Noise at work

Toolbox Talk

efnms
European Federation of National Maintenance Societies vzw

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Scope - Contents

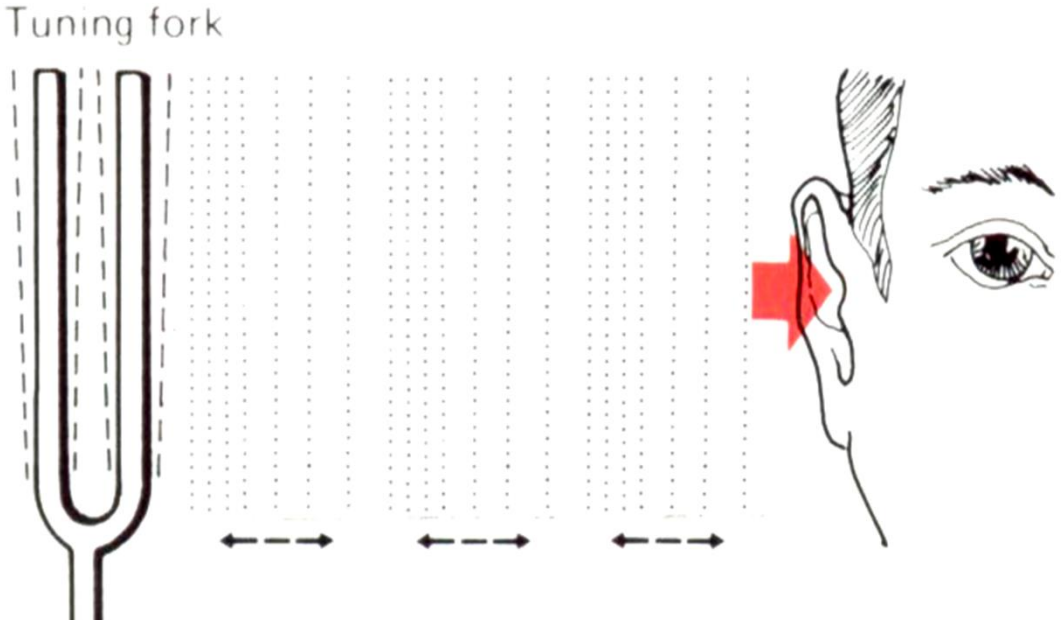
This work aims to present important information about **noise in workplaces** where maintenance is the main task. The author is the a PhD. In Acoustics Mechanical Engineer and the Technical Director of **GROUP SCIENCE**, a Greek company that deals with Noise and Vibrations since 2003 and is specialized in this field.

Contents:

1. Fundamental acoustic definitions and principles
2. European legislation
3. Noise control approach and examples
4. Findings in industries

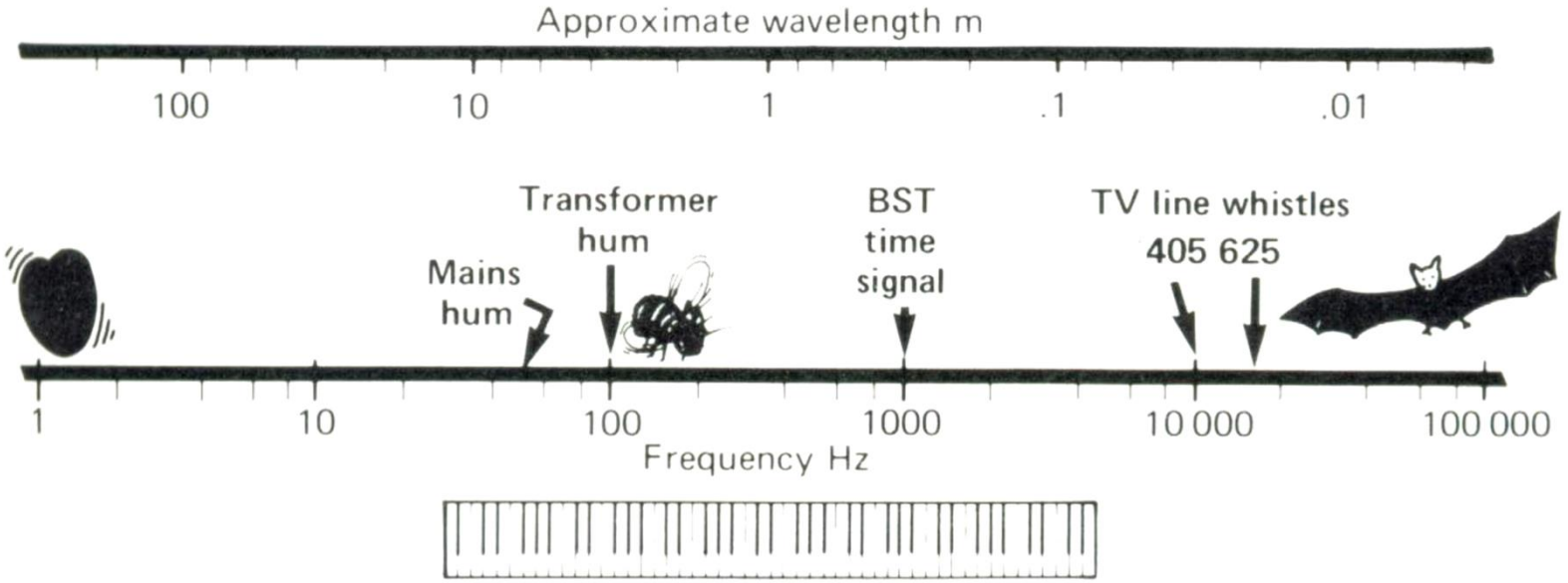
Sound- Noise

- **Sound:** The perturbation inside a fluid (e.g. air) that is caused when a source sets into motion the fluid particles next to it
- **Noise**: Unwanted sound



- The propagation of the perturbation is done via longitudinal waves that set in vibration the hearing sensor, i.e. the human eardrum.

Examples of frequency



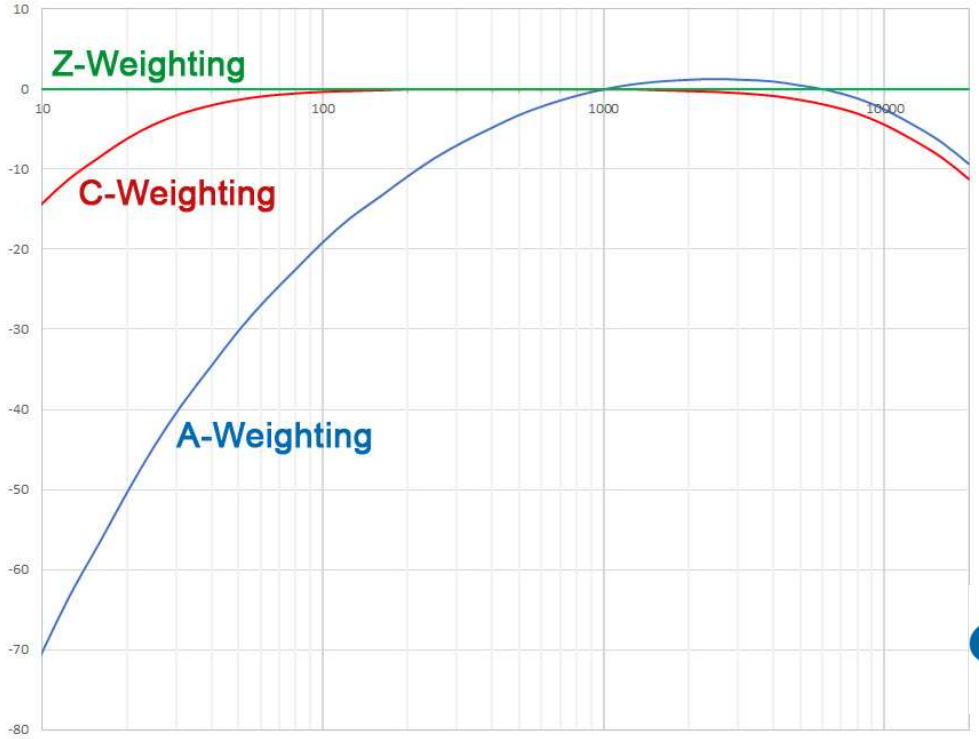
Frequencies observed by humans: 20Hz-20000Hz (20kHz)

Infrasound: Sound with frequency <20 Hz

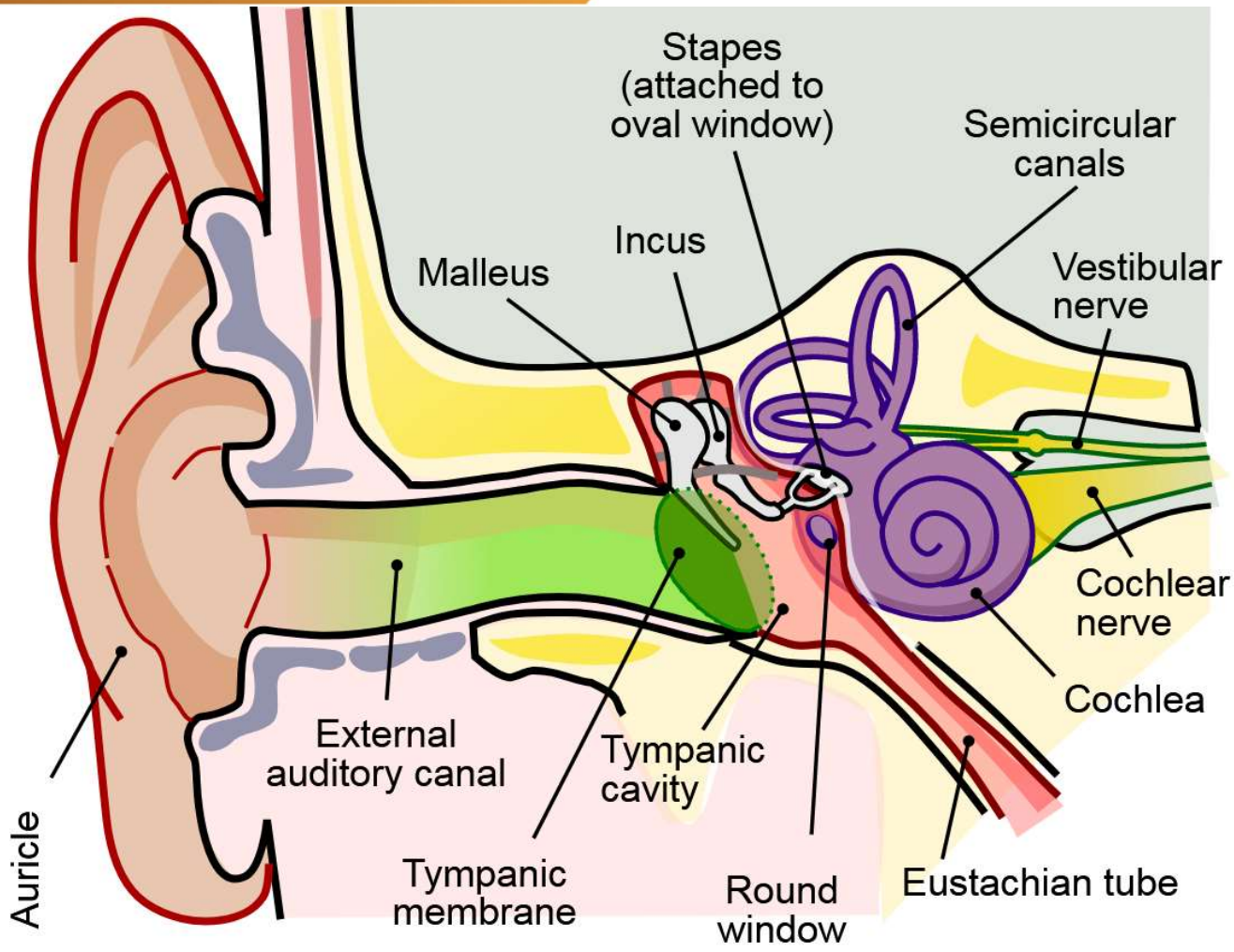
Ultrasound: Sound with frequency >20kHz

Frequency weighting filters

- The human ear does not respond the same to all frequencies.
- The sound measuring instruments (SLMs) use ‘frequency filters’ so as to *amplify* or *decrease* the frequency spectrum, depending on their impact to the (average) human ear.
- A-weighting, dB(A): It simulates the human perception of most sounds (it rolls off very low and very high frequencies while it amplifies the range 1kHz-5kHz). Sound levels are indicated L_A, L_{Aeq} etc.
- C-weighting, dB(C): It rolls off only very low and very high frequencies.



The human ear



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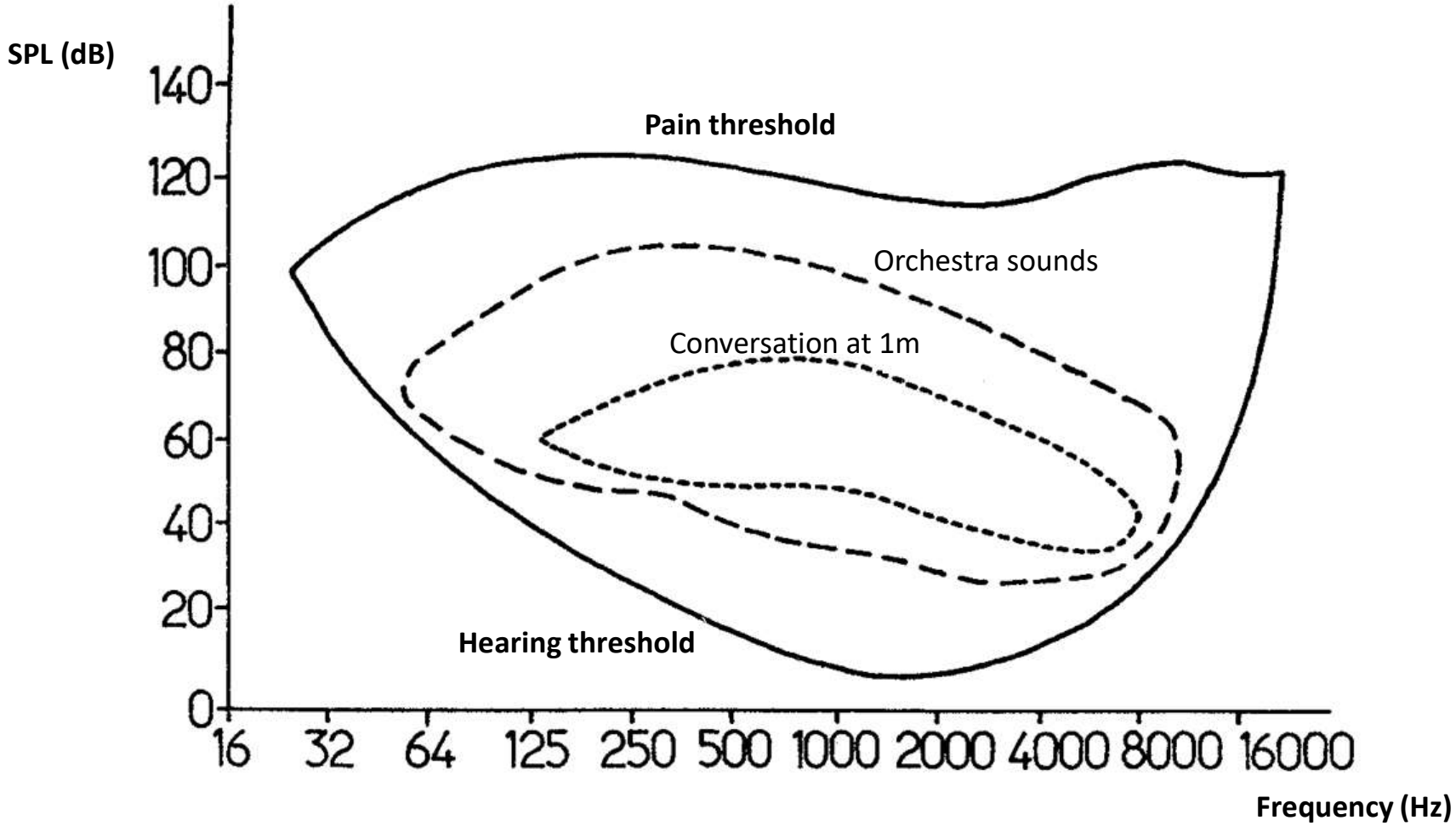
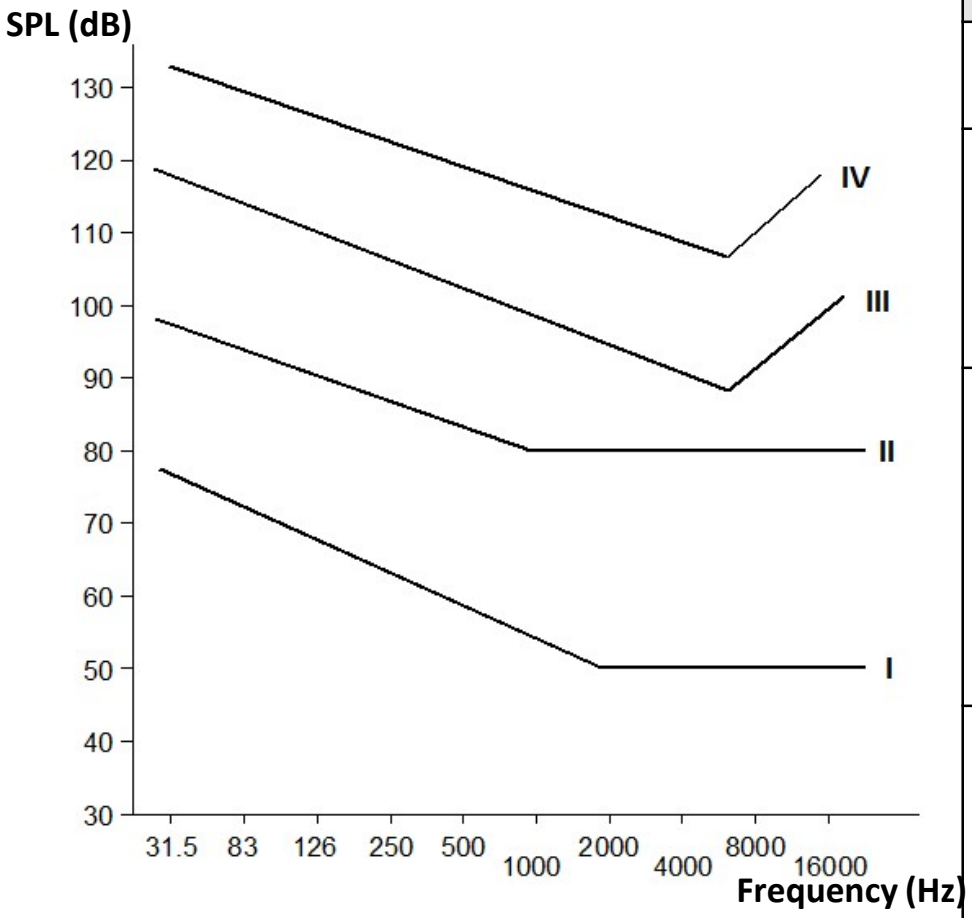
The human acoustic field

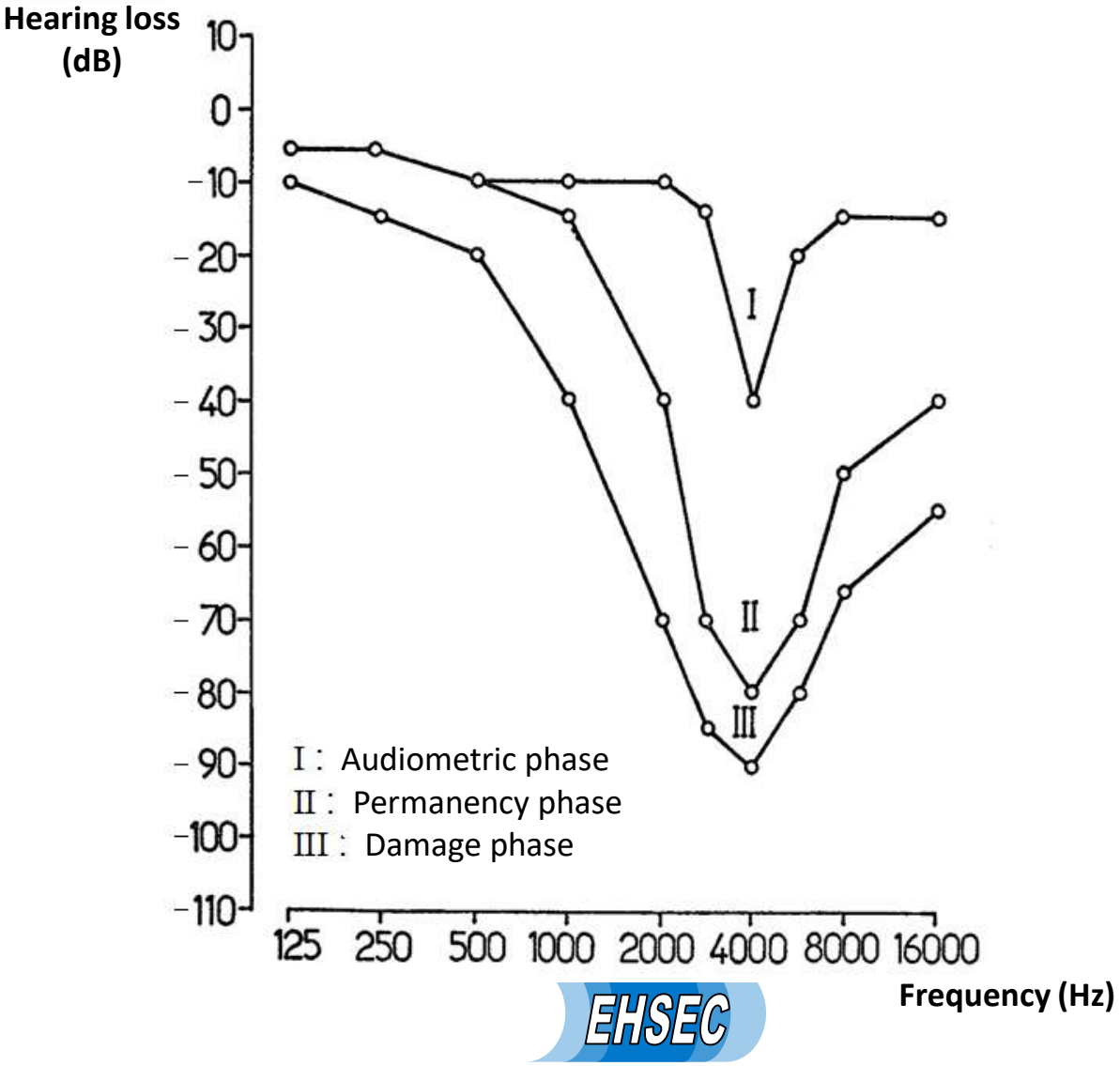


Hearing risks and effects



Sounds	*Hearing damage*	*Effects on work*
Below curve I	None	None
Between curves I and II	Curve II should not be exceeded	Mental work is difficult or very difficult
Between curves II and III	Probability 0 to 100% for 8-hour exposure every day	Additionally, handiwork is difficult. Increased probability of mistakes.
Between curves III and IV	Probability 25 to 100% for 1-hour exposure	Any work is difficult
Above curve IV	Danger even for instantaneous exposure	Any task becomes impossible

Stages of hearing loss



Noise limits

The noise limits according to 2003/10/EC are set in a scale:

- Exposure limit values: $L_{EX,8h}$=87dB(A) and P_{peak}=200Pa [140dB(C)]
- Upper exposure action values: $L_{EX,8h}$=85dB(A) and P_{peak}=140Pa [137dB(C)]
- Lower exposure action values: $L_{EX,8h}$=80dB(A) and P_{peak}=112Pa [135dB(C)]

$L_{EX,8h}$ (Daily/weekly noise exposure level): A quantity indicating the average noise level throughout a working day (or week).

P_{peak} or **L_{peak}** (peak sound pressure): A quantity indicating the maximum instantaneous noise throughout a working day (or week).

These quantities can be measured using hand-held **sound level meters** (sample short-duration measurements) or **dose-meters** (instruments carried by an employee on their shoulder throughout their shift).

Daily noise exposure variation

In maintenance:

- Noise conditions are not always predictable and repeatable,
- Noise conditions may vary significantly throughout the employee's shift,
- Noise conditions may vary significantly from day to day,
- Noise conditions may not depend on permanent machines/installation,
- Noise conditions may depend on hand tools with fluctuating operation.

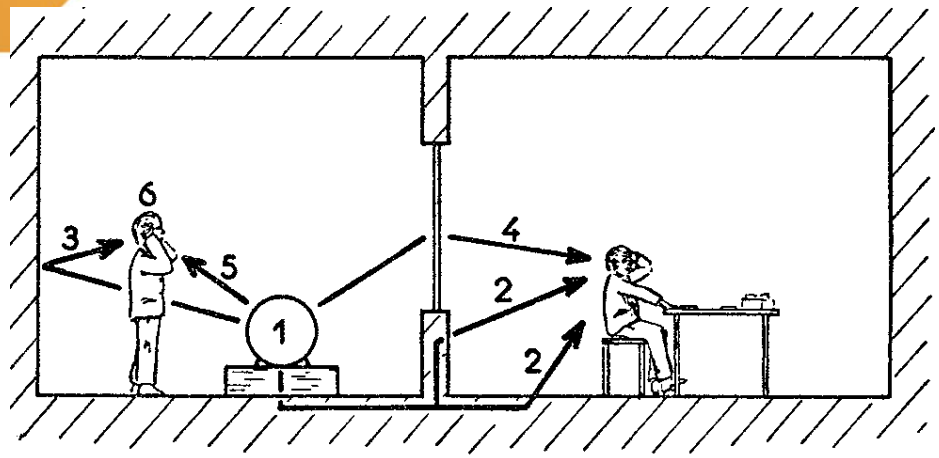
Therefore the determination of the employee's daily noise exposure may be **very difficult or impossible by sample noise measurements of short duration**.

Instead, it is advised to determine noise conditions in maintenance using repeated **8-hour dose measurements** (e.g. 5 daily measurements throughout the week). The examined week should feature representative conditions of the actual noise conditions affecting the employee.

Workplace noise transmissio

Creation/transmission of noise

1. Faulty machine
2. Ground borne transmission (vibration)
3. Amplification of noise due to reflections
4. Transmission through poor insulation
5. Direct transmission
6. Inadequate individual protection



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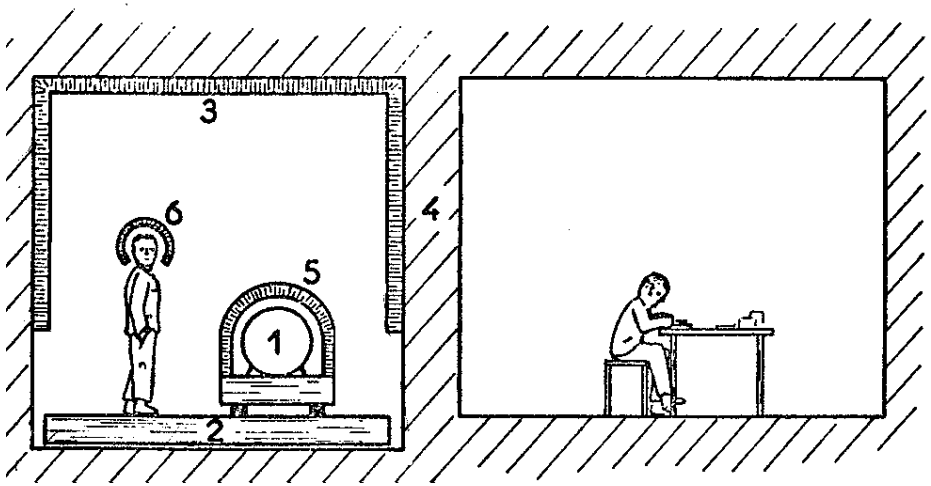
Solutions

1. Proper maintenance and/or replacement with low-noise parts
2. Anti-vibration support
3. Installation of sound absorptive surfaces
4. Insulation improvement
5. Insulation of noise source (enclosure/canopy/sound barrier etc)
6. Control rooms or proper individual hearing protectors (last resort)



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Noise solutions criteria

- Disturbance to the employee (difficulty in work tasks and/or incease of work load).
- Possible risk to employee's health.
- Obstruction of emitting/understanding speech.
- Obstruction of sensing crucial sound signals (e.g. horns, alarms, bells, PA signals).
- Obstruction of sensing secondary acoustic information (useful sounds utilized by experience operators).

Noise solutions criteria

Estimated effect of various noise control solutions to ergonomics:

	Ergonomics criteria					
Noise control solutions	Increase of workload	Operator obstruction	Health risk	Obstruction of crucial sound signals	Obstruction of useful sounds by stationary equipment	Obstruction of useful sounds by moving equipment
Reduction of sound within the source itself	None	None	None	None	None	None
Redesign of space and equipment layout	Possible	None	None	None	None	None
Isolation of noise sources	Possible	Possible	None	None	Great	None
Anti-vibration support	None	None	None	None	None	None
Covering of sources with sound insulating materials	Possible	Possible	None	None	Possible	None
Cover of room surfaces with sound absorptive materials	None	None	None	None	None	None
Individual hearing protection	None	Great	Possible	Great	Great	Great

Noise control examples

(the photographs are taken by GROUP SCIENCE projects)

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Control room


Movable sound insulating enclosure


Accessible sound insulating enclosure


Lightweight insulating enclosure


Portable sound barriers for maintenance


Sound absorbing ceiling baffles

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Maintenance noise solutions

Maintenance tools often produce high noise levels. The most typical solutions deal with the tools themselves:

- Low-noise cutting/grinding disks
- Low-noise air nozzles
- Rubber/plastic hammers/mallets

When maintaining out-of-operation equipment but noise comes from nearby equipment, portable noise barriers can be used.

Remember: The goal is to reduce the *time-average sound level* (i.e. 8-hour noise exposure), not necessarily the sound levels at all times.

Findings in Industries

- Following, statistics deriving by a sample of noise studies in major manufacturing plants are presented (various types)
- The sample involves more than 1300 work noise positions.
- The results present only the critical noise exposure indices L_{eq} [dB(A)] and L_{peak} [dB(C)] of 2003/10/EC.
- The same analysis is divided into Industry categories:

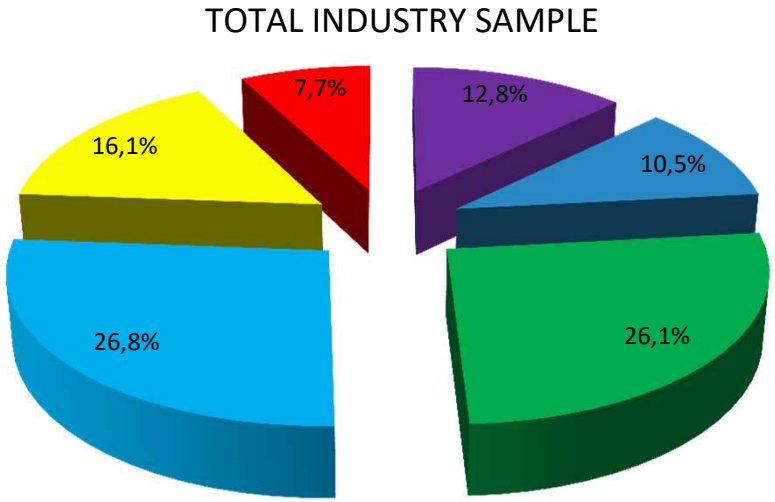
(I) : Light Industry (Bottling plants – food and beverage etc)

(II) : Middle Industry (Appliance manufacturing – pharmaceutical – cosmetics – chemicals etc)

(III) : Heavy Industry (Steel – Copper – Aluminum foundries, Piping etc)

Note: Quantities in percentage are calculated in reference to the total of each separate category

Noise exposure statistics



TOTAL INDUSTRY SAMPLE	
<75	12,8%
75-80	10,5%
80-85	26,1%
85-90	26,8%
90-95	16,1%
>95	7,7%

Notes - observations

1. Only 23.3% of records are within safe noise limits [below 80dB(A)].
2. 50.6% are above the upper action limit value and 76.7% are above the lower action limit value.
3. 23.8% of records are above 90 dB(A) → almost 1 out of 4 operators face severe hearing damage risks.

Noise in light industries