OGP

Managing major incident risks

Workshop report

Report No. 403
April 2008

International Association of Oil & Gas Producers

Publications

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Managing major incident risks – workshop report

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Summary

On 14/15th November 2006 a workshop was held to consider a range of issues associated with the management of major incident risk. While the focus was on risk management within the E&P industry, other industries were invited to participate in the workshop in an effort to identify risk management approaches and tools that could be used within the E&P industry.

The workshop was aimed at providing input to the newly formed OGP task force on Managing Major Incident Risk.

This report overviews the presentations and summarises some of the key issues arising from the workshop.

Workshop agenda

Appendix 1 contains the workshop agenda. All workshop presentations are available via :

http://www.ogp.org.uk/events/06/11-MMIR

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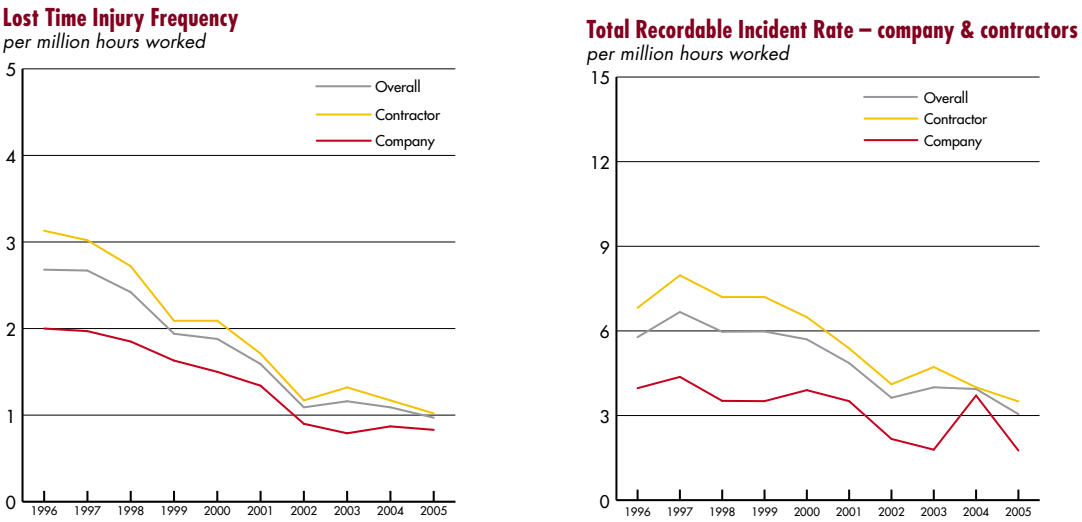
1 Introduction

During the exploration and production of oil and gas resources a range of risks are present which, if not adequately managed, have the potential to result in a major incident. Large hydrocarbon inventories, high pressure, high temperature wells, the presence of H_2S, deep water operations in harsh environments, sophisticated control systems, are a few of the factors that can contribute to an organisation having to manage a challenging risk profile.

While it can be argued that the E&P industry has been relatively successful in managing major incident risk, a number of high profile incidents that have occurred over the past few years has brought into question whether the industry can improve the process through which such risks are identified and addressed.

The International Association of Oil and Gas Producers (OGP) has been collecting and reporting safety performance data since 1985. Since then substantial improvements have been reported in most of the safety indicators the industry traditionally adopts. Figure 1, for example, shows how the Lost Time Injury Frequency (LTIF) and Total Recordable Incident Rate (TRIR) have improved over the 10 year period from 1996 to 2005.

Fig1: LTIF and TRIR from 1996 to 2005†



While the data OGP reports are representative of incidents involving a limited number of individuals (typically less than 3) the extent to which it can be used to infer a reduction in major incident risk rate is questionable.

Clearly it is likely that at whatever level an organisation makes improvements in its safety management system, it should have a positive impact on the safety performance of that organisation up to and including the management of major incident risk. However, to date, a *key performance indicator* (KPI) which can be used as a direct measure of major incident risk has yet to be agreed within the E&P industry, hence demonstrating any improvement is difficult (*see* Section 10).

Over the past few decades the industry has focused on reducing the number of fatalities, LTIs, RWDC and medical treatment cases. Due to the frequency of these types of incidents, the effectiveness of initiatives aimed at reducing these types of incident can be measured. In the case of major incident risk, the lack of an accepted KPI, and the infrequent nature of major incidents, undermines the application of the traditional management approach: identify a problem, determine and implement a change, and measure the effectiveness of that change.

Major incident risks have characteristics which differentiate them from the more frequently occurring occupational risks. Table 1 lists some of the differences.

† *Information taken from* OGP Safety performance indicators report – 2005, *report 379.*

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Table 1: Occupational Safety vs Major Incidents

Occupational Safety Incidents	Major Incidents
Frequent	Infrequent
Personal	Remote
Known	Unthinkable
Relatable	Technical
Behavioural	Systematic
Measurable	Difficult to measure
Inputs linked to outputs	Complex link between input and output
Quick feedback loop	Long timescales

These differences bring into question whether, by focusing on reducing more routine occupational safety incidents, sufficient focus has been given to improving the management of major incident risk.

OGP Managing major incident risk task force

In 2006, OGP established a task force to consider how the industry could improve its ability to manage major incident risks. As a first step, the Task Force organised a workshop, the objectives of which were to:

- Share learnings from past incidents
- Learn from other industries how they manage major incident risk
- Identify and agree relevant key performance indicators
- Consider what products would be influential in reducing major incident rates
- Influence the direction of the Managing major incident risk task force

The workshop, which took place on 14/15th November 2006, was structured into a number of sessions:

- Scene setting and high level overview
- Managing major incident risk – an E&P company perspective
- Managing major incident risks within other industries
- Key performance indicators
- Future activities of the Managing major incident risk task force

This report summarises the key issues raised within each of the above sessions†.

† *Note that this report includes information and opinions not presented during the workshop. The reader is encouraged to review the presentations in addition to the information presented in this document.*

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Defining a 'major incident'

For the purposes of the workshop and the activities of the task force the term *major incident* is used to refer to incidents with the potential to result in multiple fatalities, significant environmental damage or significant asset damage.

Well known incidents which fall within this category include the loss of the Alexandra Keilland, Piper Alpha and the loss of the semi-submersible P36. Typically these incidents are associated with a hydrocarbon release leading to a fire/explosion, major structural failure or H_2S release.

Not included within this definition of a major incident (or the remit of the task force) are incidents involving:

- Aviation
- Land transportation

While these types of incident can result in multiple fatalities, other initiatives are underway specifically aimed at addressing them.

It is recognised that the majority of fatalities reported to OGP annually are associated with individual loss of life and typically relate to an incident with little or no potential to escalate to a major incident.

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2 What can we learn from past incidents?

Key elements within any Safety Management System (SMS) are incident investigation and the identification and implementation of actions to reduce the probability of similar incidents occurring in the future. Where incidents (and/or near misses) occur relatively frequently, this management process can be relied on to produce continuous improvement and the associated risk reduction. For a similar process to work with respects to low frequency, major incidents, organisations need to look beyond their own incidents to those experienced by other organisations and industries. Where relevant, organisations need to incorporate the learnings from these incidents into their own management systems in order to achieve the same continuous improvement cycle.

The value of incident data is that it allows organisations to:

- Understand what parts of the HSE-MS need attention:
  - What barriers were missing or failed
  - What parts of the system are creating particular challenges
- Share information on new hazards or to better understand risk levels
- Identify relevant Key Performance Indicators:
  - What measures might have given an indication that an incident was imminent

A number of incidents have occurred in the E&P industry which fall within the definition of major incident (or potential major incident). From these incidents a range of high level learnings can be identified, some of which are considered below.

Incidents such as Alexandra Kielland and Piper Alpha occurred at a time when the importance of having in place an integrated and robust SMS was still relatively unappreciated. Since then most, if not all, E&P organisations operate SMS based on internationally recognised standards and guidelines[†].

A functional SMS should provide the framework within which all significant hazards are identified and measures put in place to manage the risks they pose. Hence, theoretically at least, the management of major incident risk requires little more than the appropriate application of the risk assessment tools and management processes implicit within any E&P relevant SMS. However, while certain major incidents that have occurred within the E&P industry suggest a failure to put in place the basics of an adequate SMS (or parts of it) many others point towards the challenges of applying such systems to low frequency, complicated failure scenarios where, on occasion, the hazard or risks may not be recognised.

† *For example:* Guidelines for the development of health, safety and environmental management systems, *OGP report 210.*

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New hazards, new risks

Where a hazard is not recognised, the risks it poses are not explicitly managed.

The failure, through fatigue, of the mooring line of the Girasol offloading buoy is an interesting example of a failure mode that was not recognised at the design stage. Further, it illustrates that an early warning of a failure cannot always be relied on as a precursor to a major incident occurring. The importance of having redundancy (multiple barriers) at the system level is clear, and forms the basis of mooring line design and assessment.

The move to deeper water environments has led to an increase in the use of floating systems, in particular FPSOs. Relatively early in the design and use of these types of facility it was recognised that the adoption of shipping based design practices did not provide the necessary levels of reliability for units operating in harsh environments, and which were required to maintain station for long periods of time. Further, loading events that were recognised and managed within the shipping industry, posed different and more challenging problems on structures with considerable production equipment on deck.

The bow damage to the Schiehallion FPSO is a well known example of where the full extent of the loading was not recognised, in part due to a failure (at the time of its design) to fully appreciate the nature of the hazard (*ie* the steepness of the wave climate and the resulting loads). Similarly, a number of FPSOs have suffered greenwater loading events, with subsequent damage to topside equipment and structure. Both types of event were known within the shipping industry, however the fact that they would have greater consequences on a FPSO was not fully appreciated.

While the inclusion of 'generic' safety factors and inherently safe design based approaches go someway towards managing these types of structural challenges, fundamentally unless the full extent of the risk is recognised and specifically addressed, its management will be less than ideal.

How, within the risk management process, do we ensure that sufficient robustness is built into the structures and systems we use, such that unforeseen failure modes will not lead to a catastrophic failure?

Managing risks within increasingly complex systems

As the systems we employ become increasingly more complex, questions arise as to how well traditional approaches to risk management are able to identify potential failure modes.

The P34 FPSO (2002) and the Thunderhorse semisubmersible (2005) events are incidents which question the adequacy of the traditional FMEA type processes employed within the industry. Both events suggest a failure to identify certain, critical failure paths and therefore put into place appropriate control measures. This could have been associated with complicated control systems and failure modes which may have been difficult to identify during the risk assessment process.

Is it unrealistic to assume that traditional FMEA type approaches can identify all the major failure modes within the increasingly complex hardware, software and people based systems used within the industry?

Realising the design intent

The systems and structures we operate within the E&P industry (and all other industries) have built within them certain probabilities of failure. For example, in the design of modern, offshore structures, an annual failure probability of around 10^{-5} is incorporated into the design code†.

In some regions of the world structures were designed with substantially lower levels of reliability than would be incorporated into the design of modern structures. This was, in part, driven by a failure to appreciate the loading environment in which the structures would operate when they were designed. Many of the older generation of fixed jacket structures in the Gulf of Mexico are examples of installations with relatively low levels of reliability (compared to modern structures) and when exposed to hurricane events that a modern structure might be expected to survive, a number fail. However, the fact that they are evacuated and shut in prior to the arrival of an extreme event means that their continued use can be justified on economic grounds.

Similarly, floating and other mobile structures (*eg* jack-ups) will often be assessed in a manner that will lead to substantially lower failure probabilities which may be justified on a consequence basis (*ie* no risk to personnel or the environment, only potential economic loss). As a result failures have occurred.

It can be argued that many of the major failures seen during Gulf of Mexico hurricane events fall into the category of 'realising the design intent.' Specific structures and systems that failed included the older generation of jacket structures, jack-ups, and mooring lines. In many cases the structures failed because they were designed or assessed (intentionally or unintentionally) to fail at around the loading level they experienced.

> *How often are the failures the industry experiences little more than the realisation that systems (in the broadest context) have built within them certain failure frequencies?*

Errors in design and concept selection

While it can be argued that many of the failures the industry has experienced can, to some extent, be traced back to decisions made at the design stage, perhaps the best example of a structure which was condemned before it 'left the drawing board' was the Sleipner GBS (1991). An error introduced during the modelling of the concrete sub-structure led to insufficient steel reinforcement being provided and the structure failed during testing‡.

On occasion offshore structures have been used which are not well matched to the environments in which they were intended to operate. The results have been excessive motions, increased fatigue levels (both of hardware and people) and difficult operating environments. All these factors contribute towards the potential for a major incident to occur.

The concept selection and design stages present perhaps the most cost effective opportunities to identify and introduce significant improvements in the risk profile that will be present during the operational phase. However, many of the incidents that have occurred suggest a need for improved tools to assist organisations in selecting and designing their facilities in a manner that minimises the operational risk profile.

> *What can we do to improve the identification and reduction of the 'operational risk profile' during the concept selection and design phases?*

† *ISO 19902: Fixed Steel Offshore Structures (draft international standard).*
‡ *In the majority of incidents, root cause analysis identifies many contributing factors; here we focus on just one.*

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Emergency response

The difference between a significant incident (*eg* a 'near miss'or an unignited release of hydrocarbons) and a major incident can come down to the effectiveness of the emergency response[†].

Piper Alpha (UK, 1988), Temsah platform (Egypt, 2004) and Mumbai High (India, 2006) are all examples of events in which major hydrocarbon releases were ignited. The resulting loss of life varied considerably (from 167 on the Piper Alpha to zero on the Temsah platform and the nearby jack-up) in part due to the effectiveness of the emergency response.

The H_2S release in China (2003) is an example of where a release escalated to a major incident, a major contributing factor being the failure to have in place adequate emergency response procedures (or to put them into practice).

What is clear from the frequency of incidents within the industry, is that it is unrealistic to assume that all the risks have been identified and managed to a level where the likelihood of a major incident occurring is negligible. Hence it remains essential that emergency response procedures are in place to mitigate the effects of a minor incident before it escalates to a major event, and to respond to the major incident should it occur. Such procedures should be an integral part of the SMS and recognised as an important barrier in terms of the prevention of major incidents.

> *'Do we need to focus more effort on understanding and managing incident escalation potential and major incident response?*

Learning from the incidents in other industries

The relatively infrequent nature of major incidents within individual E&P companies and industry as a whole means that alternative, relevant sources of incident information should be exploited.

Many E&P organisations operate downstream facilities. The similarities between upstream and downstream operations, hardware and safety management approaches suggest that there should be relevant and valuable learnings to be had from incidents that have occurred in either sector. Other industries include hazards, products, systems and processes that are similar to those encountered within the E&P industry. Incidents within such industries represent another valuable source of data that can be reviewed and learnt from (*see* Section 7).

> *How well do we integrate the learnings from E&P related and other relevant industries' incidents into our HSE-MS?*

† *Here 'Emergency response' is used in its broadest context,* ie *preventing escalation following a 'minor' incident and responding to a 'major' incident.*

3 MMIR – A regulatory perspective

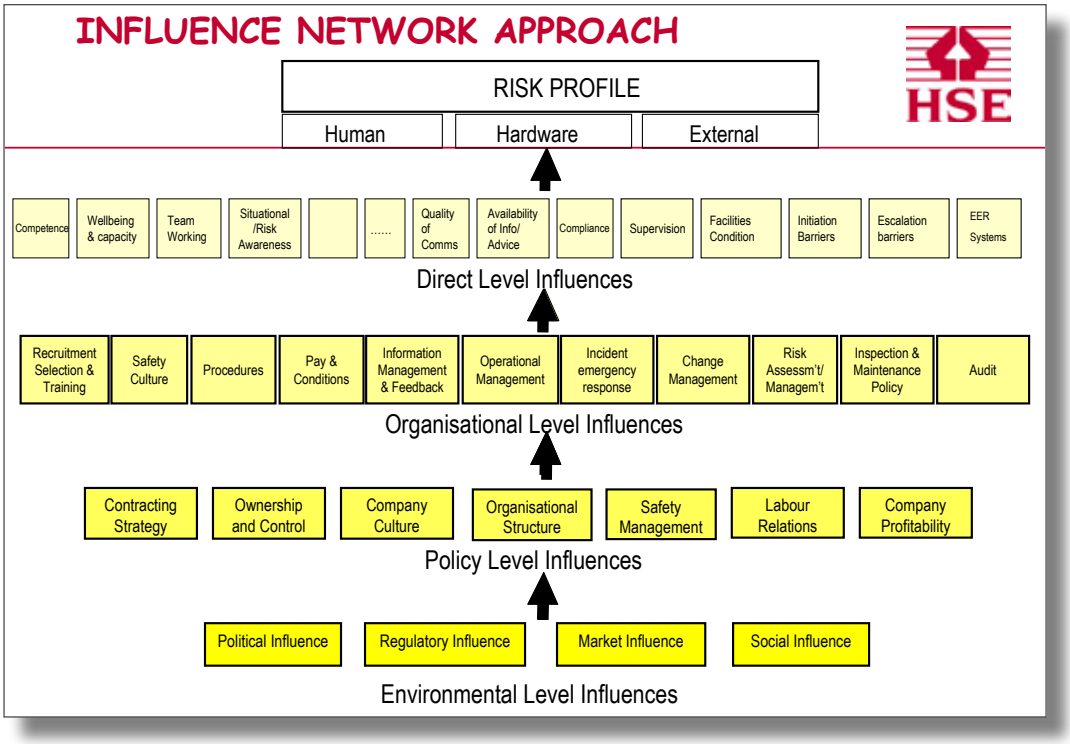
The management of major incident risk within any organisation is influenced by many internal and external factors. Probably the external factor of greatest influence in terms of managing safety is the regulatory regime within which the organisation operates.

Regulators are in the unique position of having access to the management systems of all the organisations that operate within their region. Further they are able to look across different industries and identify best practice approaches that may benefit other sectors.

The regulatory regime within which the E&P industry operates varies considerably around the world. In some regions the regulator is actively engaged in the safety management process, in other regions regulators operate in a reactive mode, addressing incident when they arise.

Key to the regulator's (UK HSE) approach to regulating major incident risk is understanding the key factors that influence their management.

Figure 2: Influence networks



As shown in Figure 2, these factors act at different levels; from those that directly influence the way the risk is managed, to the high level environmental factors that influence the culture of the organisation itself.

Understanding at what level to apply resources and pressure are viewed as key to maximising regulatory impact.

Some future challenges were noted to be:

- Continuing to provide public assurance – by industry and the regulator
- Identifying and harnessing the most effective influence levers
- Development of Key Performance Indicators – for industry and Regulator

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4 One organisation's review of incidents

Chevron undertook a detailed review of the incidents they had in 2005, the objectives being to:

- Reduce the likelihood of occurrence of future major incidents by understanding and addressing identifiable leadership/cultural and Management System issues that have factored in to past incidents.
- Identify common themes/root causes to major incidents.
- Integrate any learnings into Chevron's Operational Excellence Management System.

Figure 3 presents the root cause categories associated with the incidents reviewed. Failure to follow procedures and safe work practices was identified as a root cause in almost every incident reviewed.

Figure 3: Root cause categories

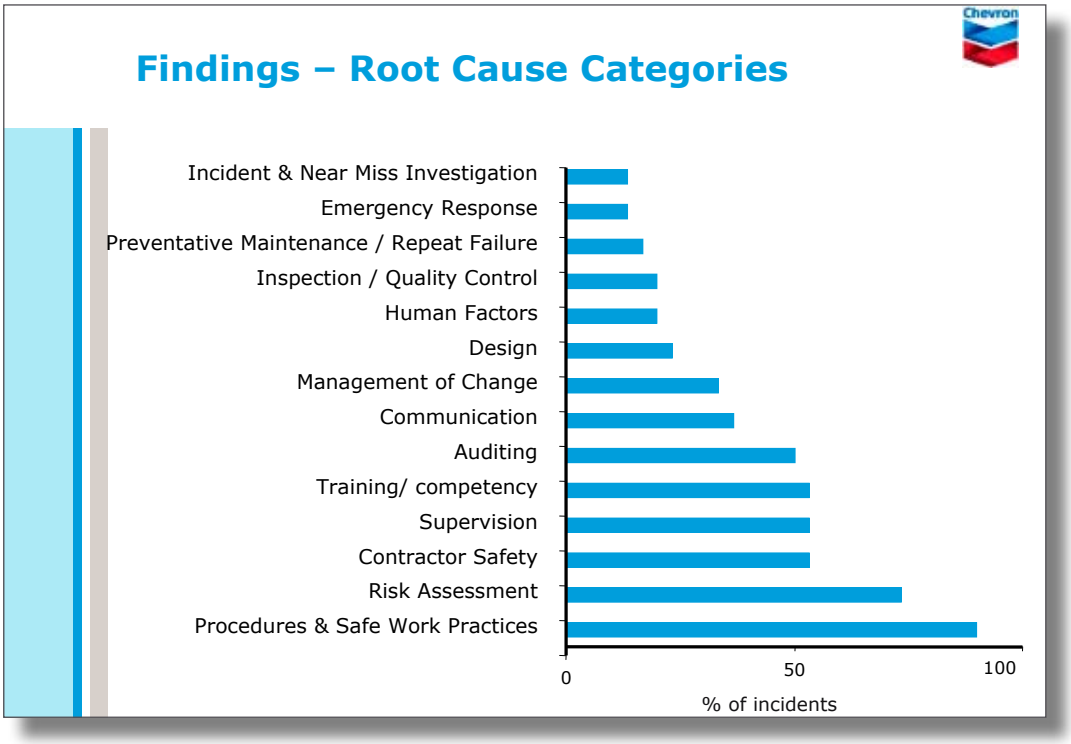
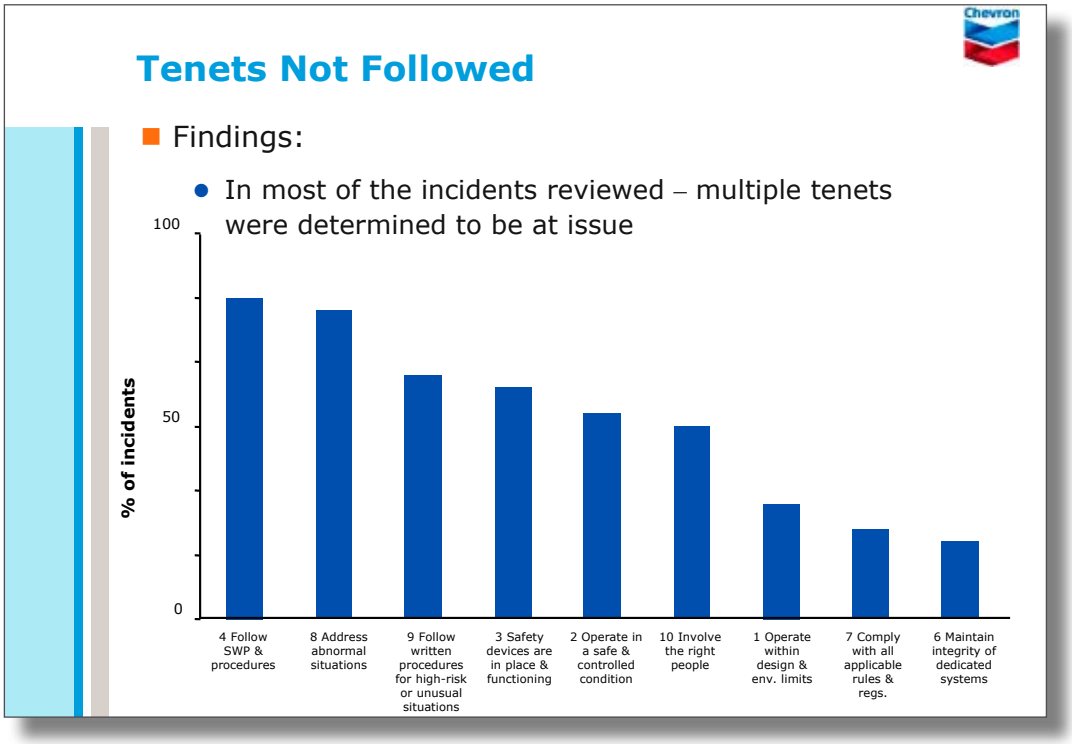


Figure 4 shows a different view of the incident data, displayed in terms of which of the company's operating tenants were not followed and contributed to the incident.

Figure 4: Operating tenants not followed



Key findings of the review were:

- **Operational Excellence Management System and Tenet of Operation are sound:** execution gaps existed.
- **Critical procedures and SWP:** gaps in adherence to critical procedures and SWP were identified as the most common root cause finding.
- **Risk evaluations:** failure to adequately assess potential risk was frequently identified as a root cause.
- **Contractor safety:** many of the incidents involved contractors. In these incidents the most common root cause finding was inadequate company and contractor oversight.
- **Learning organisation:** inadequate processes for sharing/institutionalising lessons learned often played a role.
- **Auditing:** inadequate processes for auditing the effectiveness of management systems were also identified, particularly those governing the root cause categories in the study.

Finally, some of the precursors to a major incident occurring were identified as:

- Low sense of vulnerability and understanding of hazards
- Low 'operational discipline' (adherence to procedures)
- Lack of a robust audit process focused on execution of critical work processes
- Failure to systematically learn from past mistakes

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5 Integrity management

Integrity Management can be defined as a continuous assessment process applied throughout the design, construction, operations, maintenance and decommissioning to assure that wells facilities and structures are managed safely.

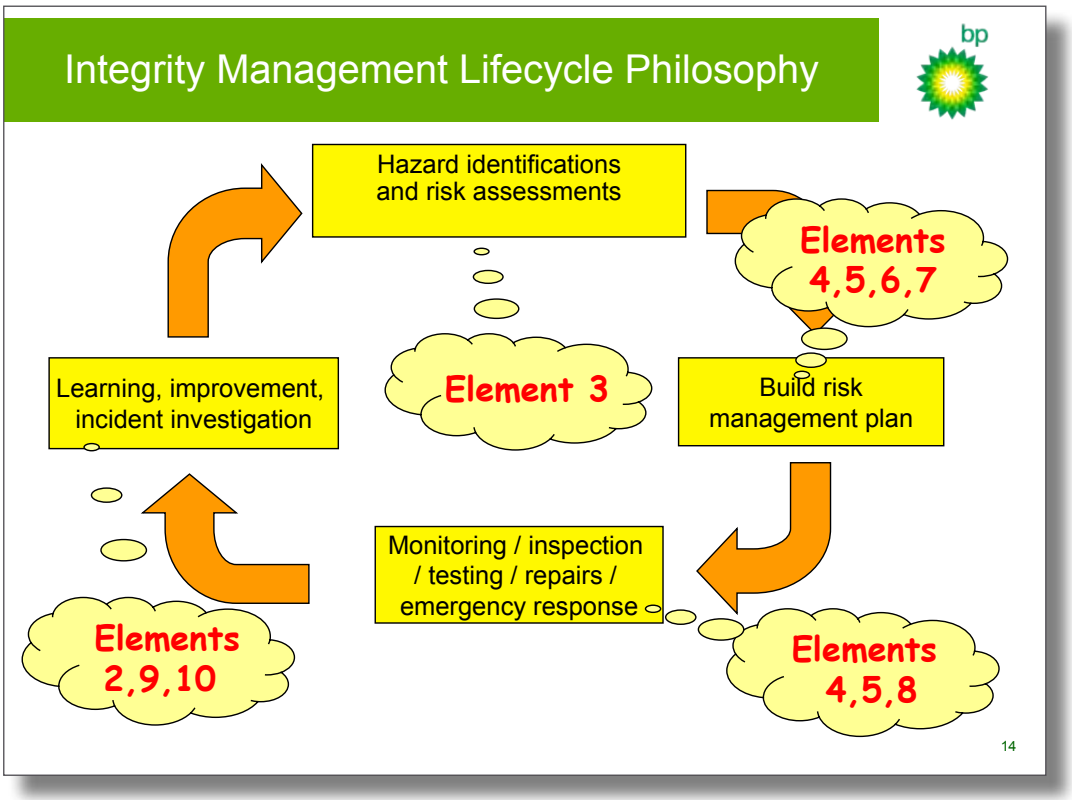
BP reviewed its integrity management (IM) standard. Included within it were the following key stages and process:

1. **IM accountabilities:** appointment of SPAs & EAs
2. **Competence:** define critical IM competencies, assess staff & contractors
3. **Hazard evaluation and risk management:** identify hazards, assess and manage risks.
4. **Facilities and process integrity:** design for integrity throughout lifecycle & compliance with STPs and operational practices
5. **Protective systems:** Installation & maintenance of protective systems & devices based on hazard evaluations/risk assessments to prevent/mitigate loss of containment
6. **Practices and procedures:** STPs to be developed consistent with Group ETPs
7. **Management of change:** all operations to apply a management of change process for temporary & permanent changes
8. **Emergency response:** Plans in place to respond to a serious IM related incident
9. **Incident Investigation and Learning:** Investigate IM related incidents & share lessons to prevent reoccurrence
10. **Performance management and learning:** IM Performance management system with KPIs. Annual IM Group risk report identifying top 5 risks per SPU by Engineering Authorities for Group Engineering Director.

How these processes map onto the organisation's Integrity Management Lifecycle Philosophy is shown in Figure 5.

The organisation's SMS includes a safety/integrity management system network This is a web based application aimed at facilitating the sharing of relevant information.

Figure 5: Mapping of BP's Integrity Management Process onto the organisations Lifecycle Philosophy



6 Technological risk assessment during development phase

Total presented the approached they adopted during the development phase to manage technological risks, noting that within the organisation:

- Technological risks related to EP's operated facilities are associated with the use or processing of toxic, flammable or explosive characteristics of substances.
- Identifying, assessing and managing risks associated with these substances are integral part of Total's continuous efforts to improve safety and sustainable development targets.
- The systematic processes of identifying hazards associated with Total's operations, assessment and management of these risks at all phases of development are known as Technological Risk Assessment.
- The management of risks involves at reducing the risks for both onsite and offsite facilities to a level As Low As Reasonably Practicable (ALARP).

The technical risk assessment the organisation implements includes features commonly seen within most SMS:

- Hazard identification
- Preliminary risk assessment
- Detailed and quantified risk assessment
- Risk assessment and ALARP demonstration
- Priority based program of actions and a register of major risk

The organisation adopted a scenario based risk assessment, in part due to the belief that it provided an excellent tool for risk communication and the identification of mitigation measures.

As with all risk assessment approaches, risk levels need to be determined which trigger certain decisions (Figure 6).

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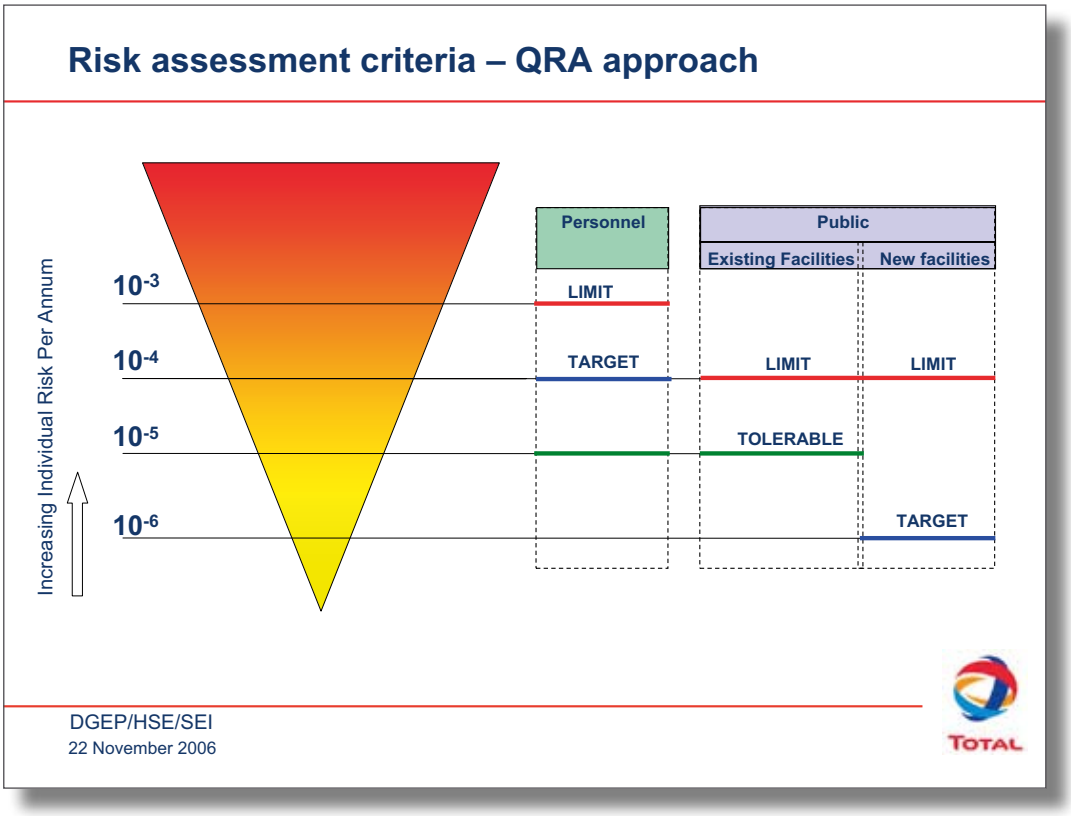
Figure 6: An example of individual risk assessment criteria



For this type of risk assessment approach to be successful, the following elements are needed:

- Clear scope of risk assessment, identification of process owners and facilitators.
- Validation at every step.
- Training and competence.
- Audit and Inspections.
- Support contractor qualification and performance monitoring.

7 Learning from other industries

Many industries have major incident risks which they need to manage. Some have similar challenges to those faced by the E&P industry such as containment of a hazardous substance or delivering good structural performance. Others, by the nature of the risks they need to address, have developed extremely sophisticated safety management systems aimed at delivering safety performance targets more demanding than those adopted within the E&P industry (*eg* the nuclear industry).

While many of the high risk industries adopt a similar approach to the overall management of risk, through the implementation of a Safety Management System (SMS), the emphasis they place on certain parts of the SMS and the tools they use to deliver good safety performance vary from those commonly adopted within the E&P industry. As such there is value in reviewing the approaches and tools adopted within other sectors and establishing whether they may have value within the E&P industry.

The workshop focused on the management of risk within two specific industries: aviation and nuclear.

Aviation industry

The aviation industry has a long history of managing major incident risk. The approach it currently adopts has developed over many decades and has been influence by the findings from incident investigation and risk assessment. It includes the following elements:

- **Life cycle based approached:** risk management from concept selection to retirement from service
- **Regulations:** A comprehensive set of international and national regulations addressing key risk areas, which are supported by standards, recommended practices and requirements.
- **Design, manufacture and certification requirements:** design assessments, system and component testing requirements and type certification
- **In service operations:**
  - Aircraft operating standards
  - Training, certification and licensing of aircrew
  - Comprehensive documentation (eg checklists, manuals and log books)
  - Incident reporting, feedback and improvement systems
  - Contingency planning (Emergency response and risk assessment and mitigation procedures)
- **Performance indicators:** collection, analysis and reporting
- **Risk mitigation:** identification of improved mitigation measures
- **Safety management systems**

Some noticeable differences between the approach adopted within the aviation and E&P industry towards the management of major incident risk, are that the aviation industry includes:

- a greater level of regulatory oversight, particularly at an international level
- a more sophisticated approach to accident investigation and the sharing of learnings
- management of modification and technical change more structured (highly regulated)
- more sophisticated approach to the training of staff

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Nuclear industry

The nuclear industry deals with a hazard that has the potential to cause serious consequences well beyond the site at which the incident occurred. A sophisticated approach to risk management is adopted that focuses on:

- Safety in design (multi-barrier approach)
  - All probable fault sequences of specific processes are considered & systems designed to cope
  - Process continues with more & more improbable fault sequences being considered & systems developed to cope or manage
  - Therefore a large margin of safety built in to every station.
- Safety in operations: use of operating rules
- Decommissioning
  - De-fuelling: hazard removal
  - Long term storage: containment

It was noted that despite a highly proactive approach to risk management, a number of well publicised events have occurred (*eg* Chernobyl and Three-Mile Island) which emphasise the importance of having good emergency response plans in place. However 'Good emergency planning is no substitute for proactive safety management and prevention'.

In terms of differences between the risk management approach adopted by the nuclear and E&P industries, within the former there is:

- A very high level of regulatory oversight
- A more sophisticated use of multiple barriers (*ie* failure tolerant systems)

In addition, it appeared that the effort expended in identifying and managing major hazard risks was considerably greater than typically adopted within the E&P industry; no doubt a reaction to the differing consequence levels.

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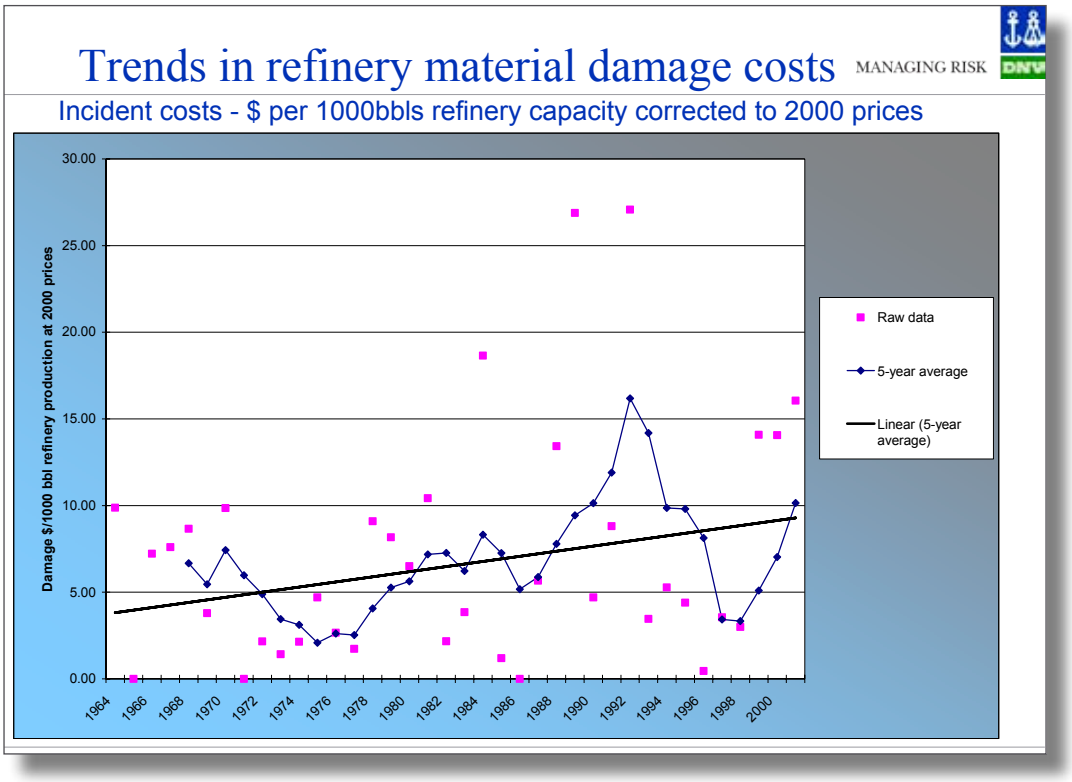
8 An auditors perspective

The auditing and certifying organisations that support the E&P and related industries have access to a wealth of information concerning the approaches adopted within different companies with respects to managing major incident risks. This information should assist in the identification of improvement opportunities and tools that may help deliver such improvements.

Figure 7 shows the material damage costs associated with incidents that have occurred in the refining industry between 1964 and 2002. It appears that the average costs associated with such incidents have almost doubled over the period. Further, analysis of USA data indicates that there has been no discernable downwards trend in incident rates.

Figure 7: Trends in refinery material damage costs



It was noted that there are many reasons why knowledge relevant to major accident hazards is not shared within an organisation:

- **Lack of understanding:** what does this have to do with process safety?
- **Lack of motivation:** why should I do it?
- **Lack of trust:** why does the other person need it?
- **Lack of 'trading':** what will I get in return?
- **Lack of technology:** how do I do it?

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From an auditor's perspective, the key lessons for the E&P industry to address if it is to reduce major incident risk are:

- Major accident hazards should be actively managed in the same way as occupational hazards
- Greater use of leading rather than lagging indicators of major accident potential needs to be made (OECD, HSE, Step Change)
- Companies with the best performance in major accident risk management do not necessarily have better systems than those with poorer performance, they are just much more diligent in doing what they say they do
- Major accident hazard industries must ensure that lessons learned both internally and externally are incorporated into their management systems
- Disruptions in utility systems on major hazard potential sites have significant implications for process safety and should not be underestimated
- Greater 'connectivity' is needed between major hazard issues and asset management
- Always adhere to inherent safety principles, don't place too much reliance on instrumented safety systems, alarms etc to solve problems if they can be avoided in the basic process design
- Risk assessments can place too much emphasis on consequence assessment, and ignore asset integrity issues. Get the balance right
- Greater emphasis needs to be placed on 'assurance' rather than 'audit'
- Achieve improvements in knowledge and information sharing
- Focus improvements efforts in the right areas, and use risk based approaches to prioritise initiatives
- Carefully evaluate the benefits of 'the latest great idea'. Does it treat the root cause of the problem or is it another sticking plaster?
- Provide clear leadership related to the issue of process safety, and give it the same attention as occupational safety

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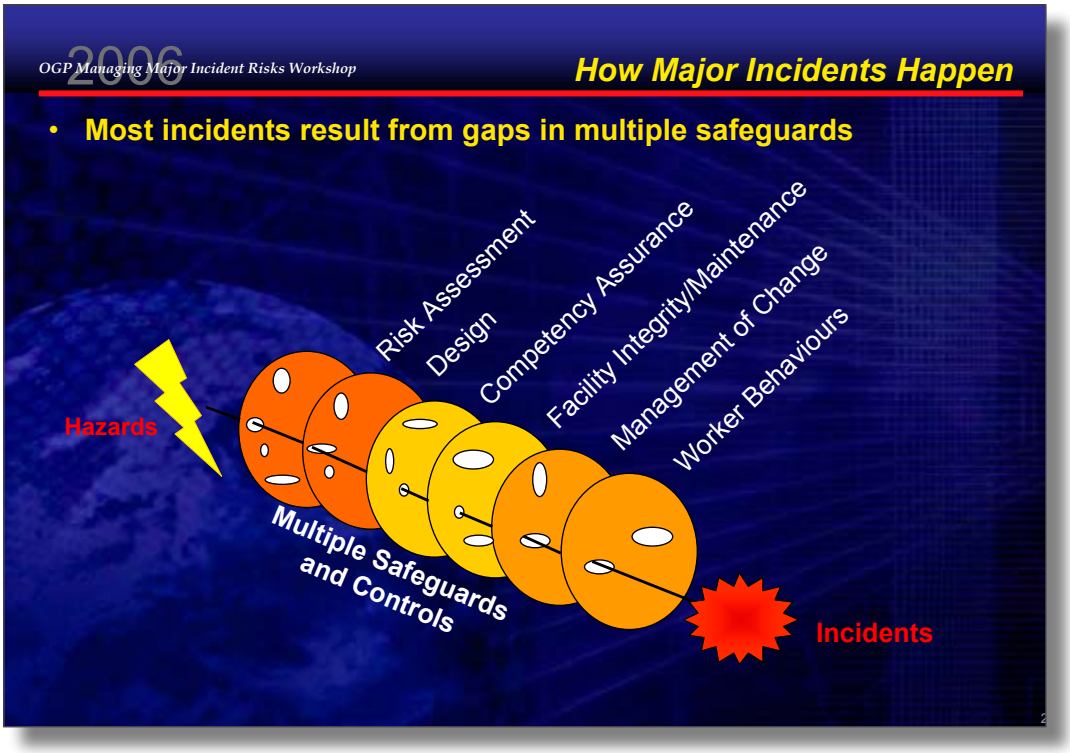
9 Understanding human factors in major incidents

Human Factors describes the influences on human performance that can prevent, or contribute to, human error:

- Equipment design and layout
- Working conditions
- Task design and staffing
- Information transfer
- Workforce diversity

Some form of human error has been a factor in most major incidents; usually as one of several contributing factors. It can contribute to the initiating event, or the response to it. Human error does not define a root cause, the error is generally associated with other factors and causes.



When incidents are reviewed, the Human Factor issues that arise include:

- Individual risk perception
  - Overestimating own abilities or underestimating effort required
  - Underestimating the consequences of familiar hazards
  - Failing to recognize subtle changes to familiar tasks
- Collective influences (Culture)
  - Quality assurance and intervention viewed as 'meddling'
  - Reduced guidance/direction seen as 'disinterest'
  - Deviations from processes mistaken for 'efficiency' or 'innovation'
  - Reluctance to slow or halt activities, regardless of the circumstances
- Other HF influences
  - Designs/configurations do not match operator expectations
  - Critical information not clearly communicated or understood

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Some of the issues that arise in a well performing organisation include:

- Shift in focus to more likely (and less severe) events
  - example: slips/trips vs. system overload
- Belief that hazards have been mitigated or are no longer present
  - less likely to question workplace status
  - statistical reinforcement that current practices are effective
  - normalization of deviations
- Greater willingness to 'push the envelope' (accept more risk)
- Less experience in recognizing and handling abnormal conditions

Based on Human Factor analyses, areas where focus should be given to reduce major incident risk include:

- High quality HF input on new designs
  - updated project development process
  - early operations participation
- Focus on constant vigilance
  - use of personal risk assessment tools (JSA, PHA)
  - transforming 'Last Minute Risk Assessment' (LMRA) into 'Every Minute Risk Assessment'
  - inclusion of "worst case" processing considerations
- Upgrade of key procedures to address abnormal conditions
  - descriptions of acceptable/unacceptable system conditions
  - automated shutdown when outside accepted operating envelope
- Visible leadership and supervision
  - positive reinforcement of proper activities
  - two-way dialogue on issues and expectations
- Individual empowerment and team accountability
  - peer reinforcement and intervention
  - 'no fault' near miss and hazard reporting and sharing

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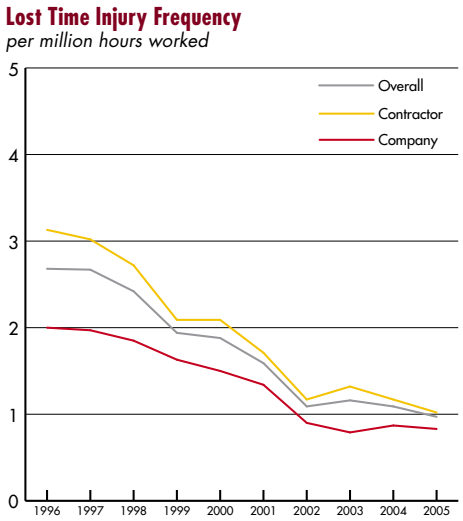
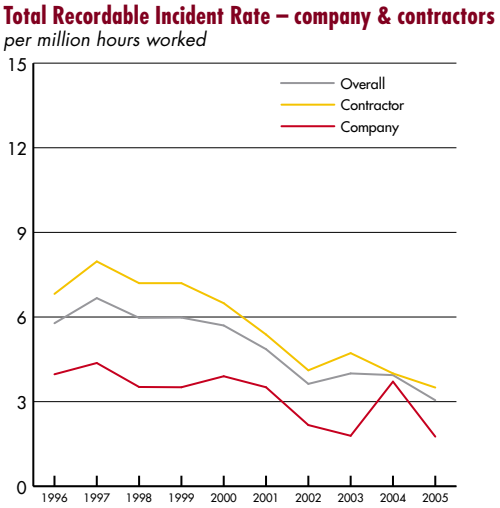
10 Key Performance Indicators

Managing and improving any process is greatly simplified if relevant performance measures can be identified. Such measures can be used to set targets and establish the effectiveness of improvement initiatives.

Much of the focus within the E&P industry has been on addressing certain Key Performance Indicators including the Fatal Accident Rate (FAR), Lost Time Injury Frequency (LTIF) and Total Recordable Incident Rate (TRIR). These lagging indicators have assisted organisations and the industry as a whole to identify and address key safety areas; recent examples include land transportation safety and lifting and hoisting safety. As figures 8 and 9 show, considerable improvement has been measured in terms of these indicators.

Figures 8 & 9: LTI & TRIR





However, the ability of these KPIs to give an indication of the potential for a major incident to occur is limited. While it can be argued that every incident provides some information on the effectiveness of the barriers that form part of an organisation's safety management system, such relationships are difficult to quantify.

The challenge is to identify KPIs for which a cause/effect relationship is difficult to demonstrate, and/or where there exists limited effects data. The complicated nature of major incidents (typically requiring the failure of a number of barriers) makes the identification of a unique KPI extremely difficult. In addition, the fact that major incidents are extremely rare within any single organisation, makes it difficult to measure the effectiveness of any initiative to reduce major incident risk.

Different approaches have been adopted towards identifying major incident KPIs. In the UK sector 3 high level KPIs have been selected which together are believed to give a measure of major incident potential (Presentation 16):

- **KPI 1:** Loss of containment (number of reportable hydrocarbon releases)
- **KPI 2:** Number of significant non-compliances (uncorrected deficiencies with function, performance or management of defined Safety Critical Elements)
- **KPI 3:** Production impact from integrity failures

In the process of identifying these KPIs, 40 other KPIs were identified (Ref: Stepchange publication 'Asset Integrity Toolkit').

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A considerably more sophisticated approach to measuring major incident potential was presented by Statoil (Presentation 15). This involved the identification and rating of ~20 technical performance standards, and using the information to produce a limited number of high level performance indicators.

It was recognised that there is a need to extend the performance indicators to include organisational and human issues and the company have a project to develop such KPIs.

Performance Standards

PS1: Containment
PS2: Natural ventilation and HVAC
PS3: Gas detection systems
PS4: Emergency shutdown
PS5: Open drain
PS6: Ignition sources control
PS7: Fire detection system
PS8: Blowdown and flare
PS9: Active fire fighting
PS10: Passive fire protection
PS11: Emergency power and lighting
PS12: Process safety
PS13: PA, alarm, emergency communication
PS14: Escape and evacuation
PS15: Explosion barriers
PS16: Offshore deck cranes
PS17: Drilling and well intervention
PS18: Ballast system and positioning
PS19: Ship collision barriers
PS20: Structural integrity

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11 Just Culture – a route to improving safety

The benefits associated with adopting a 'Just Culture' management system (Figure 10) in order to encourage the reporting and sharing of incidents were explored. The civil aviation industry was used to illustrate the benefits of such an approach.

The ICAO statement relating to the need for a just culture:

> *"Lack of full and open reporting continues to pose a considerable barrier to further safety progress in many areas. Major impediments are a fear of prosecution and a lack of appropriate confidentiality. The effectiveness of reporting is totally dependent on a conducive reporting environment – a Just Culture – defined as 'a culture in which front line operators are not punished for actions or decisions that are commensurate with their experience and training, but also a culture in which violations and wilful destructive acts by front line operators or others are not tolerated."*

Figure 10: The stages in a 'Just Culture' system

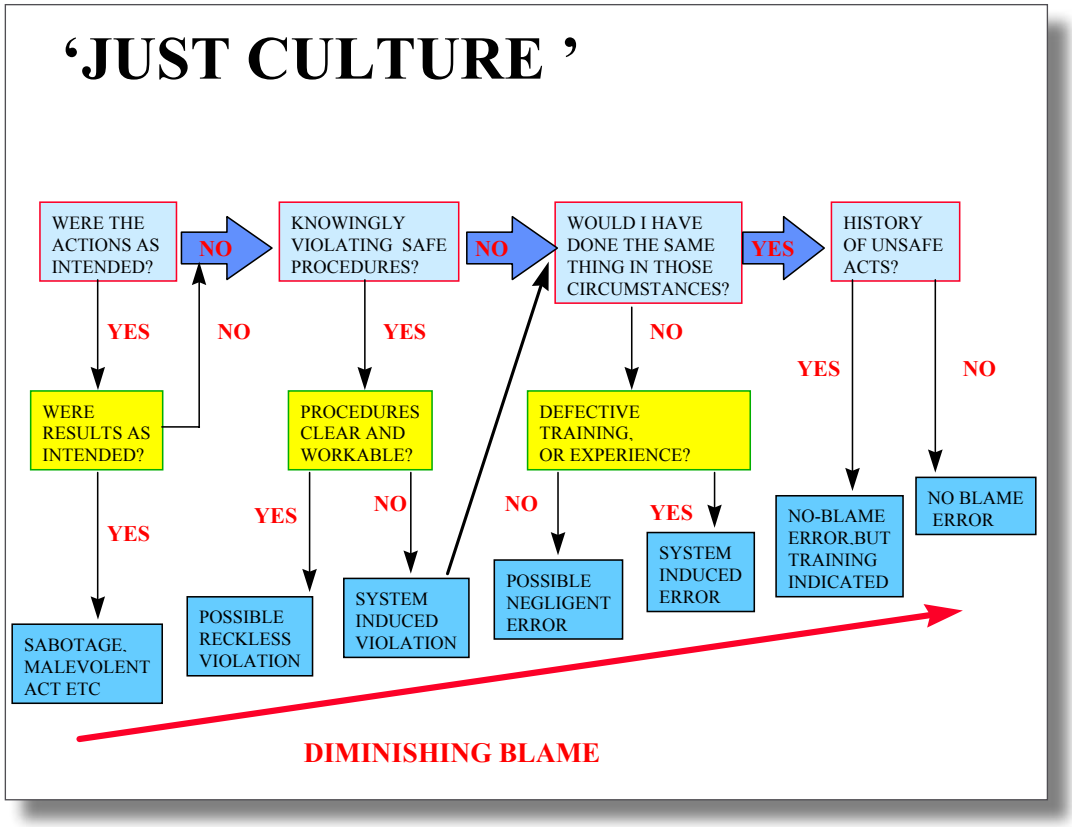

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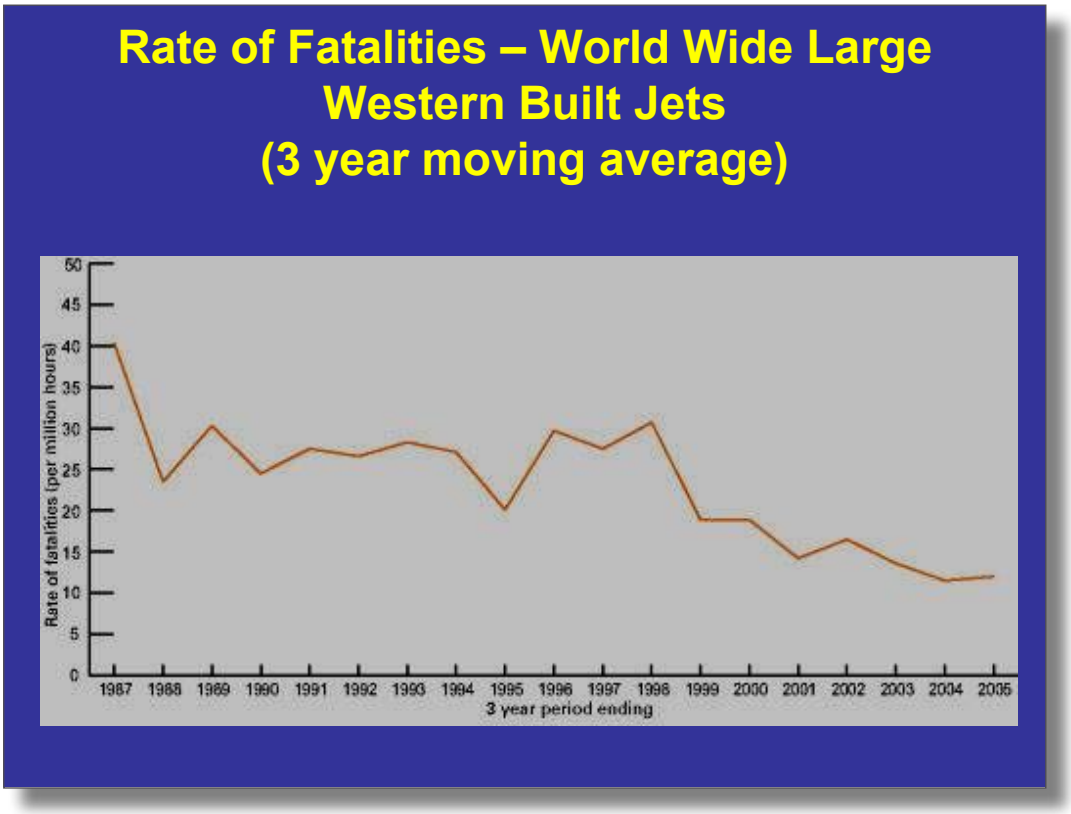
Figure 11 shows the improvement in the fatal accident rate (fatalities per million hours) in part attributed to the introduction of improved incident sharing and a just culture.

Figure 11 Rate of Fatalities – Worldwide, Large, Western Built Jets (3 year moving average)



In conclusion it was noted that the civil aviation industry has adopted an approach which results in the sharing of information on a wide scale and which has resulted in improved safety. Engineers and scientist have a duty to share information in order to improve safety.

Appendix 1: Workshop Agenda

1. Introduction

- Eamonn Naughton, BP and Chair of OGP Managing Major Incident Risk Task Force

2. Overview of major incident with a focus on E&P related incidents

- Don Smith, OGP

3. Managing Major Incidents – a regulatory, cross industry perspective

- Kevin Myers, Head of UK HSE's Hazardous Industry Division

4. Learnings from Review of Major Incidents (2005)

- Bruce Hartman, Chevron

5. BP E&P Integrity Management

- Dave Fargie, BP

6. Understanding Human Factors in Major Incidents

- Rick Winters, ExxonMobil

7. Technological Risk Assessment during development phase

- Sugunan Natarajan, Total Exploration and Production

8. HSE's Major Hazards Strategic Programme

- Colin Billington, Helicol Consultants Ltd

9. Factors Contributing to Major Incidents – Syndicate Session

- Nick Barlow, Shell

10. Managing Risks in Aviation

- Eric Clark, former chairman of OGP Aviation Safety Sub-Committee

11. A nuclear operators view of Emergency Arrangements

- Terry Kelly, UK AEA

12. Reducing Major Accident Potential: - Lessons From The Past And Opportunities For The Future

- Graham Bennett, DNV Energy

13. Managing Major Incident Risks associated with the London Millennium Event

- Colin Billington, Helicol Consultants Ltd

14. Just Culture – A route to Improving Safety

- John Bond

15. Major Incident Risk Indicators

- Odd Thomassen, Statoil

16. KPI's in the UK Sector

- Bob Kyle, UKOOA

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What is OGP?

The International Association of Oil & Gas Producers encompasses the world's leading private and state-owned oil & gas companies, their national and regional associations, and major upstream contractors and suppliers.

Vision

- To work on behalf of all the world's upstream companies to promote responsible and profitable operations.

Mission

- To represent the interests of the upstream industry to international regulatory and legislative bodies.
- To achieve continuous improvement in safety, health and environmental performance and in the engineering and operation of upstream ventures.
- To promote awareness of Corporate Social Responsibility issues within the industry and among stakeholders.

Objectives

- To improve understanding of the upstream oil and gas industry, its achievements and challenges and its views on pertinent issues.
- To encourage international regulators and other parties to take account of the industry's views in developing proposals that are effective and workable.
- To become a more visible, accessible and effective source of information about the global industry, both externally and within member organisations.
- To develop and disseminate best practices in safety, health and environmental performance and the engineering and operation of upstream ventures.
- To improve the collection, analysis and dissemination of safety, health and environmental performance data.
- To provide a forum for sharing experience and debating emerging issues.
- To enhance the industry's ability to influence by increasing the size and diversity of the membership.
- To liaise with other industry associations to ensure consistent and effective approaches to common issues.

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