Ansfelden, 24.09.2020

ACOUSTIC REPORT 2020

Testing to determine the acoustic properties of noise protection barriers in accordance with Austrian Norm EN 1793-5 (sound reflection) On-site Testing

WHISPER® NBO-40-A3

Sealed Air

Sealed Air Verpackungen GmbH
Ernst-Diegel Straße 2
36304 Alsfeld
Deutschland

Kubisch Data GmbH
Konzessioniertes Ingenieurbüro für Verkehrswesen und Lärmschutz
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Ing. U. Laimer für die Geschäftsführung
allgemein beeideter und gerichtlich zertifizierter Sachverständiger

CONTENTS

1 INTRODUCTION

1.1 Date and Extent of Contract:

On 23rd October 2019, Sealed Air Verpackungen GmbH commissioned this contract to determine the acoustic properties of the WHISPER® NBO-40-A3 products in accordance with the Austrian Norm EN 1793-5 (sound reflection).

1.1.1 CUSTOMER:

Sealed Air Verpackungen GmbH
Ernst-Diegel Straße 2
36304 Alsfeld
Deutschland

1.2 Task:

On-site testing in accordance with Austrian Norm EN 1793-5 to determine the sound reflection levels for the WHISPER® NBO-40-A3 products at the BTI test site.

The testing as described here relates to tests carried out in accordance with the European Norm EN 1793-5.

1.3 Basic Documentation:

[1] Kubisch Data GmbH: „Inspection and Measurements“, 2019
[2] AUSTRIAN NORM S 5004: „Measurements for sound immissions“, 15.04.2020
[3] Austrian Norm EN 1793-3: „Noise protection barriers on roads - test properties to specify acoustic properties - Part 3: Standardised Traffic Noise Spectrum“, 01.03.1998
[4] Austrian Norm EN 1793-5: „Noise protection barriers on roads- tests carried out to identify acoustic properties - part 5: Product-specific features - in-situ sound reflection values in dedicated sound fields“, 15.02.2019

2 TEST IMPLEMENTATION:

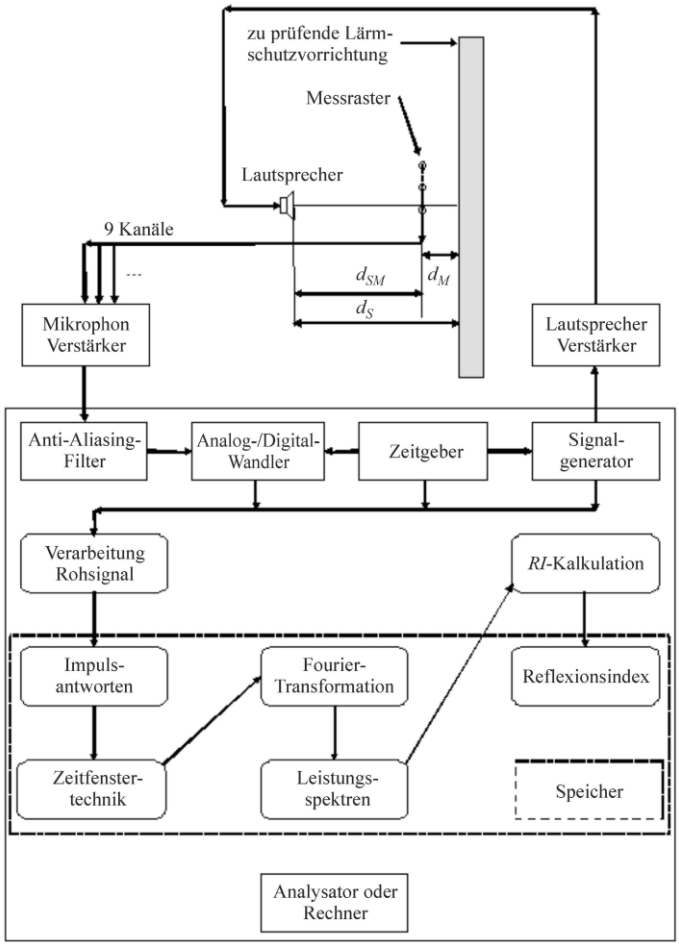
2.1 Principles of the system used to measure:

Basis of the measurements as per Austrian Standards:

The main element of the measuring system is the use of an electro-acoustic system (loudspeaker and microphone), hardware (microphone amplifier, loudspeaker amplifier, digital/analogue converter, analogue/digital converter and computer) and software (MLS Signal Generator, Fast Hadamard Transformation (FHT), Fast Fourier Transformation (FFT), RI and SI calculations.

2.2 Main components used in the measuring procedures:

The sketch shown below shows the interfaces between the electro-acoustic system, the hardware and the software.



2.3 Measuring Equipment and Devices:

The electro-acoustic system used, as well as all hardware, software and software-specific parameters are shown in the following listing and comply with all requirements as set out in Austrian Standards EN 1793-5 and EN 1793-6.

2.3.1 ACOUSTIC SOURCE:

Manufacturer	Model	Serial Number	Notes
Acoustics Engineering	LS24-H	001002	Loudspeaker
Brüel & Kjaer	2734	077003	Performance enhancer

2.3.2 MICROPHONE:

Manufacturer	Model	Serial Number	Notes
Brüel & Kjaer	4188	3099548	1/2"; Class 1
Brüel & Kjaer	4188	3099549	1/2"; Class 1
Brüel & Kjaer	4188	3099550	1/2"; Class 1
Brüel & Kjaer	4188	3099551	1/2"; Class 1
Brüel & Kjaer	4188	3099552	1/2"; Class 1
Brüel & Kjaer	4188	3099553	1/2"; Class 1
Brüel & Kjaer	4188	3099554	1/2"; Class 1
Brüel & Kjaer	4188	3099555	1/2"; Class 1
Brüel & Kjaer	4188	3099556	1/2"; Class 1

2.3.3 ANALYSER:

Manufacturer	Model	Serial Number	Notes
Acoustics Engineering	ZE-0948	032013	USB Audio Interface
Brüel & Kjaer	3053-B-120	3053-108421	LAN-XI 12-Channel
Brüel & Kjaer	2831-A	2831-102797	LAN-XI Battery module

2.3.4 SOFTWARE:

Manufacturer	Model	Serial Number	Notes
Acoustics Engineering	7841		DIRAC
Brüel & Kjaer	8400, 8401		BK Connect

2.3.5 TESTING SOUND SOURCE:

Brüel&Kjær - Type 4231 - Class 0.3 (SN. 2691667) using ½" Adapter UC-0210
Test signal: 93.85dB/113.85dB at 1000 Hz using ½" free-field microphone
Date of next official calibration: 2020

2.3.6 WEATHER STATION:

Temperature measurement instrument Testo 104-IR (SN 43592362) Penetration + infra-red thermometer
Manufacturer: Testo GmbH

Temperature measurement instrument Testo 606-1 Moisture metre for material humidity

Manufacturer: Testo GmbH

Weather Station MWS 4M (SN 1017112 V1.1g)

Manufacturer: Reinhardt System- und Messelectronic GmbH

Platine: SN 1017206 V2.62a, FW 2.41

3 TESTING LOCATION

3.1 Test Site:

Test Site at the BTI - the Institute of Structural Engineering, Karl-Leitl-Straße 2, 4048 Puchenau

3.2 Date and Times of Testing:

The tests were carried out on Saturday 21.11.2019 between 12:00 and 14:00.

3.2.1 TEST ENGINEERS:

- SV Ing. Urban Laimer, Kubisch Data GmbH
- Markus Stögner, Kubisch Data GmbH

3.3 Meteorological Conditions at the time of testing

At the time the tests were carried out, the sky was cloudy and there was a light westerly wind. The temperature was 6°C and the relative humidity was measured at 85%.

3.4 Condition of the Test Surface

Surface temperature:	8.0°C
Surface condition:	Dry

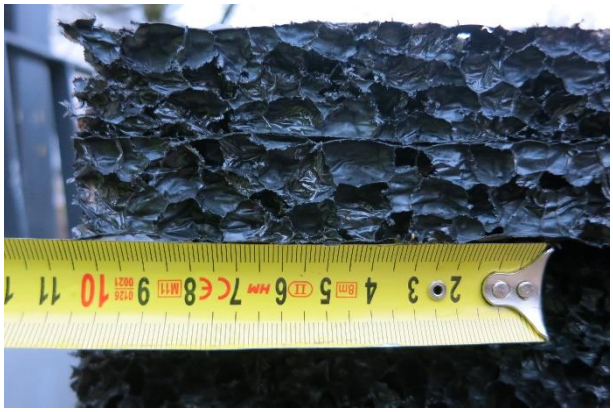
4 OBJECT TESTED

4.1 Object Tested

The absorption material 'WHISPER® NBO-40-A3' was manufactured by Sealed Air Verpackungen GmbH in 2019 and was mounted on 21.11.2019. The material was screwed on to a wooden supporting structure.

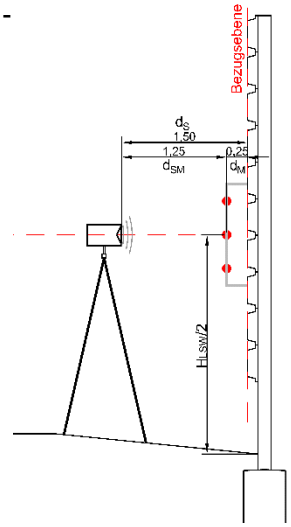
4.2 Construction of the Test Object

4.3 Photographic Documentation of the test object



5 TEST ARRANGEMENT

5.1 Test set-up for measurements in accordance with Austrian Norm EN 1793-



h_B =	5.00 m	*Total height of the noise protection barrier [m]*
h_A =	5.00 m	*Distance from the field (Element width) [m]*
h_s =	3.00 m	*Reference height (hB / 2) [m]*
d_s =	1.50 m	*Horizontal distance between loudspeaker and noise protection barrier [m]*
d_M =	0.25 m	*Horizontal distance between microphone and noise protection barrier [m]*
d_{SM} =	1.25 m	*(d_S - d_M) [m]*
h_{SO} =	1.00 m	*Height of concrete base [m]*
$h_{E,1}$ =	4.00 m	*Height of the wood section with the absorbing material [m]*

5.2 Photographic Documentation:

6 EVALUATION

6.1 The Adrienne time window

6.1.1 SOUND REFLECTION (1793-5)

The Adrienne time window as per Austrian Standard EN 1793-5 (6.0ms and 7.9ms) was used.

6.2 Testing Frequency spectrum

The measurements as per Austrian Standard EN 1793-5 call for the tested object to stand at a minimum height of 4m, in order to be able to collect DL_{RI} and DL_{SI} data in the one-third octave band spectrum from 200 to 5000 Hz. As it isn't always possible to achieve the minimum height of 4.0m, for any parts which are lower than the minimum height are tested, the individual data are calculated within a limited one-third frequency band, whilst taking into consideration the frequency thresholds which resulted. The one-third octave band is specified in the individual data and in the detailed evaluations.

7 TEST RESULTS

The following tables show the results of the measurements taken, in tabular form, in accordance with EN 1973-5.

The frequency bands which were not included in the measurements are shown in grey for information only, and are not included in the evaluation itself.

The report showing evaluation results are attached as Attachments 1 and 2 (sound reflection) to the report.

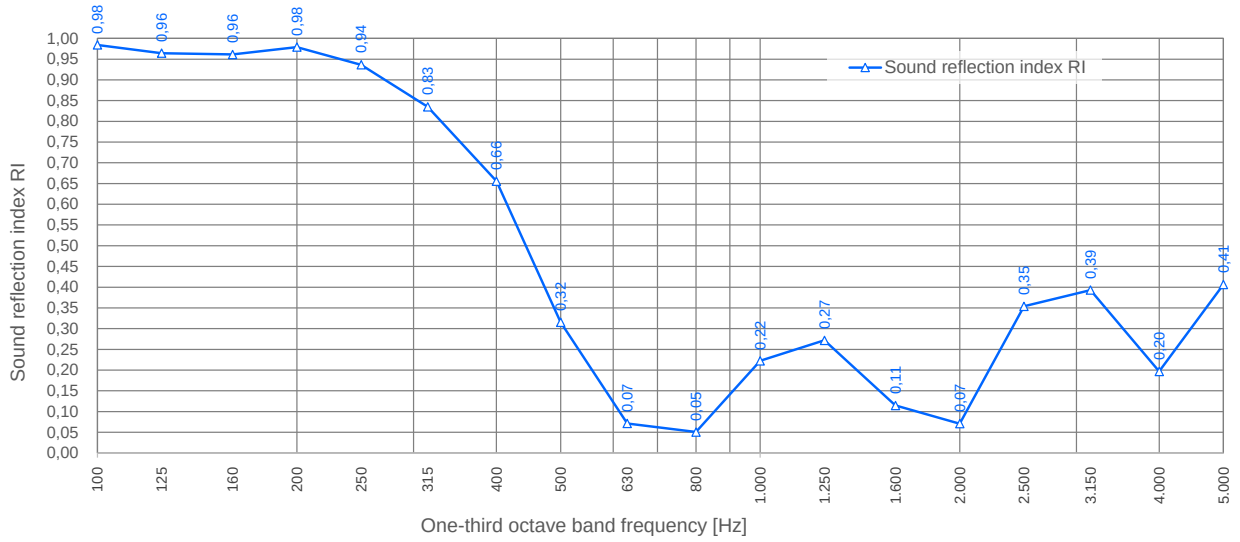
7.1 Sound Reflection Measurements - WHISPER® NBO-40-A3 (Austrian Norm EN 1793-5)

Object Tested	**Transport Sector**	**Reflection Index DL_{RI}** [$dB_{(A)}$]	Frequency limits Hz
WHISPER® NBO-40-A3	**ROAD**	**5.37**	200 - 5,000
	RAIL	**5.91**	200 - 5,000

7.2 Spectral Measurement Results:

Table 1: Sound reflection index R1

Freq. [Hz]	Mikrofon-Postion 1	2	3	4	5	6	7	8	9	RI_{mittel}
100	0,97	0,99	0,99	0,98	0,98	0,99				0,98
125	0,95	0,96	0,99	0,94	0,95	0,99				0,96
160	0,95	0,97	0,99	0,93	0,94	0,99				0,96
200	0,99	0,96	0,99	0,95	0,95	0,99	0,99	0,99	0,99	0,98
250	0,93	0,87	0,94	0,93	0,89	0,94	0,99	0,99	0,94	0,94
315	0,86	0,76	0,82	0,89	0,79	0,81	0,85	0,87	0,86	0,83
400	0,69	0,60	0,64	0,70	0,56	0,56	0,65	0,77	0,73	0,66
500	0,36	0,28	0,25	0,31	0,25	0,23	0,42	0,37	0,34	0,32
630	0,12	0,05	0,04	0,11	0,05	0,03	0,12	0,05	0,06	0,07
800	0,04	0,06	0,10	0,02	0,05	0,07	0,02	0,05	0,06	0,05
1.000	0,20	0,29	0,24	0,15	0,33	0,21	0,12	0,27	0,19	0,22
1.250	0,29	0,27	0,26	0,22	0,31	0,30	0,17	0,37	0,25	0,27
1.600	0,10	0,06	0,13	0,13	0,06	0,10	0,17	0,16	0,14	0,11
2.000	0,04	0,09	0,06	0,05	0,14	0,12	0,04	0,03	0,08	0,07
2.500	0,21	0,40	0,43	0,32	0,35	0,68	0,22	0,25	0,33	0,35
3.150	0,45	0,42	0,42	0,55	0,43	0,49	0,20	0,37	0,21	0,39
4.000	0,21	0,27	0,21	0,14	0,16	0,22	0,24	0,11	0,23	0,20
5.000	0,49	0,85	0,46	0,18	0,08	0,14	0,58	0,31	0,58	0,41



8 MEASURE OF UNCERTAINTY

The measurement of uncertainty for sound insulation is the equivalent of a 95% level of confidence as per Gaussian distribution and is shown in the following tables as per the Austrian Norms.

	Standard deviation of the comparative standard deviation value S_R			Estimate of level of uncertainty U (95%)		
[$dB_{(A)}$]	minor	Ø	significant	minor	Ø	significant
DL_{RI}	0.54	0.68	0.81	1.06	1.33	1.59

8.1 Results, taking into consideration levels of uncertainty:

The standard deviation value of repeatability and traceability have been taken at their average value.

8.1.1 NOISE REFLECTION (AUSTRIAN NORM EN 1793-5)

Object Tested	Transport Sector	**DL_{RI} ± U** ($dB_{(A)}$) [-1.33]	[+1.33]
WHISPER® NBO-40-A3	Road	4.04	6.70
	Rail	4.58	7.24

9 INDIVIDUAL DATA

The individual data for sound reflection have been calculated and entered in the given frequency ranges.

9.1 Individual data for Sound Reflection (EN 1793-5)

Object Tested	Transport Sector	**Data DL_{RI}** [$dB_{(A)}$]
WHISPER® NBO-40-A3	Road	**5**
	Rail	**6**

10 SUMMARY AND ASSESSMENT

The following tables show the results of the on-site testing for sound reflection on the WHISPER® NBO-40-A3 product.

10.1 Results for Noise reflection (Austrian Norm EN 1793-5)

The following table shows the results, adjusted to take into account the scaled uncertainty measurements (U).

Object Tested	Transport Sector	**Reflection Index DL_{RI}** [$dB_{(A)}$]	**DL_{RI} ± U** ($dB_{(A)}$) Individual values (DL_{RI}) including uncertainty measurements (U) [$dB_{(A)}$]	[$dB_{(A)}$]	Frequency range Hz
WHISPER® NBO-40-A3	Road	**5.37**	4.04	6.70	200 - 5.000
	Rail	**5.91**	4.58	7.24	200 - 5,000

ATTACHMENT 1

Test report for 1793 -5: "WHISPER® NBO-40-A3" ROAD TRAFFIC SPECTRUM (Noise reflection)

Test Report

On-site measurements in accordance with Austrian Norm EN 1793-5

Test Object: **WHISPER® NBO-40-A3**
ROAD TRAFFIC SPECTRUM

Project

Name:	Sealed Air Verpackungen GmbH
Road:	Karl-Leitl-Straße 2, Test Site - BTI
Handled By:	Laimer, Stögner

Manufacturer:	Sealed Air Verpackungen GmbH
Type:	WHISPER® NBO-40-A3
Surface:	Vertically-milled
Year of Manufacture:	2019
Condition:	NEU
Temperature of the noise p. barrier:	8,0 °C
Humidity of the noise protection barrier:	dry

Test Location/Time and Weather conditions

Date:	21.11.2019				
Prüfort:	BTI (Institute for Structural Engineering) Linz Karl-Leitl-Straße 2, Test Site - BTI				
Reference height (d_S):	1,50 m	*Horizontal distance on the reference level from the sound source to the front of the loudspeaker*			
Reference height (d_M):	0,25 m	*waagerechter Abstand der Bezugsebene von Schallquelle zum Messgitter*			
Reference height (h_S):	3,20 m	*Microphone no. 5 over ground*			
Height above top edge of conc. base:	2,50 m	*h_S ü. Top edge of concrete base*			
Time testing began:	12:30	Temperature:	6 °C	W-di.:	SO
Time testing ended:	13:30	Air pressure:	1010 hPa	Wind speed:	
Duration:	01:00	Air humidity:	85 %		0,5 m/s

Specifications as per Austrian Norm EN 1793-5:

Front: | Back:

Construction

Type	Number	Height	H_{TYPE}
Concrete Base	1	1,00	**1,00**
Whisper vertically-milled on a wooden backboard	4	1,00	**4,00**

Element length: **5,00 m** N. Protection Bar. height: **4,00 m**

Test Results:

Table 1: Sound reflection index R1

Freq. [Hz]	Mikrofon-Postion 1	2	3	4	5	6	7	8	9	RI_{mittel}
100	0,97	0,99	0,99	0,98	0,98	0,99				0,98
125	0,95	0,96	0,99	0,94	0,95	0,99				0,96
160	0,95	0,97	0,99	0,93	0,94	0,99				0,96
200	0,99	0,96	0,99	0,95	0,95	0,99	0,99	0,99	0,99	0,98
250	0,93	0,87	0,94	0,93	0,89	0,94	0,99	0,99	0,94	0,94
315	0,86	0,76	0,82	0,89	0,79	0,81	0,85	0,87	0,86	0,83
400	0,69	0,60	0,64	0,70	0,56	0,56	0,65	0,77	0,73	0,66
500	0,36	0,28	0,25	0,31	0,25	0,23	0,42	0,37	0,34	0,32
630	0,12	0,05	0,04	0,11	0,05	0,03	0,12	0,05	0,06	0,07
800	0,04	0,06	0,10	0,02	0,05	0,07	0,02	0,05	0,06	0,05
1.000	0,20	0,29	0,24	0,15	0,33	0,21	0,12	0,27	0,19	0,22
1.250	0,29	0,27	0,26	0,22	0,31	0,30	0,17	0,37	0,25	0,27
1.600	0,10	0,06	0,13	0,13	0,06	0,10	0,17	0,16	0,14	0,11
2.000	0,04	0,09	0,06	0,05	0,14	0,12	0,04	0,03	0,08	0,07
2.500	0,21	0,40	0,43	0,32	0,35	0,68	0,22	0,25	0,33	0,35
3.150	0,45	0,42	0,42	0,55	0,43	0,49	0,20	0,37	0,21	0,39
4.000	0,21	0,27	0,21	0,14	0,16	0,22	0,24	0,11	0,23	0,20
5.000	0,49	0,85	0,46	0,18	0,08	0,14	0,58	0,31	0,58	0,41

Results for sound reflection index: **DL_{RI}** [$dB_{(A)}$] **5,37**

Tabelle 4:

Test results and individual data

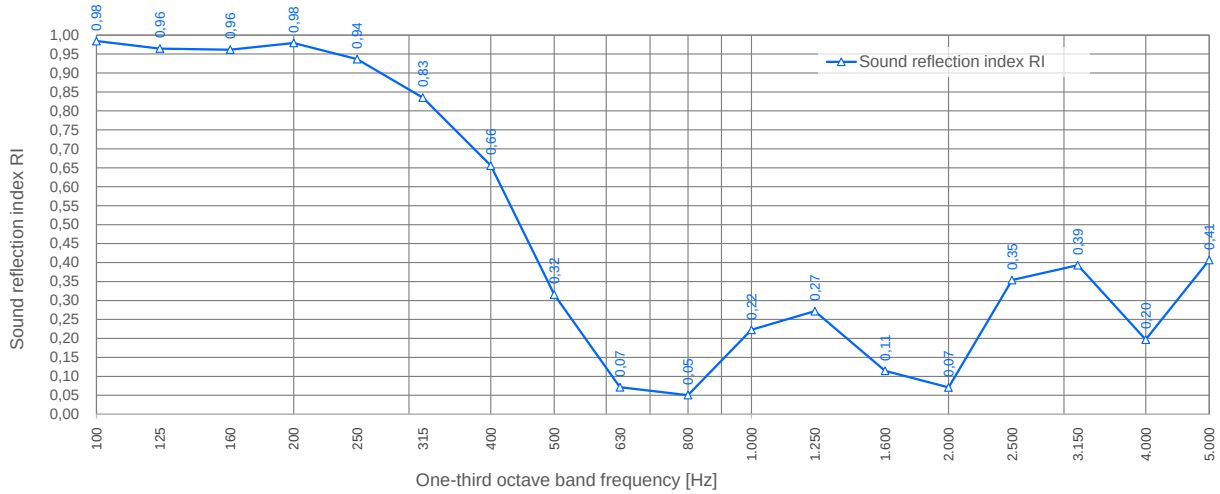
Frequency limit P1-P3:	**160 Hz**
Frequency limit P4-P6:	**200 Hz**
Frequency limit P7-P9:	**250 Hz**

	Results	Individual Data
DL_{RI} =	**5,37 dB**	**5 dB**

Tabelle 5:

Ø Measure of uncertainty

DL_{RI}	[± 1,33]	[4,04 ; 6,70]



Photographic Documentation

ATTACHMENT 2

Test report for 1793 -5: "WHISPER® NBO-40-A3"
RAIL SPECTRUM
(Noise reflection)

Test Report

On-site measurements in accordance with Austrian Norm EN 1793-5

Test Object: **WHISPER® NBO-40-A3**
RAIL SPECTRUM

Project							
Name:	Sealed Air Verpackungen GmbH						
Road:	Karl-Leitl-Straße 2, Test Site - BTI						
Handled By:	Laimer, Stögner						
Test Location/Time and Weather conditions							
Date:	21.11.2019						
Prüfort:	BTI (Institute for Structural Engineering) Linz Karl-Leitl-Straße 2, Test Site - BTI						
Reference height (d_S):	1,50 m	*Horizontal distance on the reference level from the sound source to the front of the loudspeaker*					
Reference height (d_M):	0,25 m	*waagerechter Abstand der Bezugsebene von Schallquelle zum Messgitter*					
Reference height (h_S):	3,20 m	*Microphone no. 5 over ground*					
Height above top edge of conc. base:	2,50 m	*h_S ü. Top edge of concrete base*					
Time testing began:	12:30	Temperature:	6 °C	W-di.:	SO		
Time testing ended:	13:30	Air pressure:	1010 hPa	Wind speed:			
Duration:	01:00	Air humidity:	85 %	0,5 m/s			

Manufacturer:	Sealed Air Verpackungen GmbH				
Type:	WHISPER® NBO-40-A3				
Surface:	Vertically-milled				
Year of Manufacture:	2019	Temperature of the noise p. barrier:	8,0 °C		
Condition:	NEU	Humidity of the noise protection barrier:	dry		
Specifications as per Austrian Norm EN 1793-5:					
Front:		Back:			

Construction	Type	Number	Height	H_{TYPE}
	Concrete Base	1	1,00	**1,00**
	Whisper vertically-milled on a wooden backboard	4	1,00	**4,00**
	Element length: **5,00 m**	N. Protection Bar. height:	**4,00 m**	

Test Results:

Table 1: Sound reflection index R1

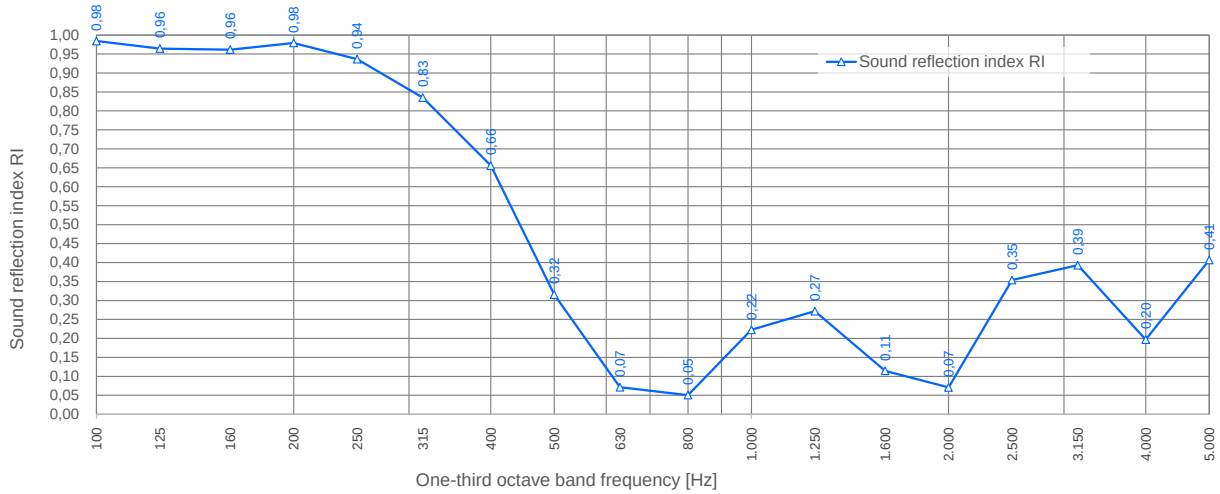
Freq. [Hz]	Mikrofon-Postion 1	2	3	4	5	6	7	8	9	RI_{mittel}
100	0,97	0,99	0,99	0,98	0,98	0,99				0,98
125	0,95	0,96	0,99	0,94	0,95	0,99				0,96
160	0,95	0,97	0,99	0,93	0,94	0,99				0,96
200	0,99	0,96	0,99	0,95	0,95	0,99	0,99	0,99	0,99	0,98
250	0,93	0,87	0,94	0,93	0,89	0,94	0,99	0,99	0,94	0,94
315	0,86	0,76	0,82	0,89	0,79	0,81	0,85	0,87	0,86	0,83
400	0,69	0,60	0,64	0,70	0,56	0,56	0,65	0,77	0,73	0,66
500	0,36	0,28	0,25	0,31	0,25	0,23	0,42	0,37	0,34	0,32
630	0,12	0,05	0,04	0,11	0,05	0,03	0,12	0,05	0,06	0,07
800	0,04	0,06	0,10	0,02	0,05	0,07	0,02	0,05	0,06	0,05
1.000	0,20	0,29	0,24	0,15	0,33	0,21	0,12	0,27	0,19	0,22
1.250	0,29	0,27	0,26	0,22	0,31	0,30	0,17	0,37	0,25	0,27
1.600	0,10	0,06	0,13	0,13	0,06	0,10	0,17	0,16	0,14	0,11
2.000	0,04	0,09	0,06	0,05	0,14	0,12	0,04	0,03	0,08	0,07
2.500	0,21	0,40	0,43	0,32	0,35	0,68	0,22	0,25	0,33	0,35
3.150	0,45	0,42	0,42	0,55	0,43	0,49	0,20	0,37	0,21	0,39
4.000	0,21	0,27	0,21	0,14	0,16	0,22	0,24	0,11	0,23	0,20
5.000	0,49	0,85	0,46	0,18	0,08	0,14	0,58	0,31	0,58	0,41
Results for sound reflection index:								**DL_{RI}** [$dB_{(A)}$]		**5,91**

Tabelle 4:

Test results and individual data		
Frequency limit P1-P3:	**160 Hz**	
Frequency limit P4-P6:	**200 Hz**	
Frequency limit P7-P9:	**250 Hz**	
	Results	**Individual Data**
DL_{RI} =	**5,91 dB**	**6 dB**

Tabelle 5:

Ø Measure of uncertainty		
DL_{RI}	[± 1,33]	[4,58 ; 7,24]



Photographic Documentation