Aalto University

10 Industrial noise control

ELEC-E5640 - Noise Control P

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SFS 5907: recommended noise level

Maximum sound level value L_{Aeq} (dB)

Type of task or space	Class A	Class B	Class C	Class D
When speech communication is especially important or when precision, speed or concentration are required. For example, control and remote control of a process, manual installation, sorting, packing and warehouse work.	50	55	60	65
Activity in which noisy equipment is usually used. Mostly manual labour, work with machines and in processes in workshops and in industry. Use of loading and conveying machines.	70	75	80	85
Production areas, characterised by sounds from ventilation and other fixed building technology, excluded production sounds.	55	60	65	70
Resting areas, changing rooms; characterised by ventilation and production sounds.	40	45	50	55
Control rooms	45	50	55	60
Tasks requiring undisturbed speech communication, see sections 5.4.5 and 5.4.6				

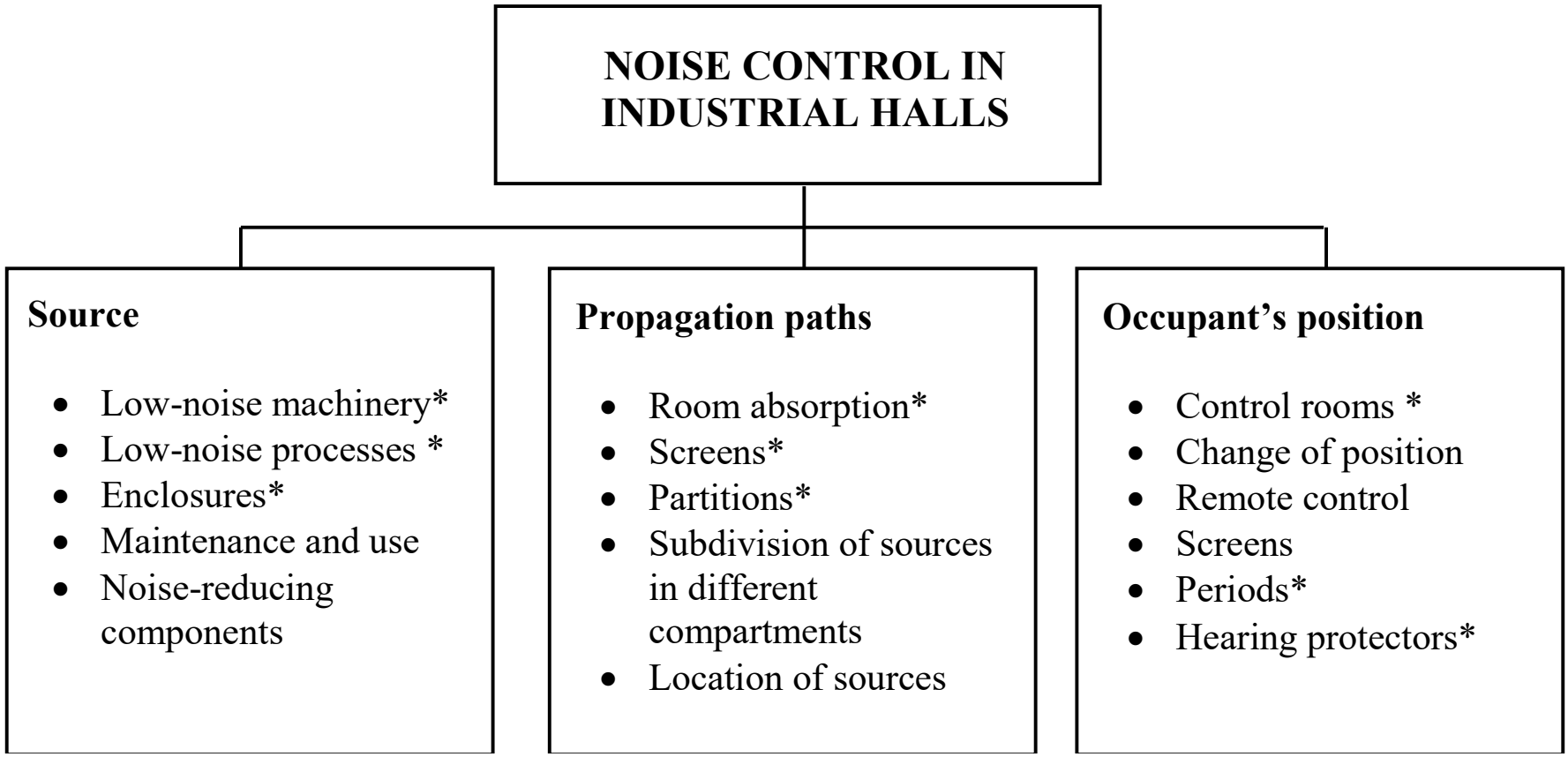
NOTE: The noise recommendations apply to the so-called general noise level in the workspace. The recommended levels are usually surpassed close to noisy equipment, such as manually controlled tools and machines. The recommendations also do not apply to unmanned engine rooms.

SFS 5907: Reverberation times

Maximum permitted reverberation time values T (s)

Type of space	Class A	Class B	Class C	Class D
Manned space, under 1000 m^3	1.0	1.2	1.5	1.8
Manned space, 1000 - 10 000 m^3	1.2	1.7	2.0	2.4
Manned space, over 10 000 m^3	1.5	2.0	2.2	2.6
Control room	0.4	0.4	0.5	0.5

In this standard, the limits for reverberation time have been presented as target times in octave bands 250, 500, 1000, 2000, 4000 Hz, measured in a furnished room (if possible, otherwise in a room with built-in furniture). The variation of the reverberation time in the above mentioned octave bands can be ±0.1 seconds. In the 125 Hz frequency band the variation can be ±0.3 seconds. The variation interval does not apply to the maximum reverberation time of a staircase, specified in the National Building Code of Finland C1/1998, referred to in section 5.1.4, Reverberation time - apartments, class C. The variation interval does not apply either to Section 5.5.4 Reverberation time – schools.

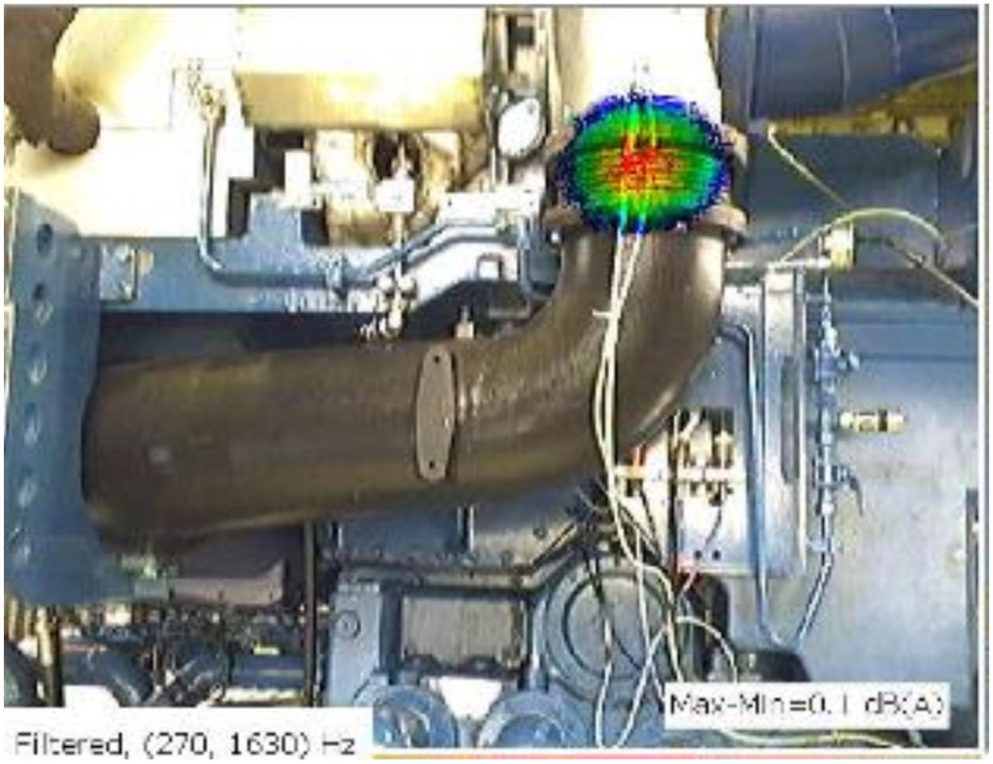

NOISE CONTROL IN INDUSTRIAL HALLS
Source
Low-noise machinery*
Low-noise processes *
Enclosures*
Maintenance and use
Noise-reducing components
Propagation paths
Room absorption*
Screens*
Partitions*
Subdivision of sources in different compartments
Location of sources
Occupant's position
Control rooms *
Change of position
Remote control
Screens
Periods*
Hearing protectors*

Localization of the source

Industrial hall can be full of sound sources. Finding the most relevant sources with respect to noise exposure or environmental satisfaction needs some efforts:

Localization techniques:

- Asking people
- Listening
- Use previous experiences
- SPL measurements
- Intensity measurements
- Vibration measurements
- Acoustic camera



Acquisition of low-noise equipment

- Low-noise equipment is the most efficient single way of reducing noise exposure $L_{A,eq,8h}$.
- European Union has made the comparison of products easy with Machinery Directive 2006/42/EC
  - Adopted to: **Valtioneuvoston asetus 400/2008**
  - **http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:157:0024:0086:en:PDF**

the following information on airborne noise emissions must be declared by the supplier:

- the A-weighted emission sound pressure level at workstations, where this exceeds 70 dB(A); where this level does not exceed 70 dB(A), this fact must be indicated, L_{AeqT}
- the peak C-weighted instantaneous sound pressure value at workstations, where this exceeds 63 Pa (130 dB in relation to 20 µPa), L_{Cpkmax}
- the A-weighted sound power level emitted by the machinery, where the A-weighted emission sound pressure level at workstations exceeds 80 dB(A). L_{WA}

Declaration of noise emission

	s_t	σ_M
Engineering grade	2.0	2.5
Survey grade	3.5	4.0

Declared single number noise emission value

- L_d [dB] is the declared value
  - Sound power level or sound pressure level
- Measurement uncertainty K is integrated to the declated value

$$L_d = L + K$$

Declared dual number noise emission value

- L and K are separately given

- K [dB] is the measurement uncertainty which depends on
  - measurement uncertainty of the test method, σ_M
  - number of equipment tested
- One equipment is tested:
  - $K=1.5*\sigma_M$
- Three 3 equipments are tested:
  - $K=1.5s_t+0.564(\sigma_M-s_t)$

Declared dual number noise emission value

Machine model number, operating conditions, and other identifying information:

Analyzer, serial number: xxxxxx

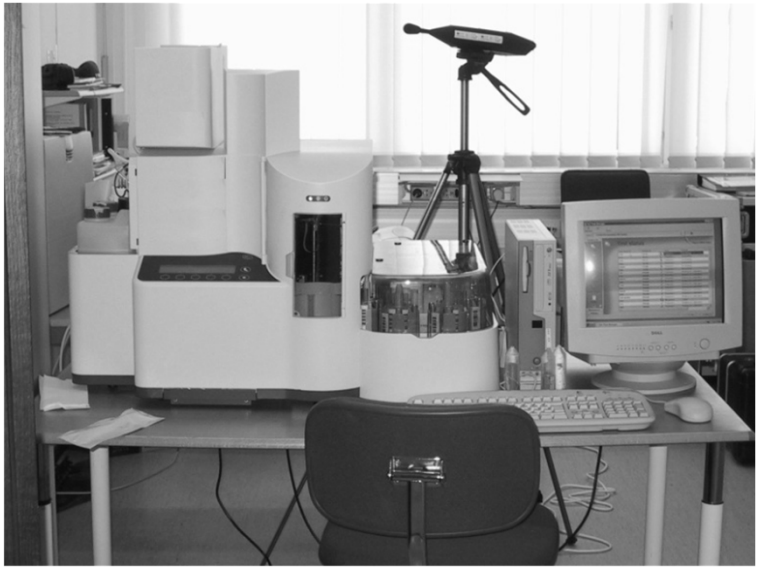
DECLARED DUAL-NUMBER NOISE EMISSION VALUES
in accordance with ISO 4871

operating mode	mode 1	mode 2	mode 3	mode 4
A-weighted emission sound pressure level, L_{pA} (ref. 20 μPa) at operator's position, in decibels	52	54	54	55
Uncertainty K_{pA} in decibels	4	4	4	4
A-weighted emission sound pressure level, L_{pA} (ref. 20 μPa) at bystander position (behind the analyzer), in decibels	55	56	56	56
Uncertainty K_{pA} in decibels	4	4	4	4

Mode 1: Startup and initialization
Mode 2: Action 1
Mode 3: Analyzation process
Mode 4: Shutdown and sleep

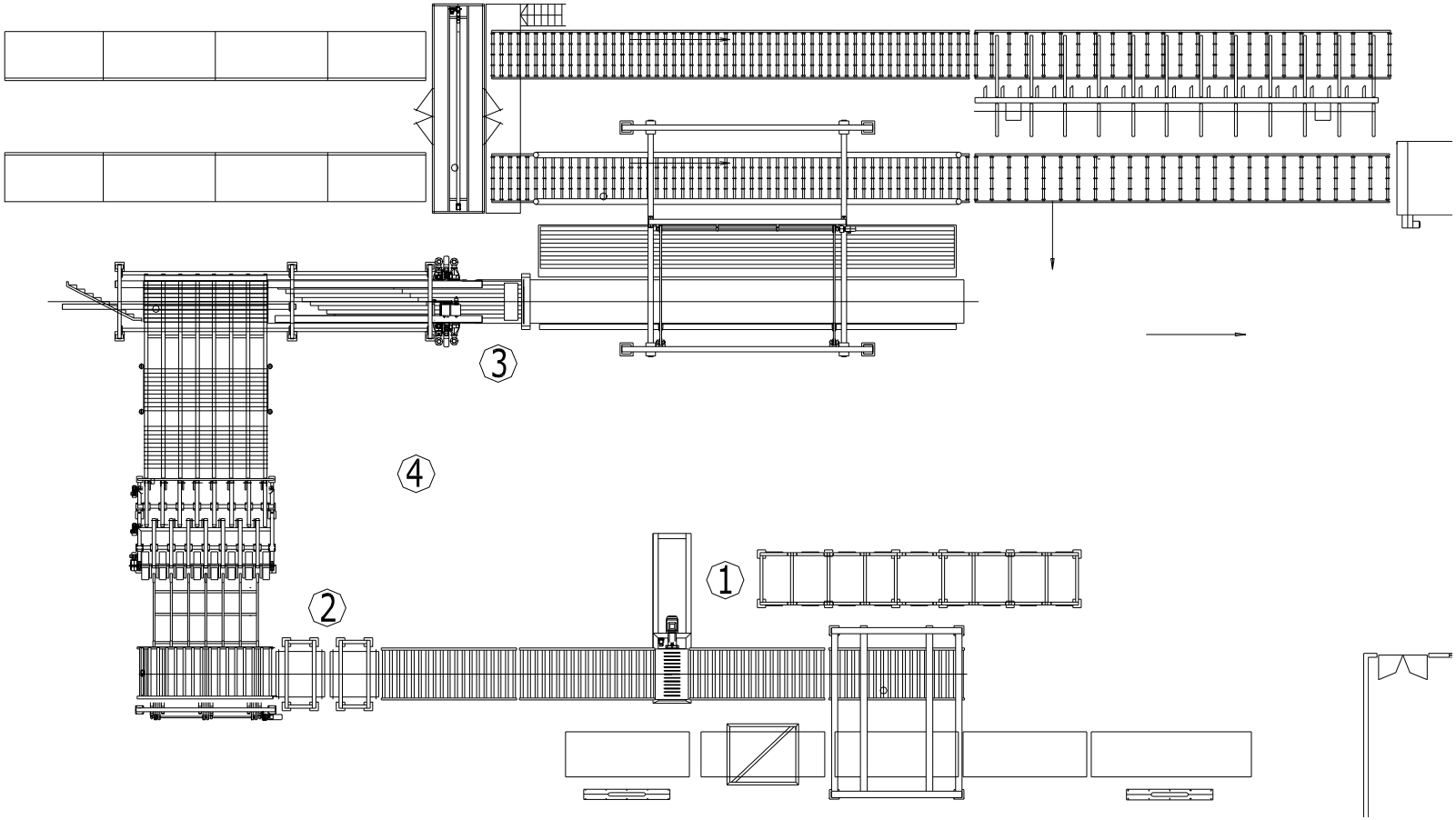
Values determined according to noise test code given in ISO 11202.

NOTES:
1. The sum of measured noise emission value and its associated uncertainty represents an upper boundary of the range of values which is likely to occur in measurements.
3. The declared L_{pA} values include the background noise correction K_{1A}= 0 dB (no correction needed)
3. The declared L_{pA} values include the local environmental correction K_{3A}= 2 dB which was determined using the measured reverberation time of the test room (ISO 11202 Annex A).



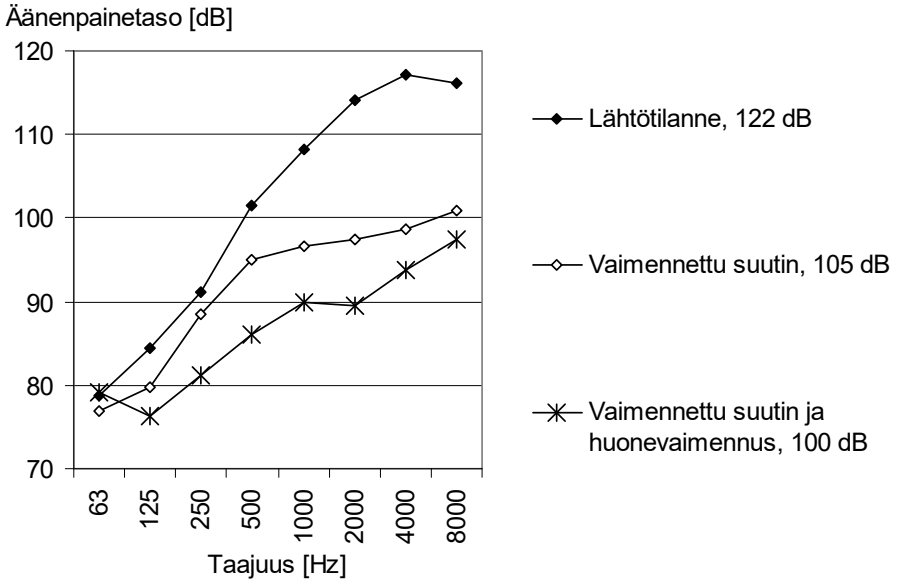
Declaration of noise emission of large production lines

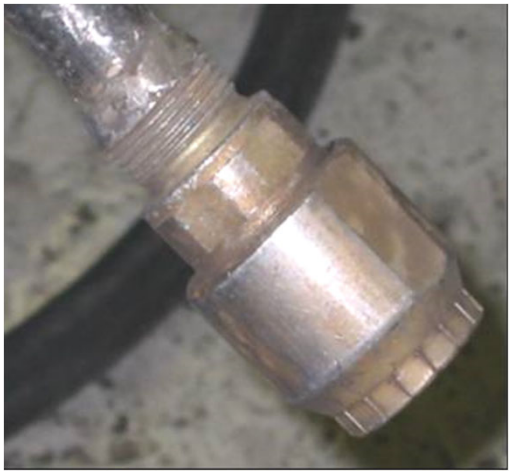
- SPL measurement in operators' positions and in most probable pass-by positions
- Emission sound pressure level is given where the room reflections are eliminated

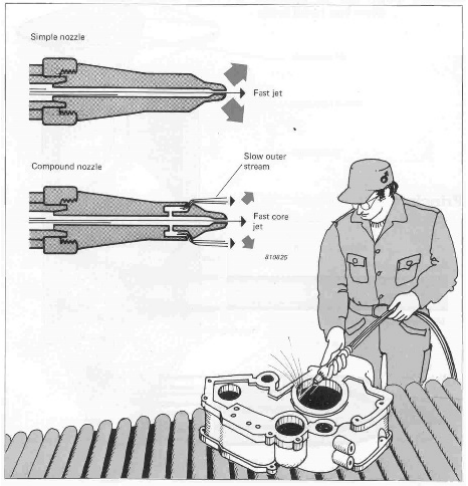


EXAMPLE Low noise machinery

- Painting room: pneumatic drying nozzle produced excessive noise: 122 dBA indoors and 100 dBA outdoors
- Silent nozzle was installed
- Room absorption was added to the painting room
- Indoor noise reduction 22 dBA
- Outdoor noise reduction 26 dBA

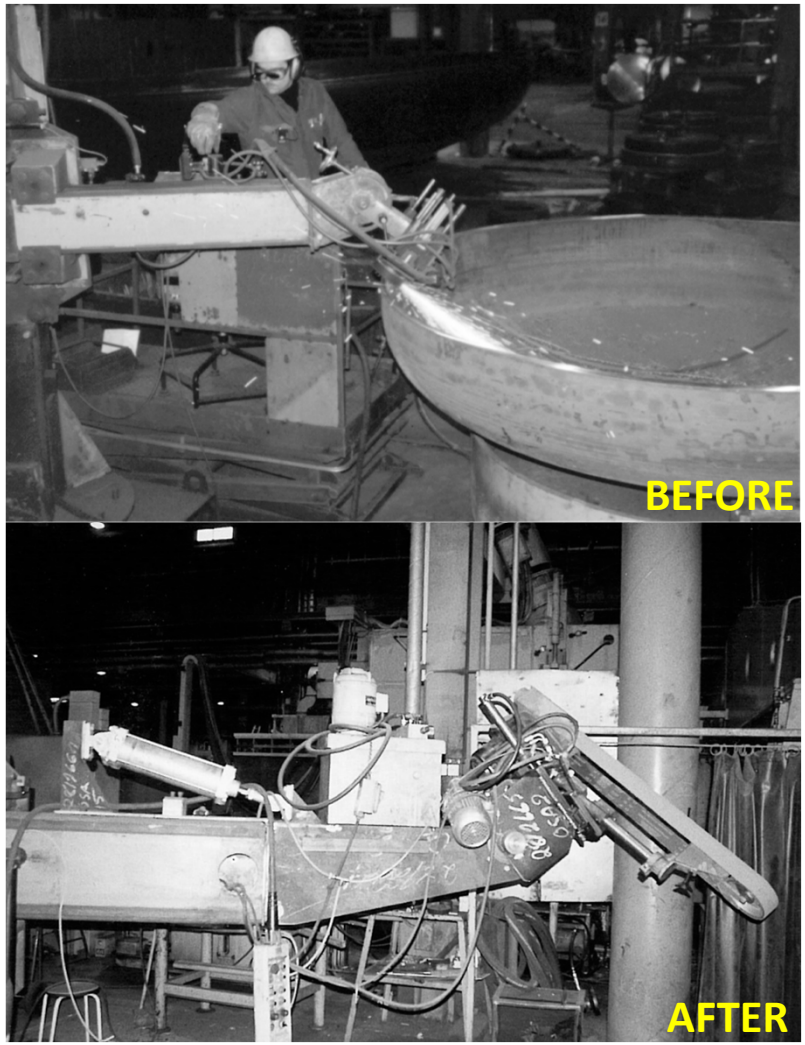






EXAMPLE Low-noise process

- 170x70x10 m hall
- three noisy angle grinders
- L_A=117 dB in the workstation, >95 dB in the hall
- Daily exposure $L_{Aeq,8h}$=104 dB
- Stone blade was producing the noise
- New method was developed which was based on sanding paper
- New robot was developed
- Noise reduction by 14 dB
- Dust increased but it could be solved by powerful exhaust fans



Enclosures

Check list:

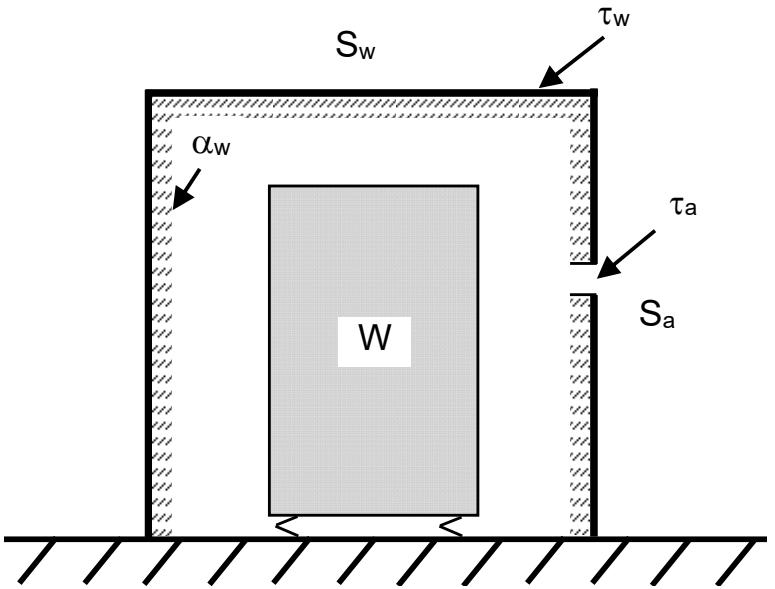
- Disadvantages of the enclosure must be minimized
  - Users should participate in the design
- Easy maintenance
  - Easy to open, dismantle and re-build
- Lighting and thermal control
- Positions of doors and windows/glazings
- Walking around the enclosure
- Avoidance of over-heating
- Electric and automatization
- Inlet openings
- Mechanical durability
- Safety aspects
- Effects to the other nearby activities

- **Full enclosure**
  - Recommendation
  - Largest sound reduction
  - Inlet holes must be well designed
  - Noise reduction depends on
    - air-tightness
    - sound reduction index
    - sound absorption of inner surfaces

- **Partial enclosure**
  - Noise reduction usually less than 10 dB
  - Profitable if the enclosure covers the noisiest part of the source

Noise reduction D [dB] of an enclosure

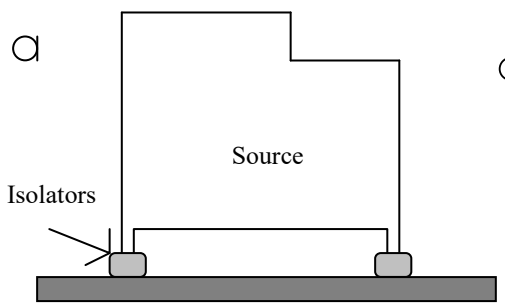
- W [W] is thesound power of the source
- W_t is the transmitted power
- τ_w is the transmission coefficient of the wall
  - Depends on the sound reduction index
- α_w is the absorption coefficient of inner surfaces
- S_a [m^2] is the area of inlet openings
- S_w [m^2] is the area of the enclosure
- τ_a is the transmission coefficient of the opening
  - Usually, τ_a=1.



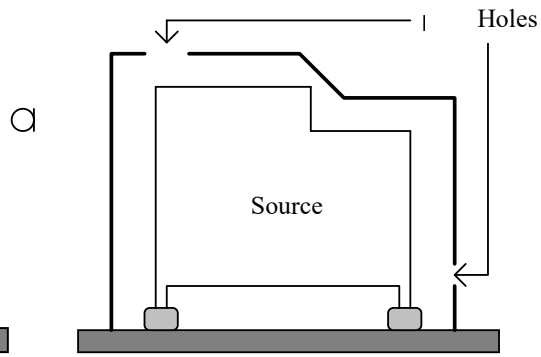
$$D = 10\lg\frac{W}{W_t} = 10\lg\frac{\frac{S_w}{S_a}\left(\alpha_w + \tau_w\right) + \tau_a}{\frac{S_w}{S_a}\tau_w + \tau_a}$$

Noise reduction of an enclosure

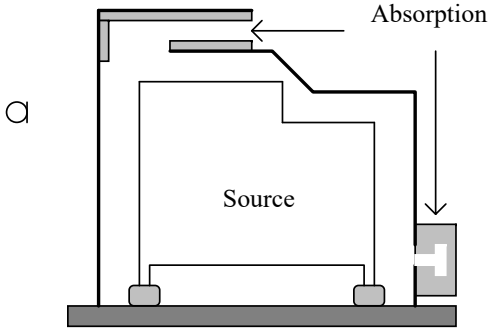
A. Vibration isolation



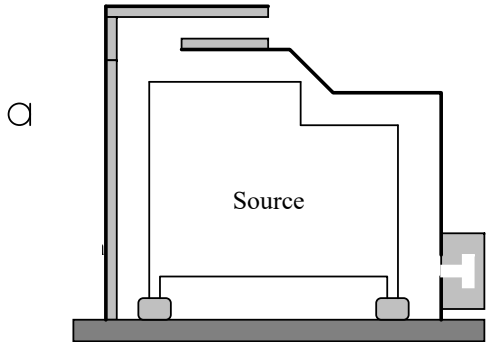
B: Enclosure, large holes

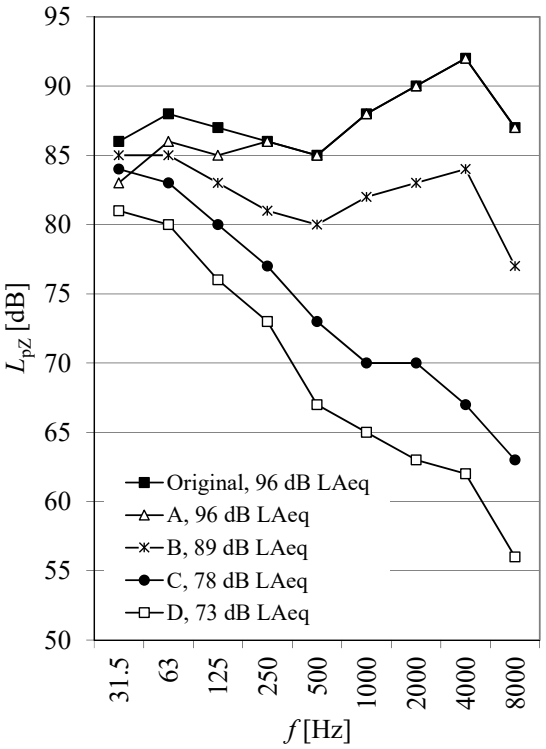


C: Holes with sound absorbing traps



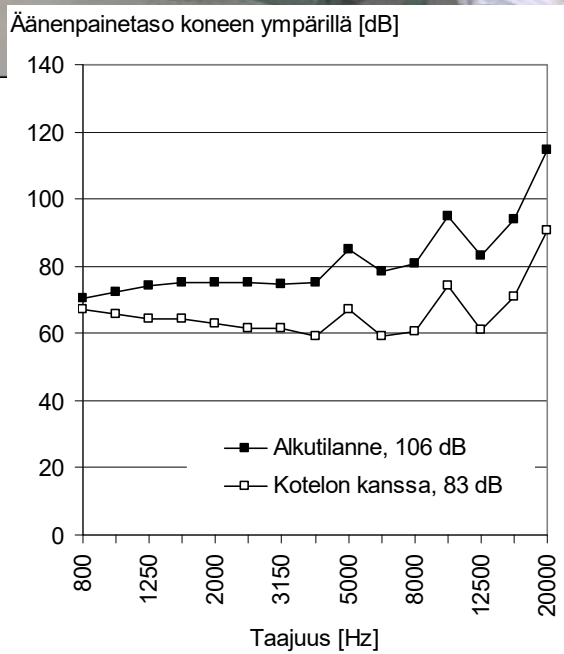
D: Additional absorption on the inner walls



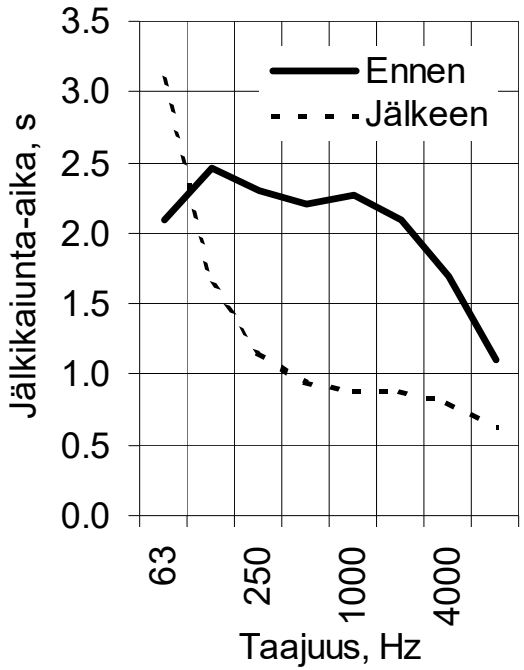


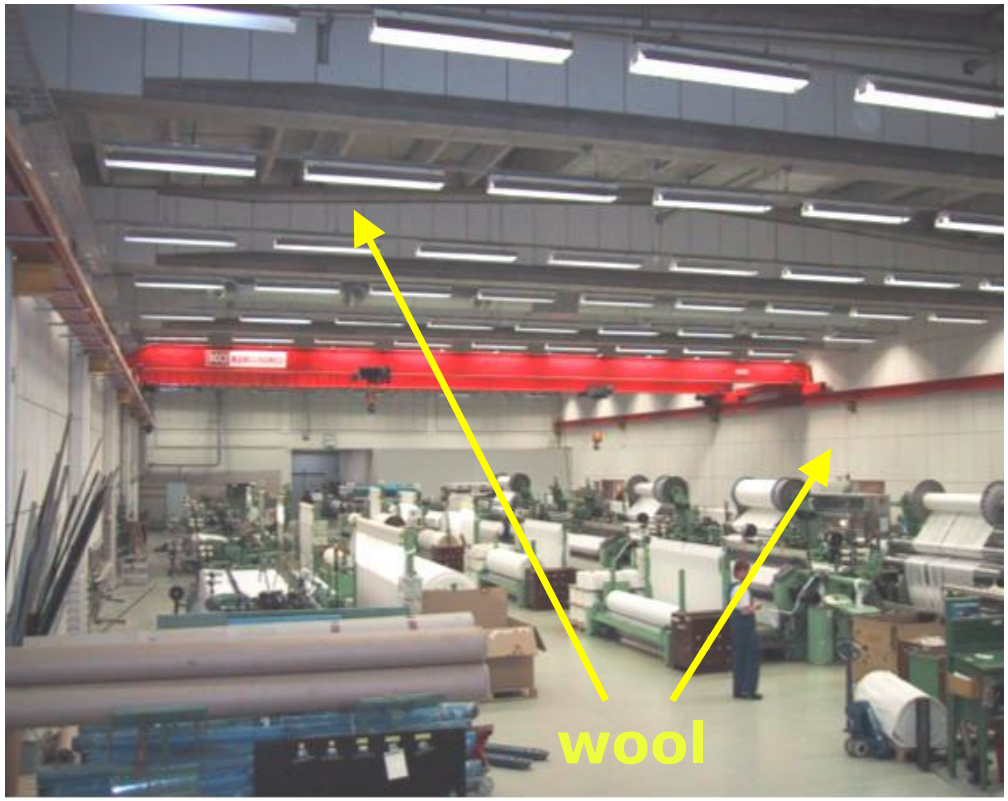
EXAMPLE Noise enclosure

- Filter fabric industry
- Border trimming machine based on ultrasound
- Original level 103-108 dB L_{Aeq} around the machine
- Solution was designed to provide easy maintenance and use of doors
- First attenuation was 10 dB. Sound leaks could be observed.
- Leaks were sealed and 19─28 dB noise reduction was achieved.
- Final SPL under 85 dB L_{Aeq}



EXAMPLE Room absorption

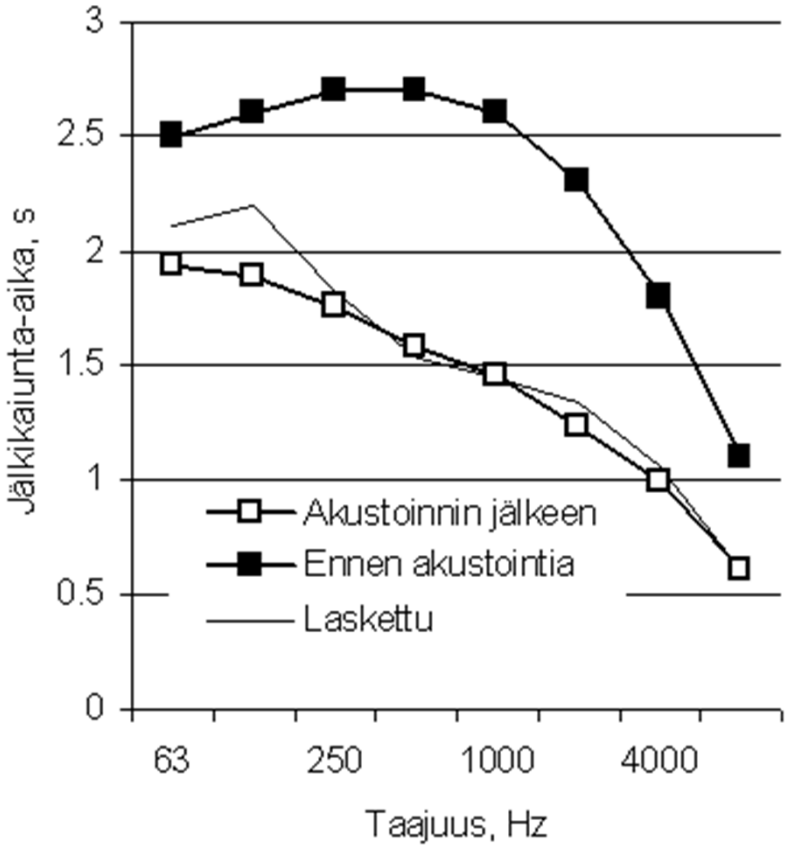


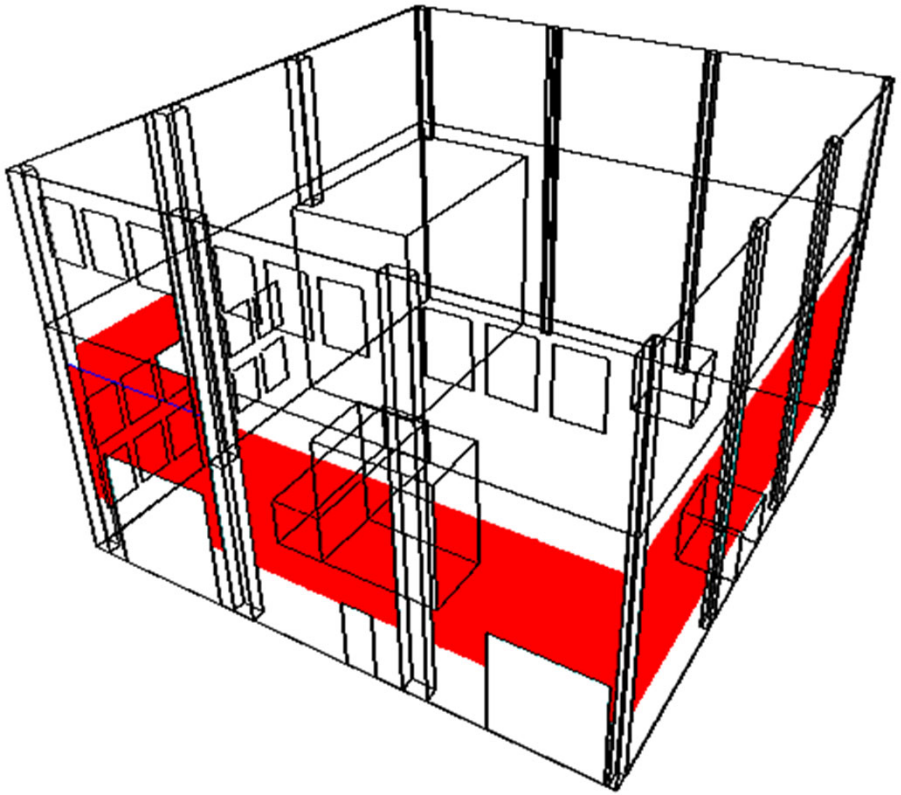


- 16 weaving machines running continuously
- 90 dB L_{Aeq}
- Walls and ceiling beams were covered with 50 mm wool
- RT reduced by 50 %, noise level reduced by 2─5 dB.

EXAMPLE Additional room absorption

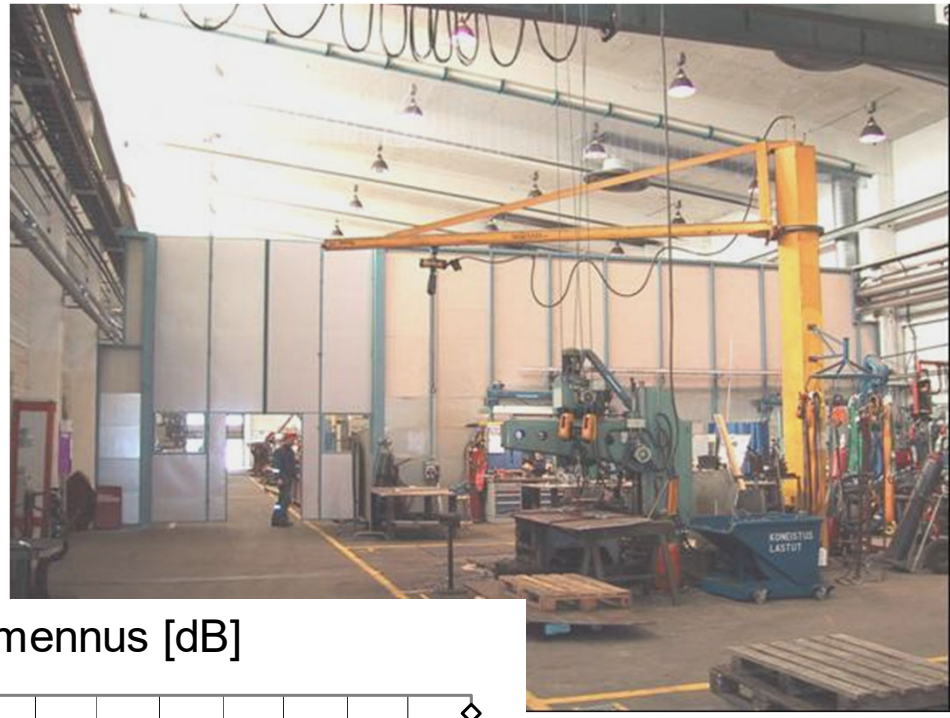
- Wall treatment with 50 mm wool

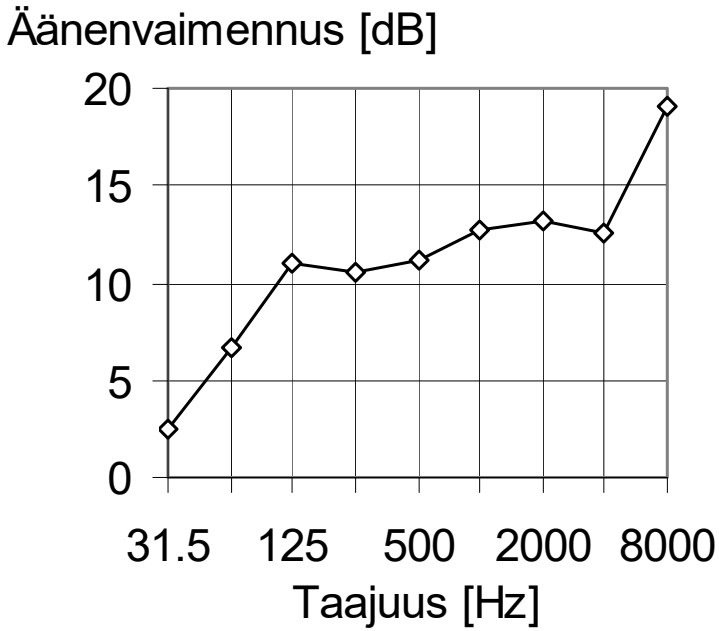




EXAMPLE Division of hall with a large noise barrier

- 140x20x10 m industrial hall contained noisy (*sheet metal workers*) and silent (*machinists*) activities
- The former disturbed the latter
- A large noise barrier was designed so that the crane could move over
- Measured noise reduction was 10 dB between the nearest workstations divided by the barrier – agreement with prediction

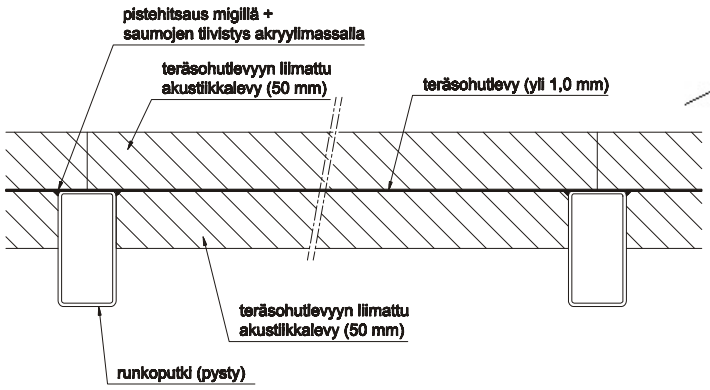




Barrier construction

Construction

- mineral wool 50 mm
- steel sheet 1 mm welded on steel conduits
- mineral wool 50 mm



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