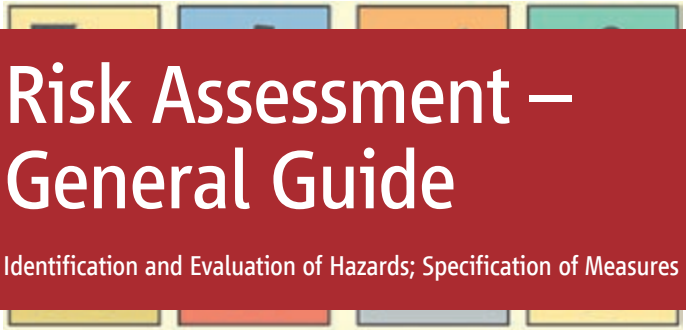
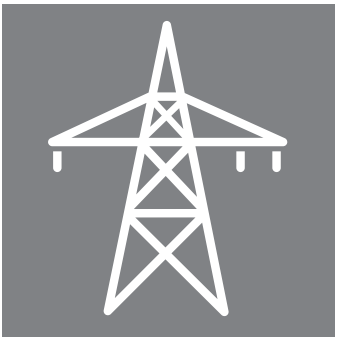
Guide for Risk Assessment
in Small and Medium Enterprises

10 Risk Assessment – General Guide

Identification and Evaluation of Hazards; Specification of Measures





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Section for Electricity
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Imprint

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Introductory Note

This brochure is addressed to micro-, small and medium-sized enterprises as a simple tool for hazard identification and risk assessment in their workplaces. Occupational safety and health and its development is closely connected with social end economical development of our society and is ranked among priorities in EU member states.

The EU regulations require to secure and to improve health and safety protection of the workers at the workplace through occupational safety measures. Health and safety protection should be conducted in an anticipatory and precautionary manner, before any specific risks arise.

Therefore risk assessment presents, together with a need of rational and optimal use of the threshold resources, the cardinal issue of importance. Therefore, risk assessment is both a legal obligation for enterprises and a basic process to ensure a necessary level of safety and health protection of workers at work.

One of the most important EU-Directives is the Framework Directive 89/391/ECC on Safety and Health of Workers at Work. The Framework Directive must be implemented by the EU member states. The most essential demand of this Directive is for employers to carry out a risk assessment.

Risk assessment is the key instrument in occupational safety and health. The employer must consider the state of the art of protective measures in line with the result of the risk assessment.

The brochure is divided into the following chapters:

1. **Risk assessment – a legal obligation**
2. **Terminology**
3. **Methodology**
4. **Hazard identification**
5. **Risk estimation and risk evaluation**
6. **Risk reduction (selecting and taking measures)**

Annex: Examples of risk assessment

For specific national aspects, please look up the respective legal transpositions (see “National Aspects”).

Based on this brochure the following specific topics were treated in this series:

- **Noise**
- **Hazards arising from machinery and other work equipment**
- **Chemical hazards**
- **Slipping and falling from a height**
- **Hazards arising from explosions**
- **Hazards arising from whole-body/hand-arm vibrations**
- **Manual handling of loads**
- **Mental workload**

1. Risk Assessment – A legal Obligation

Risk assessment is a series of logical steps to enable, in a systematic way, an analysis and evaluation of risks. There are many ways and methods used for hazard identification and risk quantification, each of them having some benefits and deficiencies. That is why selection of the suitable method is very important. In choosing an adequate method some information should be taken into account. It includes the purpose of the assessment, current state of the enterprise, data available or financial possibilities and personal dispositions of an assessor.

Each method requires sufficient transparency of particular steps both for users of the risk assessment results and all employees who can be affected by risk.

Proposition 1

The way of risk assessment, which is provided in this brochure is understood as the overall process comprising risk analysis and risk evaluation.

Proposition 2

The way of risk assessment, which is provided in this brochure is based on a general definition of risk understood as a combination of probability of harm occurrence and severity of its potential consequences.

The results are findings usable for hazardous situations occurrence prevention, preparedness for an adequate reaction and real action. A systematic risk assessment enables to determine the priorities in taking measures, option assessment, allocation of resources etc., which leads to continuous improvement and increase of the level of occupational safety and health.

This general guide uses the most concise and easy way for the employer in order to be easily understood. The aim is to provide help to them to be able to decide, whether a hazard is significant, and whether it is covered by satisfactory precautions so that the risk is acceptable.

2. Terminology

The following definitions are used in the brochure:

Harm – a physical injury or health damage

Hazard – a potential source of harm. It should be noticed that the term “harm” can be qualified in order to define its origin (e. g. mechanical hazard, electrical hazard) or the nature of the potential harm (e. g. electric set shock hazard, cutting hazard)

Protective Measure – A measure intended to achieve risk reduction, which comprises measures implemented by the designer (inherently safe design, safeguarding and complementary protective measures, information for use) and measures by the user (e. g. safe working procedures, supervision, use of additional safeguards, use of personal protective equipment, training)

Risk – combination of the probability of occurrence of hazardous event and the severity of harm

Risk Assessment – the overall process comprising risk analysis and risk evaluation

Working Manner – A source of hazards determined mainly by technical parameters of objects – working tools and measures (inter alia through their design and sizes) as well as organization and methods of work and workers’ behaviour.

Workstation – The working space, equipped with working tools and measures, in which a worker or a group of workers perform their tasks.

Working environment – The conditions of the material environment (characterized by physical, chemical and biological factors) in which working processes take place.

Task – The specific activity performed by one or more persons on or in the vicinity of the machine during its lifecycle.

3. Methodology

In this chapter the principle methodology of risk assessment is described. The basis for this chapter is the European standard EN ISO 14121-1 about risk assessment. Figure 1 shows the methodology of risk assessment (analysis and evaluation of tasks) and risk reduction.

The aim of the complete occupational risk assessment process and application of preventative actions is to reduce the risk to an acceptable level, that is the level at which the gravity of losses connected with triggering a given hazard can be accepted.

Step 1:

Specification of task

The first step of occupational risk assessment consists in collecting complete and up-to-date information concerning the type of tasks performed by a worker and the manner of their execution, working conditions, as well as operated machines and tools and the protective measures which are already in use. In the course of collecting the above information it is essential to take account of all types of tasks, including the ones performed beyond the usual working area, which requires taking account of the place where work is performed (stationary and mobile workstations).

Ways of obtaining information about hazards include:

- observation of tasks carried out at a given workstation and beyond it – including the manner of work, operated machines and tools as well as organization of work
- observation of the surroundings, e.g. the presence of workers engaged by other companies who may affect work safety, weather conditions
- interviews with workers
- analysis of available documents – technical specifications of machines and tools operated at a given workstation (aim: comparison with the factual state at the workstation) workstation-specific instructions, results of tests and sample analyses of hazardous factors and agents (dusts, noise), factsheets of chemical substances, documents on workplace accidents, occupational illnesses
- information on causes of shutdowns
- information on recurring human mistakes.

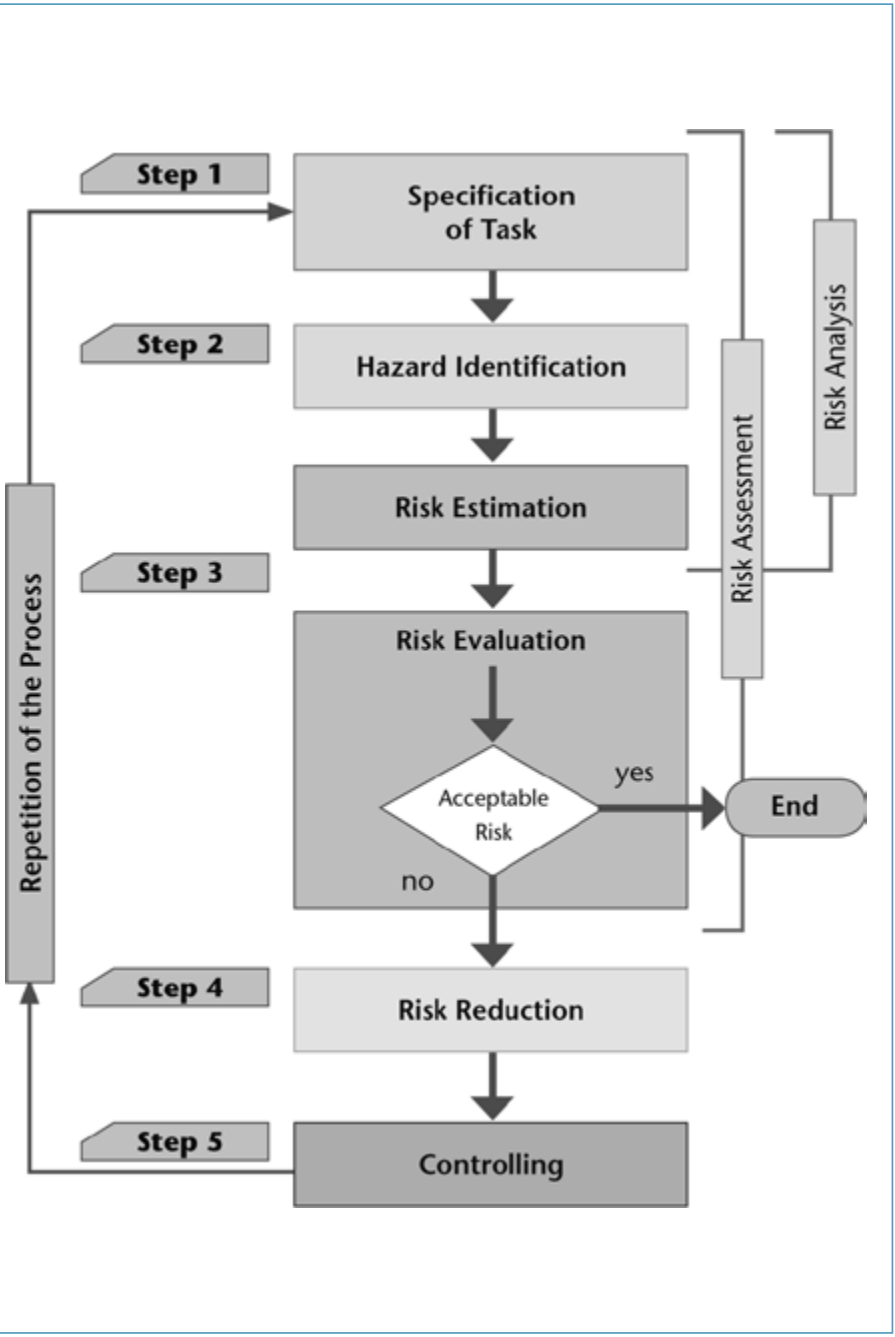

Figure 1: Methodology of risk assessment and risk reduction

Step 2:

Hazard identification

The most important phase in the occupational risk assessment process consists in identifying all hazards which, when triggered, may cause undesirable effects (injuries and other adverse health effects, material losses and other kinds of losses, for instance lost capabilities).

While implementing this phase one have to answer the following questions:

- **WHAT constitutes the hazard?**
- **WHO is exposed to the hazard?**

In this regard the following instruments can be of assistance:

- checklists, e.g. prepared for individual technological processes and production conditions or for different types of hazard
- methods such as work safety analysis which consists in defining the aims of tasks performed by a worker, drawing up a list of actions and determining hazards connected with carrying out each of the actions.

The above mentioned instruments can also be developed by a company itself. It is essential to take account of all areas where hazards can be expected.

Step 3:

Risk estimation and risk evaluation

Risk estimation consists in determining the effect of triggered hazards and the probability.

Consequently, in the risk evaluation it has to be decided whether or not and how fast actions need to be taken in order to eliminate or minimize the risk.

According to EN ISO 14121-1 the following should be considered in the risk evaluation:

- all persons possibly exposed to the hazard
- type, frequency and duration of exposure
- ration between hazard exposure and effects

- human factors (interaction between persons, psychological points of view, etc.)
- suitability of protective measures
- the possibility of defeating or circumventing protective measures
- the ability to maintain protective measures.

In this step it has to be assessed if the risk is acceptable. If working conditions are considered to be safe further actions need not to be taken.

On the other hand, if the risk connected with performing a given task cannot be accepted, it is necessary to undertake actions aimed at reducing the risk.

Step 4:

Risk reduction (selecting and taking measures)

Depending on the level of the assessed occupational risk it is necessary to plan and implement effective preventative measures.

Their aim is to eliminate or minimize the existing risk while not generating new hazards at the same time.

The general rules of organizing the preventative actions cover the following:

- technical measures which eliminate or reduce hazards at their source (the measures applied in order to eliminate hazards are most effective and they mainly consist in automation and mechanization of work processes)
- collective protective equipment
- procedural and organizational measures
- personal protective equipment.

The planning phase should provide answers to two questions:

- **Will the undertaken actions lead to expected lowering of occupational risk level?**
- **Will the applied solutions not generate new hazards?**

At the implementation phase a person (or various persons) should be designated being responsible for the supervision of:

- implementing properly selected measures
- providing training on their appropriate use
- maintaining the measures in a proper technical state to guarantee that all properties of the measures are retained.

Step 5:

Controlling

Preventative measures should be integrated and coordinated at the whole company level.

This approach will provide the basis for the development of an efficient risk management system based on the flow of information and harmonized actions.

An additional benefit of organizing preventative actions in this way is that they are subject to a systemic inspection regarding:

- taking appropriate actions
- achievement of the preset aim (elimination or reduction of risk)
- effective functioning of implemented solutions within a certain period of time.

Hence, it will be necessary to carry out periodic inspections in order to ensure that new hazards do not appear or are rapidly detected.

Fixing the periods at which the in-spection of functionality of applied measures will be carried out is not very practical. The reason for this is that working conditions are dynamically changing.

This process includes e. g. introduction of new machinery, replacement of substances or materials in use with new ones, implementation of new technologies, changes in work organization and working methods.

It would be advisable to make subsequent inspections conditional on the existence of the above situations.

Similar to documenting individual phases of the process, this phase should also be concluded with a document stating that certain predefined requirements and effects have been achieved.

Information contained in such a document is of particular importance to the worker whom it directly concerns. Therefore, it should be disclosed to this worker.

4. Hazard Identification

Risks can be detected and determined

- prospectively by direct methods (e. g. inspection rounds, interviews) or
- retrospectively through indirect methods (e. g. accident investigations, investigation of work-related diseases).

To prevent accidents at work and work related diseases has top priority. The anticipatory determination of hazards is carried out in the following steps:

1. Determination of the relevant hazard factors (injuries-causative and disease-causative factors) which prevail at the workplace or with the concrete activity.

All hazards and strains to which the workers could be subjected at the workplace must be determined. Figure 2 shows the principal and basic hazard factors.

2. Determination of the hazard sources

It is the objective to determine the cause for possible hazards.

3. Determination of the danger-causing conditions

Danger-causing conditions are those circumstances which make a coincidence of the hazard factor with a person possible (Can an injuries-causative or disease causative factor actually coincide with a person?). Also possible sources for human failure (omission, oversee or forget safety devices, etc.) have to be considered.

4. Consideration of workers' special performance requisites

Individual performance requisites of the workers need to be considered – e. g. young workers or trainees, older workers, expectant mothers, handicapped persons, foreign workers not fully fluent in the local language.

5. Gathering information

This can be for example national rules, standards and regulations (laws, ordinances, accident prevention regulations, technical rules, etc.) by the state or by statutory accident insurances exist for the determined hazard factors, which need to be complied with (e. g. workplace thresholds in case of hazardous substances).

In case such guidelines exist, they must be complied with (see "National Aspects").

1.		1.1	1.2	1.3
Mechanical hazards		unprotected moving machine parts	parts with dangerous surfaces	movable transportation equipment, movable work equipment

2.		2.1	2.2	2.3
Electrical hazards		electric shock	electric arcs	electrostatic charge

3.		3.1	3.2	3.3
Hazardous substances		gasses	vapours	aerosols

4.		4.1	4.2	
Biological hazards		Infection hazard through pathogenic microorganisms (e.g. bacteria, viruses, fungi)	allergenic and toxic substances from microorganisms	

5.		5.1	5.2	5.3
Fire and explosion hazards		fire hazard through solids, liquids, gasses	explosive atmosphere	explosive substances

6.		6.1	6.2	
Thermal hazards		hot materials/surfaces	cold materials/surfaces	

7.		7.1	7.2	7.3
Hazard through special physical impact		noise	ultrasound, subsonic noise	whole-body vibrations

8.		8.1	8.2	8.3
Hazards through work environment conditions		climate	lighting, light	drowning

9.		9.1	9.2	9.3
Physical strain		heavy dynamic work	one-sided dynamic work	static work

10.		10.1	10.2	10.3
Mental factors		insufficiently designed work tasks	insufficiently designed work organisation	insufficiently designed social conditions

11.		11.1	11.2	11.3
Other hazards		through humans	through animals	through plants and vegetable products

Figure 2: Classification of hazard factors

	1.4	1.5	1.6		
	uncontrolled moving parts	falling, slipping, tripping, twisting one's foot	falling from height		
	3.4	3.5			
	liquids	solids			
	7.4	7.5	7.6	7.7	7.8
	hand-arm vibrations	non ionising radiation	ionising radiation	electromagnetic fields	negative pressure, overpressure
	9.4				
	combination of static and dynamic work				
	10.4				
	insufficiently designed conditions of workplace and work environment				

5. Risk Estimation and Risk Evaluation

5.1 | Risk estimation

Risk estimation is a process where the combination of the probability of occurrence of harm and the severity of that harm is estimated.

Risk estimation involves the follwoing parameters:

- establishing a scale that reflects the perceived likelihood of a risk (the scale may be qualitative or quantitative)
- delineating the consequences of a risk
- establishing the impact of the risk
- appreciating the overall accuracy of risk estimation.

Risks are weighted by perceived impact and then prioritised. There are three factors that affect perceived impact:

- nature of the risk (which in turn indicates whether the problems are likely to occur)
- scope of the risk, combining its severity its overall distribution
- timing of a risk (when and for how long the impact will be felt).

While we can appreciate that risk estimation is a subjective science, it is still possible to measure the level or range of risk. Risk estimation can be performed quantitatively or qualitatively (a specific, measurable amount).

Quantitative attributes of risk are for example:

- measured exposure data
- quantity of a substance
- incidence of mortality or morbidity
- modelling of frequency of exposure.

Qualitative attributes of risk might be:

- the types of health effects from exposure
- the estimated frequency of exposure
- location of a hazard.

Both, quantitative and qualitative components of risk should be broad enough to clearly describe the entire event. In case the exposure (to a physical agent, a substance, working time on a machine, etc.) is quantifiable, it must be quantified!

Quantitative risk estimation

Quantification of occupational hygiene risks depend on their nature, ability to be measured and appropriate benchmarks or standards. The three components to risk are:

1. Frequency
2. Probability
3. Consequences.

In many cases these factors can be mathematically expressed to provide a quantitative and reliable risk estimation. The respective factors can be for

1. Frequency: Can be determined by using data such as historical exposure information or incident records.
2. Probability: Which is the chance that an event will occur. It can be rated

e. g. on a scale of 0 to 1, where 0 represents no chance and 1 is an absolute certainty that the event will occur.

3. Consequences: The consequences of exposure to a given hazard can be:
   - number of lives lost or injuries caused
   - severence of damage (minor accident, occupational disease, permanent invalidity, etc.)
   - cost of damage.

A limitation of quantitative risk estimation is, that it does not consider our incividual and subjective perception of a given hazard. Quantitative risk estimation is also the basis for a ranking of measures.

Qualitative risk estimation

As the name suggests, qualitative risk estimation using qualitative methods is subjective and often open prone to multiple interpretations and debates. There are various methods of risk estimation used at workplaces. Here one tool which can be used is shown.

Matrix for qualitative risk estimation (example)

Consequence	Probability of occurance of harm			
	practically impossible	unlikely	possible	almost certain
minor cuts, bruises, bumps (first aid injury – no time lost)				
disabling injury (lost time < 8 days)				
serious injury, occupational disease				
fatality				
multiple fatalities				

5.2 | Risk evaluation

After risk estimation, risk evaluation shall be carried out to determine if risk reduction is required or whether an acceptable safety standard is already given.

In case the risk is **unacceptable**, risk reduction has to be performed (see Figure 3).

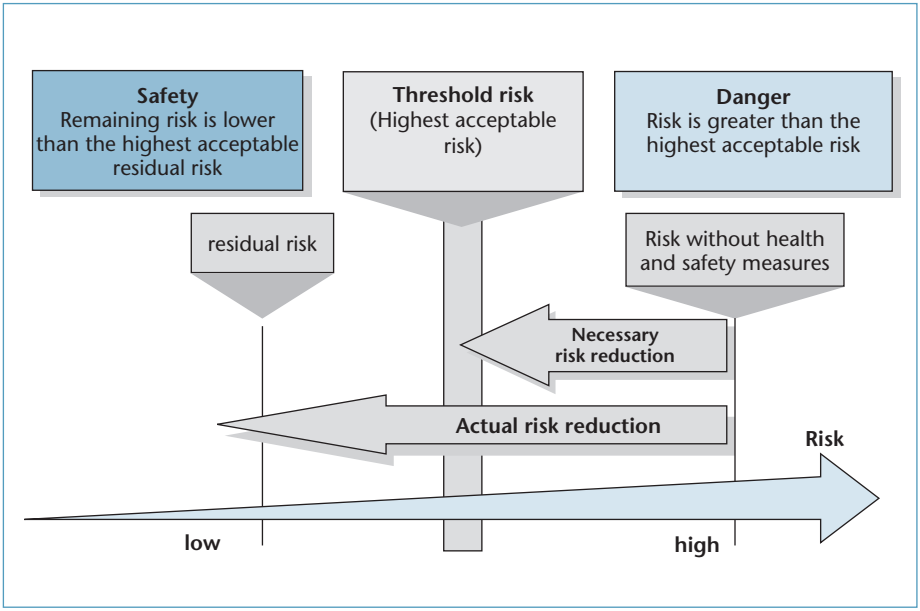

Figure 3: Connection between safety and risk

6. Risk Reduction (Selecting and Taking Measures)

The aim of risk reduction is to design or find methods that will minimise exposure, whether the hazard is physical, chemical, biological, ergonomic or psychosocial. Risk strategies might include risk avoidance, optimization, retention and risk transfer.

There are fundamental reasons for implementing occupational risk treatment:

- protection of exposed workers' safety and health
- protection of other workers and people who may be affected by the risks created by a process or workplace
- ensuring workers' comfort and safety
- compliance with legislation
- reduction in environmental pollution
- minimisation of economic loss from raw materials, products.

Whatever the reason, controls need to be realistic and cost-efficient. In many cases, there are several options available and have to be taken into account in order to reduce the risk to an acceptable level.

Hierarchy of risk treatment

Regarding the hierarchy of measures the following basic rules have to be considered: **Removal or minimisation of a risk must be the first option, that means technical and organizational measures must be preferred before behaviour-related measures (see Figure 4 on page 18).**

So the hierarchy of control options is basically :

1. Elimination
2. Substitution
3. Technical solution (safety device, ventilation, isolation, etc.)
4. Personal solution (teaching, training, Personal protective equipment)

1. **Elimination:** The best option, but in many cases a given risk can not be (totally) eliminated.
2. **Substitution:** E.g. in case of hazardous substances – a substituting agent must have lower toxicity. The problem can be, that a substitute has not the same effect and ourcome as the former (more dangerous) substance.
3. **Technical solution:** Probably the most commonly used. Its advantages lie in the ability to physically alter the path of transmission of the hazard or isolate the worker from the agent.
4. **Personal solution:** They rely on human behaviour and compliance for success. Furthermore the con-

sequent and correct use of Personal Protective Equipment (PPE) like respirators, gloves, boots, goggles, shields or hearing protection devices is a personal sulution.

Personal solutions measures are covering the remainig risks after carrying out step 1, 2 and 3.

Note:

Organizational measures like seldom exposure, worker rotation and job placement, good housekeeping and hygiene, maintenance, monitoring and health surveillance, scheduling of work are important supplementary measures.

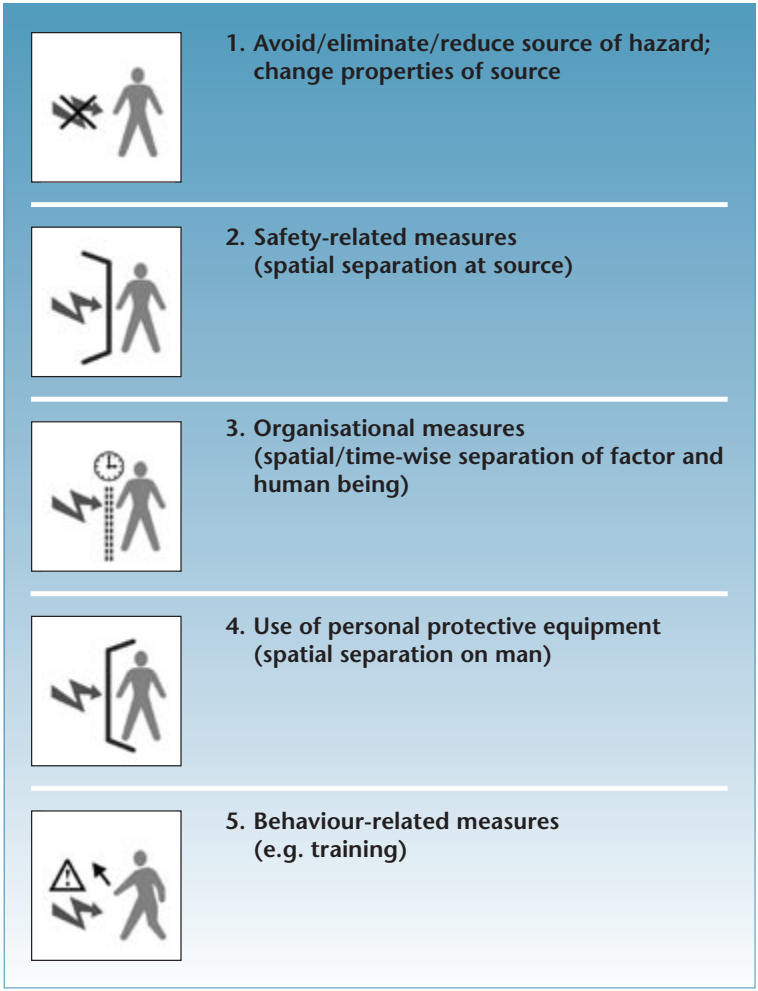

Figure 4: Hierarchy of risk treatment

Annex 1 – Examples of Risk Assessment

Introduction, Approach of the two examples

The following examples shall give a general idea how risk assessment can be carried out. It gives a step to step introduction, showing the "flow" of the process. So the essential aspect is not the technical content but the procedure of the process.

There are given two examples, a stationary office workplace and a working process (non stationary) example: maintenance work on a ladder (e.g. changing an electric bulb).

Example 1: Risk assessment of an office workplace

Short description: Office room with three workstations, three persons working 8 h per day.

Step 1 – Specification of task

In the first step the specific working conditions have to be found out. This can be done in the given case for example by

- talking with the employees
- observation by Workplace Hygienist and Safety Technician
- using a given job description.

Step 2 – Hazard identification

Based on the given working situation (step 1) the given hazards have to be identified. Support can be given by checklists (e.g. from the ISSA brochures, see chapter "Introductory Note"), standards (e.g. EN standards) or laws and directives.

In the given example the hazard identification deals especially with the following topics:

- array and positioning of the workstations
- climatical room factors (temperature, humidity, speed of air)
- room lightning and workplace lightning
- fire extinguisher, emergency exit

The hazard identification in our example brought up the following deficits resp. hazards:

1. two monitors are placed wrong (in front of the window), one of the screens is positioned too high
2. on one workplace the lightnig is too low (less than 300 Lux)
3. the general array of the workplaces should be improved and adapted to ergonomic needs

Step 3 – Risk estimation and risk evaluation

Risk estimation: To quantify the consequence and probability and to perform their combination

Risk evaluation: To evaluate the acceptability of the risk and then it is possible to determine, if there is a need to reduce this risk.

In the given case a quantified and detailed **hazard evaluation** is not necessary, as there is no imminent danger. Furthermore practicable steps towards risk reduction can be easily carried out. So the two basic questions of **hazard evaluation**

- How probable are which consequences (accident, sickness)?
- Which efforts and investments have to be undertaken for a satisfactory risk reduction?

can be satisfactorily answered without a detailed analysis.

Step 4 – Risk reduction

Considering the examined hazards (step 2) the following measures for risk reduction can be carried out:

1. replacing the two monitors so that they are standing now parallel to the windows, a wooden box, on which one of the monitors stands is removed so that the screen is positioned in a correct height, which is not over the height position of the eyes
2. a desk light is bought for the workplace with lightning too low
3. provisions are made that ergonomic aspects will be considered in the next rearrangement of the office which is planned to take place in four months

Furthermore training about ergonomics and ergonomic working posture and behaviour is performed on a regular basis, twice a year.

Step 5 – Controlling (Monitoring the effectiveness)

- One month after accomplishing the measures the Safety Technician and Workplace Hygienist check, if the taken measures and changes made are still in place and ask the affected employees if they current situation is ok for them. After the rearrangement of the office there is conducted another check. Talks with the employees and feedback about the workplace situation are carried out on a regular basis.

Example 2:
Maintenance Work on a Ladder

Short description: Company technician, performing maintenance work on a ladder, e.g. changing of electric bulbs, smaller repair works. Working place: The whole company.

Step 1 – Specification of task

The different working tasks are determined especially by the given job description and the additional statements of the worker and his superior. For this example only the activity “working on a ladder” is considered. Furthermore the mean working time per day on the ladder is examined – in the given case roughly 2 hours.

Step 2 – Hazard identification

By using the checklist from the ISSA brochure “Slipping and Falling from a height” (see chapter 2 in this brochure), by examining the work equipment and observing the worker the following risky aspects could be detected:

1. at some works the ladder is standing in traffic routes
2. long lasting works on a ladder, furthermore hard work (drilling) is done on the ladder
3. shoes not specially adequate for working on a ladder

4. in some places of the company with high ceilings the given ladder is not long enough, which is "solved" by the worker by stepping up too far.

Step 3 – Risk estimation and risk evaluation

In this case detailed risk estimation and evaluation are performed in order to find out which priorities have to be set and which "quality" of measures is necessary considering the given risk. Three basic questions have to be answered:

- How probable is an accident? (one factor is also the time spent on the ladder)
- What would be the possible accident severity? (in the case "falling from a ladder" the accident severity is general high)
- Which efforts and investments have to be undertaken for a satisfactory risk reduction?

By using the risk estimation method from the brochure "Slipping and Falling from a height" (see there chapter 3) the risk group 3 was detected, which means, that measures are immediately necessary.

Step 4 – Risk reduction

For the four under step 2 detected and under step 3 evaluated hazards the following measures were planned and carried out:

1. restricted access to the traffic routes by warning tapes, additional organizational measure: Working in such zones only in times of general low traffic frequency
2. using a mobile scaffold for longer works instead of a ladder
3. special antiskid working shoes are bought for the worker
4. another (longer) ladder is bought

Step 5 – Controlling (Monitoring the effectiveness)

For the first two weeks after the measures have been taken the worker is under special observance of his superior, which also asks about the subjective improvements and the acceptance of the measures by the worker.

Furthermore regular instructions (twice a year) and talks are done by the safety technician and superior.

The following ISSA International Sections on Prevention elaborated the brochure. They are also available for further information:

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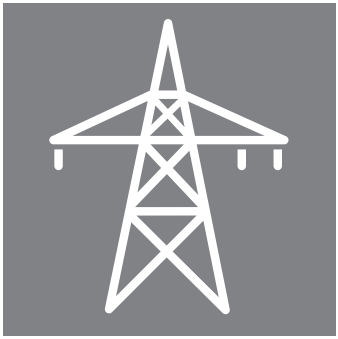

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