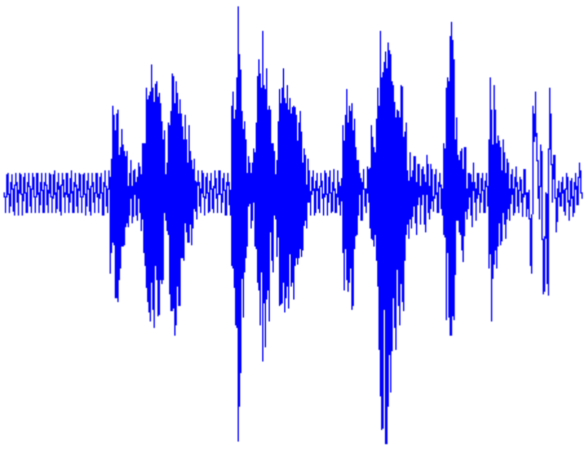
# Acoustics



$$R' = L_z - L_o + 10 \lg [ S_s : A_o ]$$

1-What is sound
- transmission
- frequency
- deciBell

2- Reflection en reverberation
- reverberation time

3- Sound absorption

4- Airborne sound insulation

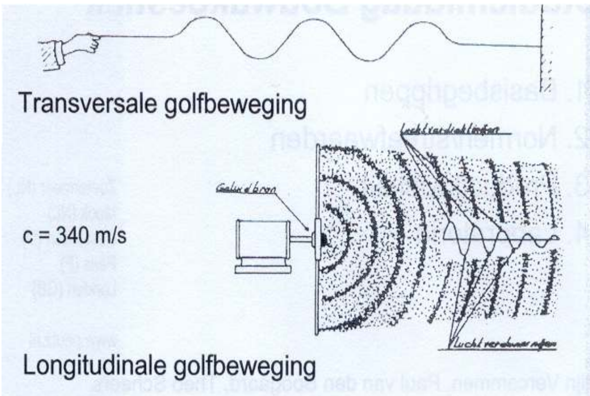
5- Sound insulation at building level

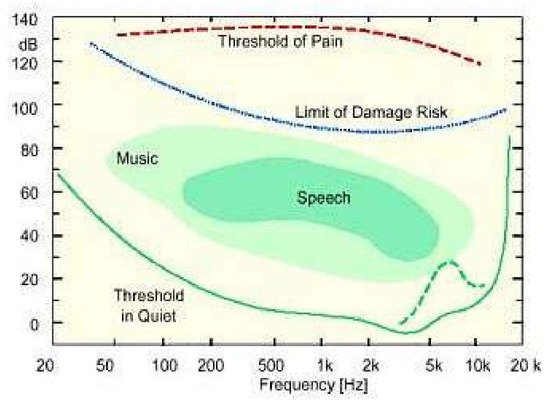
6- SRI standard for buildings?

7- Partial sound insulation

8- Maars products and sound
- partitioning systems
- doors

9- Maars sound testing facility






## 1- What is sound?

### Transmission

Any vibration in the air or other medium, some types of which are able to cause a sensation of hearing.

Speed of sound trough air = ~ 340m/s

water = ~ 1480m/2

ice = ~ 3200m/s

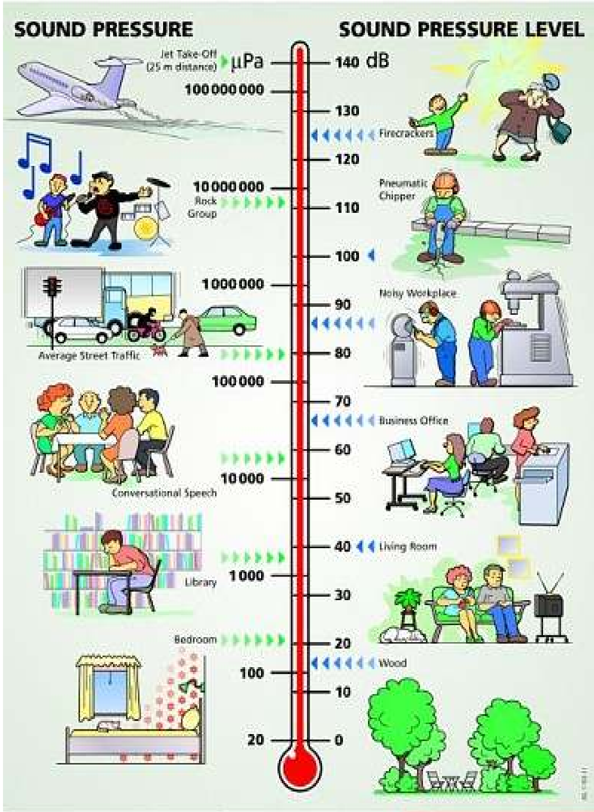
### Frequency

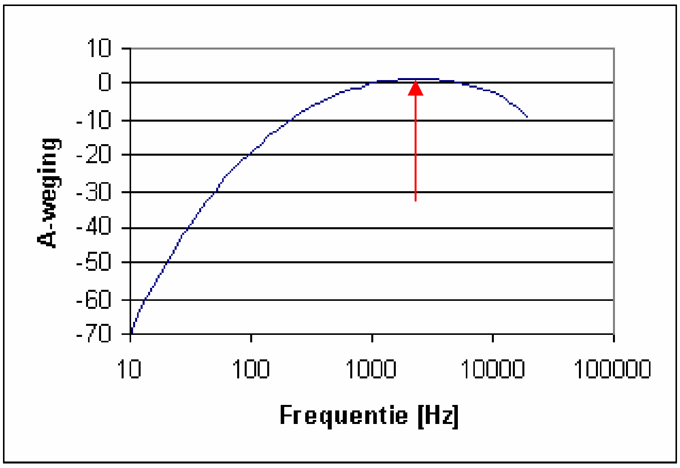
The rate of repetition of the cycles of a periodic quantity. (increased or decreased of air pressure or pitch) The wave length is called frequency and expressed in Hetz [Hz].

### deciBell

To what the human ear can hear as air pressure is between the 20 and 20,000 Hz. To sound pressure at the trash hold in quiet is about 0.00002 Pa. and at pain 200 Pa. In order to use more sensible figures the we use the deciBell scale at which ‘quiet’ of 20 μPa is put at 0dB in a logarithm scale at which each factor 10 the sound pressure increases with 20dB.

So the scale of 1 to 1 million has been brought back from 1 to 120dB



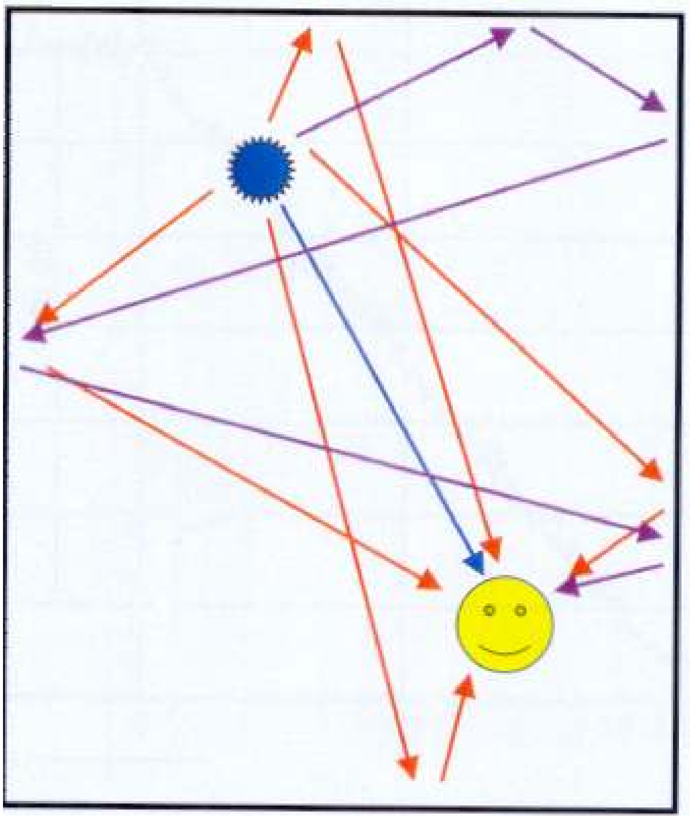




The human ear is most sensible between the 1000 and 5000Hz

Sound pressure and sound pressure level

| Hertz | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | 16000 |
|---|---|---|---|---|---|---|---|---|---|
| dB | - 26 dB | - 16 dB | - 9 dB | - 3 dB | 0 dB | + 1 dB | + 1 dB | - 1 dB | - 10 dB |

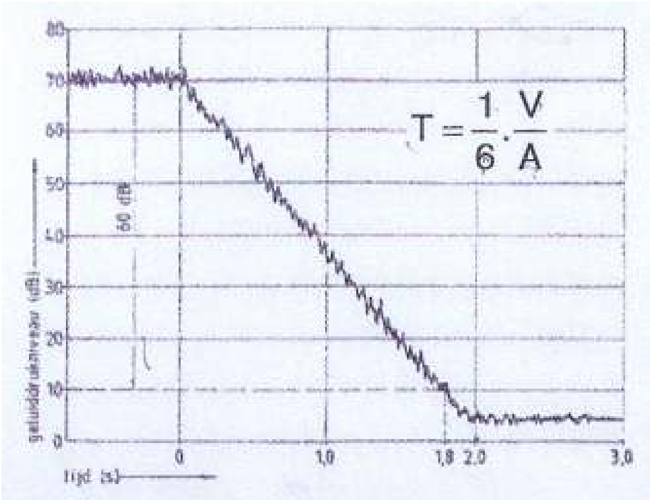
The human ear and its sensibility to sound pressure



**2- Reflections and (is) reverberation.**

Reverberation is a result of multiple reflections . A sound wave in an enclosed or semi-enclosed environment will be broken up as it is bounced back and forth among the reflecting surfaces caused by different path lengths of the sound waves.

The time sound need to get to the observer via reflections in an enclosed area is called the reverberation time.




## Reverberation time

Mr. W.C. Sabine established the official period of reverberation as the time required by a sound in a space to decrease to one-millionth of its original strength (i.e. for its intensity level to change by -60 dB).

There is a simple relation between the reverberation time, the sound absorption and the volume of a room. This relation has been determined in an experimental way  by Sabine and later in theory  derived.

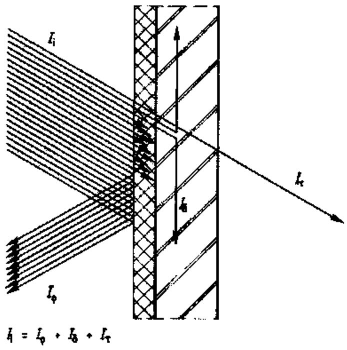
Exhaust pipe silencer


Surface open materials

## 3- Sound absorption

The loss or dissipation of sound energy in passing through a material or on striking a surface, is usually through conversion to heat energy. The term may also refer to the property of a medium, material or object to damp sound energy. That part of the sound striking a surface which is not absorbed is either reflected or transmitted. The absorption process can be measured quantitatively and is of importance in the interior design.

$$R = 10\log\left(\frac{I_{invallend}}{I_{doorgelaten}}\right)$$

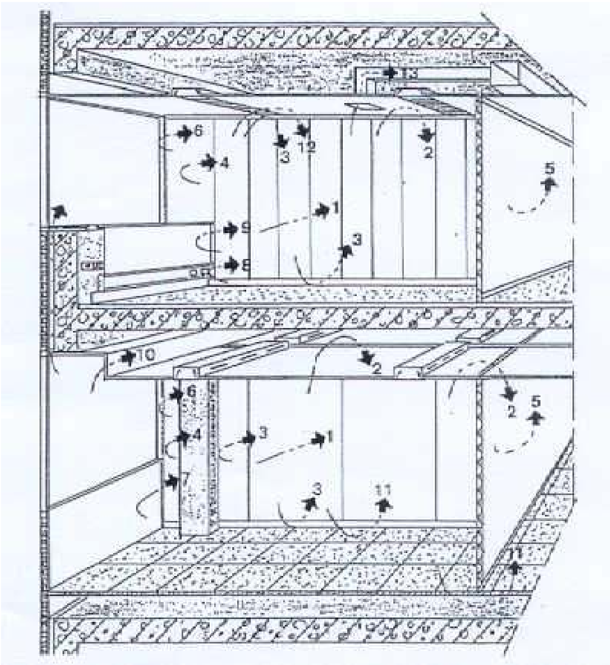


## 4- Airborne sound insulation

A system for the measurement of sound insulation properties of partitions between rooms or buildings, particularly in the case of speech or office noise interference.

Various partitions can be rank ordered on the basis of this measurement, which uses the transmission loss of sound in the frequency range 125 to 4000 Hz. In fact the $R_w$ to ISO-717 standard is defined within this ranking.

It should be noted that Partitions measured in laboratories are showing the Weighted Sound Reduction Index in $R_{\mathbf{w}}$ as a property of the specimen it self.



## 5- Sound insulation at building level.

When the test partition forms a part of an enclosure, the sound insulation obtained will depend on additional factors such as the relative surface areas involved and the volume of the receiving enclosure. Also, in buildings the transmission of sound via alternative paths may not be negligible in comparison with transmission of the test specimen alone, particularly when the SRI of the partition is high. Such indirect transmissions of the sound would result in a lower effective sound insulation.

The notation of measurements take on building sites are in $R'_w$ .

| Area and function | Requested sound insulation | Partial insulation wall | Partial insulation ceiling | Starting point lab value |
|---|---|---|---|---|
| **Between corridor and offices**<br>**-normal privacy**<br>**-increased privacy** | **R'w= 28dB**<br>**R'w= 33dB** | **R'w= 32dB**<br>**R'w= 37dB** | **R'w= 33dB**<br>**R'w= 37dB** | **Rw= 33-35dB**<br>**Rw= 38-40dB** |
| **Between offices with normal privacy** | **R'w= 38dB** | **R'w= 42dB** | **R'w= 42dB** | **Rw= 43-45dB** |
| **Between offices with increased privacy** | **R'w= 43dB** | **R'w= 47dB** | **R'w= 47dB** | **Rw= 48-49dB** |
| **Between offices with high privacy** | **R'w= 48dB** | **1)** | **1)** | **Rw= 55+ dB 2)** |

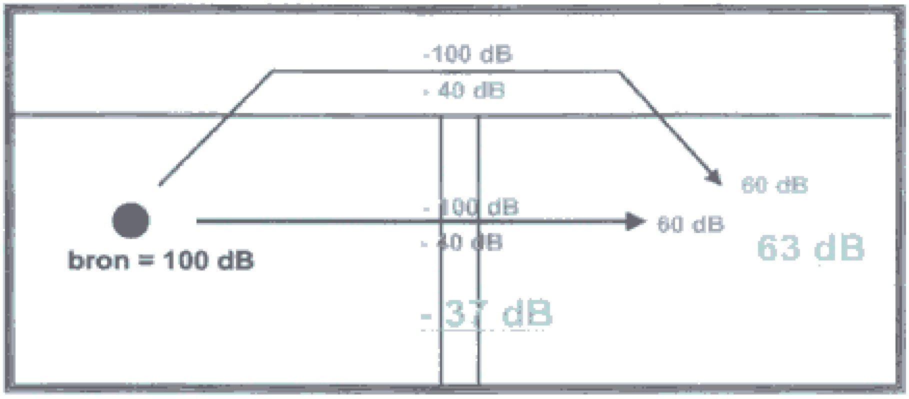
1) Partitions must put straight between concrete floors and may not have inserting.
2) Traditional build partitions normally don't reach over ~50dB.

## 6- SRI standard at buildings?

Next to 'speech privacy' and 'speech intelligibility' the main acoustic property we have to watch over is the sound insulation between offices. As stated before the total sound insulation is determined by sound transmission through flanking side ways and the partial sound insulation of all constructions that are involved in the total enclosure between rooms.

It is a given fact that the building façade, floors and walls must be of a level that reaches 7 to 10dB over the highest partial sound insulation.

Some countries have a sound insulation value for offices they attempt to strive to.



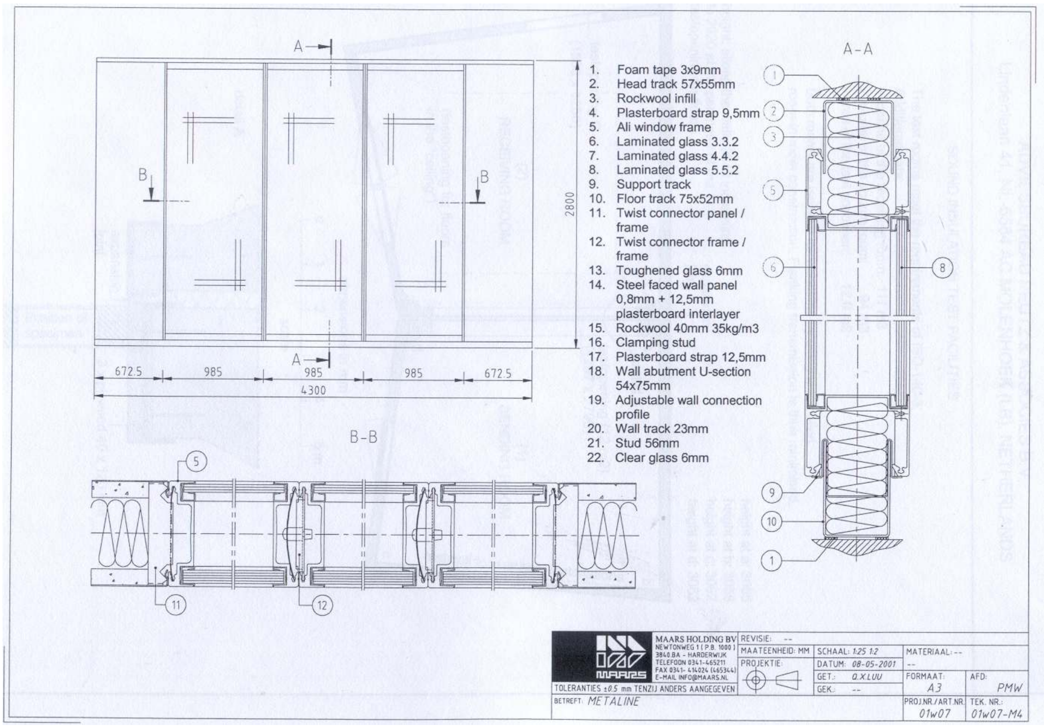

## 7- Partial sound insulation

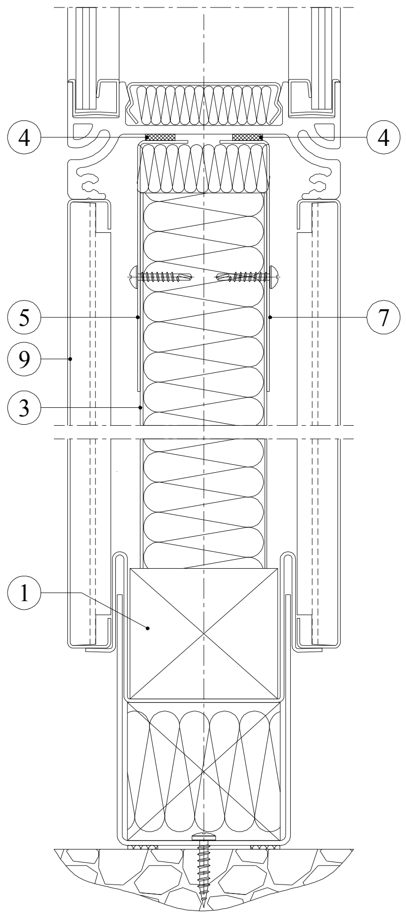
The SRI is distributed over the sound insulation property of each partial construction. The spec can give a certain rate for the suspended ceiling, sound barriers, the partitioning, raised floor, floor, window millions etc. They all cooperate and form the $R'_w$ as the total sound insulation between rooms.

The influence of different partial insulations on the total insulation result.
0-1dB = minus 3dB to lowest insulation
2-3dB = minus 2dB
10db = 0dB

# 8
# Sound measurements on Maars products

MetaLine; various glass constructions

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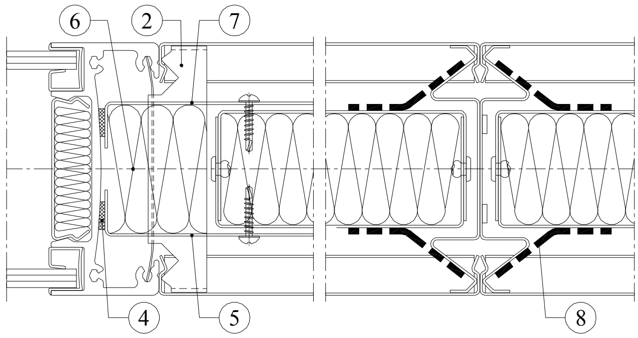
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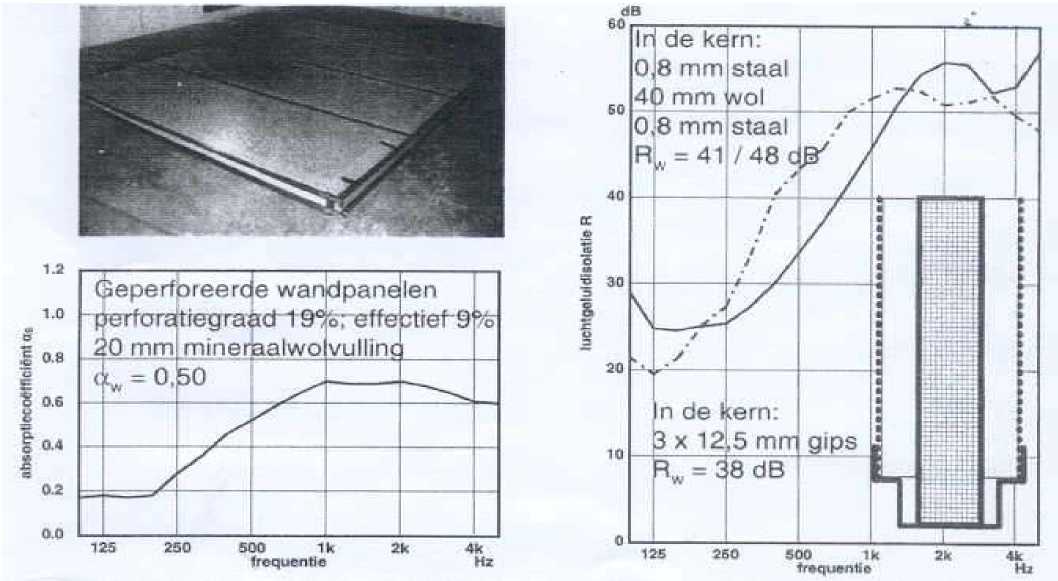
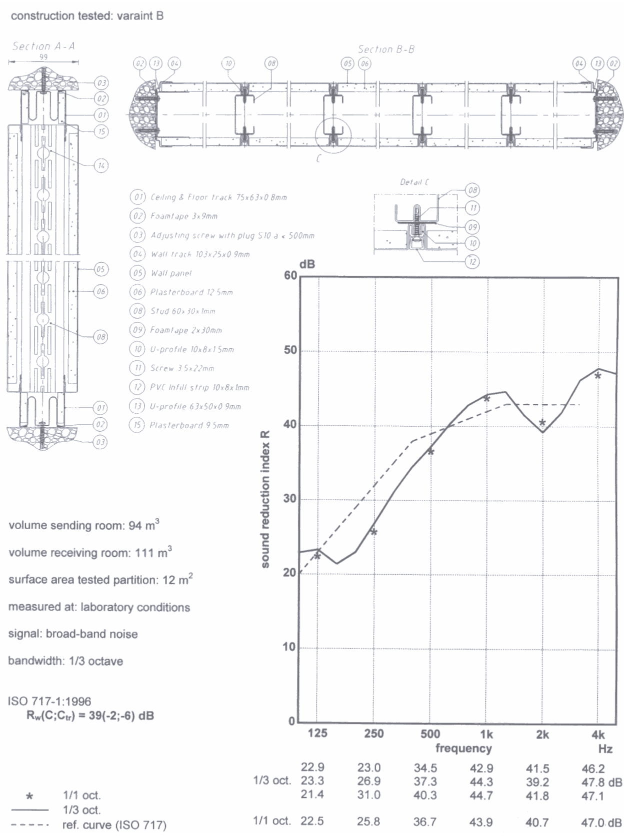
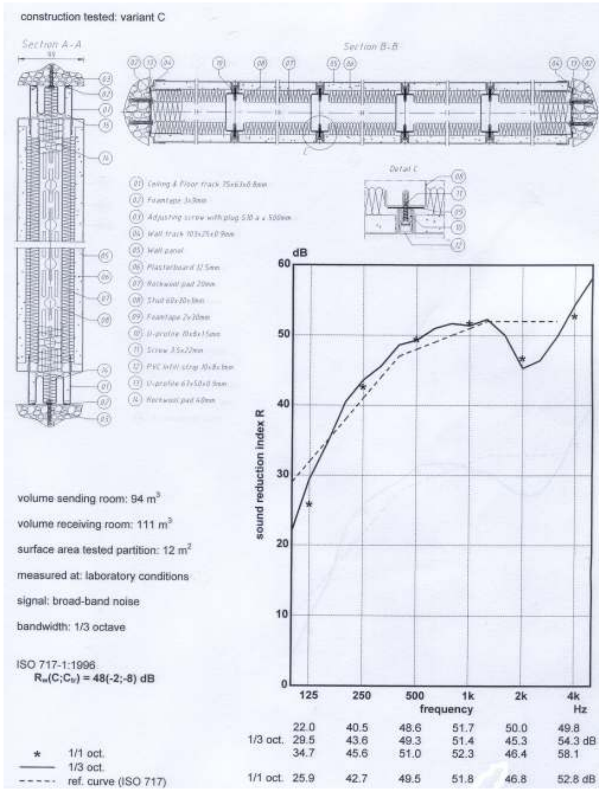


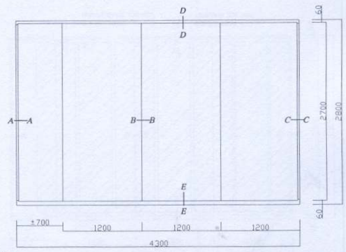

| | | |
|---|---|---|
| Type I | Cassette 0,8mm with insulation | $R_w$= 41dB |
| Type II | Cassette 0,8mm w/insulation + 2mm steel sheet | $R_w$= 46dB |
| Type III | Cassette 0,8mm met w/insulation + 2x 2mm steel sheet | $R_w$= 48dB |

MetaLine; transparency, insulation and absorption all in one!




InterSign; no insulation =39dB, with insulation =48dB construction tested: variant 1: Chipboard / 30 mm clamping strips / 50 mm Rockwool




volume sending room: 94 $m^3$

volume receiving room: 111 $m^3$

surface area tested partition: 12 $m^2$

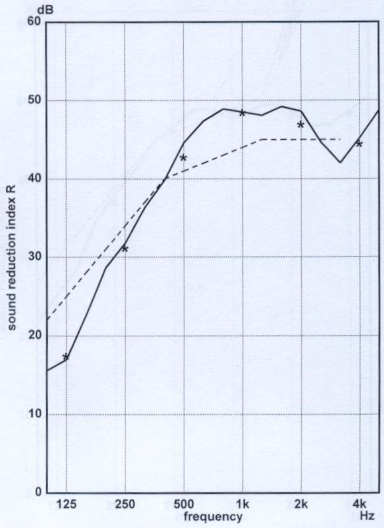
measured at: laboratory conditions

signal: broad-band noise

bandwidth: 1/3 octave

ISO 717-1:1996

**$R_w(C;C_{tr})$ = 41(-3;-9) dB**




—— 1/3 oct.

* 1/1 oct.

- - - - ref. curve (ISO 717)

| | 125 | 250 | 500 | 1k | 2k | 4k | |
|---|---|---|---|---|---|---|---|
| | 15.6 | 28.6 | 39.8 | 48.9 | 49.2 | 42.0 | |
| 1/3 oct. | 17.0 | 31.8 | 44.6 | 48.5 | 48.6 | 45.2 | dB |
| | 22.6 | 36.3 | 47.4 | 48.1 | 44.7 | 48.7 | |
| **1/1 oct.** | **17.5** | **31.2** | **42.8** | **48.5** | **47.0** | **44.5** | **dB** |

String;
-82mm
-40mm wool
-2x 12,5mm
chipboard
-$R_w$=41dB

volume zendvertrek: 111 $m^3$

volume ontvangvertrek: 94 $m^3$

oppervlakte proefwand: 12 $m^2$

massa proefwand: $kg/m^2$

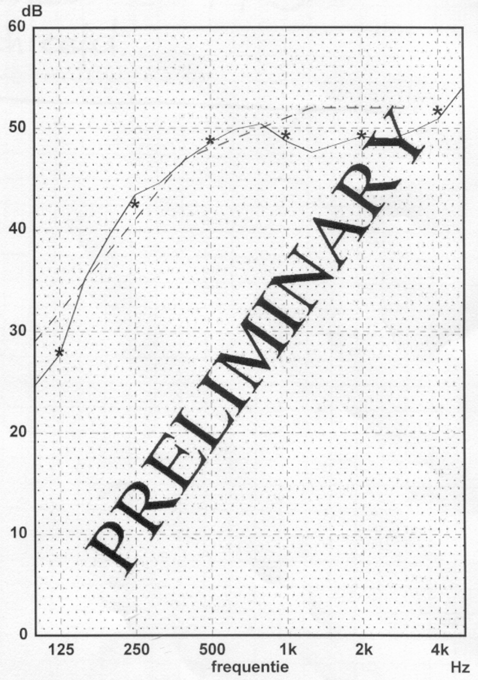
gemeten in: laboratorium

signaal: breedband ruis

bandbreedte: 1/3 octaaf

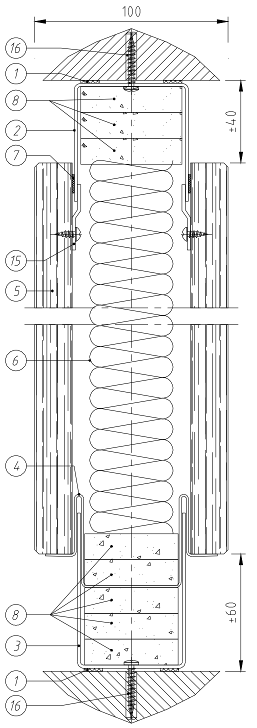
ISO 717-1:1996

**$R_w(C;C_{tr})$ = 48(-2;-7) dB**




—— 1/3 oct.
* 1/1 oct.
– – – ref. curve (ISO 717)

| | 125 | 250 | 500 | 1k | 2k | 4k |
|---|---|---|---|---|---|---|
| 1/3 oct. | 24,7 | 39,6 | 46,9 | 50,4 | 48,4 | 49,7 |
| | 27,8 | 43,4 | 48,6 | 48,7 | 49,2 | 50,9 dB |
| | 35,2 | 44,6 | 49,9 | 47,6 | 48,8 | 54,1 |
| **1/1 oct.** | **27,5** | **42,0** | **48,3** | **48,8** | **48,8** | **51,2 dB** |

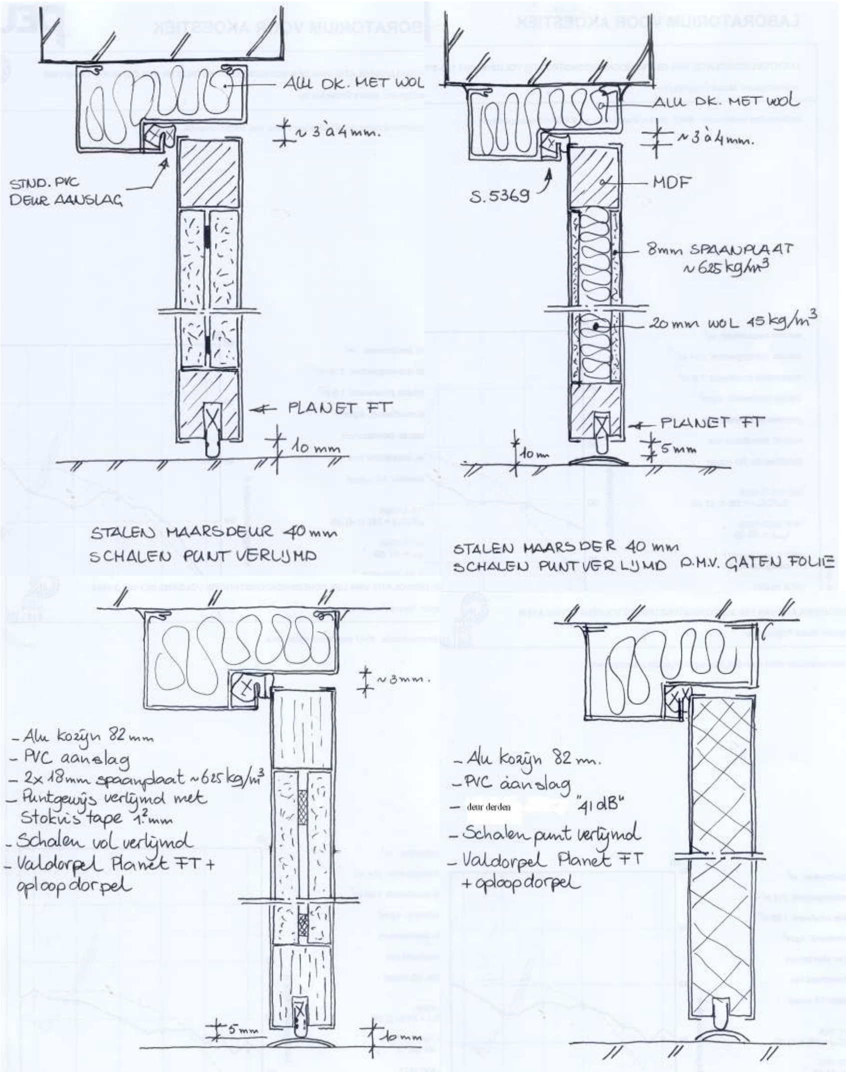



String **2**

-40mm wool

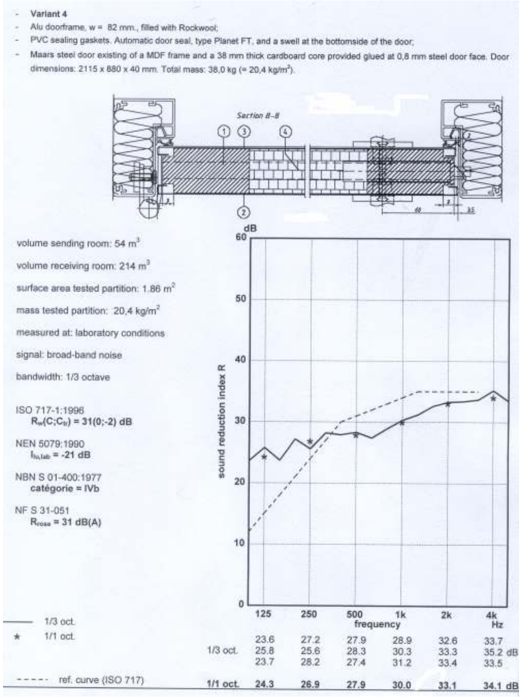
-2x 18mm chipboard

-$R_w$=45-49dB

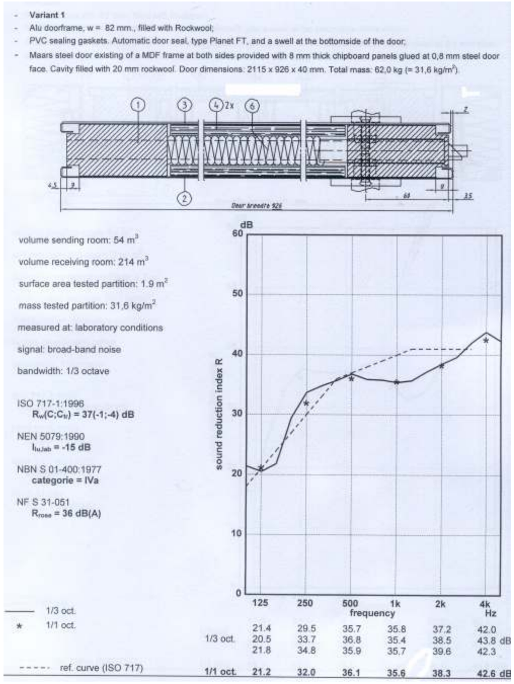



Maars steel door on a research tour!

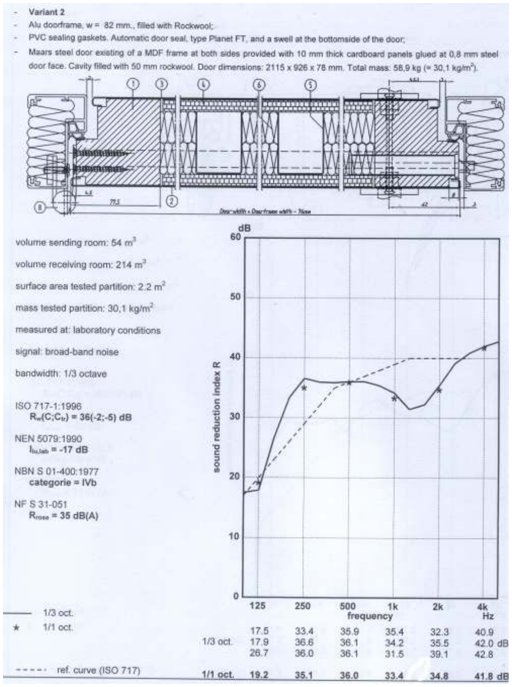
To find a solution to a project related question Maars has found ways to rank its 40mm thick Steel door leave to a Rw=37dB. This included losses through gaps, seals and joints typical for doors installed in doorframes where the majority of door manufactures only put their door bodies to a test.



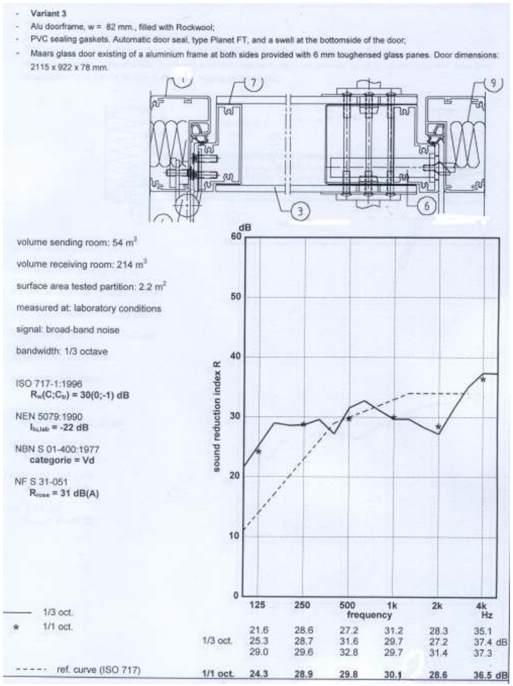

Standard steel Maars door




Steel Maars door special core




Maars XL steel Maars




Maars XL glass door

**9.**
**Maars testing facility;**
**to answer questions**
**to find finesses**
**to build knowledge**
**to serve**
**to….**