



December 14, 2004

Dear Valued *Auralex* Customer,

Thank you for your interest in *Auralex LENRDs*. Before you review the attached test, we would like to bring some important developments to your attention:

The mounting method (A-mounting in accordance with *ASTM E795*) used in the following test has been called into question. And rightly so. This mounting method is not specifically applicable to corner, "bass trap" devices. Since foam corner devices did not exist prior to *LENRDs*, no standard mounting method had ever been conceived for the application of these devices. Unfortunately, almost 9 years later, this is still the case. After in-depth discussions with world-renowned acousticians, members of the [ASTM](#), acoustical testing experts and others, we have decided to amend the 1996 test with the following notes:

1. It was never our intention to mislead our customers, despite what some of our competitors would have you believe. We simply pursued what we perceived as the best course of action at the time.
2. In an effort to thoroughly understand the application of corner devices, we are in the process of studying alternative test methods to quantify their behavior. Others have pursued corner-mounting methods that we believe to be questionable for a variety of reasons. As with any other acoustical concept, we intend to thoroughly understand the problem before committing to a solution.
3. We have learned that other, existing mounting methods are insufficient to quantify corner device behavior. Once we have completed our own studies of corner "trap" behavior, we will prepare a detailed report and post it here.
4. If you have downloaded the 1996 *LENRD* Test Report in the past, please note that, as with any acoustical test of any corner device currently on the market, the absorption numbers should be used only for cursory comparative purposes. The absorption values should not be used for any definitive acoustical modeling or other predictions.
5. If you have made decisions to purchase *Auralex LENRDs* based on the 1996 report, rest assured that the overall behavior indicative of that test *will not change* with other mounting methods. That is, *LENRDs* will provide a marked improvement in upper-low frequency response of your room, specifically between 80-100 Hz and 300-500 Hz, when used in the vertical and/or horizontal corners of a room. This has always been our claim and we stand by it.
6. In an effort to provide as much information as possible about the improvement you can expect from the installation of *LENRDs* in your facility, the *Synergetic Audio Concepts* study of *LENRD* performance, conducted independently by Pat Brown, has been attached after the official test from 1996.

Should you have any questions about these notes, the following test, or the *Syn-Aud-Con* study, please [contact us](#).

Sincerely,

The Auralex Team

RIVERBANK ACOUSTICAL LABORATORIES

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OF
IIT RESEARCH INSTITUTE

708/232-0104
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WALLACE CLEMENT SABINE

REPORT

Sound Absorption Test
RAL™-A96-74

FOR: USAFoam

Auralex™
LENRD Bass Traps

ON: LENRD Bass Trap

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CONDUCTED: 4 March 1996

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 C423-90a and E795-93. 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. A description of the measuring technique is available separately. The microphone used was a Bruel & Kjaer serial number 1330828.

DESCRIPTION OF THE SPECIMEN

The test specimen was designated by the manufacturer as LENRD Bass Trap. The overall dimensions of the specimen as measured were 2.41 m (95 in.) wide by 2.36 m (93 in.) long and 305 mm (12 in.) thick. The specimen consisted of forty-eight pieces. Each piece measured 305 mm (12 in.) wide by 406 mm (16 in.) long by 305 mm (12 in.) thick. The specimen was tested in the laboratory's 292 m³ (10,311 ft³) test chamber. The manufacturer's description of the specimen was as follows: The LENRD (Low End Node Reduction Device) Bass Trap was a three-dimensional, triangular piece of open cell polyurethane foam, approximately 1.7 lbs. density. The wedge face contained a consistent, vertical pattern of peaks, valleys and plateaus, each of varying widths and depths. A visual inspection verified the manufacturer's description of the specimen. The weight of the specimen as measured was 23.8 kg (52.5 lbs) an average of 4.2 kg/m² (0.85 lbs/ft²). The area used in the calculations was 5.7 m² (61.5 ft²). The room temperature at the time of the test was 21°C (70°F) and 60% relative humidity.

MOUNTING A

The test specimen was laid directly against the test surface.

THE RESULTS REPORTED ABOVE APPLY ONLY TO THE SPECIFIC SAMPLE SUBMITTED FOR MEASUREMENT. NO RESPONSIBILITY IS ASSUMED FOR PERFORMANCE OF ANY OTHER SPECIMEN.



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REPORT

USAfoam

Auralex™
LENRD Bass Traps

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4 March 1996

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TEST RESULTS

1/3 Octave Center Center Frequency (Hz)	Absorption Coefficient	Total Absorption In Sabins	% Of Uncertainty With 95% Confidence Limit With Specimen
100	0.97	59.62	3.10
★★ 125	1.24	75.97	3.06
160	1.11	68.46	2.73
200	1.28	78.55	2.38
★★ 250	1.28	78.68	1.56
315	1.39	85.28	1.80
400	1.45	89.38	1.67
★★ 500	1.45	89.46	1.44
630	1.45	89.11	1.05
800	1.39	85.70	0.82
★★ 1000	1.39	85.33	0.83
1250	1.32	80.96	0.70
1600	1.30	79.93	0.65
★★ 2000	1.27	78.15	0.58
2500	1.26	77.65	0.67
3150	1.27	78.33	0.52
4000	1.31	80.64	0.50
★★ 5000	1.37	84.09	0.47

NRC = 1.35

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Thinking Inside the **BOX** Part 3

No scale models this time - Bass traps in a real room

This is the final Tech Topic in this series. The first installment examined the use of a scale model to investigate room modes. We discovered that the low frequency response of a “shoebox” room is relatively predictable by the wave equation. There was good correlation between the predicted and measured responses.

The second installment examined the use of active low-frequency treatment. Resonant devices were tuned to specific frequencies and placed in the model. These band reject filters have parameters similar to electrical filters, and represent the truest form of “room tuning.”

This third and final installment uses low-frequency absorbers in a real room to “tame” the boominess associated with such spaces. Broadband absorbers differ from resonant devices in that they work over a broader range of frequencies (lower Q) and are less affected by temperature changes and room furnishings.

The absorbers used in this investigation are the LENRD™ units from Auralex Acoustics. The idea is a simple one, place absorptive material in the room corners, where sound pressure is at a maximum for all modal frequencies. The sound energy is converted into heat by the absorptive action of the trap.

Fortunately, a spare bedroom was empty and available. It is a typical gypsum board “shoebox” that one might convert into a listening room or project studio. Such spaces can become good listening environments with a little work and minimal investment.

Since we are stuck with the geometry, there is no reason to predict the modal response. It can be measured with greater accuracy. While not optimal, at least the length, width and height are different lengths - very important for good modal distribution. The room measures 3.7 m x 2.9 m x 2.4 m (12 ft x 9.5 ft x 8 ft). From our previous installment, this should place the fundamental axial modes at about 47 Hz, 60 Hz, and 70 Hz respectively. Additional axial modes will be present at integer multiples of the above frequencies. Tangential and oblique modes (four and six-surface modes) will also exist. Critical frequency for this space is 430 Hz, so we will extend our measurements to 500 Hz. Above this frequency, the modes become too diffuse to calculate.

From the above we would expect severe coloration of a loudspeaker’s response in the low-mid frequency region, which we will try to correct with treatment.



The LENRDs are 61 cm (24”) tall porous foam units that are stacked or glued into the room corners. The surface shape provides increased surface area at higher frequencies.



The room prior to corner treatment



Two of the four treated corners

The Total Response

Figure 1 shows the low frequency room response before and after the introduction of the bass traps. The loudspeaker and microphone placements are shown at right. The opposite-corner placement technique allows all axial, tangential and oblique modes to be measured. The measurement data were gathered using the transfer function mode of SIA SmartLive™ run on a notebook PC using a USBPre™ audio interface.

The effectiveness of a low frequency absorber is frequency-dependent. These relatively shallow traps (about 30 cm) provided significant absorption (>12 dB) in the low-mid spectral region (125 Hz to 500 Hz). As one would expect, their effect diminished below 100 Hz, where the acoustic wavelengths become quite large. In this region, room geometry and loudspeaker/listener placement are still the most significant factors that determine the frequency response. Even so, there is considerably more audible information between 100 Hz and 500 Hz than there is below 100 Hz, so we will be content to achieve a significant energy reduction in this spectral region.

Given the above, we can see that for a fixed-size trap, the smaller the room, the more effect it will have. Corner traps are a small-room treatment. Large auditoriums would require a different approach (or a MUCH larger trap!).

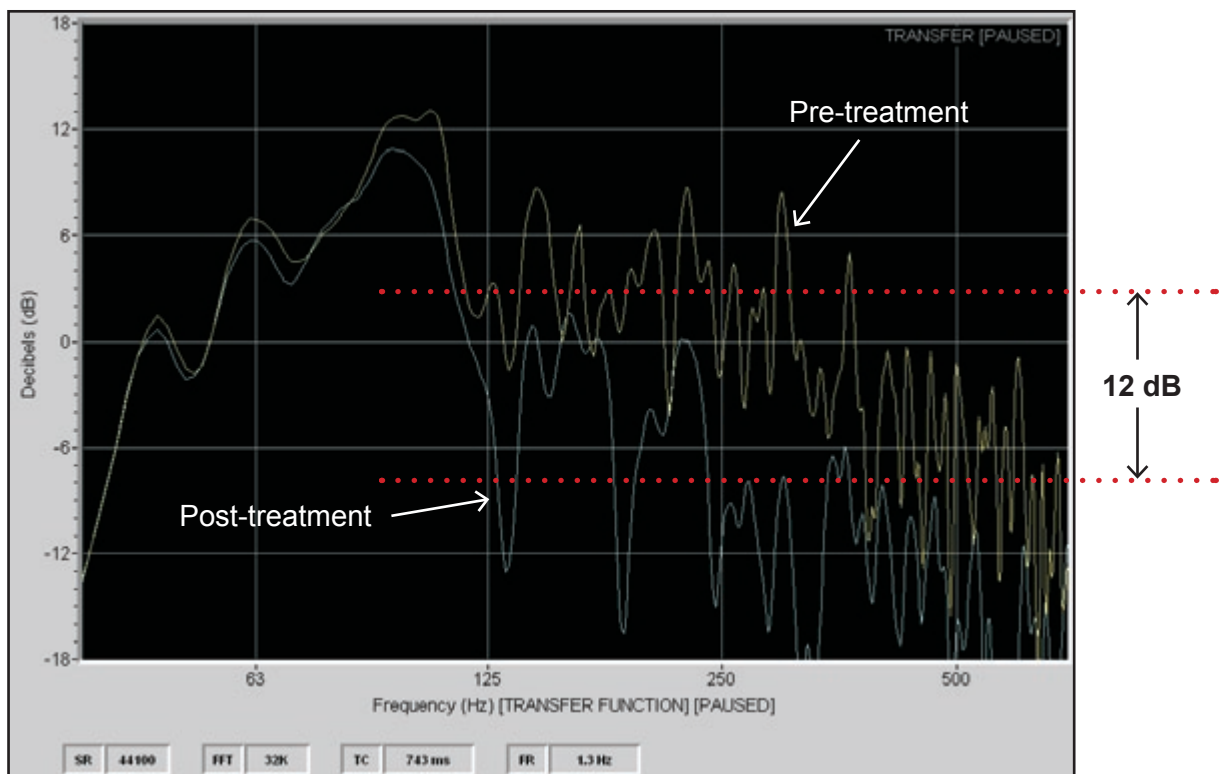
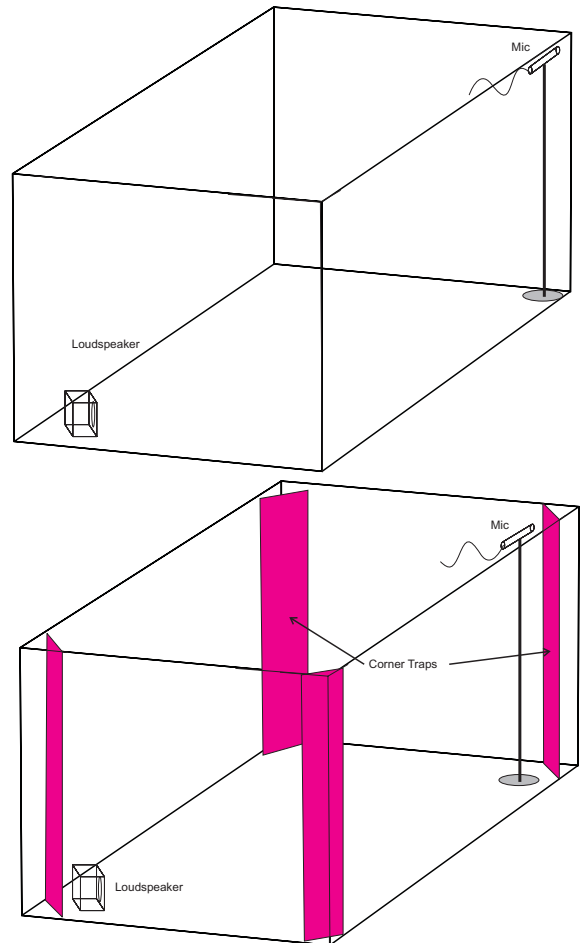


Figure 1 - Before and after corner measurements of the listening space

A Listener Position

While the corner measurements allow the complete modal response to be gathered, they don't represent an actual listener position. Next, I placed the loudspeaker on a stand and the mic at a likely typical listener position given the room's size and geometry. Figure 2 shows the effect of adding the corner traps one-at-a-time. Note the cumulative effect of treating all four corners. The subjective effect of the absorbers is to reduce the typical "boomy" sound that characterizes spaces of this size, converting it into a much more listenable space.

The use of bass traps in this space does not negate the need for good room geometry, loudspeaker placement and listener position. Below 100 Hz, these are much more effective at achieving a smooth room response than room treatment. As frequency increases, the modes become increasingly random and broadband absorption becomes a more effective treatment.

Low-frequency corner treatment leaves the major room surfaces available for diffuse and reflective coverings, allowing the room to be tailored for specific uses. The Live-End-Dead-End (LEDE) is a good example.¹

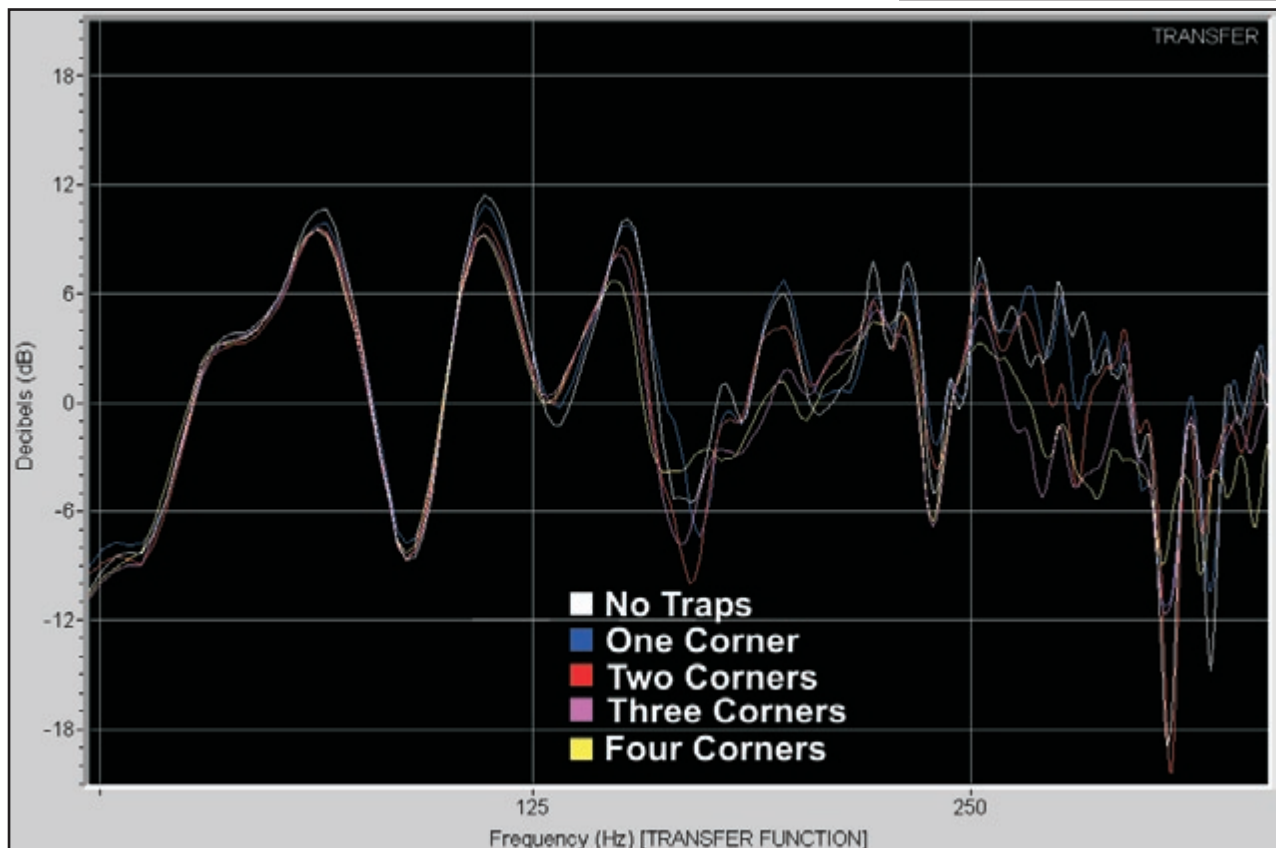
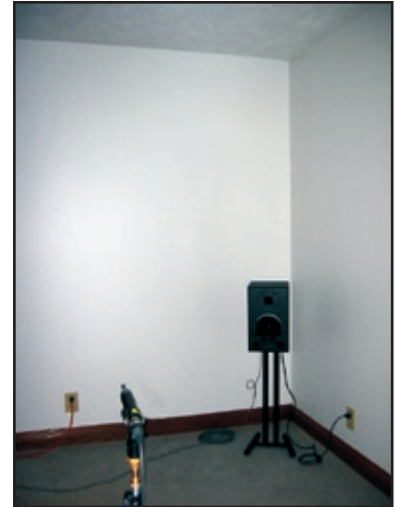
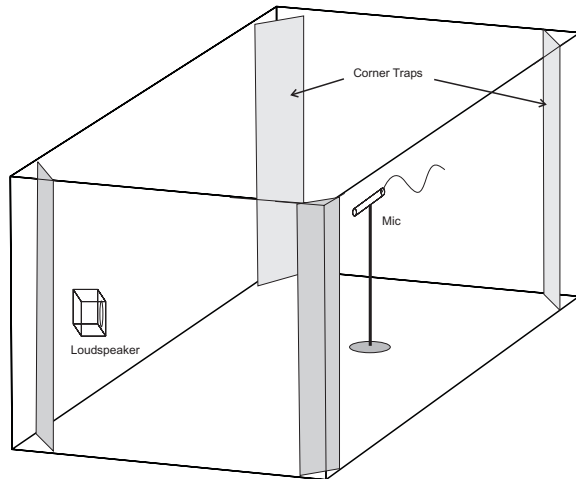


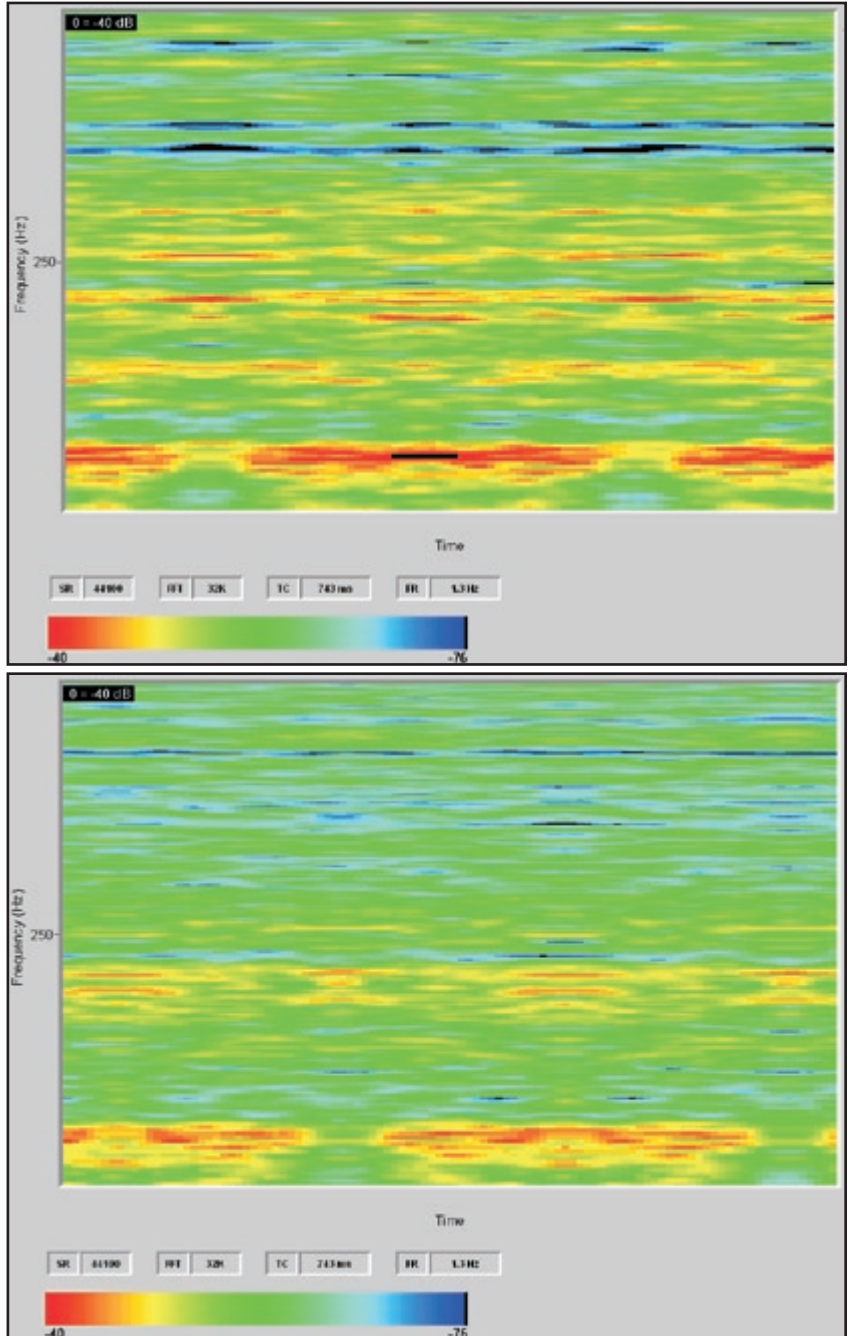
Figure 2 - Cumulative changes at a listener position

A Different Perspective...

The Spectrograph display of Smart-Live provides another interesting view of the modal response and the effect of the bass traps. The vertical axis is frequency and the horizontal is time. The colors represent the sound level. The stimulus is steady pink noise.

Room modes manifest themselves as horizontal stripes in the display. This is an alternative to the traditional “water-fall” plot that can also be used to view frequency/time trends.

The effect of adding the four corner traps is apparent. Note the diminished level of the modes. The traps have made the room response more neutral, producing less coloration of the loudspeaker’s response. Treatment is preferable to electronic equalization because the correction extends over a wider area and has less impact on the loudspeaker’s direct field.



In conclusion, I hope that you have found this series of Tech Topics both interesting and informative. I learned a lot by having to “crunch through” the math and correlate measured vs. predicted data. The principles that have been examined should aid in improving the listening experience in small spaces. For more information on room modes and treatments, I provide the following links to the World Wide Web:

www.rpginc.com
www.acousticsfirst.com
www.auralex.com

¹ *Sound System Engineering* by Don and Carolyn Davis