GETTING TO GRIPS WITH

THE HUMAN FACTOR

The puzzle that is safety management and total incident prevention

A guide for trainers

UK P&I CLUB

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Introduction

The successful management of safety has proved historically to be one of the most difficult and ellusive of all management objectives.

This, at least in part, has been due to the fact that until fairly recently, management itself has simply failed to appreciate its real significance in terms of what it can do for the totality of the business. Investing in an effective safety management system not only improves safety performance by reducing injuries but also raises the overall efficiency of a company. It also helps develop a dynamic corporate identity, a culture if you like, in which people adopt common high standards, work towards common ideals and objectives while at the same time learning to recognise the contribution that every single person has to make.

In terms of the bottom line good safety management is undoubtedly the most cost-effective form of insurance that money can buy

During the past two decades or so in Europe, a considerable amount of wholly original research has been carried out into the part that people play in accidents, particularly in the petrochemical and shipping industries. Combined with an active programme of learning from those who have demonstrably achieved impressive safety performances especially in the United States of America, a number of major advances have been made in the field of safety management. These advances advocate a more measured and proactive approach recognising (a) the role of *latent* system faults or weaknesses; (b) the role of people particularly those at the sharp end of the business; (c) lessons learnt from some of the most high profile disasters the petrochemical and shipping industries have ever seen, and; (d) the importance of applying quality management principles regardless of the size or relative maturity of the organisation involved.

In September 2003, after a two-year gestation period, the UK P&I Club launched a video entitled "No Room For Error". The video takes a slightly unconventional stance in that rather than seeking to address the errors and omissions of people (it is after all very easy to blame people), it chooses instead to address the problem of "system" or "latent" faults within an organisation. While not detracting at all from the part that people play in the accident and incident equation (for it is people whose actions almost always provide the final trigger for the final event), the video seeks to demonstrate that latent failures lay the foundations for **all** accidents regardless of their outcome. Leaving acts of sabotage to one side, the video, rather uncomfortably for some, puts the *responsibility* for accidents of whatever nature firmly with management and in particular with those at the top of the tree. The concept that senior management is responsible for accidents at the end of the day should not be construed as a mechanism for "passing the buck". Rather, it seeks to place the responsibility for the *provision* of effective safe working conditions and practices firmly with the only people within a corporate entity that have the authority and means to do so. Basically, such an approach calls for the long-term development of a more general approach based on "fire-prevention" rather than constant "fire-fighting".

Traditionally, many companies have taken a somewhat fragmented and reactive approach based on the last major incident and the easiest identifiable "quick-fix" a term much loved by senior management. The "new" approach calls for the application of a multi-faceted methodology aimed at achieving a combination of proactive long-term measures with carefully selected and targeted short and medium term remedial measures focussing on *trends* rather than single incidents. It calls for a culture based on total professionalism and adherence to impeccably maintained business standards and ethics in which our industry can ultimately be viewed by governments, environmental non-government organisations and society at large as a good neighbour and friend.

In many ways the effective management of safety is a bit like completing a giant jig-saw puzzle. From those who were doing well, we learnt what the picture on the front of the box was like. Gradually, we found some of the pieces. Some had been staring us in the face for a long time while others had been placed in inappropriate places at the wrong time. While the research referred to above revealed at least some of the "straight-edges", it was not until much later that we had been able to find the all-important "corner-pieces". Having found them we had at least gained an impression of the size of the jig-saw puzzle and the magnitude of the problem that we were dealing with. Working on the basic premise that:

"You can't manage what you don't know about"

Those who have adopted this approach have been singularly successful. But a word of warning:

There are no quick fixes, only years and years of patient and very hard work on the part of everybody in an organisation!

This guide seeks to explain and interpret the various pieces of the jig-saw puzzle in simple relevant terms. It is intended to provide safety personnel, particularly those responsible for advising senior and line management, and those responsible for training other personnel, with sufficient "state-of-the-art" background knowledge and information to enable them to take what could be referred to as a more "holistic" or general approach aimed at the development of a permanent and dynamic safety culture in which all are active participants.

Captain Malcolm Lowle

HSE Consultant

1 Safety legislation and procedures; health, safety and environmental management systems; reputation and total incident prevention

1.1 Why safety? – Setting the scene

Fundamentally safety management is about the prevention of death and injury through the planned application of controls and defences. Stating the obvious, fatalities are always considered serious and even in companies with only rudimentary safety management systems these are reported and investigated if only to satisfy mandatory national requirements. Such companies tend to develop somewhat knee-jerk and extreme remedial measures based on a few serious incidents which can only provide the scantiest basis for sustainable improvement.

That is how most companies managed safety in the "good old bad days when every seafarer's finger was a marlin spike!" But gradually it dawned on our industry that fatalities and other serious incidents, apart from being wholly undesirable, are unquestionably bad for the business. There also grew a general desire to do better and to approach the whole subject in a more disciplined manner.

1.2 Safety legislation and operating procedures

Those companies who achieve good safety performance are generally those who have embarked on a process that entails doing that "little bit more". Fundamentally that means creating a full-blown safety culture but more of that later. For those who think solely in terms of compliance with the law, industry standards and corporate procedures, after years of experience at all levels, the writer is firmly convinced that even if we achieve total compliance in all three areas this will almost certainly not make you safe. While sound legislation and formalised procedures are an absolutely vital part of the safety equation in that they form a basic standard on which to build:

> *"You cannot legislate for everything, neither can you design a procedure for absolutely everything you do"*

In terms of both legislation and safe operating procedures, these are written in an attempt to shape people's behaviour so as to minimise accidents. As such they form part of the system *defences* against accidents. Defences are installed to protect the individual, the asset or the natural environment (all "objects of potential harm") against *uncontrolled hazards* and come in two forms:

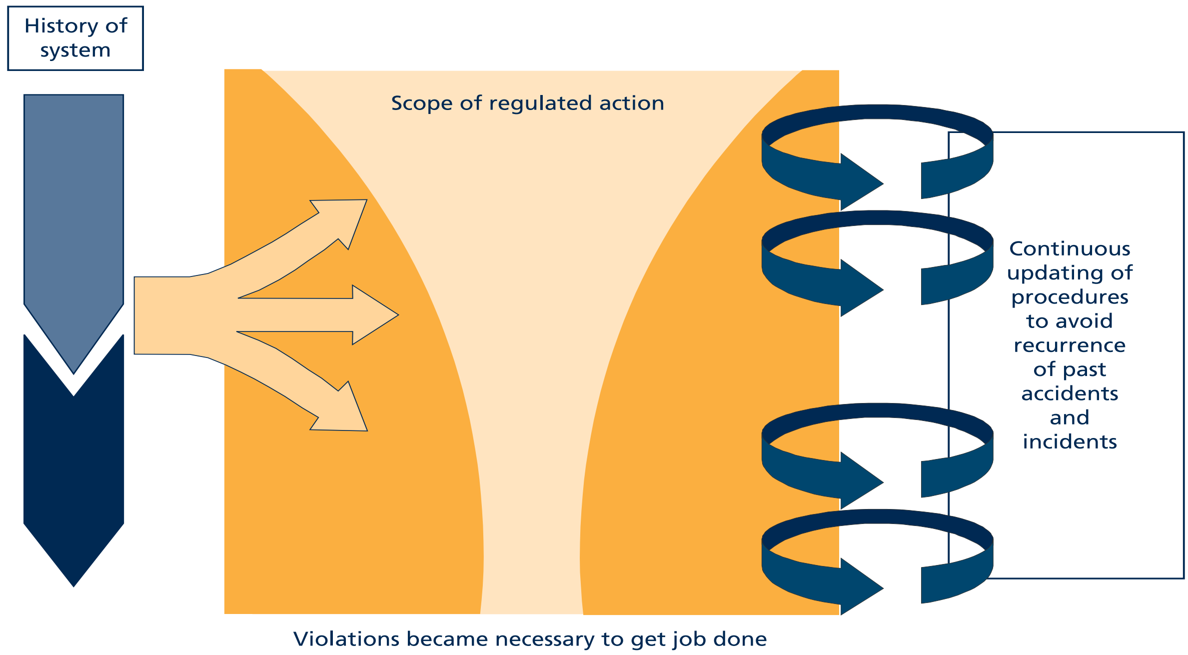
- "Hard" defences provided by fail-safe designs, engineered safety features and mechanical barriers
- "Soft" defences provided by procedures, rules, regulations, specific safety instructions and training. "Soft" defences are more easily circumvented by people than "hard" defences and thus constitute a major challenge to any safety management system

Procedures are continually being amended to cover changed working conditions, new legislation and new equipment and most particularly, to prohibit actions that have been implicated in some recent and usually serious accident. Following an accident how often have you heard people exclaim "and what did the procedures say?" Over time these procedural changes become increasingly restrictive yet the actions necessary to get the job done haven't changed and often extend beyond these permitted behavioural boundaries. Ironically then, one of the effects of continually tightening-up procedures in order to *improve* system safety is to increase the likelihood of violations being committed. The scope of permitted or allowable action shrinks to such an extent that the procedures are either routinely violated or violated whenever operational necessity demands. This is shown in the diagram overleaf.

In either case the procedures are often regarded as unworkable by those whose behaviour they are supposed to govern. Whereas errors arise from various kinds of informational under-specification, many violations are prompted by procedural over-specification – a classic own goal you might say!

> *Over-regulation + over-proceduralisation = increased scope for rule violation*

Over regulation encourages rule violation



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The International Maritime Organisation (IMO) is the only forum in which globally effective "legislation" and "standards", generally in the form of Conventions and Protocols, can be developed and indeed implemented. That is why it is so important for governments (who have a vote when it comes to approving new legislation) and non-governmental organisations (who do not), should work together in the quest for sensible workable solutions. The IMO has achieved some remarkable successes – SOLAS, MARPOL, STCW 95 and the Collision Regulations are just some examples. Amendments to existing Conventions such as the "International Management Code for the Safe Operation of Ships and for Pollution Prevention", the so-called ISM Code, as an amendment to Chapter IX of SOLAS, is just one example of a visionary enhancement whose effect is only just beginning to be felt. Unfortunately, notwithstanding the words of outward support for the IMO from some governments and regional organisations, this does not seem to prevent them from attempting to either force progress at an entirely unseemly rate or, worse still, to introduce unilateral legislation in response to some local or regional catastrophe or concern. At the end of the day such "knee-jerk" responses only serve to create problems by submerging those at the "sharp end", in this case ships' masters, in a plethora of complex and sometimes contradictory and incompatible regulations and instructions.

Much better the far-sighted global view than the short-sighted parochial one!

1.3 The expansion of safety management principles into health, safety and environment (HSE) and reputation

Most companies who have embarked on formal safety management quickly realise that, by applying the *same principles,* the closely associated areas of occupational health and the environment can be managed in very similar ways. An incident may indeed result in death or injury but it could also lead to other undesirable consequences. Whatever the consequences, it is the *same incident;* thus the prevention of similar incidents in the future must logically be based on a broader, more holistic approach. The potential outcomes of an incident are shown in the table opposite.

Note the inclusion of "reputation" – the failure to manage health, safety and the environment effectively will undoubtedly result in severely dented reputations.

Consider a collision between two ships. One of the immediate results may well be significant structural damage to the hulls of both ships and the consequential release of fuel oil, or cargo such as oil, gas or chemicals.

Category	Potential harm
People	Injury or damage to health (employees or third parties
Assets	Damage to plant or equipment – loss of material – disruption or shutdown of the operation – damage to third party assets or business
Environment	Damage or contamination
Reputation	Adverse media attention – public concern, protest – pressure from environmental NGOs – prosecution – business restriction – reactive legislation

The amount will depend on the type of ships involved and the angle and speed of impact.

At the moment of impact, crew members on both ships could have been injured, some very seriously indeed.

Continual contact between the ships could well result in fire and explosion with even more casualties. The evacuation of casualties could then be severely hampered by smoke and flame (and of course weather), thus increasing the severity of already sustained injuries and perhaps producing more. The presence of burning oil on the surface of the sea could also prevent the close approach of fire-fighting tugs even if such help were readily available. If the release of fuel oil or cargo is not checked quickly, sufficiently large amounts could enter the sea, thereby causing environmental damage sometimes on a colossal scale ("Exxon Valdez" and "Erika" are just two recent examples of that). While in the open sea spilt oil may not be that serious, at least immediately, in environmentally sensitive areas such as fisheries and public leisure facilities where both jobs and lives may be at stake, the pollution could potentially become very serious indeed.

In its turn this whole sequence will inevitably attract the world's media (bad news is good news) followed quickly by local authorities, governments and politicians of all persuasions and a good sprinkling of environmental non-governmental organisations (NGOs). Experts will quickly emerge from the woodwork to help feed the insatiable need for "informed" views and the emergency rapidly degenerates into a crisis. Unless the matter is quickly resolved, which generally speaking means a high profile clean-up operation carried out in the full glare of TV cameras with very senior people suddenly achieving high visibility and prominence, our industry suffers.

Depending on the precise circumstances, almost any incident can therefore result in a whole series of unwanted and damaging consequences. As a basic premise it therefore makes absolute sense to actively pursue the goals of:

> ***"No accidents, no harm to people, no damage to the environment and no damage to assets"***

Clearly what we are talking about is total incident prevention.

1.4 Total incident prevention

This is about the prevention of all incidents of whatever nature. On a ship this could involve incidents during cargo work, engine room maintenance, collision avoidance or navigating in shallow water, the list is in fact endless. The important point to remember is that absolutely any operation, routine or otherwise, can result in unwanted and undesirable consequences. In assessing risk nothing should be excluded.

The concept of "total incident prevention" is therefore aimed at bolstering the effectiveness of the ISM Code and in helping to meet the aspirations of the UK P&I Club in a world that has changed from "trust me" to "show me" in the course of a few short years. As we have already clearly demonstrated, the goal of avoiding all incidents is entirely reasonable and inseparable from the health, safety and environmental (HSE) management equation. It is complex; so let us now examine the components of this equation in a "holistic" way, accepting that there are no simple answers and that individual companies will have to identify their own way forward depending on where they currently are in terms of their own HSE management systems.

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2 HSE management systems (HSE-MS)

2.1 The basic structure

In its simplest form an effective HSE-MS will consist of just three components namely:

- Business integration
- Quality management
- Hazards and effects management process

A simple HSE management system

If we were to turn this diagram into the four-cornered jig-saw puzzle that we talked about earlier in the introduction, we would add a fourth all-embracing element namely "professionalism" but that will be discussed later in the section on safety culture.

Business integration means the application of management controls to all aspects of business processes that are critical to HSE performance resulting in accountabilities being defined at every level in an organisation. HSE therefore becomes an equal and integral part of the business equation and can no longer be considered as an "add-on" to be discarded when, for instance, the going gets tough or charter rates are poor.

Quality management (QM) principles, much maligned and misunderstood in recent years, include documented procedures and verifiable paper-trails, monitoring of activities, improvement, correction and feedback mechanisms which at some stage might facilitate possible certification against quality standardisation bodies such as ISO 9000 or ISO 14000.

Hazards and effects management process (HEMP). A formalised process that focuses on the hazards and effects of business activities critical to HSE performance. It is merely a more elaborate name for risk management. The process is described later in section 7.

2.2 Enhanced safety management

It is probably true to say that when most of us first "cut our teeth" on pure safety management we only dealt with a few areas of safety management and then almost certainly in the most rudimentary way. We probably first dealt with hardware (meaning machinery, equipment and plant) procedures, though probably not very completely, personal protective equipment (PPE) and emergency drills usually fire, rescue and lifeboat. In themselves they are all important parts of the equation; the problem is that, notwithstanding many years following this very credible course of action, it never actually achieved very much in terms of lowering injury rates. Typically, over a fifteen year period injury rates reduce by just 10% – not much to show for so much effort. While this is all very disappointing, it does serve to create the *right atmosphere* or corporate ethos in which to grow. We had, if you like, dug some pretty firm foundations and it was now time to build the first walls. The problem was that we really did not know what the building looked like, neither did we have much in the way of building material.

One particular oil-major with a large international fleet of oil and gas tankers sought help and advice from two US companies one of which had been formally managing safety for nearly a century. On sharing the problem, safety representatives from that company nodded sagely and said "well, all good stuff but you've been addressing the wrong area!" Devastating news! They went on to explain that whereas it is indeed appropriate to target hardware, in view of the fact that most accidents are caused by people, it is far better to address people first. Obvious when you think about it. Discussions in the US and later in the UK led to the development of a safety management process called "enhanced safety management (ESM)". Going back to jig-saw puzzles yet again, ESM represented the picture on the front of the box and consisted of the following eleven essential elements plus a twelfth "open-reporting" which was added within two years:

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- Visible management commitment to safety
- Sound safety policy
- Safety, a line management responsibility
- Competent safety advisors
- High well-understood safety standards
- Techniques to measure safety
- Realistic safety targets and objectives
- Audits of safety standards and practices
- Effective safety training
- Thorough investigation and follow-up of accidents and incidents
- Effective motivation and communication
- 'Open reporting'

Particularly novel in 1982, was the concept of setting targets and objectives meaning numerical targets and verifiable objectives. Some argued that numerical targets should be set at zero – after all they argued nobody wanted anyone to be injured. While that is true if your fleet is already having a hundred injuries a year (that you are aware of), a target of zero is a pretty tall, if not impossible, order. In the end it was agreed that:

> ***"A target should be both challenging and attainable"***

That principle is as true today as it was nearly twenty years ago. But of all the elements identified as being essential, it was clear that "visible management commitment" was the real key to success. Without commitment, progress is quite impossible. It means of course "walking the talk" and for those providing the resources for an ESM programme it occasionally means "putting your money where your mouth is" although very often it is simply a matter of reallocating existing funds or manpower. In driving ESM forward, first at fleet level, then across an entire multi-national oil company operating throughout the world, it became apparent that:

> ***"Commitment – the maximum level you get is equal to the minimum level you show you want to get"***

Coupled to an ongoing high profile training programme and the introduction of one of the earliest tools aimed at modifying human behaviour called "unsafe act awareness", the scheme was immensely successful. If you recall that it took fifteen years to achieve a 10% improvement by following the hardware route, ESM which followed the "people route", succeeded in halving injury rates within just two years. After five years rates were down to 10% of the pre-ESM figure.

The following is a very brief explanation of the *other* ten components of the ESM process:

Sound safety policy
"An operating company's policies are simple statements of its beliefs and the direction in which it wants to go."

Safety to be a line management responsibility
"The line supervisor is the only person in the right place at the right time with the authority to act and the responsibility to ensure safe working."

Competent safety advisors
"To guide and influence without having line authority requires knowledge, tact, and sometimes considerable courage."

High, well-understood safety standards
"We should be proud of our standards."

Techniques to measure safety performance
"Progress cannot be verified without measurement."

Audits of safety standards and practices
"An audit is a service to a company and its employees, not a burden – auditors should be seen as friends not enemies!"

Effective safety training
"No one can do a good job without being trained for it."

Thorough investigation and follow-up of accidents and incidents
"Why do we keep having the same accidents – can we not learn from our mistakes?"

Effective motivation and communication
"The success of an ESM programme depends on people – how they are motivated and how they communicate with each other."

Open-reporting
"You can't manage what you don't know about – help us to help you!"

2.3 The "quick-fix"

Any safety management programme takes time to implement although careful planning combined with well publicised aims and objectives can, as we have just seen, produce quite spectacular results. Typically the "people" phase (see 3.3), aimed at addressing employees, can take up to five years to become fully imbedded into a company. But that may be too slow for senior company executives. The trick is to plan and implement a long-term strategy using an agreed process, part of which will include the introduction of specific tools, some of which could be described as "quick-fixes" together with learning points from accidents and incident of serious, or potentially serious outcome. Like rule violations (more of that later) not all "quick-fixes" are bad. If an incident reveals a particular weakness that is generic to the implementation, or effectiveness of the safety management system and could be accident inducing, then clearly that weakness must be remedied though the implications of so-doing must be clearly assessed and understood. Fixing one problem should never result in the unintentional introduction of others.

2.4 A "state-of-the-art" HSE-MS

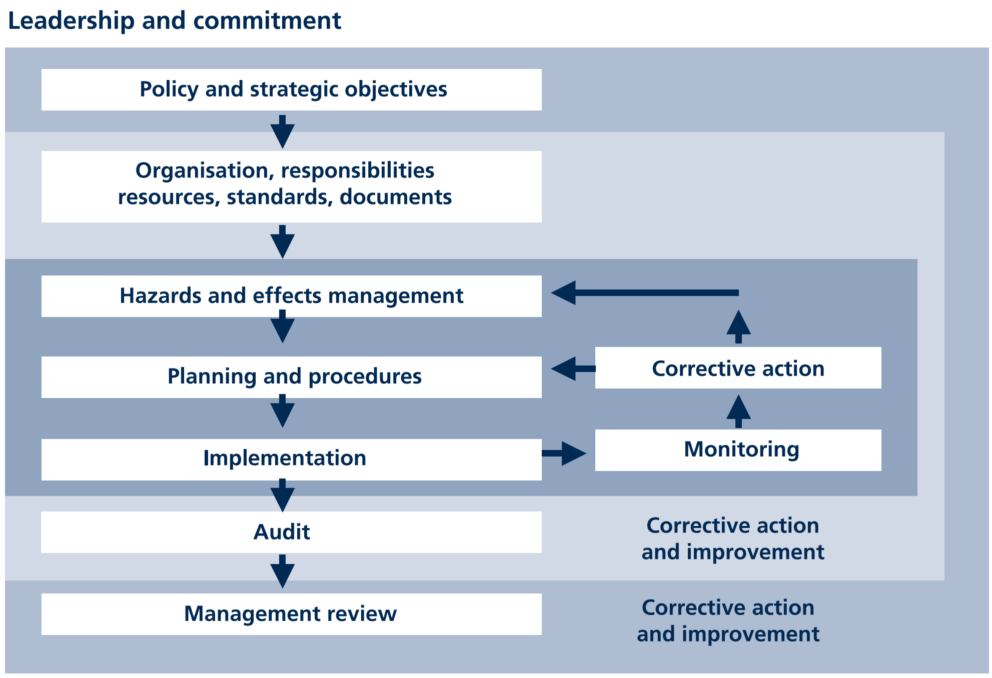
While systems like ESM serve a company well often for very long periods of time, with the growing acceptance of more formal HSE-MSs and the need to apply "quality management" principles, it is possible to evolve even more robust systems. Such a "model" system as practiced uniformly by the same company that introduced ESM in the first place (and which it now replaces) is illustrated below:

Note that leadership and commitment is all-embracing and that both the hazards and effects management process and quality management lie at the core of the system. By careful examination of this diagram it is possible to see where each of the original ESM components is located.

2.5 The certification of HSE-MSs

It was once very "fashionable" for businesses to be certificated under one or other of the recognised quality management standards. Unfortunately over-aggressive marketing techniques on the part of some rather well known audit and certification bodies somewhat discredited the idea of certification even for those companies who were practicing QM anyway. Nowadays there seems to be a gradual and more considered return to certification particularly ISO 14000 which deals specifically with environmental management.

Over regulation encourages rule violation



What is rather more important than the accreditation logo is the basic requirement to manage safety, indeed HSE, in a structured and verifiable way with particular emphasis on constant monitoring, improvement and correction. The greatest single weakness in any HSE-MS is the failure to *implement clearly identified solutions* to problems in a timely way. Even major companies are poor at this. Such solutions could be the result of an accident or incident finding, the result of an audit (either internal or external), the result of an improvement exercise, new requirements by either national or international bodies, such as the IMO, or the introduction of new equipment and plant. The usual source of such weakness is for those responsible for the investigation or audit process to either:

- Fail to prioritise action items i.e. low, medium, high or serious
- Fail to identify implementation action parties
- Fail to set a formal schedule for implementation
- Fail to check progress and close-out
- Attempt to do too much too quickly

2

Whether an organisation decides to attempt formal certification will depend mainly on its relative maturity in terms of management systems and how it views such a formal system in terms of what it will do for the business. But make no mistake about it, as already indicated in section 2, a QM system is one of the undoubted pillars of an effective HSE-MS whether we like it or not!

2.6 The International Safety Management (ISM) Code

First introduced as an amendment to Chapter IX of the SOLAS Convention, this is now a firmly established part of ship operations and management systems and, as its importance cannot be stressed too highly, a little history will not go amiss.

The origin of the Code goes back to the late 1980s when investigations into accidents revealed major errors on the part of management. In 1987 the IMO Assembly adopted resolution A.596(15), which called upon the Maritime Safety Committee (MSC) to develop guidelines concerning shipboard and shore-based management to ensure the safe operation of ro-ro passenger ferries.

The ISM Code evolved through this development work and so it was that in 1989 the "Guidelines on Management for the Safe Operation of Ships and for Pollution Prevention" were adopted by the IMO Assembly as resolution A.647(16). The guidelines were revised two years later as resolution A.680(17) and further amended to its current form, the "International Management Code for the Safe Operation of Ships and for Pollution Prevention (International Safety Management [ISM] Code)" which was adopted in 1993 as resolution A.741(18). The Code was further amended in December 2000, was accepted on 1 January 2002 and entered into force on 1 July 2002.

As with all new Codes it was recognised that (a) there was a need for uniform interpretation and implementation and (b) there might be a need for Administrations to enter into agreements in respect of the issuance of certificates by other Administrations in accordance with SOLAS Chapter IX. So it was that the "Guidelines on the Implementation of the ISM Code by Administrations" was adopted by resolution A.788(19). Revised guidelines were introduced in November 2001 by resolution A.913(22) and became effective on 1 July 2002.

The Code applies to all ships regardless of construction date as follows:

- Passenger ships including passenger high-speed craft, not later than 1 July 1998
- Oil tankers, chemical tankers, gas carriers, bulk carriers and cargo high-speed craft of 500 gross tonnage and upwards, not later than 1 July 1998
- Other cargo ships and mobile offshore drilling units of 500 gross tonnage and upwards, not later than 1 July 2002.

Note that government-operated ships used for *non-commercial* purposes are not covered by Chapter IX.

Now that all ships covered by the Code are certificated, the *effectiveness* of the Code will increase as the emphasis moves from certification to "making it work". It is indeed time for the shipping industry to "walk the talk".

Compared to most other HSE-MSs (for that is what it is), what is different about the Code is that *before* a ship qualifies for certification (in this case the safety management certificate or SMC), the managing company (responsible for the operation of the ship) must first demonstrate that it complies with the Code through a mandatory verification process and be issued with a document of compliance (DOC). It is if you like a process that requires proof that the system is in place and in operation, and then verified in the field by audit of the ships themselves. Because the DOC is verified annually during a five-year period (and then renewed) and because each ship covered by the DOC is audited twice within a five-year period (and then renewed), the verification process is particularly robust in that Administrations are involved at every stage. This has succeeded in changing the focus *away* from the ships themselves *towards* management and management systems. Uniquely, the Code also requires the appointment of a "designated person ashore (DPA)" who is there to provide a link between the company and those onboard individual ships.

It is probably true to say that the efficacy of the verification process is considerably stronger than most other HSE-MSs.

There are striking similarities between ESM, the model HSE-MS and the ISM Code particularly in the areas of:

- Safety and environmental protection policy
- Company responsibilities and authority
- Designated person(s) ashore
- Master's responsibility and authority
- Resources and personnel
- Development of plans for shipboard operations
- Emergency preparedness
- Reports and analysis of non-conformities, accidents and hazardous occurrences
- Maintenance of the ship and equipment
- Documentation
- Company verification, review and evaluation

The ISM Code is based on general principles and objectives. For instance there is no specific mention of risk management, or air pollution and certainly no mention of occupational health. There is however a clear implication that all safety and environmental risks are to be managed and that safety includes illness due to long-term exposure to specific health hazards (as opposed to injuries which are the result of single attributed events). As you simply cannot manage what you don't know about, there is a clear management requirement to consider all risks regardless of their source and that requires proper assessment.

The preamble to the Code indicates that it recognises that no two shipping companies or ship owners are the same, and that ships operate under a wide range of different conditions. But its message is crystal-clear and has been amplified in a number of governmental and industry guidelines most notable of which is the "Guidelines on the application of the IMO International Safety Management (ISM) Code" jointly produced by the International Shipping Federation (ISF) and the International Chamber of Shipping (ICS). The ultimate paragraph of the preamble states:

> *"The cornerstone of good safety management is commitment from the top. In matters of safety and pollution prevention it is commitment, competence, attitudes and motivation of individuals at all levels that determine the end result"*

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Finally the revised guidelines to the Code state:

> *"The application of the ISM Code should support and encourage the development of a safety culture in shipping. Success factors for the development of a safety culture are,* inter alia*, commitment, values and belief"*

What more can this writer say!

2

3 Safety culture

Defining a "safety culture" is actually quite difficult, mainly because you are attempting to describe a corporate "ethos" which can be achieved, or become apparent, in a number of different ways. One definition might be:

> *"A safety culture is a special case of the more general corporate culture. It is one in which safety has a special place in the hearts and minds of all those who work for the organisation.*
> *It is characterised by not only having safety as one of its core values, but also by believing that safety pays"*

Note the use of the expression "general corporate culture". That has to be about an impeccably maintained and practiced set of "business principles" based on high moral and ethical standards. Effective HSE management will be one of these publicly declared principles.

Note also the mention of "hearts and minds". HSE management is not only about complying with the law or your own procedures and safe practices. It is about convincing all employees that it is both necessary and non-negotiable. We are talking "mind-sets" here.

The mention of "safety paying" is interesting. Clearly safety cannot be regarded as another profit centre within a business. What it ultimately achieves in the prevention of potentially damaging cash-calls against the bottom line.

> *"A bad accident can spoil your whole day. A really bad one can bring down your entire company"*

And yes everyone at every level within the organisation must be involved. It is after all the people at the coal-face who have, or finally precipitate, most accidents and it's worth remembering that:

> *"The most junior officer on the bridge of one of your ships has more destructive power than the most senior member of the Board"*

3.1 Safety culture – What does it look like?

This is best explained with reference to a "before" and "after" table aimed at showing some, but by no means all, of the basic components involved.

BEFORE	AFTER
No management commitment	Total management commitment
Evasion (of the rules)	Compliance (with the rules)
Safety as an 'add-on'	Fully integrated safety
Blame culture	No-blame culture and accountability
No or limited reporting	Open and complete reporting
Reactive	Proactive
Revolutionary	Evolutionary
"Trust me"	"Show me"
Safety as a hindrance	Safety as a help
Safety as a cost centre	Safety as a means of saving money
Safety as a single-point responsibility	Safety as a line or multi-point responsibility
No or perfunctory risk assessment	Dynamic risk assessment
Unwarranted optimism	Cautious pessimism
Anticipation	Resilience
Training for specific tasks	Total professionalism
Large number of procedures with limited scope of allowable action	Small number of procedures with wide scope of allowable action
No rehearsed emergency response system – it'll be alright on the night!	Well rehearsed emergency response system based on prudent 'over-response'
'Paper' or non-existent quality management system	Assured quality management system
Auditors as "enemies"	Auditors as "friends"

3.2 "Open" and "no-blame" reporting

This is based on the simple and rather fundamental business premise that:

> *"You can't manage what you don't know about – help us to help you!"*

For management ashore, under the ISM Code and indeed under any HSE-MS including those utilised in pre-ISM days, it is only possible to manage effectively if they (management) are aware of all of the facts all of the time. If nobody tells them anything, they will continue to administer the same "medicine" in exactly the same way, happy in the illusion that all is well. In fact the medicine may be totally inappropriate and exceedingly dangerous and may well be the root-cause of the next accident but more of that later. Worse still is the situation where managers simply don't want to know or will only respond to something really serious such as a fatality or a major pollution.

Actually *achieving* "open" and "no-blame" reporting is difficult because, if the corporate culture is based solely on blame, then there will be a marked and understandable reluctance on the part of employees to report anything at all. So a vicious circle, or rather, an inward facing spiral of less and less reporting is created, literally driven by reluctance and in many cases, fear. If corporate memory can be stirred sufficiently it is unlikely not to reveal that most corporate cultures started in the "blame" mode and only slowly remedied the problem.

> *"No-blame reporting means being totally honest and sometimes requires great personal courage on the part of the reporter – and you may still be disciplined at the end of the day!"*

3

While there is a place for the apportionment of blame in certain circumstances, for instance where rules for whatever reason have been deliberately violated in a totally clear-cut way, it is wholly inappropriate to use blame as the *sole* response to unsafe acts or active failures. The later section on human error deals with this in some detail but sufficient is to say that blame does not mean no *responsibility* or no *accountability*. It is incumbent on the individual to comply with the rules and by definition to accept some form of admonishment should he or she deliberately violate them. It is in fact the duty of companies to *learn* from mistakes rather than blindly dismiss the perpetrator. Having said that, it is worth noting that one answer is to offer retraining rather than dismissal, though that will not of course be appropriate in every circumstance.

This is particularly important when considering the matter of "near-miss" or "dangerous occurrence" reporting. Thankfully incidents involving fatalities or other more serious consequences are relatively rare, thus providing relatively little useful information interest. If you accept the theory behind the "Heinrich Triangle" (see 4.1) that for every fatality there are a larger number of lesser category incidents and an even larger number of near-misses" or "dangerous occurrences", then the question has to be asked "is that rich and largely untapped seam of information not a more useful source of incident prevention material?" If open reporting is in place then that information will be forthcoming. And even if there is an element of "blame-culture" remaining in a company, if nothing has actually happened, i.e. there is no measurable and adverse consequence, then surely there is no one to blame!

In the presence of a blame-culture it will be virtually impossible to establish the truth if, following a really serious incident, the fate of those at the sharp end is already sealed. The blame-culture leads to a culture of almost automatic deceit and evasion, of lying and self-preservation at all costs. It is a culture that is singularly unhelpful at the end of the day. Remember that the object of accident and incident investigation and analysis is to *learn*. Somewhat surprisingly a number of marine investigation units across the world automatically issue a threat of prosecution at the start of their investigations – surely nothing could be less helpful than that in establishing the truth.

> *"Without doubt, companies wishing to achieve open and no-blame reporting will be asked by those at the 'sharp end' to demonstrate that they mean what they say"*

Open and no-blame reporting can only be achieved through clear *demonstration* by managers that they mean what they say. Doubtless the first reaction from ships' staff will be one of incredulity but gradually trust will be established.

3.3 Developing a safety culture

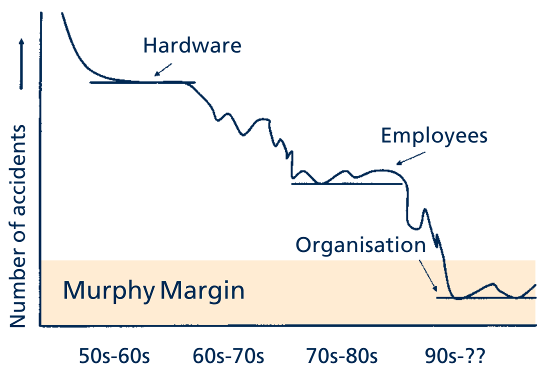
Almost by definition the successful development of a safety (and HSE) culture can only be achieved over time. Exactly how long and how you go about it will depend on where your particular company is – everybody commences from a different starting point. You may for instance already have senior management commitment. You may also have achieved some degree of open-reporting although generally speaking the "blame" element will still be there. As we have already stated there are no quick-fixes but there are a number of "critical success factors" (CSFs) that need to be put in place during the three stages of development:

	DRIVERS	FACILITATORS	PROCESS	PRODUCT
INITIATE	**Management commitment.** Long-term strategy. Goals. Champion and guru	**Planning and design.** Pilot study. Consideration to areas to be changed.	Outside consultant. **Employee involvement.**	Tool suitability.
EXECUTE	**Management commitment.** Champion and guru.	**Education and training.** **Organisational communications.** **Planning and design.** Personnel selection.	**Employee involvement.** Resources and support. Steering committee. Outside consultant teams.	Ease of use.
SUSTAIN	**Management commitment.** Long-term strategy.	**Education and training.** **Organisational communications.** Monitoring/ Feedback. Rewarding success.	**Employee involvement.** Management system.	Tool suitability. **Mature safety culture.**

Note: the major CSFs are shown in bold type.

As already stated historically it has almost been traditional to commence formal safety management efforts by addressing "hardware" i.e. procedures, equipment, personal protective equipment and emergency drills. This provided a foundation on which to build the next stage, the "employees" and then finally the "organisation" itself. Using data from an oil-major this can be shown graphically:

The three phases of the long-term development of a safety culture



Note the "Murphy Margin" often referred to as the "noise under the graph" and defined as the point in terms of accident rates that you are unlikely to get to, even with the most effective safety management system in place.

3.4 HSE "road-maps"

Experience has taught us that the best way to actually implement the changes necessary to develop a safety (and HSE) culture is to design an HSE "road-map". These usually follow a five-year plan set out in ten six-month periods. The plan does not necessarily have to adhere to the three stages referred to above as it is possible to address hardware and employees in a single phase. HSE road-maps are therefore usually arranged in the form of a table or matrix with vertical columns (one column per half year) bisected at right angles by rows each one of which forms an action item the time for implementation of which is indicated by an "X".

Thus under the eight headings obtained from the "state-of-the-art" "model" HSE-MS in 2.4, each group of action items would consist of:

- Leadership and commitment
- Policy and strategic objectives
- Organisation, responsibilities, standards and documents
- Hazards and effects management process (HEMP)
- Planning and procedures
- Implementation and monitoring
- Audit
- Review

An alternative would be to use the twelve headings of ESM. The precise choice of action items under each such heading to enable a corporate entity to monitor progress would have to be carefully considered with total "buy-in" achieved by staff and management. Providing the road-map is adhered to, progress will undoubtedly be made.

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On the map there would have to be clear starting points for both the implementation of the various and previously defined steps and the reporting of HSE performance data in two stages (1) to comply with national legislation *as a minimum* and (2) to comply with own corporate requirements, which would call for many more criteria and be much more demanding. Constant across the whole matrix, meaning in every six-month box, would be the requirement for visible management commitment, emergency response exercises including medical emergencies and six-monthly internal reviews/ audits. There would also be an annual audit by an external auditor of the state of compliance of the HSE road-map in terms of adherence to the plan and its overall HSE-MS effectiveness in terms of both quantitative and qualitative HSE performance data against annual (and longer) targets.

Towards the end of the first five-year road-map, usually at the end of year four, there would be a major review to agree the next five-year road-map. This second road-map would concentrate on proactive HSE measures (HSE health checks etc), more detailed risk assessments including those related to occupational health and the environment, plus the whole human error equation and the business of modifying human behaviour together with the implementation of the latest methodologies for investigating and analysing incidents.

By then you will truly be in the "Murphy Margin".

HSE road-maps of this nature can be tailor-made to suit any company and are exceedingly powerful tools for checking implementation progress and for checking actual HSE performance against each step of the road-map on a six-monthly basis. They can also be used to introduce new components, i.e. new or pending legislation, risk assessments carried out on new or newly identified HSE "critical" business activities, results of hazard and operability studies (HAZOPS) on both new and existing plants, accident and incident *trends,* thus avoiding "knee-jerk" responses to that last accident, new or novel ship designs, advice from equipment manufacturers and new ports to name but a few. They can also be used to check the relevancy of existing procedures and safe work practices.

Finally on the subject of the Implementation of Innovation (including the development of a safety culture) a few other points are worth remembering:

- The **will** to implement is more important than the ability to do so
- The **ability** of some developing countries to implement technology is better than most of the industrial nations
- When a new concept is **introduced**, as many people want it to fail as want it to succeed
- Knowing **what** to do **when** is more effective than doing everything at once
- The disadvantages of **overselling** a concept outweigh the benefits in the long run
- It is harder to **sell** theories of accident prevention than theories of accident causation.

4 The measurement and use of HSE data

Why measure HSE performance at all?

Because you can't manage what you don't know about!

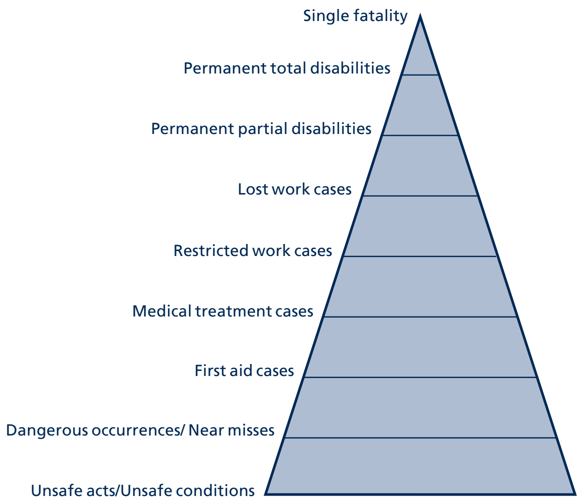
Why is there a need to measure comprehensively, accurately and consistently at both corporate and industry levels?

Because you need to establish corporate trends and industry comparisons

4.1 The Heinrich Triangle

This useful device (see below) is used to illustrate the many criteria that can be utilised to measure safety performance. For a company to measure safety performance comprehensively it is necessary to obtain and record data from each layer within the triangle.

The Heinrich Triangle



More information at the bottom = More to learn from the bottom

In the above diagram, no attempt has been made to put comparative numbers or ratios against each of the accident categories. For example: one fatality against five permanent total disabilities against ten permanent partial disabilities or whatever. The actual ratios are irrelevant. The fact is that there are far more numbers of incidents at the bottom than there are at the top thus there is far more to learn from incidents at the bottom than the top. In organisations that are in the early developmental stages of establishing a safety culture that rich vein of information at the base of the triangle will be largely untouched even if it exists at all.

Perhaps a few words of definition and clarification are appropriate:

Work-related activities – Those activities for which management controls are, or should have been, in place. Injuries occurring in the course of work-related activities are work-related injuries.

Fatality – A death directly resulting from a work-related injury *regardless of the length of time* between the injury and death.

Permanent total disability (PTD) – a work-related injury which renders the individual totally and permanently incapacitated and unable to work in any capacity either at sea or ashore. This could be loss of limbs, loss of sight or brain damage.

Permanent partial disability (PPD) – a work-related injury which results in the complete loss, or permanent loss of use, of any member or part of the body, or any impairment of the function of any part of the body, regardless of any pre-existing disability of the injured member or impaired body function, that partially restricts or limits an employees ability to work on a permanent basis at sea. Such an individual could be employed ashore but not at sea in line with industry guidelines.

Lost work case (LWC)* – Any work-related injury that renders the injured person temporarily unable to perform all their normal work on any day after the day on which the injury occurred.

*Note certain legislative regimes only recognise LWCs as such if they result in more than three days off-work. This, in the absence of formally recognised restricted or medical treatment cases, poses a dilemma when assessing the appropriateness, or otherwise, of lesser categories of injuries particularly first aid cases.

Lost time injuries (LTI) = Fatalities + PTD + PPD + LWC

Restricted work case (RWC) – Any work-related injury which results in an individual being unable to perform all normally assigned work functions during a scheduled work shift or being assigned to another job on a

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temporary basis on the day following the injury. RWCs are sometimes referred to as "light work" or "light duty" though once again some legislative regimes do not recognise this category on the basis that you are, or are not, capable of work.

Medical treatment case (MTC) – Any work-related injury which results in loss of consciousness (unless health related), or an injury requiring more than first aid treatment by a physician, dentist, surgeon or registered medical personnel, e.g. nurse or paramedic under the standing or specific orders of a physician, or if at sea with no physician onboard, could be considered as being in the province of a physician. A MTC involves neither lost workdays nor restricted workdays and generally speaking requires, or would require, invasive treatment by a physician, nurse or other medical specialist including treatment at sea by a non-professional medic or first-aider.

Total recordable cases (TRC) = LTI + RWC + MTC

First aid case (FAC) – Any single non-invasive treatment and subsequent observation of minor cuts, scratches, burns, splinters, foreign bodies in eyes etc, that do not normally require medical care by a physician, nurse or other medical specialist. Such treatment and observation is considered a first aid case even if provided by a physician, nurse or medical specialist.

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While it is sometimes quite difficult to categorise injuries particularly those on the borderline between a medical treatment and a first aid case, i.e. not becoming a TRC at all, no attempt should be made to deliberately downgrade an injury other than for quite genuine reasons. An acceptable reason might be that it was incorrectly categorised in the first place. What is more important is to categorise *consistently* against accepted and clearly understood criteria in order to accurately identity trends over time.

"Being 'creative' with injury definitions and figures is distinctly unhelpful and can border on being dishonest"

Dangerous occurrence and near-miss – an incident which in slightly different circumstances could have caused injury, illness, or damage to assets, the environment or company reputation, or consequential business loss, but did not.

Unsafe acts – Acts of error, omission or rule violation on the part of individuals that did not, but could have, precipitated detrimental or adverse events or consequences.

Unsafe conditions – Physical and sometimes environmental circumstances which in the presence of the unwary could have, but did not, precipitate detrimental or adverse events and consequences.

Unsafe acts and conditions are nowadays collectively referred to as "active failures" but more of that later.

Lost workdays (LWD) – The total number of calendar days on which the injured person was temporarily unable to work as a result of a LWC.

Restricted workdays (RWD) – The total number of calendar days counted from the day of starting restricted work until the person returns to his normal work.

Exposure hours – 24 hours per day while serving onboard. Injuries incurred while ashore on official ship's business are also included in accident statistics.

4.2 The Oil Companies International Marine Forum (OCIMF) "Marine Injury Reporting Guide"

Written in 1997 in response to a recognised need to measure safety performance in a more standard and consistent manner, this very useful and simple guide explains in some detail most of the injury categories set out in the Heinrich Triangle. The guide also contains a useful "decision tree" aimed at assisting the categorisation of injuries. The purpose of the OCIMF guide, which does not cover occupational illnesses or deaths from natural causes, is:

"... to promote, among tanker operators, an increased understanding and awareness of personal safety through the efficient and accurate reporting and recording of accidents"

Simple logic requires that this same guide is applicable to any type or size of ship in any size fleet and not just those related to the oil industry. The OCIMF guide is intended to be an integral part of this trainer's manual and while not the only work on the subject, is good enough for most practical purposes including the monitoring of *contractor* safety performance.

4.3 Finite numbers versus frequency rates

While the actual number of injuries (or occupational health related illnesses and occurrences) is vital as raw material aimed at satisfying the modern need for verifiable performance statistics, if proper trends, inferences and comparisons are to be drawn, such data must be put into its proper context. With few exceptions this can only be achieved by the use of *frequency rates*. These may be calculated in relation to the current year, a rolling 12-month period, quarter years, half years, three-quarters of a year and sometimes the current or last month.

For frequency calculation purposes the unit of exposure time are 1,000,000 man-hours (200,000 in the US) resulting in the general formula:

$$\text{Frequency} = \text{Number of injuries} \times \frac{1{,}000{,}000}{\text{Number of exposure hours}}$$

In this way the lost time injury frequency (LTIF) and total recordable case frequency (TRCF) can be easily calculated.

Note that in both cases the same number of exposure hours is used.

Thus for example in the course of a year a fleet of ten vessels, each with 25 persons on board will accumulate a total of 25 x 24 x 365 x 10 = 2,190,000 man-hours. If that same fleet experiences 5 injuries, say LTIs, then the lost time injury frequency (LTIF) will be 2.28. Because TRCs include LTIs, the TRCF can never be less than the LTIF.

Note when comparing LTIF and TRCF figures from the US it is necessary to multiply US figures by a factor of five in order to form direct comparisons with European companies.

Note also the 24 hour exposure day as used universally in the shipping industry clearly recognises the fact that (a) a ship is a home as well as a place of work often for very long periods of time; (b) it is very difficult and rather pointless to try to differentiate between "work" and "non-work" related incidents on a ship; (c) it simplifies the calculation; and, (d) it discourages attempts to make a work-related injury into a non-work-related injury. A serious injury received during heavy weather on the bridge, on deck or in a cabin (when technically he or she would usually have been off-work) is still a serious injury doubtless exacerbated by heavy weather. In either case the injured person is only onboard because he or she is a seafarer so why differentiate between accidents on the grounds of time and location?

In the case of a small fleet, say 4 ships or less, it is sometimes better from a psychological perspective to use *actual numbers* of injuries rather than frequency rates. This is because depending on the fleet size, the resultant LTIF and TRCF will appear as a large number and may vary considerably year to year making trends difficult to discern at least in a meaningful way. A fleet of just 2 vessels each with 25 crew members onboard will accumulate 438,000 man-hours a year. A single LTI will therefore produce an LTIF of 2.28. Two LTIs (one per ship) would produce an LTIF of 4.57 and so on.

A single injury sustained onboard a ship with 25 crew members in a one-ship fleet will produce a LTIF of 4.57. In terms of figures **one** injury *sounds* much better than **4.57** so as most general managers prefer to see low LTIF performance figures and target figures, typically less than one, fleet and HSE managers must think carefully how to present the data – this writer is not advocating spin but he is advocating caution as to how. Needless to say such niceties should not be allowed to cloud the real purpose of accurate data gathering which is one of monitoring progress.

The same presentational dilemma occurs over environmental data, particularly engine emissions and carbon-dioxide, where the effect of the huge numbers involved can be ameliorated a little by referencing them (as a considerably smaller number in grams) to the amount of fuel burnt in thousands of tonnes or kilos. Once again politicians might call that "spin" but having said that it is both logical and entirely accurate to do so particularly if, say, the number of ships in a fleet is increasing and there is a need to monitor CO_2 emissions in order to check the *efficiency* of combustion.

4.4 The importance of "near-miss" and "dangerous occurrence" reporting

As already mentioned the development of complete "near-miss" and "dangerous occurrence" reporting is one of the important indicators of the development of a safety culture (it is linked directly to "open" and "no-blame" reporting) and in the acquisition of sufficient data to identify accurately current trends and patterns. That is not meant to relegate the importance of first aid reporting (next layer up in the Heinrich Triangle) but as we have said before if a company still has a blame culture, if nothing material has happened (by definition neither near-misses or the dangerous occurrences can ever result in anything tangible – they are essentially "non-accidents") then there is simply no one to blame.

> *"Very often much more can be learnt from a well reported and analysed 'near-miss' than can be learnt from the real thing – there is after all no one to blame"*

4.5 The Real Cost of Accidents

There is little hard data in pounds sterling or dollars concerning the "real" costs of specific accidents and there is very little related to the overall costs to the shipping industry. There is also a tendency to look only at the "immediate" costs and to ignore the rest. Accepting that an incident of whatever nature can indeed injure and maim people but may also result in huge asset and environmental and even loss of reputation, below is list of some, but not all, of the factors involved:

- Loss of life
- Injuries
- Trauma to next-of-kin
- Fire-fighting and damage limitation
- Medivac (launch, helicopter, other ship)
- Company vessel standing by
- Short-term emergency medical treatment
- Medium-term medical treatment and nursing care
- Long-term medical treatment and nursing care particularly that related to permanent total and partial disabilities and other more serious injuries
- Repatriation costs
- Crew replacement costs both immediate and during repair period particularly if prolonged
- Additional port dues including those related to ports of refuge
- Agency fees
- Salvage fees
- Towage and support vessel standby costs
- Cost of lightering vessel(s)
- Cost of deviation of own ship (fuel, time, failure to meet lay days)
- Loss of charter at daily rate
- Cost of replacement ship for, say, missed cargo
- Cost of eventual repositioning own ship
- Cost of replacing cargo due non or late delivery
- Cost of non or late delivery to original consignees
- Possible effect of reprogramming refinery for replacement cargo of different specification
- Cost of time out due to asset damage
- Cost of replacement vessel during repair period
- Asset damage
- Vessel reactivation and re-positioning
- Environmental damage from spilt oil (bunker and cargo) to flora and fauna both short and long-term
- Immediate damage to industrial facilities, leisure complexes, marinas and marine related industries (fishing, fish farms, oyster beds, coral beds, simple beaches with public access)
- Emergency response including cost of flying out support teams and return
- Oil clean-up both short and long-term
- Monitoring of longer-term environmental damage
- Law suites
- Compensation payments
- Fines
- Cost of loss of reputation i.e. market share both locally, regionally and nationally
- PR damage limitation and media response
- Enhanced insurance premiums

In terms of the actual cost of injuries and leaving aside the immediate costs, whereas a single fatality will result in huge compensation claims and settlements, the cost of much longer term injuries, notably permanent total disabilities which effectively means "care for life" is considerably higher.

4.6 The difference between "injuries" and "occupational illnesses"

The differences between the two are often confused particularly when reviewing cases to decide where they should be allocated i.e. safety or illness. It is actually quite simple:

> *"An injury is the result of a **one-off** event, in other words it can definitely be attributed to a single occurrence"*

> *"An occupational health illness is the result of **long-term** exposure at work to particular substances or agents and environmental or psychological conditions, in other words they are illnesses that cannot be attributed to a single occurrence"*

There are exceptions to this latter definition, for instance food poisoning cannot be considered an "injury" though it could be attributed to a single batch of tainted food served in a work's canteen. Provided clear definitions are established and *applied* in a consistent manner there should be no problem in monitoring and in particular in monitoring trends.

4.7 The measurement of occupational health performance

The accurate measurement of occupational health performance requires the following elements:

- The support of line management
- The support of those at the 'sharp end' in terms of *why* it is necessary (it is not a spying exercise)
- An assured system of confidential *total absence* reporting
- A thoroughly transparent and verifiable system for differentiating between occupational or work-related illnesses and genuine sickness or ill-health
- Professional medical advice and support particularly with respect to the former point

Total sickness absence – Absence from work on the grounds of incapacity to work due to any sickness or injury, work-related or not, expressed as a percentage of the total workdays available calculated from the formula (for individuals):

$$\frac{\text{Number of absence days p.a.}}{\text{Number of available working days in year}} \times 100\%$$

Corporately this can be calculated from the formula:

$$\frac{\text{Total number of absence days of all employees p.a.}}{\text{Total number of available working days in the year}} \times 100\%$$

Note it is for line management to decide whether some absences are due to other non health or safety reasons i.e. absences for personal reasons, or no reason at all, which have been taken without prior agreement.

Note also that the second formula provides the company "norm" while the first one provides an individual figure against which unusual absentee trends can be identified as a possible indicator of ill-health (those suffering from stress for instance are very often absent from work more often than those not suffering from stress).

Total reportable occupational illness (TROI) – The sum of all identified occupational illnesses whether or not they involve lost or restricted workdays or medical treatment

Total reportable occupational illness frequency (TROIF) – The number of occupational illnesses per million exposure hours (which is exactly the same exposure time used to calculate LTIF and TRCF in safety).

4.8 The classification of occupational illnesses

It is important to have some clear definitions of what constitutes occupational illness. The following lists ten categories which cover most conditions:

1. **Infectious and parasitic diseases** – includes malaria, food poisoning, infectious hepatitis, dysentery, lambliasis and legionnaire's disease.

2. **Skin diseases and disorders** – includes contact dermatitis, allergic dermatitis, rash caused by primary irritants, sensitisers or poisonous plants, oil acne or chrome ulcers.

3. **Respiratory conditions due to dust or toxic agents** – silicosis, asbestosis, pneumoconiosis, pneumonitis, (allergic) bronchitis, alveolitis, asthma,

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pharyngitis, rhinitis or acute congestion due to chemicals, dusts, gases or fumes.

4. Poisoning (systemic effects of toxic materials) – includes poisoning by lead, mercury, arsenic, cadmium, or other metals; poisoning by carbon-monoxide, hydrogen sulphide, or other gases: poisoning by solvents; poisoning by pesticides; poisoning by other chemicals such as benzene, epichlorhydrin and formaldehyde.

5. Upper limb and neck disorders – includes synovitis, tenosynovitis, and bursitis; Raynaud's phenomenon; other disorders of the musculo-skeletal system and connective tissues associated with repeated trauma, include repetitive strain injury (RSI).

6. Back problems and lower limb disorders – as for (5) above minus RSI but including chronic back disorders caused by exposures at work.

7. Cancers and malignant blood disorders – includes mesothelioma; bladder cancer; leukaemia and other malignant diseases of blood and blood forming organs.

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8. Disorders due to mental stress – includes depression, neurosis, stress, functional disorders of the gastrointestinal tract and recurring tension headaches.

9. Noise induced hearing loss – includes loss of hearing from high volume, vibration, ultra-sound, infra-sound and environmental noise.

10. Other illnesses and disorders – includes physical disorders such as heatstroke, sunstroke, heat exhaustion and other effects of heat stress; freezing, frostbite and other effects of exposure to low temperatures; caisson disease; effects of ionising (alpha, beta and gamma rays, radium) and non-ionising (welding flash, ultraviolet rays, microwaves, sunburn) radiation; vibration (white finger). This category includes benign tumours; eye conditions due to dust and toxic agents; other (non-malignant) diseases of blood and blood-forming organs.

As can be seen from some of the medical terms, line and HSE managers alike will require expert help when setting up an occupational health reporting, recording, categorisation and analysing system. It is also necessary to emphasise the complete and verifiable confidentiality of any absentee and medical reporting and management system. If staff has no faith in its confidentiality then it will not work.

4.9 The measurement of environmental performance

The use of measurable key performance indicators (KPIs), meaning numerical indicators, will depend on the nature of the business but for shipping can be broadly divided into seven categories:

- Atmospheric emissions
- Oil and chemical spills
- Garbage, waste and sewage
- Ballast water discharges and management
- Complaints
- Non-compliances
- Fines/Arrests

Atmospheric emissions include products of combustion (CO_2, NOx, SOx, particulates), emissions due to venting of cargo spaces particularly hydrocarbons, i.e. CH_4, fire-fighting gasses and refrigerants either from domestic appliances or bulk cargo containment systems.

Oil, chemicals and other hazardous/noxious substances as covered by the MARPOL and other conventions include both permissible and accidental discharges.

Garbage, waste and sewage under the MARPOL Convention are attracting considerable attention these days so verifiable management processes need to be in place and suitable key point indicators (KPIs) developed.

Ballast water management is undoubtedly one of the more contentious issues in the shipping industry at the moment. The IMO Working Group on the subject has been in learned debate for more than a decade but the issue is clear – non-indigenous species are being introduced around the world to the detriment of native species and this must be reduced to more acceptable levels. While numerical indicators are difficult to identify (even scientists are divided as to what *standard* should be attained) the work of the IMO will continue until a new convention or protocol is agreed. Meanwhile the fact that there is an IMO model ballast water management plan should form the basis of a verifiable target or goal in terms of compliance with the latest albeit non-mandatory practice. Some countries have already implemented unilateral requirements thus compliance should be an operational "norm" for those vessels involved.

Complaints include a whole range of possibilities including noise, flares, smells and smoke. Almost by definition they will usually be of a local nature. They are however still important particularly in terms of the management of reputation. Some complaints can lead to vessels being arrested and fined.

Non-compliances include those identified by both internal and external audit or verification processes and those identified during inspections by port state, flag or one of the many inspection schemes run by the oil and chemical industries include OCIMF. Some non-compliances result in fines and if vessels in a particular company are being fined then it is appropriate to set targets aimed at a progressive reduction to zero.

Many incidents including groundings, collisions, fire and explosion can result in significant environmental damage. Such incidents are therefore not only useful performance indicators of safety and environmental damage but can also be viewed as indicators of efficiency of the whole operation.

4.10 The value and use of HSE performance data

So having got the figures what do you do with them? As already been stated earlier in this section in order to manage safety and HSE you need both numerical (so-called "hard") data and other (so-called "soft") data such as dates for the introduction of awareness programmes etc. At the end of the day though you need to understand precisely what the data means and how it can be used. Like a thermometer in a piece of machinery, the data provides a one-off "snap-shot" of *how* a system is performing at any particular moment in time. The one thing you must remember is that:

> ***"The performance of the past is no indicator of the future!"***

We like to think it is but the numbers gleaned, whether they are in the form of finite numbers of injuries or incidents, or in the form of frequency rates, i.e. numbers of injuries or incidents per unit of exposure time, are only relevant to that particular moment in time. What most of us learn very quickly is:

> ***"Take your eye off the ball, even for a moment, or assume that all will continue to be well if you do nothing more; something will come round and unexpectedly bite you on the bottom!"***

Primarily hard data is a check against hard targets. You *need to know* how you are doing in terms of your overall system and the effectiveness of remedial measures taken. If the measures you have introduced are not working then you must review what you've done and why it is not going according to plan. But don't be forced into changing your plans if improvement is apparently too slow. It is a mistake to expect too much too quickly and it all takes time.

At first there is a real need to reduce the number of serious injuries particularly fatalities and that is entirely right and proper. Whether you like the expression or not, the plain fact of the matter is that:

> ***"We are not in the business of killing people either now or in the future – the preservation of life is absolutely paramount!"***

While this writer is not a supporter of the concept of "target zero" for general matters (see later) he does support it most firmly in the case of fatalities. No fatality, *or even potential fatality* (if that is a credible worst outcome of a lesser category incident) can be considered acceptable.

Companies starting on the long road of formalised safety and HSE management and in the development of a safety culture will undoubtedly start from a bad fatality record and will, almost certainly, have been compelled to improve safety performance by addressing such incidents as *the principle driver*. Even in the worst run company there should never thankfully be enough higher category incidents to provide enough learning material to establish real improvement. Real improvement can only be obtained by addressing all incidents and then only by carefully tracking trends and patterns. To do this you need to be able to measure accurately and completely, and in order to do that you need to establish open and no-blame reporting. It is as they say a chicken and egg situation.

So while fatalities are not acceptable, because accidents are going to happen in any case targets must, as we have already seen, be both challenging (modern management jargon for difficult) and achievable. It is therefore important to confront reality by going for it "right on the nose".

The introduction and attainment of accurate and complete measurement of safety and HSE performance in a company in the throes of developing a permanent safety culture will inevitably show an *apparent* worsening of performance. The truth of the matter is that incidents will have been happening all along which management have simply not been aware of because they were never reported in the first place. As this phenomenon happens at every stage of the safety triangle this must be an expected result of open reporting. At least now you will be able to do something about it and that of course is one of the principle keys to success. You can manage the problem providing you know about it. Eventually a true or accurate *level* of safety performance will he achieved though this can take up to five years because not everyone working for a company will at first be entirely convinced of its real value, or in a corporate sense, your real intent.

Interesting by examining the *shape* of a company's safety performance triangle (the Heinrich Triangle) it is possible to monitor progress towards the development of a permanent safety culture. At the start of the process, from the numbers and types of injuries reported the triangle will be "upside down", i.e. base at the top, apex at the bottom, rather like a spinning top. This is because only fatalities and some other more serious incidents involving injuries will have been reported. Certainly there will be nothing reported below the level of "lost work case" (LWC), unless for whatever reason a particularly keen ship manager picks it up because of some port delay or additional expense incurred through agent's disbursements. That may sound slightly cynical but it is entirely accurate!

Eventually when some information starts to flow, the shape changes into an oblong with a high vertical axis, i.e. information is starting to be received from a broader range of incidents though by no means all incidents. As time progresses and reporting becomes more complete, a triangle begins to form (correctly with apex up), fatalities will decrease and ultimately will disappear except for some truly catastrophic and infrequent events. At that stage the "midriff" broadens out because while LWCs and TRCs are being reported, FACs and below will still be in the minority thus the oblong takes on a diamond shape. Eventually a well formed triangle develops the overall shape of which will improve over time as greater numbers of lesser category injuries are reported (FACs and below) and fewer TRCs occur.

Gradually injuries in the broad-based LTI category will grow small and the emphasis will shift to the even broader-based TRC category as the main serious injury reporting category. Similar patterns will be detected in both the occupational health and environmental components of the equation.

Thus looking at the various graphs of target and performance data over say a ten or fifteen year period there will be a series of *increasing targets* (you know they are happening and you can only manage what you know about) followed by a matching set of apparently worsening performance as reports flow in, followed eventually by improving performance first at the higher category levels and then lower levels as each strata in the triangle is targeted and improved.

During the process poor reporters and performers will become apparent but constant and unfailing effort in a positive and no-blame "help us to help you" mode will in the end achieve the desired result and it is worth doing.

4.11 The Concept of "as low as reasonably practical (ALARP)"

As mentioned above "target-zero" is not a particularly helpful or sustainable basis on which to seek a general improvement in safety and HSE performance. The only exceptions are for fatalities and serious explosions and fire which should all be viewed as one-off and catastrophic events to be prevented at all costs. In some cultures the idea of *not using* target-zero can be an exceedingly difficult concept to overcome in practical terms. The good news is that such difficulty can be overcome using the concept of "minimising harm to people" as a business principle. Target-zero is rather like the horizon – it can be seen, can become tantalisingly close, but can never be reached at least not on a long-term and sustainable basis. Generally speaking target-zero should therefore be viewed as an admirable management ideal recognising that not everything lies within your control particularly when it comes to the "other driver". The alternative is to manage safety and HSE in a way that is able to reduce risk to what is called "as low as reasonably practical (ALARP)".

Experience has indicated that in terms of safety and HSE management when performance figures are very low, typically for safety less than 1.0 TRCF, there is danger of spending more and more on less and less while achieving little or no tangible improvement. Thus it is necessary to

4

introduce a happy medium because it is clearly a mistake to be:

"The safest company in the world and be bankrupt"

Those companies who achieve success are those who can clearly identify how far to go in terms of "effort and reward", i.e. knowing when to seek improvement and when to maintain the *status quo*. But:

"Doing nothing is not an option"

The effort should be towards maintaining the momentum necessary to achieve your own particular corporate goals. For instance that may mean a goal of "no harm to people" and the maintenance of a TRCF of 1.0. It could, even should, mean maintaining the reporting levels of all incidents no matter where they lie in the Heinrich Triangle thus maintaining the *shape of the triangle.*

As this is essentially all about human beings and as they have a remarkable ability to hurts themselves the advice is not to shoot at the impossible but to accept instead that some things may not be achievable no matter what you do. That may sound like safety heresy but at the end of the day we must remain practical if nothing else!

In the two sections on risk identification and assessment and risk management (sections 7 and 8), a clear distinction is made between those risks that may be "critical" to HSE performance and those, which for want of a better expression, are managed by the every-day HSE and QM process. Between the two there exists a "grey" area and it is this area that sometimes causes the most problems. Certainly in terms of safety legislation there is a huge amount of basic legislation aimed at disaster prevention such as that introduced in the wake of the "Piper-Alpha" explosion in the North Sea or the "Exxon Valdez" pollution incident in Alaska. The farther you move from the disaster scenario the less concrete the legislation becomes and rightly so. There shouldn't be a rule for everything and it is noticeable that those who achieve success are those whose HSE and QM systems are robust enough to ensure that any hazardous activity is identified and correctly prioritised together with clear and unambiguous risk management measures aimed at achieving the ALARP level of result.

Section 7 explains certain quality based principles aimed at preventing the emergence of "grey areas" through the application of the "risk assessment matrix (RAM)" which in a *qualitative* way helps put relative risk into perspective along with appropriate risk management controls and defences. The RAM is also mentioned in section 5.

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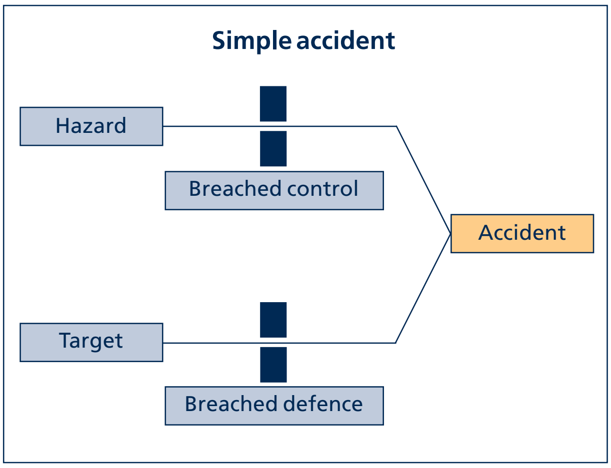
5 Accidents

5.1 What are accidents?

An accident or incident is an unplanned chain of events, which has, or could have, caused injury or illness and/or damage to people, assets, the environment or reputation. The basic components of an accident can also be shown as the simple "formula":

> *Uncontrolled hazard + Undefended target*
> *= Unwanted event (accident)*

By adding the concept of breached or missing controls and defences a simple accident can be shown diagrammatically thus:



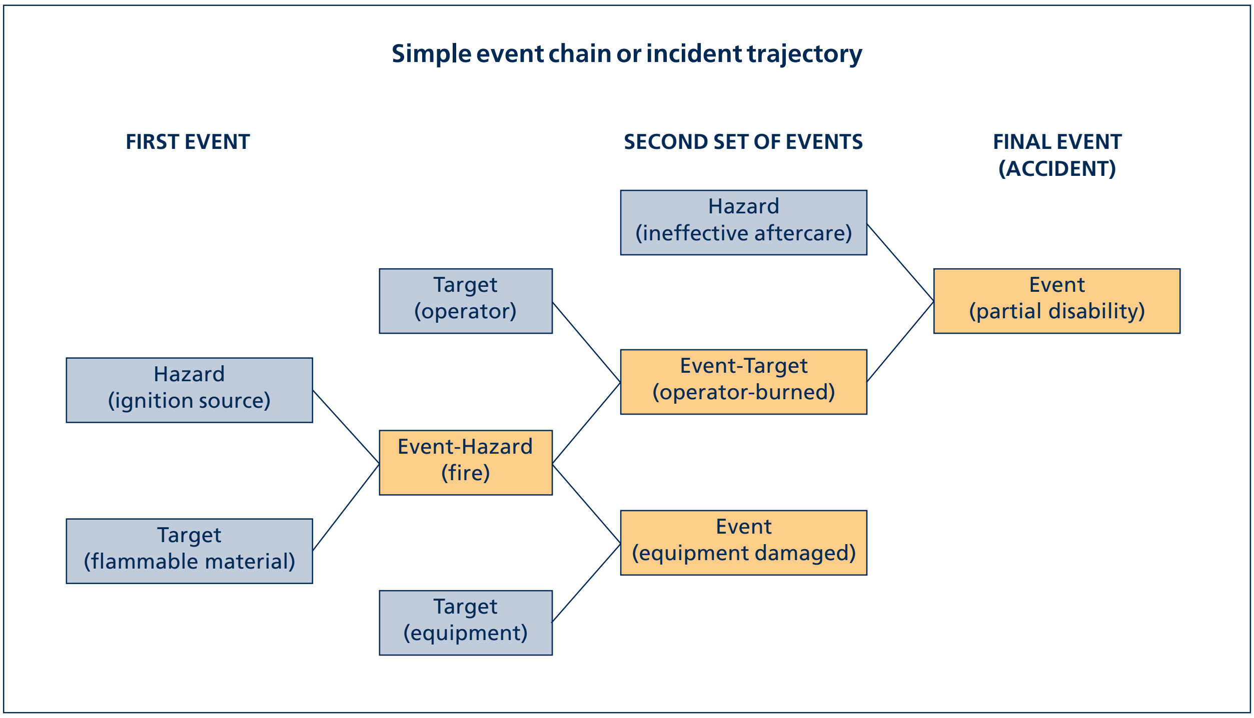
5.2 Event chains (incident trajectories)

Usually accidents are not as simple as this because there are usually several breached controls for the hazard and several breached defences for the target or "object of harm".

Also almost all accidents consist of a series of interlinking "events" in which each event becomes either a new hazard or a new target in its own right. In the presence of further targets or hazards and new and further breaches of defences and controls, a second event is created and so on. In investigating accidents it is not uncommon to identify five, six or even seven interlinking events before the final event or accident becomes a reality. The concept of the "event chain" or "incident trajectory" is shown in the diagram below:

Note the original (first) event resulted in a fire. In the presence of two new "targets", i.e. an operator and a piece of equipment, the resultant double event led to a badly burnt operator and damaged equipment (asset damage). Because the immediate aftercare of the injured operator (first aid or paramedic treatment) was ineffective (new hazard), the operator's injuries resulted in a partial disability.

Reverting to the simple accident diagram and the "formula" in orange the text box on this page, it will be observed that the hazard and target lines meet to form an event because *both* controls (for the hazard) and defences (for the target) have been breached in some way. If one of the controls or defences had not been breached, i.e. had held, then there would not have been



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an accident though it might still have been reported as a "near-miss" or "dangerous occurrence" of high potential.

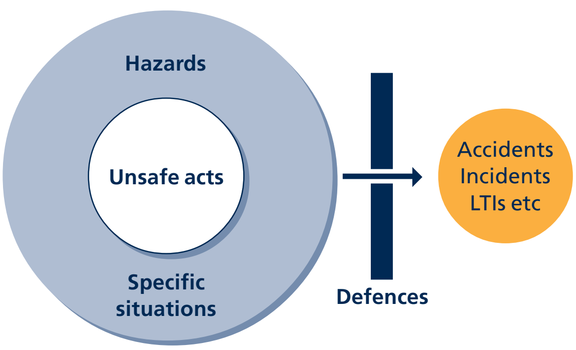
It is true to say that the usual mechanism whereby controls and defences are breached is an *unsafe act* on the part of an individual at the sharp end or coal face. Occasionally one or other may be breached by an inherent *unsafe condition* but these too will have invariably been brought about by the acts or omissions of people which may be nothing more than a simple and unintentional mistake. As has already been mentioned such unsafe acts or unsafe conditions are generally referred to as active failures.

> *"Active failures can be viewed as 'the straw that broke the camel's back'!"*

While active failures are interesting, indeed much can be learnt from them, much more can be learnt by addressing the sick camel in the first place.

5.3 The "conventional" view of accidents

Accident causation – the 'conventional view'



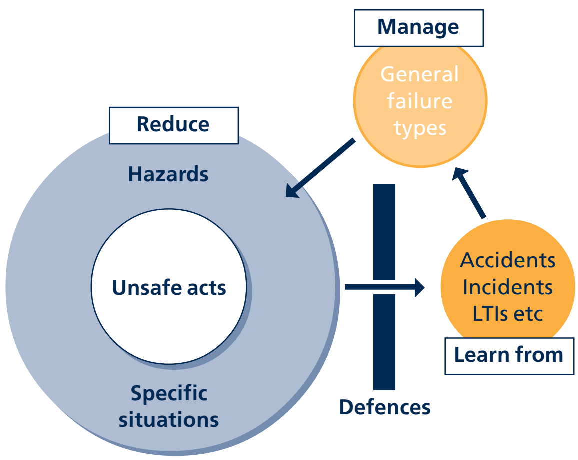
The so-called "conventional" view of an accident is shown above. Once again there is a clear recognition that defences of some kind have been breached, usually because of an unsafe act carried out in a specific situation and in the presence of hazards of some kind. That infers that the hazards were not controlled (otherwise nothing or no one would have been harmed). Thus far nothing is new.

5.4 The "Tripodian" view of accidents

What changed this long established view was some highly original research sponsored by one of the oil-majors and carried out at two major universities, one in Holland and one in the UK. The research originally set out to establish the *role of the human being* in the accident equation but very quickly established an "alternative" theory of accident causation. Because of the triangular shape of the basic model of the theory, it became known as the "Tripodian" view of accident causation. Basically it uses the "conventional" diagram above but adds a third component "general failure types" (GFTs).

The "alternative" model of accident causation is shown below:

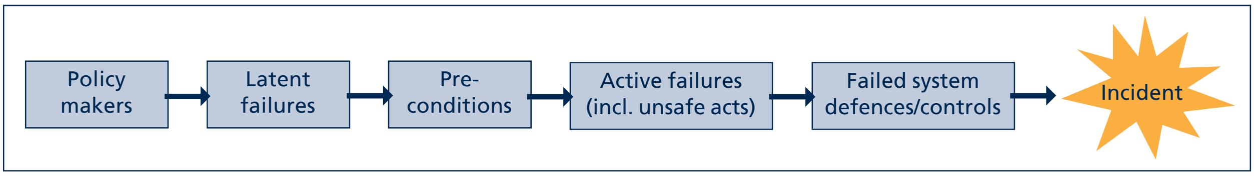
Accident causation – the 'Tripodean view'



The research accepts that properly investigated there is much to be learnt from accidents. It also recognised that unsafe acts or active failures can be reduced usually through the implementation of tools aimed at modifying human behaviour. One such tool "unsafe act auditing" or "unsafe act awareness" as it later became known (*auditing* is a threatening term in a largely blame society) had already been introduced as a way of supporting the "enhanced safety management" package already discussed at the beginning on this guide. But more importantly the research established once and for all that the "sick camel" could be made considerably healthier by managing the general failure types, of which there are just eleven individual components. Using a medical analogy these could be considered as the vital organs of the "safety body". If properly managed in terms of their inherent health or strength these could actually help prevent large numbers of accidents from ever happening at all. Once again in medical terms it's a bit like having a healthy heart and preventing heart attacks, or being vaccinated against pneumonia or 'flu – all designed to prevent illness in the first place.

5.5 The Tripod causation model

The research delved deep into the causation theory in order to establish a concrete link between breached defences and controls and active and latent failures thus the Tripod causation model was born – see diagram below:



The interesting point about this model is that it introduces two new elements into the causation chain. First it provides a linking mechanism between the active and latent failures, the *precondition* sometimes referred to as the "psychological precursor".

> *"Preconditions are the environmental, situational or psychological 'system states' or 'states of mind' that promote or directly cause active failures"*

Secondly it introduces the "*policy maker*" at the very start of the chain thus illustrating the clear relationship between commitment by the policy makers at the beginning of the chain and the results at the end of the day.

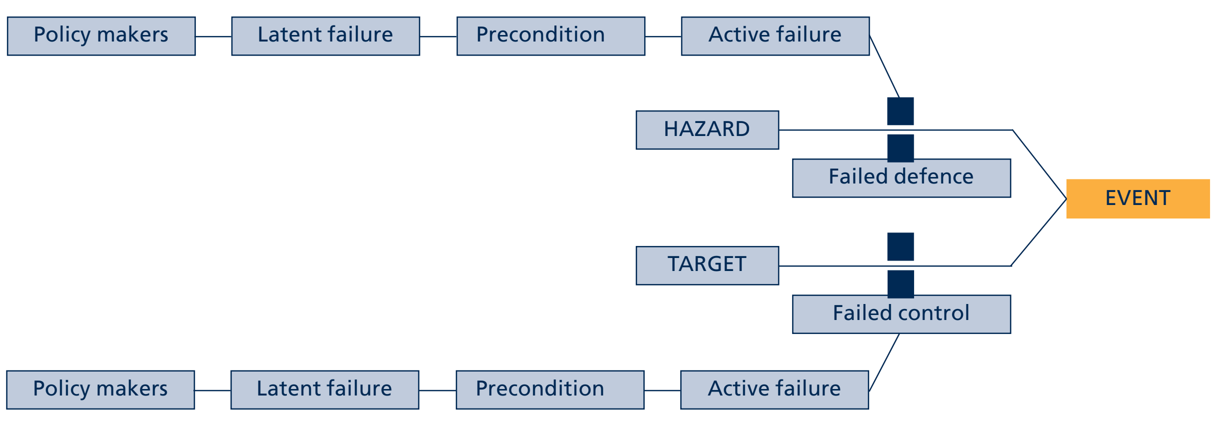
> *No commitment = No effective safety or HSE management system*

> *The Tripod causation theory is based on the premise that all accidents of whatever nature nearly always have multiple causes. The theory states that **active failures** e.g. unsafe acts, do not occur in isolation but are influenced by external factors referred to as **preconditions**. These factors are themselves routed in failures from elsewhere in the system – **latent failures**. Latent failures often originate in decisions or actions made remote in time and place by **policy makers** well away from those at the sharp end. This is not an entirely new concept – other accident causation theories have identified "immediate", "underlying" or "root" causes as elements in the equation. What Tripod does differently is to connect these causes to show that latent failures actually encourage active failures as well as magnifying their consequences.*

5.6 The Tripod-BETA tree

By comparing the diagram of the Tripod causation model, above, and the "simple accident" diagram on page 31, it should become obvious that the link between the two is established through failed defences (for the target) and failed controls (for the hazard) thus the combined accident model, known as the Tripod-BETA Tree complete with all the basic components looks like this:

The Tripod BETA tree



Bearing in mind that any accident consists of a series of interlinking *events* each with a *hazard* and *target* inputs, each of which has a series of breached, or sometimes missing, *controls* and *defences*, a completed accident tree can be exceedingly complex indeed but more of that later in this section.

5.7 Active failures: Unsafe acts or conditions – the "straw that broke the camel's back"

In this guide so far the term "active failure" has already been used a great deal. As the reader will already have surmised active failures are the failures close to the accident event that defeat the controls and defences on the hazard and target trajectories. In many cases these are the actions of people i.e. unsafe acts. Human errors are implicated in at least four out of five active failures, but human error as we will see in the next section of this guide is a broad term that includes a number of different sources of error.

Not all active failures are human actions. Physical failure of controls and defences also occur due to conditions such as over-stress, corrosion or metal fatigue. These are often referred to as "unsafe conditions". Having said that human actions are often implicated as contributory causes to this form of active failure but they are not, in themselves, unsafe acts. For instance a designer may have failed to identify the need to use a particular high tensile material in a specific circumstance thus sometime later causing component failure.

There are an almost infinite number of possible active failures and an equally large number of combinations of circumstances in which accidents can happen. It is also unlikely that an accident will happen in *precisely* the same way again. So to attempt to improve operating conditions and practices by single-mindedly following a track of learning from your last significant accident or incident is one that is unlikely to succeed, at least in the long term. It is far better to attempt a "fix" based on proactively identifying latent failures and to then build up your system's immunity from having accidents by continually strengthening the inherent "safety health" of an organisation.

5.8 Latent failures: System faults – the primary source of the "root cause"

Latent failures are the "vital organs" of the safety equation. Latent failures are deficiencies or anomalies that create the preconditions that result in the creation of active failures. Management (the so-called policy or decision maker) decisions often involve the resolution of conflicting objectives. Decisions taken using the best information available *at the time* may prove to be fallible with time. Also the future potential for adverse effects of decisions may not be fully appreciated or circumstances may change that alter their likelihood or magnitude.

The accident-producing potential of latent failures may lay dormant for a long time only becoming apparent when they combine with local triggering factors – active failures, technical faults, abnormal environmental conditions or abnormal system states, some of which even the best HSE management systems will have absolutely no control over whatsoever.

> ***"A defining characteristic of latent failures is that they have been present within the operation before the onset of a recognisable accident sequence"***

The research questioned why it should be possible for latent failures to emerge *after* an accident i.e. reactively when it should be possible to identify them *before* i.e. proactively.

Rather than dealing with an infinite number of active failures it is reassuring to note that there are just eleven latent failures on which to work to ensure absolute good health.

The eleven latent failures, which constitute what are known as the General Failure Types (GFTs) are:

- Hardware
- Design
- Maintenance management
- Procedures
- Error-enforcing conditions
- Housekeeping
- Incompatible goals
- Communications
- Organisation
- Training
- Defences

> *"The eleven latent failures represent the vital organs of the safety equation – failure to ensure their inherent good health will increase your propensity to have accidents"*

Hardware

Failures due to inadequate quality of materials or construction, non-availability of hardware and failures due to ageing, i.e. position in life-cycle. This GFT does not include:

> Error-generating mechanisms due to poorly designed equipment (design) or hardware failures caused by inadequate maintenance management which in many industries is a prime cause of accidents.

Design

Deficiencies in lay-out or design of facilities, plant, equipment or tools that lead to their misuse, or to the creation of unsafe acts, increasing the chance of particular errors and rule or procedural violations.

Maintenance management

Failures in systems for ensuring technical integrity of facilities, plant, equipment and tools, e.g. condition surveys, corrosion controls and function testing of safety and emergency equipment.

Issues relevant to the execution aspects of maintenance are considered in the GFTs: error-enforcing conditions, procedures, design, hardware and communication.

Procedures

Unclear, unavailable, incorrect, out-of-date or otherwise unusable standardised task information that have been established to achieve a desired and safe result.

Error-enforcing conditions

Factors such as time pressures, changes in work patterns, physical working conditions (hot, cold, noisy etc), acting on the individual or in the work place that promote, or make more likely, the performance of unsafe acts, errors or violations.

Housekeeping

Tolerance in deficiencies in conditions of tidiness and cleanliness of facilities and work spaces or in the provision of adequate resources (manpower or material) for cleaning and waste removal.

Incompatible goals

Failure to manage conflict: between organisational goals such as safety and production; between formal rules such as company written procedures and the rules generated informally by a work group; between the demands of individuals' tasks and their personal preoccupations or distractions.

Communication

Failure in transmitting information necessary for the safe and effective functioning of the organisation to the appropriate recipients in a clear, unambiguous or intelligible form. This the writer often refers to as the "super GFT" because of its fundamental importance to every aspect of the business. When analysing an incident it would be rare not to identify communications as a contributory factor in the incident.

Organisation

Deficiencies in either the structure of a company or the way it conducts its business that allow safety responsibilities to become ill-defined and warning signals to be overlooked. In a wider sense it is whether an organisation is able to perform its stated intentions safely and efficiently, i.e. is it fit for purpose?

Training

Deficiencies in the system for providing the necessary awareness, knowledge or skill to an individual or individuals in the organisation. In this context, training includes on the job coaching by mentors, supervisors or experienced peers as well as formal courses and information updates particularly of a technical or regulatory nature.

Defences

Failures in the systems, facilities and equipment for the control or containment of hazards or for the mitigation of the consequences of either human or component failures.

> *"Note that 'defences' is the only latent failure specifically concerned with safety – the others are simply good management"*

ERROR TYPE	DESCRIPTION	POSSIBLE CAUSES	PRECONDITION
Slip	Unintended deviation from a correct plan of action	Attention failure Mistiming	Distraction from task Preoccupation with other things
Lapse	Ommission/repetition of a planned action	Memory failure	Change in nature of task Change in task environment
Mistake (rule-based)	Intended action inappropriate to the circumstances	Sound rule applied in inappropriate circumstances Application of unsound rule	Failure to recognise correct area of application Failure to appreciate rule deficiencies
Mistake (knowledge-based)	Erroneous judgement in situation not covered by rule	Insufficient knowledge or experience – immaturity Time/emotional pressures	Organisational deficiency Inadequate training
Routine violation	Habitual deviation from required practice	Natural human tendency to take path of least resistance	Indifferent operating environment (no penalties); no rewards for compliance
Exceptional violation	Ad hoc infringement of regulated practice	Wide variety – dictated by local conditions	Particular tasks or circumstances not planned for
Act of sabotage	Deliberate violation for malicious reasons	–	–

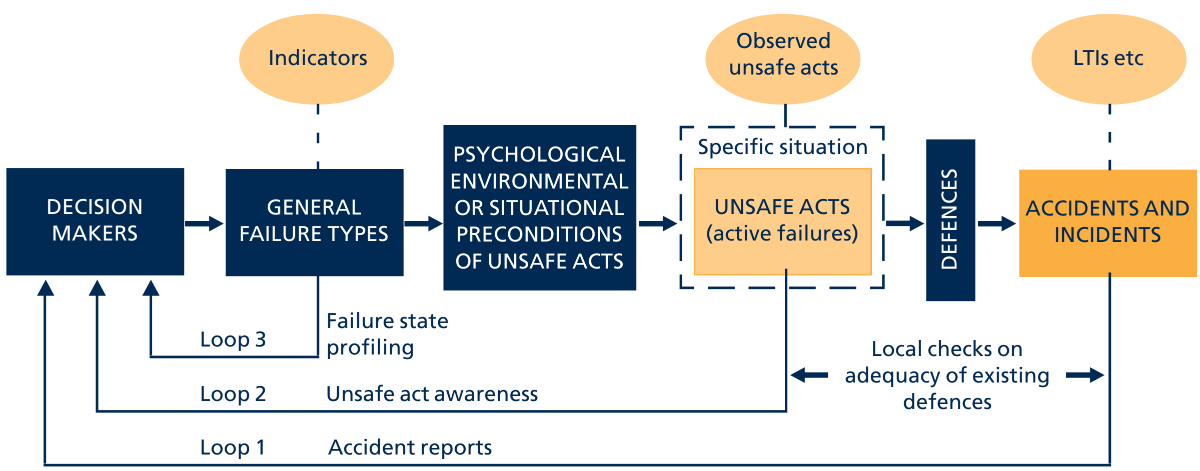
5.9 Preconditions

As indicated in 5.5 preconditions are the environmental, situational or psychological "system states" or even "states of mind" that promote, or directly cause, active failures. Preconditions form the link between active and latent failures and can be viewed as the sources of human error. They are best summed up in the table above which shows the connection between unsafe acts and typical preconditions. The somewhat unfamiliar terminology is fully explained in section 6.

5.10 The Tripod incident chain and feedback loop

The Tripod causation model can be further expanded to show the various ways of learning from (a) accidents themselves; (b) from what are called *observed unsafe acts* and: (c) by proactively measuring or assessing the state of health of the eleven GFTs. In many ways this is very similar to the "improvement" loops that lie at the heart of the model HSE-MS illustrated in 2.3 and is pure QM.

The Tripod incident chain and feedback loop

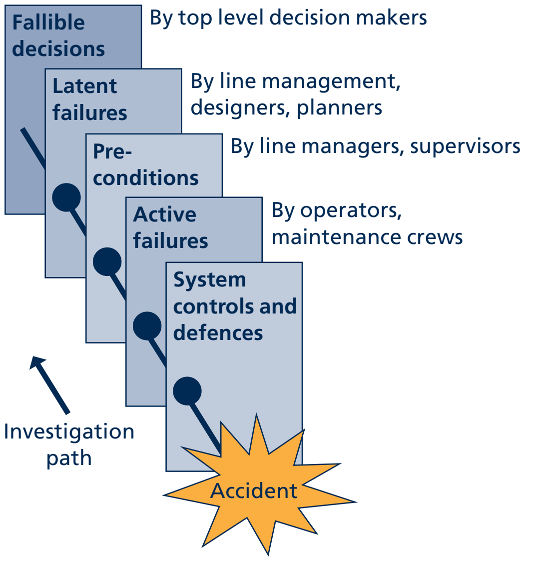


Note that all the improvement loops go straight back to the decision or policy makers. Note also the specific mention of "unsafe act awareness" which is only one of many safety tools aimed at modifying human behaviour.

5.11 The Tripod causation path and accountability

We will shortly be considering accident investigation but while the causation chain is fresh in our minds it is useful to illustrate where in that chain *accountabilities* would normally lie:

The Tripod causation path shows where to look



This diagram is also useful during accident investigations as it provides an indication of where to look for basic information – in a "no-blame" way of course!

5.12 Incident investigation

While BETA can be of great assistance in helping to identify possible lines of inquiry, conducting an exhaustive investigation process in which no stone is left unturned is absolutely vital to success. At best incomplete fact-finding can only ever produce scanty information; at worst it can result in misleading and sometimes wholly incorrect conclusions regardless of the methodologies used. The modern expression "rubbish in, rubbish out" comes instantly to mind.

> *"Remember the primary purpose of an investigation is to establish the facts surrounding an accident with a view to preventing possible recurrences in the future"*

Therefore as soon as the incident, whatever it is, has been dealt with in terms of notification, response and recovery, and the site has been properly secured from an evidential point of view, because the *quality* of evidence can deteriorate rapidly with time it is absolutely vital that the process be commenced as soon as humanly possibly. There is no doubt that delayed investigations are usually not as conclusive as those performed promptly. A prompt investigation is also a good demonstration of management commitment. "For-cause" drugs and alcohol testing should be carried out following any incident of note if only to demonstrate proof of innocence.

The investigation should include, but not necessarily be limited to, the following:

- Use of a *qualitative* risk assessment matrix (see overleaf) in order to identify the **true potential** of the incident and therefore the seniority of the investigators, the size and composition of the team and the degree of detail of the investigation
- Inspection of site
- Gathering, preservation and recording of physical evidence including automatically recorded data and photographic evidence
- Interviewing witnesses (including those injured if possible) and recording statements
- Reviewing documents, records and procedures
- Resolving conflicts/differences in evidence
- Identifying missing information
- Establishing a credible chronology of events using the final event as a starting point, i.e. in the case of a grounding start at the moment of impact and then work backgrounds to establish the pre-grounding sequence and then forwards to establish the recovery sequence
- Collect background data including all applicable procedures, legislation, local bye-laws, plans, operating manuals etc, records of instructions/ briefings given on the particular job being investigated, location plans and drawings particularly those of a contemporaneous nature, command structure and persons involved, message, directions etc given from base/head office concerning the work.
- Later it may be necessary to conduct specialised studies into certain critical aspects of the incident (ignition, explosion/fire sequences etc) and laboratory testing of failed components or equipment.

Incident follow-up – Levels of investigation

Severity	CONSEQUENCES				INCREASING LIKELIHOOD				
	People	Assets	Environment	Reputation	A Never heard of. in.......... industry	B Heard of in ..... industry	C Incident has occurred in our Company	D Happens several times per year in our Company	E Happens several times per year in a location
0	No health effect/injury	No damage	No effect	No impact					
1	Slight health effect/injury	Slight damage	Slight effect	Slight impact	Local investigation and follow-up				
2	Minor health effect/injury	Minor damage	Minor effect	Limited impact					
3	Major health effect/injury	Localised damage	Localised effect	Considerable impact			Fully investigate. Discussion and follow-up by management		
4	PTD or 1 to 3 fatalities	Major damage	Major effect	National impact				Management involvement in investigation and follow-up	
5	Multiple fatalities	Extensive damage	Massive effect	International impact					

Use of the risk assessment matrix

With regard to the use of the matrix the level of investigation should either be based on the consequences of the actual event or the *potential* consequences based on the *most likely credible scenario*, whichever is the greatest.

Investigators should be aware of the danger of reaching conclusions too early, thereby failing to keep an open mind and considering the full range of possibilities. It is only too easy to arrive at a conclusion because it fits your particular range of experience. Tripod-BETA teaches you to analyse without jumping to unjustified conclusions. Also be aware that you may be under intense pressure to produce quick results. If necessary produce a statement of facts, but do not be cajoled into carrying out a hurried analysis and an equally hurried set of findings and recommendations. They may be flawed.

5.13 Tripod – Useable tools

So much for the neat Tripod theory of accident causation. The trick now is to turn the theory into reality i.e. into useable tools aimed at addressing and modifying human behaviour for that is what we are up against and always will be.

The research developed two basic tools. The first called Tripod-BETA, while useful in assisting the investigation process, is aimed primarily at providing a well-structured and highly disciplined approach to *analysing* accidents. The second tool called Tripod-DELTA, is a proactive *safety health check*. Both tools can be supported by sophisticated software packages but in the case of BETA this is not really necessary providing the methodology is clearly understood and adhered to. The application of DELTA should only be contemplated when the company involved has (a) already implemented the many other more cost-effective measures described in this guide; and (b) succeeded in creating a culture resulting in an already improving safety, and HSE performance.

5.14 Tripod-BETA – an aid to investigation and a structured methodology for analysing accidents

Once the investigations are complete it is time to fully analyse the incident in terms of when and what happened and how did it happen. The timed sequence of events, the chronology, will have already been established so the next step is to develop a sequence of *events* leading up to the main event followed by further events in the response/recovery mode.

"It cannot be stressed highly enough that it is worth spending a very considerable amount of time in establishing an absolutely clear event tree or incident mechanism

In the experience of the writer, nearly as much time should be spent developing the event tree as is spent in the detailed examination and analysis of the breached controls and defences"

The following summarises the **first** phase of the BETA process:

- Investigate (see 5.12)
- Identify each event starting with the main one – do not proceed until this is done
- For each event identity the hazard and target (object of harm)
- For each hazard identify the breached or missing control(s)
- For each target identify the breached or missing defence(s)
- Confirm the changed status of each event i.e. each event (except the final one) becomes either a target or a hazard in its own right
- Confirm the totality of the sequence and that no events are missing i.e. the whole tree should following a continuous and verifiable sequence
- Make sure that you have not omitted any events in the response/recovery stage of the incident
- Seek out missing information identified during the first phase and repeat the process if necessary
- Graphically display the resultant event tree and recheck once more

As has already been seen in 5.2 the diagrammatical representation of an accident in its entirety is therefore a number of linked "trios" each containing three elements: an event, a hazard and a target.

The following summarises the **second** phase of the BETA process:

- For each breached or missing control on each hazard leg identity the active failure
- For each breached or missing defence on each target leg identity the active failure
- For each active failure identify the relevant precondition
- For each precondition identify the latent failure and categorise into GFTs (up to three GFTs may be involved per latent failure)
- Add up all the GFTs and graphically plot them in the form of vertical bars (a **failure state profile** (FSP), see 5.15) – the highest bars are indicators of greatest weakness and therefore greatest concern
- Identify the (fallible) decision behind each GFT where possible
- Seek out missing information identified during phase 2 and repeat the process if necessary

In this way a picture will be built up clearly showing the active failures, the preconditions and the latent failures against which are allotted one or more of the eleven GFTs. The identification of the latent failures forms the basis of recommended remedial measures.

The final phase of the BETA process concentrates on the development of prioritised remedial measures based on the failure state profile with named action parties and an agreed scheduled of implementation and review in terms of (a) effect, and (b) completion. The risk assessment matrix shown in 7.5 will greatly simplify this process.

It is absolutely vital that the investigation/analysis is led by an experienced facilitator together with a team consisting of an appropriate range of expertise and disciplines. The BETA process is thus well disciplined and subject to verification at every stage.

The principle differences between a "conventional" investigation and the BETA process are summarised overleaf

Typical "conventional" investigation

> Initial phase usually concentrates on the incident site and its immediate surroundings, gathering facts concerning the event and its consequencesThe next phase of the process examines the circumstances of the incident to identify what hazard management measures failed particularly those related to procedures. The scope may widen during this phase to include off-site activities.The final phase aims to identify the underlying causes of the incident very often drawing on similar historic events and experiences sometimes in a very ad-hoc manner. The investigation may include organisational arrangements.

Tripod-BETA analysis

> Initial phase is similar to the "conventional" process but the core of a Tripod-BETA tree defines the incident mechanism in terms of hazards, targets and connecting events.Failed, breached or missing hazard and target management measures (controls and defences) are then added to the core model in the second phase of the BETA tree building process. The result is almost a delta-wing shaped diagram.The final phase is to plot causal paths against each failed or missing control or defence, i.e. active failures, preconditions, latent failures and decisions by policy makers.By identifying latent failures, root causes can then be established and addressed.

5

A failure state profile for an individual accident does not necessarily reflect the HSE "health" of the operation under investigation at that particular time. However composite profiles obtained retrospectively by combining the latent failure categories from a number of incident analyses have been seen to correspond very closely indeed to those obtained proactively through the Tripod-DELTA process which is described in the next section.

5.15 Tripod-DELTA – a proactive safety health check

Whereas Tripod-BETA is able to identify, amongst other things, latent failures *after* an incident, Tripod-DELTA is able to identify and quantify (at least in relative terms) the existence of latent failures *before* an incident happens. It is therefore a proactive safety health check in every sense of the word.

> ***"Tripod-DELTA addresses the latent failures that are behind the active failures, most of which are caused by human error. It reveals the factors that increase the likelihood of human errors so that they can be proactively addressed"***

Safety health is about an organisation's ability to limit the number of incidents that could happen, or to restrict their severity should they happen. This is achieved by strengthening each of the GFTs.

In the same way that a doctor measures vital signs e.g. heart rate, blood pressure, cholesterol, albumen, etc as indicators for the overall health of a patient, so DELTA uses "*indicator questions*" to measure and assess an organisation's health. Doctors too use indicator questions e.g. how many cigarettes do you smoke? How much alcohol do you drink? How much do you weigh?

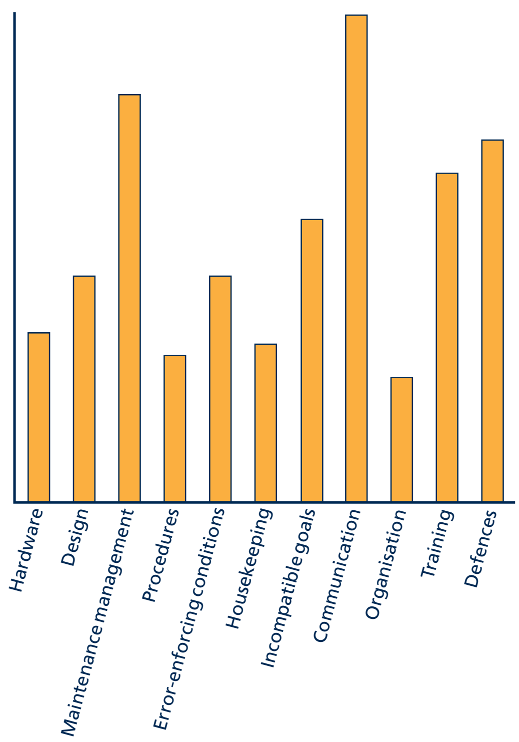
The indicator questions used in DELTA are tailor-made for the operation in question and are specifically related to each one of the eleven GFTs.

> ***"Indicator questions are objective, must be relevant to the operation, must be verifiable and can only have one desirable answer, either 'yes' or 'no'"***

But just how are they used? Basically a large number of indicator questions (up to two hundred for each GFT) are generated by teams involved with the operation together with a "preferred" answer ("yes" or "no"). The numbered questions are then imputed to a computer together with their respective preferred answers.

During the "profiling" exercise the computer randomly selects about twenty questions from each bank of indicator questions (making about two hundred and twenty in all). The questions are then displayed randomly and issued as a questionnaire.

Teams of operatives are then invited to answer the questionnaire. Extreme honesty is required which is why this type of tool cannot possibly work satisfactorily in a company with either a zero or an embryonic safety culture. The results are fed into the computer which then categorises them in terms of GFTs, analyses them comparing the yes/no answers with the preferred answers in the system. The resultant analysis is then



displayed as a "DELTA profile" based on the number of *differences per GFT* between the preferred answers and the answers given. The greater the difference the greater the height of the vertical bar and the greater the concern (see diagram above):

Each vertical bar represents one GFT i.e. Hardware, Housekeeping etc. In this case the greatest differences involve Maintenance management, Communications and Defences.

Much in the same way that a doctor, after a diagnosis, can warn a patient of imminent illness and thus prevent its manifestation, DELTA can forewarn an organisation of potential future problem areas. This gives the organisation time to correct problems *before* they potentially develop into incidents. In this case the team involved with the profiling will be invited to identify specific concerns and to apply (usually) three remedial measures for each of the three worse GFTs. This involves a two or three hour "brainstorming" session based on a "what", "when" and "who" format, i.e. what the action is, when it is to be completed and who is responsible for its implementation. DELTA profiling exercises are normally carried out at six-monthly intervals thus regular checks can be made as to progress. Over time other GFTs will emerge enabling changing and prioritised remedial measures to be applied. A useful "plus" for DELTA profiling is that it not only tells you the "bad" news, i.e. the highest bars on the profile, but it also tells you which areas are best i.e. the lowest bars.

The benefits of DELTA can be summarised as follows:

- Resource prioritisation
- Proactive approach
- Self diagnostic
- Profiling between audits
- Addresses hidden failures
- Good cost/benefit ratio
- Human-tolerant system

5.16 Conclusion

Tripod-DELTA looks at safety in a new light, examining the entire organisation at every level for latent failures instead of "traditional" safety problems. It provides feedback on potential incident causes before any incident has occurred. It identifies the strongest and weakest areas of an operation, therefore allowing the accurate prioritisation of resources. As a self-diagnostic tool it is run by the line efficiently and is flexible enough to avoid peak work periods. It delivers steady and evolutionary improvement by providing a manageable number of action items for implementation. Finally, DELTA provides a method of learning and improving that does not rely on having suffered human, material or environmental loss.

The safety (and HSE) record of a business is an excellent indicator of both quality and efficiency. The better run the business, the lower its total incident frequency. DELTA is a tool, perhaps the only proactive tool, which helps businesses become better by exposing potential shortcomings and remedying them before anything untoward happens.

5

6 Human Error – Welcome to the "Murphy Margin"!

6.1 Introduction

Over the past two decades there has been a growing appreciation of the many and varied ways that people contribute to accidents in hazardous industries or simply in every day life. Not long ago most of these would have been lumped together under the catch-all label "human error". Nowadays it is apparent that this term covers a wide variety of unsafe behaviours.

Most people would agree with the old adage "to err is human". Most too would agree that human beings are frequent violators of the "rules" whatever they might be. But violations are not all that bad – they got us out of the caves!

6.2 The Differences between errors and violations

One of the most important distinctions between errors and violations is that each has different mental origins, occur at different levels of the organisation, require different counter-measures and have different consequences. Everyone in an organisation, from members of the Board to those at the coal-face, bears some responsibility for the commission of violators. It also follows that all employees have a part to play in minimising their occurrence. Assuming that a safe operating procedure is well-founded, any deviation will bring the violator into an area of increased risk and danger. The violation itself may not be damaging but the act of violating takes the violator into regions in which subsequent errors are much more likely to have bad outcomes. This relationship can be summarised:

Errors + violations = Injury, death and destruction

It can sometimes be made much worse because persistent rule violators often assume, somewhat misguidedly, that nobody else will violate the rules, at least not at the same time as them! Violating safe working procedures is not just a question of recklessness or carelessness by those at the coal-face. Factors leading to deliberate non-compliance extend well beyond the psychology of the individual in direct contact with working hazards. They include such organisational issues as:

- The nature of the workplace
- The quality of tools and equipment
- Whether or not supervisors or managers turn a "blind eye" in order to get the job done
- The quality of the rules, regulations and procedures
- The organisation's overall safety culture, or lack of

Violations are usually deliberate, but can also be unintended or even unknowing. They can also be mistaken in the sense that deliberate violations may bring about consequences other than those intended, as at Chernobyl. In this case, out of the seven unsafe acts (*active failures*) leading up to the explosion, six were a combination of a rule violation and an error (a *misventure*). Here was a sad and remarkable case in which a group of well-motivated and exceedingly expert operators destroyed an elderly but relatively well-defended reactor without the assistance of any technical failures.

The distinction between errors and violations is often blurred but the main differences are shown in the table overleaf.

As can be seen from the table, errors may be simple memory or attentional failures and can be exacerbated by:

Routinisation – the mark of a craftsman whereby the individual becomes so expert at exercising a particular skill, that he/she no longer consciously thinks about it allowing the mind to wander and the unexpected to happen – drivers who regularly travel the same route to the station each day suffer from this – "am I here already?"

Normalisation – the process of forgetting to be afraid – interestingly most accidents on mountains happen on the way down from the summit – only a relatively small number happen on the way up the mountain – "OK let's be getting home!"

Intrinsic hazard – no matter how well you defend

Errors	Violations
Stem mainly from *informational* factors: incorrect or incomplete knowledge, either in the head or in the world.	Stem mainly from *motivational* factors. Shaped by attitudes, beliefs, social norms and organisational culture.
They are *unintended* and may be due to a memory failure (a "lapse") or an attentional failure (a "slip").	They usually involve *intended or deliberate deviations* from the rules, regulations and safe operating procedures.
They can be explained by reference to how *individuals* handle information.	They can only be understood in a *social context.*
The likelihood of mistakes occurring can be reduced by *improving the relevant information*: training, roadside signs, the driver-vehicle interface, etc.	Violations can only be reduced by *changing attitudes*, beliefs, social norms and organisational cultures that tacitly condone non-compliance (culture of evasion).
Errors can occur in any situation. They need not of themselves, incur risk.	Violations, by definition, bring their perpetrators into areas of increased risk i.e. they end up nearer the "edge".

yourself the dangers "out there" never go away – move outside your protective "bubble" and something or someone will get you!

Other factors include:

Creeping entropy – systems, policies and procedures grow old or fail to adjust to changing external factors thus increasing the propensity for accidents to happen.

Murphy's Law – if it can happen it will happen, but there is also Schultz' Law. Schultz merely said that Murphy was an optimist!

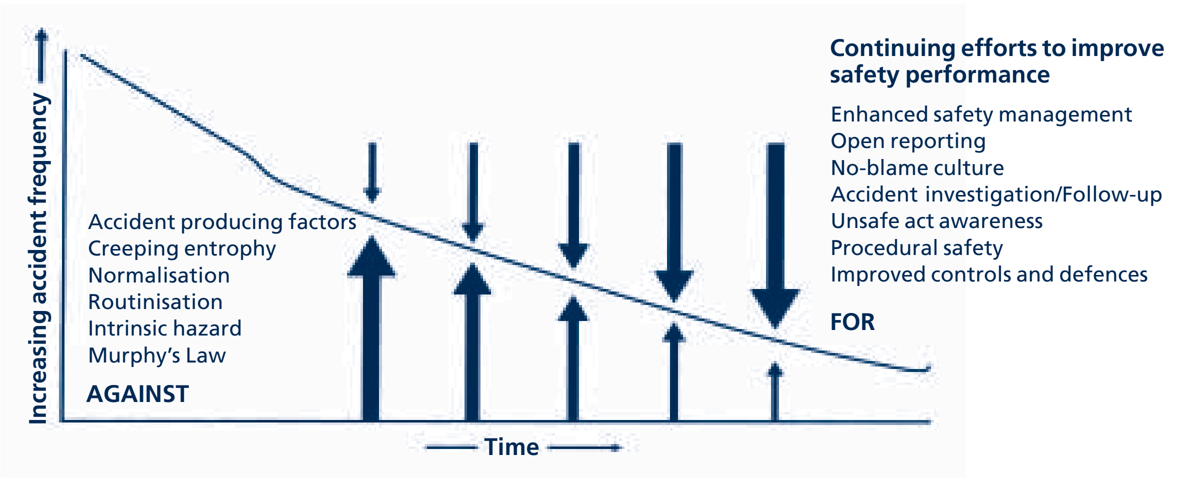
The self-explanatory diagram below shows the long term picture with all the psychological elements and the various safety processes and tools placed in context.

6.3 Error types

Now we come to the scientific bit. Error types can be classified at three levels:

- At the skill-based level, we carry out routine, highly practised tasks in a largely automatic fashion, except for occasional checks on progress. This is what people are very good at for most of the time.
- We switch to the rule-based level when we notice a need to modify our largely pre-programmed behaviour in line with some change in the situation around us. This problem is often one that we have encountered before and for which we have some pre-packaged solution. It is called rule-based because we

Understanding human error
The Murphy Margin and accident producing factors



apply stored rules of the kind*: if (this situation) then do (these actions).* In applying these stored solutions we operate very largely by automatic pattern-matching: we automatically match the signs and symptoms of the problem to some stored solution. We may then use conscious thinking to check whether or not this solution is appropriate.

- The knowledge-based level is something we come to very reluctantly. Only when we have repeatedly failed to find a solution using known methods do we resort to the slow, effortful and highly error-prone business of thinking things through on the spot. Given time and the freedom to explore the situation with trial and error learning, we can often produce good solutions. But people are not usually at their best in an emergency – though there are some notable exceptions. Quite often, our knowledge of the problem situation is patchy, inaccurate, or both. Consciousness is also very limited in its capacity to hold information, usually not more than two or three distinct items at a time. It also behaves like a sieve, forgetting those things as we turn our attention from one aspect to another. In addition, we can be plain scared, and fear (like other strong emotions) has a way of replacing reasoned action with "knee-jerk" or sometimes over-learned responses.

6.4 Classifying violations

Case and field studies suggest that violations can be grouped into four categories: routine violations, optimising violations, situational violations and exceptional violations. The relationship of these to both the performance levels and error types is summarised in the table below:

A few simple definitions will help clarify these:

- **Routine violations** – almost invisible until there is an accident (or sometimes as the result of an audit), routine violations are promoted by a relatively indifferent environment, i.e. one that rarely punishes violations or rewards compliance – "we do it like this all the time and nobody even notices".

- **Optimising violations** – corner-cutting i.e. following the path of least resistance, sometimes also thrill seeking – "I know a better way of doing this".

- **Situational violations** – standard problems that are not covered in the procedures – "we can't do this any other way". An excellent example concerns railway shunters: the rule book prohibits shunters from remaining between wagons when wagons are being connected. Only when the wagons are stopped can the shunter get down between them to make the necessary coupling. On some occasions however, the shackle for connecting the wagons is too short to be coupled when the buffers are fully extended. The job can only therefore be done when the buffers are momentarily compressed as the wagons first come in contact with each other. Thus the only way to join these particular wagons is by remaining between them during the connection and watching your head. The result is obvious.

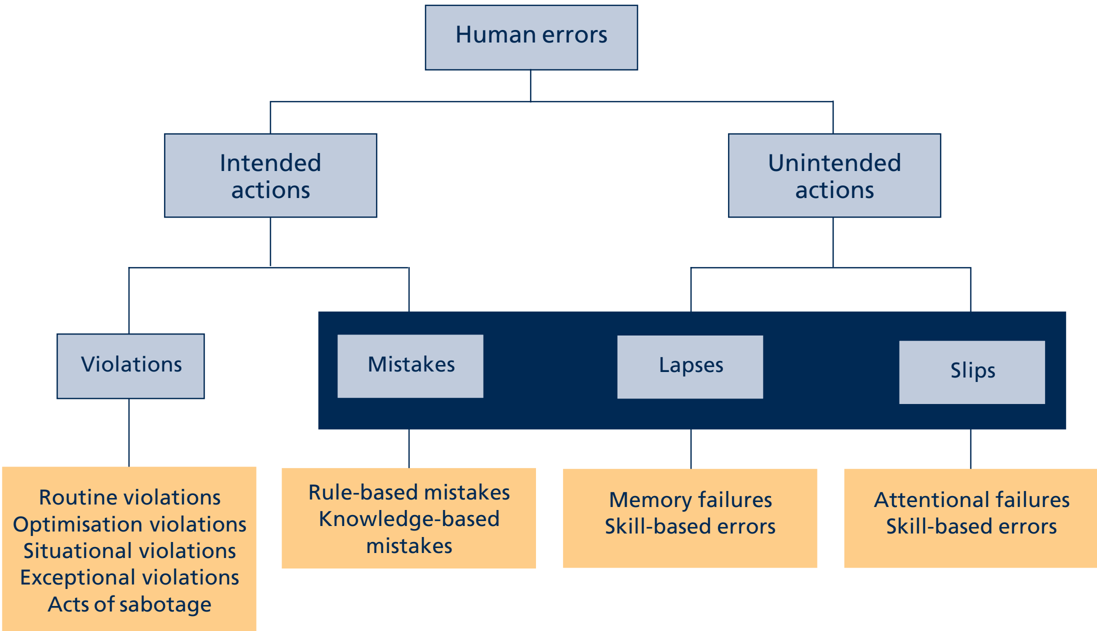
- **Exceptional violations** – unforeseen and undefined situations – "now this is what we got trained for". A simple example on an oil-rig illustrates the point: a pair of engineers were inspecting a pipeline. One of them jumps into an inspection pit and is overcome by hydrogen-sulphide fumes. His companion fully trained to handle such situations raises the alarm but then jumps down to help his partner, whereupon he too is overcome. Familiar isn't it? Nothing could have prepared the second man for the emotions that he felt on seeing his colleague in desperate need of help. Exceptional violations often involve the transgression of general survival rules rather than specific safety rules. Gut impulse is frequently stronger than the dictates of training and common-sense and quite often has fatal consequences. Survivors of such exceptional violations are often treated as heroes. Exceptional violations can sometimes be seen as an exercise of initiative even sometimes provoking reward if, that is, you get away with it.

6

PERFORMANCE LEVELS	ERROR TYPES	VIOLATION TYPES
Skills-based	Slips and lapses	Routine violations
Rules-based	Rule-based mistakes	Situational violations
Knowledge-based	Knowledge-based mistakes	Exceptional violations

Sources of human error can also be shown diagrammatically as follows:

Sources of human error



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6.5 Techniques for modifying human behaviour

There are many tools aimed at modifying human behaviour on a day-to-day basis and many of them have been in use for years. These include:

- Unsafe act awareness
- "Take 5"
- Checklists
- "Change of plan model"
- Teamwork
- Exercise of the "buddy-buddy" principle
- "Tool-box" meetings

Unsafe act awareness

As already indicated earlier in this guide "unsafe act awareness" was introduced as a means of supporting one of the very early formal safety management systems "enhanced safety management". The objective of this particular tool is to change behaviour through observation and diplomatic correction by peers. Its stated objectives are:

- To reduce significantly the potential for accidents in the individual's working practices, by addressing both the unsafe acts committed and the unsafe conditions created
- To reaffirm and improve the accepted standards of safety
- To improve communication and understanding, and so contribute towards more effective use of the total resources of the business
- To provide a more sensitive indication of safety performance than is given by higher category accident statistics
- To assist the *change of cultural attitude* towards safety, from one where:

  1. Unsafe practices are condoned
  2. Safety management is reactive
  3. Safety in seen as an extra and not as an integral part of the business
  4. Safety is seen as "someone else's" responsibility

To one where:

1. Unsafe acts and conditions are observed, identified and eradicated on the spot
2. Safety management is preventive, concerned with people
3. Safety is an integrated and cost-effective part of the business equation
4. Safety is accepted as a personal responsibility by each member of management, supervision and workforce

Unsafe act awareness was originally called "unsafe act auditing" but as the term "auditing" was considered rather threatening it was eventually changed. It was also viewed rather suspiciously by those at the sharp end as a kind of *spying* mechanism mainly because its real purpose was not properly explained face-to-face. Somewhat amusingly it became known as "shop-a-shipmate". But once these points were made clear and the system re-advertised, it actually became highly successful and in many ways pre-empted the philosophy behind the "duty of care" legislation by many years. Unsafe act awareness should be openly encouraged as an everyday tool aimed at safeguarding everybody through everybody protecting everybody else. It should not be viewed as a massive data gathering device rather the information gleaned should form part of the trend identification process aimed at improving safe working practices generally.

"Take 5"

This delightfully simple tool is aimed at risk assessment at the individual and work place level. Its intention is to encourage individuals at the sharp end to assess hazards at the start of the job and to continuously monitor them thereafter. It involves not only the individual but everyone and everything around. "Take 5" rather obviously, consists of the following five steps which individuals are required to carry out **before** undertaking any task or job:

1. Stop and look
2. Think through the task
3. Identify hazards
4. Assess and control the hazards, communicate these to others
5. Do the job safely

The result is that everybody in the work force, including supervisors and management, are *thinking* proactively and *continuously* about localised risk management and the avoidance of unsafe acts and conditions. It admirably supports the objectives behind unsafe act awareness.

Checklists

No matter what we think of them, for certain tasks or jobs, the use of checklists is quite important. They are designed to check that certain predefined safeguards and functional checks are in place. The airline industry uses them far more than the shipping industry. Pre-flight checks, literally in the form of small books, are carried out almost religiously ensuring that as near as humanly possible the aircraft, its equipment and fuel, are safe and fit for purpose.

Generic checklists in common use in the shipping industry and published in the joint International Chamber of Shipping (ICS) / Oil Companies International Marine Forum (OCIMF) / International Association of Ports and Harbours (IAPH) "International Safety Guide for Oil Tankers and Terminals" commonly referred to as "ISGOTT" include amongst others the pre-discharge Ship/Shore checklist, Hot work permits, Cold work permits and the Enclosed space entry permit. From the ICS publication "Bridge Procedures Guide" we note checklists related to Preparation for sea, Preparation for arrival in port, Pilotage, Passage plan appraisal, Navigation in restricted visibility, Changing the watch, Main engine or steering gear failure, Man overboard, Fire, Search and rescue, to name but a few. Their overall intention is to ensure that certain fundamental safeguards and procedures are not overlooked.

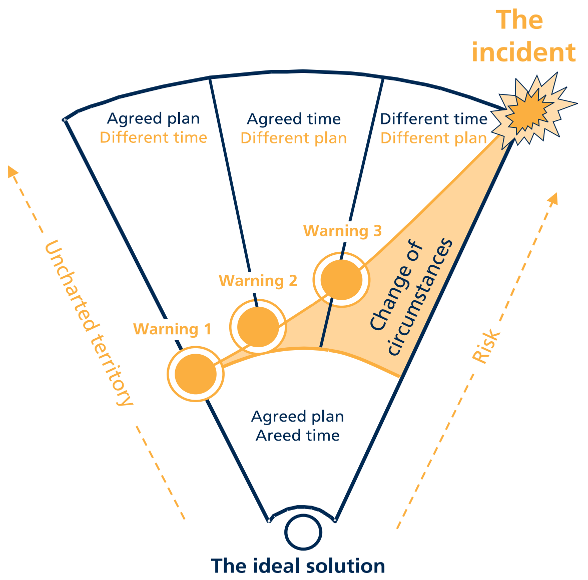
"Change of plan" model

We have all experienced, or even instructed, changes of plan sometimes at short notice. The problem here lies in the fact that changes can result in different interactions some of which may not have been appreciated and which may be unsafe.

A simple tool aimed at addressing these dangers is illustrated overleaf. It works on the premise that a plan usually consists of two basic elements – a methodology and a time. Change one of these and you move into new and possibly unknown territory in terms of risk; change the other one and the same occurs; change both and the dangers can rapidly escalate to the point where they become entirely unacceptable. The "change of plan" model generates three warnings which seek to ask those involved why such changes were necessary and whether all the relevant safety considerations have been recognised and addressed.

The model looks like this:

Change of plan model



Recognising that there are no perfect solutions to anything, the hypothetical "perfect" solution is placed at the bottom. Dangers associated with the agreed plan and time of execution of the plan are placed above and will have been properly assessed.

In the first case the agreed plan is suddenly changed to a *different time* thus generating "Warning 1" which consists of the following checklist of questions:

WARNING 1 – Change of time

- What is the original agreed time and plan?
- What circumstances have changed that warrant a change of time?
- By changing the time, are you creating new and possibly hazardous interactions with other jobs or operations?
- If YES are those involved with these "other" jobs aware of the changes and have all the safety implications been fully discussed with them?
- Have you sought the advice of a senior officer regarding the proposed time change?
- Have you the authority to proceed at the new time?

In the second case the *plan itself has changed* in some way although the original time remains unchanged thereby generating "Warning 2" as follows:

WARNING 2 – Change of plan

- What circumstances have changed that warrant a change of plan?
- By changing the plan, are you creating new and possibly hazardous interactions with other jobs or operations?
- If YES are those involved with these "other" jobs aware of the changes and have the safety implications been fully discussed with them?
- If the change involves breaching the integrity of a system i.e. electrical, hydraulic, pneumatic, cargo, fuel, ballast etc, or affects an already breached system, is it safe to proceed?
- If NO what must be done to ensure the integrity of the system?
- Have you sought the advice of a senior officer regarding the proposed change of plan?
- Have you the authority to proceed?

Note "change of plan" involves any component of the plan i.e. manpower, equipment, raw materials, back-up etc.

In the final case both the *time and plan* have changed thereby generating "Warning 3" as follows:

WARNING 3 – Change of time and plan

- What circumstances have changed that warrants such drastic action?
- By changing the time and plan, are you creating new and possibly hazardous interactions with other jobs or operations?
- If YES are those involved with these "other" jobs aware of the changes and have the safety implications been fully discussed with them?
- Have you sought the advice of the master or chief engineer regarding the proposed changes?
- Are you absolutely sure that the revised plan can be managed safely?
- If NO what are your doubts and how can they be managed?

- Have you the authority to proceed with the new plan at the new time?

> *"How many accidents do you know have resulted from a sudden change of time, plan or both?"*

Teamwork

Often considered by some to be "old fashioned" the implementation of formalised teamwork, particularly in the context of navigational bridges and engine control rooms, should result in a self-checking dynamic unit able to make use of all available resources and inputs and to be able to cope with any eventuality in a well structured clearly focussed safe manner.

In the context of the bridge, experience gained in the airline industry, particularly in Scandinavia where cockpit resource management (CRM) has been practiced for a considerable period of time in an ongoing effort to prevent airline tragedies, has been adopted by the shipping industry in the guise of bridge resource management (BRM).

Somewhat hidden away in the depths of the IMO Convention STCW 95 Section B-VIII/2 Part 3-1 (page 270 of the consolidated edition) the components of BRM are expounded in some detail. There is also specific reference in this document to the ICS publication "Bridge Procedures Guide" which in Part A section 1.2 (page 11) "Bridge resource management and the bridge team" discusses the detailed components of BRM. Linked to this is the concept of passage planning which both STCW 95 and the ICS guide cover exceedingly well. Responsible companies have been practicing both bridge teamwork and passage planning for many years as a means of preventing navigational incidents.

> *"The principles underlying BRM can be applied to any control room environment the objective being to ensure that the actions of no one man alone can precipitate disaster"*

BRM is concerned with the planned use of all available resources coupled to a complete knowledge of everything around you (sometimes referred to as "situation awareness") in which the totality of all internal and external inputs are considered to ensure the safe navigation of the vessel at all times. Pilots should be viewed as the "ultimate resource" in terms of local knowledge of a particular port or location. Likewise masters, together with their bridge teams, should be considered the ultimate resource in terms of knowledge of that particular ship. Unfortunately navigational incidents continue to occur because many pilots still do not consider themselves to be a component of the BRM equation and many masters are reluctant to welcome them in or insist that there is insufficient time to do so. Such a situation leads to little or no proper exchange of information at the beginning of the pilotage and poor communications throughout. Hardly a recipe for success!

The "buddy-buddy" principle

Personal experience gained over time can usefully be passed on to others. This is particularly relevant to life at sea which potentially can be subject to very considerable hazards and dangers.

Basically the idea is to ensure that new or inexperienced crew members are accompanied at all times by more experienced crew members who can ensure their safety whilst at the same time helping them to become familiar with the ship. This is vital when carrying out certain tasks which are inherently more hazardous than others. One such example is entry into enclosed spaces. Because so many things can go wrong especially to anyone with little or no knowledge of a particular ship, or someone very junior with little or no sea time or experience, it is essential to ensure that such individuals are rapidly and assuredly made aware of the hazards and precisely how they are managed. Of fundamental importance is their particular role in that equation. This will then ensure that no one enters an enclosed space without testing the atmosphere for a range of noxious gasses, back-up, equipment, good communications and never alone. That requires planning and the completion of standard safety check lists.

"Tool-box meetings"

These are a feature of drilling operations on oil rigs. They are quite informal meetings specifically convened to consider the safety and operational aspects of a job involving all those who are likely to participate in that job, or be involved with the planning, execution and monitoring. Typically such meetings occur at the start of a working day, before any new or urgent work and always in the event of a proposed change to an already agreed task.

6.6 And something to think about

As already stated there is a general formula which states:

Uncontrolled hazard + Undefended target = Unplanned event

Given that human beings, for whatever reason, are able to circumvent both controls and defences with sometimes quite remarkable cunning, the problem, for that is what it is, can be summed up as follows:

- Everyone is fallible and capable of bending the rules
- All systems have technical and procedural shortcomings
- Whatever you do, there's always something beyond your control that can hurt you

Finally there is the theory of "sheep and wolves". Studies have identified two sorts of people – sheep and wolves. Wolves accept rule violation as a norm. There are:

- Sheep in sheep's clothing
- Wolves in wolf's clothing
- Sheep in wolf's clothing
- But the largest group are wolves in sheep's clothing – they haven't violated the rules – yet!

7 Risk

A major component of the simple HSE-MS model shown in 2.1 is the management of risk through the so-called "hazards and effects management process (HEMP)". Any proactive organisation should be able to systematically manage risk. Serious or critical risks are generally managed in a much more formal or documented way than say everyday risks involving everyday tasks carried out in the normal course of events. Having said that while catastrophic incidents may well be the cause of multiple fatalities and injuries and have an enormous and adverse impact on the environment (with a commensurate cost), most everyday accidents and incidents do not result in death or destruction but do form the bulk of injury and incident data. The object of HEMP and the "safety case" (see later) is to recognise and document those tasks and operations which have the potential for serious or critical consequences and working on the basis (once again) that "you *can* manage what you know about" such potential should be able to be reduced to acceptable levels meaning "as low as reasonably practical (ALARP)" (see 4.11).

7.1 Risk management – the cornerstone of any effective HSE-MS

The basic steps or components of any risk management system are shown below.

Risk identification is not about identifying a "worst case" scenario every time and applying it in the most pessimistic way imaginable. The idea is to identify the most *likely* outcome in terms of severity and to then apply the most *likely* probability based on the most *credible* worse case scenario. Risk can be expressed by the general formula:

RISK = SEVERITY x PROBABILITY

It is therefore totally incorrect to consider severity and probability in isolation. Sure if you fall off a ladder from a height of two meters you could be killed but *usually* you either sprain something or at worst break a limb. Also at that height you should have been wearing a safety harness attached firmly to a point above your head so with such defences in place the *likelihood* of a fall will be small. That doesn't mean to say that the ladder should not be well secured because the *totality* of these defences are intended to reduce the risk of harm to the individual enough to ensure that you do not come to any harm no matter what. Falls from heights above that are of course treated in a completely different way though it has to be said that whether the height is two meters or twenty, the accident mechanism will be very similar.

7.2 Hazards and effects management process (HEMP)

HEMP is a formalised process for identifying and assessing risk. It will indicate those tasks and operations which have the potential to hurt people, damage the asset or harm the environment. Used in conjunction with a standardised risk assessment matrix (see 7.5), HEMP will indicate what controls and defences will have to be built-in or adopted in order to ensure that the risk, whatever it is, has been appropriately managed including during the recovery stage should something go awry.

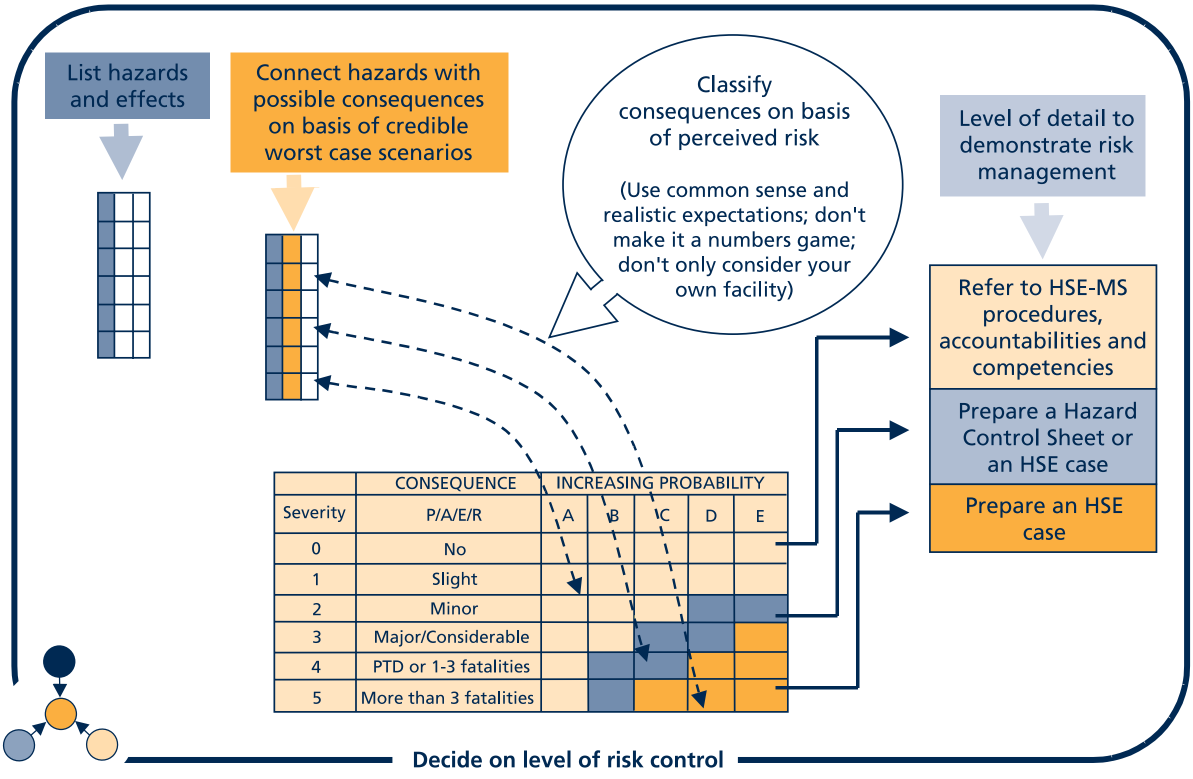
Within an organisation a named individual should be responsible for ensuring that formalised risk assessments are carried out in compliance with HEMP. The process,

Basic risk management

Identify		"What is the root cause?" "What could go wrong?"
Assess		"How serious will it be?" "How probable is it?"
Control	Prevent/eliminate Reduce probability	"Is there a better way?" "How to prevent it?"
Recover	Mitigate consequences Emergency response Reinstate	"How to limit the consequences?" "How to recover?"

7

Demonstration of risk management through HEMP



like safety however remains a line responsibility though subject to expert advice from the appropriate HSE and risk assessment personnel.

Diagrammatically the process is shown above.

The principles of "identify", "assess", "control" and "recover" shown in 7.1 apply to the entire HSE and total incident prevention equation and form the basis of HEMP with individual steps being summarised as follows:

Step 1:
Identify hazards and potential effects

- List work activities
- Identify the hazards, threats and potential hazardous events and effects which may affect, or arise from, an operation throughout the total life cycle of the operation
- For ships this would be from "cradle" to "grave" including ultimate recycling on the beaches of India, Bangladesh, Pakistan or China or where ever
- Connect these hazards with possible consequences based on a credible worst case scenario

Step 2:
Evaluate risks

- Systematically evaluate (assess) the risks from the identified hazardous taking into account the likelihood of occurrence (base on the worst most credible scenario) and the severity of any consequences to employees, assets, the environment and the public. This includes the risks associated with the deviation from limits set for environmental and occupational health hazards.
- Evaluate the risks and classify the consequences by application of an accepted screening technique such as the risk assessment matrix (see 7.5)
- Depending on where the risk lies based on **Probability** of likelihood ("x" axis) and **Severity** of consequence ("y" axis) and the colour coded boxes, apply an agreed regime of controls and defences (those expressions again!)
- Do not forget the significance of **recovery** phase **after** an incident whatever it is. A well-managed emergency response system could well be the difference between a "bad" incident and a really "serious" one – be prepared!

Step 3:
Record hazards and effects (QM requirement)

Record all those hazards and effects identified as significant in relation to the screening criteria (on the matrix those in either the pale orange and dark orange areas) in one of the following types of documents (the choice is yours depending which one is most suitable):

- HSE-MS activities catalogue
- HSE activity specification sheets
- Hazards and effects register
- HSE critical operating procedures
- Manual of permitted operations

These documents will then be included in the appropriate section of the documented HSE-MS and the HSE case.

Step 4:
Compare with objectives and performance criteria

- Compare the evaluated risks against the detailed HSE objectives and targets for the project or installation (ship)
- For all cases these targets must be maintained and be consistent with the Company Policy and Strategic Objectives
- Performance standards at all levels must meet the criteria set in the HSE Case which in turn must comply with the documented HSE-MS

Step 5:
Establish risk reduction measures

- Select, evaluate and implement appropriate measures to reduce or eliminate risks
- Risk reduction measures include those to prevent or control incidence (i.e. reducing the probability of occurrence) and to mitigate effects (i.e. reducing the consequence) through the implementation of defences designed to protect the potential "object of harm"
- Mitigation measures include steps to prevent escalation of developing abnormal situations and to lessen the direct adverse effects HSE consultancy
- Risk reduction measures also include recovery preparedness measures which address emergency procedures as well as restoration and compensation procedures to aid recovery
- Revisit Step 3 to record fully the activity/task requirements

7.3 The deliverables from HEMP

The product of all this activity particularly that related to critical operations, tasks and installations should be:

- An **inventory** of the major hazards to the environment and to the health and safety of all activities, materials, products and services;
- An **assessment** of the related risks, implementation measures to **control** these risks and to **recover** in case of control failure.

Health risk assessment should address physical, chemical, biological, ergonomic and psychological health hazards associated with work.

Environmental (impact) assessments (including a consideration of social impacts) should be conducted prior to all new activities and facility developments, or significant modifications to existing ones.

Soil and groundwater contamination (if applicable) should be assessed and, where required, control or remediation put in hand.

Product stewardship (if applicable) should be applied at all stages of product life cycle relevant to the company's activities.

7.4 Qualitative versus quantitative risk assessments

Once hazards and potential hazardous events have been identified, their causes, consequence and probability can be estimated and the risk calculated. Risk assessments can be qualitative or quantitative. Both involve the same steps. Qualitative methods *at a practical level* are usually perfectly adequate for risk assessments of simple facilities or operations where the exposure of the workforce, public, the environment or asset is low or medium. However, the application of quantitative methods is considered desirable when:

- Several risk reduction options have been identified whose relative effectiveness is not obvious

- The exposure to the workforce, public, the environment or the strategic value of the asset if high, and reduction measures are to be accurately evaluated
- Recovery or control equipment spacing allows significant risk of escalation
- Novel technology is involved resulting in a perceived high level of risk for which no historical data is available e.g. deep water developments in hostile environments, floating LNG production and storage modules in hostile or unfamiliar environments etc
- Demonstration of relative risk levels and their causes to the workforce is needed to make them more conscious or aware of the risks
- Demonstration within a company and to third parties, including regulating authorities and insurers, that risks are as low as reasonably practical is required

A point worth remembering about risk is that:

> *"Powerful people i.e. those in authority, underestimate low probability risks while powerless people over-estimate all risks"*

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For the information of the reader who may be interested in quantitative risk assessment, from the UK Health & Safety Executive we learn that general risk levels in terms of fatalities can be expressed numerically as follows (all on a per annum basis):

1 in 1,000	Risk of death in high risk groups within relatively risky industries such as mining
1 in 10,000	General risk of death in traffic accidents
1 in 100,000	Risk of death in an accident at work in the very safest parts of the industry
1 in 1 million	General risk of death in a fire or explosion from gas at home
1 in 10 million	Risk of death by lightning

The UK Health & Safety Executive has concluded that for *worker* (as opposed to the general public):

> *"In broad terms, a risk of death of 1 in 1,000 per annum is about the most ordinarily accepted figure under modern conditions and it seems reasonable to adopt it as the dividing line between what is just tolerable and what is intolerable"*

For risk to members of the *general public* it also concluded that:

> *"The maximum level (risk of death) that we should be prepared to tolerate for any individual member of the public from any large-scale industrial hazard should not be less than 1 in 10,000 i.e. tens times lower than for workers on site"*

7.5 The risk assessment matrix (RAM) and its uses

The risk assessment matrix is a tool that standardises *qualitative* risk assessment and facilitates the categorisation of risk from threats to health, safety, environment and reputation. This particular form of qualitative risk assessment matrix is unusual in that it incorporates four *types* of consequences on the same matrix i.e. people, asset, the environment and reputation. The severity of each type of outcome is described in a commensurate way (see also 1.3).

"People" includes own employees, contractors and third parties which may include members of the general public. For the purpose of risk assessment the heading "people" covers both injury and occupational illness depending on the type of exposure.

The "asset" in a marine sense could be a ship (own, chartered or third party); a jetty or installation and its equipment including loading arms for tankers, specialised cranes for container ships etc; rigs and production platforms; supply and standby vessels in oil fields; tugs; pilot vessels; service craft including helicopters and self propelled or towed barges; buoyage and navigational marks (fixed and floating); other shore facilities including public leisure beaches, fisheries, power stations, refineries or factories reliant on a clean environment and clean water or protected discharge facilities etc.

The "environment" might simply be the sea but could also include areas of a specially sensitive nature (particularly those defined at the IMO), flora and fauna, coral, water supplies particularly ground water supplies from surface contamination etc.

"Reputation" is increasingly becoming an important issue with the hydrocarbon, nuclear and shipping industries coming under increasingly aggressive scrutiny by the public, governments and environmental non-governmental agencies. There is no doubt that major shipping incidents, particularly those involving oil pollution, can have and do have an exceedingly adverse effect on our industry regardless of who is responsible or why.

> *"Reputation – a challenge to your own customer base but a generic threat to our industry"*

General risk assessment matrix (RAM)

The basic RAM is used to assess the general risk of any task or work activity. A scale of **consequences** from "0" to "5" is used to indicate increasing severity. The consequences are those based on the most likely *credible* worse case scenario (taking the prevailing circumstances into consideration) that can develop from the release of a hazard. The **potential** consequences, rather than the actual ones, are used.

After assessing the potential outcome, the **likelihood** on the horizontal axis is estimated on the basis of historical evidence or experience that such consequences have materialised within the industry, the company or a smaller unit. Note that this should not be confused with the likelihood that the hazard is released: it is the likelihood of the estimated *consequences* occurring.

The estimation of likelihood and consequence is by no means an exact science. The consequence estimates are based on envisaged scenarios of what *might happen*.

The likelihood estimates are based on historical data that such a scenario has happened under similar conditions before knowing full well that circumstances will never be exactly the same.

It is important to estimate the potential consequence first and then the likelihood last.

When estimating the risk or risks associated with a particular activity all four categories should be considered and addressed separately.

Activities positively identified as being critical, i.e. they fall into the dark orange "high risk" or "intolerable" category, will be subject to stringent examination (including a quantitative risk assessment) in order to establish the individual risk-making elements involved. The next version of the matrix would then be used to establish what broad types of action are necessary for the risk(s) to be reduced to ALARP proportions if that is possible.

Identifying broad actions aimed at reducing risks to ALARP

This version(Figure 2, overleaf) is used to identify the broad *type of control* or *risk reduction methodology* necessary to manage the identified risk to acceptable levels. Where risk reduction measures, or operational or business alternatives fail to bring the risk from the dark orange area into the pale orange area of the matrix,

Figure 1: General risk assessment matrix

Severity	CONSEQUENCES				INCREASING LIKELIHOOD				
	People	Assets	Environment	Reputation	A Never heard of. in.......... industry	B Heard of in ..... industry	C Incident has occurred in our Company	D Happens several times per year in our Company	E Happens several times per year in a location
0	No health effect/injury	No damage	No effect	No impact					
1	Slight health effect/injury	Slight damage	Slight effect	Slight impact					
2	Minor health effect/injury	Minor damage	Minor effect	Limited impact					
3	Major health effect/injury	Localised damage	Localised effect	Considerable impact					
4	PTD or 1 to 3 fatalities	Major damage	Major effect	National impact					
5	Multiple fatalities	Extensive damage	Massive effect	International impact					

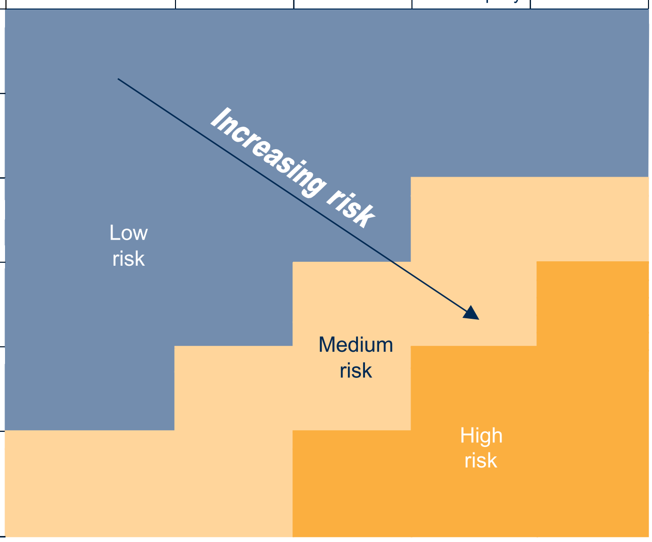

Figure 2: Matrix for risk management

Severity	CONSEQUENCES				INCREASING LIKELIHOOD				
	People	Assets	Environment	Reputation	A Never heard of. in......... industry	B Heard of in ..... industry	C Incident has occurred in our Company	D Happens several times per year in our Company	E Happens several times per year in a location
0	No health effect/injury	No damage	No effect	No impact					
1	Slight health effect/injury	Slight damage	Slight effect	Slight impact					
2	Minor health effect/injury	Minor damage	Minor effect	Limited impact		Manage for continuous improvement			
3	Major health effect/injury	Localised damage	Localised effect	Considerable impact			Incorporate risk reduction measures and demonstrate ALARP		
4	PTD or 1 to 3 fatalities	Major damage	Major effect	National impact					Intolerable – investigate alternatives
5	Multiple fatalities	Extensive damage	Massive effect	International impact					

serious thought would have to be given to ceasing that particular work-related activity no matter what the financial implications might be. Accepting that the "zero risk" option is rarely feasible the majority of activities can be managed for "continuous improvement" (the grey-blue area of the matrix) in line with QM principles.

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Demonstrating risk management

Designed to satisfy the requirements of a "show-me" world, in this version of the matrix (Figure 3) the objective is to *show* the level of risk management imposed by the system to achieve ALARP status.

Figure 3: Matrix for demonstrating risk management

Severity	CONSEQUENCES				INCREASING LIKELIHOOD				
	People	Assets	Environment	Reputation	A Never heard of. in......... industry	B Heard of in ..... industry	C Incident has occurred in our Company	D Happens several times per year in our Company	E Happens several times per year in a location
0	No health effect/injury	No damage	No effect	No impact					
1	Slight health effect/injury	Slight damage	Slight effect	Slight impact					
2	Minor health effect/injury	Minor damage	Minor effect	Limited impact		Risk controls specified in HSE-MS e.g. procedures, competence			
3	Major health effect/injury	Localised damage	Localised effect	Considerable impact			Demonstrate control of risk by preparing a hazard control sheet		
4	PTD or 1 to 3 fatalities	Major damage	Major effect	National impact					Demonstrate control of risk in HSE case
5	Multiple fatalities	Extensive damage	Massive effect	International impact					

Note that three possible ways of demonstrating risk management are described. In the "least risk" area of the matrix (grey-blue) under QM risk controls would be specified in the HSE-MS which in this case would be procedures including checklists, levels of competence and experience etc.

In the pale orange area, control of risk would be demonstrated by the preparation of a Hazard Control Sheet which can take many forms. Basically it describes the activity, the associated hazards and lists both controls and defences including those measures necessary to implement should something go amiss, i.e. the management of the so-called "recovery" phase of HEMP.

In the dark orange area, a full HSE Case would need to be prepared. As a general rule any task that has the potential to kill or indeed anything on lines 4 and 5 of the matrix, would require at least **three separate defences and three separate controls** for each identifiable target or object of harm and each hazard. In such cases it is not sufficient to rely on single or even double defences and controls.

Incident or accident investigation

Any incident with actual consequences placed on lines 4 or 5 of the matrix would warrant the most thorough investigation and follow-up but not all incidents reach their true and awful potential. Often the difference between a really serious incident with major consequences and near-miss with no consequence at all is no more than a millimetre or a micro-second in time. The important thing to remember is that the incident mechanism in both cases will be the same so it is important to be able to identify those of serious potential and to address it *as though it were the real thing*. This version of the matrix is therefore used to identify the *potential seriousness* of an incident of whatever nature and to identify the precise level of investigation in terms of the composition of the investigation team meaning seniority, professional discipline and number and the degree of management involvement which is an excellent way of demonstrating management commitment.

> ***"You can learn as much, if not more, from an incident of high potential with no actual consequence than you can from the "real thing" with horrendous consequences"***

The matrix also provides an indication of the urgency with which the report and its associated recommendations is needed.

In the grey-blue area, a local investigation and follow-up is all that is needed. Normally that would involve a local supervisor and an HSE focal point with a report going to the departmental head.

Figure 4: Incident follow-up – Levels of investigation

Severity	CONSEQUENCES				INCREASING LIKELIHOOD				
	People	Assets	Environment	Reputation	A Never heard of. in.......... industry	B Heard of in ..... industry	C Incident has occurred in our Company	D Happens several times per year in our Company	E Happens several times per year in a location
0	No health effect/injury	No damage	No effect	No impact					
1	Slight health effect/injury	Slight damage	Slight effect	Slight impact					
2	Minor health effect/injury	Minor damage	Minor effect	Limited impact	Local investigation and follow-up				
3	Major health effect/injury	Localised damage	Localised effect	Considerable impact			Fully investigate. Discussion and follow-up by management		
4	PTD or 1 to 3 fatalities	Major damage	Major effect	National impact					Management involvement in investigation and follow-up
5	Multiple fatalities	Extensive damage	Massive effect	International impact					

In the pale orange area the incident should be fully investigated (which means in Tripod-BETA format though not necessarily the full process) plus follow-up by management. Usually this would involve the asset holder, plus other line staff as required and an HSE advisor. The final report would go to company management.

In the dark orange area Tripod-BETA would be utilised to the fullest extent along with management as participating team members of the investigation/analysis team followed by very detailed and closely monitored follow-up. This would always involve a senior member of the management team, plus the asset holder, plus an HSE advisor, plus an independent person from the corporate organisation or holding company, plus specialists as required. Results of such an investigation would be reported direct to the CEO and is almost certainly serious enough to be reported to the appropriate national agency or government department.

This version of the matrix would be expected to:

- Promote near-miss reporting; improve knowledge of potentially serious investigations.
- Enhance the direction of safety efforts and make more efficient use of investigation time.
- Improve the management of risk reduction efforts, and focus on where the greatest benefits can be achieved.
- Provide a broad incident occurrence indicator.
- Assist in media handling by the public affairs staff due to an improved insight into the potential severity of the incident.

Classification of audit findings

The final version of the matrix (Figure 5), which has four areas or zones instead of the usual three, is used to prioritise audit findings in terms of "serious", "high", "medium" or "low".

Serious: Exposes a company to a major extent in terms of achievement of corporate HSE objectives or results.

High: Though not serious, essential to be brought to the attention of management. Includes medium weaknesses as a repeat from a previous report.

Medium: Could result in perceptible and undesirable effect on the achievement of HSE objectives.

Low: No major HSE impact at process level but correction will ensure greater effectiveness or efficiency in the process concerned.

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Figure 5: Audit classification overlay

Severity	CONSEQUENCES				INCREASING LIKELIHOOD				
	People	Assets	Environment	Reputation	A Never heard of. in.......... industry	B Heard of in ..... industry	C Incident has occurred in our Company	D Happens several times per year in our Company	E Happens several times per year in a location
0	No health effect/injury	No damage	No effect	No impact	LOW				
1	Slight health effect/injury	Slight damage	Slight effect	Slight impact					
2	Minor health effect/injury	Minor damage	Minor effect	Limited impact		MEDIUM			
3	Major health effect/injury	Localised damage	Localised effect	Considerable impact			HIGH		
4	PTD or 1 to 3 fatalities	Major damage	Major effect	National impact					SERIOUS
5	Multiple fatalities	Extensive damage	Massive effect	International impact					

A company would be expected to assign specific action criteria against each category for example:

- If serious to be completed within seven days, meanwhile similar plant or unit to be shut down immediately.
- If high to be completed within six weeks, meanwhile certain procedural safeguards to be applied with immediate effect.
- If medium to be completed within six months
- If low to be completed within nine to twelve months or whatever is deemed appropriate. Such follow-up would require an action party and a detailed schedule for monitoring progress and for completion and close-out.

7.6 Learning from the past

There is no doubt that much can be learnt from high profile incidents and that many such incidents have produced some very necessary innovations. On the other hand some have produced some very unwelcome additional legislation quite often to assuage apparently well-meaning politicians. Many such innovations and legislation will have a direct bearing on work and operational matters and will need to be implemented in a timely and appropriate manner as part of the improvement and compliance loop. Examples where undoubted improvements have resulted include:

- **Flixborough 1974**. In this incident a temporary pipe at a factory failed releasing some 50 tons of hot cyclohexane into the surrounding area. Once mixed with air the resultant gas cloud exploded killing 28 people, and completely destroying the plant. At the inquiry lawyers for the plant owners argued that what happened could not have been foreseen or prevented. Lord Justice Bingham disagreed pointing out that any possible adverse effect of operating any plant should be predictable using logical methodologies. The result was the introduction of what became known as the "hazard and operability study (HAZOP)". Later additional formal approaches were added to the arsenal of risk identification tools including "hazard identification (HAZID)" and "failure mode and effect analysis (FMEA)". HAZOPS are particularly useful at the design stage of a new or proposed plant.
- **Piper Alpha 1988**. In this devastating oil and gas platform incident in the North Sea, an explosion caused by a leak of condensate which occurred when members of the night shift attempted to restart a pump that had been shut down for maintenance, resulted in the deaths of 165 of the 226 people onboard, together with 2 crew members of a nearby rescue vessel. The platform was also totally destroyed. Unknown to the platform operatives, a pressure safety valve had been removed from the relief line of a pump and a blank flange assembly that had been fitted at the site of the valve was not tight. Their unawareness of the valve removal was the result of communications failures at the shift handover earlier in the evening, together with a breakdown of the permit-to-work system relating to valve maintenance. Lord Cullen, who presided over the Inquiry, apart from instigating obvious procedural changes, was also responsible for the introduction of the "safety case" to offshore installations which documents all controls and defences involved with so-called "activities critical to HSE performance". The concept of the safety case is now an integral part of any risk management programme and not just in the North Sea.

  It is interesting to note that since Piper Alpha, there has been an increasing trend amongst governments and regulatory bodies towards self-regulation and goal setting rather than prescriptive legislation. This approach requires companies to think through safety problems by identifying hazards and methods for their prevention and mitigation and encourages innovation. There are still, however, wide differences in approach and pace of change.
- **"Exxon Valdez" 1989**. This major and exceedingly high profile oil pollution incident involving the grounding of a fully laden VLCC in the pristine environment of Prince Rupert Sound in Alaska, resulted in the US OPA90 set of regulations. These unilateral requirements, whether we agreed with them or not, led to some much needed industry improvements involving ballast tank arrangements and the prevention of oil pollution in the event of collision or stranding (existing and new vessels) to name but a few. Another important measure was the introduction (for those who had not already done so) of shipboard oil pollution emergency plans and shore representatives in the US (the so-called qualified individual) able to act, with an unlimited chequebook, on behalf of polluting owner. Perhaps more significantly this incident and other more recent ones around Europe sounded the death knell of the single hull tanker all of which has now become enshrined in Annex I to the MARPOL Convention.

It is a regrettable fact that rather than acting proactively, our industry at national, regional and international levels is still very much *event driven* in terms of incident prevention.

7.7 Generic seaborne risks

Some examples of generic risks identified by industry trends (many the same as they were forty years ago) include:

- Enclosed space entry
- Lifeboat drills
- Berthing and unberthing (all situations)
- Heavy weather
- Breaking (opening) steam pipes
- Contractors, i.e. arms length or distant management

There are doubtless many more depending on the ship type and the kind of operations involved but the above will not be unfamiliar to those reading this Guide.

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> *"Some things never appear to change which persuades this writer that 'awareness' is a poor defence against even well-known risks"*

8 Occupational health and environmental risk management, emergency response and operating near the "Edge"

Referring to the diagram "Basic risk management" in 7.1, this section deals specifically with occupational health and environmental risk management and the *recovery* from the "one that got away" whatever type that might be. The principles are of course based on the Identify, Assess, Control and Recover loop in line with basic QM.

As a matter of policy companies of whatever nature should seek to:

> *"Conduct their activities in such a way as to avoid harm to the health of their employees, and to others, and to promote, as appropriate, the health of their employees"*

8.1 Minimum health management standards

In order to manage occupational health it is necessary to establish minimum occupational health standards. Compliance with national statutory requirements is of course mandatory for all aspects of health management and is a given but set out below are seven minimum requirements for the management of health which may provide a useful starting point. In applying these standards currently accepted scientific knowledge should be used in their interpretation.

Health risk assessment (HRA)

- Management programmes should be in place to assess, control and document those health risks arising from chemical, physical, biological, ergonomic and psychological hazards associated with the work environment which have been identified as potentially High or Medium on the RAM.
- HRAs should cover all activities, including new projects, acquisition, closure, divestment and abandonment of facilities including ship recycling.
- HRAs should be carried out by competent persons in line with good industry practice.
- Exposure monitoring and health surveillance programmes should be implemented where the need is identified by Company or Government requirements.
- Results of mandatory Company or Government exposure monitoring and health surveillance should be recorded.

Monitoring of health performance and incident reporting and investigation

- Annual TROIF data should be reported for Company employees with a breakdown of the ten illness categories in line with 4.8.
- All health incidents with significant impact, including non-accidental death cases should be reported and investigated where possible.

Health impact assessment

- A health impact assessment should be made in conjunction with any environmental and social impact assessments that are required for all new projects, major modifications and prior to abandonment of existing projects where there is the potential to impact on the health of the local community and/or Company and contract workers and their families.

Human factors engineering in new projects

- Human factors engineering principles should be considered and applied during the early design stage of new facilities projects where design can have a critical impact on equipment usability and user safety or health.

Product stewardship

- The hazards relating to the manufacturing, storage, transportation, use and disposal of existing, new, reformulated and re-branded products should be assessed prior to marketing or supply.
- The necessary information and advice to minimise risks should be provided to employees, contractors and customers.

Fitness to work

- Minimum fitness for duty standards should be established and applied for specific work and working conditions where there are critical occupational health or safety requirements.
- Appropriate health-related policies should be in place encompassing, as a minimum, the use of alcohol and drugs, and other substances that may impair performance.

Local health facilities and medical emergency response

- Plans should be in place to provide Company employees access to medical services, which meet acceptable standards in relation to risks exposed by the special nature or location of their employment.
- Plans should be in place to respond to medical emergencies, which meet the requirements of an accepted medical emergency procedure or guideline.

8.2 Health risk assessment (HRA)

8

Note throughout this brief section for "controls" read "controls" *and* "defences". In terms of the hazards and effects management process (HEMP), HRA is the occupational health equivalent and is defined as:

> *"The identification of health hazards in the work place and subsequent assessment of risk to health. This assessment takes into account existing or proposed control measures. Where appropriate, the need for further measures to control exposure is identified"*

HRAs are usually carried out for:

- All existing operations and activities
- All new operations and activities
- Changes to existing activities
- Post-operating activities
- Acquisition (sufficient to identify potential health risks – a full HRA is not normally required)
- A HRA is required even if a full HSE Case is not required.

The following QM steps should be employed when carrying out a HRA:

Organise

- Allocate adequate resources and form a competent team including **specialist medical resources**. Note HRAs remain a line responsibility.
- Break down activities into assessment units, i.e. ship, production unit, office block etc.

Identify the hazards

- For each assessment unit, make an inventory of all health hazards and their potential harmful effect (acute and chronic).

Assess the risks

- For each health hazard use the HSE RAM to assess the potential risk by plotting to identify low, medium and high risks.

Control the risks

- For risks assessed at **low**: identify accepted occupational health exposure limits (OELs) and other control standards and ensure that controls are established and maintained via standard procedures and staff competencies. Manage for continuous improvement.
- For risks assessed as **medium** or **high**: identify OELs for each hazard; identify the required controls to limit exposure to ALARP proportions and ensure that OELs are met; compare the required controls with current controls and identify any gaps; assess whether current controls are being effectively applied (it may be necessary to test existing controls or to carry out exposure measurements to determine their effectiveness); identify and agree any remedial actions and measures necessary to ensure that any identified gaps are addressed and that controls are consistently applied and effective (measures to ensure the continuing effectiveness of controls may include: routine exposure monitoring, health surveillance, maintenance of equipment and staff education.
- For risks assessed as **high**: give serious consideration to alternative ways of carrying out the operation to avoid the risk.

Establish recovery measures

- Identify recovery (preparedness) measures which would be required to mitigate the potential effects should exposure control measures fail.
- Compare required measures with current measures; any gaps should be identified and remedial actions determined.
- Carry out regular exercises using realistic and credible scenarios to test recovery measures and checks on necessary equipment.

Formulate and monitor remedial action plans

- Incorporate all required remedial actions into a remedial action plan (RAP), allocate the necessary resources and put in place a monitoring tracking system.

Document

- Keep written records of HRAs, RAPs and consequent actions to act as documented demonstration of control of risk.

Review

- A regular review of HRAs must be carried out as part of the formal review process of the suitability and effectiveness of the HSE-MS.

8.3 The classification of occupational illnesses

These are listed in section 4.8 of this guide.

8.4 Medical emergency response plans

Effective medical emergency response plans form the *recovery* part of the HRA. Recovery (preparedness) measures are required to mitigate potential effects should exposure control measures fail, and to prevent the potential escalation of health risks.

Examples of mitigation measures include medical emergency response arrangements including medivac by helicopter, aeroplane, ambulance, standby vessel etc, provision of trained first-aiders or paramedics, emergency communications equipment, eyewash and shower stations, chemical suits, escape equipment such as self-contained breathing apparatus and rebreathers, personal alarms and post traumatic stress counselling. Some situations may require special measures, such as the availability of calcium gluconate for hydrofluoric acid burns.

Specifications for the recovery measures should be identified, as with control measures. Decisions on adequacy are also needed. All plant and equipment needed for recovery must be routinely and regularly inspected and maintained in good working order meaning ready for immediate use. In addition, regular emergency exercises should be carried out to test the effectiveness of emergency arrangements and to help train staff.

8.5 Environmental risk management

As a matter of policy, companies of whatever nature should:

- Pursue in their operations progressive reductions of emissions, effluents and discharges of waste materials that are known to have a negative impact on the environment with the ultimate goal of eliminating them.
- Aim to provide products and services supported with practical advice which, when used in accordance with this advice, will not cause undue effects on the environment.
- Promote protection of environments which may be affected by the development of their activities and seek continuous improvement in efficiency of use of natural resources and energy.

The basic methodologies employed are the same as those used for safety and occupational health, i.e. HEMP plus the use of an appropriate risk assessment matrix in order to *inventorise* environmental risks, *assess* their potential impact in order to provide effective *controls* and to *recover* in the event of control failure (see 7.3). Such a process is called an "environmental assessment" and is formally described as:

> *"A systematic approach for the identification, description and management of hazards and effects on the environment of proposed projects and existing operations, including plant modifications and process changes and the decommissioning, abandonment or recycling of redundant facilities"*

Clearly defined standards, supported by written instructions and procedures are needed to incorporate the elements of environmental management into the operation in a systematic and reliable manner. In the shipping industry such standards include, but should most definitely not be limited to, the pollution prevention section of the IMO's mandatory "International Safety Management (ISM) Code".

These standards and procedures should include guidance to ensure that:

- All relevant environmental measures are phased into project development (including new ships) at the appropriate stage
- Materials, products and facilities are selected and used with minimum environmental impact. This requires detailed information from suppliers on all HSE properties as a condition of purchase
- Information on all HSE hazards is made available to operators via Safe handling chemical cards, by displaying warning signs in work places and with operating procedures based on information derived from Material safety data sheets
- Responsibilities are clearly understood, for example emergency response procedures. Environmental management, like occupational health and safety remains a line responsibility supported by competent advisors.

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Some *examples* of routine hazards and potential effects applicable to environmental management in the shipping industry are shown in the following tables. They are not definitive.

Energy generating equipment

Steam turbines, boilers/heaters/furnaces, propulsion units (diesel, gas turbine):

ROUTINE HAZARDS	POTENTIAL EFFECTS
CH_4	Global warming, climate change, atmospheric ozone increase
SOx	Acid deposition (local or regional), water and soil acidification
NOx	Atmospheric ozone increase, acid deposition, fertilisation
N_20	Global warming, stratosphere ozone depletion, climate change
CO_2	Global warming, climate change
CO	Health damage
continued	

ROUTINE HAZARDS	POTENTIAL EFFECTS
H_2S	Nuisance, health damage, high levels can kill instantly, ecological damage
Noise	Nuisance, health damage, wildlife damage
Light	Nuisance, health damage, wildlife damage
Odorous compounds	Nuisance, odour
Particulates/ dust	Ecological damage, health damage, soot deposition
Radiation	Ecological, health damage
PAH	Ecological, health damage
Heat	Health damage, ecological damage
PCB	Health damage, ecological damage
Trace toxics (heavy metals, chemicals etc)	Health damage, ecological damage

Venting

Tanker loading/discharging/gas-freeing/purging operations, on-voyage cargo pressure venting, fugitive venting:

ROUTINE HAZARDS	POTENTIAL EFFECTS
CH_4	Global warming, climate change, atmospheric ozone increase
VOC	Atmospheric ozone increase, health damage, ecological damage
CxHx	Atmospheric ozone increase, health damage, ecological damage
Specific chemicals	Health damage, ecological damage

Refrigeration*, Fire extinguishers (first-aid and bulk):

ROUTINE HAZARDS	POTENTIAL EFFECTS
CFC*	Global warming, climate change, stratosphere ozone depletion
Halons	Global warming, climate change, stratosphere ozone depletion

Effect on indigenous water of ballast-water, tank-bottom water, boiler-water, sewage, wash water

ROUTINE HAZARDS	POTENTIAL EFFECTS
Oil	Floating layer, unfit for drinking or recreational use, tainting of fish/shellfish etc, biological damage
Grease	Water unfit for recreation, damage to bottom sediments
Salt water	Effect on fresh water/biological damage
Fresh water	Effect on salt water/biological damage
Non-indigenous species	Adverse, sometimes catastrophic damage to indigenous species
Pathogens	Health hazard
Soil/erosion sediments	Smothering, damage to indigenous vegetation, water depth
Suspended solids	Decreased transparency, damage to coral reefs, damage to top and bottom organisms, recreation, habitat
Soluble organics or disolved HC, chemicals, corrosion inhibitors,	Tainting of fish, shellfish, unfit for drinking/recreation/irrigation/livestock, damage to aquatic organisms biocides or fungicides
Nutrients	Eutrophication
Sewage	Health damage, biological damage, eutrophication, damage to aquatic organisms, water unfit for drinking/recreation/irrigation/livestock, nuisance odour/smell
Anoxia (deoxygenation)	Biological damage
Acids/caustics Temperature change	Damage to aquatic organisms Change to oxygen concentration, damage to aquatic organisms, increased growth/blooms

8.6 Emergency response – Recovery from the one that "got away"

Emergency response is the *recovery* part of HEMP and is the same whether the actual or potential "object of harm" is people, asset, the environment or reputation, or perhaps all four.

> *"To be effective contingency planning and emergency response should be based on the philosophy of **prudent over-response**"*

Basically this means that while it is always possible to de-escalate a response i.e. to pull back a little, it is usually impossible to escalate or accelerate the response, or to regain the initiative, should that response be too slow or inadequately resourced.

In practical terms, a shipping emergency is an incident which might or has put at risk the lives of persons and/or the safety of the ship, and/or seriously pollute the environment, and/or whose consequences have or might involve other companies, third parties, governments or the media. A shipping emergency will necessitate prompt notification of the designated response organisation. Time is of the essence!

The possibility of an oil, gas or chemical spill, however remote, generates considerable concern among shipping company senior management and government agencies alike. Whenever a major spill or incident does occur, this concern extends across the industry, to shareholders, NGOs, special interest groups, the media and the general public. In these days of almost instant TV coverage many parties become rapidly involved; the ship's master and his owners are concerned for the safety of the crew and preventing the situation onboard from deteriorating any further; administrations and their regional/local authorities demand copious amounts of information and constant updating on the situation while charterers, cargo interests and underwriters are equally anxious to be kept abreast of developments.

All these parties generate a voracious demand for information, despite most having no prior involvement with the ship or its cargo. Furthermore, should government or the media identify some association that company whose reputation and business is then liable to suffer, particularly if the response is *perceived* to be inadequate.

When such circumstances arise, the credibility of the response, whilst dependent to some degree upon the severity of the incident and the location in which it occurs, will primarily hinge upon the quality of the corroborative contingency planning of the company involved and the other relevant parties.

> ***"No two incidents will ever be the same and so the advice given here is of a general nature, in order to illustrate the common underlying principles. However failure to be seen in mobilising appropriate resources in the first few hours after an emergency and to co-ordinate the flow of accurate information between the company and others can have very costly repercussions indeed"***

The threats

Shipping emergencies, namely ship casualties and/or oil, gas or chemical spills on water, all threats to the environment, cover a wide range of contingencies and include:

- Collisions (with other ships, jetties, navigation marks etc)
- Groundings (particularly in especially sensitive areas)
- Fire and/or explosion (involving cargo, accommodation and/or machinery spaces)
- Failure of ship's hull or main or auxiliary machinery (due to stress of weather or other cause) immobilising the ship and/or threatening her to break up or ground
- Terrorism, piracy, theft of cargo etc

As already stated many times in this guide incidents of this nature may threaten life, property, the environment and reputation and can involve any type of ship. But management, media and the authorities need confirmation of facts. More importantly, a speedy response, often involving external assistance (for example oil clean-up) is normally essential to avoid a deterioration of the situation. Specialist services such as salvage tugs are not always available, and many governments are reluctant to assist in providing a safe haven (port of refuge) for stricken tankers as recent events in Europe have proved.

Tiered response

The following "tiered response system" is included as an example of response to a specific threat, in this case oil, gas or chemicals on water.

The size, location and timing of an oil, gas or chemical spill is unpredictable. Spills can arise from cargo transfer operations and from a vessel collision or grounding in local ports or coastal waters. They can also arise from ships including tankers or barges operating in inland waterways, or from exploration, production operations and ships operating in international waters.

Oil spill risks and the responses that they require are classified according to the size of the spill and its geographical location. Most such response systems are based on "tiered response".

Tier 1 Operational-type spills that may occur during cargo or bunker handling operations. Such spills are generally small varying from a few tonnes at an inland barge terminal to several hundred tonnes at a major crude oil terminal. Terminal operators would typically provide sufficient material and human resources to respond and contain such a spill within one hour of call-out on a "seven days a week, 365 days a year" basis.

Tier 2 Spills which occur in coastal waters are usually caused by collision, grounding, or force of weather and will be commensurately larger than a Tier 1 spill. Although the amount of oil lost may be large it will normally only amount to a very small proportion of the total carried. However because of the proximity of land and its many and varied "objects of harm", which may range from simple leisure facilities and beaches, to power station intakes, fisheries and yacht marinas, impact is liable to be great and, dependant on prevailing wind, currents and tides, the spilt oil may come ashore very quickly indeed. Tier 2 responses are usually combinations of equipment/resources from port facilities, other industries, local authorities and possibly government response agencies in the area all of which can be called in on a mutual aid basis. Such "pooled" resources can be very effective indeed. Mobilisation may typically take several hours with response and clean-up taking days, weeks and occasionally months.

Tier 3 The most serious spill of all. Such spills may be huge and involve the total loss of a ship and its cargo. Depending on the nature of the cargo, i.e. low flash product, diesel, light crude, medium crude or fuel oils etc, the damage to the environment and to shore facilities and industry may be absolutely devastating. Tier 3 responses require huge response organisations and enormous amounts of resources. It may involve several countries working together and may continue continuously or intermittently for months. Monitoring of the effected area may have to be undertaken for several years after the incident.

Interested parties

Those most closely involved will include:

- Ship owner and/or manager
- Charterer(s), time and/or voyage
- Cargo owner, by title or risk
- Cargo shipper and/or receiver
- Terminal and/or jetty operator
- Insurer of ship, cargo, freight and/or jetty
- Other companies or traders may also be involved

Additionally organisations likely to be involved include:

- Salvors
- P&I Club
- Port authorities
- Local and national authorities
- Spill management and clean-up contractors
- ITOPF
- Local shipping agents
- Classification Society
- Hull underwriters
- Environmental organisations

All or any of the above may appoint surveyors and/or solicitors to protect their interests.

Enquiries must be expected from:

- Relatives of ship's staff
- Other employees
- The media (local, national and international)
- Environmental pressure groups and NGOs
- Peripheral service contractors
- Shareholders
- The general public from all age groups

Mobilisation

Depending on the circumstances of the particular incident, a company should decide whether to mobilise an emergency response team in either a dedicated or temporary response room or facility, or mobilise an on-site team, or perhaps both.

The function of the **emergency response team** under an experienced co-ordinator is to:

- Fulfil the specific responsibilities of the ship owner or manager
- Support the shipmaster's efforts to save life, summon assistance, and engage salvors and prevent further pollution
- Provide ship damage stability advice either own or contracted, i.e. Lloyds
- Arrange salvage, towing and/or ship-to-ship transfer of cargo
- Liaise with underwriters, P&I, charterers and cargo interests
- Obtain necessary bonds, legal advice etc
- Mobilise appropriate third party oil spill response resources
- Update Classification society
- Keep in touch with manning agency and/or next-of-kin as appropriate
- Advise media
- Mobilise on-site team if required

The function of the **on-site team** is to:

- On-site co-ordination of all activities

- Ship owner or ship manager/salvage support
- Oil, gas or chemical spill response expertise
- Legal expertise
- Ship-to-ship transfer expertise
- Pollution claims handling support
- Media relations expertise

Emergency response exercises

The *purpose* of emergency response exercises is to train the emergency response team to:

- Test the contingency plan and to become familiar with it
- Test the capabilities of the response team and train/groom each individual response team member as appropriate
- Assess/develop the physical resources available to the response team
- Learn to work with other companies, agencies, organisations etc
- Identify weaknesses in the response plans particularly those relating to call-out and general communications
- Practice individual components of the contingency plan such as damage stability calculations/control and oil spill Conventions, etc
- Become familiar with developing meaningful and accurate situation reports
- Become comfortable with managing and responding to the media

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The benefits of holding regular exercises are many. The response teams have the opportunity to practice skills that will be required in an emergency, to work closely together as a team, and to make complex decisions under stressful circumstances. Plans, equipment and systems can all be tested and the process of obtaining feedback to capture lessons will lead to further improvements in response capability. In addition, by allowing representatives of the public, media and key local organisations to observe and possibly participate, government and industry can demonstrate their commitment and effectiveness in managing the risk of oil, gas or chemical spills, and in protecting the environment.

Types of exercises:

A. Notification/Mobilisation exercises
Best held without warning. To test communications systems and process, availability of personnel and travel arrangements.Typical duration: 1 hour maximum

B. Communications/"Table-top" exercises
Best with notice of timing but no other details. To test individuals' roles and actions. Involvement of third parties as appropriate.Typical duration: 2-3 hours

C. Equipment deployment exercises
With or without notice. To test team response capability to a Tier 1 or 2 spill, provide experience and enhance individual skills and teamwork. Observers might be welcomed.Typical duration: 4-8 hours

D. Major integrated (Tier 3) exercise
Involving several parties. Best with notice. To test elements of both communications and deployment. Needs very thorough planning.Typical duration: up to 1 day

Suggested frequency of exercises (see table below)

	Tier 1	Tier 2	Tier 3
A. Notification/Mobilisation	6 monthly	Annually	Annually
B. Communications/"Table-top"	6 monthly	2 yearly	3 yearly
C. Equipment deployment	Annually	2 yearly	3 yearly
D. Major integrated exercise		3 yearly	

Relevant local authorities should be actively involved in the planning and implementation of Tier 2 and 3 exercises, together with third parties such as media contacts.

Management of exercises

Exercise management consists of four separate activities, namely: design, develop, conduct and review, that collectively describe the process for creating and running *realistic* and successful exercises.

Design Set the objectives, scope and timetable.

Develop Involves preparation and organisation of the exercise.

Conduct Consists of initiating and running the exercise, including monitoring, role-playing, controlling, facilitating and documenting activities (QM again).

Review Includes the analysis of findings and recommendations and the consequential updating of plans (improvement loop – more QM).

Conduct of exercises

Whichever type of exercise is planned, always:

1. Clearly identify objectives, players, role-players, non-players, start time, expected duration and scenario details and advise others, as appropriate.

2. Identify a realistic and detailed scenario. Outlandish scenarios never work. Real time is preferable to compressed time. Clarify whether climatic conditions, tides etc are to be real, i.e. a real port or pre-planned and fictional.

3. Identify who will initiate the exercise and how, and when and by whom subsequent developments will be injected and the exercise finally terminated. Do not deviate from the scenario or the plan.

4. Recognise practical constraints, for example time zones, unreliability of ship's ETAs (if using a real ship), conflicting commitments of potential players or interfaces with non-players – you still have to run a business!

5. Before the exercise begins, ensure all involved have appropriate details (particularly important for role-players), even if this may be restricted to the start time and expected duration.

6. Include specific provisions to avoid confusion, for example:

   - Give exercise an appropriate name
   - Ensure messages and other communications are prefaced by EXERCISE, EXERCISE, EXERCISE
   - Use an imaginary ship's name NEVER a real one
   - Warn senior managers and Public Affairs focal points in advance, even if they are not directly involved (it can be surprising how the media gets to hear these things and how quick they are to ask what's going on!)

7. Identify at least one non-playing observer.

8. Ensure time is allocated for a "wash-up" **immediately after** the exercise to identify successes and areas for improvement. Identify action parties.

9. Ensure all lessons learnt are promulgated against an agreed time table and followed-up.

For "real" events ensure that

(a) you can mount a credible response lasting 24 hours and

(b) that you can continue that response over a much longer period of time if necessary

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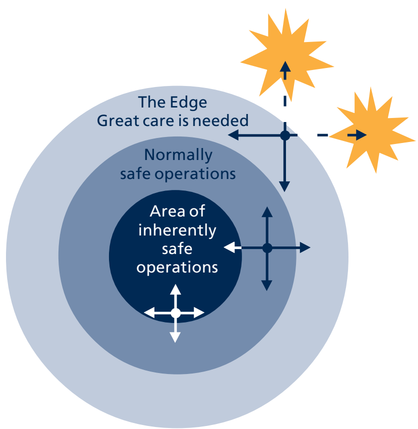
8.7 Free's model of the "Edge"

Note that the "change of plan" model (page 48) is effectively a slice out of this general model.

The "Edge" is that point where in the presence of a genuine mistake and an intentional rule violation there is a 50/50 chance of something going wrong. Nobody can

Free's model of the Edge



operate at the exact centre of this model all the time because you do not control all the circumstances which exist all the time.

*Near the Edge people **should** feel increasingly insecure*

The question for all of you is:

HOW NEAR TO THE EDGE ARE YOU?

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