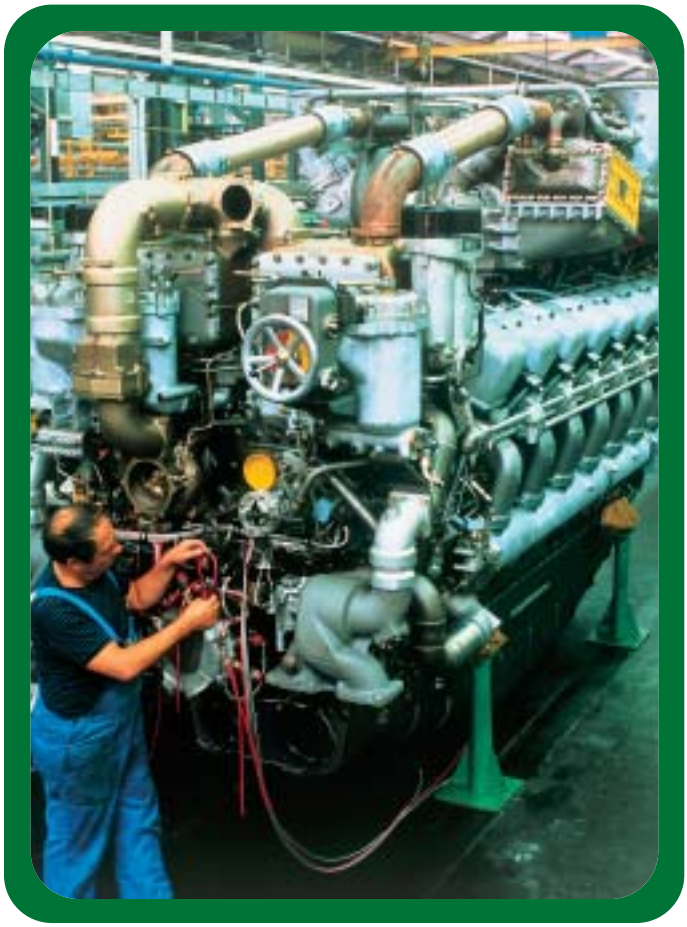
NOISE AND VIBRATION AT WORK

Occupational safety and health are major concerns throughout the world. Problems such as broken limbs, the loss of an eye, or persistent backache have to be dealt with and measures taken to minimise the risk of these things happening at work. However, it comes as a surprise to many that loss of hearing caused by noise at work is second only to the broad category "disorders of the locomotor system" on the list of occupational diseases. Millions of people suffer from noise-induced hearing loss (NIHL), resulting in a reduced quality of life. The costs of compensation and early retirement payments are immense.

Hearing conservation programmes are implemented in most countries and governed by international and national standards and legislation. Such programmes involve an assessment of the noise problem, noise control, and noise reduction measures. Important aspects of hearing conservation programs include the management of data, reporting of progress and the retrieval of data.



ASSESSING PERSONAL NOISE EXPOSURE

The essential issue in fighting noise-induced hearing loss is the assessment of noise exposure. Hearing loss can be immediate with extreme sound levels, but, in general, the problem is exposure to noise day after day, year after year. Harmful noise levels do not always cause pain, so there are often no immediate symptoms or complaints from the person under risk. Unfortunately, however, when a person does realise that his/her hearing is severely impaired, the damage is irreversible.

The permitted noise level for a working day is, in most countries, set at 85 dB, but in some 90 dB. However, in many cases, actions, such as making hearing-protection equipment available, must be taken at 80 dB. There is a worldwide trend to lower the permitted noise exposure.

Measuring Personal Noise Exposure

One method for evaluating the noise exposure for a particular person is to use a noise dose meter. This is a small, lightweight instrument worn throughout the working day. The microphone is placed close to the ear, often attached to the collar. The noise exposure of the person is then measured and is usually recorded directly as a percentage of the allowed daily exposure. This method is indispensable when workers move from place to place with no fixed schedule.

Measuring Sound Levels at the Working Point

In the many cases where working points are fixed (for example, a punch press or pneumatic nailing machine) and work schedules known, the noise exposure can be computed from the data gathered at those working points using an integrating sound level meter. Noise levels are measured at each working point and assigned according to each worker's schedule (for example, 3 hours at one task, 4 hours at another). From this data, each worker's noise exposure can be computed.

Mapping Noise Levels

For a hearing protection program to be successful, it is important to know how noise levels are distributed in the factory hall or throughout a complex. Authorities often request a noise map from companies where excessive noise levels are suspected. It is important to make a survey of noise levels and create a noise map before setting up a large-scale protection program. This allows you to concentrate your efforts on problem areas and avoid gathering unnecessary data.

Managing Data

Noise generated by a single machine affects all people in a working area and individual data must be kept for all of them. The data is archived in accordance with legislative requirements and must be easily accessible when compensation claims are made. Companies that run hearing-conservation programs do more than file data. Reports have to be prepared for the management, the authorities and the workforce.

TROUBLESHOOTING OCCUPATIONAL NOISE

Modelling Noise

Sometimes it is difficult, impossible or even hazardous to make routine measurements. This can be the case, for example, at refineries and chemical plants. In order to assess outdoor noise problems, a computer model of the sound field can be built on the basis of the sound power generated by the noise sources.

Measuring Factory Hall Acoustics

The sound levels in a factory hall do not depend on the noise emitted from machinery and manufacturing processes alone. Noise levels depend very much on the acoustic properties of the hall. The essential parameter is the Reverberation Time that tells how quickly a high level of sound decays when it is switched off.

The Problem

Many factory halls have very long reverberation time. Concrete floors and large surfaces (walls and roof) with little sound absorption material cause sound to linger. Noisy machinery placed close to reflecting walls, or even in corners, can result in excessive sound levels throughout the factory hall. In a factory hall with better acoustic properties, the same machinery may not cause the same problems because the noise levels will only be high close to the source.

Measuring Reverberation Time

Reverberation Time is measured by either using interrupted sound (a powerful sound source abruptly stopped) or impulsive sound (most often a shot with a starting pistol). In industrial settings, the latter is a common method.

Measuring Spatial Decay

The spatial decay shows how a constant level from a sound source decays with distance from the source. In a factory hall with hard reflecting floor, ceiling and walls, the level decays very slowly with distance. So a noisy machine at one end of a factory hall can produce deafening noise levels at the other end of the hall. If you measure sound levels, you can map the spatial decay, determine whether more sound absorption is needed, and measure the effect after making improvements.

NOISE AND VIBRATION AT WORK

Measuring Speech Intelligibility

In many working situations it is important to understand what is being said (for example, over a loudspeaker system) and to be able to react to acoustic signals of different kinds. An objective measure of these conditions is the Speech Transmission Index (STI).

Selecting Hearing Protection

An obvious and frequently used means of fighting excessive noise exposure is the use of hearing protectors. These are worn throughout a plant or in restricted areas. Protectors come in a variety of forms and offer widely varying noise reduction effects. In order to select the right hearing protection it is necessary to make a frequency analysis of the sound. This is the only way to choose protectors that are effective at the dominant frequencies. Suppliers of hearing protectors generally specify the attenuation in octave bands, making it easy to choose the appropriate ear defender once the spectrum is known.

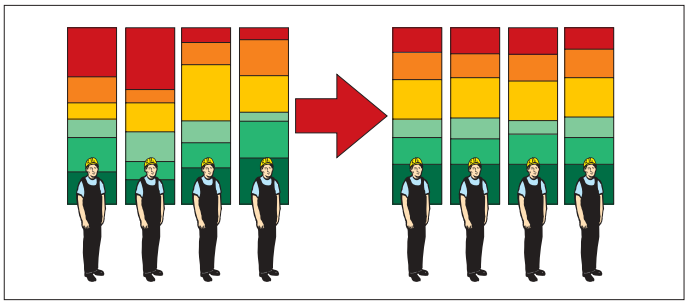
Changing the Work Schedule

In many factories only a few of the manufacturing processes pose serious noise problems. And often only a fraction of the workforce is affected by excessive noise exposure. This situation makes a simple and elegant noise control measure a feasible option – simply change the work schedule so that none of the workforce exceeds a 100% noise dose. Those workers exposed to too much noise can be identified from a database of measurements and the work schedule investigated. A change in the work schedule can be entered in a "what-if" analysis and the resulting exposure recalculated. This means that you can estimate the result of rotating workers between noisy and less noisy workplaces.

Locating the Noise Source and Measuring the Sound Power

Fighting noise problems is ideally done by locating the noise sources and reducing the emitted noise. While it can be easy to identify a noisy piece of machinery, it can be much more difficult to pinpoint exactly where and how the noise is generated. Measuring sound intensity makes the job easier, by measuring not just the sound level but also the direction in which the sound propagates. Using the same equipment, the sound power of machinery can be determined in-situ.

Effects of changing the work schedule



HUMAN VIBRATION

Human vibration is defined as the effect of mechanical vibration on the human body. The effect might be on the body as a whole, whole-body vibration, or on parts of the body, of which the hand-arm system is the most important.

Hand-arm Vibration

Hand-held power tools, such as chisels, drills and pressure hammers, expose the user to vibration. The vibration transmitted to the hand-arm system is called Hand-arm Vibration (HAV) and can be a major health concern. Excessive exposure over long periods can result in the so-called "white finger" syndrome, also known as Reynaud's syndrome. As is the case for noise-induced hearing loss, this disease is often diagnosed too late. Early symptoms are cold-induced white fingers, followed by permanent loss of feeling and dexterity.

Whole-body Vibration (WBV)

In many cases, vibration of the whole-body system arises from vehicles, land-based or otherwise, from vibrating floors in buildings, or from big machines where the operator is seated on the machine. The effects on the body as a whole are less specific than with hand-arm vibration, but the most pronounced long-term effect is found in the lumbar region of the spine, where spine deformation, lumbago and sciatica can develop. Short-term effects of whole-body vibration are those felt during or after the working day and can be fatigue, headaches, slower reactions, nausea and insomnia, all symptoms caused by vascular disorders and nervous malfunctions.

Product Guide

Brüel & Kjær offers solutions to all the above-mentioned applications. Please use this table as a guide to relevant products.

Application	Key Features	Products and their Key Features
Measuring Personal Noise Exposure	1) L_{Aeq}, L_{Cpeak} 2) Logging 3) Statistics L_N	4442 Noise Dose Meter [1] 4443 Logging Noise Dose Meter [1] [2] [3]
Measuring Sound Levels at the Working Point Mapping Noise Levels	1) L_{Aeq}, L_{Cpeak} 2) Logging 3) Statistics L_N	2239 Integrating Sound Level Meter [1] 2240 Integrating Sound Level Meter [1] 2238 Mediator [1] [2] [3]
Managing Data and Reporting Changing the Work Schedule Calculate Noise Exposure	Import measurement data Calculate noise exposure Present and report results	7825 Protector
Modelling Indoor Noise	Noise level mapping, Auralisation	7837 ODEON
Modelling Outdoor Noise	Noise level mapping	7810 Predictor
Measuring Spatial Decay Selecting Hearing Protection Measuring Reverberation Time	1) L_{Aeq} 2) T_{20}, T_{30} 3) $^1/_1$ octave spectra	2260 Observer [1] [2] [3] 2260 Investigator [1] [2] [3] 2250 Hand-held Analyzer [1] [3]
Measuring Speech Intelligibility	STI, RASTI	7841 DIRAC
Locating the Noise Source and Measuring the Sound Power	Sound intensity	2260 Investigator
1) Hand-arm Vibration 2) Whole-body Vibration		2537 Hand-arm Vibration Meter [1] 2239B [1] 1700 3-channel Human Vibration Front-end [1] [2]

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