UCL

Leonard Wolfson Experimental Neurology Centre

Noise Survey and Assessment

R01a-jh

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Ove Arup & Partners Ltd
13 Fitzroy Street
London
W1T 4BQ
United Kingdom
www.arup.com

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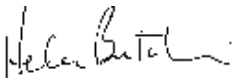
		Signature			
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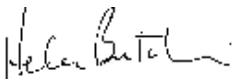
		Signature			
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		Name	Joe Hornby BSc AMIOA	Charlotte Adcock MSc MIOA MCIEH	Helen Butcher BSc CEng FIOA
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1 Introduction

New mechanical services plant is proposed on the roof of the University College London (UCL) lecture theatre building. Arup has been commissioned to assess noise emissions from the proposed development with regard to planning.

This report details the noise survey work that has been carried out to measure existing background noise levels and the assessment of noise emissions from proposed new plant. The second survey was requested by London Borough of Camden Environmental Health department to measure existing background noise levels when the roofplant already operating and in situ on UCL lecture theatre roof is not in operation. The location and protocol for the survey was agreed on site with the EHO, prior to the second survey taking place. It should be noted however that there was other plant in operation permanently on the adjacent rooftop of Great Ormond Street Hospital, which was not in our control, but formed part of the measured background for both surveys. The assessment is carried out in accordance with London Borough of Camden's (LBC) noise emissions policy.

2 Survey

A baseline noise survey consisting of both attended and unattended measurements has been carried out to measure the background noise levels at sensitive receivers nearest to the proposed development.

Measurements were made between 1300 on 5 November and 1300 on 6 November 2012.

A further attended survey was carried out at the same location on 7 February 2013 as prescribed by the LBC EHO. This survey was carried out to ascertain the contribution, if any, of local existing mechanical services on the UCL building rooftop.

Measurements were made between 0230hrs and 0300hrs on the 7th February 2013.

The surveys were conducted by Arup Acoustics' engineers Joe Hornby and Joseph Mendis. Weather conditions were dry and calm throughout. At any time conditions were within the acceptable limits with wind speeds under $5ms^{-1}$.

2.1 Method

2.1.1 Measurement Procedure

An unmanned noise logger was used to measure noise levels over a 24 hour period in the form of consecutive 10 minute measurements. An additional attended measurement was carried out logging at 5 minute intervals.

The measurement location is shown in Figure 1. The sound level meters for both surveys were mounted on a tripod on the roof of the single storey UCL lecture theatre, which is the proposed location for the new plant. This location is enclosed by the taller surrounding UCLH hospital buildings on two sides, and Great

Ormond Street Hospital buildings on the other two sides. A windshield was fitted to the microphone at all times to minimise the effects of wind induced noise across the microphone diaphragm.

2.2 Observations

The four existing condensor units were running when the measurement period started for the un-attended measurements, and it is our understanding that this is normally the case. It was noted that for the attended measurements the condenser units remained inactive apart from the occasional running of one condenser unit for not more than 20 seconds. The dominant noise source was the plant operating on Great Ormond Street hospital roof, immediately adjacent to our site.

The measurement position was exposed to direct and reflected sound, although the relative contribution of these two components could not be established. It is estimated from experience that direct sound from the existing UCL roof plant would be of the order of 2dB lower than the overall level measured.

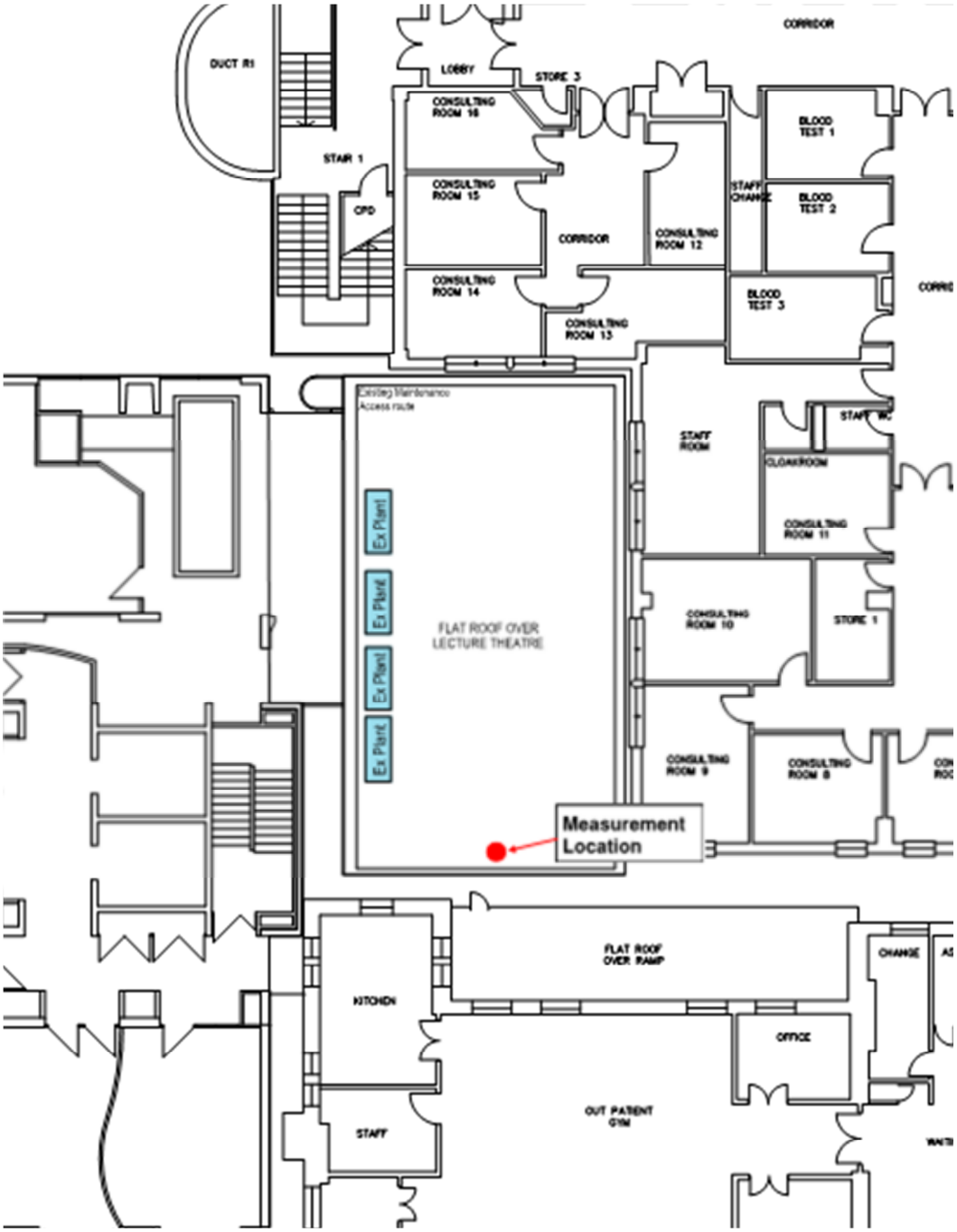

Figure 1 Measurement location

2.2.1 Instrumentation

The instrumentation used to carry out the noise survey was as follows:

- Rion NL-52 sound level meter with environmental logging kit-(unattended survey)
- Rion NC-74 sound pressure level calibrator (unattended survey)
- B&K 2260 sound level meter (attended survey)

Immediately before and after each series of measurements was carried out, the SLM's calibration was checked using the calibrator.

All noise measuring instrumentation owned and used by Arup Acoustics is checked for correct calibration to traceable national and international standards on an annual basis. Routine 'in-house' spot checks are also conducted as part of Arup Acoustics' QA policy.

2.3 Measurement results

Results for the unattended survey are given graphically in Figure 2 and numerically in Appendix A. For the unattended survey the lowest measured background noise level was 60 $dBL_{A90,10mins}$. The overall ambient noise level for daytime (0700-1900) was measured as 62$dBL_{Aeq,12hrs}$ and for evening (1900-2300) was measured as 63$dBL_{Aeq,4hrs}$.

The background noise level recorded during the attended survey was 55dBL_{A90} averaged over 30 minutes. The overall ambient noise level for the period was 56$dBL_{Aeq,30mins}$. Results are presented numerically in Appendix A.

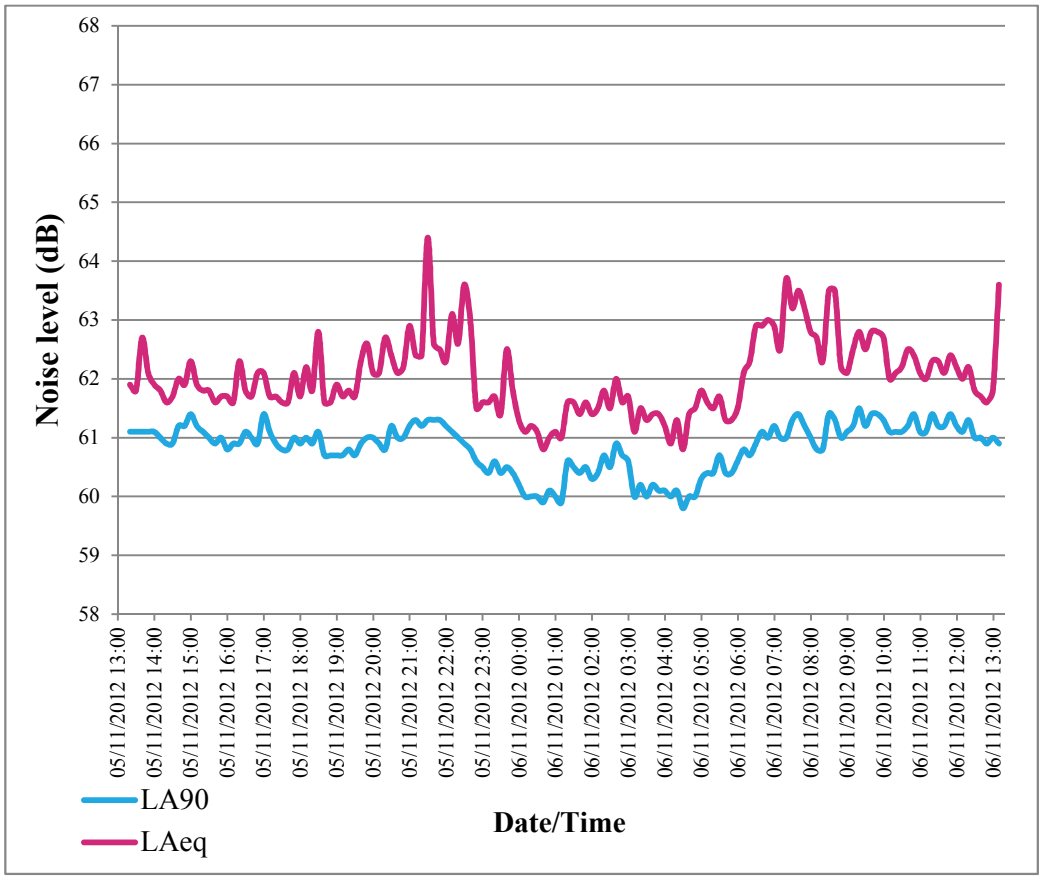

Figure 2 Unattended measurement results

Figure 2 reveals that little change in background noise occurred during the 24 hour period, indicating that existing plant emissions (as well as the contribution from other sources) remain relatively constant.

3 Planning and noise emissions

3.1 Noise sensitive premises

The nearest noise sensitive receivers to the proposed plant on the flat roof are the surrounding UCLH and Great Ormond Street hospital buildings.

3.2 Noise emissions limit

Camden London Borough Council's Local Development Framework policy document DP28 - *Noise and vibration* sets out noise emissions limits for proposed plant and machinery.

The maximum noise emissions level ($L_{Aeq,10mins}$) is defined as 5dB below the lowest measured background level ($L_{A90,10mins}$) at 1m from sensitive facades. Where the emitted noise is tonal, impulsive or intermittent, the maximum noise emissions level is defined as 10dB below the lowest measured background noise level at 1m from sensitive facades. These limits apply for background noise levels of 60dBL_{A90} or less.

Where the existing background noise level exceeds 60dBL_{A90}, the maximum noise emission level must not exceed 55dBL_{Aeq}, 1m from sensitive facades.

Considering the attended survey results recorded during the early hours and the lower background noise levels, it is proposed that these results be used to set the noise emissions levels. It is envisaged that this would reflect the quietest period and hence the expected lower noise levels.

The lowest background noise measured at the nearest noise sensitive premises was 55 dB$L_{A90,10mins}$. Therefore the noise emissions limit is 50dBL_{Aeq} for continuous, non-tonal noise and 45dBL_{Aeq} for tonal or intermittent noise at the surrounding UCLH buildings.

For new plant, reflected sound will cause the resulting sound level at 1m from nearby facades to be approximately 2-3dB higher than the direct component alone. This means that for the direct component, the applicable limits are 47dBL_{Aeq} for continuous, non-tonal noise and 42dBL_{Aeq} for tonal or intermittent noise, 1m from the surrounding UCLH buildings.

3.3 Plant noise emissions

The proposed new plant comprises two air handling units with sound power levels as detailed in Appendix C and a condenser with a sound power level of 65dB(A). All new plant would be located on the roof of the UCL lecture theatre, at least 3m away from the surrounding hospital buildings.

A full equipment list and noise level data for each item of plant have been provided by the services engineer. On the basis of these data we have calculated direct noise levels 1m from the nearby facades, with the following conclusions.

1. Casing break-out noise from the AHUs is insignificant (less than 30dBA at the facades).
2. The ducted AHU supply and return connections into the building will not produce significant noise.
3. Open fresh air inlets to the AHUs would cause noise levels which would marginally exceed the limits at the nearest facades. Therefore these inlets should be provided with a duct connection and attenuator, with the minimum insertion losses shown in Table 1. The resulting direct noise level would then be approximately 45dB(A)
4. Noise from the ducted exhaust air connections is likely to be just compatible with the required limits, but we consider it prudent to allow for a similar level of attenuation as the intakes. . The resulting direct noise level would then be approximately 42dB(A)
5. The noise level from the condenser unit 1m from the nearest facade will be of the order of 49dB(A), and therefore compatible provided it is not tonal.

Octave Band Frequency	63	125	250	500	1kHz	2kHz	4kHz	8kHz
Insertion Loss	0.0	0.0	-7.0	-11.0	-9.0	-5.0	-2.0	0.0

Table 1 Required attenuator insertion losses.

In total the resulting noise level will be below 52dB(A).

4 Conclusion

Noise emissions from proposed new plant at UCL have been assessed. A noise survey has been carried out to establish existing background noise levels.

In accordance with Camden London Borough Council noise emission policy, a noise emissions limit of 55dBL_{Aeq} for continuous, non-tonal noise and 50dBL_{Aeq} for tonal or intermittent noise has been set 1m from the surrounding UCLH buildings.

With attenuation measures to the proposed AHUs as set out above, the new plant should be compatible with these limits.

Appendix A

Measurement results

Unattended Survey		
Date & Time	**Measured $L_{Aeq,10mins}$(dB)**	**Measured $L_{A90,10mins}$(dB)**
05/11/2012 13:00	64	62
05/11/2012 13:10	64	62
05/11/2012 13:20	62	61
05/11/2012 13:30	62	61
05/11/2012 13:40	63	61
05/11/2012 13:50	62	61
05/11/2012 14:00	62	61
05/11/2012 14:10	62	61
05/11/2012 14:20	62	61
05/11/2012 14:30	62	61
05/11/2012 14:40	62	61
05/11/2012 14:50	62	61
05/11/2012 15:00	62	61
05/11/2012 15:10	62	61
05/11/2012 15:20	62	61
05/11/2012 15:30	62	61
05/11/2012 15:40	62	61
05/11/2012 15:50	62	61
05/11/2012 16:00	62	61
05/11/2012 16:10	62	61
05/11/2012 16:20	62	61
05/11/2012 16:30	62	61
05/11/2012 16:40	62	61
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05/11/2012 17:00	62	61
05/11/2012 17:10	62	61
05/11/2012 17:20	62	61
05/11/2012 17:30	62	61
05/11/2012 17:40	62	61
05/11/2012 17:50	62	61
05/11/2012 18:00	62	61
05/11/2012 18:10	62	61
05/11/2012 18:20	62	61
05/11/2012 18:30	63	61
05/11/2012 18:40	62	61
05/11/2012 18:50	62	61
05/11/2012 19:00	62	61

05/11/2012 19:10	62	61
05/11/2012 19:20	62	61
05/11/2012 19:30	62	61
05/11/2012 19:40	62	61
05/11/2012 19:50	63	61
05/11/2012 20:00	62	61
05/11/2012 20:10	62	61
05/11/2012 20:20	63	61
05/11/2012 20:30	62	61
05/11/2012 20:40	62	61
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06/11/2012 00:30	61	60
06/11/2012 00:40	61	60
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06/11/2012 07:40	64	61
06/11/2012 07:50	63	61
06/11/2012 08:00	63	61

06/11/2012 08:10	63	61
06/11/2012 08:20	62	61
06/11/2012 08:30	64	61
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06/11/2012 11:50	62	61
06/11/2012 12:00	62	61
06/11/2012 12:10	62	61
06/11/2012 12:20	62	61
06/11/2012 12:30	62	61
06/11/2012 12:40	62	61
06/11/2012 12:50	62	61
06/11/2012 13:00	62	61
Attended Survey		
Date & Time	**Measured $L_{Aeq,5mins}$(dB)**	**Measured $L_{A90,5mins}$(dB)**
07/02/2013 02:42:30	55.7	55.2
07/02/2013 02:47:30	56.7	55.0
07/02/2013 02:52:30	55.7	55.2
07/02/2013 03:00:39	55.5	54.8
07/02/2013 03:05:50	55.9	55.2
07/02/2013 03:11:01	55.6	55.0

Appendix B

Acoustic terminology

Decibel (dB)

The ratio of sound pressures which we can hear is a ratio of 106 (one million:one). For convenience, therefore, a logarithmic measurement scale is used. The resulting parameter is called the 'sound pressure level' (L_p) and the associated measurement unit is the decibel (dB). As the decibel is a logarithmic ratio, the laws of logarithmic addition and subtraction apply.

dB(A)

The unit used to define a weighted sound pressure level, which correlates well with the subjective response to sound. The 'A' weighting follows the frequency response of the human ear, which is less sensitive to low and very high frequencies than it is to those in the range 500Hz to 4kHz.

In some statistical descriptors, the 'A' weighting forms part of a subscript, such as L_{A10}, L_{A90}, and L_{Aeq} for the 'A' weighted equivalent continuous noise level

Equivalent continuous sound level

An index for assessment for overall noise exposure is the equivalent continuous sound level, L_{eq}. This is a notional steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

Frequency

Frequency is the rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the hertz (Hz), which is identical to cycles per second. A 1000Hz is often denoted as 1kHz, eg 2kHz = 2000Hz. Human hearing ranges approximately from 20Hz to 20kHz. For design purposes the octave bands between 63Hz to 8kHz are generally used. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For more detailed analysis, each octave band may be split into three one-third octave bands or in some cases, narrow frequency bands.

Sound pressure level

The sound power emitted by a source results in pressure fluctuations in the air, which are heard as sound.

The sound pressure level (L_p) is 10 times the logarithm of the ratio of the measured sound pressure (detected by a microphone) to the reference level of 2 x 10^{-5}Pa (the threshold of hearing).

Thus L_p (dB) = 10 log $(P_1/P_{ref})^2$ where P_{ref}, the lowest pressure detectable by the ear, is 0.00002 pascals (ie $2x10^{-5}$ Pa).

The threshold of hearing is 0dB, while the threshold of pain is approximately 120dB. Normal speech is approximately 60dB(A) or more and a change of 3dB is only just detectable. A change of 10dB is subjectively twice, or half, as loud.

Statistical noise levels

For levels of noise that vary widely with time, for example road traffic noise, it is necessary to employ an index which allows for this variation. The L_{10}, the level exceeded for 10% of the time period under consideration, and can be used for the assessment of road traffic noise (note that L_{Aeq} is used in BS 8233 for assessing traffic noise). The L_{90}, the level exceeded for 90% of the time, has been adopted to represent the background noise level. The L_1, the level exceeded for 1% of the time, is representative of the maximum levels recorded during the sample period. A weighted statistical noise levels are denoted L_{A10}, dBL_{A90} etc. The reference time period (T) is normally included, eg $dBL_{A10,\ 5min}$ or $dBL_{A90,\ 8hr}$.

Appendix C

Plant data sheets

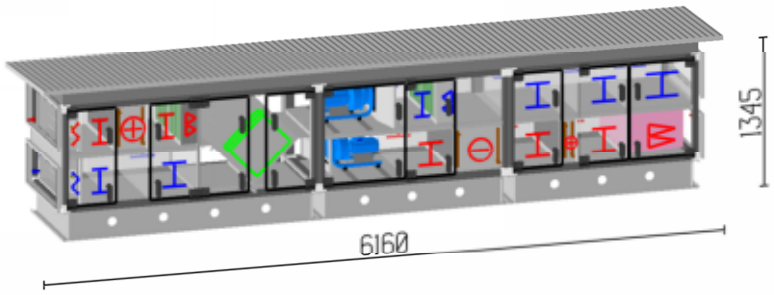
systemair

Systemair A/S - Air handling unit design 06/11/2012
SystemairCAD - Version C2012-07.03.B9 Page 1

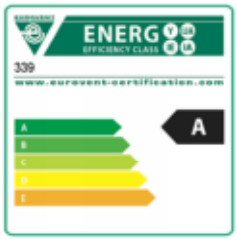
Project: Unit: Danvent DV 10 Plant no.: AHU-01/

Summary for unit no. 1

Unit size	10	Roof unit
Unit width	970	mm
Weight	1128	kg



	Supply		Extract	
Airflow (1,205 kg/m³)	0.49	m3/s	0.41	m3/s
Face velocity (unit)	1.37	m/s	1.15	m/s
External pressure	200	Pa	200	Pa
Filter	F7		G4	
Fan	77.3	%	71.0	%
	590	Pa	368	Pa
	3011	RPM	2440	RPM
Motor	0.75	kW	0.75	kW
	3x400	V	3x400	V
	1.77	A	1.77	A



SFP, clean filters including frequency converter	1.35	kW/(m³/s)
SFP, clean filters excluding frequency converter	1.28	kW/(m³/s)

Heat recovery	52.4 %
Heating	4.22 kW - Air 10.9/18.0°C - Water 80/60°C - 0.8 kPa - 0.05 l/s
Pipe connections	3/4" / 3/4"
Heating	5.90 kW - Air -5.0/5.0°C - Water 80/60°C - 1.5 kPa - 0.07 l/s
Pipe connections	1/2" / 1/2"
Cooling	8.20 kW - Air 31.0/18.0°C - Water 6/12°C - 19.9 kPa - 0.32 l/s
Pipe connections	3/4" / 3/4"

Sound power level	63	125	250	500	1k	2k	4k	8k	Hz	Total	
Supply air	62	61	66	66	64	57	53	41	dB	68	dB(A)
Outdoor air	62	59	64	64	58	52	50	44	dB	64	dB(A)
Exhaust air	60	60	66	65	66	62	57	52	dB	69	dB(A)
Extract air	61	59	64	63	60	57	54	55	dB	66	dB(A)
Sound break out	59	55	49	44	40	36	34	31	dB	47	dB(A)

Systemair Fans&Spares Ltd.
Telephone : +44 1213220200
Telefax : +44 1213220201
www.systemair.co.uk
mailbox@systemair.co.uk

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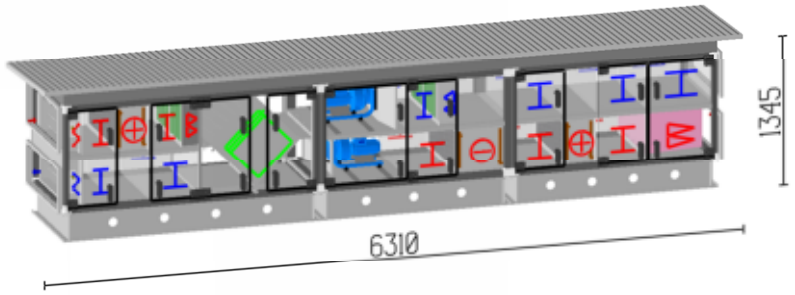
systemair

Systemair A/S - Air handling unit design 06/11/2012
SystemairCAD - Version C2012-07.03.B9 Page 10

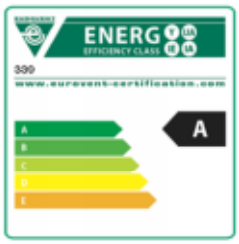
Project: Unit: Danvent DV 10 Plant no.: AHU-02/

Summary for unit no. 2

Unit size	10	Roof unit
Unit width	970	mm
Weight	1134	kg



	Supply		Extract	
Airflow (1,205 kg/m³)	0.35	m3/s	0.28	m3/s
Face velocity (unit)	0.98	m/s	0.78	m/s
External pressure	200	Pa	200	Pa
Filter	F7		G4	
Fan	74.4	%	68.2	%
	468	Pa	305	Pa
	3036	RPM	2443	RPM
Motor	0.55	kW	0.55	kW
	3x400	V	3x400	V
	1.29	A	1.29	A



SFP, clean filters including frequency converter	1.09	kW/(m³/s)
SFP, clean filters excluding frequency converter	1.04	kW/(m³/s)

Heat recovery	52.5 %
Heating	3.00 kW - Air 10.9/18.0°C - Water 80/60°C - 0.4 kPa - 0.04 l/s
Pipe connections	3/4" / 3/4"
Heating	4.21 kW - Air -5.0/5.0°C - Water 80/60°C - 0.8 kPa - 0.05 l/s
Pipe connections	1/2" / 1/2"
Cooling	5.86 kW - Air 31.0/18.0°C - Water 6/12°C - 19.9 kPa - 0.23 l/s
Pipe connections	3/4" / 3/4"

Sound power level	63	125	250	500	1k	2k	4k	8k	Hz	Total	
Supply air	57	55	61	62	62	58	50	41	dB	65	dB(A)
Outdoor air	56	53	58	61	57	52	50	45	dB	62	dB(A)
Exhaust air	54	55	61	62	63	62	56	50	dB	68	dB(A)
Extract air	54	53	59	61	59	58	55	53	dB	64	dB(A)
Sound break out	52	49	43	41	39	36	34	31	dB	45	dB(A)

Systemair Fans&Spares Ltd.
Telephone : +44 1213220200
Telefax : +44 1213220201
www.systemair.co.uk
mailbox@systemair.co.uk

EUROVENT CERTIFIED PERFORMANCE

Heating & Cooling

Seasonal Classic

INDOOR UNIT					FAQ71C	FAQ100C	FAQ100C
Cooling capacity	Nom.			kW	6.8 *	9.5 *	9.5 *
Heating capacity	Nom.			kW	7.5 *	10.8 *	10.8 *
Power input	Cooling	Nom.		kW	2.12	3.16	3.16
	Heating	Nom.		kW	2.08	3.17	3.17
EER					3.21	3.01	3.01
COP					3.61	3.41	3.41
SEER					5.11 *	4.91 *	4.91 *
SCOP					3.81 *	3.81 *	3.81 *
Annual energy consumption				kWh	1,059	1,580	1,580
Energy label	Cooling/Heating				A/A	B/B	B/B
Casing	Colour				Fresh White		Fresh White
	Material				Resin		Resin
Dimensions	Unit	Height×Width×Depth		mm	295×1,050×238	340×1,200×240	340×1,200×240
Weight	Unit			kg	13	17	17
Fan - Air flow rate	Cooling	High/Nom./Low		m^3/min	18/16/14	26/23/19	26/23/19
	Heating	High/Nom./Low		m^3/min	18/16/14	26/23/19	26/23/19
Sound power level	Cooling	High/Nom./Low		dBA	61/58/56	65/62/58	65/62/58
	Heating	High/Nom./Low		dBA	61/58/56	65/62/58	65/62/58
Sound pressure level	Cooling	High/Nom./Low		dBA	45/42/40	49/45/41	49/45/41
	Heating	High/Nom./Low		dBA	45/42/40	49/45/41	49/45/41
Piping connections	Liquid	OD		mm	9.52		9.52
	Gas	OD		mm	15.9		15.9
	Drain	OD		mm	-		-
Power supply	Phase / Frequency / Voltage			Hz / V	1~ / 50/60 / 220~240/220		1~ / 50/60 / 220~240/220

(1) Energy label scale from A (most efficient) to G (less efficient) (2) Annual energy consumption: based on average use of 500 running hours per year at full load (nominal conditions) (3) Cooling: indoor temp. 27°CDB, 19°CWB; outdoor temp. 35°CDB; equivalent piping length: 5m, level difference: 0m (4) Heating: indoor temp. 20°CDB, outdoor temp. 7°CDB, 6°CWB; equivalent refrigerant piping: 5m, level difference: 0m (5) Annual energy consumption is according to Energy labelling directive 2002/31/EC (6) SEER and SCOP are according to EN 14825 (7) Refered to 3D076919

OUTDOOR UNIT					RZQSG71LV1	RZQSG100LV1	RZQSG100LY1
Dimensions	Unit	Height×Width×Depth		mm	735×800×330	990×940×330	990×940×330
Weight	Unit			kg	67	81	82
Fan	Air flow rate	Cooling	Nom.	m^3/min	52	76	76
		Heating	Nom.	m^3/min	48	83	83
Sound power level	Cooling	Nom.		dBA	65	69	69
Sound pressure level	Cooling	Nom./Silent operation		dBA	49/47	53/49	53
	Heating	Nom.		dBA	51	57	57
Compressor	Type				Hermetically sealed swing compressor		Hermetically sealed swing compressor
Operation range	Cooling	Ambient	Min.~Max.	°CDB	-5.0~46.0		-5.0~46.0
	Heating	Ambient	Min.~Max.	°CWB	-15.0~15.5		-15.0~15.5
Refrigerant	Type				R-410A		R-410A
Piping connections	Liquid	OD		mm	9.52		9.52
	Gas	OD		mm	15.9		15.9
	Drain	OD		mm	26		26
	Additional refrigerant charge			kg/m	See installation manual 4PW72942-1	See installation manual 4P302555-1	See installation manual 4P302555-1
	Level difference	IU~OU	Max.	m	15	30.0	30.0
		IU~IU	Max.	m	0.5		0.5
Power supply	Phase / Frequency / Voltage			Hz / V	1~ / 50 / 220~240		3N~ / 50 / 380~415

(1) PED assembly = category I, excluded from scope of PED due to article 1, item 3.6 of 97/23/EC. (2) See separate drawing for electrical data (3) Equipment complying with EN/IEC 61000-3-12: European/international technical standard setting the limits for harmonic currents produced by equipment connected to public low-voltage system with input current > 16A and ≤ 75A per phase (4) Short-circuit power (5) See separate drawings for electrical data (6) European/international technical standard setting the limits for harmonic currents produced by equipment connected to public low-voltage system with input current larger than 16A and ≤ 75A per phase. (7) Refered to 3D076918

Indoor unit
FAQ-C

Wired remote control
BRC1E52A/B

Outdoor unit
RZQG-L7V1/LY1