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## Measurements of sound absorption coefficients in a reverberation room according to SS-EN 20354 (ISO 354) (16 enclosures)

### Test object

Isoflex insulation material type ISOFLEX/MONIFLEX made of 37,5 µm cellulose diacetate in layers with a thickness of 20, 30, 40, 50, 60 and 120 respectively. The mass per square metre is stated in enclosure 16. The insulation material arrived at SP on February 12, 1998.

### Date of test

February 20, 23 and 24, 1998

### Results

The sound absorption factors  $\alpha$  and the practical sound absorption factors  $\alpha_p$  are given in enclosures 1-12. The weighted sound absorption factors  $\alpha_w$  and the sound absorption classes have been calculated according to EN ISO 11654 and the Swedish Standards SS 02 52 59 and SS 02 52 60. The results are given in the table below. The reverberation times  $T_1$  at each frequency of the empty room are given in enclosure 13 - 15.

Object	EN ISO 11654		SS 02 52 59 / SS 02 52 60		Encl.
	$\alpha_w$	Absorption class	$\alpha_w$	Absorption class	
<b>ISOFLEX/MONIFLEX - 20</b> Thickness: 20 mm Mounting depth: 20 mm.	0,20	E	0,2	1)	1-2
<b>ISOFLEX/MONIFLEX - 30</b> Thickness: 30 mm Mounting depth: 30 mm	0,25	E	0,2	1)	3-4
<b>ISOFLEX/MONIFLEX - 40</b> Thickness: 40 mm Mounting depth: 40 mm	0,35	D	0,3	D	5-6

1) Not possible to classify according to SS 02 52 59 / SS 02 52 60

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Object	EN ISO 11654		SS 02 52 59 / SS 02 52 60		Encl.
	$\alpha_w$	Absorption class	$\alpha_w$	Absorption class	
<b>ISOFLEX/MONIFLEX - 50</b> Thickness: 50 mm Mounting depth: 50 mm.	0,40	D	0,4	D	7-8
<b>ISOFLEX/MONIFLEX - 60</b> Thickness: 60 mm Mounting depth: 60 mm	0,40	D	0,4	D	9-10
<b>ISOFLEX/MONIFLEX - 120</b> Thickness: 120 mm Mounting depth: 120 mm	0,45	D	0,4	D	11-12

### Measurement method

The measurements have been carried out according to SS-EN 20354:93 (ISO 354: 1985).

4 loudspeakers and 6 microphones (Brüel & Kjaer 4166) have been used giving 24 different combinations. Depending on the integration time ( $<T/20$ ), 3-5 decays have been recorded with each microphone and loudspeaker combination. Ensemble averaging has been used.

The absorption coefficient  $\alpha_S$  has been evaluated from :

$$\alpha_S = \frac{55.3 V}{c \cdot S} \left( \frac{1}{T_2} - \frac{1}{T_1} \right)$$

where

V = Volume of the reverberation room (m<sup>3</sup>)

S = Area of the test object (m<sup>2</sup>)

c = Speed of sound in air (m/s)

c = 331 + 0.6 · t where

t = Temperature in the air (°C)

T<sub>1</sub> = Reverberation time of the room without test object (s)

T<sub>2</sub> = Reverberation time of the room with test object (s)

### Measurement uncertainty

From a world wide Round Robin, in which SP took part, with 23 participating laboratories from 11 countries, the following measurement uncertainty has been calculated

Frequencies (Hz)	Uncertainty <sup>1)</sup>
100-630	± 0,15
800-1250	± 0,10
1600-2500	± 0,15
3150-5000	± 0,20

<sup>1)</sup> The figures are calculated from the twice the standard deviations, rounded to the nearest 0,05. The data from the Round Robin is documented in a letter from the ASTM to the participating laboratories.

### Test room

A reverberation room with the dimensions 7,64 m x 6,16 m x 4,25 m giving the volume 200 m<sup>3</sup> and the total surface area 211 m<sup>2</sup> was used. The suspended diffusers have been arranged according to the Nordtest method NT ACOU 012 and SS-ISO 354.

### Mounting

The panels with the total area 11 m<sup>2</sup> were placed on the floor. The edges were sealed with a wooden frame and a tape (made of an elastic woven material) to prevent air leakage. The mounting depth is the distance between the floor and the front surface (upper) of the test objects.

### List of instruments

Instrument	Manufacturer	Type	Serial no
Microphone	Brüel & Kjaer	4166	M20
Microphone	Brüel & Kjaer	4166	M21
Microphone	Brüel & Kjaer	4166	M22
Microphone	Brüel & Kjaer	4166	M23
Microphone	Brüel & Kjaer	4166	M24
Microphone	Brüel & Kjaer	4166	M25
Microphone Preamplifier	Brüel & Kjaer	2619	970994
Microphone Preamplifier	Brüel & Kjaer	2619	886538
Microphone Preamplifier	Brüel & Kjaer	2619	469993
Microphone Preamplifier	Brüel & Kjaer	2619	970880
Microphone Preamplifier	Brüel & Kjaer	2619	970951
Microphone Preamplifier	Brüel & Kjaer	2619	970865
Microphone Multiplexer	Norsonic	834	10050
Real-Time Analyzer	Norsonic	830	11533
Sound Level Calibrator	Brüel & Kjaer	4230	1410947
Programme	SP	Absorp	960627

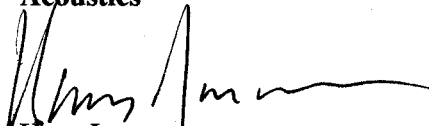



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Power amplifier	PA1		
Noise generator	NG1 ( white noise )		
Loudspeakers	SP	HGT2, HGT7, HGT8, HGTtak	
Hygrometer	Vaisala	HM 132	42154
Temperature meter	Vaisala	HM 132	42154

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