ACOUSTICS 3A
DETERMINING THE SOUND REDUCTION PERFORMANCE OF GLAZING

In order to determine the acoustic performance of glazing, physical testing is carried out, followed by the calculation of octave band and weighted performance values. Often glazing requirements are based on weighted values only, however, glazing, and other building elements, is also often specified based on octave band centre frequencies.

TESTING PROCEDURES

The acoustic performance of glazing is currently measured in accordance with ISO 10140-2:2010, previously ISO 140-3:1995 [1, 2]. Acoustic measurements are carried out in purpose built test chambers, with a source and receiving room, both being isolated from the floor and ceiling. Between the two rooms is a sound damping wall to prevent any transmission of sound through any element except the test sample.

Figure 1 - Test setup for acoustic measurement

For each third octave band centre frequency, the noise level will be measured at various points within both the source and receiving chamber, and from this the level of sound reduction at these frequencies can be determined.

THIRD-OCTAVE CENTRE AND OCTAVE CENTRE PERFORMANCE

The testing provides performance at third octave band centre frequencies, from which the performance at octave band centre frequencies can then be calculated, again, in accordance with EN 10140-2:2010, as below.

$$R_{OCT} = -10log\left(\sum_{n=1}^{3}\frac{10^{-R_{1/3OCT,n}/10}}{3}\right)$$

For this reason, the performance at the one third octave band centre frequencies will not typically match that for the respective octave band centre frequencies, as below.

Table 1 - Example conversion of 1/3 to 1/1 octave band centre frequency values

1/3 Octave Band Centre Frequency (Hz)	$R_{1/3\ OCT}$ (dB)	$R_{1/1\ OCT}$ (dB)	1/1 Octave Band Centre Frequency (Hz)
50 63 80	31 35 29	31	63
100 125 160	29 28 27	28	125
200 250 315	28 32 34	31	250
400 500 630	38 40 42	40	500
800 1000 1250	44 43 39	42	1000
1600 2000 2500	39 44 49	42	2000
3150 4000 5000	53 57 57	55	4000

WEIGHTED VALUES

As well as the octave centre band values, weighted values, Rw, Rw,C and Rw,Ctr, can also be calculated, in accordance with ISO 717-1:2013 [3]. The weighted performance is calculated from the performance at one third octave band centre frequencies.

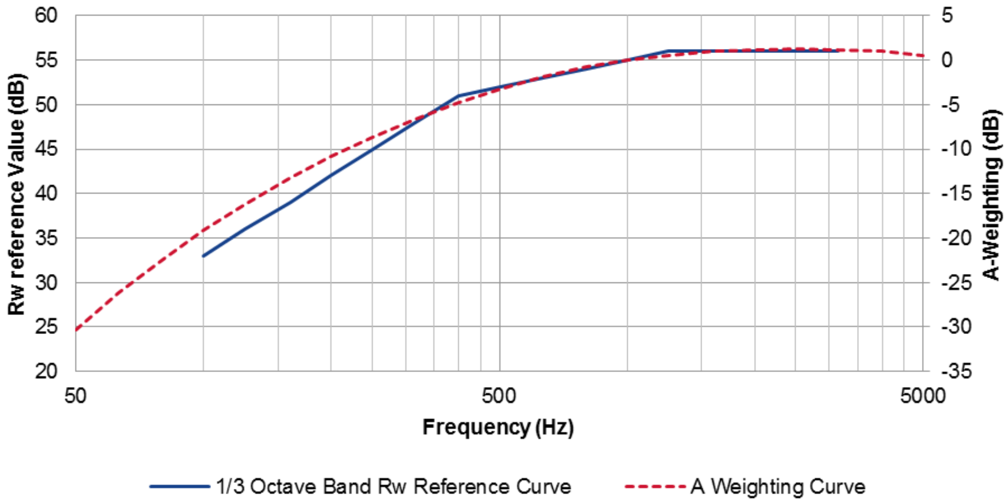


Figure 2 - Overlay of R_w reference curve & A-Weighting curve

Weighted values are adjusted to compensate for the sensitivity of human hearing and/or the source sound type. R_w, is a weighted sound reduction index [3], which closely follows the trend of the A weighting curve used in acoustic measurements. The two curves are illustrated below for comparison.

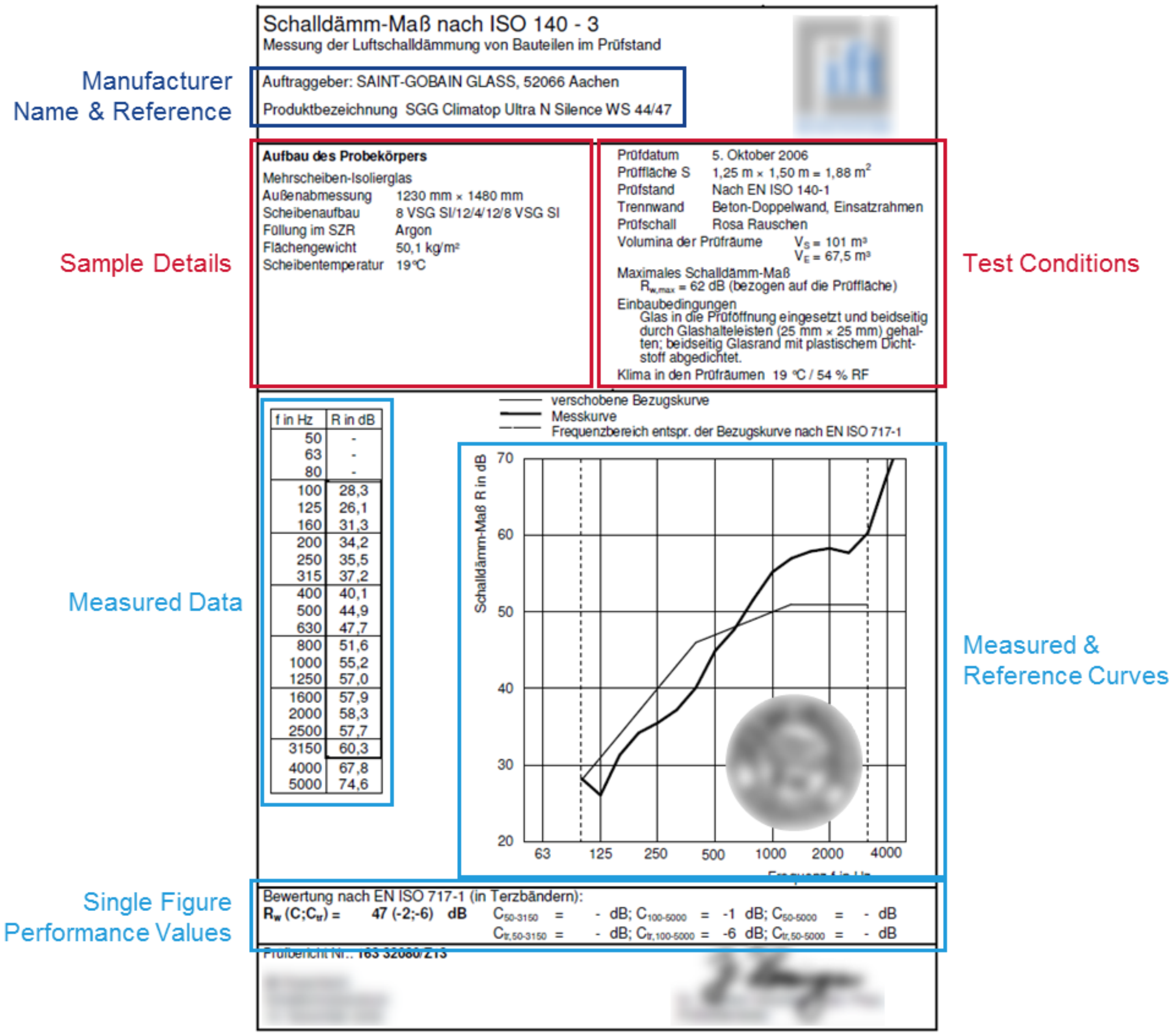
Ctr and C are the spectrum adaptation terms for traffic noise and pink noise respectively, and give an indication of how the glazing will perform with respect to noise from the related sources. When subtracted from the Rw weighted performance, the Rw,Ctr and Rw,C values are obtained. ISO 717-1:2013 also provides some examples of noise sources relevant for these adaptation terms, as below:

Table 2 - Example noise sources for adaptation factors

Adaptation Term	Noise Source
C	Living Activities (Music, Radio, TV) Children Playing Locomotive - Medium & High Speed Automotive - >80 km/h Jet Aircraft - Short Distance Factories - Medium & High Frequency Noise
Ctr	Urban Road Traffic Locomotive - Low Speeds Aircraft - Propeller Driven Jet Aircraft - Distant Disco Music Factories - Medium & Low Frequency Noise

MEASUREMENT REPORTS

The values to be reported within acoustic measurement reports are determined by ISO 10140-2:2010, which also contains an example report. Acoustic reports will typically follow this format, and contain the information as below:



Schalldämm-Maß nach ISO 140 - 3

Messung der Luftschalldämmung von Bauteilen im Prüfstand

Auftraggeber: SAINT-GOBAIN GLASS, 52066 Aachen

Produktbezeichnung SGG Climatop Ultra N Silence WS 44/47

Aufbau des Probekörpers

Mehrscheiben-Isolierglas

Außenabmessung 1230 mm × 1480 mm

Scheibenaufbau 8 VSG SI/12/4/12/8 VSG SI

Füllung im SZR Argon

Flächengewicht 50,1 kg/m²

Scheibentemperatur 19°C

Prüfdatum 5. Oktober 2006

Prüffläche S 1,25 m × 1,50 m = 1,88 m^2

Prüfstand Nach EN ISO 140-1

Trennwand Beton-Doppelwand, Einsatzrahmen

Prüfschall Rosa Rauschen

Volumina der Prüfräume V_S = 101 m³, V_E = 67,5 m³

Maximales Schalldämm-Maß $R_{w,max}$ = 62 dB (bezogen auf die Prüffläche)

Einbaubedingungen: Glas in die Prüföffnung eingesetzt und beidseitig durch Glashalteleisten (25 mm × 25 mm) gehalten; beidseitig Glasrand mit plastischem Dichtstoff abgedichtet.

Klima in den Prüfräumen 19 °C / 54 % RF

f in Hz	R in dB
50	-
63	-
80	-
100	28,3
125	26,1
160	31,3
200	34,2
250	35,5
315	37,2
400	40,1
500	44,9
630	47,7
800	51,6
1000	55,2
1250	57,0
1600	57,9
2000	58,3
2500	57,7
3150	60,3
4000	67,8
5000	74,6

Bewertung nach EN ISO 717-1 (in Terzbändern):

R_w (C;C_{tr}) = 47 (-2;-6) dB $C_{50-3150}$ = - dB; $C_{100-5000}$ = -1 dB; $C_{50-5000}$ = - dB

$C_{tr,50-3150}$ = - dB; $C_{tr,100-5000}$ = -6 dB; $C_{tr,50-5000}$ = - dB

Prüfbericht Nr.: 163 32080/Z13

Figure 3 - Example certificate for acoustic performance

ACCURACY OF EN 140-3/EN 10140-2 MEASUREMENTS

Although testing of the acoustic performance of glazing is carried out in line with defined standards, and under controlled conditions, there is still some inherent variability in the results. Various factors can influence the measured performance, such as room size and shape, background noise and the level of sealing of the unit being tested.

For these reasons, often the measured performance between identical unit constructions can vary. The below graph shows two performance measurements for a unit comprising a 4 mm and a 6 mm pane of float, with a 20 mm argon cavity. The performance in the lower frequency range (<100 Hz) is up to 15 dB, and in the 100 – 5000 Hz range, up to 6 dB.

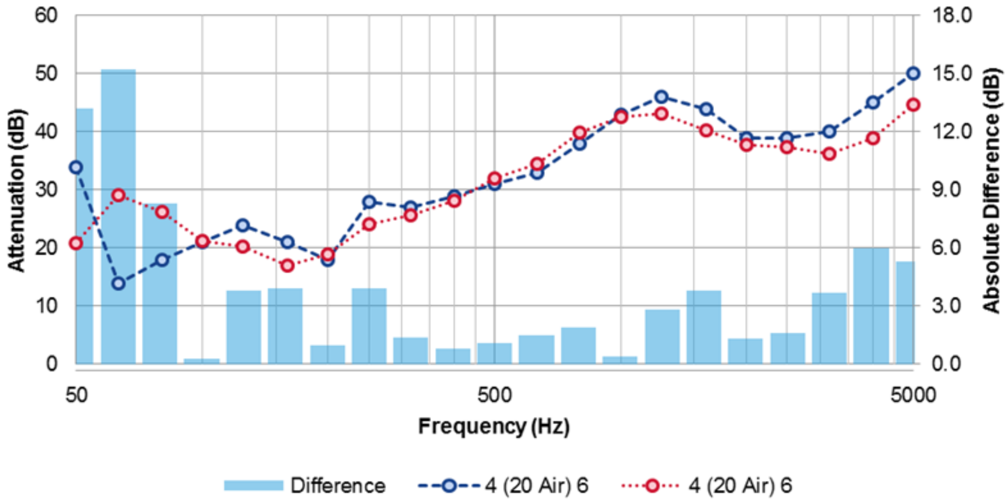


Figure 4 - 1/3 Octave centre band performance data, 4 (20 Air) 6

Table 3 - Single figure performance data, 4 (20 Air) 6

Construction	R_w (dB)	C (dB)	C_{tr} (dB)
4 (20) 6	35	-1	-5
4 (20) 6	34	-1	-5

Measurements at lower frequencies are generally considered to be less reliable, and testing at these frequencies is discussed in Annex F of ISO 140-3:1995 [2].

With regards to unit sealing, the main effects are seen at higher frequencies, above 500 Hz, with units having poor sealing showing a reduced performance at these higher wavelengths [4]. The below is shown for illustrative purposes only.

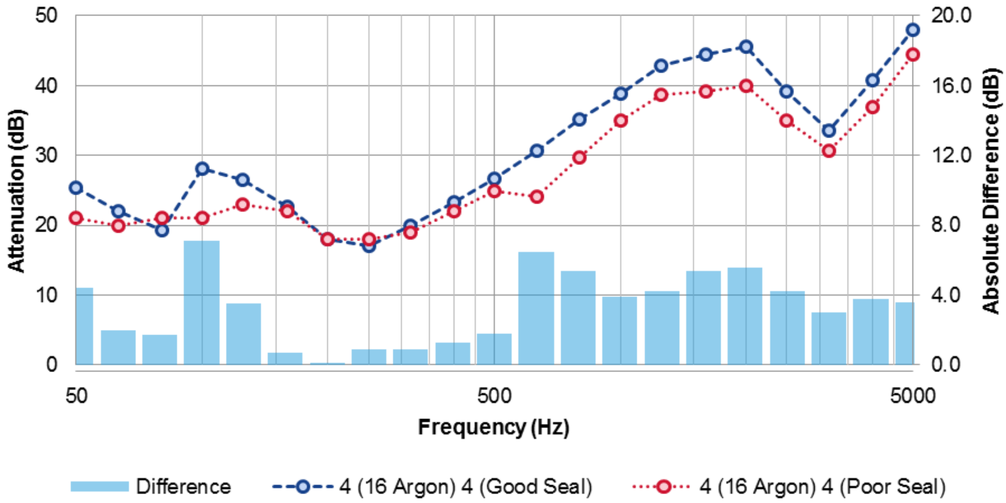


Figure 5 - 1/3 Octave centre band performance data, 4 (16) 4

REFERENCES

[1] International Organization for Standardization, *ISO 10140-2:2010 - Acoustics - Laboratory measurement of sound insulation of building elements - Part 2: Measurement of airborne sound insulation,* ISO, 2010.

[2] International Organisation for Standardization, *ISO 140-3:1995 - Acoustics - Measurement of sound insulation in buildings and of building elements - Part 3: Laboratory measurements of airborne sound insulation of building elements,* ISO, 1995.

[3] International Organization for Standardization, *ISO 717-1:2013 - Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation,* ISO, 2013.

[4] T. Wszolek, "Uncertainty of sound insulation measurement in laboratory," *Archives of Acoustics,* vol. 32, no. 4, pp. 271-277, 2007.