SonoLab
SOUND COMPLIANCE

How to Model Industrial Noise.

Industrial noise sources are often typified by a constant presence, prolonged (potentially damaging and debilitating) sound. Tonal components like the hum of a machinery, impact noises or beeps of warning signals, can all have a damaging effect and lead to hearing loss over time. Industrial noise tends to be generated from a fixed source but can be amplified or propagated by location, type of building materials and lateral diffraction. By understanding this background, you can begin to map sound power levels and model industrial noise on your site.

Why model industrial noise?

Noise at work can cause permanent hearing loss and can be debilitating. Hearing loss isn't the only issue. Workers may develop tinnitus (ringing, whilstling, buzzing or humming in the ears), a distressing condition which can lead to disturbed sleep.

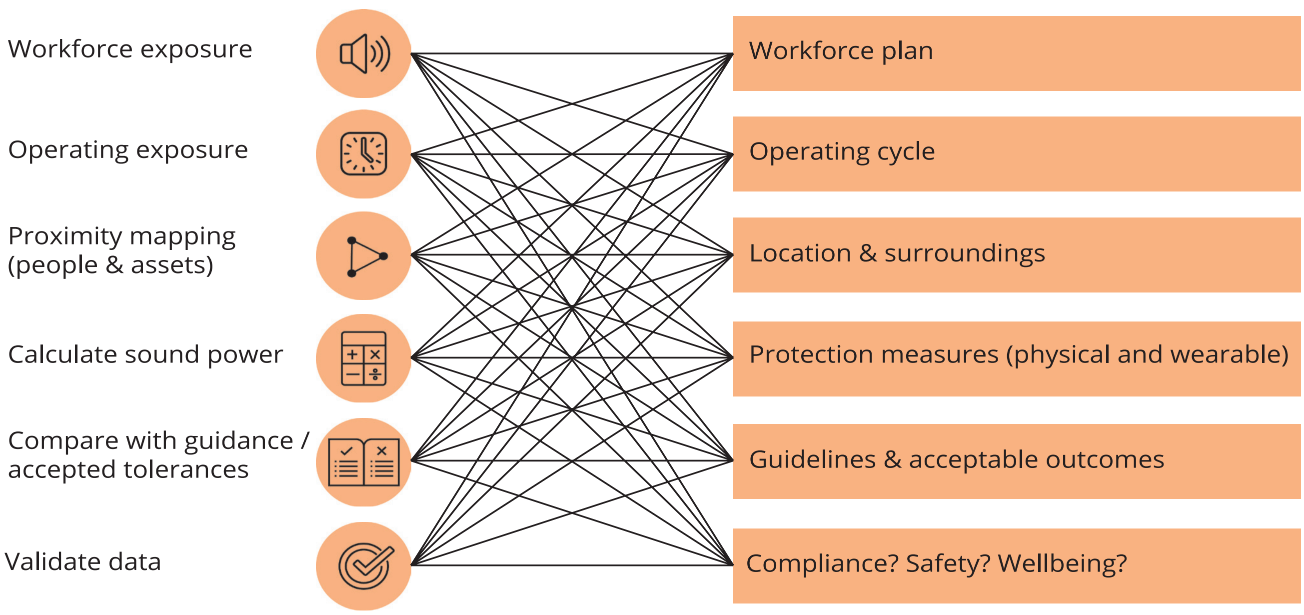
Noise at work can alo create safety issues by interfering with communications and make warnings harder to hear. It can reduce a worker's awareness of their surroundings leading potentially to safety risks of injury or death.

The law

The Control of Noise at Work Regulations 2005, require employers to eliminate or reduce risks to health and safety from noise at work. You need to take action to reduce noise exposure (so you need to model noise and understand the risk), and supply workers with hearing protection (it may be physical noise control and / or wearable).

General duties (Section 3 of the Health and Safety Act at Work 1974), require employers in some circumstances to consider workers' health and wellbeing outside work resulting from work-induced activities.

Noise modelling decision factors and choices.



Getting started

1. Gather relevant sound power data
2. Input operating times
3. Map assets, function, location, proximity and surrounding area data
4. Calculate noise performance
5. Compare with best practice, peer site bench marks, safety regulations and compliance guidelines
6. Validate the noise performance and map (check independently)

Step 1: Input of sound power levels

Use appropriately calibrated devices to record sound points. Sound sources are complex and will exhibit geometry, sound-generating mechanisms and radiation / amplifier properties. You need to simplify the real, physical properties into a source model that deals with source and amplification.

Direct noise sources (eg electric motors, pumps, compressors, looms, fans, boilers, valves, operating machinery, furnaces etc) can be obtained by direct noise measurements. Take measurements by grid within a defined area and relatively near the object of interest and transform the mean measured pressure levels in to power levels by summing the surface area that is enclosed by the measuring points including the measured object(s). This power level may be corrected for reflections in nearby walls, ceilings, background noise. You need to ensure input data sets are consistent (1/1 octave or 1/3 octave bands).

Create an Asset Register and a set of Fact Sheets for each noise source including:

Name of Asset
Title and number of the standard / guideline
Short description
Method category
Sound power result (direct and amplification)
Manufacturer benchmark sound power guideline
Workforce exposed to sound power
Remarks
Related standards

Accurate, consistently taken sound power data is crucial for successful sound mapping and must address source, location, proximity, surroundings, operating conditions, working hours at source. However, try to avoid unnecessary and excessive amounts of data. Accurate mapping of a food and beverage plant for example, spanning 25,000m2 may take at least 4 man days and one bad dataset can throw out all calculations. To save time, you may want to rely on the source manufacturer guidelines (eg CE label data). GDMR has developed a software tool (SourceDB) for easy filtering of data.

Step 2: Operating times

Annual average active hours are an essential input in determining long-term averaged noise indicators such as L_{day} and L_{night}. If a machine is operating 1 or 12 hours during daytime, this will result in about 11dB difference in the L_{day} noise power result from this machine. Working hours should be calculated by day, evening and night and then averaged to get a yearly data point.

It's normal to separate out dominant sources (ie sources that contribute most to noise, or low power sources in close proximity to workforce who are exposed continually, or short high-power sources).

A warehouse and 3PL packing facility for example, may generate cyclical sound power related to production with planned or regular stoppages. A petrochemical plant will typically generate different sound power performance over time.

Step 3: Model Industrial and Surrounding Areas

If a building is characterised by specific operating noise, sound power needs to be measured throughout the designated area by source and refraction points. Screening points, buildings, walls, ceiling protection etc needs to be integrated in to the calculation scheme.

Walls, earth banks, proximity of barrier buildings or enclosures, also needs to be integrated in to data to get a consolidated data result.

The acoustic properties of a machine or piece of equipment producing sound, can usually be categorised by:

(i). "Type" of sound (point, line, area)
(ii). Source height(s)
(iii). Total sound produced by the source
(iv). Spatial distribution of the sound radiation

These categories, and particularly (iii) and (iv), are frequency dependent. "Type" is important especially "point source" because all machines have a finite size but when the distance from the source is far larger than the machine dimensions, the sound can be assumed to radiate from a single point on the source.

You also need to consider a representative source height. A "line source" is a source with one dimension much greater than others. A line source can also be a source point that moves along a fixed route. The sound power will be given per unit source length (dB/m). A line source is often modelled as a series of uncorrelated point sources.

The radiated sound power from each point corresponds to the partial source length ("element length") that it represents. The distance between the point sources should always be smaller than the distance to the nearest receiver position divided by a factor greater than or equal to 1.5.

An "area source" is a source with large dimensions compared with distance to the receiver. It can be the surface of a building, an industrial site with many complex sound sources distributed over an area, an area with fixed mobile sound power sources and so-on. The source power will be given per unit of source area (dB/m2). A complex noisy industrial site may have different power levels and heights – which is why appropriate grid mapping is required.

Sources treated as point sources may have large physical dimensions, and all frequency components may not be generated at the same position. Heavy construction machines comprising an engine, exhaust, fan hydraulics etc, tend to have particular characteristics as sound sources and radiating sound contributors. Different sound power outcomes are generated and radiated in, for example, a large commercial dairy site. There are many different ways of accounting for the difference. You can divide the source in a number of point sources with a radiation model linked to affected area size and workforce proximity. A simpler calculation is to define the overall source in terms of sound power, directivity, and source height for each 1/3 octave band.

Model noise inventories

Once the sound power levels of the sources have been determined whether by measurement or from literature, a model of the industrial site including buildings and noise barriers (physical protection) and wearable protection, can be created. Sound power tends to be source, area and line-related. Workforce may be tied to one part of the area but is still mobile (getting to / from an area) so take care to map and validate actual sound power, height, exposure and workforce exposure.

Common errors

- Don't assume that because the workforce is mobile, sound power can be diluted from actual levels generated
- Don't assume that physical protection (buffers, acoustic panels, earplugs etc) will reduce risk – it often just changes the line of sound power rather than risk
- Do ensure you calculate sound power by day, evening, night operating to create 'highs', 'lows' and an annual average
- Remain flexible. Be prepared to ask questions and questions behind questions
- Don't view noise as a necessary operating condition – you can engineer-out and mitigate noise, especially from a workforce wellbeing point of view
- Don't confuse cost of corrective action with inability to respond. In reality, engineering-out noise costs less than you think and costs can be recouped typically within 6-24 months with ROI calculated through CSR, reduced absenteeism,employer reputation, lower insurance premiums etc
- Don't look for overly complex solutions. Typically, noise control, physical protection, wearable protection and noise-related awareness on site, is an inter-linked journey based on best practice and workforce wellbeing
- Think holistically. These days, eSigns and Remote Monitoring enable you and employees to have 24/7 visibility of noise and software as a service can demonstrate your commitment to workforce wellbeing and sound compliance

Further information

By visiting the SonoLab website at **www.sonolab.com**, you can learn more and get free downloads. **Discover our tactical noise control quick wins** (Fact Sheet). Read about **strategic considerations – do I have an industrial noise issue and what am I expected to do about it** (Fact Sheet). Share pictures and / or video and **ask for remote noise risk support** or a **free site survey** (90 minutes).

About SonoLab

SonoLab are hearing loss prevention and compliance specialists. We supply high quality consulting and practical engineering across industrial acoustics, noise management and protection (design and install). We specify and fit remote monitoring, eSigns and smart dashboards which help you monitor site compliance and demonstrate safety. Our focus is on sound compliance and prevention of hearing loss through work-induced noise. We engineer-out noise. We also pioneered and supply Instant Fit Custom-Moulded earplugs for customers around the world.