
Data Centre Noise Control

Industrial Noise & Vibration Centre

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Data Centre Noise Control – Existing Installations

Data centres (or “data centers” in the USA) are being built in ever increasing numbers across the world to provide the increasing digital services, including AI and crypto mining facilities and energy centres.

Noise complaints – improving poor regulation and ordinances

As they are inherently noisy, there has been a worldwide tsunami of complaints about environmental noise from data centres. In many states, planning and noise ordinances are inadequate as they only consider overall broadband “dB(A)” data, ignoring the tonal low frequency hums generated by these facilities that are a major cause of stress and complaints from nearby residents.

We have considerable experience in the development of regulator noise guidance that addresses these issues. Effective noise planning and ordinances that take into account all the factors governing the impact of environmental noise do not have to be complicated – a simple sound level meter plus a smartphone are all that are required.



[Contact us](#) if you would like to discuss how to improve this aspect.

“Green Peace” – sustainable – or even carbon negative noise control

Modern noise control engineering technology not only dramatically reduces the embodied carbon of conventional acoustic enclosures and silencers, it also provides a more sustainable alternative that simultaneously cuts costs, carbon and energy consumption.

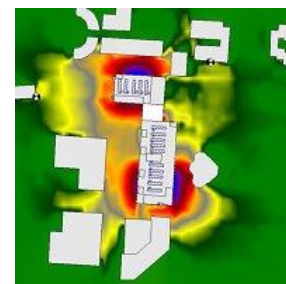
Green Peace

How to optimise data centre noise mitigation – the guide

This guide explains the major sources of the noise issues and what can be done to solve the noise issues. Example case studies are given in the follow-up guide “How to Fix your Data Centre Noise Problem”.

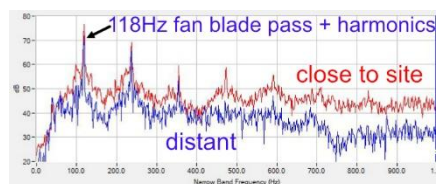
New build planning – inadequate data

Plan! As experts in advising on the noise aspects of plans for new data centres across the world, we know that you cannot start the process early enough... Whilst we can create accurate noise model predictions and evaluate the noise control measures proposed by suppliers against often much lower cost best practice, there is a serious problem: acquiring accurate noise data from suppliers. A process that in theory should take only weeks often takes many months.



Past experience often allows us to spot data that may not be accurate, but ultimately, we depend on reasonably accurate noise data being provide by suppliers **under the correct operating conditions**.

In addition, we have **never** encountered a supplier that provides tonal noise data like the analysis shown here. This is despite the fact that tonal noise is not only a common element in planning noise specifications and ordinances but also a very common cause of complaints.



We have to resort to persuading them to provide a short smartphone video clip of a similar installation anywhere on the planet for us to analyse. Very simple, very effective.

More detailed information is provided in the section below.

What are the causes of data centre noise?

The primary noise sources in data centres and crypto mining operations are the cooling systems. Typically, these involve armies of fans that generate not only the headline overall dB(A) noise level, but also much more insidious (and difficult to treat) tonal noise (whines, hums, drones etc).



This creates a substantial problem as the traditional noise control methods involving silencers, enclosures and barriers reduce cooling efficiency and increase power consumption.

To maintain reliable operation there are usually power generators on-site, a combination of standby generators such as diesel generator sets (these have to be tested) and continuous operation generators such as gas turbines and CHP installation. These can also cause noise problems.

As specialists in this field, we have developed innovative environmental noise mitigation technologies for all of these noise problems. These not only reduce noise, but that can also improve fan efficiency ([by up to 20% in one case](#)). This can render noise reduction projects self-financing.

The most common costly noise control mistake – lack of diagnosis

A \$5 million noise control mistake + \$232k in fines for lack of a 5-minute diagnosis...

For most data centre sites, when noise specifications are set or when there are complaints, only dB(A) measurements of the overall noise level are considered. Occasional this works. However, in many cases, this measurement parameter provides little useful information about the nature of the noise that is the cause of complaints.

It does **not** evaluate the tonal noise or low-frequency hums that often plague residents near the sites. It is **not possible** to evaluate data centre site noise accurately and effectively without using narrow band frequency analysis.

It is not possible to evaluate data centre site noise accurately and effectively without using [narrow band frequency analysis](#).

Time and again there are continuous reports of noise complaints about data centre noise, and yet the facilities may meet the dB(A) requirements. This highlights the inadequacy of the noise specifications and ordinances often used.

There is a similar problem when it comes to noise control. Unless the precise cause of the noise complaints has been diagnosed, any noise control project will be based on guesswork, wasting time and money.

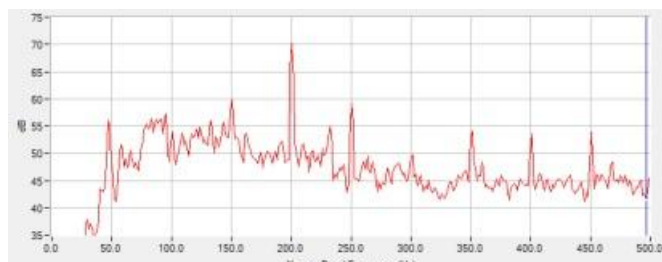
Step1: the diagnostic process

The first step is to understand the nature of the noise that is the cause of the problems. There are 2 possibilities:-

- mid-high frequency broadband noise measured as dB(A). This is the single figure overall noise level. However, measuring dB(A) means that low frequency noise components have been filtered-out, posing a problem if there are low-frequency noise components (very common from cooling fans). Moreover, there it does not provide any information about annoying tonal noise.
- low-frequency (or other) tonal noise from the site, the common "hum".

Go through the following process to determine which of the above is the dominant issue.

Analyse: in addition to any dB(A) measurements, carry out a narrow band frequency analysis to identify any tones. If you don't have access to a suitable professional analysis system, download a free noise spectrum analysis app to your smartphone (there are many).



Tonal noise analysis: 49.9Hz + harmonics

Set the maximum frequency range to around 1k - 2kHz and analyse the noise signature at the worst locations. If there are large peaks at particular frequencies (see example below), then there are tones (hum or drone).

Step 2: identify the primary contributing noise sources

There are three potential types of noise source on typical data centre sites, each with their own characteristic noise signatures.

- **cooling systems:** basically, numerous fans of various types in chillers and AHUs. These generate mid and high frequency broadband noise (measured using dB(A)) plus tonal noise at rotation plus the blade pass frequency and harmonics and are the most common noise issue. Low-frequency fan hum or drone travels large distances and doesn't show in dB(A) readings. Neither silencers or barriers are effective to cut this type of noise.
- **generators (where there is power generation on site):** turbines and/or diesel generator sets (also used as standby for emergencies). These produce both broadband

noise (as above) and tonal noise at specific frequencies e.g. turbine rotation, diesel firing frequency related.

- **transformers:** where installed they can generate high levels of low-frequency tonal noise at x2 mains frequency and harmonics.

Once the diagnosis is complete, it is then possible to define the precise cause(s) of the noise issues and link them back to specific items of plant.

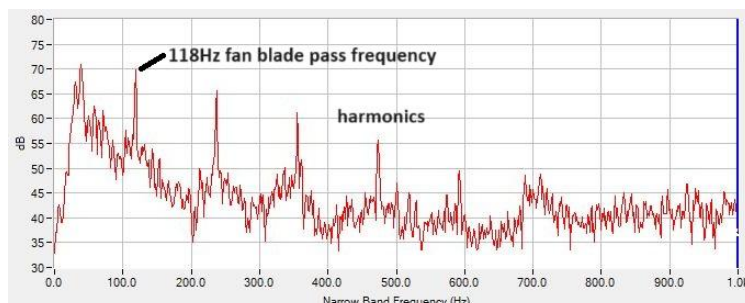
The typical lack of accurate diagnosis is a very common mistake and is the reason for many extremely costly failed data centre noise mitigation projects as illustrated below.

\$5 million wasted on the wrong solution to a data center noise problem

An Atlas Power data center at Williston in the USA (hence the spelling) has been the cause of many noise complaints plus a court case. The company had been fined \$232,000 and spent \$5 million on a massive noise wall that was ineffective.



The reason it was ineffective was a lack of diagnosis as described above. The problem was not the dB(A) addressed by the acoustic barrier, but a low-frequency tone at 118Hz plus harmonics. This plot shows the analysis we carried out on the soundtrack of a news broadcast video at a complainant with the noise wall in place.



Any competent noise consultant or noise control company could have predicted that the noise wall would not work as low-frequency tones simply pass over the top. They should have diagnosed the problem and then selected the correct solution rather than wasting \$5million on a guess...

Data center noise analysis with "noise wall" in place

Our remote online diagnosis took just 5 minutes to prove that the cause of the noise problem is low-frequency tones from the 6 bladed cooling fans running at 1180rpm and [for which there is a simple solution that would also cut running costs by making the fans more efficient.](#)

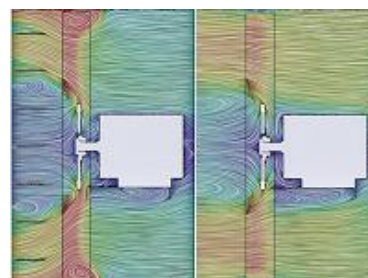
Conventional noise control vs modern high-efficiency technology

Traditional noise reduction methods are based on adding noise control equipment to the plant, acoustic enclosures and barriers, attenuators and acoustic louvres etc., all of which can reduce cooling efficiency and increase running costs. Our innovative approach is based on engineering noise control at source that is not only more effective but can cut running costs by improving fan efficiency. It is also typically a fraction of the cost of the conventional palliatives.

Modern innovative and more sustainable techniques

Innovative noise control technologies: cooling system aerodynamics

We focus on improving fan efficacy by modifying aerodynamics to improve cooling system efficiency. (by up to 20%). Consequently, fans can be run at lower speeds, saving energy and reducing the broadband noise and the problem tones (typically by 90% - 99% i.e. 10dB – 20dB). As fan noise is proportional to speed to the 5th power, a small speed reduction provides large reductions in noise.



This process often involves Computational Fluid Dynamics (CFD) modelling as in this example (left hand fan before aero-modification, right hand fan after modification: 20% increased flow). The [“Green Peace”](#) carbon negative alternative.



We design aerodynamic inserts that can be either designed-in or retrofitted to fans to eliminate tones at source. These can be fitted with very little downtime and last the lifetime of the fan without maintenance and without any drop in performance. Additionally, as this approach reduces the noise at source, it simultaneously cuts intake, exhaust and casing radiated noise, unlike conventional techniques.

Innovative technologies: meta-barriers

Where lower-frequency broadband noise is an issue, we can use cutting-edge metamaterial noise barriers. Despite having around 25% open area, these provide the attenuation of a brick or steel barrier whilst allowing airflow so cooling efficiency is maintained.

Innovative technologies: geometry and acoustic conversion of existing structures

We design innovative retrofit modifications to geometries, ductwork and other existing components to make them acoustically effective to provide additional attenuation without affecting performance.

Traditional techniques

The embodied carbon content in these solutions is high and some of the materials used are not easy to recycle at end of life.

Traditional technology: acoustic barriers and louvres

Conventional acoustic barriers must be placed as close to the source as possible to provide high attenuation. This creates a tension between attenuation and efficiency as proximity to fans, chillers and coolers reduces airflow. There are also potential issues with wind loading and structural considerations (traditional barriers are heavy).

Acoustic louvres typically provide modest attenuation and very little at low frequencies and can generate significant backpressure that



affects free cooling and system efficiency. As they are often fitted at the roof edges, structural strength and wind loading factors must be taken into account. Where the noise is dominated by broadband dB(A) and relatively little attenuation is required, they can be an effective option, but should be costed against alternatives.

Neither of these traditional noise control options can attenuate low-frequency sound.

Traditional technology: silencers and enclosures

Conventional attenuators can be a very effective mitigation measure for mid-high frequency noise (dB(A)). However, they do introduce backpressure and have **very limited** performance at low frequencies unless they are several metres long so are not usually suitable to mitigate low frequency tones (the minimum one wavelength silencer for an 80 Hz tone is 4m).

They can also be costly, particularly where installation requires extensive downtime and the use of cranes and the addition of structural support. Depending on circumstances, they may also require regular maintenance as they can clog.



As a result, there is usually no practical way to use conventional silencers and enclosures (where airflow is necessary) to attenuate low-frequency tones. Perhaps this is why there is such focus on reducing the overall dB(A) (which can be attenuated using these techniques) rather than the often much more problematic low-frequency noise features.

What are the causes of data centre hum?

Perhaps the most common cause of complaints about data centre noise is a low-frequency hum or drone. This travels long distances and passes through windows with little attenuation and does not affect the measured dB(A) (the “A” filter progressively attenuates low frequencies).

The most common sources of this low-frequency tone are numerous fans in the chillers or other cooling systems fans used to control equipment temperatures 24/7. Technically, the hum is caused by the fan impeller aerodynamics that varies in frequency (pitch) if the fan speed changes with temperature.

The other common sources are from diesel generators (engine firing frequency related) or from turbines (rotational speed). The former are run on test on a regular basis and, quite often, the exhaust silencers are inadequate at low frequencies.

In the case of turbines, the intake and exhaust silencer may have been designed to address only the overall dB(A) and not low frequencies – which offer a serious technical challenge for conventional attenuators.

How do you eliminate data centre hum?

Fans

Cooling system fans very often generate high levels of low-frequency tonal noise (hum or drone) that is omnidirectional and travels large distances. Sadly, we have found that it is virtually impossible to get information about tonal noise from fan suppliers. We usually have to resort to analysing smartphone video clips for similar plant installed anywhere in the world to evaluate tonality.

In almost every case, the only practical option to eliminate fan hum is to use the [innovative, low-cost aerodynamic solutions](#) outlined above. These can also increase cooling efficiency, making projects self-financing.

Generators

Improved proprietary reactive silencers that are designed to provide high attenuation over the critical frequency range are available. In the case of turbines, it is often possible to design retrofit elements to improve low frequency attenuation.

Data centre planning: noise modelling, specification + cost savings

The accuracy and utility of noise models depends on the acoustic knowledge and practical expertise of the consultant. We use our extensive experience of creating [noise models](#) to generate the following:

You cannot commence noise modelling too early! Sadly, obtaining accurate noise data from suppliers is often a very drawn-out and iterative process...

- acquiring (and evaluating for accuracy) noise data from suppliers. Sadly, this process is often unnecessarily long-winded and difficult. Obtaining tonal noise (hum etc) data is particularly difficult (we have yet to encounter a supplier that has this available). Consequently, we will usually have to acquire smartphone video clips from similar plant anywhere for our analysis
- noise contour maps to aid in meeting environmental noise criteria and ordinances for planning applications for new projects
- setting plant-specific noise specifications for all significant site noise sources
- evaluating supplier noise control technique proposals against what constitutes current best practice. Very substantial cost savings can often be made in this arena...
- to aid in meeting environmental noise criteria for changes to existing sites
- optimising noise control (as above) where there have been complaints





In addition to remote desktop noise modelling projects (we can also check or update existing noise models), we can also provide full environmental noise assessment services.

Naturally, we also provide noise mitigation best practice evaluations for new or existing plant issues.

Keep in touch for future (and updated) best practice guides...

[Contact us if you'd like to discuss a data centre noise project...](#)

About INVC

The Industrial Noise & Vibration Centre (INVC) is an award-winning noise and vibration consultancy that specialises in fan noise control. Capture a short video of your problematic fan using your smartphone, and our experts can conduct an initial diagnosis remotely. We pinpoint the source of the noise and customise a solution, ensuring your environment enjoys the serenity it deserves. Let's silence the noise and usher in a new era of calm and productivity.

Our Guarantee

Accurate Assessments: We guarantee accurate and comprehensive assessments of noise and vibration. Our team of experts utilise state-of-the-art equipment and industry-leading methodologies to ensure precise measurements and analyses, providing you with reliable data for informed decision-making.

Tailored Solutions: We understand that every project has unique noise and vibration challenges. We guarantee customised solutions that are specifically tailored to your needs, taking into account project specifications, regulatory requirements, and stakeholder expectations.

Mitigation Strategies: We are committed to delivering effective noise and vibration mitigation strategies. We guarantee the implementation of practical and innovative solutions that reduce or eliminate noise and vibration disturbances, ensuring compliance with applicable regulations and enhancing the comfort of affected individuals.

Timely Reporting: We guarantee timely reporting of assessment results, findings, and recommendations. Our commitment to efficient communication ensures that you receive clear and concise reports in a timely manner, enabling you to make informed decisions and progress with your project accordingly.

Ongoing Support: Our guarantee extends beyond project completion. We provide ongoing support and guidance, ensuring that the implemented noise and vibration control measures continue to meet expectations. We remain available to address any concerns, provide additional insights, and assist with monitoring or compliance needs.

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