EPA VICTORIA

Noise guideline: Assessing noise from residential equipment

Publication 1973 May 2021

VICTORIA State Government

Publication 1973 May 2021
Authorised and published by EPA Victoria
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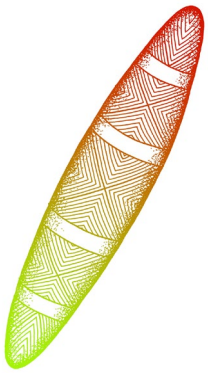

EPA acknowledges Aboriginal people as the first peoples and Traditional custodians of the land and water on which we live, work and depend. We pay respect to Aboriginal Elders, past and present.

As Victoria's environmental regulator, we pay respect to how Country has been protected and cared for by Aboriginal people over many tens of thousands of years.

We acknowledge the unique spiritual and cultural significance of land, water and all that is in the environment to Traditional Owners, and recognise their continuing connection to, and aspirations for Country.

About this guideline

This guideline is for local councils' residential noise enforcement officers to use when investigating reports of excessive noise from residential properties.

It sets out how to assess noise from fixed residential equipment including air conditioners for heating and cooling, heat pump hot water systems, swimming pool pumps, water pumps and ducted heating systems.

It will also help homeowners, equipment suppliers and installers to understand the requirements for controlling noise so they can prevent unreasonable noise.

This guideline replaces sections 1 and 17 (Fixed domestic plant and home occupation noise, and noise assessment technique) of *Noise control guidelines* (publication 1254).

What is unreasonable noise?

Noise may be unreasonable, for example if it is too loud, and/or continues too long, happens too often or sounds disturbing. This list is not exhaustive and other circumstances could amount to unreasonable noise.

Any noise emitted from residential premises at any time may be assessed as unreasonable. The *Environment Protection Act 2017* section 3(1) definition of ***unreasonable noise*** lists the factors to consider when deciding if noise emitted from a residential property is unreasonable.

See EPA's website (https://www.epa.vic.gov.au/for-community/environmental-information/noise/residential-noise) for more information.

Types of residential equipment assessed using this guideline

This guideline applies to fixed residential equipment, which is equipment that operates at the same location on a residential property. Fixed residential equipment includes the equipment listed in group 3 and 4 in the table to regulation 114 of the Environment Protection Regulations 2021 (https://www.legislation.vic.gov.au/as-made/statutory-rules/environment-protection-regulations-2021) and other fixed equipment and appliances such as:

- heating equipment (air conditioners/heat pumps and central heating)
- hot water systems
- water pumps for swimming pools, spas and other purposes
- air conditioning systems and evaporative cooling units
- exhaust fans
- ducted vacuum cleaner systems.

When is noise from fixed residential equipment unreasonable?

Night operation

At night during the prohibited times, noise from residential equipment is unreasonable if it can be heard in a ***habitable room*** within any other residence, regardless of whether any door or window giving access to the room is open. This does not apply where the equipment is used in the case of an emergency. It also doesn't apply to an item in group 4 (equipment used for cooling) when a heat health alert is in effect in the weather forecast district in which the item is located.

Prohibited times for fixed residential equipment

For heating equipment (including central heating, a hot water system or a heat pump, air conditioner or split system used for heating), a vacuum cleaner, swimming pool pump, spa pump, and water pump (other than a pump being used to fill a header tank), the prohibited times for noise to be heard in any other residence are:

- Monday – Friday 10 pm – 7 am
- Weekends and public holidays 10 pm – 9 am

For an air conditioner, evaporative cooler or split system used for cooling:

- Monday – Friday 11 pm – 7 am
- Weekends and public holidays 11 pm – 9 am

Environment Protection Regulations 2021 set the prohibited times for the types of equipment used at residences (regulation 114).

A *habitable room* means a room other than a kitchen, storage area, bathroom, laundry, toilet or pantry. See section 167(3) of the *Environment Protection Act 2017*.

Day/evening operation (non-prohibited hours)

During the day and evening (non-prohibited times), noise from residential equipment may be unreasonable having regard to the factors in the definition of ***unreasonable noise*** under the *Environment Protection Act 2017*.

When assessed at a *relevant area* (see **Assessment location**), the noise emission may be considered unreasonable if it interferes with the enjoyment or use of the residential premises on a recurring or ongoing basis and any of the following points apply:

- includes clearly noticeable rattles or vibrations
- is the dominant sound heard over background sounds, such that the loudness of the noise makes people in the relevant area move away or raise their voices to hold a normal conversation
- is noticeable, such that it can be clearly heard over the background sounds, even when not paying specific attention, and has at least one distinctive and prominent tonal, impulse or intermittent character
- is detectable over the background sounds when listening intently and two or more character adjustments apply (for example when the noise is both tonal and intermittent, or when it is tonal and impulsive), or

- the **assessed noise level** exceeds the background noise level by more than 5 dB at the measurement point in the relevant area.

What may happen if noise from fixed residential equipment is unreasonable?

A council may issue the person with a residential noise improvement notice where council reasonably believes:

- a person emits unreasonable noise, or permits unreasonable noise to be emitted, and
- the unreasonable noise is likely to continue or re-occur.

This notice may require the person to abate the noise, or do any other thing that the council reasonably considers necessary to prevent or minimise the noise.

Actions to abate, prevent or minimise noise from fixed residential equipment may include replacing the equipment with quieter alternatives, relocating equipment further away from sensitive areas on the neighbour's property, using barriers and screens to reduce noise, and maintaining equipment in good working order.

Other enforcement actions are available to council and police officers.

Assessing unreasonable noise from fixed residential equipment

Residential noise enforcement officers can investigate unreasonable noise from fixed equipment at residences.

Noise from fixed residential equipment emitted during the day and evening can be assessed by:

- its *intensity*, which may be represented by the measured noise level in decibels
- its *character* of noise
- the *duration* of the noise
- the *circumstances in which it is emitted*, and
- *how often it is emitted*.

The terms in *italics* are factors of ***unreasonable noise*** as defined in the *Environment Protection Act 2017*.

The assessment of unreasonable noise from residential equipment needs to be conducted at an appropriate time and place. The assessment method includes considering the circumstances of the noise emission and listening to the noise. It may include noise measurements.

Assess the noise at an appropriate time

Assess the noise at a time and circumstance representative of the likely worst case of impact considering:

- when the equipment is likely to be operating
- the equipment setting consistent with normal operation (discuss with affected person and equipment owner)
- that multiple items that generally operate together be assessed together, and
- representative background sound levels.

Background sound levels are normally lower in the evening than in the day and are usually highest during periods of peak traffic. Equipment noise will be more intrusive when background levels are lower. So, if the noise affects a neighbour in the late evening, assessments of background and equipment noise should be made at this time.

Assess noise at a relevant location

The assessment location must represent the relevant indoor and/or outdoor area affected by the noise of interest.

Relevant outdoor areas

Relevant outdoor areas include parts of the residential property used by the affected resident for recreational and domestic activities such as rest and enjoyment. It will exclude areas not normally used for rest, recreation or enjoyment, such as an access walkway, or a utility area. Examples of relevant outdoor areas are gardens, outdoor entertaining areas, and courtyards.

Relevant indoor areas

Relevant indoor areas include habitable rooms, such as bedrooms, living areas and study areas. Relevant indoor areas are not limited to ***habitable rooms*** but may exclude infrequently and briefly used rooms such as a laundry or storage area.

Circumstances of the noise emission

In forming an opinion as to whether the emission of noise is unreasonable, the assessing officer may consider the circumstances of the noise emission such as:

- What time does the noise happen?

Note that the noise emitted is unreasonable if it can be heard within a habitable room of the affected residence at a time prohibited by the Environment Protection Regulations 2021 irrespective of whether the window or door of the room is open (see **Night operations**).

Noise that occurs at times other than the prohibited times needs to be assessed further, as follows:

- How does the noise interfere with the affected resident's use of their home or property?
- Does the equipment rattle or vibrate, indicating that it is poorly installed, or needs maintaining or replacing?
- How often does the equipment emit noise?

Equipment that is used daily across all days of the week and throughout the year is more disturbing than equipment that is used infrequently. For example, ongoing use of a reverse cycle air conditioning used for heating and cooling across the seasons, is more disturbing over time than an air conditioner used occasionally (a few days a year) for cooling.

- How long does the noise continue?

Equipment that emits noise for long periods of time (hours each day) such as a heating unit is more disturbing than equipment that emits noise for brief periods of time, such as a rainwater tank pump used for garden irrigation.

Listening to the noise

The assessing officer must listen to the noise (or a noise logger recording of the noise) from the fixed residential equipment and consider:

- Can the noise be heard within relevant areas (indoor or outdoor) of the affected residential property?
- Is the noise at a level that would prevent the affected resident(s) from enjoying their own home, or impact upon the affected person's ability to watch television, have a conversation, or focus on tasks such reading or studying?
- What other sounds can be heard and at what level relative to the noise being assessed?
- Whether traffic noise is much louder than the noise being assessed, or the noise being assessed can be heard clearly over other sounds.
- How long does the noise continue for during your inspection, or during the noise logger recording?
- Does the noise continue at the same level?

If the equipment noise is not continuous at the same level, the assessing officer must note the pattern of noise recurrence, as the noise might be intermittent.

Assess the noise character: intermittent, tonal or impulsive

The assessing officer must listen to the noise and decide whether the noise being assessed has character that makes it more disturbing. The noise being assessed is:

- intermittent if it suddenly becomes noticeably louder and maintains the louder level for at least one minute.
- tonal if its sound can be described as squealing, whining, humming, droning or throbbing.
- impulsive if it has a sudden burst of sound that can be described as banging, hammering or thudding.

By listening to the noise and understanding the circumstances in which it is emitted, the assessing officer may form an opinion that the noise emitted is unreasonable having regard to the factors of unreasonable noise in the *Environment Protection Act 2017*.

The assessing officer may choose to measure the noise to complement their assessment of the noise.

The next section is for assessing officers when they decide to measure noise from fixed residential equipment. It describes the types of equipment, and the measurement procedure including locations, times, and suitable weather conditions.

Noise measurement

When measuring the noise, the assessing officer must first consider the circumstances of the noise emission and listen to the noise as described in the previous section.

The next step is to measure the noise with suitable equipment using the following procedure based on Australian Standard AS 1055:2018, *Acoustics-Description and measurement of environmental noise*.

When not to use the measurement procedure

This measurement procedure may not be appropriate if the measured noise level (as adjusted) does not represent the impact on the affected resident, such as:

- residential equipment generates intrusive low frequency noise within the affected residential premises, or
- structurally transmitted noise where noise is caused by vibration that travels through the building structure and produces noise at the affected residential premises. It might occur in properties with adjoining walls, such as apartment buildings or duplex.

In such cases, when deciding whether the emission of noise is unreasonable, the assessing officer may have regard to other factors such as the time, place and other circumstances in which the noise is emitted, including the relevant area affected (for example while lying in bed), and how often the noise is emitted and what the noise sounds like.

Measurement equipment

A complete measurement system includes:

- sound level meter, data analyser, or noise logger with sound recording
- portable reference sound source (portable field calibrator).

It may include sound recording instruments.

Equivalent sound pressure level ($L_{Aeq,T}$) and percentile level ($L_{A90,T}$) may be measured using a data analyser for sampling the running value of A-weighted sound pressure level.

If a sound level meter is used:

- an integrating-averaging sound level meter set to 'A' frequency-weighting and 'F' (fast) time-weighting is to be used to measure $L_{Aeq,T}$.
- a sound level meter with built-in capability for measuring $L_{A90,T}$ set to 'A' frequency-weighting and 'F' (Fast) time-weighting is to be used to measure the percentage exceedance $L_{A90,T}$.

Many integrating-averaging sound level meters used for measuring sound as $L_{Aeq,T}$ can also measure the percent-exceedance level $L_{A90,T}$.

Sound level meters must meet the specifications for Class 1 as specified in Australian Standard AS IEC 61672.1 *Electroacoustics - Sound level meters*.

All sound measuring instrumentation, statistical analysers, data loggers, storage devices and recorders must meet the specifications and performance requirements of AS 1055 to ensure the accuracy of the measurement is adequate.

Laboratory calibration and maintenance

The sound level meter, data analyser and portable sound level calibrator must be calibrated at least every two years by a NATA accredited calibration laboratory.

Field calibration checks

The accuracy of the sound level meter, or data analyser, when in use, must be checked using a portable sound level calibrator or pistonphone immediately before and after measurements are made.

For extended measurement periods, such as where multiple measurements are made during a longer time period, these checks must be performed before and after each measurement sequence.

If the measurement system registers a calibration discrepancy of 1 dB or more between consecutive checks, any measurements made between the two checks are invalid and should be repeated.

Measurement procedure

Measurement position

The noise must be measured at:

- a relevant outdoor area, or
- an outdoor location that represents the noise affecting a relevant indoor area, or
- within a relevant indoor area.

The measurement must be made where the greatest intrusion of noise to the relevant area (outdoor or indoor) occurs.

An outdoor measurement location is preferred.

Outdoor measurements

When measuring the noise outdoors, minimise the influence of noise reflection on the measured noise level by positioning the microphone of the sound level meter, or data analyser, at least 3.5 m from any reflective structure, such as walls or buildings, other than the ground. The microphone should be located 1.2 to 1.5 m above the ground.

Where there is a solid boundary fence, or other solid structure such as a shed, more 1.5 m high, that acts as a barrier between the relevant area and the residential equipment, the noise should be measured away from the fence, at a point where the noise sounds the loudest. If the boundary fence, or structure, does not provide a barrier to noise between the residential equipment and relevant area, the noise may be measured immediately above the boundary fence.

If it is not possible to position the microphone 3.5 m from reflective structures, such as outdoor measurements near buildings, the measurement positions are 1 m outside the external facade of the affected residence and 1.2 to 1.5 m above each floor level of interest.

The sound level meter should be positioned with the microphone oriented so that it is evenly sensitive to the noise coming from the source under investigation.

The microphone may be placed on a boom out of a partially open window, to obtain an outdoor measurement.

If the noise under investigation comes from directly opposite that facade, an adjustment of -2.5 dB is to be made to the measured sound pressure level to account for the reflection of sound. This adjustment does not apply when determining $L_{A90,T}$. When considering adjustment for reflection in other more complex situations, AS1055:2018 note 3 to clause 6.2.3 *Outdoor measurements near buildings* may be used.

For outdoor measurements, the microphone must be fitted with a windscreen suitable for the weather conditions occurring during the measurement. Refer to the manufacturer's documentations for the performance of the windscreen.

Indoor measurements

If possible, a representative outdoor measurement (for example, near the facade of the affected area) should be taken for noise affecting indoor areas. This helps to avoid potential indoor measurement complications such as reflections or internal extraneous noise.

If it is not possible to measure the noise outdoors, or an outdoor measurement does not represent the noise intrusion into the most affected relevant indoor area, the noise may be measured indoors.

An indoor measurement must be made within a habitable room of the noise-affected residential premises. Any window or door that is the major transmission path for the noise must be fully open during the measurement.

The microphone position should be at least 1 m from the walls or other major reflection surfaces and about 1 5 m from windows. The microphone must be positioned 1.2 to 1.5 m above the floor.

Weather conditions

Wind and rain can affect the measured sound levels - directly at the microphone, and by increasing the ambient background sounds such as leaf rustle from wind blowing through trees, rain falling on hard surfaces and vehicle tyres rolling on wet roads.

For this reason, measurement of the noise source and background level must be made during dry weather and low wind conditions. The wind speed at the measurement position may be estimated using the Beaufort scale, or alternatively, data from the nearest relevant meteorological station may be used where appropriate and justified.

Beaufort scale categories 0, 1 or 2 are suitable for noise measurement, which is approximately up to 3.3 m per second. In any case, noise measurements should not be conducted if wind speed is greater than 5 m/s unless a special windscreen is fitted to the microphone and wind noise is confirmed as not affecting the measurement, as described in AS1055:2018 clause 6.3.1.

Wind direction can also affect how sound carries from the noise source. It may substantially increase or decrease the noise level at distances of 100 m or more from the source.

For example, a light breeze blowing from the direction of the noise source towards the measurement location can increase the received noise levels at 100 m by around 5 dB. The magnitude of the change in received noise level due to weather conditions also depends on any temperature inversion and the frequency of the noise emitted, with lower frequency sound being less affected.

If the noise source being investigated is more than 100 m away, the measurement should be made at a time when a breeze is coming towards the receiver location from the direction of the

noise source, so that the measurement obtained represents the higher noise levels experienced by the affected resident.

For long-term measurements, data measured during periods of rainfall or overly windy weather is to be discarded from the dataset.

The weather conditions during measurement period must be recorded.

Measurement interval

Measurements are to be taken to obtain a representative sample of the source operation and of the background without the source operation.

If the noise being investigated is steady, that is, the level varies less than +/- 3 dB, the measurement interval is to be not less than 10 minutes.

If the noise being investigated is not steady such that it fluctuates over time, the measurement interval needs to include all significant variations in noise emission from the noise source but must not be less than 10 minutes.

If the noise being investigated is steady with stepped variations in level, such as equipment cycling between higher and lower operating conditions with a clearly audible difference in noise levels, the noise should be measured over three or more cycles to at least 10 minutes of measurement time. Alternatively, measure the sound pressure level (L_{PAi}) and duration of each operating condition separately, for at least three full cycles of variation.

For long-term measurements, the time of the measurements should be chosen to represent the worst-case noise level at the measurement position considering:

- source operating conditions, such as highest equipment power settings, and
- weather conditions that increase the noise level at the receiver location.

The time interval for the data analyser/logger should be 15 minutes.

Measurement descriptor and adjustments

Equivalent continuous sound pressure level (L_{Aeq}) for noise being investigated

Using an integrating-averaging sound level meter or data analyser or noise logger, measure the noise source as the continuous equivalent sound pressure level ($L_{Aeq,T}$), with the 'A' frequency-weighting and 'fast' time-weighting.

The measured L_{Aeq} must not include any unusual noise not relevant to the noise being investigated that could affect the level of noise being assessed. The extraneous noise must be excluded using the pause function of the sound level meter, or be discarded from the analysis of L_{Aeq} during later post-processing of the data.

In the context of assessing residential equipment noise, extraneous noise is any noise which is not part of the noise being assessed. Extraneous noise includes the effect of wind on any vegetation and on the microphone diaphragm, and noise from vehicles passing by, aircraft, trains, construction activities, barking dogs, lawn mowing, and birds chirping nearby. For indoor measurements, extraneous noise includes noise sources at the affected residence where the noise is being assessed, such as washing machines, televisions and voices. Because of their continuous operation, refrigerators and freezers can be included in the measurement of both the equipment noise and background sound level.

Write down or save the measured L_{Aeq} of the noise source operating. When determining the extent of noise emergence of a steady sound above background, it is useful to write down or save the L_{A90} with the residential equipment noise source(s) operating and the L_{Aeq} and L_{A90} with the noise source not operating.

For noise that is steady with stepped variations in level, the sound pressure level (L_{PAi}) and the duration of each operating condition for each time interval (T_i) is measured separately, the L_{Aeq} for the full cycle can be calculated using the method in Clause 6.5.4 of AS1055:2018.

Adjustments

What the noise sounds like can make it more disturbing for the listener. Banging and hammering (impulsive sound), humming or squealing (tonal sound) and noise that gets louder then drops back to the original lower level (intermittent sound) are more disturbing than indicated by the measured level (in decibels) alone.

The presence of tonal, impulsive and intermittent characteristics creates additional annoyance. Adjustments are made to the measured noise level to account for the noise character.

Assessment of tonality needs to consider tones of any frequency, including high frequency squealing or whining and low frequency humming, droning or throbbing.

If a tone is present in the noise being investigated, the tonal adjustment is:

- +2 dB for tonal character that is just detectable, such that it is noticed when listening intently to the noise
- +5 dB for tonal character that is prominently audible such that it is noticed even when not paying specific attention to the noise.

If impulsiveness is a significant characteristic of the noise being investigated, the impulse adjustment is:

- +2 dB that is just detectable when listening intently to the noise
- +5 dB for impulsiveness that is readily detectable.

If the noise being investigated varies in level, increasing rapidly and maintaining the higher level for at least one minute during the measurement interval, the intermittency adjustment is based on the change in level from the lower level to the higher level as:

- +3 dB for noise that increases in level by 5 to 10 dB
- +5 dB for noise that increases in level by more than 10 dB.

Assessed noise level

For determining unreasonable noise from residential equipment measured in accordance with this guideline, the **assessed noise level** is the measured L_{Aeq} plus the adjustments for noise character – tonal, impulse and intermittency.

Assessed noise level = L_{Aeq} + Tonal adj + Impulse adj + Intermittency adj

The adjustments in total must not exceed 10 dB.

Measure background sound level

If possible, the background sound level is to be measured at the same position where the noise source is measured with the noise source(s) not operating. Alternatively, if it is not possible or appropriate to turn off the noise being investigated, the background sound level can be measured at another similar location that represents the background level at the measurement position. A similar location is one which would be expected to have a similar background level to the measurement position, such as traffic flow, commercial activity and similar distances to roads and other busy areas.

The background sound level must be representative of the background at the time of noise impact. The measurement interval for the background sound level must be least 10 minutes.

For background measurements longer than 1 hour, data must be chosen that represents the background sound level at the time of noise impact. Any descriptive statistics, such as the average, median, minimum, or percentile value must not be adopted as the background without justification, considering whether the value chosen represents the background level at the time of noise impact.

The noise being assessed and non-typical local noises, such as local construction noise, rubbish collection, street cleaning, or domestic equipment used at the affected residence (for example washing machines, lawn mowers), must be excluded from the measurement of background sound level.

90 per cent exceedance sound pressure level (L_{A90}) for background measurement

Using a sound level meter, data analyser or noise logger, with an in-built statistical analyser, measure the background sound level as L_{90} with the 'A' frequency-weighting and 'fast' time-weighting.

Information to be recorded

For all measurements, record and keep details of:

- date, time and duration of measurements
- measurement equipment used – make, model, serial number, most recent laboratory calibration date(s)
- equipment settings - frequency weighting, time weighting, descriptor (L_{A90}, L_{Aeq})
- measurement position, including distance to nearest acoustically reflective surface other than the ground, and height above ground level or floor level
- field calibration checks – time, date and calibration check level
- weather conditions during the measurements
- type and location of the residential equipment under investigation and its operating conditions, if known
- a description of the equipment noise heard, including any distinctive character, such as tonal, impulse, intermittent, or vibration
- noise due to other sources (extraneous noise)
- description of background sounds present during the measurement of the background sound level and the equipment noise being investigated
- background sound level.

Further resources

EPA Victoria, Residential noise
www.epa.vic.gov.au/for-community/environmental-information/noise/residential-noise

Annoyed by Noise? (publication 406)

Cool air quietly and efficiently (publication 1176)

Regulating residential noise – local government toolkit (publication 1969)

Standards Australia, AS 1055:2018 *Acoustics – Description and measurement of environmental noise*.

Australian Standard AS IEC 61672.1 *Electroacoustics - Sound level meters*.

Australian Institute of Refrigeration, Air Conditioning and Heating, Residential air conditioning best practice guideline (Victoria)
www.airah.org.au/AIRAH/Navigation/Resources/BestPracticeGuides/Best_Practice_Guidel.aspx#resair