MEMORANDUM

BDP.

TO	Bob Blezko (BB)	DATE	22 May 2017
FROM	Laura de Azcarate (BDP)	CC	May Lam (BDP) Mark Middleton (BDP) Jai Shikotra (BDP) Richard Grove (BDP)
file ref	P2002877/MEM(00)U001		

SUBJECT **NOISE EMISSIONS ASSESSMENT – GREAT ORMOND STREET HOSPITAL**

1. INTRODUCTION

BDP has been requested by Balfour Beatty to provide a noise impact assessment for a partial approval of details reserved by conditions to the London Borough of Camden pursuant to planning permission reference: 2015/5353/P for the installation of four chiller units at roof level of the Variety Club Building (east west roof) with associated screening and pipework. This application is for the west roof only. Details for the east roof, will be subject to a separate application for approval of detail.

This memorandum provides a noise impact assessment based upon information supplied by Balfour Beatty, in order to assess compliance with London Borough of Camden (LBC) noise policy as detailed in *Camden Development Policies (2010)*.

2. BACKGROUND

NON-GOSH SENSITIVE RECEPTORS (SR1)

London Borough of Camden outlines its noise policy in *Camden Development Policies (2010)*, in which it stipulates the following:

CPG6: Amenity

The Council requires detailed noise and vibration information in the form of a report for development which proposes:

- The installation of plant, ventilation or air conditioning equipment;
- A use that will create significant noise;
- A noise sensitive development in an area where existing noise sources are present;
- A use that will generate a significant amount of traffic.

DP28: Noise and Vibration

The Council will seek to ensure that noise and vibration is controlled and managed and will not grant planning permission for:

a) development likely to generate noise pollution; or
b) development sensitive to noise in locations with noise pollution, unless appropriate attenuation measures are provided.

The Council also sets out the fixed plant noise rating levels related to measured background noise levels, which forms the basis for granting of planning permission, as summarised in Table 1. For reference, the council considers the following to be noise sensitive developments: housing, schools, hospitals, offices, workshops, and open spaces.

Noise description and location of measurement	Period	Time	Noise level
Noise at 1m external to a sensitive facade	Day, evening and night	00:00 – 24:00	5 dB(A) <L_{A90}
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1m external to a sensitive facade	Day, evening and night	00:00 – 24:00	10 dB(A) <L_{A90}
Noise that has a distinguishable impulses (bangs, clicks, clatters, thumps) at 1m external to a sensitive facade	Day, evening and night	00:00 – 24:00	10 dB(A) <L_{A90}
Noise at 1m external to sensitive facade where L_{A90} > 60 dB	Day, evening and night	00:00 – 24:00	L_{Aeq} 55 dB

Table 1 London Borough of Camden noise policy

GOSH SENSITIVE RECEPTORS (SR2,SR3,SR4)

With regards to noise emissions from the proposed plant items affecting the noise sensitive receptors within the GOSH itself (e.g. ward accommodation), plant noise limits have been proposed based on the internal noise criteria for single bedroom wards during the night, as set by HTM 08-01: Acoustics; 35 dB $L_{Aeq,1hour.}$ Based on achieving the above internal noise criteria and a maximum loss of 10 dB through a partially open window, the plant noise criterion at the nearest ward window has been proposed as follows:

Plant noise emissions must not exceed a cumulative noise level of 45 dB when measured at 1m from the nearest ward window. This method has been agreed with Environmental Health Department of Camden Borough Council

3. NOISE EMISSIONS LIMITS

The fixed plant noise rating levels for the proposed simultaneous operation of all plant items are presented in Table 2 below
.

GOSH/Non-GOSH	Noise Sensitive Receptor Description	Plant Noise Emission Limits
Non-GOSH	SR1 (National Hospital for Neurology and Neurosurgery)	48 dB $L_{Aeq,1hr}$*
GOSH	SR2 (Variety Club Building)	45 dB $L_{Aeq,1hr}$
	SR3 (proposed Phase 2B Premier Inn Cardiac Building)	45 dB $L_{Aeq,1hr}$
	SR4 (Southwood Building)	45 dB $L_{Aeq,1hr}$

Table 2 Plants noise emission limits at 1m from each noise sensitive receptor

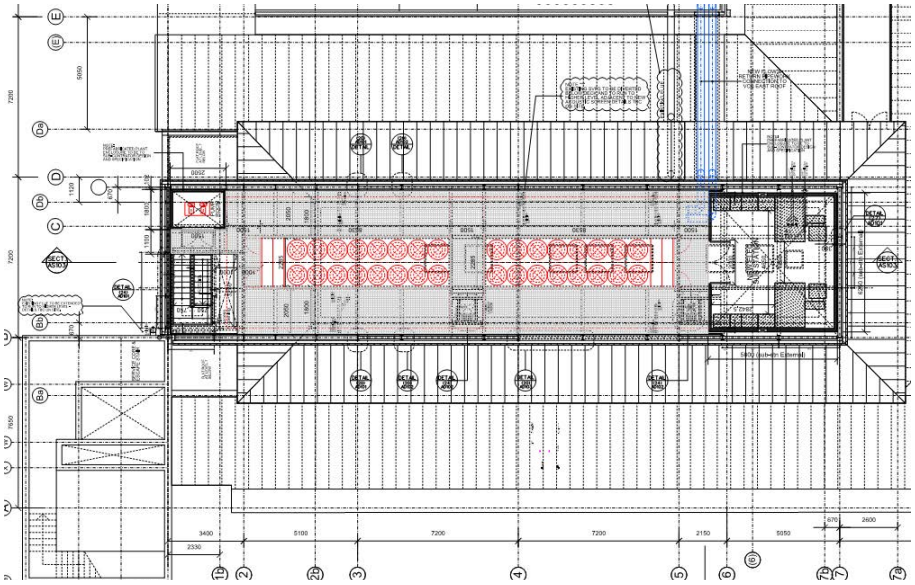
* 43dB $L_{Aeq,1hr}$ when noise emissions have a distinguishable discrete continuous note “hum” from the electrical substation

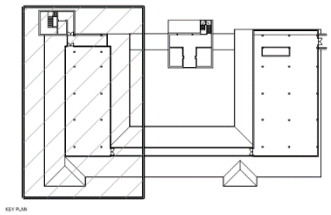
4. SITE DETAILS

GOSH runs its services from a campus in Bloomsbury, in the London Borough of Camden. The campus is bounded to the north by Guilford Street, to the east by Guilford Place and Lamb's Conduit Street, Queens Square to the west and Great Ormond Street to the south, after which the hospital is named.

The Variety Club Building is located within the main hospital site, and is bounded by the Southwood Building, Morgan Stanley Clinical Building, an external courtyard and the grade II* listed Chapel of St. Christopher to the north. To the west lies the Frontage Building, and to the south is the Paul O'Gorman Building. Powis Place is a privately owned road, is situated to the west.
The new plant is located within an external plant space located on the 7th floor west roof of Variety Club Building. The west plant space contains two chiller units, two chilled water pumps and a new electrical substation. The plant space is located on a new support structure which is screened by a new impermeable acoustic plant screen located around the plant space.

The plan below shows where the items of plant are installed on the west roof. In relation to the location of the plants, the nearest noise sensitive receptors are located at different distances to the noise sensitive receptors SR1, SR2, SR3 SR4 (Location plan in Appendix A)





5. PLANT DETAILS

The new chillers are located within an external plant space located on the 7th floor west roof of the GOSH Variety Club Building. The west plantroom contains two chiller units, two chilled water pumps and a new electrical substation. The chiller plant details have been provided by the manufacturer *Daikin,* the pump details have been provided by the manufacturer *Grundfos* and are included in Appendix B for reference.

The following items are installed on the west VCB roof:

- ACC/VCB/(W) 01 - Daikin chiller unit - model EWAD980-C11CZX
- ACC/VCB/(W) 02 - Daikin chiller unit - model EWAD980-C11CZX
- PMP CHW01 - Grundfus run & standby pumps – model NB 125-315/336 AS-F2-A-E-BQQE Product no. 98975779
- PMP CHW02 - Grundfus run & standby pumps – model NB 125-315/336 AS-F2-A-E-BQQE Product no. 98975779
- ESS - Packaged Electrical Substation supplied by Systemair-ST UPU 20b

Details of the plant noise emission levels for the proposed plant items on the west VCB roof have been provided by the manufacturers of the equipment, and are presented in Tables 2 and 3 below.

Plant Item	Sound Pressure Level at 1m from the unit, dB (ref. 2 x 10^{-5} Pa)									Sound Power Level, L_w dB(A)
	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	dB(A)	
ACC/VCB/ (W) 01 &02(1)	83	74	74	73	72	64	60	53	**74**	**96**
PMP CHW 01 & 02 (2)	52	53	50	49	51	50	50	47	**57**	**-**
ESS (3)	55	55	56	53	47	49	48	45	**57**	**77**

Table 3 Sound pressure level for the installed plants items

Notes

(1) The octave band spectrum has been adjusted from the a weighted levels provided by the manufacturer
(2) The octave band spectrum is taken from typical pump units and adjusted to match the A-weighted sound pressure level provided by the pump manufacturer.
(3) The electrical substation manufacturer has provided the linear sound pressure level measured at 2m from the unit.

It has been advised by Balfour Beatty that the plant is going to operate 24h at 100% operational load at any given time. As such, these parameters have been applied in assessing the plant noise levels.

6. ASSESSMENT

The resultant noise level from each installed plant item has been calculated at the nearest noise sensitive receptors, with the solid acoustic barriers in place. Distance and directivity corrections have been taken into consideration, with the height of the solid acoustic barrier being the same as the height of the chillers on their mountings.

The contribution from each element of plant is presented below in table 4, with the cumulative noise level compared against the design criterion.

Plant Ref.	Location	Resultant Noise Level at each Noise Sensitive Receptor			
		SR1	SR2	SR3	SR4
ACC/VCB (W) 01	VCB west roof	43 dB	40 dB	28 dB	40 dB
ACC/VCB (W) 02	VCB west roof	42 dB	41 dB	28 dB	34 dB
PMP CHW 01	VCB west roof	11 dB	8 dB	3 dB	12 dB
PMP CHW 01	VCB west roof	11 dB	8 dB	3 dB	12 dB
ESS	VCB west roof	30 dB	36 dB	22 dB	28 dB
Total Predicted Noise Level		**46 dB**	**44 dB**	**32 dB**	**42 dB**
Night-time Noise Emission Limits		**48 dB**	**45 dB**	**45 dB**	**45 dB**
Difference		**-2 dB**	**-1 dB**	**-13 dB**	**-3 dB**

Table 4 Resultant sound pressure levels at the nearest noise sensitive receptors after mitigation

Table 4 above demonstrates that, with the solid acoustic barrier in place, the cumulative noise levels at the noise sensitive receptors comply with the requirements of LBC and the recommendations for internal noise levels in bedroom wards within HTM08-01.

Based on resultant levels at the receivers and considering not having any distinguishable tonal characteristic, the plant noise assessment has been carried out and as per LBC requirements and the recommendations for internal noise levels in bedroom wards within HTM08-01.

7. CONCLUSIONS

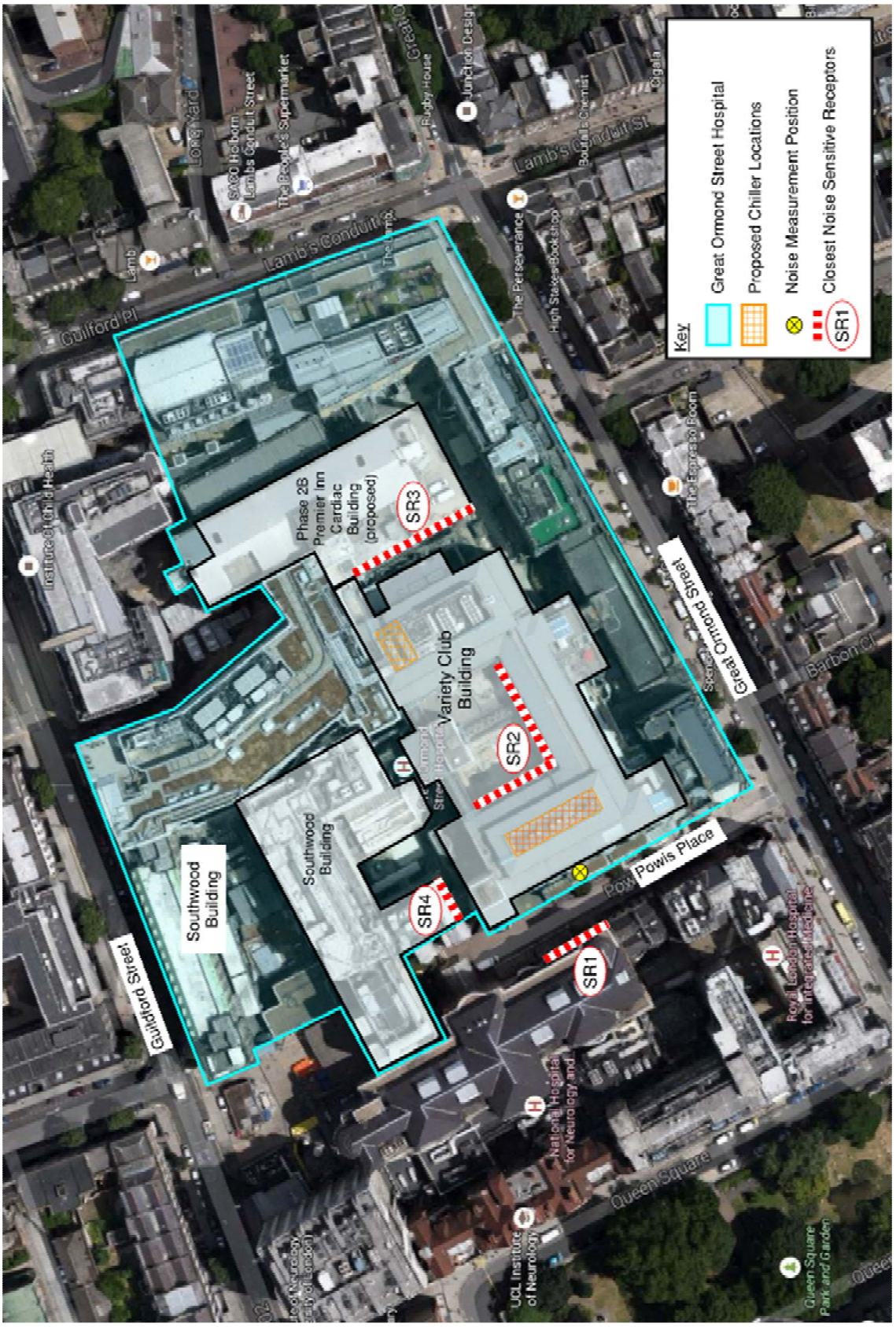
BDP Acoustics has undertaken a plant noise assessment of the new rooftop plant items serving GOSH VCB. The assessment focusses specifically on the west chiller units and associated plant and equipment, and has been undertaken in order to meet recommendations for mechanical plant noise emissions provided by the London Borough of Camden (LBC).

Details of the noise emissions levels of all installed plant items have been provided by the manufacturers. These noise emissions levels have been used in a detailed assessment to calculate the resultant cumulative external noise levels at the nearest noise sensitive receptors.

The assessment has demonstrated that, with the installed mitigation measures, and correct application of penalties relating to tonal characteristics of plant items, the cumulative noise levels at the noise sensitive receptors comply with the requirements of LBC and the recommendations for internal noise levels in bedroom wards within HTM08-01.

Laura de Azcarate MSc AMIOA
Assistant Acoustic Consultant

APPENDIX A Site map



APPENDIX B Installed Plant Data (EWAD980-C11CZX)

EWAD CZXR

MODEL		640	700	790	850	980	C10	C11	C12
Capacity - Cooling (1)	kW	635	700	789	852	976	1031	1170	1235
Capacity control - Type	---	Stepless	Stepless	Stepless	Stepless	Stepless	Stepless	Stepless	Stepless
Capacity control - Minimum capacity	%	20,0	20,0	20,0	20,0	20,0	20,0	20,0	20,0
Unit power input - Cooling (1)	kW	260	242	271	314	347	388	408	455
EER (1)	---	2,44	2,89	2,91	2,71	2,81	2,65	2,86	2,71
ESEER	---	5,52	5,71	5,76	5,76	5,79	5,49	5,41	5,05
IPLV	---	5,94	6,14	6,32	6,37	6,34	6,05	5,96	5,67
CASING									
Colour (2)	---	IW	IW	IW	IW	IW	IW	IW	IW
Material (2)	---	GPSS	GPSS	GPSS	GPSS	GPSS	GPSS	GPSS	GPSS
DIMENSIONS									
Height	mm	2540	2540	2540	2540	2540	2540	2540	2540
Width	mm	2285	2285	2285	2285	2285	2285	2285	2285
Length	mm	6725	6725	7625	7625	8525	8525	10325	10325
WEIGHT									
Unit Weight	kg	6170	6470	7100	7360	7950	7950	9120	9530
Operating Weight	kg	6430	6720	7340	7600	8390	8390	9500	9920
WATER HEAT EXCHANGER									
Type (3)	---	S&T	S&T	S&T	S&T	S&T	S&T	S&T	S&T
Water Volume	l	263	248	241	241	441	441	383	383
Nominal water flow rate - Cooling	l/s	30,3	33,4	37,6	40,7	46,6	49,2	55,8	58,9
Nominal Water pressure drop - Cooling	kPa	79	76	54	59	58	64	43	48
Insulation material (4)		CC	CC	CC	CC	CC	CC	CC	CC
AIR HEAT EXCHANGER									
Type (5)	---	HFP	HFP	HFP	HFP	HFP	HFP	HFP	HFP
FAN									
Type (6)	---	DPT	DPT	DPT	DPT	DPT	DPT	DPT	DPT
Drive (7)	---	DOL	DOL	DOL	DOL	DOL	DOL	DOL	DOL
Diameter	mm	800	800	800	800	800	800	800	800
Nominal air flow	l/s	41536	49843	58151	58151	66458	66458	83072	83072
Quantity	No.	10	12	14	14	16	16	20	20
Speed	rpm	700	700	700	700	700	700	700	700
Motor input	kW	7,8	9,4	11,0	11,0	12,5	12,5	15,7	15,7
COMPRESSOR									
Type	---	Asymm Single Screw	Asymm Single Screw	Asymm Single Screw	Asymm Single Screw	Asymm Single Screw	Asymm Single Screw	Asymm Single Screw	Asymm Single Screw
Oil charge	l	32	32	35	38	38	38	44	50
Quantity	No.	2	2	2	2	2	2	2	2
SOUND LEVEL									
Sound Power - Cooling	dB(A)	95	95	96	96	96	96	97	97
Sound Pressure - Cooling (8)	dB(A)	74	74	74	74	74	74	74	74
REFRIGERANT CIRCUIT									
Refrigerant type	---	R134a	R134a	R134a	R134a	R134a	R134a	R134a	R134a
Refrigerant charge	kg	128	146	162	162	200	200	250	250
N. of circuits	No.	2	2	2	2	2	2	2	2
PIPING CONNECTIONS									
Evaporator water inlet/outlet		168.3 mm	168.3 mm	168.3 mm	168.3 mm	219.1 mm	219.1 mm	219.1 mm	219.1 mm

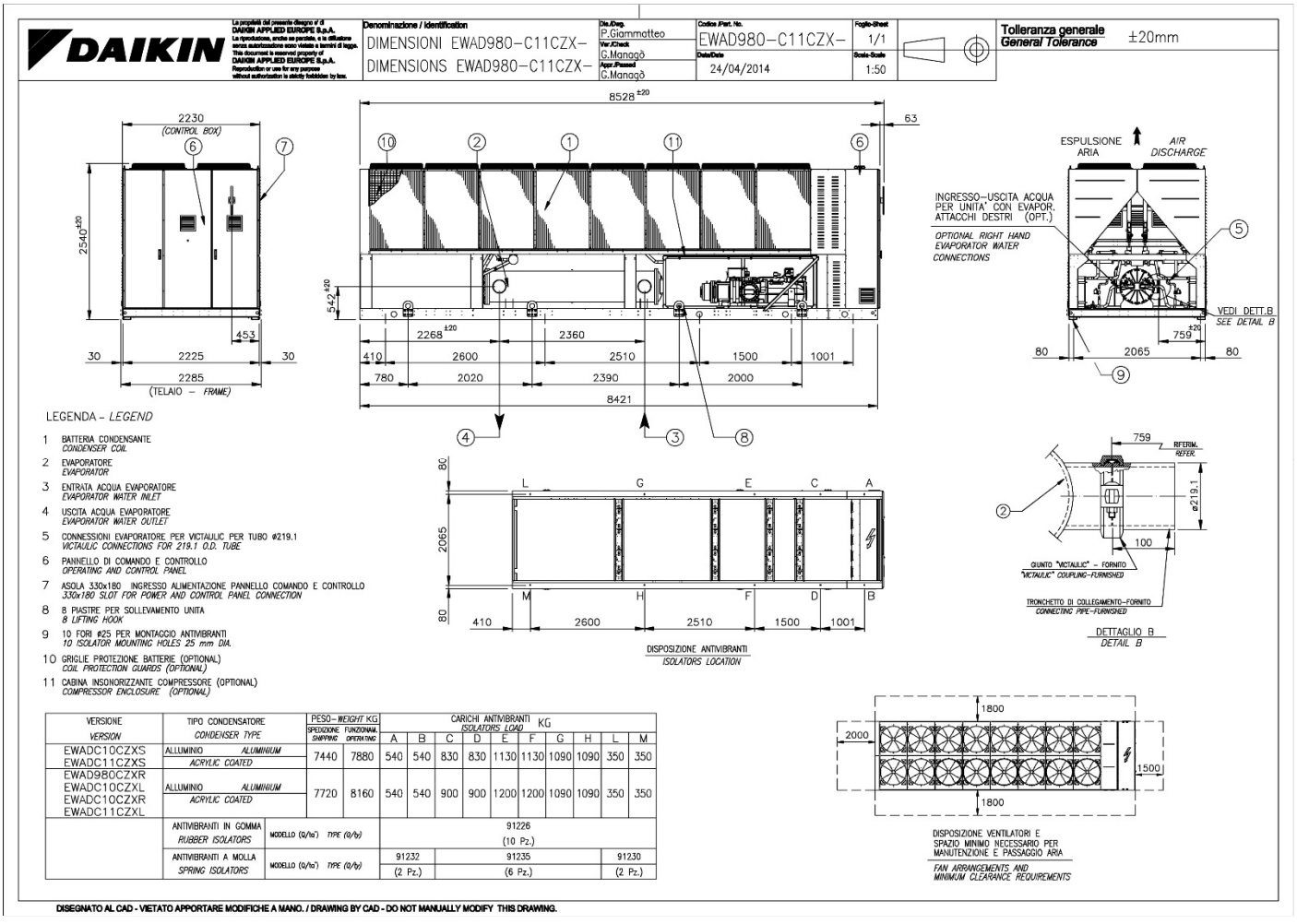
Fluid: Water
(1) Cooling capacity, unit power input in cooling and EER are based on the following conditions: evaporator 12,0/7,0°C; ambient 35,0°C, unit at full load operation;
(2) IW: Ivory White; GPSS: Galvanized and Painted Steel Sheet; (3) PHE: Plate Heat Exchanger --- S&T: Single Pass Shell & Tube
(4) CC: Closed Cell; (5) HFP: High efficiency fin and tube type with integral subcooler
(6) DPT: Direct Propeller Type; (7) DOL: Direct On Line - VFD: Inverter - BRS: Brushless
(8) The values are according to ISO 3744 and are referred to: evaporator 12/7°C, ambient 35°C, full load operation.

Figure1 Technical specifications of the installed chillers

EWAD CZXR

MODEL	Sound pressure level at 1 m from the unit (rif. 2 x 10-5 Pa)									Power
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	dB(A)	dB(A)
640	56,6	57,9	64,7	69,3	71,0	64,8	60,6	51,5	**73,5**	**94,6**
700	57,2	58,5	65,2	69,8	71,5	65,4	61,2	52,0	**74,1**	**95,2**
790	57,2	58,5	65,2	69,8	71,5	65,4	61,2	52,1	**74,1**	**95,5**
850	57,2	58,5	65,2	69,8	71,5	65,4	61,2	52,1	**74,1**	**95,5**
980	57,2	58,5	65,3	69,9	71,6	65,4	61,2	52,1	**74,1**	**95,9**
C10	57,2	58,5	65,3	69,9	71,6	65,4	61,2	52,1	**74,1**	**95,9**
C11	57,3	58,6	65,3	69,9	71,6	65,5	61,3	52,2	**74,2**	**96,5**
C12	57,3	58,6	65,3	69,9	71,6	65,5	61,3	52,2	**74,2**	**96,5**
C13	57,3	58,6	65,3	69,9	71,6	65,5	61,3	52,2	**74,2**	**97,1**
C14	57,3	58,7	65,4	70,0	71,7	65,5	61,3	52,2	**74,2**	**97,1**
C15	59,0	60,3	67,0	71,6	73,3	67,2	63,0	53,8	**75,8**	**98,8**
C16	59,0	60,3	67,0	71,6	73,3	67,2	63,0	53,9	**75,9**	**99,0**
C17	59,0	60,3	67,0	71,6	73,3	67,2	63,0	53,9	**75,9**	**99,2**

Figure2 Sound levels of the installed chillers



VERSIONE / VERSION	TIPO CONDENSATORE / CONDENSER TYPE	PESO – WEIGHT KG SPEDIZIONE / SHIPPING	PESO – WEIGHT KG FUNZIONAM. / OPERATING	CARICHI ANTIVIBRANTI / ISOLATORS LOAD KG A	B	C	D	E	F	G	H	L	M
EWADC10CZXS EWADC11CZXS	ALLUMINIO / ALUMINIUM ACRYLIC COATED	7440	7880	540	540	830	830	1130	1130	1090	1090	350	350
EWAD980CZXR EWADC10CZXL EWADC10CZXR EWADC11CZXL	ALLUMINIO / ALUMINIUM ACRYLIC COATED	7720	8160	540	540	900	900	1200	1200	1090	1090	350	350
	ANTIVIBRANTI IN GOMMA / RUBBER ISOLATORS	MODELLO (Q/ta') TYPE (Q/fy)		91226 (10 Pz.)									
	ANTIVIBRANTI A MOLLA / SPRING ISOLATORS	MODELLO (Q/ta') TYPE (Q/fy)		91232 (2 Pz.)		91235 (6 Pz.)						91230 (2 Pz.)	

Figure3 Dimensions of the installed chillers

OFFER N.: OF 000010 rev. 1 date : 28/02/2017 - **B** **CUSTOMER :** GREAT ORMOND STREET HOSPITAL SUBST ST UPU 20b

UNIT : DOWFLOW AIR COND.WITH CHILLED WATER COIL

TECHNICAL SPECIFICATIONS

Ver. 3.2.1.246 - 13/02/2017

Top suction, bottom discharge.Metal sheet frame dark grey colour (antracite).

Closing pannels made of metal sheet painted in epoxidic dark grey color. Selfextinguishing thermoacustic insulation material covered by antifriction film (A1- UNI/ISO 3795)

Microprocessor control Survey EVO. Temperature and humidity control. Standard equipped with RS485 (Modbus), terminals for smoke/fire and temperature sensor on supply.

Complete electric panel. Door lock main switch. All components are protected against short circuit or overload.

POWER SUPPLY **400/3/50+N+PE (not suitable for IT power distribution system)**

Altitude [m] 0

FILTERING SECTION

Pleated air filter. Pressure switch for dirty filter alarm

Quantity	[n]	1
Filtering efficency :		G4 (EN779)
Suggested final pressure drop	[Pa]	250
Dimensions	[mm]	700 x 640 x 48

CHILLED WATER CIRCUIT

Chilled water coil

Regulating valve : 3 way modulating ball valve

CHILLED WATER CIRCUIT PERFORMANCES

Performance are declared according EN 14511 (at gross of the heat generated by the fan)

Fluid Water + Glycole 0.0%
100 % recirculation

Re-suction air	[°C]		34.0	Water temp.inlet:	[°C]	6.0
Re-suction air	[%] 30.0	WB [°C]	20.7	Water temp.outlet:	[°C]	12.0
Discharge air	[°C]		9.4	Chilled water flow :	[l/h]	4,740
Discharge air	[%]		99.9	Coil pressure drop .	[kPa]	82.7
Total cooling capacity:	[kW]		33.2	Valve pressure drop	[kPa]	56.6
Sens.cooling capacity:	[kW]		26.4	Total pressure drop :	[kPa]	139.4
EER (Energy Effinciency Ratio)			50.30	EER = total cooling capacity / fans power input.		

VENTILATING SECTION

Plug fan EC type, air flow control according cooling capacity EC type plug fan for supply air flow regualtion in

Available static pressure :	[Pa]	30	Total power input	[kW] 0.66
Total air flow :	[m3/h]	3,200	R.P.M.	88 %
Fan	[n]	1		

ACOUSTIC PERFORMANCES

SWL fan discharge	[dB(A)]	77 at the air supply mouth without sound absorbers
SPL front of the unit	[dB(A)]	57 at 2mt in free field (ISO 3744)

SOUND PRESS.AND POWER LEV.IN OCTAVE BAND

Freq.of the cent.of the oct.band	Tot.	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
SWL fan discharge	77	75	75	76	73	67	69	68	65
SPL front of the unit	57	55	55	56	53	47	49	48	45

Figure4 Technical specifications of the installed electrical substation

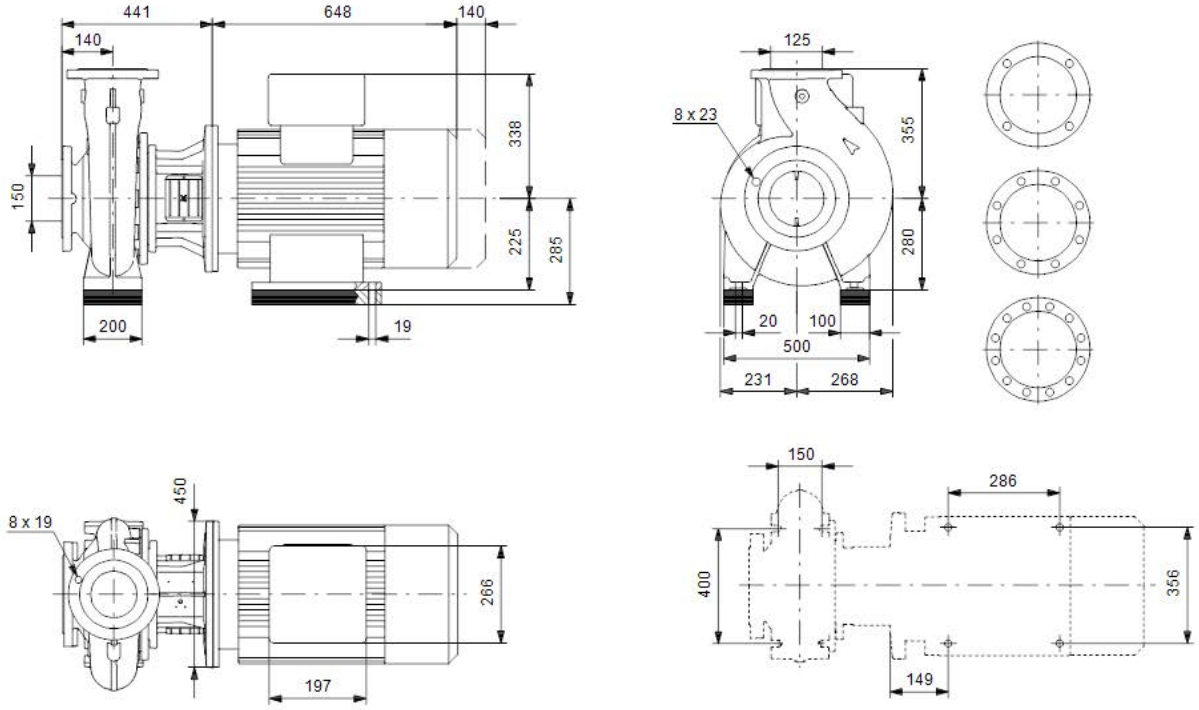


Figure5 Dimensions of the installed water pumps

Sound pressure level

Data in this table applies to pump including motor.

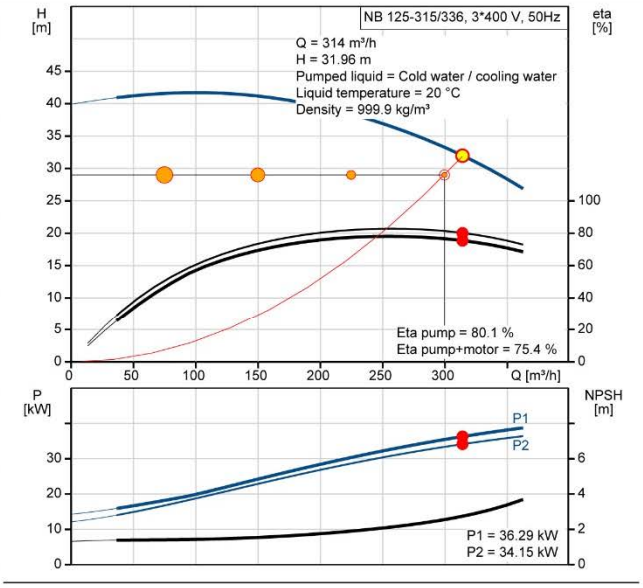
Motor [kW]	Maximum sound pressure level [dB(A)] - ISO 3743		
	Three-phase motors		
	2-pole	4-pole	6-pole
0.25	56	41	-
0.37	56	45	-
0.55	57	42	40
0.75	56	42	43
1.1	59	50	43
1.5	58	50	47
2.2	60	52	52
3	67	58	63
4	69	58	63
5.5	68	64	63
7.5	68	64	67
11	70	65	67
15	70	65	57
18.5	70	57	57
22	67	57	57
30	67	57	57
37	67	57	57
45	67	57	58
55	71	57	58
75	73	65	59
90	73	65	59
110	73	65	60
132	73	65	60
160	76	65	63
200	76	65	67
250	78	73	68
315	82	74	71
355	77	75	71
400	-	75	

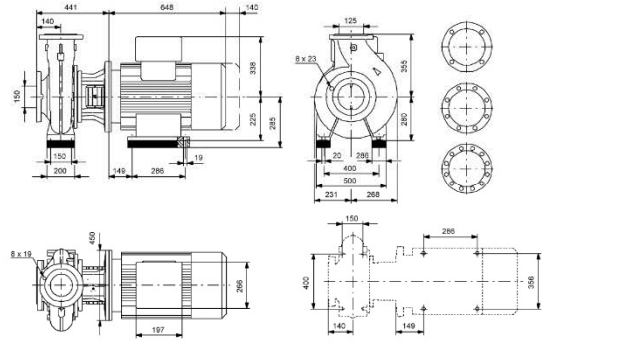
Figure6 Sound pressure level of the installed water pumps

GRUNDFOS

Company name: John Gaunt Pump Supplies
Created by: Neil Baker
Phone: 01954-232323
Email: neil@johngauntpumps.co.uk
Date: 05/12/2016

Description	Value
General information:	
Product name:	NB 125-315/336 AS-F2-A-E-BQQE
Product No:	98975779
EAN number:	5712604549360
Technical:	
Speed for pump data:	1480 rpm
Actual calculated flow:	314 m³/h
Resulting head of the pump:	31.96 m
Actual impeller diameter:	336 mm
Impeller nom:	315 mm
Primary shaft seal:	BQQE
Secondary shaft seal:	NONE
Shaft diameter:	42 mm
Shaft:	Stainless steel
	304
Curve tolerance:	ISO9906:2012 3B
Pump version:	AS
Materials:	
Pump housing:	Cast iron
	EN-GJL-250
	ASTM A48-40 B
Impeller:	Cast iron
	EN-GJL-200
	ASTM A48-30 B
Material code:	A
Rubber:	EPDM
Code for rubber:	E
Installation:	
Maximum ambient temperature:	55 °C
Maximum operating pressure:	16 bar
Flange standard:	EN 1092-2
Connect code:	F2
Pump inlet:	DN 150
Pump outlet:	DN 125
Pressure stage:	PN 16
Wear ring(s):	neckring(s)
Liquid:	
Pumped liquid:	Cold water / cooling water
Liquid temperature range:	-25 .. 120 °C
Liquid temp:	20 °C
Density:	999.9 kg/m³
Kinematic viscosity:	1 mm2/s
Electrical data:	
Motor type:	SIEMENS
IE Efficiency class:	IE3
Rated power - P2:	37 kW
Mains frequency:	50 Hz
Rated voltage:	3 x 380-420D/660-725Y V
Rated current:	69,0-64,0/39,5-37,0 A
Starting current:	640-640 %
Cos phi - power factor:	0,9
Rated speed:	1480 rpm
Efficiency:	IE3 93,9%
Motor efficiency at full load:	93.9-93.9 %
Motor efficiency at 3/4 load:	94.5-94.5 %
Motor efficiency at 1/2 load:	94.4-94.4 %
Number of poles:	4
Enclosure class (IEC 34-5):	55 Dust/Jetting
Insulation class (IEC 85):	F
Motor protec:	PTC
Motor No:	99032202





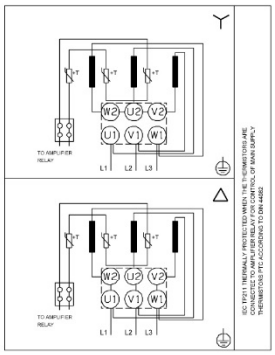


Figure7 Technical specifications of the installed water pumps