



**Assessment, elimination  
and substantial reduction  
of occupational risks**





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Prevention report on assessment, elimination and substantial reduction of occupational risks

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The Kooperationsstelle Hamburg works out of the House of the Trade Unions of Hamburg, which was completed in 1906 and mostly built by the workers themselves. It was one of the first large buildings in which the windows opened to the inside. Traditionally, the windows could only be opened to the outside to save space within the rooms. Falling out of the window was a high risk for women at home and cleaners in office buildings. This risk was almost eliminated by the decision to change the opening direction of the window. Today, no one gives a thought to this long forgotten but still effective risk elimination.



*Typical street scene from the beginning of the last century — windows wide open (Hamburg — Gängeviertel)*

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## FOREWORD

Everybody has an interest in keeping workers safe and healthy. And most work-related accidents and illnesses are preventable. But how? Risk assessment is the first step.

Risk assessment is the start of the risk management process. It enables employers to understand the action that they need to take to improve workplace health and safety, as well as productivity.

The European Agency for Safety and Health at Work (EU-OSHA) has developed a European-wide information campaign focusing on risk assessment. Healthy Workplaces is a two-year European campaign which aims to promote an integrated management approach to risk assessment. Risk assessment is the cornerstone of the European approach to occupational safety and health, and there are good reasons for this. If risks are not assessed or properly dealt with, a suitable risk management process cannot be started and appropriate preventive measures are unlikely to be put in place. Systematic risk assessment therefore improves workplace safety and health and business performance in general.

Since the adoption of the European Framework Directive in 1989, risk assessment has become a familiar concept for organising prevention in the workplace, and hundreds of thousands of companies all over Europe assess their risks regularly. Nevertheless, the figures on accidents and illness at work show that improvements are needed. Every year, millions of people in the EU are injured at work, or have their health seriously harmed in the workplace.

This report supports the campaign by providing information on successful interventions in the workplace illustrating how the hazards identified after a risk assessment can be eliminated or controlled. The report is aimed at those who are responsible for carrying out risk assessments in the workplace and for preparing decisions on risk elimination or control measures.

I would like to take this opportunity to thank all our European partners as well as Agency and Topic Centre Working Environment staff who have contributed to the compilation of the report.

Jukka Takala

Director

European Agency for Safety and Health at Work

July 2009



## EXECUTIVE SUMMARY

This report features cases from a variety of workplaces that demonstrate how a risk assessment process has led to a risk being identified and successfully eliminated or substantially reduced. The main aim of the report is to illustrate how risk elimination or risk reduction at source can be achieved at workplace level.

Employers have a general duty to ensure the safety and health of workers in every aspect related to work and to carry out a risk assessment. The EU Framework Directive <sup>(1)</sup> highlights the key role played by risk assessment and sets out basic provisions that must be followed by every employer. It also introduces the general principles of prevention.

*The employer shall implement the measures (necessary for the safety and health protection of workers) on the basis of the following general principles of prevention:*

- (a) avoiding risks;*
- (b) evaluating the risks which cannot be avoided;*
- (c) combating the risks at source;*
- (d) adapting the work to the individual;*
- (e) adapting to technical progress;*
- (f) replacing the dangerous by the non-dangerous or the less dangerous;*
- (g) developing a coherent overall prevention policy;*
- (h) giving collective protective measures priority over individual protective measures;*
- (i) giving appropriate instructions to the workers <sup>(2)</sup>.*

Among these principles there are two, 'avoiding risks' and 'combating the risks at source', which are highlighted as priority principles. The majority of cases presented in the report show how these and the other principles are put into practice.

There are a number of risks which can be completely avoided or eliminated. The remaining risk is then assessed as very low or close to zero. Cases dealing with risks from electric current, infection, manual handling, unprotected handling of dangerous substances and exposure to noise demonstrate how such results can be achieved.

In other cases where the complete elimination of risks is not possible, most actions described aim 'to combat the risks at source', i.e. the prevention action is focused at the source of the risk. This often results in a substantial risk reduction to a much lower level. The report shows how these results are obtained in areas such as accident prevention, work organisation, exposure to dust, sawdust or electromagnetic fields. In a few cases, the possibility of combating the risk at source or adopting collective preventive measures is investigated but because the risk cannot be combated at source, personal protective measures are instead implemented.

<sup>(1)</sup> Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work.

<sup>(2)</sup> Article 6.2 of Council Directive 89/391/EEC.



The basic success factors identified in the report for effective risk assessment are:

- a detailed risk assessment and accurate assessment of the problem/situation;
- strong motivation on the part of an important and powerful group (such as a department, a workers' steering committee, the employer);
- support from top management to ensure all necessary resources are available, such as financial and human resources;
- involvement of relevant actors such as the workers (participatory risk assessment), ergonomic experts, human resources, financial department, health professionals, etc.;
- good analysis/knowledge of effective solutions, best practice and scientific or technological innovations available (often more than one solution/measure is adopted);
- trust and cooperation between the parties involved;
- no strong hindrances to the adoption of the preventive or protective measures.

The report shows that there are some additional success factors that motivate the actors to go further than usual to achieve results that are far above average. These so-called 'super success factors' complement the basic success factors listed above.

They are:

- high motivation to be the best performer in a particular economic sector, or at least to be as good as possible;
- prominent role played by those in the workplace concerned (or the people at risk) in work flow;
- difficulty in replacing sick workers;
- high motivation to develop an integrated occupational safety and health approach;
- internal capacities to identify (or develop) good solutions;
- internal capacities and motivation to go beyond the 'average';
- simple solutions for high risks available;
- support for complicated or advanced solutions available;
- proper monitoring of the preventive or protective measures adopted (Are the measures actually implemented? Are they working? Are they adequate?);
- public support for SMEs (in a whole economic sector, for instance);
- strong motivation to reduce the related costs of accidents and diseases in high-risk occupations or areas.

An analysis of the cases discussed in the report shows that it is crucial to follow up the risk assessment with well-planned action to develop and adopt the appropriate preventive and protective measures.





# 1.

## INTRODUCTION



Risk assessment plays a crucial role in any occupational safety and health policy. It is the basis for successful health and safety management, and the key to reducing work-related accidents and occupational diseases. If implemented well, it can improve not only workplace safety and health, but business performance in general.

Risk assessment is the process of evaluating risks to workers' safety and health from workplace hazards. It is a systematic examination of all aspects of the work undertaken to consider:

- what could cause injury or harm;
- whether the hazards could be eliminated; and, if not,
- which preventive or protective measures are, or should be, in place to control the risks <sup>(3)</sup>.

Employers have a general duty to ensure the safety and health of workers in every aspect related to work and to carry out a risk assessment. The EU Framework Directive <sup>(4)</sup> highlights the key role played by risk assessment and sets out basic provisions that must be followed by every employer. It also introduces the general principles of prevention.

The employer shall implement the measures (necessary for the safety and health protection of workers) on the basis of the following general principles of prevention:

- (a) *avoiding risks;*
- (b) *evaluating the risks which cannot be avoided;*
- (c) *combating the risks at source;*
- (d) *adapting the work to the individual;*
- (e) *adapting to technical progress;*
- (f) *replacing the dangerous by the non-dangerous or the less dangerous;*
- (g) *developing a coherent overall prevention policy;*
- (h) *giving collective protective measures priority over individual protective measures;*
- (i) *giving appropriate instructions to the workers* <sup>(5)</sup>.

The European Agency for Safety and Health at Work (EU-OSHA) has developed a Europe-wide information campaign focusing on risk assessment. Healthy Workplaces is a two-year campaign which aims to promote an integrated management approach to risk assessment. This report supports the campaign by providing information on successful interventions in the workplace to eliminate or control risks. The report is aimed at those who are responsible for carrying out risk assessments in the workplace and for making decisions on risk elimination or control measures.

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<sup>(3)</sup> European Commission, *Guidance on risk assessment at work*, Luxembourg, Office for Official Publications of the European Communities, 1996, p. 12.

<sup>(4)</sup> Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work.

<sup>(5)</sup> Article 6.2 of Council Directive 89/391/EEC.



## THE AIM OF THIS REPORT

# 1.1.

This report identifies cases in which a risk assessment process has successfully identified a risk and allowed it to be eliminated, drastically reduced, or very well controlled. The primary focus of the report is on the solutions developed for risks identified in the workplace, and not on ready-made technical solutions by designers or manufacturers at the product, workplace or work-process design stage. However, some of the cases illustrate that such solutions can have a part to play in risk management at workplace level.

This case study report aims to illustrate the implementation of the general principles of prevention at workplace level (especially the first two: 'avoiding risks' and 'combating the risks at source'). The analysis of cases shows that in practice a number of these principles are applied in one single action and that interconnected measures (at different levels) are put in place.

The report discusses a number of different hazards (e.g. physical strains, biological and chemical agents, accidents, electromagnetic fields, dust and noise exposure, work organisation) in a range of sectors (e.g. manufacturing and engineering, forestry, mining, packaging, office work, etc.).

## METHODOLOGY

# 1.2.

The partners involved in the project identified cases based on material from the Work Environment Topic Centre's<sup>(6)</sup> own network, material from Focal Points<sup>(7)</sup>, and material from the literature. Each partner was responsible for providing a number of cases and the task leader was responsible for the comprehensive analysis and reporting.

Eighteen case studies and seven snapshots (shorter cases) are presented (see Table 1) from a range of occupations and sectors across Europe in order to share good practice examples with regard to risk assessment.

The description of cases includes an analysis of some background information on the company/project, the aims and objectives of the action, an explanation of what was done, the results of the action, the problems faced, the success factors and some information about the transferability of the project.

<sup>(6)</sup> Topic Centres are consortia of national safety and health institutions that collect and analyse existing national data to support key areas of Agency's work.

<sup>(7)</sup> The Agency's main safety and health information network is made up of a focal point in each EU Member State, as well as in candidate countries and EFTA countries. Focal points are nominated by each government as the Agency's official representative in that country, and they are normally the national authority for safety and health at work. Working with national networks including government, workers' and employers' representatives, the focal points provide information and feedback that helps to support Agency initiatives.



**Table 1: List of cases (*snapshot cases in italic*)**

Country	Area	Acronym and full name of the case	Partner
Netherlands	Ergonomics and design	3.1 ROADWORKERS Reduction of physical strain in a group of roadworkers	PREVENT
<i>France</i>	<i>Ergonomics and design</i>	<i>3.2 SNAPSHOT CASE: TRAINING PROJECT MANAGER Training in an 'ergonomic approach to work situations'</i>	<i>EUROGIP</i>
Belgium	Ergonomics and design	3.3 BETTERLIFT Introducing a semi-automatic exhaust manipulator to reduce a high absenteeism rate	PREVENT
Italy	Ergonomics and design	3.4 PLEASURE BOATS Improved load handling during shaft assembly operations in the manufacture of pleasure boats	ISPESL
<i>France</i>	<i>Ergonomics and design</i>	<i>3.5 SNAPSHOT CASE: LAYOUT WORK AREAS Improving the layout of work areas</i>	<i>EUROGIP</i>
Italy	Ergonomics and design	3.6 INKJET Elimination of risks arising from repetitive upper limb movements	ISPESL
<i>Germany</i>	<i>Ergonomics and design</i>	<i>3.7 SNAPSHOT CASE: STEHLUST STATT SITZFRUST (standing's great, sitting's a grind)</i>	<i>KOOP</i>
Italy	Ergonomics and design	3.8 USING PNEUMATIC SCREWDRIVERS Elimination of risks arising from hand-arm vibration exposure	ISPESL
Country	Accident prevention	Acronym and full name of the case	Partner
Finland	Accident prevention	4.1 HPD-RAILROAD Eliminating accident risk on the Finnish railway	FIOH
Spain	Accident prevention	4.2 NOACCIDENT Radical reduction in the number of accidents in a metallic packaging company	EUROGIP
Germany	Accident prevention	4.3 NEEDLESTICK How to prevent needlestick injuries effectively	BAUA
Luxembourg	Accident prevention	4.4 CRUSHED FINGERS Modification of a protective plate in order to eliminate the risk of crushed fingers	PREVENT



Country	Dust, chemical substances, biological risks	Acronym and full name of the case	Partner
France	Dust	5.1 DENTAL LABORATORY Capturing pollutants at source	EUROGIP
Austria	Biological risk	5.2 VACCINATION Programme of TBE-vaccination by an accident insurance company	KOOP
Poland	Dust	5.3 NOCODUST Reduction of risks arising from exposure of workers to high dust levels in coal mines	CIOP-PIB
Germany	<i>Dangerous substances</i>	5.4 SNAPSHOT CASE: <i>BRAKE CLEANING</i> <i>Brake cleaning by hot water washer</i>	<i>KOOP</i>
Poland	Dust, chemical substances, noise	5.5 NOWODUST Elimination of risks arising from exposure to chemical substances and reduction of exposure to wood dust and noise in the timber industry	CIOP-PIB
Country	Work organisation/ psychosocial loads	Acronym and full name of the case	Partner
Germany	Risk assessment	6.1 HOLISTIC RA Holistic risk assessment	BAUA
Germany	Work organisation	6.2 ROTOWORK Job rotation of cleaning tasks in a medical laboratory	KOOP
Germany	Psychosocial	6.3 STRESS IN HOSPITALS Assessment of psychosocial and physical risks	BAUA
Country	Noise, electricity and climate	Acronym and full name of the case	Partner
Cyprus	Noise	7.1 SNAPSHOT CASE: CEMENT MILL <i>Installation of a 'roller'-type cement mill with low noise emission</i>	ELINYAE
Poland	Electricity	7.2 WELDERS' EMF Reduction of welders' exposure to magnetic fields from induction heaters used in power stations	CIOP-PIB
Greece	Noise	7.3 SNAPSHOT CASE: <i>NOISE INSULATION</i> <i>Noise insulation of a press and of a palette stacking machine</i>	ELINYAE
Finland	Electrical power	7.4 GLUE EMF Electromagnetic field control, for example in glue drying devices	FIOH
Cyprus	Climate	7.5 SNAPSHOT CASE: <i>TEMPERATURE 40/28</i> <i>Reduction of temperature by installing water coolers in a building</i>	ELINYAE



# 1.3. GENERAL CONSIDERATIONS FOR RISK ELIMINATION/ RISK REDUCTION

The term 'elimination' is used in the sense that a risk is reduced to zero without a shifting of the risk elsewhere. Elimination is the ideal objective of any risk management. Four out of the 18 extended case studies show that it is possible to eliminate or to reduce certain risks close to zero. The other cases present measures that show a substantial risk reduction but not elimination in this sense. The risk cannot be eliminated completely; a significant residual risk remains.

In some of these cases the elimination of one risk is combined with a shift to other — generally much lower — risks. Some risk reduction measures require the complete elimination of a certain work operation or a radical transformation of the entire workplace. In these cases the work may now be done in a different way, e.g. a machine may now lift goods that were formerly lifted manually by a worker and the worker may now be responsible for operating that machine. The new form of work — permanent operating of a machine — will pose some risks, but probably minor ones.

The following two sections group the cases into those where the risk was eliminated and those where there was a substantial reduction in risk. The impact of risk reduction measures obviously depends on the nature of risks, the available solutions and the practical measures taken.

## 1.3.1. Risk elimination

Some examples of risk elimination are presented in this report. Typical areas of full risk elimination can be found in the following cases:

- in the automation of lifting and transport operations which reduces manual lifting and load bearing, often to zero;
- in the substitution of a hazardous chemical with a non-hazardous alternative which poses no new other risks;
- in the full reduction of dangerous levels of noise by encapsulation or by introducing new equipment;
- in the elimination of infection risk by vaccination <sup>(8)</sup>;
- in the elimination of accidents by changes in technology or changes to the typical risk areas in buildings.

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<sup>(8)</sup> It is evident that the vector actually cannot be eliminated at source but the risk of infection can be removed.



**Table 2: Cases demonstrating risk elimination**

Risk	Elimination	Very low remaining risk/ very low new risk	Description in case No
Infection by bacteria or virus	Vaccination (if possible)	Remaining small percentage of persons without protection	5.2 VACCINATION
Needlestick injuries	Safety equipment, training	Within 12 months, no further injuries	4.3 NEEDLESTICK
Manual handling	Automation	Accidents	3.3 BETTERLIFT
Noise	New noise avoidance technologies  Enclosing the source of noise	Noise level reduction from 92 to 45 dB(A)	7.1 SNAPSHOT: CEMENT MILL
Accident prevention	Protection plate on machine	Almost no remaining accident risk	4.4 CRUSHED FINGERS
Dangerous substances	Substitution	Non-relevant (higher) use of water and power	5.4 SNAPSHOT: BRAKE CLEANING

### 1.3.2. Substantial risk reduction

In the following cases a substantial risk reduction was brought about by the implementation of effective solutions. In most cases the degree of risk reduction is not quantifiable. A quantitative calculation of the impact of the risk reduction measure could be feasible in cases that apply to a large number of workplaces and where there is an easily quantifiable risk such as accidents.

**Table 3: Cases demonstrating substantial risk reduction**

Risk	Reduction	Remaining risk/ new risk/ shift of risks	Description in case No
Exposure to dust	Significant reduction by new technologies	A certain, much lower, level of dust cannot be avoided	4.2 NOACCIDENT 5.3 NOCODUST 5.5 NOWODUST
Chemical substances (VOCs)	Reduction of exposure to dangerous substances by introduction of new technologies	Reduction by a factor of three	5.5 NOWODUST
Exposure to electric fields	New protection technologies	A certain degree of exposure cannot be avoided	7.2 WELDERS EMF 7.4 GLUE EMF
Accident prevention	Technologies	Reduction of accidents by a factor of eight	4.2 NOACCIDENT
Accident prevention	Technologies, instruction	Remaining lower risk	5.1 DENTAL LABORATORY
Accidents, MSD, work org.	Overall RA	Remaining lower risk	3.8 SCREWDRIVERS



Risk	Reduction	Remaining risk/ new risk/ shift of risks	Description in case No
Noise	Significant reduction by introduction of new technologies	Remaining lower risk	5.5 NOWODUST 7.3 SNAPSHOT: NOISE INSULATION
Noise	Hearing protection	Remaining lower risk	4.1 HPD-RAILROAD
MSD	Planning, design, technology, instruction	Remaining lower risk	3.1 ROADWORKERS 3.7 SNAPSHOT: STEHLUST STATT SITZFRUST
Temperature	Cooling system	Remaining temperature risk of infections	7.5 SNAPSHOT: TEMPERATURE 40/28
Manual handling	Semi-automation	Remaining elements of unfavourable postures and movements	3.1 ROADWORKERS 3.4 PLEASURE BOATS 3.6 INKJET
Ergonomics and design	Training, work organisation	At best elimination; remaining risks depend on case of application	3.2 SNAPSHOT: TRAINING PROJECT MANAGER 3.5 SNAPSHOT: LAYOUT OF WORK AREAS
Psychosocial risks	Holistic risk assessment and measures	Remaining lower risk	6.1 HOLISTIC RA
Work overload	Risk assessment and measures	Remaining lower risk	6.2 ROTOWORK
Psychosocial risks, physical risks, work overload	Risk assessment and measures, work organisation	Remaining lower risk	6.3 STRESS IN HOSPITALS

In any risk assessment and the subsequent elimination of risk or application of control measures, it is essential that the risk is not transferred, namely that providing a solution to one problem doesn't create another problem. For example: it would be of doubtful benefit to provide double glazing to office windows in order to reduce noise from outside, unless provision was made for adequate ventilation.

Equally importantly, risk must not be transferred to another area; for example by providing exhaust ventilation of toxic substances in such a way that the discharge poses a risk to another workroom or to the public off-site (at one hospital the exhaust ventilation from a mortuary was discharged below the windows of a children's ward) <sup>(9)</sup>.

<sup>(9)</sup> European Commission, *Guidance on risk assessment at work*, Luxembourg, Office for Official Publications of the European Communities, 1996, p. 12.



# 2.

## SHORT DESCRIPTION OF CASES



This chapter presents short abstracts of each case.

## **Ergonomics and design**

### **Roadworkers — reduction of physical strain**

Roadworkers in the municipality of Delft were subject to a lot of physical strain which resulted in a high prevalence of knee and back problems. A physiotherapist was consulted to study the physical strain and to map the working methods in order to define the problem areas. Solutions were described in an action plan and implemented successfully. As a result, the absenteeism rate decreased by 3.9 %, which was mainly related to a decrease in the physical strain.

### **Betterlift — introducing a semi-automatic exhaust manipulator to reduce a high absenteeism rate**

Absenteeism was high among exhaust assembly workers at Ford's Genk plant in Belgium. Workers reported heavy strain on their back, shoulders, neck and wrists from repetitive lifting, holding and fixing exhausts. To alleviate the problem the ergonomic team designed, built and implemented a semi-automatic exhaust manipulator, which decreased the physical workload of the operators. The introduction of the manipulator resulted in a fall in repetitive strain injury (RSI) complaints and absenteeism, a decrease in the number of operators needed to perform the job and consequently a decrease in costs related to this job.

### **Pleasure boats — improved load handling during shaft assembly operations**

A preliminary assessment of the risks involved in the manual handling of loads showed that the shaft assembly operations were particularly critical. In order to reduce the risks involved, a trolley was built that completely changed the shaft assembly procedure, thus reducing the necessity for the manual handling of loads.

### **Inkjet — elimination of risks arising from repetitive upper limb movements**

An analysis of risks related to repetitive movements was performed using the OCRA method developed by the EPM Research Unit in Milan. A change in the working cycle was carried out as a first intervention, while the second intervention encompassed a redesign of the workstation. Following the two interventions, the risk index according to the OCRA checklist dropped from the yellow zone (medium risk level) to the green zone (absence of risk).

### **Using pneumatic screwdrivers — elimination of risks arising from hand-arm vibration exposure**

The assembly lines of a factory showing various cases of upper limb pathologies were studied. According to the risk assessment, it was assumed that vibrations generated by pneumatic screwdrivers might be related to the increasing number of pathologies



occurring in the factory. A two-year intervention plan was implemented, and it led to the complete replacement of the 801 screwdrivers with new ergonomic screwdrivers. The number of workers affected by upper limb disorders gradually decreased with the introduction of the new screwdrivers.

## Accident prevention

### HPD-railroad — elimination of accident risk on the Finnish railway

In railway work, in addition to high noise exposure, there is a risk of fatal accidents. This risk is particularly high for workers with impaired hearing. To reduce this risk, many railway companies have set minimum recommended hearing levels for workers. Passive hearing protectors can increase the accident risk. Using level-dependent hearing protectors, the hearing of workers can actually be improved and thus reduce the accident risk without compromising the sound exposure.

### Noaccident – radical reduction in accidents in a metallic packaging company

The introduction of the STOP programme (occupational safety through observance of risk prevention rules) has enabled the number of occupational injuries to be reduced from 15 to 2 in two years. This programme is based on the daily assessment of risks and analysis of the causes of accidents. Preventive measures are also introduced (signage, adaptation of machinery, chemical substances 10 times lower than the limit values, etc.) as well as assessment of psychosocial risks and ergonomic risks.

### Needlestick — how to prevent needlestick injuries effectively

This project of the university hospital of Heidelberg and the State Health Office of Baden-Württemberg wanted to give answers to the crucial question of the effectiveness of safety needles for the prevention of needlestick injuries (NSI). It introduced new safety equipment, accompanied by training and education measures, in an effort to reduce the NSI prevalence among hospital staff. Within 12 months NSIs had been reduced to zero.

### Crushed fingers — modification of a protective plate in order to eliminate the risk of crushed fingers

At Avery Dennison, the protective plate from one of the machines used for cutting paper rolls was displaced. The displacement of the protective plate created a dangerous situation for all workers using this machine. As required by Avery procedures, one of the operators reported the dangerous situation by means of the online reporting system.

This system enabled the gravity and extent of the risk to be assessed and immediate and adequate preventive or corrective measures to be taken. A poster was put up to



notify the workers about the situation. The team leaders also suggested asking the maintenance team to modify the plate.

### **Dust, chemical substances, biological risks**

#### **Dental laboratory — capturing pollutants at source**

Certain dusts, silica in particular, can cause serious diseases in dental laboratory technicians. By equipping all the workstations with appropriate capture systems, the dental prosthesis laboratory of the Lyons Primary Health Insurance Fund (CPAM) now assures the best possible protection for each member of its team.

#### **Vaccination — programme of TBE-vaccination by an accident insurance company**

Tick-borne encephalitis (TBE), a severe infection which results in brain inflammation, can be prevented by immunisation. Especially at risk are workers who work outside, such as farmers and forest workers. The General Accident insurance company in Austria (AUVA) carried out a vaccination programme in 1976 to protect workers and introduced a campaign afterwards which is still ongoing. Since then the approved occupational TBE cases have decreased to nearly zero.

#### **Nocodust — reduction of risks arising from exposure of workers to high dust levels in coal mines**

Elimination of risks arising from the exposure of workers to high dust levels was the subject of the project conducted in recent years at the KOMAG Mining Mechanisation Centre. The project had two goals — to design and implement new technical dust collecting solutions (LDCU-630 Labyrinth Dust Collecting Unit and DRU-400 Dust Removing Unit) and to build an awareness of risks connected with dust among miners. The results of the project (new dust collecting units) were implemented in coal mines, which should reduce the number of lung diseases among miners and the number of accidents in coal mines.

#### **Nowodust — elimination of risks arising from exposure to chemical substances and reduction of exposure to wood dust and noise in the timber industry**

Timber industry workers are exposed to hazardous factors throughout the entire production process. Hazardous factors at Barlinek S.A. were associated with exposure to harmful chemical substances, high wood-dust levels and excessive noise levels. Between 2000 and 2006, a comprehensive project was carried out in the company with the aim of protecting workers against harmful factors. As a result, a large-scale investment programme was initiated which led to the reduction, or elimination, of risk factors within the company. This led to improved working conditions for 540 employees.



## Work organisation/psychosocial load

### Holistic RA — holistic risk assessment

SICK AG, a manufacturer of sensor technology, has been carrying out risk assessments since 1998. Its approach concentrated on the assessment of physical risks, but this was considered to be insufficient. The management decided to develop a new programme that would include psychosocial risks, in cooperation with the University of Freiburg. The so-called 'holistic risk assessment' was included in the new in-house health promotion policy. In 2005 the first holistic risk assessments were carried out as pilots. The aim was to identify mental strain at work without neglecting the physical workload and accident prevention aspects and to come up with measures to eliminate or reduce existing risks. Monitoring by external specialists helped to ensure that the 'holistic RA' project was a success, and from 2009 it will be incorporated into standard risk assessment practice.

### Rotowork — job rotation of cleaning tasks in a medical laboratory

The project aimed to reduce the risk of long-term absenteeism and early retirement due to work overload in the cleaning sector. The actions taken covered all aspects of a full risk assessment and the consequent risk reduction measures. A comprehensive analysis was followed by implementation measures in ergonomics and design, but the major change was the introduction of qualified elements (laboratory cleaning) into the work of institutional cleaners.

### Stress in hospitals — assessment of psychosocial and physical risks

Hospital work is known to be physically and psychologically demanding. A pilot project was therefore set up in a hospital with 470 employees to assess workplace risks and organisational aspects. The workers were exposed to physical strain, risks from chemical and biological agents and psychosocial strain. They were also stressed by administrative tasks. After the assessment the results were analysed, action plans drawn up and measures implemented. Risk assessment became a standard part of quality and health management systems, including training.

## Noise, electricity and climate

### Welders' EMF — reduction of welders' exposure to magnetic fields from induction heaters used in power stations

Induction heating is commonly used for the preheating of arc welded pipes in power stations. Power stations use metallic pipes that are multiple kilometres in length for water transportation as cooling, and water vapour as the driving medium of electric turbo generators. These pipes are constantly being repaired or replaced, which necessitates the use of arc welding. Induction heating is used to pre-heat connecting sections of pipes to obtain the best quality of arc welds. The welders work in close proximity to the induction heating systems, within a strong magnetic field. In this



case, limits set by national regulations and Directive 2004/40/EC on permissible exposure of welders to electromagnetic fields can be exceeded. Following the analysis of risk related to magnetic fields produced by induction heating systems, an electromagnetic shield was designed. It reduced workers' exposure to magnetic fields three to fourfold, to an acceptable level.

### **Glue EMF — electromagnetic field control, for example in glue drying devices**

Electromagnetic guidelines are exceeded by 30–50 % in workplaces with glue drying devices. It is therefore necessary to take actions to reduce exposure to these electromagnetic fields. The most typical actions are shielding, change of work methods, repairing systems and grounding. There are difficulties in applying protective actions, but these can be avoided by careful planning of measures taken. Also, information for the workers is important. Automated processes are easier to create according to guidelines.

#### **Snapshot cases**

*Training project manager — training in an 'ergonomic approach to work situations'*

*Layout work areas — improving the layout of work areas*

*Stehlust statt Sitzfrust (standing's great, sitting's a grind)*

*Brake cleaning — brake cleaning by hot water washer*

*Cement mill — installation of a roller-type cement mill with low noise emission*

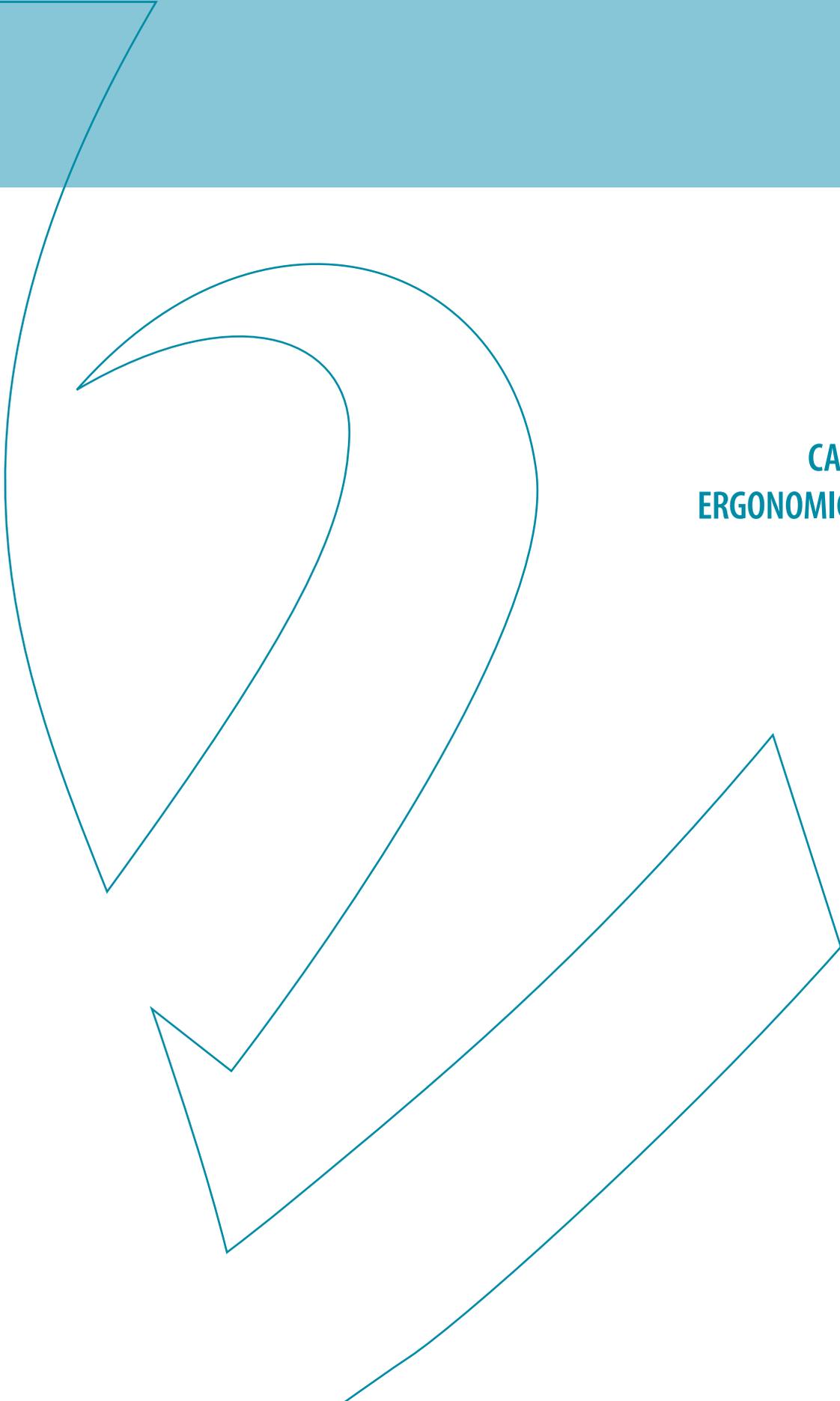
*Noise insulation — noise insulation of a press and a palette stacking machine*

*Temperature 40/28 — reduction of temperature by installing water coolers in a building*



# 3.

## CASE STUDIES — ERGONOMICS AND DESIGN



# 3.1. ROADWORKERS — REDUCTION OF PHYSICAL STRAIN

## THE NETHERLANDS

### Key points

- Reduction of physical strain.
- Participation of roadworkers in reduction of occupational risks.
- Cooperation between designers and executors of solution enhances trust between the two parties.

### Organisation

Municipality of Delft

### Introduction

Roadworkers in the Municipality of Delft are exposed to considerable physical strain, which resulted in a high prevalence of knee and back problems. A physiotherapist was consulted to study the physical strain and to map the roadworkers' working methods in order to define the causes of the problem. Solutions were devised and implemented successfully. As a result the absenteeism rate decreased by 3.9 %, mainly because of the decrease in the physical effort required to do the job.

### Background

The main reason to start with the project was a request from the roadworkers themselves. They complained mainly about knee and back pain. Based on this request, a periodic study concerning occupational health (PAGO <sup>(10)</sup>) was performed in 1999.

*[The] PAGO or periodic study concerning occupational health finds its origin in Article 18 of the Law on working conditions (Arbowet) <sup>(11)</sup>. In case of presence of occupational risks, the employer is obliged to provide the employees with the opportunity to undergo a periodic occupational health examination. The examination has to be focused on the prevention or limitation of the occupational health risks. The objective of the PAGO is to trace possible (early) health effects on individual workers, as a consequence of the occupational risks, in order to prevent professional diseases <sup>(12)</sup>.*

<sup>(10)</sup> PAGO — periodiek arbeidsgeneeskundig onderzoek.

<sup>(11)</sup> This law describes the rights and obligations of both employer and employees concerning working conditions. Source: Published by the Ministry of Justice, 29 April 1999 (<http://wetten.overheid.nl/cgi-bin/sessioned/browsercheck/continuation=19659-002/session=039281986429963/action=javascript-result/javascript=yes>).

<sup>(12)</sup> Source: State University Groningen (<http://www.rug.nl/bureau/expertisecentra/amd/gezondheiden/welzijn/gewpago/index>). More information on PAGO can be found on the website of the Ministry of Social Affairs and Work ([http://www.arboportaal.nl/arbo\\_a\\_tm\\_z/a/arbobeleid](http://www.arboportaal.nl/arbo_a_tm_z/a/arbobeleid)).



The PAGO showed that physical strain is an important occupational risk for roadworkers. Many of the 40 roadworkers and service employees in the road maintenance department at the Municipality of Delft have problems with their knees or back. During participative consultation, the employees, management and the safety expert made a joint decision to consult an occupational physiotherapist, who came to play an important role in the project.

The results from the PAGO had already established that measures needed to be taken to improve working conditions for the roadworkers. However no action was taken until 2002 when the municipality's new prevention officer conducted several interviews with the workers. They complained that there had been no improvement in their working conditions, especially with regard to the heavy physical work they were required to do. In collaboration with the manager, the prevention officer therefore started a project that ran from 2003 to 2005.

### *Aims and objectives*

The main objective of the project was to reduce physical strain in order to lower the prevalence of knee and back problems and cut the rate of absenteeism. To achieve this objective, the main sources of physical strain had to be defined and proper solutions had to be found.

Those involved in the project soon realised that it wasn't enough to change the working method of the workers. In some cases it is not possible to provide manual handling aids and the task itself has to be changed in this case, by altering the street design. Thus, a second objective was to address the designers and make clear to them that they have to consider human factors when designing a street.

### *Scope of the project — what was done*

The results from the PAGO showed a high prevalence of knee and back problems among road construction workers. Therefore the prevention officer and the manager agreed that a specialist in the field of anatomy who was familiar with occupational hygiene strategies would be necessary for the development and implementation of the project. They decided to contact an occupational physiotherapist. The physiotherapist succeeded in gaining the attention of the workers by adapting his strategy to the target group, which was necessary because of the specific characteristics of the group.

The different steps of the project were as follows:

1. A meeting was held to discuss the high absenteeism rate in view of the heavy physical strain incurred by the road construction workers during their work.
2. The PAGO was performed to collect quantitative and qualitative data about the situation.
3. Discussions took place between management, a safety expert and the participative body representing the workers. They decided to consult a physiotherapist.
4. The physiotherapist studied the physical strain and used videos to map the working methods of the workers. Based on the images, they were able to define some problem areas.
5. The municipality set up a working group representing both workers and management.



6. The physiotherapist informed all members of the working group about the guidelines and risks related to physical strain.
7. Discussion of the results and bottlenecks concerning physical strain.
8. Discussion of possible solutions within the field of ergonomics: techniques, organisational factors and individual factors. An approach plan was set up. The plan is based on regulations from the 'Arbowet' (the law on working conditions), which requires the provision of solutions in the following order: first technical adaptations, then organisational solutions and, as a final option, an individual solution.
9. Measurement of the situation before the implementation of the solutions by using the *Arbomonitor Gemeenten*. This is a questionnaire on working conditions from SKB specifically designed for municipalities <sup>(13)</sup>.
10. The following solutions were implemented:
  - (a) a small motorised vehicle that is able to transport stones and sand (called a 'skidster', these skidsters were considered for a subsidy on the basis of the 'Farbo' arrangement <sup>(14)</sup>);
  - (b) buying stones weighing less than 4 kg;
  - (c) mechanical paving instead of manual;
  - (d) special tool for lifting larger stones;
  - (e) attune work between the roadworker and the stone supplier;
  - (f) using special knee protection;
  - (g) using a crane in the preparation phase.
11. Another meeting was held to discuss the progress of the project with the working group.
12. The physiotherapist was consulted a second time to advise on:
  - (a) educating road designers about physical strain sustained by road builders;
  - (b) making agreements about pavement material in dialogue with a few street workers.
13. Impact measuring by means of the *Arbomonitor Gemeenten* (this also enabled the project to approach the A+O Fund <sup>(15)</sup> for financing to help co-fund the services of the physiotherapist). The results from this second *Arbomonitor* revealed that the roadworkers felt that the physical strain had diminished.

The project was co-financed by the A+O Fund for 50 % of the costs for the occupational physiotherapist. This amounted to two instalments each of EUR 10 000; one at the beginning of the project and one after the evaluation.

<sup>(13)</sup> SKB (the Foundation for Quality in Occupational Health) is the largest institute in the Netherlands concerned with occupational health. See SKB online on <http://www.skbs.nl/>.

<sup>(14)</sup> The 'Farbo' arrangement provides entrepreneurs with the possibility to request a subsidy for the purchase of equipment that decreases the risk of health problems. (Source: [http://home.szw.nl/navigatie/dossier/dsp\\_dossier.cfm?set\\_id=99](http://home.szw.nl/navigatie/dossier/dsp_dossier.cfm?set_id=99))



### *Results and evaluation of the project*

Between 2003 and 2005 absenteeism among the roadworkers declined by 3.9 %. The roadworkers now feel that their concerns are taken seriously and that the road designers now understand their position better.

The manual (public space) that specifies the types of materials used to construct the various parts of the road has been amended. Lighter stones are now permitted to be used for street paving, which means that the occupational risk during manual handling has been diminished.

Designers are more conscious of the risks of physical strain among the executors (roadworkers). The main occupational risk in their work has been dealt with and diminished.

### *Problems faced*

According to the safety and health team manager, the following were the main problems faced by the project.

- The project lasted for two years, which is quite a long time, and which made it sometimes difficult to stay focused on the topic.
- Workers do not like filling in questionnaires. For this reason, they decided to let the workers fill in the questionnaires in groups during work time with support provided.
- Sometimes, attention focused too much on the non-cooperating workers instead of on the cooperating workers.
- A new standard concerning occupational strain on roadworkers was published recently, specifying that when the surface that has to be paved is above a certain threshold (1500 m<sup>2</sup>), a mechanised method must be used. However, this has meant that some designers now specify that work is done in smaller 'batches', apparently to avoid having to apply the new standard. This indicates that not all road designers are committed to reducing the workload of the road construction workers.

### *Success factors*

The involvement of the workers themselves was an important factor in the success of this project. Workers accept solutions much more readily when they can participate and when they feel that they are taken seriously. The workers are the only party that knows what will really work in practice.

The focus wasn't only on the working methods of the workers but also on the design of the streets. When the street is designed in such a way that the physical strain of the workers is high, a change in working methods won't solve the problem. An integrated solution is indeed the best.



Figure 1: Variations from zero in a group of roadworkers

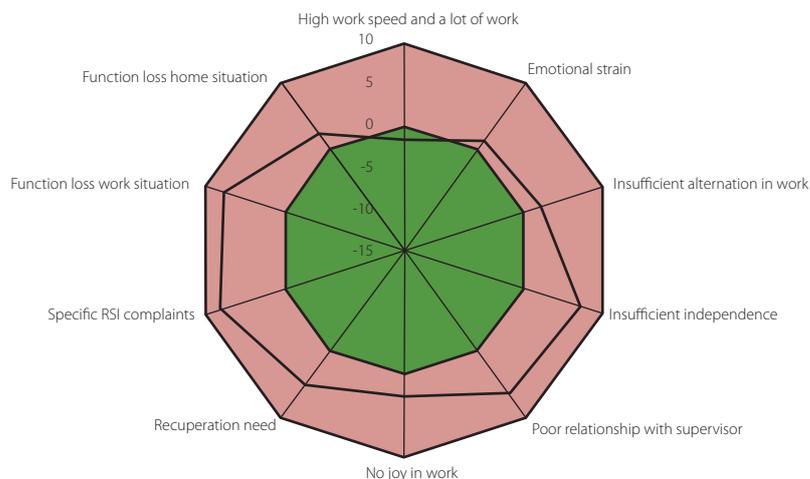
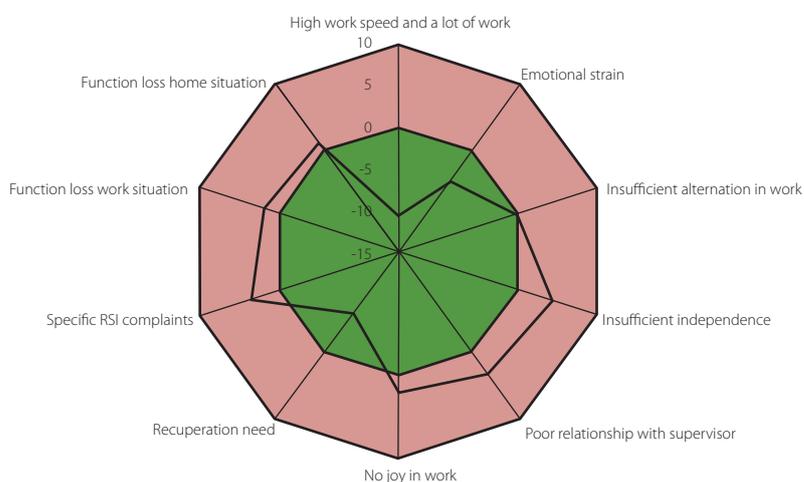


Figure 2: Figure showing the effect of intervention



Source: Municipality of Delft

Figures 1 and 2 give the results. In these diagrams, the reference group is set on zero. This is indicated by the black line around the green circle. The other black line presents the difference between the examined group and the reference group. If this line falls in the green circle, then the examined group scores favourably compared to the reference group. If the line falls outside the green circle, then the examined group scores unfavourably compared to the reference group. The stars indicate to what extent the score for a specific factor is significant.

The factors on the diagram, starting at the top and then moving clockwise are: high work speed and a lot of work, emotional strain, insufficient alternation in work, insufficient independence, poor relationship with supervisor, no joy in work, recuperation need, specific RSI complaints, function loss work situation, function loss home situation.

*Zero measurement*

The results from the zero measurement (see Figure 1) show that the examined group scores unfavourably compared to the reference group for all but one factor. Only for the factor 'high work speed and a lot of work' does the examined group score favourably.



*Effect measurement*

The results from the effect measurement (see Figure 2) show that the effort really paid off. The results for the examined group for most of the factors are much better compared to the reference group than in the previous measurement. Especially for the factors 'high work speed and a lot of work', 'recuperation need' and 'emotional strain' the examined group scores compared favourably to the reference group.

*Transferability of the project*

According to the safety and health team manager, there is great potential in making the designers of public spaces responsible not only for their own personnel, but also for the contractors so that these parties also take human factors into account.

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## SNAPSHOT CASE: TRAINING PROJECT MANAGER — TRAINING IN AN 'ERGONOMIC APPROACH TO WORK SITUATIONS'

# 3.2.

### FRANCE

*Introduction*

Training in the ergonomic approach to work situations in project management (AEST-CP), introduced in 2006 by the regional health insurance fund (CRAM) of Normandy, helps companies make better allowance for human activity on a day-to-day basis. In so doing it helps provide workers with more comfortable working conditions and helps prevent work-related illness.



### **Background**

Nowadays, business pressure means that companies have to be increasingly competitive. This sometimes entails a deterioration of working conditions. Hence the question: is the occurrence of accidents due to the reactive nature of the new organisations, or does it result from a failure to take into account working conditions at the time of their introduction?

The CRAM Normandy fund is based on the observation that in many enterprises, work organisation and ergonomics are not taken into account. It is often very hard to make project planners aware of the importance of work organisation at the project design stage. Too often the technical and economic decisions taken at the start of the project do not factor in the question of future work organisation and may make it impossible at a later date to find satisfactory solutions in terms of organisation, ergonomics and occupational health and safety.

This was observed in particular following several training sessions organised by the CRAM fund on the Ergonomic Approach to Work Situations. The goal of this training was to educate the trainees (members of CHSCTs (committees for health, safety and working conditions), nurses, safety facilitators, and production engineers) on the ergonomic approach, to enable them to examine work situations within their organisations that pose a health problem for the workers concerned.

However, in many cases the trainees were unable to apply the methods learned during the course, because the project was too far advanced to make the necessary organisational and ergonomic changes. If these factors are taken into account at the project design stage it is easier to eliminate risk at source and avoid becoming trapped in a situation that it is hard to change later.

Accordingly, the coordinators of this training course noted an increasingly strong demand by the trainees to take into account working conditions and risk prevention throughout the changes implemented in their enterprise, which included:

- architectural changes (premises, space, etc.);
- organisational changes (merging of departments, job switching, work in units, reorganisation of working hours, etc.);
- economic changes (increased production, quality policy, etc.);
- technical changes (new machinery, information systems, etc.).

The CRAM Normandy fund organised a new training course in 2006 entitled 'Ergonomic Approach to Work Situations — Project Manager' (AEST CP) designed to help those involved in designing new projects to factor in actual working conditions and occupational risk prevention in project management.

### **Aims and objectives**

The aim of this training is to allow Project Managers to take part upstream of the project, when it is still at the design stage, and make allowance for risk prevention and work organisation so they do not feel constrained once the project has started, and so than they can eliminate possible health and safety risks at source.

### **Scope of the project — what was done**

The CRAM Normandy fund prepared a training course entitled 'Ergonomic Approach to Work Situations in Project Management' (AEST-CP). Designed for Project Managers as well as those involved only indirectly through their task in the enterprise (purchasing, committee for health, safety and working conditions, Safety



Manager, etc.), the training provides basic knowledge and concepts, and a guide to methodology.

This training aims to generate new competencies to enable project managers to:

- better organise risk prevention (and the elimination of risks insofar as possible) and the quality of operating conditions throughout the project;
- learn about the reasoning of the various stakeholders in the project, and their particular competencies (and their limitations);
- involve the various stakeholders in the project;
- find out about the various stages of a project, the issues at stake and the strategic points in time in project management.

The latter point relates in particular to preliminary studies, the timing of each stage, the need to call on a work specialist at a strategic moment of the project and the way in which specifications are drawn up. This demonstrates that solutions, which concern space, equipment and work organisation, are created collectively as the project proceeds.

The training takes place over five days, alternated with work in sub-groups on case studies, presentation of papers, and experience sharing. A two-day follow-up/review course is organised the following year. To enrol, participants have to have completed the 'Ergonomic Approach to Work Situations in Project Management' (AEST) training course and to be involved in the management of a project being carried out in business.

The initial training course was held from 12 to 16 June 2006. Ten people (four production engineers, four safety managers and two nurses) from six enterprises and a safety inspector took part.

This training enabled participants to go from the diagnosis stage to drawing up the specifications necessary for the transformation of work situations, or to carry out design projects taking into account the methodological procedures necessary for a human-centred approach.

### ***Results and evaluation of the project***

An example is given here of the implementation of a project in an organisation, following the training course.

A safety inspector of the CRAM Normandy fund attended the AEST-CP training course. She is now working with a company in the textile sector on a noise abatement project. The company wanted to change the covers on its machines. However, it had performed no analysis of noise pollution and had no precise objective in mind.

It therefore proposed undertaking a real project approach. It began by establishing a multidisciplinary group, supervised by a member of the industrial department. The group shared their knowledge and ideas concerning noise and revised the main acoustics rules; an action plan was drawn up.

The first goal was the elimination of the noise risk and, together with downscaling of the factory's activity, covered machines became a priority in the production programme. The second goal was to combat the risk at source, in particular through the design of effective covers.

An elimination plan was drawn up at the end of June 2007, eliminating the noisiest machines. Regarding the second goal, an analysis of machine access needs was carried out, using cardboard boxes in particular. After a plan and a prototype had been worked out, it was believed that the study would lead to a maximum reduction in openings and glazed surfaces. The physical measurements laboratory of the CRAM



Normandy fund is due to take part in contributing expertise on the materials to be used and its knowledge of suppliers. At the same time it will check the actual gain due to the measures taken.

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## 3.3. BETTERLIFT — INTRODUCING A SEMI-AUTOMATIC EXHAUST MANIPULATOR TO REDUCE A HIGH ABSENTEEISM RATE

### BELGIUM

#### *Key points*

- High absenteeism rate related to repetitive strain injury (RSI).
- Semi-automatic exhaust manipulator.
- Multidisciplinary ergonomics process.

#### *Organisation*

Ford Motor Company

#### *Introduction*

Absenteeism was high among exhaust assembly workers at Ford's Genk plant in Belgium. Workers reported heavy strain on their back, shoulders, neck and wrists from repetitive lifting, holding and fixing exhausts. To alleviate the problem the ergonomic team designed, built and implemented a semi-automatic exhaust manipulator, which decreases the physical workload of the operators. The introduction of the manipulator resulted in a fall in repetitive strain injury (RSI) complaints and absenteeism, a decrease in the number of operators needed to perform the job and consequently a decrease in costs related to this job.



## Background

From 1994–2000 the senior medical officer at Ford Genk carried out a study on absenteeism related to RSI. He compared production-related and non-production-related departments for both the incidence and severity rate. The study revealed a clear difference between the two departments. Production jobs in particular had a high absenteeism rate, caused by the repetitive actions performed in this work, and the assembly department showed the highest rate of all.

Workers in the assembly department (especially the chassis line) reported more complaints of pain in the shoulder, back, neck and wrists than other workers. These complaints are related to the weight of the exhaust. As technology has improved and more double exhausts are now used, exhausts have gained in weight, placing a greater strain on workers.

## Aims and objectives

With the introduction of the semi-automatic exhaust manipulator, Ford Genk aimed to:

- decrease absenteeism due to RSI;
- make it possible for the task to be carried out by a much larger percentage of possible workers (50 % of women and 95 % of men; Lifting Index = 1.5);
- optimise safety when performing this job;
- increase motivation and morale;
- eliminate compulsory job rotation (which was only intended as a temporary measure);
- reduce the number of workers needed for this process (two to three workers were involved) to reduce the costs of this workstation and achieve break-even in this project as soon as possible — the second worker from the workstation was transferred to another workstation under the leadership of the same supervisor.

## Scope of the project — what was done

The project was done in two phases: production of the first manipulator for the Mondeo Sedan and production of the second manipulator for the Mondeo Wagon, the S-max and Galaxy. The first project was entitled LEC project 3E289 and the second LEC project 3E304.

### *General ergonomic approach and strategy*

The starting point of the ergonomic approach within Ford Genk is 'adapting work to people'.

Each of the four areas of Ford Genk has a Local Ergonomic Committee (LEC), which is a multidisciplinary team (safety advisor, financial services, HR, unions, ergonomic services, medical services, production, maintenance, etc.) that identifies ergonomic problems and helps resolve them. This team aims to put the Ford ergonomic philosophy into practice. The members of the LEC are trained in using a six-step methodology, the 'job improvement cycle', to identify, evaluate and solve ergonomic problems.

The job improvement cycle.

#### 1. Identify priority jobs

The LEC investigates which jobs have ergonomic problems, based on several information sources. The 'Problem Logbook' gives an overview of all running/pending ergonomic issues, with their priority rate, based on the gravity of possible lesions or on the number of employees involved.



2. Evaluate straining jobs (with potential ergonomic hazards)  
The LEC analyses the problem in order to point out the exact causes. The evaluation requires an investigation of the process, the work method and the environment.
3. Development of solutions  
The LEC comes up with one or more solutions to the identified problems, and discusses ways in which the workstation or process can be altered.
4. Implement solutions  
The reorganisation or redesign of the job is put into practice. Workers have to receive instructions on how to deal with the new situation.
5. Document the project  
The LEC has an 'Evidence Book' containing all information on current and finished projects. Anyone is entitled to consult the book and prevention experts check it regularly.
6. Follow-up  
After the implementation, the LEC has to visit the operations and evaluate the effects of the improvements on a regular basis. Further adjustments might be possible.

**A. The job-improvement-circle applied on the LEC project 3E289**

1. Identify priority jobs

The adjustment of the workstation was identified as priority No 1 based on the following facts:

- complaints from operators, reported through supervisor or union delegates;
- high grade of FTOV (first-time occupational visit): 21 records;
- high absenteeism: 1 018 days lost — Sedan: 627 & Wagon: 391;
- high grade of sickness periods: 43 — Sedan: 26 & Wagon: 17;
- operation only suited for a limited number of workers.

2. Evaluate straining jobs (with potential ergonomic hazards)

Based on the ergonomic assessment, the following description of the former task can be given:

Two workers from the chassis line pick up exhausts — ranging in weight from about 20 to 28 kg — from the conveyor system, bring them towards the vehicle and deck them under the car. Two or three operators manually lift the exhaust over head height and support it with one arm whilst they connect the exhaust to the exhaust isolator on the body (Figures 3 and 4).

This process puts excessive strain on the upper limbs and particularly on the shoulders, the worst part being the one-handed support of the exhaust at head height.



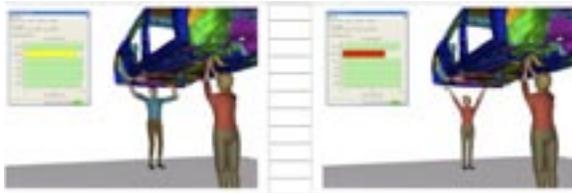
*Figures 3 and 4: Operators picking up the exhaust from the rack and decking it under the vehicle.*



The NIOSH lifting equation was used to calculate the recommended weight limit and the Lifting Index. Ford used the Ford Design Action Limit, which is based on the 50th percentile of women and 95th percentile of men and is  $LI = 1.5$  ( $LI =$  Lifting Index).

When this action limit was applied to the former situation (manual manipulation), it became clear that the situation was unacceptable. In several instances the  $LI$  was higher than 1.5.

Based on the actual situation (and the results from NIOSH) it was possible to do a digital simulation of the job with the 'Jack' software, which showed that many women couldn't perform the job because of anthropometrical and strength-related reasons. Even 10 % of the male population couldn't perform the task, without repetition, because of strength-related reasons (see Figures 5 and 6).



Figures 5 and 6:  
Screenshot from 'Jack' software —  
simulation of men and women decking  
the exhaust

### 3. Development of solutions

Ford Genk examined how other Ford plants and other automobile organisations handle such problems. For example, Rover had already developed an exhaust manipulator. The LEC developed the idea of making an exhaust manipulator that would relieve workers from having to lift, hold and fix heavy exhausts repeatedly.

12.2.2002 to 3.4.2002

The engineering team, in conjunction with three workers, built a first wheeled prototype that had to be pushed or pulled towards the car.

3.4.2002 to 20.5.2003

This prototype turned out to be impractical. Pulling and pushing the manipulator took too long because the wheels regularly slipped on the soap that is used at this workstation. (The rubbers that are attached to the exhaust in order to put it beneath the car are soaped. The soap leaks onto the floor where the manipulator passes.)

20.5.2003 to 13.1.2004

LEC suggested creating an automatically driven manipulator on rails in the floor. This system allows the operators to work faster. A test version gave the workers the opportunity to try it out and give feedback. In the stage of testing and retesting, the operational buttons were also ergonomically tested to determine whether they were well placed, easy to push, the right colour, etc.

### 4. Implement solutions 9.2.2004

The exhaust manipulator was put into use in the Sedan (Mondeo) workstation.

The task can now be described as follows:

The exhaust manipulator picks up the exhaust from the conveyor system and brings it towards the vehicle. The worker operates the manipulator so that the machine positions



the exhaust just beneath the vehicle. Then the operator fixes the exhaust on the car. The operator pushes a button, which makes the manipulator return to start where it will pick up a new exhaust. The process is repeated every 42 seconds (current cycle time).



Figure 7: The manipulator carries the exhaust towards the car – Figure 8: The operator makes the manipulator lift the exhaust – Figure 9: The operator fixes the exhaust to the car – Figure 10: The manipulator goes towards the rack in order to pick up a new exhaust

### 5. Document the projects

LEC project number 3E289 was documented and put into the 'Evidence Book'. This document also describes all the actions that were taken at different times.

### 6. Follow-up

Some characteristics of the manipulator had to be adjusted to improve efficiency. These adjustments will serve as 'lessons learned' in the follow-up LEC project 3E304.

### **B. The job-improvement-circle applied on LEC project 3E304**

After the successful implementation of the exhaust manipulator in the Sedan workstation, a new manipulator was built for the Wagon workstation. Based on the deficiencies of the first type, adjustments were made.

The second manipulator was electric rather than pneumatic. This provides more control possibilities, the manipulator goes faster and maintenance is easier.

At the bottom of the manipulator an additional safety measure was installed. A bar detects when workers stand in the path of the machine. When a signal is sent to the operating cell, the machine shuts down.

At present, due to process modifications, only this second and most efficient version of the manipulator is still in use, not only for the Wagon series but for all variants of Mondeo, S-max and Galaxy.

#### *What kind of risks were dealt with?*

The manipulation of heavy weights (the exhaust pipes) above the head placed heavy strain on the back, neck, arms and wrists. This led to health complaints and a high absenteeism rate.

#### *Finances available for the action*

For the LEC project 3E289 no budget was estimated in advance but the Area Manager gave his permission to use finances from Area 3, which is the Assembly Department. A cost breakdown shows the actual budget used for the engineering, fabrication and implementation of the first manipulator (Table 4).



**Table 4: Estimated budget for exhaust project**

Work done or parts used	Amount/EUR
Pneumatic parts/linear guideway	45 505
Civil works	16 700
Mechanical parts	11 942
Construction	12 518
Legal requirements	1 782
CAD design	4 456
<b>Total</b>	<b>92 903</b>

For the second project, a budget was provided based on the amount spent for the implementation of the first one.

### Other resources

Apart from the financial resources, human resources were also provided. For both projects a multidisciplinary team was put together that consisted of:

- the Senior Medical Officer,
- the Supervisor, Tool & Equipment Shop FG-3E1,
- the Checker, Equipment & Automation,
- the Work Coordinator, Toolmakers,
- the Proactive Ergonomist Genk plant.

### Results and evaluation of the project

#### *The number of lost days before and after installation of the exhaust manipulator*

Before the installation of the manipulator, the loss of time due to absenteeism was very high in both workstations. After the implementation of the exhaust manipulator in Workstation 1, absenteeism fell to zero lost days between January 2004 and February 2006. In Workstation 2 where no manipulator was implemented until 2006, 36 days were lost during the same period. Despite the fact that in Workstation 2 no exhaust manipulator was implemented during that period, the number of days lost fell considerably. This was because of the introduction of an efficient compulsory rotation system. After 30 minutes of fixing exhausts workers had to switch to a task that did not involve handling heavy weights. The decrease can also partially be explained by a reorganisation at the end of 2003 that resulted in a change in the composition of staff at the station (Table 5).

**Table 5: Number of days of absence before and after the project**

	1.2000 until 6.2003	1.2004 until 2.2006
Workstation 1	(without manipulator) 627 inactivity days, 26 sickness periods, 14 operators	(manipulator in use) 0 inactivity days, 8 operators
Workstation 2 (without manipulator)	391 inactivity days, 17 sickness periods, 9 operators	36 inactivity days, 3 sickness periods, 3 operators



#### *Working conditions before and after the exhaust manipulator*

The job has become accessible to more workers and puts far less strain on the workers. Workers no longer complain about the job; instead the job has become quite 'popular' because the strain is quite low.

#### **Problems faced**

Problems were mainly related to the technical part of the project, such as constructing the manipulator. When the first solution was tested, the manipulator on wheels, there were problems with the stability and the manoeuvrability. Soap that leaked on the floor made it difficult to handle the manipulator. Another solution was suggested, namely to create a rail on which the manipulator could move from one place to another.

A second problem was periodic technical failure of the machine. To increase the technical efficiency, the second type of semi-automatic manipulator, ran on electric rather than pneumatic power. This also allowed the machine to go faster, which was a request from the manufacturing department.

#### **Success factors**

##### *Concerning the initiators involved in the project*

The LEC or local ergonomic committee initiated and coordinated the whole project. The multidisciplinary nature of this committee ensured that the project would take every aspect of the problem into account when coming up with a solution.

##### *Concerning partners involved in the project*

According to the procedures for taking expensive facility measures, top management has to approve a project at the OPC (Operations Policy Committee, top management meeting). Management gave its approval for the implementation of the exhaust manipulator, which ensured (financial) support from the beginning. Once the top management supported the project, all other partners followed.

Another important group of people whose support is necessary are the union delegates. These delegates were involved from the start because some workers reported complaints about the job via their union. As this project would result in the improvement of working conditions, they supported it from the beginning.

##### *Concerning the target group*

The workers themselves were also involved throughout the whole process. They reported complaints about the job, they were represented in the LEC and they had the chance to test the manipulator in advance.

##### *Concerning the methodology used*

Ford uses a structured approach in the implementation of ergonomic projects and documents all projects very well. This makes the progress and follow-up of a project much easier. When similar projects are carried out in future, they can easily check what was done the first time and what has to be done differently.

##### *Concerning what was produced or what was done*

The manipulator was fully designed and built in-house by workers who are familiar with the process and the problems related to it. They have a comprehensive view



on the situation. Apart from that, workers are often less resistant to solutions from colleagues than from outsiders.

In the future it will also be easier and cheaper to repair the manipulator if necessary.

A separate area was provided in order to set up a trial version. This allowed the engineers to detect flaws in the system and to ask the opinion of the workers. The operators were better prepared for what was coming.

### *Transferability of the project*

The implementation of the exhaust manipulator is transferable to all manufacturers from the car industry that fix exhausts beneath cars. The project has already been added to Ford's 'best practice replication system', which means that all Ford plants over the world can consult the methodology.

Ford's ergonomics process approach can serve as a good practice example for all kinds of companies from different sectors.

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## PLEASURE BOATS — IMPROVED LOAD HANDLING DURING SHAFT ASSEMBLY OPERATIONS

# 3.4.

### ITALY

#### *Key points*

- Elimination of risk from manual handling of loads.
- Designing aids for load handling.

#### *Organisation*

AZIMUT YACHTS Shipyards of Turin



### Introduction

The manufacture of pleasure boats requires various operations involving manual load handling. Sometimes these operations are not carried out in an ergonomically sound way, with workers operating in environments that are poorly laid out and handling items that are of sizes, weights and shapes that make it very difficult to apply any technical solution to improve work organisation.

These operations involve a definite level of risk, associated with the manual handling of loads. In many situations it is not possible to measure and therefore assess such risk because the operations concerned are not carried out in a systematic way, except for very short work processes that in any case do not affect the actual level of risk to which workers in charge of harder work processes are exposed.



Figure 11: The hull on its cradle

Below are some definitions concerning the mechanical and structural components of the boats which will be mentioned in this report and which are shown in Figure 11:

- shafts: ground steel shafts measuring between 2680 mm and 3840 mm and weighing between 66 kg and 150 kg according to boat size;
- shaft support: bracket external to the hull, assembled below the hull itself and through which the shaft passes;
- hull: lower body of the boat;
- through hull: slot made in the hull, thus enabling communication between the interior and exterior of the craft, inside which the shaft passes through;
- shafting: connection between the engine (placed inside the hull) and the propeller by means of a steel shaft;
- cradle: metal-framed trolley on which the hull and/or the boat is placed.

### Background

In a preliminary risk assessment related to manual handling of loads, both experts in charge of risk analysis and the workers themselves believed the shaft assembly phase



Figure 12: Shaft assembly phase

was particularly critical. This phase involves mechanically connecting a steel shaft between the engine, placed inside the boat, and the propeller placed outside the craft.

The shaft assembly phase may be described as follows (Figure 12): workers lift the shaft off the storage trolley, then they move it until it is placed in line with the hull in order to position the shaft at height and insert it through the hull while holding the shaft in position until it is mechanically locked.

This operation is carried out by teams of different sizes depending on the model of boat being fitted out:

- AZ 55 model: two persons, with shaft measuring 2680 mm and weighing 66 kg;
- AZ 62 model: three persons, with shaft measuring 3685 mm and weighing 111 kg;
- AZ 68 model: five persons, with shaft measuring 3840 mm and weighing 150 kg.

During a preliminary analysis the experts tried to assess the risk associated with the manual handling of loads by applying the NIOSH (National Institute for Occupational Safety and Health) method to determine the recommended weight limit, but this was not possible because the phase involved a variety of activities, unexpected spinal column postures and overload.

The experts noted that although the phase could not be properly measured and therefore the estimated risk of the manual handling could not be calculated, the risk was nevertheless present because the following problems were identified:

- the weight lifted per subject exceeded 30 kg;
- shaft lifting operations were carried out under the hull, which meant an unnatural posture had to be adopted (spinal column bent forward);
- operations were carried out in narrow spaces because of the cradle on which the hull is placed (ergonomically unsound postures);
- an inadequate grip, given the particular shape of the shaft and the surface finish quality (hand slipping);
- shaft falling risk;
- number of workers who were involved in the working procedure;
- difficulty of finding the correct shaft angle between the engine and the through hull and from these components towards the support (three fixed components);
- replacement of the shaft whenever it was damaged by knocks resulting from slipping;
- shafting assembly times which are not standard due to difficulties that teams may encounter when inserting the shaft inside the through hull.

### ***Aims and objectives***

Designing a shafting assembly and handling system that could eliminate the risk from manual handling of loads in this work procedure.



*Figure 13: The shaft holder trolley*



### **Scope of the project — what was done**

The system devised, planned and developed to carry out the shaft assembly phases is made up of two components: a metal-framed trolley equipped with a shaft holder cradle and a winch assembled on a metal-framed structure to be hooked to the inner side of the hull.

The metal-framed shaft holder trolley (Figure 13) consists of:

- six 360-degree revolving wheels equipped with mechanical brake, while the front wheels may be directionally locked by inserting the appropriate pin;
- shaft holder cradle equipped with cylindrical balls in order to enable the shaft traversing movement without scratching the ground surface and a rubber plug placed on the bottom of the cradle in order to cushion knocks;
- handle for moving the trolley and placing it under the hull;
- hydraulic cylinder to adjust the cradle angle;
- hydraulic cylinder to adjust the cradle rear height;
- oil-pressure unit equipped with: pump lever, selector for the cradle's angle or height adjustment and pressure opening and closing valve.

The metal-framed winch consists of:

- steel cable winch;
- threaded bushing to be coupled to shaft head;
- metal-framed structure to be attached to the inner side of the hull.

When the new shafting assembly system was put into effect, the operational phase was completely changed, as can be seen from the procedure detailed as follows:

- (a) *lifting the shaft from the storage trolley by using a bridge crane and placing it on the 'cradle' of the new trolley;*
- (b) *manually moving the trolley under the hull;*
- (c) *aligning the trolley with the shafting;*
- (d) *locking the trolley's wheels by means of mechanical catches;*
- (e) *installing the winch inside the hull;*
- (f) *unwinding the steel cable and coupling the bushing to the shaft head;*
- (g) *adjusting the cradle angle by operating the oil-pressure lever mechanism;*
- (h) *adjusting the cradle's height;*
- (i) *checking the angle by using a laser goniometer;*
- (j) *manually activating the winch to hoist the shaft inside the hull;*
- (k) *mechanical locking of the shaft;*
- (l) *removing the assembly system.*

### **Results and evaluation of the project**

The main results of the project were as follows:

- workers in charge of the shaft assembly phase no longer handle the shaft manually;
- manual lifting of the shaft beneath the hull no longer occurs, therefore workers are no longer required to bend their spinal column;
- it is no longer necessary to operate in narrow spaces;
- the risk of letting the shaft slip out of one's hands has been eliminated, since manual handling of the shaft is no longer required;
- the risk of dropping the shaft has been eliminated;



- the number of workers assigned to the process has been reduced from three to two for the AZ62 boat and from five to two for the AZ68 boat;
- the use of the system in addition to a laser goniometer allows immediate and accurate determination of the shaft angle;
- reduced wear and tear on the shaft when inserting it in the through hull;
- optimisation of time required for the assembly phase.

### *Problems faced*

The design was not easy to develop due to the number of variables associated with the use of the handling device in question:

- weight and size variability of the shafts, depending on the type of boat;
- different heights between floor level and the hulls, also depending on the boat and the cradle;
- variation of distances between the support and the through hull;
- shaft angle adjustment;
- shaft surface finish quality (ground shaft);
- presence of two threads on the shaft, one placed at the top and one at the bottom.

### *Success factors*

A cost-benefit analysis reveals that the economic benefits (reduction in the number of workers in charge of the assembly phase, reduction in costs for shaft replacement, etc.) proved to be greater than the investments made by the company in order to develop the new systems.

### *Transferability of the project*

The methods used for the risk assessment and designing a proper aid device to eliminate the manual handling of loads may be applied to cases where similar risk situations occur.

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# 3.5. SNAPSHOT CASE: LAYOUT WORK AREAS — IMPROVING THE LAYOUT OF WORK AREAS

## FRANCE

### *Introduction*

The regional health insurance fund CRAM Normandy has introduced local firms to a methodology to design work areas taking into account occupational injuries and diseases. Developed by the national research and safety institute INRS, this approach can be applied by all companies and could permanently improve working conditions while optimising productivity.

### *Background*

Good organisation of work premises creates safer working conditions and improves productivity. Based on this observation, the Work Equipment and Ergonomics Department of INRS in partnership with several regional health insurance funds (Normandy, Brittany, Central France, Rhône Alpes) has developed a method to help with the layout of work areas.

### *Aims and objectives*

The objective is to prevent unsatisfactory work layouts by helping company managers define their needs before the layout is finalised. The idea is to place greater emphasis on the work people actually do when designing work premises. This sort of planning avoids expensive mistakes that are difficult to rectify once the workplace is finalised. It eliminates or reduces occupational risks while optimising work flows.

### *Scope of the project — what was done*

Inappropriate layout of workspaces can have severe consequences: risks of injuries at work (dangerous storage, numerous handling operations, etc.), risks of occupational diseases due to noise, chemical pollution etc., complex material flows (crossovers and reversing, numerous operations that require bending down, etc.), information flow problems (low visibility workshop management, poor corporate image, etc.).

This approach is designed to be applied during the reorganisation, extension or construction of new premises, to avoid these problems and the risks arising from them. It has already been put into practice in sectors of activity as diverse as food processing, metallurgy, transport, joinery and electromechanical engineering, and has enabled companies to achieve an overall improvement in safety, productivity and quality.

Optimising the layout of work areas involves research to define the requirements, constraints and expectations of the company. It takes place well before any formal plans are drawn up.

The first stage is an analysis of the general context of the project. This makes it possible to perform initial occupational risk assessment, find out about the company's



future strategy (planned business expansion) and identify environmental constraints (noise emission, housing located near the site, etc.).

The second stage involves identifying sectors of activity (manufacturing process, storage, shipment, personnel entrances/exits, administrative and staff rooms, etc.).

All this research takes place in the company with the participation of the main stakeholders in the project. Discussion between various members of the workforce enables all relevant facets of the problem to be considered. It leads the company to consider in depth its wishes, needs and constraints. As a result the stakeholders generally feel a strong sense of 'ownership' of the method.

A layout always depends on several criteria. The managers focus on certain criteria according to their primary concerns. These include, for example: trying to reduce the number of movements required and distances to be travelled (optimisation of flows), ensuring the prevention of risks due to unfavourable physico-chemical environments and simplifying the exchange of information. The third stage of the approach is then worked out: a proximity/remoteness table taking into account sectors of activity which should be very close to, or on the contrary very remote from, the workstation to comply with the predefined criteria.

From this, one obtains a functional chart from which an initial sketch can be produced of the general layout of the various sectors of the enterprise. This research in no way changes the subsequent work of the project manager; there is no interference with his activity.

Subsequently, the INRS developed a performance aid to make allowances for occupational risk prevention in the design of workplaces and situations. This software can simulate various layout solutions with an assessment of the advantages and disadvantages of each configuration. It also encourages more active participation by all the project stakeholders. The application of this tool showed its potential for use and its contributions to the manual layout design method.

### ***Results and evaluation of the project***

Aid with the layout of work areas is an approach which can be applied by all enterprises, and has already been applied in several sectors of activity.

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# 3.6. INKJET — ELIMINATION OF RISKS ARISING FROM REPETITIVE UPPER LIMB MOVEMENTS

## ITALY

### *Key points*

- Prevention of work-related upper limb disorders (WRULDs).
- Elimination of risk due to awkward postures.

### *Organisation*

Olivetti Tecnost Group

### *Introduction*

The Olivetti Tecnost Group promotes a policy of respect for people and for the environment, a time-honoured legacy of the Olivetti culture. In view of this, the company places a high priority on prevention-related activities in the field of environmental health and safety. One way it does this is by undertaking intensive research into conditions that may potentially impact on its workers.

Many production processes at the group require activities involving repetitive movement of the upper limbs. To tackle this, the company has a policy of:

- informing management about WRULDs-related issues;
- providing information and targeted training for key staff such as occupational physicians and technicians working for the Prevention and Protection Service on assessing risk by determining the OCRA index and applying the workstation checklist;
- identifying, in collaboration with occupational physicians, the potentially more critical movements that contribute to the WRULDs risk, with monitored assessment of the relevant risk indexes and definition of the preliminary corrective intervention measures;
- systematically examining the various productive settings, with analysis/evaluation/definition of corrective intervention measures;
- planning information and training interventions for employees;
- compiling a database containing medical information about employees and the risk indexes for individual workstations.

In order to carry out an analysis of risks attributable to repetitive movements, the methods fine-tuned by the EPM (Ergonomics of Posture and Movement) Research Unit were applied:

- slow-motion analysis of film footage by technicians in collaboration with the occupational physician detailing the workstations deemed to be at risk;
- calculation of the OCRA index;
- correlation with medical history data;
- redesign project.



## Background

An analysis was conducted into the activity of testing inkjet heads. The workstation examined (Figures 14, 15 and 16) is a rectangular plan; positioned on this area are three printers, one PC and two trolleys located to the left and the right of the female operator, on which are arranged containers containing the heads to be tested and those already tested. The activity involves inserting the heads into the carriage of each printer in succession. The tester presses a button which 'instructs' the PC to print out a special text on each printer. The operator visually monitors the printer output to verify that the printer is functioning correctly and the printed text is of the required quality. If so, the head is functioning correctly. The heads are then placed in different trays, depending on the result of the test, and sorted for the next stage of processing.

The distance of the printer from the operator requires the shoulder to be bent and (for shorter operators) the trunk to be pushed forward. Taking (Figure 16) and repositioning the heads in the last rows of the blister pack involves the abduction of the shoulder and in some cases the lateral inclination of the trunk. A raised-arm posture is maintained for over one third of the working cycle.

The turnover of employees is very low because of the long induction phase required to become proficient in the testing standards. Most workers doing this activity are women; their average age is 30 years and average length of service five years.

Routine employee health surveillance revealed a moderate incidence of pain to the right shoulder among these operators. A more detailed survey was therefore carried out to determine the type and extent of disorders relating to the upper limbs. The data confirmed that the right shoulder was the only clinically involved part of the body. The discovery of a pathology that was likely to be linked to the occupational activity in question triggered the immediate implementation of a plan that the company had already prepared to tackle such problems.

Analysis of the activity performed by the operators showed that the most critical factor related to posture. The repetitive movement risk index, obtained through the OCRA checklist, fell within the yellow zone (very low risk).

## Aims and objectives

The aim was to redesign the workstation in order to eliminate the risk due to (incorrect) posture and repetitive movements of the upper limbs.

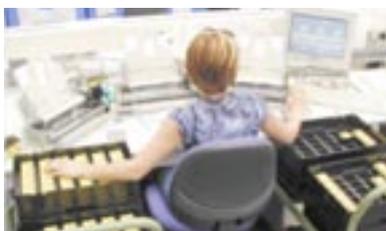


Figure 14: The original layout of the workstation



Figure 15: The original layout of the workstation

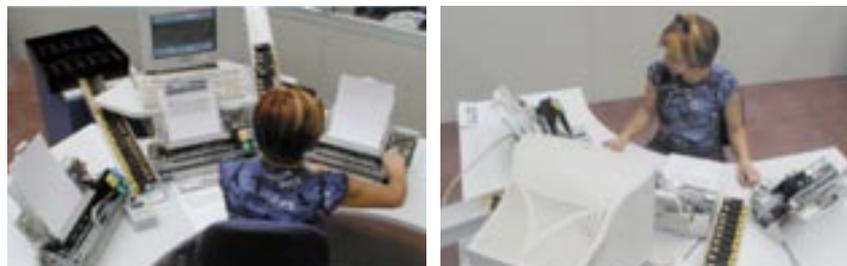


Figure 16: Insertion of the head into the printer (original layout)



### *Scope of the project — what was done*

The workstation was redesigned according to the prototype layout shown in Figure 17. This resolved the relevant problems of posture and, at the same time, reduced production times by eliminating the paper-input phase of the working cycle.



Figures 17 and 18: The revised workstation layout

Semicircular workbenches were used, with proper support for the monitor positioned directly in front of the operator. The printers, following the shape of the workbench, were brought closer to the operator. The shape of the workbench allows the printer carriages to be reached more easily; having the monitor in the centre eliminates the need for the operator to rotate her head (Figure 18). A slide to the right of the central printer automatically discharges the heads to be tested directly from the preceding work phase. Once tested, the heads are moved using a similar slide placed to the left of the central printer, and this is connected with the following work phase. The use and positioning of sliding conveyor belts eliminates the undue abduction of the arms which previously occurred, except perhaps for the act of depositing the heads in the appropriate container for reprocessing. This operation does not occur frequently, however.

The alteration in the working cycle was followed by proper training of the staff, which proved indispensable to help the operators understand and hence accept the need to change an undesirable working method which had become habitual.

### *Results and evaluation of the project*

Following intervention, the index of risk from repetitive movements resulting from the OCRA checklist dropped from the yellow (very low risk) to the green zone (acceptable level of risk).

The employees were satisfied with the changes made and there was a general improvement in symptomatology.

### *Problems faced*

Training had the effect of slowing down the rhythm of activity for a few days, but its benefits far outweighed this inconvenience.

### *Success factors*

The interventions described did not negatively affect productivity in the slightest, and the cost of the product remained the same. The results proved a success in terms of employee satisfaction and improvement in symptomatology: all of this confirms the value of the whole process undertaken and the desire to continue on the same course.



***Transferability of the project***

Musculoskeletal disorders of the upper limbs are an issue in many occupational activities involving awkward postures and repetitive movements of the upper limbs. The method applied in this case may be transferred without difficulty to activities and workplaces similar to those described.

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## SNAPSHOT CASE — STEHLUST STATT SITZFRUST (STANDING'S GREAT, SITTING'S A GRIND)

# 3.7.

## GERMANY

***Introduction***

Dräger, in cooperation with officeplus GmbH, carried out a project to eliminate musculoskeletal disorders (MSDs) at the workplace.

Dräger Medical, a Dräger and Siemens Company, is one of the world's leading manufacturers of medical equipment. The company offers products, services and integrated CareArea™ Solutions throughout the patient care process from emergency care through perioperative care to critical care, perinatal care and home care. With headquarters in Lübeck, Germany, Dräger Medical employs nearly 6 000 people worldwide, around half of whom work in customer sales & services.

officeplus is a manufacturer of ergonomic office furniture and fixtures such as integrated standing desks and mobile standing desks. officeplus has pioneered stand-sit dynamics in offices and its standing desks have been given awards by the AGR (Aktion gesunder Rücken e.V. — Campaign healthy back e.V., [www.agr-ev.de](http://www.agr-ev.de)). In addition officeplus is tested and recommended by the 'German back school' and a forum that promotes back health, the 'Forum gesunder Rücken — besser Leben e.V.' (<http://www.forum-ruecken.de/>).

***Background***

MSDs are still the most common work-related health problem in Europe, affecting millions of workers. In the past few years occupational computer use has become very common in offices. Office workers are particularly prone to lack of exercise and sitting for long periods in one position.



Having to sit or stand in one position for a long time requires static muscle work instead of dynamic muscle work. This provokes musculoskeletal disorders. Exercise and changes of position at the workplace is one of the most effective methods of preventing these disorders. Studies have shown that the use of standing desks as a health-supporting measure for office workers and people working at display workstations is recommended (see Figure 19). Where this is not possible, varying different tasks such as computer work and workshop jobs offers the possibility of alternating sitting and standing positions facilitated by integrated standing tables.



Figure 19: The integrated standing desk

### ***Aims and objectives***

The aim of the project was to eliminate musculoskeletal disorders in office workers and therefore to decrease the sickness absence (sick leave) at Dräger. The idea was to motivate and stimulate the workers to change their working positions regularly.

### ***Scope of the project — what was done***

Thirty-eight workstations were equipped with integrated standing desks which enabled the workers to change their work position regularly. The employees used the integrated standing desk mainly while using the phone or reading. About 90 % of employees used the standing desk more than 10 times a day.

The employees also took part in ergonomic training. This supports the new concept (*Steh-Sitz-Arbeitsplatz*, stand-sit-dynamics) of alternated sitting and standing, and helps people break the habit of sitting for long periods.

Alternating between standing and sitting in combination with ergonomic training helps to relax the spinal column and prevent tiring postures and therefore reduce (prevent) back injuries and back pain.

### ***Results and evaluation of the project***

Surveys were carried out after three months and again after six years.

The first survey showed a considerable improvement: two thirds of the workers reported an improvement in their well-being at work.

After six years 70 % of the employees reported an improvement in their well-being at work. Although the duration of computer use increased during those six years, the sickness absence of employees who used the standing desk regularly decreased. Fewer employees took days off because of musculoskeletal problems.



Overall, 33 % of the employees said that they had less back pain since they began using the integrated standing desk and 60 % said the 'stand-sit dynamic', i.e. frequent changes between sitting and standing, prevents neck and shoulder pain.

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## USING PNEUMATIC SCREWDRIVERS — ELIMINATION OF RISKS ARISING FROM HAND-ARM VIBRATION EXPOSURE

# 3.8.

### ITALY

#### **Key points**

- Elimination of the risk of hand-arm vibrations.
- Reduction of vibrations generated by a pneumatic screwdriver.

#### **Organisation**

Electrolux Zanussi SPA factory, Forlì



### *Introduction*

Increasing attention has been paid in recent years to work-related upper limb disorders (WRULDs), and this has been justified by growing confirmation at the epidemiological level and by the inclusion of these pathologies among those recognised as relevant to the occupational arena. Such pathologies are characterised by the constant functional involvement of the various sections of the upper limb, shoulder, elbow, wrist and hand, and of their musculo-tendonous structures. Current practice is to assess exposure to risk through a multifactorial approach which takes into consideration all possible factors of an occupational/organisational nature.

From a biomechanical point of view in particular, a general analysis model should focus on certain elements which are considered to be the main factors responsible for the onset of risk, which are:

- repetitiveness of the actions (frequency);
- application of force;
- awkward postures;
- inadequate periods of recovery;
- prolonged exposure.

To these may be added a series of complementary factors such as the use of vibrating instruments, exposure to unfavourable microclimatic conditions, the need to use personal protective equipment such as gloves and carrying out precision work, all of which contribute towards increasing the overall conditions of discomfort.

### *Background*

The Forlì Electrolux Zanussi SPA factory produces electrical kitchen appliances. As a result of increased levels of production and the corresponding need to introduce new workers to the assembly lines — primarily women with no previous work experience — WRULDs have been on the rise.

At the Forlì factory there is continuous daily use of pneumatic appliances (screwdrivers) in many workstations. The Prevention and Protection Service suspected a correlation between the vibrations generated by these tools and the increase in WRULDs in the factory.

The pneumatic screwdriver is a tool which, powered by compressed air, has an internal motor which causes the rotation of a connector of a shape suitable for the screwing of screws, nuts, bolts.

The level of vibration generated by a pneumatic screwdriver depends on the power of the internal motor and on the construction technology of the clutch which intervenes in reaching the tightening torque.

The vibrations of screwdrivers should firstly be reduced at source. For this purpose, the most modern screwdrivers are equipped with a clutch which automatically and immediately stops the feeding air when the preset torque is reached. Screwdrivers of the traditional kind, however, use a mechanical slip clutch, in which two toothed steel components, placed against each other, slide against one another and thus produce high levels of vibration.

In addition to generating significantly lower levels of vibrations, screwdrivers equipped with automatic air shut-off devices also reduce the duration of operator exposure to vibrations. In fact, these screwdrivers automatically and immediately stop when the preset torque is reached, whereas in the more traditional screwdrivers equipped with



slip clutch the arrest of the screwdriver is left to the discretion of the operator. In the case of screwdrivers equipped with automatic air shut-off devices, vibration exposure time is four times less than with traditional screwdrivers.

### *Aims and objectives*

The aim was the elimination at source of the risk from vibrations transmitted to the hand-arm system by bringing the vibration exposure to below the action values defined by Directive 2002/44/EC, by substitution of the pneumatic screwdrivers that produce higher levels of vibrations.

### *Scope of the project — what was done*

The following actions were taken:

- an inventory of the screwdrivers existing on-site;
- vibration tests in the laboratory;
- vibration surveys on the production line;
- an intervention plan for substitution of screwdrivers.

#### *Inventory of screwdrivers*

An inventory was made of all screwdrivers on the assembly lines, and then the tools were divided into families and types.

It was found that at the Forlì factory there were 1 167 screwdrivers of different types and of these 801 had a slip clutch while the remainder had an air shut-off clutch. There were 97 different types of screwdrivers, 49 with slip clutch and 48 with air shut-off clutch; 9 types of screwdrivers with slip clutch however amounted to 78 % of the number in use at the factory, equivalent to 628 implements.

#### *Vibration tests in the laboratory*

The various families of screwdrivers undergoing inventory were subjected to tests. The equipment used was a Larson Davis 3200L/1 spectrum analyser equipped with a suitable accelerometer. For each type of screwdriver, five screwings were carried out using the mechanical brake defined in ISO/DIS 8662-7 Standard.

The screwdrivers with slip clutch in the laboratory showed values of weighted acceleration from 2.042 to 5.66 m/s<sup>2</sup>, whereas for screwdrivers with air shut-off clutches the interval was from 0.9 to 2.21 m/s<sup>2</sup>.

#### *Vibration surveys on the production line*

The types of screwdrivers tested in the laboratory were then used directly on the production line. The most representative phases of the assembly lines were selected for carrying out the vibration surveys. The tests were first performed on all the machines with slip clutch and then on those with air shut-off clutch.

Using the data thus obtained, a calculation was made of exposure to the total equivalent frequency-weighted acceleration during the eight hours of the pre-selected phases.

The comparison of exposure values using the two different types of equipment confirmed that when only equipment with air shut-off clutches was used on the production line, exposure could fall below the action values defined in Directive 2002/44/EC.



#### *An intervention plan for substitution of screwdrivers*

The company management decided to carry through a systematic plan of substitution of the tools with slip clutch.

The first phase of the plan was to substitute all screwdrivers at workstations showing equivalent acceleration exposure values above the action value ( $2.5 \text{ m/s}^2$ ); the second, to be completed during the following year, provided for the complete substitution of the older pneumatic tools by new ones equipped with automatic air shut-off clutch, which had the effect of reducing the vibrations generated to below the action level defined by Directive 2002/44/EC, thereby attaining the lower level of vibrations which applied on the assembly lines.

#### **Results and evaluation of the project**

The conclusion of the plan anticipated that 88 % of the work phases (312) should produce vibrations below the value of  $1 \text{ m/s}^2$ , and that around 12 % should present a value of between 1 and  $2.5 \text{ m/s}^2$ . The complete substitution of screwdrivers, including the remaining 173 screwdrivers that presented difficulties because they were utilised for particular processes, further improved the values but did not significantly influence the above data.

Progress in cases of WRULDs was monitored by the factory infirmary on a monthly basis. The introduction of the new screwdrivers had the effect of gradually reducing the number of operators affected by upper limb disorders, by 55 % in the course of one year.

#### **Problems faced**

It was not easy to find a screwdriver which, in addition to reducing vibrations, had characteristics specifically tailored to the activities carried out in the factory. Initially a product was sought on the market that would satisfy both these requirements, and then attention was focused on researching, designing and producing an ergonomic screwdriver within the Zanussi engineering department.

Substituting the screwdrivers cost the company a considerable amount of money.

#### **Success factors**

The major success factor in this project was to have the capacity, at company level, to properly assess the risk from vibrations and to reduce the risk at source through a well designed intervention plan.

#### **Transferability of the project**

This experience is easily transferable to all sectors in which pneumatic screwdrivers are used.

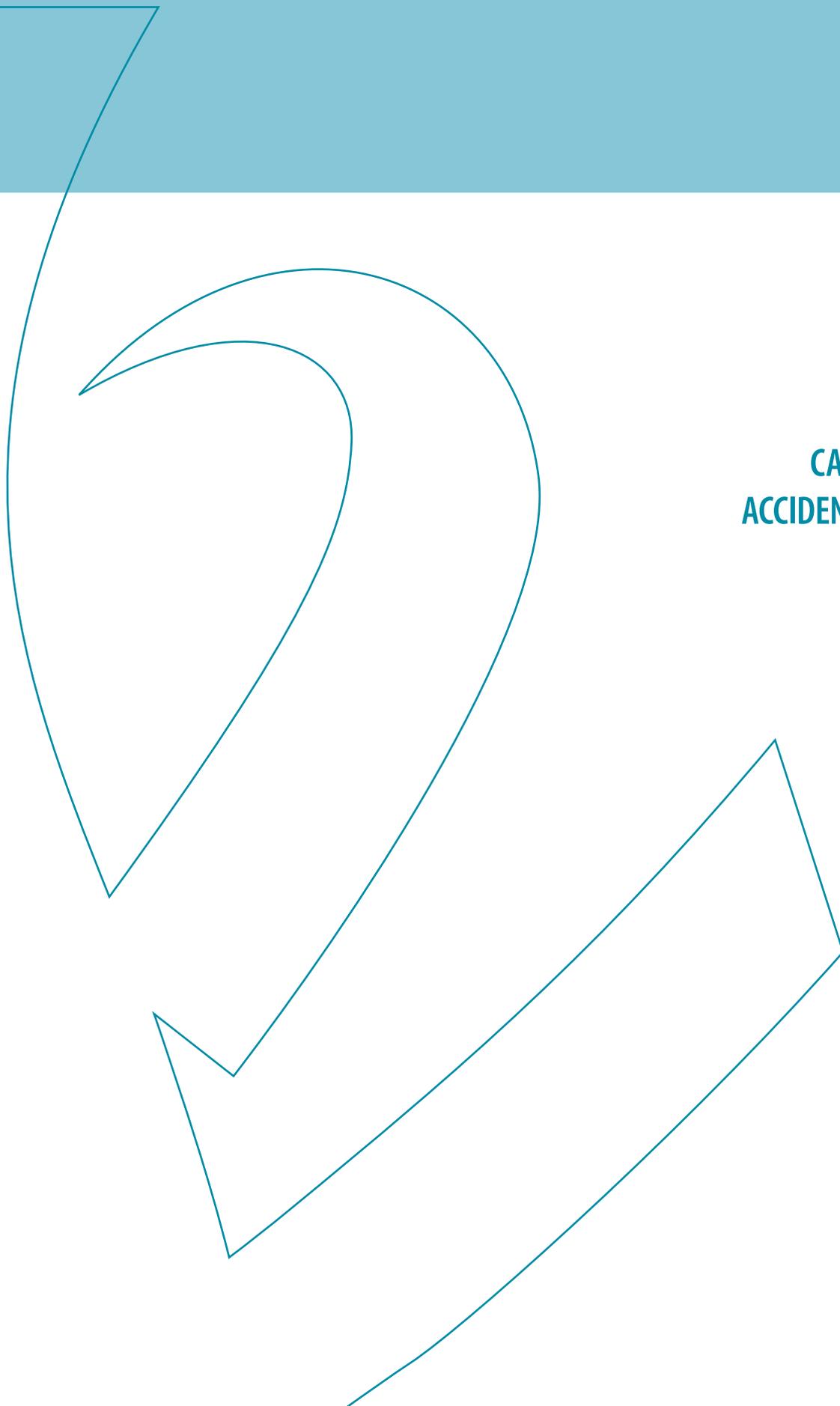
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# 4.

## CASE STUDIES — ACCIDENT PREVENTION



# 4.1. HPD-RAILROAD — ELIMINATING ACCIDENT RISK ON THE FINNISH RAILWAY

## FINLAND

### Key points

- Reduction of accident risk caused by noise.
- Because the noise source can't be eliminated, hearing protectors were introduced.

### Organisation

Finnish railways and Finnish Institute of Occupational Health (FIOH)

### Introduction

In the railroad yard there are many high-intensity noise sources, which cause the noise exposure level of 85 dB(A) to be exceeded daily for the workers (Table 6).

**Table 6: High-intensity noise sources in the railroad yard**

Noise source	Noise characteristics	Max level (dB)
Locomotive brakes	High frequency noise > 2.5 kHz	over 115
Wheel noise in turnings	High frequency noise > 2.5 kHz	over 115
Typhoons <sup>(16)</sup> high frequency	0.8 and 1.6 kHz	over 115
Typhoons low frequency	0.5 kHz	over 115
Pressured air	4–8 kHz	115

In addition to the noise, there is an accident risk caused by moving trains. All workers must be able to hear an approaching train and the direction from which it is coming. Failure to do this has resulted in fatal accidents. To ensure that all employees have adequate hearing the Railway Medical Services (UIMC) recommends the following criteria (Table 7).

**Table 7: The minimum recommended hearing level in rail yard work according to UIMC**

Condition	1 kHz	2 kHz	3 kHz	4 kHz
When work starts (*)	20	20	20	25
When working (**)	25	25		

(\*) Or hear whispering from 5 m with both ears.  
 (\*\*) Or hears conversation from 5 m with both ears.

<sup>(16)</sup> Typhoon is the term used for the train whistle. All whistles working with compressed air are typhoons.



However, the Finnish railways has used somewhat different requirements (Table 8).

**Table 8: The minimum required hearing levels according to the Finnish railways**

Condition	Speech frequencies (0.5–2 kHz)	3–4 kHz
When starting work	20 dB	40 dB
When working (*)	40 dB	60 dB

(\*) Speech must be understood from 2–4 m distance.

After several trials the Finnish railroad concluded that nothing can be done about the noise sources. So the only option left is hearing protectors. With hearing protectors on, the workers' hearing must still be better than the values given in Table 8 to avoid the risk of accidents.

### Background

Although the recommendations described above are clear, they are not easy to follow. As hearing may deteriorate very quickly, audiometry testing must be carried out at least every year on workers with hearing loss that is near the limits. Also, there is a limit to the attenuation provided by hearing protectors. Otherwise the hearing at work is worse than the limits in Table 8 even with minor hearing loss.

### Aims and objectives and scope of the project — what was done

The Finnish Railway and the Finnish Institute of Occupational Health wanted to develop a simple method of selecting hearing protectors without compromising the safety of workers.

After a survey of the existing types of hearing protectors, two types were selected for further study:

- earplugs with appropriate audio filter; and
- level-dependent earmuffs.

Because typhoons (train whistles) have only discrete frequencies it might be possible to attenuate the noise levels without compromising the hearing by attenuating only the typhoons frequencies and frequencies above 2.5 kHz. A questionnaire was sent to the manufacturers about whether they could design such a filter. The answer was negative. Thus, only the second option was left.

For the level-dependent hearing protector the following requirements were made:

- lightweight
- stereo hearing
- amplification of low-level sound
- resistant to ambient conditions, like rain and cold.

Several hearing protectors designed for hunting were found to fill the requirements. The selection was made based on financial terms and user tests.

### Results and evaluation of the project

The selected solution has the following advantages:

- the sound exposure of men working in the railway yard could be reduced below 85 dB without compromising the safety of workers;
- no more discomfort due to the high noise levels (Table 6);



- when using hearing protectors, the hearing level was always better than without protectors and, thus, the requirement of hearing was always fulfilled at work and very frequent hearing tests were no longer mandatory;
- the overall costs of the solution are lower than the cost of the previous solution: the price of electronic muffs was lower than the cost of frequent hearing inspections.

The major disadvantage of the solution was related to more complex logistics. Batteries and/or charging of the device had to be arranged.

#### *Problems faced*

No real problems were faced during the project.

#### *Success factors*

The major success factor in this project was the analysis of all the related factors. Without this detailed analysis it is not easy to motivate the additional cost of level-dependent muffs.

#### *Transferability of the project*

Hearing requirements vary between rail companies, but the concept of the project can be transferred directly to other similar concerns. The concept is valid in all transport industries where good hearing is mandatory because of accident risk, provided that the possibility of adopting other solutions like combating risk at source and/or collective protective measures have been analysed previously.

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## NOACCIDENT — RADICAL REDUCTION IN ACCIDENTS IN A METALLIC PACKAGING COMPANY

# 4.2.

### SPAIN

#### *Key points*

- Observation of people during their work in order to eliminate the causes of accidents.
- Involvement of all personnel, from senior management to workers.
- Focus on the relationship between productivity and occupational safety.

#### *Organisation*

CROWN CORK IBERICA S.L.U.

#### *Introduction*

Historically, the metallography sector is one of the sectors most affected by occupational injuries, on account of the production processes, the raw material and, finally, the lack of risk prevention policies in these companies.

CROWN CORK IBERICA decided to implement the STOP programme of occupational safety, not only to reduce the number of occupational injuries in its factory but also to eliminate their causes.

Involvement of a company's managers and participation of the employees are two essential requirements for the success of occupational health and safety initiatives. Accordingly, the involvement of supervisory staff (who organise and supervise production) is of fundamental importance when initiating preventive action. Social dialogue between the company and the occupational safety and health (OSH) representative and with the trade unions is also one of the keys to the success of such action.

#### *Background*

CROWN CORK IBERICA is a small company with 43 employees in Montmeló (Barcelona) that specialises in the manufacture and sale of metal packaging. The company is part of a multinational group with 256 enterprises worldwide (including 12 in Spain), with headquarters in Philadelphia, United States.

#### *Aims and objectives*

The objective in adopting this programme was to considerably reduce the number of occupational accidents and incidents at the company by looking for the causes and eliminating them through the involvement of all the personnel, from senior management to the workers themselves.

#### *Scope of the project — what was done*

The worker representatives of CROWN CORK IBERICA initiated preventive action that had been developed and promoted by the company's management. This was partly in response to objectives set by the Head Office concerning the reduction of injuries and the costs they entail.



In 1999 the company proposed setting up the STOP programme for occupational safety. This programme was created by the American multinational DUPONT and one of its basic principles is to compare the relationship between productivity and occupational safety.

Accordingly, the company applied a method of occupational health and safety management which involves all the personnel (management, health and safety coordinators, OSH representatives, and the workers in general) with a view to putting an end to occupational injuries.

STOP is based on the observation of people during their work, then taking steps to reinforce safe work practices and correct unfavourable working conditions and unsafe work practices. The programme requires the involvement of the entire company, and, more specifically, of the workers, who must accept the idea of being observed and change their habits at their workstation.

CROWN CORK IBERICA introduced several measures as part of this programme. For example, a safety group was set up, consisting of the safety coordinator and the OSH representative. They hold quarterly meetings with the company manager, covering subjects such as the budget and capital expenditure for the current financial year, as well as action plans, training and information plans for the workers, risk assessment on the workstations, human factor engineering, noise measurement, lighting, heat, vibration, accidents and their causes, and a plan for monitoring all these aspects.

The reduction in the number of injuries is strongly related to the involvement of the company's executives — management, supervisors and maintenance managers — in other words all those who have the power to implement the preventive actions of the STOP programme.

The STOP initiative promoted a training programme for all the firm's employees, including the manager, the OSH representative and all the workers.

The accidents and incidents that still occur are now investigated thoroughly and without delay, in order to help prevent similar accidents or incidents from recurring.



Figure 20: Tidy and safe storage is being emphasised as part of the new system

Once a month the group of STOP supervisors meet (department managers, section heads, etc.) with the health and safety coordinator and the OSH representative. The system implies constant evaluation of situations day by day — with the involvement and help of the workers and never through force or by asserting authority — to analyse the causes of accidents and incidents. The technicians in the occupational health and safety department (both internal and external) also help in this task.

A series of preventive measures have also been taken, such as signage in corridors, the clear demarcation of work and rest areas, the adaptation of machinery and a greater focus on order and cleanliness (see Figure 20). The results have been spectacular. For example, the company succeeded in reducing chemical pollutants to 10 times below the limit values.

### ***Results and evaluation of the project***

The positive results very soon became evident, and the company won special recognition from its multinational parent company because it succeeded in reducing the number of occupational injuries.

Further improvements are nevertheless planned, such as the retrofitting of machinery, the introduction of a method to assess psychosocial risks and the assessment of ergonomic risks.

### ***Problems faced***

Until this programme started, neither the supervisors nor the workers had much knowledge of risk prevention. The corporate culture therefore had to be changed very quickly, and everyone had to adopt new habits.

### ***Success factors***

These results were achieved because of the involvement of all relevant parties and through dialogue between the employee representatives and the company, which facilitated good cooperation and participation.

### ***Transferability of the project***

This method of eliminating risks is easily transferable to other firms, in any sector of activity. However, it requires a strong commitment from both management and workers.

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## 4.3. NEEDLESTICK — HOW TO PREVENT NEEDLESTICK INJURIES EFFECTIVELY

### GERMANY

#### Key points

- Prevention of needlestick injuries in the health-care sector.
- Use of safety needles.
- Prevention of biological hazards in the health-care sector.

#### Organisation

State Health Office Baden-Württemberg (Landesgesundheitsamt) and the University Hospital of Heidelberg (Universitätsklinikum) in cooperation with Statutory Accident Insurance for the Health Care Sector (BGW) and Statutory Accident Insurance for the Public Services Baden-Württemberg (UKBW) as well as with the Freiburg research centre for occupational and social medicine (FFAS).

#### Introduction

In Germany some 750 000 people work in hospitals and other patient treatment facilities. Studies showed that the number of needlestick injuries (NSI) per worker per year can be as high as 0.41 (Hasselhorn et al., 1995) or even 0.98 (Beie, 2000). It has been estimated that there are up to 500 000 NSI per year in Germany, less than 50 % of which will be registered (Beie, 2000; Berger et al., 2000). For the workers the consequences of a single needlestick injury can be severe or even fatal: the risk comes from blood that remains on the needle and can lead to infections. The most common risks are Hepatitis B and C and HIV infections. In 2004 the German Statutory Accident Insurance associations BUK and HVBG (now merged into DGUV — Deutsche Gesetzliche Unfallversicherung) recognised 218 cases of hepatitis infections and eight cases of HIV as occupational diseases (Müller-Barthelmeh et al., 2007).



Figure 21: Injuries from needles can be serious and even lethal

## **Background**

Considering these statistics, excellent occupational medical care of workers including preventive check-ups, vaccinations, etc., should be standard, as well as the registration of each NSI as an accident at work. During vocational training the staff should be shown safe working practices (no recapping) and special containers should be provided for used needles.

Nonetheless the crucial problem that needs to be solved remains: how can needle-stick injuries be prevented as efficiently as possible? The university hospital of Heidelberg and the State Health Office of Baden-Württemberg wanted to give answers to the crucial question by carrying out a two-year on-the-job intervention study into the effectiveness of safety needles and other preventive measures.

## **Aims and objectives**

The aims of this study were to quantify the effectiveness of different prevention strategies, such as the use of safety instruments in comparison with conventional instruments, and the effectiveness of special sensitisation training for staff concerning NSI.

The intention was also to investigate the usability of safety instruments in comparison with conventional needles and syringes, and to verify the accuracy of the registration rate of accidents at work at the university hospital.

The overall goal of the public health department was to determine whether official recommendations for the use of certain instruments, or for the promotion of certain work techniques, could be given.

## **Scope of the project — what was done**

At the beginning of the study, 18 departments of surgery, gynaecology, internal medicine, and skin diseases of the hospital were chosen to participate in the study. Three groups were formed by volunteers, comparable in terms of number of workers, number of patients and job description/tasks (intensive care, general care, and ambulant care):

- Group 1 (160 workers) carried on working with conventional needles and syringes and were not given any additional training;
- Group 2 (143 workers) were given special advice before the study in order to sensitise them with regard to NSI and working techniques;
- Group 3 (138 workers) were also given special advice before the study and, additionally, the workers were required to work only with safety instruments for 12 months whenever possible.

All safety instruments used by Group 3 in the study had to fulfil the NIOSH safety criteria (NIOSH, 1999). The instruments provided could be used for taking blood samples/blood withdrawal from capillaries, veins and arteries, for injections (subcutaneous and intramuscular), and for intravenous catheters. Safety containers were provided for the disposal of used instruments.

After the participants had been recruited they all had to fill in a questionnaire entitled 'a single prick infects' (in the following quoted as Q1) about accidents and prevention measures during the previous 12 months. Questions included: how many NSIs occurred? Was the accident registered? How did it happen? Has any vaccination against hepatitis taken place? Did the worker use personal protective equipment (e.g. safety gloves when handling infectious material)?



The workers in Groups 2 and 3 were given special advice regarding NSIs. Group 3 was also trained in working with the new safety instruments and in the safe disposal of needles and syringes.

Over the next 12 months the safety containers of Group 3 were checked periodically to determine whether the safety instruments were being used and disposed of correctly. The workers in Group 3 also had to evaluate the usability of the safety instruments after six months and at the end of the study. After 12 months all participants were asked to fill in the original questionnaire again (in the following quoted as Q2) in order to compare data from before and during the study.

On the basis of the data from both questionnaires, the usability evaluation and the monitoring during the study, FFAS Freiburg (Freiburg Research Centre for Occupational and Social Medicine) carried out the final evaluation. The study data were also compared with long-term accident data contained on the university's database.

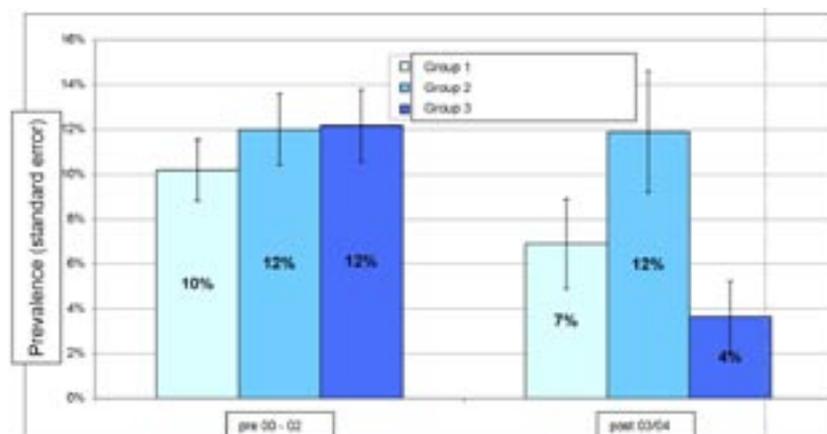
### Results and evaluation of the project

#### Results of the questionnaires 'a single prick infects'

In all, 194 workers filled in both questionnaires. They were chosen for the final evaluation as only their given data were considered to be comparable.

- In all three groups there was a drop in NSIs from 12 % to 8 % at the end of the study. In Group 1 the statistical average dropped from 11 % to 8 %, in Group 2 from 16 % to 11 % and in Group 3 from 7 % to 4 %.
- The most dangerous tasks identified in questionnaire 1 (Q1) were disposal of instruments, drawing up the injection, recapping, and sewing. In questionnaire 2 (Q2) the most dangerous task mentioned was drawing up the injection.
- The most dangerous instruments were cannulas, syringes and catheters. Fewer accidents happened when using surgical instruments (e.g. blades).
- Most accidents happened in patients' rooms.
- In Q1 50 % of accidents were declared to have been registered, in Q2 62 %. Most workers consulted the occupational physician, or the hospital emergency unit.
- In Q1 55 % of the workers were wearing safety gloves when the accident occurred, in Q2 52 %. Concerning gloves, 86 % said they wore safety gloves when handling infectious material.
- In Q2 91 % of the workers said they had been vaccinated, 7 % were not sure about their status, and 2 % said they had not been vaccinated.

**Table 9: Prevalence (needlestick injuries) in the three groups of the study pre- and post-intervention**



*Study data in comparison with long-term data from university's database*

Since 1990 all NSIs at the university hospital have had to be registered. Since 1997 the registration has been standardised and mainstreamed in a central database. Data can be searched by hospital department and according to different tasks.

Between 1997 and 2002 a total of 291 NSIs, which equals an annual average of 48.5, were registered for the departments which took part in the study. The annual minimum of registered NSIs was 42 while the maximum was 51. The long-term average risk/NSI prevalence (registered cases only) per worker was 10.77 %<sup>(16)</sup>.

If the group-specific annual long-term NSI prevalence for the years 2000–02<sup>(17)</sup> is compared to the study data, the following findings can be stated:

- In Group 1, the annual long-term NSI prevalence was between 12 % and 7.2 %. During the study the accident rate among the workers was about 6.9 %.
- In Group 2, the annual long-term NSI prevalence was between 13.7 % and 10.8 %. During the study the accident rate was 11.9 %.
- In Group 3, the annual long-term NSI prevalence was between 13.1 % and 10.9 %. During the study it dropped to 3.6 %, which equalled five registered cases within 12 months.
- It should be noted that all five accidents to workers in Group 3 happened when they were using conventional instruments.

*Monitoring of the study/checking disposal containers*

Before the study and during the advice and training phase, 273 instruments disposed of by Group 3 were checked and 22 % were found to have been recapped.

During the study 4 586 instruments disposed of by Group 3 were examined: 89 % were safety instruments with correctly activated safety mechanisms and in 5 % of cases the safety mechanism was not activated. Of the instruments disposed, 6 % were of conventional design. A minimal number of needles had been recapped.

*Usability aspects*

Two additional polls among the workers in Group 3 yielded findings on the usability of the safety instruments. The first poll was done six months after the intervention study had commenced, and the second after 12 months. Eleven specific questions were about the usability of the safety needle, disposal issues and training on the new device, and two additional items were about the users' general impression of the safety instruments.

Generally, acceptance of the new needles grew with the time in use and users' experience in handling them. After 12 months the response to all specific questions, as well as the workers' general impressions, were more positive than in the first poll. Detailed findings were:

- workers who had been trained several times on the new devices were more positive than workers who had been trained only once;

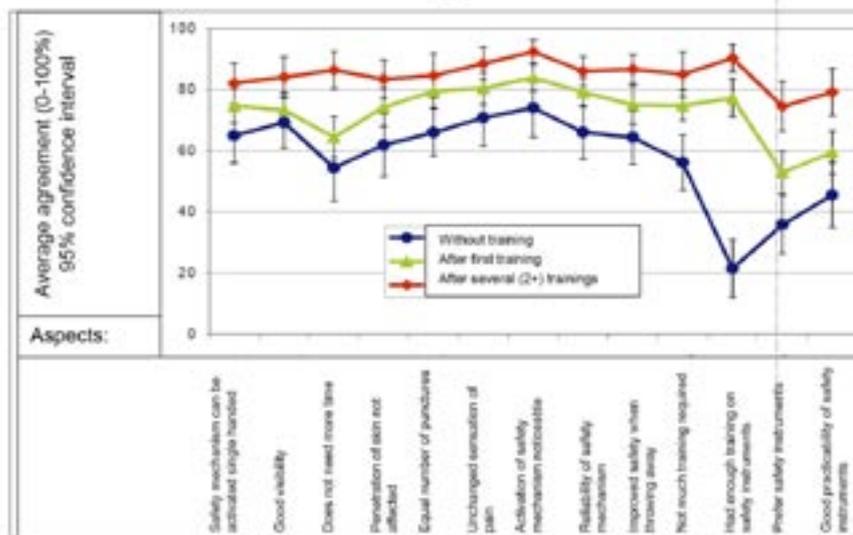
<sup>(16)</sup> In these data multiple accidents — more than one worker involved in a single accident — were not included so that the real number has to be estimated to be slightly higher. It can be seen that the general prevalence rates are lower than in the cited reports (Hasselhorn 1995; Beie 2000); the project team thought one possible explanation might be that the care personnel in the university hospital were generally well trained.

<sup>(17)</sup> The years 2000—02 were chosen because of the comparability of the workers who also participated in the study. Data from these years were defined to be pre-intervention findings.



- untrained workers were more likely than their trained colleagues to reject the safety instruments;
- workers accepted the new equipment more readily if they were aware of the personal advantages of reducing their risk of infection;
- the easier the safety mechanism was to activate (less training needed, one-handed rather than two-handed activation, as quick to use as possible) the greater was the acceptance of the new instrument and the general impression on the part of the user.

Table 10: Usability of new safety equipment



Evaluation of the results

The usability polls and the collected disposal samples show that, in general, the safety instruments were commonly used (94 %) by the workers and there was a growing acceptance of, and satisfaction with, the new equipment with better training and more on-the-job experience.

New safety equipment is less accepted by workers who have not been trained in its use. To enhance acceptance, re-training should be offered periodically. Furthermore the safety mechanism should be easy to activate and as quick to use as possible.

A comparison of the data from the questionnaires shows a drop in the number of NSIs before and during the study among all three groups. This can probably be attributed to short-term sensitising effects among all workers.

The comparison of intervention study data with long-term data reveals that the NSI prevalence of Groups 1 and 2 was comparable to or only very slightly better than long-term prevalence. The results of Group 2, which was given additional advice only, show in particular that sensitising alone is not sufficient to reduce the risk of NSI effectively.

In contrast to Groups 1 and 2, the findings among Group 3 show a statistically significant reduction of NSI below the long-term accident rates. It must be noted that all registered accidents to workers of Group 3 happened when they were working with conventional instruments.



In other words, during the study not a single accident with a safety instrument was registered. This underlines the efficacy of safety needles and good disposal practice in the prevention of NSIs.

### *Problems faced*

The project team did not face any major problems. The cooperation with the partner was excellent. With regard to the study design it was extremely helpful that the team could rely on long-term data from the University Hospital of Heidelberg.

In more general terms, it can be observed that hospitals and other health-care facilities do not invest in safety instruments: the management is wary of the higher costs, although their effectiveness in accident prevention has been proven. But the idea that safety instruments don't make financial sense simply isn't true: researchers at the University of Wuppertal have estimated that safety equipment causes additional costs of EUR 63 per worker a year while each needlestick accident costs around EUR 480 (Wittmann & Zylka-Menhorn, 2007).

### *Success factors*

The most effective way to reduce the NSI prevalence among health-care workers is to use several prevention methods at once. Technical improvement should go hand in hand with enhancing workers' knowledge and skills. That means:

- sensitising workers to the specific risk of working with sharp and infectious equipment;
- introducing safety equipment which is easy to use with safety mechanisms that are easy to activate;
- providing safety disposal containers to help eliminate danger from discarded needles;
- offering vocational training on the new equipment and periodically refreshing workers' knowledge.

Safety measures should be monitored by registering accidents in a central database. This will also mean that the workers know what to do and who to contact in the event of an accident. In this way the sustainability of accident prevention measures can be ensured and, in the case of an increase in accidents, new measures can be taken.

### *Transferability*

As a result of the project the State Health Office of Baden-Württemberg officially recommends the use of, and training of workers on, the safety equipment which was used in the study and which is approved for medical use in Germany.

The study itself was observed with great interest in the health-care sector and stimulated further hospitals to evaluate safety and accident registration in regard to NSIs at their facilities. The State Health Office of Baden-Württemberg carried out a follow-up project in 2008 in collaboration with the University Hospital of Heidelberg to verify the data. Results will be published soon.

The German TRBA 250 (Technical Rule on Biological Substances in the Health Care Sector, 2003, last modified 2008) declares the use of safety disposal containers for sharp instruments and needles to be obligatory. Furthermore, the use of safety instruments has become obligatory for workers (except for the self-employed) in emergency medical services, prison hospitals, in facilities where highly infectious



patients are treated, and for tasks that pose the risk of contact with body fluids in sufficient quantity to cause infections (for more information see LADR, 2008; BAuA, 2008; Wittmann & Zylka-Menhorn, 2007).

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# CRUSHED FINGERS — MODIFICATION OF A PROTECTIVE PLATE IN ORDER TO ELIMINATE THE RISK OF CRUSHED FINGERS

## 4.4.

### LUXEMBOURG

#### *Key points*

- Accident prevention in manual handling of a machine by the installation of a protective plate.
- EHS incident investigation system of Avery Luxembourg.

#### *Organisation*

Avery Dennison

#### *Introduction*

At Avery Dennison, the protective plate from one of the machines used for cutting paper rolls was displaced. The displacement of the protective plate created a dangerous situation for all workers using this machine. As required by Avery procedures, one of the operators reported the dangerous situation by means of the online reporting system.

#### *Background*

Avery Dennison has a procedure in place for the management of occupational accidents, first aid, incidents and dangerous situations. According to this procedure, workers are obliged to report all accidents, incidents, first aid, near misses and dangerous situations that arise in the factory to the responsible person in the section concerned (team leader, lead operator, or senior operator). All reported cases have to be documented in the EHS (environment, health and safety) system by the responsible person of the team from the department concerned. Under this system, the worker who first observed the situation has to identify the facts and explain the situation to the responsible person.

Within the framework of this policy, a worker at Avery followed the procedure by reporting the dangerous situation caused by the displacement of the protective plate from slit 13. Because of this displacement, the protective plate of the slit was too short which created a gap in which fingers of employees might get crushed while working with the machine.

#### *Aims and objectives*

By adjusting the protective plate, the EHS department and the employees wanted to contribute to a safer work environment. The employee who detected the dangerous situation carried out his responsibility within the framework of Avery Dennison's system for investigating dangerous situations.



## Scope of the project — what was done

### General approach and strategy

In 2000 Avery Luxembourg set up a registration system for the management of occupational accidents, first aid, incidents and dangerous situations. The idea is that when an accident or incident occurs or when a dangerous situation is noticed, the team leaders have to carry out an initial investigation (*première enquête*). The purpose of this investigation is to assess the gravity and extent of the risk and to come up with immediate and adequate preventive or corrective measures. The team leader from the department concerned has to contact the other team leaders (coating, finishing, maintenance, flow-cell) in order to carry out the initial investigation. The presence of the other team leaders is obligatory. Apart from taking immediate action, they can propose short- and medium-term actions in the EHS declaration. The team carrying out the inquiry has to decide whether operators can continue working or whether they have to be removed from the post.

After the initial investigation, the team leader from the department concerned has to register the matter using the EHS database in Lotus Notes. They have to fill in a declaration form which requires the following information:

1. Background information such as where and when the accident or incident happened: in which zone of which department? What day and time? Who was involved? Who witnessed the situation?
2. Information gathered at initial inquiry: who were the participants in this investigation? The facts and if possible pictures. Which types of risks are present and what are the probable causes? Which actions were taken immediately and which further actions do you propose? If the EHS team is not satisfied with the initial investigation they might perform a second investigation, for which the same information will be put in the template.
3. Actions resulting from the EHS investigation: who is responsible for which action? What is the deadline and what was the actual date on which the matter was resolved?

Once the form is filled in, it is sent to the staff and the responsible persons (manager, coordinator, team leaders) of the department concerned.

Communication is very important throughout the whole procedure. The team leader has to post a notice about the dangerous situation on the board reserved for the workstation concerned. The EHS department has to e-mail this notice to the departments which they believe to be involved. The team leaders of each department have to communicate the dangerous situations during the 'safety huddle' at the beginning of each shift.

Finally, the person responsible for safety analyses the EHS declaration no later than 24 hours after the declaration was registered in the EHS system. He can decide either:

- to archive the declaration if the measures taken have resolved the problem; or
- to put the declaration on hold if the proposed actions are satisfactory but aren't yet realised.

This instrument is very dynamic, meaning that each registration goes through different stages, namely 'new', 'running' and 'filed'. A new registration means that someone reported a recent case. A running registration means that additional actions have to be taken, proposed actions aren't taken yet, the EHS team hasn't approved



the first investigation yet, etc. A filed registration means that the EHS team is satisfied with the first or second investigation and that the proposed actions have been taken. However, it is possible to undo the ‘filed’ status when, for example, the measures that were taken don’t solve the problem.

*The ‘slitter 13’ project*

The worker in the finishing department in the zone of slitter 13 reported the dangerous situation to his team leader. The protective plate from slitter 13 was displaced. Because of this displacement, the protective plate of the slitter was too short when the intermediary wagon from the machine is turning over towards the trolley which transfers the slitted rolls to the bins. Because of this, a gap was created in which the fingers of employees might get crushed while working with the machine.



Figure 22: Slitter 13 before modification — risk of crushing fingers

The initial enquiry was carried out in collaboration with the team leaders from the other departments, in accordance with company policy. They decided to take immediate action by putting a poster on the intermediary wagon in order to notify the workers about the situation. The team leaders also suggested asking the maintenance team to modify the plate.

After the first inquiry was finished, the team leader from the Finishing Department registered the facts in the EHS system. Figure 23 shows a screen shot from the online declaration.

**AVERY DENNISON LUXEMBOURG**

**DECLARATION SITUATION DANGEREUSE**  
Statut: **Archivé**

Objet: **Finishing**      Zone de l'événement: **Slitter 13**

Nom du salarié impliqué:      Témoin accidenté: **François Schabus**

Date et heure des événements: **le 02/12/2017 à 16:30**

**François Schabus**

Participants: **Thierry Des, François Schabus et Laurent Wehmel**

Description des faits: **Quand le chariot intermédiaire du SRT est en position de basculement vers le chariot bin, la plaque de protection est trop courte.**

Pièces jointes (Photos): **Slitter 13 - 05\_03\_2017**      **Slitter 13 - 04\_03\_2017**

Type de risque: **Risque d'écrasement**

Catégorie opération de l'événement:

Actions immédiates prises: **affichage de la photo sur le chariot intermédiaire**

Autres actions proposées: **demande à la maintenance pour modifier la plaque de protection**

Actions suite à investigations EHS:

N°	Description des actions	État de la date de mise en œuvre	Statut	Date de réalisation
1	Notifier à plein le service	Terminé	OK	02/12/2017 à 16:30
2				02/12/2017 à 16:30
3				02/12/2017 à 16:30

Rapport d'investigation rédigé par: **Amosel, Luc/Des et F. Schabus**

Figure 23: Screen shot from the online reporting system



On the declaration form there is a table in which the team leader can fill in future actions. In this case the action is ‘modifying the protection plate’. The responsible person for this action is the coordinator of the maintenance department. The action was realised on 13 March 2007 (the dangerous situation was reported on 8 March). As one can see in the right top corner, the declaration is in ‘filed’ status.

### *Results and evaluation of the project*

The intention was to eliminate the risk of crushing fingers beneath the protective plate, which was achieved by the modification of the plate.

In this case only a small modification was needed, which might seem unimportant and not urgent to employees but, in Avery, employees are involved and have a responsibility in the detection and follow-up of dangerous situations. Because of that, employees will take each dangerous situation seriously and try to find a solution as soon as possible.

This action doesn't need a complicated and extensive assessment to discover whether it improved the working situation. The gap beneath the plate was removed by adjusting the plate. The risk of crushing fingers is eliminated.

### *Problems faced*

There were no problems during the action. The fact that the investigation system encourages employees to report dangerous situations themselves contributes to the safety awareness in the organisation. Employees who report an accident, incident or dangerous situation themselves are more motivated to support the actions because they are involved. A problem that occurs every so often is the insufficient completion of the forms but this is already happening less often than when the system was newly introduced.



*Figure 24: Slitter 13 after modification — risk of crushing fingers has been eliminated*

### *Success factors*

An operator spotted the dangerous situation. He took his responsibility and reported it immediately to his team leader. The safety awareness of this operator has led to the elimination of the risk of an occupational accident.

Thanks to the well-defined company policy concerning the management of dangerous situations and the structured procedure for the declaration of dangerous situations, this situation was quickly observed, reported, dealt with and filed. The procedure involves workers, which has a positive impact on their safety awareness.

All internal stakeholders are involved in the system: operators, team leaders, coordinators, managers, which makes communication much easier.



### ***Transferability of the project***

The investigation system used at Avery to report and follow-up accidents, first-aid, incidents and dangerous situations could be very useful for other organisations too.

This kind of investigation system enables all employees to be involved in creating a safer work environment. It is a dynamic instrument that can easily be included in existing health policy systems at other organisations.

This system can even be extended to ergonomic issues, hygienic issues, facility problems and all kinds of other problems. So it is not restricted to industries but can also be used in service organisations.

The case itself, the problem and the solution are very organisation-related.

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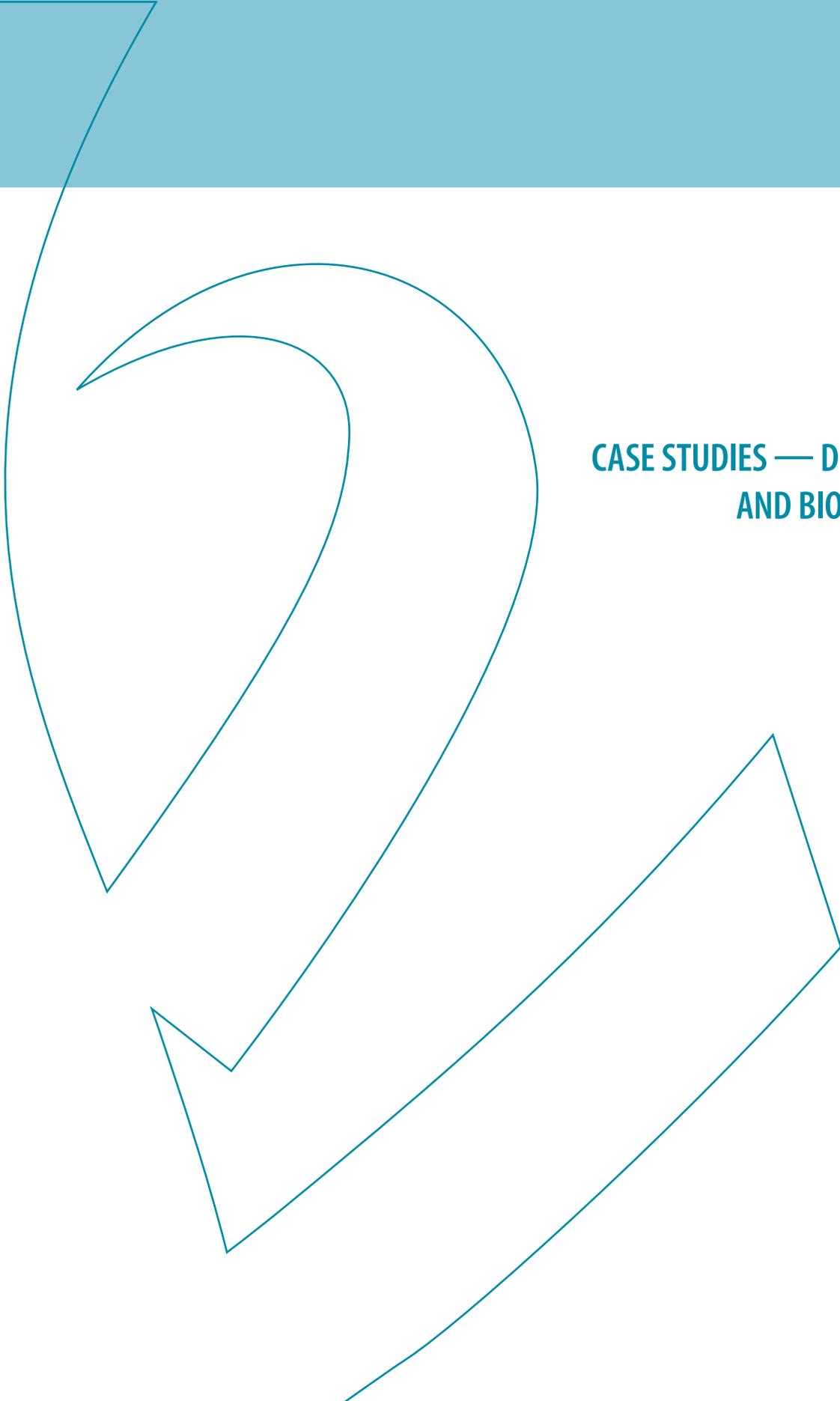
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# 5.

**CASE STUDIES — DUST, CHEMICAL  
AND BIOLOGICAL RISKS**



# 5.1. DENTAL LABORATORY — CAPTURING POLLUTANTS AT SOURCE

## FRANCE

### *Key points*

- Eliminating health risks for dental laboratory technicians by capturing pollutants at source.
- A good example of how a company was able to comply with occupational health and safety requirements, despite constraints like its location in an old building in the heart of the city centre.

### *Organisation*

Primary health insurance fund (CPAM) laboratory in Lyon — Regional health insurance fund (CRAM) Rhône-Alpes.

### *Introduction*

Certain dusts, silica in particular, can cause serious diseases in dental laboratory technicians. By equipping all its workstations with appropriate capture systems, the dental prosthesis laboratory of the Lyons Primary Health Insurance Fund (CPAM) now provides each member of its team with the best possible protection.

### *Background*

Dental laboratory technicians are exposed to numerous pollutants that could cause occupational diseases in the medium or long term, such as bronchitis, asthma, silicosis and other respiratory complaints.

Silicosis is a serious lung complaint caused by the inhalation of silica dusts. Silicosis and pulmonary fibrosis, diseases affecting the miners of old, can affect dental laboratory technicians. Exposure occurs chiefly during the preparation of moulds (refractory coatings), during the sanding of parts and when performing finishing operations (scraping).

Dusts of non-precious alloys (cobalt, chromium, nickel, etc.) and methyl methacrylate vapours (methacrylic resins) can be added to the silica. However, the CPAM laboratory has not used nickel-chromium alloys containing beryllium for some time. This metal, used even today in some laboratories for its high resistance to deformation, is extremely toxic. It is likely to cause allergic symptoms but also respiratory complaints. Each stage in the production of a dental prosthesis can entail the inhalation of a number of harmful substances.

At present, the most effective means of combating the risk of inhalation of noxious substances is to capture pollutants at source.

For this purpose the CPAM laboratory in Lyons has installed an exemplary ventilation system. All polluting workstations have been equipped with collecting systems connected to one of the two centrally controlled exhaust units via collection networks.



### *Aims and objectives*

The objective of the CPAM laboratory in Lyons was to eliminate the health risks for dental laboratory technicians by capturing the pollutants at source.

### *Scope of the project — what was done*

The dental prosthesis laboratory of the CPAM in Lyons has 34 laboratory technicians and the dental team has 29 dentists.

In 2001 the laboratory initiated a programme to equip polluting workstations with an effective system for capture at source.

The main difficulty faced was deciding which type of ventilation system to install. The choice was between a central exhaust ventilation system installed with the discharge outside the laboratory, or exhaust devices with a filter at each workstation but with discharge inside the laboratory.

The chemistry laboratory of CRAM Rhône-Alpes advised the dental laboratory to equip all polluting workstations with a collecting system connected to one of the two centrally controlled exhaust units via collection networks. The chemistry laboratory not only took part at the project design stage, but also during validation of the systems, based on measurement of the capture rates defined beforehand as result targets. Accordingly, each assembly and bench finishing station was equipped with a capture system incorporated in the anchor.

The scraping stations for 'skeleton' prostheses (prostheses with a metallic base), where the presence of cobalt increases the toxic risk, were placed in ventilated enclosures (scraping boxes).

Preparation of the coatings, which involves handling highly silicogenic products for short periods, is performed under exhaust ventilation, using a swivelling collector for ceramic work and by working under a fume cupboard (suction hood with a raisable screen) when handling dental prostheses.



*Figure 25: Preparation of coatings and de-moulding of cylinders now takes place under a suction hood to reduce dust emission*

© CRAM Rhône-Alpes

In the same way, the operation of filling bronze moulds with resin and compressing it, which causes the emission of noxious, flammable methyl methacrylate vapours, is now performed under a ventilated hood.

Some equipment, such as polishing and sanding machines, has been altered to allow it to be connected to the exhaust ventilation network. The equipment previously used had a filtration system incorporated in the polishing and sanding machines which filtered the dust and kept it in a bag, and then discharged the filtered air straight into



the laboratory. This system was subject to numerous leaks and there was a risk that the air discharged into the laboratory could still contain some dust.

The new filtration system comprises two units that remove dust by a wet path and then discharge the polluted air outside the building. The ventilation system also includes two units to allow fresh air to be introduced into the building. This air is warmed in winter by an electric heating unit located in the suspended ceiling in the stairwell, and cooled in summer by a refrigeration unit placed on a terrace.

The fresh air is distributed in each room by circular vents in ducts positioned in the suspended ceiling. Each ventilation unit is controlled by a programmable logic controller which constantly determines the exhaust ventilation delivery needs (operating start-up of one to five turbines) and adjusts the inflows of fresh air accordingly. This permits optimum exhaust ventilation operation without excessive energy expenditure.

### *Results and evaluation of the project*

When the CPAM in Lyons set up this system, it was considered very innovative to connect all the workstations to two centrally controlled collector networks leading into two exhaust ventilation units in a plant room, and with the air discharged outside the building after purification. This system therefore helps eliminate pollutants at source.

The whole system meets the requirements of the Labour Inspectorate, the occupational medicine department, the occupational safety and health (OSH) organisations, management and the personnel. The system was installed as part of a larger renovation of the laboratory and required a total investment of about EUR 300 000.

The new ventilation system has changed certain habits, but everyone in the firm is now convinced of the health benefits. The CPAM dental prosthesis laboratory in Lyons has also shown that it was possible to comply with occupational health and safety requirements, despite the constraints due to its location in an old building in the heart of the city centre. The dental prosthesis laboratory is today a benchmark for all the laboratories in the Rhône-Alpes region.

### *Problems faced*

The CPAM dental laboratory is located in an old building in the centre of Lyons, which complicated the task of installing the new exhaust ventilation system. For example, it was a challenge to find a room in this old building to install the exhaust ventilation units so as to protect the staff from the noise generated by the equipment.

Also, to be able to discharge air outside but not via the front of the building, a duct and a chimney running along the building were created to remove the treated air via the roof — no mean task considering that the laboratory is on the second floor of a seven storey building. Finally, to allow fresh air to enter, air intakes were created and two air production units were installed: one in a suspended ceiling and the other on the terrace.

There was also some difficulty in getting the laboratory staff to adapt to the new work methods required by the new exhaust ventilation system. For example, there was some reluctance on the part of staff to work in enclosed boxes.

On other finishing stations, the exhaust ventilation system incorporated in the anchor is fitted with a small cover allowing channelling of the exhaust ventilation. Initially, staff members preferred to remove the cover in some cases, which greatly reduces the quality of exhaust ventilation. However, these reservations disappeared over time, and all staff are now convinced of the value of all these improvements made to their working conditions.



**Success factors**

The success of this initiative is largely due to the commitment of the management of the CPAM laboratory. Indeed, management was a strong driving force in planning and implementing this system for exhaust ventilation of pollutants at source, and it has also subsequently equipped another smaller laboratory with the same system.

**Transferability of the project**

This action can be transferred to other laboratories taking into account all the constraints of each building and workplaces.

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## VACCINATION — PROGRAMME OF TBE VACCINATION BY AN ACCIDENT INSURANCE COMPANY

# 5.2.

### AUSTRIA

**Key points**

- Vaccination programme for farmers and forest workers as a preventive measure.
- Elimination of tick-borne encephalitis in these groups of workers through prevention.

**Organisation**

Allgemeine Unfallversicherungsanstalt in Österreich (AUVA) (General accident insurance company in Austria)

**Introduction**

Tick-borne encephalitis (TBE) is a very severe infection of the brain that is transmitted by ticks. TBE occurs in the warm forested parts of central and eastern Europe and is the most important arthropod-transmitted viral disease in Europe (WHO, 2007). Austria is one of the European countries most at risk. The TBE virus is found in nearly



all Austrian provinces. The main endemic areas are rural regions of Styria, Carinthia, Lower Austria and Upper Austria, as well as Salzburg, the Burgenland, and the suburban area of Vienna (Land Steiermark, 2008; Arge Gesundheitsvorsorge, 2005a).

In the pre-vaccination era Austria had the highest incidence of TBE in Europe: more than 700 cases were recorded annually (Kunz, 2001). The vaccine became available in 1976. The farmers' accident insurance company was particularly interested in this vaccine, because farmers and forest workers were a high risk group.



(Picture available free, from H. Hautumm, pixelio.de)

Figure 26: TBE is one of the many diseases caused by ticks

The vaccine was so successful that TBE virtually disappeared in these professional groups. Since then the AUVA has run such vaccination campaigns continuously.

### Background

TBE is a brain inflammation caused by a virus, usually transmitted by ticks that are infected with the virus. TBE is a severe infection and is fatal in 1 % to 5 % of cases (European type of TBE) (WHO, 2007). Between 35 % and 58 % of all patients develop long-lasting or permanent neuropsychiatric late damage (Stodulka, 2006).

There is no specific drug therapy for TBE, but it can be successfully prevented by vaccination (Unterweger, 2007), which has a protection rate of almost 100 % (AUVA, 2009).

Since 1980 Austria has had a universal annual national vaccination campaign (WHO, 2007). The current vaccination rate in Austria is 88 %, which is very high compared to other European countries (10 %). Since 1980 about 35 million people have been immunised and the number of infections has decreased from 700 cases to 84 cases in 2006 (Arge Gesundheitsvorsorge, 2005b).

### Aims and objectives

The aim of the vaccination campaign was to minimise and eventually eliminate the risk of tick-borne encephalitis.

### Scope of the project — what was done

The legal driver for the campaign is the General Social Insurance Act (ASVG), which requires preventative measures to be taken to protect workers. The vaccination campaign is run by the AUVA, which finances the vaccine (serum). The campaign costs between EUR 150 000 and EUR 200 000 which corresponds to 13 000 and 16 000 ampoules of serum.



Companies inform the AUVA about their workers at risk. The AUVA then commissions a pharmacy to provide the company with an appropriate amount of vaccine. AUVA also monitors the time intervals for the booster immunisation in order to maintain long-term protection. The companies concerned are responsible for providing their workers with the vaccine. The workers have to consult a physician to be vaccinated.



TBE (Picture available free, from J. Goetzke, pixelio.de)

Figure 27: Forest workers are at high risk of infection by TBE

Until 1995 all workers took part in the vaccination programme but since then only workers from high-risk groups in terms of the list for approved occupational diseases have been included.

### Results and evaluation of the project

The Austrian vaccination experience over more than 30 years has succeeded in reducing the number of TBE cases from more than 700 a year to less than 100 today. The mass vaccination rate is about 88 % of the population (Stodulka, 2006). It is obvious that the decrease in morbidity rate has gone hand in hand with an increase in vaccination rate.

Although climate changes enhance the risk of TBE, the infection rate has not increased in Austria. Compared to other European countries the infection rate in Austria is very low (see Table 11). No occupational infections with TBE were reported in 2002, 2004 and 2005. In 2001, 2003 and 2006 only one case of TBE infection per year was recognised.

Table 11: Increased number of TBE cases between 1993 and 2006 (Kunze, 2007)

Increase in number of TBE cases between 1993 and 2006							
Country	Mean number of cases between 1993 and 2002	2003	2004	2005	2006	Increase between 2005 and 2006 (%)	Increase between 1993–2002 and 2006 (%)
Austria	89	82	54	100	84	– 16	– 8
Czech Republic	566	606	500	642	10 017	58	80
Germany	105	270	274	431	535	24	109
Poland	197	393	262	174	308	77	56
Switzerland	82	116	131	207	258	24	212



### **Problems faced**

Companies sometimes do not have the resources to organise the vaccine distribution and monitor the intervals of primary immunisations and booster immunisation. The AUVA does, however, provide help for companies in order to assure correct vaccination and long-term immunity.

At present there is a shortage of TBE serum in Europe; this is also affecting the AUVA.

### **Success factors**

Keeping the population informed through factsheets, websites and news releases has proved to be an important factor in the success of the initiative.

### **Transferability of the project**

The long-term experiences with the vaccination programme in Austria and the very good results could serve as an example for other European countries.

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## NOCODUST — REDUCTION OF RISKS ARISING FROM EXPOSURE OF WORKERS TO HIGH DUST LEVELS IN COAL MINES

# 5.3.

### POLAND

#### Key points

- Reducing workers' exposure to high dust levels.
- Eliminating risks of coal dust explosion.
- Raising awareness of risks from exposure to dust.

#### Organisation

Centrum Mechanizacji Górnictwa (Mining Mechanisation Centre) KOMAG

#### Introduction

The problem of worker exposure to high dust levels is present in many industries, especially mining. It affects all underground workers and all coal and rock transportation systems above ground. The risk caused by dust has two elements. On one hand, the dust collects in the lungs, which causes pneumoconiosis. On the other hand, coal dust poses an explosive risk when combined with air. This action aimed to tackle both elements of the risk — to reduce lung diseases caused by dust and to eliminate risks of coal dust explosion.

#### Background

The project was conducted by KOMAG Mining Mechanisation Centre. KOMAG is involved in research and development activity leading to new, competitive technologies and technical solutions in mechanical systems and environmental engineering.



The project arose from close cooperation between users of dust control equipment in coal mines, manufacturers of old-type dust collecting units and designers from KOMAG. Experience gained by these three groups was shared and applied in the project.

### *Aims and objectives*

The main aims of the project were:

- to develop new dust-collecting units to reduce the exposure of workers to high dust levels and eliminate the risks of coal dust explosion;
- to increase awareness among coal mine workers of the risks of exposure to dust;
- to provide information to staff about proper exploitation of new dust collecting units at the roadhead;
- to improve the new dust collecting units using feedback from staff who work in roadheads, supervisors in coal mines and the manufacturers of dust collecting units.

### *Scope of the project — what was done*

The broad aim was to increase the workers' awareness of the risks of exposure to dust. This goal was achieved in two ways: first by designing new dust collecting units, and second by conducting an information campaign in coal mines.



Figure 28:  
The LDCU-630 Labyrinth Dust Collecting Unit



Figure 29:  
The DRU-400 Dust Removing Unit

The new dust collecting units were designed for maximum reliability and efficiency. All parts driven by electric engines were placed away from the flow duct. The path of polluted gases was made complex to use inertia forces instead of additional power from electric drives. Two new units were designed: the LDCU (Labyrinth Dust Collecting Unit) and DRU (Dust Removing Unit). They are proved to have a 99 % level of effectiveness. Both devices have been tested in KOMAG laboratories and certified by KOMAG for work in explosive atmospheres (underground).

At the start of the project, an information campaign was conducted in coal mines. Designers of dust collection units visited sites where these devices are installed and talked to the staff at the roadhead. Workers were able to explain to them any problems they had when using these devices. Training sessions and information meetings were also conducted at the KOMAG Centre. The new solutions were also presented at KOMAG meetings to which representatives from coal mines were invited.



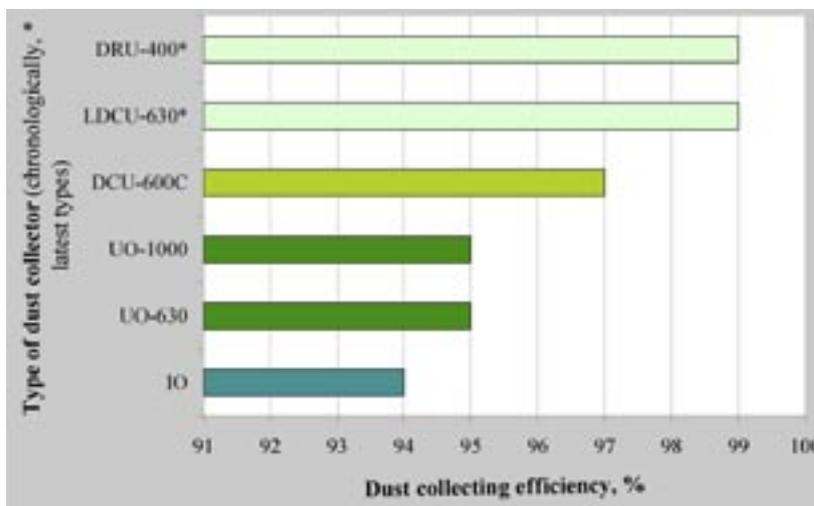
Involving mine workers, supervisors and the manufacturers of dust collecting units allowed a broad exchange of opinions and information and helped solve many practical problems.

Finances for the project came from two sources: statutory funds of KOMAG and NOT (Naczelna Organizacja Techniczna — Polish Federation of Engineering Associations). The project lasted from 2004 to 2006.

### Results and evaluation of the project

The main result of the project was the development of an improved dust collecting unit for coal mines. The new units are currently being installed to replace old dust collectors and are receiving very good feedback from users. The efficiency of the new units compared with other dust collectors is shown in Table 12.

**Table 12: The efficiency of the new dust collectors compared with other dust collectors**



The new units are very reliable because of their simplified structure, which prevents faults and damage from occurring. Older dust collecting units were powered by electric motors. Dust collection units in coal mines use water to remove dust from the air because it neutralises the explosive properties of coal dust. However, water tended to penetrate to the motors, causing damage and breakdown. Removing the motors therefore removed one of the most common causes of faults.

Another valuable result of the project was a greater awareness of the risks of dust exposure. Dust in coal mines poses two hazards: it may cause an explosion, and it can bring about lung disease. Dust collecting units help to eliminate those risks. The information campaign had two goals: to maintain a high operating efficiency of dust collecting units and to raise awareness of the influence of dust on human health. The awareness of dust's explosive properties was relatively high, while awareness of its negative effect on health was very low. The project helped both workers and supervisors to realise that the negative influence on human health does not end with coughing when the dust is inhaled but has more serious long-term effects.

The project had no negative side effects. The only difficulty was in raising sufficient funds to start production of the new dust collecting units.



### *Problems faced*

Lack of motivation in the main target group, especially among workers, was one of the most significant problems encountered. At the beginning of the project many of them said they believed there was nothing more to achieve in the field of dust fighting in coal mines. It was therefore very important to get across to the representatives of the project target group that levels of dust protection could in fact be improved. Therefore the project was not limited to the design of new dust collecting devices, but it also aimed to achieve higher awareness by launching a broad information campaign among relevant staff representatives at coal mines.

Another challenge was to design units that could be used in all mines. The local conditions in each coal mine are unique. Therefore it was very important to draw up a set of basic guidelines to ensure that units are usable whatever the conditions in a particular mine.

Another problem related to the failure on the part of workers operating those units to comply with technical recommendations in the operating manual. This failure meant that the units did not operate correctly. It is very important to assemble a unit in strict accordance with the manual. Any inconsistency may cause the unit to fail — the unit may expel polluted air without removing the dust, or water may leak from it. It was observed that workers who experienced those problems tended not to look for a solution (proper assembly and strict conformity to the manual) but just accepted the ‘fact’ that the unit was not working properly. The manuals for the new units therefore stressed that any observed fault must be corrected immediately.

### *Success factors*

The main success factors of the project were:

- Introduction of new dust collecting units (labyrinth dust collecting units — LDCU — and dust removing unit — DRU) that would ensure high reliability and high effectiveness. These units are now being installed in coal mines and the feedback from users is good.
- Increased awareness among mine workers of:
  - risks from exposure to dust;
  - the importance of proper assembly and operation of the new dust collecting units for safety.

The long-term results of the project will be monitored by studying the number of cases of lung disease among miners.

- The exchange of opinions and knowledge between all the parties involved in the project — designers, members of the certifying body, makers of the units, and workers and supervisors in coal mines. There is consensus that the new units are effectively reducing the risks from exposure to high levels of dust in mine roadheads.

### *Transferability of the project*

The results of the project may be quite easily transferred to other industries where workers are exposed to dust. Dust collecting units designed in the project are not confined to use in coal mines. They have a simple structure and are relatively cheap, so they should have widespread application in many workplaces with high levels of dust.



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## SNAPSHOT CASE: BRAKE CLEANING — BRAKE CLEANING BY HOT WATER WASHER

# 5.4.

### GERMANY

**Introduction**

The environmental services department of the city of Bielefeld wanted to cut down on hazardous substances in their maintenance and repair workshop. Of major concern was the use of highly volatile aerosols for brake cleaning. Not only were these aerosols released into the environment, causing air pollution, but they also posed a major health hazard.

**Background**

Bielefeld's environmental services department is responsible for refuse collection. The refuse lorries have to be inspected regularly and their brakes cleaned. This is traditionally done by using conventional (commercial) brake cleaners. These products contain mixtures of highly volatile aliphatic hydrocarbons and alcohols or acetones that pose a risk not only to the environment but also to the health and safety of the workers. Nonetheless, they are widely used because they clean the brakes very quickly and leave them dry as the solvents evaporate quickly.



To prevent health and safety risks for the workers from these hazardous substances, environmental services decided to try a new cleaning process using low-pressure hot water.

### *Aims and objectives*

To eliminate the risk of dangerous substances at the workplace and to improve the health and safety of the workers.

### *Scope of the project — what was done*

The garage manager of the environmental services department of the city of Bielefeld initiated the substitution of conventional brake cleaners. At first the department tried cleaning using a vacuum cleaner: brakes were covered in plastic and cleaned by compressed air, with the vacuum cleaner removing the dust. But this method still produced an unacceptable level of dust in the workshop, which affected the health and safety of the workers. So the garage manager looked for other alternatives.

Compared with other conventional methods, the hot water washer has the advantage of being chemical-free. Unlike the vacuum cleaner method, this method binds the dust, so that the workers are not exposed to dust at all.

The water is heated to 90 °C and the cleaned parts dry rapidly. Nonetheless, the jet does not cause scalding of skin, because it is sprayed in a very fine mist.

This method is an effective, economical, healthy and environmentally sound way of cleaning brakes because all dangerous dust can be bound safely and be removed quickly and cleanly.

Furthermore, the method is economical because it does away with the need to purchase cleaning agents.



Photo by ph-cleantec

Figure 30: The new hot water washer

### *Results and evaluation of the project*

The hot water washer was purchased in 2002. It has operated successfully since then and the department is very satisfied with its performance.

This best practice example is part of the CLEANTOOL database, a Europe-wide database for parts cleaning, metal surface cleaning, component cleaning and degreasing, based on real processes in numerous European companies.



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## NOWODUST — ELIMINATION OF RISKS ARISING FROM EXPOSURE TO CHEMICAL SUBSTANCES AND REDUCTION OF EXPOSURE TO WOOD DUST AND NOISE IN THE TIMBER INDUSTRY

# 5.5.

### POLAND

**Key points**

- Identifying and assessing hazardous factors present in workstations.
- Eliminating or reducing occupational exposure to chemical substances (including volatile organic compounds — VOCs), wood dust and noise.
- Selecting and applying new technological processes, equipment and materials that meet safety requirements.

**Organisation**

Barlinek S.A.



### *Introduction*

Barlinek S.A. is a long established company in the timber industry that currently employs about 1 400 people. Its main activity is the production of domestic and exotic wood flooring products.

As a result of the analysis of risks related to hazardous factors at its workstations, the company launched a programme to improve safety in 2000. This project targeted three harmful factors in particular:

- chemical substances emitted at the old varnishing line;
- wood dust emitted at the production line;
- noise emitted by the machinery.

Improvements carried out between 2000 and 2006 led to a decrease in exposure levels to wood dust and noise, and elimination of the exposure to chemical substances.

### *Background*

Between 1996 and 1998 the extent of occupational exposure to hazardous factors was assessed at all workstations at Barlinek S.A. The investigation revealed that the main harmful factors present at the workstations were chemical substances, wood dust and noise. In 1999 the management of the company, in consultation with national labour inspectors and OSH specialists as well as representatives from the company's various departments, decided to target these harmful factors with the aim of providing safe and healthy working conditions in accordance with the requirements of Polish legislation.

The elimination or reduction of risk at source was also considered to be a very important task for at least two reasons. Firstly, the exposure to chemical substances, wood dust and noise is closely associated with a variety of adverse health effects including cancer, dermatitis, allergic respiratory effects, mucosal and non-allergic respiratory effects and occupational hearing loss. Secondly, many woodworking processes cause explosion hazards.

The results of the investigation are presented below.

#### *Chemical substances*

The investigation carried out from 1996 to 1998 indicated that harmful chemical substances emitted at the old varnishing line were volatile organic compounds (VOCs), such as acetone, toluene, n-butyl acetate, xylene, ethyl acetate, methyl ethyl ketone, and benzene. Some of these substances were recognised as carcinogenic. Due to the toxicology effects, the total exposure indicator was calculated for all these chemical substances.

In 1996, an investigation of the emission of VOCs was carried out over eight working hours at the three main workstations located at the old varnishing line. All of the above hazardous substances were detected. Additionally, the results showed that the level of ethyl acetate was higher than for other chemical substances. Although the threshold limit value for each of these hazardous substances was not exceeded, the calculated total exposure indicator was higher than the threshold limit value required by law.

In order to protect employees from hazardous chemical substances, in 1997 a rotation system was introduced on each shift. Investigations carried out one month



later and one year later (in 1998) established that the applied solution had been effective because the legal limits were not being exceeded. However, all of the above mentioned volatile organic compounds (VOCs) were still detected in significant quantities.

#### *Wood dust*

A variety of activities at Barlinek S.A. generate wood dust including sawing, sanding, milling, planing, routing, etc. These activities occur from the tree felling stage to final manufacturing processes.

A study of wood dust exposure conducted at Barlinek S.A. indicated that employees are exposed to airborne wood dust of different particle sizes, concentrations and compositions. The size of the dust particles, the amount of dust and the exposure of staff working in these areas depend on a number of factors including the equipment being used, the state and type of timber, the general and local exhaust ventilation and the extraction system and, finally, any personal protective equipment that may be used by employees.

By 2000 some solutions had been applied in order to reduce the exposure to wood dust, e.g. mechanical separation of the technical processes and the shavings and dust extraction systems, but even so, the indoor air quality was not good enough to conclude that these solutions fulfilled their protection functions in a satisfactory way. Unfortunately, the exposure level increased significantly in some areas of the factory. The sawing, sanding and milling were found to be the main processes that gave rise to high wood dust exposure levels.

#### *Noise*

At Barlinek S.A. employees were exposed to high level of noise generated from equipment and tools throughout the entire production process (e.g. from panel saw, circular saws, planer with saw blades).

By 2000 checks had been conducted to assess occupational noise exposure and to indicate noise levels emitted from specific jobs within the company. Wood flooring operations were exposed to higher noise levels than other operations. Dangerously high levels of noise were produced by tasks including sawing, planing, sorting of finished products and varnishing. The study conducted in 1996 found that noise exposure levels in these tasks were above 85 dB(A), i.e. the noise exposure was higher than admissible by Polish law. To conclude, these results showed that workers were exposed to noise levels that put them at considerable risk of hearing loss.

### ***Aims and objectives***

The main targets of the project were to:

- eliminate or reduce the main hazardous factors at the workstations (chemical substances, wood dust and noise) in order to protect employees against them;
- apply materials, components and technological processes that meet safety requirements, e.g. not creating explosion hazards;
- decrease the amount of materials and components used in manufacturing processes and reduce the amount of timber waste (pro-ecological investments).

The actions were also taken to improve the company's competitiveness and position in the timber market.



### *Scope of the project — what was done*

Before action could be taken to eliminate or minimise the risks described above, a survey was done of new and existing technologies, machines and equipment.

This survey included:

- analysis of the parameters of machines currently in use at the factory;
- an examination of chemical substances, wood dust and noise levels emitted from the specific machinery and processes carried out by the company;
- consultations with trained and professional advisers to gather information about appropriate solutions for machine constructions;
- tests on different solutions for machine constructions, e.g. machines with enclosure construction, quieter machine tools.

#### *Elimination of occupational risk arising from exposure to chemicals*

One of the main objectives of the project was to eliminate the occupational risk arising from the exposure to chemical substances emitted from the old varnishing line. The new Barlinek's varnishing house was designed to be fully automated. The new line is based on a lacquer hardened by UV technology, i.e. a water-based photohardened lacquer, which does not contain organic solvents and is mainly composed of solid components (99 %). Furthermore, there is no need to pour additional substances (e.g. solvents) into the lacquer during the varnishing process.

The modernisation of the old varnishing house permitted the elimination of the occupational risk arising from the exposure to chemical substances as well as increasing the quality of products and widening the application features of products.

#### *Reduction of occupational risk arising from exposure to wood dust*

In order to protect the employees against high levels of wood dust and to avoid a risk of explosion:

- the dust removal systems were changed, i.e. the general and the local exhaust ventilation as well as the extraction system used to remove sawdust and wood dust at source were redesigned and installed;
- machine tools that were likely to produce a lot of dust were comprehensively replaced by new ones that meet safety requirements, i.e. located inside an enclosure construction that assures adequate protection against wood dust and has vacuum or exhaust systems that capture wood dust at source;
- a modern high-efficiency filter system was purchased and installed to separate sawdust and wood dust suspended in the air;
- fully automated and computer-controlled manufacturing processes were introduced;
- an explosion hazard detecting system and automated fire fighting system were purchased and installed.

Since the introduction of these measures, the manufacturing processes have been nearly 'dust-free'.

#### *Reduction of occupational risk arising from exposure to noise*

The main actions of the programme of noise protection were:

- buying and installing of new machinery that emitted a lower level of noise (e.g. double-blade panel saw, circular saws and planer with saw blades);



- exchanging the existing compressor rooms for quieter ones;
- erection of protective baffle boards and noise suppressors which reduce the noise generated by the manufacturing equipment;
- using acoustic enclosures to separate machines and even all manufacturing processes;
- automating some workstations to protect employees against high levels of noise.

Although this project is a continuous challenge for the company, the solutions introduced have significantly reduced the level of noise emitted by machinery operated at Barlinek S.A.

Resources for the project came from investment credits and the company's budget.

### Results and evaluation of the project

In order to check if the company expectations were met, several investigations of exposure and assessment of occupational risks at Barlinek S.A. were carried out by the Sanitary and Epidemiological Station in Gorzów Wielkopolski or by National Institute of Hygiene in Warsaw as well as the Wood Technology Institute in Poznań and were documented in accordance with the national and international standards and Polish occupational safety and health law. In conformity with Polish law, the process was implemented at all positions of the company.

The emission rates of volatile organic compounds (VOCs) from varnishing processes were determined using procedures based on the adsorption of the tested compounds and separation of the adsorbed compounds using a gas chromatography method with use of thermal desorption and mass spectrometer identification. Before the implementation of the new varnishing house, the concentration of VOCs was very high at all workstations. The following substances were detected: acetone, methyl ethyl ketone, ethyl acetate, toluene, n-butyl acetate, and xylene. After the implementation of the new varnishing house the investigation identified only a trace amount of n-butyl acetate. The exposure indicator was significantly lower than 0.01 of threshold limit value. The results confirmed that the risk arising from the exposure to VOCs had been eliminated (see Figure 31). Therefore, the applied solution is a relevant instrument for the elimination of industrial emission of VOCs. The rotation system introduced several years ago was changed and instead of three people only one person on each shift operates the varnishing process.

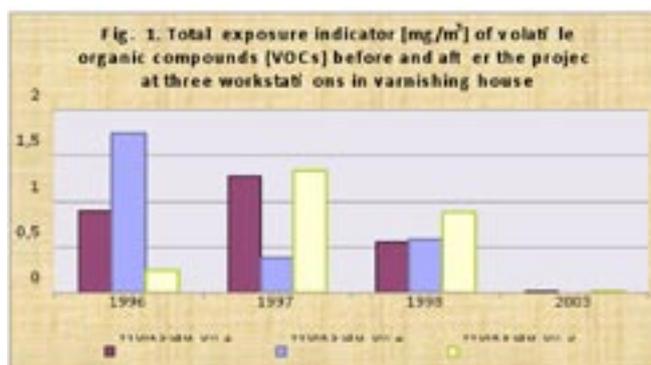


Figure 31: Action taken to reduce exposure to VOCs was so successful that the risk was virtually eliminated



Actions taken to reduce the exposure to wood dust at source as well as to avoid a risk explosion were definitely successful. They reduced exposure to wood dust to the lowest level (see Figure 32).

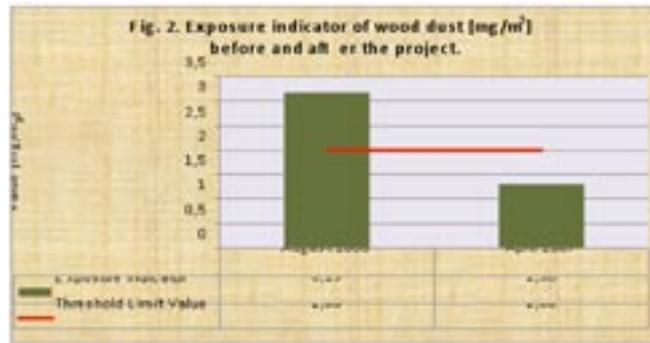


Figure 32: Actions taken to reduce wood dust at source were very successful

Regarding the level of noise, in 2006 the exposure level was 82.1 dB(A) and was lower than the threshold limit value (according to Polish regulations) — 85 dB(A) (see Figure 33). Nevertheless, the noise reduction project is still being carried out in the hope of reducing this level even further.

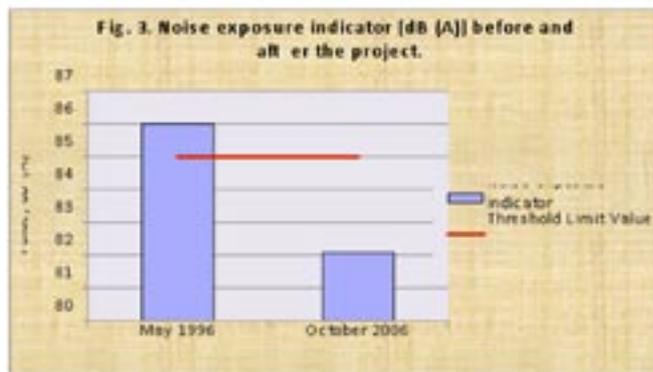


Figure 33: Noise exposure indicator before and after the project

As a result of the project the number of exposed employees decreased steadily and the working conditions at the company were improved for as many as 540 employees. Furthermore, the amount of materials and components used in manufacturing processes has decreased. This in turn translates into a reduction of expenditure on purchasing and manufacturing.

The example of Barlinek S.A. shows that health and safety initiatives should not only be seen as a legal obligation for a company but also as an essential element of the long-term development strategy.



Figure 34: Some noisy machine tools are now in acoustic enclosures



Figure 35: Some machine tools that produce a lot of dust are now enclosed in special chambers



### *Problems faced*

The main problem was in selecting appropriate producers that provided high-quality materials, machines, and equipment. Almost every producer offered a huge range of desired goods and it was very difficult to choose between them. This selection process was also time-consuming. Before the most reliable producer could be selected, Barlinek S.A had to carry out several tests on the relevant materials or equipment, or else a visit had to be paid to the company concerned in order to check how they run their business. This problem occurred at every stage of the process.

To win support from the employees for the new technical solutions and to familiarise them with their use, training courses were held between 2000 and 2006. These included a course to raise employee awareness of the modified processes, machines and equipment and of occupational safety issues. Other courses aimed to change employees' routine behaviour, related, in particular, to the manual use of machinery. The employees were also trained in the correct use and maintenance of the machinery and equipment.

### *Success factors*

The main success factors of the project were:

- elimination of the exposure to volatile organic compounds (VOCs) at source,
- reduction of the exposure to wood dust at source,
- reduction of the risk of explosion,
- reduction of the level of noise emitted by the machinery,
- increase in the quality of products,
- improving the products' features,
- creation of the company's international image,
- improving the efficiency and productivity of the company.

### *Transferability of the project*

Most of the investments, e.g. the fully automated varnishing line, the wood dust removal systems and the machinery emitting lower level of noise, could be used successfully by other companies in the timber sector.

### *Contact information*

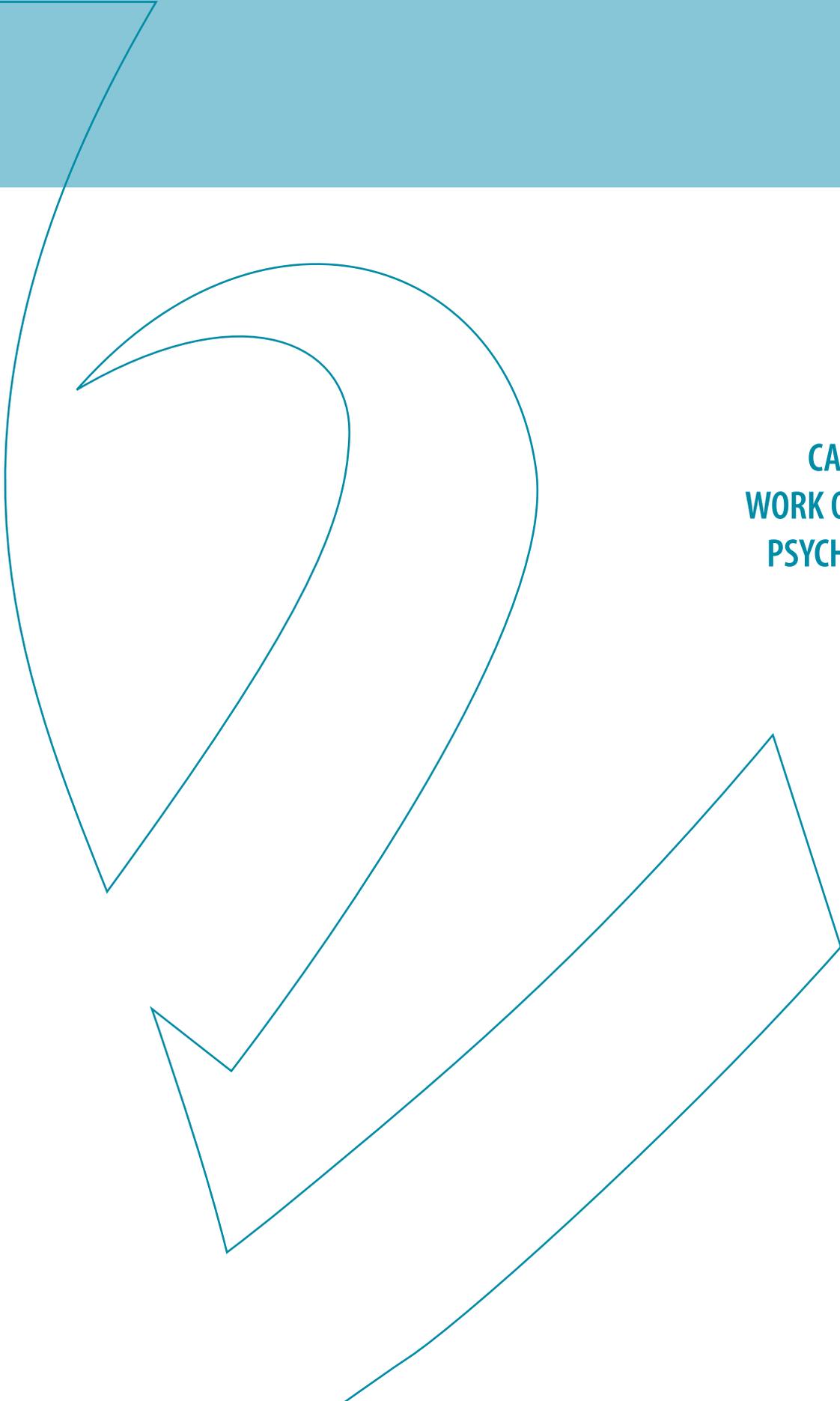
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# 6.

## CASE STUDIES — WORK ORGANISATION, PSYCHOSOCIAL LOAD



# 6.1. HOLISTIC RA — HOLISTIC RISK ASSESSMENT

## GERMANY

### Key points

- Risk assessment of physical and psychosocial risks.
- Reducing psychological risks.
- Assessment of both office and factory workstations.

### Organisation

SICK AG

### Introduction

SICK AG is a company that specialises in manufacturing sensor technology for industrial applications. The company and its subsidiaries employ 5 300 people worldwide and are represented in 40 countries. Its headquarters and main production facilities are in Waldkirch (Germany). Since 1998 risk assessments of office and production workplaces have been carried out at the headquarters but the approach taken is no longer considered to be adequate. Among other things, it did not provide a comprehensive assessment of mental strain at work. Consequently the management decided to carry out a so-called ‘holistic risk assessment’ based on the new in-house health promotion policy.

This policy focuses on integrated occupational safety and health management and in-house health promotion, based on the principles of cooperative management culture and participation of the workers and their representatives. The company believes that reduction of risks at work should go hand in hand with promoting the welfare of the workers. This is why it signed the Luxemburg Declaration on Workplace Health Promotion in 2007 <sup>(18)</sup>.

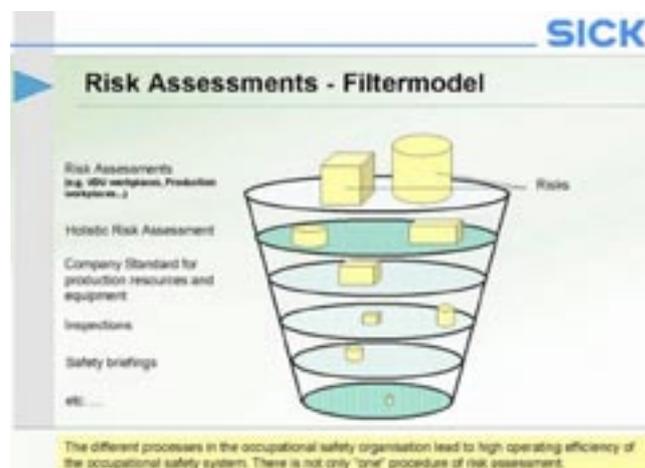


Figure 36: Filter model of SICK OSH management

<sup>(18)</sup> For more information: [www.enwhp.org/fileadmin/downloads/luxembourg\\_declaration.pdf](http://www.enwhp.org/fileadmin/downloads/luxembourg_declaration.pdf)



With regard to risk assessment, this new approach was designed to include the thorough assessment of both physical and mental strain at work. It was intended to be carried out by and include all stakeholders in the company, including the management, workers, and workers' committee. It was guided and evaluated by experts from the University of Freiburg <sup>(19)</sup>.

In 2005 the first holistic risk assessments were carried out as pilots. The project team decided to cover both office and production workstations. Special attention was given to risk factors that could lead to stress and to accidents at the workplace, such as time pressure, noise, interruptions, permanent alertness, as well as on general circumstances such as work-life balance, work-time allocation, physical inactivity and fatigue. Initial evaluations were done in 2006, followed by a second pilot in 2006/2007, and new holistic risk assessments were planned for 2008. After that the project will be transferred into an ongoing process covering the whole enterprise.

### **Background**

With the implementation of the Law on Occupational Safety and Health (*Arbeitsschutzgesetz*), coming into force in 1996 and transposing the Framework Directive 89/391/EEC, it became obligatory for all companies to carry out workplace risk assessments. SICK AG fulfilled its legal obligation by carrying out risk assessments of production and office workstations on its premises. Risk assessments were carried out by means of inspections, with the help of checklists. Results were documented with the help of software. The focus was on assessing physical strain and workplace ergonomics. Common hazards that could be identified were dangerous substances (toxic gases), repetitive strains and monotonous work.

Changing working conditions meant that these risk assessments were no longer adequate. The stress of greater competition, the need for more flexibility, just-in-time production, and constantly changing workplaces are all placing mental strain on workers in manufacturing industries. Therefore it was decided to strengthen the assessment of psychosocial risks and to shift from a mainly physical risk assessment towards a holistic approach.

### **Aims and objectives**

In 2005 SICK AG began to carry out a pilot project of holistic risk assessment. Three areas in production and in administration were selected to participate in the assessment of psychosocial risks: a production line, a research and development department and the order processing department. Scientific partners were the Department for Work and Organisational Psychology of the University of Freiburg, bringing in expertise in assessing mental strain with the help of questionnaires.

The aim of the project was to identify mental strains at work, without neglecting the physical workload and accident prevention aspects and to come up with adequate measures to eliminate or reduce existing risks. The experiences gathered in the pilot project would later be used in ongoing risk assessment processes throughout the company.

### **Scope of the project — what was done**

During the first pilot the workstations of 183 workers were studied. Typical workstations in the participating departments (production line, research and development/R&D, order processing) are:

- production: machine operating, pick and place, quality control;
- R&D: application development, chip development, project management;
- order processing: accounting control, financial accounting.

<sup>(19)</sup> Since 2007 the project has been guided by the University of Applied Sciences of North-Western Switzerland.



The project itself consisted of various work packages.

1. Analyses of existing documentation, such as enquiries among workers and organisational charts and interviews with management representatives. The University of Freiburg team wanted to gain an overview of workflows, work organisation and job descriptions.
2. The analysis of the working conditions was done in two steps, beginning with analyses of individual experience of workloads and resources (subjective experience of working conditions) and afterwards with task analyses (objective data on working conditions). For individual experience, workers were asked to fill in questionnaires on mental workload and resources. The questionnaire was anonymous. It was accompanied by a log on working conditions that each worker was encouraged to fill in daily, recording both positive and negative experiences at work. The aim was to determine the typical working conditions that can lead to elevated mental strain (stressors) and resources.
3. The university team presented the results of the analyses at a workshop. They were discussed and evaluated in dialogue with the workers, and measures for improvement suggested.
4. The measures were implemented under the guidance of the management, assisted by volunteers from the departments who took care of practical implementation and supervision of the measures.
5. The measures were evaluated six months after implementation in a feedback workshop and one year after implementation by questionnaire (see below). Frequent meetings were also held between the risk assessment steering committee, management representatives and the worker volunteers.



Figure 37: Holistic RA steps and milestones

The risks identified included ‘permanent interruptions, high noise level, permanent alertness’: incoming e-mails, incoming orders per mail and telephone, incoming rush orders, questions from colleagues and info centre, parallel tasks, personnel requisitions, offices used as material stock, etc. All these factors led to continuous interruptions in work flow. Printers, copy machines, telephone calls and discussions of office colleagues, etc. caused permanent noise in the offices. Symptoms were tiredness, fatigue, general discontent, unfriendliness, aggression, lack of concentration, feeling of pressure at work, and decline in performance.



A workshop was held to discuss possible measures for improvement, especially with regard to how easy they would be to implement:

**Table 13: Workshop results**

Complex	Reasons	Measure	Comment
interruptions/noise/ alertness	Open-plan offices	New office layout, reduce number of workers per office to three	Effectiveness high, implementation easy
	Material stock in office	Separate stock rooms	Effectiveness high, implementation easy
	Noise caused by telephone calls	Lower voice, thoughtfulness	Effectiveness high, implementation easy
	Multiple tasks	More personnel resources, team assistants	Effectiveness high, implementation easy
	Freelancers and trainees are unsure about equipment	Improve information on the intranet (user manuals)	Effectiveness high, implementation easy
	Interruptions in workflow because colleague is unavailable	Promoting the use of existing message techniques (answering machine, messenger)	Effectiveness high, implementation easy
	Freelancers and trainees are unsure about processes	Optimising processes, better information management on intranet	Effectiveness medium, implementation medium
	Multiple tasks	Better share of work (project work and daily routine), optimising processes	Effectiveness medium, implementation medium
	Office equipment causing high noise emissions	New office equipment with low noise emissions	Effectiveness high, implementation more difficult
	Interruptions by phone calls	Defining office hours for responding to phone calls	Effectiveness depends on workplace, implementation more difficult
...	...	...	...

Finally the measures were implemented in order of priority. Measures of high efficiency which were considered to be easy to implement were of highest priority.

At this stage of the project, the findings of the risk assessment on physical strain and ergonomics which had been carried out beforehand could also be taken into account. A good example is the new design of office workplaces: by changing the office layout and reducing the number of workstations, a number of ergonomic deficiencies could be eliminated at the same time. For example:

- changing office geometry and positions of desks; placing them at 90 degree angles to windows or walls;
- mounting new multiple socket outlets to avoid trip wires;
- mounting visors and glare shields to prevent glare on computer monitors;
- changing monitor positions (height and angle);
- buying new office equipment, e.g. desk pads and desk lights.



### *Problems faced*

Talking about mental strain at work and particularly stress seems to be a taboo for both workers and management. People don't want to give the impression that they cannot cope with stress at work or that they are not able to work under pressure. Therefore it was very important to overcome prejudices by talking frankly about fears and common misunderstandings. Risk assessment of psychosocial risks at work is not about assessing personalities but about assessing external stressors in the work environment and work organisation and finding ways of getting rid of them.

### *Success factors*

The project was carried out with full backing of the management. The workers of the assessed areas were included and informed from the very beginning. This helped create a trustful atmosphere in the company and to enhance communication and understanding between workers and management, especially in respect of problems at work and different points of view about them.

With the help of the university experts and a variety of instruments, risk assessment could be carried out taking into account objective and subjective, qualitative and quantitative data. Furthermore the project could be tailored to the needs of the different departments included. This was particularly helpful not only for the results of the first pilot, but also for follow-up projects and for installing holistic risk assessment permanently.

### *Results and evaluation of the project*

The evaluation was done in two steps. Six months after implementing the initial measures all workers and management representatives were invited to attend a feedback workshop. All participants reported on their experiences, i.e. whether the measures had been carried out properly and if any further problems were encountered.

After one year (October 2007) the scientific staff of the University of Freiburg checked on the effectiveness of the measures by administering a questionnaire to all workers. They found that the following risks had been reduced substantially:

- environment: 46 % of the workers involved considered the situation after the intervention to be better than before, no one considered it to be worse;
- noise: 50 % said that noise at work had been reduced, only 11 % disagreed with this;
- narrow offices: 60 % stated that the new designed offices are more spacious while 11 % considered their workplace to be narrower than before.

The results also showed workers' satisfaction as far as the implemented measures were concerned.

- 50 % considered the overall situation at their workplace had (significantly) improved by the risk assessment process. Nobody considered it to be worse.
- 50 % considered their personal well-being had (significantly) improved. Only 11 % considered it to be worse.
- 78 % considered the measures regarding the collaboration with colleagues to be helpful.
- 33 % considered that the quality of work and the results had improved while 6 % considered that it had deteriorated.



With regard to the overall project:

- 72 % agreed that it had been worthwhile;
- 67 % felt that they were well informed and involved in the project;
- 33 % felt that they had learned about strains at work and what they could do to combat them.

### *Transferability of the project*

SICK AG used the experiences from the first pilot for further improvements. Meanwhile the holistic risk assessment has been expanded to other areas. By 2009 the SICK AG management expects the pilot phase to be finished and the holistic risk assessment will be incorporated permanently into management processes.

Experiences so far show that holistic risk assessment can be carried out both in offices and production facilities. It is suitable for both workers and management representatives. But it must be adapted to the particular needs and circumstances of the organisation in order to get the best results possible.

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## 6.2. ROTOWORK — JOB ROTATION OF CLEANING TASKS IN A MEDICAL LABORATORY

### GERMANY

#### *Key points*

- Reduction of high workload and absenteeism.
- Integrated project from risk assessment to intervention and evaluation.
- Work organisation approach.

#### *Organisation*

Hygiene Institute of the Free Hanseatic City of Hamburg

#### *Introduction*

The City of Hamburg Hygiene Institute was the major institute responsible for protecting the population against infection and infection diseases during the period of this action. It had 250 employees and around 690 000 contacts with customers in the form of examinations, personal advice and vaccinations per year. This required hospital-like equipment and strict disinfection rules. The tasks required three groups of cleaners: cleaners for the laboratory equipment, cleaners for the employees' clothes and those responsible for room cleaning. The cleaners suffered from ailments common among cleaning personnel: MSD and skin irritations, combined with stress, low social recognition and low wages. All in all this led to a high rate of absenteeism. The employer started a project in collaboration with scientists to change the basic patterns of work organisation.

#### *Background*

The cleaning team consisted of 15 people, all female. The youngest woman was 41, and the average age was 53 years. The employer was interested in reducing absenteeism and job turnover on this team.

#### *Aims and objectives*

The aim of the action was to reduce absenteeism as far as possible and to organise the work in such a way that workers over 50 or 55 could remain in the job.

#### *Scope of the project — what was done*

The action covered all aspects of a full risk assessment and consequent comprehensive risk reduction measures.

#### **Analysis**

The project started with a risk assessment in the form of an expert assessment followed by a survey about personal strains and a medical examination. The results were summarised according to the Finnish work ability index.

The questionnaire included more than 40 questions, including an individual assessment of the worker's personal health situation.



The survey gave hints on major subjective feelings about the following aspects of the workload:

- unfavourable working hours
- awkward or extreme postures, heavy lifting
- monotonous work
- speed of work
- low cooperation and support
- relations with management
- work environment in general.

In general, most of the answers showed a relatively high degree of satisfaction. More than 70 % of the cleaners were happy with the job the supervisors did, believed the work environment was good and did not suffer from lack of recognition. The specialist assessment identified that one negative aspect of the work was equipment that required unnecessary heavy lifting or awkward postures.

As regards medical evaluation, all cleaners showed functional problems of the musculoskeletal system and skin irritations. Using the Finnish work ability index the average figure was 42 points. This is a value between low and medium work ability (28 to 43 is medium work ability).

### **Intervention**

The employer collaborated with the scientists to come up with interventions to reduce the risks. These interventions covered the areas of ergonomics and design and work organisation (including training).

#### *Ergonomics, design and personal protection*

The equipment was designed to reduce unnecessary strain and awkward postures. In many single aspects, improvements and effective risk reduction could be achieved. Training was offered to the workers to help them reduce the strain on the body and to avoid awkward postures and overload.

The project group implemented a number of improvements:

- the equipment was made more adjustable to lighten the load;
- containers for glass or for transporting clothes were redesigned or support devices were installed to aid lifting;
- different 'ergonomic' cleaning equipment was tested and partly introduced;
- a plan for skin protection was developed.

### **Work organisation**

The main idea of the project group was to alternate work between institutional cleaning and cleaning in the laboratory. The idea was to relieve the monotony of the work. Other more radical options were discussed but not implemented due to labour relations difficulties and possible reduction in wages.



### **Cleaning work in the laboratory consists of:**

- supervision of all glass equipment
- disposal of special waste
- cleaning of refrigerators
- handling of dangerous substances
- supply of certain equipment (new bottles and tubes)
- quality assurance
- documentation of the work done.

### **Training**

The cleaning staff were given training to work in the laboratory. This phase, including on-the-job training, lasted six months.

Training programme:

Week 1: Introduction to special cleaning work in the laboratory

Weeks 2 to 4: Introduction to the legal handling of dangerous substances including waste handling, handling of samples

After four weeks:

- introduction to quality assurance
- introduction to less frequent special tasks
- documentation of work in a laboratory
- maintaining the equipment service diaries.

### ***Results and evaluation of the project***

After six months the scientists of the project group developed another survey to evaluate the results. Most of the workers stated that they were very content, and the researchers concluded that the basic precondition for success was the willingness of the parties concerned to adapt to new tasks. A long-term evaluation showed that the institute is still using this system, although it has since been merged with a larger institute.

### ***Problems faced***

Job enrichment is not encouraged by the wage system. Higher wages are paid for late and early work whilst the qualified cleaning work in the laboratory is done during the daytime. Job rotation is also not supported by the inflexible wage system in the public sector, which makes it very difficult to calculate wages for a person performing very different jobs.

### ***Success factors***

The project benefited from public support by a scientific project and the stable environment of the public sector. Most of the relevant parties showed interest and motivation and there was a high level of involvement on the part of workers. The complex cleaning tasks require motivated and qualified personnel. Outsourcing of cleaning tasks to an external service company had never been an option, as it would be in many other establishments.



***Transferability of the project***

The approach has been used in other projects, such as cleaning in a hospital. The large Austrian service company DUSSMANN used the results of the project to improve the working conditions of its staff.

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## STRESS IN HOSPITALS — ASSESSMENT OF PSYCHOSOCIAL AND PHYSICAL RISKS

# 6.3.

### GERMANY

***KEY POINTS***

- Methods of assessing psychosocial risks at work.
- Evaluation of work organisation.
- Individual health promotion measures.

***Organisation***

Havelland Hospitals (Havellandkliniken) GmbH (in cooperation with University of Potsdam, Institute of Psychology (Universität Potsdam, Institut für Psychologie, Lehrstuhl für Arbeits- Organisations- und Betriebspsychologie) and INQA — Initiative New Quality of Work).

***Introduction***

The Havelland Hospital Nauen is a new hospital in Brandenburg that was founded after German reunification and inaugurated in 1998. With its 470 employees and apprentices it is one of the most important employers and apprenticeship institutions in the Havelland district. Together with the Paracelsus Hospital Rathenow, it forms the Havelland Hospitals Group. Rathenow employs a further 290 workers.

Havelland Hospitals focuses on health promotion not only with respect to the patients in the 17 specialised clinics in both facilities, but also when it comes to the workers. Havelland is a member of the DGNfK-Network (WHO Network Health Promoting Hospitals).



Most hospital workers are health-care staff (nurses, carers, midwives, etc.). Their work involves physical strain (lifting, manual patient handling, working in awkward positions), risk from chemical and biological agents (disinfecting agents, blood), and psychosocial strain (shift work, intensive work, responsibility for patients and equipment, lack of scope for own decisions, etc.). This project illustrates what can be done to reduce psychosocial strain among care workers and to promote individual stress prevention strategies.



© Photo by Uwe Völkner, Fotoagentur Fox

Figure 38: Workers in a busy office at Havelland Hospitals

### Background

From the very beginning Havelland Hospitals has taken responsibility for health promotion among both patients and workers. An in-house steering committee oversees this health promotion. The members of the steering committee are the Statutory Accident Insurance (LUK) Brandenburg, health insurance companies (AOK, Barmer, DAK, and IKK), Neuruppin Labour Inspectorate, and in-house stakeholders including management representatives, occupational physician, workers' council, health management representative, etc.

At its biannual meetings the steering committee also discusses how mental strain at work could be reduced. In 2003 it requested funding from the Initiative New Quality of Work (INQA) to undertake a thorough assessment with regard to psychosocial risks at work and to install a health management system accordingly. The University of Potsdam acted as a consultant and undertook the scientific coordination of the project.

### Aims and objectives

The aim of the project was to thoroughly assess psychological risks at work and their organisational aspects. Assessment methods were chosen in accordance with ISO 10075-3. INQA also aimed to set up a pilot project for assessing mental workload in hospitals, in view of the fact that hospital work is known to be physically and psychologically strenuous.

### Scope of the project — what was done

Analysis was done between April 2003 and March 2004. The following wards were included: gynaecology, paediatrics, intensive care, emergency ward, anaesthesia, and surgery, at both facilities. At Rathenow internal medicine and maternity were also included. In total 238 workers were included in the analysis.

The project team used various instruments for the assessment.

- Existing documents relating to quality management were analysed (e.g. patients' feedback, image analyses, complaints and suggestions, etc.).



- Experts interviewed middle management (nursing management, heads of wards). This was to determine hospital practice concerning workers, ward organisation, work environment, equipment, communication and cooperation, work time, training measures, quality and health management, sick leave, etc.
- Nurses and aftercare workers were asked to fill in questionnaires about work and working conditions. These questionnaires took into account personal working conditions and psychosocial strain. A total of 87 care workers were included. Additionally, health screenings of the workers were carried out.
- The work in different wards was observed by experts from the university. Sixteen whole shift observations were done, including all three regular work shifts (early, late, and night) and standby duties. Working conditions were assessed with regard to type and frequency of tasks, physical and mental requirements, communication and cooperation, equipment, room for own decisions, working environment, interruptions and unexpected occurrences, pauses and time for rest, etc.

### Instruments for the assessment of psychological risks

Psychological risks at work can be assessed by means of different instruments developed by psychologists and occupational safety specialists. In this case the assessment was done with the help of the SPA Questionnaire — Screening of psychological workload (Metz & Rothe, 2003) of the University of Potsdam. The SPA combines both job and personal analyses and consists of three parts:

- SPA-S (situation) allows a condition related assessment of labour situation through external examiners;
- SPA-P (person) is subdivided into the SPA-P1, which includes the individual reflection of labour situation and the SPA-P2, which ascertains the individual strain through the situation features;
- SPA-S and SPA-P are both subdivided into five fields of analysis to enable direct comparability:
  - (a) decision latitude,
  - (b) complexity/variability,
  - (c) qualifying requirements,
  - (d) risk-prone work situations/special requirements to operation reliability,
  - (e) strenuous working conditions.

Within these fields of analysis, which are itemised into 37 questions, fault loads can be considered unlikely (value 0), likely (1), most likely (2), or acute (3).

- SPA-E (effect) is a list of possible somatic or mental complaints reported by employees during recent months. Workers describe different physical and mental complaints which can be categorised according to the individual experience as 'low', 'obvious' or 'strong'.

AVEM diagnosis (Work Related Archetypes of Experience and Behaviour, Schaarschmidt & Fischer, 2003) was used to analyse individual experience of psychosocial strain and individual strategies on coping with stress.

Results were completed with the questionnaire Salutogene subjective work analysis — SALSA (Udris & Rimann, 1999). The SALSA-Questionnaire is based on the concept of 'salutogeneses'. It is designed to evaluate how workers view certain characteristics of their work. SALSA comprises scales in five key ranges:



job characteristics, organisational resources, social resources, workload, and load caused by working environment or external conditions.

Teamwork aspects were analysed using the Questionnaire on teamwork — FAT (Kauffeld, 2004). Successful teamwork depends on all team members having the same goal. The precondition is that a team can adequately manage its job requirements. Based on this, it can develop mutual trust, support and respect which enhance the cohesion of the team. The FAT-questionnaire helps evaluate teamwork by means of scales measuring goal orientation, task accomplishment, cohesion, and assumption of responsibility for the teamwork.

After the first phase of the assessment, the results were analysed, then presented by the university's experts and discussed by the steering committee. Feedback workshops were organised to present the results to ward managers, nurses and care workers. This enabled action plans to be drawn up and implemented.

Two health circles were set up in Nauen: one on the emergency ward, and the second comprising nurses from various different wards. Health circle members were nominated by the hospital management board. The health circle work was guided by experts from the University of Potsdam and underwent training from quality management representatives. The aim of the health circles was to discuss solutions in terms of individual and collective preventive measures. The second health circle was also required to address interface and communication problems between different wards in the hospital. At the end of the health circle work concrete proposals for interventions were presented to the hospital's management for further action.



© Photo by Uwe Völlner, Fotosagentur Fox

Figure 39: The risk of mental strain is particularly acute among nurses working in high-care wards

### Results and evaluation of the project

#### Loads and resources

The experts considered that there was an acute risk of mental strain, particularly among nurses working in intensive care, emergency ward, anaesthesia and the surgical ward. This strain came about because of a combination of:

- reduced latitude for decision-making;
- high complexity and variability of work;
- extreme requirements concerning reliability of work;
- additional strain due to other unfavourable working conditions.



The nurses themselves perceived their work situation in the same way, particularly with regard to the high need for reliability and accuracy in their work. On the positive side, they found their work diversified and challenging. They were able to use their professional qualifications, and enjoyed social coherence and good cooperation with colleagues. They did express reservations about the latitude allowed for decision-making and the limited possibilities for participation (e.g. when compiling work timetables and standby rosters).

Further points of criticism were the short settling-in period for new nurses and caregivers, a lack of coordination in compiling operating room schedules and carrying out in-house patient transfer between wards in general. These and other issues were discussed in the health circles and as a result new guidelines were drawn up for the training of new workers. Changes were also made in the management of patient transfer and assigning operating rooms.

The limited scope for individual decision-making and the lack of general participation were also discussed in the health circles. The health circles accommodated complaints by promoting a new way of drawing up timetables and standby rosters that delegated more responsibility to the wards. The management also tested job rotation cycles, taking into account the new training guidelines for the nurses and caregivers participating. Initial feedback was positive, so the initiative will be expanded and prolonged.

*Time budget and communications analysis*

Time budget analysis revealed that the nurses were spending a lot of time doing administrative work. They spent one third of their overall working time with patients and 24 % of their time doing administrative and office tasks. Another 5 % of their time was spent on general ward routine. Other major tasks were supporting physicians or colleagues and execution of medical prescriptions.

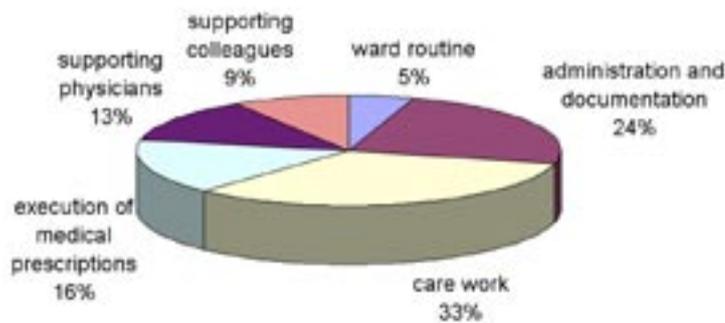


Figure 40: Percentage of time nurses at Havelland spent on various tasks

The administrative tasks, in particular, were perceived by the nurses to be distracting and onerous. They felt that paperwork kept them away from important care work. Consequently, administrative tasks were delegated to the night shifts, where there was more time to devote to them as the amount of care work fell at night.

*Further intervention and training measures*

Some concrete work environment interventions were carried out to enhance the general working conditions of the care personnel. Examples are:

- better lighting for laparoscopy (surgery) in operation rooms;
- fastening of oxygen resuscitation apparatus in anaesthesia;
- installing additional bed tables in intensive care ward;
- installing new software for accessing laboratory results on PC in emergency ward.



The health circles also introduced a programme for individual prevention that included training measures in progressive muscle relaxation, stress management, communication strategies, and conflict management. Training is provided on how to handle violence at work and dealing with death and mourning. Additional training sessions are offered in cooperation with Lufthansa Flight Training: ward teams go on two-day seminars where they reflect on strengths and weaknesses of their work organisation and teamwork. Teams are encouraged to come up with practical solutions to enhance the work situation in their ward.

#### *Management approach*

As a consequence of the project, the hospital management has been able to convert risk assessment and health promotion into permanent processes and integrate both into its quality and health management systems. Principles of management were adopted, including further training sessions and health management standards which can be measured with a 'balanced scorecard'.

Feedback on occupational safety and health is now an integral element in appraisal interviews as well as in staff and team meetings. In this way, workers' feedback on safety and health issues is integrated in ongoing management processes.

#### *Problems faced*

Workers had to be persuaded of the necessity and profit of health promotion measures, because to be successful health promotion needs the full cooperation of the target group. A key activity was therefore informing and motivating workers to participate in stress evaluation and health promotion measures. The management suspected that ongoing training had become so routine for employees that there was a need to really motivate them to pay particular attention to the health promotion measures.

Only two health circles were established. More participation would have been desirable. In addition some workers criticised the policy of nominating members for health circles, saying they would have preferred it if participation had been voluntary.

#### *Success factors*

The project had the full backing of the hospital management, who in fact motivated for the project in the first place. In-house experience in health promotion was also useful during the assessment phase.

The comprehensive approach of the project was a great advantage: by including data from various sources (integrated management system documentation, questionnaires, observations, and health circles) the stressors and weak points in organisation could be identified.

The existing quality management system allowed the quick integration of the health management after the project phase. The project could be transferred into a permanent design easily by using existing processes, infrastructure, and personnel resources.

#### *Transferability*

The presented project is a beacon in the way it shows how psychosocial risks at work can be integrated into the risk assessment process. It shows how and why every employer should take mental strain and questions on good work organisation into consideration when carrying out risk assessments. Mental strain and bad work organisation can easily lead to overload and also cause somatic disorders. Statistics



show that mental disorders are among the main reasons for permanent or long-term incapacity for work.

At the Havelland hospitals new projects and interventions were started afterwards. In the follow-up the working conditions of physicians and medical staff were evaluated (proof that the project can be transferred to other wards, companies, etc.). One example of the results is the introduction of new work time models for both groups of workers.

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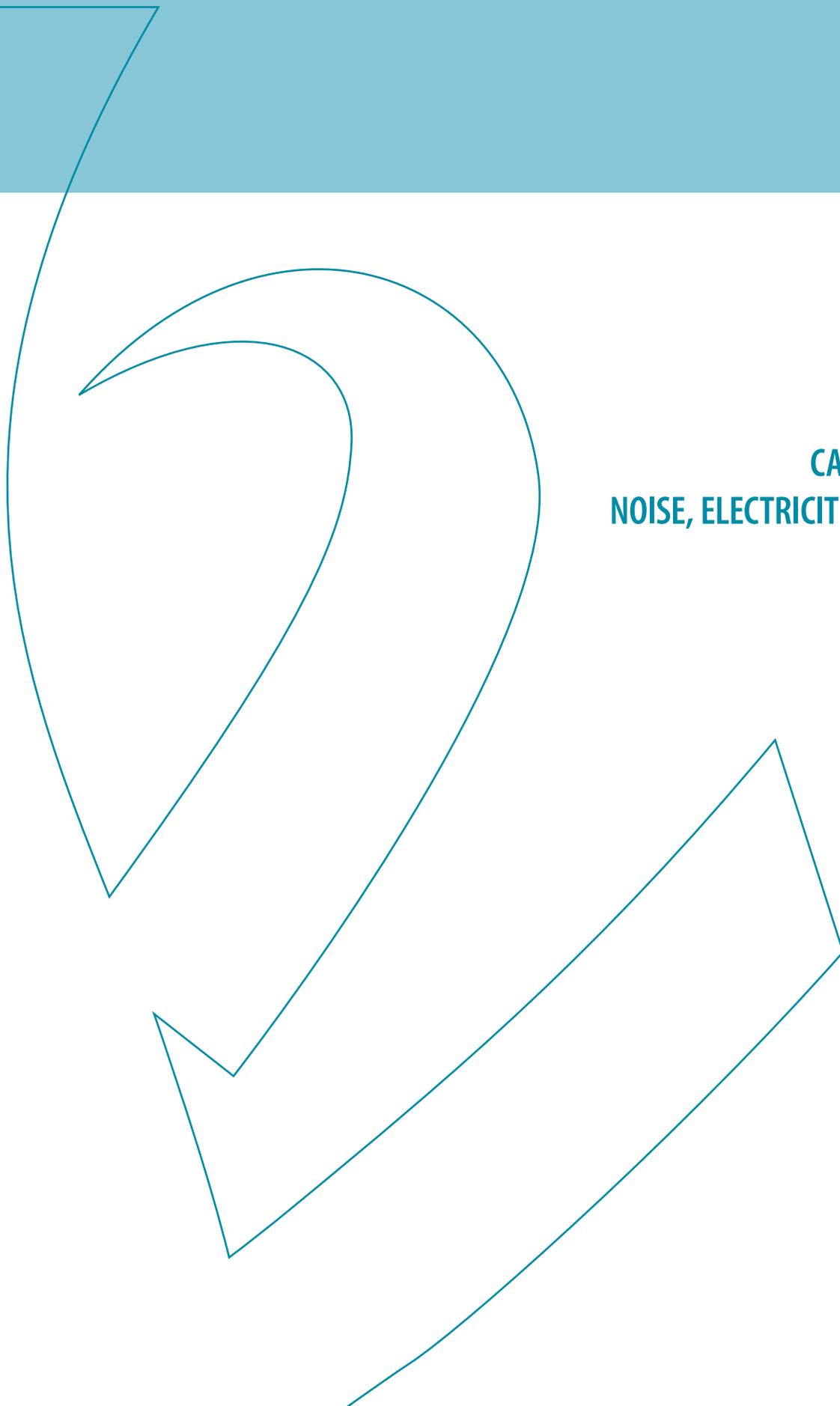
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# 7.

## CASE STUDIES — NOISE, ELECTRICITY AND CLIMATE



# 7.1. SNAPSHOT CASE: CEMENT MILL — INSTALLATION OF A ROLLER-TYPE CEMENT MILL WITH LOW NOISE EMISSION

## CYPRUS

### *Introduction*

The activity took place in the cement milling process in a cement industry. The problem was high levels of noise.

### *Background*

The milling process was using traditional pearl mills with high noise emissions. This resulted in hearing disorders in the workers near the machine. In addition the pearl mill located on the east side of the factory produced a noise nuisance for neighbouring houses, especially at night when the mill continues to operate.

### *Aims and objectives*

The aim of the project was to reduce the noise level by installing a new type of mill.

### *Scope of the project — what was done*

The company wanted to increase the amount of cement produced by purchasing an additional cement mill. In view of the need to reduce the noise during the cement milling process it was decided to buy a 'roller' type mill. The target was to reduce noise levels below 45 dB(A). It was also decided to locate the new mill east of the old mill in order to avoid annoyance to neighbouring houses from the noise of the mill.

### *Results and evaluation of the project*

With the installation of the new roller type mill noise levels fell from 92 dB(A) to < 45 dB(A). Furthermore, complaints from the neighbours have stopped.

The cost of the entire installation was around EUR 7 000 000. This was considered relatively high, but the results were impressive. The new mill solved the productivity problem of the plant and at the same time, without extra cost, solved the problem of noise levels.

The application of this low-emission technology in the cement industry can be transferred to other companies too.



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## WELDERS EMF — REDUCTION OF WELDERS' EXPOSURE TO MAGNETIC FIELDS FROM INDUCTION HEATERS USED IN POWER STATIONS

# 7.2.

### POLAND

**KEY POINTS**

- Reduction of workers' exposure to electromagnetic fields (EMF).
- Reduction of occupational risks related to exposure to EMF.
- Application of an effective technical method for the reduction of electromagnetic hazards in the workplace.
- Application of effective action for the reduction of electromagnetic hazards at EMF source.

**Organisation**

BOT Elektrownia Bełchatów S.A.

**Introduction**

Electromagnetic fields (EMF) are present in the work environment as a result of the use of electrical devices. Industrial devices for induction heating are examples of common sources of exposure to EMF. A strong magnetic field (MF) exists in the vicinity of induction heaters, used for the pre-heating of high-mass arc-welded metal elements and supplied by a high electrical current, usually from 50 Hz to 10 kHz. EMF exposure may cause various biological effects with a variety of consequences for human beings which may lead to health hazards. To protect against the adverse health effects of EMF, the exposure limits are defined as national regulations or international guidelines published by scientific bodies. National Occupational Safety and Health (OSH) legislation in Poland has covered EMF produced by induction heaters since 1995. The Directive 2004/40/EC on health and safety requirements for workers exposed to EMF was adopted in 2004.



Various technical measures can be applied to avoid overexposure of workers. The action described here was undertaken to reduce the level of welders' exposure to MF from induction heaters used in power stations during welding of metal pipes to a level compliant with OSH regulations.

### Background

The source of EMF exposure (induction heaters used for pre-heating arc-welded pipes) was identified as part of a workplace evaluation of health and safety conditions at a power station in the context of reinforcing Polish national legislation. The action was taken by the management of BOT Elektrownia Bełchatów Power Station S.A. at the initiative of welders who work in the vicinity of induction heaters pre-heating arc-welded pipes, and focused on EMF exposure from inductors. Following the assessment, it was decided to take measures to reduce exposure by reducing EMF at its source. The company funded the costs of the exercise, and called in the help of experts from CIOP-PIB (the Central Institute for Labour Protection — National Research Institute).

### Aims and objectives

The main aims of the project were:

- to determine the characteristics and level of welders' exposure to EMF from inductors pre-heating arc-welded pipes;
- to reduce workers' EMF exposure level to make it compliant with legal requirements;
- the practical use of electromagnetic shielding as a technical means of reducing electromagnetic hazard at source.

### Scope of the project — what was done

Power stations use metallic pipes that are multiple kilometres in length for water transportation as cooling and water vapour as the driving medium of electric turbo generators. These pipes are constantly being repaired or replaced, which necessitates the use of arc welding. Induction heating is used to pre-heat connecting sections of pipes to obtain the best quality arc welds.

Inductors comprising a few wire coils have to be mounted at a distance of a few centimetres from the ends of welded pipes. The inductors and cables supplying them with electric current are sources of strong magnetic field (MF) of intermediate frequency (usually from 50 Hz–10 kHz).

The welding process is commonly hand operated by two welders, who work approximately 30–50 cm from the work surface.

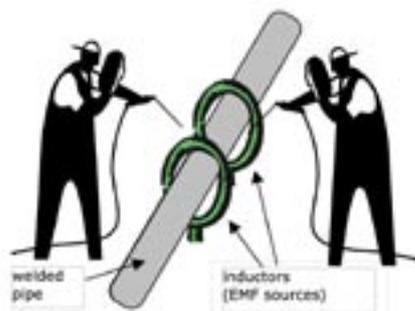


Figure 41: EMF exposure conditions during arc welding of pipes pre-heated by inductors



The first step was to identify the EMF exposure characteristics and assess the welders' exposure level. Measurements and assessment of electromagnetic hazards showed that in the above mentioned conditions workers can be exposed to MF of magnetic flux density up to a few tens of microteslas. It means that the level of welders' exposure to MF from inductors exceeds limits set by Directive 2004/40/EC of the European Parliament and of the Council on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) as well as OSH legislation laid down in Poland.

The results of the initial assessment led to the second step of the action. The company decided to design and make electromagnetic shielding to reduce EMF risk at source and reduce welders' exposure to an acceptable level. An analysis of the distribution of MF in the vicinity of induction heaters and the characteristics of a welder's activity showed that an electromagnetic shield of inductors would be the best technical solution to reduce exposure level. Electromagnetic shielding of EMF sources is an effective technical method for elimination or reduction of workers' exposure. This method is recommended by the Directive 2004/40/EC and the International Labour Organisation as a reliable way to reduce electromagnetic hazards.

Consequently, a shielding structure was designed to accommodate the ergonomic characteristics of welders' activities in the vicinity of inductors. The shields were then manufactured. Next, the EMF exposure level of welders present in the vicinity of shielded inductors was measured. Measurements of shielding effectiveness of prototype shields confirmed the appropriateness of the selected method. Shields made from various materials were then tested and a final version decided upon.

The action was carried out by BOT Elektrownia Bełchatów S.A. with scientific support by external experts from CIOP-PIB. These technical experts were responsible for taking EMF measurements, assessing workers' exposure and providing scientific support on shielding design. The shielding design and production were executed by BOT workers. The costs were covered by BOT power station.

### ***Results and evaluation of the project***

The main result of the action is the effective use of electromagnetic shielding to reduce the level of MF in the vicinity of induction heaters and hence reduce workers' exposure level. Workers' exposure to MF was reduced three to fourfold and fell to an acceptable level.

The method used to reduce electromagnetic hazards at EMF source allowed the company to achieve compliance with OSH requirements without significant financial costs. The design of the shielding structure was adapted to the ergonomic characteristics of welders' activities in the vicinity of inductors and was accepted by workers as routine practice.

### ***Problems faced***

Workers and management of the company were fully engaged in the project. As a result, there were no problems relating to financing or level of commitment. However, a significant technical problem arose because of the lack of published recommendations on detailed methods for electromagnetic shielding. This method of EMF reduction is still a 'work in progress', and assessment of the efficiency of a particular shield is possible only after it has been manufactured and installed in the actual work environment. The process of shielding structure design was supported by the numerical simulations of EMF distribution in the vicinity of inductors, including a realistic scenario of the workplace.



### Success factors

The main success factors of the project were:

- the reduction of workers' exposure to EMF by the practical implementation of electromagnetic shielding;
- the reduction of welders' exposure to an acceptable level;
- the exchange of experience, knowledge and opinion among the different actors involved in the action — workers, designers, scientific experts and management.

### Transferability of the project

The method of reducing the risk at source described above can be transferred to other enterprises using similar technology of arc welding of pre-heated metal structures. The problem of workers' overexposure to MF is a universal one because of the character of workers' activities during maintenance of pipeline systems. The experience with the use of electromagnetic shielding can be applied in other workplaces in industries that use induction heating of metallic elements e.g. forging, hardening, cutting, brazing, annealing, tempering and stress relieving. The need for assessment and reduction of workers' exposure to EMF has become a priority throughout all of Europe because of the process of legal transposition of the requirements of Directive 2004/40/EC in every Member State (mandatory until 2012).

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## SNAPSHOT CASE: NOISE INSULATION — NOISE INSULATION OF A PRESS AND A PALETTE STACKING MACHINE

# 7.3.

### GREECE

#### *Introduction*

The initiative was undertaken by the plasterboard production department of KNAUF Plaster Works A.B.E.E, where a press and a palette stacking machine operate. These two machines produce high noise levels often exceeding 105 dB(A).

#### *Background*

The action was undertaken because noise exposure in the plasterboard production department was far exceeding the limit value set by legislation.



### ***Aims and objectives***

The action was initiated by the factory's director with the aim of significantly reducing the noise levels at source, protecting the 13 workers operating the press and palette stacking machines.

The idea was to reduce the noise level of these machines by moving them into special insulated rooms.

### ***Scope of the project — what was done***

The director, safety engineer, head of department and technicians had jointly decided to put the noisy machines into special insulated rooms. The walls of each insulated room were lined with two layers of plasterboard containing a layer of rock wool 10 cm thick. Noise-absorbing material (rigofon) 5 cm thick was placed on the internal side of the construction. Thus the final thickness of the walls was 20 cm. The roof in both cases (press room and palette stacking machine room) was constructed of the same insulating material and could be easily removed for maintenance purposes. All windows and doors were double glazed. Both rooms have two large double-glazed windows to enable workers to oversee machine operations.

In the palette stacking machine room two openings, one at either side of the machine, had to be constructed to facilitate production. As a result there was dissipation of noise in two directions.

The overall cost of the intervention including materials and construction was EUR 14 000.

### ***Results and evaluation of the project***

According to measurements carried out throughout the production line, noise levels in the press room dropped from 105 dB(A) to less than 86 dB(A). Noise levels in the palette stacking machine dropped from 92 dB(A) to less than 85 dB(A).

The initial goal of the action was to minimise the exposure of workers to noise. This was achieved to a significant degree. Nevertheless problems remained due to the fact that noise levels are still relatively high.

The technical components of the intervention can be successfully transferred to other companies facing similar problems.

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## GLUE EMF — ELECTROMAGNETIC FIELD CONTROL, FOR EXAMPLE IN GLUE DRYING DEVICES

# 7.4.

### FINLAND

#### *Key points*

- Exposure of workers to electromagnetic fields.
- Reduction of the risk by shielding and work positions.

#### *Organisation*

Finnish Institute of Occupational Health (FIOH)

#### *Introduction*

Radio frequency (RF) sealers and glue drying devices typically work at frequencies of 13.56 and 27.12 MHz. Some types of glue materials can be dried very quickly by radio frequency fields. In Finland this technique is mainly used in the production of wooden materials like bent plywood furniture, window and door frames and board plates. It does, however, mean that workers are exposed to high electromagnetic fields. FIOH has measured average exposure values for electric field of 82 V/m and 0.22 A/m (n = 46), and about 16 % of exposures exceeded the ICNIRP guidelines (ICNIRP, 1998; Kusuotoma et al., 2001).

The ILO has published a good practical guide on safety in the use of radiofrequency dielectric heaters and sealers (ILO, 1998). However, there are some special features of glue drying devices and electromagnetic field reduction (EMFR) that deserve further evaluation. There is also a Directive on protection of workers from risks arising from electromagnetic fields (Directive 2004/40/EC). In Sweden and the US studies have been carried out on RF heaters (Kolmodin-Hedman et al., 1988; Eriksson & Hansson, 1985).

#### *Background*

The Finnish Institute of Occupational Health inspects and monitors companies in the area of electromagnetic fields. In Finland a special law, VNp 473/85, states that for electromagnetic stray fields of high frequency devices (10–100 MHz) the exposure of workers should not exceed 60 V/m or 0.2 A/m and instantaneous peak levels are 300 V/m and 0.8 A/m. When the exposure values are exceeded a re-evaluation must be done every third year. As part of this evaluation, since 1985 many workplaces using high frequency electromagnetic devices have been monitored regularly.

#### *Aims and objectives*

The aim of these inspections and re-inspections has been to reduce the exposure levels under the guidelines given in VNp 473/85. All in all, FIOH has carried out these measurements and evaluations for more than 230 workplaces in Finland, and about 50 enterprises have used the Institute's services several times for re-inspection purposes.

#### *Scope of the project — what was done*

The project was carried out to get an overall picture of the exposure values for workers and to gather enough data for the development of recommendations for workplaces.



The measurements made by FIOH during inspections and re-inspections could serve as a basis for these recommendations. The relevant workers would be given education and training on the new recommendations.

**Results and evaluation of the project**

The results of measurements of plastic sealers and glue hardeners are shown in Table 14. About 30–50 % of the measurements were found to exceed the threshold values of international guidelines at the exposure sites, and about 70–80 % of the measurements were found to exceed these threshold values near the machines. This means that there is enormous scope for reduction of radio frequency fields.

**Table 14: Results of the measurements near plastic sealers and glue hardeners**

	E field exposure, V/m	E field average max at workplace, V/m	H field exposure, A/m	H field average max at workplace, A/m
Average (n)	82 (n = 47)	442 (n = 23)	0.22 (n = 46)	1.1 (n = 23)
The highest peak value in the whole material	900	1 800	0.8	5.2
ICNIRP and VNp 473 guidelines — threshold values	60	300	0.2	0.8
The number of workplaces exceeding guidelines	11 of 47 (23 %)	11 of 23 (48 %)	16 of 46 (35 %)	8 of 23 (35 %)

(n = number of measurements)

Usually companies reduce the fields by shielding, by using special work methods, and by grounding. The most typical shielding method is to use a Faraday cage — a metallic mesh net. The electrode should be shielded as well as possible, but for glue drying devices it is sometimes possible for the whole area to be shielded by a Faraday cage. The loading and reloading is done so that one wall is lifted away by an electric motor. For these glue hardeners the field-on time is usually several minutes, and then the workers need not be near the machine while the RF field is on.

The other important means of reducing exposure is maintaining a distance from the moulds where the RF field is on. Nowadays these machines are highly automated and it is necessary for the workers to be made aware of where the stray field is coming from. In this respect FIOH has recommended that companies should paint yellow lines inside which the guidelines can be exceeded, and also install a light that flashes when the field is on. Warning notices can also be placed at the boundaries of those areas so that all factory personnel can be warned when they enter this area.

Directive 2004/40/EC requires that workers be informed about the dangers of the RF fields. Also, maintenance personnel should be informed about the dangers of EMF if they go inside cages or generator enclosures.

**Problems faced**

Grounding is not always successful. Sometimes grounding can even increase the exposure if the grounded floor material goes under the worker. Then the body currents can directly go to grounded material.



Loose metallic parts can cause sparks near the machines, and this can give rise to an explosion if dust or exploding chemical gas is present.

Handling switches for high frequency machines are sometimes installed directly on the generator or the structure of the glue hardener device. This can be overcome by removing switching boards from the radiation source.

Sometimes surface charges at the generator or near other enclosures can be very high and this can lead also to problems with other electrical devices and electrical shocks to humans.

### Success factors

In highly automated factories where the workers only observe (from a distance) the process, the exposure to EMF is well controlled. The only exception is when maintenance workers have to go near these radiating devices when the EMF power is on. If the machine is manually loaded, work phases are organised in such a way that the worker can be further from the machine when the EMF power is on. Shielding can be done either around the machine or around the worker.

### Transferability of the project

These data can be applied to other high frequency devices, but, for example, for plastic sealing devices, many other techniques may also apply such as back electrodes, electrode shielding and so on. These can be more powerful solutions for those purposes. Workplaces need practical information on how to reduce EMF, and hopefully the national implementation of the Directive helps in doing that. There is a need for a training package for this purpose.

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## 7.5. SNAPSHOT CASE: TEMPERATURE 40/28 — REDUCTION OF TEMPERATURE BY INSTALLING WATER COOLERS IN A BUILDING

### CYPRUS

#### **Introduction**

The activity took place in a frame-making building in a cement factory where the temperature was extremely high.

#### **Background**

During summer months the temperature in the plant was 39–42 °C. Initially the company tried to solve the problem by installing 22 small fans on the site. However the situation didn't improve. After interventions and recommendations from the Labour Inspectorate the company management decided to implement a drastic solution to improve the well-being of employees. The safety manager of the site decided to install two air coolers.

#### **Aims and objectives**

Reduction of temperature by installing water coolers in a building.

#### **Scope of the project — what was done**

The safety manager of the factory, after studying the technical details of the building, decided to install two air coolers with water inside the building. They were installed



before the summer, during routine maintenance of the factory. The cost of the air coolers was EUR 4 000 and that of the water filters was EUR 800.

### ***Results and evaluation of the project***

The system had excellent results and all workers enjoy an improved work environment. The installation of the water coolers dropped the temperature in the building from 40 to 28 °C.

The only problem was that the final solution was not found from the beginning and the company had to invest in two types of solutions. The technical solution applied here can be successfully transferred for similar high temperature problems.

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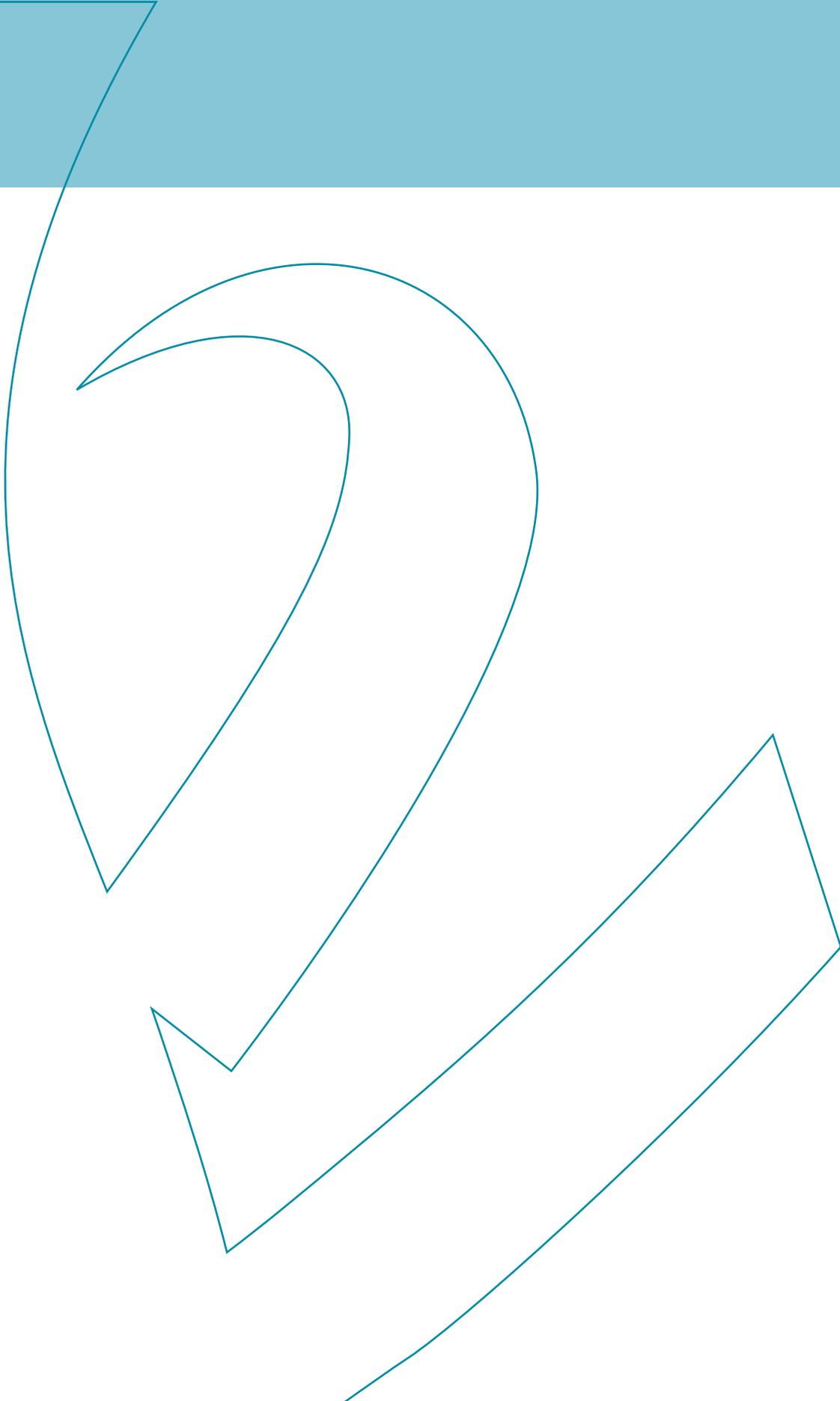
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# 8.

## CONCLUSIONS



Eighteen cases (and seven snapshots) were drawn from a range of occupations and economic sectors across Europe. They illustrate how specific companies have assessed and managed their risks. Some have eliminated or prevented the identified risk, while others have managed to reduce the risk drastically. The actions taken to assess the risks and to manage them are transferable to similar jobs and economic sectors and to other EU Member States. Of course, they will need to be adapted to the specificities of each industry or workplace.

## 8.1. BASIC SUCCESS FACTORS

The variety of cases makes it difficult to clearly identify the main success factors. However, all the cases have some basic factors in common.

- A detailed risk assessment is the logical and structural precondition for an effective risk elimination/reduction.
- Strong motivation on the part of an important and powerful group (such as a department, a workers' steering committee, employer). High motivation by the initiators of the action to manage the risks or a specific risk and no strong objection by other parties in or outside the institution.
- Support from top management. This is essential to ensure that necessary resources such as budget, human resources, equipment, etc., are made available for the project.
- Involvement of relevant actors such as workers themselves (participatory risk assessment), human resources, financial department, OSH practitioners, etc. An important group that has to be motivated and involved from the beginning are the workers. They should be involved not only in the risk analysis itself but also during the identification and implementation of possible solutions. Their practical and detailed knowledge and competence is often needed to develop workable preventive measures.
- A good analysis/knowledge of effective potential solutions, best practice and scientific or technological innovations available.
- A trusting and cooperative atmosphere among the key actors involved in the risk assessment process.
- Absence of major obstacles to the adoption of the preventive or protective measures. These might include:
  - economic barriers such as lack of economic resources or negative cost-benefit assessment;
  - a lack of available solutions such as alternative technologies, machinery, work processes;
  - negative effects for others (workers, departments) by transferring the risk to another area.



- Strong motivation of an important and powerful group
- Support from top management
- Involvement of relevant actors
- Detailed risk assessment
- Analysis of effective solutions and best practice
- Trust and cooperation between the parties
- Absence of major obstacles to the adoption of preventive/protective measures

## ADDITIONAL 'SUPER' SUCCESS FACTORS

# 8.2.

Besides these basic success factors, which are common to all the cases, the analysis of the cases shows that there are some additional success factors that motivate the actors to go further than usual to achieve results that are far above average.

Some of these additional factors are:

- a high motivation to be the best in the sector, or just to be as good as possible, or to improve the image of the company or to improve the image of the safety and health department (e.g. NOACCIDENT, CRUSHED FINGERS, BETTERLIFT);
- the prominent role played by those in the workplace concerned (or the people at risk) in planning workflow (e.g. BETTERLIFT, INKJET);
- the existing difficulties in replacing sick workers (e.g. ROADWORKERS, PLEASURE BOATS, INKJET);
- a high motivation to develop an integrated occupational safety and health approach (e.g. HOLISTIC RA, STRESS IN HOSPITALS, ROTOWORK, BETTERLIFT);
- the existence of internal capacities to identify (and develop) effective solutions (e.g. BETTERLIFT, NOCODUST);
- the availability of simple solutions for high risks (e.g. VACCINATION, CEMENT MILL, TEMPERATURE 40/28, BRAKE CLEANING);
- proper monitoring of the preventive or protective measures adopted (are the measures actually being implemented? are they working? are they adequate?) (e.g. BETTERLIFT, ROADWORKERS, CRUSHED FINGERS, STRESS IN HOSPITALS);
- the availability of external support for complicated or advanced solutions (e.g. NOCODUST, NOWODUST, GLUE EMF, HPD-RAILROAD, NEEDLESTICK, SCREWDRIVERS, INKJET, STRESS IN HOSPITAL, ROTOWORK);
- the existence of public support for SMEs in a whole sector (e.g. VACCINATION);
- motivation to reduce the related costs of accidents and diseases in high-risk occupations or areas (e.g. ROADWORKERS, ROTOWORK, VACCINATION).



### Positive background factors

- High motivation to be the best in the sector/as good as possible
- Important role of the workplaces in the work flow
- Difficulties in replacing sick workers
- High motivation for an integrated approach
- Internal capacities to identify effective solutions

### Solution facilitating factors

- Internal capacities and motivation to go beyond the 'average'
- Simple solutions for high risks available
- Public support for complicated or advanced solutions available
- Objective to reduce high costs

If such additional factors are added to the basic success factors, a strong risk reduction or even the elimination of the risk seems to be feasible.

One crucial factor in success is to connect the risk assessment phase successfully to the next step, namely the planning or risk management phase. The main aim of this phase is to identify and adopt the possible risk elimination/reduction measures.

In SMEs these capacities to plan and conduct larger projects and develop effective solutions are generally less developed. But, as some of the cases show, like larger companies, SMEs can be supported effectively by scientific or technological projects or public support activities.

Most of the case studies feature a mixture of preventive measures (combating risk at source, adapting the work to the individual, adapting to technical progress, giving appropriate instructions to workers, etc.). The adoption of these interconnected measures at various levels (organisational, individual, etc.) is also a key success factor.

After the solutions have been implemented, it is important not to forget to assess the results in order to identify the possible transfer of risks or emergence of new risks. Risk assessment processes are part of a strategy of continuous improvement.

Some of the benefits of carrying out a proper and detailed risk assessment and eliminating or substantially reducing risks at the workplace are clearly described in these cases. These benefits include:

- healthy and safe workplaces (less sick leave, lower staff turnover, a motivated workforce, fewer complaints, a better work environment (less discomfort due to high levels of noise, working in awkward postures, high temperatures, etc.);
- a reduction in costs arising from occupational accidents and illness (less absenteeism);
- in some cases the overall costs of the solution are lower than the cost of the previous solution/situation;
- the implemented changes (the reorganisation of the workplace, new or adapted machinery, new work processes) are not only safer and healthier but also more efficient and more productive;



- the solution adopted means that the job can be done by a wider range of workers (due to a decrease in the amount of physical strength needed, for instance).

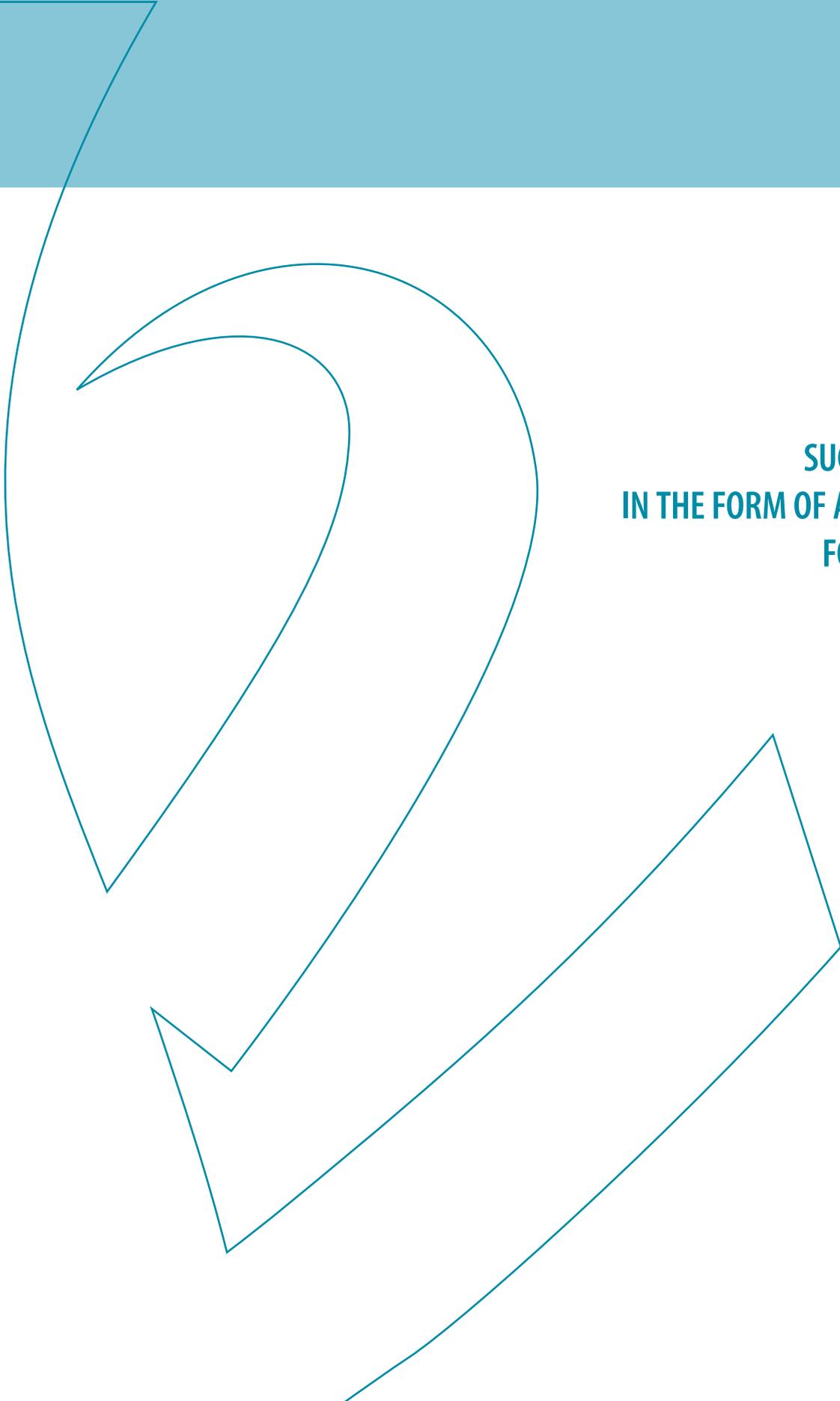
Systematic risk assessment therefore improves workplace safety and health and business performance in general.





# 9.

## SUCCESS FACTORS IN THE FORM OF AN ACTION LIST FOR EMPLOYERS



This checklist brings together the success factors from the projects discussed in this document to enable employers to learn from the practical experience of others and ensure that all possible angles of the situation are covered when carrying out risk assessments and coming up with solutions to identified risks.

		Yes, absolutely	Yes, probably	Indefinite	No, probably not	No, absolutely not
<b>Risk assessment</b>	Did I/we cover all relevant aspects?					
	Did I/we consider risk elimination or different risk reduction options?					
	Did I/we involve all relevant people, including employees and specialists?					
<b>Solutions</b>	Did I/we check the availability of a solution (reference processes in similar enterprises, best practice guidance)?					
	Did I/we ask the suppliers of equipment?					
	Is there potential within the enterprise to come up with a good solution (competencies, time)?					
	Will the indirect and indirect costs of the risk reduction measures be high?					
	Might this solution induce new risks?					
<b>Motivation</b>	Is there high motivation among the people concerned?					
	Are there relevant groups who might be put at a disadvantage?					
<b>Improvements in the medium/ long run? Do you expect:</b>	Fewer accidents or diseases?					
	Good or better image of the enterprise?					
	Medium and long-term cost savings?					
	Technological advantages that might result from this risk reduction measure?					
	Better work flow?					



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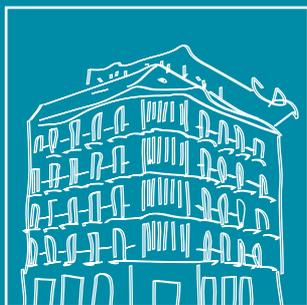
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