

1 ACOUSTIC ISSUES

In the case of heat pumps and air/water coolers, in view of the outdoor installation, it is important to assess the noise aspect connected with the units' positioning, both to check compliance

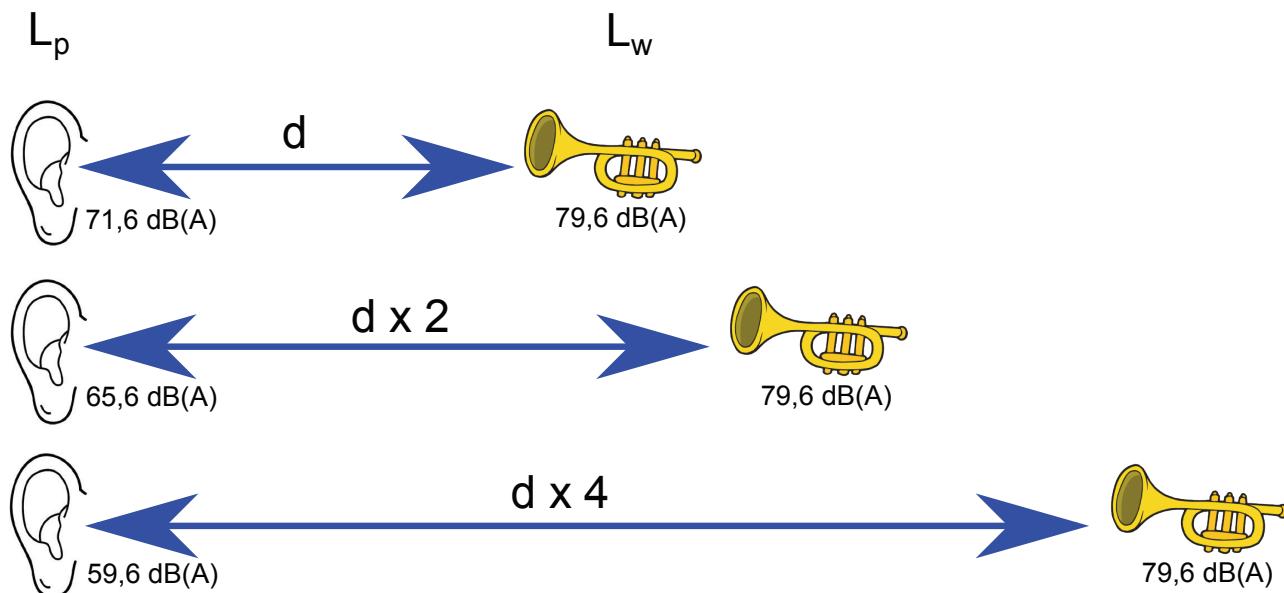
with regulatory limits, and to assess the acoustic comfort of users surrounding the installation site.

2 DEFINITIONS

Firstly, a distinction should be made between sound power L_w and sound pressure L_p .

Figure 2.1 p. 1 lets you intuitively appreciate the difference between sound power L_w and sound pressure L_p .

Figure 2.1 Sound power and pressure



L_w [dB(A)] is the sound power

L_p [dB(A)] is the sound pressure at a precise distance, with precise source position

2.1 SOUND POWER L_w

The sound power L_w in dB(A) characterises the overall sound emission capacity of the source: it is an intrinsic property of the sound source, regardless of distance.

This figure is usually measured in appropriately equipped laboratories and makes it possible to compare different emission sources (appliances).

2.2 SOUND PRESSURE L_p

The sound pressure L_p , also expressed in dB(A), however, is an index of the sound level perceived in a given place and therefore depends on a number of factors:

- distances of the various sound sources;
- directionality factors;
- environmental conditions (reverberation);
- background noise.

Since it is a local parameter, it is usually measured on site with a sound level meter.

3 ACOUSTIC ASSESSMENT

Acoustic assessment cannot disregard correct unit positioning, also in connection with the installation context and the level of naturally occurring background noise (which is higher e.g. in urban settings than in rural settings).

Table 3.1 p. 2 shows a generic indication of the levels of naturally occurring background noise in certain environments of reference, expressed as Equivalent Continuous Sound Pressure (Leq), which represents an average of the sound energy level.

This type of table is established by national and/or local regulations, since they are necessarily affected by lifestyles, climate

and architecture of the buildings.

Table 3.1 Sound source limit values - L_{eq} [dB (A)]

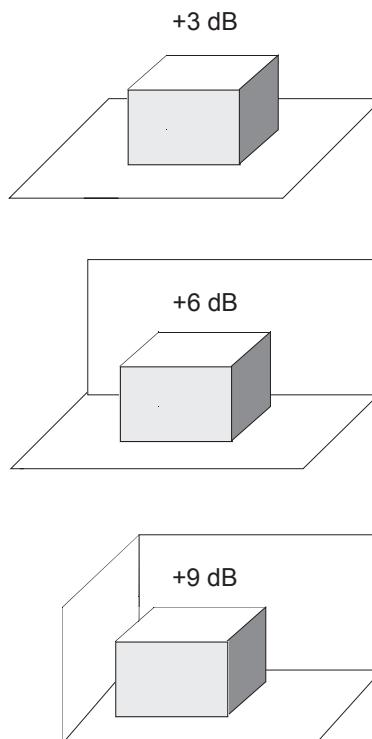
Type of area	Day	Medium	Night
Hospitals, rest areas, protected natural areas	45	40	35
Rural or peripheral residential areas, with low traffic (vehicular/aircraft)	50	45	40
Urban residential areas	55	50	45
Residential and retail areas with medium high traffic (vehicular/aircraft)	60	55	50
Retail and industrial areas (light industry)	65	60	55
Industrial areas (heavy industry)	65	65	65

Limit emission figures according to Italian regulations DPCM 14/11/97

Figure 3.1 p. 2 sets out the sound pressure increase depending on source positioning with respect to any obstacles able to

reflect sound.

As reference (increase equal to zero) the sound source is considered to be sufficiently removed from any obstacle.

Figure 3.1 Sound reflection factors

One should take into account that any sound shielding may be combined with visual screening, often required regardless of

any critical sound aspects.

4 OVERALL RESULTING SOUND PRESSURE

The overall sound pressure resulting from the simultaneous presence of several sound sources may be calculated either in a simplified or analytical manner.

4.1 SIMPLIFIED CALCULATION

Simplified calculation may only be used if there are two appliances, due to the simplifications it implements.

One considers the difference between the sound pressure L_p of the appliances (both referring to the same distance and under the same measurement conditions), and on its basis, the figure indicated in Table 4.1 p. 2 is added to the highest L_p .

Table 4.1 L_p resulting simplified calculation table

Difference in dB(A) between L_p figures	DB(A) to be added to the highest L_p
0-1	3
2-3	2
4-6	1
6+	0



Example of calculation with identical units

Two identical GAHP A HT Standard (sound pressure L_p at 5 metres (max) 57,6 dB(A)) give an overall resulting sound pressure L_p of (57,6 + 3 = 60,6 dB) since the difference between the L_p levels of the two sound sources is 0 dB therefore the figure to be added to the highest L_p is 3 dB.



Example of calculation with different units

One GAHP A HT S1 (sound pressure L_p at 5 metres (max) 52,0 dB(A)) operating simultaneously with a ACF 60-00 (sound pressure L_p at 5 metres (max) 57,6 dB(A)) give an overall resulting sound pressure L_p of (57,6 + 1 = 58,6 dB) since the difference between the L_p levels of the two sound sources is between 4 and 6 dB therefore the figure to be added to the highest L_p is 1 dB.

4.2 ANALYTICAL CALCULATION

The Formula 4.1 p. 3 must be used to analytically calculate the overall resulting sound pressure.

Figure 4.1 Sound pressure calculation formula

$$L_p = 10 \log_{10} \left(\sum_{i=1}^n 10^{\frac{(L_p)_i}{10}} \right)$$

Lp is the overall resulting sound pressure level and (Lp) is the sound pressure level of the individual sources (all referring to the same distance and the same measurement conditions).

5 EN ISO 9614 TABLES

After the general remarks of the previous paragraphs, one may now analyse the specific sound data of Robur units.

The technical data in section B set out the sound pressure level Lp referring to a distance of 5 m, in front of the source, considering a directionality factor equal to 2 (corresponding to a semi-reflective surface).

The sound intensity levels shown below have been measured according to standard EN ISO 9614:2009.

The sound intensity test, compliant with standard EN ISO 9614, is a method for determining the sound power levels of a source with stationary noise, by measuring the sound intensity on the surfaces of an ideal parallelepiped and/or semi-sphere that contains the source.

5.1 GAHP-AR AND GA ACF

For units GAHP-AR Standard, GAHP A HT Standard and GA ACF standard versions see Table 5.1 p. 3 and Figure 5.1 p. 3.

Table 5.1 Sound levels EN 9614 standard GAHP-AR, GAHP A and ACF

Frequency	Surface					Sum over frequencies
	Top	Left	Front	Right	Back	
Hz	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	A [dBA]
50	53,2	-	-	-	-	-
63	59,0	58,3	51,3	-	46,0	-
80	59,3	-	-	-	-	-
100	59,8	56,5	57,4	56,3	56,3	64,5
125	61,7	60,7	55,2	56,7	49,8	65,5
160	60,2	-	-	-	-	-
200	69,8	59,1	64,0	64,2	62,9	72,4
250	64,8	61,0	58,0	58,2	62,9	68,8
315	63,0	60,4	57,1	57,4	59,1	67,0
400	66,1	60,5	61,6	60,9	62,5	69,9
500	66,1	63,3	59,7	62,5	63,1	70,4
630	67,1	64,6	61,6	62,6	64,8	71,5
800	67,9	66,2	61,3	64,9	65,8	72,7
1000	67,7	64,8	61,2	65,1	65,4	72,3
1250	66,7	64,2	61,0	64,1	64,0	71,4
1600	66,3	63,6	60,6	63,2	63,3	70,8
2000	65,8	63,1	59,9	62,2	62,7	70,1
2500	65,3	62,6	60,9	61,7	62,2	69,8
3150	62,1	59,9	59,6	60,0	59,2	67,3
4000	59,4	58,6	58,0	58,1	58,3	65,5
5000	56,7	57,5	56,2	56,1	56,5	63,6
6300	53,8	53,3	-	53,3	54,6	-
A [dBA]	78,1	74,8	72,5	74,1	74,7	82,1

Front refers to the unit side that has the removable maintenance panel



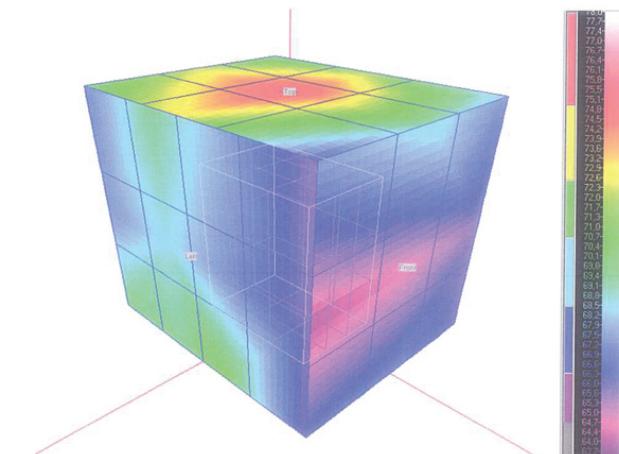
Example of calculation

Two GAHP-AR S (sound pressure Lp at 5 metres (max) 53,0 dB(A) each) operating with a GAHP A HT S1 (sound pressure Lp at 5 metres (max) 52,0 dB(A)) lead, after applying Formula 4.2 p. 3 to an overall resulting sound pressure of 57.5 dB(A).

Figure 4.2 Example of sound pressure calculation

$$L_p = 10 \log_{10} \left(\frac{53}{10^{10}} + \frac{53}{10^{10}} + \frac{52}{10^{10}} \right)$$

Figure 5.1 EN 9614 standard unit sound intensity

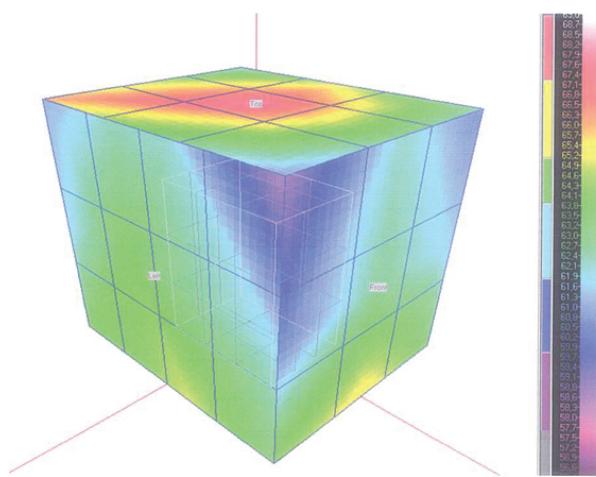


For units GAHP-AR S and GA ACF silenced versions (S) see Table 5.2 p. 4 and Figure 5.2 p. 4.

Table 5.2 Sound levels EN 9614 silenced GAHP-AR and GA-ACF

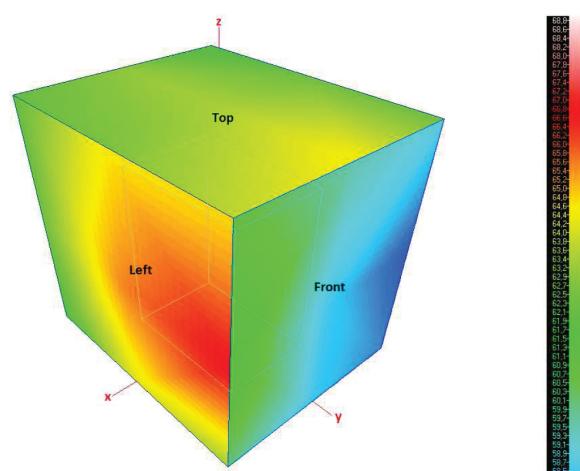
Frequency	Surface					Sum over frequencies
	Top	Left	Front	Right	Back	
50 Hz supply	DB(A)	DB(A)	DB(A)	DB(A)	DB(A)	A [dBA]
50	50,5	-	-	-	-	-
63	48,6	-	-	-	-	-
80	51,5	-	-	-	-	-
100	57,9	60,3	62,3	58,3	62,0	67,5
125	58,1	43,7	43,6	44,3	44,6	58,7
160	-	-	-	-	-	-
200	-	-	-	-	-	-
250	55,5	51,7	53,4	49,9	51,9	59,9
315	56,7	55,4	52,0	55,8	54,1	62,1
400	56,9	55,1	53,6	54,9	55,2	62,3
500	58,5	57,7	56,7	59,7	56,3	65,0
630	58,9	59,6	58,0	58,5	58,6	65,7
800	60,7	60,9	57,7	60,1	59,6	66,9
1000	60,9	57,4	53,2	56,6	57,0	64,7
1250	61,9	57,3	53,9	57,1	58,0	65,4
1600	59,1	56,1	55,5	56,0	55,1	63,6
2000	56,9	55,0	54,8	53,4	54,5	62,1
2500	55,1	54,3	56,9	54,8	53,4	62,1
3150	56,7	57,7	54,9	56,6	55,8	63,5
4000	56,8	57,1	50,9	54,0	58,1	63,0
5000	57,2	57,3	55,0	56,5	56,2	63,5
6300	-	46,0	-	51,4	50,3	-
A [dBA]	70,6	69,2	68,0	68,7	69,0	76,1

Front refers to the unit side that has the removable maintenance panel

Figure 5.2 EN 9614 GAHP-AR S and GA ACF S sound intensity**Table 5.3** Sound levels EN 9614 GAHP A S1

Frequency	Surface					Sum over frequencies	
	Top	Left	Front	Right	Back		
50 Hz supply	DB	DB	DB	DB	DB	L [dB]	A [dBA]
50	79,0	75,2	69,9	78,7	74,0	83,4	53,2
63	62,2	60,3	55,4	60,8	58,6	67,0	40,8
80	66,4	58,8	59,2	57,6	59,1	68,7	46,2
100	73,8	72,4	70,4	69,8	71,2	78,8	59,7
125	58,2	55,6	55,3	55,5	54,3	62,9	46,8
160	66,5	61,5	60,1	60,3	60,8	69,6	56,2
200	61,1	60,9	60,5	59,0	57,5	67,0	56,1
250	63,2	58,9	58,2	55,7	56,9	66,4	57,8
315	61,9	60,0	58,4	57,8	59,2	66,7	60,1
400	61,5	60,9	56,8	59,5	59,2	66,9	62,1
500	62,3	64,6	60,1	64,0	62,3	69,9	66,7
630	62,6	64,5	58,1	61,5	59,3	68,8	66,9
800	62,0	64,8	57,3	59,4	59,0	68,3	67,5
1000	60,7	63,6	57,4	58,2	57,7	67,2	67,2
1250	58,3	61,5	54,9	55,2	54,8	64,8	65,4
1600	55,6	56,4	49,9	54,9	54,4	61,7	62,7
2000	53,0	52,2	46,0	51,8	51,0	58,3	59,5
2500	52,6	53,8	46,2	53,8	53,0	59,6	60,9
3150	46,6	45,3	38,3	44,9	44,8	51,7	52,9
4000	44,0	44,0	37,1	43,6	43,2	50,0	51,0
5000	41,1	40,0	35,2	41,0	29,6	46,8	47,3
6300	38,0	37,6	33,7	36,5	36,4	43,6	43,5
L [dB]	81,1	78,5	74,7	79,8	76,9	85,7	75,3
A [dBA]	69,1	70,8	65,1	67,5	66,8		

Front refers to the unit side that has the removable maintenance panel

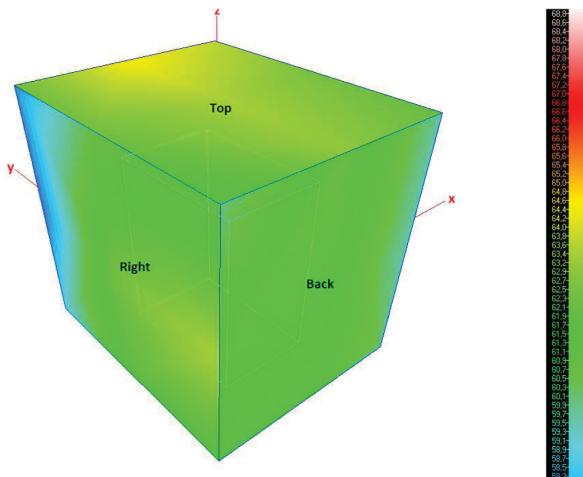
Figure 5.3 EN 9614 GAHP A S1 front sound intensity

Sound intensity measured on unit GAHP A HT S1 surface, front, top and left side view

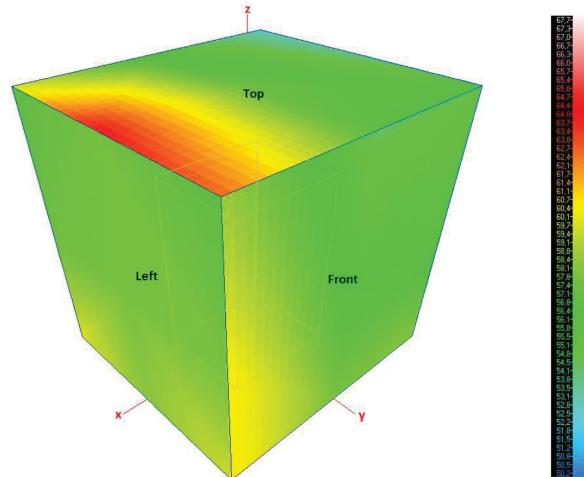
5.2 GAHP A

For unit GAHP A HT Standard see Table 5.1 p. 3 and the relevant Figure 5.1 p. 3.

For unit GAHP A HT S1 see Table 5.3 p. 4 and Figures 5.3 p. 4 and 5.4 p. 5.

Figure 5.4 EN 9614 GAHP A S1 rear sound intensity

Sound intensity measured on unit GAHP A HT S1 surface, rear, top and right side view

Figure 5.5 EN 9614 GAHP GS/WS front sound intensity

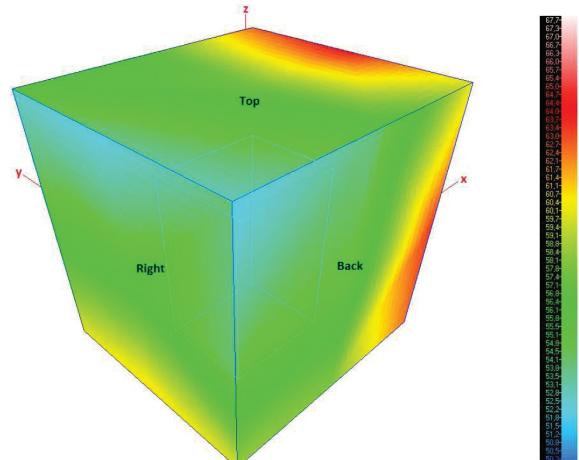
Sound intensity measured on unit GAHP GS/WS surface, front, top and left side view

5.3 GAHP GS/WS

Table 5.4 Sound levels EN 9614 GAHP GS/WS

Frequency	Surface					Sum over frequencies	
	Top	Left	Front	Right	Back	L [dB]	A [dBA]
50 Hz supply	DB	DB	DB	DB	DB		
50	59,2	61,9	61,9	60,1	60,2	67,8	37,6
63	52,2	61,4	59,6	56,7	58,0	65,5	39,3
80	52,3	56,5	57,7	59,1	58,4	64,3	41,8
100	55,3	72,5	64,7	56,6	65,1	73,9	54,8
125	55,8	57,4	60,4	57,9	57,2	65,0	48,9
160	49,8	54,3	56,7	53,2	52,0	60,8	47,7
200	57,2	57,1	57,9	55,4	56,8	64,0	53,1
250	52,8	53,7	56,6	52,0	56,4	61,7	53,1
315	55,1	58,3	56,4	57,3	58,8	64,3	57,7
400	50,7	54,3	53,8	53,6	52,8	60,2	55,4
500	53,0	59,1	56,2	52,9	56,6	63,2	60,0
630	56,4	57,7	58,9	58,9	59,6	65,4	63,5
800	54,5	53,9	54,6	53,1	55,3	61,3	60,5
1000	57,8	51,6	54,5	50,7	55,7	61,8	61,8
1250	59,3	51,6	53,6	49,0	57,7	62,8	63,4
1600	49,7	45,8	48,4	46,1	48,4	54,9	55,9
2000	44,6	42,9	46,7	47,7	43,7	52,4	53,6
2500	40,0	40,0	41,9	44,9	40,4	48,9	50,2
3150	41,1	38,2	44,8	48,2	41,2	51,1	52,3
4000	37,4	35,9	38,7	48,2	39,7	49,7	50,7
5000	34,5	33,9	34,1	35,5	33,4	41,3	41,8
6300	32,4	33,0	31,7	32,4	32,6	39,4	39,3
L [dB]	67,5	74,1	70,6	68,1	70,4	77,8	70,4
A [dBA]	64,1	62,9	63,2	62,0	64,3		

Front refers to the unit side that has the removable maintenance panel
The sound levels have been measured with type C unit installation

Figure 5.6 EN 9614 GAHP GS/WS rear sound intensity

Sound intensity measured on unit GAHP GS/WS surface, rear, top and right side view