Heat Pump Acoustics in a Typical Residential Setting

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Abstract

This article presents a background to heat pump acoustics in a residential setting, providing information in the design, installation and control of external noise from heat pumps. Details are presented of how to carry out a basic desktop assessment of expected sound pressure levels at the site boundary and how to conduct field measurements. An introduction to environmental law relating to assessment of external heat pump noise and some common mitigation methods at the design and installation stage are presented.

Introduction

Air source 'heat pumps' are a common heating and cooling solution in many New Zealand homes. Space heating and cooling accounts for around 35% of the energy a typical New Zealand home uses. The Building Research Association of New Zealand [BRANZ] reported that there could be as many as 170,000 heat pumps installed in New Zealand as at 2007 [Ref: BRANZ Build Magazine, 2007 'Heat Pumps – Energy Solution or Issue?].

Space Heating Choices

There are several options available for space heating in a dwelling, including solid fuels such as wood, natural gas, solar heating and electricity. Various factors come into play regarding which type of fuel and heating system is chosen by the home owner including but not limited to cost; namely the capital cost to set up the system, and operational costs to run the system on a daily basis. How 'environmentally friendly' the system is and other factors such as how quickly the system can produce heat when switched on are also issues that home owners should consider.

Anecdotal evidence suggests that the capital and operational costs are two key factors in the selection process. In the specific case of a heat pump, the heating or cooling is fairly 'instant' i.e. at the press-of-a-button on the remote control unit. Noise emissions and related environmental effects are often secondary [if considered at all] in the selection process. Generally it is not until noise becomes an issue at a neighbouring residential site that the home owner is aware of their obligations to control noise from the external heat pump unit under their control on their property.

Figure 1: Photo of internal [top] and external [bottom] heat pump units [wiring and piping not shown].

Types of Air Source Heat Pumps

There are various kinds of heat pumps, however as stated above the 'air source heat pump' [also known as air-to-air] are the most frequently used models in New Zealand homes. Heat pumps operate on the same basic principle of heat transfer, that is an air source heat pump uses outside air as a heat source or heat sink. Regardless of the type of system a heat pump is made up of several key components these relate to the external unit outdoors which is connected to an internal unit. A compressor, condenser and refrigerant system is used to absorb heat at one place and release it at another.

The most common type of residential systems used to heat large volume areas such as living rooms are split systems which have an external compressor unit connected to the internal unit [usually wall mounted] by refrigerant copper pipes and electrical wiring. The interior unit which transfers the heat/cool energy into the room is made up of electrical controls and a fan unit often with directional fins.

The pipes and electrical wiring run between the external and internal units [usually passing through a penetration in the external building facade] and are covered over for weather protection and insulation purposes. The split system can come in different modes including multi-split which refers to the external unit connecting to more than one internal unit or ducted systems which are usually located in the sub-floor or roof space with ducted outlets and flush mounted grille outlets.

There may also be multiple external compressor units, with one unit linking to the downstairs area of a dwelling and the other external unit linking to upstairs for example. Systems can also vary with the larger external units having two large fans and related auxiliary components.

Figure 1 (page 4) illustrates a photo of a typical heat pump internal [wall mounted] unit and external inverter unit.

There are several types of heat pump models including reverse cycle heat pumps which can heat and cool a room. Most new residential heat pumps currently use inverter technology, which has a variable speed motor that speeds up or slows down to maintain temperature indoors.

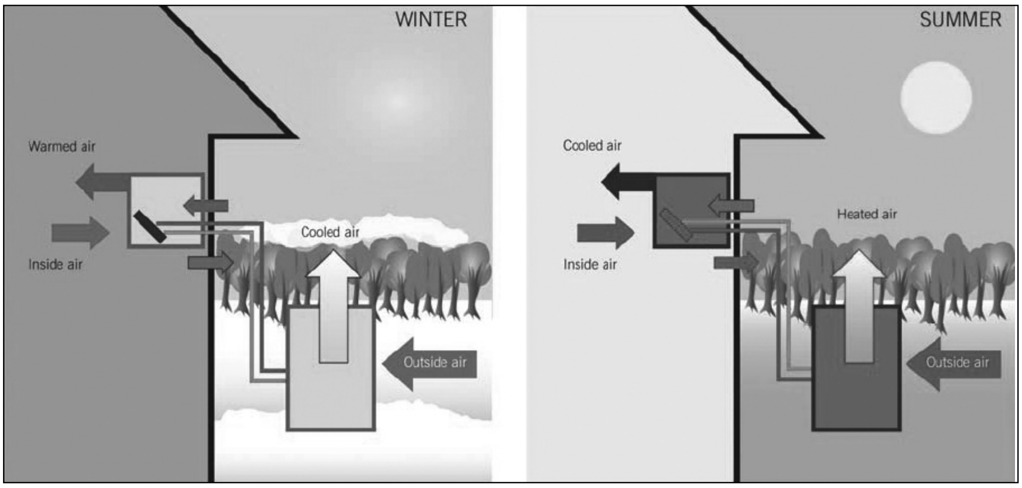

Figure 2: Photo of how air source heat pump modes work. Reproduced with the Permission of BRANZ [© BRANZ].

The inverter models have benefits over the single speed models in that they are generally more energy efficient, perform better in cooler external conditions, and do not create 'surges' in the demand for electricity.

Older types of heat pump which did not have inverter technology relied on a single speed motor that was either switched on or off. This generally means that the heat pump turns off when it reaches the programmed temperature inside the room. The system then turns itself back on when the temperature drops and the cycle continues [much like a fan heater with a simple thermostat]. Single speed or fixed speed models are not common in the market any more.

Heat Pump Heating and Cooling Modes

The outside air gets heated up by energy from the sun. Even when the sun is not shining, or it is the middle of winter, there is still 'solar heat energy' to be gained. Because heat pump systems only use electricity to 'move' heat they are viewed as being relatively efficient i.e. for a heat pump with 300% efficiently this means for every 1 kWh of electrical power the unit uses the unit will generate a 3 kWh heat output.

Heat pumps don't 'make' heat themselves like traditional electric heaters. In order to keep food chilled a fridge will move internal heat from inside the fridge to the outside of the fridge to maintain the desired internal temperature.

This is a heat pump system in itself. A space heating system uses the same principal but in reverse with the transferring heat from outside the dwelling via the external unit to the inside via the internal unit.

Like the fridge example in cooling mode the heat pump takes warmth out of the air inside the dwelling and moves it to the outside. If designed appropriately, heat pumps can still take heat out of the air below freezing, which is often required in some New Zealand climates, particularly in the lower South Island and centre of the North Island.

Figure 2 illustrates the winter and summer modes for a typical heat pump.

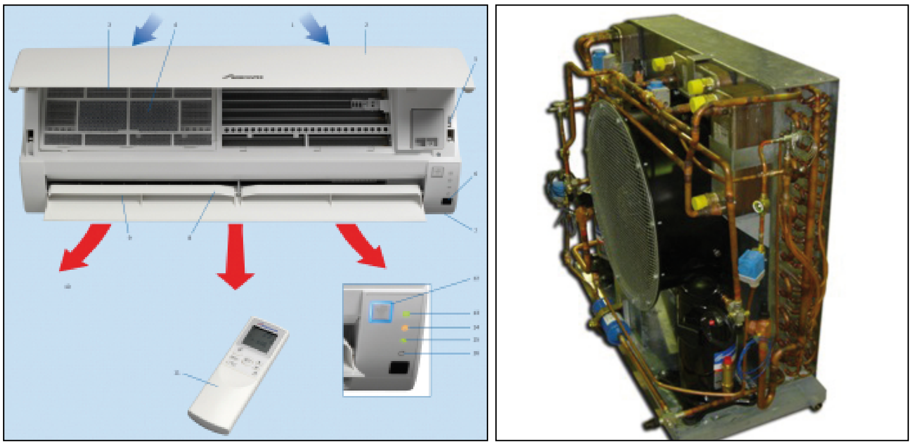

Figure 3: [Left] Internal heat pump unit with remote. [Right] Typical external heat pump unit with the cover removed.

Design, Layout and Installation

An installer will usually carry out a site visit and then provide advice on the recommended unit type, model and placement. Installers should be aware of the need to take account of the noise emissions, especially relating to the external unit.

In most cases the client will request that the external unit is placed in an area where it won't be seen, generally due to aesthetic reasons. The outdoor unit needs to be away from any position where normal air flow is restricted, including under the dwelling or deck for example. The units also require space to allow for proper air circulation.

In addition the outdoor unit is usually placed within proximal distance to the indoor unit i.e. in most cases back to back. Based on these factors and limited size of many residential lots, the external unit will often end up being placed close to an adjoining site boundary where noise emissions may become an issue. In many cases the neighbouring dwelling is also within close proximity of the site boundary. In certain cases such as inner city lots where the dwellings building footprint covers the majority of the site, external units may be elevated, being either attached to the side of the dwelling on a bracket type support system or located on the roof in some cases.

Heat Pumps as Noise Sources

A heat pump has several main components; with regards to external environmental noise the key noise sources associated with the external unit of an open air heat pump are the fans. Secondary components include the compressor, evaporator, condenser, coils and reversing valve.

On the end of the external unit a liquid refrigerant is pumped through coils. The fan pulls the outside air over these coils; the liquid in the coils absorbs the heat energy from the air and starts to expand the vapour. The expanding vapour is run through the compressor which increases in pressure and hence

increases the temperature of the gas – the vapour then flows to the indoor coils, the refrigerant condenses back into a liquid as it cools and flows outside to perform the cycle again to 'pick up' more heat, meanwhile the heat is released into the dwelling via the internal unit.

Figure 4: Photo of a heat pump being measured under typical summer cooling mode.

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Fan [blade] noise is generally the dominant [and audible] noise source. Noise from the internal unit is seldom an issue outside the dwelling; however air distribution by the fan inside can produce audible noise, especially at higher air flow settings when increased air flow is being forced through the grille.

Outdoors, noise annoyance often occurs because the unit produces noise which is received at levels over and above the background sound levels. This means that audibility of the heat pump sound is often more important than the absolute level of noise present.

Heat pumps are generally used for heating in cooler months and in some parts of the country cooling in the summer months. Space heating occurs mostly at night when occupants are home in the evening, which coincides with times when background sound levels decrease due to a general reduction in outdoor activities.

Figure 3 (page 7) illustrates a typical internal unit of a heat pump with open front panel [left] and external heat pump unit with the cover removed [right].

Sample of External Heat Pump Sound Pressure Levels

Figure 4 (above) illustrates a photo of a heat pump being measured under typical summer cooling mode.

A sample of a time varying sound level trace at 5 metres directly in front of an external heat pump unit is shown in Figure 5 (below). Measured levels [LAeq (1 Sec)] shown in the sample were predominately fan blade noise. The sample illustrates that this measured heat pump noise is a periodic cycle.

The cycle consists of the unit operating for approx three to four minutes, switching off for a couple of minutes and then turning on again, this cycle repeats itself over and over

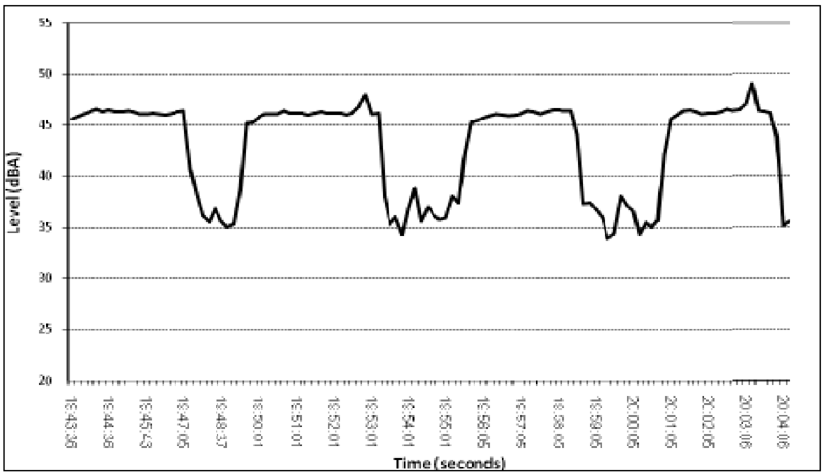

Figure 5: Graph of sample time varying [steady sound with stepped variations] in sound pressure levels during heating mode.

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Understanding the Numbers

Most external heat pump units have a rated sound level on the side of the unit in the form of a sticker or plate. It is not uncommon for the external heat pump sticker to provide a warning along the lines of 'consult the supplier as to whether the outside out levels will be within acceptable limits', referring to the acceptable noise limits set out within local authority district plan.

The quoted sound level rating is normally provided as a sound power level [as opposed to a sound pressure level]. The sound power level relates to a calculated reference power of 10-12 Watts. The sound pressure level is the parameter that is usually controlled by noise limits and relates to the level of sound received at a specific distance from source i.e. 65 dB @ 3m.

A sound pressure level at a distance from source will always be lower than the respective sound power level. No noise assessment is possible if it is not clear whether the quoted decibel level is a sound power rating or a sound pressure level.

Figure 6 (page 9) illustrates a typical label found on the side of a residential heat pump external unit. This specific label provides a sound power level of 64 dBA for the external unit.

In order to carry out a desk top calculation of the expected sound pressure level at the site boundary [at distance R] for a source on the ground against the side of a building, the following

formula may be used. The sound power level for the external unit and distance between the source and receiver [R] must be known.

The following formula can be used to provide an estimated sound pressure level at distance [R] when the rated sound power level is known:

Sound Pressure Level (Lp) = Rated Sound Power Level (Lw) - 20*lg[R] - 5 [dB]

OR

Lp = Lw - 20*lg[R] - 5 [dB]

The heating capacity of a heat pump [in the heating mode] is generally between 2 kW and 15 kW for residential systems. The rated sound power level would generally range from 50 dBA up to 80 dBA. In the case of the sample shown in Figure 6 with a rated outside sound power level of 64 dBA, the expected sound pressure levels at various distances from the external unit are provided in Table 1 (below).

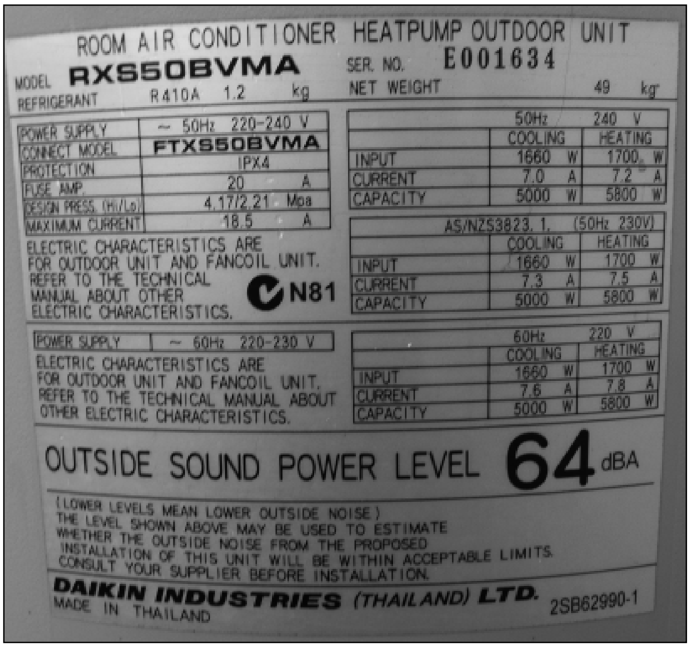

Figure 6: Photo of external unit sound power level plate.

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The above formula, used to calculate the expected sound pressure levels in Table 1 is based on an external unit positioned against a single wall [reflecting surface]. The formula does not take account of factors such as screening from fences and buildings or any type of correction factors such as directivity, additional reflective surfaces, or special audible characteristics from the noise under investigation [if present].

Distance from External Heat Pump Unit to Receiver	Expected Sound Pressure Level
2 metres	53 dB LAeq
4 metres	47 dB LAeq
6 metres	43 dB LAeq
8 metres	41 dB LAeq
10 metres	39 dB LAeq
12 metres	37 dB LAeq

Table 1: Table of distances versus sound pressure levels from example external unit.

Specialist advice from an acoustic consultant would be advised in situations where compliance is marginal or there is a situation involving screens or barriers for example.

Who is Responsible for Noise Emissions from Heat Pumps?

The applicable law in New Zealand [Resource Management Act 1991, RMA] establishes the site occupant is responsible for noise emissions from their site, regardless of whether the site occupant is renting the dwelling or owns the dwelling.

In addition to specific noise limits, Section 16 of the RMA is key regarding environmental noise management as it places a general duty on all occupiers to adopt the best practicable option [BPO] to ensure noise emitted from any site does not exceed a reasonable level.

So what is reasonable level of noise? Interestingly what constitutes a "reasonable level" is not prescribed by the Act. However the permitted day and night noise criteria as set out in district plans may be used as a guide. It should be noted that audibility i.e. the fact that heat pump sound can be heard at the site boundary does not necessarily mean the noise is unreasonable or above the permitted district Plan noise limits.

In addition to Section 16 of the RMA another key section in relation to environmental noise is Section 17 - the "duty to avoid, remedy, or mitigate adverse effects" which includes noise effects. Section 17 states every person has a duty to avoid, remedy, or mitigate any adverse effect on the environment arising from an activity carried out by or on behalf of that person, whether or not the activity is in accordance with a rule in a plan.

Individual territorial authority (city or district councils) sets noise limits in district plans which usually apply at the site boundary in a residential setting. These noise limits are generally set higher for daytime and lower for night-time, reflecting a higher degree of protection for sleep and amenity. An example of a permitted daytime noise limit may be 55 dB LAeq (15 min) and 45 dB LAeq (15 min) for night-time.

Heat pump noise is generally regarded as a "residential activity". There are a mixture of rules across New Zealand in district plans for residential zones. In some cases the noise limits only apply to non-residential activities, so heat pumps as a residential activity are exempt from the noise limits. A sample of wording from a district plan may read [emphasis added]:

"...*All* **non residential** *activities must not exceed*

the specified sound limits when assessed anywhere within a residential activity area other that the site on which the activity takes place…"

Alternatively, there are other examples such as the Wellington City Plan which specifically includes mechanical plant under the noise limits in a residential setting. The Wellington City Plan Residential Area Rules state that [emphasis added]:

"…Noise emission levels resulting from noise associated with power generation, **heating, ventilation or air conditioning systems**, *or water or sewage pumping/treatment systems or other similar domestic installations when measured at or within the boundary of any site, other than the site from which the noise is generated, in the Residential Area shall not exceed the following limits:.."*

The final type of rule is a 'blanket' rule which states that all activities [including heat pumps] must not exceed the permitted district plan noise limits. Regardless of the type of rule and whether heat pumps are included or excluded from the noise limits, the RMA still applies including Section 17 that imposes a general duty to avoid, remedy or mitigate potential adverse effects, including noise, and Section 16 that requires noise emitted from a site not to exceed a reasonable level in line with the best practical option.

This duty applies to every person, company, legal entity, and the Crown, and includes persons undertaking activities on designated sites. There are generally no exceptions. The duty to adopt the best practicable option is in addition to the duty to comply with territorial authority's district plan noise limits, and not in substitution.

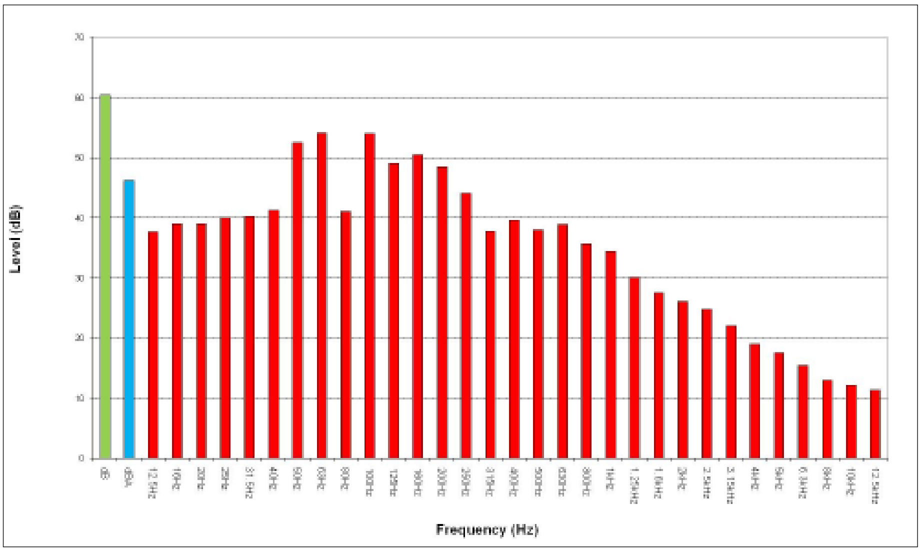

Figure 7: Graph of third octave sample from heat pump sound pressure levels during heating mode.

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Year	Number of Complaints Received	Non-Complying Action Required
2000	1	0
2001	1	0
2002	0	0
2003	6	2
2004	12	2
2005	7	0
2006	17	4
2007	10	2
2008	27	9
2009	29	10

Table 2: Noise complaints received regarding heat pumps in Christchurch City since 2000.

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Additional Penalties and Adjustments

In addition to ensuring the overall sound pressure level complies with the permitted District Plan noise rules, the content of the sound, e.g. frequency spectrum, must also be considered. Not all sound pressure levels are equally loud. Human hearing does not respond equally to all frequencies. Our ears are much more sensitive to sounds in the frequency range approx 1 kHz to 4 kHz than to very low or high frequency sounds. When using sound level meters, frequencies are 'weighted' [A-weighted i.e. dB (A)] similar to hearing. The A-weighting is used in most noise standards in district plans.

Most District Plans require noise to be measured and assessed using the New Zealand Standards NZS 6801 and 6802, the most recent versions being NZS 6801:2008 Acoustics - Measurement of Environmental Sound and NZS 6802:2008 Acoustics - Environmental Noise. Any special audible characteristic such as prominent tonal noise is judged to be more subjectively annoying and attracts up to a 6 dB penalty under these standards. Such a penalty would reduce a permitted level of 45 dB LAeq (15 min) to 39 dB LAeq (15 min).

In the case of heat pump noise it would be uncommon for a modern unit to be assessed as requiring adjustment for special audible characteristics. Such a situation would be likely to only occur where maintenance has not been carried out and a rotating mechanism such as a fan blades are out of balance, and rubbing for example, providing an obvious unnatural noise characteristic for the unit.

Figure 7 (page 10) shows the third octave frequency spectrum of a heat pump external unit. As with all rotating machinery, while there is increased energy at certain frequencies, this is not unduly prominent and would not attract a penalty for special audible characteristics. .

6802:2008 Acoustics - Environmental Noise states under Section 5.4 "Adjustments" that where there are structures other than the ground [i.e. reflections that may affect the sound field near the microphone] such reflections need to be taken into account.

The provisions of NZS 6801:2008 Acoustics - Measurement of Environmental Sound shall be used to adjust such assessment and measurements. This standard provides guidance on adjustment for such things as facade corrections.

Who is Responsible for Enforcing Noise Limits Relating to Heat Pumps?

Territorial authorities [city or district councils] have the primary responsibility for managing the effects of noise. In preparing this article several city and district councils were contacted, including both Environmental Health Officers and Planners. From the limited information available heat pump noise complaints do exist, however as a percentage of the total number of noise complaints heat pump complaints are minor. This does not mean that more people are not upset by the noise than complaints actually reported.

Information provided by the North Shore City Council [NSCC] shows that in the period of 1 October 2007 to 30 September 2008 there was a total of 12 complaints relating to heat pump noise, and in comparison to a total of 6159 noise complaints for the same period this is less than 0.2%. Party music was the biggest complaint making up over 90% of all complaints.

Information provided by Wellington City Council [WCC] for noise complaints received between May to October 2009 show 7 complaints regarding heat pump or small plant noise. In total there were 3930 noise complaints and of these 2347 were residential noise complaints. As with NSCC, of the 7 complaints, if all were residential complaints from heat pumps, this would equate to less than 0.3% of the total residential noise complaints.

Although the statistics that are available show that as a percentage of overall complaints heat pumps are minor, the trend from anecdotal comments appears to be that complaints from this noise source are significantly on the rise. Information provided by Christchurch City Council show that in the year 2000, only one complaint was received about a heat pump. However in 2009 as at the beginning of November there were 29 complaints, 10 of which were categorised by this council as 'non-complying and requiring action'.

However Christchurch City Council [CCC] does state that many of these complaints were resolved by simply

talking with the two parties and arriving at an acceptable resolution which is a sensible and pragmatic approach. The Christchurch City Council is one of several councils which have taken the initiative of producing design guidelines to assist its rate payers with the installation of heat pumps. Table 2 (previous page) illustrates the number of complaints received regarding heat pumps in Christchurch City since 2000.

Management Tips for Territorial Authorities to Deal with Noisy Heat Pumps

If a council assesses heat pump noise emissions to be in breach of the permitted district plan noise limits or to be 'excessive' or 'unreasonable' there are several control mechanisms available. The three main tools for the control of intrusive noise under the RMA are abatement notices; enforcement orders and excessive noise direction notices. Some basic tips for councils to consider are set out as follows:

- Work with the home owners of heat pumps so that they are made aware of their duties and responsibilities including Sections 16 and 17 of the RMA.
- Monitor potential problem sites. Talk to the affected neighbours to understand the nature of the problem. This involves assessment of the degree of impact and the type and scale of required noise mitigation.
- If council believes there is an issue or potential future issue they should consider informing the noise maker of breaches and possible breaches of noise limits as soon as possible.
- Councils should consider avoiding using excessive noise direction notices to deal with known, on-going noise problems that are not temporary, including a fixed heat pump on a residential site. In such circumstances it may be more efficient to use an abatement notice or enforcement order for on-going noise nuisance activities which are failing to adopt effective noise control measures.

Council should consider use of such notices being employed only after council has attempted to work through the issues with noise makers - as issuing an excessive noise direction notice for example does not always achieve the aim of long term noise mitigation, it is a sticking plaster approach in most cases. Time and investment of council may be better used assisting the home owner. In some circumstances where there is an extremely noisy event this may on balance require immediate attention after consideration of all possibilities - an excessive noise direction notice would be the most efficient method to use in such a case.

Design Precautions

Proper planning prior to purchase and installation can avoid noise problems with heat pumps. As indicated above there can be limited space between residential site boundaries and external heat pump units. Clients should ask suppliers and installers to provide evidence that the heat pump external unit can comply with the district plan permitted noise levels at the closest site boundary.

The preferred approach is for control at source recognising the general duty to avoid unreasonable noise by containing as much of the sound as possible, this

can be achieved by two key methods described as:

- Management based methods [particularly the specification and selection of the heat pump external unit] and;
- Physical precautions [external unit location, orientation and design]

In the case that the external unit may not meet the permitted noise rules from appropriate placement or specification of the unit then the design of physical noise mitigation measures such as screening would need to be considered. This is a less preferred approach compared to appropriately locating the unit away from noise sensitive boundaries.

The following are some common noise control methods to assist in reducing external noise.

Acoustic Rating and Location of Heat Pump

The first two issues that should be considered are the overall rating [sound power] and location of the heat pump. As discussed above noise complaints usually arise from the location of the external unit being too close to the site boundary or habitable spaces such as bedrooms. There is a long list of do's and dont's for the installer to consider to best optimise the performance of the unit, which don't include noise, so when obtaining a quote ensure that the installer and/or supplier undertakes the appropriate assessment to ensure that the unit can comply with the relevant district plan rules, including noise. Ask for this to be included in the contract.

Check the following with the installer:

- Distance factor from site boundary to external unit – The closer the unit is to the site boundary the lower the sound power level will need to be on the external unit.
- Overall rating sound power level – select a unit with the lowest sound power level or at least a unit which will ensure compliance with the noise rules.
- Ensure that cumulative sound levels have been considered if there is more than a single unit present.
- Special audible character – ensure the external unit does not produce significant tones during normal operation as a tone may carry with it a sound "penalty" when assessing compliance with noise rules under most district plans. High-quality manufacturers test and publish results including the overall noise levels and noise spectrum.
- Assess the surrounding environment i.e. once you have tentatively decided on a location assess other factors such as barriers which may assist in reducing noise, or on the other hand reflective surfaces [including barriers] may also reflect noise to unwanted areas. In this case the best solution is to position the external unit where a solid barrier will assist in blocking sound so that the line of sight between source and receiver is blocked, but avoid reflected sound from multiple surfaces, such as between a fence and a house.

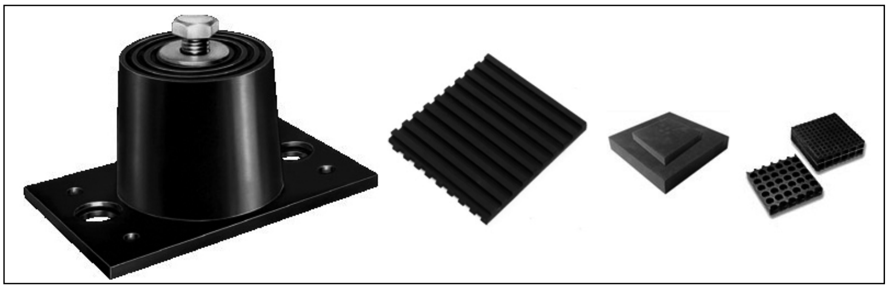

Figure 8: Typical acoustic solutions isolation mount [Left] [Reference: Mason Industries Inc] and Isolation pads [Right] [Reference: Farrat Isolevel Limited]

Figure 9: Acoustic Isolation pads [insert] and concrete plinth [main photo].

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Installation of Heat Pump

Depending upon the installer and design requirements the external unit is usually installed onto the side of the building façade or onto large solid blocks. There are acoustic issues with both options. In the case of large blocks these need to be installed onto a solid compacted base which will not sink or move over time. If the blocks move then mechanism in the unit such as the fan blade can become misaligned and cause rubbing and hence noise may become an issue.

In all cases ensure the installer:

- Installs the outdoor unit so that the unit sits level in all directions and

ensure the unit is fully supported and cannot move;

- Ensure the unit has minimum recommended clearance and has unobstructed gaps around it i.e. under it all for leaves, dirt built up to clear - Ensure if a proprietary footing is provide for clearance under the external unit that it is securely attached to both the foundation and unit and that it is massive [heavy and solid] enough not to cause vibration issues.
- Install the unit so that the fan and outlets and facing away from noise sensitive locations i.e. site boundary; this will help the direction of the sound face away from noise sensitive locations.
- Install the unit so that it is away from noise sensitive locations inside the dwelling i.e. away from habitable spaces such as bedrooms or living areas or under windows for example.
- Where the unit is attached to the dwelling ensure that vibration is reduced and eliminated by installing neoprene isolation mounts or rubber isolation pads to attenuate the transfer of vibration. Anti-vibration mounts may be needed in certain situations such as the unit being attached to a roof or wall [i.e. metal galvanised bracket - acoustic isolation should be designed to ensure the heat pump chassis does not produce structure-borne vibration and hence unnecessary airborne noise radiated from the structure. Note in cases such as fixing to light weight timber walls or above decks, additional timber [i.e. joists] may be required under the external unit to assist with loading and vibration issues. In the case of a roof the support for the unit should be attached back to the solid roof structure not the roofing iron as this could vibrate. A solid concrete foundation [plinth] is less likely to vibrate compared to a lightweight timber deck. Following install there should be no vibration felt on the unit.
- Ensure any gaps that are drilled in the building facade are sealed with a flexible sound seal product which can expand and contract– note any penetrations such as holes produced from drilling or cutting to allow for pipes and wires will need to be within the limits specified by building code requirements [if relevant]. Holes in the building facade should be airtight.
- Ensure all auxiliary items such as plastic trunking over drainage pipes and the pipes themselves are fitted and tied back to a solid structure so not to loosen over time or move and create a noise nuisance in high winds for example.

Figure 8 (page 14) illustrates some typical acoustic solutions isolation mounts.

Figure 9 (page 14) illustrates a typical acoustic isolation pad [insert] installed on a solid concrete plinth [150mm].

In the case that additional noise reductions are required then the following could be considered:

Physical Barrier to Mitigate Sound Propagation

Acoustic barriers to control noise emission or to reduce noise received on any particular site can be effective; however the effects of reflected sound need to be considered within the design and orientation. Multiple reflections between the wall of a house and a parallel reflective barrier can nullify any potential benefits of the barrier.

Vegetation is not considered an effective sound barrier and will not block noise emissions. One common method is to construct an acoustic grade fence or upgrade existing fencing to meet the minimum requirements of an acoustic fence. This will help reduce noise off site.

An acoustic fence must be high enough and long enough to ensure the line of sight between the source [unit] and receiver is blocked. An acoustic fence also relies on mass to some extent, in most cases depending upon the incident sound. For a fence to be 'acoustic grade' it must also have no gaps in or under it. Barriers may work best when combined with internal absorptive materials to absorb sound reflections.

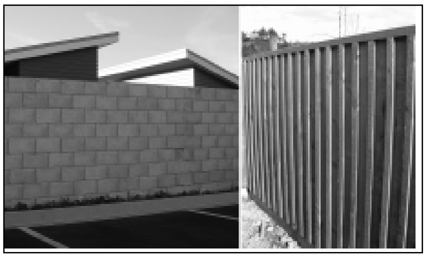
Figure 10 (below) illustrates correct and incorrect acoustic barrier solutions.

Acoustic Enclosure

Advice is often given regarding providing an enclosure for heat pumps. It is recommended that only very carefully designed partial enclosures be used – due to ventilation issues generally full-enclosures should be avoided, unless specific design requires this.

In such cases it is critical that adequate airflow is maintained as it is essential to have unimpeded airflow around the coil, hence fully enclosing the unit would prevent operation and not be recommended. Partial enclosures close to the source would be acceptable however the final design and layout should take account of access for maintenance etc.

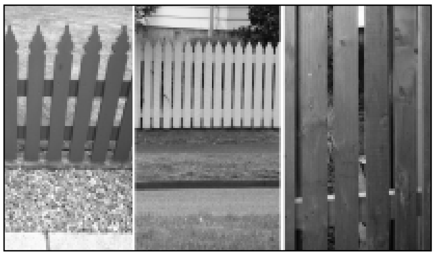
Figure 11 (page 16) illustrates an effective acoustic enclosure made from solid, continuous internal timber panels



CORRECT SOLUTION

Fence with no gaps in or under fence.

Fence high and wide enough to block line of sight between source & receiver positions.



INCORRECT SOLUTION

Holes and gaps in and under fence.

Fences too low and/or not wide or high enough to block line of sight between source and receiver positions.

Figure 10: Acoustic barriers correct and incorrect barriers types.

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with internal perimeter absorptive linings.

Note the front panel [access door] of the enclosure is shown as open in the photo for illustration purposes – this front panel would be closed when in use.

On-going Maintenance

Following the installation of the unit on-going maintenance is crucial especially with regard to rotating parts such as the fans. Noise can become an issue over time when items become worn or out of alignment.

Figure 11: Schematic of typical acoustic enclosure for residential setting. [Ref: Acoustic Sciences Corporation]

In regards to fittings and fixtures such as screws or housing of the unit these too become loose over time and require tightening to prevent vibration and noise occurring.

The installer/supplier should provide an appropriate maintenance plan and if required should carry out annual maintenance.

The information contained in this document is intended as an educational aid only and therefore any user should establish the applicability of the information or advice in relation to any specific circumstances by seeking advice from a professional acoustic consultant or suitably qualified and experienced expert.

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