Chartered Institute of Environmental Health

Institute of Acoustics
Sound • Noise • Vibration

Briefing Note

Heat Pumps
Professional Advice Note

Heat pumps are part of the Government's strategy to reach net zero carbon emissions by 2050. However, the technology generates noise, and it can operate during the night and day. As a result, it has the potential to cause significant adverse effects to people living nearby. This note is intended to provide guidance for practitioners to avoid or reduce potential noise and vibration impacts from heat pumps.

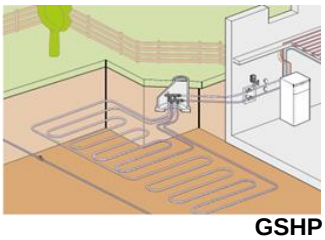
Aims of the advice note:

- Set out advice to enable the use of heat pumps (HP) as a source of low carbon heating and cooling, whilst minimising the risks of sound and vibration from the units causing significant adverse impacts or statutory nuisance.

- Outline the expectations for mitigation to minimise impacts as far as reasonably practicable, to protect amenity and quality of life and the quality of the existing acoustic environment.

Introduction

Permitted Development (PD) rights allow Microgeneration Certification Scheme (MCS)[1] approved HP installations without the need for planning consent. It is important to check with the local planning authority (LPA) that an installation is considered to be PD[2]. Where planning consent is required, this advice note provides an alternative approach to an assessment based on BS4142[3]. However, for PD installations, adherence to the MCS scheme alone may not avoid the creation of significant adverse impacts from noise and vibration. This is because there are a number of factors that can increase the potential for disturbance that are not fully covered in the MCS Scheme,[4] including:



GSHP

- Tonality
- Intermittency of operation
- Sound levels in reverse cycle
- Low background sound levels
- Structure borne sound and vibration transmission

ASHP

Where PD does not apply, a planning application will be necessary and, under those circumstances, a noise assessment should be provided, undertaken by a Suitably Qualified Acoustician (SQA) or Environmental Health Practitioner (EHP)[5]. The assessment should be proportionate and take into account the local circumstances and the nature of the installation.

Considerations

Whilst initial considerations regarding HPs are likely to focus on the purchase/running costs and its operating efficiency, the potential implications of noise and vibration should not be ignored.

[1] Microgeneration Certification Scheme: https://mcscertified.com/wp-content/uploads/2021/10/MCS-020.pdf
[2] There is a difference in PD rights between nations of the UK, although the MCS method is the same.
3 BS 4142:2014 +A1:2019 Methods for rating and assessing industrial and commercial sound (BSI 2019)
4 The MCS scheme was designed to be relatively straightforward for ease of implementation and therefore could not cover all these issues.
[5] Corporate Member of the Institute of Acoustics with at least 3 years' relevant experience or Environmental Health Practitioner with at least 3 years of experience of noise assessment and management and supporting qualifications.

Considering these in advance can help avoid potential problems for owners and neighbours. Resolving noise issues post-installation can be expensive and disruptive to the person responsible (as there can be implications for the whole heating system) and can strain relationships with others in the same or other households.

The main sources of noise in HPs are fans and compressors for Air Source Heat Pumps (ASHP) and pumps and compressors for Ground Source Heat Pumps (GSHP). However, the stated sound power level of a heat pump is only one assessment consideration as any distinctive sound characteristics are also important. For example, an installation which produces an audible hum, buzz, or clunk sound could be more annoying than a similar installation which generates the same sound level without that sound characteristic. The methodology used by manufacturers to calculate the sound levels from their products uses an average sound level, which does not take account of any sound characteristics, meaning that direct comparisons between the potential annoyance that may be generated by different models, during all modes of operation, is not generally possible.

The relative importance of sound levels and character will depend on the proposed location of the unit, the proximity of those who might be affected by the noise from it and the existing sound environment. If it is possible to locate a heat pump where it will be remote, or well screened, away from windows (particularly those serving living rooms or bedrooms) or valued external amenity areas (such as gardens or balcony spaces) noise will be less likely to be an issue. This is not always possible and it is common for units to be close to such locations, making a significant adverse impact more likely as a result. If the prevailing existing sound levels in the vicinity of the unit are generally low, providing little masking sound, and residents are accustomed to quiet conditions, then this risk is even greater.

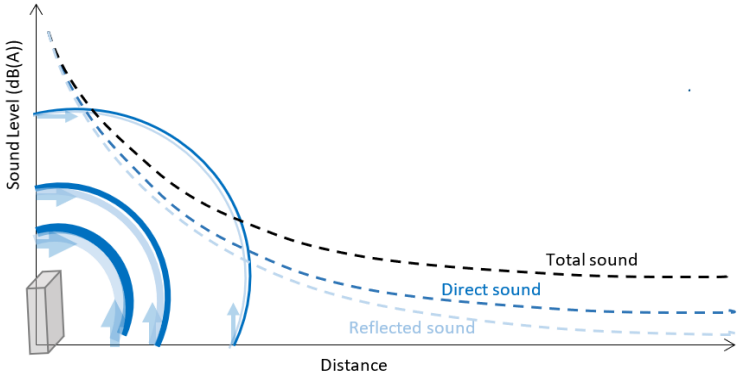
Vibration

If a heat pump is rigidly fixed to a building or to solid ground on or near foundations, vibration will transfer into the structure and may cause structure borne noise to be re-radiated inside. This can cause annoyance and a significant adverse impact to occupiers even if the associated sound level is relatively low. In noisy areas, where buildings are very well insulated against external noise, internal masking noise levels may be lower, allowing the re-radiated noise to be more noticeable. To minimise structure borne noise the type of mountings used for the HP are important and should ideally isolate the unit from the structure appropriately.

ASHP on anti-vibration mounts but near opening

Noise

Where a unit is wall mounted, or adjacent to a wall (or walls), sound will be reflected from those surfaces, effectively resulting in higher sound levels at locations opposite the unit. So, if a unit is tucked into a corner the overall sound levels from the unit experienced would be higher than anticipated based on free-field noise data.



Schematic showing airborne sound attenuation with distance near to two reflective surfaces and also in a corner.
(used with permission of P Rogers)

Cumulative noise impacts
Where more than one unit is proposed, a cumulative impact from multiple units on one site or single units on adjacent sites may occur as a result of the combined sound from the various units. Where units exist that cause audible sound at sensitive receptors or multiple units are proposed, greater care will be needed with the assessment so that appropriate standards and criteria are achieved. (See below).

Selecting appropriate heat pumps
Only use manufacturers which provide good noise output information, which should include octave frequency band information for different operating modes and not just a single figure noise output value at a given distance. Care should be taken with the manufacturer's data, as this can often be misleading as it may not be expressed in accordance with a recognised test standard or relate to the noisiest operating mode, such as can occur during reverse cycles. Furthermore, information about potentially distinctive sound characteristics such as such as tonality or intermittency of operation may not be reported by manufacturers. Where noise may be an issue, one option could be to request a Noise Control Pack, although these are not always as effective as claimed. A further option may be to have the system compressor installed inside the building with the fan unit outside. The overall sound power level of an external ASHP unit would be reduced and it is likely to be less noticeable in external amenity areas where there is other residual sound in the environment.

Mitigation and retrofitting
Although acoustic enclosures are available, they are not always effective for heat pumps. Acoustic treatment of the individual components at source, inside the case, is generally a more effective approach.

Assessment
For single units, located in noisy locations which are remote from sensitive receptors, simple desktop assessments may be sufficient as part of a proportionate approach. Conversely, a much more thorough assessment may be necessary for installations in high density living environments where there may be multiple units and receptor locations. Multiple heat pumps installed over time could result in an increase sound level of the prevailing environment. This may be an important factor in determining suitable acoustic criteria for new installations and may be a subject worthy of local planning policy development.

Guide criteria & relevant standards

For the majority of domestic installations, it is recommended that an absolute rating level target, which takes account of the sound character, is a proportionate approach. This advice draws on expertise available at the time of writing and provides an alternative criterion to the implied limit within Permitted Development Rights MCS criteria of 38dB $L_{Aeq,T}$[6]. Larger heat pump installations, which require full planning applications, may require a more comprehensive noise assessment to be undertaken (typically based on BS 4142:2014+A1:2019).[3]
Where it is practical to do so, it is recommended that the installation sound rating level[7,8] does not exceed 35dB at any noise sensitive façade of neighbouring residential premises[6]. If it can be

[6] At one metre from the relevant building façade, including the contribution from the sound reflecting from that facade
[7] Rating level is the sound level averaged over 15 minutes ($L_{Aeq,15mins}$) from the unit alone at both full duty and when in reverse mode, plus any adjustment for the characteristic features of the sound such as tones, impulsivity and intermittency.
[8] Where the equipment emits sound that contains a prominent tone during its operation or during reverse cycle operation or has a noticeable intermittency then features corrections should be applied, in accordance with the method set out in BS4142:2014+A1:2019, using information provided by the manufacturer. If the manufacturer cannot provide this information, or it is not sufficient to be able to determine the correction,

demonstrated that it is not practical to achieve this value, and the local context[9] supports a relaxation, then a higher criterion may be suitable. Under those circumstances it is recommended that the reasons for the relaxation are fully set out and justified. Nevertheless, it is recommended that the sound rating level should not exceed 40dB.

Calculation Check

Use the downloadable spreadsheet here to check your product meets the suggested criterion, to minimise the risks of causing an adverse impact. It can be used to complete an illustrative calculation check but should not be relied on in favour of professional advice.

Do's and Don'ts when considering Heat Pumps

✅	❌
Source: Do carefully select the unit to minimise sound levels and avoid pronounced acoustic features such as tones.	**Location:** Don't locate in quieter locations, or near sensitive amenity spaces.
Orientation: Do locate the unit as far away as possible from neighbouring premises and especially away from openable windows to noise sensitive rooms such as living rooms or bedrooms.	**Position:** Don't mount the unit on a wall or roof (note 2), especially if they are shared.
Position: Do place on facades that are already exposed to noise wherever possible (i.e., roadside).[10]	
Screening: Do screen the unit so your neighbours do not have a line of sight to it (note 1).	
Installers: Do use reputable installers (e.g. MCS Scheme).	

Note 1: Screening can be provided by existing structures such as a garden wall. The screen must be solid and imperforate to be effective and at least 10kg/m^2 surface density (this is a similar weight to 18mm plywood). Hedges are not acoustic screening. As well as using existing structures, noise can be mitigated using purpose built acoustic enclosures. Care needs to be taken however so that any enclosures are carefully engineered as they can affect the thermal output. Furthermore, they not always as effective as claimed.

Note 2: There will be exceptions, for example, in urban areas where walls and roof space may be the only realistic option. At height, where there would be increased airborne sound transfer to windows and doors of habitable rooms and external amenity spaces with line of sight, or where there would be a direct structure-borne sound path for sound to be radiated internally.

it is recommended that a feature correction of 6dB is added to the calculated sound pressure level in order to obtain the rating level. This adjustment assumes the maximum tonal penalty that is found in BS 4142:2014+A1:2019.

[9] Taking account of the character of the area, including the prevailing sound level which may influence the extent of the impact caused.

[10] Having said that, the current MCS scheme discourages this good practice

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Summary

- It is recognised that heat pumps are part of the Government's drive towards net zero carbon emissions by 2050 and this Professional Advice Note is offered to assist this transition towards a more sustainable future by addressing potential noise issues that might otherwise hinder this process.
- Prevention is better than cure. Taking a precautionary approach is advised.
- Potential noise and vibration impacts should be considered in advance of installation.
- The owner should take all reasonable steps by:
    - selecting a heat pump that will avoid significant adverse noise and vibration impacts.
    - using certified installers.
- For PD - installers should provide an MCS noise assessment. Having said that, it does not allow for tonality or include vibration, and is no guarantee of avoiding significant adverse noise impacts.
- Check with LPA if a proposed installation is PD or not. If not, a noise impact assessment completed by an SQA, will probably be necessary to support a planning application to the LPA. This may avoid planning issues arising and subsequent significant adverse noise impacts occurring.
- Any assessment approach should be informed by, and proportionate to, the local circumstances and the degree of risk of a significant adverse noise impact occurring.
- Cumulative impacts that may result from multiple installations over time should be taken into account.

For more information please email: Briefings@ioa.org.uk

The Institute of Acoustics *(IOA) is the UK's professional body for those working in the field of acoustics, sound and noise management. Its 3,000 members include consultants, academics and regulators and its activities include working for the building industry, developers and local authorities in all matters associated with sound and noise management in the built and natural environment. www.ioa.org.uk.*

The Chartered Institute of Environmental Health *(CIEH) is the professional voice for environmental health representing over 7,000 members, working in the public, private and third sectors, in 52 countries around the world. It ensures the highest standards of professional competence in its members, in the belief that through environmental health action people's health can be improved. https://www.cieh.org/*

About this Good Practice Note

This note was produced by a joint working group of noise specialists, representing members of the Institute of Acoustics and the Chartered Institute of Environmental Health, including:

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A link to the public information version of this note is found here.