Report No:
Donmar Warehouse Discharge of Planning Conditions 4 and 6 18012021

Date:
18th January 2021

For:
Haworth Tompkins Architects

Report Title:

DONMAR WAREHOUSE
41 Earlham Street, London WC2H 9LX

DISCHARGE OF PLANNING CONDITIONS 4 AND 6

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REVISION SCHEDULE

Document Revision	Date	Document Title	Details	Prepared by	Approved by
00	18/12/2020	Donmar Warehouse Discharge of Planning Conditions 4 and 6	DRAFT FOR COMMENT	Lucie Zalberg 	Tim Scott 
01	15/01/2021	Donmar Warehouse Discharge of Planning Conditions 4 and 6	DRAFT	Lucie Zalberg 	Tim Scott 
02	18/01/2021	Donmar Warehouse Discharge of Planning Conditions 4 and 6	ISSUED	Lucie Zalberg 	Tim Scott 

TABLE OF CONTENTS

1.0 EXCECUTIVE SUMMARY

New mechanical ventilation plant is proposed to be located on the roof of Donmar Warehouse located 41 Earlham Street, London WC2H 9LX adjacent to Seven Dials, within the London Borough of Camden. A noise survey was carried out by Gillieron Scott Acoustic Design (GSAD) from Friday 8th July to Monday 11th July 2016 and a planning report dated 01/02/2017 was submitted 'Donmar Warehouse Noise Impact Assessment 01022017'.

Based on survey results, noise limits have been derived for noise emissions from the proposed new plant in line with London Borough of Camden policy and as described in the initial planning report. An assessment of noise emissions from the new plant concluded that the limits can be achieved with conventional mitigation measures, including sound attenuators to the air intake and exhaust, acoustic louvres, duct/bend lining and acoustic absorption to required areas.

Based upon this assessment, it is predicted that the cumulative noise from all plant will satisfy Planning Conditions 4 and 6.

2.0 INTRODUCTION

This supplementary acoustic report is to discharge Planning Conditions 4 and 6 in order to comply with the London Borough of Camden council noise requirements.

Gillieron Scott Acoustic Design (GSAD) have been commissioned as acoustic consultants on Donmar Warehouse project. Donmar Warehouse is a small not-for-profit theatre, undergoing refurbishment works which include the replacement of old externally mounted services equipment and the introduction of new units. It should be noted that the hours of operation for new items of plant replacing existing items of plant servicing Donmar Warehouse will remain unchanged as 0700-2300 hours (daytime only) in line with Planning Condition 5.

The findings of the noise impact assessment are presented in the following sections of this report together with the supporting Figures and Appendices.

3.0 NOISE ASSESSMENT CRITERIA – PLANNING CONDITIONS 4 AND 6

Planning conditions are shown in London Borough of Camden's letter dated 17th October 2017, Application Ref. 2017/1556/P

''4. Noise levels at a point 1 metre external to sensitive facades shall be at least 10dB(A) less than the existing background measurement (L_{A90}), expressed in dB(A) when all plant/equipment (or any part of it) is in operation.

Reason: To safeguard the amenities of the adjoining premises and the area generally in accordance with the requirements of policies G1, CC1, D1,and A1 of the London Borough of Camden Local Plan 2017.''

''6. Prior to commencement of works to the rooftop plant area, full details of all plant equipment, with an accompanying noise report demonstrating how it will meet the requirements of condition 4, shall be submitted to and approved in writing by the local planning authority. The submission shall include details of all acoustic mitigation and anti-vibration measures.

Use of the plant equipment shall not commence until any acoustic and vibration mitigation measures as approved are installed. The plant equipment and mitigation measures shall thereafter be retained and maintained in accordance with the manufacturers' recommendations.

Reason: To safeguard the amenities of the adjoining premises and the area generally in accordance with the requirements of policy G1, A1, A4, D1 and CC1 of the London Borough of Camden Local Plan 2017.''

This report includes

- Baseline conditions
- Location of noise sensitive receptors
- Noise emission criteria

- Summary of plant locations and noise data
- Predicted noise levels at sensitive receptors and why these are acceptable against noise criteria

4.0 SITE LAYOUT, ENVIRONMENT AND CONTEXT

Donmar Warehouse is located in Earlham Street, adjacent to the Seven Dials in the London Borough of Camden. Buildings surrounding the theatre are largely commercial in nature, however, two residential properties have been identified, the nearest being at the rear façade of Neil Street dwellings, about 3 metres away from the edge of the plant room, which have view of the existing partially enclosed plant area on the roof of the building which serves the theatre. The second nearest residential receptor has been identified as being at the rear façade of residential dwellings on Short's Gardens, approximately 5-7 metres away from the plant room.

Numerous third party plant items are located in the immediate area. The most prominent third party item is a kitchen extract which belongs to the Flesh and Buns restaurant, vents to atmosphere at high level and is in continuous operation during their opening hours.

The acoustic environment at the residential receptors located near Donmar Warehouse include sources of noise such as road traffic and air traffic noise, sirens, building works near and far, noise from theatre performances and externally mounted services equipment, both third party and from the theatre.

Subjectively, when the theatre's services equipment is switched off, the dominant source of noise that defines the immediate acoustic environment at local residential dwellings is from the kitchen extract servicing the Flesh and Buns restaurant.

The theatre's plant area is enclosed from all four sides (the front being made of acoustic louvres, the sides made of cement board walls and the rear being Donmar's Building). The roof is made of open louvres with solid sheet backing behind except for one area which is proposed to have weather louvres only (no sheet backing) to allow sufficient air flow to service the units. All new items of plant will be located within the enclosed plant area except for AHU4 which will be located on the curved roof area.

Refer to Appendices A, B and C for location of noise sensitive receptors and Appendix H for mechanical layout.

5.0 SURVEY DETAILS AND RESULTS

5.1 Survey Details

A noise survey was carried out by Gillieron Scott Acoustic Design (GSAD) from 1300 Friday 8th July to 1445 Monday 11th July 2016 at a single fixed monitoring location that was positioned at roof height, approximately 1.5m from the nearest residential window and a planning report dated 01/02/2017 was submitted 'Donmar Warehouse Noise Impact Assessment 01022017'.

The measurement position was located between the theatre's rooftop plant area and the nearest noise sensitive residential dwelling at the rear façade of Neil Street residential dwellings. The microphone position is indicated in Appendices B and C.

It was noted while installing the environmental noise survey that numerous third party plant items were located in close proximity to the Donmar Warehouse and would operate intermittently.

Care was taken in selecting a microphone position that afforded the greatest amount of acoustic screening from third party plant items.

The sound level meters were synchronised to the correct time before deployment and set to integrate sound levels over 15-minute periods in synchronisation mode. The equipment was field calibrated before and after the survey period and no drift in calibration was noted.

Measured data has been used to specify limits from new mechanical services and specify insertion losses for all attenuators, acoustic screen and other mitigation measures for Donmar Warehouse's plant to achieve the Local Authority requirements.

5.2 Noise Indices

The following noise indices used in this assessment are as follows:

- $L_{Aeq,T}$: The A-weighted equivalent continuous sound pressure level over a period of time, T.
- $L_{A90,T}$: The A-weighted sound pressure level exceeded for 90% of the measurement period. Indicative of the background noise level.

The L_{A90} is considered most representative of the background noise level for the purposes of complying with any Local Authority requirements.

Sound pressure level measurements are normally taken with an A-weighting (denoted by a subscript 'A', e.g. L_{A90}) to approximate the frequency response of the human ear.

5.3 Site Survey Weather Conditions

During the unattended noise measurements, an automatic logging weather station was deployed as part of the assessment to ensure all data used in the determination of the representative background sound level occurred during conditions that are considered conducive to acoustic measurement. Weather data is presented in Appendix E.

These weather conditions are considered suitable for representative measurements.

6.0 SURVEY RESULTS AND NOISE LIMITS

A summary of the background noise levels from GSAD noise survey and the plant noise limits 1m from the nearest noise sensitive receptors with all plant operating simultaneously and rating level limits of 10dB below background noise as per planning condition 4 are shown in Table 1 below.

Table 1 – Summary of long-term noise monitoring results and plant noise limits

Measurement Position	Representative Background $L_{A90,15min}$ (dB) Day	Rating Level Limits L_{Aeq} (dB) Day
Position 1	50	40

This level has been used in the assessment of noise from plant items.

Full survey results to one decimal place are available on request. A graphical representation of the results is presented in Appendix D. Logged background sound levels have been plotted as histogram for day period to determine the representative L_{A90} values.

7.0 ITEMS OF PLANT, LOCATION AND ASSOCIATED NOISE LEVELS

Plant in Table 2 is proposed to be located on the roof within the plant enclosure except for AHU4 which is proposed to be located on the curved roof area.

Refer to Appendix G for mechanical drawings showing location of plant and acoustic enclosure and Appendix F for noise data.

Table 2 – Items of plant and noise data

Item	Fan Details	SWL Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Ductable Air Cooled Chiller Sound Power Level at Discharge (L_{wA}) 87.4 dBA Sound Power Level Radiated (L_{wA}) 87.4 dBA Sound Pressure Level Radiated at 10.0 m (L_{pA}) 55.6 dBA 30RBSY120 Located in the plant room Ducted at high level and discharging through weather louvres (ductwork/bend lined with 25mm acoustic foam) 3dB reduction has been taken into account in the calculations/model for the unit working at 50% load at 25 degrees C ambient	Reradiated +Inlet L_p at 10m (dB)	-	56	56	53	51	48	41	-
	Reradiated +Inlet L_w (dB)	-	88	87	85	82	80	73	-
	Outlet ducted L_w (dB)	-	91	90	85	82	78	70	-
AHU 01 External AUDITORIUM FLAKWOODS EQ PRIME 32 2700l/s 200Pa Located in the plant room, attenuators to inlet/outlet	Inlet L_w (dB)	64	70	67	62	57	54	51	48
	Outlet L_w (dB)	77	85	79	81	78	74	70	70
	To surroundings L_w (dB)	67	66	59	47	44	42	40	30
AHU 02 External BOH NUAIRE-XBOX XBC65HA-ELN-C-LS1W 503l/s 297Pa Located in the plant room, attenuators to inlet/outlet	Inlet L_w (dB)	78	78	71	65	63	58	47	33
	Outlet L_w (dB)	84	84	78	74	71	68	60	54
	To surroundings L_w (dB)	70	68	55	50	44	40	34	19
AHU 03* FOH Located in the plant room, attenuators to inlet/outlet	Inlet L_w (dB)	70	62	62	51	51	49	41	32
	Outlet L_w (dB)	75	68	72	58	59	59	53	49
AHU 04 External FOYER NUAIRE XBC55HA-ELN-C-LS1W 344l/s 315Pa Located on curved flat roof, attenuators to inlet/outlet	Inlet L_w (dB)	79	73	73	61	62	59	51	39
	Outlet L_w (dB)	84	80	82	69	70	69	64	61
	To surroundings L_w (dB)	70	64	59	45	43	41	38	26

Condenser unit MITSUBISHI PURY-P400YNW-A Located in the plant room, to operate at low noise mode during noise sensitive hours	Sound pressure 65/69dB(A) at 1m Lp Measured in anechoic room – cooling/heating mode	73.5	63.5	66	64	59	54.5	48.5	45
	Sound pressure 52(A) at 1m Lp Measured in anechoic room – low noise mode	60	58.5	55	48	43.5	43.5	39	34.5

* AHU03 will be installed at a later stage.

Other items consist of boilers, pumps and smaller mechanical units and are deemed not to contribute to the overall noise level at the noise sensitive receptors.

Refer to Appendix F for noise data from mechanical services and Appendix H for mechanical drawings.

8.0 PLANT NOISE IMPACT ASSESSMENT

8.1 Plant Noise Impact Assessment and Mitigation Measures

Noise from mechanical ventilation with all plant operating shall be designed to satisfy the relevant statutory criteria at 1m from the façade of any noise sensitive properties in accordance with Camden Council's requirements of 10dBA below background noise and BS4142 'Rating Industrial Noise Affecting Mixed Residential and Industrial Areas'.

BS4142: 2014 provides methods for rating and assessing industrial and commercial sound. The standard is used to rate sound from fixed installations. The standard requires a "Specific Sound Level", in terms of L_{Aeq}, is determined either by measurement or calculation at a receptor location. This Specific Sound Level may then be corrected for the character of sound and is then termed the "Rating Level".

Once the Rating Level has been determined, the background sound level is subtracted from it and the greater the difference, the greater the likelihood of an 'adverse impact'. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact. The standard advocates that each site and situation should take the context of the scenario into consideration and that "not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact".

The standard provides reference periods over which the assessment should take place which have been reproduced in the table below.

Table 3 – Reference Periods

Period	Hours	Assessment Period
Typical Daytime	0700 – 2300	1 hour assessment period
Typical Night-time	2300 – 0700	15 minute assessment period

A computer model using CADNA-A noise mapping software has been created to predict the noise impact of the proposed new items of plant at the nearest residential windows.

The existing and nearby buildings were entered in the model based on architectural plans and aerial photos.

The main items of plant are to be located within plant room on the roof, except for AHU04 located on the flat curved roof.

8.2 Mitigation Measures

The plant room will be made of acoustic louvres 270mm thick at the front e.g. Gilbert 27, cement board walls to the sides, Donmar Building to the rear. The roof will be made of 3mm sheet panel with weather louvres e.g. Gilberts WGC 38 with an open area made of weather louvres only (no solid backing).

Plant inlets/outlets will be ducted and lagged with 10kg/m2 acoustic lagging where required and attenuated using attenuators.

3dB reduction has been accounted for the chiller running at 50% load. The chiller outlet is ducted and discharging at high level through the weather louvres. The outlet duct and rectangular bend will be lined with 25mm acoustic foam. There is no line of sight from the chiller outlet to any residents.

The condenser unit will be operating in low noise mode during noise sensitive hours.

The back of the open area and the underside of the plant room soffit will be lined with 50mm thick sound absorbing treatment.

Refer to Appendix G for acoustic enclosure details and acoustic louvres.

8.3 Vibration Isolation

All plant in the building will be mounted on vibration isolated mounts selected to reduce structure borne noise transmission to Donmar Warehouse Theatre.

8.4 Table of Results

In order to comply with planning condition 4, a rating level limit of 10dB below background noise, ≤40dB L_{Aeq}, should be achieved.

The nearest noise sensitive receptors have been identified to be at the rear façade of Neil Street dwellings, about 3 metres away from the edge of the plant room and at the rear façade of residential dwellings on Short's Gardens, approximately 5-7 metres from the plant room.

The computer noise mapping model results shown in Appendix I, with noise levels from plant as shown in Table 2 and mitigation measures as shown in Section 8.2, demonstrates that noise levels of proposed new items of plant at the nearest noise sensitive receptors are predicting to meet the planning requirements. A summary of results is shown in Table 4 below.

Table 4 – Summary of results at noise sensitive receivers

Position	Predicted noise level at noise sensitive receptor Day L_{Aeq} (dB)	Rating Level Limits Day L_{Aeq} (dB)
Residential building 1 – rear façade of Neil Street (approximately 3m away)	37	40
Residential building 2 – rear façade of Short's Gardens (approximately 5-7m away)	40	40

9.0 STATEMENT OF COMPETENCE

The assessment has been undertaken by the author of this report: Lucie Zalberg, BSc(Physics) MSc(Architectural Acoustics) MIOA. The author is Associate Director of Gillieron Scott Acoustic Design with 12+ years' experience since completing a degree at Pierre et Marie University in Paris and Bath University. The author has undertaken numerous noise assessments according to the 1997 revision of the British Standard and the most recent 2014 revision of the standard.

The assessment has been checked by: Tim Scott BSc (Hons.), MIOA a Director of Gillieron Scott Acoustic Design with 18+ years' experience since completing a degree in Audio Technology at the University of Salford in the late 1990's who has undertaken numerous assessments according to the 1997 revision of the British Standard and the most recent 2014 revision of the Standard.

10.0 CONCLUSION

Donmar Warehouse is undergoing refurbishment works which include the replacement of old externally mounted services equipment and the introduction of new units.

A representative background sound level of 50 dB $L_{A90,15min}$ has been determined over the proposed operational hours of the plant items, 0700-2300.

Noise levels from the proposed items of plant located on the roof of Donmar Warehouse have been assessed for their impact to the surrounding noise sensitive buildings.

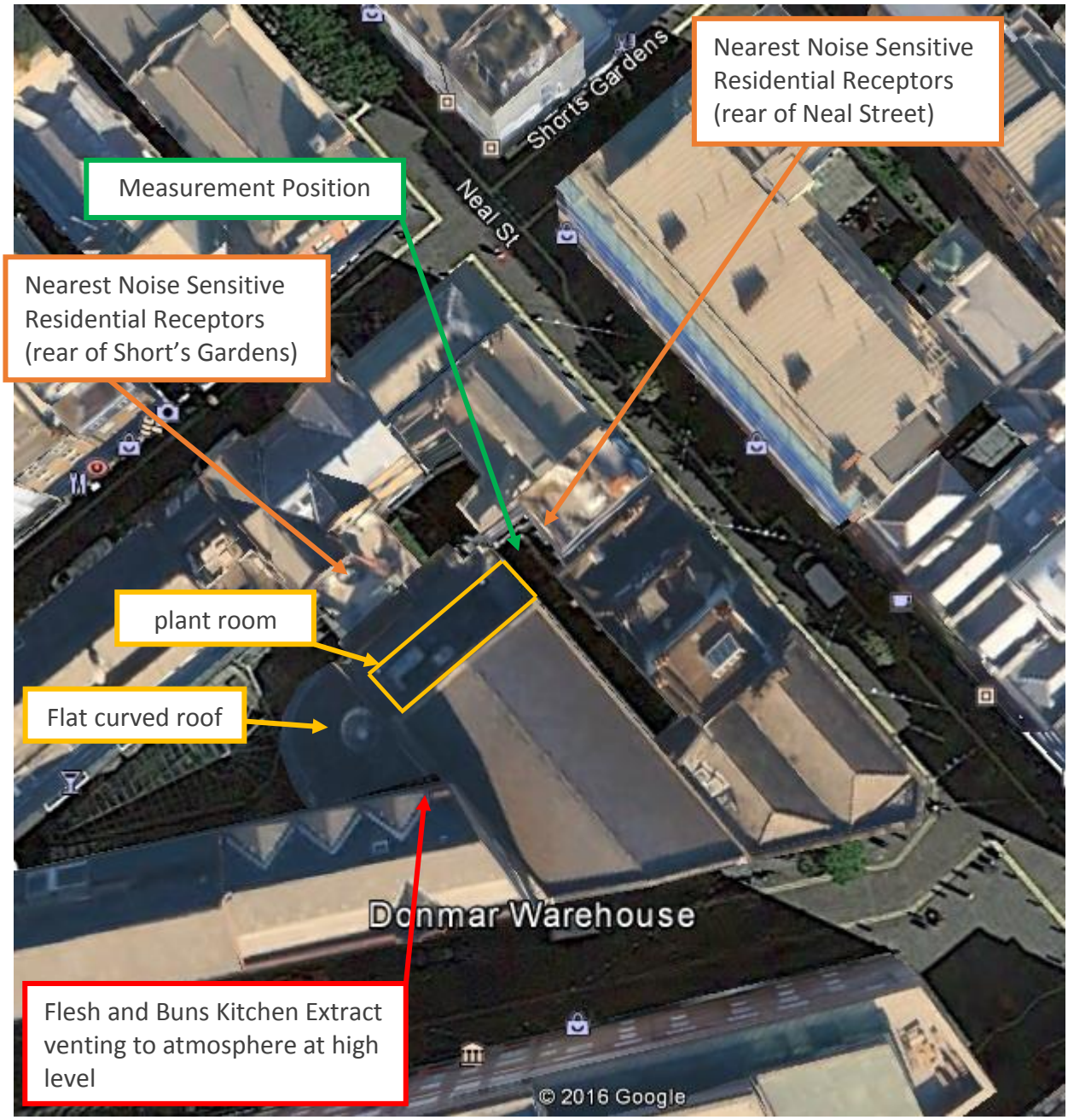
Units will be located within a plant room on the roof of Donmar Warehouse except for AHU4 which will be located on the flat curved roof. Mitigation measures have been specified to reduce noise from plant to required levels.

On the basis of the measurements and details provided in this report, it is predicted that the cumulative noise from all plant will satisfy Planning Conditions 4 and 6.

APPENDICES

APPENDIX A: Site Demise

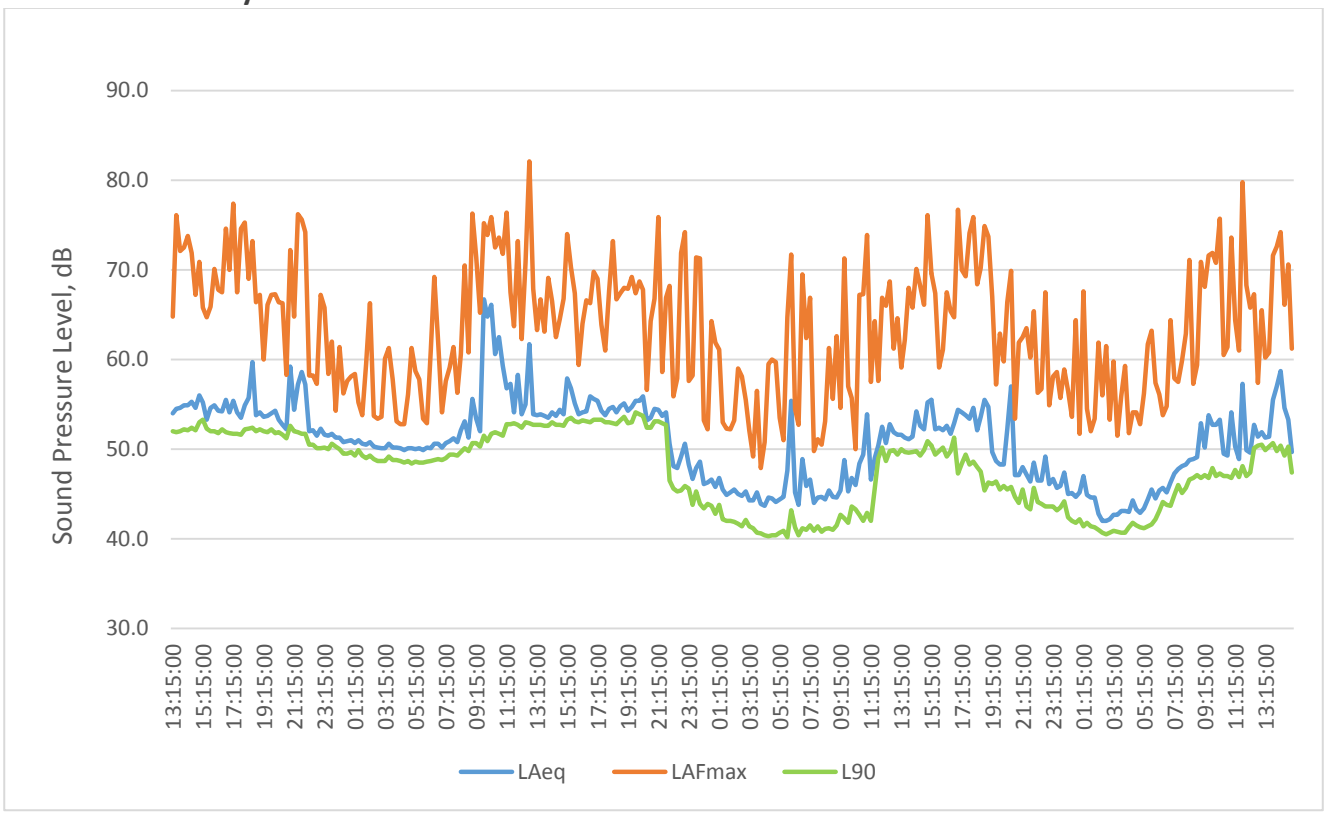
APPENDIX B: Measurement Position, Receptor Location & Rooftop Plant Area



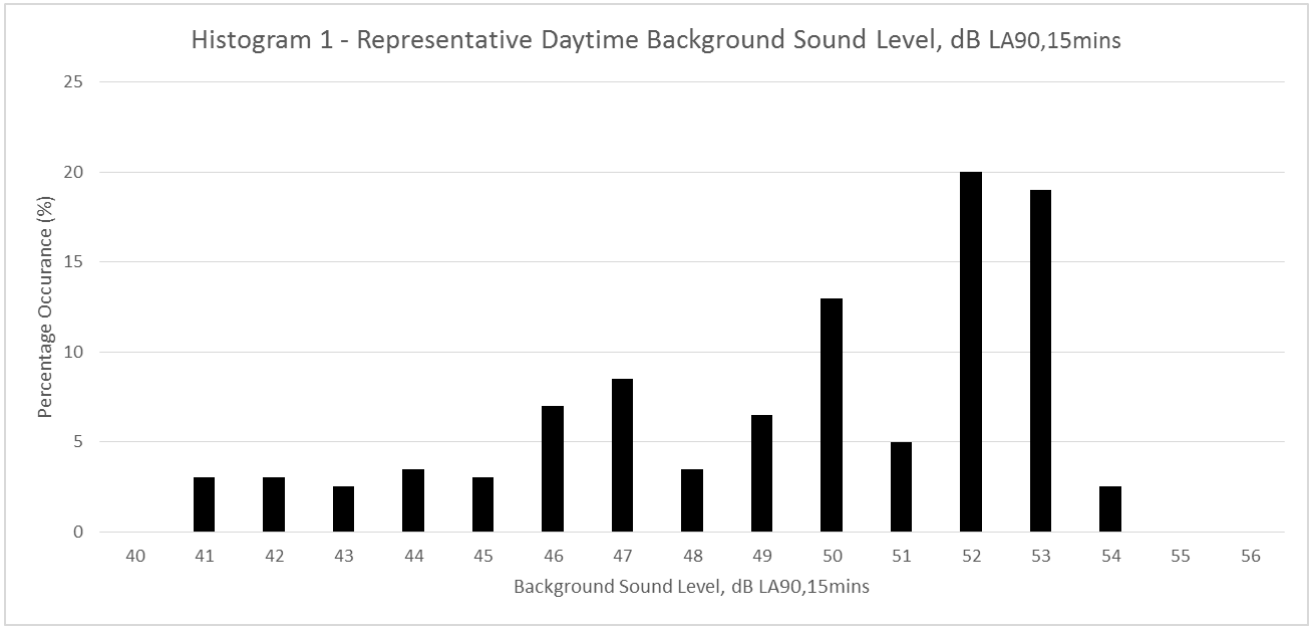
APPENDIX C: Measurement Position Photograph

APPENDIX D: Survey Results

Noise Time History – Donmar Warehouse

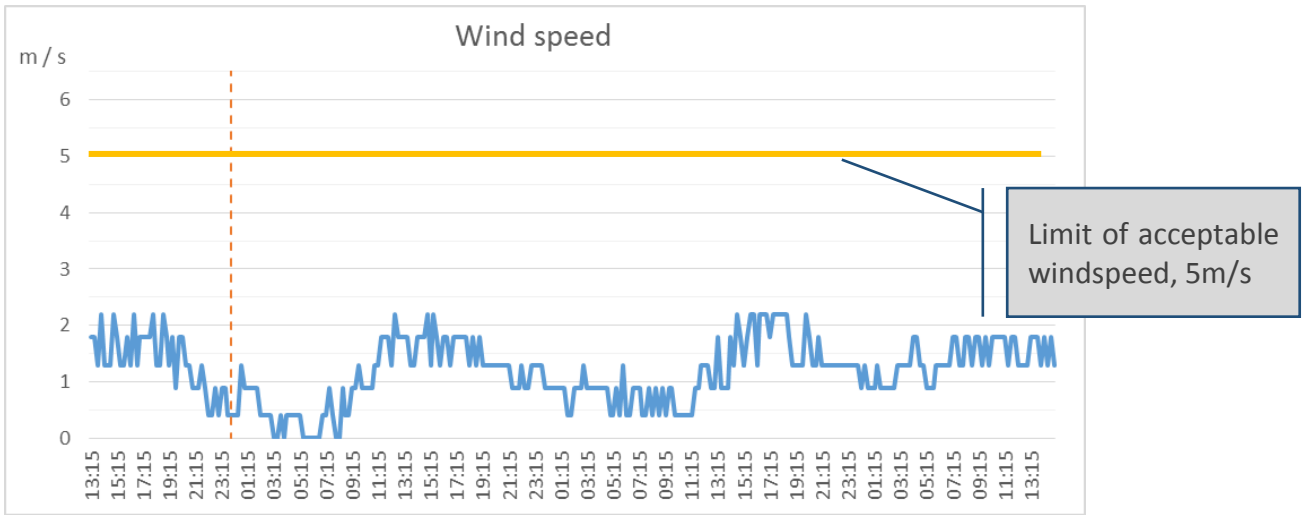


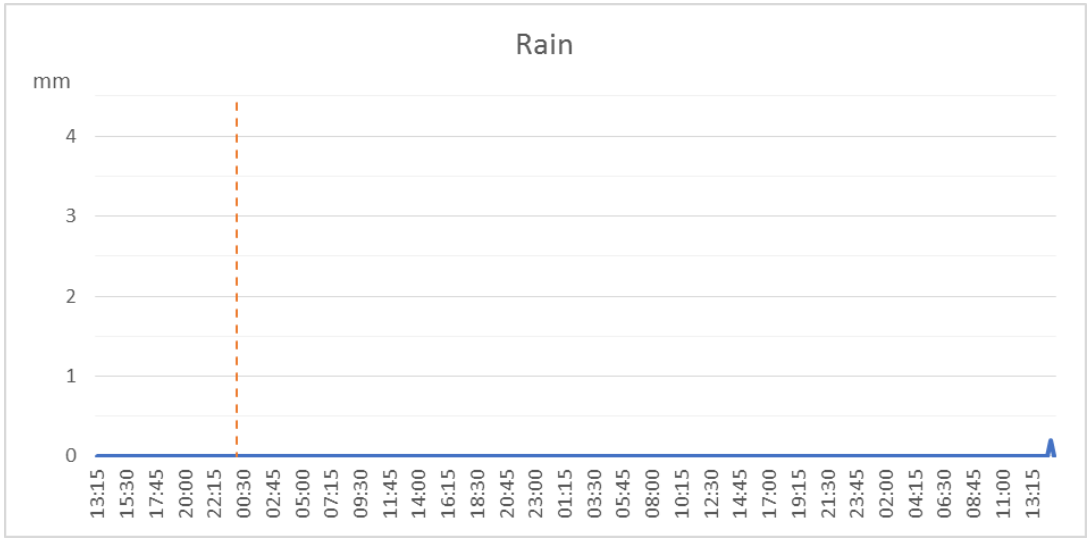
Logged background sound levels over proposed operational hours, 0700-2300, have been plotted in the histogram below to determine the representative daytime L_{A90}.



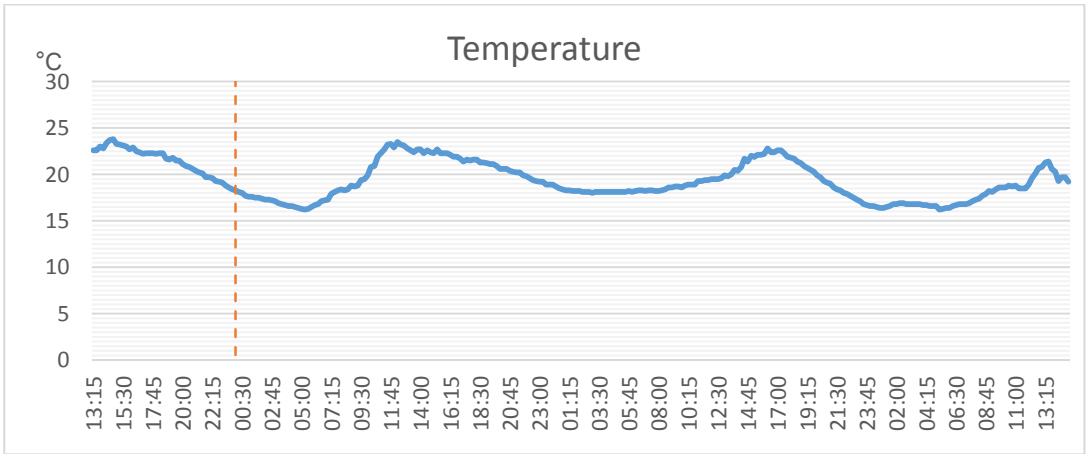
From the above histogram, a representative daytime background sound level of 50 dB $L_{A90,15min}$ has been determined. This background sound level will be used in the assessment of noise from plant items in the following section.

APPENDIX E: Weather Data





No rainfall logged during the measurement time interval



APPENDIX F: Noise Data for Proposed Plant

CHILLER

30RBSY 120B

Ducted air-cooled liquid chiller with scroll compressor

Performance Information		
Mode		**Cooling**
Cooling Capacity (1)	kW	114
Cooling Efficiency (EER) (1)	kW/kW	2.69
Unit Power Input (1)	kW	42.5
Sound Power Level at Discharge (LwA) (1)	dBA	87.4
Sound Power Level Radiated (LwA) (1)	dBA	87.4
Sound Pressure Level Radiated at 10.0 m (LwA) (1)	dBA	55.6

(1) All performances are compliant with EN14511 - 3 : 2018. Sound power level according to ISO9614 - 1.

Non contractual picture

Operating Conditions			
System element			**Cooling**
Evaporator			
Fluid	Fluid Type		Fresh Water
	Fouling Factor (4)	(sqm-K)/kW	0.0176
	Leaving Temperature	°C	7.0
	Entering Temperature	°C	13.0
	Fluid Flow	l/s	4.55
Hydronic Module	External Static Pressure	kPa	164
	Pump Power Input	kW	2.17
Condenser			
Air	Entering Air Temperature	°C	35.0
Altitude		m	0
Air Flow Data	External Static Pressure at 20°C	Pa	160
	Total Air Coil Flow at 20°C	l/s	8222

(4) The impact of fouling factor is calculated as per AHRI 550/590-551/591 method

Seasonal Efficiency (3)		
Allowed applications for CE mark:		
Comfort Cooling : T≥ 2°C*	SEER 12/7°C | η_s cool	**4.29 | 169**
Comfort Cooling : T≥ 13°C*	SEER 23/18°C | η_s cool	**5.40 | 213**
High Temp. Process Cooling : T≥ 2°C*	SEPR 12/7°C	**5.90**

* ECODESIGN Compliant per (EU) N°2016/2281

(3) All data related to seasonal efficiency are given for standard units and main options (Brine, pump, energy efficiency,...).

Unit Configuration	
116W	HP VSD dual-pump hydraulic mod.
149	Bacnet over IP
15LS	Very low noise level
25	Compressor Soft Starter
293	Expansion tank
307	Water buffer tank module
311	Set point adjustment by 4-20mA signal
42B	Exchanger & hydraulic frost protection
70	Main disconnect switch without fuse

Unit Information		
Manufacturing Source		Montluel
Refrigerant Type		R410A
Refrigerant Weight	kg	11
Tonnes CO2 Equivalent	Tonnes	24
Number of Refrigerant Circuit		1
Number Of Compressor		3
Number Of Fan		2
Operating / Shipping Weight	kg	1356/1037
Unit Dimensions (LxWxH)	mm	2273x2122x1971

Electric Information		
Unit Voltage	V-Ph-Hz	400-3-50
Standby Power	kW	0.198
Power Factor		0.840
		Circuit 1
Maximum Current	A	119
Start Up Current	A	187
Current at Eurovent Conditions	A	88

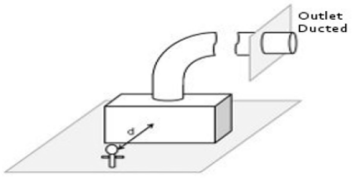
Documentation	
	PSD
	IOM
	Technical Drawing
	Revit File

Outlet Air duct systems				
Air Duct Conditions		**Cooling Mode**		
Air duct pressure drop (Pa)	**Fan velocity (rpm)**	**Gross Power Input Variation**	**Cooling cap variation**	**EER variation**
0 (Unducted)	720.0	0.995	1.000	1.005
50	800.0	0.997	1.000	1.003
100	880.0	0.998	1.000	1.002
130	928.0	0.999	1.000	1.001
160	976.0	1.000	1.000	1.000
200	1039.0	1.012	0.998	0.986
240	1102.0	1.023	0.996	0.973

Acoustic Information										
Octave Band Center Frequency		**Hz**	**125**	**250**	**500**	**1K**	**2K**	**4K**	**8K**	**Total**
Outlet Ducted	Sound Power at Chiller Acoustic Center	dB	91	90	85	82	78	70	-	87
	A-Weighted Sound Power	dBA	75	81	81	82	79	71	-	87
Radiated +Inlet	Sound Power at Chiller Acoustic Center	dB	88	87	85	82	80	73	-	87
	A-Weighted Sound Power	dBA	72	79	82	82	81	74	-	87
	Sound pressure at specified distance in a free field	dB	56	56	53	51	48	41	-	56
	A-Weighted Sound Pressure Level	dBA	40	47	50	51	49	42	-	56

Acoustic Notes

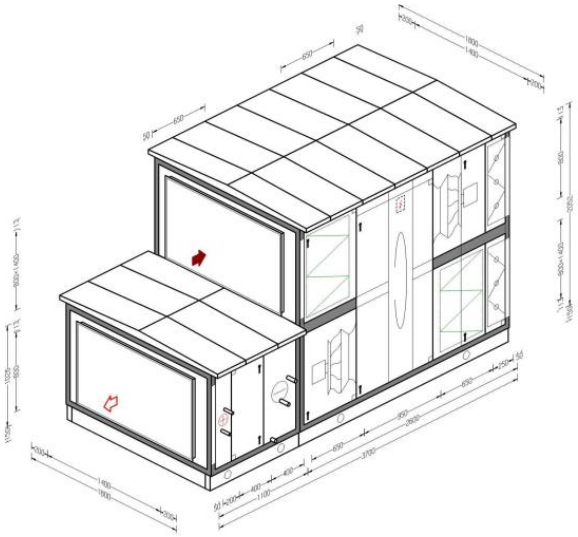
d - Horizontal Distance From Chiller to Receiver = 10.0 m
Estimated Sound Power levels - dB re: 1 picowatt
Estimated Sound Pressure levels - dB re: 20 micropascal
Estimated sound levels given above are assumed to originate at the acoustic center of the chiller.



Sound Power level Lw in accordance with ISO 9614-1. Only the Total Sound Power level Lw is certified by Eurovent, at Full Load in cooling mode, with all fans and pumps running at nominal speed, and for inlet air temperature at the condenser between 30°C and 35°C. The sound levels by octave band are guideline values only and not contractually binding.

Estimated average sound pressure Lp at a given distance on a reflective surface in a free field environment.

AHU01



Customer id	2459	**Project name**		Donmar Theatre	
Project	25223	**Unit name**		(DE) / AHU 01 External	
Unit	2	**Supply air**	eQ Prime-032	2.70 m³/sec	
AOC	ACON-02694880	**Exhaust air**	eQ Prime-032	2.70 m³/sec	

Supply air volume flow rate	2.70 m³/sec	Exhaust air volume flow rate	2.70 m³/sec
External static pressure	200 Pa	External static pressure	200 Pa
Mains electricity	3x400VAC±10%+N+PE, 50Hz	Weight	1300 kg
Specific el. power demand (SFPv)	1.47 kW/(m³/s)	Dimensioned for wet condition	
Ref. density	1.2 kg/m³	Ref. altitude above sea level	0 m

SUMMARY

Functional sections in direction of air flow	v0 (m/s)	Et (%)	tw (°C)	ts (°C)	dP* (Pa)
Supply air:					
Connection section	0.0				4
Filter	2.4				111
Heat exchanger	2.7	81.9	-4 / 17.3	32 / 25.6	167
Plenum fan		69.3	17.3 / 18	25.6 / 26.3	612
Air cooler	2.2			32 / 17	113
Inspection section					0
Air heater	2.1		18 / 21		17
Connection section	0.0				0
Supply outlet					200
Exhaust air:					
Exhust inlet					200
Connection section	0.0				0
Filter	2.2				102
Heat exchanger	2.7		22 / 1.9	24 / 30.4	166
Plenum fan		67.4			472
Connection section	0.0				4

*Refers to the fan design case
Fan system effect is taken into account in fan performance

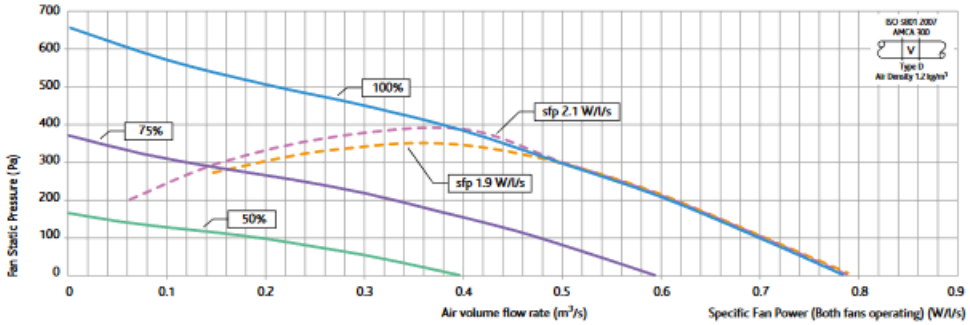
SOUND POWER LEVELS

(standard: EN13053 ISO/CD 13347-2)

	Lw per octave band (dB)								LwA
Octave band (Hz)	63	125	250	500	1k	2k	4k	8k	dB(A)
Fresh air connection	64	70	67	62	57	54	51	48	64
Supply air connection	69	82	75	77	74	67	60	57	78
Extract connection	72	73	68	62	56	54	52	52	65
Exhaust connection	77	85	79	81	78	74	70	70	83
To surroundings	67	66	59	47	44	42	40	30	55

AHU02

XBC65 HORIZONTAL HEAT EXCHANGE UNITS
PERFORMANCE & TECHNICAL INFORMATION



XBC65 UNIT PERFORMANCE - EXAMPLE 0.55m³/s @ 150Pa = SFP 1.2, 32dBA @ 3m

Fan Speed		External Static Pressure (Pa) 0	50	100	200	300	400	500	600	700
100%	Airflow (m³/s)	0.78	0.75	0.71	0.62	0.50	0.37	0.22	0.08	
	sfp (W/l/s)	1.20	1.28	1.34	1.52	1.78	2.20	3.40	3.95	
	dBA@3m	35								
75%	Airflow (m³/s)	0.59	0.54	0.48	0.32	0.13				
	sfp (W/l/s)	0.68	0.75	0.83	1.10	2.50				
	dBA@3m	29								

Fan Speed		External Static Pressure (Pa) 0	50	100	200	300	400	500	600	700
50%	Airflow (m³/s)	0.39	0.31	0.18						
	sfp (W/l/s)	0.30	0.38	0.55						
	dBA@3m	20								
25%	Airflow (m³/s)	0.20								
	sfp (W/l/s)	0.10								
	dBA@3m	< 20								

Specific Fan Power figures are the total for both fans operating.

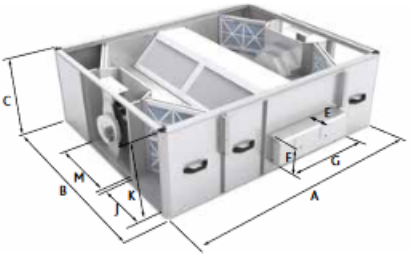
For accurate figures, please refer to Nuaire Fan Selection Programme at www.nuaire.co.uk

Unit Code	Voltage / Phase / Frequency	Input Power (W)	FLC / SC (A)	Max Operating Temperature	Fan Speed (rpm)	Unit Weight (kg)	Packed Weight (kg)	Pallet / crate dimensions (mm)
XBC65-H-L**	230 / 1 / 50	1540	8 / 8	40°C	1700	469	619	2150L x 1800W x 800H
XBC65-H-E**	230 / 1 / 50	10540*	47 / 47	40°C	1700	476	626	2150L x 1800W x 800H
XBC65-H-N**	230 / 1 / 50	1540	8 / 8	40°C	1700	465	615	2150L x 1800W x 800H

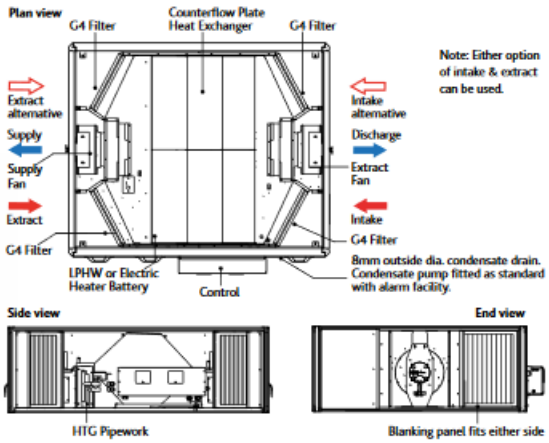
**Add relevant code ie: BC, ES, CO or AT for control type. *Includes 9kW Electric Heater.

FAN UNIT DIMENSIONS (mm)

Note: All models (BC, ES, CO or AT) have a fold down (90°) pivoting control box for easy commissioning.



XBC65 FAN CONFIGURATION



Fan Unit Dimensions (mm) A	B	C	Control for all Models Dimensions (mm) E	F	G	Rectangular Aperture Dimensions (mm) J	K	M	Weather Roof for Code XBC10-H-WP H x W x L
1900	1560	620	120	200	670	398	580	588	95 x 1560 x 2200

Service & Maintenance Requirements

The unit is designed for side access as standard and must be installed with a minimum of 260mm clearance from a wall or barrier. This will provide access to filters, coil, fan, heat exchanger, condensate tray and pump.

2 attenuator flanges are attached to every unit. Add 50mm to dimension 'A' to include both flanges.
Weather roof is separate code and can be retro fitted on site.

XBC65 FAN - SOUND DATA

Fan Speed	Sound Power Levels (dB re 1 pW)	Frequency (Hz) 63	125	250	500	1000	2000	4000	8000	Spherical dBA@3m	Fan Speed	External Static Pressure (Pa) 63	125	250	500	1000	2000	4000	8000	Spherical dBA@3m
100%	Induct Intake	79	79	72	66	64	59	48	34	35	50%	64	64	57	51	49	44	33	< 20	20
	Induct Supply	83	85	79	74	72	68	61	54			68	70	64	59	57	53	46	39	
	Induct Discharge	85	85	79	75	72	69	61	55			70	70	64	60	57	54	46	40	
	Induct Extract	81	79	70	67	64	60	48	35			66	64	55	52	49	45	33	20	
	Casing Radiated	71	69	56	51	45	41	35	20			56	54	41	36	30	26	20	< 20	
75%	Induct Intake	73	73	66	60	58	53	42	28	29	25%	49	49	42	36	34	29	< 20	< 20	<20
	Induct Supply	77	79	73	68	66	62	55	48			53	55	49	44	42	38	31	24	
	Induct Discharge	79	79	73	69	66	63	55	49			55	55	49	45	42	39	31	25	
	Induct Extract	75	73	64	61	58	54	42	29			51	49	40	37	34	30	18	5	
	Casing Radiated	65	63	50	45	39	35	29	< 20			41	39	26	21	< 20	< 20	< 20	< 20	

*Casing Radiated (Breakout).

ATTENUATOR DIMENSIONS (mm), DYNAMIC INSERTION LOSS (dB) & WEIGHTS (kg)

Attenuator Code	Attenuator Dimensions Length	Width	Height	Air path	Dynamic Insertion Loss (dB) 63	125	250	500	1000	2000	4000	8000	Attenuator Weight (kg)	Packed Weight (kg)
XBC65-HS-MS10	1050	592	578	S / D	4	11	14	23	23	22	14	9	63	68
XBC65-HE-MS10	1050	402	578	I / E	3	8	12	15	10	6	3	2	55	58
XBC65-HS-MS12	1250	592	578	S / D	6	13	18	30	31	28	17	11	77	82
XBC65-HE-MS12	1250	402	578	I / E	5	10	16	22	18	12	6	4	67	70
XBC65-HS-MS16	1600	592	578	S / D	8	15	22	37	37	34	20	13	96	101
XBC65-HE-MS16	1600	402	578	I / E	7	12	20	29	24	18	9	6	84	87

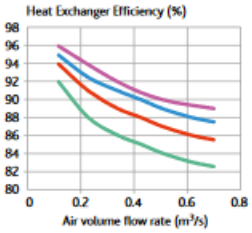
S / D = Supply / Discharge I / E = Intake / Extract. Coding: The S / D denotes the type of silencer required for the supply or discharge. The I / E denotes the type of silencer required for the extract or fresh air intake on the unit. All XBC matched silencers are double skinned.

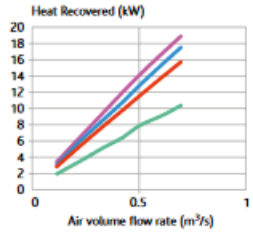
COUNTERFLOW HEAT EXCHANGER EFFICIENCY (%)

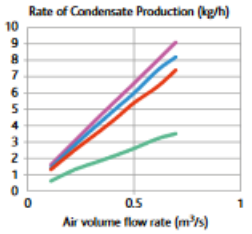
Performance based on:
Indoor Conditions 21 Deg C / 50 % RH

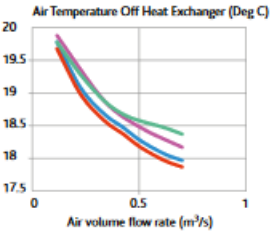
Key to performance curves

Intake Temperature (Deg C)
- -5 Deg C Intake Typically Specified Values
- -3 Deg C Intake Typically Specified Values
- -1 Deg C Intake Typically Specified Values
- 6 Deg C Approx. Average outdoor temperature (UK heating season)









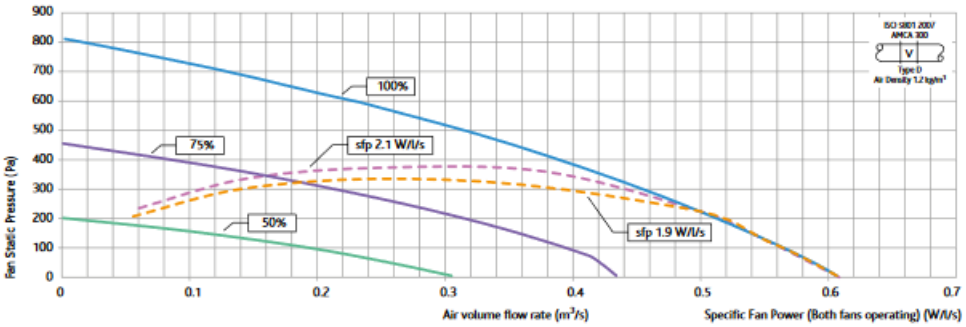
HEATING COIL DATA LPHW

LPHW Deg C	Airflow (m³/s)	Output (kW)	Air Off Temp (C*)	Water flow (l/s)	Coil ΔP (kPa)	Pipe Connection (mm)	Valve ΔP (kPa)	Valve Type
LPHW 82/71	0.6	14.4	30	0.32	15.0	22	15	4 Port
	0.45	13.5	35	0.30	13.3	22	13.3	
	0.3	10.7	40	0.24	8.2	22	8.2	
LPHW 80/60	0.6	11.6	26	0.15	3.0	22	3	4 Port
	0.45	10.4	29	0.13	2.7	22	2.7	
	0.3	8.2	33	0.10	1.6	22	1.6	
LPHW 60/40	0.6	6.7	19	0.08	1.0	22	1	4 Port
	0.45	6.2	21	0.07	0.8	22	0.8	
	0.3	4.8	23	0.06	0.5	22	0.5	

*Nb Limited to 30 Deg C for Ecosmart Units. Data based on 10 Deg C Air On temperature.

AHU04

XBC55 HORIZONTAL HEAT EXCHANGE UNITS
PERFORMANCE & TECHNICAL INFORMATION



XBC55 UNIT PERFORMANCE - EXAMPLE 0.38m³/s @ 150Pa = SFP 1.2, 29dBA @ 3m

Fan Speed		External Static Pressure (Pa) 0	50	100	200	300	400	500	600	700
100%	Airflow (m³/s)	0.61	0.59	0.57	0.51	0.46	0.39	0.31	0.23	0.13
	sfp (W/l/s)	1.60	1.64	1.69	1.82	2.03	2.38	2.91	3.67	4.71
	dBA@3m	35								
75%	Airflow (m³/s)	0.46	0.43	0.39	0.32	0.21	0.09			
	sfp (W/l/s)	0.90	0.95 1	.00	1.24	1.76	2.72			
	dBA@3m	28								

Fan Speed		External Static Pressure (Pa) 0	50	100	200	300	400	500	600	700
50%	Airflow (m³/s)	0.31	0.26	0.20	0.01					
	sfp (W/l/s)	0.40	0.45	0.59	1.52					
	dBA@3m	20								
25%	Airflow (m³/s)	0.15	0.00							
	sfp (W/l/s)	0.10	0.38							
	dBA@3m	< 20								

Specific Fan Power figures are the total for both fans operating.

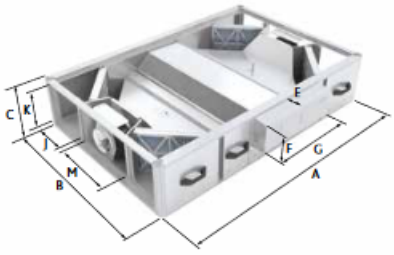
For accurate figures, please refer to Nuaire Fan Selection Programme at www.nuaire.co.uk

Unit Code	Voltage / Phase / Frequency	Input Power (W)	FLC / SC (A)	Max Operating Temperature	Fan Speed (rpm)	Unit Weight (kg)	Packed Weight (kg)	Pallet / crate dimensions (mm)
XBC55-H-L**	230 /1 / 50	1100	6.9 / 6.9	40°C	2400	368	468	2150L x 1500W x 650H
XBC55-H-E**	230 /1 / 50	10100*	46 / 46	40°C	2400	375	475	2150L x 1500W x 650H
XBC55-H-N**	230 /1 / 50	1100	6.9 / 6.9	40°C	2400	364	464	2150L x 1500W x 650H

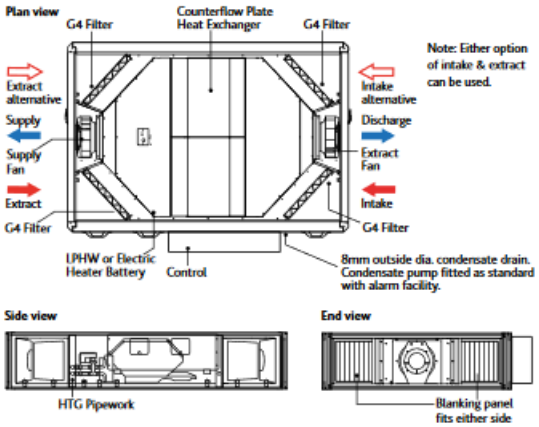
**Add relevant code ie: BC, ES, CO or AT for control type. *Includes 9kW Electric Heater.

FAN UNIT DIMENSIONS (mm)

Note: All models (BC, ES, CO or AT) have a fold down (90°) pivoting control box for easy commissioning.



XBC55 FAN CONFIGURATION



Fan Unit Dimensions (mm) A	B	C	Control for all Models Dimensions (mm) E	F	G	Rectangular Aperture Dimensions (mm) J	K	M	Weather Roof for Code XBC10-H-WP H x W x L
1900	1560	470	120	200	670	398	430	588	95 x 1560 x 2200

Service & Maintenance Requirements

The unit is designed for side access as standard and must be installed with a minimum of 760mm clearance from a wall or barrier. This will provide access to filters, coil, fan, heat exchanger, condensate tray and pump.

2 attenuator flanges are attached to every unit. Add 50mm to dimension 'A' to include both flanges.
Weather roof is separate code and can be retro fitted on site.

XBC55 HORIZONTAL HEAT EXCHANGE UNITS
PERFORMANCE & TECHNICAL INFORMATION

XBC55 FAN - SOUND DATA

Fan Speed	Sound Power Levels (dB re 1 pW)	Frequency (Hz) 63	125	250	500	1000	2000	4000	8000	Spherical dBA@3m	Fan Speed	External Static Pressure (Pa) 63	125	250	500	1000	2000	4000	8000	Spherical dBA@3m
100%	Induct Intake	81	74	75	63	64	61	53	41	35	50%	66	59	60	48	49	46	38	26	20
	Induct Supply	85	80	84	71	72	70	66	61			70	65	69	56	57	55	51	46	
	Induct Discharge	86	81	84	71	72	71	66	63			71	66	69	56	57	56	51	48	
	Induct Extract	82	75	75	63	64	62	53	43			67	60	60	48	49	47	38	28	
	Casing Radiated	72	65	61	47	45	43	40	28			57	50	46	32	30	28	25	13	
75%	Induct Intake	75	68	69	57	58	55	47	35	28	25%	51	44	45	33	34	31	23	< 20	<20
	Induct Supply	79	74	78	65	66	64	60	55			55	50	54	41	42	40	36	31	
	Induct Discharge	80	75	78	65	66	65	60	57			56	51	54	41	42	41	36	33	
	Induct Extract	76	69	69	57	58	56	47	37			52	45	45	33	34	32	23	< 20	
	Casing Radiated	66	59	55	41	39	37	34	22			42	35	31	<20	<20	<20	<20	<20	

*Casing Radiated (Breakout).

ATTENUATOR DIMENSIONS (mm), DYNAMIC INSERTION LOSS (dB) & WEIGHTS (kg)

Attenuator Code	Attenuator Dimensions Length	Width	Height	Air path	Dynamic Insertion Loss (dB) 63	125	250	500	1000	2000	4000	8000	Attenuator Weight (kg)	Packed Weight (kg)
XBC55-HS-MS10	1050	592	428	S / D	4	10	17	19	23	18	15	11	54	59
XBC55-HE-MS10	1050	402	428	I / E	3	6	12	15	15	11	6	4	47	50
XBC55-HS-MS12	1250	592	428	S / D	6	12	21	26	31	24	18	13	67	72
XBC55-HE-MS12	1250	402	428	I / E	5	8	16	22	23	17	9	6	57	60
XBC55-HS-MS16	1600	592	428	S / D	8	14	25	33	37	30	21	15	84	89
XBC55-HE-MS16	1600	402	428	I / E	7	10	20	29	29	23	12	8	71	74

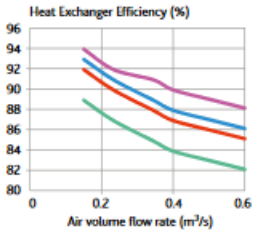
S / D = Supply / Discharge I / E = Intake / Extract. Coding: The S / D denotes the type of silencer required for the supply or discharge. The I / E denotes the type of silencer required for the extract or fresh air intake on the unit. All XBC matched silencers are double skinned.

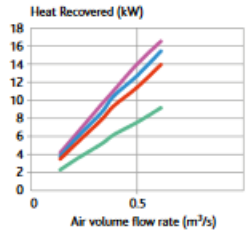
COUNTERFLOW HEAT EXCHANGER EFFICIENCY (%)

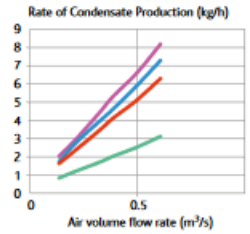
Performance based on:
Indoor Conditions 21 Deg C / 50 % RH

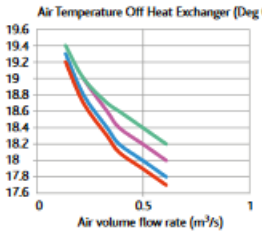
Key to performance curves

Intake Temperature (Deg C)
- -5 Deg C Intake Typically Specified Values
- -3 Deg C Intake Typically Specified Values
- -1 Deg C Intake Typically Specified Values
- 6 Deg C Approx. Average outdoor temperature (UK heating season)









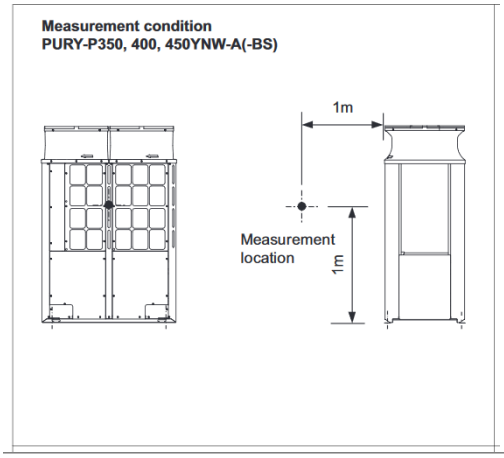
HEATING COIL DATA LPHW

LPHW Deg C	Airflow (m³/s)	Output (kW)	Air Off Temp (C°)	Water flow (l/s)	Coil ΔP (kPa)	Pipe Connection (mm)	Valve ΔP (kPa)	Valve Type
LPHW 82/71	0.5	12.0	30	0.27	8.6	15	9	4 Port
	0.375	11.3	35	0.25	7.6	15	8.0	
	0.25	8.9	40	0.20	4.7	15	4.9	
LPHW 80/60	0.5	9.7	26	0.12	1.7	15	1.7	4 Port
	0.375	8.7	29	0.11	1.5	15	1.5	
	0.25	6.9	33	0.09	0.9	15	0.9	
LPHW 60/40	0.5	5.6	19	0.07	0.6	15	0.6	4 Port
	0.375	5.2	21	0.06	0.5	15	0.5	
	0.25	4.0	23	0.05	0.3	15	0.3	

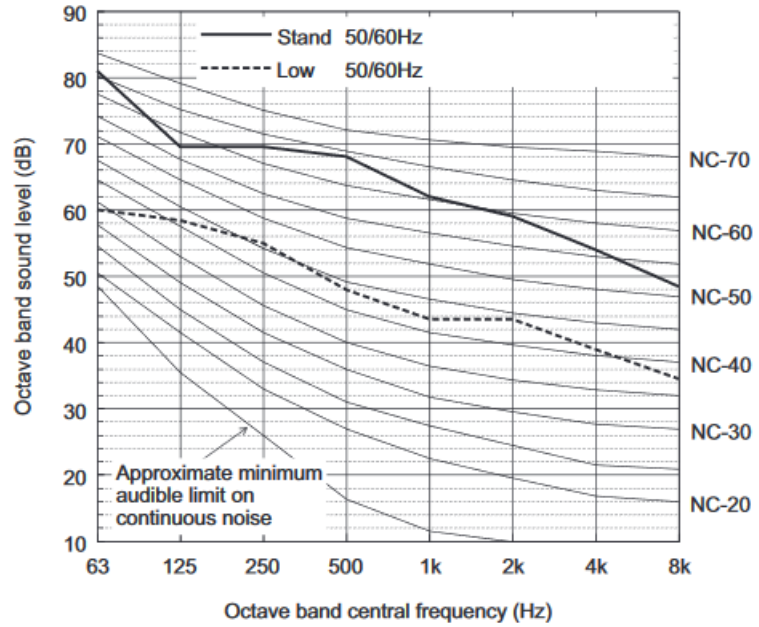
*Nb Limited to 30 Deg C for Ecosmart Units. Data based on 10 Deg C Air On temperature.

CONDENSER UNIT

5. SOUND LEVELS



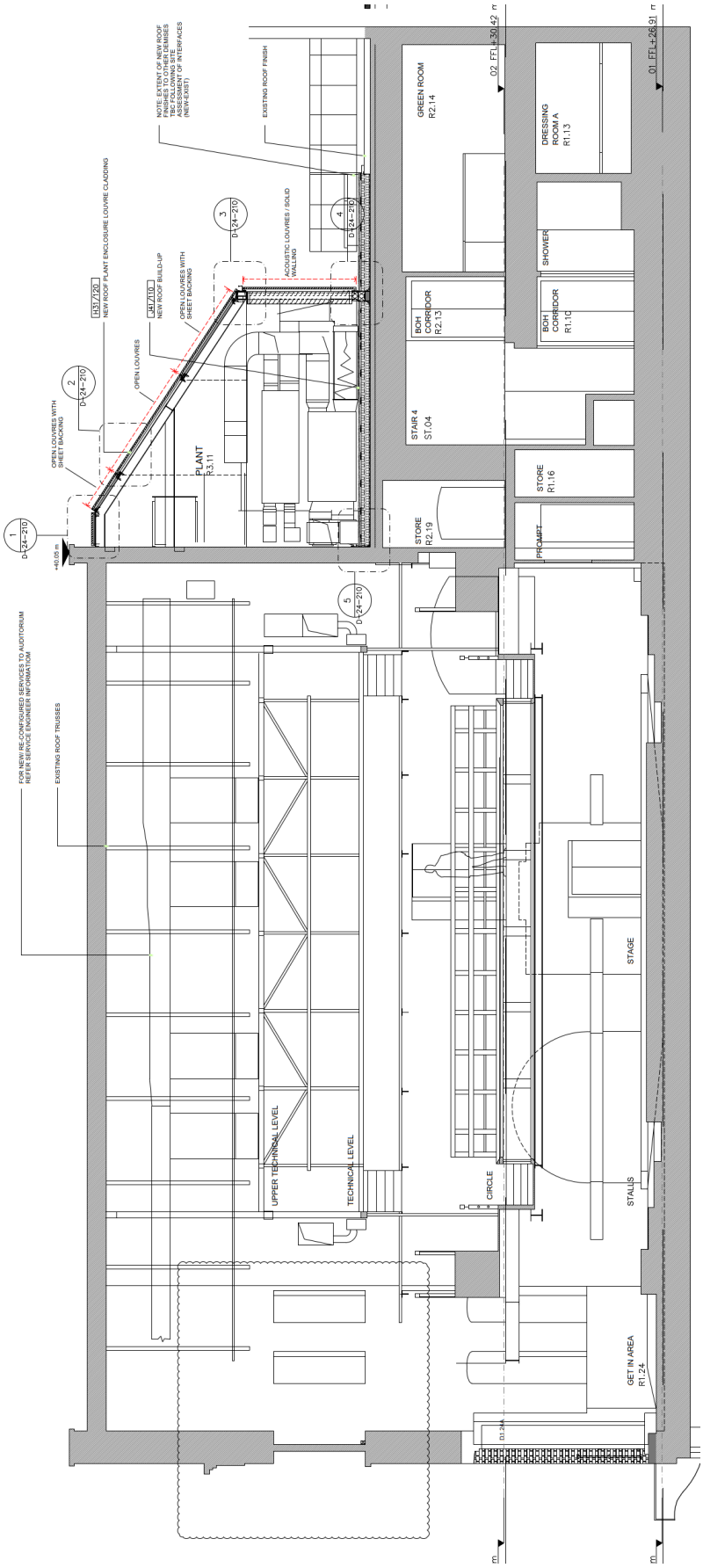
Sound level of PURY-P400YNW-A(-BS)

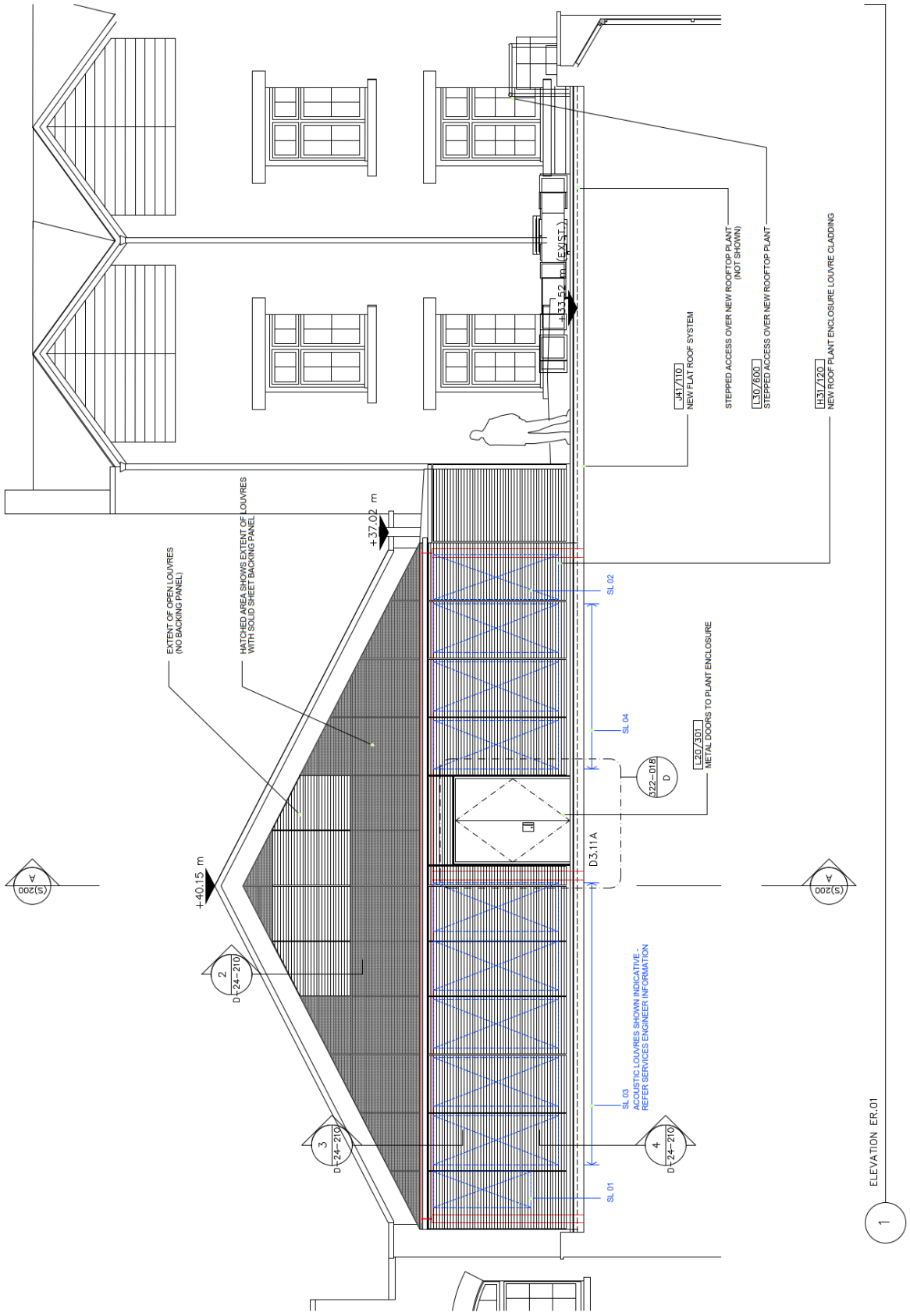


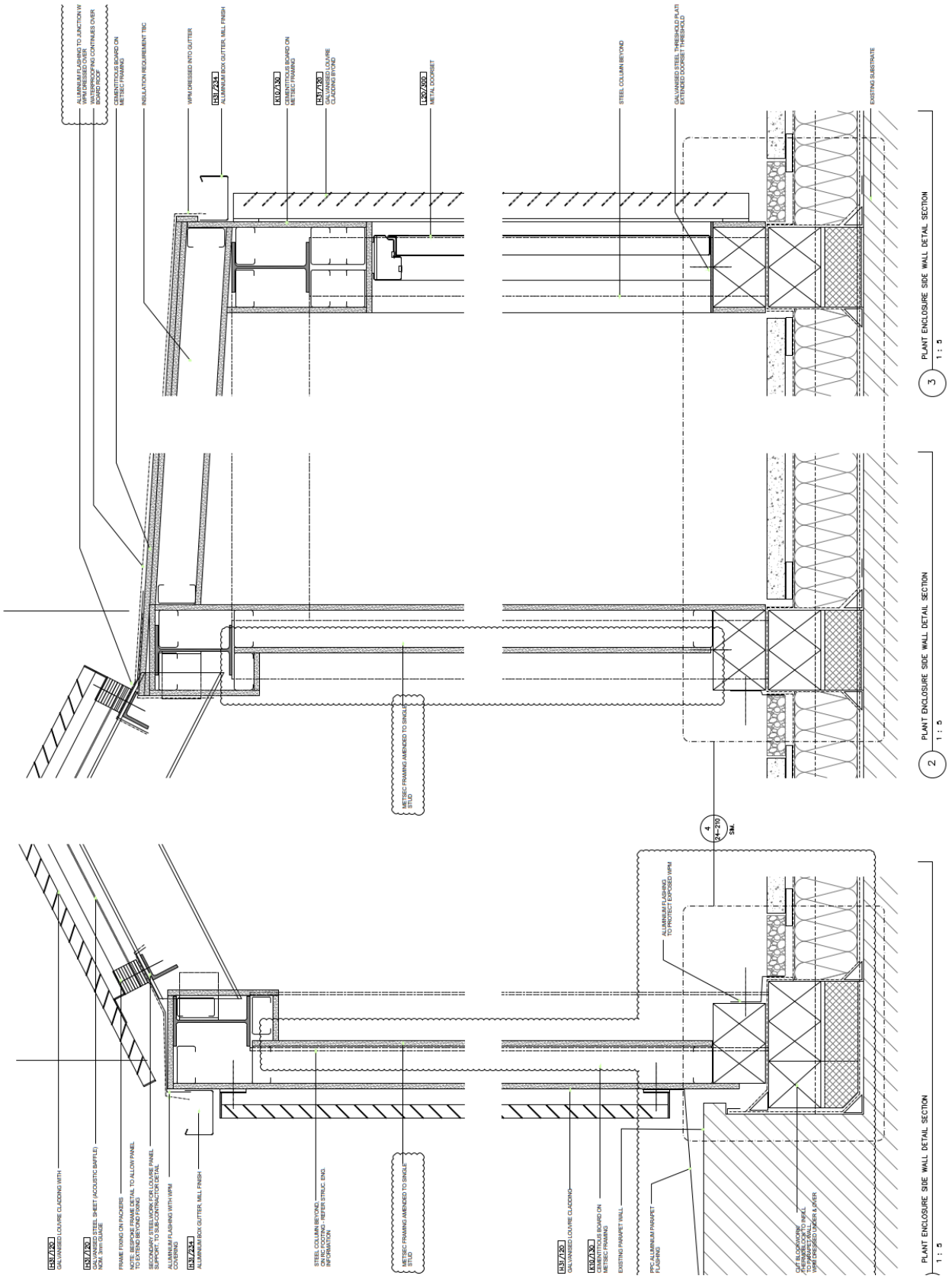
		63	125	250	500	1k	2k	4k	8k	dB(A)
Standard Heating	50/60Hz	81.0	69.5	69.5	68.0	62.0	59.0	54.0	48.5	69.0
Low noise mode	50/60Hz	60.0	58.5	55.0	48.0	43.5	43.5	39.0	34.5	52.0

When Low noise mode is set,the A/C system's capacity is limited. The system could return to normal operation from Low noise mode automatically in the case that the operation condition is severe.

APPENDIX G: Acoustic Enclosure Details




+33.52 m (EXIST.)
+37.02 m
+40.15 m
L41/110
NEW FLAT ROOF SYSTEM
STEPPED ACCESS OVER NEW ROOFTOP PLANT (NOT SHOWN)
L30/600
STEPPED ACCESS OVER NEW ROOFTOP PLANT
H31/120
NEW ROOF PLANT ENCLOSURE LOUVRE CLADDING
EXTENT OF OPEN LOUVRES (NO BACKING PANEL)
HATCHED AREA SHOWS EXTENT OF LOUVRES WITH SOLID SHEET BACKING PANEL
L20/301
METAL DOORS TO PLANT ENCLOSURE
D3.11A
SL 01
SL 02
SL 03
SL 04
ACOUSTIC LOUVRES SHOWN INDICATIVE - REFER SERVICES ENGINEER INFORMATION
D22-018
D
D1-24-210
D1-24-210
D1-24-210
A (S)200
A (S)200
ELEVATION ER.01
1


ALUMINIUM FLASHING TO JUNCTION W WPM DRESSED OVER
WATERPROOFING CONTINUES OVER BOARD ROOF
CEMENTITIOUS BOARD ON METSEC FRAMING
INSULATION REQUIREMENT TBC
WPM DRESSED INTO GUTTER
M37/234 ALUMINIUM BOX GUTTER, MILL FINISH
K10/130 CEMENTITIOUS BOARD ON METSEC FRAMING
M37/726 GALVANISED LOUVRE CLADDING BEYOND
M57/300 METAL DOORSET
STEEL COLUMN BEYOND
GALVANISED STEEL THRESHOLD PLATE EXTENDED DOORSET THRESHOLD
EXISTING SUBSTRATE
3 PLANT ENCLOSURE SIDE WALL DETAIL SECTION
1 : 5
METSEC FRAMING AMENDED TO SINGLE STUD
4 SK-210
2 PLANT ENCLOSURE SIDE WALL DETAIL SECTION
1 : 5
M37/726 GALVANISED LOUVRE CLADDING WITH
M37/726 GALVANISED STEEL SHEET (ACOUSTIC BAFFLE) WALL BEYOND
FRAME FIXING ON PACKERS
NOTE: BESPOKE FRAME DETAIL TO ALLOW PANEL TO EXTEND BEYOND FIXING
SECONDARY STEELWORK FOR LOUVRE PANEL SUPPORT. TO SUB-CONTRACTOR DETAIL
ALUMINIUM FLASHING WITH WPM COVERING
M37/234 ALUMINIUM BOX GUTTER, MILL FINISH
STEEL COLUMN BEYOND ON RC FOOTING - REFER STRUC. ENG. INFORMATION
METSEC FRAMING AMENDED TO SINGLE STUD
ALUMINIUM FLASHING TO PROTECT EXPOSED WPM
M37/726 GALVANISED LOUVRE CLADDING
K10/130 CEMENTITIOUS BOARD ON METSEC FRAMING
EXISTING PARAPET WALL
PPC ALUMINIUM PARAPET FLASHING
CUT TO ENSURE ADEQUATE DEPTH TO INFILL WITH PRESSED LADDER & JOIER
1 PLANT ENCLOSURE SIDE WALL DETAIL SECTION
1 : 5

Acoustic louvre e.g. Gilbert 27

SERIES 15, 27, 30 & 45

Accoustic Weather Louvres

Introduction

Gilberts acoustic weather louvre ranges interface directly with the exterior fabric of a building in either steelwork frames and cladding or brickwork.
Primarily utilised where a combination of good weathering protection and accurate noise emission control are required, the louvre can be manufactured to accommodate the various dimensional and aesthetic requirements a project may demand. With size ranges from 300 x 300 to 1500-2000 in single assemblies, larger formats can be accommodated by the use of a modular approach to assist on site handling and installation. The louvre is available with a channel frame housing for side or rear fixing and 50mm flange for front face fixing. Model variations from Series 15 up to Series 45 offer a selection of noise reduction characteristics.

Construction

Standard construction comprises of outer casings of not less than 1.2mm galvanised mild steel with outer faces at the top and bottom support sections not less than 0.7mm. Inner absorptive faces will not be less than 0.7mm galvanised perforated mild steel sheet.
Materials and finishes available include stainless steel, anodised aluminium and aluminium with a polyester powder paint finish to the BS/RAL colour range. The mineral wool acoustic infill is organic, flame, moisture and vermin proof with a minimum density of 48 Kg/m3. It is packed under compression to prevent voids due to settlement. Bird guards or insect screens can be fitted if required.

Performance Data

	Octave bands								
	63	125	250	500	1k	2k	4k	8k	Hz
Series 15 Transmission Loss	4	4	6	9	12	17	11	10	dB
Series 27 Transmission Loss	6	7	10	13	17	19	13	11	dB
Series 30 Transmission Loss	6	6	9	14	21	29	27	27	dB
Series 45 Transmission Loss	9	10	14	20	30	33	32	30	dB

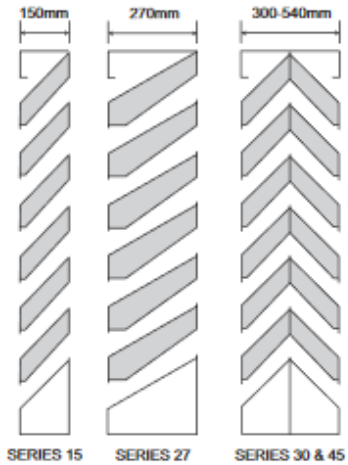
Performance test in accordance with BS 2750:1980

Transmission Loss

This is the acoustic performance (dB) of an acoustic louvre to BS 2750:1980 and is defined as the ratio, in decibels, of acoustic energy transmitted through the louvre sample to that which is incident upon it. Also expressed as Sound Reduction Index SRI.

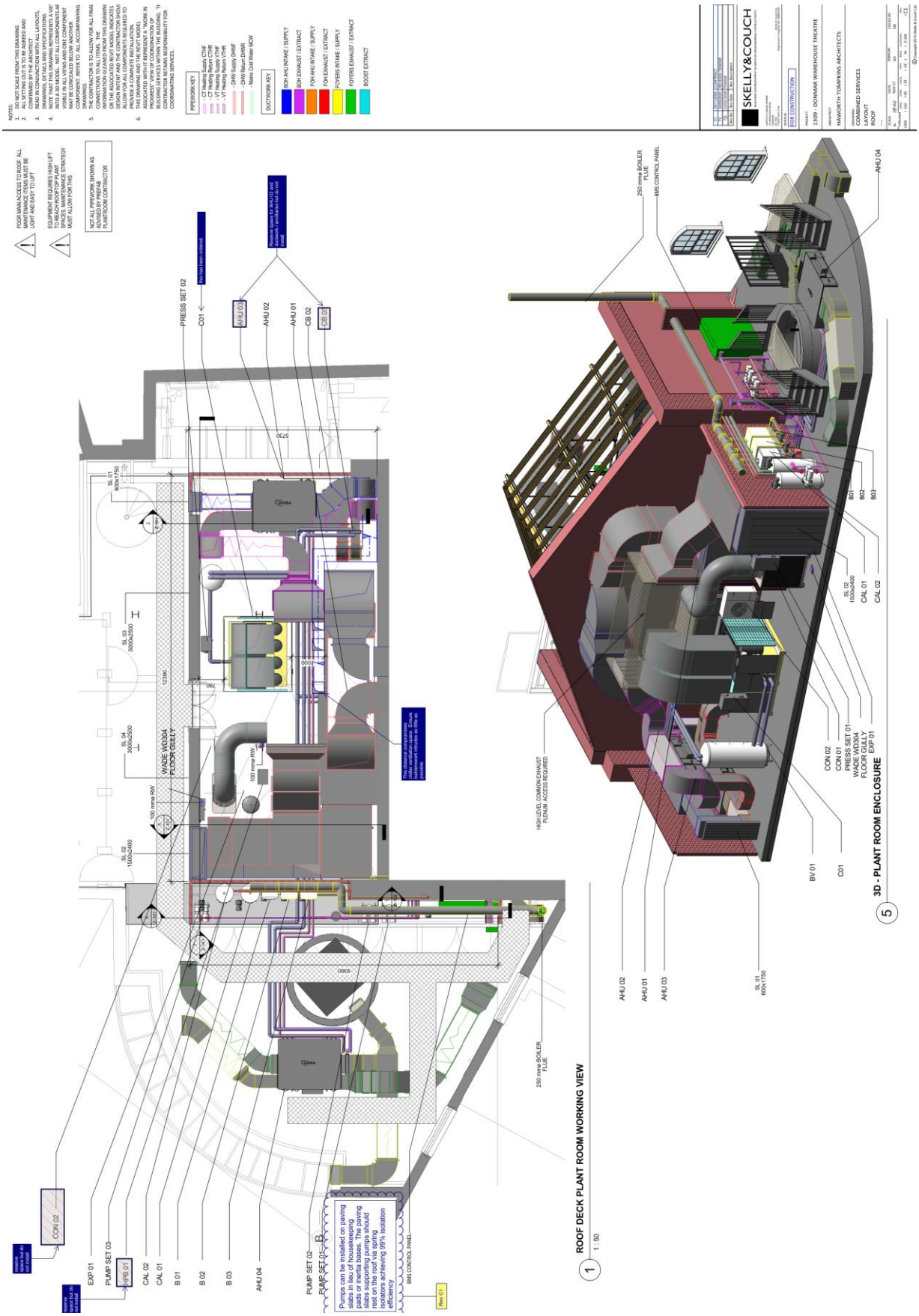
The aerodynamic performance of single acoustic louvres is as follows:-

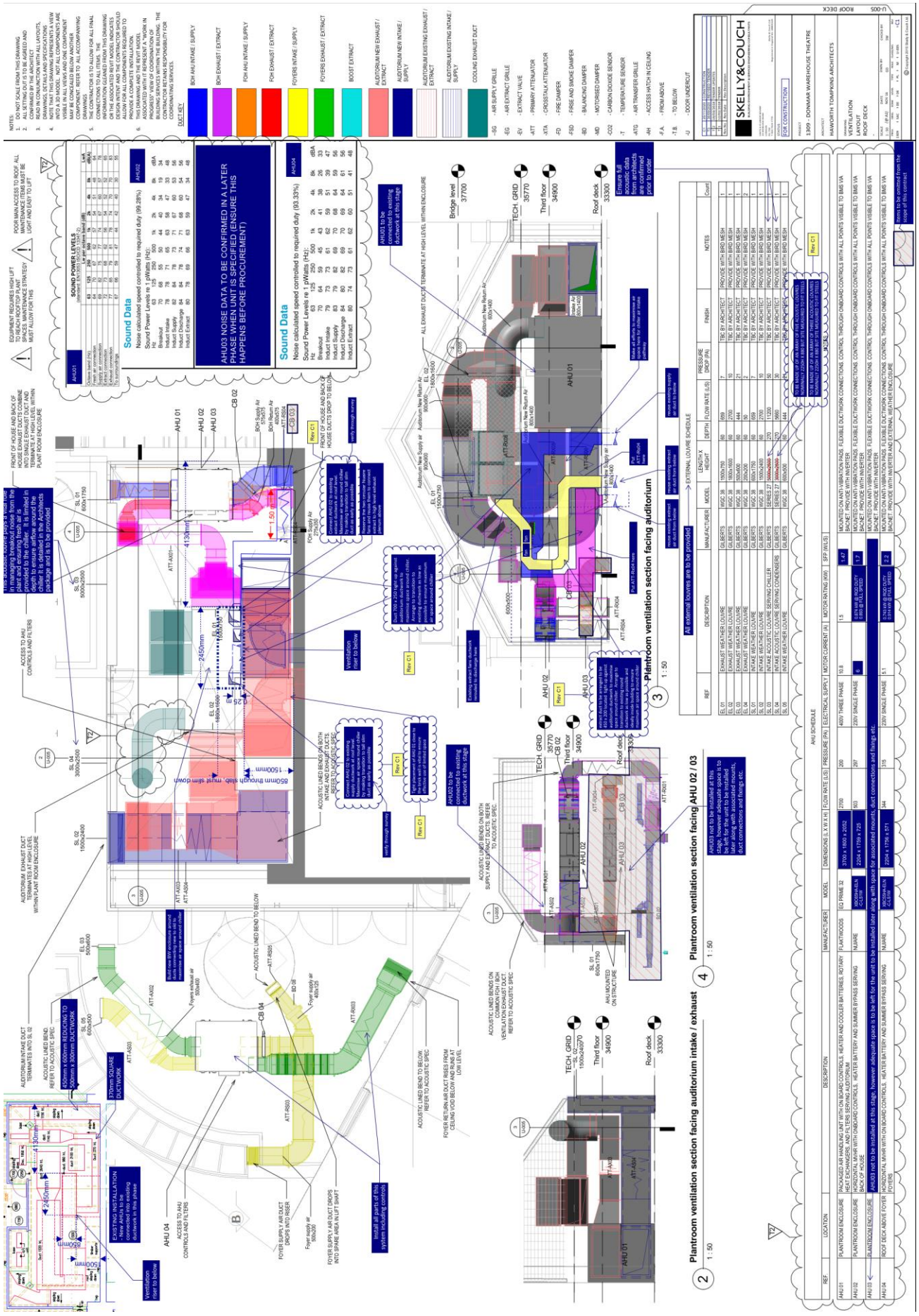
Face Velocity (m/s)	Series 15 (N/m²)(Pa)	Series 27 (N/m²)(Pa)	Series 30 (N/m²)(Pa)	Series 45 (N/m²)(Pa)
1.0	10	10	20	20
1.5	15	17	27	30
2.0	20	24	34	40
2.5	28	35	45	55
3.0	40	50	56	70
Weight per m²(kg)	30	55	60	108



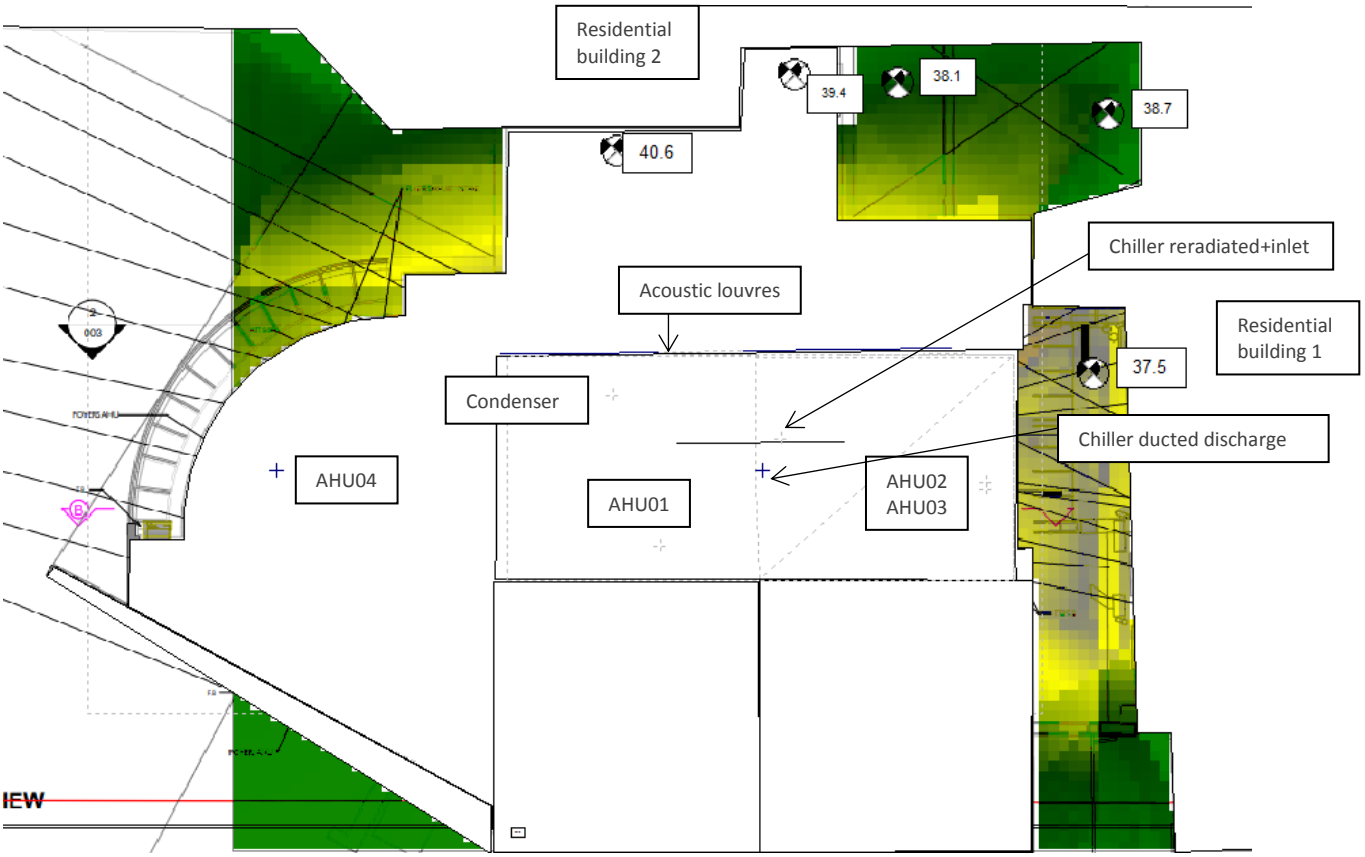
GILBERTS

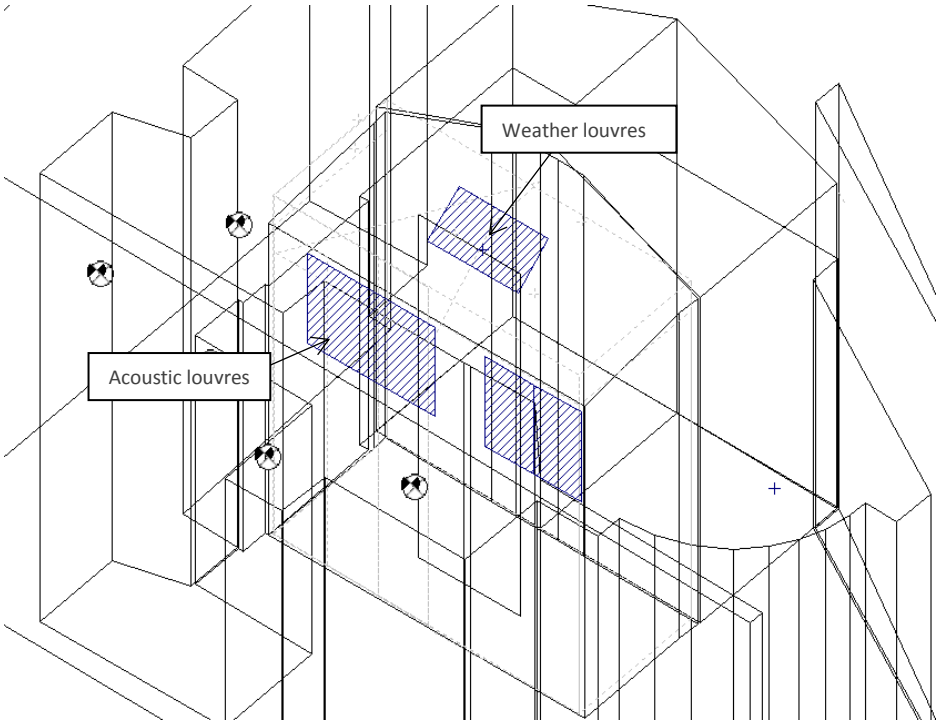
APPENDIX H MECHANICAL DRAWINGS




AHU01 NOISE DATA TO BE CONFIRMED IN A LATER PHASE WHEN UNIT IS SPECIFIED (ENSURE THIS HAPPENS BEFORE PROCUREMENT)
Sound Data
Noise calculated speed controlled to required duty (99.28%)
Sound Data
Noise calculated speed controlled to required duty (93.33%)
Plantroom ventilation section facing auditorium
Plantroom ventilation section facing AHU 02 / 03
Plantroom ventilation section facing auditorium intake / exhaust
AHU SCHEDULE
All external louvres are to be provided
EXTERNAL LOUVRE SCHEDULE
SKELLY&COUCH
HAWORTH TOMPKINS ARCHITECTS
1309 - DONMAR WAREHOUSE THEATRE
VENTILATION LAYOUT ROOF DECK
FOR CONSTRUCTION

APPENDIX I: CADNA-A Results





APPENDIX J: Glossary of Acoustic Terms

DECIBEL (dB) - A unit of sound pressure measurement
Sound Pressure Level in dB (*L*p) = 20 log (Measured sound pressure/Reference sound pressure = 20 µPa)

dB(A) - The A -weighted sound pressure level, the weighting network reduces low frequency sound in a similar way to the human ear.

REVERBERATION TIME (RT or *T*) – decay of sound in rooms
The time taken for a sound, once terminated, to fall through 60dB i.e. to one millionth of its original sound intensity. *T*30 – RT for first 30dB of decay. RT_{500} - Mid frequency RT.
HERTZ (Hz) - a unit of frequency measurement. The normal range of hearing is from 20Hz to about 15kHz.

ABSORPTION COEFFICIENT – degree to which a material absorbs sound.
The ratio of absorbed to incident sound energy (perfect absorber = 1)

SOUND REDUCTION INDEX *R* – quantity which describes a material's ability to reduce the sound pressure level across it (e.g. a wall or floor)

$R = L1 - L2 + 10\log (S/A)$

*L*1 - Average sound pressure level in source room (averaged from 100 Hz – 3150 Hz)
*L*2 - Average sound pressure level in receiving room (averaged from 100 Hz – 3150 Hz)
S – Wall Area (m^2)
A – Total absorption in receiving room (m^2 units)

*R*w – weighted sound reduction index

AVERAGE ROOM TO ROOM LEVEL DIFFERENCE – *D*, dB = *L*1 – *L*2, averaged 1/3 octave bands from 100Hz – 3150kHz.

*D*w – weighted value of D (usually 2 - 3dB higher)

*D*nT, w – *D*w corrected for reverberation time of receiving room

NOISE RATING CURVES (NR CURVES) – set of curves used to describe optimum background noise levels for different tasks.

*L*10/90 LEVEL (dB) - The level in dB of a time varying sound pressured level (e.g. traffic) exceeded for 10%/90% of the time of measurement.
*L*90 is usually called the BACKGROUND NOISE LEVEL.

*L*eq AVERAGE SOUND PRESSURE LEVEL – level dB of a time varying sound pressure level with equal amounts of energy above and below it, for the time of measurement.

TONAL NOISE – noise of a single frequency (or a narrow band of frequencies that can be perceived as a tone), audible above the broad band noise background. Noise which is at least 5dB above the average of the 1/3 octave band sound pressure levels immediately on either side of it.