

ROCA Finland Oy
Kai Dunder
Fiskarsinkatu 7
20750 TURKU
kai.dunder@roca.fi



DETERMINATION OF AIRBORNE SOUND INSULATION IN LABORATORY CONDITIONS

1 CLIENT

ROCA Finland Oy, Kai Dunder. Tender April 23, 2020. Order date May 11, 2020.

2 DESCRIPTION OF THE COMMISSION

Sound reduction index R was measured for specimen within 100-5000 Hz according to ISO 10140-2:2010. Weighted sound reduction index was determined according to ISO 717-1:2013.

3 RESULTS

The results are summarized in Table 1. Detailed results are presented in Annex 1.

Table 1. Weighted sound reduction index R_w for tested specimens.

| Test | Glass | Door Threshold | R_w [dB] |
|------|---|--|---------------|
| 1 | 10 mm tempered glass | ROCA Decibel threshold, RG-581 | 32 |
| 2 | 10 mm tempered glass | Automatic threshold sealing RG-592 for ROCA dB | 31 |
| 3 | 5+5 mm laminated and tempered glass with noise reduction interlayer 0.76 mm | ROCA Decibel threshold, RG-581 | 34 |
| 4 | 5+5 mm laminated and tempered glass with noise reduction interlayer 0.76 mm | Automatic threshold sealing RG-592 for ROCA dB | 32 |

ROCA Decibel door frame, RG-580, M10x21 (990x2083) and ROCA Glass wall profile RG-502 were used in all measurements.

4 SIGNATURES



Valtteri Hongisto
Research Group Leader



Reijo Alakoivu
Research Engineer

Turku University of Applied Sciences
Engineering and Business, Construction Industry
Laboratory of acoustics

ANNEXES

- Annex 1 – Test results (4 pages)
- Annex 2 – Structure drawings (2 pages)
- Annex 3 – Mounting of specimen (1 page)
- Annex 4 – Measurement arrangements (3 pages)

Determination of airborne sound insulation according to ISO 10140-2:2010 in laboratory conditions

Specimen id: Test 1: 10 mm tempered glass, ROCA Decibel threshold, RG-581
ROCA Decibel door frame, RG-580, M10x21 (990x2083) + ROCA Glass wall profile RG-502

Manufacturer: Roca Finland Oy

Client: Roca Finland Oy

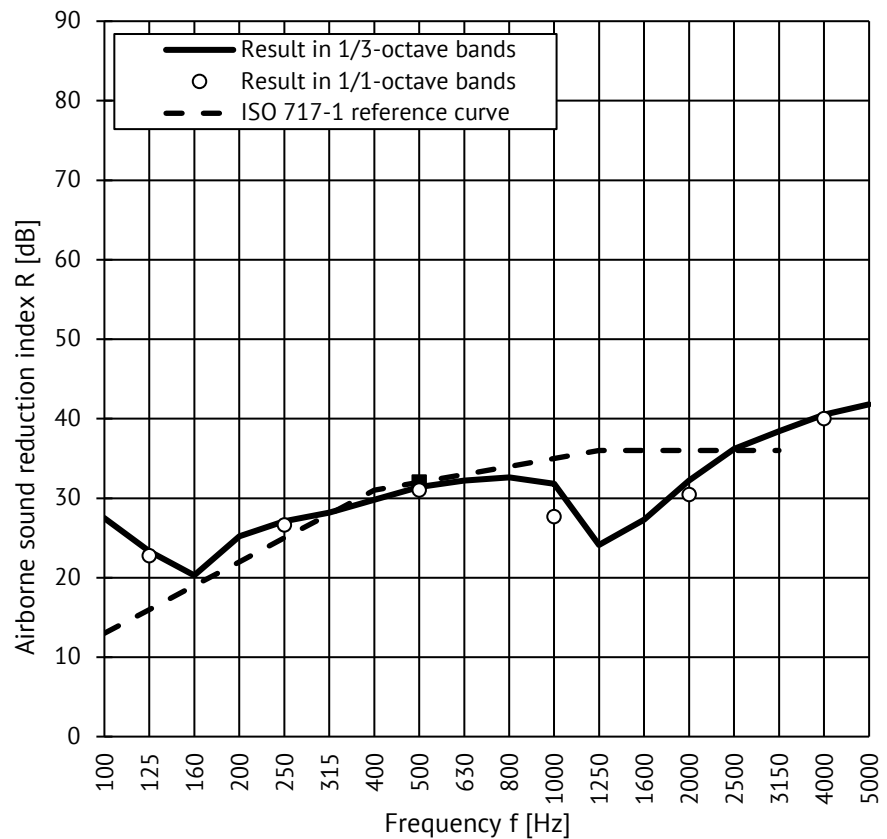
Contact person: Jarkko Kosonen

Mounting by: Turun Lasipalvelu Oy

Test laboratory: Turku University of Applied Sciences, Laboratory of Acoustics
Lemminkäisenkatu 14-18 B, 20520 Turku, Finland.
www.tuas.fi/en/research-and-development/research-groups/indoor-environment/

Room temperature: 22,9 °C Area of test element, S: 10,1 m²
Relative humidity: 30 % Mass per unit area: 25 kg/m²
Source room volume: 81 m³ Test date: Jun 2, 2020
Receiving room volume: 113 m³ Test file: R020620B

| f [Hz] | R [dB] | R [dB] |
|--------|--------|--------|
| 50 | 28,4 | |
| 63 | 19,2 | 18,6 |
| 80 | 15,6 | |
| 100 | 27,5 | |
| 125 | 23,3 | 22,8 |
| 160 | 20,3 | |
| 200 | 25,2 | |
| 250 | 27,1 | 26,7 |
| 315 | 28,2 | |
| 400 | 29,8 | |
| 500 | 31,4 | 31,0 |
| 630 | 32,2 | |
| 800 | 32,6 | |
| 1000 | 31,8 | 27,7 |
| 1250 | 24,1 | |
| 1600 | 27,3 | |
| 2000 | 32,2 | 30,5 |
| 2500 | 36,2 | |
| 3150 | 38,4 | |
| 4000 | 40,5 | 40,0 |
| 5000 | 41,8 | |



Single-number quantities according to ISO 717-1

| | |
|--|--------------|
| R_w | 32 dB |
| R _w +C | 29 dB |
| R _w +C _{tr} | 28 dB |
| R _w +C ₁₀₀₋₅₀₀₀ | 30 dB |
| R _w +C ₅₀₋₃₁₅₀ | 29 dB |
| R _w +C ₅₀₋₅₀₀₀ | 30 dB |
| R _w +C _{tr,100-5000} | 28 dB |
| R _w +C _{tr,50-3150} | 28 dB |
| R _w +C _{tr,50-5000} | 28 dB |

Signs F and B indicate that the declared result is an underestimate in this frequency band. The true value is larger.



R. Alakoivu
Reijo Alakoivu
research engineer
test performer

Determination of airborne sound insulation according to ISO 10140-2:2010 in laboratory conditions

Specimen id: Test 2: 10 mm tempered glass, Automatic threshold sealing RG-592 for ROCA dB
ROCA Decibel door frame, RG-580, M10x21 (990x2083) + ROCA Glass wall profile RG-502

Manufacturer: Roca Finland Oy

Client: Roca Finland Oy

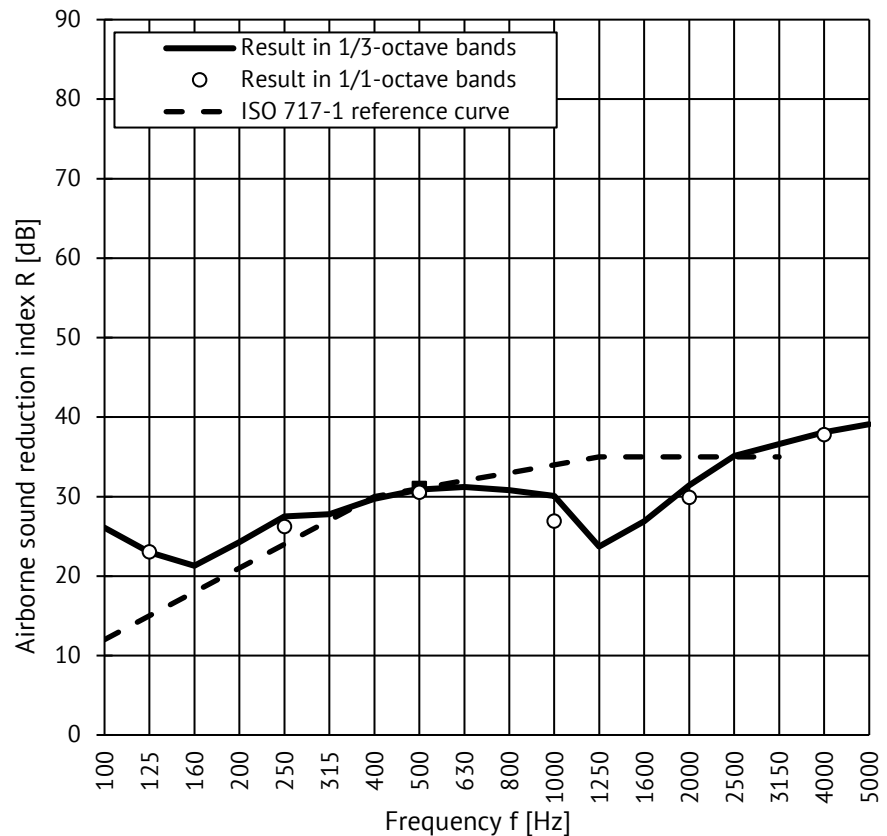
Contact person: Jarkko Kosonen

Mounting by: Turun Lasipalvelu Oy

Test laboratory: Turku University of Applied Sciences, Laboratory of Acoustics
Lemminkäisenkatu 14-18 B, 20520 Turku, Finland.
www.tuas.fi/en/research-and-development/research-groups/indoor-environment/

Room temperature: 22,8 °C Area of test element, S: 10,1 m²
Relative humidity: 30 % Mass per unit area: 25 kg/m²
Source room volume: 81 m³ Test date: Jun 2, 2020
Receiving room volume: 113 m³ Test file: R020620a

| f [Hz] | 1/3 1/1 | |
|-----------|-----------|-----------|
| | R [dB] | R [dB] |
| 50 | 28,3 | |
| 63 | 19,9 | 18,3 |
| 80 | 14,9 | |
| 100 | 26,1 | |
| 125 | 23,0 | 23,0 |
| 160 | 21,3 | |
| 200 | 24,3 | |
| 250 | 27,5 | 26,2 |
| 315 | 27,8 | |
| 400 | 29,7 | |
| 500 | 30,9 | 30,6 |
| 630 | 31,2 | |
| 800 | 30,8 | |
| 1000 | 30,1 | 26,9 |
| 1250 | 23,7 | |
| 1600 | 26,9 | |
| 2000 | 31,4 | 29,9 |
| 2500 | 35,1 | |
| 3150 | 36,6 | |
| 4000 | 38,1 | 37,8 |
| 5000 | 39,1 | |



Single-number quantities
according to ISO 717-1

R_w 31 dB
R_w+C 29 dB
R_w+C_{tr} 28 dB
R_w+C₁₀₀₋₅₀₀₀ 30 dB
R_w+C₅₀₋₃₁₅₀ 29 dB
R_w+C₅₀₋₅₀₀₀ 29 dB
R_w+C_{tr,100-5000} 28 dB
R_w+C_{tr,50-3150} 27 dB
R_w+C_{tr,50-5000} 27 dB

Signs F and B indicate that the declared result is an underestimate
in this frequency band. The true value is larger.



R. Alakoivu
Reijo Alakoivu
research engineer
test performer

Determination of airborne sound insulation according to ISO 10140-2:2010 in laboratory conditions

Specimen id: Test 3: 5+5 mm laminated and tempered glass with noise reduction interlayer 0.76 mm, ROCA Decibel threshold, RG-581
ROCA Decibel door frame, RG-580, M10x21 (990x2083) + ROCA Glass wall profile RG-502

Manufacturer: Roca Finland Oy

Client: Roca Finland Oy

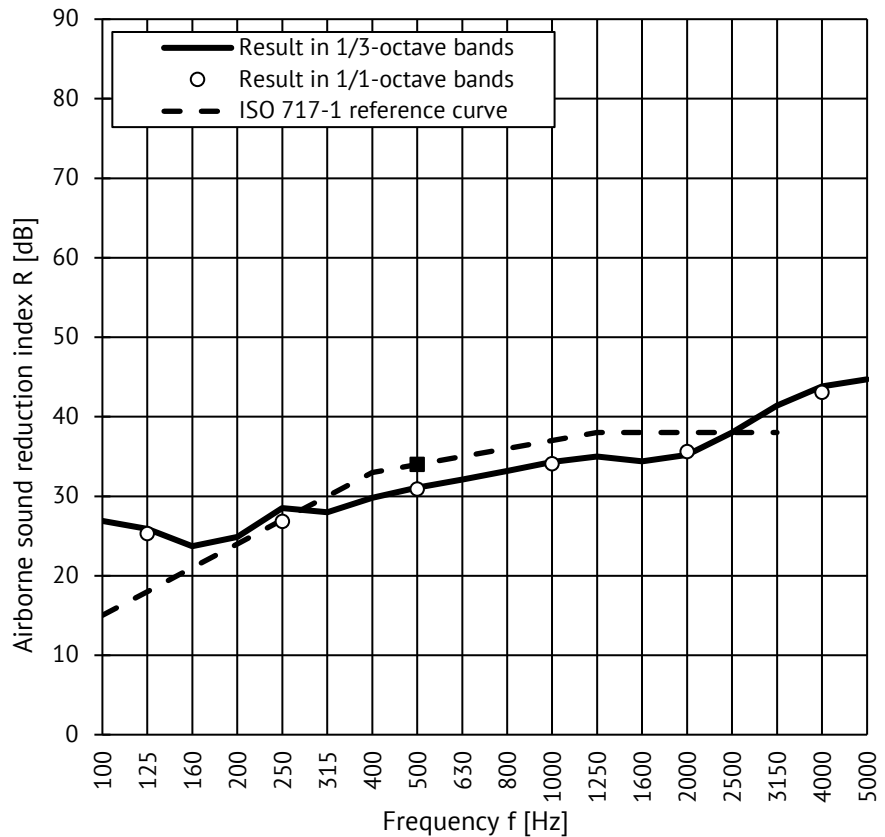
Contact person: Jarkko Kosonen

Mounting by: Turun Lasipalvelu Oy

Test laboratory: Turku University of Applied Sciences, Laboratory of Acoustics
Lemminkäisenkatu 14-18 B, 20520 Turku, Finland.
www.tuas.fi/en/research-and-development/research-groups/indoor-environment/

Room temperature: 22,9 °C Area of test element, S: 10,1 m²
Relative humidity: 30 % Mass per unit area: 25 kg/m²
Source room volume: 81 m³ Test date: Jun 2, 2020
Receiving room volume: 113 m³ Test file: R020620C

| f [Hz] | R [dB] 1/3 | R [dB] 1/1 |
|--------|------------|------------|
| 50 | 28,3 | |
| 63 | 23,7 | 21,6 |
| 80 | 18,3 | |
| 100 | 26,9 | |
| 125 | 25,9 | 25,3 |
| 160 | 23,7 | |
| 200 | 24,9 | |
| 250 | 28,5 | 26,8 |
| 315 | 28,0 | |
| 400 | 29,8 | |
| 500 | 31,1 | 30,9 |
| 630 | 32,1 | |
| 800 | 33,2 | |
| 1000 | 34,3 | 34,1 |
| 1250 | 35,0 | |
| 1600 | 34,4 | |
| 2000 | 35,2 | 35,6 |
| 2500 | 38,0 | |
| 3150 | 41,4 | |
| 4000 | 43,8 | 43,1 |
| 5000 | 44,7 | |



Single-number quantities according to ISO 717-1

| | |
|--|--------------|
| R_w | 34 dB |
| R _w +C | 34 dB |
| R _w +C _{tr} | 32 dB |
| R _w +C ₁₀₀₋₅₀₀₀ | 34 dB |
| R _w +C ₅₀₋₃₁₅₀ | 33 dB |
| R _w +C ₅₀₋₅₀₀₀ | 34 dB |
| R _w +C _{tr,100-5000} | 32 dB |
| R _w +C _{tr,50-3150} | 31 dB |
| R _w +C _{tr,50-5000} | 31 dB |

Signs F and B indicate that the declared result is an underestimate in this frequency band. The true value is larger.



R. Alakoivu
Reijo Alakoivu
research engineer
test performer

Determination of airborne sound insulation according to ISO 10140-2:2010 in laboratory conditions

Specimen id: Test 4: 5+5 mm laminated and tempered glass with noise reduction interlayer 0.76 mm
Automatic threshold sealing RG-592 for ROCA dB
ROCA Decibel door frame, RG-580, M10x21 (990x2083) + ROCA Glass wall profile RG-502

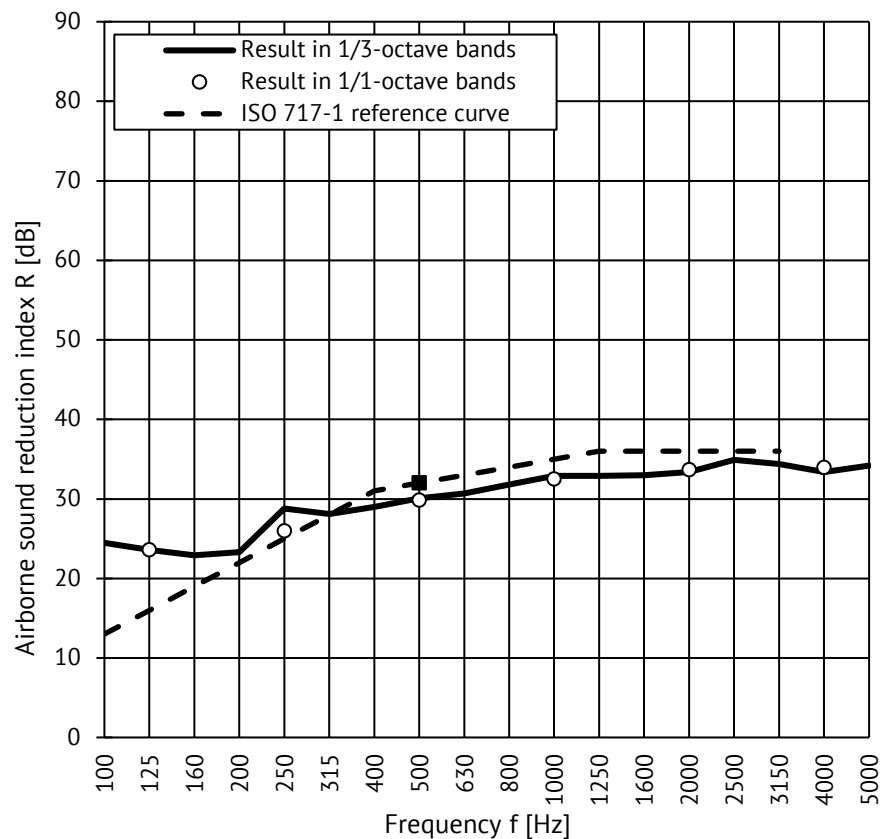
Manufacturer: Roca Finland Oy
Client: Roca Finland Oy
Contact person: Jarkko Kosonen
Mounting by: Turun Lasipalvelu Oy
Test laboratory: Turku University of Applied Sciences, Laboratory of Acoustics
Lemminkäisenkatu 14-18 B, 20520 Turku, Finland.
www.tuas.fi/en/research-and-development/research-groups/indoor-environment/

Room temperature: 22,9 °C Area of test element, S: 10,1 m²
Relative humidity: 30 % Mass per unit area: 25 kg/m²
Source room volume: 81 m³ Test date: Jun 2, 2020
Receiving room volume: 113 m³ Test file: R020620

| f [Hz] | R [dB] | R [dB] |
|--------|--------|--------|
| 50 | 32,3 | |
| 63 | 23,6 | 19,2 |
| 80 | 15,1 | |
| 100 | 24,5 | |
| 125 | 23,6 | 23,6 |
| 160 | 22,9 | |
| 200 | 23,3 | |
| 250 | 28,8 | 26,0 |
| 315 | 28,1 | |
| 400 | 29,0 | |
| 500 | 30,1 | 29,9 |
| 630 | 30,7 | |
| 800 | 31,8 | |
| 1000 | 32,9 | 32,5 |
| 1250 | 32,9 | |
| 1600 | 33,0 | |
| 2000 | 33,4 | 33,7 |
| 2500 | 34,9 | |
| 3150 | 34,4 | |
| 4000 | 33,4 | 34,0 |
| 5000 | 34,2 | |

Single-number quantities according to ISO 717-1

| | |
|--|--------------|
| R_w | 32 dB |
| R _w +C | 32 dB |
| R _w +C _{tr} | 30 dB |
| R _w +C ₁₀₀₋₅₀₀₀ | 32 dB |
| R _w +C ₅₀₋₃₁₅₀ | 32 dB |
| R _w +C ₅₀₋₅₀₀₀ | 32 dB |
| R _w +C _{tr,100-5000} | 30 dB |
| R _w +C _{tr,50-3150} | 29 dB |
| R _w +C _{tr,50-5000} | 29 dB |

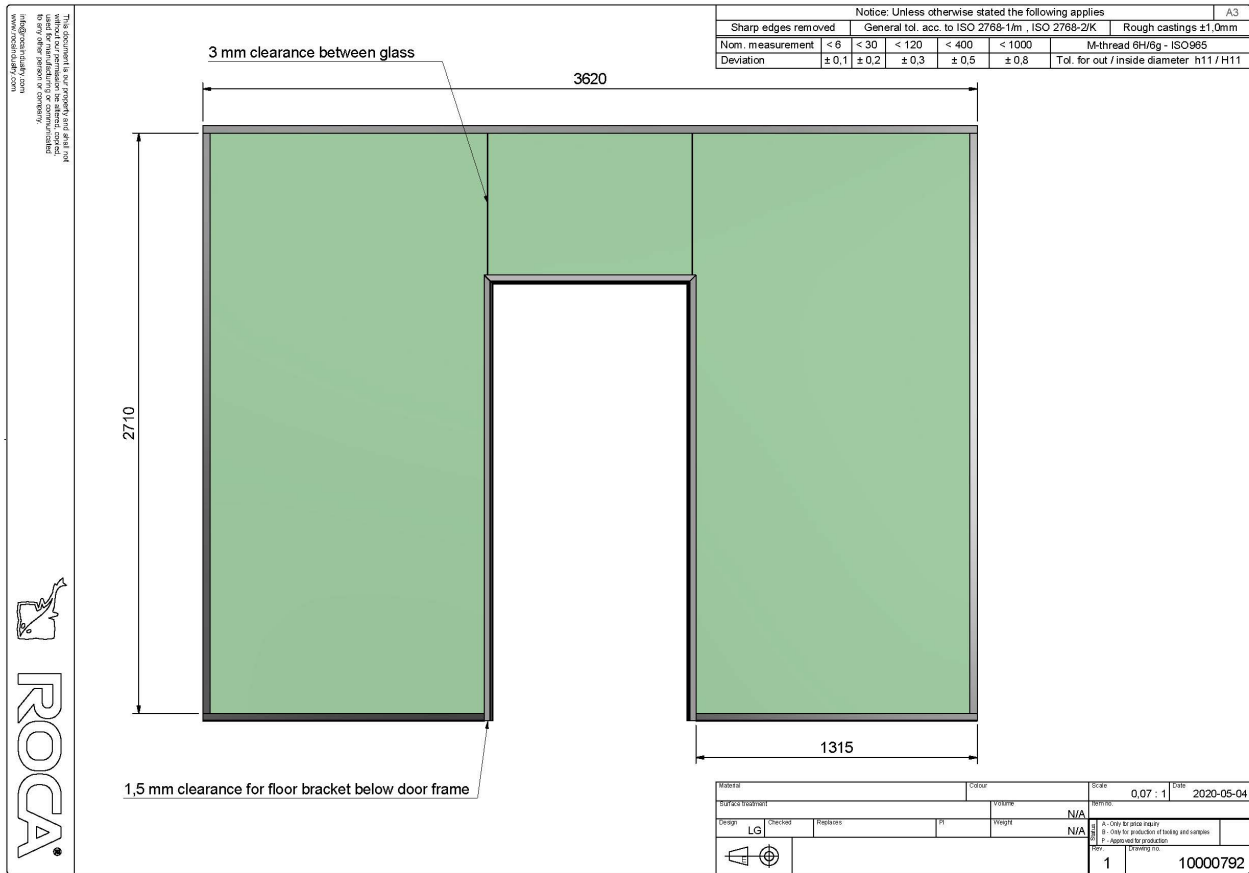


Signs F and B indicate that the declared result is an underestimate in this frequency band. The true value is larger.

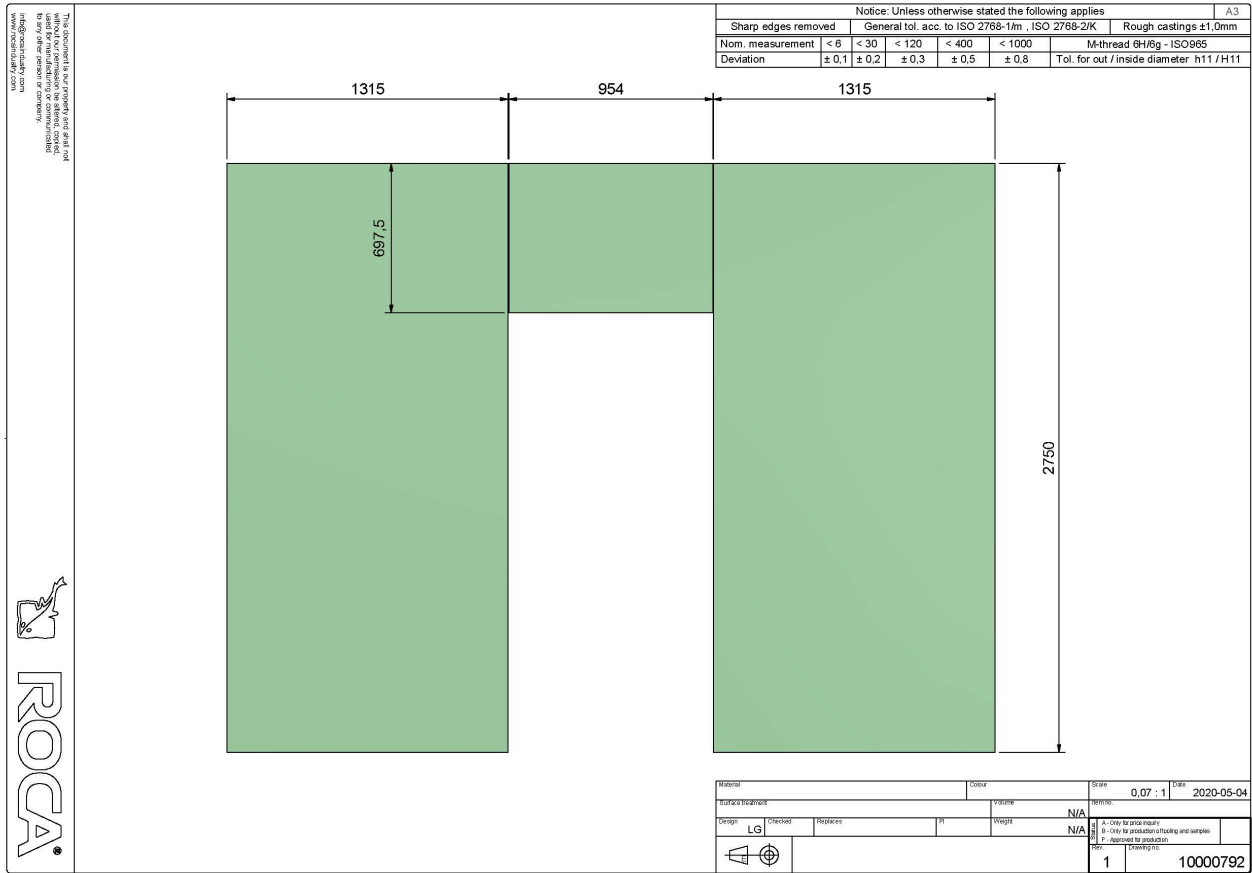


R. Alakoivu
Reijo Alakoivu
research engineer
test performer

ANNEX 2 – STRUCTURE DRAWINGS



The structure drawing was provided by the client. Turku University of Applied Sciences has not verified the structure.



The structure drawing was provided by the client. Turku University of Applied Sciences has not verified the structure.

ANNEX 3 – MOUNTING OF SPECIMEN

The specimen was mounted to the 10.1 m² test opening. ROCA glass wall profile RG-502 was attached to the frame of the test opening (ceiling, floor and vertically, but in the middle of the floor there was an opening for the door). Two glasses (2750 × 1315 mm) were mounted to the attached profile and sealed with rubber gasket. The glasses were on the left and right side of the opening so there was space in the middle for the door. ROCA decibel door frame, RG-580 was attached the middle of the test opening. A smaller glass (697.5 × 954 mm) was mounted above the door. The door glass with accessories was installed and a threshold was added below it. Figure A3.1 shows views of the installation. Annex 2 provides a more detailed description of the structure of the specimen.

The total size of specimen area was approximately 10.1 m² (2780 × 3620 mm). Two types of glass were used in the tests: 10 mm tempered glass and 5×5 mm laminated and tempered glass. In addition, two types of thresholds were used with the door: ROCA Decibel threshold, RG-581 and Automatic threshold sealing RG-592 for ROCA dB.



Figure A3.1. Specimen as seen from the source room (left) and the receiving room (right).

ANNEX 4 – MEASUREMENT ARRANGEMENTS

1 Acoustical measurements

The sound was produced in the source room using five different sound sources and with five uncorrelated pink noise generators (Behringer Ultra curve DEQ 2496). The loudspeaker signals were amplified with three terminal amplifiers (QSC RMX 850, 850, 2450). The sound level in the source room and in the receiving room was measured using two rotating microphone booms (Brüel&Kjær 3923) and two condenser microphones (Brüel&Kjær 4165 and preamplifier Brüel&Kjær 2669). The radius of rotation was 100 cm. The averaging time was 64 seconds. The level measurements were made simultaneously. The microphones and the measurement channels were calibrated before the measurements with a sound level calibrator (Brüel&Kjær 4231).

For the reverberation time measurement in the receiving room, the pink noise test signal was produced with the real time analyzer and amplified with a terminal amplifier (QSC 900 W USA). Two fixed loudspeaker positions were used and the microphone was placed in three positions. The reverberation time was determined in conformance with ISO 3382-2:2008 using 2 averaged decay signals from the decay range of -5 to -25 dB in each measurement. The sound analysis was made with the two-channel real time analyzer (Norsonic 121).

The acoustical measurement equipment does not fulfil the requirements of IEC 61672, because the manufacturer has not tested the real time analyzer in conformance with IEC 61672-1 and 2.

The acoustical measurement equipment fulfilled the following IEC standards and grades of accuracy:

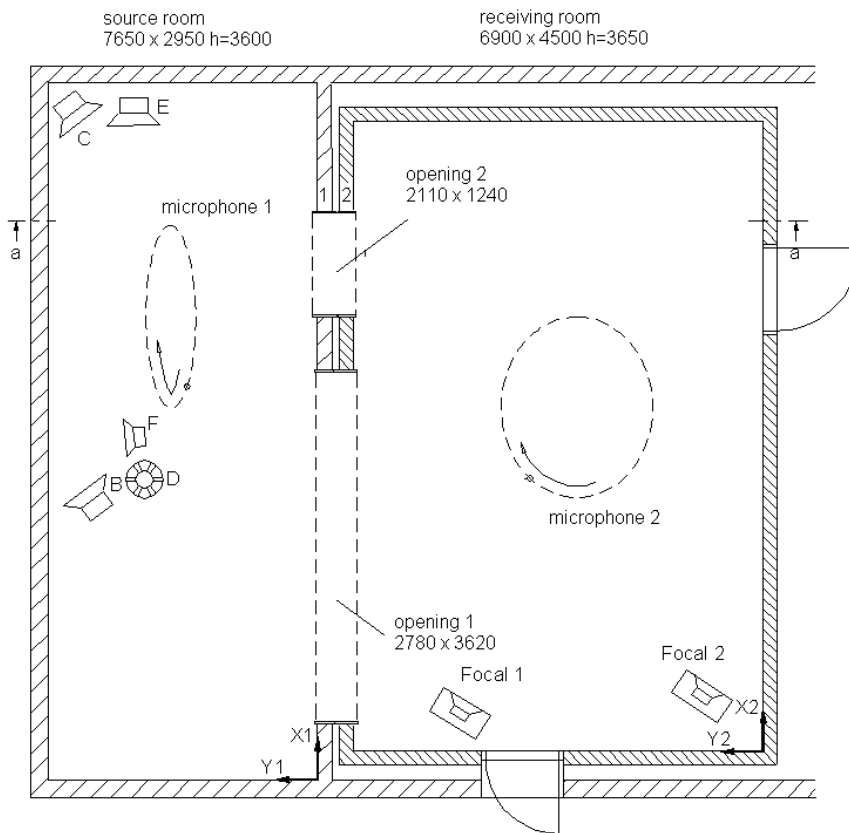
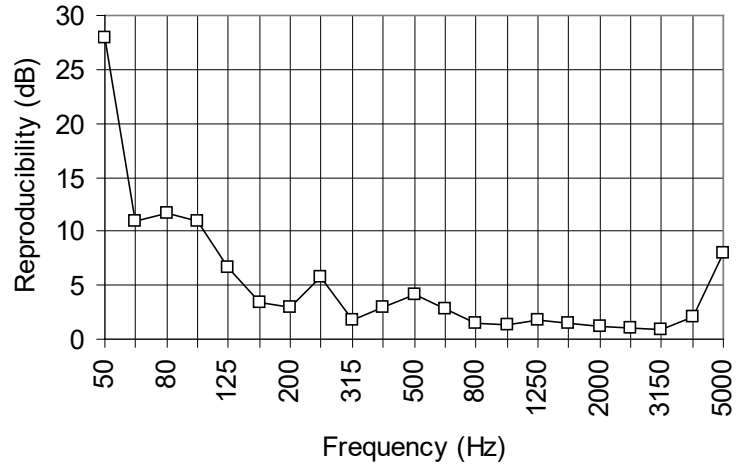
| | | |
|-----------|--|----------------|
| IEC 60651 | Sound level meters (replaced by IEC 61672) | type 1 |
| IEC 60804 | Integrating sound level meters (replaced by IEC 61672) | type 1 |
| IEC 61260 | Octave-band and fractional-octave-band filters | class 1 |
| IEC 60942 | Sound level calibrators | class 1 |

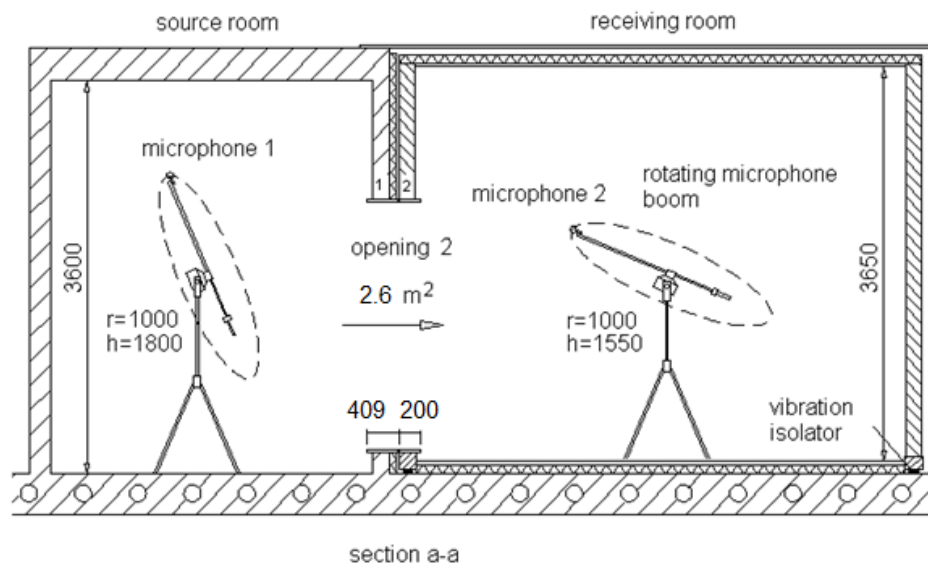
2 Other measurements

The temperature and the relative humidity of the measurement rooms were measured using an environmental measurement device (Thermo Recorder TR-73U). The specimen was weighed with a 150 kg precision weighing machine (PM 150). The dimensions of the specimen were measured with a roll meter (K-Prof).

3 The uncertainty of sound insulation measurement

The uncertainty of reproducibility expresses the differences between the laboratories. In an Inter-Laboratory test Nordtest 2001, in which five Nordic laboratories were participating, the uncertainty of the sound reduction index R_w was ± 1.7 dB. The uncertainty in third-octave bands is presented in the figure below.





Measurement arrangements according to ISO 10140-2:2010(E).

4 References to the ISO standards

ISO 10140-2:2010 (E) Acoustics – Laboratory measurement of sound insulation of building elements – Part 2: Measurement of airborne sound insulation

ISO 717-1:2013 (E) Acoustics – Rating of sound insulation of building elements - Part 1: Airborne sound insulation

ISO 3382-2:2008 (E) Acoustics – Measurement of room acoustic parameters - Part 2: Reverberation time in ordinary rooms

ISO 140-2:1991 (E) Acoustics - Measurement of sound insulation in buildings and of building elements – Part 2: Determination, verification and application of precision data.

Olesen H S, Laboratory measurement of sound insulation in the frequency range 50 Hz to 160 Hz – A Nordic intercomparison, Nordtest project No. 1545-01, AV 108/02, Project PNT 870071, Delta Denmark, 2002