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TEST REPORT

SPONSOR: RIVERBANK ACOUSTICAL LABORATORIES | GENEVA, IL

PRODUCT NAME:

221 EMPTY 12 OZ. LONGNECK BEER BOTTLES

TEST DATE:

JUNE 27, 2023

TEST METHOD:

ASTM C423-23

RATING:

ARRAY-NRC = 0.10 OVER 38.2 ft^2 OF EXTENDED CONTINUOUS SURFACE AREA

Note: α_{ARRAY} *(SABINS/*FT^2*) OF 0.43 AT 200Hz!*

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Test Report

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FOUNDED 1918 BY
WALLACE CLEMENT SABINE

SPONSOR: **Riverbank Acoustical Laboratories**
Geneva, IL

Sound Absorption
RAL™-A23-175

CONDUCTED: 2023-06-27

ON: 221 Empty 12oz. Longneck Beer Bottles (17 rows of 13 bottles each, rows and objects spaced 64 mm (2.5 in.) apart)

TEST METHODOLOGY

Riverbank Acoustical Laboratories™ is accredited by the U.S. Department of Commerce, National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP) as an ISO 17025:2017 Laboratory (NVLAP Lab Code: 100227-0) and for this test procedure. The test reported in this document conformed explicitly with ASTM C423-23: "Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method." The specimen mounting was performed according to ASTM E795-23: "Standard Practices for Mounting Test Specimens During Sound Absorption Tests." A description of the measurement procedure and room specifications are available upon request. The results presented in this report apply to the sample as received from the test sponsor.

INFORMATION PROVIDED BY SPONSOR

The test specimen was designated by the sponsor as 221 Empty 12oz. Longneck Beer Bottles 17 rows of 13 units per row spaced 2.5" apart. The following nominal product information was provided by the sponsor prior to testing. The accuracy of such sponsor-provided information can affect the validity of the test results.

Product Under Test

Product Name:	12 oz. Longneck Beer Bottles (empty, open)
Material:	Glass Bottles

SPECIMEN MEASUREMENTS & TEST CONDITIONS

Through a full external visual inspection performed on the test specimen, Riverbank personnel verified the following information:

Test Specimen

Product Type:	Empty glass bottles, open tops
Diameter:	221 bottles @ 60.08 mm (2.3655 in.) diameter each
Height:	229 mm (9 in.)
Overall Weight:	44.11 kg (97.25 lbs)

Physical Measurements (per object)

Dimensions:	0.06 m (2.3655 in) diameter
Height:	0.23 m (9.0 in)
Weight:	0.2 kg (0.44 lbs)

Test Environment

Room Volume:	291.98 m³
Temperature:	22.7 °C ± 0.0 °C (Requirement: ≥ 10 °C and ≤ 5 °C change)
Relative Humidity:	62.35 % ± 0.3 % (Requirement: ≥ 40 % and ≤ 5 % change)
Barometric Pressure:	98.5 kPa (Requirement not defined)

Based on simplification of the geometry of each bottle to that of a right-angle cylinder with the same height and diameter as the bottle, each sound absorbing object had an exposed surface area of 0.0460 m^2 (0.495 ft^2). The total exposed surface area of all sound-absorbing objects was 10.163 m^2 (109.39 ft^2).

MOUNTING METHOD

Type JV-MOD Mounting: The specimen is an array of 221 spaced sound absorbing objects placed directly on top of the horizontal test surface. The objects were distributed in 17 rows of 13 bottles each, with rows spaced 64 mm (2.5 in.) apart and objects in each row spaced 64 mm (2.5 in.) apart. The width of the installed object array was 1588 mm (62.5 in.) and the length of the installed object array was 2096 mm (82.5 in.). The area of extended continuous surface attributed to the object array was 3.55 m^2 (38.2 ft^2).

Figure 1 – Specimen mounted in test chamber

Figure 2 – Specimen mounted in test chamber

Figure 3 – Detail of individual specimen bottle

TEST RESULTS

The preferred presentation of sound absorption test results for arrays of spaced objects is sound absorption (m^2) per object and total sound absorption (m^2) at each one-third-octave band

ASTM C423-23 Appendix X2 allows calculation of sound absorption per m^2 (SA/m^2) based on the projected horizontal surface area attributable to an array of objects. The extended continuous surface area used in this calculation is to be determined the following procedure:

1. $S_{array} = (w + w_1) \times (l + l_1)$ If the set of objects consists of a rectangular array of equal sized objects with equal space between each object in a row and equal space between rows. (ASTM E423-23 X.2.3.1)

Where:
S_{array} = area of extended continuous surface attributed to the test specimen, m^2
w = the measured width of the installed object array, in meters
w_1 = the space between objects in the array along the width, in meters
l = the measured length of the installed object array, in meters
l_1 = the space between objects in the array along the length, in meters

The sound absorption per m^2 (SA/m^2) is calculated based on the following formula:

$$\alpha_{array} = (A_2 - A_1)/S_{array}$$

Where:

α_{array} = sound absorption per m^2 (SA/m^2) of extended continuous surface, no units,
A_1 = absorption of the empty reverberation room, m^2 and
A_2 = absorption of the room after the specimen has been installed, m^2.
S_{array} = area of extended continuous surface attributed to the test specimen, m^2

TEST RESULTS (continued)

1/3 Octave Center Frequency	Total Absorption		Absorption per Object		α_{array} (Sabins/ft^2)
(Hz)	(m^2)	(Sabins)	(m^2 / Object)	(Sabins / Object)	(SA/m^2)
100	0.30	3.22	0.00	0.01	0.08
** 125	0.14	1.50	0.00	0.01	0.04
160	0.34	3.61	0.00	0.02	0.09
200	1.53	16.44	0.01	0.07	0.43
** 250	0.18	1.92	0.00	0.01	0.05
315	0.09	0.93	0.00	0.00	0.02
400	0.05	0.49	0.00	0.00	0.01
** 500	0.08	0.89	0.00	0.00	0.02
630	0.23	2.44	0.00	0.01	0.06
800	0.08	0.85	0.00	0.00	0.02
** 1000	0.32	3.40	0.00	0.02	0.09
1250	0.55	5.95	0.00	0.03	0.16
1600	0.27	2.89	0.00	0.01	0.08
** 2000	0.69	7.41	0.00	0.03	0.19
2500	0.54	5.77	0.00	0.03	0.15
3150	0.29	3.17	0.00	0.01	0.08
** 4000	0.25	2.66	0.00	0.01	0.07
5000	0.17	1.88	0.00	0.01	0.05

Array-NRC 0.10 over 3.55 m² of extended continuous surface area
Array-SAA 0.11 over 3.55 m² of extended continuous surface area

Tested by: Marc Sciaky, *Senior Experimentalist*

Report by: Keith Kimberling, *Test Engineer*

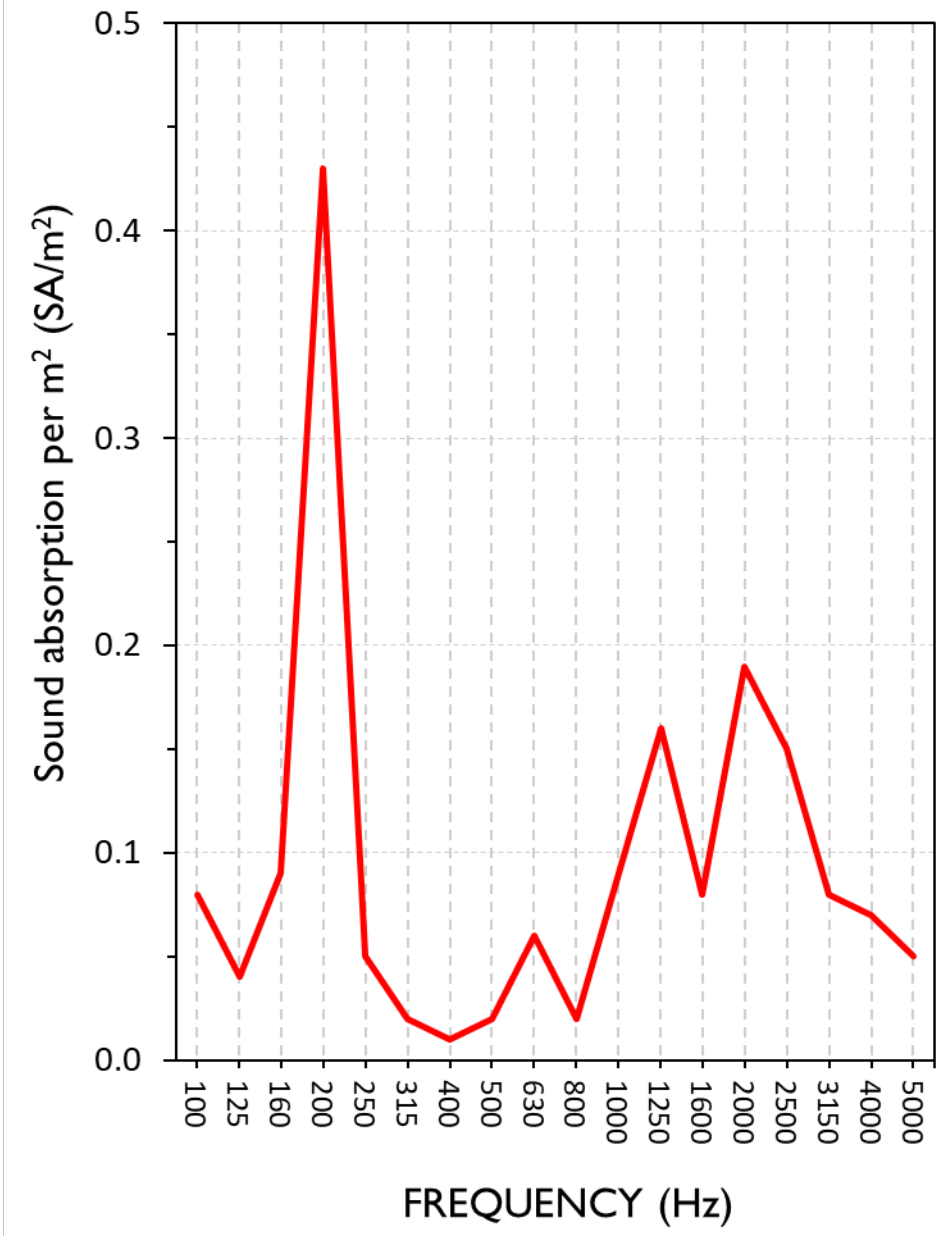
Approved by: Eric P. Wolfram, *Laboratory Manager*

Digitally signed by Eric P Wolfram
Date: 2023.06.28 09:45:10 -05'00'

Note: Sound absorption per m^2 (SA/m^2), and therefore the reported Single Number Ratings, are highly dependent on the exact sample shape, size, spacing, and extended continuous surface area present in the test and subsequent calculations. Changes to any of these parameters will change the resulting values. These presented results are valid only for the specific configuration present in this test.

SOUND ABSORPTION REPORT

221 Empty 12oz. Longneck Beer Bottles 17 rows of 13 units per row spaced 2.5" apart
(17 rows of 13 bottles each, rows and objects spaced 64 mm (2.5 in.) apart)



Array-NRC 0.10 over 3.55 m^2 of extended continuous surface area
Array-SAA 0.11 over 3.55 m^2 of extended continuous surface area

APPENDIX A: Extended Frequency Range Data

Specimen: 221 Empty 12oz. Longneck Beer Bottles 17 rows of 13 units per row spaced 2.5" apart (See Full Report)

The following non-accredited data were obtained in accordance with ASTM C423-23, but extend beyond the defined frequency range of 100Hz to 5,000Hz. These unofficial results are representative of the RAL test environment only and intended for research & comparison purposes.

1/3 Octave Band Center Frequency	Total Absorption		Absorption per Object		α_{array} (Sabins/ft^2)
(Hz)	(m^2)	(Sabins)	(m^2 / Object)	(Sabins / Object)	(SA/m^2)
31.5	0.40	4.29	0.00	0.02	0.11
40	0.11	1.21	0.00	0.01	0.03
50	0.57	6.15	0.00	0.03	0.16
63	0.10	1.09	0.00	0.00	0.03
80	0.40	4.32	0.00	0.02	0.11
100	0.30	3.22	0.00	0.01	0.08
125	0.14	1.50	0.00	0.01	0.04
160	0.34	3.61	0.00	0.02	0.09
200	1.53	16.44	0.01	0.07	0.43
250	0.18	1.92	0.00	0.01	0.05
315	0.09	0.93	0.00	0.00	0.02
400	0.05	0.49	0.00	0.00	0.01
500	0.08	0.89	0.00	0.00	0.02
630	0.23	2.44	0.00	0.01	0.06
800	0.08	0.85	0.00	0.00	0.02
1000	0.32	3.40	0.00	0.02	0.09
1250	0.55	5.95	0.00	0.03	0.16
1600	0.27	2.89	0.00	0.01	0.08
2000	0.69	7.41	0.00	0.03	0.19
2500	0.54	5.77	0.00	0.03	0.15
3150	0.29	3.17	0.00	0.01	0.08
4000	0.25	2.66	0.00	0.01	0.07
5000	0.17	1.88	0.00	0.01	0.05
6300	0.38	4.06	0.00	0.02	0.11
8000	0.27	2.89	0.00	0.01	0.08
10000	0.09	1.01	0.00	0.00	0.03
12500	0.28	3.02	0.00	0.01	0.08

APPENDIX B: Instruments of Traceability

Specimen: 221 Empty 12oz. Longneck Beer Bottles 17 rows of 13 units per row spaced 2.5" apart (See Full Report)

Description	Model	Serial Number	Date of Certification	Calibration Due
System 1	Type 3160-A-042	3160-106968	2022-07-12	2023-07-12
Bruel & Kjaer Mic And Preamp G	Type 4943-B-001	2525858	2023-05-03	2024-05-03
Bruel & Kjaer Pistonphone	Type 4228	2781248	2022-07-22	2023-07-22
EXTECH Hygro 639	SD700	A.103639	2022-12-07	2023-12-07

APPENDIX C: Revisions to Original Test Report

Specimen: 221 Empty 12oz. Longneck Beer Bottles 17 rows of 13 units per row spaced 2.5" apart (See Full Report)

Date	Revision
2023-06-27	Original report issued

END