REPORT

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Determination of sound power level of air purifiers according to ISO 3741

(1 appendix)

(Compared with the original report P804370A-en, in this revised version, P804370A-en-rev1, the changes are: (1) The quiet air purifiers LightAir IonFlow 50 and the purifier coded AP have been measured using a low-noise microphone; (2) appendix 1 has been added.)

(One related measurement report is P803889A.)

Test object

LightAir IonFlow 50 and the other 6 air purifiers coded as BA, SH, EX, DA, BO and AP, respectively. (The coding was provided by Light Air AB).

Arrival of test object

August 25, 2008: Air purifiers BA, SH, EX and DA.

August 27, 2008: LightAir IonFlow 50 together with air purifiers BO and AP.

Date of test

August 28, 2008, September 16 and 22, 2008

Results

The A-weighted sound power levels (L_{WA}) stated to the nearest half decibel are given in table 1. The sound power levels (L_W) of the octave bands 63 – 8000 Hz are given in table 2. The results are valid for the tested objects only.

Table 1 A-weighted sound power levels

Air purifier	Speed	Operating condition	A-weighted sound power level L_{WA} (dBA)
LightAir IonFlow 50	-	230 V, 50 Hz	≤21,0*
BA	silent	230 V, 50 Hz	33,0
BA	low	230 V, 50 Hz	38,0
SH	quiet	110 V, 50 Hz	37,0
EX	low	230 V, 50 Hz	35,5
DA	low	230 V, 50 Hz	36,5
DA	medium	230 V, 50 Hz	45,5
BO	low (still)	230 V, 50 Hz	46,5
AP	-	230 V, 50 Hz	< 17,5**

* : The measured sound pressure level of the test object is very close to the background noise level. The reported result is an upper limit level.
** : The measured sound pressure level of the test object is indistinguishable from the background noise level (The A-weighted sound power level of the background noise is 17,5 dB).

Table 2 Frequency band sound power levels

Air purifier	Sound power level L_W (dB) in the octave frequency bands (Hz)							
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
LightAir IonFlow 50*	≤22	-	-	≤10	-	≤11	≤13	≤20
BA –silent	≤29	≤31	38	33	20	≤14	≤18	≤24
BA –low	≤31	35	42	38	28	≤17	≤18	≤23
SH -quiet	≤27	≤31	35	37	29	29	25	≤25
EX -low	≤28	≤30	34	39	24	≤17	≤20	≤24
DA -low	≤30	37	40	35	28	≤19	≤21	≤28
DA -medium	39	45	48	45	40	31	25	≤28
BO -low (still)	40	45	47	46	43	34	25	≤24
AP*	-	-	-	-	-	-	-	-

* : The quiet air purifier has been measured using a low-noise microphone but the frequency band levels have been indistinguishable from those of the background noise levels.

Measurement method

The measurements were carried out according to ISO 3741:1999 in a reverberation room with the volume 200 m^3 and total boundary surface area 211 m^2. The comparison method was used. The reference sound source was calibrated in accordance with ISO 6926:1999. At and above 100 Hz it was calibrated according to the hemi-free field method and below 100 Hz it was calibrated in the reverberation room, which is qualified for measurements according to ISO 3741 in the frequency range 100 – 10000 Hz. In the one-third octave bands below 100 Hz the standard requires a room volume of > 200 m^3.

Attention! The sound power level is referred to the actual barometric and temperature conditions. This is in line with the recent ISO/FDIS 3741 but a deviation from ISO 3741:1999 which refers results to $\rho c = 400\ Ns/m^3$.

Sound pressure levels were measured at least at 1 source position and 6 different microphone positions in the one-third octave bands 50 – 10000 Hz. The number of source and microphone positions depend on the standard deviation between the microphone positions. The integration time at each microphone position was 32 s. In case the level difference with respect to background noise was less than 10 dB, the measured values have been corrected by 0,5 dB. These measured values are marked with "≤" in the report. This correction has had no effect on the A-weighted sound power levels.

The sound power level, L_W, was calculated using the following equation:

$$L_W = L_p + (L_{Wr} - L_{pr}) \text{ (dB)}$$

where

L_W = the sound power level of the test object, in dB, reference: 1 pW
L_p = the measured sound pressure level of the test object, in dB, reference: 20 µPa
L_{Wr} = the sound power level of the reference sound source, in dB, reference: 1 pW
L_{pr} = the measured sound pressure level of the reference sound source, in dB, reference: 20 µPa

Operating conditions

Voltage:	230 ±2 V eller 110 ±1 V		
Frequency:	50 ± 0,05 Hz		
	August 28, 2008	Sept. 16, 2008	Sept. 22, 2008
Barometric pressure:	985 ±5 hPa	1006 ±5 hPa	1004 ±5 hPa
Temperature:	22° C ±1 ° C	21° C ±1 ° C	21° C ±1 ° C
Relative humidity:	46% ± 5%	32% ± 5%	37% ± 5%

Mounting conditions

The test object was placed on the floor at a distance of ≥ 1,5 m from the room walls, according to ISO 3741. (Photos of the tested objects are presented in appendix 1.)

Measurement uncertainty

The standard deviation of the reproducibility, as given in ISO 3741:1999, is given in table 3 together with the expanded measurement uncertainty with a coverage factor of two which provides a level of confidence of approximately 95%.

Table 3 Measurement uncertainty

1/3 octave band mid frequency (Hz)	Standard-deviation of reproducibility (dB)	Expanded measurement uncertainty (dB)
100 to 160	2,5	±5,0
200 to 315	1,5	±3,0
400 to 5000	1,0	±2,0
6300 to 10000	2,0	±4,0
A-weighted	0,5	±1,0

List of instruments

Instrument	*Manufacturer*	*Type*	*Serial no / SP no*
Real time analyser	Norsonic	830	11533
	National Instruments		A700440
Program	SP	MB Effekt5 951110	
	National Instruments	LabVIEW	
Multiplexer	Norsonic	834	502329
Microphones	Brüel & Kjaer	4943	2479445
	Brüel & Kjaer	4943	2206273
	Brüel & Kjaer	4943	2206274
	Brüel & Kjaer	4943	2206276
	Brüel & Kjaer	4943	2206277
	Brüel & Kjaer	4943	2206278
	Brüel & Kjaer	4179	1698198
Amplifiers	Brüel & Kjaer	2619	970948
	Brüel & Kjaer	2619	726624
	Brüel & Kjaer	2619	469905
	Brüel & Kjaer	2619	726792
	Brüel & Kjaer	2619	726825
	Brüel & Kjaer	2619	970968
	Brüel & Kjaer	2660	1097450
Calibrator	Brüel & Kjaer	4230	1411048
Barometer	Druck	DPI 140	502504
Temperature- and humidity instrument	Testo	615	503962

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Appendix

Appendix 1

Short technical specification on each represented technology used at the benchmark test at SP in Aug-Sep 2008

(Provided by LightAir AB)

Ionization LightAir IonFlow 50

Ionizing air purifiers generate large amount of electrons which transform into negative ions which charge particles in the air negative. The particles are then attracted by and attached to a positively charged collector. Some ionizers also generate ozone.

HEPA filter BA

A true HEPA filter removes up to 99.97% of all particles as small as 0.3 microns. This device creates a fan driven airflow through a very dense mechanical filter which is similar to HEPA. Such filters need to be changed frequently not to loose effect over time. Size, material and construction of the actual filter are important factors for the capacity of particle reduction. Very few portable air purifiers use true HEPA filters.

Conventional electrostatic precipitator SH

Conventional electrostatic precipitators are based on similar principles as ionization technology. They electrically charge the particles in a fan driven airflow. The particles continue into the counter pole collector cassette where they are attracted and get caught. The collector cassette is generally a conductive construction of metallic plates which must be frequently cleaned to keep the level of performance. Some conventional electrostatic precipitators also generate ozone.

Modified electrostatic precipitator EX

Modified electrostatic precipitator is based on the concept of a conventional electrostatic precipitator. However the plates in the collector cassette are made of material with a quite low conductivity (cellulose or plastic).The filter must be cleaned less frequently and keeps a good performance level over time. Some modified electrostatic precipitators could also generate ozone.

Hybrid DA and BO

A hybrid air purifier uses a combination of several technologies to capture different sizes of particles from the air. They also use a fan driven airflow and often include ionization of some kind. A hybrid can use a mixture of pre-filters (remove large particles), HEPA filters, electrostatic precipitation, active carbon filters (adsorbing odours and gases), antibacterial/germicidal filters and/or UV light. All filters need to be replaced regularly.

Heat AP

Heat is used to make the air move upwards (air convection) through the device where particles and microorganisms are destroyed at high temperatures. Like all devices using an airflow it only cleans the air which actually passes through the unit. In this case the airflow is extremely small.