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Prevention of "simple accidents at work" with major consequences

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Abstract

The concept "simple accidents" is understood as traumatic events with no more than one victim. In the last 10 years many European countries have seen a decline in the number of fatalities, but there still remain many severe accidents at work. In the years 2009-2010 in European countries 2.0-2.4 million occupational accidents a year were notified leading to 4500 fatalities and 90,000 permanent disabilities each year

The article looks at the concept "accident" to find similarities and distinctions between major and simple accident characteristics. The purpose is to find to what extent the same kinds of prevention or safety methodologies and procedures established for major accidents are applicable to simple accidents.

The article goes back to basics about accidents causes, to review the nature of successful prevention techniques and to analyze what have been constraints to getting this knowledge used more broadly. This review identifies gaps in the prevention of simple accidents, relating to safety barriers for risk control and the management processes that need to be in place to deliver those risk controls in a continuingly effective state.

The article introduces the "INFO cards" as a tool for the systematic observation of hazard sources in order to ascertain whether safety barriers and management deliveries are present. Safety management and safety culture, together with the knowledge included in the INFO cards are important factors in the prevention process.

The conclusion is that we must look at safety as a part of being a professional in all kinds of jobs and occupations as well as at management level.

Keywords:

Highlights

- Definition of accidents and the conditions for prevention
- Connection between critical events, management and safety culture
- Safety measures that can be observed,
- INFO cards with hazard specific question relating to specific safety barriers
- Safety as a part of the professionalism of doing a good job

Introduction

The concept "simple accidents" is understood as traumatic events with usually no more than one victim in contrast to major accidents. The use of the term "simple accidents" is intended to underline that this kind of accident is perceived as trivial, common or traditional, and that such accidents seem to be rather simple to explain, both as to why they happen and when they happen. These accidents result primarily in injuries with minor consequences, but also once in a while people may be more seriously harmed and the consequences may turn fatal. Most occupational accidents are simple and happen in all occupations, sectors and countries - more or less everywhere.

Through the last 10 years many European countries have seen a decline in the number of fatalities, but there still remain many severe accidents at work. In the years 2009-2010 in European countries 2.0-2.4 million occupational accidents a year were notified (Eurostat, 2013) leading to about 4500 fatalities and about 90,000 permanent invalidities each year (see Table 1).

Table 1 about here

These worrying statistics need to be discussed taking into account the developments in the field of occupational health and safety. Safety legislation has been growing continuously for the last 50-60 year, making employers the main ones responsible for their employee's safety. Safety organizations have been established and specific regulations have been established for many types of hazards and activities. Frequent safety campaigns are a prioritized support activity by authorities and insurance companies. Safety training and education courses have been established and technology has improved remarkably with regard to in-built safety. However, the costs of injuries from occupational accidents for EU 15 is still estimated at 55 billion euros (Eurostat, 2004). Other cost calculations tell stories of great costs for both employers, employees and the broader society (Gavious, et al., 2009), (Rikhardsson & Impgaards, 2004), (Labour Organisation in Denmark, 2010), (Eurostat, 2004). If employees, employers, the regulatory authorities or politicians are asked, then all agree that nobody should be injured when they are at work and certainly not be made permanently disabled or get killed. Furthermore they agree that it is better to prevent than to cure.

The question then is why we still see so many occupational accidents happening again and again. What do we miss or have not understood about how to avoid these accidents?

This paper is divided into three parts:

Part 1will look at the concept "accident" to find similarities and distinctions between major and simple accident characteristics. The purpose is to find to what extent the same kind of prevention or safety methodologies and procedures established for major accidents are applicable for simple accidents.

Part 2 will go back to basics about accidents causes, to review the nature of successful prevention techniques and to analyze what have been constraints to getting this knowledge used more broadly. To do this we will start our description of the causes of occupational accidents with the injury and its consequences and go back in the causal sequence through the immediate, proximal causes to the root causes. This review will identify gaps in the prevention of simple accidents, relating to safety barriers for risk control and the management processes that need to be in place to deliver those risk controls in a continuingly effective state. A safety barrier is understood to be a physical and/or behavioral barrier blocking the development of a scenario from becoming a loss of control and leading to harm. They include technical safety barriers that need to be provided, used, maintained and monitored as well as behavioral safety barrier covering procedures, plans, rules, availability, manpower, competence, commitment, conflict resolution, coordination and communication. (Hale & Guldenmund, 2003)

Part 3 introduces a proposal for how to cover the gaps found in part 2, relating to information about hazard sources, safety barriers and management delivery systems for different risks. This will present the concept of "INFO cards" as a tool for the systematic observation of hazard sources in order to ascertain whether safety barriers and management deliveries are present.

Part 4 looks at the problem of getting safety to be prioritized in a company and the need for integration at all levels of the hierarchy. Safety management, safety culture and safety climate, together with the knowledge included in the INFO cards are important factors in this process. (Glendon, et al., 2007), (Hale A.R., 2010), (Jørgensen, 2002), (Zohar, 2008).

The conclusion will be that we must look at safety as a part of being a professional in all kinds of jobs and occupations as well as at management level.

1: The concept "accident"

Accident models and theories in safety and prevention have traditionally treated accidents as all of the same kind. Nevertheless, there has sometimes been a distinction made between major accidents and occupational accidents in the sense that some theories, models and cause analyses have been based either on major accidents or on occupational (simple) accidents. But the definitions, the causal modelling and analyses and the discussions about preventive measures seem to treat accidents as all of one kind. We need to look a bit more closely at the phenomenon "accident" to untangle this.

1.1.   *Definition*

The definition of an accident has been formulated in many ways throughout history. However, an analysis of different accident models shows that three elements are always to be found in models; the description of the causes, the events leading up to them and the consequences (the injury or damage) (Jørgensen, 1982). The causes are most often described as multiple and sequential; the events as sudden, unexpected and unplanned and the consequences as harm to people, materials, production or other values (Kletz, 2002), (Sklet, 2004), (Jørgensen, 1982), (Eurostat, 2002), (Eurostat, 2013). The main difference between the definition of major accidents and that of simple, occupational accidents is that major accidents have consequences not restricted to the immediate occupational area and are characterized by harm to many people, valuables and materials, while occupational accidents happen at work and normally have consequences for only one person.

1.2.   *Frequency and seriousness*

Major hazards can therefore be defined as events resulting in very severe consequences. Exactly because of these potentially severe consequences a lot of effort has been, and has to be, taken to obtain the lowest possible probability for such an accident, often through technologically complex and tightly coupled systems with a high degree of control and defense-in-depth, developed through predictive analyses. As and when a major accident happens a lot of effort has been put into identifying causes and cause –consequence relations driving a learning process aimed at removing causes (Sklet, 2004), (Rasmussen & Svedung, 2000), (Rasmussen, 1997).

Simple occupational accidents have a much higher frequency and have in fact killed or permanently injured more people in total than all the major accidents which have occurred. Nevertheless, the consequences for each individual occupational accident can be seen as minor compared to the major accidents. However this is only according to a view from society or the regulator; for the victims it does not make any difference whether they are killed or maimed alone or as one of a crowd. The types of hazards and causes leading to occupational accidents and injuries are many and complex and occur often in loosely coupled (work) systems. Most importantly, these

systems are believed to be controllable by the victims or those close to them by removing the root causes, identified often by statistical analysis as their errors. (Rasmussen & Svedung, 2000). The question is if that is true.

1.3. *Hazard information*

Frequency and seriousness are also a question of who is at risk, when, where and in what situations and with what probability a given type of accident can lead to serious consequences. Hazards regarded as major hazards are largely connected to processes, technologies, and materials with well-defined hazards such as explosions, crashes or collapses, which we can easily locate (Rasmussen & Svedung, 2000), (Sklet, 2004), (Stoop & Roed-Larsen, 2009). Major hazards are, for the same reason, controlled, or at least isolated technologically and are surrounded with procedures and rules in tightly coupled systems to control the hazard (Bird & Germain 1985), (Glendon, et al., 2007), (Hale & Guldenmund, 2003), (Rasmussen & Svedung, 2000), (Sklet, 2004), (Stoop & Roed-Larsen, 2009), (Perrow, 1984)

In contrast to the strong focus on major hazard prevention, the many types of occupational hazards are so common in every work process that most people hardly think about them. These include a fall when walking on stairs or from a ladder, injury to the back or other body part when handling a load, or coming into contact with a knife or other sharp tool, etc. These are called "simple hazards" (Jørgensen, et al., 2010). They are hazards all of which can lead to serious or fatal injuries for the individual, but they are also hazards that individuals seldom recognize as resulting in such injuries. They are the kinds of hazards so commonly found that people have largely learned to deal with them without getting injured. They are therefore seen not as hazards to be eliminated, or tightly technologically controlled, in the same way as major hazards, but as within the control of the potential victims, and therefore their own fault if things eventually go wrong. They are latent hazards that can be seen as a kind of sleeping hazards, one that people are unable to perceive or where it takes an unusual set of circumstances to be present for the hazard to manifest itself as an incident with harm. Given the general experience that everybody knows very well how these hazards should be handled, Carin Sundström-Frisk expressed the view that people can work day in and day out in such a hazardous environment. Through their thoughtfulness, ingenuity, attention and physical abilities they can compensate for poorly designed equipment, facilities and routines, and thus prevent the risks being triggered (Sundström-Frisk, 1985), (Jørgensen, 1982).

1.4. *Accident investigations*

Various detailed methods have been developed for the analysis of accidents, but they are used primarily in relation to the major accidents (Sklet, 2004), (Katsakiori, et al., 2009). The norm is that an investigation team is established to investigate a major accident and every observation, statement and evidence is written down for in-depth analyses.

Occupational accidents are mainly investigated by the regulatory authorities to assign responsibility or by the company safety organization, in the best cases to drive prevention, but mostly only for statistical purposes. Investigations of occupational accidents lead mainly to short descriptions of the consequences, the mode of injury and the harmful agent that caused the injury, with sometimes information about the deviations occurring. If the consequences are minor and the event seems to be simple, most often time and resources are not put into more investigation. Hence the information from simple occupational accidents is very often only recorded in statistics for either the company or the authorities. This information is mostly used to "measure" the level of safety rather than for the purpose of learning to improve preventive controls. This drives a vicious circle, that, despite being relatively so common, they are not seriously investigated to understand why they still occur so relatively frequently and their prevention is seen as simple; without that

investigation, they are seen as the fault of the victims and hence not that of the management; with the result that their underlying causes are not investigated and addressed.

In recent years different initiatives have begun to be taken to developed methods to analyze occupational accidents much more deeply. These include "Tripod" (Pietersen, 2006), the "Danish Safety Organization analysis method" (Jørgensen, 2011) and the "Dutch Storybuilder" (Bellamy, et al., 2007). However, it seems that only large companies with a dedicated safety department have the ability to put such methods to use.

The primary learning from the occupational accidents investigated by regulators and contained in the official statistics focus mainly on establishing whether the occurrence was a breach of the law. Different small-scale research on specific branches or activities has shown results on linkage from consequences to the root causes (e.g. Hale, et al., 2012), but the only notable, large-scale project which has been undertaken is the Dutch ORCA project where over 20,000 serious injuries were analyzed using the bowtie method and in which the essential safety barriers for 64 types of hazards are described (Ale, 2006), (RIVM, Worm Metamorphosis Consortium, 2008), (Bellamy, 2010). A bowtie is an analysis methodology that analyses an accident from the critical event, e.g. a fall from a ladder, with a fault tree analyses on the left side of the loss of control and consequence analyses on the right side.

It is paradoxical that people seem to perceive that occupational safety measures are based on empirical data, but in practice (with the rare exceptions cited above) this is not the case.

1.5. *Blame and guilt*

A further difference between the major accidents and simple accidents is the question 'who do we consider responsible for accidents, if and when they happen'. It seems that major accidents are so complex and concern so many people that the "blame" (certainly in the last 50 years) has been placed at the level of the organization behind the process (Kletz, 2002). In contrast to this, for occupational accidents we have a tendency to blame the victim and so absolve the organization from its responsibility. It is a more or less common agreement that 90 % of this kind of accidents are caused by human mistakes and poor behaviour (Heinrich, 1959). An opposing view to this argument can be found in the work of Carin Sundström-Frisk (1985) who concluded that we do not have as many accidents as might be expected, precisely because of the human factor; that people are actually very good at maintaining their safety using their human qualities.

1.6. *Risk awareness and risk aversion*

We can also look at our risk awareness and estimation of risk. Many studies (e.g. Lin et al 2007, Slovic 2000, Slovic et al. 1981, Hale & Glendon 1987) have shown us how people tend to overestimate the risks that have a high potential to be fatal. These are risks that are seen as technologically complex, scientifically unknown, where people are involuntarily exposed, where the risk is controlled by others, where the risk or the consequences are dealt with irresponsibly or where the risk is memorable from recently-occurring accidents. The risks that are underestimated are the normally non-fatal risks, where exposure is seen to be voluntary, where the risks are scientifically well known, risks that can be controlled or dealt with responsibly, where the consequences are reversible and the risk is not dramatic or memorable. These findings show that awareness is more about feelings than about knowledge or objective risk assessments and the prevention efforts and safety activities have to take this into account (Lin & Petersen, 2007).

1.7. *Conclusion to part 1*

The conclusion to this brief review is that the definition of an accident can be used for all kind of accidents as a phenomenon, but the conditions for prevention for different types of accident have

major differences in frequency and seriousness, hazard information, the depth of their investigation, the blame allocated and the risk awareness of those concerned.

2: The nature of successful prevention techniques

Accident causation models have been expressed in many forms, going from the sequence of event (Andersson, 1994) to representation of the whole system (Katsakiori, et al., 2009). But they have all dealt more or less with the following issues (Andersson, 1991), (Bird & Germain, 1985), (Feyer & Williamson, 1994), (Groeneweg, 1996), (Hale, et al., 1997), (Koornneef & Hale, 1995), (Raouf, 1994), (Rasmussen & Svedung, 2000), (Jørgensen, 2002), (Zohar, 2010), (Reason, 1997):

1. The consequences - the injury and the victim,
2. The critical event - deviation and harmful agent
3. The immediate causes most often related to the work situation and the victims' behaviour, and the safety barriers or risk control measures introduced to control these causes.
4. The root causes related to management conditions and processes delivering controls.

Rasmussen and Svedung (2000) identified two further levels extending the above with:

5. The management's strategic prioritization and commitment
6. External conditions such as legislation, competition, market relations, stakeholder requirements etc.

The sequence is presented in the order in which the causes are usually dealt with in an investigation, from the proximal to the distal causes. These 6 stages in their reverse, causal order are distinct in time and place but also represent 6 stages in the hierarchy of decisions and power, from the employee to the line managers and middle managers, further to the top management and the external forces. I will go through these 6 stages to see briefly what we know of them from research about occupational accidents; whether and what we know things from research about major accidents that can be adopted in prevention of occupational accidents and what have been the constraints in practice for the prevention of the risks and the creation of safety.

2.1. The consequences –the victim and the injury

When people have already been involved in an accident with injury the important thing to do is to provide the best treatment and best recovery possible. First aid and immediate treatment are important and call for a first aider, a physician and/or an ambulance and a well-functioning hospital system. Also the insurance systems are important to mitigate additional financial harm to the victims and their families. Occupational injuries have been monitored through notification systems for more than 100 years and through hospital surveys for at least 50. The consequences for victims are well known. As a result of occupational accidents victims get wounded, break their bones, strain their muscles and backs, get poisoned, get burned etc. The seriousness of the injury is measured in different ways either through the type of injury, the sick leave or grade of incapacity. In the last 15 years research on the cost to the victim and to the enterprise has documented that occupational injuries are relatively rather expensive and it seems to be a win-win situation to raise the safety level for both the employees, the employers as well as society (Eurostat, 2004), (Rikhardsson & Impgaards, 2004), (Gavious, et al., 2009).

2.2. The critical event – the deviation and the harmful agent

The harmful agents in the critical events leading to most simple accidents are well known by most people e.g. a knife can cut, a fall can hurt, a collision can wound, chemicals can be toxic, fire can give burns, etc. To protect people from being injured in the case of a critical event different kinds of personal protective equipment and/or technical protection equipment have been developed

and used. But this is shutting the door after the horse has bolted; the etiology of critical events is actually much more complex. The fact is that most hazards will not injure anybody most of the time, because they are observed and taken care of by people's behavior. These are therefore a kind of sleeping hazard. The critical event will occur only when several precursors happen at the same time and in the right combination (Hollnagel, 2008), (Jørgensen, 2011). It is the simultaneous combination of disparate causes that results in a critical event. For people to be aware of what may happen simultaneously and in combination is really difficult and very seldom communicated to them.

To avoid being injured depends on people's ability to recognize these simultaneously occurring potential combinations of causes. They need to understand that the situation is then relatively much more dangerous. They have to be able to do this in time to act and must know how to act and have the ability to take the action. The questions are: What must they be able to see, can they understand what they see and do they know what to do.

2.3. *The immediate causes*

The immediate causes relate to the explanation for what made the critical event happen at that moment. This is most often connected to either unsafe conditions at the workplace, unsafe acts or chance variation (Heinrich, 1959), (Jørgensen, 1982), (Reason, 1997), (Zohar, 2010), (Jørgensen, 2002), (Hollnagel, 2002).

Unsafe conditions in the working situation can be related to the design of the work situation or its surroundings, to products, equipment, devices, environment, etc. Lack of ergonomic design, good plans for the work, maintenance of equipment and housekeeping of the workspaces are some of the causes leading to poor working situations (Jørgensen, 2002).

Unsafe acts have been classified into different human failure types (Reason, 1990). We see slips, lapses and mistakes in the simple accidents as well as intended unsafe acts, which come from the motivation to get the work done more quickly and/or with less inconvenience (Rasmussen & Svedung, 2000).

2.4. *The root causes*

Most accident analysis for simple accidents stops at the preceding stage of the immediate causes. However, it should go on to question how we could anticipate human failures, as things that relate to lack of knowledge and awareness about hazards, lack of ability to foresee and react to hazards and lack of motivation to take care of the hazards because, among other things, injuries seldom happen to individuals (Sundström-Frisk, 1985).

Important underlying issues are the need to have a dialogue between workers at the sharp end and the management (designers, operations, maintenance, etc.) about hazards, to identify and assess them and to control them. However it is difficult to find research that tells us about what hazards there are in what situations and how to identify and assess the simultaneous occurrences of precursors which characterize these sleeping hazards. This raises questions about what it is that the frontline supervisors need to observe and have dialogue with the workers about and where do they get this knowledge from?

If it is so that the sleeping hazards are difficult to observe and the simultaneous combination of causes (that may differ from time to time) are difficult to recognize and understand in time to react, what could be done instead in advance? Could it be to observe that the safety barriers are in place and used? In this case how do we teach workers to observe the safety barrier, to understand how important it is that the safety barriers are maintained and used correctly and to act if the safety barriers are missing or are inappropriate?

The root causes relate to the management processes delivering the barriers or risk controls that influence the immediate causes in the working situation as well as employees working conditions including the workers' ability to react and behave as needed. These management deliveries are the processes of design, procurement, installation and maintenance of equipment, the recruitment, training and manpower planning of employees, their motivation and resolution of potential conflicts between safety and other objectives, and communication and planning of groups to coordinate their prevention tasks. The root causes are connected at the middle level or the daily routine in an organization linked to the staff and line function delivering the crucial resources and controls to safety critical tasks at the lower level (Hale, 2005), (Hale & Guldenmund, 2004). The root causes are recognized as gaps, inadequacies or un-prioritized parts of these management deliveries that have an influence on making the immediate causes possible. But do these line and middle managers know what to look for and what is needed?

If the workers have to observe, use and maintain safety barriers, then the managers must provide those safety barriers and ensure that they are purchased, used and maintained. The managers must also provide the managerial safety processes so that the workers have plans and goals to follow, have resources enough to carry out the work, have the competences to use the safety barriers effectively, have dialogue and communication about the work situation and the conflicts that may occur. This requires that the managers knows what safety barriers they have to observe as their own responsibility, what is needed if the safety barrier is not in place and what they must do to act when needed.

The workers must act in the working situation they are in, but the manager has to act in advance to prepare and provide the optimum working situation for the worker.

2.5. The management's strategic prioritization and commitment

Senior managers are concerned with policy making and the establishment of procedures to facilitate policy implementation, while supervisors at lower hierarchical levels execute these policies and associated procedures through daily decisions and routine interaction with employees. (Zohar, 2008). The importance of top management support for successful safety performance and change is almost universally demonstrated or claimed (Hale, et al., 2010), (Shannon, et al., 1997), (Robson, et al., 2007). Different books and research results tell how important the managers' engagement and commitment towards safety is for the creation of a safety culture (Antonsen, 2009). Creating a good safety culture and safety climate is part of the discussion about the safety management system.

The top manager must also ensure training to the line managers in such a way that they can fulfil their motivating roles towards employees that energize the safety interventions (Hale, et al., 2010). It is the top manager who decides whether to invest in hazard prevention, control systems, safety instructions, behaviour-based programs etc., whereas supervisors or middle managers can only promote the use of such things once they become available (Zohar, 2010).

The top manager must know what kind of training the middle managers need and what organizational procedures make both the physical and behavioural safety barriers work in practice.

2.6. External conditions

Because the simple hazards and simple events are so widely disseminated and so difficult to prioritize in companies and at the same time so expensive for the society and unacceptable in general, at least in the western world, there has been an expansion of legislative initiatives from governments throughout the last 40 years. In this legislation it has become a fundamental rule that the employer be targeted as the main person responsible for safety in the company and for the establishment of a safety organization and for education of workers and safety representatives. But

what has been seen is that this safety organisation is in many companies separated from the line of production and safety questions are not a part of the line manager's daily work or routine (Frick, et al., 2000)

A whole new employment sector has risen to implement and monitor a certified safety management system and to measure the level of safety. This measurement is mostly based on lost time injuries (LTIs), because they are relatively easy to measure. But the number of LTIs is a poor measure of safety, partly because it is possible to manipulate the figures, partly because the level of safety and the number of LTIs at a given time do not need to be correlated. The newest fashion is to measure the safety culture, but this research shows us that there are a lot of constraints and limitations to this approach, notably in relating the measurement taken to the actual safety performance (Reniers, 2013), (Hollnagel, 2014). It is the contention of this paper that observation of safety barriers could lead to a new and better proactive set of leading indicators.

2.7. Conclusion to part 2

We know a great deal about what kinds of accidents happen, with what consequences, critical events and hazards. We also have a rather good idea that management commitment, driving the safety climate and safety culture, means a lot for safety in an organization and both the managers' and the workers' behaviour. But it seems that there is something in between that is missing. That is knowledge about what essential safety measures can be observed, which can be understood and be possible to change or respond to proactively. Safety barrier observation (of both the physical and behavioural safety barriers) seems to be important for the frontline level, the daily supervisor level and the top manager level.

3: Safety barrier knowledge and INFO cards

A safety barrier is defined as a system that has been designed and implemented to prevent, control or mitigate the propagation of a condition or event into an undesired event (a loss of control over the hazard), (Sklet, 2004), (Hollnagel, 2008). Safety barrier have also been described as both physical safety barriers and behavioural safety barriers (Hale & Guldenmund, 2003).

The Dutch program of work by the Ministry of Social Affairs and Employment developed a model for quantifying work activity risks (Ale, 2006). To date the project has analyzed more than 20,000 occupational accidents with serious injuries using the "Storybuilder" methodology (Bellamy, et al., 2007). The analysis used the software Storybuilder to capture the richness of the data in a graphical bowtie structure. Structures for 36 hazard types were built resulting in the identification of 400 safety barriers. Behind the identified barrier failures there were around 16,000 organizational failure events across 8 management delivery systems. (Bellamy, et al., 2010), (RIVM, Worm Metamorphosis Consortium, 2008).

A significant element in the analyses in Storybuilder and subsequent "bowties" is the identification of which safety barriers have failed or not been present, which has led to the accidents happening. In some cases the safety barriers are easy to understand and review, while in other cases they require more detailed information. One example of a complex safety barrier is the one that ensures that the support for scaffolding is in order. Here, the safety is dependent upon the correctness or adequacy of the surface condition, the support's surface and placement, the presence of a spacing support and its distance etc. Simpler barriers are personal protective equipment and machinery guarding, but even these need to meet defined quality and suitability criteria.

It is also necessary not only to identify that the safety barriers are in place but also that they are of a suitable quality and which factors are relevant to this quality. The factors that have an influence on the quality of the safety barriers, and hence have an influence on the likelihood of an accident occurring, have been given the designation PIEs, which stands for "Probability Influencing Entity",

that is to say factors that can influence the likelihood of failure. For example the PIE´s for the stability of a ladder can be how the ladder is anchored, how the ladder is secured from sliding, how the ladder is prevented for being knocked against, etc. The PIEs can also be understood as the quality parameter of the safety barriers. The idea is that if all PIEs are completely in order, then the safety barriers are also and therefore the risk of an accident is at its lowest given the intrinsic effectiveness of the barrier. If some of these PIEs are faulty, not in order or not in place, then the safety barrier is bad and the risk of an accident is higher (Ale, 2006), (Jørgensen, et al., 2010).

The 36 bowties resulted in the identification of 64 types of critical events or hazard sources. For each of these hazard sources the failures of the primary and supporting safety barriers were identified; for each safety barrier the PIEs were also identified.

This project represents maybe the only systematic documentation of the safety barriers needed against simple accidents. The project also made documentation of how to evaluate the requirements of the managerial delivery systems relating to the safety barriers needs. It is important to note that different hazard sources need several different safety barriers and that the different safety barriers need different management delivery systems (Bellamy, 2010).

The Storybuilder analyses start from the critical event, identify the lack of physical safety barriers, then the lack of the provision, use, maintenance and monitoring (PUMM) of the barriers and finally link this to the management delivery system (MDS) which failed to support that PUMM. These MDSs are plans and procedures, equipment, ergonomic design, availability of people, competences, communication, motivation and conflict resolution between tasks.

Risk assessment has to go in the opposite direction from the investigation process described in the 6 stages in part 2, starting from what the manager has to observe, understand and act on and leading to what the worker has to observe and understand and act on. For the senior and middle manager this must start with the knowledge of what kind of MDSs and PUMMs are most important for ensuring that the different safety barriers are in place and the quality of the safety barrier and the PIEs themselves.

The question is how we can make this valuable information available for many different users, both managers and workers, in an easy way. The idea is to create "information (INFO) cards" for different kinds of hazard sources with the purpose to identify:

☐ What is to be observed? What are the safety barriers? This concerns primary questions about whether a safety barrier is provided and whether it is used correctly.

☐ What is to be assessed? What are the quality parameters to be evaluated? This covers the need to provide the safety barrier, to maintain a safety barrier in good operation and the need for instruction of the user about the safety barrier.

☐ What should be done, given deficiencies that are discovered? This covers the action to be taken to provide a missing safety barrier, to maintain a failing safety barrier and to provide instruction and motivation for the correct use of a safety barrier (Jørgensen, et al., 2010).

In order to accomplish this the employer and the workers need to be able to observe, assess and act in advance before the employees start on their work tasks. To do this two sets of INFO cards have therefore been devised:

1. The first set is aimed at employers and supervisors, to ensure that they will identify where safety barriers are needed and will provide adequate safety barriers in advance, ensuring that they are in place before work starts.
2. The second set is aimed at employees, to ensure that the safety barriers provided are properly used, maintained and monitored during the course of their work.

In doing this we are able to shift our focus from risks that may be difficult to observe and control, to a focus on the safety barriers that lend themselves much more to being observed and

controlled. That is to say, the risk assessment and auditing, etc. are able to look at control through the safety barriers and their quality parameters (PIEs) including the management delivery system.

3.1. Development of a set of generic INFO cards

The basis for the development of INFO cards must be information about the different hazard sources, the safety barriers and the connected PIEs, PUMMs and MDS. To investigate and form the questions for the generic INFO cards the triangle of knowledge, ability and willingness (Bloom, 1965), (Sundström-Frisk, 1985) was of great help. The knowledge concerns what is in the employees´ heads – do they know and understand what they have to do; ability concerns the characteristics of the task and the requisite human skills that make it possible for the employees to do what they have to do (demands and capacities); and willingness concerns the employee's motivation to do the task (properly).

Whether the safety barrier has been properly resourced by the MDS has therefore to be observed, evaluated and acted upon according to the knowledge, skills and motivation needed.

The challenge for the development of the INFO card is on the one hand to make it easy and available for users (workers and managers) and on the other hand to cover all hazard sources and all connected information. If you make such a system short and easy then it often becomes too general, but to cover all can be just too unmanageable. Going through all of the safety barriers we can see that some are very generic and appear in nearly all hazard types while other safety barriers are generic for subgroups of hazard sources and finally some are very specific for specific hazards. For this reason the INFO cards were developed in three steps, to avoid too much repetition of the same questions:

1. This covers what has to be observed, evaluated and acted on in general for all risk situations as a generic option for both the employer and the employee. This covers the generic safety barriers that are needed in more or less all kinds of risk situations, like technical safeguarding, personal protective equipment, operational control, avoidance of danger zones, emergency response, employees in a healthy condition. The generic INFO card collects these kinds of general options. Figure 1 shows the employer version of the generic INFO card.

Figure 1 about here

2. This covers what has to be observed, evaluated and acted on for subgroups of hazard sources where the task cannot be explicitly described in terms of the very specific hazards that may arise. The cross-cutting safety barriers are the generic safety barriers for all of the hazard sources included in the subgroup. The subgroups of activities and critical events used are given in Table 2. Figure 2 shows the employer version of the cross-cutting safety barrier for falls to a lower level.

Figure 2 about here

3. This covers what has to be observed, evaluated and acted on for the specific hazards which require very specific safety barriers for their control. These specific safety barriers for specific risks are a précis of each single risk, based on single Storybuilder factsheets (e.g. 36 Storybuilder bow-ties or 64 risk bow-ties). Figure 3 shows the employer version of the specific INFO cards for falls from a vehicle.

Figure 3 about here

Table 2 shows the identification of the 64 specific types of critical events or hazard sources and their division into sub groups as follows:

The first sub-division consists of the characteristics of 4 main different risk situations:

    A. The surface that is being walked on or worked on, covering the risk of falling.

    B. The surroundings that are being travelled in or worked in covering the risk in the surroundings of something colliding with you from outside, or of colliding with something.

    C. What is being worked with or on, covering the risks of becoming caught up in/wedged in something, stabbing yourself, cutting yourself, straining yourself.

    D. The surroundings of a particularly dangerous nature covering conditions that require particular vigilance, such as fire and explosion, electricity and lack of oxygen.

The second level of division consists of 17 subgroups of activities and connected critical events or hazards sources. The third level consists of the 64 types of hazard sources.

Table 2 about here

The basic reason for dividing the INFO cards into three types is to help the enterprises going from the general level to the more specific level with the possibility to choose when to use the subgroup level and when to use the specific level as "a pick up and use" possibility. The idea is also to provide the enterprises with a systematic view of what hazard sources need to be controlled by what safety barriers and management delivery systems.

3.2. How should a company use INFO cards?

A company must first examine its own activities in order to determine which risks require (improved) awareness and prevention. This should be done through incident analysis, risk assessment, analysis of employee experience and perceptions, etc. Knowledge from national or enterprise statistics, published facts and figures can be helpful for describing the most important risks, as well as attention to the company's own history of incidents.

Knowing this, the company can take the following steps:

1. Go through the generic INFO cards assessing what they already have and what they need to supply additionally in the organization.

2. Take the most important cross cutting INFO cards covering risks that represent many work places or many different work situations in the company and assess what needs to be supplied in their (daily) control and supervision.

3. Follow the specific INFO cards covering any specific risks that exist in special tasks, workplaces or work situation and identify the supervisors and workers who need the related knowledge, ability to act and motivation.

This way the company can use a sample of INFO cards that cover the risks of which it is most important for the company to improve its control. To tailor them to a specific company, it may be necessary to include the special names of technologies or technical terms and sometimes more detailed specifications will be needed to give exact checks of barriers. For example it would not be enough to have a safety barrier for a pipeline telling that rust must be monitored; more information of how to monitor and how to detect would be necessary.

The next step would be to introduce the use of the customized INFO card for the company, which probably requires a targeted approach where performance management and change management will provide useful governance. The INFO cards can also be a valuable input for auditing, daily dialogue, training sessions as well as in assessment of risks.

3.3. Conclusion to part 3

The INFO cards can be seen as another observational risk assessment tool in the line of Energy Analysis or FMEA, The difference is that the INFO cards contain the practical and validated results from the Dutch "Storybuilder" research (op. cit.), with its very concrete and detailed observations and analyses. Furthermore the INFO cards include both physical and behavioral safety barriers which are targeted both at the manager and at the employee.

What has been demonstrated is that different hazard sources need different safety barriers and different management delivery processes. This tells us that if we want to minimize the risk of fall accidents, we must select safety barriers specific for the risk of falls and deliver the managerial activities relevant for those safety barriers, while if we want to minimize the risk of explosion, we must choose the safety barrier and management delivery processes relevant for that kind of hazard sources. Whilst there are some barriers which are generic across those two hazard types, they are few and generic prevention will not solve our risk control problem.

This puts the discussion about observation of accidents and near accidents as measurement for the safety level in perspective. It transfers attention from the unwanted injuries and harm to the functioning of the prevention, replacing a reactive with a proactive performance indicator. Also it introduces the necessary level of specificity. For example, if the accidents and near accidents which are occurring are falls on the same level and the safety initiative set in place is only focused on that hazard source, then you may see a better safety for these kind of risks, but it will have absolutely no effect on e.g. the risk for explosion. This expands on the conclusion from part 1; accidents are not all of a kind, but concern many different risks, with at least 64 hazard sources, which must be controlled by different safety barriers and management delivery processes. The Dutch ORCA project's information and the INFO card may be of help in managing this diversity. This message may seem trivial once stated, but it is one which has not penetrated sufficiently to prevention practice, which may tend to look for panaceas such as safety culture, which it hopes will solve all problems in one wave of the magic wand.

4: Discussion

But – there is always a "but" – as Rasmussen told us 15 years ago, the top manager has other duties to prioritize. The effectiveness of the company, the financial situation, productivity, the customers' need for a low price and fast delivery play a crucial role for the company´s survival and growth (Rasmussen & Svedung, 2000). Safety is only prioritized if it is crucial for the company´s survival, or to sustain a profile as a responsible company, or at the lowest level to fulfil legislative requirements.

The knowledge about what good safety management is has primarily been found in larger companies with major risks or in very big international companies with a stated goal towards zero accidents (Robson, et al., 2007). Very few SMEs are to be found implementing a good safety management system.

Most enterprises are SMEs and most simple accidents happen in SMEs. We know that the SME´s resources for safety are limited as well as their own experience with accidents. Small enterprises are generally described as simple structures. According to Mintzberg, they are characterized by the strategic apex dominating the supervision of the work done by the operating core (Mintzberg, 1983). More popularly expressed, it is the employer who sets the agenda, deciding which tasks are to be performed and under what circumstances. Limited formalization of decision making means that communication routes are short, but there are also limited planning activities (Hasle & Limborg, 2004). This results in a great need for, but concomitant lack of, systematic management, such as systematic access to working environment management. Small enterprises

choose not to participate in these because such a system is too time consuming and expensive and does not fit their way of operating (Antonsson & Smidt, 2003).

In practice in these SMEs, for most traditional work situations an agreed way to do the work has been developed informally over time as a part of the professional opinion of how work has to be carried out. This is mostly driven by a focus on the quality of the end product and its effectiveness, more than on the safety of the process producing that product. Safety is in most of the traditional sectors seen as something that is based on individual behaviour, which often results in belief in the expression "you are your own safety officer". The problem with this is that only very experienced people with a good mind for safety will be able to foresee the combinations of circumstances that trigger the simple hazards and be able to act successfully in such a hazardous situation. People who can do that must be seen as the true professionals, people who have the competence to make judgments of the situation for both the safety and quality of the work. This is the reality we are facing when promoting prevention through safety management, safety culture, safety climate, safety behaviour etc.

What if we turn the view around and start with what is needed for a company to survive and to make profit? Can we see if we can integrate efforts for reducing injuries and losses in what else may be needed in a company? We could also look at what is of importance for the employees, what they could be proud to be.

Others have seen the need for the integration of safety in production. Rasmussen (2000) showed us that the management's wish to obtain the highest effectiveness in organizations and the employees' wish to make the workload easier are two very strong drivers for the drift to danger. Others have drawn similar conclusions, that safety should be as equally important a part of an organization's mission as being a financial success (Geller, 1994). If management has equal attention to productivity and safety, then it exhibits a culture that has the potential to host both (Hopkins, 2005). We must ask ourselves how we ensure that effectiveness includes safety and quality, and how we ensure that the easy way to perform the job also is the safest and highest quality way.

Several researchers have found that the financial loss from accidents and error in production can be tremendous for a company, but also that a high level of safety and quality assurance are related to high performance in production in the long run. Financial success is both when you earn more money but also when you minimize your losses (Elsier & Nikov, 2003), (EU-OSHA , 2011), (Foldspang, et al., 2014).

In this view of effectiveness you must know what can go wrong both for production, processes and financial transactions as well as for safety and quality. This entails knowing how to observe, what to observe, how to understand what you see and how to know what to do about it. This can all be summarized as a professional attitude to work, its content and context.

The discussion for the future will be if something like INFO cards could a good help for this process concerning the safety question.

5: Conclusion

The conclusion is that simple accidents, which are caused by simple hazards and simple critical events, even though their related injuries can be serious at least for the vistims, are very seldom analyzed for root causes. The combination of precursors which characterize the triggering of these simple hazards is difficult to observe or be aware of; those on the front line find it difficult to see the wood for the trees. The safety barriers for different hazards are different and the management delivery processes required to install and keep the barriers functioning also differ for different safety barriers. The links between these simple accidents, the critical event leading to them and the required safety barriers and management delivery processes have mostly not been communicated to

the big group of exposed employees or their responsible supervisors and managers; hence they are not aware of, or prepared for their role in prevention. This is also partly because they operate from the belief that such accidents are under the control of the victims, so they do not see the need for that prevention information and hence they do not even ask for it. What is needed is a structure that links for them the different stages in the causal chain and explains their personal role in controlling it, so that the information given to them is not too general, or too enormous, nor involving too many persons. They also need to be convinced in the end that someone really cares.

The lessons learnt from research and practice is that:

1. We know the types of simple accidents, events and hazards including the injury frequency and seriousness, but we cannot foresee where and when these accidents will occur because of the multiple combinations of causes and hazard distributions.

2. We know how to protect both human and technological system elements from unwanted releases of energy, but not all uncontrolled flows of energy can be protected against.

3. We know that humans' behaviour is dependent on their knowledge and awareness of hazards, their ability and possibility to handle hazardous situations and their motivation to behave as a professional; but most hazards are sleeping hazards and when, where and why hazardous situation crop up is mostly difficult to foresee.

4. As researchers and practitioners we know what types of safety barriers are needed for the different hazards but this knowledge is not commonly known by those working with them.

5. We know how to design work environments with a high passive safety, but in most industries and services especially in SMEs this is seldom utilized.

6. We know that active safety is based on the line managers' focus on safety when making instructions, plans, coordination and communication, but that is seldom realized in practice, especially if decisions about safety issues are placed in a parallel organization separated from the production management line.

7. We know that it is important for the manager to create a high level of safety culture, but there is very little knowledge about how to create and measure the manager´s ability to do so for the simple accidents and hazards.

8. We know that management delivery processes are important for the presence and quality of safety barriers, but these delivery processes differ from safety barrier to safety barrier. It is necessary for managers to know about this, to be able and motivated to ensure the delivery, despite the fact it may be in conflict with other important management deliveries.

9. We know that the manager's commitment and engagement for safety is of great importance for how the whole organization prioritizes safety, but other issues like finance, customer demands, production, technology, time pressure have most often a higher priority for the company to survive.

It is obvious from the above that we do have a lot of knowledge of what works, but there also seem to be many constraints on implementation in most industries and companies especially the SMEs. Simple accidents may be simple to explain once they happen, and it therefore might seem that what is understandable for a company should also be simple to prevent. However, nothing could be more wrong. Because of the abundance of sleeping hazards, the difficulty is to observe the hazardous situation before it is too late, to understand the different needs for safety barrier (incl. their continuing maintenance) and management delivery processes. It is to be hoped that INFO cards could be of great help for this purpose.

We have to make safety a part of the professionalism of doing a good job, not making safety a separate issue, but an integrated part of what are the good and proper ways to do things for both the frontline workers, the supervisors as well as the top managers.

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Table 1. Registered accident at work in 2009-2010 reported to Eurostat from 27 EU countries + Norway according to the severity of the accidents and the duration of absence.

Severity:	Fatal	Permanent disability	3-6 months absence	1-3 months absence	14-30 days absence	4-13 days absence	Unknown	Total
Year 2009	4,381	98,771	102,116	439,358	604,386	906,396	284,952	2,440,360
Year 2010	4,567	83,294	83,230	369,126	506,760	744,500	267,600	2,059,077
Total	8,948	182,065	185,346	808,484	1,111,146	1,650,896	552,552	4,499,437

Figure 1. The manager's generic INFO card covering the generic safety barriers.

Manager's generic INFO card		
Observe	**Evaluate**	**Act**
Observe whether…	*Evaluate the need for…..*	*Act to ensure provision, use, maintenance and monitoring /improvement of safety barriers for….*
Safeguarding is provided and used by the employee	Better safeguarding	Safeguarding
Personal protective equipment is provided and used by the employee	Better personal protective equipment	Personal protective equipment
Operational control of the technical system is safely provided and managed safely by the employee	Better operational control system	The operational control system
Avoidance of the danger zone is provided for in the task and respected by the employee	Better avoidance of danger zone	Avoidance of danger zone
Emergency response is provided and able to be used by the employee	Better emergency response	Emergency response
The employee's health condition is satisfactory and enables them to do the task safely.	Better health monitoring and if it is necessary, changing the employee's current task	Employees who are in poor health condition (change the task)
The employee has the right knowledge and skills and is using them correctly	More training and instruction	Competence (through training and instructions)
Information about risks and safety barriers is communicated to and understood by the employee	Better communication of information about risks and safety barriers	Communication about the risks and safety barriers
Safe equipment is provided and used by the employee	Improving equipment to be in a safe condition, right for the task and possible to use in a safe way	Equipment changed to a better and more safe product
Safety is integrated into plans and procedures for the task and followed by the employee	Improving plans and procedures so they are right for the task and possible to follow by the employee in a safe way	Plans and procedures adapted to be safe for the task and to the level of understanding of the employee
Equipment, technical devices, and the workplace conditions are provided in an ergonomic and safe design and used by the employee and maintained	Improving equipment, technical devices, workplace conditions so that they are in a proper ergonomic condition	The ergonomic design of equipment, technical devices, work surroundings
Sufficient and qualified people are available for the routine and non-routine tasks when needed	More people or people with other qualifications for the tasks (including in the night, for emergency response and specialist tasks that are rarely carried out)	The availability of qualified people for all the possible task demands
There is pressure to carry out the task in a quicker and less safe way due to conflict with operational goals or other tasks	Removing the conflict situation between tasks and goals so that the employee will choose to do his task the safe way and ensuring the employee is getting the right message from management about the importance of safety.	Reduction or removal of the conflict between safety and production, ensuring that safety is prioritised over production goals when they come into conflict
The employee is motivated to carry out the task in a safe way	Improving the employee's motivation and awareness for carrying out the task in an acceptably safe way, including improving the effectiveness of motivational and awareness raising initiatives and maintaining alertness on a continuing basis	Motivation and risk awareness of the employee for carrying out the tasks in a safe way on a continuous basis, including the removal of distractions and maintenance of alertness

Figure 2. The manager's cross-cutting INFO card for falls from height

Manager's cross cutting INFO card for falls from height		
Observe	**Evaluate**	**Act**
Observe whether…	*Evaluate the need for…..*	*Act to ensure provision, use, maintenance and monitoring /improvement of safety barriers for….*
Strength of supporting equipment or structures when working at height is in good order and clean	Checking and providing strength and cleanliness of the equipment or structures when working at height.	Making sure that structures that have to be worked on are strong enough to support persons and other loads. Maintaining or replacement of the equipment. Maintaining strength of structures for working at height.
There is a need for edge protection and if so that the edge protection is of good quality and correctly installed	Checking edge protection quality and correct installation/fixing in place	Maintaining or installing edge protection of appropriate safe design
The placing of equipment (including what it is placed on) and the possibility for it to be affected by external circumstances could affect its safe use.	Adjustment of how equipment is placed and the possibility for external circumstances which could affect its safe use	The secure placement of equipment Maintaining safeguarding against external circumstances that could affect the integrity of the equipment
Competences for using the equipment or being at height is provided and used by the employee.	Instruction/training for working at height	Maintaining workers´ competences for working at height
Employee is motivated to use the equipment or work at height in a safe way	Motivation actions towards working at height	Maintaining the motivational activities for safe behavior when working at height

Figure 3. the managers specific INFO cards for falling from a non-moving vehicle

Manager's specific INFO card for falling from non-moving vehicle		
Observe	**Evaluate**	**Act**
Observe whether….	**Evaluate the need for….**	**Act to ensure provision, use, maintenance and monitoring/improvement of safety barrier for…**
Equipment strength		
The vehicle is strong enough to support the weight	Limitation of weight	Vehicle is strong enough for the weight
The vehicle is overloaded or loaded one-sidedly	Changes to the loading method	The correct load and balanced loading methods
Edge and access protection		
Edge protection is absent, insufficient or has been removed or is broken	Edge protection	Adequate edge protection
The vehicle and the load are safely accessible for the required activities	Changing the access	Safe access to vehicle loads
Equipment placement		
The vehicle placement is stable	Changing the placement of the vehicle	Stable placement of vehicle
Load configuration is stable	Changing the load configuration	Stable load configuration
Load displacement/movement/loading or unloading threatens user stability or the stability of the vehicle	Changing the displacement/movement/ loading or unloading procedure	Displacement/movement/loading or unloading procedures to prevent instability
Employer ability and competences		
The employee is able to keep balance	Prevention of loss of balance	Being fit enough to balance on the vehicle
The employee is able to work safely on the non-moving vehicle	Changing the work conditions that might cause loss of balance	Work conditions for preventing loss of balance
The access behavior is safe	Changing access behavior	Safe access behavior
The surface conditions are safe for the activity, also with respect to access	Changing the surface conditions that might cause loss of balance	Safe surface conditions for the activities, also with respect to access

Table 2. The list of 64 hazard sources and 17 subgroups of critical events and activities

Characteristics of main risk situations	Subgroup of activities	Subgroup of critical events	Specific hazard sources
A. The surface that is being travelled on or worked on;	1. Work at heights	Falls from heights	1. Falls from heights - movable ladders
			2 Falls from heights – fixed ladders
			3 Falls from height – stepladders
			4 Falls from heights – rope ladders
			5. Falls from heights – mobile scaffolding
			6. Falls from heights – fixed scaffolding
			7. Falls from heights – erection/dismantling of scaffolding
			8. Falls from heights - roofs
			9. Falls from heights – areas, floors with large differences in level
			10. Falls from heights – fixed platforms
			11. Falls into deep holes (e.g. in the earth, floors)
			12 Falls from heights – mobile platforms
			13. Falls from heights – stationary vehicles
			14. Falls from heights – other work at height without protection
	2. Work at the same level	Falls on the same level	15. Risk of stumbling or skidding on the same level
			16. Falls on steps or inclined surfaces
B. The surroundings that are being travelled on or worked on;	3. Falling objects	Being struck by falling objects	17 Being struck by falling objects – cranes or hoists
			18. Being struck by falling objects - mechanical lifting (e.g. cranes)
			19. Being struck by falling objects – from conveyances or conveyor belts
			20. Being struck by falling objects – from manually lifting
			21. Being struck by falling objects – other objects at height
	4.Fragments	Being struck by fragments	22. Being struck by fragments – from machinery or hand tools
			23. Being struck by fragments – from objects under pressure/ stress
			24. Being struck by fragments – that are blown by the wind
	5. Colliding against, between, being struck by	Being struck by moving objects, becoming caught up/jammed, crushed.	25. Pedestrians being struck by vehicle
			26. Being struck by rolling/sliding objects
			27. Being struck by hand tools held by another person
			28. Being struck by objects held by another person
			29. Being struck by swinging objects
			30. Becoming caught/jammed between objects
			31. Colliding against/with objects
	6. Sliding of materials	Becoming buried	32. Buried under loose material
	7. Aggression	Violence	33. Exposure to aggressive people (violence)
			34. Exposure to the behaviour of animals (falls, bites, stings, kicks)
C. What is being worked on or with;	8. Technical aids	Being struck by moving objects, becoming caught up/jammed, cutting	35. Being struck by own hand tools
			36. Being struck by moving parts of machinery - operating
			37. Being struck by moving parts of machinery - maintenance
			38. Being struck by moving parts of machinery - preparing
			39. Being struck by moving parts of machinery - cleaning

Characteristics of main risk situations	Subgroup of activities	Subgroup of critical events	Specific hazard sources
	9. Vehicles	Traffical events	40. The drivers loss of control over vehicle
	10. Electricity	Electric shock	41. Contact with electricity – electrical equipment
			42. Contact with electricity – when installing/repairing
	11. Heat or cold	Burns	43 Burns - frostbite/burns from cold/hot surfaces or naked flames
			44 Fires – combustion from "hot" work
	12. Chemical	Poisoning, etching	45. Discharge of hazardous chemicals from open containers
			46. Contact with uncovered hazardous chemicals (without discharge)
			47 Release of chemical risk from closed containers - work/filling/draining
			48 Release of chemical risk from closed containers - without transportation
			49. Release of chemical risk from closed containers – when closing containers
			50. Release of chemical risk from closed containers – work in the proximity of a discharge
	13. Lifting, heavy loads	Strain injuries	51. Extreme exertions – heavy lifting
			52. Extreme exertions – inappropriate movements
D: Surroundings of a particularly dangerous nature.	14. High voltage	Electric shock	53. Contact with electricity – high voltage cables
	15. Fire	Fire	54 Fire – flammable and easily combustible substances
			55. Fire – fire extinguishing
	16. Lack of oxygen and water	Suffocation, poisoning or drowning	56. Suffocation/poisoning – work in confined spaces
			57. Suffocation/poisoning – work with respirators
			58. Drowning – work in/under the water or liquids
			59. Drowning – work above/in the proximity of water
	17. Explosion	Explosion	60. Physical explosion
			61. Chemical explosion – vapour or gas
			62. Chemical explosion - dust
			63. Chemical explosion - explosives
			64. Chemical explosion – exothermic reaction