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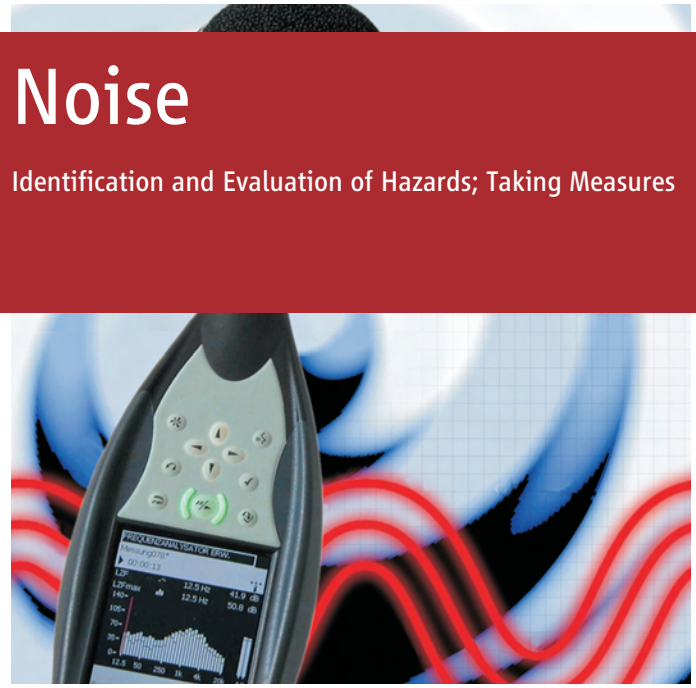
Guide for Risk Assessment in Small and Medium Enterprises

1 Noise

Identification and Evaluation of Hazards; Taking Measures



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Section for Electricity
Section for Iron and Metal
Section for Machine and System Safety

Guide for
Risk Assessment in
Small and Medium Enterprises

1 Noise

Identification and Evaluation of Hazards; Taking Measures

Imprint

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Introductory Note

This brochure at hand is intended to meet the requirement for risk assessment in the case of exposure to noise.

The information is divided into four chapters:

1. **Basic information**
2. **Checklist for Risk Assessment – Noise**
3. **Estimation and Evaluation of Noise**
4. **Corrective Measures**

Note:

This brochure is dealing exclusively with the European aspects, laid down in the directives for protection of workers at work (89/391/EEC and single directives). For specific national aspects please look up the respective legal transpositions (see page 15).

The present series of brochures is not intended to deal with the documentation of evaluated risks, since the pertinent rules and regulations differ widely in the individual EU member states.

Other topics treated in this series of brochures organised along the same lines and already published or being prepared are:

- **Hazards arising from machinery, equipment and materials**
- **Chemical hazards**
- **Hazards arising from electricity**
- **Hazards arising from fire and explosions**
- **Hazards arising from whole-body/ hand-arm vibrations**
- **Falls**
- **Physical strain (e.g. heavy and one-sided work)**
- **Mental workload**

1. Basic Information

1.1 | Legal Basis

The legal basis for minimum requirements for the protection of workers from the hazards of noise is Directive 2003/10/EC of 6 February 2003 (17th Individual Directive under the Protection of Workers Framework Directive 89/391/EEC). Under Article 4 of said Directive employers are under the obligation to evaluate and assess the risks incurred by workers due to the exposure to noise, and when necessary adopt measures to avoid or reduce such exposures.

1.2 | Provisions Governing Manufactures

Noise exposure is frequently due to machinery or vehicles (e. g. construction machines). The manufacturers of such machinery and vehicles are in principle under the obligation to design them so as to emit a minimum of noise.

In this respect, see the following two legal bases:

- Machinery Directive 98/37/EC of 22 June 1998 (which will be replaced in 2010 by the new machinery directive, Directive 2006/42/EC of 17 May 2006)
- Directive 2000/14/EC on noise emissions in the environment by equipment and machinery for outdoor use

If manufacturers' data on noise emission are taken into consideration when purchasing such equipment, noise will mostly present no major problem! Another effective means to reduce noise at the source would be including in the purchase agreement provisions stipulating specific emission levels at the place of use of the equipment in question.

Note: Provisions binding on manufacturers indicate emission levels, i. e. noise pressure levels in the open air; these are measured under standard conditions and for the most part do not reflect actual operating conditions.

1.3 | Procedure for the Risk Assessment

Step 1:	**Hazards identification (noise)**	It must be determined whether workers could be exposed to noise.
Step 2:	**Assessment and evaluation of noise risk**	The assessment takes place in accordance with Article 4 of the Directive 2003/10/EC to determine whether exposure limit values and exposure action values might be exceeded in the area under investigation (based, in particular, on measurements and the daily/weekly noise exposure levels determined).
Step 3:	**Decision on measures to be taken**	Wherever possible, at the source of noise emission or for the area under investigation, with due consideration of Articles 5 to 9 of Directive 2003/10/EC.

1.4 | Exposure Limit Values, Exposure Action Values

Article 3 of Directive 2003/10/EC defines the exposure limit and exposure action values in terms of daily noise exposure levels and peak sound pressure levels as follows:

Exposure limit values:

$L_{EX,8h}$ = 87 dB (A) resp. p_{peak} = 200 Pa

Upper exposure action values:

$L_{EX,8h}$ = 85 dB (A) resp. p_{peak} = 140 Pa

Lower exposure action values:

$L_{EX,8h}$ = 80 dB (A) resp. p_{peak} = 112 Pa

1.5 | Sound Pressure Level and Noise Level Perception

What is to be measured is the A-weighted sound pressure level. What changes occur in the sound pressure level when two individual noise sources of equal intensity are operated simultaneously?

Since the sound pressure level is a logarithmic quantity, it follows that:

Noise source	Energy	Increase by
2 noise sources of the same type	2-fold energy	3 dB
4 noise sources of the same type	4-fold energy	6 dB
10 noise sources of the same type	10-fold energy	10 dB
100 noise sources of the same type	100-fold energy	20 dB

A twofold sound pressure level (+3 dB) doubles the risk of hearing impairment!

Note:

If a noise abatement measure leads to reduction in the level of 6 dB, the risk of hearing impairment is thereby reduced to 1/4th.

A level difference of 10 dB is perceived as a doubling – or halving – of the sound intensity.

The following values may serve for guidance:

Conversation	60 dB
Vacuum cleaner	70 dB
Traffic noise	80 dB
Heavy lorry (at 5 m distance)	90 dB
Jack-hammer (at 2 m distance)	100 dB
Ambulance siren	110 dB
Jet during take-off (at 100 m distance)	130 dB

From 65 dB(A)	upwards telephone conversations become problematic.
At 85 dB(A)	normal talking is only just possible at a distance of 1 m.
At approximately 95 dB(A)	communiction requires shouting even at a distance of 50 centimetres.

1.6 | Approximate Noise Levels of Various Types of Machinery and Work

Below you will find some approximate values regarding typical sound pressure levels for certain types of machinery or certain forms of work.

Actual levels may be influenced by a variety of factors such as:

- Selected working procedures and individual working habits
- The tools used, e. g. low-noise circular saw blades
- Tool maintenance and servicing (e. g. blunt tools produce more noise than sharp ones)
- The choice of tool speed, cutting rate, feed rate and other machine-related parameters
- The workpiece/tool combination as well as lubrication
- Reduction of airborne sound by shielding, enclosures and room acoustics
- Vibration damping extras

Noise source	Average level L_{Aeq} in dB (A)
■ Metallworking	
Angle grinding	90 – 102
Punching	85 – 100
Welding	75 – 90
Cutting machines (lathes, milling machines, drills)	75 – 92
Belt sanding	83 – 88
Saw blade grinding	85 – 95
Circular cold saw	78 – 88
Mitre-box saw for metal sections	84 – 95
Squaring shears	80 – 95
Bending press	77 – 87
Nibbling machine	82 – 100
Air jet (for blowing out or blowing off)	85 – 105
Gas cutting machine	82 – 94
Pneumatic tools (hand)	83 – 95

Noise source	Average level L_{Aeq} in dB (A)
■ still Metallworking	
Pneumatic or electric jigsaws	98 – 105
Section cutter	85 – 92
Sheet metal flattening	up to 130
■ Woodworking	
Reciprocating saw	90 – 95
Circular saw bench	85 – 100
Band saw	80 – 90
Mitre saw (d = 180 cm)	100 – 105
Thicknesser	90 – 100
Surface planing	90 – 100
Portable sander	ca 90
■ Paper Industry	
Paper machines	85 – 95
Reel slitting machine	85 – 100
Refiner	95 – 100
Cross-cutting machine	80 – 90

1.7 | Measuring Noise Levels

In order to identify and evaluate risks to noise exposure, noise measurements have to be carried out. They have to be carefully planned and executed by experts at appropriate intervals.

Such measurements must at any rate be performed whenever changes in the acoustic environment have occurred due to refurbishing of buildings or the introduction of new machines or technologies (work processes).

Measurements may only be performed by experts (trained persons) or institutions, including staff members of the enterprise in question who have the necessary expertise and experience to perform noise measurements and evaluate the data obtained.

At the same time, the measuring instruments used must be adequate and reliable. Sound level meters have to be calibrated each time they are used.

The following requirements must be met:

- Operators have to have the necessary expertise and experience
- Measuring instruments have to be reliable and in good condition
- Measurements have to be performed at all workplaces and for all persons likely to be exposed

Measured results have to be recorded as daily average continuous sound pressure levels.

For risk assessment the daily noise exposure levels have to be determined for all exposed workers.

2. Checklist for Risk Assessment – Noise

Work area: _____ **Date:** _____

Assessed by: _____

Register-No.: _____

Subjective perception	yes	no	Remarks
noise level impairs mental work			
interferes with concentration			
makes telephone calls impossible			
normal talking at 1 m impossible			i. e. min. 85 dB
shouted information not understood at a distance of 50 cm			i. e. min. 95 dB
painful pulsed noise			i. e. level appr. 140 dB

Noise abatement measures taken*)	yes	no	Remarks
measures to improve room acoustics implemented			
low-noise machinery in use			
low-noise technologies and work processes			
enclosure, sound absorbers provided			
low-vibration mounting of machines			
screening of noisy environments (noise protection screens)			
noisy environments labelled			
appropriate hearing protection devices			
ear plugs correctly inserted			
hearing protectors consistently worn			
Other factors:			

*) **Note:** The questions listed under “noise abatement measures taken” allow a first overall impression to be gained of the situation on site.

3. Estimation and Evaluation of Noise

In the course of risk assessment the actual exposure to noise is determined for the individual workers involved.

The following parameters are indispensable for risk assessment:

- the sound pressure levels of different noisy environments ($L_{Aeq,i}$)
- duration of exposure of workers in noisy environments ($T_{e,i}$)

3.1 Determination of Noise Exposure Levels

The graph can be used to determine the noise exposure level as a function of the duration of exposure.

It is based on an assessment period corresponding to an 8-hour workday, i. e. for a 480-minute (8-hour) exposure the noise exposure level is identical with the measured noise level averaged over time (average level L_{Aeq}).

If the exposure time is shorter – the noise exposure level is reduced accordingly (vertical scale).

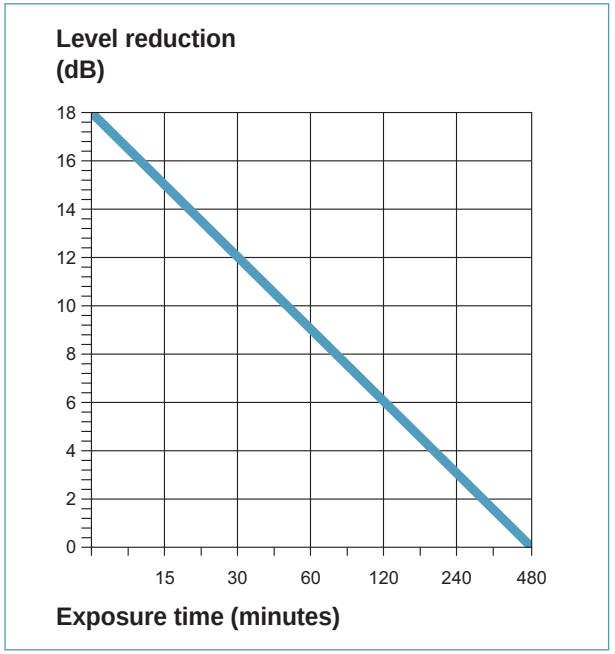

Diagram 1

Examples:

Duration of Exposure T_e (h)	Sound Pressure Level L_{Aeq} (dB)	Level Reduction (see Diagram 1) (dB)	Daily Noise Exposure Level (dB)
4	**90**	**3**	**87**
2	**90**	**6**	**84**
0,5	**90**	**12**	**78**

During a working day, if a worker crosses through areas of diverse noise exposure levels, or if the worker fulfils tasks which entail diverse noise exposure levels, the partial noise exposure levels must be considered.

The daily noise exposure level can be determined as follows:

The highest partial level is taken as a basis. The numerical difference to the second highest level is then plotted as a value on the x-axis, and the level adding can be read off the y-axis.

The determined value serves as a basis for the next (third highest) individual value.

This procedure can be applied analogously for further partial levels.

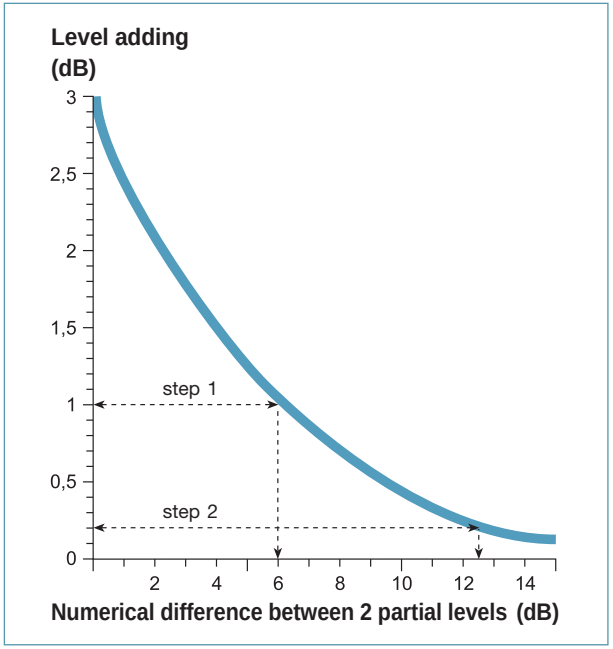

Diagram 2

Example:

A worker is subject to the following daily exposure (for partial noise exposure levels, please see diagram 1 on page 9):

$T_{e,1}$ = 2 hours	at noise exposure level $L_{Aeq,Te,1}$ of 90 dB	➡	84 dB partial level
$T_{e,2}$ = 1 hour	at noise exposure level $L_{Aeq,Te,2}$ of 87 dB	➡	78 dB partial level
$T_{e,3}$ = 5 hours	at noise exposure level $L_{Aeq,Te,3}$ of 75 dB	➡	72,5 dB partial level
8 hours			

▶ The highest partial level is **84 dB**.

▶ The difference to the second highest level is (84 dB – 78 dB) = 6 dB.
Diagram 2 depicts a level addition of **1 dB** (step 1).
The resulting intermediate value is (84 dB + 1 dB) = 85 dB.

▶ The difference to the third highest level is (85 dB – 72,5 dB) = 12,5 dB.
Diagram 2 depicts a level addition of **0,2 dB** (step 2).
Thus the daily noise exposure level for the worker results is (85 dB + 0,2 dB) = 85,2 dB.

3.2 | Risk Evaluation

The object of risk evaluation is to relate the severity of any possible damage to the probability that such damage occurs.

Important note:

Where conditions for determined risks and strain already exist in National Laws and Directives (e. g. threshold values) compliance is mandatory. The risk evaluation has already been carried out by experts.

Risk assessment in general and risk evaluation in particular will have to be undertaken whenever general protection objectives have to be translated into concrete practice at the enterprise level or when further action in excess of minimum standards is needed.

As far as possible, risk evaluation should be based on objective criteria. Where noise is subjectively perceived as a severe nuisance, for instance in offices where high-level mental work requires full concentration, a quantitative evaluation will not be possible, since the exposure level is estimated on subjective grounds and hearing damage is not to be expected (despite prevailing threshold values). Obviously, this should, however, not prevent corrective action!

In assessing the risks incurred by exposure to noise, the relevant parameters are the daily or weekly noise exposure value and, in the case of high peak levels, the C-weighted peak sound pressure level.

If, in the course of a working day, an employee is working in different environments in terms of noise intensity, risk evaluation must be based on the daily noise exposure value, which is to be determined on the basis of the different levels of the individual noisy environments concerned and the periods of daily exposure to these noise levels. On the basis of this data the actual exposure level can be determined by the calculation presented in 3.1 above.

4. Corrective Measures

4.1 | Basic Aspects of Noise Reduction Measures

In a great many cases, people exposed to noise will opt for some personal hearing protection as “by way of a reflex” without giving any thought to other forms of noise reduction.

Just as for other risks, the following consideration also applies to noise:

Taking account of technical progress and of the availability of measures to control the risk at source, the risks arising from exposure to noise shall be eliminated at their source or reduced to a minimum (Article 5, para. 1 of Directive 2003/10/EC)!

Directive 2003/10/EC lists in Articles 5 to 9 possible noise abatement measures with due consideration of the following aspects and subjects:

1. Structural measures and measures concerning room acoustics
2. Measures at source
3. Measures relating to materials, equipment and working processes
4. Technical and organisational measures
5. Personal protective equipment (last or additional choice)

4.2 | Structural Measures and Measures Concerning Room Acoustics

Structural measures to avoid or reduce the exposure to noise may be the appropriate design and layout of rooms and workplaces.

In principle, the aim is to reduce the size of noisy environments as much as possible, i. e. to ensure that a minimum number of workers are exposed to or affected by noise.

Where possible, room acoustics should be adjusted to ensure that a mean sound absorption of

- $\alpha_{m,B}$ = 0.25 (empty room, design value) or
- α_m = 0.3 (furnished room) for the octave band mean frequencies of 500, 1000 and 2000 Hz are achieved.

In particular, structural and acoustic issues should already be addressed in the planning and design phase of new workplaces and work stations!

Consideration (by the architect) of the necessary structural and acoustic measures during the planning phase will not only ensure greater efficiency but also result in considerable savings in terms of construction and equipment costs!

4.3 | Measures at Source

The term “measures at source“ comprises measures by which a reduction of the exposure to noise is to be achieved by acting upon the source by which the noise is generated.

Such measures may be:

- The use of less noisy working processes, e. g. less frequent use of compressed-air nozzles
- The use (or purchase) of equipment that emits less noise (such as low-noise machinery or compressed-air nozzles); the machine manufacturer is obliged to include information about noise emission in the operating instructions
- Adequate maintenance programmes for work equipment including connecting elements and mountings

4.4 | Measures Relating to Materials, Equipment and Working Processes

In part, similar to measures at source. Measures regarding work equipment and tools may consist in:

- The use of low-noise tools (such as circular saw blades)
- Best possible choice and adjustment of operating parameters such as speed, feed, cutting depth, type of tool or lubricants
- Noisy work equipment or processes should be carried out in a separate room
- Organisational measures through which as few workers as possible are present in the noise area
- Vibration-damping measures regarding tubing, piping and other components

4.5 | Technical and Organisational Measures

Technical measures according to the directive are:

- Measures for reducing airborne noise, e. g. by shields, enclosures, sound-absorbent coverings or
- Reducing structure-borne noise, e. g. by damping or isolation.

Organisational measures are:

- Increasing the distance to a source of emission, e. g. to a loud machine for workers who are not working on this machine
- Low-noise work processes and handling of work equipment
- Limitation of the individual period of exposure, e. g. through adequate breaks and rest periods
- Labelling of noisy environments (in line with the Labelling Directive)

Workers, who during their work are exposed to noise equivalent to the lower action values or higher must be informed about the risks arising from this exposure (Article 8 of the Directive 2003/10/EC).

4.6 | Personal Hearing Protective Equipment

If the risks arising from exposure to noise cannot be prevented by any other means, Directive 89/656/EEC (Third Individual Directive under the Protection of Workers Framework Directive 89/391/EEC, “Use of Personal Protective Equipment“) requires that workers be furnished with suitable and properly adjusted personal hearing protection devices.

Recommendations for the selection and use of such devices:

- Select the correct type of protective device in accordance with working conditions, e. g. ear muffs for short-time exposures, ear plugs for work in dusty or soiled environments
- Select protective devices with adequate noise reduction ratings, avoiding both underprotection and overprotection
- Make sure that ear plugs are correctly inserted; do not re-use ear plugs
- Store protective devices in the area where they are to be used
- Use protectors consistently and at all times; even short periods of working without protection will drastically reduce the effectiveness of protection

The basic rule is:

The best protective device is the one you wear!