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February 7, 2022

File: 2697-22A R2

Carey Hall
5920 Iona Dr
Vancouver, BC V6T 1J6

Attention: Sam Nakai

Dear Mr. Nakai,

Re: Carey Theological College Additions
Noise from Rooftop Mechanical Equipment

As requested, we have reviewed plans for new mechanical equipment to be installed on the rooftop of the existing 2005 Carey Hall and the rooftops of the proposed new buildings on Lots 40b and 42. The purpose of our review is to confirm that noise from this equipment will comply with the noise limits specified in the University Neighbourhoods Association (UNA) Noise Control Bylaw. Of particular concern are the neighbouring residential buildings.

The limits stated in Clause 10 of the Bylaw for "Continuous Sound" are 55 dBA during the Daytime and 45 dBA during the Nighttime when measured at a Point of Reception. The Point of Reception is defined as any point outside the property line of the real property from which Noise emanates and is at least 1.2 metres above the surface of the ground. In most cases, there is a road between the College property and the neighbouring buildings and we have considered the Points of Reception to be the nearest facades of the neighbouring buildings. Since noise from rooftop equipment will generally have the greatest impact on the highest floor levels of neighbouring buildings, we have predicted noise levels at these worst-case floor levels.

The new rooftop equipment consists of VRV condenser units and Air Source Heat Pumps. Several different sizes of the Daikin REYQ VRV units will be used but according to information from the manufacturer, the sound levels produced from all of them are fairly similar. The loudest units will be the REYQ168XAYCU 14-ton units, which produce 65 dBA sound pressure level at 1m and we have assumed this worst-case level for all of the VRV units. Sound power level data has also been provided by Colmac, the manufacturer of the CxV-5 Air Source Heat Pumps that will be used on this project. However, the only data available is for a unit with ECM-controlled fans running at 250V. The units to be installed at Carey College will run on 208V and as a result, will have lower RPM, resulting in lower sound emission. Although the reduction will undoubtedly be significant, it cannot be quantified so we have used the sound power level data provided for 250V operation. Manufacturers' data sheets are enclosed. (Note that sound pressure levels and sound power levels cannot be compared directly but both can be used to predict sound levels at a distance.)

We have used the internationally recognized 3-D noise mapping software Cadna/A to predict noise levels at the Points of Reception. The model accounts for acoustic shielding by any obstructions such as barriers or building components in-between the noise source and the receiver. Acoustic shielding is

frequency dependent so all of the equipment source levels were provided to us in octave bands and the model accounts for the frequency dependence of acoustic shielding.

We have assumed that all of the new rooftop equipment may operate simultaneously during nighttime hours so the applicable noise limit at Points of Reception is 45 dBA. Although the drawings show 2 metre high architectural screens surrounding all of the new rooftop equipment, we assumed initially, that they may be perforated or louvred and only effective visually. Hence, they were not accounted for in the initial modelling. However, the initial modelling results indicated that 45 dBA would be exceeded at some locations. Therefore, we have recommended that at least some portions of these 2 metre high screens should be solid in order to provide additional sound attenuation.

Predicted sound levels, assuming that solid screens are provided as indicated in Figures 1, 2 and 3, are shown in Figure 4. The solid sections required are indicated by red lines in Figures 1, 2 and 3. The one additional screen on the rooftop of the Lot 40b Building, between the VRV units and the heat pumps is necessary because it needs to be close to the heat pumps in order to provide sufficient sound attenuation.

Referring to Figure 4, there is a single location at the top floor of the Corus Building directly southwest of Lot 40b where a level of 46 dBA is shown. However, the level at that location is controlled by noise from the air source heat pumps on the rooftop of the Lot 40b Building. As noted previously, noise from the heat pumps will actually be lower than assumed in the modelling due to fans operating at lower voltage and lower rpm. Hence, we are confident that the noise level, even at this location, will not exceed 45 dBA.

The solid screens could utilize almost any material having a surface weight of at least 2 lb/ft^2 (10 kg/m^2). For example, steel, aluminum or transparent panels formed of plastic polymers could be used as long as they have an impervious surface with a negligible number of holes or cracks (< 0.2% of total area) and they have the required surface weight. Ideally, there should be no gap along the bottom edge but a few scuppers could be provided for drainage if required. If the architectural screens that are already shown on the drawings do not meet these requirements, they could be retained but backed by a solid layer at the required locations, thereby retaining a consistent visual appearance from an outside viewpoint.

Based on our assessment and assuming that the recommended acoustic screens will be provided, it is our professional opinion that the requirements of the UNA Noise Control Bylaw will be fully satisfied.

Sincerely,

BKL Consultants Ltd.

per:

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
Feb. 7, 2022
D. S. KENNEDY

Douglas S. Kennedy, P.Eng.
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Enclosures: Figures 1 – 4
Equipment Data Sheets

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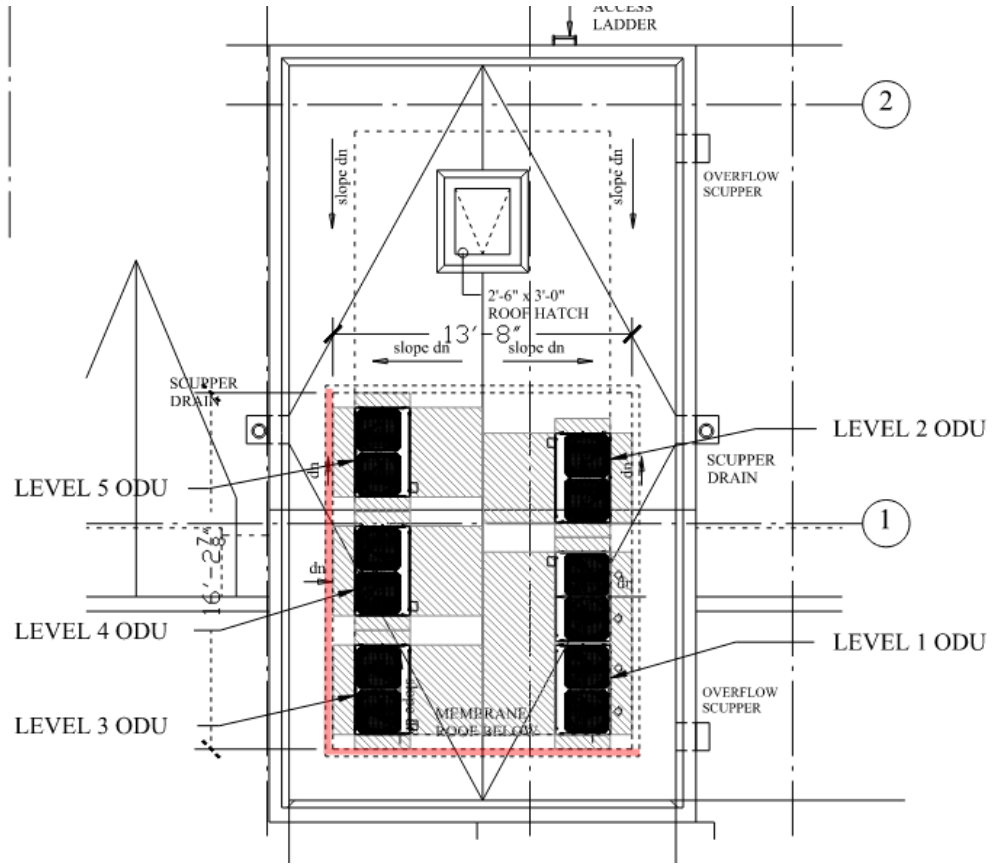


Figure 1: VRV Units and Screening on Rooftop of Existing 2005 Building

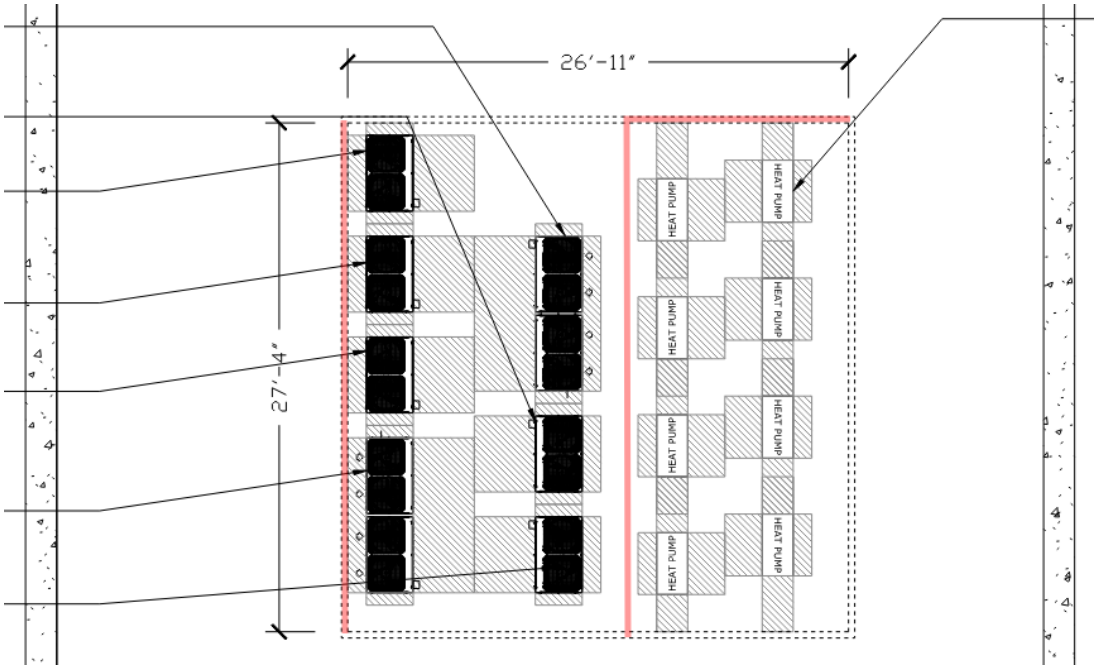


Figure 2: VRV Units and Heat Pumps on Rooftop of New Building 40

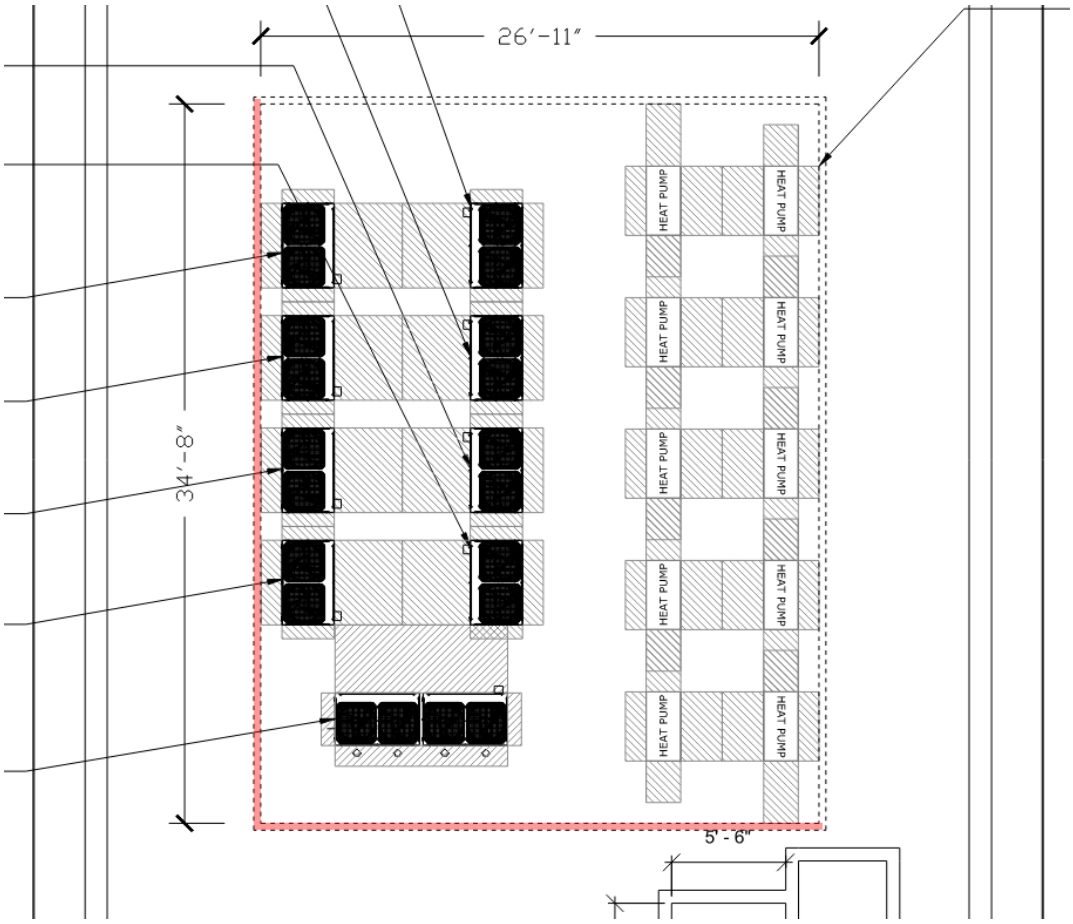


Figure 3: VRV Units and Heat Pumps on Rooftop of New Building 42

Figure 4: Predicted Noise Levels (dBA) at nearest Points of Reception

Submittal Data Sheet

14 ton, 575V, VRV IV X HR

REYQ168XAYCU

FEATURES

- Industry's first 3 phase VRF system to integrate with communicating gas furnaces.
- Design flexibility to enlarge system from single to dual module or dual to triple module without changes to installed main pipe sizes.
- Engineered with Daikin vapor injection compressor for optimized part load efficiencies.
- Hot gas defrost circuit with improved control logic allows installation without base pan heater.
- New service window provides quick access to multi-functional display and configuration buttons.
- Multi-functional display provides refrigerant pressures and temperatures eliminating the need to connect gauges during regular maintenance check.
- Easy commissioning with ability to program settings off site using configurator tool.
- Assembled in the US to increase flexbility and reduce lead times.
- Standard Limited Warranty: 10-year limited parts warranty.

BENEFITS

- Choice of gas furnace or heat pump heating for optimizing operational costs based on utility cost.
- Engineered to optimize capital on phased & tenant fit out commercial buildings.
- Year round comfort and energy savings with Variable Refrigerant Temperature technology (VRT).
- Modular and lightweight - enables flexibility in system layout and installation
- Corrosion resistance 1000hr salt spray tested Daikin PE blue fin heat exchanger
- Refrigerant cooled inverter technology keeps PCB cool independent of ambient temperature
- Field performable Intermittent outdoor fan operation to help minimize snow accumulation on fan blades when the system is off.
- Backwards compatible with T-series Branch Selector boxes.

Submittal Data Sheet

14 ton, 575V, VRV IV X HR

REYQ168XAYCU

PERFORMANCE

Outdoor Unit Model No.	REYQ168XAYCU	Outdoor Unit Name:	14 ton, 575V, VRV IV X HR
Type:	Heat Recovery	Unit Combination:	
Rated Cooling Conditions:	Indoor (°F DB/WB): 80 / 67 Ambient (°F DB/WB): 95 / 75	Rated Heating Conditions:	Indoor (°F DB/WB): 70 / 60 Ambient (°F DB/WB): 47 / 43
Rated Piping Length(ft):			
Rated Height Difference (ft):			
Rated Cooling Capacity (Btu/hr):	160,000	Rated Heating Capacity (Btu/hr):	180,000
Nom Cooling Capacity (Btu/hr):	168,000	Nom Heating Capacity (Btu/hr):	188,000
Cooling Input Power (kW):	15.50	Heating Input Power (kW):	15.70
EER (Non-Ducted/Ducted):	10.70 / 10.60	Heating COP (Non-Ducted/Ducted):	3.5 / 3.2
IEER (Non-Ducted/Ducted):	22.30 / 20.40	Heating COP 17F (Non-Ducted/Ducted):	2.1 / 2.1
		SCHE (Non-Ducted/Ducted):	25.50 / 22.20

OUTDOOR UNIT DETAILS

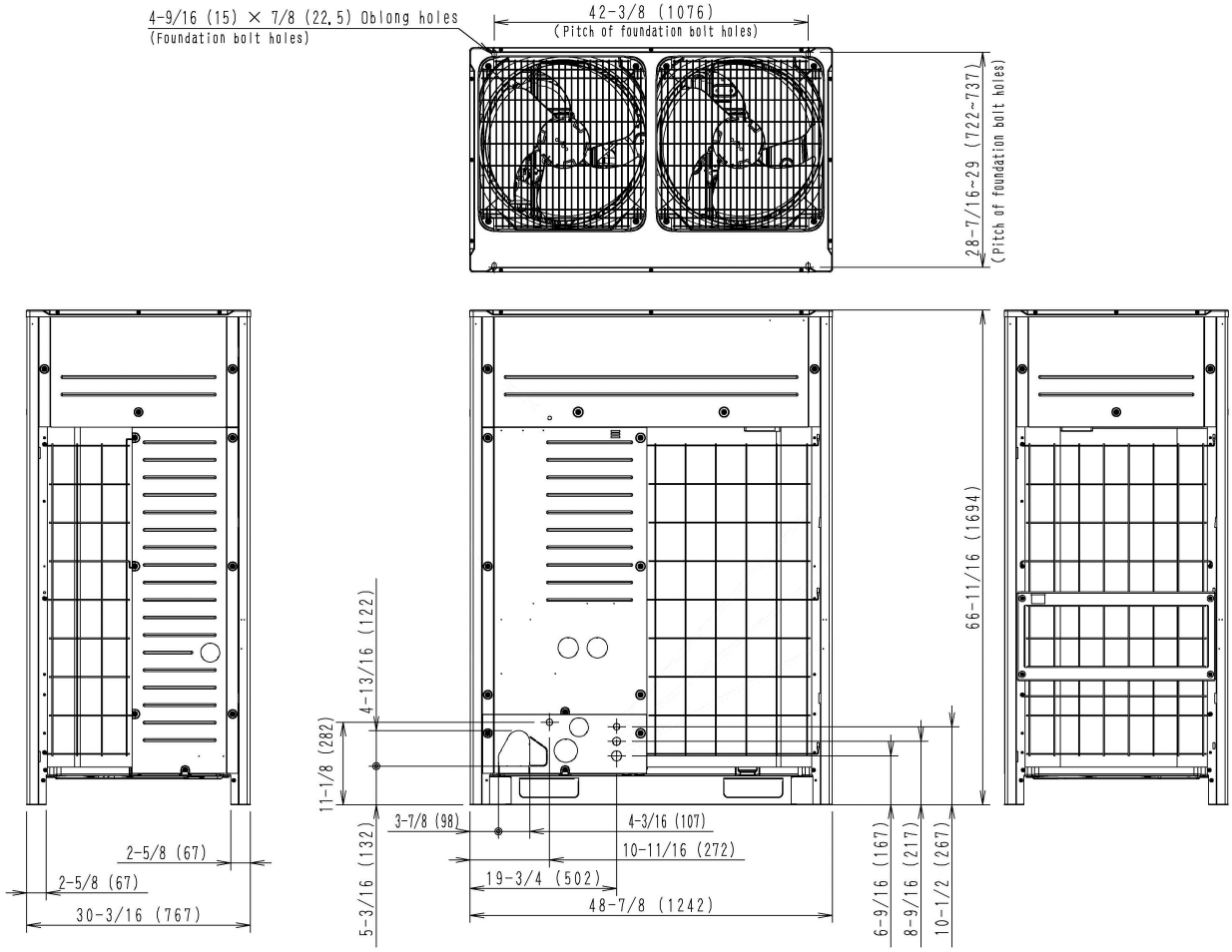
Power Supply (V/Hz/Ph):	575 / 60 / 3	Compressor Stage:	
Power Supply Connections:		Capacity Control Range (%):	12 - 100
Min. Circuit Amps MCA (A):	24.9	Capacity Index Limit:	84.0 - 218.0
Max Overcurrent Protection (MOP) (A):	30	Airflow Rate (H) (CFM):	9480
Max Starting Current MSC(A):		Gas Pipe Connection (inch):	1-1/8
Rated Load Amps RLA(A):	17.7	Liquid Pipe Connection (inch):	5/8
Dimensions (Height) (in):	66-11/16	H/L Pressure Connection (inch)	7/8
Dimensions (Width) (in):	48-7/8	H/L Equalizing Connection (inch)	
Dimensions (Depth) (in):	30-3/16	Sound Pressure (H) (dBA):	65
Net Weight (lb):	793	Sound Power Level (dBA):	

Submittal Data Sheet
14 ton, 575V, VRV IV X HR
REYQ168XAYCU

SYSTEM DETAILS

Refrigerant Type:	R-410A	Cooling Operation Range (°F DB):	23 - 122
Holding Refrigerant Charge (lbs):	25.8	Heating Operation Range (°F WB):	-13 - 60
Additional Charge (lb/ft):		Max. Pipe Length (Vertical) (ft):	295
Pre-charge Piping (Length) (ft):		Cooling Range w/Baffle (°F DB):	-
Max. Pipe Length (Total) (ft):	540	Heating Range w/Baffle (°F WB):	-
Max Height Separation (Ind to Ind ft):			

DIMENSIONAL DRAWING



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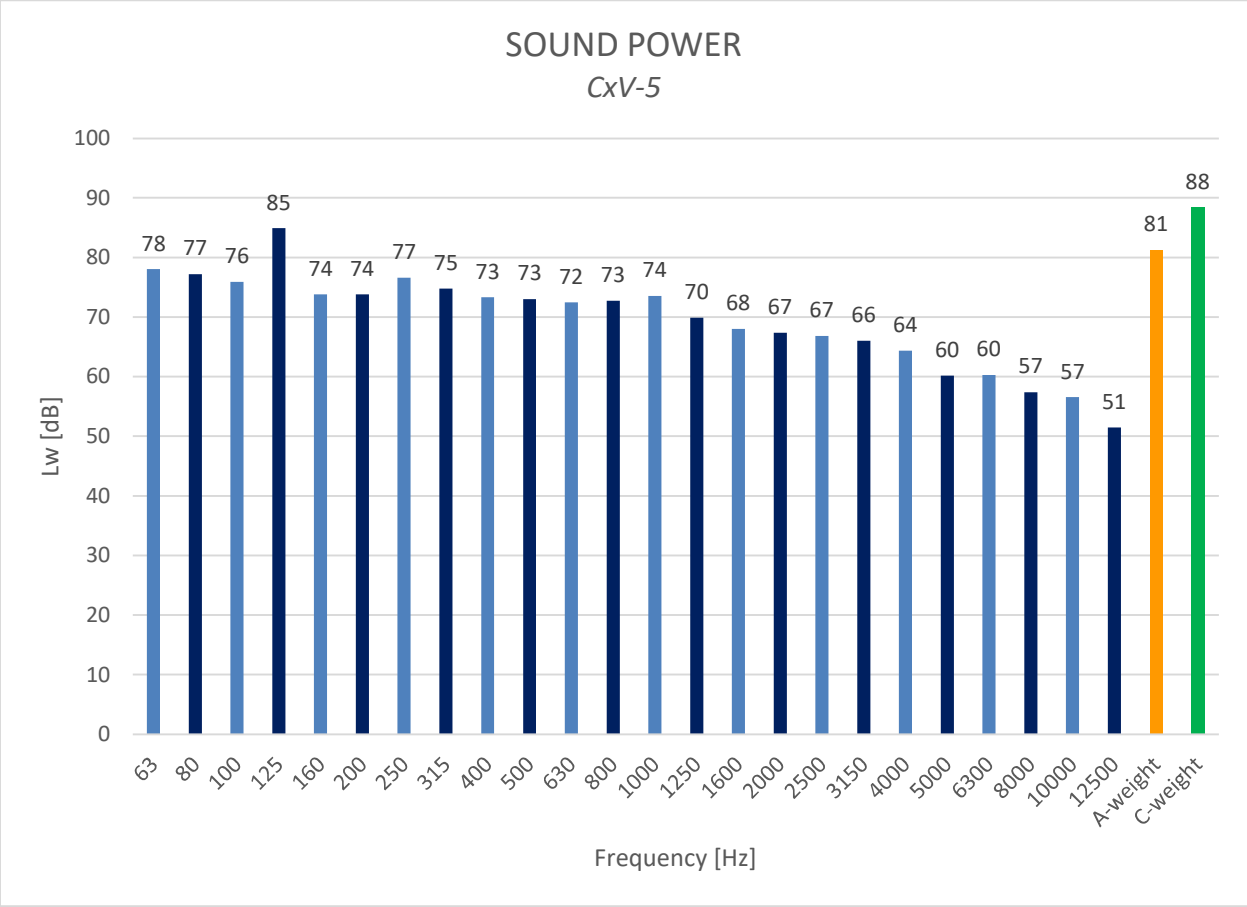
CxV-5 Sound Power Report



Testing, calculations, and reporting procedures conforms to standards *ANSI/ASA S12.54-2001 / ISO 3744:2010*.

Disclaimer: Testing performed with service voltage 250V. Fan is not ECM-controlled so RPM and sound power will be higher than typical 208V or 230V installations.