Data Centre noise

Data Centre Noise

Current Data Centre noise impact evaluation is poor
How it can be improved…

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In conjunction with Quiet Communities + UK Noise Association
https://www.quietcommunities.org/ https://www.uknoiseassociation.com/

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Data Centre noise: the worldwide problems...

The key, very ignored fact
- data centres typically generate LF tonal noise, a major cause of complaints. Inherent in the plant: cooling fans; diesel generators/turbines, transformers...

dB(A) + dB(C) + octaves - inadequate...

The key problems – existing facilities
- inadequate noise analysis and assessment reporting (inc. UK BS4142)
- abysmal knowledge of modern noise control technology – leads to predicted high costs that delay (or even prevent) mitigation

The key problems – planned new facilities
- inadequate planning / noise ordinance requirements
- commercially influenced noise impact and modelling prediction reporting – the use of deliberate tautological inexactitude to downplay the impact on local communities. *"We don't want any problems with planning consent"*

These are worldwide problems that could so easily be avoided...

Details of how to improve planning noise specifications at:
https://invc.com/noise-assessment/data-center-noise-regulation-ordinances/

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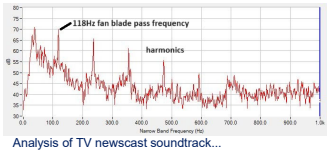
Atlas Power data center: Williston, N Dakota

https://youtu.be/9HJe_SDFNPY?si=oSrv9yTM1M-Mi1r1



Analysis of TV newscast soundtrack...

$5 million wasted on ordinance dB(A) reduction – spent on the wrong problem...

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$5 million wasted on dB(A) - the wrong problem

$5 million noise wall + $232,000 fines

Hum complaints ignored in favour of dB(A).
Noise wall ineffective at cutting fan hum.
Frequency analysis of the news broadcast TV video **proved** that the noise wall would not be ineffective. $5 million wasted due to use of dB(A) and lack of 5 minutes of analysis. The noise consultant should be sued...

Best practice solution: aerodynamic fan mods
Eliminates hum, fans more efficient, self-financing project...

Data center noise indoors: external dB(A) criterion met, so theoretically fine!

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Misleading Data Centre Planning Application: UK

Consultant noise impact assessment report to support planning application to add 2nd data centre to an existing site that is **already** the cause of LF noise complaints. The EHO queried the report.

Noise impact report
"There is no evidence that the noise from the site would be tonal"

"Based on the character of the proposed ventilation plant no penalties are considered necessary for intermittency, tonality or impulsivity of the sound arising from the development."

Deliberate misinformation?
Extreme incompetence?

Complainant video

EA noise consultant report quality survey: 2023
60% extremely poor, 30% very poor, 5% poor. Total 95%

https://invc.com/resources/newsposts/ea-survey-95-environmental-noise-reports-are-inadequate/

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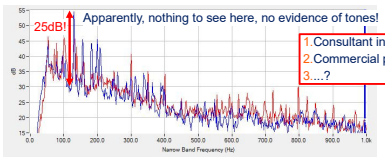
Misleading Data Centre Planning Application: UK

1. Consultant used **only** "A" weighting criteria in baseline measurements of the **existing** data centre.
2. Only dB(A) and octave band data used in the noise model, ignoring the fact that low-frequency tonal noise, "hum", is a **very** common cause of data centre noise complaints and is **already** the cause at this site
3. Only considered high-cost palliative mitigation measures (less effective for LF), **not** Best Practicable Means (BPM)



Complainant video analysis

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Low frequency noise and hum – a widespread problem

Plant noise data used in computer models

- noise models are typically based on dB(A) plus the use of octave band plant noise data – to predict dB(A) off site.
- ditto for the effects of potential mitigation options
- no narrow band noise data, no account for hum, no modern mitigation evaluation

Note

Due to the laws of physics, compared with higher frequencies, low frequency noise (e.g. "hum") can travel for miles and is little attenuated by barriers or windows.

Data centres are 24/7 – so no escape, even indoors

Hum can sound much worse indoors as higher frequency sounds are attenuated more by windows. Hum can be amplified by echoes within a room (standing waves)...

Property values

Would you buy a property when it sounds like this indoors?

Diesel generator hum indoors

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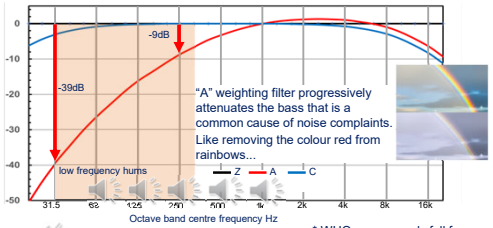
Why dB(A) is deaf to low frequencies

Note: dB(C) noise weighting does not filter low frequencies. A 10dB difference between dB(A) and dB(C) values indicates significant LF noise (WHO*) but **does not assess hum**. 2 sounds with the same dB(C): no hum, no complaints; with hum, many complaints...



Music courtesy: Ross Wilson

* WHO recommends full frequency analysis at a 10dB difference

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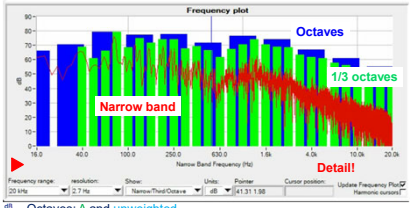
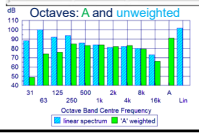
Frequency Analysis





- Octaves cannot identify tones
- 1/3 octaves are unreliable for tonal ID
- Narrow band (FFT) analysis is the only reliable and accurate way to ID tones

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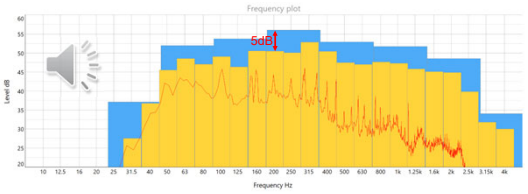
Detailed frequency analysis: data centre noise recording

Octaves: no use 1/3 octaves: unreliable narrow band: the reality!



Why would anyone try to identify tonal noise using 1960s tech. that is of little use compared with narrow band FFT (available for free) and that discards invaluable diagnostic information?

https://invc.com/noise-control/using-tonal-noise-analysis-is-best-practice/

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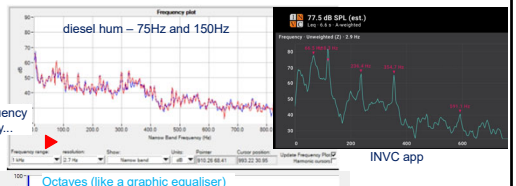
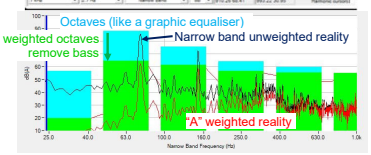
Frequency Analysis – diesel generator



Narrow band frequency analysis, the reality...

INVC app



Anyone with a smartphone can use a free app to identify tones

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When is a tone (hum)? Narrow Band. Simple…

Assuming c 2 - 3Hz frequency resolution, tonal amplitude above broadband masking

Smartphone app accuracy

While the overall amplitude at any frequency is uncalibrated:

- Tonal amplitude (dB) above broadband – "**Type 1" accurate**
- Frequency of tones (Hz) – "**Type 1" accurate**

Note: we persuaded the Irish EA to include app FFT in their new noise guidance.

https://invc.com/resources/downloads/how-to-use-a-free-android-narrow-band-frequency-analysis-app/

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UK regulatory noise character penalties (BS4142)

Industrial noise character	Perceptibility		
	Just	Clearly	Highly
Tonality	+2	+4	**+6**
Impulsivity	+3	+6	+9
Intermittency	0	+3	+3
Other character	0	+3	+3

All the noise character corrections are additive.

Easy improvement

Why not **automatically add a 6dB penalty** to specifications unless the developer can **prove** (narrow band) there are no tones? **Simple!**

Current problems

Why do consultants...

1. ...use subjective evaluations of tones? Very inaccurate and subject to bias + not done indoors.
2. ...use 1/3 octave evaluations of tones? Antediluvian tech. that often doesn't work and is useless for diagnosis…
3. ...not rank sources in terms of subjective impact? In difficult cases, why not use filtered audio to play to complainant?

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Regulatory stick with performance and cost carrot

The specification stick

- Set better, policed and more effective noise specifications for developers and operators.
- Do not take consultant noise reports at face value.

The cost and performance carrot

- Show how the cost of the typical current noise control measures used on plant can be cut dramatically by switching to modern methods that can also reduce running costs.
- Avoid massively costly legal and planning delays caused by noise issues

The environmental carrots

- Improved health and wealth (e.g. house prices) of local communities
- The "green peace" dividend

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Mitigation – modern noise control technology

Data centre elements are reduced to noise radiating "black boxes". So, the only solution is – another box... Or a silencer. Or a barrier...

Add acoustic enclosures, noise barriers and silencers because there has been zero diagnosis?

These palliatives are less effective at low frequencies...

Or diagnose the problem!

There is no attempt to determine WHY plant is noisy. What are the causes of the noise? Are there simple, low-cost engineering modifications that would cut the noise?

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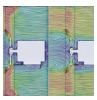
Data Centre Fan Noise Control

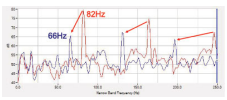
Low-frequency tones at c 82Hz and harmonics caused extensive complaints. Conventional silencers: massive + compromised cooling.

CFD modelling + aero tech.

- 16dB reduction in 82Hz hum (97.5%)
- 22.7% reduced fan power (same duty point, lower speed)
- 2.9x delta p generated by the fan

Aerodynamic modifications worth implementing for the efficiency gains, even if there was no noise problem…





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"Green Peace" Noise Control – cutting environmental impact

Diagnosis + source control technology - dramatically cuts carbon footprints

- use only a fraction of the material quantities
- local manufacture, so reduced transportation costs

Remote noise control - hold the site visits...

We have developed the technology to complete many worldwide noise control projects without site visits.

- reduces our carbon footprint (flights and other transport costs etc)
- projects completed much faster and at lower costs
- email and remote presence (e.g. Whatsapp) to diagnose the best practice noise control options.

Improving fan efficiency - less noise and reduced power consumption

Our primary question "Can we improve system efficiencies?"

- less noise and lower running costs

Organisations worldwide are using our aerodynamic fan noise control tech. to save megawatts per day. e.g. 22% higher cooling fan efficiency post noise control project

https://invc.com/resources/noise-control-case-studies/3-fans-silenced-in-3-weeks-without-silencers/

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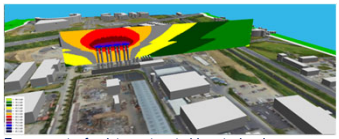
Noise Modelling – planning new data centers



Energy centre for data centre - turbine stack noise

Data centre fans + gen sets

Environmental noise modelling for complex projects new or modified builds.

Powerful tool to make better decisions – provided accurate diagnostic analyses and **all** the best practice noise control options are included in the model.

Octaves and narrow band, not just dB(A)

Properly used, this can save substantial sums of money (e.g. above: euros 3 million saved from 4 million noise control quote)...

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Summary – the problem and simple solutions

1. **Make planning and noise ordinance requirements fit for purpose**
   - Don't base noise specifications solely on dB(A) or dB(C) comparison. They **must** also include specifications for low frequency sound and hum. **Anyone** can use a smartphone app to detect tonal noise
2. **The simplest immediate improvement?**
   - Automatically apply a 6dB penalty to the required noise level unless the developer can **prove** there are no tones (using narrow band frequency analysis, **not** octaves or 1/3 octaves).
3. **Noise reports**
   - Require consultants to report and use dB(A), octaves **and narrow band** + include modern mitigation methods
4. **Mitigation**
   - Knowledge of modern engineering noise control technology is, sadly, **abysmal**. It must be included for both planning and for existing sites.

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Resources

Reporting and regulating

https://invc.com/noise-assessment/data-center-noise-regulation-ordinances/
https://invc.com/noise-control/tonalysis-adding-simple-low-frequency-tonal-analysis-to-dba/
https://invc.com/resources/newsposts/ea-survey-95-environmental-noise-reports-are-inadequate/
https://invc.com/resources/newsposts/why-are-noise-consultant-reports-inadequate-cieh-noise-conference-2019/
http://www.association-of-noise-consultants.co.uk/wp-content/uploads/2018/06/Acoustic-Reports-the-EA-receives-Tony-Clayton.pdf

Analysis and Diagnosis

https://invc.com/resources/newsposts/low-frequency-noise-complaints-do-more-with-less/
https://invc.com/noise-control/using-tonal-noise-analysis-is-best-practice/
https://invc.com/noise-control/outsourcing-industrial-environmental-noise-complaints/
https://invc.com/resources/technical-notes-environmental-noise/eho-and-environment-agency-noise-resources/

Noise Control

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