

Laboratory for Acoustics



Determination of the sound absorption (reverberation room method) of LivePanel, manufacturer Mobilane Nederland





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| Principal | Mobilane B.V. Viola 3 6681 RA BEMMEL The Netherlands |
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| Representative | R.T. Allan |
| Author | J. Konings +31 85 8228675 j.konings@peutz.nl |

peutz bv, postbus 66, 6585 zh mook, +31 85 822 86 00, info@peutz.nl, www.peutz.nl

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1 Introduction

At the request of Mobilane B.V. based in Bommel (The Netherlands), laboratory measurements of the sound absorption (reverberation room method) were carried out on:

**LivePanel,
manufacturer Mobilane Nederland**

The measurements were performed in the Laboratory for Acoustics of Peutz bv, situated at Lindenlaan 41, 6584 AC in Molenhoek (the Netherlands). See Appendix 1 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:

| | |
|-----------------------------|---|
| ISO 354:2003 ^{1,2} | Acoustics Measurement of sound absorption in a reverberation room this international standard has been accepted within all EU- countries as European standard EN ISO 354:2003 |
| EN ISO 11654:1997 | Acoustics Sound absorbers for use in buildings Rating of sound absorption |
| ASTM C423-22 | Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method |
| NEN EN ISO 12999-2:2020 | Acoustics – Determination and application of measurement uncertainties in building acoustics – Part 2: Sound absorption (ISO 12999-2:2020) |

1



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

The RvA is member of the EA MLA (**EA MLA: European Accreditation Organisation MultiLateral Agreement**: <http://www.european-accreditation.org>).



EA: "Certificates 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 T_1 and T_2 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 construction

The data presented here have been received from the principal or obtained by own observations.

The measurements have been carried out on the following materials.

| | | |
|-----------------|---|--|
| Type | LivePanel |  <p>Plants with heights of 150 – 250 mm</p>  <p>Pruned plants</p> |
| Manufacturer | Mobilane | |
| System | Plant cassettes with slots that are placed in gutter profiles that serve as a water reservoir | |
| Plant cassettes | 0,4 x 0,4 m | |
| Total height: | 150 - 250 mm | |

Tested constructions:

1. Live Panel; with plant heights of 150 – 250 mm
2. Live Panel; pruned plants

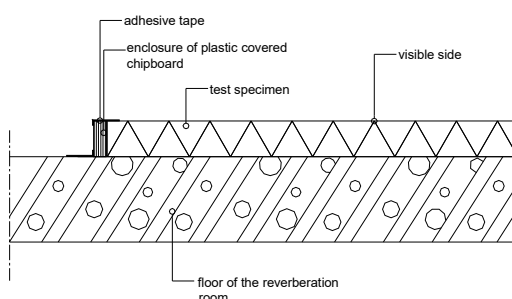
The results as presented here relate only to the tested items and laboratory conditions as described in this report. The laboratory can make no judgement about the representativity of the tested samples. The test report ahead is valid as long as the tested constructions and/or materials are unchanged.

4 Measurements

4.1 Mounting set-up

The panels to be measured (see chapter 3) have been mounted directly on the floor of the reverberation room, mounting type A according to ISO 354:2003. This setup is depicted in figure f1. The sides of the set-up were enclosed by reflecting panels and sealed by tape.

f1 Mounting setup



4.2 Method

The tests were conducted in accordance with the provisions of the test method ISO 354 in the Laboratory for Acoustics of Peutz bv in Mook (the Netherlands) (see appendix 1). The relevant data regarding the reverberation room are given in appendix 1.2 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 formula 1 and expressed in m^2

$$A_1 = \frac{55,3 V}{c T_1} - 4 V m_1 \quad (1)$$

in which:

V = the volume of the reverberation room [m³]

T_1 = the reverberation time in the empty reverberation room [sec.]

m_1 = "power attenuation coefficient" in the empty room,
calculated according to formula [m⁻¹]

c = the speed of sound in the air, in m/s, calculated according to [m/s]

$$c = 331 + 0,6 t \quad (2)$$

in which:

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

$$m = \frac{\alpha}{10 \log(e)} \quad (3)$$

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, also expressed in m²

$$A_2 = \frac{55,3 V}{c T_2} - 4 V m_2 \quad (4)$$

in which:

c and V have the same definition as in formula 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 3 [m⁻¹]

The equivalent sound absorption A of the test specimen has been calculated according to formula 5 and is expressed in m²

$$A = A_2 - A_1 \quad (5)$$

When the test specimen consists of one plane with an area between 10 and 12 m² the sound absorption coefficient α_s has to be calculated according to formula 6:

$$\alpha = \frac{A}{S} \quad (6)$$

in which:

S = the area of the test specimen [m²]

4.3 Accuracy

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

4.3.1 Repeatability r

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.

the probability will be 95% that the difference between the two test results will be less than or equal to r .

In order to evaluate the repeatability r for the sound absorption measurements performed in the reverberation room of "Peutz bv" in Mook (the Netherlands) eight series of measurements have been carried out according to ISO 354:1985 annex C.

From the results of those measurements the repeatability r has been calculated. It was found that for the frequency range from 100 to 200 Hz and at 5000 Hz the repeatability r is 0,21 as a maximum. For the frequency range 250 to 4000 Hz the repeatability r is 0,09 as a maximum.

4.3.2 Reproducibility R

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 ISO 12999-2 standard, the reproducibility with regard to the single number value α_w is $\pm 0,07$ dB.

4.4 Environmental conditions during the measurements

t4.1 Environmental conditions during the measurements at April 5th, 2023

| reverberation room | temperature [°C] | barometric pressure [kPa] | relative humidity [%] |
|--------------------|---------------------|------------------------------|--------------------------|
| empty | 17,3 | 102 | 72,5 |
| occupied | 17,4 - 17,6 | 102 | 53,7 – 55,2 |

4.5 Results

The results of the measurements are given in table 4.2 and in appendix 2. 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 octaveband. From those values the following one-figure ratings have been calculated and stated:

- the "weighted sound absorption coefficient α_w " according to ISO 11654;
- 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.

t4.2 measurement results Mobilane LivePanel

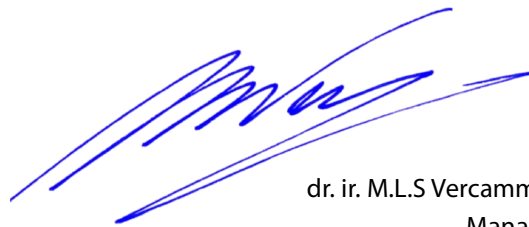
| | sound absorption coefficient α_s | | | |
|-----------------|---|----------|----------|----------|
| measurement nr. | 1 | | 2 | |
| record nr. | #73 | | #110 | |
| Appendix | 2.1 | | 2.2 | |
| frequency [Hz] | 1/3 oct. | 1/1 oct. | 1/3 oct. | 1/1 oct. |
| 100 | 0,11 | | 0,07 | |
| 125 | 0,17 | 0,21 | 0,12 | 0,15 |
| 160 | 0,36 | | 0,25 | |
| 200 | 0,50 | | 0,39 | |
| 250 | 0,77 | 0,69 | 0,63 | 0,58 |
| 315 | 0,80 | | 0,73 | |
| 400 | 0,77 | | 0,78 | |
| 500 | 0,76 | 0,77 | 0,78 | 0,78 |
| 630 | 0,78 | | 0,77 | |
| 800 | 0,81 | | 0,76 | |
| 1000 | 0,86 | 0,83 | 0,76 | 0,75 |
| 1250 | 0,82 | | 0,72 | |
| 1600 | 0,80 | | 0,65 | |
| 2000 | 0,78 | 0,77 | 0,60 | 0,60 |
| 2500 | 0,73 | | 0,54 | |
| 3150 | 0,71 | | 0,52 | |
| 4000 | 0,62 | 0,64 | 0,48 | 0,48 |
| 5000 | 0,58 | | 0,44 | |
| α_w | 0,75 | | 0,65 | |
| SAA | 0,77 | | 0,68 | |

The sound absorption coefficient of a material is not a material property. It should be taken into account that the sound absorption of a construction depends on the dimensions, the way of mounting of the material and its position in the room.

Mook,



R.T. Allan
Laboratory Supervisor



dr. ir. M.L.S Vercammen
Manager

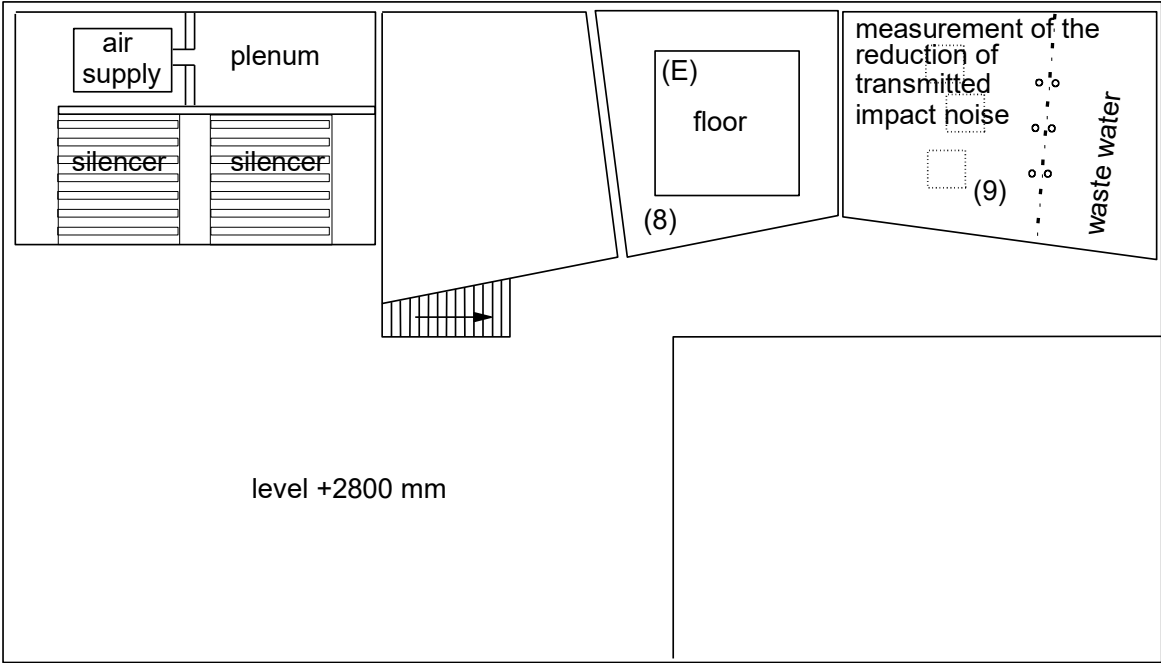
This report contains 11 pages and 2 appendices.

| | | |
|------------|---------------------|-----------|
| Appendix 1 | Plans and Section | (2 pages) |
| Appendix 2 | Measurement results | (2 pages) |

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

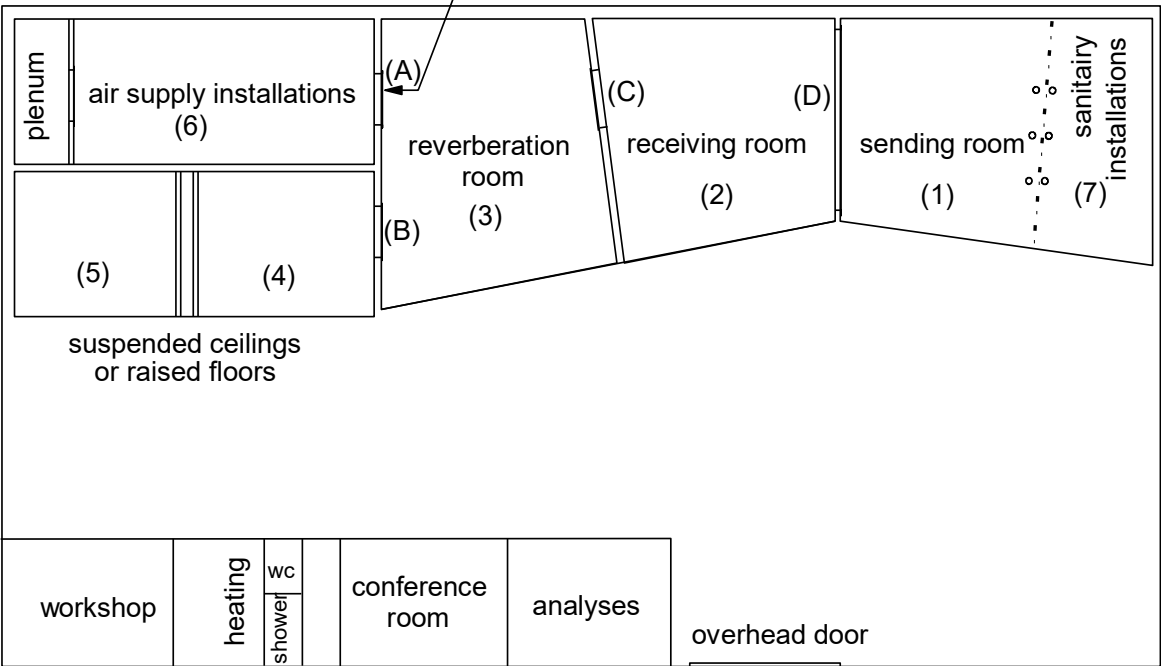
OVERVIEW

Story



Ground level

opening (A) (closed)
w x h = 1300 x 1905 mm



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

PEUTZ bv
Lindenlaan 41, 6584 AC MOLENHOEK (LB)

REVERBERATION ROOM

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

additional data:

volume : 214 m³
total area St (walls, floor and ceiling) : 219 m²

diffusion: by the shape of the room and by adding 6 curved and 2 flat reflecting elements with a total area of approx. 13 m² a sufficient diffusion has been gained.

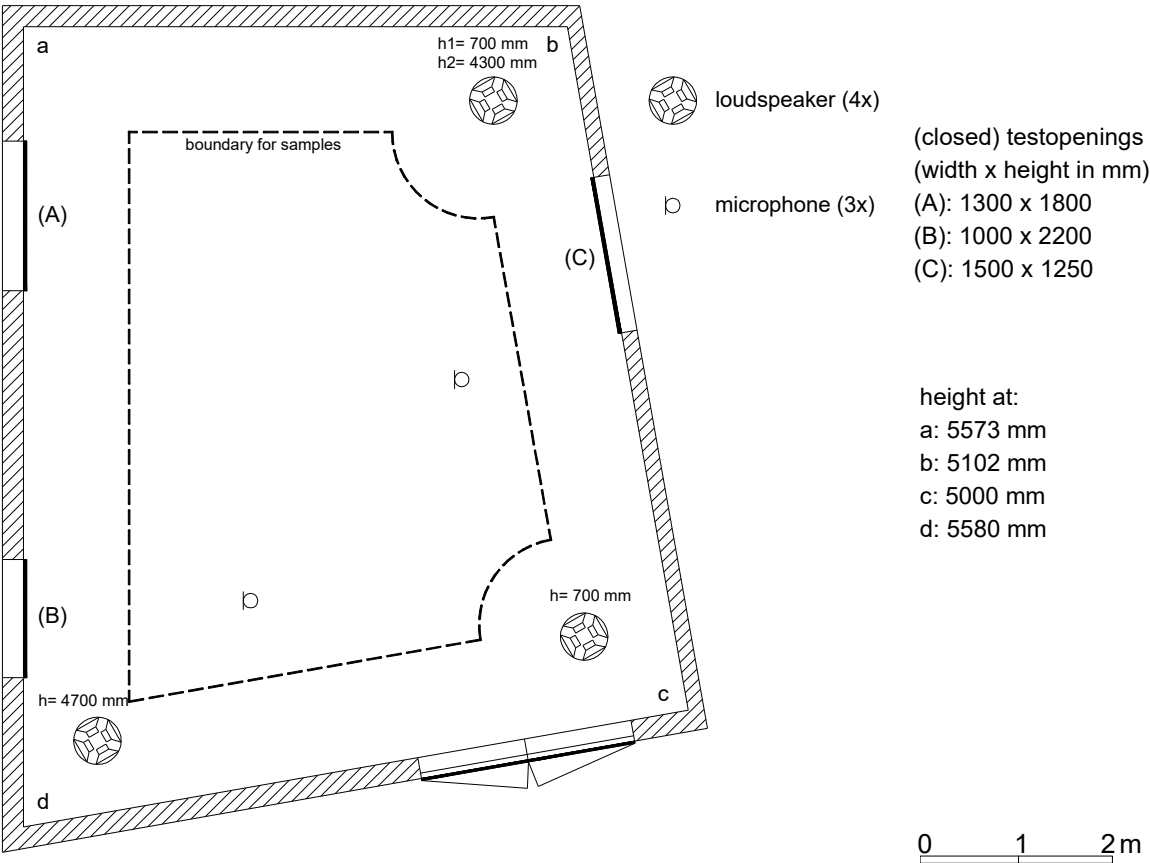
reverberation time of the empty reverberation room during measurements of 05-04-2023

| | | | | | | | |
|----------------------|------|------|------|------|------|------|------|
| frequency (1/1 oct.) | 125 | 250 | 500 | 1000 | 2000 | 4000 | Hz |
| reverberationtime | 8,95 | 7,22 | 6,78 | 6,33 | 4,69 | 3,11 | sec. |

repeatability 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



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



Principal: Mobilane B.V.

#1; Live Panel; with plant heights of 150 – 250 mm



volume reverberation room: 214 m³

surface area sample: 10,5 m²

measured at: Peutz Laboratory for Acoustics

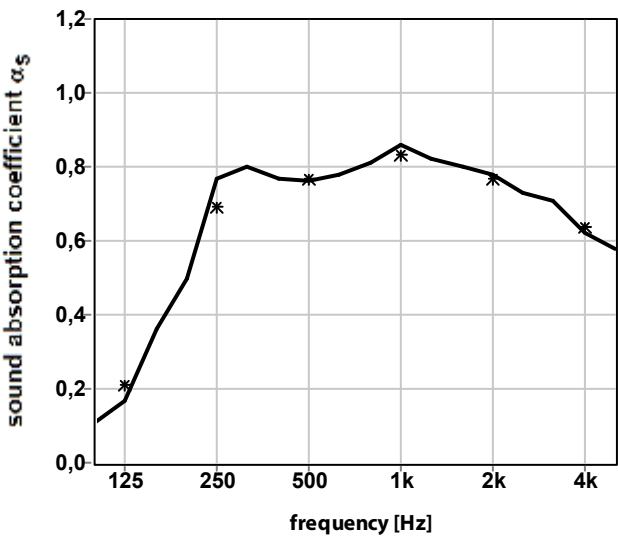
signal: broad-band noise

bandwidth: 1/3 octave

α_w (ISO 11654) = 0,75

SAA (ASTM - C423) = 0,77

— 1/3 oct.
* 1/1 oct.



| | | | | | | |
|----------|------|------|------|------|------|------|
| | 0,11 | 0,50 | 0,77 | 0,81 | 0,80 | 0,71 |
| 1/3 oct. | 0,17 | 0,77 | 0,76 | 0,86 | 0,78 | 0,62 |
| | 0,36 | 0,80 | 0,78 | 0,82 | 0,73 | 0,58 |
| 1/1 oct. | 0,21 | 0,69 | 0,77 | 0,83 | 0,77 | 0,64 |

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Mook, measured at 05-04-2023

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



Principal: Mobilane B.V.

#2; Live Panel; pruned plants



volume reverberation room: 214 m³

surface area sample: 10,5 m²

measured at: Peutz Laboratory for Acoustics

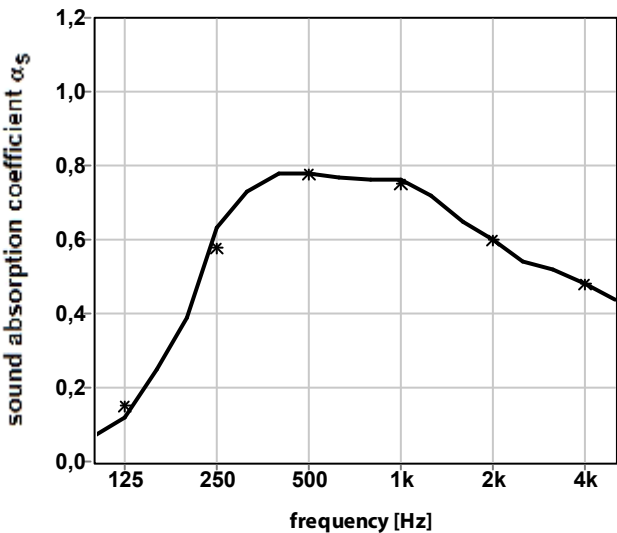
signal: broad-band noise

bandwidth: 1/3 octave

α_w (ISO 11654) = 0,65

SAA (ASTM - C423) = 0,68

— 1/3 oct.
* 1/1 oct.



| | | | | | | |
|----------|------|------|------|------|------|------|
| | 0,07 | 0,39 | 0,78 | 0,76 | 0,65 | 0,52 |
| 1/3 oct. | 0,12 | 0,63 | 0,78 | 0,76 | 0,60 | 0,48 |
| | 0,25 | 0,73 | 0,77 | 0,72 | 0,54 | 0,44 |
| 1/1 oct. | 0,15 | 0,58 | 0,78 | 0,75 | 0,60 | 0,48 |

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Mook, measured at 05-04-2023