



INVESTOR IN PEOPLE

# Technical Report

**Report Number** C/07/5L/20123/R01a  
**supersedes SRL report** C/07/5L/20123/R01

**Date** 11 March 2008

## *Project*

**The Laboratory Determination of  
The Random Incidence Sound  
Absorption Coefficient of  
Various Ceiling Tiles**

## *Prepared for*

**Rockfon  
Rockwool A/S  
Hovedgaden 501  
DK-2640 Hedehusene  
Denmark**

## *By*

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0444

## **Sound Research Laboratories Limited**

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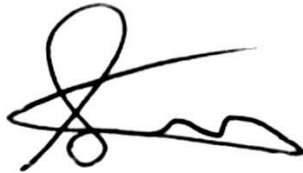
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## 1.0 Summary

Tests have been done in SRL's Laboratory at Holbrook House, Sudbury, Suffolk, to determine the random incidence sound absorption coefficient of various ceiling tiles in accordance with BS EN ISO 354:2003.

From these measurements the required results have been derived and are presented in both tabular and graphic form in Data Sheets 1 to 7.

The results are given in 1/3rd octave bands over the frequency range 50Hz to 10kHz, which is beyond that required by the test standard. Measurements outside the standard frequency range are not UKAS accredited.



.....  
**Allen Smalls**  
Laboratory Manager  
Quality Manager



.....  
**Trevor Hickman**  
Executive Consultant  
Deputy Technical Manager

For and on behalf of  
Sound Research Laboratories Ltd



## **Contents**

- 1.0** Summary
- 2.0** Details of Measurements
- 3.0** Description of Test
- 4.0** Results

### **Data Sheets 1 to 7**

### **Appendix 1: Test Procedure**

### **Appendix 2: Measurement Uncertainty**

### **Appendix 3: Sampling Forms**

## 2.0 Details of Measurements

### 2.1 Location

Sound Research Laboratories Ltd  
 Holbrook House  
 Little Waldingfield  
 Sudbury  
 Suffolk  
 CO10 0TH

### 2.2 Test Dates

23 January 2008

### 2.3 Instrumentation and Apparatus Used

| Make                     | Description  | Type  |
|--------------------------|--|---|
| E D I                    | Microphone Multiplexer<br>Microphone Power Supply Unit   |   |
| Norwegian<br>Electronics | Real Time Analyser   | 830   |
| Brüel & Kjaer            | 12mm Condenser Microphones<br>Windshields<br>Pre Amplifiers<br>Microphone Calibrator<br>Omnipower Sound Source | 4166<br>UA0237<br>2639, 2669C<br>4231<br>4296 |
| Larson Davis             | 12mm Condenser Microphone  | 2560  |
| Darton                   | Fortin Barometer   | P411  |
| Thermo Hygro             | Temperature & Humidity Probe   |   |
| TOA                      | Graphic Equalizer<br>Power Amplifier   | E-1231<br>DPA-800                             |

## 2.4 References

|                      |   |
|----------------------|---|
| BS EN ISO 11654:1997 | Sound absorbers for use in buildings.<br>Rating of sound absorption.                      |
| BS EN ISO 354:2003   | Measurement of sound absorption in a<br>reverberation room                                |
| ASTM C423-01         | Sound Absorption and Sound Absorption<br>Coefficient by the Reverberation Room<br>Method. |

## 2.5 Personnel Present

|             |         |
|-------------|---------|
| Tim Spencer | Rockfon |
|-------------|---------|

## **3.0 Description of Test**

### **3.1 Description of Sample**

Various ceiling tiles, details in datasheets and in section 4.0.

The mounting conditions referred to in section 4.0 are taken from BS EN ISO 354:2003.

Appendix 3 contains the clients sampling forms for the products tested.

Sampling plan: Selected at random.

Sample condition: New.

Details supplied by: Rockfon.

Sample installed by: Rockfon.

### **3.2 Sample Delivery date**

22 January 2008

### **3.3 Test Procedures**

The sample was mounted/located and tested in accordance with the relevant standard. The method and procedure is described in Appendix 1. The measurement uncertainty is given in Appendix 2.

## 4.0 Results

The results of the measurements and subsequent analysis are given in Data Sheets 1 to 7 and summarised below.

Results relate only to the items tested.

| SRL Test No. | Description in Brief  | $\alpha_w$ | Mounting Condition |
|--------------|---|------------|--------------------|
| 2            | 20mm Sonar 1200x600x20mm<br>Production code 748513                      | 1.00       | E-200              |
| 3            | Sonar Plan (Smooth)<br>1200x600x20mm<br>Production code 749111          | 1.00       | E-200              |
| 4            | Sonar Activity 1200x600x40mm<br>Production code 748513                  | 1.00       | E-200              |
| 5            | Sonar Activity Plan (smooth)<br>1200x600x40mm<br>Production code 749111 | 1.00       | E-200              |
| 6            | Sonar 1200x600x20mm<br>Production code 802431                           | 1.00       | E-220              |
| 7            | Sonar Activity 1200x600x40mm<br>Production code 748513                  | 0.95       | A                  |
| 8            | Sonar Activity Plan (smooth)<br>1200x600x40mm<br>Production code 749111 | 0.90       | A                  |

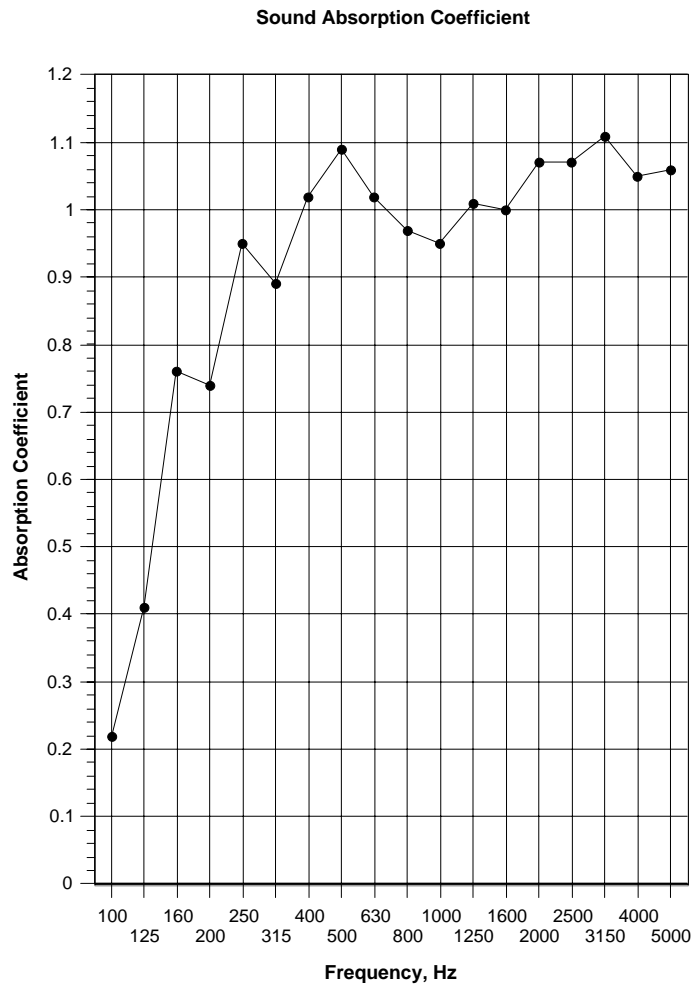
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[Data Sheet 1](#)

The Laboratory Measurement of Random Incidence Sound Absorption to BS EN ISO 354:2003

Client: **Rockfon**  
 Test Date: 23/01/2008  
 Empty Room: Temperature: 18.9 °C Humidity: 51 %RH Pressure: 1020 mbar  
 Room with Sample: Temperature: 19.4 °C Humidity: 47 %RH Pressure: 1020 mbar  
 Sample: **20mm Sonar 1200x600x20mm**  
 Description: **Production code 748513**  
 Sample Area: 12.96 m<sup>2</sup>  
 Mounting Type: **E-200**  
 Chamber Volume: 300 m<sup>3</sup>

| Test 2  |        |        |              |                          |
|---|--------|--------|--------------|--------------------------|
| Freq Hz   | T1 sec | T2 sec | Absorp Coeff | Practical Absorp Coeff # |
| 50*   | 3.80   | 3.82   | -0.01        |                          |
| 63*   | 4.01   | 2.85   | 0.38         | n/a                      |
| 80*   | 4.67   | 3.55   | 0.25         |                          |
| 100   | 6.34   | 4.63   | 0.22         |                          |
| 125   | 6.74   | 3.87   | 0.41         | 0.45                     |
| 160   | 6.64   | 2.82   | 0.76         |                          |
| 200   | 7.16   | 2.96   | 0.74         |                          |
| 250   | 7.01   | 2.51   | 0.95         | 0.85                     |
| 315   | 6.39   | 2.53   | 0.89         |                          |
| 400   | 6.02   | 2.27   | 1.02         |                          |
| 500   | 5.34   | 2.09   | 1.09         | 1.00                     |
| 630   | 5.03   | 2.12   | 1.02         |                          |
| 800   | 5.39   | 2.24   | 0.97         |                          |
| 1000  | 5.74   | 2.33   | 0.95         | 1.00                     |
| 1250  | 5.59   | 2.22   | 1.01         |                          |
| 1600  | 5.23   | 2.17   | 1.00         |                          |
| 2000  | 4.55   | 1.97   | 1.07         | 1.00                     |
| 2500  | 3.97   | 1.84   | 1.07         |                          |
| 3150  | 3.31   | 1.65   | 1.11         |                          |
| 4000  | 2.64   | 1.49   | 1.05         | 1.00                     |
| 5000  | 2.08   | 1.28   | 1.06         |                          |
| 6300*   | 1.52   | 1.06   | 0.98         |                          |
| 8000*   | 1.14   | 0.85   | 0.98         | n/a                      |
| 10000*  | 0.80   | 0.65   | 0.88         |                          |
| $A_w$   |        |        | 1.00         |                          |
| Class A   |        |        |              |                          |
| Calculated to EN ISO 11654:1997                                       |        |        |              |                          |
| NRC   |        |        | 1.00         |                          |
| Calculated to ASTM C 423-01   |        |        |              |                          |
| * Denotes frequencies outside the range covered by BS EN ISO 354:2003 |        |        |              |                          |
| T1, empty room reverberation time                                     |        |        |              |                          |
| T2, room reverberation time with sample                               |        |        |              |                          |



# Practical absorption coefficient, BS EN ISO 11654:1997

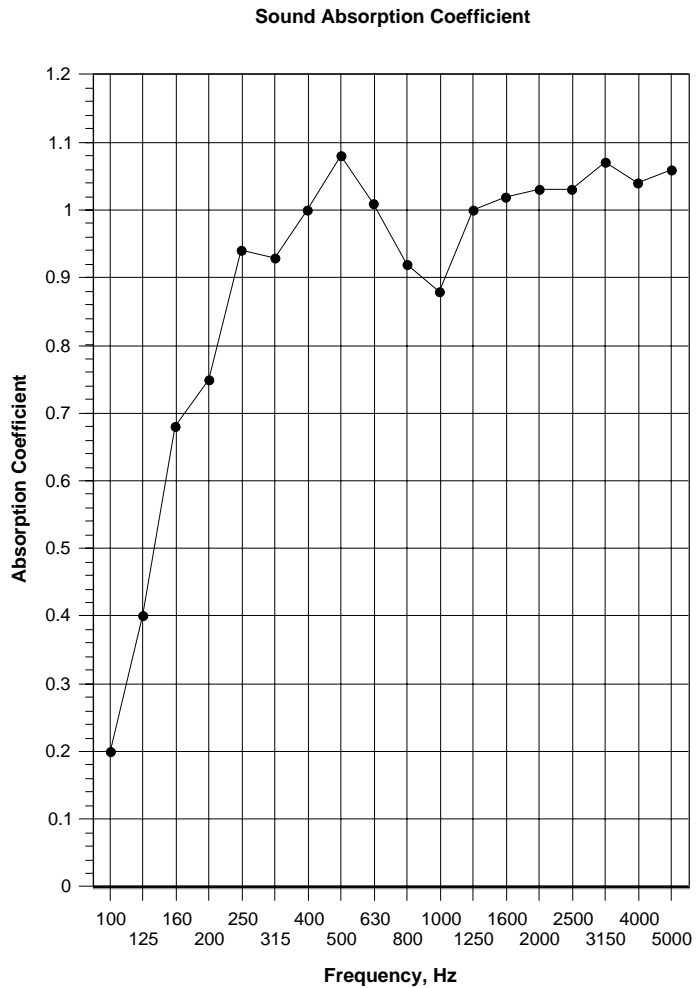
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The Laboratory Measurement of Random Incidence Sound Absorption to BS EN ISO 354:2003

Client: **Rockfon**  
 Test Date: 23/01/2008  
 Empty Room: Temperature: 18.9 °C Humidity: 51 %RH Pressure: 1020 mbar  
 Room with Sample: Temperature: 19.3 °C Humidity: 47 %RH Pressure: 1020 mbar  
 Sample: **Sonar Plan (Smooth) 1200x600x20mm**  
 Description: **Production code 749111**  
 Sample Area: 12.96 m<sup>2</sup>  
 Mounting Type: **E-200**  
 Chamber Volume: 300 m<sup>3</sup>

| Test 3  |        |        |              |                          |
|---|--------|--------|--------------|--------------------------|
| Freq Hz   | T1 sec | T2 sec | Absorp Coeff | Practical Absorp Coeff # |
| 50*   | 3.80   | 3.78   | 0.00         |                          |
| 63*   | 4.01   | 3.01   | 0.31         | n/a                      |
| 80*   | 4.67   | 3.34   | 0.32         |                          |
| 100   | 6.34   | 4.71   | 0.20         |                          |
| 125   | 6.74   | 3.90   | 0.40         | 0.45                     |
| 160   | 6.64   | 3.00   | 0.68         |                          |
| 200   | 7.16   | 2.93   | 0.75         |                          |
| 250   | 7.01   | 2.53   | 0.94         | 0.85                     |
| 315   | 6.39   | 2.46   | 0.93         |                          |
| 400   | 6.02   | 2.30   | 1.00         |                          |
| 500   | 5.34   | 2.10   | 1.08         | 1.00                     |
| 630   | 5.03   | 2.13   | 1.01         |                          |
| 800   | 5.39   | 2.31   | 0.92         |                          |
| 1000  | 5.74   | 2.44   | 0.88         | 0.95                     |
| 1250  | 5.59   | 2.23   | 1.00         |                          |
| 1600  | 5.23   | 2.15   | 1.02         |                          |
| 2000  | 4.55   | 2.01   | 1.03         | 1.00                     |
| 2500  | 3.97   | 1.88   | 1.03         |                          |
| 3150  | 3.31   | 1.68   | 1.07         |                          |
| 4000  | 2.64   | 1.50   | 1.04         | 1.00                     |
| 5000  | 2.08   | 1.28   | 1.06         |                          |
| 6300*   | 1.52   | 1.04   | 1.04         |                          |
| 8000*   | 1.14   | 0.85   | 0.97         | n/a                      |
| 10000*  | 0.80   | 0.66   | 0.78         |                          |
| <i>A<sub>w</sub></i> 1.00   |        |        |              |                          |
| Class A   |        |        |              |                          |
| Calculated to EN ISO 11654:1997                                       |        |        |              |                          |
| NRC 1.00  |        |        |              |                          |
| Calculated to ASTM C 423-01   |        |        |              |                          |
| * Denotes frequencies outside the range covered by BS EN ISO 354:2003 |        |        |              |                          |
| T1, empty room reverberation time                                     |        |        |              |                          |
| T2, room reverberation time with sample                               |        |        |              |                          |



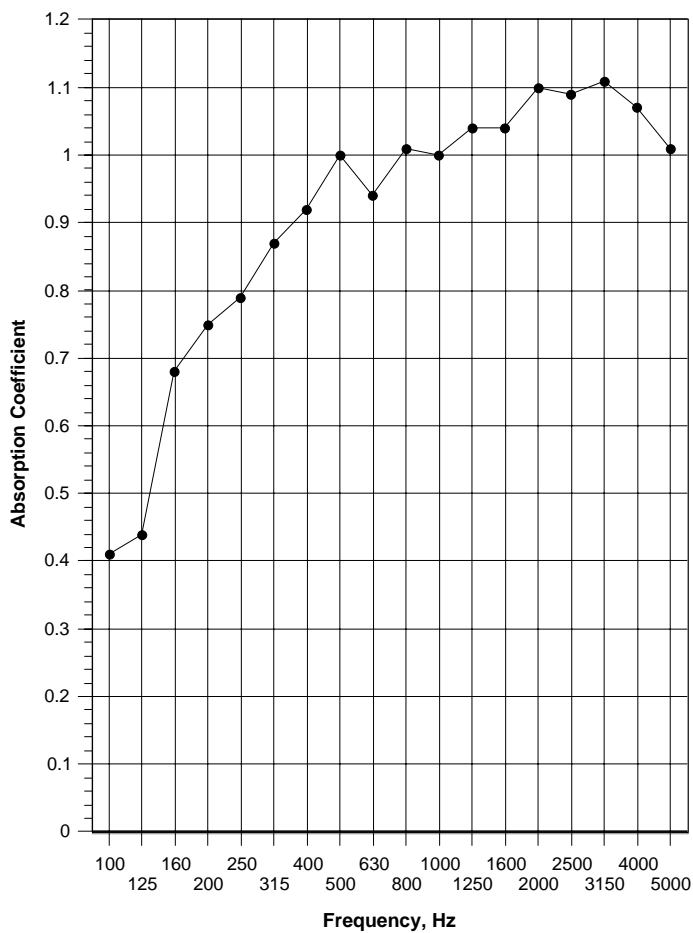
# Practical absorption coefficient, BS EN ISO 11654:1997

The Laboratory Measurement of Random Incidence Sound Absorption to BS EN ISO 354:2003

Client: [Rockfon](#)  
 Test Date: 23/01/2008  
 Empty Room: Temperature: 18.9 °C Humidity: 51 %RH Pressure: 1020 mbar  
 Room with Sample: Temperature: 19.2 °C Humidity: 47 %RH Pressure: 1020 mbar  
 Sample: [Sonar Activity 1200x600x40mm](#)  
 Description: [Production code 748513](#)  
 Sample Area: 12.96 m<sup>2</sup>  
 Mounting Type: [E-200](#)  
 Chamber Volume: 300 m<sup>3</sup>

| Test 4  |        |        |              |                          |
|---|--------|--------|--------------|--------------------------|
| Freq Hz   | T1 sec | T2 sec | Absorp Coeff | Practical Absorp Coeff # |
| 50*   | 3.80   | 3.73   | 0.02         |                          |
| 63*   | 4.01   | 2.69   | 0.46         | n/a                      |
| 80*   | 4.67   | 3.07   | 0.42         |                          |
| 100   | 6.34   | 3.73   | 0.41         |                          |
| 125   | 6.74   | 3.74   | 0.44         | 0.50                     |
| 160   | 6.64   | 3.00   | 0.68         |                          |
| 200   | 7.16   | 2.93   | 0.75         |                          |
| 250   | 7.01   | 2.82   | 0.79         | 0.80                     |
| 315   | 6.39   | 2.56   | 0.87         |                          |
| 400   | 6.02   | 2.42   | 0.92         |                          |
| 500   | 5.34   | 2.20   | 1.00         | 0.95                     |
| 630   | 5.03   | 2.22   | 0.94         |                          |
| 800   | 5.39   | 2.20   | 1.01         |                          |
| 1000  | 5.74   | 2.26   | 1.00         | 1.00                     |
| 1250  | 5.59   | 2.18   | 1.04         |                          |
| 1600  | 5.23   | 2.12   | 1.04         |                          |
| 2000  | 4.55   | 1.94   | 1.10         | 1.00                     |
| 2500  | 3.97   | 1.83   | 1.09         |                          |
| 3150  | 3.31   | 1.65   | 1.11         |                          |
| 4000  | 2.64   | 1.48   | 1.07         | 1.00                     |
| 5000  | 2.08   | 1.30   | 1.01         |                          |
| 6300*   | 1.52   | 1.07   | 0.93         |                          |
| 8000*   | 1.14   | 0.89   | 0.77         | n/a                      |
| 10000*  | 0.80   | 0.67   | 0.68         |                          |
| $\alpha_w$ 1.00   |        |        |              |                          |
| Class A   |        |        |              |                          |
| Calculated to EN ISO 11654:1997                                       |        |        |              |                          |
| NRC 0.95  |        |        |              |                          |
| Calculated to ASTM C 423-01   |        |        |              |                          |
| * Denotes frequencies outside the range covered by BS EN ISO 354:2003 |        |        |              |                          |
| T1, empty room reverberation time                                     |        |        |              |                          |
| T2, room reverberation time with sample                               |        |        |              |                          |

Sound Absorption Coefficient

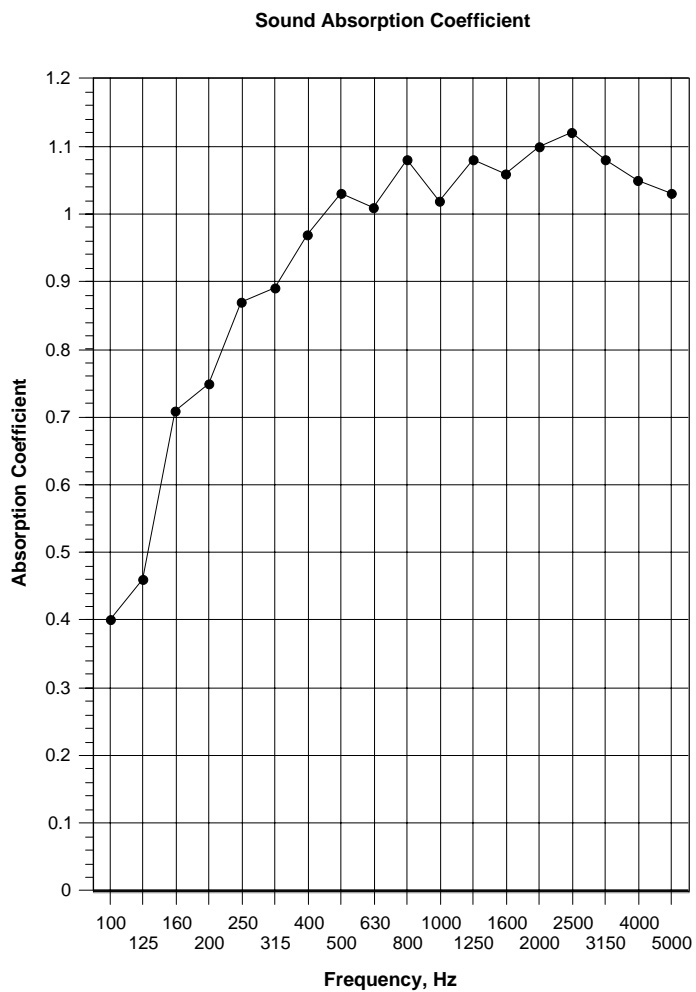


# Practical absorption coefficient, BS EN ISO 11654:1997

The Laboratory Measurement of Random Incidence Sound Absorption to BS EN ISO 354:2003

Client: **Rockfon**  
 Test Date: 23/01/2008  
 Empty Room: **Temperature:** 18.9 °C **Humidity:** 51 %RH **Pressure:** 1020 mbar  
 Room with Sample: **Temperature:** 19.2 °C **Humidity:** 48 %RH **Pressure:** 1020 mbar  
 Sample **Sonar Activity Plan (smooth) 1200x600x40mm**  
 Description: **Production code 749111**  
 Sample Area: 12.96 m<sup>2</sup>  
 Mounting Type: **E-200**  
 Chamber Volume: 300 m<sup>3</sup>

| Test 5  |        |                                 |              |                          |
|---|--------|---------------------------------|--------------|--------------------------|
| Freq Hz   | T1 sec | T2 sec                          | Absorp Coeff | Practical Absorp Coeff # |
| 50*   | 3.80   | 3.60                            | 0.05         |                          |
| 63*   | 4.01   | 2.72                            | 0.44         | n/a                      |
| 80*   | 4.67   | 3.01                            | 0.44         |                          |
| 100   | 6.34   | 3.79                            | 0.40         |                          |
| 125   | 6.74   | 3.69                            | 0.46         | 0.50                     |
| 160   | 6.64   | 2.94                            | 0.71         |                          |
| 200   | 7.16   | 2.94                            | 0.75         |                          |
| 250   | 7.01   | 2.66                            | 0.87         | 0.85                     |
| 315   | 6.39   | 2.54                            | 0.89         |                          |
| 400   | 6.02   | 2.35                            | 0.97         |                          |
| 500   | 5.34   | 2.16                            | 1.03         | 1.00                     |
| 630   | 5.03   | 2.13                            | 1.01         |                          |
| 800   | 5.39   | 2.11                            | 1.08         |                          |
| 1000  | 5.74   | 2.23                            | 1.02         | 1.00                     |
| 1250  | 5.59   | 2.13                            | 1.08         |                          |
| 1600  | 5.23   | 2.10                            | 1.06         |                          |
| 2000  | 4.55   | 1.94                            | 1.10         | 1.00                     |
| 2500  | 3.97   | 1.80                            | 1.12         |                          |
| 3150  | 3.31   | 1.68                            | 1.08         |                          |
| 4000  | 2.64   | 1.50                            | 1.05         | 1.00                     |
| 5000  | 2.08   | 1.30                            | 1.03         |                          |
| 6300*   | 1.52   | 1.06                            | 1.00         |                          |
| 8000*   | 1.14   | 0.87                            | 0.91         | n/a                      |
| 10000*  | 0.80   | 0.67                            | 0.75         |                          |
| $\alpha_w$  |        | 1.00                            |              |                          |
| Class A   |        | Calculated to EN ISO 11654:1997 |              |                          |
| NRC   |        | 1.00                            |              |                          |
|   |        | Calculated to ASTM C 423-01     |              |                          |
| * Denotes frequencies outside the range covered by BS EN ISO 354:2003 |        |                                 |              |                          |
| T1, empty room reverberation time                                     |        |                                 |              |                          |
| T2, room reverberation time with sample                               |        |                                 |              |                          |

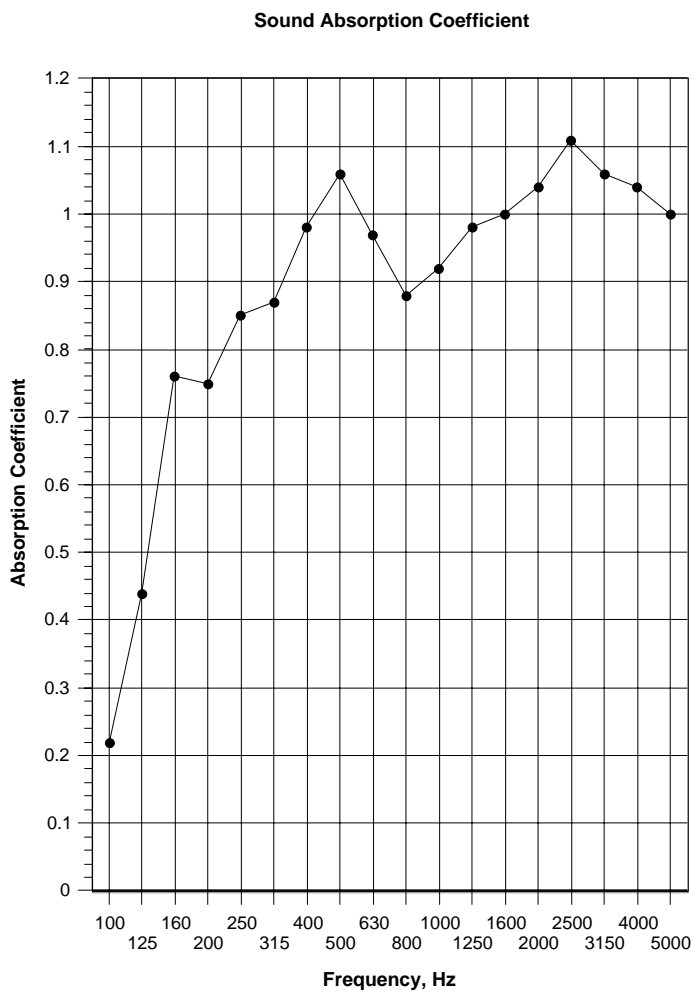


# Practical absorption coefficient, BS EN ISO 11654:1997

The Laboratory Measurement of Random Incidence Sound Absorption to BS EN ISO 354:2003

Client: **Rockfon**  
 Test Date: **23/01/2008**  
 Empty Room: **Temperature:** 18.9 °C **Humidity:** 51 %RH **Pressure:** 1020 mbar  
 Room with Sample: **Temperature:** 19.1 °C **Humidity:** 49 %RH **Pressure:** 1020 mbar  
 Sample **Sonar 1200x600x20mm**  
 Description: **Production code 802431**  
 Sample Area: **12.96 m<sup>2</sup>**  
 Mounting Type: **E-220**  
 Chamber Volume: **300 m<sup>3</sup>**

| Test 6  |        |        |              |                          |
|---|--------|--------|--------------|--------------------------|
| Freq Hz   | T1 sec | T2 sec | Absorp Coeff | Practical Absorp Coeff # |
| 50*   | 3.80   | 3.88   | -0.02        |                          |
| 63*   | 4.01   | 3.01   | 0.31         | n/a                      |
| 80*   | 4.67   | 3.42   | 0.29         |                          |
| 100   | 6.34   | 4.60   | 0.22         |                          |
| 125   | 6.74   | 3.75   | 0.44         | 0.45                     |
| 160   | 6.64   | 2.83   | 0.76         |                          |
| 200   | 7.16   | 2.93   | 0.75         |                          |
| 250   | 7.01   | 2.70   | 0.85         | 0.80                     |
| 315   | 6.39   | 2.56   | 0.87         |                          |
| 400   | 6.02   | 2.33   | 0.98         |                          |
| 500   | 5.34   | 2.12   | 1.06         | 1.00                     |
| 630   | 5.03   | 2.18   | 0.97         |                          |
| 800   | 5.39   | 2.37   | 0.88         |                          |
| 1000  | 5.74   | 2.38   | 0.92         | 0.95                     |
| 1250  | 5.59   | 2.26   | 0.98         |                          |
| 1600  | 5.23   | 2.18   | 1.00         |                          |
| 2000  | 4.55   | 2.00   | 1.04         | 1.00                     |
| 2500  | 3.97   | 1.82   | 1.11         |                          |
| 3150  | 3.31   | 1.70   | 1.06         |                          |
| 4000  | 2.64   | 1.51   | 1.04         | 1.00                     |
| 5000  | 2.08   | 1.32   | 1.00         |                          |
| 6300*   | 1.52   | 1.08   | 0.96         |                          |
| 8000*   | 1.14   | 0.92   | 0.71         | n/a                      |
| 10000*  | 0.80   | 0.69   | 0.64         |                          |
| $\alpha_w$ 1.00   |        |        |              |                          |
| Class A   |        |        |              |                          |
| Calculated to EN ISO 11654:1997                                       |        |        |              |                          |
| NRC 0.95  |        |        |              |                          |
| Calculated to ASTM C 423-01   |        |        |              |                          |
| * Denotes frequencies outside the range covered by BS EN ISO 354:2003 |        |        |              |                          |
| T1, empty room reverberation time                                     |        |        |              |                          |
| T2, room reverberation time with sample                               |        |        |              |                          |



# Practical absorption coefficient, BS EN ISO 11654:1997

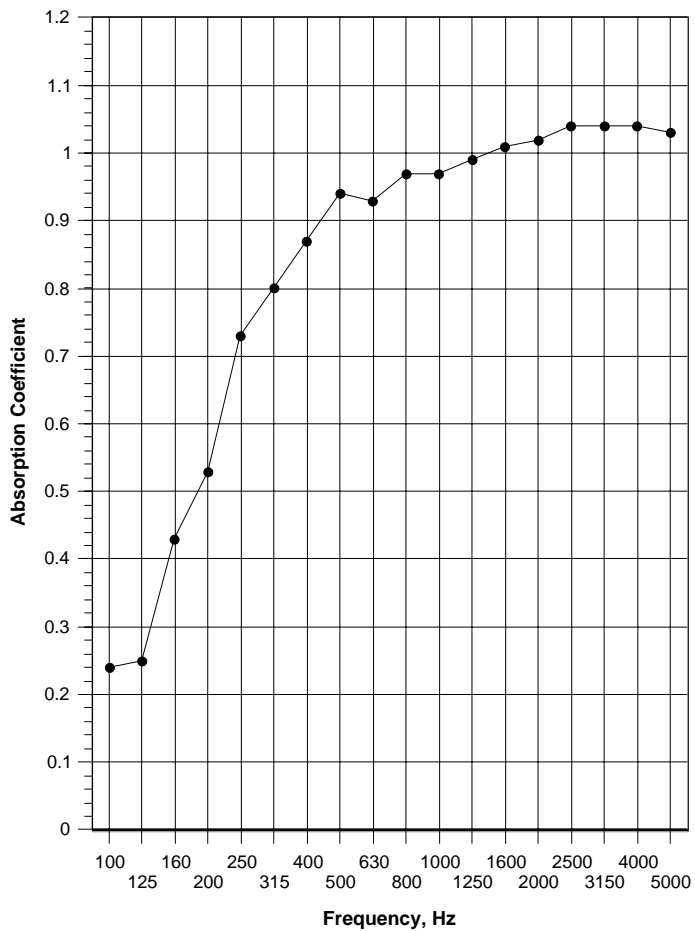
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The Laboratory Measurement of Random Incidence Sound Absorption to BS EN ISO 354:2003

Client: [Rockfon](#)  
 Test Date: 23/01/2008  
 Empty Room: Temperature: 18.9 °C Humidity: 51 %RH Pressure: 1020 mbar  
 Room with Sample: Temperature: 19.1 °C Humidity: 49 %RH Pressure: 1020 mbar  
 Sample [Sonar Activity 1200x600x40mm](#)  
 Description: [Production code 748513](#)  
 Sample Area: 12.96 m<sup>2</sup>  
 Mounting Type: [A](#)  
 Chamber Volume: 300 m<sup>3</sup>

| Test 7  |        |        |              |                          |
|---|--------|--------|--------------|--------------------------|
| Freq Hz   | T1 sec | T2 sec | Absorp Coeff | Practical Absorp Coeff # |
| 50*   | 3.80   | 3.62   | 0.05         |                          |
| 63*   | 4.01   | 3.90   | 0.03         | n/a                      |
| 80*   | 4.67   | 4.02   | 0.13         |                          |
| 100   | 6.34   | 4.53   | 0.24         |                          |
| 125   | 6.74   | 4.63   | 0.25         | 0.30                     |
| 160   | 6.64   | 3.78   | 0.43         |                          |
| 200   | 7.16   | 3.55   | 0.53         |                          |
| 250   | 7.01   | 2.95   | 0.73         | 0.70                     |
| 315   | 6.39   | 2.70   | 0.80         |                          |
| 400   | 6.02   | 2.50   | 0.87         |                          |
| 500   | 5.34   | 2.28   | 0.94         | 0.90                     |
| 630   | 5.03   | 2.23   | 0.93         |                          |
| 800   | 5.39   | 2.25   | 0.97         |                          |
| 1000  | 5.74   | 2.31   | 0.97         | 1.00                     |
| 1250  | 5.59   | 2.25   | 0.99         |                          |
| 1600  | 5.23   | 2.17   | 1.01         |                          |
| 2000  | 4.55   | 2.02   | 1.02         | 1.00                     |
| 2500  | 3.97   | 1.88   | 1.04         |                          |
| 3150  | 3.31   | 1.71   | 1.04         |                          |
| 4000  | 2.64   | 1.51   | 1.04         | 1.00                     |
| 5000  | 2.08   | 1.31   | 1.03         |                          |
| 6300*   | 1.52   | 1.09   | 0.92         |                          |
| 8000*   | 1.14   | 0.90   | 0.81         | n/a                      |
| 10000*  | 0.80   | 0.69   | 0.64         |                          |
| $\alpha_w$  |        |        | 0.95         |                          |
| Class A   |        |        |              |                          |
| Calculated to EN ISO 11654:1997                                       |        |        |              |                          |
| NRC   |        |        | 0.90         |                          |
| Calculated to ASTM C 423-01   |        |        |              |                          |
| * Denotes frequencies outside the range covered by BS EN ISO 354:2003 |        |        |              |                          |
| T1, empty room reverberation time                                     |        |        |              |                          |
| T2, room reverberation time with sample                               |        |        |              |                          |

Sound Absorption Coefficient



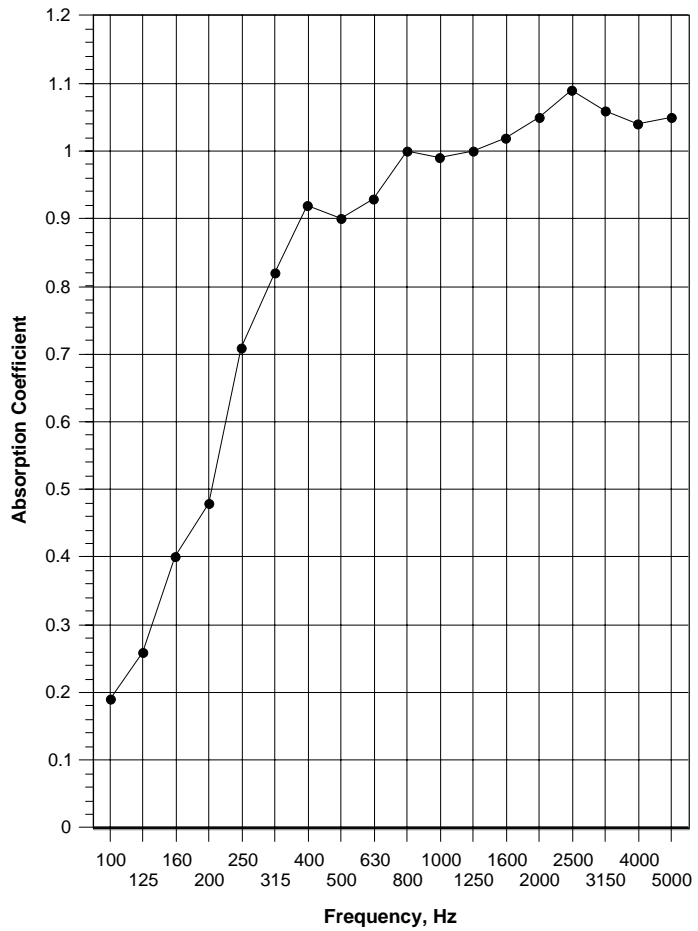
# Practical absorption coefficient, BS EN ISO 11654:1997

The Laboratory Measurement of Random Incidence Sound Absorption to BS EN ISO 354:2003

Client: **Rockfon**  
 Test Date: 23/01/2008  
 Empty Room: Temperature: 18.9 °C Humidity: 51 %RH Pressure: 1020 mbar  
 Room with Sample: Temperature: 19.1 °C Humidity: 50 %RH Pressure: 1020 mbar  
 Sample: **Sonar Activity Plan (smooth) 1200x600x40mm**  
 Description: **Production code 749111**  
 Sample Area: 12.96 m<sup>2</sup>  
 Mounting Type: **A**  
 Chamber Volume: 300 m<sup>3</sup>

| Test 8  |        |        |              |                          |
|---|--------|--------|--------------|--------------------------|
| Freq Hz   | T1 sec | T2 sec | Absorp Coeff | Practical Absorp Coeff # |
| 50*   | 3.80   | 3.83   | -0.01        |                          |
| 63*   | 4.01   | 3.75   | 0.06         | n/a                      |
| 80*   | 4.67   | 4.14   | 0.10         |                          |
| 100   | 6.34   | 4.77   | 0.19         |                          |
| 125   | 6.74   | 4.61   | 0.26         | 0.30                     |
| 160   | 6.64   | 3.90   | 0.40         |                          |
| 200   | 7.16   | 3.72   | 0.48         |                          |
| 250   | 7.01   | 3.00   | 0.71         | 0.65                     |
| 315   | 6.39   | 2.66   | 0.82         |                          |
| 400   | 6.02   | 2.42   | 0.92         |                          |
| 500   | 5.34   | 2.33   | 0.90         | 0.90                     |
| 630   | 5.03   | 2.23   | 0.93         |                          |
| 800   | 5.39   | 2.21   | 1.00         |                          |
| 1000  | 5.74   | 2.28   | 0.99         | 1.00                     |
| 1250  | 5.59   | 2.24   | 1.00         |                          |
| 1600  | 5.23   | 2.15   | 1.02         |                          |
| 2000  | 4.55   | 2.00   | 1.05         | 1.00                     |
| 2500  | 3.97   | 1.84   | 1.09         |                          |
| 3150  | 3.31   | 1.70   | 1.06         |                          |
| 4000  | 2.64   | 1.52   | 1.04         | 1.00                     |
| 5000  | 2.08   | 1.31   | 1.05         |                          |
| 6300*   | 1.52   | 1.09   | 0.95         |                          |
| 8000*   | 1.14   | 0.89   | 0.90         | n/a                      |
| 10000*  | 0.80   | 0.67   | 0.87         |                          |
| $\alpha_w$  |        |        | 0.90         |                          |
| Class A   |        |        |              |                          |
| Calculated to EN ISO 11654:1997                                       |        |        |              |                          |
| NRC   |        |        | 0.90         |                          |
| Calculated to ASTM C 423-01   |        |        |              |                          |
| * Denotes frequencies outside the range covered by BS EN ISO 354:2003 |        |        |              |                          |
| T1, empty room reverberation time                                     |        |        |              |                          |
| T2, room reverberation time with sample                               |        |        |              |                          |

Sound Absorption Coefficient



# Practical absorption coefficient, BS EN ISO 11654:1997

## Appendix 1

### Test Procedure

#### Measurements of Random Incidence Sound Absorption Coefficients to BS EN ISO 354:2003 - TP14 (Plane Absorbers)

In the laboratory, random incidence sound absorption coefficients are determined from the rate of decay of a sound field in a reverberation room, with and without a test sample installed. The rate of decay is described by the time a sound field takes to decay by 60dB, known as the reverberation time.

The reverberation room is constructed from 215mm brick, which is internally plastered with a reinforced concrete roof and floor. The room is rectangular and has a volume of 300 cubic metres and a total surface area of 275m<sup>2</sup>. From the ceiling hang 10 randomly positioned diffusers, each measuring 1.2m x 2.14m. The room is isolated from the surrounding structure by the use of resilient mountings and seals, ensuring good acoustic isolation.

Using at least two omnidirectional loudspeaker positions, broad band random noise is produced in the room using an electronic generator and power amplifier. When the amplification system is switched off, the decay of sound is filtered into one-third octave band widths and the reverberation times measured. This process is repeated for each of six microphone positions and the values arithmetically averaged to obtain a final value for each frequency.

The sample, which has an area between 10m<sup>2</sup> and 15.7m<sup>2</sup> is then laid over a pre-assembled laboratory test rig positioned on the floor of the reverberation room so that no part of it is closer than one metre from any edge of the boundaries. The test rig provides a space beneath the sample, the depth of which can be varied to simulate specific requirements such as the void above a suspended ceiling system. The procedure of measuring the reverberation times then repeated.

The sound absorption coefficients are calculated from the difference in decay rates for each frequency according to the formula:

$$a_s = \frac{A_t}{S}$$

where

- $a_s$  is the random incidence absorption coefficient
- $A_t$  is the increase in equivalent sound absorption area of the test specimen (m<sup>2</sup>)
- $S$  is the area covered by the test specimen (m<sup>2</sup>)

The equivalent absorption area of the test specimen is further defined as:

$$A_T = 55.3V\left(\frac{1}{c_2T_2} - \frac{1}{c_1T_1}\right) - 4V(m_2 - m_1)$$

where

- $V$  is the volume of the empty reverberation room ( $m^3$ )
- $c_1$  is the speed of sound in the empty room (m/sec)
- $T_1$  is the reverberation time in the empty room (sec)
- $m_1$  is the power attenuation coefficient calculated according to ISO 9613-1 using the climatic conditions that have been present in the empty rooms during the measurement.

$c_2$ ,  $T_2$  and  $m_2$  have the same meanings as  $c_1$ ,  $T_1$  and  $m_1$  but with the test specimen in the room.

It is occasionally found that the absorption coefficient derived in this manner reaches a value greater than unity. This is impossible, by definition, and investigation has shown that this anomaly is due to diffraction of the impinging sound waves at the edges of the sample. In practical terms this is insignificant.



## Appendix 2

### Measurement Uncertainty BS EN 20354:1993, ISO 354 - TP14

#### 1. Introduction

The estimated values of uncertainty are based on a standard uncertainty multiplied by a coverage factor of  $K = 2$ , which provides a level of confidence of approximately 95%.

**Table 1: Uncertainty For Equivalent Absorption Area Measurement**

| Frequency, Hz | Expanded uncertainty<br>K = 2, 95%<br>% of A <sub>1</sub> or A <sub>2</sub> |
|---------------|---|
| 100           | 9.0   |
| 125           | 8.1   |
| 160           | 5.6   |
| 200           | 6.7   |
| 250           | 4.3   |
| 315           | 8.1   |
| 400           | 4.6   |
| 500           | 5.0   |
| 630           | 5.3   |
| 800           | 3.2   |
| 1000          | 3.5   |
| 1250          | 3.1   |
| 1600          | 2.8   |
| 2000          | 2.7   |
| 2500          | 2.2   |
| 3150          | 1.8   |
| 4000          | 1.6   |
| 5000          | 1.6   |

#### 2. Estimation of Expanded Uncertainty For Sample Equivalent Sound Absorption Area

The expanded uncertainty,  $U_{A,m^2}$  is estimated by using the following formulae:-

$$U_A = \sqrt{\left(\frac{uA_1}{100}\right)^2 + \left(\frac{uA_2}{100}\right)^2}$$

|       |       |  |
|-------|-------|--|
| where | $U_A$ | is the expanded uncertainty for the sample equivalent sound absorption area, for $K = 2$ , 95%, $m^2$  |
|       | $u$   | is the estimated expanded uncertainty for the equivalent sound absorption area, taken from Table 1 above, $K = 2$ , 95%, % of $A_1$ or $A_2$ |
|       | $A_1$ | is the equivalent sound absorption area of the empty room, $m^2$   |
|       | $A_2$ | is the equivalent sound absorption area of the room with the sample, $m^2$   |

### 3. Estimation of expanded Uncertainty For Sound Absorption Coefficients

The expanded uncertainty for sound absorption coefficients,  $U_{a_s}$ , is estimated using the following formulae:-

$$U_{a_s} = \frac{a_s U_A}{A}$$

|       |           |   |
|-------|-----------|---|
| where | $U_{a_s}$ | is the expanded uncertainty for sound absorption coefficients, $K=2$ , 95%                      |
|       | $a_s$     | is the sound absorption coefficient   |
|       | $U_A$     | is the expanded uncertainty for the sample equivalent sound absorption area, $K=2$ , 95%, $m^2$ |
|       | $A$       | is the sample equivalent sound absorption area, $m^2$   |

## Appendix 3 - Sampling Forms



**BELGIAN CONSTRUCTION CERTIFICATION ASSOCIATION asbl  
BCCA**

Founded by : BBRI and SECO

### SAMPLING FORM

Sampling is done by the manufacturer based on a prearranged sampling plan. Data concerning identification and traceability are handed over by the manufacturer to BCCA.

|          |  |       |    |
|----------|--|-------|----|
| Product: | mineral wool, suspended ceiling membrane | Mark: | CE |
|----------|--|-------|----|

|                 |              |              |                          |
|-----------------|--------------|--------------|--------------------------|
| File n° BCCA:   | BC1-533-1817 | Sampling n°: | Gjall - Sound Absorption |
| Representative: | Jan Verbeke  | Date:        | 08/01/2008               |
|                 |              | Location:    | Cigacice (PL)            |
|                 |              | Visit n°:    |                          |

|               |   |                 |                           |
|---------------|---|-----------------|---------------------------|
| Manufacturer: | Rockwool Polska Sp. z o.o                     | Contact person: | Mr. Artur Nehring         |
| address:      | u.l. Kwiatowa 14<br>66 131 Cigacice<br>Poland | Tel.:           | 0048 68 38 50 250         |
|               |   | Fax:            | 0048 68 38 50 511         |
|               |   | Email:          | artur.nehring@rockwool.pl |

|                    |                            |                                       |                 |
|--------------------|----------------------------|---------------------------------------|-----------------|
| Nature of samples: | Dimensions:                | Production date:<br>(production code) | Identification: |
| SONAR 8.000.01 PL  | 1200 x 600 x 20 mm, ± 15m² | 8024.. (10/01/2008)                   |                 |

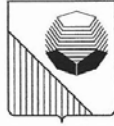
|                  |                   |                 |         |
|------------------|-------------------|-----------------|---------|
| Tests            | Test method       | Number of tests | Remarks |
| Sound Absorption | EN ISO 354 : 2003 | 1               |         |

|                                 |  |
|---------------------------------|--|
| Laboratory:                     | Sound Research Laboratories Ltd., att. Allen Smalls, Suffolk, UK |
| Test reports available before:  |  |
| Invoice must be send to:        | Rockfon, Rockwool A/S, Hovedgaden 501, DK - 2640 Hedehusene      |
| Number of reports (+ language): | 1 (language = ENGLISH)   |
| Reports must be send to:        | Mr. Thomas Nellemose (Rockfon, Rockwool A/S in Hedehusene)       |
| Remarks:                        |  |

|                         |                                   |  |   |
|-------------------------|-----------------------------------|--|---|
| Representative BCCA:    | Manufacturer: (2)<br>for approval | Carrier: (3)<br>For execution of the mission | Laboratory: (4)<br>For reception of the samples and<br>acceptation of the execution |
| Name <i>Jan Verbeke</i> | Name <i>Thomas Nellemose</i>      | Name   | Name <i>A. SMALLS</i>   |
| signature<br>           | signature<br>                     | signature                                    | signature<br>   |
| date <i>08/01/2008</i>  | date <i>23.07.08</i>              | date   | date <i>23.1.08</i>   |

**Remarks :**

- (1) The laboratory shall follow the confidential rules, given in NBN EN 17025.
- (2) The producer accept by the signature of his delegate all modalities mentioned on this document. He will send an order form for ditto to the indicated laboratory.
- (3) The carrier of the sample confirms by his signature the delivering of the sample at the laboratory.
- (4) The laboratory confirms by the signature of his delegate the arrival of the sample, the test modalities and the term of execution of the tests. He will send within 7 days after arrival of the sample a copie of this document to SECO/BCCA
- (5) If the laboratory can not accept the mission, SECO/BCCA shall be informed within 4 days, so that the necessary actions can be taken.
- (6) The laboratory shall inform SECO/BCCA of every failure detected on the samples and every problem appearing during the handling and testing, as soon as possible.



## BELGIAN CONSTRUCTION CERTIFICATION ASSOCIATION asbl BCCA

Founded by : BBRI and SECO

### SAMPLING FORM

Sampling is done by the manufacturer based on a prearranged sampling plan. Data concerning identification and traceability are handed over by the manufacturer to BCCA.

|                 |   |                 |                           |
|-----------------|---|-----------------|---------------------------|
| Product:        | mineral wool, suspended ceiling membrane      | Mark:           | CE                        |
| File n° BCCA:   | BC1-533-1817                                  | Sampling n°:    | Gjall - Sound Absorption  |
|                 |   | Date:           | 08/01/2008                |
| Representative: | Jan Verbeke                                   | Location:       | Cigacice (PL)             |
|                 |   | Visit n°:       |                           |
| Manufacturer:   | Rockwool Polska Sp. z o.o                     | Contact person: | Mr. Artur Nehring         |
| address:        | u.l. Kwiatowa 14<br>66 131 Cigacice<br>Poland | Tel.:           | 0048 68 38 50 250         |
|                 |   | Fax:            | 0048 68 38 50 511         |
|                 |   | Email:          | artur.nehring@rockwool.pl |

| Nature of samples:     | Dimensions:                            | Production date:<br>(production code) | Identification: |
|------------------------|--|---------------------------------------|-----------------|
| SONAR 8.000.01 PL      | 1200 x 600 x 20 mm, ± 15m <sup>2</sup> | 748513                                |                 |
| SONAR 8.000.01 PL      | 1200 x 600 x 40 mm, ± 15m <sup>2</sup> | 748513                                |                 |
| SONAR PLAN 8.000.07 PL | 1200 x 600 x 20 mm, ± 15m <sup>2</sup> | 749111                                |                 |
| SONAR PLAN 8.000.07 PL | 1200 x 600 x 40 mm, ± 15m <sup>2</sup> | 749111                                |                 |

| Tests            | Test method       | Number of tests | Remarks |
|------------------|-------------------|-----------------|---------|
| Sound Absorption | EN ISO 354 : 2003 | 4               |         |

|                                 |  |
|---------------------------------|--|
| Laboratory:                     | Sound Research Laboratories Ltd., att. Allen Smalls, Suffolk, UK |
| Test reports available before:  |  |
| Invoice must be send to:        | Rockfon, Rockwool A/S, Hovedgaden 501, DK - 2640 Hedehusene      |
| Number of reports (+ language): | 1 (language = ENGLISH)   |
| Reports must be send to:        | Mr. Thomas Nellemose (Rockfon, Rockwool A/S in Hedehusene)       |
| Remarks:                        |  |

| Representative BCCA:    | Manufacturer: (2)<br>for approval | Carrier: (3)<br>For execution of the mission | Laboratory: (4)<br>For reception of the samples and<br>acceptation of the execution |
|-------------------------|-----------------------------------|--|---|
| Name <i>Jan Verbeke</i> | Name <i>Thomas Nellemose</i>      | Name   | Name <i>A. SMALLS</i>   |
| signature<br>           | signature<br>                     | signature                                    | signature<br>   |
| date <i>08/01/2008</i>  | date <i>23.01.08</i>              | date   | date <i>23.1.08</i>   |

**Remarks:**

- (1) The laboratory shall follow the confidential rules, given in NBN EN 17025.
- (2) The producer accept by the signature of his delegate all modalities mentioned on this document. He will send an order form for ditto to the indicated laboratory.
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