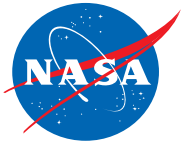

Acoustic Test Characterization of Melamine Foam for Usage in NASA's Payload Fairing Acoustic Attenuation Systems

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Overview

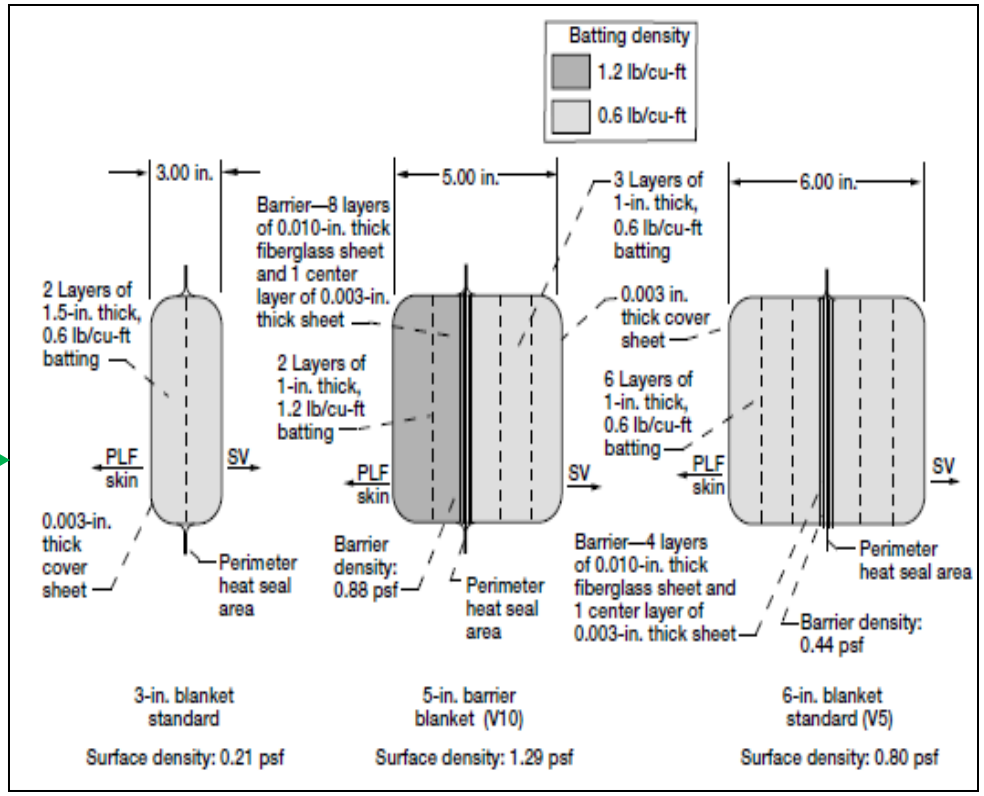
- **Challenge:**
  - Increased propulsion capability of NASA's future heavy lift launch vehicles
  - Aerospace Industry is moving to foam for acoustic attenuation systems
  - NASA is developing a database of acoustic properties of melamine foam
- **Actions:**
  - NASA Engineering and Safety Center Enhanced Melamine Foam Acoustic Test (NEMFAT)
  - NEMFAT Acoustic Analysis
  - NEMFAT Test Planning
  - NEMFAT Acoustic Testing
- **Results:**
  - NEMFAT ASTM C423 Sound Absorption Tests
  - NEMFAT ASTM E90 Sound Transmission Loss Tests

Internal Fairing Acoustic Liftoff Levels

- The noise reduction capability of NASA's future heavy lift vehicle fairing designs have been evaluated.
- Unprecedented high external acoustic liftoff levels could produce internal acoustic fairing levels as much as 10 dB higher than typical ELVs due to the increase in propulsion capability of the vehicles.
- Increased internal fairing acoustic noise levels between 20 to 400 Hz would likely be detrimental to payload flight hardware.

PLF Acoustic Attenuation Approach

- Past NASA acoustic attenuation efforts have focused on use of fiberglass blankets for typical PLF applications.
- Specialized acoustic treatments are sometimes necessary. For example, a thicker fiberglass blanket with an internal mass barrier was developed to reduce acoustics/vibration associated with the RTG's of NASA's Cassini spacecraft.
  - NASA TMs: #107266 (May 1966), #107474 (November 1996), #107475 (November 1996), #2000-209387 (September 2000)
- Today, the Aerospace Industry is moving to the use of (melamine) foam acoustic treatments.
- NASA Engineering and Safety Center (NESC) funded testing was initiated to characterize acoustic attenuation of melamine foam.



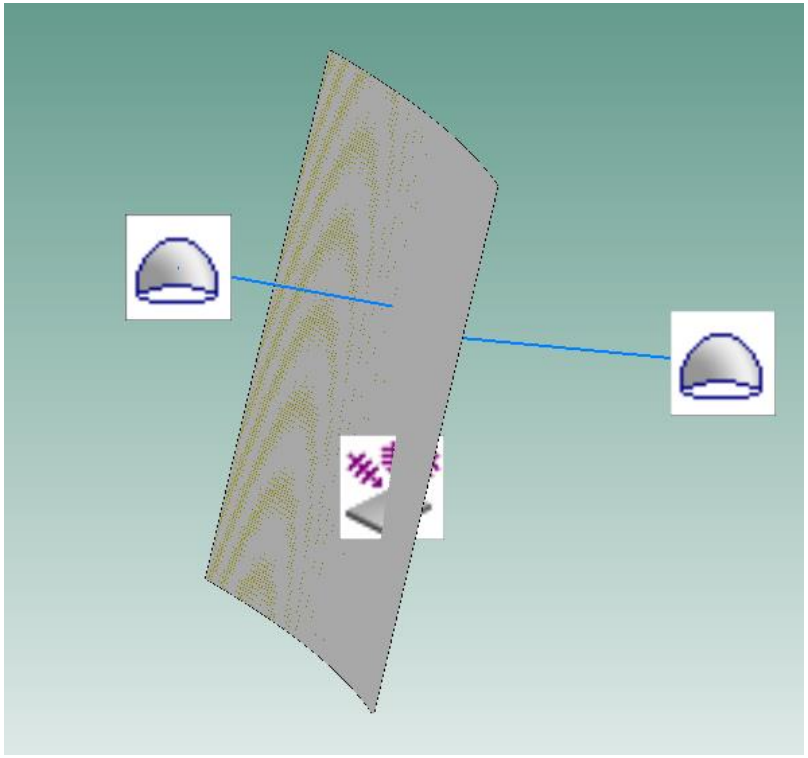
Cassini Blanket Development

NESC Enhanced Melamine Foam Acoustic Test (NEMFAT)

- Proposal to NESC Loads and Dynamics Technical Discipline Team to perform analysis and testing on melamine acoustic foam was accepted, and NASA GRC initiated NEMFAT effort in January 2013.
- NEMFAT is the first step in a much larger effort actively being completed by NASA GRC to mitigate acoustics for future NASA Heavy Lift vehicles.
- Initial NEMFAT proposal consists of acoustic testing of the following materials:
    - Fiber Reinforced Foam (FRF) panel
    - Melamine foam (ML) standard density (grey)
    - Enhanced Melamine foam
    - Melamine foam with mass barrier
- Absorption and Transmission Loss measured
  - Data can be utilized to ground modeling predictions for future NASA PLF designs
- Test completed in July 2013 at Riverbank Acoustical Laboratories
- 1 week of testing

NEMFAT Acoustic Analysis

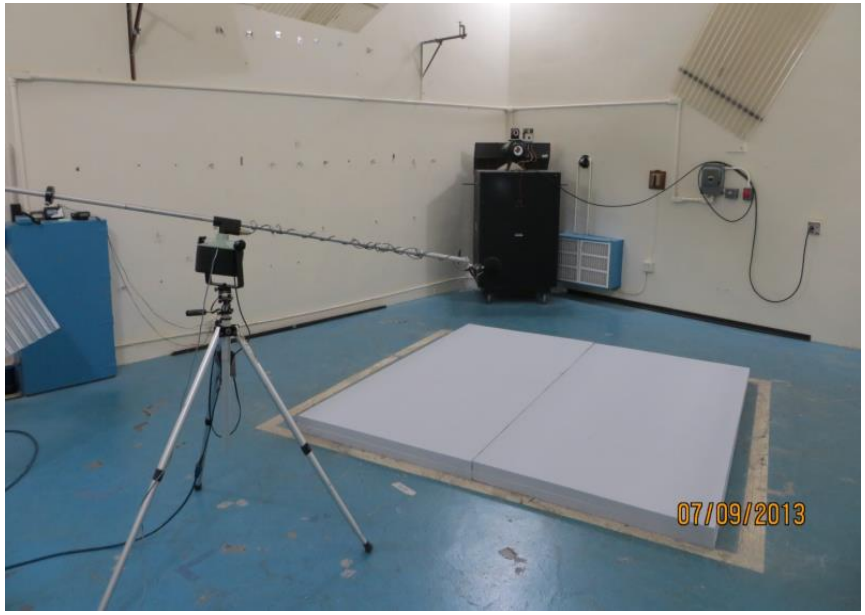
- An exhaustive series of enhanced melamine foam acoustic treatment designs were evaluated (VAOne Hybrid TL) with a composite (8’ x 6.5’) representative panel fairing material.
- Parameters varied were foam treatment thickness and density, and barrier density and location. Size and number of enhanced foam treatment elements were also varied.
- TL analysis resulted in subset of selected test configurations for the NEMFAT tests.

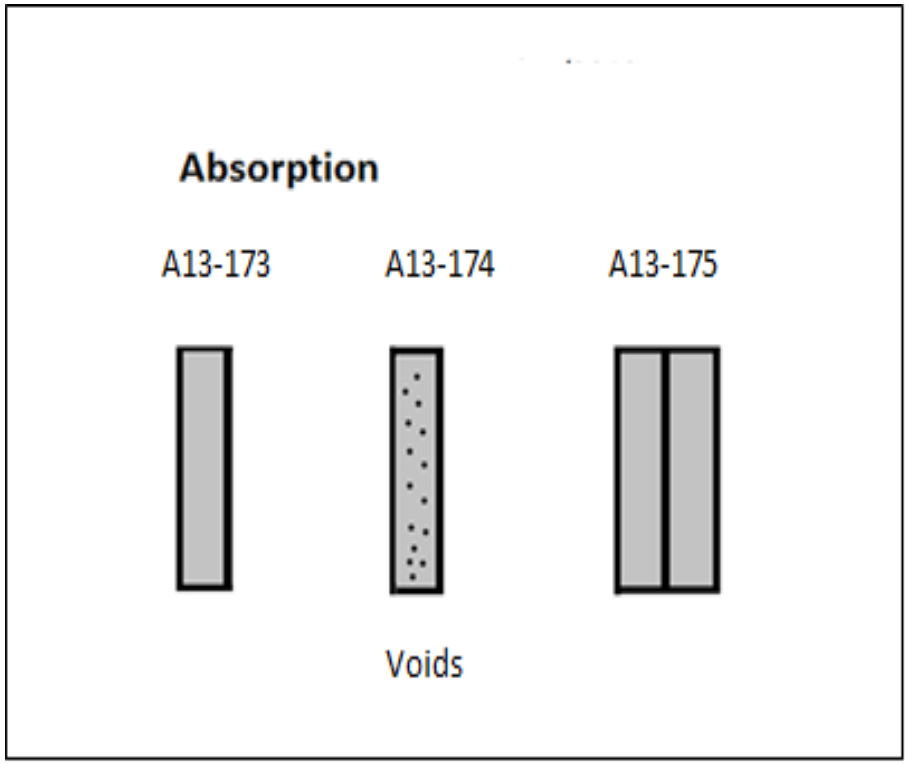


NEMFAT analysis led to selection of improved acoustic treatment design test candidates

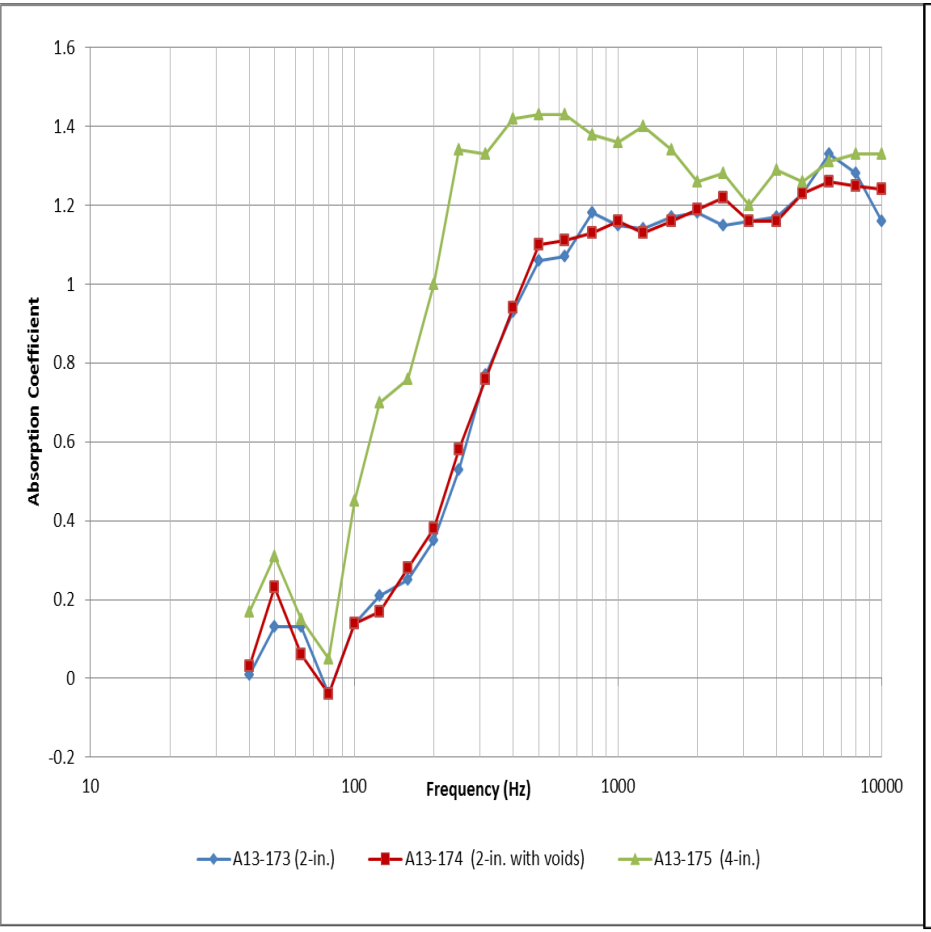
ASTM C423 Sound Absorption Tests

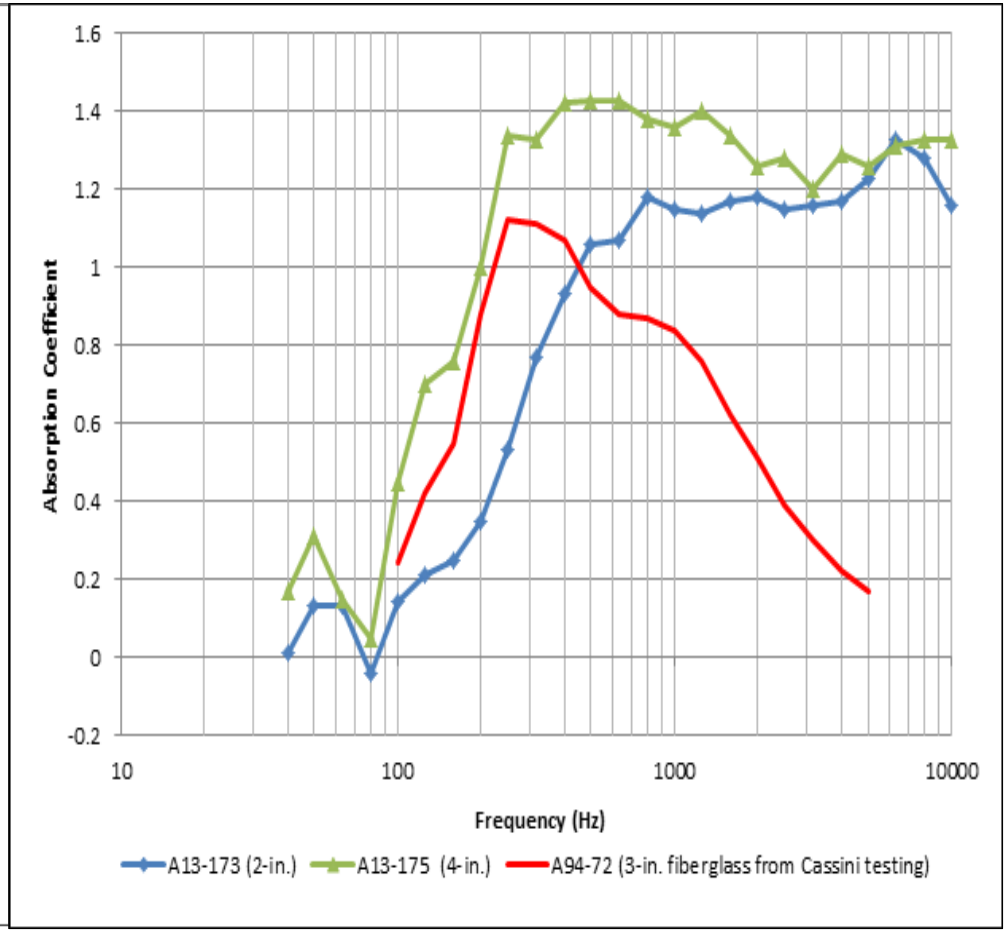
- A13-173 – 2-in. ML foam
- A13-174 – 2-in. ML foam with voids
- A13-175 – 4-in. ML foam





NEMFAT Absorption Test Results

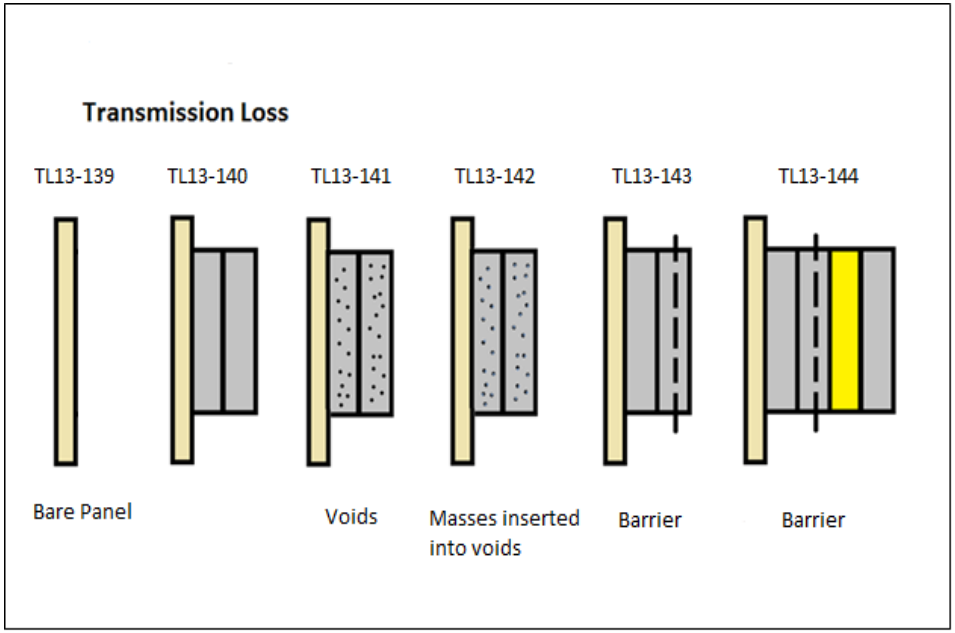




Increased absorption at low frequency with foam thickness.
The voids as tested did not change the performance.
Absorption of melamine foam without a cover sheet does not fall off with increasing frequency.

ASTM E90 Sound Transmission Loss Tests

- 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 Ultralight (yellow) foam (2 in.) and ML foam (6 in.) combination with a mass barrier

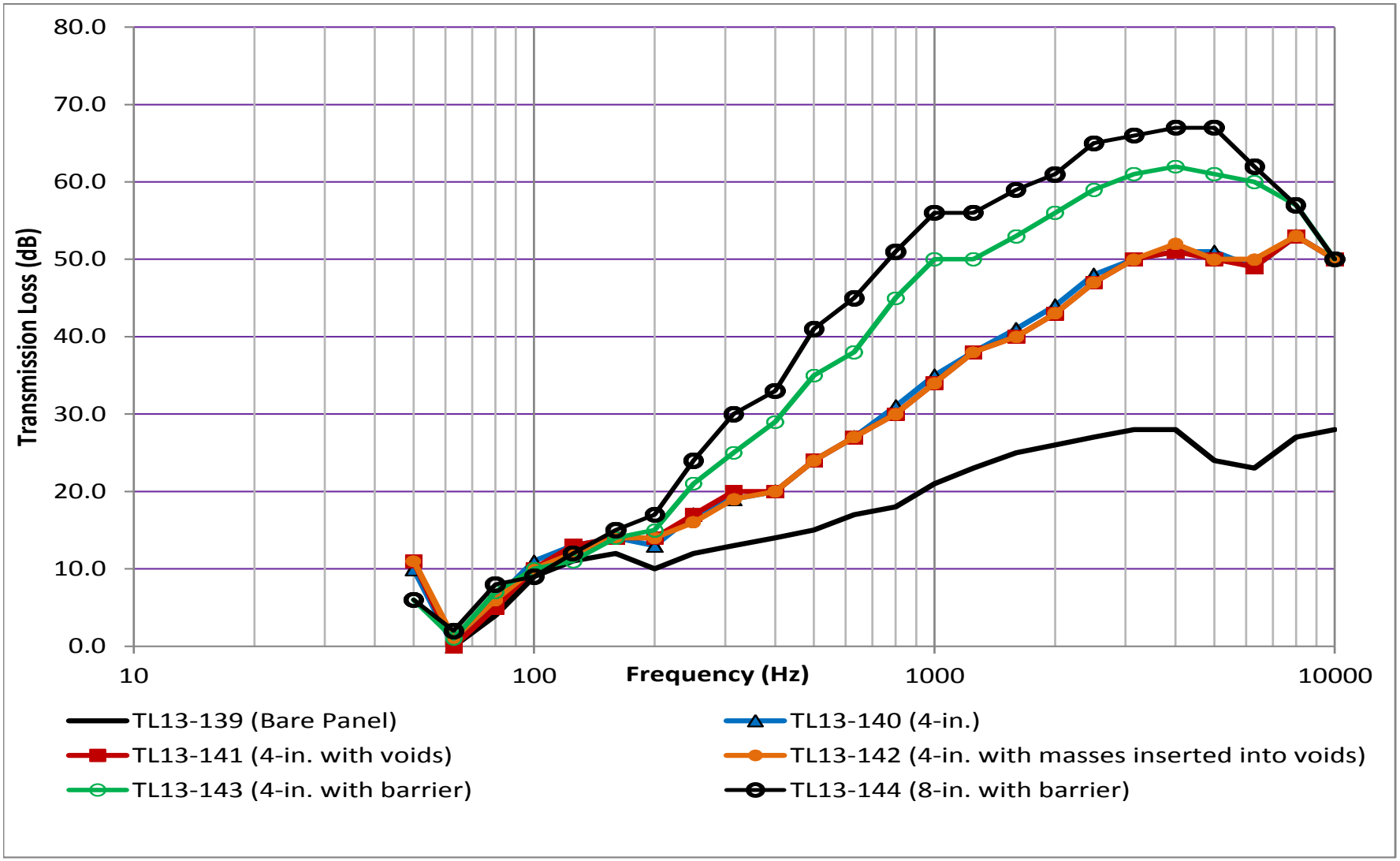


ASTM E-90 Airborne Sound TL for Building Partitions and Elements Method

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)

NEMFAT TL Test Results



Foam increases the TL greater than the mass law effect.
Voids and mass inclusions as tested did not provide any TL benefit.
Foam and barrier combinations provided the best TL result.

Summary

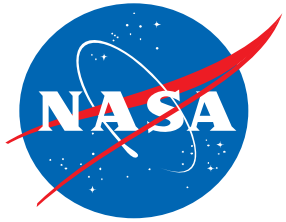
- NASA's NEMFAT testing was successful in that it established an initial database of acoustic properties of melamine foam for NASA.

- Melamine foam's improved acoustic performance and lighter mass relative to fiberglass acoustic blankets makes them an ideal candidate for future NASA Heavy Lift PLFs.

- NEMFAT acoustic testing of several melamine foam attenuation systems was completed July 2013. Both absorption and transmission loss testing were performed on several test configurations.

- Test and analysis report is available as a NASA TM.
  - McNelis, A. M., W. O. Hughes and M. E. McNelis, "NASA Engineering and Safety Center (NESC) Enhanced Melamine (ML) Foam Acoustic Test (NEMFAT)," NASA/TM-2014-218162, February 2014.

NEMFAT provided a "Proof of Concept" characterization of Melamine Foam and serves as starting point for development for future NASA PLF attenuation systems.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