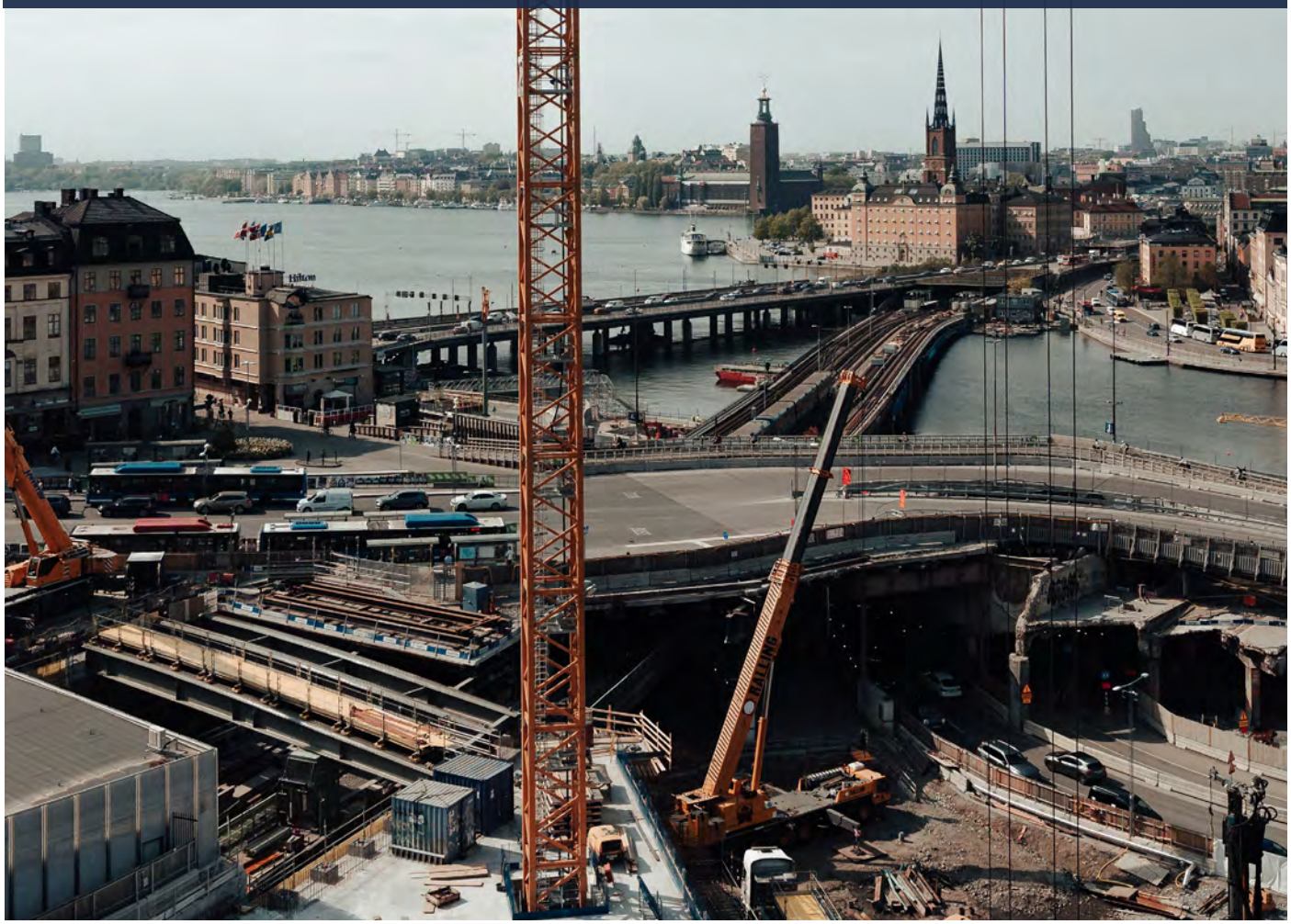
CAMPBELL ASSOCIATES
SOUND, VIBRATION & AIR SOLUTIONS

MONITOR YOUR CONSTRUCTION SITE
How to get started



WELCOME

With growing construction works across the UK and an increase in public awareness to environmental emissions, the need to monitor them has never been greater.

Campbell Associates, with our partners have invested in developing new hardware and cloud solutions, to provide automated and efficient real time monitoring to ease this burden. Continuous accurate monitoring to the cloud platform enables you to effectively deal with any potential complaints from neighbouring residents, avoiding any costly delays to the project.

With over 2000 monitors operational we have back room and on-site support to assist should you need it. We have a large hire fleet of systems so whether your project is weeks, months or years you will have the equipment needed and when you need it.

We have put together this guide on environmental monitoring to help explain why we do it and how it is done. We hope you find the observations useful but if you still haven't found what you need my colleagues and I are only a phone call away. ▪

John Campbell
Director of Sales

NOISE, VIBRATION AND DUST MONITORING
HIGH LEVELS OF AUTOMATION FOR EFFICIENT MONITORING

NOISE - EM2030

- BATTERY AND SOLAR OPTIONS
- AUDIO CAPTURE - LISTEN TO & VERIFY TRIGGER EVENTS
- COMPACT AND TOUGH
- AUTOMATED NOISE IDENTIFICATION

VIBRATION - AvaTrace

- ROBUST - DESIGNED FOR SITE
- MONITOR FOR BS5228 PART 2
- UP TO 8 MONTHS BATTERY LIFE

DUSTSENS - DM30

- MCERTS FOR PM10 & PM2.5
- LONG BATTERY LIFE
- DATA AUTOMATICALLY LOGGED ON THE SONITUS CLOUD

SITESENS - DM30N

- COMBINED NOISE & DUST MONITOR
- MCERTS FOR PM10 & PM2.5
- CLASS 1 SOUND LEVEL MONITOR

BEFORE WORKS COMMENCE - SECTION 61

Section 61 is commonly referred to when discussing construction or demolition related noise and vibration pollution impact on the environment. Section 61 of the Control of Pollution Act 1974 is referred to when a construction or demolition firm applies to the local authority for consent to carry out works, which are likely to have a significant impact on the neighbourhood due to its generation of noise and vibration.

Section 61 applications outline the works which are planned to take place, the working hours of the site and a plan to mitigate potential noise and vibration impact by best practical means. As a developer, you must apply for a section 61 within 28 days before the intended works are to take place. If you have carried out any works prior to this date, except for any minor preparation, then a prior consent will not be issued.

Having it, demonstrates to the local authority a pro-active approach to reducing environmental impact, outlining what methods are in place to minimise disruption to the neighbourhood, thus reducing the number of potentials complaints.

By having section 61 consent, a local authority may not issue a section 60 notice and it minimises the likelihood of the contractor's work being stopped, as a mitigation plan is already in place.

A great tool to support your section 61 application with regards to noise would be the use of noise prediction software.

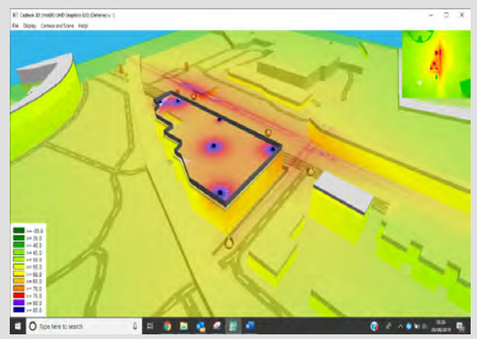
Using Datakustik CadnaA noise modelling software it is possible to predict noise levels at sensitive buildings and receptors. CadnaA allows the integration of Google maps, open street maps and imported drawings to map terrains and model machinery, barriers and buildings.

Once a CadnaA map is created it is possible to model different phases of a project to identify potential noise issues. Acoustic barriers can be applied to quickly show the difference they make.

With 3D and animation, it is a great presentation and reporting tool. We run dedicated training for using CadnaA and BS5228-1 construction noise. Please contact us if you would like to attend any upcoming sessions. ▪

THE BENEFITS OF A SECTION 61 APPLICATION

- Reduced environmental impact
- Consideration plans in place to help protect the community and reduce the number of complaints
- Can protect you from further legal action - Section 61 can be used in an appeal against a noise abatement notice
- Evidences that the developer has considered the environment and has set out to reduce environmental impact (by best means practical)
- Reduced risk of costly delays and penalties



DataKustik

NOISE (LAeq'S) - WHY DO WE MONITOR IT?

The effects of sound on noise-sensitive premises are varied and complicated. They include interference with speech communication, disturbance of work or leisure activities, disturbance of sleep, annoyance and possible effects on mental and physical health. Local Authorities have environmental emissions from construction & demolition sites high on their agenda.

Many local authorities now produce codes of practice for noise (but also vibration and dust) control in their district. These codes of practice documents commonly refer to guidance and the limits set out in BS5228 Code of Practice for Noise and Vibration Control on Construction and Open Sites.

BS5228 Code of Practice for Noise Control also outlines recommendations for noise mitigation measures that should be considered. Noise limits are not set in BS5228; however, these can be easily determined by carrying out a background noise assessment prior to any works undertaken on site; the noise limit is implemented based on measured results. See our blog on setting noise limits using the ABC method **here**.

Some local authorities will outline noise limits within section 61 consent or referral to a code of practice written by the local authority.

Most council's restrict noise from construction & demolition to:
- 8am - 6pm, Monday to Friday
- 8am - 1pm on Saturday

No noisy work should take place on Sundays or bank holidays.*

The noise limits/alerts can be set in relation to background noise data.

Example limits can be as follows:
- 75 dB LAeq Monday to Friday working day (08:00-18:00);
- 75 dB LAeq Saturday working day (09:00 – 14:00)

* Some exceptions will apply. These are examples and may vary in different locations.

With the Sonitus Systems Noise monitoring range you can measure noise continuously in real time. Instant alerts enable a fast reaction to noise events, which can help reduce or eliminate possible complaints from nearby residents.

The Sonitus monitors are plug and play devices, housed in a weather protective enclosures. Such a device is configured remotely, for site engineers to put power to the device and the monitor will automatically start-up and log without any human command prompt.

Monitors with the Audio Recording option have full access to the A-N-I (Automated Noise Identification) feature. ANI automatically listens to noise breaches and will label them accordingly within the Sonitus Cloud. It will also tally all the recordings in each category and tell users the proportion of breaches that were site related.▪

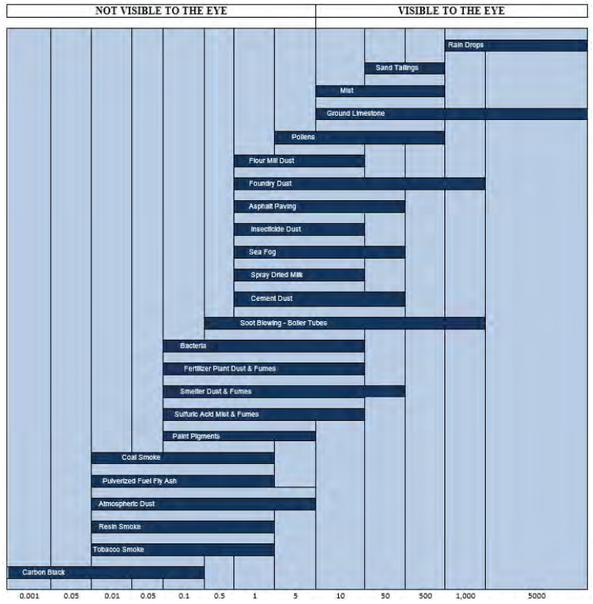
ANI AUTOMATED NOISE IDENTIFICATION

DUST & PARTICULATE MATTER - ALL THE ANSWERS!

When we talk about particulate air pollution we talk about an air-suspended mixture of both solid and liquid particles and these are all related to size and the possible harm they can do to the human body.
The size of the particles defines three classifications:

1. Ultrafine particles: <0.1µm in diameter;
2. Fine: 0.1 to 2.5µm in diameter;
3. Coarse: between 10µm and 2.5µm in diameter.

Local councils have historically only be interested in PM10 which covers most harmful emissions. When monitoring PM10 all particles smaller than 10 µm are logged – which includes fine and ultrafine particles. These particles include dust, pollen and mould spores (PM10) and combustion particles, organic compounds and metals (PM2.5). The table shows where particulate matter comes from which highlights that PM2.5 is more important to monitor as it can do far more harm.



The World Health Organisation (WHO) believes particulates are affecting more people worldwide than any other pollutant. Damage to respiratory and cardiovascular systems are one of the primary health effects. The small particles can easily penetrate into the deepest parts of our lungs as well as access the gas exchange regions of the lung via diffusion.

As a result of the damaging health effects from PM10 & PM2.5 the WHO recommend the exposure limit is:
PM10: 45 µg/m³ 24 hour mean
PM2.5: 15 µg/m³ 24 hour mean

To control dust on construction sites local councils, allow higher limits but for shorter time periods. These are often PM10, levels of 200 or 250 µg/m³ per 15 minutes as a red alert. Controlling particulate emissions on site will help to reduce the PM10 levels in communities. It is estimated 30% of PM10 in London comes from construction sites.

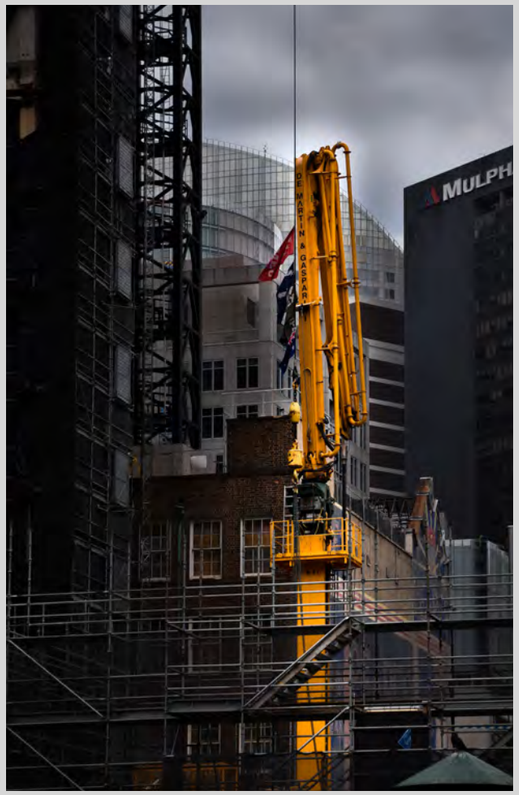
Particles larger than PM10 are normally referred to as nuisance dust as this is the dust we see deposited on windows and cars. It is not deemed such a direct health risk as it is normally trapped in the nose and throat before reaching the respiratory tract. We sometimes measure this, and it is referred to as TSP (Total Suspended Particulate).

These limits can be hard to meet because of the background levels in our major cities, but the understanding and seriousness of the issue is a great step forward. Monitoring certain activities that have a higher risk of producing these particulates, like construction & demolition, will eventually lead to a cleaner and more sustainable environment.

Many London Boroughs have updated their Code of Practices to include measurement and control of both PM10 & PM2.5.▪

PEAK PARTICLE VELOCITY - WHY DO WE MONITOR IT?

Ground vibrations are associated with different types of elastic waves propagating through the ground. These are surface waves, and bulk longitudinal waves and transverse waves (or shear waves) propagating into the ground depth. Typical frequency range for environmental ground vibration is 1 – 200 Hz. Waves of lower frequencies (below 1 Hz) are usually called microseisms, and they are normally associated with natural phenomena, e.g. water waves in the oceans.



Ground vibration is measured in terms of Peak Particle Velocity (PPV) with units in mm/s or mm/s-1. It should be noted that the PPV refers to the movement within the ground of molecular particles and not surface movement. The displacement value in mm refers to the movement of particles at the surface (surface movement).

Environmental ground vibration generated by rail and road traffic may cause annoyance to residents of nearby buildings both directly and via generated structure-borne interior noise. Very strong ground vibrations, e.g. generated by heavy lorries on bumped roads, may even cause structural damage to very close buildings. Typical values of ground vibration particle velocity associated with vehicles passing over traffic calming road humps are in the range of 0.1 – 2 mm/s.

The main sources of ground vibration in construction are pile driving, dynamic compaction, blasting, and operation of heavy construction equipment. These vibrations may harmfully affect surrounding buildings, and their effect ranges from disturbance of residents to visible structural damage.

Table B.1 BS5228-2 Guidance on effects of vibration levels

Vibration Level	Effect
0.14 mm.s-1	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mm.s-1	Vibration might be just perceptible in residential environments.
1.0 mm.s-1	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents.
10 mm.s-1	Vibration is likely to be tolerable for any more than a very brief exposure to this level.

Ground vibration can cause serious structural damage but can also be a nuisance to local residents. There are clear limits mentioned for vibration due to construction/demolition in BS 5228-2.

In table B.1 - page 36 of BS 5228-2 you will find the guidance on effects of vibration levels. These levels set out the human response to vibration, as in nuisance. When we look at potential damage to buildings table B.2 comes into place. Depending on the type of building there are different limits which are generally higher than the nuisance limits. In general, magnitudes of ground vibrations that are considered to be able to cause structural damage to buildings are above 15 mm/s.

Every ground vibration can be recorded and measured automatically. Since it is simple for everyone to protect people, buildings, infrastructure, soil, air and watercourses from negative environmental impact we have seen more demand for continuous automated monitoring, so construction & demolition can move forward; and communities can be developed with minimal disturbance.

To minimize the impact of vibration caused by construction & demolition works, governing bodies often set limits that are aimed to protect individuals from levels likely to cause nuisance and potential cosmetic damage to buildings. You will often see limits of 10 mm/s which is a level likely to cause complaints and is close to the level of potential cosmetic damage in lightweight structures. Amber alerts can also be sent at lower levels to give warning that vibration levels are getting closer to the limits.

It is also useful to store a waveform (very detailed data) when high vibration levels are recorded. This enables you to investigate the actual frequency content of the vibration event. BS 5228-2, table B.2 gives separate limits by frequency which can therefore be accurately assessed.

The levels in the tables below are for guidance. You will see separate guidance limits on vibration close to historic buildings, utilities infrastructure and sensitive measurement equipment found in universities and hospitals.

With a very long life battery, the AVA M80 is small and mobile; allowing users to easily move it to any location on site without hassle. ▪

Table B.2 Guidance on effects of vibration levels

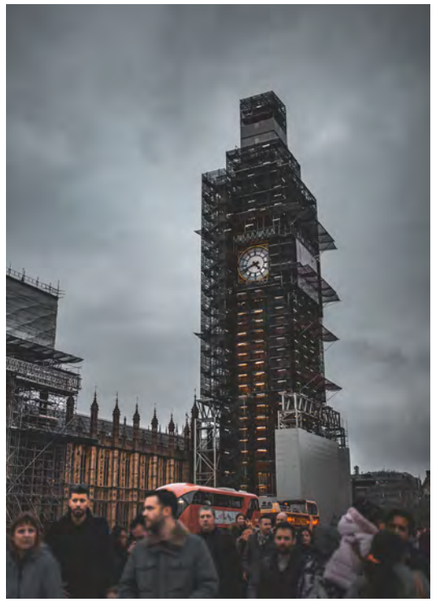
Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz & above
Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	50 mm/s at 4Hz and above
Unreinforced or light framed structures Residential or light commercial buildings	15 mm/s at 4Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz & above

Note 1 - Values referred to are at the base of the building.
Note 2 - For line 2, at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) is not to be exceeded.

WHY YOU SHOULD BE MONITORING NO_2 EMISSIONS ON CONSTRUCTION & DEMOLITION SITES.

CONSTRUCTION SITES AND NO_2

It is well known that construction sites can generate and emit many different forms of pollution, the most obvious being material waste, visible dust, noise and vibration. However, construction and demolition sites also produce less obvious pollutants which are of serious concern for human health and impact on the environment. Two of these pollutants are the gas nitrogen dioxide (NO_2) and fine dust particles called particulate matter. (PM)



It is estimated that in London, NRMM (Non-Road Mobile Machinery) contributes to 7% of NOx, 14% of PM2.5 and 8% of PM10 and it is believed to be a similar situation in other major conurbations.

NRMM on construction sites generate NO_2 from diesel or gasoline fuelled engines in trucks, excavators, loaders, bulldozers, mobile cranes, off-road machinery and static engines such as pumps and electricity generators. Idling engines are a significant contributor to NRMM emissions and personal exposure to PM2.5, PM10 and NO_2. It is estimated that 15% of diesel fuel consumed per year in the UK is associated with NRMM, which equates to approximately 4 billion litres.

HOW IS NO_2 GENERATED?

Combustion of fossil fuels produces oxides of nitrogen (NO_2). NOx is primarily made up of nitric oxide (NO) and nitrogen dioxide (NO_2). NO_2 is of most concern due to its impact of health. However, NO easily converts to NO_2 in the air – so to reduce concentration of NO_2 it is essential to control emissions of NOx. National ambient air quality standards set NO_2 as a criteria pollutant and indicator of the larger group of nitrogen oxides.

HEALTH EFFECT OF NO_2

Scientific evidence links short-term NO_2 exposures with adverse respiratory effects including airway inflammation in healthy people and increased respiratory symptoms in people with asthma. Studies also show a connection between short-term exposure and increased hospital admissions for respiratory illnesses. In addition to contributing to ground-level ozone effects on the respiratory system, NOx reacts with ammonia, moisture and other compounds to form small particles. These small particles can penetrate deeply into sensitive parts of the lungs. ▪

WHAT POWER OPTIONS ARE THERE?

There is much discussion about clean energy on construction sites with construction managers keen to adopt newer, cleaner solutions for the safety of staff, the public and the environment. The default power source to date when mains hasn't been an option, has been diesel generators. However, these generate considerable CO2 which is a known greenhouse gas and also NO2 and Particulate Matter which contributes to poor air quality in urban areas. Climate changing greenhouse gases and poor urban air quality are driving the shift from diesel to alternative power sources across the industry.

Solar: Local Solar/ Wind

Off grid power systems using solar panels and small wind turbines are a popular solution. There is an investment to purchase but when in place they offer emission free energy for site. Solar and wind offers emission free low-cost power for construction sites. Unless people on site are willing to change backup batteries in winter months then solar is only part of the solution and it should be combined with another source such as hydrogen.

Advantages vs diesel:	**Disadvantages vs diesel**
· Zero emissions · Near zero running costs	· With extended poor light/ wind, systems will turn off. · The size of panels required for year-round use prohibits solar panels on many sites. · Additional power generation normally needed as backup.

Hydrogen:

Hydrogen (H2) is a clean zero emission fuel which is commercially available as a power source for construction sites. It is used in a hydrogen fuel cell to generate power to charge batteries to store and distribute power. They are often combined with solar and wind generation to share the load of charging batteries.

The generation of hydrogen creates greenhouse gases. Most hydrogen (95%) is produced by a thermal process where steam reacts with a hydrocarbon fuel (normally natural gas). H2 produced this way is normally referred to a grey hydrogen. It is estimated that grey hydrogen production creates 3 times the greenhouse gases compared diesel. However when used hydrogen produces zero NO2, whereas diesel generates a considerable amount. The net result is that the complete process of production and consumption is that H2 produces about 50% of the CO2 emissions compared to Diesel.

Benefits vs diesel:	**Disadvantages vs diesel:**
· Reduction in greenhouse gas/CO2 emissions by up to 100% at point of use. · Improves local air quality - Reduction in NOx & Particulate Matter emissions by 100% · Easily combined with wind & solar solutions to reduce H2 consumption.	· It can be more expensive – This depends on the application. · Requires investment in new hardware. · Generation of Hydrogen creates greenhouse gases.

Battery:

From D cell to large lithium-ion, batteries are a low power alternative to diesel generators that doesn't emit harmful emissions at site with the added benefit of drastically reducing noise. Compared to diesel generators battery power is a highly flexible & versatile option, most commonly lightweight and portable sites can place batteries anywhere across their site.

Benefits vs diesel:	**Disadvantages vs diesel:**
· Reduce noise pollution · Increase energy efficiency · Long term cost savings	· Higher upfront cost · Requires mains to recharge

WHERE TO FIT THE MONITORS ON SITE

Noise, vibration & dust monitors are typically installed at the edge of the site boundary, nearest or at sensitive receptors of those likely to be affected by the work. For example, sensitive receptors can include anything from local services such as; power, gas & water mains, underground services, public, residential or commercial buildings, and even road and rail.

When commissioning monitors on-site, special attention should be made to the local conditions and the best practical mean (BPM) should apply. Real-time monitors should be commissioned according to any standards set out by the local authority, client or third parties. Should there be an absence of this information, it is typical to refer to 'code of practice for noise & vibration control on construction and open sites - BS5228'. For guidance on dust and air quality, it is typically common to refer to World Health Organisation limits, but further guidance is typically resourced from IAQM for construction and demolition sites.

These available resources give clear instructions to site managers and engineers on where and how best to install equipment on site. For example, the microphone from a noise monitor should be mounted in a free field (at least one metre away from any reflective façade or barrier) and mounted at a height of approximately 1.2 to 1.5 metres above ground level. When mounting the microphone to hoarding the microphone should be mounted above the hoarding or a correction applied.

The positioning of dust monitor samplers inlet should be located in a clear, unobstructed position, and some metres away from any large structures (such as walls of buildings and welfare cabins) that might interrupt airflow. Above the inlet, it should be open to the sky with no overhanging trees or other structures. The air inlet should be ideally mounted between 1.5 to 4m above ground level.

Where monitoring concentrations of PM10, sensors may be located upwind and downwind of the site, but in complex urban areas, this may be difficult to determine, therefore additional monitoring points may be required. On low-risk sites, one monitor could suffice, but it is typical to have one dust and noise monitor on each boundary of the site for directivity of the pollution.

Vibration monitors can be fixed in various ways depending on the application, and selecting the appropriate sensor is important. The measurement sensor must be fitted appropriately according to the required works, standards and guidelines and therefore more measurement points may be required. The sensor of the vibration monitor should be fixed to a solid surface, such as a floor, wall or heavy metal floor plate. For further advice on commissioning a noise, vibration or dust monitor, please get in touch with one of your local technical sales engineers. ▪

SONITUS CLOUD - ONLINE INTERFACE

SONITUS CLOUD

SIMPLE ONLINE PORTAL TO ACCESS ALL YOUR DATA IN ONE PLACE, ANYTIME, FROM ANY DEVICE

Noise, vibration and dust monitoring has never been so easy. Emissions from construction and demolition sites are often a target for complaints from the general public.

Our internet enabled devices record data in real time and can be accessed anytime via the Sonitus Cloud. All systems provide automated SMS and email alerts, ensuring you can take any necessary action in a timely manner.

These features allow you to keep on top of emissions and can respond to any complaints easily and confidently with accurate data. Without this, you could have unwanted restrictions placed on activities, incurring costly delays. ▪

- COST SAVING
- SAFE AND SECURE
- MAINS OR BATTERY
- AUTOMATIC REPORTS
- SMS & EMAIL ALERTS
- FEWER SITE VISITS

WHY MONITOR WEATHER?

Verify and improve your data –

- You can remove noise data where there is high winds and rainfall.
- You can also identify if dust is blowing onto or away from site.

Health and Safety on Site – Alerts for high Windspeed!

The BCSA recommends stopping all crane activity if wind gusts exceed 27 mph. Above 40 mph, the recommendation is to stop all outdoor construction, even activities that don't involve a crane.
The MaxMet range of weather stations can be fitted directly to any new Sonitus Systems monitors and can be retrofitted to any older versions. Contact us for details.

MaxiMet GMX200

✓ Wind Speed & Direction
✓ Compass
✓ Data on the Sonitus Cloud

MaxiMet GMX240

✓ Wind Speed & Direction
✓ Precipitation
✓ Data on the Sonitus Cloud

MaxMet GMX600

✓ Wind Speed & Direction
✓ Temperature,
✓ Humidity & Pressure
✓ Precipitation
✓ Compass
✓ Data on the Sonitus Cloud

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