

Safety in Building and Construction Industries: State of the art and perspectives on prevention

Report from a Nordic occupational safety research seminar



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Thursday October 9, 2003 at the National Institute of Occupational Health,
Copenhagen, Denmark

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Nordic Co-operation on Working Environment

is based on The Nordic Convention on working environment, which entered into force on the 24th of March 1990. It is designed to strengthen and develop Nordic co-operation and to promote progressively better working environment in all the Nordic countries. The co-ordination of stipulations and rules governing the working environment is part of this work as well as research and training programmes. The agreement is also designed to promote a common Nordic standpoint in matters of the working environment treated by international organizations and in other international contexts.

The Nordic Council of Ministers

was established in 1971. It submits proposals on co-operation between the governments of the five Nordic countries to the Nordic Council, implements the Council's recommendations and reports on results, while directing the work carried out in the targeted areas. The Prime Ministers of the five Nordic countries assume overall responsibility for the co-operation measures, which are co-ordinated by the ministers for co-operation and the Nordic Co-operation committee. The composition of the Council of Ministers varies, depending on the nature of the issue to be treated.

The Nordic Council

was formed in 1952 to promote co-operation between the parliaments and governments of Denmark, Iceland, Norway and Sweden. Finland joined in 1955. At the sessions held by the Council, representatives from the Faroe Islands and Greenland form part of the Danish delegation, while Åland is represented on the Finnish delegation. The Council consists of 87 elected members - all of whom are members of parliament. The Nordic Council takes initiatives, acts in a consultative capacity and monitors co-operation measures. The Council operates via its institutions: the Plenary Assembly, the Presidium and standing committees.

Seminar objectives

- To identify, through our combined knowledge, relevant accident factors that can be modified through intervention
- To give an insight into the contemporary occupational safety research in the Nordic countries within the building and construction industry
- To stimulate and strengthen Nordic research cooperation

Planning committee

The Nordic Network of Occupational Safety Research:

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Final report

The seminar was attended by 40 researchers and practitioners from Denmark, Finland, Iceland, Norway and Sweden. This final report provides:

1. An Executive summary from the seminar
2. Abstracts and slides from the plenary presentations
3. Summaries of the roundtable discussions following the four plenary presentations at the seminar
4. Over 75 abstracts of ongoing or recently completed research projects regarding safety in Nordic building and construction industries
5. Employment and injury statistics regarding Nordic construction industries
6. List of participants registered for the seminar.

Editor

Pete Kines, PhD, Occupational Safety Researcher. Division of Safety Research, National Institute of Occupational Health, Denmark.

The abstracts presented in this report are by no means exhaustive and any omissions are unintentional. The views expressed in the abstracts do not necessarily reflect those of the organisers or sponsors of the seminar.

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1 Executive summary

1.1 Introduction

The Nordic Network for Occupational Safety Research held a Nordic seminar in Copenhagen on October 9, 2003, with a focus on safety research in the Nordic building and construction industries. The goals of the seminar were: a) to identify relevant accident factors that can be modified through intervention, b) to give an insight into the contemporary occupational safety research in the Nordic building and construction industries, and c) to stimulate and strengthen Nordic research cooperation.

This report provides conclusions of roundtable discussions from four plenary sessions regarding construction safety, including accident investigation and prevention, the meaning and significance of safety culture and safety climate, the influence of firm size on occupational safety and, finally, good practices for safety management. In addition to this, the report contains abstracts of over 75 ongoing or recently completed safety research projects in the Nordic building and construction industries, as well as injury and employment statistics for the period 1992-2001.

1.2 Summary of plenary presentations and roundtable discussions

Injury and employment statistics for the Nordic construction industries for the period 1992-2001 show that there are significant increasing injury trends in Iceland, Norway and Finland, whereas there is a significant decreasing trend in Sweden and no significant changes in Denmark. There are differences in the definitions of 'reportable' accidents as well as in the level of reported accidents. Finland claims a 100% reporting rate, whereas the other Nordic countries estimate a 20-50% reporting rate.

The session regarding accident investigation and prevention emphasised that risk assessments of construction projects/sites should be included in the planning/design stage, and should incorporate *realistic* and proper accident investigation procedures. A *representative* from the company as well as the building site should take part in accident investigations, particularly someone with the necessary 'on-site' knowledge of the work being carried out and equipment being used. Prompt and visible feedback and action should be given, and results incorporated into future investigations. It was generally agreed that time pressure is a challenging, and yet unavoidable factor in the construction industry. Work needs to be properly planned and coordinated in order to avoid 'downtime' (unproductive or wasted time), yet at the same time there is a need for some form of flexibility, and 'downtime' could provide the opportunity for exchanging information regarding safety and accident prevention.

Safety culture is described as common understandings that in interaction with organisational structures and relations create the basis for behaviour related to safety and risk taking. On the other hand, safety climate is described as joint perceptions and attitudes concerning safety within an organisation at a certain time. Safety climate is the group members' attitudes to safety while safety culture constitutes the cause to these attitudes. Risk taking is often a part of the safety climate among construction workers, and good role models are hard to find. Behavioural rules and regulations are often difficult to enforce, and solutions for these matters involve the interrelationship between systematic (rules, regulations, planning) and on-site

communication. There is a need for more knowledge regarding interactions between the organisation and the individual worker in creating a climate of safety.

The session regarding the size of construction companies revealed that over 93% of construction companies in the Nordic countries and in the EU in general have less than nine employees, and that the majority are of firms are often one-to-two man companies. Safety management in small construction companies (93% < 9 employees) is often left up to the individual worker. Therefore, safe practice needs to be an integral part of trade schools to ensure better knowledge of construction workers. In addition, employees and employers in small construction companies need more *continued* education about safe procedures and accident prevention. The roundtable discussions revealed that this was best accomplished through already existing contacts and networks such as through accountants, health services, consultants, trade schools, occupational inspection agencies, peer-system and daily networking among other construction workers.

In the session regarding construction safety management, a list of 11 good practices for safety management was presented, including management and worker commitment and coordination, adequate, planning, staffing, education training, site specific safety instructions, safety performance reviews and inspections, feedback, rewards and accident reporting and investigation. In addition, the presentation dealt with the process of adopting of a 'Zero Accident' philosophy. The roundtable discussions focused on the challenge of motivating and building commitment among employees and employers in a dynamic industry with constantly changing workplaces and workforce. There is a need for more widespread use of including health and safety demands in tenure contracts, and which apply to both contractors and subcontractors. In addition, there is a need for increasing opportunities for workers to formally or informally share health and safety information.

1.3 Conclusions

The Nordic Occupational Research Seminar provided the opportunity for collecting and exchanging information regarding *contemporary* occupational safety research in the Nordic construction industries. The format of the seminar worked well in allowing for dialogue between researchers and practitioners, and provided the opportunity for stimulating and strengthening Nordic research cooperation, as reflected in the project regarding the development of a Nordic Occupational Safety Climate Questionnaire (see section 3.1.1).

The construction industries in each of the five Nordic countries are very similar, and an individual Nordic country's safety research results are in many ways generalisable to the other Nordic countries. In addition to this, large multinational construction companies now operate in all five of the Nordic countries.

The seminar showed that there is a great need for *continued* opportunities for exchanging safety research results, and for close dialogue and cooperation between researchers and practitioners. There is a particular need for looking into aspects that are relevant for small or medium sized construction companies, as well as safety management and safety climate aspects in large companies.

The plenary presentations and discussions stressed the need for:

- *Proactive* planning, risk assessment and allocation of resources for accident investigation
- Making 'Safety culture and climate' more understandable
- Use of existing contacts and networks to reach small and medium-sized companies

- Adoption of a ‘Zero Accident’ philosophy
- Developing and adopting good practices for worker *and* client involvement and commitment to safety
- More positive on-the-job feedback and in taking pride in safety and health, and
- Comparative studies between the different Nordic countries in order to better understand differences in accident incidence and safety climate

These issues are only to a certain extent covered by current Nordic research activities. Future research in the construction sector should also focus on Nordic cooperative studies in the fields of:

- National and cross-national comparative studies at workplace level concerning safety culture/climate and performance shaping features
- Research focused on small or medium enterprises and ways to approach them concerning improved safety performance

2 Plenary abstracts, presentation slides and summary of roundtable discussions

2.1 Nordic inter-country comparisons of injury incidence time-trends (1992-2001)

Plenary speaker: Kim Lyngby Mikkelsen, MD, Senior Researcher, Division of Safety Research, National Institute of Occupational Health, Denmark.

The following is based on Nordic injury incident statistics – see section 8.

2.1.1 Plenary abstract

Comparing time-trends

When comparing injury incidences in different countries, a number of factors have to be similar in order for the comparisons to make sense. Time-trends are less problematic to compare, as trends are primarily intra-country comparisons. In this way, differences between countries in such factors (– the definitions of a ‘reportable accident’, – the reporting fraction, and – the definition [in terms of included trades] and the make-up [in terms of size of enterprises] of the construction sector) are of less importance *as long as these factors do not change over the time period studied.*

The definition (in terms of included trades) and the make-up (in terms of size of enterprises) of the construction sector in the five Nordic countries compared (Iceland, Norway, Sweden, Finland, Denmark) are very similar. E.g. more than 80% of all employees in the construction sector in all countries are employed in companies with less than 5 employees, and in all countries throughout the period 1992-2001, about 5-7% of the labour force is employed within the construction sector. On the other hand, the definitions of a reportable injury and the reporting fractions do differ considerable:

Definition of ‘reportable injury’

- I: At least one day of absence beyond the day of injury
- N: All injuries that need medical treatment or with any absence
- S: At least one day off work, and/or accidents that lead to injury, acute hearing loss or psychological reaction – even if there is no sick leave (Combined figures for work accidents, commuting accidents and work sickness).
- FI: All compensated accidents and occupational diseases (Construction 2001: accidents at work site 93,8%, commuting accidents 3,6%, work traffic accidents 0,5%, occupational diseases 2,2%)
- DK: At least one day of absence beyond the day of injury

Estimated reporting fraction (number of reported versus the number of reportable injuries)

I: 20% (Labour Inspection)

N: 30-50%(Labour Inspection)

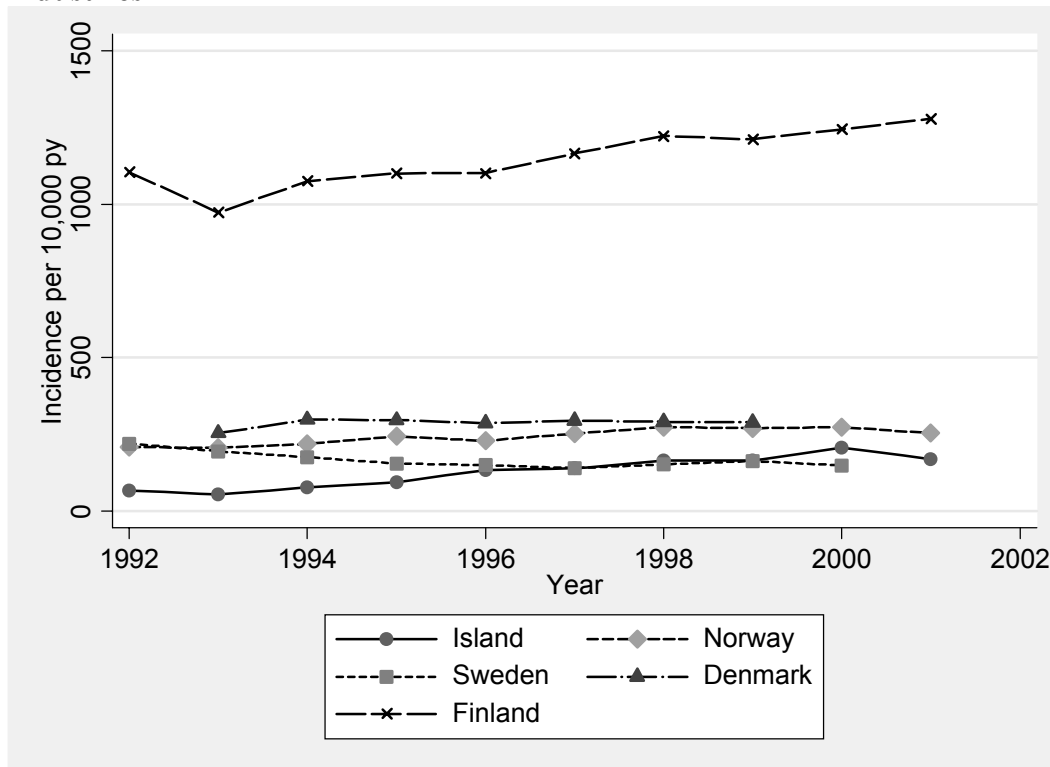
S: No estimation is possible

FI: All are reported

DK: 40-50% (Labour Inspection)

The most striking difference is probably the fact that all accidents in Finland are reported. The reason for this is that in Finland, unlike the other Nordic countries, the worker's compensation is insurance-based. Judging from the reported incidences (see figure below), the very big differences in the levels of reported injury incidences between Finland and the other 4 Nordic countries might suggest that the estimated reporting fractions from Iceland, Norway, and Denmark are much too optimistic (no reporting fraction estimate from Sweden). Differences in the definitions of reportable injuries might also play a role, let alone real differences in the injury incidences between the countries.

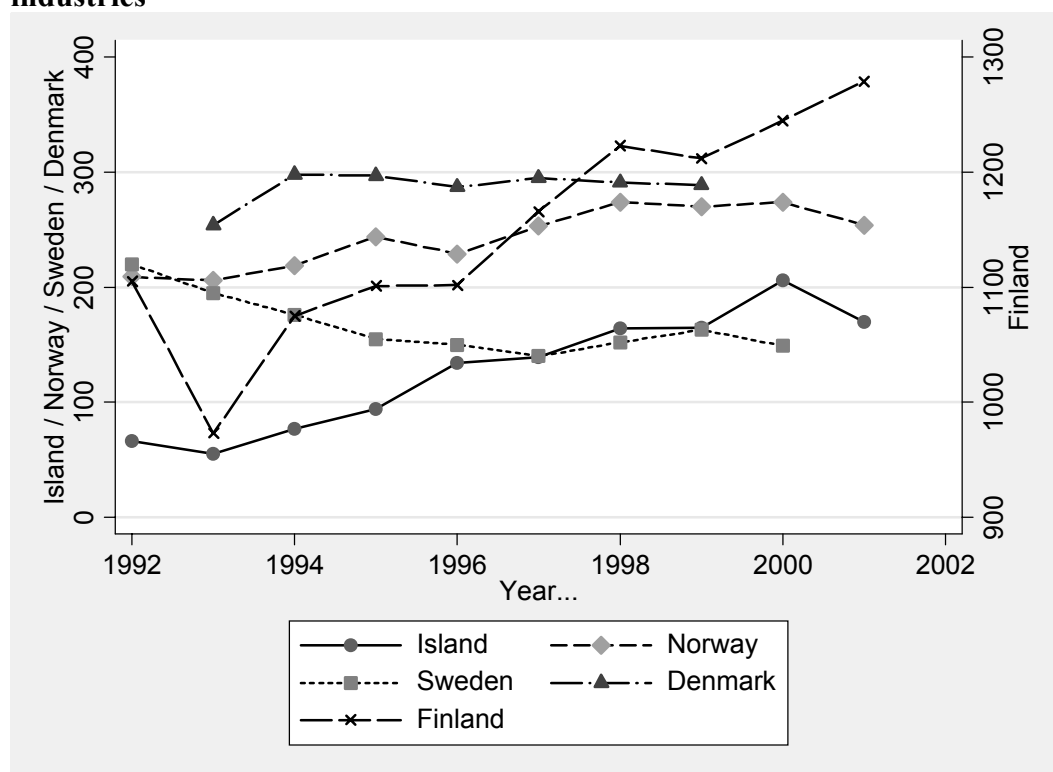
All injuries, incidence per 10,000 person years, Nordic building and construction industries



Time-trends, all injuries in the construction sector

Taking a closer look at the time-trends of the reported incidence (see figure below), Denmark had a small increase in the early 1990ies. Overall, however, there is no trend. In Sweden, there is a significant decreasing trend, although the major decrease took place before 1995. In Sweden, the insurance changed in 1994, which made a difference, and also since 1994, is it possible to assume a constant reporting fraction in Sweden.

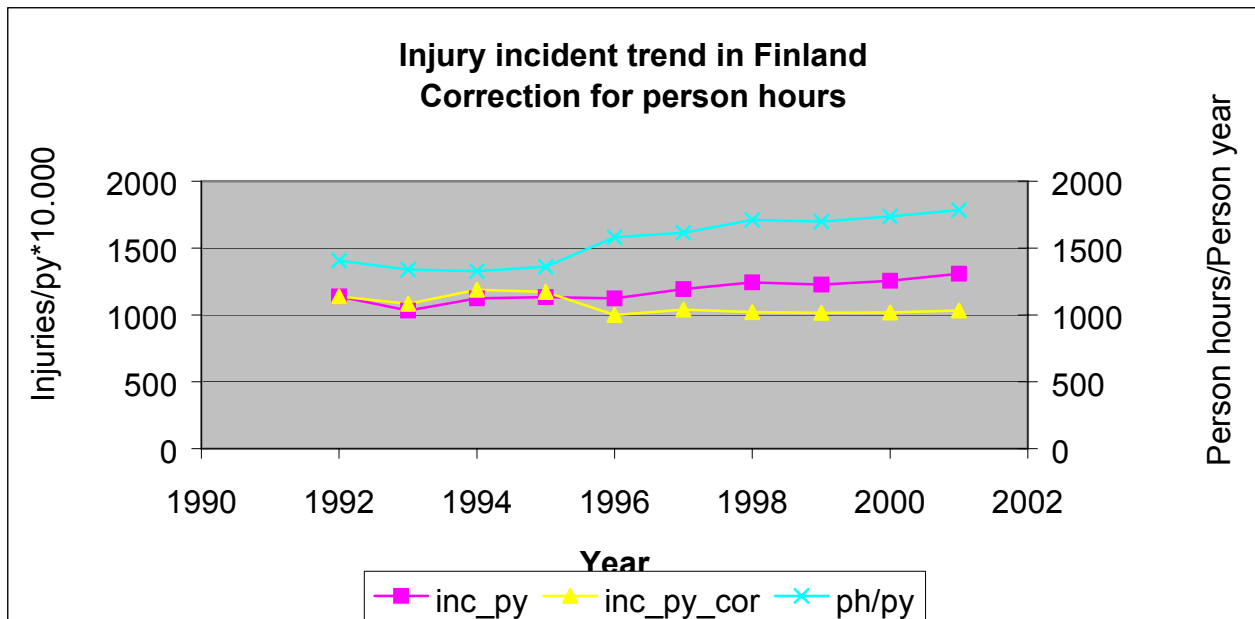
All injuries, incidence per 10,000 person years, Nordic building and construction industries



Note: Date from Finland refer to the right y-axis, whereas data from Iceland, Norway, Sweden and Denmark refer to the left y-axis. The increasing trend in Finland is only apparent, see text below.

In Iceland, Norway and Finland the trends are increasing and these trends are all statistical significant. The reason for the increasing injury incidence rates in Norway and Iceland is unknown. In Iceland, at least part of the increase is presumable due to an increasing reporting fraction over the years. In Finland, the increasing injury rate cannot be explained by changes in the reporting fraction, as the reporting fraction for all years is 100%. For Finland, however, not only the number of person years (number of employees) but also the actually number of person working hours is known. Since the recession in the construction industry in Finland in 1994, the number of working hours per year has increased more than 30% (from 1328 hours/year in 1994 to 1784 hours/year in 2001).

When the numbers of working hours per year are taking into account, the apparent increasing trend in Finland is turned around, and the trend in Finland has in fact decreased significantly on average with about 2% each year in this 10 year period.



Note: Inc_py = incidence per person years, Inc_py_cor = incidence per person years corrected for differences in number of working hours per year (A mean of 1570 hours per year was used in the correction, with reference to year 1992). Ph/py = number of working hours per year (right y-axis). When corrected for number of working hours per year, the injury incidence trend in Finland is actually decreasing.

The **Nordic Network of Occupational Safety Research** has a forthcoming project, also funded by The Nordic Council of Ministers, where we are developing a questionnaire on Safety Climate (see 3.1.1). With this questionnaire we hope to be able to see whether differences in safety climate will be able to give a better insight into the differences in occupational injury incidences and trends.

2.2 Accidents in construction - the search for preventable causes

Plenary speaker: Hans Magne Gravseth, MD, Occupational Safety Researcher, Oslo Emergency Ward, Norway.

2.2.1 Plenary abstract

Design of study

50 construction workers with a serious injury, according to the definition of the Labour Inspection, were extensively interviewed face to face with a questionnaire with open-ended questions (mostly qualitative data). The accidents took place in the period September 2002 – January 2003. In about half the cases, on-site investigations were carried out, some of them together with a specialist in occupational accidents, to find contributing factors to the injury, including factors in the organisation (behind the “man-machine”-system).

A group of four specialists on injury investigations was formed: two experienced labour inspectors, one psychologist and one technologist with product safety experience. Together with the physician who carried out the interviews and site investigations, the descriptions of the 50 accidents were studied in order to identify contributing factors of psychological, technological and organisational type. Also, a reference group was formed with representatives from national employer and labour organisations, national and local labour inspectorates, and health institutions.

Some results

These 50 injured workers were all males. Median age was 34 years, with a range from 18-63 years. 13 of them were carpenters, the most frequent profession. The rest had various professions, like electricians, painters, plumbers, scaffold workers, masons etc.

24 of the accidents, i.e. about 50%, were falls. Ten of these falls were from ladders and stepladders. Other falls included falls from lifts and scaffoldings, falls in stairs and falls on the same level.

The second biggest injury type was electric injuries, with 6 cases. Other important injury types were injuries in demolition work and injuries involving knives, electric saws and nail guns. There was one fatal accident: two workers were killed during demolition work when a roof fell down on them.

Some medical information: 10 of the workers had finger injuries, 9 had head injuries whereas 7 had wrist fractures. It is estimated that 16 of the injuries will be of a permanent character.

Risk factors and possible preventable causes

One finding was that time pressure was an important risk factor, as more than 1/3 of the workers said that time pressure might be a contributing cause to the accident. Some of them said that their strict deadlines were an important stress factor and that the cooperation between different professions on the construction site was difficult to coordinate. For instance, the plumbers are stressed because the carpenters are waiting for them to get finished, whereas the

painters are stressed waiting for the carpenters etc. Quite a few workers admitted that they purposely had done their task in a sub-optimal way to save time.

The reports from the accidents were compared with the Labour Inspection's reports on the same accidents. One conclusion on this comparison was that these two ways of investigating accidents emphasize different aspects of the incidents. The Labour Inspection is primarily focused on whether there has been any breach of the legislation. If not, they often don't put too much effort in finding the causes. Their reports usually did not have more information on organisational conditions than this study. But if the accidents resulted in reporting to the police (which was the case in three of the accidents in the study), the Labour Inspection did a more detailed investigation.

One preventing effort then is that the Labour Inspection also should focus more on matters that are not covered in the legislation. They should pay more attention to their role as teaching supervisors. The inspectors in the Labour Inspection probably need a better education to teach them about this.

The study revealed several other suggestions for preventing efforts. Some key words for these efforts are preventing efforts concerning time pressure, safety education, fall accidents, demolition work, and electric accidents (these will, if relevant, be referred to in more detail at the Nordic seminar).

Other relevant current literature

Chau et al. (2003) investigated causes and severity of occupational injuries in construction workers and related them to job, age and different life conditions. They found that the risks for each worker depended on age, body mass index, hearing disorders, sleep disorders and sporting activities.

Kines (2003; 2001) found that the background factors for fatal, serious and minor construction fall injury incidents are not necessarily the same (i.e., age, gender, type of injury incident, type of working surface, time of day, trade, firm size). This has important implications for identifying preventable causes and targeting injury prevention.

Richter & Pedersen (2002). Causes were directly related to unfit, worn-out and/or physical straining equipment, insufficient instructions in work-procedures and equipment, deficiencies in the delivery and quality control of materials, plus shortcomings in the design.

References:

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- Richter & Pedersen (2002). Ulykkesårsager indenfor bygge og anlæg – en dybere analyse af årsager til arbejdsulykker: BAR for Bygge og Anlæg og DTU. (see 4.2.2 – this document)

2.2.2 Plenary slide presentation

**Accidents in construction –
the search for preventable causes**

Nordic Research Seminar
Copenhagen October 9, 2003

Hans M Gravseth
Oslo Emergency Ward

NMR-Seminar October 9 2003

**The most obvious way to search
for the accidents' causes and
identify risk factors:**

Investigate accidents!

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Study design

- September 2002 – January 2003
- Construction workers with serious injury
- In depth interviews
- On site investigations/reconstructions

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Specialist group

- One technologist with product safety experience
- One psychologist
- Two experienced labour inspectors

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Specialist group cont

- Read through the reports on all the accidents
- Discussed causes and preventing efforts
- One of the members took part in a few on site investigations
- Signed a declaration of confidentiality

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Results

- * 50 accidents were investigated
- * Males 18-63 years, median age 34 years
- * 24 (~50%) falls:
Ladders, stepladders, lifts, scaffoldings etc
- * 6 electric injuries
- * Other types:
Electric saws, nail guns, demolition work...
- * One fatal accident (two persons killed)

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Medical information

- 10 workers had finger injuries
- 9 head injuries
- 7 wrist fractures
- 5 fractures of the vertebral column
- 16 injuries are assumed to be of a permanent character

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Labour Inspection

- 37 of the 50 accidents were duty to report to LI in Oslo
- 12 were reported
- 10 were investigated by the LI
- 9 of these reports were compared with the reports from the study

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LI comparisons

- In general the same conclusions conc. description of the incidents and causality considerations
- LI primarily focused on legislation
- In depth study: more background information
- Usually the same information on organisational conditions
- Police reported accidents: LI investigations were detailed

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Risk factors and possible preventable causes

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Time pressure

- Important risk factor, mentioned by > 1/3 of the interviewed
- Could often lead to sub-optimal procedures
- Related to
 - strict deadlines
 - problems with cooperation between professions
 - piece rate pay

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Personal protective equipment

- Relevant equipment not used in at least 9 cases
- Helmet, glasses, gloves
- Also some cases where PPE was used, but did not protect enough

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Preventing efforts

- The standard contracts should open for re-negotiation of deadlines during the construction period
- There should be an accident commission that investigated serious accidents
- The Labour Inspection should stress their education function, not only their enforcement function

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Preventing efforts cont

- Safety education: safety must be taught as an integrated part of all tasks – not as an "appendix" that could be dropped by lack of time
- Accidents could be reported anonymously, or the reporter could be guaranteed no punishment. *Prevention* should be the purpose with reporting, not finding someone to blame

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Preventing efforts cont

- There is a great potential for improved design on many fields (lifts, nail guns, PPE and other products)
- What about a competition for industry designers or technical college students?
- Communication and safety culture: Campaigns like "Concern about your fellow worker" – let people know when risky behaviour is observed

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Possible topics for discussion

- 1a) Who should investigate accidents? How? (In-depth?)
- 1b) Time pressure as a risk factor – how to cope with this?
- 2) How can cooperation between practice and research be improved in order to substantially improve safety?
- 3) Where do we need further knowledge?
- 4) What are the differences and similarities between the Nordic countries in regards to accident investigation and prevention?

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2.2.3 Summary of roundtable discussions

In regards to accident investigation:

- Risk assessments of construction sites should be included in the planning/design stage, and should incorporate *realistic* and proper accident investigation procedures
- A *representative* from the company as well as the building site should take part in the accident investigations. In particular, someone with the necessary knowledge of the work being carried out and equipment being used
- The investigation team should leave behind knowledge of their investigation – what happened, what were the contributing factors, and how might similar incidents be prevented
- Visible preventive action should be taken based on the results of the accident investigation
- Future accident investigations at a site should include experience and results from previous investigations at the site
- Current accident investigation methods should be realistically adapted to the industry, trade or work site
- It is important that there are sufficient resources available for proper accident investigation
- The results of accident investigation and prevention should be recorded electronically
- Experience from Norway shows that it is possible that the same type of information regarding accidents can be gathered through the health care system as through the labour department.
- Reports from the labour inspection focus on violations of rules and regulations and have little to do with active accident prevention.

In regards to time pressure:

- The factors contributing to time pressure are complex, and are often seen as the results of the interrelationships between time, costs and ways of working
- It was generally agreed that time pressure is an unavoidable factor in the construction industry
- Workers often claim that they are under time pressure, when in fact a great deal of time is wasted
- Work needs to be properly planned and coordinated in order to avoid ‘downtime’ (unproductive or wasted time)
- The concept of ‘partnering’ is crucial, and involves including all parties in the planning process
- Work schedules can be too tight. There is also a need for some form of flexibility, and ‘downtime’ could provide the opportunity for having staff/toolbox meetings
- Risk assessment should be based on each individual workers’ own capabilities

2.3 What makes people choose – or not choose – safe behaviour? Meaning and significance of safety culture and safety climate

Plenary speaker: Marianne Törner, Associate Professor, National Institute for Working Life/West, Göteborg, Sweden.

2.3.1 Plenary abstract

What is it that actually causes an accident at work? Or should the question be rephrased: What is it that allows an accident to happen. Initial work on occupational safety was directed towards technical matters. No doubt this helped to improve safety tremendously. But it was not enough. A decade or two ago focus shifted towards human error and this led to opening up the view on the man-machine system and the organisation. James Reason is to have stated that human error is an effect rather than a cause (reference missing). The last two decades, the view on safety as a social construct has attracted increasing interest in research and practice. This adds a dimension to Reason's statement: Yes, human error is an effect rather than a cause, but the individual him/herself participates in creating the conditions! Risk situations may occur due to unintentional actions, caused by bad design, inadequate instructions, etc. They may also occur due to intentional actions, such as short cuts in procedures, prioritising production goals at the cost of safety, etc. At a quick glimpse these actions may easily be put down to human error or highly situational factors, and the remedy for the situation not to occur again is often "The operator was instructed to be more observant next time". Will there be a next time? Will there be another situation, which will be so similar to the previous one that the operator can avoid injury simply by extrapolation from experience of this previous event? Probably not. And this fact can, and often does, blur the vision for us: Accidents are so "unsystematic", they are so different from each other and so wide-spread over the plant that they seem entirely stochastic. How can you systematically fight accidents that are stochastic? We have to find another route to understand how accidents occur. For that we must try to understand what creates the setting for unsafe behaviour and accidents. Here we come to the issue of safety culture. The concept of safety culture has its basis in theory on organisational culture of which safety culture is considered to be one aspect. There are two different approaches to understanding organisational culture and how it evolves. Richter (2001) presents an overview of the distinctions between two paradigms, a functionalistic and a symbolic perspective on organisational culture, respectively. The functionalistic perspective is characterized by viewing culture as being based on values and norms common to the whole or at least a major part of the organisation and thus binding the members of the organisation together by creating a joint 'philosophy'. This joint culture is created through group learning – the culture is "taught" to newcomers as "the way we do things around here". The formal leader(s) of the organisation are considered as central in the creation of the organisational culture and the leaders are considered to be able to intervene and achieve desired change in organisational culture. The symbolic perspective on organisational culture, on the other hand, rejects the existence of a culture common to the entire organisation (except in extreme cases). The creation and maintenance of culture is viewed as a dynamic process where the members of the organisation are viewed as constantly active in creating their own 'reality' in interplay with physical environment, social structures and relations with others, not only within the organisation but also through other

types of social networks and identities - 'cultural traffic'. The term interpretive is sometimes used to describe this latter view on organisational culture (Glendon and Stanton, 2000, citing Waring, 1992, 1993, 1996a). The individual in interaction with others interprets the meanings to him/herself of physical conditions, structures and relations. According to this approach, several subcultures exist within the organisation and these subcultures may be both horizontal and vertical, i.e. encompass individuals on different hierarchical levels (Richter, 2001; Rochlin 1999).

Culture is, however, functional in that it constitutes a frame of reference for behaviour (Guldenmund, 2000). Another function, stated by the same author, citing Van Hoewijk, (1988), may be that it makes behaviour more predictable, hereby reducing anxiety, as well as providing stability and continuity within the organisation.

Safety culture is the part of organisational culture that relates to risks and safety. What is then the distinction between safety culture and safety climate? The use of terminology in literature is not consistent. Guldenmund (2000), citing Glick (1985), states that the study of culture emanates from anthropology, using mainly qualitative methodology, such as participative observations. The study of climate stems from social psychology, mainly relying on quantitative methods, such as questionnaires. Guldenmund concludes that the term climate more and more has come to mean the overt manifestation of culture within an organisation and he suggests a framework distinguishing different levels of expression of organisational culture. In this framework basic assumptions and beliefs constitute the core of the organisational culture, whereas attitudes and perceptions, encompassing also those related to safety, constitute organisational climate. These aggregated safety attitudes, cognitive as well as affective, are by Guldenmund equated with safety climate. Flin et al. (2000) refer to safety climate as a snapshot of safety culture.

It is of interest and importance to reflect upon how safety culture develops. Richter (2001), who takes her stand point in the symbolic paradigm, offers the following definition of safety culture: Safety culture is the joint and learnt opinions, experiences and understandings - partly expressed through symbols - that in interaction with the structures and relations within the organisation, create the basis for actions with relevance to safety and risk taking.

Although the concept of safety culture has not yet been fully interpreted or well defined, the importance of safety culture to occupational safety is generally accepted (e.g. Zohar, 1980; Donald and Canter, 1994; Cox and Flin, 1998; Rochlin, 1999; Guldenmund, 2000; van Vuuren, 2000). If and how it may be influenced through intervention is, however, controversial. Safety culture no doubt is a stable construct, and modifying it is bound to take time. Richter (2001) states that changes in safety culture may occur only when there is room for learning obtained through good safety management. Some important characteristics of this room for learning is that risks and safety are perceived as a matter of joint concern, that flexibility in relation to rules is possible, that there is possibility to reflect on procedures and that top management allocates the resources necessary for safety considerations and safety work. The importance of reflection on practice is also pointed out by others (e.g. Pidgeon, 1998). Understanding of where and how safety culture or climate develops is of great importance for the success of efforts to improve safety. If a certain type of safety culture and climate encompasses the major part of the participants of an organisation it may be easier to distinguish common "weak points" that need approaching, than if many diverse parallel cultures exist. Also, if the safety culture is mainly generated through processes within the organisation, they may be easier to influence than if a large extent of culture traffic takes place. The question on how culture may be influenced must also be carefully considered. If, as is suggested within the functionalistic

paradigm, culture development goes in the direction from top to bottom, safety culture may be directly “managed” by company management. If, on the other hand and which is more likely, culture – as suggested within the symbolistic or interpretive paradigm – is developed through a complex interaction of the individual with structures and relations, attempts to directly “manage” safety culture from company management may even be counter productive (e.g. Rochlin, 1999). What are then the principal dimensions of a good safety culture? Approaches for measuring different dimensions of safety culture are discussed by Glendon and Stanton (2000). Accepting the reasoning that safety climate is an expression of safety culture, identifying main dimensions of safety climate may be more accessible.

Much work has been put into trying to determine which dimensions constitute the main components of a good safety climate (for review, see e.g. Dedobbeleer and Béland, 1998; Cox and Flin, 1998; Flin et al., 2000; Guldenmund, 2000; Glendon and Stanton, 2000). Flin et al. (2000) In a review of 18 studies, identified five main themes of safety climate, namely management/supervision, safety system, risk, work pressure and competence, where the first three were most common. A sixth dimension was presented by Flin et al. (2000), although there was not as strong support for this factor in literature This dimension was procedures/rules, covering perceptions of rules, attitudes to rules and procedure compliance.

Management/supervision.

Most commonly mentioned aspect of management concerns management commitment to safety but also decentralised decision-making and empowerment are put forth. The important role of the first line supervisors is often stressed.

Perceptions on safety systems

Perceptions on safety systems, e.g. status/strength of safety officer and safety committee, contentedness/confidence with safety policies and arrangements, emerge as an important area in several studies.

Risk

As for the influence of risk perception on workers’ involvement or responsibility in safety, no conclusive results have been presented. To understand this it may be important to consider other factors, e.g. personality factors. Another important aspect for understanding the role of risk perception may be to what extent a high-risk perception is accompanied by perceived manageability of risk. A study among farmers (Stave and Törner, 2003) showed that high-risk perception was associated with safety engagement only if accompanied by perceived manageability. If, on the other hand, high risk perception was associated with high perceived psychological pressure, the association with safety engagement was negative.

Work pressure

Priority of safety versus other production goals in many studies stands out as a principal component of safety climate. This constitutes part of the factor dimension work pressure, presented by Flin et al. (2000).

Competence

Competence includes training and the importance of adequate safety training, which is a frequently suggested principal dimension.

Other dimensions found central in several studies, but not mentioned by Flin et al. are communication, individual safety responsibility/motivation, teamwork/group involvement in safety and incentives for safety, such as positive feedback and effects of safety involvement on possibility for promotion and on social status (see e.g. Guldenmund, 2000; Neal et al., 2000). Hofmann and Stetzer (1998) suggest that management encouraging open communication on safety sends a strong signal on how safety is valued. Rochlin (1999) reported on research on the role of communication in high reliability organisations. Communication was there found not to be limited to what might be considered critical exchange of information but also consisted of a large amount of interaction that may seem superficial. It played an important role, however, for nurturing communication and co-operation and to maintain integration. Another important function of an extensive and free communication was that experienced operators monitoring this flow of what seemed to be sometimes trivial or superficial information this way often could discern warning signals.

So, although there may be many flaws, it seems that results concerning principal dimensions of safety climate are converging into a core of a limited number of dimensions. The next issue then to be resolved is how these dimensions relate to each other and how they influence safety performance, such as safety behaviour and the occurrence of near accidents and accidents. For this we need longitudinal data that is data acquired through repeated measurements over several years, and preferably in several different types of occupational life!

In an ongoing longitudinal study in Swedish construction industry, where we follow the construction of the Götatunnel, a road-tunnel under central parts of Göteborg, we decided to use a model on safety climate and its influence on safety activity, we decided to test a model developed by Cheyne et al. (1998) (Figure 1). Data are acquired through questionnaires directed towards all customer, contractor and sub-contractor personnel engaged in the tunnel work. The respondents gather during working hours six times (“waves”) over four years to answer the questionnaire. After an initial pilot study we have up till now performed three waves. Results from the pilot study and the first wave showed that some associations with work place hazards and physical environment, respectively, were not significant, but otherwise the structural safety climate model was reliable also in this new context (Pousette et al., 2001; Törner et al., 2001).

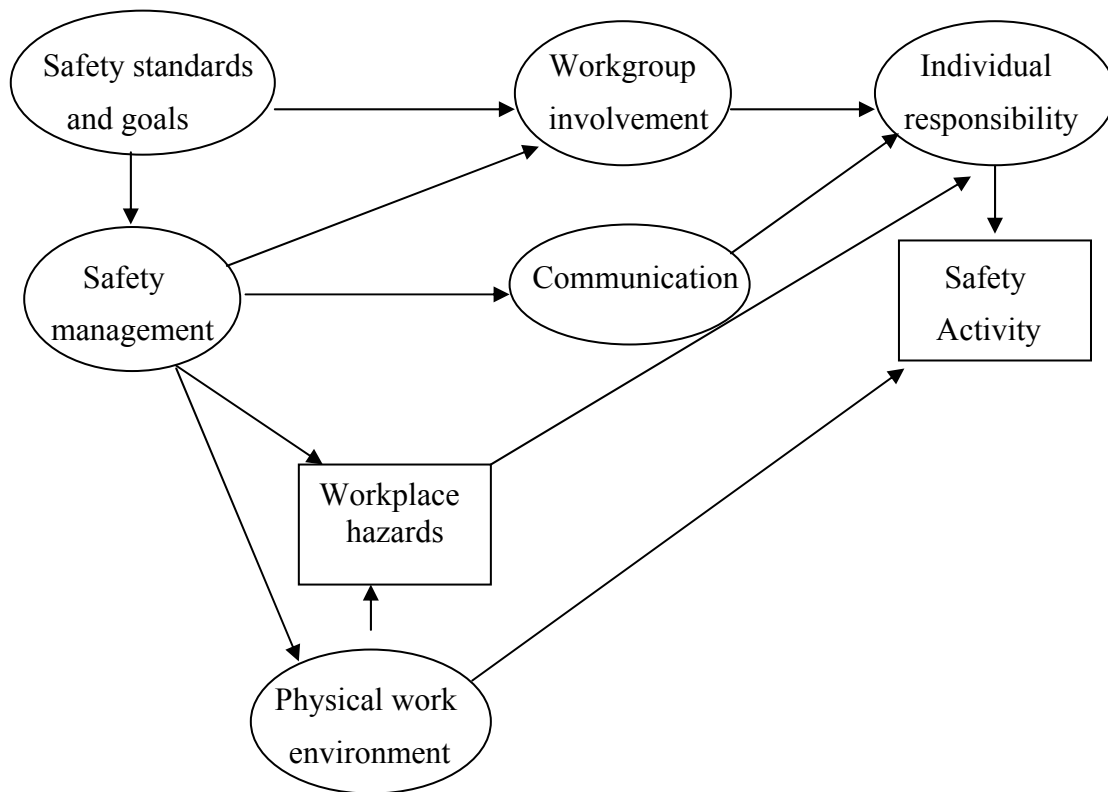


Figure 1. Model on safety climate (Cheyne et al. 1998).

Good measurement tools and models open up a possibility for measuring safety climate as a performance indicator within an organisation, something that would be very useful for practitioners, such as managers and occupational health and safety personnel. However, it must always be kept in mind that there is no such thing as a universal tool or remedy. Effective safety work, like all successful change, must be allowed adequate (normally quite substantial) time and be based on broad participation and fingertip feeling for the culture(s) of the occupational branch and organisation in question.

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2.3.2 Plenary slide presentation

M Törner
1

Risk management and safety at work

Risk research team at National Institute for Working Life West, Göteborg, Sweden:

Marianne Törner, ass prof., reg director NIWL West

Anders Pousette, PhD, psychologist

Susanna Larsson, doctoral student, personell management

Christina Stave, doctoral student, M psych

External co-operation:

Petra Willquist, doctoral student, civil engineering

Eric Rosenlund, work environment engineer



M Törner
2

Why do people chose – or not – safe behaviour?



M Törner
3

What causes an accident?

- Technology?
- Individual behaviour?
- Man-machine interaction?
- Organisation?
- Culture?



M Törner
4

Safety culture

Functionalistic definition:

Basic assumptions and values which the group have integrated and which have been found to work well and therefore are being taught to new co-workers as the correct way of perceiving, thinking and feeling concerning safety in relation to work.

(Freely after Schein, 1992)



M Törner
5

Safety culture

Symbolistic/interpretative definition:

Common understandings that in interaction with organisational structures and relations create the basis for behaviour related to safety and risktaking

(Freely after Richter, 2001)



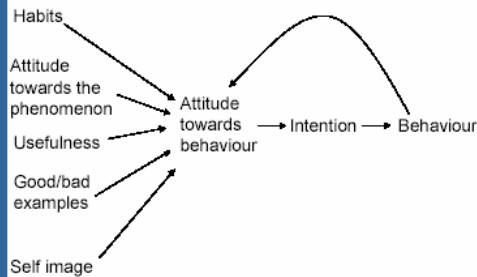
M Törner
6

Safety climate

Joint perceptions and attitudes concerning safety within an organisation at a certain time. Safety climate is the group members' attitudes to safety while safety culture constitutes the causes to these attitudes.



Forming of attitudes and behaviour



Model adapted from Eagly & Chaiken (1993)



Components of safety climate (Flin et al., 2000)

- Management/supervision
- Safety systems
- Risk
- Work pressure
- Competence

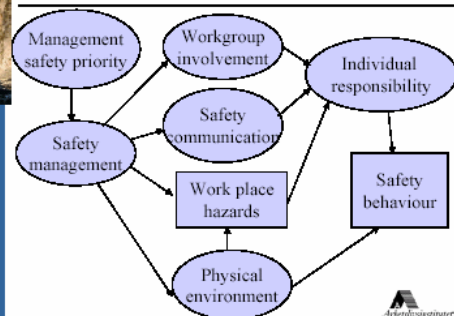


Components of safety climate (e.g. Guldenmund, 2000, Neal et al., 2000)

- Communication
- Individual responsibility/motivation
- Team work/group involvement
- Incentives and
- Reflection on practice!



Safety climate (adapted after: Cheyne et al, 1998)



Possible topics for discussion

- 1) How can we co-operate in attracting interest in second order problems for second order solutions?
- 2) How can cooperation between practice and research be improved in order to substantially improve safety?
- 3) Where do we need further knowledge?
- 4) What are the differences and similarities between the Nordic countries in regards to risk management?



2.3.3 Summary of roundtable discussions

In regards to safety climate:

- It makes sense to differentiate between first and second order problems and solutions in the construction industry. First order problems are man-machine oriented, whereas second order problems and solutions deal with issues on the organisational level. Identifying such problematic areas, and dealing with them, has the potential of solving not only safety problems, but problems with a variety of negative outcomes due to deficient internal quality management
- Companies need to acknowledge the difference between first and second order problems and solutions, and focus more on problems and solutions of the second order
- There are many barriers/challenges in the construction industry which prevent organisation focusing on second order problems and solutions
- The level of safety culture/climate is often dependent on construction branch, trade and work site
- Risk taking is part of the construction industry's safety culture. So-called 'unsafe' behaviour is most often rewarding, and seldom leads to accidents. Risk taking is often a contributing factor to construction injury incidents
- Even though risk taking is often a contributing factor to construction injury incidents, it is essential to investigate the underlying causes of such risk taking
- Management is accountable for providing a safe working environment
- Rules are needed for everyone involved in and on company grounds, from the manager, workers, visitors and cleaning personnel
- Solutions involve the interrelationship between systemic issues (rules, regulations, planning) and on-site communication. The systemic approach can become static, leading to unsafe behaviour. Reflection on practice is essential for continual improvement
- There are advantages and disadvantages of safety 'bonus' programs
- Safety is an integrated part of production, e.g., company image, and can effect customer satisfaction
- There is a need for a 'safe working environment' tool, in addition to the tools for improving 'safe behaviour'. Safe behaviour tools can become too mechanistic, and we miss seeing possibilities in improving the work environment
- There is too much focus on the individual and man-machine environment, rather than on the organisation
- There is a need for more knowledge regarding interactions between the organisation and the individual worker in creating a climate of safety
- Not all injury incidents are of equal interest. There is a need for a greater focus on more serious accidents, yet at the same time, we can certainly learn from near-accidents.
- Safety culture is an important aspect of the solution to worker safety, but it is not the single solution
- Great progress in attracting interest to both first and second order safety has been achieved though programs that deal with worker rehabilitation and injury prevention, such as when injured workers tell others of their injury and rehabilitation experience.
- There is an increasing focus on thinking more holistically in terms of safety, incorporating dialogue, participation and thinking in systems
- It is difficult to find good role models for 'safety culture'

- There is a need for more positive feedback regarding safe behaviour and performance, and in taking pride in safety
- Change processes may take a long time to get started, but once started can become self-generating and easy to administer
- There is a need for making safety climate more visible and understandable by attaching/associating words to it, e.g., motivation, work pressure and teamwork.

Communication and education

- Communication is a key aspect of safety, requiring dialogue between the different parties
- Good communication involves sharing knowledge that gives meaning to the people who own the problem.
- It is important to pay attention to each individual's reality
- Some people think primarily in technical terms, and are not used to dealing with the human aspect. Their lack of communication skills creates barriers to dialogue and process
- Workers should learn to take a more critical approach to their work, asking questions as to the safety of work routines and equipment
- The Nordic countries are often referred to when thinking of non-hierarchical, whereas companies in many other European countries have a hierarchical structure

2.4 Occupational accidents in small and medium sized companies

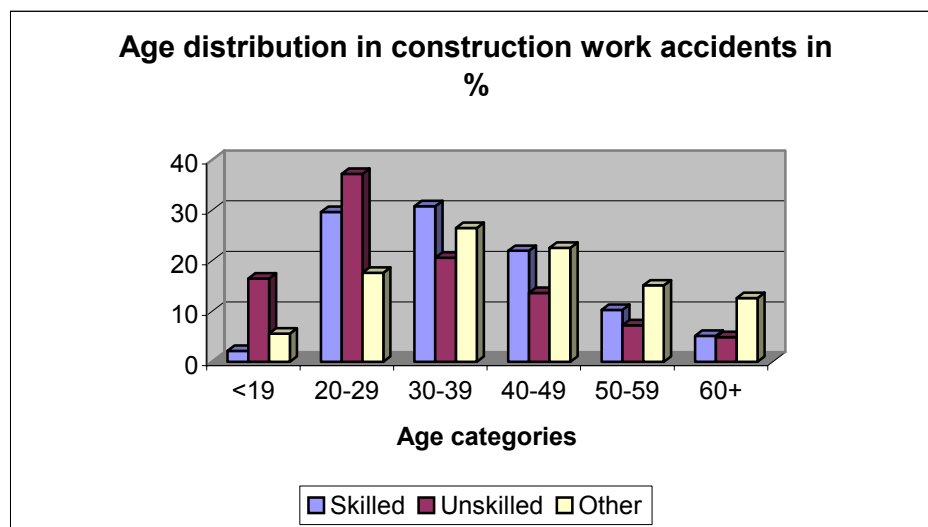
Plenary speaker: Kristinn Tómasson, Dr.med, Medical Director, Administration for Occupational Health and Safety, Iceland

2.4.1 Plenary abstract

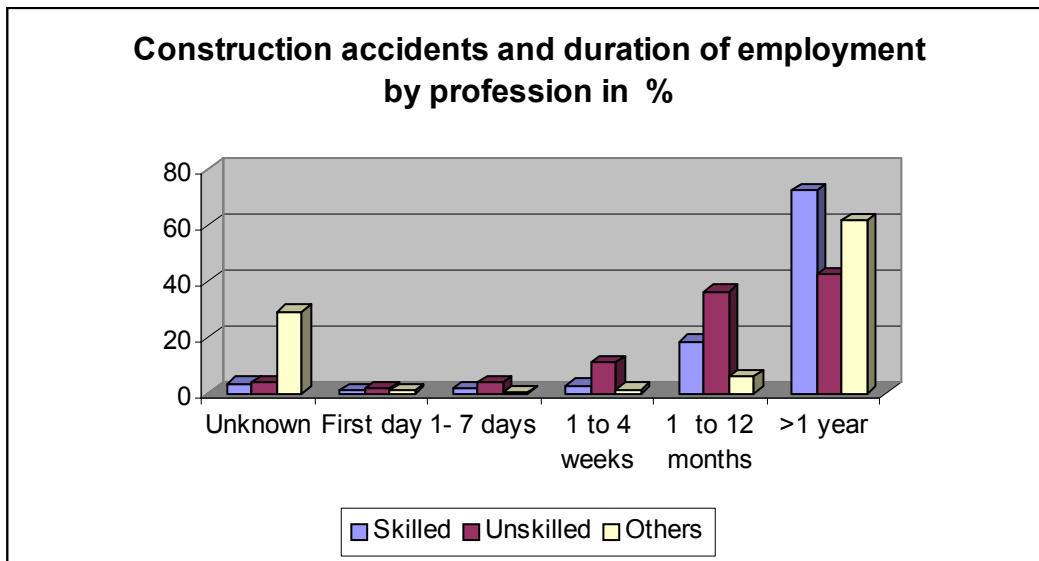
The construction industry in Iceland has been recognized as one of the most occupational accident-prone industry in Iceland on land with 13% of all reported occupational accidents. Looking at all accidents both occupational and others encountered by skilled construction workers compared with others the Odds Ratio (OR) is 1.87 for them getting into any type of accident ($p < 0.035$) which if adjusted for gender is not significant. Thus skilled construction workers are not, as such, more accident-prone than others.

Thus, given that background, it is important to look at occupational accidents at the construction site.

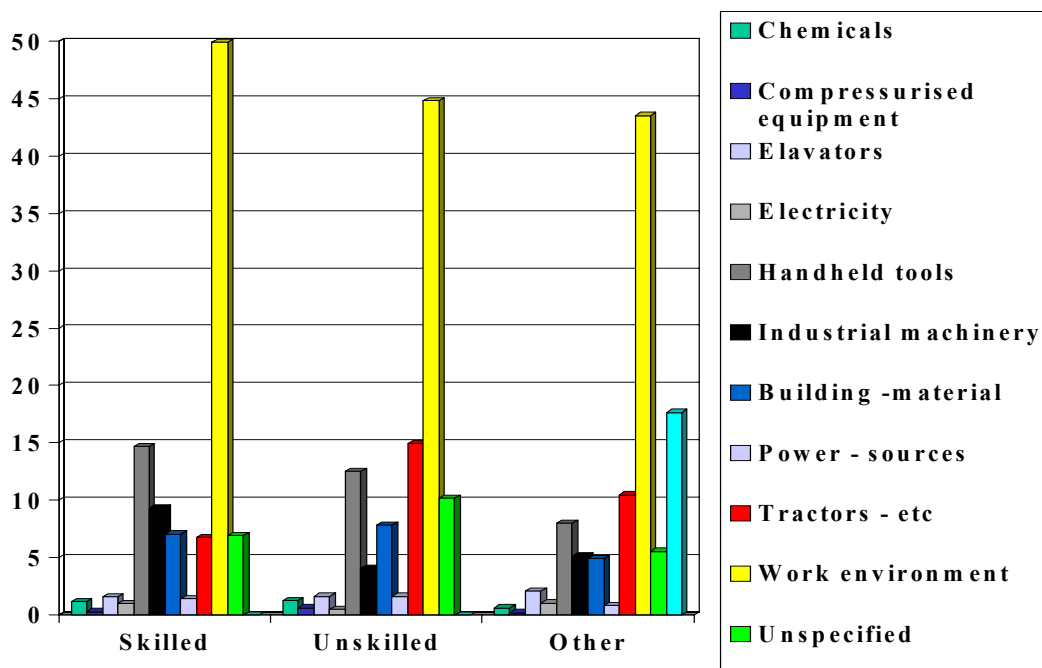
Who is involved? How old are they?



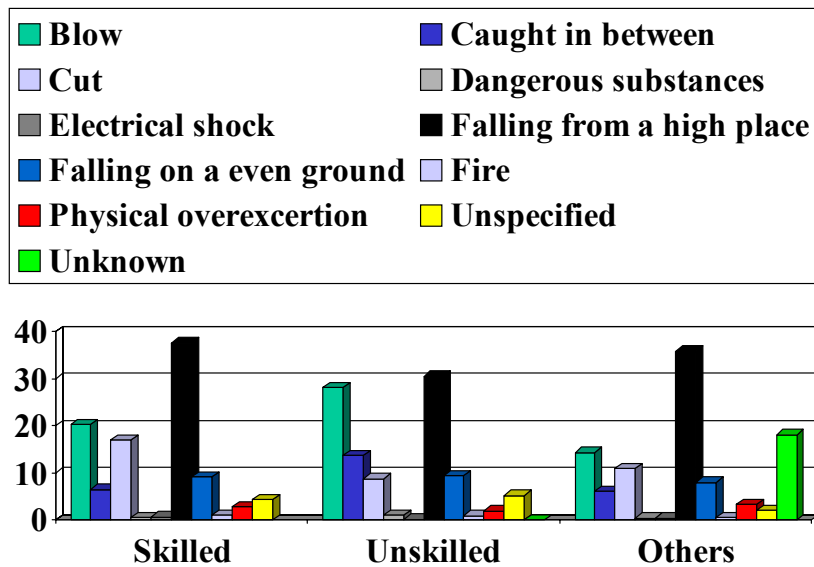
How long have they been working for the company?



What are the causes of the accidents?



What causes the injury?



In assessing the workplace, several factors need to be looked at. These include, whether potentially dangerous areas are visible, clearly marked, whether the work area is continuously kept clean and free of hazards, and whether the noise level at the workplace prevents alarm signals from being heard. Also, is safety equipment in use not only by regular employees of the work area, but also by visitors and employees coming to the worksite on an irregular basis? Has the risk evaluation been completed and do the employees know the results, and do they know how to respond in case of an emergency? Are the employees sufficiently skilled, trained, and supervised for the task. Do they have medical problems like visual or hearing impairment or others that may influence their ability to tackle their work safely? Finally, do they have lifestyle problems resulting in that they show up for work tired due to lack of sleep or due to excess use of alcohol or other substances?

It is clear that for small and medium sized construction companies the task of maintaining the work-place accident-free is a continuous task, with changes involved in every new work the company is involved with. Companies, due to their size, will have to rely on the workers to take the necessary safety steps – thus the cardinal focus of occupational accident prevention, especially within small and medium sized companies, is to better educate construction worker as to what is safe practice.

2.4.2 Plenary slide presentation

Micro, small and medium sized firms

Kristinn Tómasson, Iceland

Percentage of enterprises and employment by size class in EU

Number of employees	Percentage of enterprises	Percentage of employment
1-9	93.1	33.8
10-49	5.9	18.8
50-249	0.8	13.2
250+	0.2	34.2

Nordic Research Seminar
Safety in Building and Construction Industries
Copenhagen 9.10.2003
European agency for safety and health at work 2003

Occupational injuries with >3 days absence and fatal accidents per 100.000 employees by firm size in EU + Norway (true for most industries)

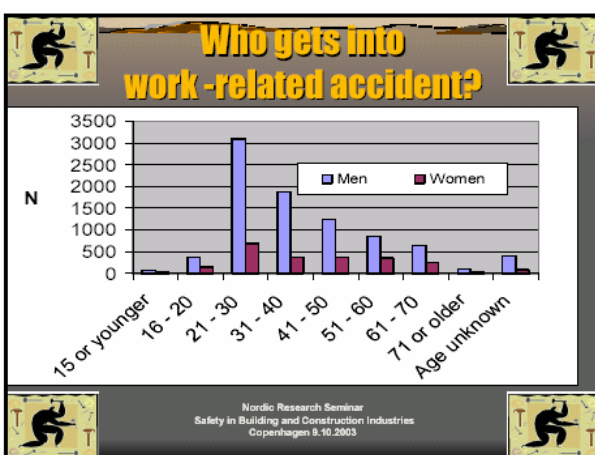
Number of employees	Occupational injury >3 absense	Fatal accidents
1-9	3886	6.4
10-49	5218	6.1
50-249	4085	3.1
250+	3254	2.4

Nordic Research Seminar
Safety in Building and Construction Industries
Copenhagen 9.10.2003
European agency for safety and health at work 2003

To consider

- Most construction firms are very small
- For most safety management is the responsibility of the individual worker
- Expert knowledge only available through outside consultation
- Larger construction firms engage smaller construction in specific tasks
 - The following data is from
 - Icelandic accident registry

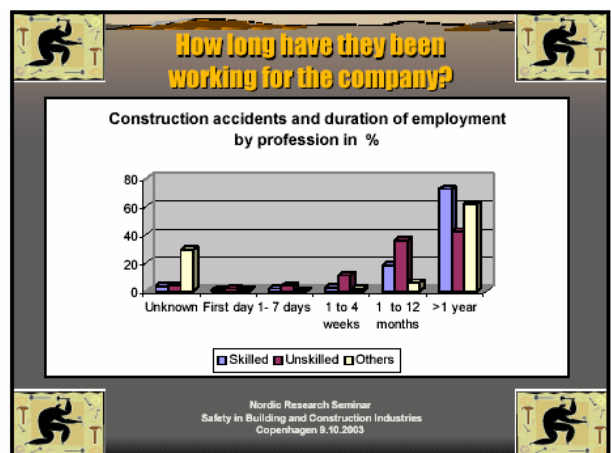
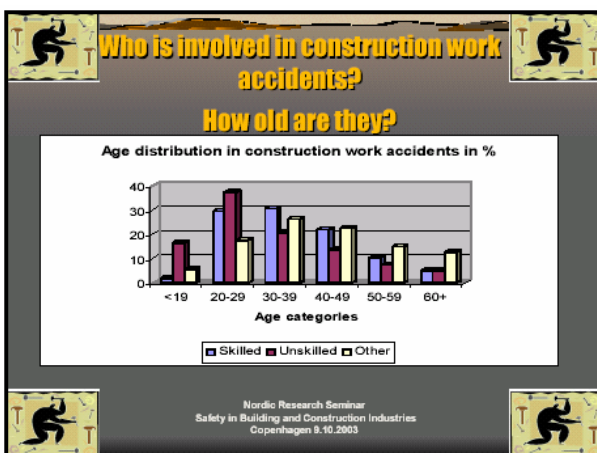
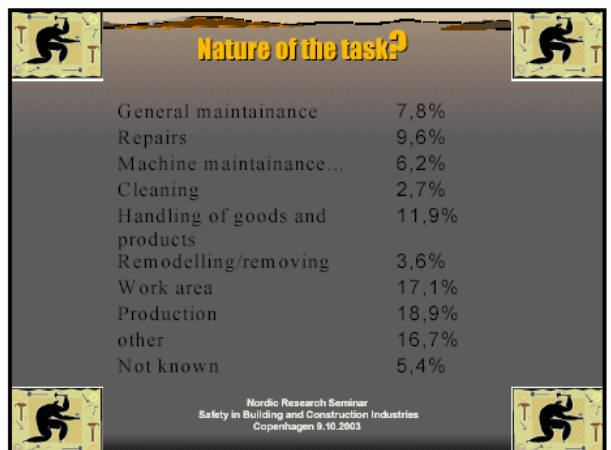
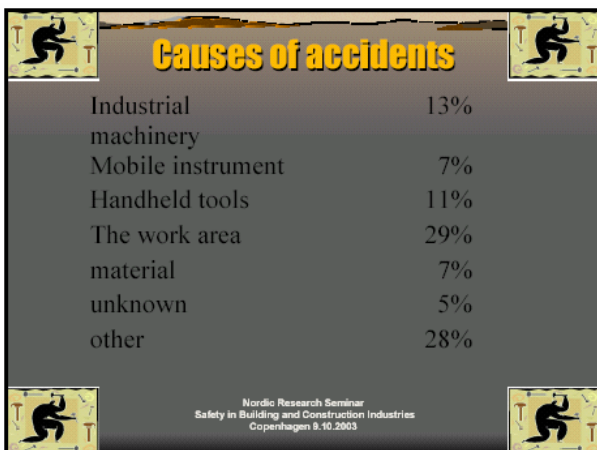
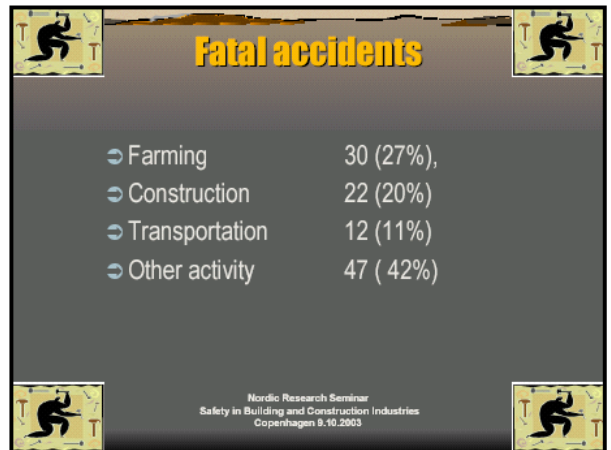
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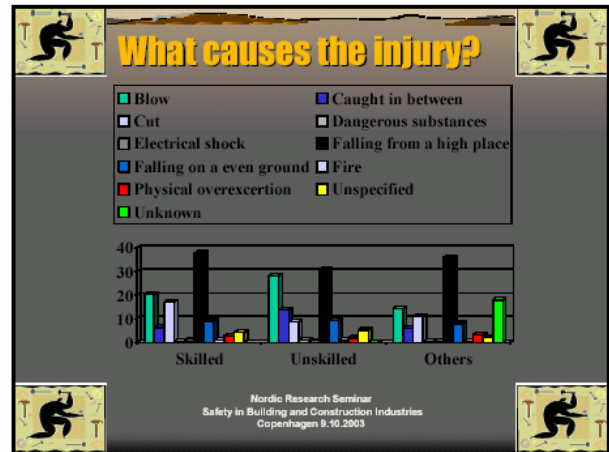
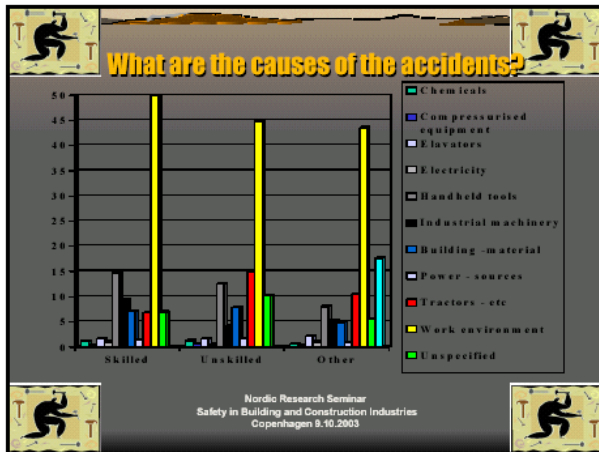


Fatal accidents

- Most common between the age 20 and 30 years of age.
- For those younger than 40, there are 6 fatal accidents for each 1000 reported accidents
- 11 fatal accidents per 1000 reported accidents for those who are older

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Occupational accident assessment requires knowledge

- ⇒ About the workplace
- ⇒ Safety equipment
- ⇒ The skills of the workers
- ⇒ Health of the workers
- ⇒ Lifestyle of the workers

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Conclusion

- ⇒ Construction workers in SME need more education about safe procedures and occupational accident prevention
- ⇒ But

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Possible topics for discussion

- ⇒ How should they obtain the information and how should they call for new solutions?
- ⇒ How can cooperation between practice and research be improved in order to substantially benefit the SME construction worker?
- ⇒ Where do we need further knowledge?
- ⇒ What are the differences and similarities between the Nordic countries in regards to SMEs?

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2.4.3 Summary of roundtable discussions

In regards to construction firm size:

- Small companies need to abide by the same rules and regulations as large companies
- The most relevant laws and regulations should be provided in a brochure targeted towards small firms
- Small companies have fewer resources than large companies to focus on safety.
- Small companies are often difficult to reach and initiate in dialogue. The use already existing contacts or networks within small companies is of great potential in reaching out to the small companies, e.g., accountants, health services, consultants, trade schools, occupational inspection agencies, peer-system and daily networking among other construction workers. This can be in more or less indirect approaches, such as using the opportunity of talking about a company's financial situation to discuss health and safety issues.
- Safety information for small companies can also be passed on in more indirect approaches, e.g. in discussions about economics, health, etc.
- Make greater use of peer system, daily networking among construction companies and workers, and use of large companies to show the way to an improved healthy and safe work environment
- Improve the professional education of construction workers, with an increased focus on safety and health issues
- A group of small companies could jointly employ an occupational safety and health consultant
- Increase use of certification for documented good safe work practices and records
- There is a need for information on how current health and safety regulations do or do not reach small companies? Do the regulations have an impact? Why or why not?
- Health and safety information to small companies needs to be informative yet short and simple to understand. Use of pamphlets or 1 page leaflets
- Small companies need incentives for investing in health and safety
- Reinforce pride for having good safe work practices

2.5 Accident prevention – Good practices for safety management in construction

Plenary speaker: Jorma Lappalainen, Occupational Safety Specialist, Tampere Regional Institute of Occupational Health, Tampere, Finland.

2.5.1 Plenary abstract

Starting point

This presentation is based on a recently completed Finnish publication of good practices for safety management in the construction industry ¹⁾. The starting point is the "Zero Accident" philosophy. It is possible, also in construction. All accidents are preventable.

Goal

The goal was to obtain information on the most important practices for helping construction sites decrease accidents drastically. It was not the purpose to create some form of complete system, but rather, to devise practices that every company can apply in their own way as they develop their safety practices.

Content

The content is based on data screened from Finnish and international information on safety practices. In addition, key persons were interviewed from the two construction sites that were rated best in the annual Finnish construction site competition (2001).

11 good practices

The result was 11 good practices. For comparison, five were published in the USA in 1993, and the list has been expanded to nine ²⁾, of which eight are the same as the items on our list. Drug and alcohol testing are not included, but site co-ordination, follow-up, inspections and safety instructions are.

The good practices for safety management in construction are:

1. Demonstrated management commitment
2. Co-ordination and management of safety on site
3. Staffing for safety
4. Safety training and education
5. Safety planning
6. Subcontractor management; safety included in agreements
7. Site-specific safety instructions
8. Safety performance reviews and inspections
9. Worker involvement and commitment
10. Feedback and rewards
11. Accident/incident reporting and investigation

How to implement good practices for safety management in a company

Top management should

- 1) adopt the "Zero Accident" philosophy and make it a company goal
- 2) set up a development programme for occupational safety
- 3) create a culture that will encourage all employees to accept the "Zero Accident" philosophy and goal
- 4) recognise and inform all that profit lost through worker injury is not covered by insurance
- 5) apply all (11) good practises for safety management in the company
- 6) establish the practice of including safety requirements in all contracts
- 7) define explicitly the authorities and responsibilities of all personnel regarding occupational safety on construction sites
- 8) encourage the owner to be an active participant in implementing the "Zero Accident" philosophy
- 9) conduct audits of safety activities and the work environment regularly and implement needed improvement measures
- 10) ensure that all parties working on a site are active advocates of safety and that they try to achieve the same safety level.

Effects of good practices

One earlier Finnish study showed based on accident statistics on selected construction sites that these sites were able to develop much better than average safety by using good practices. The accident frequency of these sites was only one-fourth the average for construction sites (Figure 1) ³⁾

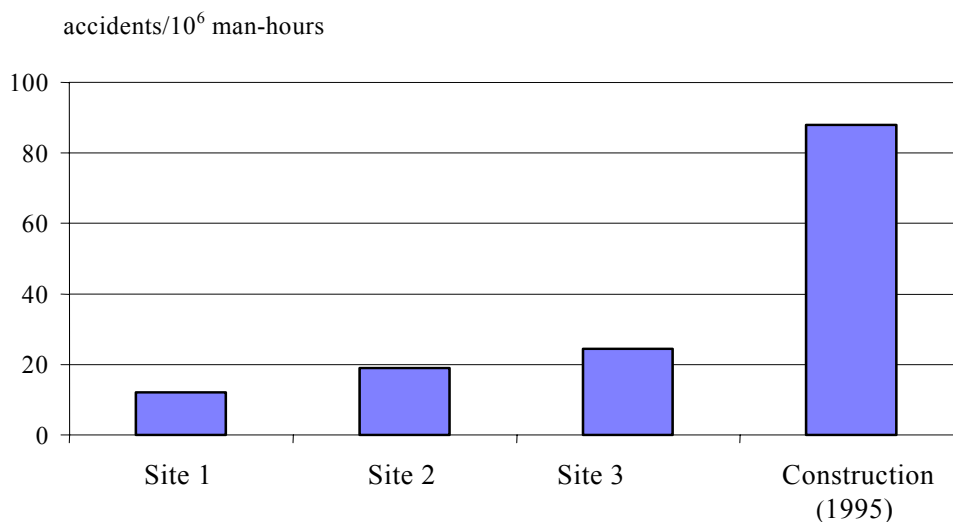


Figure 1. Accident frequency on the three good sites and in construction in general in 1995.

In the USA it has been found that construction sites that implement most of the advocated good practices have a recordable incident rate of 2 workers/1000 versus 38/100 for sites on which only a few of these practices are in force.⁴⁾

References

- 1) Lappalainen J., Sauni S. & Piispanen P.: Rakennustyön turvallisuusjohtamisen hyviä käytäntöjä. Mitkä ovat tehokkaita keinoja vähentää työtaturmia? RATUKE-hanke. Rakennusteollisuuden Kustannus RTK Oy. 2003. 32s.
- 2) The Construction Industry Institute Zero Accident Task Force 1993. Zero Injury Techniques. Publication 32-1.
- 3) Lappalainen, J., Sauni, S., Piispanen, P., Nurmi, S.: Good Safety Management on Combined Construction Sites. Symposium: Safety and Health in the Construction Industry in the 21st Century, International Section of the ISSA for the Prevention of Occupational Risks in the Construction Industry & Allgemeiner Unfallversicherungsantalt (AUVA), Proceedings, Wien 1999, 291-293.
- 4) Mathis J.: Making Zero Accidents A Reality. Making Zero Accidents A Reality Project Team. CPI Conference 2001. (http://construction-institute.org/cpi2001slides/mathis_cpi.ppt)

2.5.2 Plenary slide presentation

ACCIDENT PREVENTION - GOOD PRACTICES FOR SAFETY MANAGEMENT IN CONSTRUCTION

Jorma Lappalainen

Nordic Research Seminar. Safety in Building
and Construction Industries: State of the Art
and Perspectives on Prevention

Copenhagen 9.10.2003

JL/Nordic Research Seminar
9.10.2003

1

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- ♦ It is possible also in construction.
- ♦ All accidents are preventable!
- ♦ This presentation is based on a recently completed Finnish publication of good practices for safety management in the construction industry.



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2

GOAL

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- ♦ It was not the purpose to create some form of complete system but, instead, to devise practices that every company can apply in their own way as they develop their safety practices.



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3

CONTENT

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- ♦ In addition, key persons were interviewed from the two construction sites that were rated best in the annual Finnish construction site competition (2001).



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11 GOOD PRACTICES

- ♦ The result was 11 good practices
- ♦ For comparison:
 - USA 1993: 5 good practices (techniques);
 - Now 9, from which 8 are the same as items in our list.
 - Drug and alcohol testing are not included,
 - but site co-ordination, follow-up, inspections and safety instructions are.



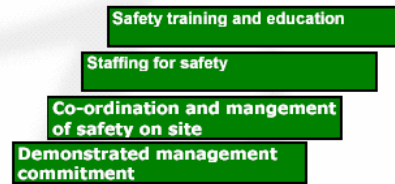
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THE MOST IMPORTANT GOOD PRACTICES (1-4)

"basement completed"



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THE MOST IMPORTANT GOOD PRACTICES (5-8)

"framework completed "



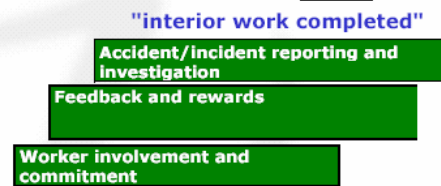
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THE MOST IMPORTANT GOOD PRACTICES (9-11)

"house of safety ready"



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8



HOW TO IMPLEMENT GOOD PRACTICES FOR SAFETY MANAGEMENT IN A COMPANY 1

Top management should

- 1) adopt the "Zero Accident" philosophy and make it a company goal
- 2) set up a development programme for occupational safety
- 3) create a culture that will encourage all employees to accept "Zero Accident" philosophy and goal
- 4) recognise and inform all that profit lost through worker injury is not covered by insurance

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HOW TO IMPLEMENT GOOD PRACTICES FOR SAFETY MANAGEMENT IN A COMPANY 2

- 5) apply all (11) good practises for safety management in the company
- 6) establish the practice of including safety requirements in all contracts
- 7) define explicitly the authorities and responsibilities of all personnel regarding occupational safety on construction sites

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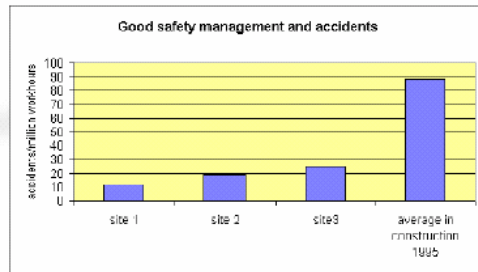
HOW TO IMPLEMENT GOOD PRACTICES FOR SAFETY MANAGEMENT IN A COMPANY 3

- 8) encourage the **owner** to be an active participant in implementing the "Zero Accident" philosophy
- 9) conduct **audits** of safety activities and the work environment regularly and implement needed improvement measures
- 10) ensure that **all parties** working on a site are active advocates of safety and that they try to achieve the same safety level

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11

THE EFFECT OF GOOD PRACTICES. A result of one earlier Finnish study.

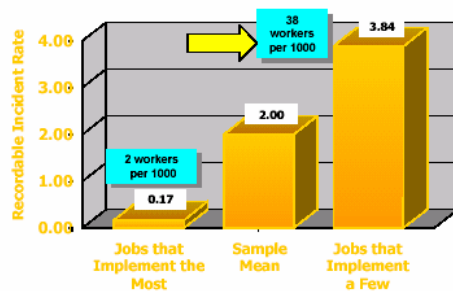


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Project Safety Performance Experience from the USA (Mathis 2001)

Results of implementing best practices



SAFE WORK RUNS SMOOTHLY!



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Possible topics for discussion

- 1) We have found that 2 of these 11 good practices are **weaker** than others: a) worker involvement and commitment, and b) feedback and rewards. Do other countries have the same? Do you have good examples of these?
- 2) How can cooperation between practice and research be improved in order to substantially **improve safety**?
- 3) Where do we need further **knowledge**?
- 4) What are the differences and similarities between the Nordic countries in regards to **safety management**?

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2.5.3 Summary of roundtable discussions

In regards to safety management:

- The two 'good practices' that were found to be weaker than the other nine (worker involvement and commitment, feedback and rewards) are key dimensions in safety culture
- Make workers visible for health and safety achievements
- Use of incentives for attaining different levels of good health and safety practices and records
- Safety culture is one of the biggest problems in construction
- Sharing of tacit/silent knowledge
- Three interdependent dimensions for success: experienced workers, motivation for sharing information and an opportunities to share health and safety information, e.g., at formal or informal meetings
- It is important that there be feedback, both positive and negative. Feedback is important for a continual learning progress
- Health and safety is increasingly included in tender contracts, include demands to subcontractors
- There is a need for more knowledge regarding use of intrinsic rewards. What motivates people? Is it having made a contribution?
- Difficult to motive and build commitment among employees and employers in a dynamic industry with constantly changing workplaces and workforce
- Difficulties in involving workers may be linked to higher level personnel, often engineers, who are not trained in dealing with people, such as in involving workers in decision making

3 Nordic Projects

3.1 Ongoing Nordic projects

3.1.1 Nordic occupational safety climate questionnaire

Project coordinator: Kim Lyngby Mikkelsen

Affiliation: Division of Safety Research, National Institute of Occupational Health, Denmark

E-mail: klm@ami.dk

Summary: The goal of this Nordic project is to establish a safety climate questionnaire for use in companies in the Nordic countries. The questionnaire will form the basis for studies of safety climate within and between the Nordic countries. A safety climate questionnaire will be developed specifically for the construction industry, followed by a general questionnaire for use in all industries.

The project is carried out by the **Nordic Network of Occupational Safety Research**, with representatives from the Ullevål University Hospital, Norway, the Finnish Institute of Occupational Health, the National Institute for Working Life, Sweden, the National Institute of Occupational Health, Denmark and the Administration for Occupational Health & Safety, Iceland.

Time period: 2003-2004

4 Denmark

4.1 Ongoing Danish projects

4.1.1 Absence due to injuries during construction of the Copenhagen Metro

Project coordinator: Søren Spangenberg

Affiliation: Division of Safety Research, National Institute of Occupational Health, Denmark

E-mail: ssp@ami.dk

Summary: The purpose of this study is to identify which types of occupational injury contribute most to absence during heavy construction work.

Time period: 2002-2003

Report: A peer reviewed article is under preparation

4.1.2 Accident prevention in construction companies – safety culture and learning

Project coordinator: Anne Richter

Affiliation: Technical University of Denmark, Department of Civil Engineering

E-mail: ari@byg.dtu.dk

Summary: The objective of this project is to attain knowledge regarding opportunities and barriers for the prevention of occupational accidents within certain parts of the construction industry. The goal is to develop practical methods that can help make accident prevention more effective than it is today. The methods used in the study have a safety-culture, developing and learning perspective, and are to be used in construction companies and in construction trade education.

The focus is on how safety culture develops and changes, and on company structural conditions. On the basis of these analyses, a risk analysis method is introduced, based on learning, in both schools and in companies.

Time period: 2002-2004

4.1.3 Hospitalising injuries among tunnel and bridge construction workers

Project coordinator: Søren Spangenberg

Affiliation: Division of Safety Research, National Institute of Occupational Health, Denmark

E-mail: ssp@ami.dk

Summary: The aim of this study was to compare annual hospitalisation rates due to injuries among people employed in the construction of major tunnel and bridge traffic links in Denmark 1994-2000, with those obtained in the Danish construction industry at large.

Time period: 2002-2003

Report: Peer reviewed article – submitted

4.1.4 Identification and handling of risks in the building and construction industry

Project coordinator: Johnny Dyreborg

Affiliation: Division of Safety Research, National Institute of Occupational Health, Denmark

E-mail: jd@ami.dk

Summary: The building and construction industry is one of the economic sectors with the greatest amount of injury incidents in relation to the number of employees. Risk factors are present in all types of activities, but some companies have more success than others when it comes to controlling risks. The purpose of this PhD project is to study the organisational processes involved in controlling risks. In other words, how risks are identified, defined and handled through managerial decisions and work activities. The focus is on how companies reach an 'acceptable' level of risk, as well as how measures are implemented. The project will develop methods to measure the level of injury risk control as well as to identify possible improvements in the handling of risks within the building and construction industry.

Time period: 2002-2005

Report: PhD thesis

4.1.5 Knowledge and Practice - an anthropological study of safety at a Danish construction site

Project coordinator: Charlotte Baarts

Affiliation: Division of Safety Research, National Institute of Occupational Health, Denmark

E-mail: cb@ami.dk

Summary: The objective of this project is to discuss how a group of construction workers' knowledge of safety is practiced at a Danish construction site. As such, the problem under study is the relationship between knowledge and practice. However, this relationship is not to be understood as a linear or causal relation where knowledge simply is transformed to practice and performed. Practice is performed in a social field, where aspects such as professional pride, solidarity, trust, language and sociality among others is part of the game.

The study is based on an ethnographic fieldwork, which took place at a Danish construction site. The researcher worked as an apprentice for seven months sharing experience, knowledge and practice with the construction workers. At the end of the fieldwork qualitative interviews with the construction workers were performed.

The project is carried out in connection with the Division of Safety Research at the National Institute of Occupational Health, Denmark, and in cooperation with the Danish Working Environment Council's Service Centre, the Department of Anthropology at the University of Copenhagen, and the National Institute of Working Life in Stockholm.

Time period: 2001 to 2004

Report: PhD thesis

4.1.6 Morbidity among bridge and tunnel construction workers who worked long hours and long days constructing the Great Belt Fixed Link

Project coordinator: Finn Tüchsen

Affiliation: National Institute of Occupational Health, Denmark

E-mail: ft@ami.dk

Summary: The aim of this study was to estimate the morbidity of hospital treatment among bridge and tunnel workers who worked long hours, and long weeks to construct the Great Belt Fixed Link in shifts around the clock.

Time period: 2002-2003

Report: Peer reviewed article – Submitted

4.1.7 Prevention of occupational injuries during construction of major traffic links

Project coordinator: Søren Spangenberg

Affiliation: Division of Safety Research, National Institute of Occupational Health, Denmark

E-mail: ssp@ami.dk

Summary: During the construction of the Great Belt Link (1988-1998), the number of occupational injury incidents soon exceeded the average injury incidence rate of the building and construction industry in Denmark. During construction of the Øresund Link (1992-2000) between Denmark and Sweden and the Copenhagen Metro (1997) it was therefore decided to put more focus on occupational injury prevention, and various safety arrangements were implemented: including a multi-faceted safety campaign, a safety inspection method called “Mønterarbejdsplads” and on-site medical treatment facilities. The multi-faceted safety campaign and the safety inspection method aimed both at preventing occupational injuries, while the medical facilities aimed at providing immediate medical assistance to workers subjected to injuries, and at reducing lost working time.

The construction of several other major road and rail traffic links, like the Øresund Link, are currently in the planning stages, e.g. a 20-km link across the Fehmarn Belt between Germany and Denmark is being planned. Therefore, the purpose of the present Ph.D. project is to evaluate the effectiveness of these safety arrangements in preventing or reducing lost-time injuries, and to point out possible improvements.

At certain work sites Danish and Swedish workers were employed in the same organization and in cross-national work gangs (the languages are very similar) with the same type of tasks. Comparison of injury data shows that the lost-time injury rate of the Danish construction workers is significantly higher than the lost-time injury rate of the Swedish construction workers.

From a preventive perspective – construction is an industry with high LTI-rates - it is important to identify injury risk factors that contribute to the observed difference in LTI-rates between Danish and Swedish construction workers. Thus the purpose of the Ph.D. project is furthermore to point out factors, which might explain the national difference in LTI-rates.

Time period: 2003-2004

Report: PhD thesis (see also abstracts 4.1.10; 4.2.4; 4.2.9)

4.1.8 Qualitative case studies of safety culture in small construction companies

Project coordinator: Annette Kamp

Affiliation: Technical University of Denmark, Department of Civil Engineering

E-mail: ak@byg.dtu.dk

Summary: Not yet available.

Time period: 2003

Report: In press

4.1.9 Safety culture and occupational accidents

Project coordinator: Kent Nielsen

Affiliation: Department of Occupational Medicine, Herning Hospital

E-mail: heckjn@ringamt.dk

Summary: The objective of this project is to study what “safety culture” is, through use of different supplementary methods (questionnaire, interviews, auditing, walk-throughs, observations). The goal is to make/study the connection between safety culture at a workplace and the physical environment, e.g., the meaning or influence of the actual safety culture on the number of accidents. Studies are carried out with companies in the building and construction industry.

This joint venture project operates under the national Centre for Occupational Accident Research, which includes researchers from the Department of Occupational Medicine - Herning Hospital, Research Centre RISØ, Division of Safety Research at the National Institute of Occupational Health, and the Department of Civil Engineering at the Technical University of Denmark.

Time period: 2003-2005

4.1.10 The efficiency of a nurse based and a first aid based on-site medical facility during construction of the Øresund link between Sweden and Denmark

Project coordinator: Søren Spangenberg,

Affiliation: Division of Safety Research, National Institute of Occupational Health, Denmark

E-mail: ssp@ami.dk

Summary: The purpose of the present study was to evaluate the efficiency in reducing lost-time injuries of two standards of on-site medical facilities during construction of the link across the Sound, Øresund, between Sweden and Denmark. One medical facility employed licensed nurses, who had advanced medical assistance at their disposal. The other medical facility utilized first aid trained watchmen. The on-site medical facilities aimed both at providing immediate medical assistance to workers subjected to occupational injuries, and at reducing lost working time.

Time period: 2002 to 2003

Report: Peer-review article – Submitted

4.1.11 Tools to prevent occupational accidents

Project coordinator: Anne Richter

Affiliation: Technical University of Denmark, Department of Civil Engineering

E-mail: ari@byg.dtu.dk

Summary: The objective of this project is to develop a tool to analyse occupational accidents and near-miss-accidents in the construction industry. This is a process-tool that at the same time can be used to prevent similar situations, and, in addition, can be used as a basis for companies' accident statistics.

The tool is based on the National Working Environment Authority's "Sherlock-Holmes" method, and is adapted to conditions in the construction industry.

Time period: 2002-2003

4.2 Completed Danish projects

4.2.1 Accidents, illness and mortality: Work environment, health and camps

Project coordinator: Finn Tüchsen

Affiliation: Department of Epidemiology and Work Environment Surveillance, National Institute of Occupational Health, Denmark

E-mail: ft@ami.dk

Summary: The purpose of this project was to study accidents, illness and mortality of construction workers involved in the building of the Great Belt Bridge, the Øresund Link or the Copenhagen Metro. The project concludes that workers involved in large construction projects and who live in camps have a reduced accident risk compared to workers who commute to and from the project. Bridge and tunnel workers had a higher hospital treatment rate than for all occupations combined and within the construction industry.

Time period: 2002 to 2003

Report: Tüchsen F, Hannerz H, Spangenberg S. (2003). Ulykker, sygelighed og dødelighed: Arbejdsmiljø, helbred og camps. Center for Alternative Samfundsanalyse, København, Denmark.

4.2.2 Accidents in building and construction – a more in-depth analysis of causes of occupational accidents

Project coordinator: Anne Richter

Affiliation: Technical University of Denmark, Department of Civil Engineering

E-mail: ari@byg.dtu.dk

Summary: The Danish construction industry comprises a wide range of dangerous tasks and work settings many of which take place in temporary sites. The incidence of occupational accidents thus average 288 per 10.000 workers, exceeding the average on the labour market as a whole, which is 188. Often an accident is characterised as “one of those accidents, which might happen to anyone”, missing out opportunities to subsequently introduce preventive measures.

By initiative of Sectional Working Environment Council within Construction and Building, the Technical University of Denmark and employees from Occupational Health Centres have carried out an in-depth analysis of background and barriers of these situations.

Methods:

Both quantitative and qualitative methods were applied. Special running of the Danish Labour

Inspection's statistics on occupational accidents was worked up to give a more detailed background of the range of accident-occurrence in the industry. An analytical framework was developed taking in risks, technology, level of experience/qualifications, workplace, size of firm, plus type of construction and phase of completion.

The in-depth study took place in three big construction firms, representing the core of tasks and trades of the industry. Key members of the main safety-committee were interviewed. Focus was safety issues in relation to the firm; organisation, co-operation, employees, customers, construction projects, technology, health and safety-work, policies, relations to partners, accidents, statistics, personal experiences, objectives in relation to preventive measures, etc.

Random occurrence of 15 accidents in the three construction firms was recorded on the site of the accident. All involved persons including the injured person - if present -, were interviewed in regards to the course of events resulting in the accident, tasks, injury, preventive measures, resources, material, tools and building components used, working environmental issues, work organisation, type of contract, managerial control, health and safety etc.

The interviews were carried out by employees from the Occupational Health Centres and analysed by researchers from the Technical University of Denmark.

Results:

Data from the 15 accidents indicates, that several of the accidents might have been avoided, if a better risk assessment had been carried out, and/or if systematic health and safety procedures or tools to control and prevent accidents had been integrated into the planning and execution of the work. Causes given for not having done this were related to conflicting messages from management, - say between safety and profit -, traditions of co-operation between various actors on site and failing participation in the health and safety-work.

The analysis of the accidents classifies insufficient working conditions and working environment and also technical and organisational weakness' to be the main reasons behind accidents. Only in a few cases could events leading to the accident be related directly to unsafe behaviour of the injured worker.

Causes were directly related to unfit, worn-out and/or physical straining equipment, insufficient instructions in work-procedures and equipment, deficiencies in the delivery and quality control of materials, plus shortcomings in the design. Underlying causes related to organisational and technical policies and choices were scarcely mentioned.

Conclusions:

An in-depth and participative approach to analysis of accidents may convert personal responsibility and guilt to shared learning experiences on risks and accidents prevention.

This could enable the firms to govern and address barriers towards preventive actions on accidents. Currently, however, a range of methods to analyse accidents adapted to the construction industry are needed.

Time period: 2002

Report: Richter A, Pedersen EF, 2002; Ulykkesårsager indenfor bygge og anlæg – en dybere analyse af årsager til arbejdsulykker: BAR for Bygge og Anlæg og DTU.

4.2.3 Construction workers' falls through roofs: fatal versus serious injuries

Project coordinator: Pete Kines

Affiliation: Division of Safety Research, National Institute of Occupational Health, Denmark

E-mail: pk@ami.dk

Summary: The study examined risk factors for fatal versus serious injuries of construction workers' falls through roofs. Fatal injury falls (N=10) were matched against serious injury falls (N=10), and descriptive analyses were carried out retrospectively of investigation reports. Fatal injuries occurred predominantly on farms, in the afternoon, and without the use of passive personal fall protective equipment (safety net, lifeline, etc.). In contrast, serious injuries disproportionately occurred in the morning hours, and were likely due to decreased risk perceptions and less safe behavior, possibly as the result of the greater utilization of passive personal fall protective equipment. Risk factors for fatal and serious roof fall injury incidents differ in terms of farm/non-farm location, time of day and use of passive personal fall protective equipment. Occupational injury incident surveillance systems need to collect data systematically regarding the status and role of personal protective equipment.

Time period: 2001 to 2002

Report:

Kines P (2002). Construction workers' falls through roofs: fatal versus serious injuries. *Journal of Safety Research* 33(2), 195-208. (see abstract 4.2.5)

4.2.4 Factors contributing to the difference in work related injury rates between Danish and Swedish construction workers

Project coordinator: Søren Spangenberg

Affiliation: Division of Safety Research, National Institute of Occupational Health, Denmark

E-mail: ssp@ami.dk

Summary: Comparison of Danish and Swedish national occupational injury statistics shows that the reported LTI-rate, or number of reported lost-time injuries per million working hours, for Danish construction workers is significantly higher than the reported LTI-rate for Swedish construction workers. In terms of injury prevention it is important to identify injury risk factors that contribute to the observed differences in LTI-rates. In the present Øresund Link study Danish and Swedish workers worked in cross-national work gangs, carried out the same types of tasks and utilized the same reporting procedures for occupational injuries. Thus, factors that usually confound comparisons between countries were eliminated in this study. Furthermore, factors at company level were to a great extent excluded in the study design, which provided a unique opportunity to investigate the importance of injury risk factors at group and individual level for Danish and Swedish workers.

LTI-rates and injury risk factors were compared for Danish and Swedish workers during the construction of the combined rail and road link across the 16-km wide sound, Øresund, between Denmark and Sweden. The comparison showed that the LTI-rate of the Danish construction workers was approximately fourfold the LTI-rate of the Swedish construction workers. Factors at the micro-level (group and individual level), e.g. differences in education and experience, training and learning, and attitude, were important for the explanation of the significant difference in LTI-rates between Danish and Swedish construction workers. The study also indicated that comparison of national data on LTI-rates should be carried out with great caution.

Time period: 2001 to 2002

Report: Spangenberg et al. (2003), *Safety Science* 41, 517-530. (see abstract 4.1.7)

4.2.5 Male occupational falls from heights – In-depth analyses

Project coordinator: Pete Kines

Affiliation: Division of Safety Research, National Institute of Occupational Health, Denmark

E-mail: pk@ami.dk

Summary: This objective of this PhD project was to promote a better understanding of the genesis of male occupational falls from heights, for use in improved targeting of safety research and injury prevention. Unique methodological approaches in collecting and analysing injury incident data supplemented traditional methodologies in looking more in-depth at the interrelationships of human, technical, environmental and organisational factors, both proximal and distal to injury incident events. National (Danish) occupational injury surveillance data and police and work environment authority investigation reports were used in testing the Identical Causation Hypothesis. Factors involved in fatal, serious and minor injury incidents, were analysed and compared, with a focus on falls in the construction industry. The results added credibility to the Differential Causation Hypothesis by revealing that risk factors varied for injury severity by gender, age, economic sector, type of injury incident, construction firm size, construction trade, type of working surface, time of day and month of the year, geographic location and status of personal fall protective equipment. In addition, there was a proposed differential interrelationship in fatal versus serious injury falls through roofs by construction workers for the variable time of day, geographic location and status of passive personal fall protection equipment. The quantity and quality in the four data sources revealed a need for more comprehensive and systematic approaches in registering, investigating and analysing injury incidents.

Time period: 2000 to 2002

Report:

Kines P (2003). *PhD thesis* – Male occupational falls from heights – In-depth analyses.

National Institute of Occupational Health (Division of Safety Research) and Technical University of Denmark (Department of Civil Engineering). Copenhagen, Denmark.

Kines P (2001). Occupational Injury Risk Assessment Using Injury Severity Odds Ratios: Male Falls From Heights in the Danish Construction Industry, 1993-1999. *Human and Ecological Risk Assessment*, 2001, 7(7) 1929-1943. (see abstract 4.2.7)

Kines P & Mikkelsen KL (2003). The effects of firm size on risks and reporting of elevation fall injury in construction trades. *Journal of Occupational and Environmental Medicine*, 45(10), 1074-1078. (see abstract 4.2.10)

Kines P (2002). Construction workers' falls through roofs: fatal versus serious injuries. *Journal of Safety Research* 33(2), 195-208. (see abstract 4.2.3)

Kines P (2003). Case studies of occupational falls from heights: Cognition and behavior in context. *Journal of Safety Research*, 34 (3), 263-271.

4.2.6 Occupational accidents in Danish industry – new structures, safety culture or accident prone?

Project coordinator: Annette Kamp

Affiliation: Technical University of Denmark, Department of Civil Engineering

E-mail: ak@byg.dtu.dk

Summary: The objective of this project was to contribute to the basis for a research effort that is relevant for Denmark, and that reflects experience with accident prevention research in other countries. The project is based on a literature study, visits to research environments in northern Europe, as well as to selected Danish companies.

Five traditions within accident prevention are presented: psychological, technical, systems, cultural and social oriented accident research. The conclusion is that research and development efforts to strengthen accident prevention should be focused on the organisation, including the use of newer organisational theory. In this way, there is not just a focus on a mechanical understanding and formal structure, but also other approaches such as culture and learning.

Experience with Danish leading-edge companies shows a need for a broad-spectrum of initiatives that are adapted to individual companies. Research and development initiatives should help to identify problems and to develop methods that can solve them.

Time period: 1998

Report: Arbejdsulykker i dansk industri - nye strukturer, sikkerhedskultur eller ulykkesfugle?
- Rapport fra et forprojekt (In Danish)

4.2.7 Occupational injury risk assessment using injury severity odds ratios: Male falls from heights in the Danish construction industry

Project coordinator: Pete Kines

Affiliation: Division of Safety Research, National Institute of Occupational Health, Denmark

E-mail: pk@ami.dk

Summary: To allow for an improved targeted approach to occupational injury research and prevention, detailed risk analyses of fatal, serious, and minor occupational injuries were completed with a focus on male falls from heights in construction. Reported lost-time-injuries in Denmark (1993-1999) were analyzed for proportions, relative rates, and an injury severity odds ratio to assess relative hazards and reporting. Different types of injury risks, such as elevation falls *through* surfaces, were identified by contrasting fatal, serious and minor injuries. Trade-specific analyses provided evidence that the carpentry-trade group merits increased attention, as this group has excessively high proportions, rates and hazards for falls from heights, compared to the entire construction industry. Age-specific analyses of workers aged 20-59 revealed that the rates of serious-injury falls from heights increase with increasing age. This relationship was inverted for elevation fall injuries from roof surfaces. A focus on construction and falls from heights is necessary not only in terms of fatal injuries, but also for serious injuries. The use of an injury severity odds ratio to assess relative hazards and reporting is a useful supplement to proportions and injury rates in contributing to more precise targeting of subgroups for primary injury prevention.

Time period: 2000 to 2001

Report:

Kines P (2001). Occupational Injury Risk Assessment Using Injury Severity Odds Ratios: Male Falls From Heights in the Danish Construction Industry, 1993-1999. *Human and Ecological Risk Assessment*, 2001, 7(7) 1929-1943. (see abstract 4.2.5)

4.2.8 Planning accident prevention in demolition work

Project coordinator: Knud Christensen

Affiliation: Technical University of Denmark, Department of Civil Engineering

E-mail: kc@byg.dtu.dk

Summary: Demolition tasks are currently under transformation, and the demands for solutions for these tasks have increased, especially when seen in the perspective of growing environmental demands. This requires an increased need for the building sector to be able to handle demolition tasks in a technical, professional and effective administrative manner.

The Danish Contractors' Demolition Section has already entered into a voluntary agreement about "Selective Demolition" of public demolition tasks, and has developed quality and environmental management systems for use in this field. Only a few building owners and consultants have yet developed corresponding practical and administrative special knowledge

within the field.

In the latest notices from the Danish Working Environment Service – 574, 576 and 589 – there are growing demands for the planning and coordination of safety work on sites. These rules also apply for demolition tasks – whether the tasks are isolated or integrated in modernization and rebuilding projects. The rules demand identification, assessment and planning of “particularly hazardous work” and involving particular risks for safety and health. The present project focuses on the handling of “particularly dangerous work in demolition projects”. In the project report the demands for planning are made more specific and are related respectively to the duties of the building owner, the consultant and the contractor.

The perception of risk is crucial in the control systems and public instructions developed for quality and environmental management within the construction industry – there is a tendency to avoid paperwork and to concentrate planning and control around circumstances involving the particular risk of a serious failure. As an example, the latest circular about quality securing in building works requires a consultant to prepare a “statement about hazardous circumstances”. In the project report, a simple and convenient workable risk control model is described, setting the scene for a systematic assessment and handling of work that might involve a particular risk for safety and health during progress.

The demolition field is quantitatively moderately represented in the accident statistics - the project report refers to former research of this. To have a more qualitative and adequate picture of the particular risks in demolition work our own experience is supplemented with descriptions of hazardous incidents during demolition work. Information about such incidents has been collected in interviews with demolition contractors and is described in the annexes of the project report.

Knowledge about particularly hazardous work in relation to demolition is, along with the similar circumstances mentioned in the rules summarized in a check form designed for both consultants and contractors in relation to the identification and assessment of particular risks. Furthermore, proposals for control forms have been prepared which are intended for use in both the tender situation and during the actual work. These forms, along with an explanation of them, can be found in chapter 6 in the project report, and they represent an independent proposal for the contents of a potential set of instructions suitable for use in future demolition tasks.

The general philosophy of the suggested procedure is that the risks identified during planning and tender should be able to be carried on to the subsequent phases so that, as far as possible, information does not disappear. The method is tested in two cases and the results are used as examples in the guide.

The process of a demolition task is in a way the reverse of that for the construction of a new building – physically the building is demolished and removed instead of being built up. This means that the rules from the Danish Working Environment Service concerning building works are not entirely appropriate for demolition works.

In the project report there is a review of which rules are relevant for demolition works. This review is included in the proposal for the planning guide (chapter 6).

In summary the project report is an expression of the authors’ effort to contribute to the knowledge of how working accidents can be reduced effectively.

Time period: 2003

Report: N.T. Christensen, K. Christensen. 2003. Planlægning af ulykkesforebyggelse ved nedbrydningsarbejde. BYG•DTU. Lyngby.

4.2.9 The construction of the Øresund link between Denmark and Sweden: the effect of a multi-faceted safety campaign

Project coordinator: Søren Spangenberg

Affiliation: Division of Safety Research, National Institute of Occupational Health, Denmark

E-mail: ssp@ami.dk

Summary: The purpose of the present study was to evaluate the effect of a safety campaign implemented midway during the construction of the railway and road link across the Sound, Øresund, between Denmark and Sweden. The safety campaign was multi-faceted and aimed both at promoting positive attitudes towards safety, and at the behavioural aspects of safety at work. The effect of the campaign was a 25% reduction of the number of injuries resulting from accidents. This effect became only just statistically significant when heterogeneity of type of work before and after the campaign was taken into account. The modest effect of the safety campaign might be explained by the fact that the site, like any construction site, was a temporary workplace, where several contractors had short-term project assignments. Apparently, the contractors' working routines were not sufficiently affected by the safety campaign. Other factors, that might affect a safety campaign at a construction site, are discussed.

Time period: 2000-2001

Report: Spangenberg et al. (2002), *Safety Science* 40, 457-465. (see abstract 4.1.7)

4.2.10 The effect of firm size on risks and reporting of elevation fall injury in construction trades

Project coordinator: Pete Kines

Affiliation: Division of Safety Research, National Institute of Occupational Health, Denmark

E-mail: pk@ami.dk

Summary: Although many occupational safety programs are targeted towards large firms, the construction industry is dominated by smaller firms. This study examines the differential effect of firm size on the risk and the reporting of over 3,000 serious and minor nonfatal elevation fall injuries in Danish construction industry trades (1993-1999). Small firms (<20 employees) accounted for 93% of all firms and 55% of worker-years. There was an inverse relationship between firm size and *serious* injury rates, and a direct relationship between firm size and *minor* injury rates. An inverse relationship between firm size and injury severity odds ratios (serious versus minor) was found for carpentry, electrical work, general contracting and the remaining *other trades*.

Some of the possible explanations for the findings are that large firms can have greater expertise, resources and often motivation (*e.g.*, image) for investing in health and safety issues. This includes both controlling hazards (hence the lower serious injury rates), and reporting of minor injury incidents, (hence the high rates of minor injury incidents). The lower serious injury rates in large companies may also reflect their ability to outsource or sub-contract potentially hazardous tasks, such as scaffolding and roofing.

The prevention and control of elevation fall injuries in small firms, particularly in the carpentry trade group, should focus on falls involving ladders and roof surfaces, whereas middle and large-sized firms, particularly in general construction contracting, should emphasise elevation falls involving stairs and sources other than ladders, scaffolds and roofs. Health and safety issues, legislation and enforcement in the construction industry should, to a greater degree, be focused on smaller firms.

Time period: 2001 to 2002

Report:

Kines P & Mikkelsen KL (2003). The effects of firm size on risks and reporting of elevation fall injury in construction trades. *Journal of Occupational and Environmental Medicine*, 45(10), 1074-1078. (see abstract 4.2.5)

5 Finland

5.1 Ongoing Finnish projects

5.1.1 A workplace guide to occupations in the construction industry (RATS)

Project coordinator: Panu Oksa

Affiliation: Tampere Regional Institute of Occupational Health

E-mail: panu.oksa@ttl.fi

Summary: Currently, about 350 of the existing Finnish occupational health care units offer services to construction enterprises. They are generally small, with a staff of less than 20 people. Occupational health professionals are not able to visit all of the work sites of an enterprise as they attempt to familiarise themselves with the work conditions, organisation or occupational hazards.

Objectives

A workplace guide to occupations in the construction industry (RATS - Rakennusalan Ammattikohtaiset TyöpaikkaSelvitykset) has been designed as a tool for Finnish occupational health professionals in planning and carrying out occupational health care, risk assessments, workplace visits, health examinations and programs to help to improve and maintain the work ability of workers in the construction industry.

RATS provides occupational health professionals with experts' descriptions of hazards and recommendations for the prevention of such hazards. It is available free of charge through the Internet, and CDs are available for occupational health professionals who have no possibility to access the Internet version.

Data and its use

RATS is comprised of workplace data related to occupations specifically found in the construction industry. For each occupation, the tasks of the worker are first defined. For each occupation the following are described: accident hazards, physical and chemical hazards, physical work loads, occupational diseases and tips for health examinations

RATS use

The users of RATS can familiarise themselves with different aspects of the workplace for a particular construction occupation before they visit a workplace or before a construction worker comes for a health examination or, for example, before planning a program for improving and maintaining workability within an enterprise.

RATS also contain information on the following factors for all the occupational groups: mental load, risks of violence, biological hazards, work arrangements, personal protectors and ergonomic equipment

In addition, RATS offers recommendations for work conditions with respect to each factor.

Thus far, RATS offers data on the following construction occupations: *pipefitter, carpenter, painter, bricklayer, electrician and concrete reinforcement worker*.

These occupational groups cover about 60% of the construction workers in Finland. We have started the second phase of the project to increase the coverage to 90%.

Expert group

RATS is a working group within the Finnish Institute of Occupational Health: Anneli Kaukiainen, special researcher (physical load), Jorma Lappalainen, occupational safety engineer (accident risks, violence risks), Mika Nyberg, physiotherapist (project secretary), Pekka Roto & Panu Oksa, physicians (health examinations, mental load), Riitta Riala & Pekka Olkinuora, occupational hygienists (chemical hazards, physical hazards) and Eero Palomäki, architect (biological exposures).

Finance

The Finnish Work Environment Fund, the Finnish Institute of Occupational Health, the Finnish Ministry of Social Affairs and Health, and the Social Insurance Institution of Finland financed the project.

The use of RATS

RATS can be used via Internet (<http://www.ttl.fi/rakennusterveys>) or by CD.

Time period: Part 1 2001-2002; Part 2 2003-2004

Report: Kaukiainen A., Lappalainen J., Nyberg M., Oksa P., Palomäki E., Roto P., Olkinuora P., Riala R.: Rakennusalan ammattikohtaiset työpaikkaselvitykset (RATS). Opas työterveyshuolloille. Tampereen aluetyöterveyslaitos 2002. CD ja internet-sivusto (<http://www.ttl.fi/rakennusterveys>).

5.1.2 The National Project for Improving Safety in Construction Work in Finland (The RATUKE Project)

Project co-ordinator: Anssi Koskenvesa

Affiliation: Mittaviiva Oy, Linnoitustie 2 B, FIN-02600 Espoo

E-mail: koskenvesa@mittaviiva.fi

Summary:

Objectives of the project

- Complete turnabout of the trend towards accidents in the construction industry
- Continual decrease in the number and severity of occupational accidents
- Development of a Zero Accident attitude and practices supporting this attitude on construction sites
- Improved ability to compete in the construction industry, as well as an improved image as a

workplace

- Collaboration between all parties involved in construction in the effort to improve occupational safety

Content of the project

The project will comprise many research, training and communication subprojects. The main target will be construction sites, people and companies where construction work takes place. Measures will focus on both the preparation and implementation phases of construction projects.

Special focus will be on...

- identification and assessment of hazards
- correct and safe working methods
- safe work environment and safe tools
- development of knowledge and skills
- management of operations

Time table of the project

The project will continue to 2005. A specific plan for implementation and information will be prepared yearly. Year 2003: 1) Publication of initial material for the project, 2) Co-operation with other projects (Scaffolds and Fall Protection projects), 3) Launch of nation wide safety competition and 4) Support of R&D.

Publication of initial material for the project

- Collection of basic information on occupational accidents in the construction industry
- Review of research literature on safety in the construction industry (<http://www.ttl.fi/rakennusterveys>)
- Guide book for Good Practices for Safety Management in Construction (Principles, practical examples).

Time period: 2002-2005

5.1.3 Development of databank of occupational health and safety for training in construction work

Project co-ordinator: Jorma Lappalainen

Affiliation: Tampere Regional Institute of Occupational Health

E-mail: jorma.lappalainen@ttl.fi

Summary:

Objectives of the project

- to develop training material of occupational health and safety especially for training of trainees at work sites and in vocational schools
- to create an Internet portal, which will connect all, www-pages of occupational health and safety in construction and gives an easy access to all essential knowledge.

Partners of projects

- Tampere University of Technology, Occupational Safety Engineering
- Siikaranta Institute (the training institute of the Finnish Construction Trade Union)
- Two vocational schools (Kangasala and Helsinki)
- Main labour market organisations (employers and employees)
- Ministry of Social Affairs and Health

Time period: 2002-2004

5.2 Completed Finnish projects

5.2.1 A participative approach to control safety risks in the building of windmills

Project coordinator: Anneli Pekkarinen.

Affiliation: Oulu Regional Institute of Occupational Health, Oulu, Finland

E-mail: anneli.pekkarinen@ttl.fi

Summary: Windmills consist of several heavy and big parts and are built up in windy and sometimes cold environments. This was the first windmill of Finish design using new technology, so there was no previous experience of windmill construction involved. Since the market for several new windmills in the north of Finland looked promising, the company wanted to train their staff to become professional windmill constructors. Safety was regarded as one of the most important aspects and the training of workers was started in co-operation with Oulu Regional Institute of Occupational Health and Oulu Polytechnic.

Objectives

The objectives of the study were that the safety risks be controlled and safe working habits be adopted in the building of windmills. The idea was to prepare for the first building operation, as well as possible, and to collect data during the building phase for further safety analysis.

Approach

A participative approach was used in three phases. The preparation phase consisted of learning discussions with experts about essential points like safety in lifting and handling of heavy loads, working in the cold, wind and at heights, safety equipment, appropriate clothing and ergonomics. The second phase was called learning at the work site. It included data collecting by observing and videofilming during the building of the first windmill. During the third phase the study group analysed the building of the windmill with the help of the collected data; what happened, what should be done differently? Checklists were made of all the things that need to be paid attention to at future building sites. The size of the study group was 15 persons, the managing director being engaged in all meetings.

Results

During the building of the first windmill no serious accidents occurred, but some dangerous situations were found. The building took more time than was planned, and the weather conditions changed a lot, from nice sunshine to hard wind and rain.

In the risk analysis the checklists concentrated on: organising the work, co-operation with the subcontractors, connections between the workers on ground and at the top of the mill, climbing up and lifting goods, safe work environment and good order, appropriate tools and machines, clothing and personal safety equipment.

Conclusions

The procedure proved to be useful and all people involved were very motivated and committed in the process. The contribution and interest of the management has previously proven to be

most important when it comes to safety, which also proved to be relevant in this case. It was also agreed upon that the participative approach is one of the best ways to adopt safe working habits. The study group was active and took the demanding environments and accident risks seriously. The effects are shown later in the future when several windmills have been built up in different seasons.

Limitations

This kind of approach was found interesting and functional even though it required several meetings, was quite laborious to carry out and a limited amount of employees could attend. In the future the risk analysis can be part of normal functions and meetings.

Contributions of the project to the field

The method can be applied also in other economic sectors where work is done in demanding circumstances and includes serious safety risks.

Time period: 2001

Report: No report.

5.2.2 Effective and safe framework construction by means of re-engineering

Project coordinator: Eeva Rantanen

Affiliation: VTT Technical Research Centre of Finland, Industrial Systems, Reliability and Risk Management, Tampere, Finland

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Summary: Frame Construction was one of the subprojects of the larger research project "Site process re-engineering in house building". The goal was to work out what has to be done in a house-building project in order to get considerable improvements in site productivity, site safety and quality in prefabricated concrete framework construction.

Construction site safety and working conditions can be improved by taking the best practices used elsewhere and superimposing the development work for safety from other lines of business. Safety management research has identified many existing examples of best practices in good, affluent companies that others can use to develop their own working methods. The challenge is on how to get these practices into use at construction sites.

The main result of a survey of contractors' safety practices indicated that good safety performance under construction is already established at the planning and design stage. Another remarkable outcome for researchers was that during the development project, the developers did not adequately consider the safety point of view in an integrated way, or then not at all if not reminded. To get any improvement in safety performance, it must be integrated into the production management system.

The project covered subjects from modelling and analysing existing processes to planning new processes and working methods. The searching of targets for development and the modelling were conducted on two levels: business and assembly processes. The modelling and analysis

was carried out in workshops, and also involved taking photos and video photography of the construction site and interviewing personnel. The work was done jointly by the designers, manufacturers and the contractors based on a 3-directional partnership. Process researchers led the development work together with health and safety researchers. The safety management and safety practices were studied in this phase.

It was deemed that four processes in this project be improved: the inquiry-tender-order process, the design process, the assembly process, and the 'productification' process. The re-planning of these processes, with a safety point of view, was done by the 3-directional partnership together with researchers. Safety was considered in all phases, and the safety practices were integrated into the new processes.

To implement the safety procedures into practice the personnel need to internalise a new way of thinking. Only this will ensure that the safety point of view is considered in all development work and working methods. The top executives have a very important role to play in this, and their commitment to and visibility in leading the safety management and the assertive leadership of site foremen are important targets for development.

Time period: 2002-2003

Report: Ruuhilehto, K., Rantanen, E.: Nyt rakentamaan turvallisesti.. Rakentajain kalenteri 2004.
Rakennustieto Oy 2003. (in print).

5.2.3 Handrail Height of Spiral Stairs

Project coordinator: Janne Sinisammal

Affiliation: University of Oulu, Department of Industrial Engineering and Management, Work Science, Oulu, Finland

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Summary: The main purposes of the stair handrail are to prevent a loss of balance, to help one regain balance, to help moving by allowing one to pull up while ascending a stair, and to give directional guidance and stability for those with visual and balance deficits. In descent, the hand is slid down the rail in a continuous motion to give the user a sense of security and for some greater postural stability. In ascent, the handrail is grabbed at regular intervals and used to help pull the user up the stair and to give extra postural stability (Templer 1992).

Researchers (e.g. Maki et al. 1998, Marletta 1991) have found evidence that it is possible to grab a handrail and generate sizeable stabilizing force very quickly in response to a postural disturbance. A handrail is also important, as it will serve to help prevent the initial occurrence of a slip or misstep. Johnson (1998) and Templer (1992) state that once a person starts falling there is little chance that the fall will be arrested unless the person can grab and hold onto a handrail.

Study

The aim of the study was to estimate the preferred handrail height for spiral stairs. The radius of the stairway used in the study was 120 cm and the direction of ascent was clockwise. With 17 steps (18 riser heights, each ~17.3 cm) the height of the whole stairway was 3.12 m. A fitting trial with 20 participants yielded a preferred handrail height of 95 cm for Finnish adult males both for ascending and descending. It was also discovered that stature seems to have the closest relationship between handrail height preferences.

It is suggested that the preferred handrail height is the optimal handrail height, because the preferred handrail height is the most comfortable handrail height, thus being the height that most efficiently encourages people to use handrails whenever they are using stairs. In case of an emergency the importance of decent handrail height design is highlighted. When people have to move quickly on stairs, e.g. to get out of a burning house, the handrail may save lives by providing support at adequate height. Unfortunately, pedestrians usually do not seem to accept the importance of handrails as insurance for safe stair use. Handrails may remain unused even if they are within reach.

References

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Time period: 2002

Report:

Sinisammal J. Handrail Height of Spiral Stairs. Masters Thesis (ergonomics), Luleå University of Technology, Department of Human Work Science, Division of Industrial Ergonomics, Luleå, Sweden 2001.

Sinisammal, J. Teollisuuden kierreportaat – kirjallisuuskatsaus, käsijohteen korkeus ja asiantuntijahaastattelu. Project Reports of Work Science Laboratory No. 13, University of Oulu, Finland. 65 p. (ISBN 951-42-6665-X) 2002.

5.2.4 How to eliminate falling hazards in the planning and implementation of construction

Project coordinator: Jorma Lappalainen

Affiliation: Tampere University of Technology, Occupational Safety Engineering

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Summary: An operations model for preventing falls on construction sites has been designed primarily for the management of construction or installation at work sites. The model forms a flow chart that goes from the bidding and agreement phase of a contract to safe work (see the figure below). It comprises 16 elements that are divided into "critical path" elements and elements that support the critical elements. The critical path elements (blue boxes, 1-7) are as follows:

- bidding and agreement phase of the contract,
- decision on the implementation form of the contract,
- identification of falling hazards,
- decision on the need to implement fall protection,
- implementation of fall protection, and
- approval of fall protection.

The immediate supporting elements (yellow boxes, 8-13) are as follows:

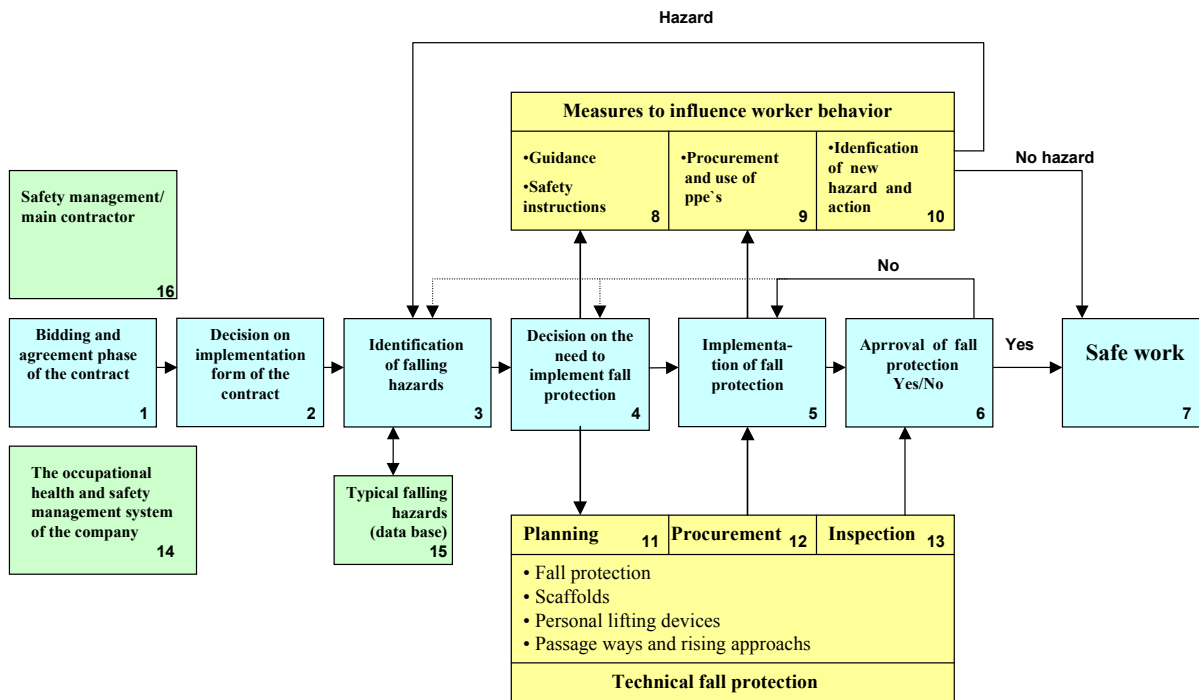
- technical fall protection (planning, procurement, inspection)
- measures to influence worker behaviour (instructions, use of personal safety equipment, observation of hazards).

There are also some general elements, which (green boxes, 14-16) are as follows:

- the occupational health and safety management system of the company
- typical falling hazards
- safety management of main contractor or client

Each element of is described very briefly with some practical examples. There are also some examples of investigated falling accidents. The figure below shows the structure of the model.

An operations model for prevention of falling hazards on construction sites



Time period: 1999-2001

Report:

Tint M., Lappalainen J., Koivula K., Palukka P.: Rakentamisen putoamistapaturmat - turvallisuuskulttuuri ja turvallisuustilanne. Tampereen teknillinen yliopisto, Turvallisuustekniikka, Raportti 89. Tampere 2003. 71s. +liitt.

Tint M., Lappalainen J., Sauni S.: Putoamisvaaratekijöiden poistaminen rakennushankkeen toteutuksessa. Toimintamalli. Tapaturmavakuutuslaitosten liitto, Sosiaali- ja terveystieteiden tutkimuskeskus, Rakennusteollisuus RT ry. 2003. 17s.

5.2.5 Occupational health and safety as part of professional ability - teaching construction students in Finland

Project coordinator: Tarja Mäkelä

Affiliation: Tampere University of Technology, Occupational Safety Engineering

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Summary: The aim of teaching occupational health and safety to new construction workers is to give enough knowledge and skills for them to start their career. During the year 2000, we made an extensive survey of occupational safety and health teaching in Finnish schools providing training for construction occupations. The purpose of the RAKTU2000 project was to get information of the content, methods and educational material used for occupational safety and health in the teaching programs of all Finnish schools that educate construction workers, foremen and engineers. Data was gathered from 129 schools from all levels of education (vocational schools, colleges and universities). Most of the information was gathered with a questionnaire filled out by 2000 students (answering rate 52 %), 358 teachers (54 %) and 105 school representatives (84 %). Also 54 teachers and 64 students were interviewed from twelve collaborating schools. The questionnaire dealt primarily with teaching materials and methods, occupational accidents and students' and teachers' attitudes towards occupational safety and health.

According to the questionnaire, students primarily (64%) chose construction as their profession because of their interest in it. Altogether 90% of the students and 62-75% of the teachers had a positive attitude towards occupational safety and health. However, when the respondents were asked if risk taking is necessary in construction work, 50% of the vocational students considered taking risks necessary, and the corresponding proportion of university and adult education students was 29%. The most alarming result was possibly the fact that 25% of the students in technical colleges and universities reported that occupational safety and health is hardly taught at all in their schools, even though these students are being trained to be foremen and designers.

Almost every student felt that teaching occupational safety and health is important and that a part of good vocational skills is to understand occupational safety regulations. Only 35 % of the students at colleges and universities felt teaching successful. The most usual discussed matters during teaching were working surfaces, general order and tidiness of a site, dangers of falling and fall protection, machines and appliances, and personal protective equipment (altogether more than 74 %). The least discussed matters were protecting young workers, psychosocial risks at work, risk assessment and management, work-related diseases and the safety organization (22-31 %)

However, the survey indicated that a positive attitude towards occupational safety and health is dominant among the teachers and students of all the schools included in the study. This finding is a positive sign when considering the development of teaching programs for schools that educate new construction workers.

The content of the current teaching programs corresponded with the needs for accident prevention in the construction industry. The results also indicate that the quality and content of occupational safety and health education differ quite a lot between schools at every level of education. An important aim is to identify good practices that make teaching and learning more productive.

Time period: 2000

Report: Mäkelä, Tarja.(et al.) Työturvallisuus ja -terveys osaksi rakentajien ammattitaitoa - RAKTU2000. Työterveyslaitos:Tampere: 2000: 102 s.

5.2.6 Road vehicle safety -training programme for contractors involved in working on roads and in other transport areas

Project coordinator: Simo Sauni

Affiliation: VTT Technical Research Centre of Finland, Tampere

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Summary: Workers do not always recognise the dangers caused by traffic. Drivers of work transport are not always aware of risks to pedestrians on work sites. Consequently a significant number of work accidents resulting in death and injury involve transport. In Finland, construction work on roads is defined as a high-risk area.

Solution

To meet their duties to ensure that employees of contractors have been made familiar with risks at the workplace, the Finnish Road Administration (Finnra) is introducing a work traffic safety-training programme, which must be given to the staff of contractors. The training is an eligibility requirement for contractors engaged in roadwork operations and is written into the contract agreement between Finnra and the contractor. The two-part training programme includes written examinations. The training does not replace the responsibility of employers to familiarise their employees with the basic work to be done.

Part 1 road safety training is for:

- people who participate in road surfacing work;
- drivers transporting road-surfacing materials;
- operators of road construction and maintenance vehicles;
- those who participate in Road Safety 2 training;
- those involved in supervisory and control tasks for the Finnish Road Administration.

In future, part 1 training will also be for:

- people engaged in the inspection of tasks on Finnish Road Administration roads;
- those working on a regional contractor's road;
- those responsible for the occupational safety and road safety of other contractors.
- all staff working for contractors;
- others on whom the training requirement is imposed.

Training in Road Safety 2 is for:

- people responsible for occupational safety and road safety within the main roadwork developer organisation;
- those engaged in planning tasks for management, supervision and traffic circulation in work relating to road maintenance;
- Finnish Road Administration road engineers and road inspectors;
- those preparing contract documents;
- those preparing work permits for contractors;
- those preparing decisions on speed limits during working hours.

Safety performance and competence are components of the tendering and contract management process. Requirements are included in tender documents and the management system includes safety check-ups. Monitoring of the training forms part of this process.

Results

A survey conducted by the Finnish Road Administration showed improvements in traffic circulation at work sites, improved visibility of work sites and higher hazard awareness. However, it is too early to see significant improvements in accident rates.

Time period: 1998-2003

Report: Tieturva-koulutus. Kurssinjohtajan ohje. Tiehallinto. Helsinki 2003. 10 s.
Tieturva I Tietöiden liikenteen järjestely- ja turvallisuuskoulutus. Tiehallinto. Helsinki 2002. 41 s.

5.2.7 The validity and use of the TR- Safety Observation Method

Project coordinator: Heikki Laitinen

Affiliation: 3T Results Ltd, Peltomäenkatu 10 A, FIN-04250 KERAVA

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Summary: The TR Safety Observation Method for construction sites was developed in the years 1992-1993. The purpose was built up a common standardized and simple tool for Safety Inspectorates and for companies to evaluate the safety level of building construction sites. The observed safety aspects are: working habits, scaffolding and ladders, machines and equipment, protection against falling, lighting and electricity, and order and tidiness. Each item is scored as "correct" if it meets the safety standards and developed special criteria, otherwise the item is scored as "not correct". The safety index is calculated as a percentage of the "correct" items

related to all the observed items.

In the validation study we used the data gathered by the safety inspectors carried at 305 sites. The observation results were compared with the accident figures of the same sites. The sites were grouped according to the observed safety index in order to limit the huge random variation in the accident rates of single sites. There was a statistically significant correlation between the observed safety index and the accident rate of the site groups. The average accident rate of the sites with the lowest safety index had, on average, a three times higher accident rate than the sites with the highest safety index.¹

In another study (years 1993-94) we organised an experiment at two sites in order to test the usability of the method as the tool for internal safety inspections. Internal safety inspection has to be carried out weekly on building construction sites in Finland. Eight safety rules were formulated together with the safety personnel of the company. Once a week the supervisor and the workers' safety delegate observed the safety level, using a standard observation method. After baseline observations, an information meeting was organised for all workers, and thereafter the safety index of each weekly observation round was marked on a large graph on the wall of the dining room. The safety index rose from the baseline of 60 % to 89 % during the feedback at Site 1. At Site 2 the index rose from 67 % to 91 %. The stage of the construction process had no significant effect on the results; the index level of 90 % was achieved at all stages of the process. The most visible change was an improvement in order and tidiness. The sub-indexes concerning protection against falling, machine safety, scaffoldings and use of personal protective devices improved to nearly 100 %, which should prevent severe injuries in particular.²

The companies also found the new method useful and practical. Training and material for the use was developed and big companies started to use the TR Method at their sites. In the year 1997 the Safety Inspectorate in Uusimaa district, the Construction Employer's association and the Union of Construction Workers together launched the safety competition, which was mainly based on the TR-audits at sites. Twenty-four companies participated in the competition, which is still going on.

Labour inspectors make evaluation visits without notice on the sites of the companies. Best companies are rewarded every year. The competition resulted in radical improvement of the working environment. Before the competition the average index of the same companies was 68% on average. During the first competition year 1997 it was already 74%, and in 1999 it reached 80%. After that the average index has stabilized, even if the best companies reach 90% on average.

Time period: 1997-2000

Reports:

1) Laitinen H, Marjamäki M, Päivärinta K: The validity of the TR safety observation method on building construction. *Accident Analysis and Prevention* 31 (1999) 463-472.

2) Laitinen, H. and Ruohomäki, I.: The effects of feedback and goal setting on safety performance at two construction sites. *Safety Science*, Vol. 24 (1996):1, 61-73.

5.2.8 Tampere improves the safety of street construction works. VTT and the City develop new procedures and training for street workers

Project coordinator: Simo Sauni

Affiliation: VTT Technical Research Centre of Finland, Tampere

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Summary: The safety of street construction sites in the City of Tampere is being improved thanks to new procedures and training developed jointly by VTT and the City. The City aims to reduce accident and traffic dangers on the sites of street construction works. Related safety training will be given to about 5,000 employees of the City and contractors.

The City of Tampere plays a number of roles on street construction sites: planner, road keeper, client, subcontractor and employer. The City is also responsible for the safety of the traffic environment. The new procedures will clarify the City's responsibilities in each role and will improve the safety of temporary traffic arrangements on street working sites.

The Finnish Road Administration, which is the government authority responsible for the upkeep of public roads, has long required road workers to undergo road safety training developed by VTT and the authority. This was used as the basis for the City of Tampere's own street safety training, which addresses the special challenges of street construction works. These include lack of space, pedestrian and cycle traffic, electrical, water and telecommunication services, and the inconvenience and hazards of street works for local residents. The fact that there may be workers from dozens of different city units on a single site and that a single unit may play a number of different roles on the site also poses a challenge.

"We got the basic rules as well as clear instructions necessary to take account of factors affecting work safety already at the planning stage of street construction works. The new practices will bring a better work safety culture to our field. That will improve safety on street construction sites and reduce traffic delays," says *Markku Kivistö*, the Health & Safety Representative for the City of Tampere's Technical Department.

VTT and the City developed Tampere's safety practices and street safety training packages with funding provided by the City and the Finnish Work Environment Fund. Other units of the City's Technical Department will also be able to exploit the results of the project. The material can also be tailored to develop safety-enhancing practices for other cities and municipalities.

Time period: 2002

Report: Tampereen kaupungin katuyksikön turvallisuushallintajärjestelmän ja -koulutuksen kehittäminen. Katuturva-hanke. Yhteenveto. Työsuojelurahaston Hanke 101317. Tampere 2003.

5.2.9 What are the differences between the safety of small and large construction enterprises?

Project coordinator: Jorma Lappalainen

Affiliation: Tampere Regional Institute of Occupational Health

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Summary: Small enterprises seem to have a lower level of occupational safety than large enterprises, especially in the construction industry. According to statistics, the frequency of accidents decreases as the size of the enterprise increases. However, there are very little data on how the safety features of small enterprises differ from those of large enterprises. This knowledge is necessary if safety is to be improved in small enterprises.

Objectives

The objective of this study was to determine the difference between the safety of the work environment in small and large enterprises and the relationship with enterprise management and safety planning for worksites.

Materials and methods

A work environment assessment of 51 worksites of 4 large and 16 small construction firms that participated in a safety contest in eastern Finland was done with a standardized safety observation method, which allocates a safety index for the site. At the same time, enterprise management and the planning of worksite safety were also assessed. In conjunction with the safety analysis done for each enterprise, the personnel were asked to assess the safety activities of their workplace.

Results

The measurements produced a mean overall index of safety of work environment of 86% (range 83-89%) for the worksites of the 4 large enterprises. The management index was 96%, and that for safety planning was 87%. For the worksites of the 16 small enterprises, the mean overall index of safety of work environment was 81% (range 64-94%), with a management index of 73% and a safety-planning index of 60%.

According to the assessments of the personnel, the safety activities of the small firms were deficient in respect to the following aspects: occupational safety information for the worksites, safety regulations in the individual firms, safety knowledge and expertise, introduction of new and temporary workers to the worksite, monitoring and inspection, activities of the occupational safety organizations, follow-up and feedback on the results of safety activities, and the availability, maintenance and use of personal protection equipment.

Conclusions

The results show that small companies have more problems with the safety than big companies. The results also indicate that, in the large enterprises, safety had been a high priority. Management and safety planning were in greater need of improvement in the small enterprises than in the large ones. There were also great differences between the individual firms. The best firms had a safety management level comparable with that of the large firms.

The general conclusion is that the small firms have big needs for the training of company safety management. They also need appropriate worksite safety planning tools.

Time period: 1999-2000

Report:

Lappalainen J.: What are the differences between the safety of small and large construction enterprises? XXVIth International symposium ISSA construction. Dynamic management of health and safety in the construction industry. Practical solutions. December 12, 13 and 14, 2001, Paris, France. Abstracts, 3-5.

Lappalainen, J., Laitinen, H., Sauni, S. Piispanen, P.: Differences between the occupational safety of small and large construction enterprises. In: Mondelo, P; Mattila, M.; Karwowski, W. Proceedings of the 1st International Conference on Occupational Risk Prevention 23. - 25.2.2000, Tenerife, Spain. ISBN: 84-699-1242-9 (CD-ROM)

6 Norway

6.1 Ongoing Norwegian projects

6.1.1 Delayed Injuries following low voltage electrical accidents

Project coordinator: Lars Ole Goffeng

Affiliation: National Institute of Occupational Health, Oslo

E-mail: lars.goffeng@stami.no

Summary: Possible delayed injuries following low voltage electrical accidents are studied. We examine the relationship between such accidents and health, based on a thorough exposure characterisation and a health examination, prognostic factors in the acute phase, and the importance of acute health care follow-up for later function. Accident circumstances are investigated to facilitate accident prevention.

Background

Electric accidents are much more frequent than commonly believed. In the year 2000, 71 accidents were reported to the Norwegian Directorate for Fire and Electrical Safety. Average for the period 1990-99 was 51.3. There is a considerable underreporting of accidents, particularly of accidents without serious acute effects. Annual occurrence of occupational electric accidents regarded serious by the victims, is estimated to about 2.000 in Norway.

Materials and methods

This is a cross-sectional study of individuals who experienced electric accidents reported to the Norwegian Directorate for Fire and Electrical Safety, eastern region, 1994-2001. The study group consists of N=50 male electricians who experienced passage of low-voltage electricity between the hands or arms, and N=40 who had burn injuries following light arcs without passage of current through the body.

All participants are given a health examination consisting of a neuropsychological test battery, pure tone audiometric examination, a clinical examination of neck and shoulder, and the questionnaires "Health following electrical accidents. A follow-up study", SCL-90 (Symptom Check List - 90), PTSS-10 (Post Traumatic Stress Symptoms-10 questions), and a questionnaire aimed at describing movement disorders.

Results

The study is ongoing. No results are consequently available at present.

Reference: www.stami.no/stromskader

Time period: 1998-2004

Report: Not yet available

6.1.2 Final report about desertion and expelling in the construction industry

Project coordinator: Jon Frode Blichfeldt

Affiliation: Work Research Institute, Oslo

E-mail: jon.frode.blichfeldt@afi-wri.no

Summary: Together with the reports 6.2.10 and 6.2.14 (below), this completes a major project about desertion and expelling in the construction industry. The project is carried out at the Work Research Institute.

Time period: 2002-2003

Report: The final report is expected late autumn 2003. No results are yet available.

6.1.3 Prevention of accidents in the construction industry

Project coordinator: Hans Magne Gravseth

Affiliation: Oslo Emergency Ward, Oslo

E-mail: hansmagne.gravseth@ullevaal.no

Summary: This is an ongoing project carried out at the Oslo Emergency Ward by Hans Magne Gravseth. It was started as a result of study 6.2.13 (“Occupational injuries in Oslo: a study of occupational injuries treated by the Oslo Emergency Ward and Oslo Ambulance Service”), where one of the conclusions was that construction workers were at highest risk in Oslo. In the first study, too little detailed information about the accidents was collected. This led to the initiation of this in-depth study.

50 construction workers with a serious injury, according to the definition of the Labour Inspection, were extensively interviewed face to face with a questionnaire with open-ended questions (mostly qualitative data). The accidents took place in the period September 2002 – January 2003. In about half the cases, on-site investigations have been carried out, some of them together with a specialist in occupational accidents, to find contributing factors to the injury, including factors in the organisation (behind the “man-machine”-system).

A group of four specialists on injury investigations was formed: two experienced labour inspectors, one psychologist and one technologist with product safety experience. Together with the physician who carried out the interviews and site investigations, the descriptions of the 50 accidents were studied in order to identify contributing factors of psychological, technological and organisational type.

In addition, a reference group was formed with representatives from national employer and labour organisations, national and local labour inspectorates, and health institutions.

Time period: 2002-2004

Report: Not yet available

6.2 Completed Norwegian projects

6.2.1 Acute and chronic injuries after electrical accidents: a review and guidelines for follow-up

Project coordinator: Kaj Bo Veiersted

Affiliation: National Institute of Occupational Health, Oslo

E-mail: bo.veiersted@stami.no

Summary: Electrical accidents are potentially fatal incidents with effect on the cardiovascular, nerve and musculoskeletal systems and on the skin (burns). The electrical engineering industry points out that the follow-up of injured persons from site of accident to hospital is quite random. This paper gives a review of the current literature and proposes guidelines for the follow-up of victims of electrical accidents.

Material and methods

A search of the literature was conducted on Medline, Embase, Biosis, Healthline, the Cochrane Library, the ISI citation databases, and on several other search engines. The revised guidelines were developed in consultation with 23 medical and industry institutions.

Results and interpretation

Serious acute effects of electrical accidents include cardiac arrest, respiration failure, burns (also “internal burns” with necrosis of e.g. muscle tissue), injuries to the nerve system, and renal failure. Traumas caused by falls are also frequent. Possible chronic effects are mostly seen in the nerve system as encephalopathy and psychological sequelae or as spinal cord and peripheral nerve injury. Most importantly, long latent periods are possible for some chronic nerve injuries. This paper suggest guidelines for acute “on the spot” action and criteria for referral to hospital, observation in hospital and further follow-up.

Time period: 2001-2003

Report: Tidsskr Nor Lægeforen 2003; 123: 2453-6

The article is available on the internet, with a summary in English:

www.tidsskriftet.no/pls/lts/PA_LT.VisSeksjon?vp_SEKS_ID=879460

6.2.2 Chronic effects of accidents caused by low-voltage electricity

Project coordinator: Kaj Bo Veiersted

Affiliation: National Institute of Occupational Health, Oslo

E-mail: bo.veiersted@stami.no

Summary: The article describes the symptomatology of three patients following electrical accidents. The flow of the current was from hand to hand, voltage was 220/380 V, and duration was at least a few seconds for all patients.

The development of symptoms was the same, and may be explained as a thermal effect of electricity on the tissue. Initially the patients experienced transient confusion, followed by stiff muscles after 1 to 3 days, and then pain in the muscle attachments and joints close to path of the current. This pain increased slowly during the first two weeks. Recovery was gradual, but often incomplete. The case notes showed that electrical accidents may be followed by chronic rotator cuff tendonitis. The clinical examination also revealed a hearing loss at about 2,000 Hz and above 4,000 Hz. The neuropsychological testing indicated a diffuse impaired function in only one patient.

Accidents caused by low-voltage electricity might have chronic effects on the musculoskeletal system and could lead to hearing loss. Chronic effects on the central nervous system cannot be excluded.

Time period: 1997

Report: Tidsskr Nor Lægeforen 1997; 117: 3363-5.

Abstract of the article is available on www.tidsskriftet.no/tsweb/199723/art5.html

6.2.3 Company development – reduction of stress and sick leave: Construction

Project coordinator: Lars Andersen

Affiliation: SINTEF Industrial Management, Trondheim

Tel.: (+47) 73 59 29 96

Summary: The background for the project was that earlier research had shown that the efforts that are most efficient to reduce sick leave are the ones directed against organisational conditions in the companies. It also mainly was on the organisational and psychosocial levels that the companies needed more competence to develop new strategies.

The project has a qualitative and a quantitative part. The qualitative part is based on interviews of 75 persons on three construction sites, mainly ordinary workers. Experience conferences were arranged. The quantitative part is based on questionnaires that were distributed to workers on 114 different construction sites; 753 completed questionnaires were received.

The survey showed that the most important causes for stress and health problems for the workers are the same as the causes for ineffective production. Thus, a development that takes these causes away will both improve efficiency and reduce health problems and sick leave among workers.

Some important stress causes are referred to: The work might be hard to predict, the work pace can be high, logistics can be failing, the cooperation between different job groups can be poor, the workers might have poor overview of the work process, the social support can be poor, the leaders can be inaccessible etc. Some more indirect stress causes are also mentioned. Two different types of the organisational working environment are described: The silent environment and the open environment without liability.

Then some initiatives and efforts are suggested, directed against these stress causes to reduce them. Instruments for changing working environments from silent or without liability towards “the third alternative” are also presented.

Time period: 1998-2000

Report: The report is available via contact to SINTEF Industrial Management (telephone (+47) 73 59 25 59, telefax 73 59 25 70), or directly to the project leader.

The Federation of Norwegian Construction Industries has edited a short report (“Slik oppnår du bedre bedriftsøkonomi og lavere sykefravær gjennom å fjerne stress, mas og misforståelser på din arbeidsplass” – How to improve your company’s economy and reduce sick leave through eliminating stress and misunderstandings on your work place) that is based on this research report.

The short version is available via contact to Roar Skjetne in the Federation of Norwegian Construction Industries (e-mail: roar.skjetne@bnl.no).

6.2.4 Compensation for occupational injury and disease in Norway: ranking of job groups

Project coordinator: Nils Bull

Affiliation: Section for Occupational Medicine, Department of Public Health and Primary Health Care, University of Bergen

E-mail: nils.bull@isf.uib.no

Summary: The health risk of various job groups in Norway was estimated by ranking them according to the annual occupational insurance costs per capita. This was done by dividing the costs of work-related injury and disease from 1991 to 1996 in various job groups by the number of workers in these groups. Occupational groups were also ranked according to total annual costs.

The five occupational groups with the highest total costs were metalworkers, woodworkers, nursing-related workers, fisheries workers, and teachers. The groups with the highest annual cost per worker were shoe and leather workers, oil and gas extractors, fisheries workers, miners and quarry workers, and ship's officers.

Time period: 1998-2001

Report: Journal of Occupational and Environmental Medicine, 2000: 42; 621-8.

6.2.5 Falls – do they have to happen?

Project coordinator: Harry Eide

Affiliation: Regional Safety Delegate in Bergen, Norway

Tel.: (+47) 55 30 91 57

Summary: 602 construction sites were visited one or more times in the period November 2000 until June 2001. They were investigated to figure out whether work on high levels was carried out according to the legislation or not. The visits were performed by the regional safety delegates in several districts of Norway.

On 254 sites, they found so grave conditions that they had to stop the works immediately. In addition, 1500 other serious and 773 minor breaches of regulations were found. None of the sites visited were in perfect condition. No major differences related to the size of the construction sites were found.

They conclude that stronger action has to be taken in the construction industry to prevent falls from ladders, scaffolds and roofs. Four suggestions of attempts to be taken are presented:

- New legislation to reduce the time of executive work and more use of fines.
- More cooperation between the Labour Inspection and the regional safety delegates. Companies whose work is stopped for three times should be reported to the police.
- More use of visits and controls on construction sites; more local projects towards the construction industry.
- Companies that are reported to the police because of major breaches of the Working Environment Act must be followed up by local authorities (loss of licences and certificates etc)

Time period: 2000-2001

Report: The report is available via contact to the project leader.

6.2.6 Health, environment and safety in the construction industry

Project coordinator: Kjell Arne Johansen

Affiliation: Directorate of Labour Inspection, Oslo

Tel: (+47) 22 95 70 68

Summary: This is a small handbook made for the persons responsible for HES: Builders, project leaders and employers. It is a collaborative project between the Labour Inspection and several of the actors in the construction industry, for instance the Federation of Norwegian Construction Industries, Labour Organisation and the Employer's Federation. It was first edited 2001, and it has become real popular.

The paper deals with roles, responsibilities and tasks for the different parts in the system: building employers, project leaders, HES coordinators, principal enterprises, employers, local and regional safety delegates and employees. Moreover, important issues that must be taken care of in connection with planning and execution of building projects are illuminated, for instance risk assessment during the projecting phase. Advice about how to work out an HES-plan and a plan of progress are given. The relation between the HES regulation and the Building employer regulation is illustrated. The latter regulation is printed in detail as an attachment.

Time period: 2001

Report: The handbook is presented on the internet:

www.arbeidstilsynet.no/publikasjoner/brosjyrer/bros575.html

On this site it is also possible to download it as a pdf-file, or to order it via the publishing firm

6.2.7 HES 2000 on construction sites

Project coordinator: Einar Bendiksen

Affiliation: Gunvald Johansen AS, Bodø

E-mail: einar.bendiksen@gj.no

Summary: This project was carried out in 2000 by the construction company Gunvald Johansen AS in Bodø, Norway, in cooperation with another similar but smaller company (Byggm. V. Lillegaard AS).

The project used three different instruments in the same process of accomplishment:

- Compose and customize an effective control system for HES on construction sites
- Education and motivation as an integrated part of the development work
- Work related illness and injuries were carefully followed up, to find infirmities in the HES system of the enterprise

The project was carried out as an exactly planned cooperation between the two construction companies involved, and one shared safety and health centre. The companies placed one building project each at disposal as an arena for development.

In connection with the working out of a control system for HES, major simplifications were achieved. Thus, adequate HES systems could on short time and with a high degree of accuracy be established in connection with new building projects. The accomplishment of HES on construction sites will act as a natural part of the work, it will seem comprehensible and “to the point”, and will lead to less absence due to sickness and reduced risk for injuries.

The use of the system, with following up of illness and injuries, will lead to a continuous developing of the HES system, as work related deviations, injuries or illnesses are registered.

The education of personnel put in the context of planned HES work, will appear considerable better in terms of make the most of results, compared with sending personnel to 40 hours of education in an isolated course context.

Time period: 2000

Report: The report is available via the contact person.

There is also a link to the project via the home page to the Confederation of Norwegian Business and Industry (Næringslivets Hovedorganisasjon - NHO): www.nho.no - click "Arbeidsmiljø og helse", then "Arbeidsmiljøfondet" and then "Tematisk oversikt over prosjekter". The contact person in NHO is Siri Møllerud, telephone (+47) 23 08 83 11.

6.2.8 Incidence and prevention of occupational electrical accidents

Project coordinator: Lars Ole Goffeng

Affiliation: National Institute of Occupational Health, Oslo

E-mail: lars.goffeng@stami.no

Summary: The Norwegian Directorate for Fire and Electrical Safety receives an annual total of 50 reports of injuries caused by electricity, while the Labour Inspection Authority receives 150 reports. The underreporting is, however, considerable. In this article we estimate the incidence of occupational electrical accidents and describe the legislation regulating the reporting of injuries from electrical accidents.

Material and methods

326 of 343 electricians (95%) returned a questionnaire on electrical accidents.

Results and interpretation

We received reports that indicated an incidence of 7.6 serious accidents per 100 person-years, which equal more than 3000 electrical accidents annually in Norway. Underreporting complicates accident prevention. Doctors should more often report occupational accidents than what is common today.

Time period: 2001-2003

Report: References: Tidsskr Nor Lægeforen 2003; 123: 2457-8

The article is available on the internet, with a summary in English:

www.tidsskriftet.no/pls/lts/PA_LT.VisSeksjon?vp_SEKS_ID=879880

6.2.9 Investigation of accidents

Project coordinator: Endre Nagell Bjordal

Affiliation/publishing firm: Arbeidsmiljøforlaget

Tel.: (+47) 815 59 750

Summary: This is a paper that gives guidance in investigation of occupational accidents, mainly the serious ones (duty to reporting). It contains analytical methods to

- systematize and illustrate the course of events that resulted in the accident
- find both the direct and indirect causes to the accident
- identify persons and departments that contributed to the causes
- place together the causes with those who contributed to the causes

An overview of the legislation is given, and there is a brief overview of the public investigation of major accidents.

Two models for accident investigation are presented: The American ILCI model, and an alternative model developed by SINTEF in Trondheim, Norway. The principles for the STEP-diagram are shown as an analytic tool (STEP = Sequentially Timed Events Plotting). The models are illustrated with various examples. Methods for analysing the organisational conditions in the companies are also presented.

Time period: 2001

Report: The report is available via contact to the publishing firm:

Arbeidsmiljøforlaget,

Postboks 9326 Grønland, N-0135 Oslo

6.2.10 Machine operators' working environment

Project coordinator: Asbjørn Grimsmo

Affiliation: Work Research Institute, Oslo

E-mail: asbjorn.grimsmo@afi-wri.no

Summary: This report contains the analysis and the results from a research project on machine operators working in the Norwegian construction industry. During 2002, researchers from the Work Research Institute carried out a national survey among machine operators (N=443) as well as interviews with entrepreneurs and employers, union representatives, health & safety consultancies and former machine operators.

More than 50% of the machine operators say that they still work as machine operators in 5 years from now. Three main reasons were given:

- High-quality work environment, good co-worker relations, being satisfied with the job
- Income, apprenticeship training, promising future
- The job fits well with family life and labour market

A little less than 50% of the Norwegian machine operators are unsure whether or not they will still be working as machine operators in 5 years from now. Five main reasons were given:

- Interest in trying other jobs
- Family concerns
- Health concerns
- Unpredictable jobs and/or uncertain future
- Poor working environment

Machine operators working in smaller companies (with less than 10 employees) encounter fewer problems than those working in larger companies. Workers in smaller companies are also more content with the information they are provided about work tasks, and feel that the possibility to cooperate and influence work environment issues is better. The quality of the social relations and learning environment are valued higher in smaller companies. Furthermore, the accident risk seems to increase with higher numbers of employees. Working in smaller companies seems to entail more regular work hours. Organizational problems increase along with company size, but seem to decrease if the organizational structure is better.

More than 50% of the machine operators have experienced “near accidents” during the past year, and almost one third of the machine operators have experienced a workplace accident in the same period. Few machine operators are injured in these accidents. The analysis points out that there is a correlation between the machine operators’ fear of consequences caused by mistakes and the appearance of an accident. There is also a connection between facing harassment, criticism or teasing, and the risk of accidents. Machine operators themselves think accidents in most cases are caused by human error, wrong procedure or short time available.

The report in addition contains much information about the machine operators’ health issues and the health and safety systems.

Summary by Hans Magne Gravseth

Time period: 2002

Report: The report is presented on www.afi.no/trykksak/publication_detail.asp?iProjectId=105

6.2.11 Mounting safety in the concrete element trade

Project coordinator: Arne Skjelle

Affiliation: Betongelementforeningen, Oslo

Tel.: (+47) 23 08 76 02

Summary: This collaboration project was completed in 1998. Several organizations in the trade took part, amongst them the National Concrete Industry Association. It was accomplished under the supervision of the Norwegian Building Research Institute.

The background for the project was that increasing prefabrication of the building process implicates that construction sites to a high degree have become a place for mounting of already completed components. Thus, safety and quality during the mounting process is more essential than earlier. Accidents happen now and then, as a reminder that mounting of concrete elements is complicated. There are technical challenges, and it represents an organisational point of intersection, where the distribution of responsibility might seem unclear. The industry wanted to find the best way of distributing responsibility, organisational matters and the different jobs, to make a proper and systematical health, environment, safety (HES) and quality work. In addition, the legislation on the field must be followed.

Three different building projects in the Oslo area were chosen. The documents were studied, and different persons involved were interviewed about issues relevant for the mounting process. Thus, experiences, knowledge, project organisation and points of view were collected from experienced persons and companies involved. Finally, group and plenary sessions with the same persons were held, to make sure that the conclusions were representative and that the actions suggested were appropriate.

The project suggests an integrated quality plan with check lists, formed as one document with three sub-parts:

- Control plan, with focus on the requests in the Building Act
- HES plan, with focus on HES requests
- Private plan, with focus on requests not regulated in law

In addition, a “project binder” for filing control documentation was worked out.

Time period: 1998

Report: The report is available via contact to the Norwegian Building Research Institute: Norges Byggforskning, Postboks 123 Blindern, 0314 Oslo.

There is also a link to the project via the home page to the Confederation of Norwegian Business and Industry (Næringslivets Hovedorganisasjon - NHO): www.nho.no - click "Arbeidsmiljø og helse", then "Arbeidsmiljøfondet" and then "Tematisk oversikt over prosjekter". The contact person in NHO is Siri Møllerud, telephone (+47) 23 08 83 11.

6.2.12 New demands to HES and quality: Challenges for SMEs in the construction industry

Project coordinator: Ove Njå

Affiliation: Rogalandsforskning, Stavanger

E-mail: ove.njaa@rf.no

Summary: The background for the project was that on July 1st 1997, a change in the Building Act was made. This revision was quite extensive, and it implied a reorganisation of the building regulations with regard to form of procedure, distribution of responsibility, requests of documentation, inspection etc. This influenced the conditions for small or medium enterprises (SMEs). With relatively limited resources, they had to update and start using the new set of rules.

The project evaluates the companies' motivation to accept and see the purpose in the new regulations. The main objective was to develop/point to possible instruments that could lead SMEs in the construction industry to take advantage of a functionally based set of rules.

29 persons from construction companies in Rogaland district were extensively interviewed. Most of them were experienced leaders of SMEs. There were several project group meetings, two seminars were held, and the literature was reviewed.

The reform of the legislation did not seem to have any positive effect on the heavy time pressure in the trade, nor on the communication between the SMEs and the other actors (consultants, building authorities etc).

The project suggests several possible actions, with the object to improve quality and HES in the building process and the building products. These actions are categorized into three different levels:

- Actions directed towards each single SME
- Actions directed towards the organisation of the building site. These actions involve several different contractors.
- Actions directed towards the regulations/framework conditions – even though this actually is beyond the mandate of the project.

Time period: 1998-1999

Report: Information about the project can be given by contact to the project leader.

There is also a link to the project via the home page to the Confederation of Norwegian Business and Industry (Næringslivets Hovedorganisasjon - NHO): www.nho.no - click "Arbeidsmiljø og helse", then "Arbeidsmiljøfondet" and then "Tematisk oversikt over prosjekter". The contact person in NHO is Siri Møllerud, telephone (+47) 23 08 83 11.

6.2.13 Occupational injuries in Oslo: a study of occupational injuries treated by the Oslo Emergency Ward and Oslo Ambulance Service

Project coordinator: Hans Magne Gravseth

Affiliation: Oslo Emergency Ward, Oslo

E-mail: hansmagne.gravseth@ullevaal.no

Summary: There is little reliable information about the incidence and severity of occupational injuries in Norway.

Material and methods

Occupational injuries occurring at worksites in Oslo and treated by Oslo Emergency Ward or Oslo Ambulance Service were recorded over a period of three months. Patients with serious injuries were interviewed about the accident.

Results

1,153 injury incidents were registered, 229 (20%) were considered serious. Median age was 32 years. Estimated annual incidence for injuries at worksites in Oslo treated by Oslo Emergency Ward/Oslo Ambulance Service was 14 per 1,000 employees, for all injuries in Oslo requiring treatment, 20 per 1,000 employees. Men had three times the incidence of women. The incidence was highest in the youngest age groups. Of those with serious injuries, 30% had a non-Scandinavian language as their first language. Electricians, carpenters and police officers had the highest observed injury incidences. 87 injuries (8%) were caused by violence.

Interpretation

The incidence of occupational injuries in Oslo is reduced by about 40% since the 1970s. There is, however, no reduction for women. Construction workers are still at high risk. Workers of non-Scandinavian origin are also at high risk, probably due to selection into high-risk occupations. The injury register provides a good overview, but in-depth studies are needed to identify specific risk factors.

Time period: 2001-2002

Report: Tidsskr Nor Lægeforen 2003; 123: 2060-4.

The article is available on the internet, with a summary in English:

www.tidsskriftet.no/pls/lts/PA_LT.VisSeksjon?vp_SEKS_ID=855835

6.2.14 Organisation development in complicated organisations

Project coordinator: Lars Klemsdal

Affiliation: Work Research Institute, Oslo

E-mail: lars.klemsdal@afi-wri.no

Summary: This report is a theoretical study of organisational and work life issues within the construction industry. Two interrelated issues are addressed. The first one is the status of the industry as of today from a trans-national perspective. The second one is how the industry can improve the working environment for its employees, and its performance as a producer of renowned quality products.

The first part of the report paints a picture of the structural transformation of the construction industry as it has developed over the last thirty years. The description is based on recent studies from different countries. The principle finding is that the industry, although traditionally rather fragmented, has moved towards an even more significant fragmentation during the period: Outsourcing and subcontracting over the last ten years have never been more prevalent. Some of the most important consequences of this development are identified and illustrated.

In the second part, it is asked how it is possible to make organisational improvements in an industry based on traditions and conditions that seem to preclude organisational learning and systematic change.

The last two parts of the report give a brief outline of the work carried out by the *Rethinking Construction*-group in the UK, which inspired the authors in making their own suggestions for a research strategy for improving the Norwegian construction industry.

Summary by Hans Magne Gravseth

Time period: 2002-2003

Report: The report is presented on www.afi.no/trykksak/publication_detail.asp?iProjectId=764

6.2.15 Safety handbook for carpenters

Project coordinator: Roar Skjetne

Affiliation: Federation of Norwegian Construction Industries, Oslo

E-mail: roar.skjetne@bnl.no

Summary: This is a small paper (16 pages) that carpenters could have in their pocket. It is edited 2002 by the Federation of Norwegian Construction Industries, in collaboration with the Association of Building Contractors.

It contains an overview of an employer's responsibility and duties if accidents or near-accidents happen, and how they should be reported. Some basic rules and advice about fall safety are given, as well as some words about safety in the use of electrical saws, angle

grinders and nail guns. There even is information about fires and a few lines about first-aid. Important phone numbers are given, and there are forms to fill in and deliver to superiors about accidents or unwanted events.

Time period: 2002

Report: The report is available via contact to the contact person

6.2.16 Systematical HES-work in SMEs: Accident investigation

Project coordinator: Ranveig Kviseth Tinmannsvik

Affiliation: SINTEF Industrial Management, Trondheim

E-mail: ranveig.k.tinmannsvik@sintef.no

Summary: This is report no. 3 in a set of 7 reports about systematic health, environment and safety (HES) work in small or medium enterprises (SMEs). The report is carried out in collaboration with a network of medium-sized enterprises, under the supervision of SINTEF, Trondheim. It was edited 1997. It is not restricted to the construction industry.

The report takes as a starting point the “accident pyramid” and the fact that accidents and near-accidents often have the same causes. Systematic investigation of accidents and near-accidents will give an understanding of dangerous conditions on the work place. These conditions should be improved to prevent new events from occurring.

Accidents should be investigated systematically to

- Search for all relevant conditions that could have influence on the course of events
- Make suggestions for preventing actions that otherwise could be disregarded

The STEP model is then introduced, and this is the main part of the report (STEP = Sequentially Timed Events Plotting). This is a model for investigation of accidents and near-accidents that give the desired systematics in the analyses of the course of events. The model is thoroughly presented, even with various examples.

Time period: 1997

Report: The report can be ordered by request to SINTEF Industrial Management, Safety and Reliability, telephone (+47) 73 59 27 56.

6.2.17 The Building employer regulation in practice in the Municipality of Oslo

Project coordinator: Roar Skjetne

Affiliation: Federation of Norwegian Construction Industries, Oslo

E-mail: roar.skjetne@bnl.no

Summary: This is a collaboration project that started 1999 with the local Labour Inspection, the Federation of Norwegian Construction Industries, the Federation of Trade Unions and the School Department in the municipality of Oslo.

The background for the project was that the legislation by many is understood as confusing and over-complex. The intentions and the set of rules in the Building employer regulation are also to a large degree not followed up by private and public building employers, as well as by other actors in construction projects.

The objects of the project was to make a model for a more simple way of understanding and documentation of how the Building employer regulation could be implemented. It was also the intention to find out in what way short projecting and construction time limits influence the handling of the Building employer regulation. Finally, the aim was to illuminate the problems with less serious actors, for instance the way these actors work at completely other hours than the rest of the construction site. This may lead to that parts of the site could turn into more or less HES-free zones.

The School Department in the municipality in Oslo was chosen as the largest and most professional public building employer in Oslo. The construction of two schools was followed carefully. One of them was completed before the other. The aim was to use the experiences from the building of the first one in the planning, projecting and building of the other one. In addition, several rehabilitation projects of the school department were visited.

Some of the conclusions are:

- In public projects, where political decisions are necessary, the decision-makers must considerate that they are responsible for a proper time scale in the projects.
- Unjustifiable short building and projecting times represent obstacles for accomplishing the decisions and intentions in the Building employer regulation. Right time scale is an absolute condition for a proper HES-work
- There is a great potential for a better health, environment and safety work through a correct distribution of responsibility, through written appointments and powers of attorney and a proper apprehension of each part's role

Time period: 1999-2001

Report: The report is available via contact to the project coordinator

6.2.18 Underreporting of occupational injuries to the Labour Inspection

Project coordinator: Hans Magne Gravseth

Affiliation: Oslo Emergency Ward, Oslo

E-mail: hansmagne.gravseth@ullevaal.no

Summary: The Labour Inspection investigates occupational accidents and publishes injury statistics annually. Information is based upon two main sources: copies of reports to the National Insurance Service and compulsory reports from employers to the Labour Inspection.

Material and methods

Occupational injuries treated by Oslo Emergency Ward and Oslo Ambulance Service during a period of three months were compared with injuries recorded by the Labour Inspection.

Results

Four months after the end of the study period, the Labour Inspection had received reports from the National Insurance Service on 150 (13%) of the 1,153 injuries recorded by Oslo Emergency Ward/Oslo Ambulance Service. Among all injuries registered, 208 serious injuries (according to the criteria of the Labour Inspection) affected employees. Only 19 (9%) of these were reported directly to the Labour Inspection from employers in accordance with the legal requirement. The study recorded 17 serious injuries caused by violence affecting employees; none of these were reported directly to the Labour Inspection.

Interpretation

Data on occupational injuries collected by the Labour Inspection are far from complete. In Oslo alone, the Labour Inspection may annually overlook some 900 – 1,000 serious injuries. Data quality can be improved and delayed reporting avoided by using information from doctors and medical institutions that provide treatment.

Time period: 2001-2002

Report: Tidsskr Nor Lægeforen 2003; 123: 2057-9.

The article is available on the internet, with a summary in English:

www.tidsskriftet.no/pls/lts/PA_LT.VisSeksjon?vp_SEKS_ID=855331

6.2.19 Work-related injuries and occupational health and safety factors in smaller enterprises – a prospective study

Project coordinator: Nils Bull

Affiliation: Section for Occupational Medicine, Department of Public Health and Primary Health Care, University of Bergen

E-mail: nils.bull@isf.uib.no

Summary: The aim of this study was to determine whether any of the HES factors registered by visiting small mechanical enterprises in Norway at the start of the study could predict the risk of occupational injuries in subsequent years. Twelve HES factors, including injury awareness, programme for action, employee participation, training and use of personal safety devices, were registered. A questionnaire was completed by interviewing the employer and observing production.

Two variables based on observation of the use of safety equipment were significantly correlated with occupational injuries. There is potential for prevention in smaller enterprises by increasing the use of personal protection devices and safety equipment on machines. Frequent inspection with feedback to the workers is probably the most effective means of attaining the desired result of reducing injuries.

Time period: 1998-2001

Report: Journal of Occupational Medicine, 2002: 52; 70-4.

The article is also available on the internet, but payment is necessary:

<http://occmed.oupjournals.org/cgi/reprint/52/2/70>

Abstract if the article is available for free on:

<http://occmed.oupjournals.org/cgi/content/abstract/52/2/70>

7 Sweden

7.1 Ongoing Swedish project

7.1.1 Additional substances in asphalt – influence on working environment and environment

Project coordinator: Bengt-Olle Persson

Affiliation: Peab Asfalt AB

E-mail: bengt-olle.persson@peab.se

Summary: The project aims at finding out relevant facts on substances added to asphalt and the possible negative effects of those on health and environment. The long-term aim is to inform the industrial sector on possible risks, point at areas where further knowledge is needed and to reduce the use of such additional substances that may compromise environmental concerns. The project also aims at developing a basis for regulations of use of additional substances in asphalt.

Cooperation with Lund University of Technology.

Time period: 2003-2004

7.1.2 Building non-dependent of weather

Summary: The most important external source of production disturbances in building work is the weather. A more weather protected production environment must be created. The initial part of the project aims at showing how this can be dealt with in new ways. More info on www.sbuf.se

7.1.3 Concrete handling machine

Project coordinator: Bo Träff

Affiliation: Golvimporten Entreprenad AB

E-mail: bo.traff@golvimporten.se

Summary: The aim of the project is to develop a mobile unit for laying of concrete in connection with stone flooring (e.g. terrazzo). The unit is based on combination and reconstruction of existing machines.

Time period: 2002-2003

7.1.4 Experience from weather protected production

Project coordinator: Lars Söderlind

Affiliation: Lars Söderlind Konsult HB

E-mail: larsolof.soderlind@telia.com

Summary: The project aims at documenting the products, systems, aids and methods used today within building industry to supply weather protection. The documentation is completed by the experience the use of such protection has given, mainly regarding economy, work environment and production conditions. The emphasis is on new production. The knowledge is gathered in a handbook with advice and recommendations.

Co-operation with Akademiska Hus AB nad Högskolan i Halmstad/CMB.

Time period: 2002-2004

7.1.5 Future production environment – the route to a industrial on site building

Project coordinator: Lars Söderlind

Affiliation: NCC AB, Sweden

E-mail: larsolof.soderlind@telia.com

Summary: Aims at developing a better work environment and to create preconditions for developing building from a process- and production perspective. Co-operation with Centrum för Management i Byggandet.

Time period: 2000-2005

7.1.6 Handbook on garbage handling

Project coordinator: Marita Björklund

Affiliation: VVS-Installatörerna

E-mail: Marita.Bjorklund@vvs.se

Summary: The aim of the project is to develop a practical handbook directed towards installation industry. The handbook shall be useful in education and information but also in daily work.

Time period: 2003

7.1.7 Keeping elderly workers' competence in building service

Project coordinator: Bengt Jolof

Affiliation: Kungsfiskaren Bygg och Fastighet AB

E-mail: bengt.jolof@peab.se

Summary: The project aims at developing an organisational model that enables keeping elderly workmen professionally active for a longer period than today and the knowledge and experience of elderly staff to be passed on to younger and less experienced colleagues and the organisation as such.

Time period: 2003-2004

7.1.8 Lifting equipment for carts/containers for garbage to containers

Project coordinator: Lars-Åke Björnudd

Affiliation: ALTIMA AB

E-mail: Lars-Ake.Bjornudd@altima.se

Summary: The aim of the project is to develop a lifting device to simplify emptying of garbage carts into standard containers. A prototype will be developed for testing at a building site. An inventory will be made of market available carts for transportation of garbage.

Time period: 2003-2004

7.1.9 More women in building industry

Project coordinator: Eva Hedman-Pétursson
Affiliation: LTU, Avdelningen för Stålbyggnad
E-mail: ehp@ce.luth.se

Summary: The aim of the project is to map why some female engineers chose to leave the building industry and why others chose to stay. Methods: questionnaires, interviews, register studies etc. The goal is to generate information on how university education and work roles may be changes to attain more women to join the industry and to stay within the building sector.

Co-operation with Luleå University of Technology.

Time period: 2003

7.1.10 Project Z-axis

Project coordinator: Johan Rosenquist
Affiliation: NCC AB /Jan Hedälv, Sweden
E-mail: johan@furniture.se

Summary: The aim of the project is to investigate if the patented so-called Z-axis can be used on carts and make materiel transportation at building sites safer and more efficient. Co-operation with Galaxen.

Time period: 2003-2004

7.1.11 Risk management in large construction projects with a complex organisation. Development of a strategy for prevention of occupational accidents, applied in the construction of the Götatunnel in Göteborg, Sweden

Project coordinator: Marianne Törner
Affiliation: National Institute for Working Life/West, Göteborg, Sweden
E-mail: marianne.torner@arbetslivsinstitutet.se

Summary: The building and construction industry has a high frequency of occupational accidents. Such accidents have severe consequences for the victim, and also induce high costs for production disturbances in the companies. Since the customer of large construction projects often is a public authority, accidents in this occupational branch often result in high costs to society.

There is a need for scientific analysis of the implications of different factors for safety in large construction projects, as well as of the effect of different types of safety measures. A research team at the National Institute for Working Life West, in a longitudinal research and development (R&D) project, is following the construction of the Götatunnel in Göteborg. In this project, factors of significance to risks for occupational accidents to the construction workers are studied. The study has its basis partly in the concept of safety climate, i.e. the attitudes and perceptions of the employees concerning different safety-related factors. In addition to this, the significance of general psycho-social factors, stress and so called locus of control, as well as the companies' and customer organisation's formalised systems and routines for safety work, are studied. The influence of these factors on safety behaviour and the occurrence of accidents and near-accidents are of special interest.

Data are gathered through a six-wave questionnaire study, interviews, safety audits and field studies. Questionnaire data are analysed using structural equation modelling, which enables analysis of large data materials, and following the development over time of the studied factors on the individual level, as well as of how the different factors relate to each other.

The aim of the study is to investigate how factors on the company level, group level and individual level influence the safety of the construction workers;

- to investigate how safety aspects are handled in the coordination of the work of the different actors in the Götatunnel project
- to develop the possibilities of companies in the construction sector to continuously improve safety work, one part of this being the development of a safety questionnaire for practical use by the companies and the OSH services

The project team consists of the following persons:

Marianne Törner, ass prof, (project manager), National Institute for Working Life West, Göteborg

Anders Pousette, PhD, psychologist, National Institute for Working Life West

Susanna Larsson, doctoral student, National Institute for Working Life West

Eric Rosenlund, work environment engineer

Time period: The project runs over the period 2001-01-01 until 2005-12-31, with financial support from the Swedish National Road Administration, Vinnova, AFA-insurance and Swedish Builders Development Fund.

Report: Not yet available.

7.1.12 Stressless

Project coordinator: Jimmy Larsson

Affiliation: Peab AB

E-mail: Jimmy.larsson@peab.se

Summary: The project aims at giving knowledge and 'tools' to leaders and managers in building- and construction companies for handling stress, stress reactions and on how stress related problems may be detected and prevented in one self and among co-workers, as well as decreasing negative effects of stress in the organisations.

Time period: 2003-2005

7.1.13 Technique for heavy lifting in building industry

Project coordinator: Bo Broberg

Affiliation: Håltagaren i Laholm AB

Summary: A pre-study was performed and presented in April 2003. It aimed at creating co-operation between several actors, developing a common list of necessary criteria and a model of best technical solution for drilling in concrete.

Time period: 2002-2003

7.1.14 The healthy building site

Project coordinator: Bo Johansson

Affiliation: Luleå Tekniska Universitet, Arbetsvetenskap, Industriell produktionsmiljö

E-mail: bo.johansson@arb.luth.se

Summary: Project at Lund University of Technology aiming at identifying and describing strategies and activities (Best Practice) for success in the battle against work related musculoskeletal diseases in the building industry. Literature studies and case studies at 5-15 larger building companies.

Co-operation with ByggForum Nord.

Time period: 2003-2004

7.1.15 Work environmental aspects in the use of vibration free concrete

Project coordinator: Thomas Gevert

Affiliation: Färdig Betong, Sweden

Summary: Concerns studies of effects on work environment of chemical emission and exposure.

Time period: 2000-2003

7.2 Completed Swedish projects

7.2.1 Better work environment during concrete drilling

Project coordinator: Kjell-Åke Söderberg

Affiliation: Galaxen Nord Bygg AB

E-mail: kjell-ake.soderberg@galaxenbygg.se

Summary: The aim of the project is to develop already existing equipment to reduce the risk of musculoskeletal and vibration injury and dust exposure during concrete drilling in confined spaces.

Time period: 2002

7.2.2 Development of rational and risk reducing methods in the use of pre-fabricated building material

Project coordinator: Linda Rose

Affiliation: ERAK Ergonomi & Akustik HB

Summary: Development of methods for transportation, placing, mounting and casting of pre-fabricated building material, in order to obtain more rational methods and methods that generate less personal injuries than methods used at present. At an early stage of the project solutions were developed and presented in the report 'Utveckling av rationella och riskminskande metoder vid användning av prefabricerade skalelement - skalmursvägg och plattbärla', Linda Rose, ERAK (20 pages). The report is an example of concrete problem solving in production.

Time period: 2002

7.2.3 Dust hindrance in reconstruction

Project coordinator: Rickard Gisselgård

Affiliation: Kungsfiskaren, Sweden

Summary: Development of an adjustable, easy-to-handle module system for plumbing work and other similar tasks in apartment buildings.

Time period: 1996-2002

7.2.4 Health and safety issues in connection with clearance and ground investigation work

Project coordinator: Hans Kronberg

Affiliation: Skanska Sweden

Summary: The project resulted in a practical and accessible information publication describing laws and regulations to be adhered to in connection with risk of hazardous exposure of ground contaminants.

Co-operation with National Board for Occupational Safety and Health, J&W and others.

Time period: 2001-2002

7.2.5 Health effects of extremely long working periods

Project coordinator: Björn Samuelsson

Affiliation: NCC/Selmer, Sweden

Summary: The project investigated if very long working periods and short time of recovery has any negative health effects. Co-operation with Bygginustrins Centrala Arbetsmiljöråd och Institutet för Psykosocial Miljömedicin.

Time period: 1999-2000

7.2.6 Hip-Harry

Project coordinator: Henrik Andersson

Affiliation: Galaxen, Sweden

Summary: Aims at developing ergonomics tools and aids in ceiling building work.

Time period: 1999-2000

8 Accident statistics in the Nordic building and construction industries

1. Definition of the “Building and construction industry”:

1.1 The definition of the “Building and construction industry”.

E.g., industrial sector F = 45 (Construction) in the NACE classification system

I: Icelandic version of NACE rev.1. (ISAT95 version 2)

N: Industrial sector F=45 (construction) in NACE

S: The definition in old reports is in Swedish standard SNI92, though based on EU's NACE rev.1.

FI: After NACE

DK: NACE, ISIC Rev3

1.2 Has the classification been changed during the period 1992-2001

I: No change

N: Yes, in 1998, but older injuries were re-coded

S: Definition has not changed but the insurance changed in 1994, and made a difference

FI: No change

DK: Yes, ISIC Rev3 adopted in 1995. 1993-1994 data reclassified

2. Definition of a reportable accident:

2.1 The definition of a reportable accident, *e.g.*, at least one day of absence beyond the day of injury

I: At least one day of absence beyond the day of injury

N: All injuries that need medical treatment or with any absence should be reported

S: The only definition is a reported accident. Statistics contain combined figures for work accidents, commuting accidents and work sickness. Reportable accidents in the ISA (Informationssystemet om arbetsskador) require at least one day off work, and /or accidents that lead to injury, acute hearing loss, psychological reaction (*e.g.*, robbery) – even if there is no sick leave

FI: All compensated accidents and occupational diseases (Construction 2001: accidents at work site 93,8%, traffic accidents from and to home 3,6%, work traffic accidents 0,5%, occupational diseases 2,2%)

DK: At least one day of absence from work beyond the day of injury

2.2 Has the definition been changed during the period 1992-2001

I: No change

N: No changes

S: Reported accidents became independent of sick leave after 1990

FI: No change

DK: No change

3. Underreporting of reportable accidents

3.1 An estimate of the general reporting fraction for the construction industry, as well as for all sectors combined (*Reporting fraction = number of reported injuries/ number of reportable injuries*)

I: For all sectors combined estimated to 20% (Labour Inspection); Construction ??

N: According to the Labour Inspection – 30-50% for both. According to Hans' current research results approximately 25% for all sectors combined, and maybe slightly less for construction

S: No estimation is possible

FI: All are reported.

DK: Estimated 40-50%

3.2 Is it safe to assume a constant reporting fraction during the period 1992-2001?

I: According to Labour Inspection the reporting fraction has increased greatly during the ten-year period

N: According to Labour Inspection the reporting fraction has gradually increased, partially due to new legislation (Workers compensation Law 1990). According to Hans' current research, the reporting fraction has probably not changed

S: After 1994, it is possible to assume a constant reporting fraction

FI: Yes

DK: Yes

4. Classification of injury severity

4.1 How are occupational injuries classified and defined?

- I: Fatal and non-fatal.
- N: Fatal and non-fatal. Fatal – no written definition. Serious injuries (defined as fractures, brain concussions, injuries that require hospital treatment etc.) should be reported directly to the Labour Inspection by phone or similar. However, these injuries are not recorded and not shown in the official statistics
- S: Fatal; over seven day's absence; under seven day's absence
- FI: Serious accident= more 30 days absence
- DK: Fatal = death within one year of the incident; Serious = fracture, amputation, multi-trauma; Minor = all other reportable nonfatal injury incidents

4.2 Have the classifications and definitions been changed during the period 1992-2001?

- I: No change
- N: No change
- S: After 1994, it is possible to assume a constant reporting fraction
- FI: No change
- DK: No change

5. Measure of incidence rate data:

5.1 What measure of injury incidence is used? *E.g.*, number of injuries per 10,000 employees per year or working hours etc.

- I: Per 100,000 employees per year
- N: Per 1,000 employees per year
- S: Per 1 million working hours/1000 employees. In the private construction industry per 1000 employees per year
- FI: Per 1,000,000 working hours
- DK: Per 10,000 employees per year

5.2 Has this measure been changed during the period 1992-2001?

- I: No change
- N: Yes, until 1998 the incidence measure was injuries per 1,000,000 working hours
- S: No change
- FI: No change
- DK: No change

Table 1**Number of employees in “construction” and “all sectors combined”, 1992-2001**

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Construction										
Island	9900	10000	10000	9700	9200	10100	10900	10600	10500	11400
Norway	116200	106400	108200	114000	120000	129300	135800	135900	132900	138700
Sweden	-	221731	222187	223837	217433	208627	215495	216852	228601	-
Finland	147000	122000	109000	115000	118000	130000	139000	149000	149000	145000
Denmark	-	144582	139600	151659	154163	156595	161082	165475	167603	174224
All sectors										
Island	143000	144200	145400	149000	147500	147800	152100	156500	160100	162700
Norway	2031100	2041200	2069200	2113400	2156400	2219500	2275800	2294300	2303800	2315700
Sweden	4209000	3964000	3928000	3986000	3963000	3922000	3979000	4068000	4159000	4239000
Finland	2206000	2071000	2054000	2099000	2127000	2169000	2222000	2296000	2335000	2367000
Denmark	-	2609859	2584866	2617096	2648808	2669658	2699314	2747488	2759308	2772868

Table 2**The make-up of the construction sector by size of enterprise (local unit), 2001**

Distribution of enterprises in percent (%)	Micro			Small		Medium	Large		Number
	0	1-4	5-9	10-19	20-49	50-99	100-249	250+	
Island	2.1	88.8		8.4		0.7		0.0	1 426
Norway*	63.7	21.3	7.3	4.4	2.4	0.6	0.2	0.1	42 956
Sweden	No possible information at present								-
Finland		84.2	8.8	4.4	2.0	0.4	0.2	0.1	29 585
Denmark**	36.4	28.2	18.3	10.4	5.1	1.1	0.5		23 857

*N: 2003

**DK: 1993-1999

Table 3**Building and construction industry, accident incidence*, 1992-2001, all injuries**

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Island	66	55	77	94	134	139	164	165	206	170
Norway	209	206	219	244	229	253	274	270	274	254
Sweden	220	195	176	155	150	140	152	163	149	-
Finland	1105	973	1075	1101	1102	1166	1223	1212	1245	1279
Denmark	-	254	298	297	287	296	292	303	278	246

*Incidence: number of accidents per 10,000 employees per year

Table 4**Building and construction industry, accident incidence*, 1992-2001, serious injuries**

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Island	Serious injuries not recorded									
Norway	Serious injuries not recorded									
Sweden	No possible information at present									
Finland	125	116	138	129	126	134	138	137	140	145
Denmark	-	41.6	47.1	45.9	44.4	43.5	45.1	41.7	-	-

* Incidence: number of accidents per 10,000 employees per year

Table 5**Building and construction industry, accident incidence*, 1992-2001, fatal injuries****

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Island	1.01	0.00	3.00	0.00	1.09	1.98	0.00	0.00	2.86	0.88
Norway	1.2	0.94	0.92	1.05	1.58	0.85	1.1	0.96	0.45	0.29
Sweden	-	-	-	0.67	0.55	0.58	0.46	0.36	0.57	-
Finland	0.68	0.90	1.01	1.39	0.76	1.23	1.08	0.81	1.14	0.90
Denmark	-	0.55	1.00	1.05	0.84	0.77	0.87	0.61	-	-

*Incidence: number of accidents per 10,000 employees per year.

**Only fatal accidents at work site

Table 6**National incidence (all sectors combined), 1992-2001, all injuries**

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Island	47	46	46	59	73	84	88	87	90	86
Norway	124	126	130	141	145	150	155	147	139	132
Sweden	122	105	99	90	91	87	94	99	90	-
Finland	522	506	511	538	532	556	565	537	527	511
Denmark	-	172	187	193	194	192	186	182	174	169

* Incidence: number of accidents per 10,000 employees per year

Table 7**National incidence (all sectors combined), 1992-2001, serious injuries**

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Island	Serious injuries not recorded									
Norway	Serious injuries not recorded									
Sweden	No possible information at present									
Finland	55	51	57	56	50	52	54	52	50	47
Denmark	-	18.7	20.0	20.5	20.9	20.5	20.5	19.5	-	-

* Incidence: number of accidents per 10,000 employees per year

Table 8**National incidence (all sectors combined), 1992-2001, deaths****

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Island	0.21	0.28	0.48	0.20	0.20	0.27	0.13	0.51	0.31	0.06
Norway	0.32	0.30	0.21	0.27	0.25	0.29	0.28	0.25	0.25	0.16
Sweden***	0.25	0.25	0.23	0.23	0.22	0.23	0.17	0.16	0.14	-
Finland	0.32	0.35	0.39	0.28	0.32	0.34	0.38	0.34	0.37	0.35
Denmark	-	0.24	0.29	0.33	0.28	0.31	0.30	0.25	0.25	0.19

*Incidence: number of accidents per 10,000 employees per year.

**Only fatal accidents at work site

***For 1994 the 146 deaths in the Estonian accident are not included

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