Laboratory for Acoustics

TESTING
RvA L 334

Determination of the sound absorption (reverberation room method) of decorative and acoustic cork tiles type BRICKX, manufacturer Greenmood

Reportnumber A 3544-7E-RA-001 d.d. 25 September 2023

Laboratory for Acoustics

Determination of the sound absorption (reverberation room method) of decorative and acoustic cork tiles type BRICKX, manufacturer Greenmood

Principal:	Greenmood HQ Atomiumsquare 1/102 1020 Brussels Belgium
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1 Introduction

At the request of Greenmood HQ based in Brussels (Belgium) laboratory measurements of the sound absorption (reverberation room method) were carried out on:

decorative and acoustic cork tiles type BRICKX
manufacturer Greenmood

The measurements were performed in the Laboratory for Acoustics of Peutz bv, situated at Lindenlaan 41, 6584 AC in Molenhoek (the Netherlands). See Appendix 2 for a plan of the laboratory.

2 Standards and guidelines

The measurements have been carried out according to the Quality Manual of the Laboratory for Acoustics as well as:

EN ISO 354:2003[1,2]	Acoustics Measurement of sound absorption in a reverberation room
EN ISO 11654:1997[1]	Acoustics Sound absorbers for use in building Rating of sound absorption
ASTM C423-23[1]	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method (SAA)
EN ISO 12999-2:2020	Determination and application of measurement uncertainties in building acoustics- Part 2: Sound absorption

[1]

For these type of measurements the Laboratory for Acoustics has been accredited by the Dutch Accrediatation Council (RvA).

The RvA is member of the EA MLA (**EA MLA**: **E**uropean **A**ccreditation Organisation **M**ulti **L**ateral **A**greement: http://www.european-accreditation.org).

EA: "Certifates and reports issued by bodies accredited by MLA and MRA members are considered to have the same degree of credibility, and are accepted in MLA and MRA countries."

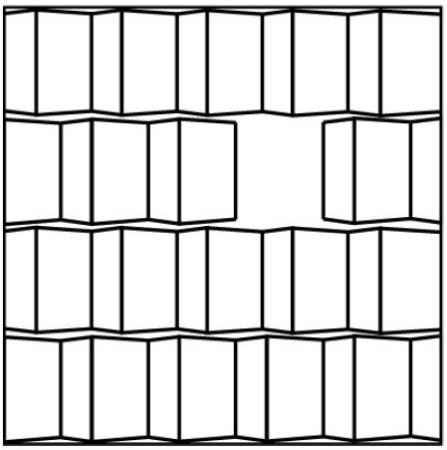
[2] According to this norm, the report should include for each measurement the mean reverberation times T1 and T2 at each frequency. Because these figures are not relevant for judging the quality of the product being tested, but merely for judging the accuracy of the calculations, they have been omitted in this report. It is possible of course to reproduce those figures at any time if the principal requests this.

3 Tested constructions

The following data have been provided by the principal, supplemented by observations in the laboratory where applicable.

The following materials have been investigated:

Variant 1	
Type	BRICKX - DARK
Manufacturer	Greenmood
Material	Cork
Dimensions	405 x 405 mm
Thickness:	12 – 50 mm
Mass:	10,97 kg/m² (weighted)



The results as presented here relate only to the tested items and laboratory conditions as described in this report. The laboratory can make no judgement about the representativity of the tested samples. The test report ahead is valid as long as the tested constructions and/or materials are unchanged.

4 Measurements

4.1 Measurement results

The results of the measurements (panels mounted as plane absorbers) are given in table 4.1 and in appendix 3. The measurements were made in 1/3-octave bands. The results presented in octave-bands are the arithmetic average of the results of the three 1/3-octave bands belonging to that octave band.
From the sound absorption coefficients the following one-figure ratings have been calculated and stated:

- the "weighted sound absorption coefficient α_w" according to ISO 11654;
- the "Noise Reduction Coefficient NRC" according to ASTM C423, being the average of the absorption coefficients (1/3 octave values) at the frequencies of 250, 500, 1000 and 2000 Hz, rounded to the nearest 0,05;
- the "Sound Absorption Average SAA" according to ASTM-C423, being the average of the absorption coefficients (1/3 octave values) at the frequencies of 200 Hz up to 2500 Hz, rounded to the nearest 0,01;
- the "sound absorption classes" according to ISO 11654.

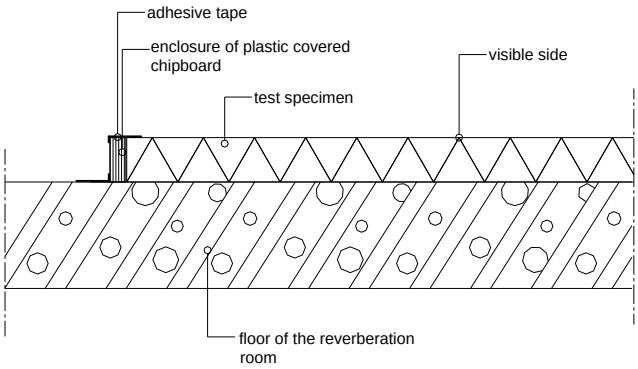
t 4.1 Measurement results (uncertainty under reproducibility conditions)

variant nr.		α_w ± U (k=2)	Class	NRC	SAA	Record nr.	Figure nr.
1	BRICKX - DARK	**0,25(H)** ± 0,07	E	0,20	0,19	#186	3.1

4.2 Measurement set-up

The panels to be measured (see chapter 3) have been put directly on the floor of the reverberation room (Type A mounting according to ISO 354:2003), the facing side of the panels was up. No suspension-system has been used, the panels were put tight to each other. The sides of the setup were enclosed by 18 mm thick plastic covered chipwood. See also figure 4.2.

f 4.2 measurement set-up plane absorbers



4.3 Method

The tests were conducted in accordance with the provisions of the test method ISO 354 in the reverberation room of "Peutz bv" in Mook (the Netherlands). The relevant data regarding the reverberation room are given in appendix 2.2 of this report.
By means of reverberation measurements the reverberation time of the room is measured under two conditions:

- when the reverberation room is empty
- when the construction under test is inside the reverberation room

In general, once material is placed into the reverberation room a lower reverberation time will result.
The difference in reverberation times is a measure of the amount of absorption brought into the room.

Measurements and calculations were carried out in 1/3-octave bandwidth from 100 to 5000 Hz, according to the norms. Where applicable the octave values have been calculated from these 1/3-octave values.

From the reverberation measurements in the empty reverberation room the equivalent sound absorption A_1 is calculated (per frequency band) according to 4.1 and expressed in m^2

$$A_1 = \frac{55{,}3\,V}{cT_1} - 4Vm_1 \qquad (4.1)$$

in which:

V	the volume of the reverberation room	[m^3]
T_1	the reverberation time in the empty reverberation room	[sec]
m_1	"power attenuation coefficient" in the empty room, calculated according to formula 4.3	[m^{-1}]
c	the speed of sound in the air, in m/s, calculated according to	[m/s]

$$c = 331 + 0{,}6t \tag{4.2}$$

in which:

t	the temperature; this formula is valid for the temperatures between 15 and 30 °C	[°C]

$$m = \frac{\alpha}{10\log(e)} \tag{4.3}$$

in which:

α	"attenuation coefficient" according to ISO 9613-1	

In the same manner the equivalent sound absorption A_2 for the room with the test specimen is calculated according to formula 4.4, also expressed in m^2

$$A_2 = \frac{55{,}3\,V}{cT_2} - 4Vm_2 \tag{4.4}$$

in which:

c and V have the same definition as in formula 4.1 and

T_2	the reverberation time of the reverberation room with the test specimen placed inside	[sec]
m_2	"power attenuation coefficient" in the room with the test specimen placed inside, calculated according to formula 4.3	[m^{-1}]

The equivalent sound absorption A_T of the test specimen has been calculated according to formula 4.5 and is expressed in m^2

$$A_T = A_2 - A_1 \tag{4.5}$$

When the test specimen consists of one plane with an area between 10 and 12 m^2 the sound absorption coefficient α_S has to be calculated according to formula 4.6:

$$\alpha_s = \frac{A_T}{S} \tag{4.6}$$

In which:

S	The area of the test specimen	[m^2]

4.4 Measurement uncertainty

The accuracy of the sound absorption as calculated can be expressed in terms of repeatability (tests within one laboratory) and reproducibility (between various laboratories).

4.4.1 Repeatability

The repeatability describes when: - two tests are performed on identical test material - within a short period of time - by the same person or team - using the same instrumentation - under unchanged environmental conditions - the difference between the two test results.

As stated in the EN ISO 12999-2 standard, the repeatability with regard to the single number value α_W is ± 0,04. See appendix 1 of this report for a further explanation.

4.4.2 Reproducibility

The reproducibility describes when: - two tests are performed on identical test material - in different laboratories - by different person(s) - under different environmental conditions - the difference between the two test results.

As stated in the EN ISO 12999-2 standard, the reproducibility with regard to the single number value α_W is ± 0,07. See appendix 1 of this report for a further explanation.

4.5 Environmental conditions during the measurements

Table below shows the environmental conditions measured at the time of the sound absorption measurements.

t 4.6 Environmental conditions during the measurements at Septeber 7th, 2023

Reverberation room	temperature [°C]	relative humidity [%]	barometric pressure [kPa]
Empty	21,2	53,5	101,6
With test specimen	21,3-21,9	55,5-59,5	101,6-101,7

The values presented in this report are calculated from the measurements under laboratory conditions. In practice, deviating measurement results can be found if the situation differs from the situation in the laboratory.

R.T. Allan
Laboratory Supervisor

dr. ir. M.L.S. Vercammen
Manager

This report contains 13 pages and 3 appendices.

appendix 1	Measurement uncertainty	(2 pages)
appendix 2	Plans and sections	(2 pages)
appendix 3	Measurement results plane absorbers	(1 page)

Appendix 1
Standard uncertainty

For the measurement uncertainty of sound absorption, a connection is sought to the values and formulas given in standard ISO 12999-2:2020.

Standard deviation for equivalent sound absorption area
Formula 1.1 was used to determine the standard deviation of the equivalent sound absorption area A_T under reproducibility conditions.

$$\sigma_R = m\,A_T + n\,S \tag{1.1}$$

In which:

A_T Equivalent sound absorption area in accordance with ISO 354
S Constant, S = 10 m^2
m, n Frequency-dependent numerical constants given in tabel I.1

t I.1 frequency-dependent numerical constants (derived from tabel 1 of EN ISO 12999-2)

1/3-octave band mid frequencies [Hz]	m	n
100	0,240	0,015
125	0,180	0,015
160	0,140	0,015
200	0,110	0,015
250	0,090	0,015
315	0,075	0,015
400	0,060	0,015
500	0,050	0,015
630	0,045	0,015
800	0,040	0,015
1000	0,040	0,015
1250	0,040	0,016
1600	0,037	0,018
2000	0,035	0,021
2500	0,030	0,026
3150	0,030	0,032
4000	0,030	0,040
5000	0,026	0,060

Formula 1.2 was used to determine the standard deviation of the sound absorption coefficients or equivalent sound absorption areas under repeatability conditions.

$$\sigma_r = 0{,}6\,\sigma_R \tag{1.2}$$

Standard deviation for the practical sound absorption coefficient
Formula 1.3 was used to determine the standard deviation of the practical sound absorption coefficient under reproducibility conditions.

$$\sigma_R = m\,\alpha_P + n \tag{1.3}$$

In which:

α_P the practical sound absorption coefficient determined according ISO 11654
m, n Frequency-dependent numerical constants given in tabel I.2

t I.2 frequency-dependent numerical constants (derived from tabel 2 of EN ISO 12999-2)

octave midband frequencies [Hz]	m	n
250	0,059	0,016
500	0,000	0,040
1000	0,000	0,040
2000	0,000	0,040
4000	0,000	0,050

The reproducibility standard deviation of the weighted sound absorption coefficient, α_W, determined according to ISO 11654 is given by Formula 1.4

$$\sigma_R = 0{,}035 \tag{1.4}$$

The repeatability standard deviation of the weighted sound absorption coefficient, α_W, determined according to ISO 11654 is given by Formula 1.5

$$\sigma_r = 0{,}020 \tag{1.5}$$

Expanded uncertainty
The expanded uncertainty under reproducibility conditions, U, is calculated according to standard ISO 12999-2:2020 for the 95% confidence level, with the coverage factor k=2. It is calculated according to formula 1.6:

$$U = u \cdot k \tag{1.6}$$

In which:

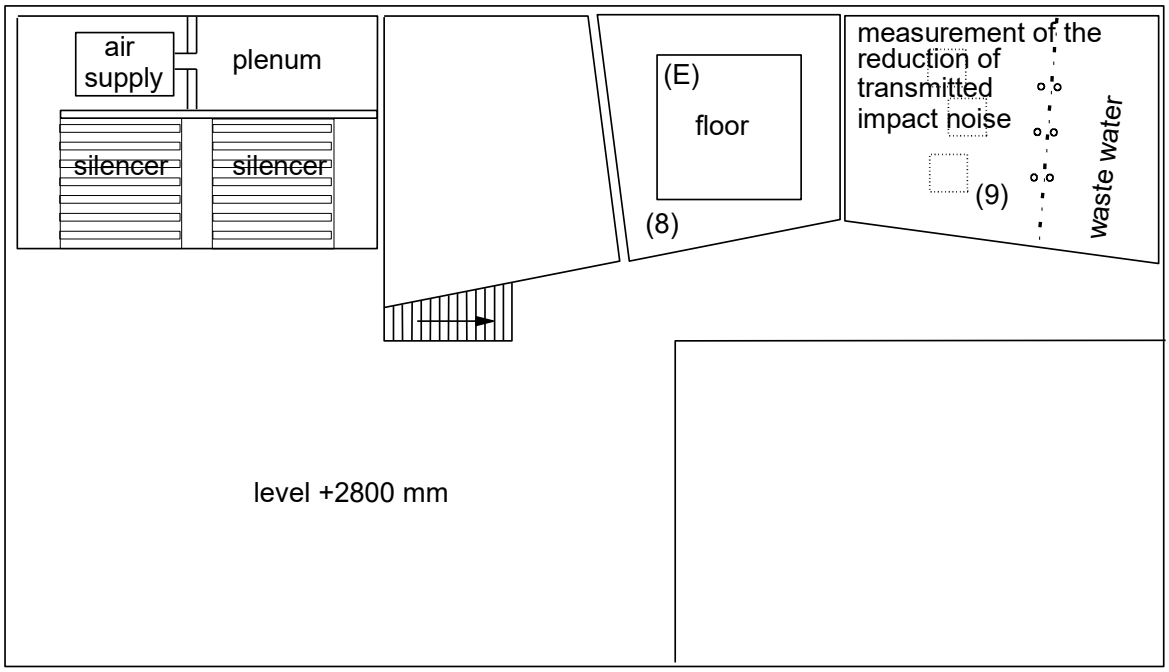
u uncertainty under reproducibility or repeatability conditions
k Coverage factor (k=2 for a 95% confidence level)

EXAMPLE
The reported weighted sound absorption coefficient, α_W should be read as: α_W = 0,70 ± 0,07 (k=2).

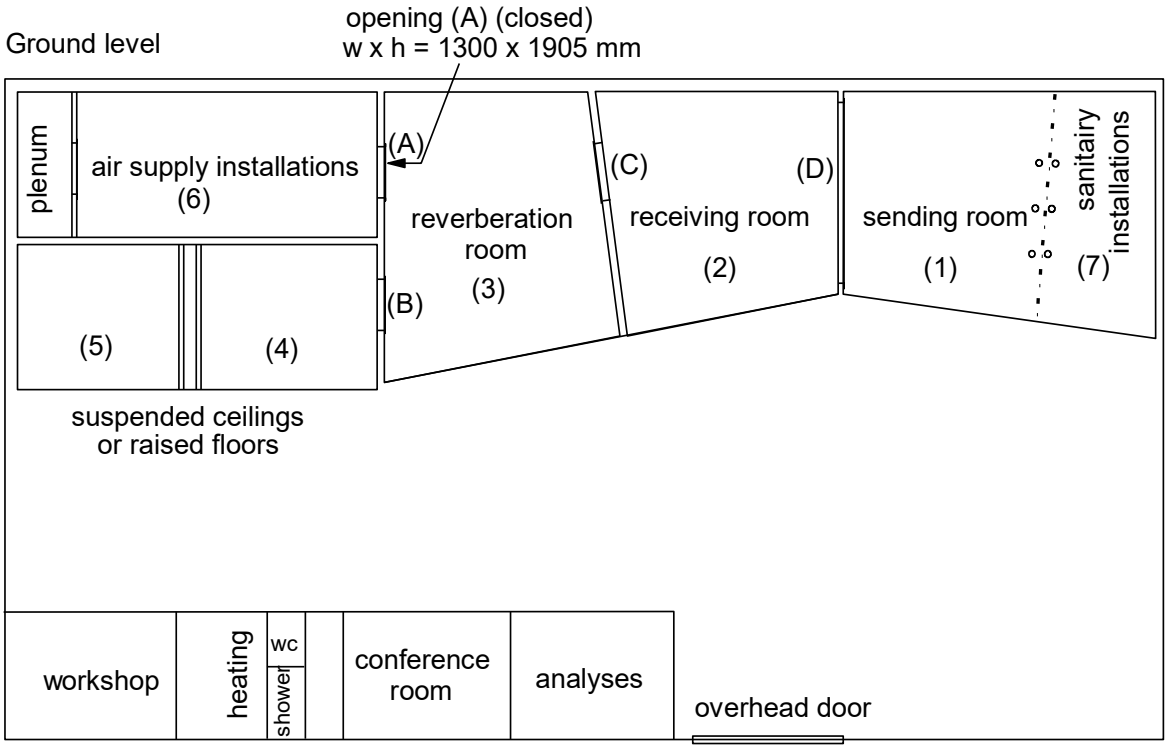
PEUTZ bv
Lindenlaan 41, NL-6584 AC MOLENHOEK (LB), THE NETHERLANDS

OVERVIEW

Story



Ground level



TEST OPENINGS (w x h in mm)
(B) 1000 x 2200
(C) 1500 x 1250
(D) 4300 x 2800
(E) 4000 x 4000

0 1 2 3 4 5 m
scale

Figure 2.1

PEUTZ bv
Lindenlaan 41, 6584 AC MOLENHOEK (LB)

REVERBERATION ROOM

The reverberation room meets the requirements of ISO 354:2003.

additional data:
volume : 214 m^3
total area St (walls, floor and ceiling) : 219 m^2

diffusion: by the shape of the room and by adding 6 curved and 2 flat reflecting elements with a total area of approx. 13 m^2 a sufficient diffusion has been gained.

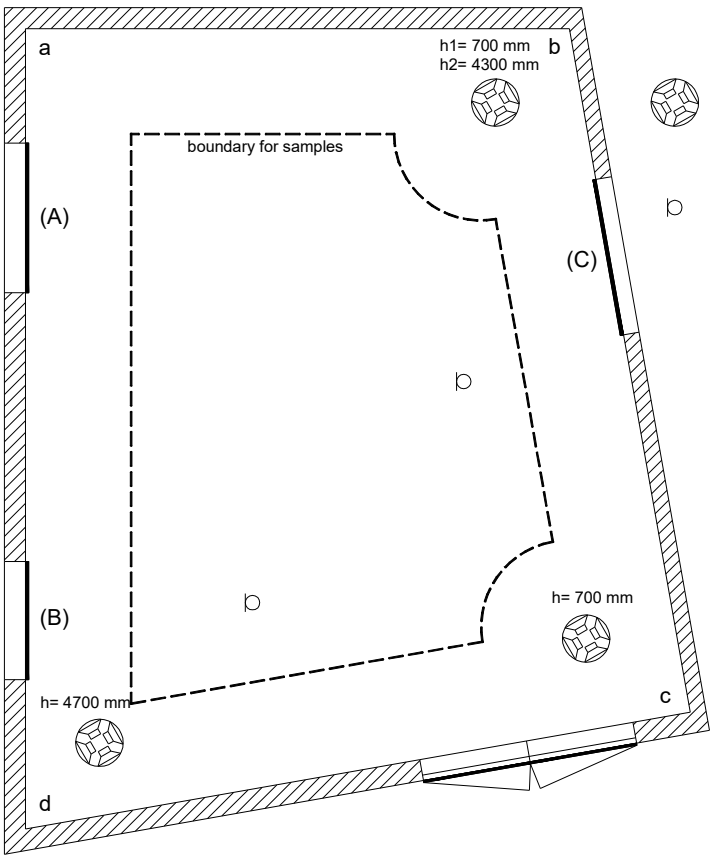
reverberation time of the empty reverberation room during measurements of 07-09-2023

frequency (1/1 oct.)	125	250	500	1000	2000	4000	Hz
reverberationtime	8,96	7,27	6,77	6,24	4,66	2,99	sec.

repeatibility r (1/1 oct.) c.f. ISO 354:1985 annex C (see chapter 4.2 of this report).

r at high α	0,13	0,04	0,04	0,02	0,02	0,08	-
r at low α	0,09	0,02	0,01	0,02	0,02	0,04	-

plan



Absorb, versie 5.10.1 mode 7, file: a3544 E#:1-36 T_1 = 21,2 °C p_1 = 101,6 kPa h_1 = 53,5 %

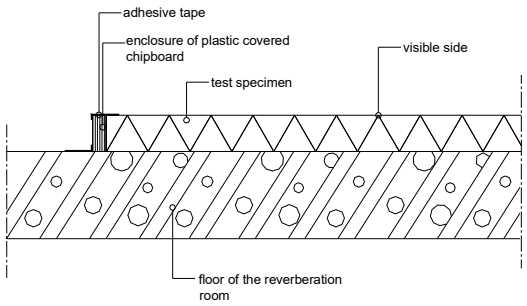
Figure 2.2

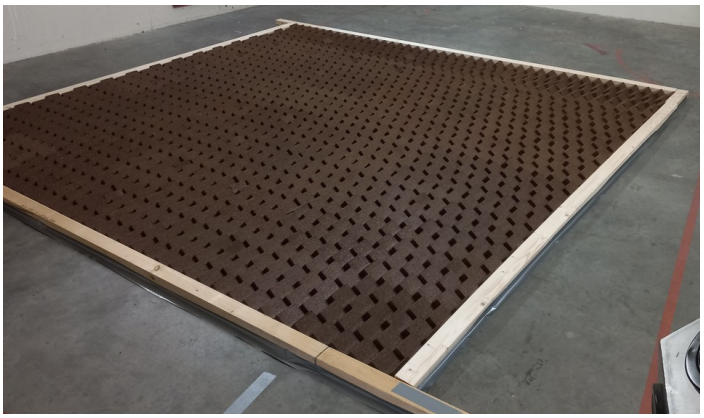
MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM
ACCORDING TO EN-ISO 354:2003

TESTEN
RvA L 334

principal: Greenmood

#1; - Brickx – Dark





volume reverberation room: 214 m^3

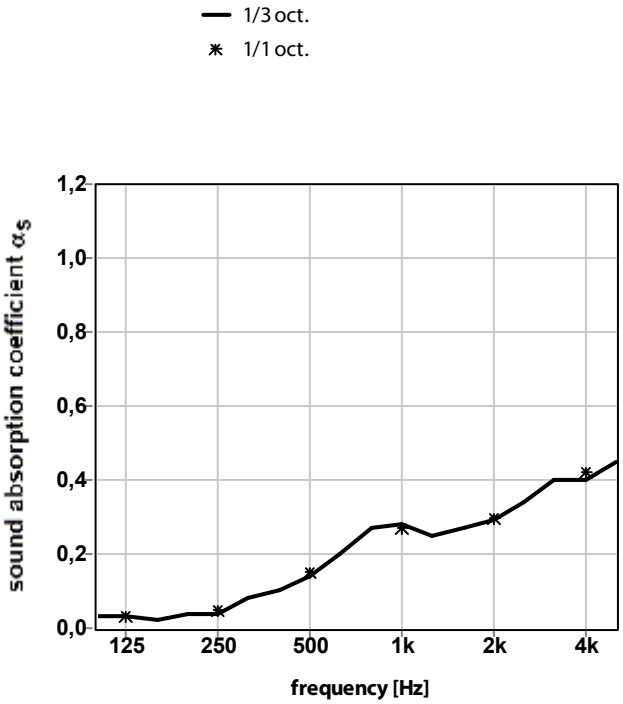
surface area sample: 10,5 m^2

heigth of the construction: 0,045 m

measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

bandwidth: 1/3 octave



α_w (ISO 11654) = 0,25(H)

SAA (ASTM - C423) = 0,19

	0,03	0,04	0,10	0,27	0,27	0,40
1/3 oct.	0,03	0,04	0,14	0,28	0,29	0,40
	0,02	0,08	0,20	0,25	0,34	0,45
1/1 oct.	**0,03**	**0,05**	**0,15**	**0,27**	**0,30**	**0,42**

Mook, measured at 07-09-2023

Absorb, versie 5.10.1 mode 7, PM: RA, file: a3544 E#:1-36 F#:150-185 A#:186 T_1 = 21,2 °C T_2 = 21,5 °C p_1 = 101,6 kPa p_2 = 101,6 kPa h_1 = 53,5 % h_2 = 58,2 %

A 3544-7E-RA-001 (C640501F) REMKO