The essentials

FOR PREVENTING SERIOUS INJURIES, FATALITIES AND MAJOR TECHNOLOGICAL ACCIDENTS

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COLLECTION LES ESSENTIELS DE LA SÉCURITÉ INDUSTRIELLE

Editorial

Following *The essentials of Safety Culture*, here is the second instalment in the *essentials* series. This is the flagship of our 2018-2019 campaign focusing on *The prevention of serious injuries, fatalities and major technological accidents*.

This theme emerged as a priority through the work carried out by the *Serious Accident Prevention* and *Safety Culture and Process Safety* discussion groups. What they found is alarming: in most sectors, a drop in the incident rate does not lead to a drop in fatalities. Nor is it in any way a guarantee of effective major technological accident prevention. A real shift in the focus of the prevention policy is necessary to ensure that resources are allocated to the prevention of the most serious occupational accidents and major technological accidents as a priority. In every company, this requires a shared awareness of the most significant risks and a strategy for reducing situations with a high potential for serious injuries and fatalities which combines a general framework, proper anticipation when planning the work, and constant vigilance from all employees in real time.

In addition to these *Essentials*, ICSI places a number of other resources on this topic at the disposal of anyone involved in prevention, including animated videos and an e-learning lesson. In doing so, the Institute hopes to contribute to a much needed wake-up call.

François Daniellou,
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and Michel Descazeaux,
Development Director at ICSI

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Preventing

the risks leading to the most serious accidents

Key points

Safety policies and associated resources are too often focused on reducing the most frequent accidents, which are usually the most minor. **Companies should focus their attention and strategy on what is essential: preventing serious injuries, fatalities and major technological accidents** which, although rare, have dramatic consequences.

Reducing the incident rate does not in any way guarantee effective prevention of the most serious accidents. A better interpretation of the Heinrich-Bird pyramid shows the need to focus on the "prevention diamond", i.e. the **serious incidents that have actually occurred, but also high-potential incidents or incidents with a high potential for serious consequences (HIPos).**

Everyone in the company needs to agree on the risks leading to the most serious accidents: risks linked to processes, to the work environment and the movements/procedures required, to simultaneous operations and to a combination of these different aspects... It is essential for everyone to be involved in establishing and updating the list of situations in which serious accidents are possible.

Hazard and risk

A hazard is an intrinsic property of products, equipment, processes... that can lead to injury. For example: the presence of energy, a high temperature, a toxic substance, the mass of a load, a confined space, being high off the ground, a cutting machine...

Risk results from the exposure of a person, facility or the environment to a hazard. For example: inhaling or being in contact with chemical substances, being crushed by falling objects, cuts from work tools, falling from height, electrocution, fire, explosion... It is characterised by the seriousness of its potential consequences and the probability that the event will occur.

"Another serious accident! But our incident rate is improving... What are we to do? We've tried everything!" is something we hear often. But does managing the minor risks prevent the most serious accidents? How much attention should be given to events without consequences which could have been serious in slightly different circumstances?

Organisations can be exposed to **several types of risks:**

- relatively frequent and minor occupational accidents,
- more serious or even fatal occupational accidents,
- major industrial accidents, which are thankfully rare but can affect the company's employees and facilities, the wider population and the environment.

The priority of a "safety culture" approach is to **control the most significant risks or, in other words, minimise serious injuries, fatalities and major technological accidents**. Because these pose the greatest threat to the organisation's employees and to its survival.

The most significant risks vary according to the company's activities. It is important for **all stakeholders to agree on what their most significant risks are** and for this inventory to be updated regularly and shared.

THE LIMITATIONS OF THE INCIDENT RATE

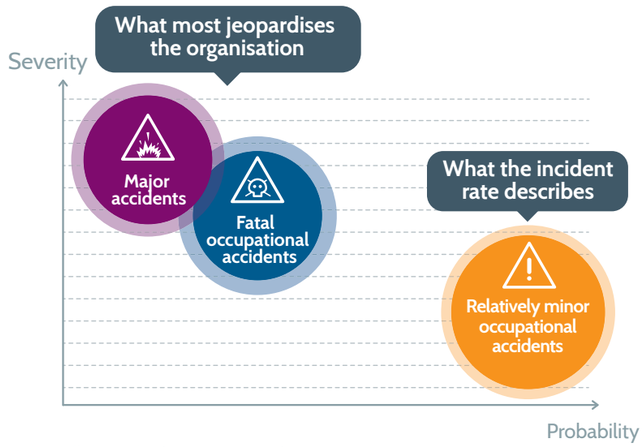
Many companies assess their level of safety by looking at their incident rate, which reflects the number of lost-time accidents per million hours worked. For example: one accident within the course of a year in a company with 60 employees is equivalent to an incident rate of 10, while one accident per year in a company with 300 employees is equivalent to an incident rate of 2. Or, with an incident rate of 2, a team of 6 people experience one accident every 50 years, and with an incident rate of 15, statistically-speaking each employee has one accident over the course of their working life...

But **this indicator has limits**. First of all, it varies according to the chosen scope, e.g. whether or not contractors are included, the policy for reporting lost time injuries, and the measures put in place to avoid lost time. And more importantly, the incident rate is a retrospective indicator. It describes events that have already occurred, and therefore minor events in particular. **It does not in any way indicate the probability of a serious or major accident which has not yet occurred.**

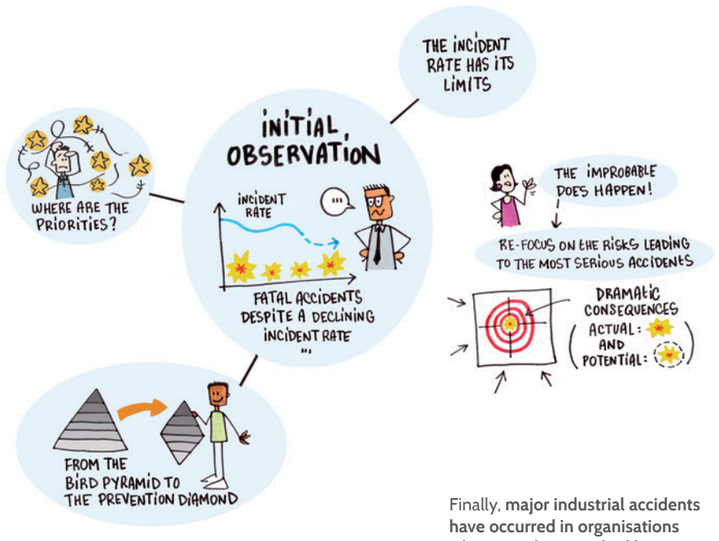
So reducing the incident rate, a legitimate pursuit for many companies, is one thing, but is it enough to prevent the most serious incidents?

No... **many organisations have seen a sharp decline in their incident rate with no drop in their number of fatal accidents.**

> **Improving the incident rate does not in any way guarantee the prevention of the most serious accidents.**



▲ Serious accidents and minor accidents



Let's look at a few concrete examples. In France, between 2003 and 2016, there was a 50% decline in the number of accidents in the metallurgical industry and a 20% drop in the construction industry, while the number of fatalities stagnated for both. And worldwide, between 2011 and 2016, in the oil and gas industries, the overall number of accidents declined by 45% but there was only a 5% drop in fatal accidents...

Finally, **major industrial accidents have occurred in organisations whose incident rate had been excellent for several years!** This was the case, for example, for the 2005 accident in Texas City, where management was focused on the great occupational accident numbers. Or in Macondo (Deepwater Horizon), where the good safety results were celebrated just before the disaster occurred, on 20 April 2010... Other indicators must be monitored to detect an increase in the risk of serious accidents (p. 18).

The probability x severity product is meaningless

Calculating the probability of minor incidents is simple: it can be done using their actual frequency as reported in the past. But for very rare events or those that have never occurred before... it's much more complex! Complicated probabilistic calculations do exist, but they are not reliable. The proof: extremely improbable events have actually occurred and the Fukushima disaster is one example. As for severity, it cannot be reduced to a single numerical value. It is impossible to estimate how many times more serious a death is than a broken arm... Instead, establish categories of severity and event probability, to obtain a matrix which will help you prioritise your actions.

Estimated probability ▸ \ ◂ Severity potential ▸	Major	Very serious	Serious	Average	Negligible
Highly probable	Immediate action required				
Probable		Action to be scheduled ASAP			
Possible			Action to be scheduled in the medium term		
Improbable				Action to be scheduled in the longer term	
Highly improbable				No action	

DETECTING HIGH-POTENTIAL INCIDENTS

The widespread belief that improving the incident rate would guarantee a reduction in serious incidents stems from an erroneous interpretation of the famous Heinrich-Bird pyramid. Depicting a proportional relationship between the number of least serious accidents (the base) and the number of serious incidents (the top), it was taken to mean: "there is a continuity of causes; if we reduce the base of the pyramid by half, then we reduce the most serious risks by half".

Yet in the base of the pyramid, there are two distinct types of minor events:
- those which might have been very serious in slightly different circumstances (a heavy load that falls... just a few centimetres away from a sharp-end worker)
- and those, occurring very frequently, which could not have developed into a serious accident (a sharp-end worker bangs his knee on a crate that was not in its proper place). If organisations spend their resources and energy managing all these minor events, this will have little to no effect on the prevention of the more serious events...

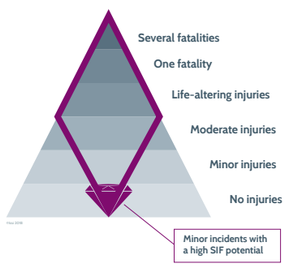
But let's go back to the first category briefly... these incidents that could have had dramatic consequences are the ones to focus on! Those we call **"high-potential incidents" or HIPos.** Let's transform our pyramid to obtain an effective prevention policy that focuses on the following as a priority:

▾ The pitfalls of the Heinrich-Bird pyramid

- the serious incidents that have actually occurred and which we want to guard against in future,
- the high-potential incidents, which should be extracted from the mass of incidents reported and seen as the "diamonds" that hold the most valuable information for prevention.

This requires the implementation of a **mechanism for detecting, collecting and analysing these high-potential incidents**, and the Health, Safety and Environment department cannot do this alone. As soon as a situation is flagged as dangerous, the people reporting it must be able to indicate whether or not, in their opinion, this situation had a high potential for serious consequences. How? By simply asking themselves: "Would I have been surprised if this event had caused a serious injury or a fatality?".

▾ The prevention diamond



SERIOUS OCCUPATIONAL ACCIDENTS AND INDUSTRIAL ACCIDENTS, THE SAME BATTLE

When prevention is being organised in companies, a distinction is often made between:
- occupational accidents directly linked to the victim's work environment or activity,
- industrial accidents linked to a loss of control over physical or chemical phenomena in the industrial process.

The departments in charge of preventing each of these types of accidents are often different, which does not afford a broad vision of what can happen. Yet serious or fatal occupational accidents and major industrial accidents often result **from the same mechanisms, which stem from organisational shortcomings**: lack or disruption of prevention measures, uncontrolled simultaneous operations, insufficient managerial presence, decisions favouring productivity over safety... Individual aspects and behaviours generally have little influence on the occurrence of serious incidents.

Companies must ensure that their prevention of the most serious occupational accidents and of industrial accidents is consistent by working on the fundamentals of their organisation.

The incident rate in practice

- With a high incident rate, a company must organise two types of action: one targeting the prevention of the most frequently occurring occupational accidents, and the other focused on preventing the most serious accidents,
- With a low incident rate, a company must avoid pouring most of its energy into reducing its incident rate (a decrease from 1.8 to 1.7 has no overall effect on safety) and channel it instead into preventing the most serious accidents.

The zero serious accidents goal

"Pursuing the 'zero serious accidents' goal as a priority is a great way to build a culture in which the basic safety rules are rigorously followed. Such a culture is absolutely essential for managing major risks. Then, when this culture exists, it becomes possible to mobilise a large number of employees to pursue the 'zero accidents' goal. Because on the one hand we can capitalise on the previous success, and on the other hand we don't risk overlooking the management of major risks since its priority is well established."

Marcel Simard, Sociologist and Professor at the University of Montreal, Canada.

Improving
the defence-in-depth system

Key points

To prevent serious injuries, fatalities and major technological accidents, **HIPo situations must be anticipated** and three lines of defence must be put in place: **prevention, recovery and mitigation.**

Each line includes **one or several barriers**, each of which may have aspects that are technical, related to the safety management system, and/or linked to human and organisational factors. The barriers are alive: they are implemented and put in place (kinetic), and their effectiveness must be maintained over time. At every stage of their life, their performance can be affected by many different types of disruptive elements.

Detecting **combinations of disruptive elements** at the sharp end through collective vigilance and **having appropriate fixes in place** to deal with them is therefore essential.

Are the risks leading to the most serious accidents prevented in the same way as all other risks within an organisation? How do the prevention, recovery and mitigation lines of defence fit together? How are HIPo situations incorporated into the design of defence systems? What role do frontline staff play?

Deadly ingredients

The most serious accidents are the result of a combination of failures at different stages:

- Insufficient consideration of safety during the design phase,
- Hazards omitted when producing the safety case,
- Incomplete listing of HIPo situations,
- Lack of thought given to barrier compatibility with the reality at the sharp end,
- The illusion that once the barriers are in place they will always be effective,
- Insufficient sharing of hazards, risks, barriers and conditions for effectiveness,
- The work planning is insufficient or incompatible with the reality at the sharp end,
- Insufficient real-time information to identify disruptive elements,
- Critical tasks performed simultaneously, dividing the attention of workers,
- Insufficient communication between the different occupational groups,
- Communication about safety is top-down only,
- Absence of group mechanisms for detecting and reporting disruptive elements and putting fixes in place,
- Managerial decisions or user company/external contractor company relationships that grant insufficient importance to safety considerations,
- Insufficient attention given to HIPo situations, which get lost among all the minor incidents.

To prevent the most significant risks, action must be taken on all of these aspects, with appropriate involvement from the specialists (engineering, HSE...), the operational teams (management and employees of both the user companies and external contractor companies) and staff representatives.

To avoid serious accidents, a defence system must be devised and implemented at the time of designing the facilities and procedures. First, **all associated hazards and risks must be identified**, such as falls from height, exposure to chemical substances, explosions, fires...

Based on this, you can identify the different **scenarios for HIPo situations. What serious events could occur if prevention measures were lacking, ineffective or unsuitable?** For example, an employee could be faced with electrical equipment that is still live after lockout/tagout, a person could be working at height without the appropriate protective equipment, someone could be working on a tank when its pressure starts to rise abnormally...

A defence system can be devised and implemented to avoid or limit the consequences of these HIPo situations. **Such a system includes three lines of defence:**

- **Prevention** to avoid exposure to hazards/danger,
- **Recovery** to regain control over a risky situation,
- **Mitigation** to limit the consequences of any accident that might occur.

These three lines of defence are safeguards to protect against accidents. **They are made up of different types of barriers.** The barriers can be physical or automatic systems (guardrail, holding pond...), or rules intended to equip the work teams and employees who are the final safeguard, the human barriers of the defence system. The **barriers are therefore linked to the three pillars of safety**: the technical aspects, the management system, and the organisational and human factors.

BARRIER PERFORMANCE AND KINETICS

A barrier is a system designed to prevent a risk, recover from a HIPo situation, or mitigate the effects of an hazardous event. Like any set of precautions that is designed and then put to use, **a barrier must be monitored, checked, maintained, and modified or replaced if it is obsolete**. Each stage in the "life cycle of a barrier" must be reviewed on a regular basis.

Although some barriers, such as safety valves, are permanent and likely to age or to wear over time, thus requiring their condition to be monitored regularly, many barriers don't need to be permanent.

3 amber lights equal 1 red light!

The simultaneous existence of three disruptive elements significantly increases the risk of weakening the barriers. For example, today the most experienced worker is absent, a piece of equipment is unavailable, and there is a great deal of pressure to finish the work tonight... in this type of configuration you have to "stop" to analyse the situation and put some fixes in place.

The accident path in pictures

Let's look at a concrete example to understand what we call "the accident path".

A worker needs to perform a simple operation on some electrical equipment. The hazardous situations identified are electric shock, or even electrocution. The potential accident is serious and could even be fatal.

The preventive line of defence includes ensuring that the equipment is deenergized and locked out and the worker has the appropriate training and a permit to work.

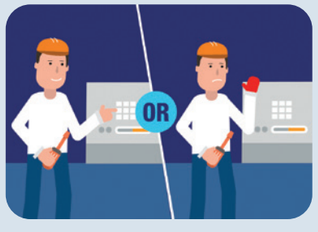
If the preventive line of defence fails, the equipment is still live and the worker is in a HIPo situation. If nothing is done to recover the situation, an accident is imminent.

This is where the recovery line comes in. The barriers put in place at this level are the triggering of an automatic alarm, the use of an approved device by the worker to check that the equipment is deenergized, a colleague raising the alarm...

If these recovery barriers work, the situation is once again under control and there are no significant consequences. The situation should still be reported and addressed, however, because the equipment should have been deenergized before any work was performed on it.

But if these recovery barriers don't work, an hazardous event occurs...

Here, the mitigation line can reduce the severity of the consequences. The barriers planned in this case are the wearing of personal protective equipment, the installation of an insulating mat, but also a fast response from emergency services...



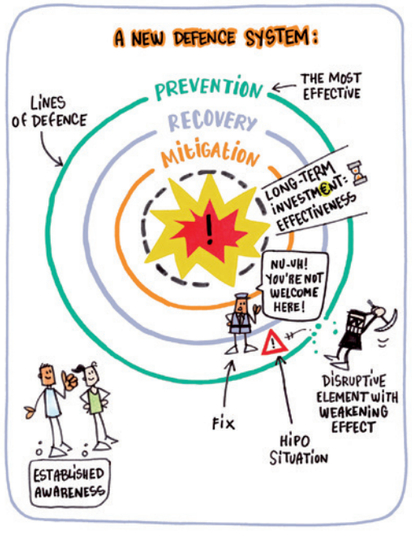
If these mitigation barriers work, there may be no consequences at all or the accident can have minor or average consequences. In any case, the incident will have to be reported and addressed.

But if these mitigation barriers don't work either, the consequences can be serious or even... deadly.

"As early on as the design phase, prevention, recovery and mitigation barriers must be established and sharp-end workers must find them credible.

Let's take electrical hazards as an example: before any work can be carried out on electrical equipment, it must be deenergized and a lockout/tagout must be performed. It would make no sense for the equipment to always be locked out and tagged out, as this would render it unusable... Certain stages must therefore be defined and scheduled with precision: people need to be informed of the need to implement the barrier, its implementation must be decided (which can require certain compromises), the implementation must be carefully designed and planned, compliance with rules, standards and other barriers already in place must be checked...

A barrier is not something that is static; it is a living organism. It often requires coordination between several actors: often, those who lock out/tag out electrical equipment are not those who perform the work once lock out/tag out is complete.



DISRUPTIVE ELEMENTS AND FIXES

The HIPo situations have been identified and described and an effective defence system has been put in place. Yet, one or several of the barriers are not working and an accident is looming... Why? **Because the barriers can be weakened by different disruptive elements:**

- a sudden frost blocks the safety equipment,
- an urgent request from a customer suddenly changes the production schedule,
- unexpected absences affect the team headcount or the skills available,
- an equipment failure changes the way an operation was supposed to be carried out,
- conflicting instructions were given by two different supervisors,
- a manager doesn't push safety messages to his/her team,
- accumulated delays increase time pressure...

Although these disruptive elements might seem "manageable", or at least "not serious" when taken individually, **when they are combined they are much more dangerous** and can even cause the lines of defence to collapse... These disruptive elements can be chronic, in which case a lasting solution needs to be found in the medium term, or they can be occasional.

Fortunately, the frontline workers and managers at the sharp end can identify these disruptive elements and put fixes in place:

- pausing to gain a better understanding of the situation,
- replacing a piece of equipment,
- negotiating a new deadline with the customer,
- temporarily limiting the activity,
- assigning additional resources or skills...

The range of fixes available and their effectiveness in the moment depend on **how well the organisation is prepared and on how invested it is in the long term**. For example, a worker won't feel right about blowing the whistle unless the company has built a culture that encourages such a practice.

Capitalise on operational experience feedback

When it comes to safety, nothing is set in stone. Operational experience feedback is essential to gradually enrich current thinking and continue to improve the prevention of the most serious accidents. It should focus on HIPo situations and incidents, but also on disruptive elements, their effects and their causes, fixes and the lack of them or their failings.

Cultivating

a shared awareness of the most significant risks

Key points

Risk perception is an essential part of risk management. Over- or under-estimating risks jeopardises prevention.

To improve risk perception when it comes to rare events, **specific means** are required: explaining the content of the safety case to the operational teams, simulations, group study of past incidents or events that have occurred elsewhere...

Accurate risk perception requires **knowledge of the possible HIPo situations, the different barriers, and confidence** in the state of these barriers based on active involvement in checking them on a regular basis.

In real time, gaining **an accurate picture of a situation** will depend on the quality of the available information, the training and experience of the operational staff, and an organisation that enables focusing on critical tasks without attention being scattered.

While minor accidents are common, serious injuries, fatalities and major technical accidents are rare... or may even never have occurred before. So how do we get an accurate picture of the most significant risks? How do we maintain and share an awareness of what poses the greatest threat to us in order to adopt the right behaviours? How do we get employees to see the danger in situations in real time?

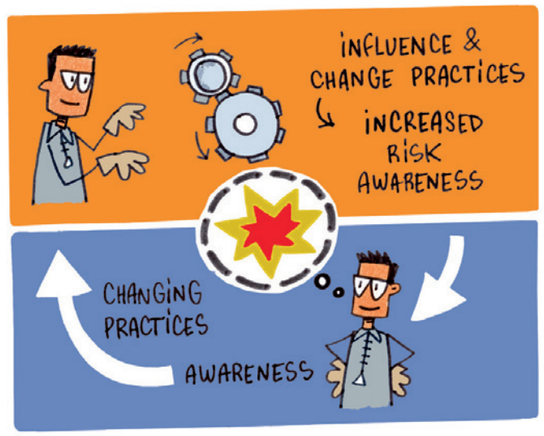
The ways of doing and thinking influence each other:
- the risk perception and mental model of a situation influence the actions that will be taken,
- the practices looked upon favourably by the organisation influence the mindset, perceptions and values of workers.

In this chapter, let's look at how **working on risk perception and awareness can lead to changes in safety practices**. The chapter following will present the initiatives the organisation can take to change safety practices in order to raise awareness of the most significant risks.

ENSURING ACCURATE RISK PERCEPTION

Risk perception determines the mental model we form of a risk and thus **guides our safety behaviours and the decisions we make**.

> **To be psychologically bearable, knowledge of hazardous phenomena must be combined with confidence in the barriers put in place to avoid them.**



Yet it is complex and dependent on the characteristics of the risk but also on the person assessing it:
- their education and training, their personal history, their experience,
- their knowledge of the hazard and **whether or not they have the possibility of taking some form of action to protect themselves**,
- the other elements they have to manage: remuneration by the hour, productivity...
- the groups they are part of, as these all have their own view of whether the risk is acceptable or not.

Underestimating, but also overestimating a risk, can have negative consequences on safety. Overestimating the risk can cause paralysis or overwhelm and is not conducive to appropriate behaviour. Underestimating it leads to taking risks and therefore putting ourself in danger. To ensure accurate risk perception and safe actions, the following is essential:
- knowledge of the hazards, risks and HIPo situations,
- knowledge of the barriers that make up the defence system,
- **individual and collective involvement in checking and maintaining the barriers,**
- confidence in the barriers and work group.

SPECIFIC COURSES OF ACTION FOR THE OPERATIONAL TEAMS

Safety cases are often very technical, with a level of formalism that meets regulatory requirements... but is not suitable for appropriation by the operational teams. And their results are seldom shared. Add to this changes - new equipment, a rise in production, reduced maintenance - that impact on the systems, and it becomes difficult to perceive and get an accurate picture of the most significant risks faced by the operational teams.

To remedy this, **the operational teams, and ideally any contractors, should be taken into consideration and closely involved in safety cases.**

Here are a few tried and tested good practices. Feel free to draw inspiration from them!

GOOD PRACTICE N°1:
Make the operational teams and contractors a target audience or even participants in safety cases and risk analyses.

How? Show them that safety cases aren't just complicated regulatory documents; liven up your analyses! Get the workers to tell you about the risky situations they have faced, ask them for their opinion on the state of the defence barriers, talk about the disruptive elements, the imagined consequences...

GOOD PRACTICE N°2:
Simulate the hazardous phenomena and their consequences... in total safety.

How? Organise drills with simulation exercises, so workers can visualise the consequences of an electric arc, stretching a material to its limits, changing production parameters, staff shortages... Debriefings should be rich, include the emotional aspect and foster the development of risk awareness.

GOOD PRACTICE N°3:
Encourage first-hand accounts and group analysis of incidents.

How? Are you familiar with the law of proximity? It states that the further away from us an incident happens, the less it captures our attention. The same is true for our awareness of the most significant risks, so it is important to get old-timers who have been through disasters to talk about their experience in their own words. First-hand accounts are more compelling than studies. This creates a memory of the event that occurred, thus creating proximity and making it real.

GOOD PRACTICE N°4:
Holding "culture & practices" workshops.

How? Get operational staff and contractors together for one hour each day over the course of a week and encourage them to talk about dangerous situations, the disruptive elements that can threaten the barriers they use, their ideas for improving and maintaining these barriers... The key to success: at the end of the week they should make concrete suggestions for improvements that can be implemented at their level.

GOOD PRACTICE N°5:
Have the occupational groups debate complex work situation scenarios in order to better identify the risks involved (case analysing the risks faced by patients undergoing radiotherapy, Sylvie Thellier, IRSN).

How? Organise discussions with at least two representatives from each occupational group. Allow 30 minutes to elaborate a complex work situation scenario, 30 minutes to list the success modes of the patient care team mobilised to manage it, and 30 minutes to analyse how these success modes could generate risks for patients.

This work helps to improve the safety of the treatment process by discussing work organisation and by establishing validity criteria for the success modes, along with preventive and corrective measures.

Develop the safety imagination

Several tools can help develop a shared awareness of the most significant risks:
- simulations and role-playing,
- training using virtual reality,
- first-hand accounts from old-timers who have been through an accident,
- studying and discussing accident analyses, even if the incidents occurred elsewhere...

These help to make the scenarios plausible and the threat real. They enable people to imagine themselves in and experience potentially dangerous situations... in total safety.

CULTIVATING A SHARED AWARENESS OF THE MOST SIGNIFICANT RISKS

WHEN THE RISK SEEMS TOO GREAT

It is difficult for the human brain to imagine a serious event that has not been experienced: when a risk is too great, **the subconscious is tempted to minimise it to make it bearable**. This is what we call a psychological defence mechanism, which protects against fear and not danger. This individual defence mechanism is often supported by the ideology of the group to which the individual belongs: some groups promote the idea that "it's not that dangerous".

Lastly, a company culture that grants insufficient importance to risks that are ever-present, with too many "the situation is under control" type messages, trivialises significant risks.

HAVE A CLEAR PICTURE OF RISKY SITUATIONS IN REAL TIME

Maintaining the effectiveness of the prevention, recovery and mitigation barriers in spite of any disruptive elements that crop up is always contingent upon the ability of the managers and operational staff present to **gain a clear picture of the situation** in which they are working. Yet **gaining a clear picture of a situation depends on several factors.**

First of all, **our initial understanding of a situation guides our search for available information**. Since we have a greater chance of finding information we are seeking rather than that we are not, if our initial understanding is erroneous we risk overlooking important information. Of course, any information perceived shifts our understanding and guides new searches. Consequently, there are risks when information is missing, erroneous or ambiguous: broken testing equipment, incorrectly configured sensor, unavailable readings...

A mental model is formed by accumulated knowledge and routines, by training and experience, which enable us to interpret situations and take action. **But it can be misleading**... rare and hazardous situations that begin the same way as, or resemble, an ordinary, safe situation, are difficult to distinguish. Because our brain tends to rely on what it knows to categorise the incident as the one we see the most often, and therefore the one posing the least risk... Let's borrow an example from the field of medicine, where some rare but serious diseases begin the same way as tonsilitis... doctors are then trained to look for additional information. Regular drills using role-plays are a great way to enrich the mental models of workers.

The actions being carried out influence the understanding of the situation. Indeed, if attention is divided between several objectives and different tasks need to be carried out simultaneously, this reduces the probability of perceiving information about an incident that is occurring.

Finally, **group influence plays an important role** due to how difficult it is to break away from the interpretation of the majority - the groupthink effect - or that imposed by a superior.

GIVE THE HUMAN BARRIERS EVERY CHANCE

To give workers the best possible chance of detecting and identifying a HIPo situation, it is important to:

- share knowledge of the risks and of the prevention, recovery and mitigation barriers,
- offer training and organise individual and group drills for the situations that are likely to occur, with a view to enriching the mental model,
- ensure that the right information is available at the right time,
- manage the workload to avoid performing critical tasks simultaneously and dividing attention,
- give teams the possibility of asking a manager or an expert for help in understanding a situation,
- implement a learning culture, which encourages drawing lessons from past incidents.

Risk perception, bias and illusions

"Beliefs influence risk perception and lead to biases, illusions, which themselves can affect safety behaviours and involvement in accident prevention. The most widely known biases or illusions include defensive denial of risk, illusions of control, invulnerability or experience, the superiority bias and unrealistic optimism. Risk perception cannot be dictated. But it is important to know how to recognise these biases to get closer to the reality of the risks at the sharp end and encourage effective prevention."

Excerpt from the "Risk Perception" webinar with Rémi Dongo Kouabenan, Professor of Work and Organizational Psychology. ICSI, Safety Academy

Succeeding

at preventing the most serious accidents

Key points

Giving priority to the prevention of serious injuries, fatalities and major technological accidents implies **a reorientation of the safety policy, based on coordination between overall management and local management**.

The reporting and handling of information about HIPo situations must be organised, with a central role given to **sharp-end management and to discussions within the teams**. Resources must be allocated to investigating the causes of HIPo situations as a matter of priority.

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Local residents can play an active role in preventing major risks. Their behaviour in the event of a crisis will depend on the trust built "in peacetime".

Giving full attention to the prevention of serious injuries, fatalities and major technological accidents is a new way of doing things, focused on HIPo situations. How should such an approach be managed? What indicators and success criteria can be put in place?

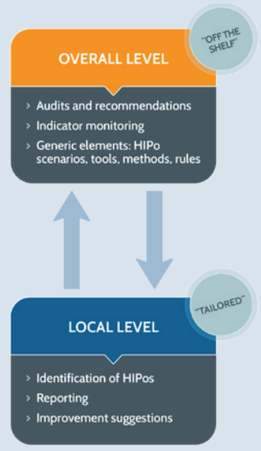
For an approach to prevention that is specific to the most serious accidents, **two levels of management are necessary: local and overall.**

Local management is nearest to the reality of the work being performed and the problems encountered. That is where HIPo situations are identified, the lines of defence devised and monitored, the disruptive elements observed... Local management must be hands-on every day, take into account sharp-end visits, on-site briefings and meetings, include discussions with contractors. **Local management is in charge of the "tailored" aspect of prevention.**

Overall management drives the process: it conveys the importance top management grants to the prevention of the most serious accidents. It is in charge of building a locally useful "common frame of reference" for the generic lines of defence, the general methods used, the most frequent disruptive elements and fixes... It can advise and support, carry out audits, monitor specific indicators. **Overall management is in charge of the "off the shelf" aspect of prevention.**

Complementary types of management

It is important for local and overall management to be coordinated, as they should feed off each other. One provides information about repetitive or exceptional and abnormal situations, while the other brings solutions in the form of generic measures and methods.



▲ Coordination between local level and overall level

SPECIFIC INDICATORS

New indicators dedicated to the risks leading to the most serious accidents must be implemented. They must be understandable to everyone and limited in number.

These can be performance indicators reflecting:
- incidents, accidents and HIPo situations. In process industries: loss of containment (leaks), fire outbreak... For electrical work: cases where the equipment is still live even though it was supposed to have been locked out and tagged out...
- the state of the barriers: level of compliance during systematic reviews, number of safety measures bypassed, percentage of compliant guardrails,
- recoveries from HIPo situations,
- serious recurring or occasional disruptive elements.

These can also be **indicators measuring staff engagement** in the process:
- presence of management and supervisors at the sharp end, briefings conducted, systematic risk reviews and adaptation of lines of defence, follow-up of reported issues, HIPo situations discussed during team meetings, and quality of their analysis (investigation of root causes, issues reported)...
- simulations of HIPo situations for the operational teams,
- consideration of safety in the relationship between user company and external contractor companies: number of joint HSE documents/number of contracts, feedback from contractor companies regarding anomalies that can be attributed to the client, reviews of risks and defence systems conducted together...

And finally, **indicators measuring the evolution of the strategy** and of the associated ecosystem can also be implemented:
- budget allocated to preventing the most serious accidents, to facility maintenance or upgrading...
- progress made in safety culture

SUCCEEDING AT PREVENTING THE MOST SERIOUS ACCIDENTS

"Use every available opportunity, such as toolbox talks, 15-minute safety meetings and sharp-end visits, to discuss HIPo situations with the teams.

diagnoses and programmes,
- implementation of a just culture encouraging the upward flow of information,
- number of trainings where safety is included as an essential part of a job well done.

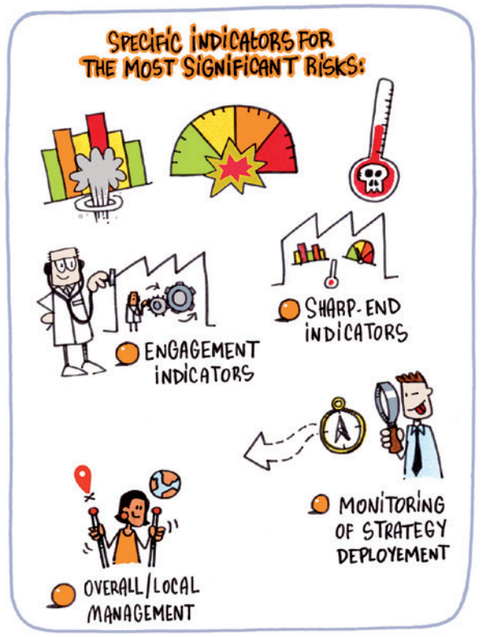
HIPo SITUATIONS AT THE HEART OF INFORMATION REPORTING AND ANALYSIS

Often, a great deal of information is available at the sharp end, but a lot of it never makes it up the chain of command... this is called **"organisational silence"**. The following must be done in order to make progress in this area:
- express approval when information is reported; even if a mistake is made, the person should not fear being blamed or punished,
- encourage the development of a just culture,
- loop back to those who reported the issue, once solutions have been found.

Beware though, if you don't want to find yourself buried under a mass of information you are unable to process, it is important to give priority to information about potentially serious situations - the aforementioned "prevention diamond". **The potential for serious consequences is a crucial criterion; it is vital to ensure that all workers are aware of this and know how to assess it.**

Many companies consider that a HIPo situation which was successfully recovered - and therefore without consequences - is a solved problem that need not be reported... On the contrary, encourage this reporting and analyse the information to determine not only the causes but also the best practices that led to the recovery!

Of course, while the purpose of analysing incidents and situations with a high potential for serious consequences is to eliminate the hazardous situation as quickly as possible, it also helps to identify recurring circumstances and thus better prevent them. This type of analysis requires:
- searching for the underlying causal factors rather than simply blaming the incident on human error,
- looking carefully at how the work was planned and executed,
- checking whether the scenario for the HIPo situation had been identified,
- seeing which barriers failed or were not in place,
- determine which disruptive elements were at play,
- asking ourselves why these disruptive elements had not been identified and addressed using fixes.



Analysis of these data aims **to identify where actions need to be focused as a priority and what resources need to be allocated**: this could be equipment or machinery, types of rules that are problematic to apply, categories of personnel requiring training or awareness raising, missing or weakened barriers, recurring disruptive elements... The results of these analyses must be shared, along with any decisions reached.

The 4 key roles of the line manager

Dear line manager, your mission, should you choose to accept it, is essential to prevent serious injuries, fatalities and major technological accidents!

Planning the work
You review the HIPO situations and lines of defence. You identify the disruptive elements and corresponding fixes, increase certain precautions, or postpone the operation if necessary. You organise coordination meetings with external contractor companies.

Running the briefings and debriefings
During the briefing, you tell the team about the particularities of the day's operations and the context. You remind them of the most significant risks and the lines of defence, establish no-goes... You identify any missing resources (faulty equipment, lack of a particular skill). You remind them how important it is that they look out for each other's safety and that they have a duty to intervene. You listen to what the operational staff have to say. Your conduct a debriefing and take the opportunity to thank your team for a safely executed operation.

Encouraging issue reporting
You facilitate team discussions about risks, reduced barrier performance, HIPO situations, and to find fixes together. You let the team know what to do about the issues raised. You encourage feedback.

Being present at the sharp end
You attend the sharp end regularly to ascertain the conditions in which operations are being carried out. You periodically review the state of the different lines of defence. You spend time talking to sharp-end workers.

GOLDEN RULES, AN EMBLEMATIC REQUIREMENT FOR SUCCESS

Every company accumulates rules and procedures... so many, at times, that it becomes difficult or even impossible to follow them all. So a rule is broken, once, twice, and then another rule is broken... and that leads to the normalisation of deviance.

Implementing golden rules, also known as "life-saving rules", **means choosing a few inviolable rules aimed at preventing the most significant risks.** Golden rules must meet the following criteria:
- they save lives if they are strictly followed,
- they apply to everyone and are common to everyone,
- they are non-negotiable,
- they are easy to remember, simple, and can be understood by everyone,
- they are elaborated using a participatory approach to ensure they are suited to the different work contexts,
- they impose a two-pronged obligation: sharp-end workers are obligated to follow them, but they must also be able to invoke them to justify a refusal to work if the conditions for following the rules are not in place.

Having too many golden rules in place would significantly reduce the likelihood of employees actually applying them! To avoid them being perceived as just "yet another set of rules" or a "cover" enabling the company to protect itself in the event of an accident, the golden rules must be the result of a consultation process involving as many people as possible. **Rules that are co-constructed are credible and therefore legitimate.**

FOR COOPERATION WITH CONTRACTOR COMPANIES

Sharing the same vision of the most significant risks with one's contractors is another requirement for the successful prevention of the most serious accidents. Attention must be paid to this major

requirement at all times, throughout the contractual relationship: is the request for proposal (RFP) clear enough regarding risks and mandatory safety measures? Has the work planning made it possible to establish common golden rules? Are HIPo situations shared? Are the briefings and debriefings seen as an opportunity for the parties to discuss barriers put in place?

Common safety culture elements must be elaborated around the three pillars of safety:
- develop a mutual knowledge of the techniques and measures linked to the safety of the user company's processes and the external contractor company's work procedures,
- seek coherence between the policies and goals for preventing the most serious accidents,
- get user-company and contractor-company management working together on the prevention of serious accidents.

Most often, the user company assesses the contractor company to determine whether to ultimately renew the contract or not. But the final **performance of the contracted works should be seen as a co-production and its assessment should be carried out jointly**. This would afford the contractor company with an opportunity to give feedback on the working conditions provided by the user company.

USE EVERY MEANS AVAILABLE TO TALK ABOUT HIPo SITUATIONS!

Golden rules and genuine cooperation between user companies and contractor companies appear to be the top requirements for the effective prevention of the most serious accidents. But **it is just as important for daily actions to quite simply reflect and embody the message**. It's the same in love: grand romantic dinners make an impression, but feelings develop and become stronger over time thanks to the small gestures!

Think about it... during your sharp-end visits for example, talk to people about what seems paramount to them when it comes to safety. Listen, ask questions, focus these on the most significant risks and hazardous situations. Ditto during briefings, meetings, project planning, risk and defence system reviews, feedback sessions. Don't waste an opportunity!

LOCAL RESIDENTS AND MAJOR RISKS

Finally, major risks don't only affect organisations and their employees, they also affect surrounding areas and their populations. Living next to a high-hazard site means exposing oneself to major risks such as fires, explosions... It means living within a zoning defined by a Technological Risk Prevention Plan (PPRT) in France and by equivalent measures in other countries. It sometimes means having to perform maintenance work that is a consequence of the proximity to the site, but it can also mean benefiting from the jobs and dynamism created by the company... **Local residents can play an active role in the prevention of major accidents**, by reporting a leak, an odour, by displaying safety behaviours in the event of an accident (evacuation, confinement...).

Citizens have little trust in industrial companies... To ensure the best possible conditions for cohabitation, the following are recommended:
- encourage local residents and associations to become actively involved, and share a safety culture with them,
- listen to and be respectful of their questions and concerns,
- multiply interactions with the various stakeholders (associations, elected officials, the press, social media, emergency services, research and training centres, schools...),
- ensure transparency regarding risks, barriers and incidents. Trust in the event of a crisis will depend on what was built "in peacetime".

A just culture to counter organisational silence

To encourage a climate of trust and have workers feel free to speak up, developing a just culture is a great lever. It includes:
- a clear boundary between what is acceptable and what is not: life-saving rules, golden rules...
- appropriate and consistent managerial reactions to deviations: the right to make mistakes, fair treatment...
- giving recognition for positive contributions: initiatives and suggestions for improvement, but also reporting incidents...

A few examples of golden rules

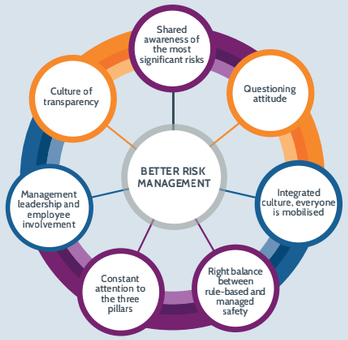
Golden rules relating to prevention:
- Only work on equipment if its power source is isolated
- Never enter a confined space without authorisation and monitoring
- Never walk or stand under a suspended load
- Keep well clear of any moving load or machine

Golden rules relating to recovery:
- Intervene if a co-worker or third party is about to walk or stand under a load
- If in doubt, stop working and ask the most appropriate person for help
- Exercise your right to stop work and notify a superior when you notice or find yourself in a high-hazard situation

Golden rules relating to mitigation:
- Know where all safety equipment and features are located on site: assembly point, emergency exits, shower, telephone, fire extinguisher...
- Wear your personal protective equipment
- Fasten your seat belt and keep to the speed limit

Conclusion

The 7 attributes



A strategy for preventing the most serious accidents mobilises the seven attributes of an integrated safety culture:

- **a shared awareness of the most significant risks is an absolute must, because without agreement on what poses the greatest threat to the organisation prevention is impossible,**
- **a questioning attitude and a culture of transparency, as these foster a climate of trust that is conducive to the development of caution and rigour in work practices,**
- **constant attention to the three pillars of safety, which underly a good defence system,**
- **the necessary balance between what we know to anticipate when planning the work and what will need to be identified and handled in real time (such as combinations of disruptive elements),**
- **the mobilisation of all parties – particularly employee representative bodies and external contractor companies –, management leadership, and the involvement of employees to ensure this strategy for preventing the risks leading to the most serious accidents is upheld and implemented each day.**

Implementing a strategy for preventing serious injuries, fatalities and major technological accidents is an essential transformation that has a profound effect on the safety culture of organisations.

Everyone must be firmly committed to identifying and sharing the most significant risks and HIPo situations and to planning and managing the defence systems at their own level. It requires **5 steps:**

- **a diagnosis** of the safety culture and the state of the key requirements for preventing serious accidents must be performed,
- **a vision** must be constructed to determine what to move towards, in how much time, and with whom to build this process and really see it through,
- **a programme** focused on preventing the most serious accidents must be co-constructed, with sharing that mobilises and with a constructive social dialogue,
- **the way** forward must be punctuated with possible and tangible wins to sustain motivation, and it must encourage the teams to learn from first-hand experiences,
- **anchoring** - actions reflecting the priority given to the prevention of serious injuries, fatalities and major technological accidents must be anchored into practices (analyses of HIPo situations presented to the executive committee and to employee representative bodies, briefings/debriefings, managerial visits, team debates…).

For this, you'll need to be patient. This type of transformation takes time, as ways of doing and ways of thinking (mindset) need to evolve in order for everyone to become aware and convinced that it is possible and crucial to pay close attention to the risks leading to the most serious accidents.

Find out more

These *Essentials* emerged from the work conducted by the *Serious Accident Prevention and Safety Culture and Process Safety* discussion groups.

The *Preventing Serious Injuries and Fatalities* Cahier is available as a free download from the Publications section of our website, www.icsi-eu.org.

Visit our YouTube channel for short animations covering our key topics

To Bird or not to Bird

The accident path

HIPO situations

Shared awareness of the most significant risks

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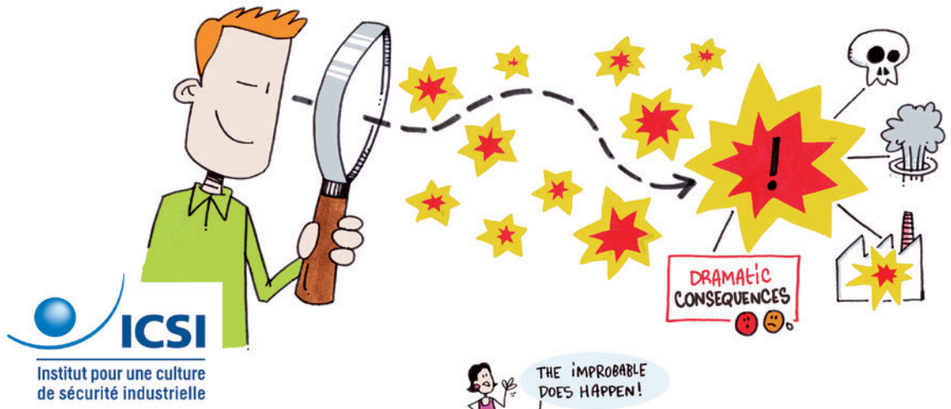
PAYING ATTENTION TO THE ESSENTIALS:
PREVENTING SERIOUS INJURIES, FATALITIES & MAJOR TECHNOLOGICAL ACCIDENTS



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THE IMPROBABLE DOES HAPPEN!

RE-FOCUS ON THE RISKS LEADING TO THE MOST SERIOUS ACCIDENTS

DRAMATIC CONSEQUENCES
ACTUAL:
AND
POTENTIAL:

THE INCIDENT RATE HAS ITS LIMITS

WHERE ARE THE PRIORITIES?

INITIAL OBSERVATION

INCIDENT RATE

FATAL ACCIDENTS DESPITE A DECLINING INCIDENT RATE

FROM THE BIRD PYRAMID TO THE PREVENTION DIAMOND

MINOR OR SERIOUS RISK?

RISK PERCEPTION

WHAT IS A SIGNIFICANT RISK? WE NEED TO AGREE ON THIS!

IDENTIFY HIPO

INVOLVE FRONTLINE STAFF

PREVENTION STRATEGY:

RISKS LEADINGS TO THE MOST SERIOUS ACCIDENTS OR THOSE THAT ARE POTENTIALLY THE MOST SERIOUS

THE TARGET:
SERIOUS ACCIDENTS

NEED:
STRATEGY
SIGNIFICANT RISKS

AIM

DEVELOP / ANCHOR RIGOUR AND CAUTION IN PRACTICES

➡ QUESTIONING ATTITUDE

CULTURE OF DOUBT

LIMIT OPTIMISM BIAS

NO WORRIES!

CAUTION & RIGOUR WHEN FACED WITH THE MOST SIGNIFICANT RISKS

➡ BENEFIT TO MINOR RISKS

PRIORITY

FATAL OR SERIOUS ACCIDENTS

MAJOR INDUSTRIAL ACCIDENTS

SAME CAUSES

ORGANISATIONAL WEAKNESSES

HUMAN ERROR

OOPS

A NEW DEFENCE SYSTEM:

LINES OF DEFENCE

PREVENTION
RECOVERY
MITIGATION

THE MOST EFFECTIVE

LONG-TERM INVESTMENT: EFFECTIVENESS

NU-UH! YOU'RE NOT WELCOME HERE!

DISRUPTIVE ELEMENT WITH WEAKENING EFFECT

Fix

HIPO SITUATION

ESTABLISHED AWARENESS

SPECIFIC INDICATORS FOR THE MOST SIGNIFICANT RISKS:

ENGAGEMENT INDICATORS

SHARP-END INDICATORS

MONITORING OF STRATEGY DEPLOYEMENT

OVERALL/LOCAL MANAGEMENT

PRACTICES/AWARENESS:

GOLDEN RULES

PREVENTION SYSTEM TARGETING THE MAJOR RISKS

JUST CULTURE

PRELIMINARY CLIENT COMPANY/ CONTRACTOR COMPANY VISIT

UPWARD REPORTING

BRIEFING/ DEBRIEFING

SHARED VIGILANCE

INFLUENCE & CHANGE PRACTICES

INCREASED RISK AWARENESS

CHANGING PRACTICES

AWARENESS

OPERATIONAL EXPERIENCE FEEDBACK

DISCUSSIONS, INTERFACE & SYNERGY

SIMULATIONS

NEW RECRUIT ON BOARDING

SHARE THE CONTENT OF THE SAFETY CASE

FIRST-HAND ACCOUNTS FROM OLD-TIMERS

INCIDENT ANALYSIS

OLIVIER SAMPSON

The essentials

for preventing serious injuries, fatalities and major technological accidents

Preventing the risks leading to the most serious accidents

Safety policies and associated resources are too often focused on reducing the most frequent accidents, which are usually the most minor. **Companies should focus their attention and strategy on what is essential: preventing serious injuries, fatalities and major technological accidents** which, although rare, have dramatic consequences.

Reducing the incident rate does not in any way guarantee effective prevention of the most serious accidents. A better interpretation of the Heinrich-Bird pyramid shows the need to focus on the "prevention diamond", i.e. the **serious incidents that have actually occurred, but also high-potential incidents or incidents with a high potential for serious consequences (HIPos).**

Everyone in the company needs to agree on the risks leading to the most serious accidents: risks linked to processes, to the work environment and the movements/procedures required, to simultaneous operations and to a combination of these different aspects... It is essential for everyone to be involved in establishing and updating the list of situations in which serious accidents are possible.

Improving the defence-in-depth system

To prevent serious injuries, fatalities and major technological accidents, **HIPo situations must be anticipated** and three lines of defence must be put in place: **prevention, recovery and mitigation.**

Each line includes **one or several barriers,** each of which may have aspects that are technical, related to the safety management system, and/or linked to human and organisational factors. The barriers are alive: they are implemented and put in place (kinetic), and their effectiveness must be maintained over time. At every stage of their life, their performance can be affected by many different types of disruptive elements.

Detecting **combinations of disruptive elements** at the sharp end through collective vigilance and **having appropriate fixes in place** to deal with them is therefore essential.

Cultivating a shared awareness of the most significant risks

Risk perception is an essential part of risk management. Over- or under-estimating risks jeopardises prevention.

To improve risk perception when it comes to rare events, **specific means** are required: explaining the content of the safety case to the operational teams, simulations, group study of past incidents or events that have occurred elsewhere...

Accurate risk perception requires **knowledge of the possible HIPo situations, the different barriers, and confidence** in the state of these barriers based on active involvement in checking them on a regular basis.

In real time, gaining **an accurate picture of a situation** will depend on the quality of the available information, the training and experience of the operational staff, and an organisation that enables focusing on critical tasks without attention being scattered.

Succeeding at preventing the most serious accidents

Giving priority to the prevention of serious injuries, fatalities and major technological accidents implies a **reorientation of the safety policy, based on coordination between overall management and local management.**

The reporting and handling of information about HIPo situations must be organised, with a central role given to **sharp-end management and to discussions within the teams.** Resources must be allocated to investigating the causes of HIPo situations as a matter of priority.

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