. Since the results are representative of the test environment only, they are unofficial and intended for research and development guidelines rather than for commercial purposes. The transmission loss values at the additional frequencies were as follows:

RAL™-TL13-139

1/3 Octave Center Frequency (Hz)	Sound Transmission Loss (dB)
40	27
50	11
63	0
80	4
6300	23
8000	27
10000	28

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TEST REPORT

FOR: **NASA Glenn Research Center**
Cleveland, OH

Sound Transmission Loss
RAL™-TL13-140

CONDUCTED: 10 July 2013

Page 1 of 5

ON: FRF Panel with 4" of Gray Melamine Foam (2 Layers of 2") - FRF Faces Source

TEST METHOD

Unless otherwise designated, the measurements reported below were made with all facilities and procedures in explicit conformity with the ASTM Designations E90-09 and E413-10, as well as other pertinent standards. Riverbank Acoustical Laboratories has been accredited by the U.S. Department of Commerce, National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP) for this test procedure (NVLAP Lab Code: 100227-0). A description of the measuring technique is available separately.

DESCRIPTION OF THE SPECIMEN

The specimen was designated as follows: FRF Panel with 4" of Gray Melamine Foam (2 layers of 2") - FRF faces source. The test specimen was designated by the manufacturer as two layers of 50.8 mm (2 in.) thick Soundcoat Soundfoam® ML (Gray Melamine Foam) behind the NASA Standard Fiber-Reinforced Foam Panel (FRF Panel). The FRF panel faced the sound source during this test. A visual inspection by Riverbank staff verified the manufacturer's description of the specimen. See the attached "Technical Data Sheet" for a detailed material specification.

The overall dimensions of the specimen as measured were 1.21 m (47.75 in.) wide by 2.43 m (95.75 in.) high and 129.03 mm (5.08 in.) thick. The measured weight of the entire specimen was 20.6 kg (45.5 lbs.), an average of 7.0 kg/m^2 (1.4 lbs/ft^2). The specimen was placed directly in the laboratory's 1.22 m (4 ft) by 2.44 m (8 ft) test opening. The FRF panel was sealed on the periphery (both sides) with dense mastic. The foam panels were not fully sealed, per the client's request. For this test, Room 3 served as the source room and Room 2 served as the receive room.

The source room temperature at the time of the test was 23±0°C (74±1°F) and 59±1% relative humidity. The receiving room temperature at the time of the test was 24±0°C (75±1°F) and 59±1% relative humidity. The source and receive reverberation room volumes were 140 m^3 (4,929 ft^3) and 178 m^3 (6,298 ft^3), respectively. The transmission area used in the calculations was 3.0 m^2 (32 ft^2).

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TEST REPORT

NASA Glenn Research Center
10 July 2013

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Figure 1 - The specimen mounted in test opening.

Figure 2 - The "Receive Room" configuration

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TEST REPORT

NASA Glenn Research Center | **RAL™-TL13-140**
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TEST RESULTS

Sound transmission loss values are tabulated at the eighteen standard frequencies. A graphic presentation of the data and additional information appear on the following pages. The precision of the TL test data is within the limits set by the ASTM Standard E90-09.

FREQ.	T.L.	C.L.	DEF.	FREQ.	T.L.	C.L.	DEF.
100	11	0.57		800	31	0.13	
125	13	0.72		1000	35	0.09	
160	14	0.42	1	1250	38	0.08	
200	13	0.26	5	1600	41	0.13	
250	17	0.34	4	2000	44	0.07	
315	19	0.35	5	2500	48	0.11	
400	20	0.25	7	3150	50	0.11	
500	24	0.24	4	4000	51	0.07	
630	27	0.21	2	5000	51	0.08	

STC=28

ABBREVIATION INDEX

FREQ. = FREQUENCY, HERTZ, (cps)
T.L. = TRANSMISSION LOSS, dB
C.L. = UNCERTAINTY IN dB, FOR A 95% CONFIDENCE LIMIT
DEF. = DEFICIENCIES, dB<STC CONTOUR (SUM OF DEF = 28)
STC = SOUND TRANSMISSION CLASS

Digitally signed by Eric Wolfram
DN: cn=Eric Wolfram, o=Alion Science and Technology, ou=Riverbank Acoustical Laboratories, email=ewolfram@alionscience.com, c=US
Date: 2013.07.17 10:49:48 -05'00'

Tested by Marc Sciaky, *Experimentalist* — Approved by Eric P. Wolfram, *Laboratory Manager*

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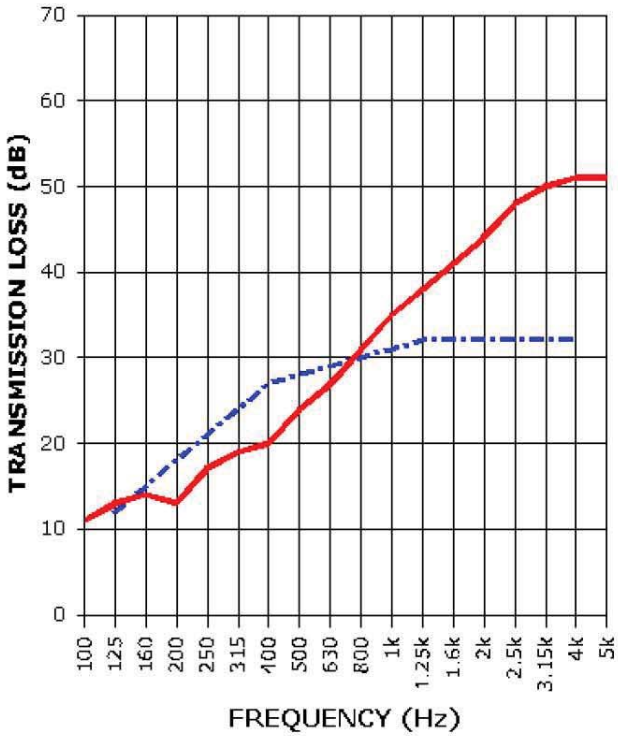
TEST REPORT

NASA Glenn Research Center
10 July 2013

RAL™-TL13-140
Page 4 of 5

SOUND TRANSMISSION REPORT

FRF Panel with 4" of Gray Melamine Foam (2 Layers of 2") - FRF Faces Source



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TRANSMISSION LOSS
SOUND TRANSMISSION LOSS CONTOUR

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TEST REPORT

NASA Glenn Research Center
10 July 2013

RAL™-TL13-140
Page 5 of 5

Appendix to ASTM E90 Sound Transmission Loss Test
Extended Frequency Range Data

Product Description: FRF Panel with 4" of Gray Melamine Foam (2 Layers of 2") - FRF Faces Source (See Full Report)

As requested by the client, transmission loss (TL) values were calculated at additional test frequencies. Although the measurements were made in accordance with the procedures described in ASTM E90-09, they do not qualify as part of the standard. Since the results are representative of the test environment only, they are unofficial and intended for research and development guidelines rather than for commercial purposes. The transmission loss values at the additional frequencies were as follows:

	RAL™-TL13-140
1/3 Octave Center Frequency	Sound Transmission Loss
(Hz)	(dB)
40	25
50	10
63	0
80	6
6300	49
8000	53
10000	50

*Headquarters: 1 Burt Drive, Deer Park, NY 11729 * Tel. 800-394-8913 * Fax: 631-242-2246*
West Coast: 16901 Armstrong Avenue, Irvine, CA 92606 Tel. 949-955-9202 * Fax: 949-222-0834*

SOUNDCOAT *Technical Data Sheet*

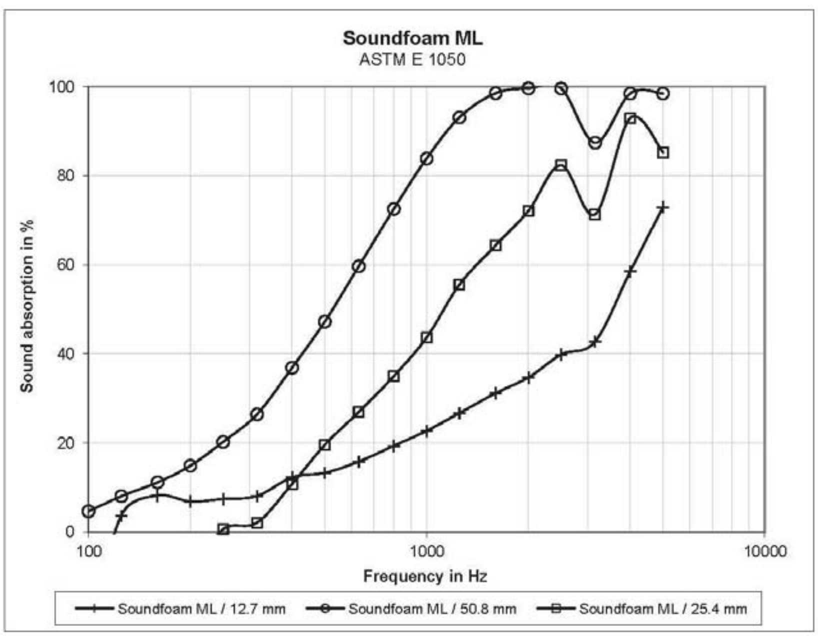
SOUNDFOAM® - ML

Product Description (w/ Features & Benefits):

SOUNDFOAM ML is a lightweight, flexible, open-cell, melamine based acoustic quality foam having excellent flame* and heat resistance. It exhibits a very low degree of flammability, does not drip upon ignition, ceases to burn after removal of ignition source, and produces a minimum amount of smoke. Compared with some glass-fiber based acoustical products, **SOUNDFOAM ML** has better strength, lower compression set, and higher resiliency. It is recommended for use as acoustic or thermal insulation in aerospace, marine, or ground units, etc., where light weight, heat resistance, and fire safety are of the utmost concern. It is available plain or with decorative and protective surface finishes of reinforced aluminized polyester film, Tedlar®, Nomex®, etc. For customer convenience, the foam is supplied with one of several high performance pressure-sensitive adhesives for ease of installation. Soundfoam ML is available in standard sheet sizes or in custom sheet sizes or as custom cut parts.

How It Works:

The sound absorption performance of elastic porous materials is determined mainly by the porosity and airflow resistance (air permeability) of the materials. Sound absorption data for various surface finishes are available upon request. Following are typical sound absorption curves.



Physical Properties:

Chemical Type:	Flexible Melamine Foam
Color:	Grey
Thickness, mm (in.):	Std. 6.4 (0.25), 12.7 (0.5), 19.0 (0.75), 25.4 (1), and 50.8 (2)
Sheet Size, mm (in.):	Std. 1219 x 610 (48 x 24) or 2438 x 1219 (96 x 48)
Density, kg/m^3 (lb/ft^3):	9 (0.562) per ASTM D 3574-77 Test A
Tensile Strength, kPa (psi):	120 (18) per ASTM D 3574-77 Test E
Elongation, %:	20 per ASTM D 3574-77 Test E
Tear Strength, N/m (lb/in)	87 (0.5) per ASTM D 3574-77 Test F
CLD (25%), N/mm^2 (psi):	0.01 (1.4) per ASTM D 3574-77 Test C
Compression Set (50%), %	30 per ASTM D 3574-77 Test D
Thermal Conductivity, kcal.m/hr.m^2.°C (BTU.in/hr.ft^2.°F):	46 (0.25) per ASTM C 117 at 24°C (75°F)
Service Temperature:	-43° to 200°C (-45° to 392°F)
Flame Resistance*:	• FAR 25.853 (b) Vertical Burn Test ○ Burn Length: 2.54 cm (1.0 in.) ○ Post Burn Time: 0 s, no dripping • FAR 25.856(a) ○ Pass • UL-94 ○ Meets HF-1 and V-0 classification requirements • ASTM E 84 Tunnel Test ○ Flame Spread: 2.5 ○ Smoke Developed: 16.9 • ASTM E 162 ○ <25 • ASTM E 662 ○ <100
Airflow Resistivity:	13410 Rayls/m

Typical Sound Absorption Performance:

Sound absorption coefficients measured per ASTM C 384:

Thickness \ Frequency	125	250	500	1000	2000	4000
6.4 mm (0.25 in)	0.05	0.05	0.10	0.20	0.39	0.81
12.7 mm (0.5 in)	0.13	0.15	0.26	0.43	0.76	0.93
25.4 (1.0 in)	0.18	0.25	0.50	0.82	0.97	1.00

For further information regarding this product, please contact our Technical Support Department at 1-800-394-8913, ext. 147.

Visit us on the web at www.soundcoat.com to see our complete line of absorption, damping, and barrier materials for the OEM marketplace.

Rev 3/13

SOUNDCOAT .... *Keeping it Quiet for 40 years*

The information contained herein is based on laboratory test data developed by or for Soundcoat and is believed to be reliable, but its accuracy or completeness is not guaranteed. The buyer must test this product to determine its suitability for his specific application before use. ONLY use a Soundcoat product after thoroughly consulting instructions on the data sheet for the specific product. SOUNDCOAT DISCLAIMS ANY RESPONSIBILITY FOR: 1) WARRANTIES OF FITNESS AND PURPOSE, 2) VERBAL RECOMMENDATIONS, 3) CONSEQUENTIAL DAMAGES FROM USE AND 4) VIOLATION OF ANY PATENTS OR TRADEMARKS HELD BY OTHERS.

* This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions. The Federal Trade Commission consider that there are no existing test methods or standards regarding flammability that are accurate indicators of the performance of cellular plastic materials under actual fire conditions. Any result of existing methods, such as ASTM D 1692 and UL-94, are intended only as a measurement of the performance of such materials under specific, controlled conditions.

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TEST REPORT

FOR: **NASA Glenn Research Center**
Cleveland, OH

Sound Transmission Loss
RAL™-TL13-141

CONDUCTED: 10 July 2013

Page 1 of 5

ON: FRF Panel - 4" Gray Melamine Foam with 1/4" Holes - (2 Layers of 2") - FRF Faces Source

TEST METHOD

Unless otherwise designated, the measurements reported below were made with all facilities and procedures in explicit conformity with the ASTM Designations E90-09 and E413-10, as well as other pertinent standards. Riverbank Acoustical Laboratories has been accredited by the U.S. Department of Commerce, National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP) for this test procedure (NVLAP Lab Code: 100227-0). A description of the measuring technique is available separately.

DESCRIPTION OF THE SPECIMEN

The specimen was designated as follows: FRF Panel - 4" Gray Melamine Foam with 1/4" Holes - (2 layers of 2") - FRF faces source. The test specimen was designated by the manufacturer as two layers of 50.8 mm (2 in.) thick Soundcoat Soundfoam® ML (Gray Melamine Foam) behind the NASA Standard Fiber-Reinforced Foam Panel (FRF Panel). Each foam panel was perforated with 18 randomly placed penetrations with a range of approx. 7 mm to 10 mm in diameter. All holes penetrated through the single panel, but were not congruent through both panels. The FRF panel faced the sound source during this test. A visual inspection by Riverbank staff verified the manufacturer's description of the specimen. See the attached "Technical Data Sheet" for a detailed material specification.

The overall dimensions of the specimen as measured were 1.21 m (47.75 in.) wide by 2.43 m (95.75 in.) high and 129.03 mm (5.08 in.) thick. The measured weight of the entire specimen was 20.6 kg (45.5 lbs.), an average of 7.0 kg/m^2 (1.4 lbs/ft^2). The specimen was placed directly in the laboratory's 1.22 m (4 ft) by 2.44 m (8 ft) test opening. The FRF panel was sealed on the periphery (both sides) with dense mastic. The foam panels were not fully sealed, per the client's request. For this test, Room 3 served as the source room and Room 2 served as the receive room.

The source room temperature at the time of the test was 23±1°C (73±2°F) and 59±1% relative humidity. The receiving room temperature at the time of the test was 23±1°C (74±1°F) and 61±2% relative humidity. The source and receive reverberation room volumes were 140 m^3 (4,929 ft^3) and 178 m^3 (6,298 ft^3), respectively. The transmission area used in the calculations was 3.0 m^2 (32 ft^2).

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TEST REPORT

NASA Glenn Research Center
10 July 2013

RAL™-TL13-141
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Figure 1 - Test specimen with penetrations.

Figure 2 - The Receive Room configuration.

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TEST REPORT

NASA Glenn Research Center — **RAL™-TL13-141**
10 July 2013 — Page 3 of 5

TEST RESULTS

Sound transmission loss values are tabulated at the eighteen standard frequencies. A graphic presentation of the data and additional information appear on the following pages. The precision of the TL test data is within the limits set by the ASTM Standard E90-09.

FREQ.	T.L.	C.L.	DEF.	FREQ.	T.L.	C.L.	DEF.
100	10	0.52		800	30	0.13	
125	13	0.57		1000	34	0.12	
160	14	0.50	1	1250	38	0.08	
200	14	0.33	4	1600	40	0.09	
250	17	0.41	4	2000	43	0.08	
315	20	0.26	4	2500	47	0.10	
400	20	0.29	7	3150	50	0.07	
500	24	0.20	4	4000	51	0.05	
630	27	0.19	2	5000	50	0.05	

STC=28

ABBREVIATION INDEX

FREQ. = FREQUENCY, HERTZ, (cps)
T.L. = TRANSMISSION LOSS, dB
C.L. = UNCERTAINTY IN dB, FOR A 95% CONFIDENCE LIMIT
DEF. = DEFICIENCIES, dB<STC CONTOUR (SUM OF DEF = 26)
STC = SOUND TRANSMISSION CLASS

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DN: cn=Eric Wolfram, o=Alion Science and Technology, ou=Riverbank Acoustical Laboratories, email=ewolfram@alionscience.com, c=US
Date: 2013.07.17 10:52:01 -05'00'

Tested by ______________ Approved by ______________

Dean Victor
Senior Experimentalist

Eric P. Wolfram
Laboratory Manager

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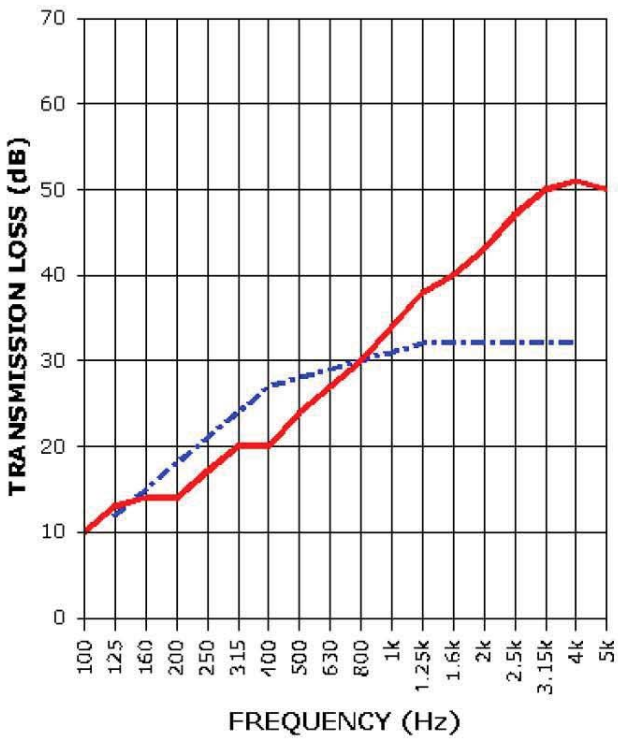
TEST REPORT

NASA Glenn Research Center
10 July 2013

RAL™-TL13-141
Page 4 of 5

SOUND TRANSMISSION REPORT

FRF Panel - 4" Gray Melamine Foam with 1/4" Holes - (2 Layers of 2") - FRF Faces Source



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TRANSMISSION LOSS
SOUND TRANSMISSION LOSS CONTOUR

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TEST REPORT

Appendix to ASTM E90 Sound Transmission Loss Test
Extended Frequency Range Data

Product Description: FRF Panel - 4" Gray Melamine Foam with 1/4" Holes - (2 Layers of 2") - FRF Faces Source (See Full Report)

As requested by the client, transmission loss (TL) values were calculated at additional test frequencies. Although the measurements were made in accordance with the procedures described in ASTM E90-09, they do not qualify as part of the standard. Since the results are representative of the test environment only, they are unofficial and intended for research and development guidelines rather than for commercial purposes. The transmission loss values at the additional frequencies were as follows:

	RAL™-TL13-141
1/3 Octave Center Frequency	Sound Transmission Loss
(Hz)	(dB)
40	25
50	11
63	0
80	5
6300	49
8000	53
10000	50

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West Coast: 16901 Armstrong Avenue, Irvine, CA 92606 Tel. 949-955-9202 * Fax: 949-222-0834*

SOUNDCOAT *Technical Data Sheet*

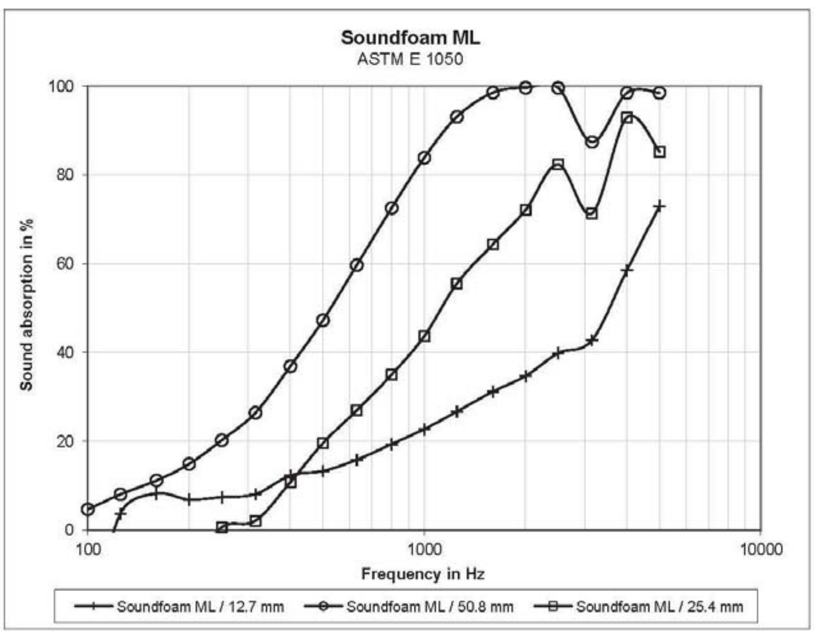
SOUNDFOAM® - ML

Product Description (w/ Features & Benefits):

SOUNDFOAM ML is a lightweight, flexible, open-cell, melamine based acoustic quality foam having excellent flame* and heat resistance. It exhibits a very low degree of flammability, does not drip upon ignition, ceases to burn after removal of ignition source, and produces a minimum amount of smoke. Compared with some glass-fiber based acoustical products, **SOUNDFOAM ML** has better strength, lower compression set, and higher resiliency. It is recommended for use as acoustic or thermal insulation in aerospace, marine, or ground units, etc., where light weight, heat resistance, and fire safety are of the utmost concern. It is available plain or with decorative and protective surface finishes of reinforced aluminized polyester film, Tedlar®, Nomex®, etc. For customer convenience, the foam is supplied with one of several high performance pressure-sensitive adhesives for ease of installation. Soundfoam ML is available in standard sheet sizes or in custom sheet sizes or as custom cut parts.

How It Works:

The sound absorption performance of elastic porous materials is determined mainly by the porosity and airflow resistance (air permeability) of the materials. Sound absorption data for various surface finishes are available upon request. Following are typical sound absorption curves.



Physical Properties:

Chemical Type:	Flexible Melamine Foam
Color:	Grey
Thickness, mm (in.):	Std. 6.4 (0.25), 12.7 (0.5), 19.0 (0.75), 25.4 (1), and 50.8 (2)
Sheet Size, mm (in.):	Std. 1219 x 610 (48 x 24) or 2438 x 1219 (96 x 48)
Density, kg/m^3 (lb/ft^3):	9 (0.562) per ASTM D 3574-77 Test A
Tensile Strength, kPa (psi):	120 (18) per ASTM D 3574-77 Test E
Elongation, %:	20 per ASTM D 3574-77 Test E
Tear Strength, N/m (lb/in)	87 (0.5) per ASTM D 3574-77 Test F
CLD (25%), N/mm^2 (psi):	0.01 (1.4) per ASTM D 3574-77 Test C
Compression Set (50%), %	30 per ASTM D 3574-77 Test D
Thermal Conductivity, kcal.m/hr.m^2.°C (BTU.in/hr.ft^2.°F):	46 (0.25) per ASTM C 117 at 24°C (75°F)
Service Temperature:	-43° to 200°C (-45° to 392°F)

Flame Resistance*:	• FAR 25.853 (b) Vertical Burn Test
	  ○ Burn Length: 2.54 cm (1.0 in.)
	  ○ Post Burn Time: 0 s, no dripping
	• FAR 25.856(a)
	  ○ Pass
	• UL-94
	  ○ Meets HF-1 and V-0 classification requirements
	• ASTM E 84 Tunnel Test
	  ○ Flame Spread: 2.5
	  ○ Smoke Developed: 16.9
	• ASTM E 162
	  ○ <25
	• ASTM E 662
	  ○ <100

Airflow Resistivity:	13410 Rayls/m

Typical Sound Absorption Performance:

Sound absorption coefficients measured per ASTM C 384:

Thickness \ Frequency	125	250	500	1000	2000	4000
6.4 mm (0.25 in)	0.05	0.05	0.10	0.20	0.39	0.81
12.7 mm (0.5 in)	0.13	0.15	0.26	0.43	0.76	0.93
25.4 (1.0 in)	0.18	0.25	0.50	0.82	0.97	1.00

For further information regarding this product, please contact our Technical Support Department at 1-800-394-8913, ext. 147.

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Rev 3/13

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* This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions. The Federal Trade Commission consider that there are no existing test methods or standards regarding flammability that are accurate indicators of the performance of cellular plastic materials under actual fire conditions. Any result of existing methods, such as ASTM D 1692 and UL-94, are intended only as a measurement of the performance of such materials under specific, controlled conditions.

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TEST REPORT

FOR: **NASA Glenn Research Center**
Cleveland, OH

Sound Transmission Loss
RAL™-TL13-142

CONDUCTED: 10 July 2013

Page 1 of 6

ON: FRF Panel - 4" Gray Melamine Foam with 1/4" Holes Filled with Serrated Hex Flange Bolts 5/16-18 x 2" - (2 Layers of 2") - FRF Faces Source

TEST METHOD

Unless otherwise designated, the measurements reported below were made with all facilities and procedures in explicit conformity with the ASTM Designations E90-09 and E413-10, as well as other pertinent standards. Riverbank Acoustical Laboratories has been accredited by the U.S. Department of Commerce, National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP) for this test procedure (NVLAP Lab Code: 100227-0). A description of the measuring technique is available separately.

DESCRIPTION OF THE SPECIMEN

The specimen was designated as follows: FRF Panel - 4" Gray Melamine Foam with 1/4" holes filled with serrated hex flange bolt 5/16 – 18 x 2" - (2 layers of 2") - FRF faces source. The test specimen was described by the manufacturer as two layers of 50.8 mm (2 in.) thick Soundcoat Soundfoam® ML (Gray Melamine Foam) behind the NASA Standard Fiber-Reinforced Foam Panel (FRF Panel). Each foam panel was perforated with 18 randomly placed penetrations with a range of approx. 7 mm to 10 mm in diameter. All holes penetrated through the single panel, but were not congruent through both panels. All holes were filled with serrated hex flange bolts 5/16-18 x 2". The FRF panel faced the sound source during this test. A visual inspection by Riverbank staff verified the manufacturer's description of the specimen. See the attached "Technical Data Sheet" for a detailed material specification.

The overall dimensions of the specimen as measured were 1.21 m (47.75 in.) wide by 2.43 m (95.75 in.) high and 129.03 mm (5.08 in.) thick. The measured weight of the entire specimen was 21.4 kg (47.3 lbs.), an average of 7.3 kg/m^2 (1.5 lbs/ft^2). The specimen was placed directly in the laboratory's 1.22 m (4 ft) by 2.44 m (8 ft) test opening. The FRF panel was sealed on the periphery (both sides) with dense mastic. The foam panels were not fully sealed, per the client's request. For this test, Room 3 served as the source room and Room 2 served as the receive room.

The source room temperature at the time of the test was 23±1°C (74±1°F) and 57±1% relative humidity. The receiving room temperature at the time of the test was 24±1°C (75±1°F) and 56±1% relative humidity. The source and receive reverberation room volumes were 140 m^3 (4,929 ft^3) and 178 m^3 (6,298 ft^3), respectively. The transmission area used in the calculations was 3.0 m^2 (32 ft^2).

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TEST REPORT

NASA Glenn Research Center
10 July 2013

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Figure 1 - Test specimen in test frame.

Figure 2 - Receive Room configuration.

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TEST REPORT

Figure 3 - Detail of penetrations filled with bolts.

Figure 4- Bolt package.

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TEST REPORT

TEST RESULTS

Sound transmission loss values are tabulated at the eighteen standard frequencies. A graphic presentation of the data and additional information appear on the following pages. The precision of the TL test data is within the limits set by the ASTM Standard E90-09.

FREQ.	T.L.	C.L.	DEF.	FREQ.	T.L.	C.L.	DEF.
100	10	0.61		800	30	0.14	
125	12	0.49		1000	34	0.12	
160	14	0.43	1	1250	38	0.12	
200	14	0.38	4	1600	40	0.12	
250	16	0.31	5	2000	43	0.08	
315	19	0.35	5	2500	47	0.10	
400	20	0.28	7	3150	50	0.08	
500	24	0.22	4	4000	52	0.05	
630	27	0.22	2	5000	50	0.05	

STC=28

ABBREVIATION INDEX

FREQ. = FREQUENCY, HERTZ, (cps)
T.L. = TRANSMISSION LOSS, dB
C.L. = UNCERTAINTY IN dB, FOR A 95% CONFIDENCE LIMIT
DEF. = DEFICIENCIES, dB<STC CONTOUR (SUM OF DEF = 28)
STC = SOUND TRANSMISSION CLASS

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DN: cn=Eric Wolfram, o=Alion Science and Technology, ou=Riverbank Acoustical Laboratories, email=ewolfram@alionscience.com, c=US
Date: 2013.07.17 10:52:54 -05'00'

Tested by ____________ Approved by ____________

Dean Victor
Senior Experimentalist

Eric P. Wolfram
Laboratory Manager

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TEST REPORT

NASA Glenn Research Center — **RAL™-TL13-142**

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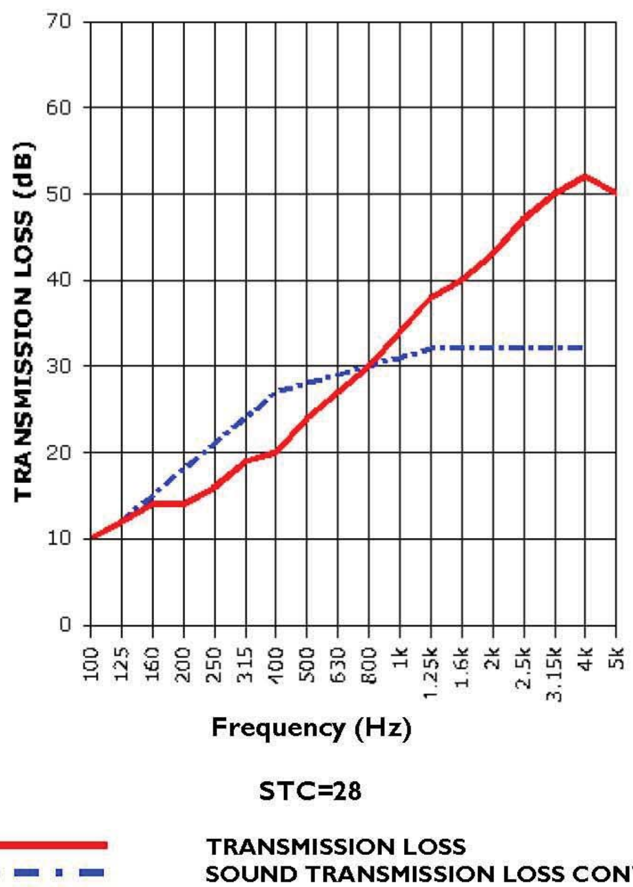
SOUND TRANSMISSION REPORT

FRF Panel - 4" Gray Melamine Foam with 1/4" Holes Filled with Serrated Hex Flange Bolts 5/16-18 x 2" - (2 Layers of 2") - FRF Faces Source



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TEST REPORT

NASA Glenn Research Center — **RAL™-TL13-142**
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Appendix to ASTM E90 Sound Transmission Loss Test
Extended Frequency Range Data

Product Description: FRF Panel - 4" Gray Melamine Foam with 1/4" Holes Filled with Serrated Hex Flange Bolts 5/16-18 x 2" - (2 Layers of 2") - FRF Faces Source (See Full Report)

As requested by the client, transmission loss (TL) values were calculated at additional test frequencies. Although the measurements were made in accordance with the procedures described in ASTM E90-09, they do not qualify as part of the standard. Since the results are representative of the test environment only, they are unofficial and intended for research and development guidelines rather than for commercial purposes. The transmission loss values at the additional frequencies were as follows:

RAL™-TL13-142

1/3 Octave Center Frequency (Hz)	Sound Transmission Loss (dB)
40	25
50	11
63	1
80	6
6300	50
8000	53
10000	50

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TEST REPORT

FOR: **NASA Glenn Research Center**
Cleveland, OH

Sound Transmission Loss
RAL™-TL13-143

CONDUCTED: 10 July 2013

Page 1 of 5

ON: FRF Panel - 2" Soundcoat Soundfoam® ML - 2" Aerospace DURA-SONIC® - (2 Layers of 1") - FRF Faces Source

TEST METHOD

Unless otherwise designated, the measurements reported below were made with all facilities and procedures in explicit conformity with the ASTM Designations E90-09 and E413-10, as well as other pertinent standards. Riverbank Acoustical Laboratories has been accredited by the U.S. Department of Commerce, National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP) for this test procedure (NVLAP Lab Code: 100227-0). A description of the measuring technique is available separately.

DESCRIPTION OF THE SPECIMEN

The specimen was designated as follows: FRF Panel - 2" Soundcoat Soundfoam® ML - 2" Aerospace DURA-SONIC® - (2 layers of 1") - FRF faces source. The test specimen was designated by the manufacturer as one layer of 50.8 mm (2 in.) thick Aerospace DURA-SONIC® with 60 oz. mass-loaded, reinforced sound barrier material Style 5666 behind one layer of 50.8 mm (2 in.) thick Soundcoat Soundfoam® ML (Gray Melamine Foam) behind one NASA Standard Fiber-Reinforced Foam Panel (FRF Panel). The FRF panel faced the sound source during this test. A visual inspection by Riverbank staff verified the manufacturer's description of the specimen. See the attached "Technical Data Sheet" for a detailed material specification.

The overall dimensions of the specimen as measured were 1.21 m (47.75 in.) wide by 2.43 m (95.75 in.) high and 129.03 mm (5.08 in.) thick. The measured weight of the entire specimen was 27.0 kg (59.5 lbs.), an average of 9.1 kg/m^2 (1.9 lbs/ft^2). The specimen was placed directly in the laboratory's 1.22 m (4 ft) by 2.44 m (8 ft) test opening. The FRF panel was sealed on the periphery (both sides) with dense mastic. The foam panels were not fully sealed, per the client's request. For this test, Room 3 served as the source room and Room 2 served as the receive room.

The source room temperature at the time of the test was 23±0°C (74±1°F) and 54±1% relative humidity. The receiving room temperature at the time of the test was 23±0°C (74±1°F) and 53±1% relative humidity. The source and receive reverberation room volumes were 140 m^3 (4,929 ft^3) and 178 m^3 (6,298 ft^3), respectively. The transmission area used in the calculations was 3.0 m^2 (32 ft^2).

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TEST REPORT

NASA Glenn Research Center — **RAL™-TL13-143**
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Figure 1 - Receive Room configuration.

Figure 2 - DURA-SONIC barrier detail.

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TEST REPORT

NASA Glenn Research Center — **RAL™-TL13-143**
10 July 2013 — Page 3 of 5

TEST RESULTS

Sound transmission loss values are tabulated at the eighteen standard frequencies. A graphic presentation of the data and additional information appear on the following pages. The precision of the TL test data is within the limits set by the ASTM Standard E90-09.

FREQ.	T.L.	C.L.	DEF.	FREQ.	T.L.	C.L.	DEF.
100	10	0.57		800	45	0.15	
125	11	0.52	6	1000	50	0.18	
160	14	0.37	6	1250	50	0.12	
200	15	0.38	8	1600	53	0.08	
250	21	0.29	5	2000	56	0.12	
315	25	0.28	4	2500	59	0.11	
400	29	0.24	3	3150	61	0.08	
500	35	0.21		4000	62	0.06	
630	38	0.27		5000	61	0.07	

STC=33

ABBREVIATION INDEX

FREQ. = FREQUENCY, HERTZ, (cps)
T.L. = TRANSMISSION LOSS, dB
C.L. = UNCERTAINTY IN dB, FOR A 95% CONFIDENCE LIMIT
DEF. = DEFICIENCIES, dB<STC CONTOUR (SUM OF DEF = 32)
STC = SOUND TRANSMISSION CLASS

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DN: cn=Eric Wolfram, o=Alion Science and Technology, ou=Riverbank Acoustical Laboratories, email=ewolfram@alionscience.com, c=US
Date: 2013.07.17 11:07:57 -05'00'

Tested by Marc Sciaky — Approved by

Marc Sciaky
Experimentalist

Eric P. Wolfram
Laboratory Manager

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TEST REPORT

NASA Glenn Research Center
10 July 2013

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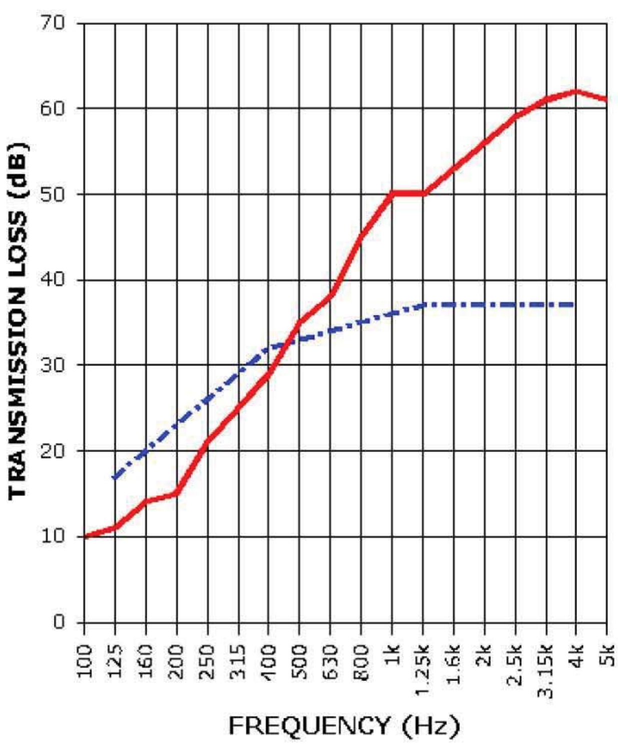
Page 4 of 5

SOUND TRANSMISSION REPORT

FRF Panel - 2" Soundcoat Soundfoam® ML - 2" Aerospace DURA-SONIC® - (2 Layers of 1") - FRF Faces Source



STC=33

TRANSMISSION LOSS
SOUND TRANSMISSION LOSS CONTOUR

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TEST REPORT

NASA Glenn Research Center — **RAL™-TL13-143**
10 July 2013 — Page 5 of 5

Appendix to ASTM E90 Sound Transmission Loss Test
Extended Frequency Range Data

Product Description: FRF Panel - 2" Soundcoat Soundfoam® ML - 2" Aerospace DURA-SONIC® - (2 Layers of 1") - FRF Faces Source (See Full Report)

As requested by the client, transmission loss (TL) values were calculated at additional test frequencies. Although the measurements were made in accordance with the procedures described in ASTM E90-09, they do not qualify as part of the standard. Since the results are representative of the test environment only, they are unofficial and intended for research and development guidelines rather than for commercial purposes. The transmission loss values at the additional frequencies were as follows:

	RAL™-TL13-143
1/3 Octave Center Frequency	Sound Transmission Loss
(Hz)	(dB)
40	22
50	6
63	1
80	7
6300	60
8000	57
10000	50

Headquarters: 1 Burt Drive, Deer Park, NY 11729 * Tel. 800-394-8913 * Fax: 631-242-2246
West Coast: 16901 Armstrong Avenue, Irvine, CA 92606* Tel. 949-955-9202 * Fax: 949-222-0834

SOUNDCOAT

Technical Data Sheet

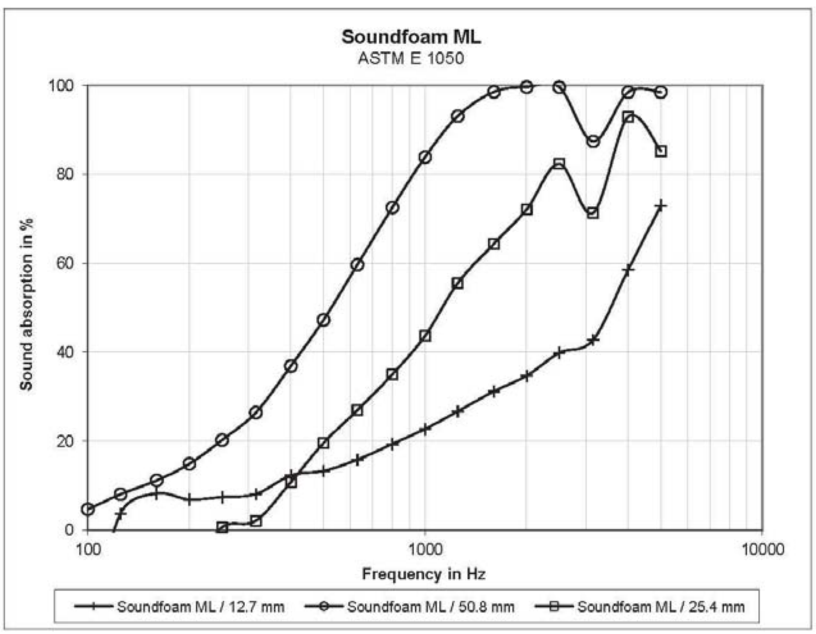
SOUNDFOAM® - ML

Product Description (w/ Features & Benefits):

SOUNDFOAM ML is a lightweight, flexible, open-cell, melamine based acoustic quality foam having excellent flame* and heat resistance. It exhibits a very low degree of flammability, does not drip upon ignition, ceases to burn after removal of ignition source, and produces a minimum amount of smoke. Compared with some glass-fiber based acoustical products, **SOUNDFOAM ML** has better strength, lower compression set, and higher resiliency. It is recommended for use as acoustic or thermal insulation in aerospace, marine, or ground units, etc., where light weight, heat resistance, and fire safety are of the utmost concern. It is available plain or with decorative and protective surface finishes of reinforced aluminized polyester film, Tedlar®, Nomex®, etc. For customer convenience, the foam is supplied with one of several high performance pressure-sensitive adhesives for ease of installation. Soundfoam ML is available in standard sheet sizes or in custom sheet sizes or as custom cut parts.

How It Works:

The sound absorption performance of elastic porous materials is determined mainly by the porosity and airflow resistance (air permeability) of the materials. Sound absorption data for various surface finishes are available upon request. Following are typical sound absorption curves.



Physical Properties:

Chemical Type:	Flexible Melamine Foam
Color:	Grey
Thickness, mm (in.):	Std. 6.4 (0.25), 12.7 (0.5), 19.0 (0.75), 25.4 (1), and 50.8 (2)
Sheet Size, mm (in.):	Std. 1219 x 610 (48 x 24) or 2438 x 1219 (96 x 48)
Density, kg/m^3 (lb/ft^3):	9 (0.562) per ASTM D 3574-77 Test A
Tensile Strength, kPa (psi):	120 (18) per ASTM D 3574-77 Test E
Elongation, %:	20 per ASTM D 3574-77 Test E
Tear Strength, N/m (lb/in)	87 (0.5) per ASTM D 3574-77 Test F
CLD (25%), N/mm^2 (psi):	0.01 (1.4) per ASTM D 3574-77 Test C
Compression Set (50%), %	30 per ASTM D 3574-77 Test D
Thermal Conductivity, $kcal.m/hr.m^2.°C$ ($BTU.in/hr.ft^2.°F$):	46 (0.25) per ASTM C 117 at 24°C (75°F)
Service Temperature:	-43° to 200°C (-45° to 392°F)

Flame Resistance*:	• FAR 25.853 (b) Vertical Burn Test
	  ○ Burn Length: 2.54 cm (1.0 in.)
	  ○ Post Burn Time: 0 s, no dripping
	• FAR 25.856(a)
	  ○ Pass
	• UL-94
	  ○ Meets HF-1 and V-0 classification requirements
	• ASTM E 84 Tunnel Test
	  ○ Flame Spread: 2.5
	  ○ Smoke Developed: 16.9
	• ASTM E 162
	  ○ <25
	• ASTM E 662
	  ○ <100

Airflow Resistivity:	13410 Rayls/m

Typical Sound Absorption Performance:

Sound absorption coefficients measured per ASTM C 384:

Thickness \ Frequency	125	250	500	1000	2000	4000
6.4 mm (0.25 in)	0.05	0.05	0.10	0.20	0.39	0.81
12.7 mm (0.5 in)	0.13	0.15	0.26	0.43	0.76	0.93
25.4 (1.0 in)	0.18	0.25	0.50	0.82	0.97	1.00

For further information regarding this product, please contact our Technical Support Department at 1-800-394-8913, ext. 147.

Visit us on the web at www.soundcoat.com to see our complete line of absorption, damping, and barrier materials for the OEM marketplace.

Rev 3/13

SOUNDCOAT .... *Keeping it Quiet for 40 years*

* This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions. The Federal Trade Commission consider that there are no existing test methods or standards regarding flammability that are accurate indicators of the performance of cellular plastic materials under actual fire conditions. Any result of existing methods, such as ASTM D 1692 and UL-94, are intended only as a measurement of the performance of such materials under specific, controlled conditions.

Aerospace DURA-SONIC

60oz. Mass-loaded, Reinforced Sound Barrier Material specifically formulated for Acoustic & Flame Resistant Aerospace Applications with Improved Flexibility.

Styles 5666

TYPICAL PHYSICAL PROPERTIES

Aerospace DURA-SONIC® products combine the noise abatement properties of our Dura-Sonic line with the high temperature flame resistant properties of our Dura-Trim. This latest generation provides improved flexibility.

DURA-SONIC® 5666 is REACH compliant, Deca-BDE free and can be certified to the Boeing BMS 8-374 requirements.

Typical Physical Properties

Weight / FTM 5041	60 oz/yd^2
Thickness	<0.060"
*Flame / FAR 25.853	
After Flame	<15 sec
Burn Length	<8 in
Radiant Panel	Front and Back
Flame / FAR25.856	
After Flame	<3 sec
Propagation	<2 in
Breaking Strength	>200 lbs/in
BMS8-374	Class 1&2 Type I

NOTE: The information provided is the best currently available and has been obtained by prevailing test methods. It is true and accurate to the best of our knowledge at this time. The information is provided as guidelines, should not be considered as specifications and is subject to revision as additional knowledge and experience on this product are gained. It is the responsibility of the end user to determine the suitability of our products for their particular application.

RO
Rev 12/03/12
NC

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TEST REPORT

FOR: **NASA Glenn Research Center**
Cleveland, OH

Sound Transmission Loss
RAL™-TL13-144

CONDUCTED: 10 July 2013

Page 1 of 5

ON: FRF Panel over 2" Soundfoam ML over 2" DURA-SONIC® over 2" Soundfoam UL over 2" Soundfoam ML (FRF Faces Source)

TEST METHOD

Unless otherwise designated, the measurements reported below were made with all facilities and procedures in explicit conformity with the ASTM Designations E90-09 and E413-10, as well as other pertinent standards. Riverbank Acoustical Laboratories has been accredited by the U.S. Department of Commerce, National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP) for this test procedure (NVLAP Lab Code: 100227-0). A description of the measuring technique is available separately.

DESCRIPTION OF THE SPECIMEN

The test specimen was designated by the manufacturer as:
One NASA Standard Fiber-Reinforced Foam Panel (FRF Panel), over
One layer of 50.8 mm (2 in.) thick Soundcoat Soundfoam® ML (Gray Melamine Foam) over
One layer of 50.8 mm (2 in.) thick Aerospace DURA-SONIC® with 60 oz. mass-loaded, reinforced sound barrier material Style 5666
One layer of 50.8 mm (2 in.) thick Soundcoat Soundfoam® UL (Yellow Ultralight Foam) over
One layer of 50.8 mm (2 in.) thick Soundcoat Soundfoam® ML (Gray Melamine Foam).

The FRF panel faced the sound source during this test. See the attached "Technical Data Sheet" for a detailed material specification. The overall dimensions of the specimen as measured were 1.21 m (47.75 in.) wide by 2.43 m (95.75 in.) high and 205.23 mm (8.08 in.) thick. The measured weight of the entire specimen was 29.1 kg (64.3 lbs.), an average of 9.9 kg/m^2 (2.0 lbs/ft^2). The specimen was placed directly in the laboratory's 1.22 m (4 ft) by 2.44 m (8 ft) test opening. The FRF panel was sealed on the periphery (both sides) with dense mastic. The foam panels were not fully sealed, per the client's request. For this test, Room 3 served as the source room and Room 2 served as the receive room.

The source room temperature at the time of the test was 23±1°C (73±1°F) and 49±2% relative humidity. The receiving room temperature at the time of the test was 23±1°C (74±1°F) and 49±2% relative humidity. The source and receive reverberation room volumes were 140 m^3 (4,929 ft^3) and 178 m^3 (6,298 ft^3), respectively. The transmission area used in the calculations was 3.0 m^2 (32 ft^2).

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TEST REPORT

Figure 1 - Receive Room configuration.

Figure 2 - Material layer configuration (top faces source).

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TEST REPORT

NASA Glenn Research Center — **RAL™-TL13-144**
10 July 2013 — Page 3 of 5

TEST RESULTS

Sound transmission loss values are tabulated at the eighteen standard frequencies. A graphic presentation of the data and additional information appear on the following pages. The precision of the TL test data is within the limits set by the ASTM Standard E90-09.

FREQ.	T.L.	C.L.	DEF.	FREQ.	T.L.	C.L.	DEF.
100	9	0.42		800	51	0.14	
125	12	0.59	7	1000	56	0.11	
160	15	0.41	7	1250	56	0.12	
200	17	0.48	8	1600	59	0.10	
250	24	0.32	4	2000	61	0.10	
315	30	0.19	1	2500	65	0.11	
400	33	0.23	1	3150	66	0.11	
500	41	0.20		4000	67	0.07	
630	45	0.15		5000	67	0.05	

STC=35

ABBREVIATION INDEX

FREQ. = FREQUENCY, HERTZ, (cps)
T.L. = TRANSMISSION LOSS, dB
C.L. = UNCERTAINTY IN dB, FOR A 95% CONFIDENCE LIMIT
DEF. = DEFICIENCIES, dB<STC CONTOUR (SUM OF DEF = 28)
STC = SOUND TRANSMISSION CLASS

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Date: 2013.07.17 11:05:16 -05'00'

Tested by Marc Sciaky, *Experimentalist* — Approved by Eric P. Wolfram, *Laboratory Manager*

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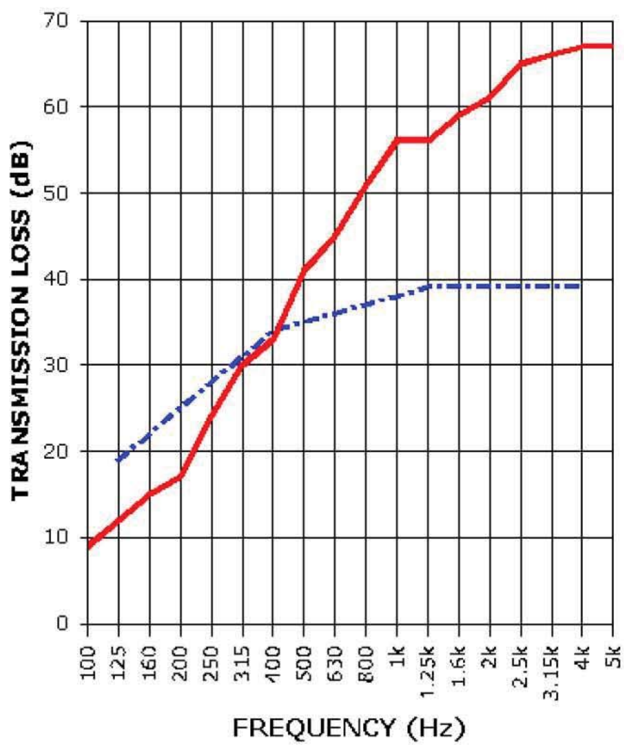
TEST REPORT

NASA Glenn Research Center
10 July 2013

RAL™-TL13-144
Page 4 of 5

SOUND TRANSMISSION REPORT

FRF Panel over 2" Soundfoam ML over 2" DURA-SONIC® over 2" Soundfoam UL over 2" Soundfoam ML (FRF Faces Source)



STC=35

TRANSMISSION LOSS
SOUND TRANSMISSION LOSS CONTOUR

NVLAP
NVLAP Lab Code 100227-0

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TEST REPORT

NASA Glenn Research Center — **RAL™-TL13-144**
10 July 2013 — Page 5 of 5

Appendix to ASTM E90 Sound Transmission Loss Test
Extended Frequency Range Data

Product Description: FRF Panel over 2" Soundfoam ML over 2" DURA-SONIC® over 2" Soundfoam UL over 2" Soundfoam ML (FRF Faces Source) (See Full Report)

As requested by the client, transmission loss (TL) values were calculated at additional test frequencies. Although the measurements were made in accordance with the procedures described in ASTM E90-09, they do not qualify as part of the standard. Since the results are representative of the test environment only, they are unofficial and intended for research and development guidelines rather than for commercial purposes. The transmission loss values at the additional frequencies were as follows:

	RAL™-TL13-144
1/3 Octave Center Frequency (Hz)	Sound Transmission Loss (dB)
40	21
50	6
63	2
80	8
6300	62
8000	57
10000	50

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West Coast: 16901 Armstrong Avenue, Irvine, CA 92606* Tel. 949-955-9202 * Fax: 949-222-0834

SOUNDCOAT Technical Data Sheet

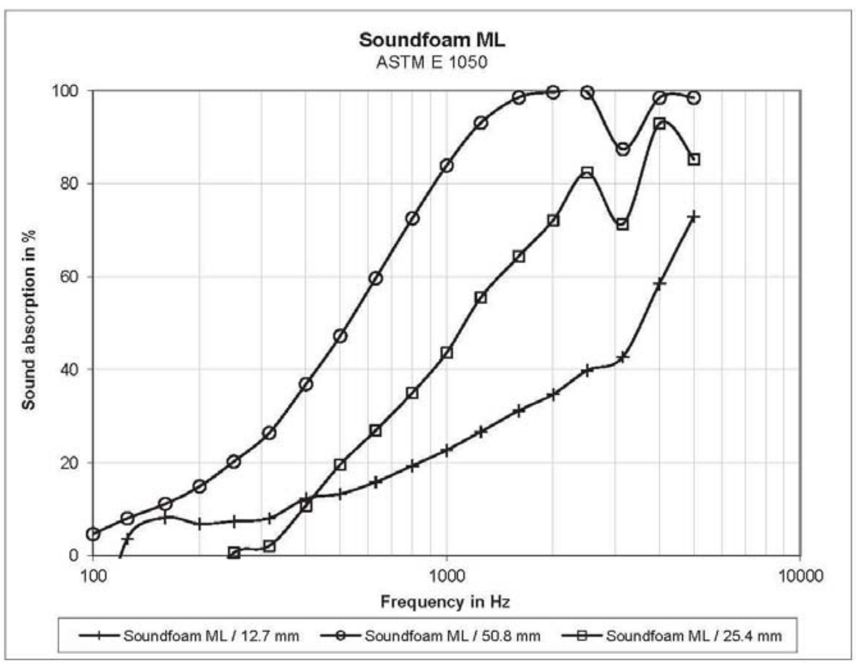
SOUNDFOAM® - ML

Product Description (w/ Features & Benefits):

SOUNDFOAM ML is a lightweight, flexible, open-cell, melamine based acoustic quality foam having excellent flame* and heat resistance. It exhibits a very low degree of flammability, does not drip upon ignition, ceases to burn after removal of ignition source, and produces a minimum amount of smoke. Compared with some glass-fiber based acoustical products, **SOUNDFOAM ML** has better strength, lower compression set, and higher resiliency. It is recommended for use as acoustic or thermal insulation in aerospace, marine, or ground units, etc., where light weight, heat resistance, and fire safety are of the utmost concern. It is available plain or with decorative and protective surface finishes of reinforced aluminized polyester film, Tedlar®, Nomex®, etc. For customer convenience, the foam is supplied with one of several high performance pressure-sensitive adhesives for ease of installation. Soundfoam ML is available in standard sheet sizes or in custom sheet sizes or as custom cut parts.

How It Works:

The sound absorption performance of elastic porous materials is determined mainly by the porosity and airflow resistance (air permeability) of the materials. Sound absorption data for various surface finishes are available upon request. Following are typical sound absorption curves.



Physical Properties:

Chemical Type: Flexible Melamine Foam
Color: Grey
Thickness, mm (in.): Std. 6.4 (0.25), 12.7 (0.5), 19.0 (0.75), 25.4 (1), and 50.8 (2)
Sheet Size, mm (in.): Std. 1219 x 610 (48 x 24) or 2438 x 1219 (96 x 48)
Density, kg/m^3 (lb/ft^3): 9 (0.562) per ASTM D 3574-77 Test A
Tensile Strength, kPa (psi): 120 (18) per ASTM D 3574-77 Test E
Elongation, %: 20 per ASTM D 3574-77 Test E
Tear Strength, N/m (lb/in) 87 (0.5) per ASTM D 3574-77 Test F
CLD (25%), N/mm^2 (psi): 0.01 (1.4) per ASTM D 3574-77 Test C
Compression Set (50%), % 30 per ASTM D 3574-77 Test D
Thermal Conductivity, kcal.m/hr.m^2.°C (BTU.in/hr.ft^2.°F): 46 (0.25) per ASTM C 117 at 24°C (75°F)
Service Temperature: -43° to 200°C (-45° to 392°F)
Flame Resistance*:

- FAR 25.853 (b) Vertical Burn Test
  - Burn Length: 2.54 cm (1.0 in.)
  - Post Burn Time: 0 s, no dripping
- FAR 25.856(a)
  - Pass
- UL-94
  - Meets HF-1 and V-0 classification requirements
- ASTM E 84 Tunnel Test
  - Flame Spread: 2.5
  - Smoke Developed: 16.9
- ASTM E 162
  - <25
- ASTM E 662
  - <100

Airflow Resistivity: 13410 Rayls/m

Typical Sound Absorption Performance:

Sound absorption coefficients measured per ASTM C 384:

Thickness \ Frequency	125	250	500	1000	2000	4000
6.4 mm (0.25 in)	0.05	0.05	0.10	0.20	0.39	0.81
12.7 mm (0.5 in)	0.13	0.15	0.26	0.43	0.76	0.93
25.4 (1.0 in)	0.18	0.25	0.50	0.82	0.97	1.00

For further information regarding this product, please contact our Technical Support Department at 1-800-394-8913, ext. 147.

Visit us on the web at www.soundcoat.com to see our complete line of absorption, damping, and barrier materials for the OEM marketplace.

Rev 3/13

SOUNDCOAT .... *Keeping it Quiet for 40 years*

* This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions. The Federal Trade Commission consider that there are no existing test methods or standards regarding flammability that are accurate indicators of the performance of cellular plastic materials under actual fire conditions. Any result of existing methods, such as ASTM D 1692 and UL-94, are intended only as a measurement of the performance of such materials under specific, controlled conditions.

*Headquarters: 1 Burt Drive, Deer Park, NY 11729 * Tel. 800-394-8913 * Fax: 631-242-2246*
West Coast: 16901 Armstrong Avenue, Irvine, CA 92606 Tel. 949-955-9202 * Fax: 949-222-0834*

SOUNDCOAT® *Technical Data Sheet*

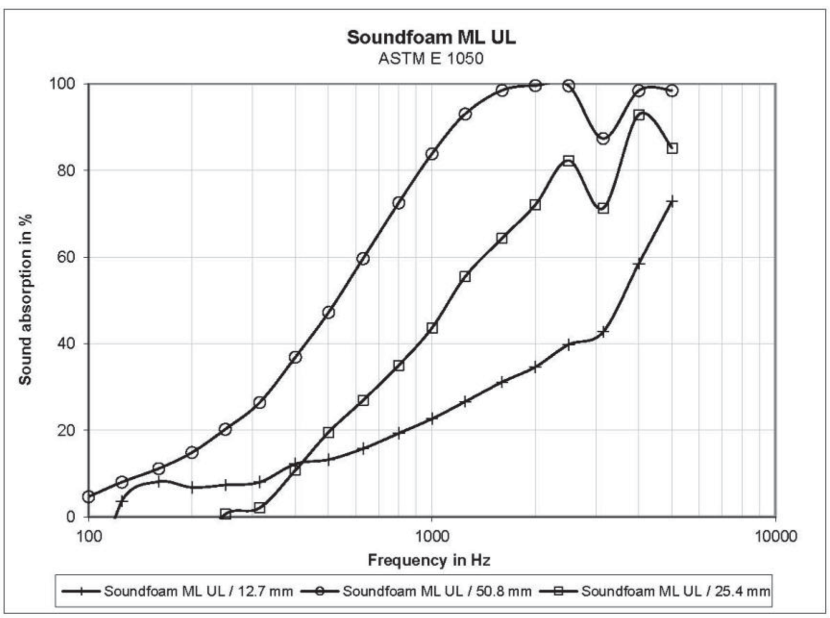
SOUNDFOAM® - ML UL

Product Description (w/ Features & Benefits):

SOUNDFOAM ML UL is a very lightweight, flexible, open-cell, melamine based acoustic quality foam having excellent flame* and heat resistance. It exhibits a very low degree of flammability, does not drip upon ignition, ceases to burn after removal of ignition source, and produces a minimum amount of smoke. Compared with some glass-fiber based acoustical products, **SOUNDFOAM ML UL** has better strength, lower compression set, and higher resiliency. It is recommended for use as acoustic or thermal insulation in aerospace, aircraft and other applications where a very light weight, heat resistance, and fire safety are of the utmost concern. It is available plain or with decorative and protective surface finishes of reinforced aluminized polyester film, Tedlar®, Nomex®, etc. For customer convenience, the foam can be supplied with one of several high performance pressure-sensitive adhesives for ease of installation. Soundfoam ML UL is available in standard sheet sizes or in custom sheet sizes or as custom cut parts.

How It Works:

The sound absorption performance of elastic porous materials is determined mainly by the porosity and airflow resistance (air permeability) of the materials. Sound absorption data for various surface finishes are available upon request. Following are typical sound absorption curves.



Physical Properties:

Chemical Type:	Flexible Melamine Foam
Color:	Yellow
Thickness, mm (in.):	Std. 6.4 (0.25), 12.7 (0.5), 19.0 (0.75), 25.4 (1), and 50.8 (2)
Sheet Size, mm (in.):	Std. 1219 x 610 (48 x 24) or 2438 x 1219 (96 x 48)
Density, kg/m^3 (lb/ft^3):	6 (0.375) per ASTM D 3574-77 Test A
Tensile Strength, KPa (psi):	80 (12) per ASTM D 3574-77 Test E
Elongation, %:	16 per ASTM D 3574-77 Test E
Tear Strength, N/m (lb/in)	50 (0.3) per ASTM D 3574-77 Test F
CLD (25%), N/mm^2 (psi):	0.01 (1.4) per ASTM D 3574-77 Test C
Compression Set (50%), %	30 per ASTM D 3574-77 Test D
Thermal Conductivity, kcal.m/hr.m^2.°C (BTU.in/hr.ft^2.°F):	46 (0.25) per ASTM C 117 at 24°C (75°F)
Service Temperature:	-43° to 200°C (-45° to 392°F)
Flame Resistance*:	• FAR 25.853 (b) Vertical Burn Test ○ Burn Length: 2.54 cm (1.0 in.) ○ Post Burn Time: 0 s, no dripping • FAR 25.856(a) ○ Pass • UL-94 ○ Meets HF-1 and V-0 classification requirements • ASTM E 84 Tunnel Test ○ Flame Spread: 2.5 ○ Smoke Developed: 16.9 • ASTM E 162 ○ <25 • ASTM E 662 ○ <100
Airflow Resistivity:	13410 Rayls/m

Typical Sound Absorption Performance:

Sound absorption coefficients measured per ASTM C 384:

Thickness \ Frequency	125	250	500	1000	2000	4000
6.4 mm (0.25 in)	0.05	0.05	0.10	0.20	0.39	0.81
12.7 mm (0.5 in)	0.13	0.15	0.26	0.43	0.76	0.93
25.4 (1.0 in)	0.18	0.25	0.50	0.82	0.97	1.00

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The information contained herein is based on laboratory test data developed by or for Soundcoat and is believed to be reliable, but its accuracy or completeness is not guaranteed. The buyer must test this product to determine its suitability for his specific application before use. ONLY use a Soundcoat product after thoroughly consulting instructions on the data sheet for the specific product. SOUNDCOAT DISCLAIMS ANY RESPONSIBILITY FOR: 1) WARRANTIES OF FITNESS AND PURPOSE, 2) VERBAL RECOMMENDATIONS, 3) CONSEQUENTIAL DAMAGES FROM USE AND 4) VIOLATION OF ANY PATENTS OR TRADEMARKS HELD BY OTHERS.

* This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions. The Federal Trade Commission consider that there are no existing test methods or standards regarding flammability that are accurate indicators of the performance of cellular plastic materials under actual fire conditions. Any result of existing methods, such as ASTM D 1692 and UL-94, are intended only as a measurement of the performance of such materials under specific, controlled conditions.

Aerospace DURA-SONIC

60oz. Mass-loaded, Reinforced Sound Barrier Material specifically formulated for Acoustic & Flame Resistant Aerospace Applications with Improved Flexibility.

Styles 5666

TYPICAL PHYSICAL PROPERTIES

Aerospace DURA-SONIC® products combine the noise abatement properties of our Dura-Sonic line with the high temperature flame resistant properties of our Dura-Trim. This latest generation provides improved flexibility.

DURA-SONIC® 5666 is REACH compliant, Deca-BDE free and can be certified to the Boeing BMS 8-374 requirements.

Typical Physical Properties

Weight / FTM 5041	60 oz/yd^2
Thickness	<0.060"
*Flame / FAR 25.853	
After Flame	<15 sec
Burn Length	<8 in
Radiant Panel	Front and Back
Flame / FAR25.856	
After Flame	<3 sec
Propagation	<2 in
Breaking Strength	>200 lbs/in
BMS8-374	Class 1&2 Type I

NOTE: The information provided is the best currently available and has been obtained by prevailing test methods. It is true and accurate to the best of our knowledge at this time. The information is provided as guidelines, should not be considered as specifications and is subject to revision as additional knowledge and experience on this product are gained. It is the responsibility of the end user to determine the suitability of our products for their particular application.

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Rev 12/03/12
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13. SUPPLEMENTARY NOTES

14. ABSTRACT

The NASA Engineering and Safety Center (NESC) funded a proposal to achieve initial basic acoustic characterization of ML (melamine) foam, which could serve as a starting point for a future, more comprehensive acoustic test program for ML foam. A project plan was developed and implemented to obtain acoustic test data for both normal and enhanced ML foam. This project became known as the NESC Enhanced Melamine Foam Acoustic Test (NEMFAT). This document contains the outcome of the NEMFAT project.

15. SUBJECT TERMS
NESC Enhanced Melamine Foam Acoustic Test; NASA Engineering and Safety Center; Fiber Reinforced Foam; Transmission Loss

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