MARSH

Energy Practice

LOSS CONTROL NEWSLETTER

2015 – EDITION 1

SOLUTIONS...DEFINED, DESIGNED, AND DELIVERED.

MARSH & McLENNAN COMPANIES

CONTENTS

NOTE: Full URL destinations of resources referenced within this edition can be found on page 49.

FOREWORD

Welcome to the first edition of the Loss Control Newsletter (LCN) for 2015, issued to coincide with Marsh's Energy seminar: Engineering for Success, which takes place in Abu Dhabi on February 10-11.

As detailed in the latest edition of Marsh's 100 Largest Losses, eight of the top 20 largest property damage losses in the hydrocarbon industry occurred in the US, which includes the 2013 loss at a petrochemical plant in Geismar, Louisiana. In December 2014, the U.S. Chemical Safety Board (CSB) announced that to "modernize US process safety management regulations" is the Board's newest, most-wanted safety improvement. The CSB highlighted process safety management (PSM) issues in a poignant video to mark the 30th anniversary of the Bhopal disaster. These, and other recent safety developments, can be found in the "Safety news from around the world" section of this publication.

Equating workplace safety with process safety is a seductive philosophy, with parallels to the idiom "look after the pennies, and the pounds will look after themselves". London-based risk engineer Trevor Hughes considers why this is not a valid conclusion in an article focused, not on the technical content of PSM implementation, but on the different cognitive challenges of PSM as a possible explanation.

In late 2014, the Fire and Blast Information Group released the final report on the "dispersion and explosion characteristics of large vapor clouds" as observed in the 2005 Buncefield incident. Marc Joseph – a Dubai-based risk engineer– reviews the research into vapor cloud explosion characteristics, with specific reference to the Buncefield incident investigations undertaken over recent years.

On the topic of standards in the energy industry, Graeme McMillan – another Dubai-based risk engineer – outlines three new first edition standards from the American Petroleum Institute, recently issued to enhance refinery safety and inspection programs.

Fire, machinery breakdown, terrorism, natural catastrophes and cyber-attacks all have one thing in common – the threat of business interruption (BI). Marsh's BI Centre of Excellence (BICoE) was formed to help clients feel more comfortable with BI risk, to improve understanding of the exposures, and to provide a clear guide to risk-transfer solutions available. Chris Price-Kuehne, senior risk engineer and BI specialist interviews Caroline Woolley, Marsh's EMEA Property Practice leader and head of the BICoE.

In another article, Michael Eason, a risk engineer based in London, considers the importance of establishing accurate plant values, and the careful considerations to be taken when embarking on a valuation exercise.

This edition also includes regular items such as "From the archives", in which we take the opportunity to share a lesson learned from previous LCNs. Our usual selection of "Safety snippets" are dispersed throughout and, as always, we provide a selection of recent energy losses from around the world in the "Losses" section.

We also introduce five new risk engineers who joined Marsh in 2014 — part of a growth plan that further increases our global risk engineering capability.

Finally, we always welcome any comments on *LCN* content, as well as what you might like to see in future editions. Please contact us at LCN.editor@marsh.com.

INSIDE THIS ISSUE

SAFETY NEWS FROM AROUND THE WORLD

Latest global safety news.

MANAGING PROCESS SAFETY

Trevor Hughes, a London-based risk engineer, examines ways in which process safety differs from workplace safety, with some consequences for the management of high hazard processes. The article focuses on the different cognitive challenges of PSM rather than the technical content of process safety management (PSM) implementation.

API RELEASES NEW FIRST EDITION STANDARDS

The American Petroleum Institute recently issued three new first edition standards to enhance refinery safety. Graeme McMillan, a risk engineer based in Dubai, takes a look at what these standards can offer. They include: RP 583 Corrosion Under Insulation and Fireproofing; RP 584 Integrity Operating Windows; and RP 585, Pressure Equipment Integrity Incident Investigation.

THE BUSINESS INTERRUPTION CENTRE OF EXCELLENCE (BICOE)

Oil, gas, and petrochemical facilities do not operate in isolation; they are part of a complex network with multiple stakeholders. Whether a BI trigger is damage at a business's own location or at a customer or supplier location, new and "disruptive" business practices demand new solutions. Marsh is using its international network of experts to develop new BI solutions. Senior risk engineer Chris Price-Kuehne talks to Caroline Woolley – head of Marsh's BICoE.

THE BUNCEFIELD VAPOR CLOUD EXPLOSION MECHANISM

In 2014, a formal report was issued on the dispersion and explosion characteristics of vapor clouds as observed in the Buncefield incident. The objective was to understand vapor cloud development, characteristics of explosions from large, flat flammable vapor clouds, and the explosion mechanisms that give rise to high overpressures over a large area, as observed at Buncefield. Marc Joseph, a Dubai-based risk engineer, reviews the research behind this report and other investigations undertaken in recent years.

PLANT PROPERTY VALUATION FOR ENERGY INSURANCE

Knowing the true value at risk is vital to establish an accurate estimated maximum loss (EML), therefore enabling the setting of appropriate policy limits. However, arriving at an accurate plant property value is not easy. Michael Eason, a London-based risk engineer, considers the importance of establishing accurate plant values, and the considerations to be taken when embarking on a valuation exercise.

FROM THE ARCHIVES...

We include an article written by Nigel Cairns, a London-based risk engineer, that appeared in an edition of the *Loss Control Newsletter* back in 2011, from which lessons can still be drawn today. The article is a review of Chemical Safety Board information in relation to hot work activities at facilities handling hydrocarbons, which provides some valuable lessons.

MARSH NEWS

Marsh's global energy risk engineering team continues to strengthen, with five new risk engineers joining in 2014. Here, we introduce our new starters, and the value they bring to our team.

LOSSES

Here, we provide a summary of incidents of particular interest from the past 12 months.

SAFETY NEWS FROM AROUND THE WORLD

CALIFORNIA TO LEAD THE WAY ON OIL REFINERY SAFETY

CSB Chairman hails California's proposed regulations, which promise to introduce a new way of conducting refinery operations.

A recent letter from CSB chair, Dr. Moure-Eraso, talks about a major breakthrough that will see California leading the US in making oil refineries much safer. The proposed regulations promise to deliver a new way of conducting refinery operations and be a national model.

He says the proposed rules will revamp the code for PSM in refineries; a move away from the current rules that tend to "encourage paperwork, but don't actually reduce risk." Refineries would need to adopt safer processes and equipment to the greatest extent feasible or, if not, fully document why not. Smaller accidents or near-misses would require internal investigation, with changes instituted to prevent larger accidents.

Interestingly, the letter highlights observations from Allianz that oil and gas industry losses are the highest of any industrial sector, as well as those from Swiss Re that reveal the US has three to four times the accident rate of the better-regulated European refinery industry.

The letter can be found at: **http://www.idevmail.net/link.aspx?l=1&d=86&mid=425615&m=1479**

FUNCTIONAL SAFETY IN THE PROCESS INDUSTRY

A new publication from Rockwell Automation provides a straightforward introduction to functional safety and the application of European and American safety standards in the process industry.

Process Safebook 1 is a new 170-page book from Rockwell Automation, which provides an introduction to functional safety for process applications and guidance in the application of IEC 61511. The book offers a wealth of useful information, and presents visual examples. Even better, it's free to download as a PDF from the Rockwell Automation website: **http://www.rockwellautomation.com/rockwellautomation/industries/oil-gas/resources/process-safebook-1.page**

CYBER-ATTACK CAUSES "MASSIVE DAMAGE" AT INDUSTRIAL SITE

The German Federal Office for Information Security reveals details of "massive damage" to a blast furnace at a steel mill following a cyber-attack.

The incident which occurred at a German steel mill was reported in the annual report of the German Federal Office for Information Security (BSI), BBC News revealed.

Apparently, hackers used e-mails to capture login details allowing access to the plant's industrial control system. Subsequent malicious activity on the control system prevented the controlled shutdown of the blast furnace, causing significant damage.

The report highlights the skill of the hackers who used a "spear phishing" campaign to acquire sensitive login names and passwords from employees in the company, and thereby access to the plant control system. The BSI said that, as well as defeating the business IT system security, the attackers were also familiar with how to sabotage the plant via the industrial control system.

The company that was victim to the attack was not revealed in the report, and the BSI said it did not know the background of the perpetrators.

Marsh has previously warned of the cyber threat to industrial control systems in articles featured in earlier editions of the Loss Control Newsletter (2011, Edition 2 and 2013, Edition 1). This latest report further highlights the risk of security gaps in firewalls between industrial control systems, and business networks connected to the internet.

LATEST EDITION OF BLOWOUT PREVENTER GUIDELINES RELEASED

Oil & Gas UK has released a second edition of its guidelines on blowout preventer (BOP) operations for offshore wells – a development that should assist drilling contractors and well operators to comply with relevant legislation.

Oil & Gas UK has released a second edition of its guidelines on blowout preventer (BOP) operations for offshore wells to improve cross-industry understanding of well-related issues on the UK Continental Shelf. In addition to providing operating, drilling, and well service companies with the latest industry guidance for operating subsea BOPs, the latest edition includes guidance for offshore surface BOPs. Also included is a summary of the main differences between these guidelines and the fourth edition API 53 standard.

These guidelines should help drilling contractors and well operators comply with BOP aspects of relevant legislation – mainly the Offshore Installations and Wells (Design and Construction) Regulations 1996, and the Offshore Installations (Safety Case) Regulations 2005.

The guides are available to Oil & Gas UK forum members to download for free via the Oil & Gas UK extranet, or to others in CD format for a small charge – see following link:

http://www.oilandgasuk.co.uk/publications/viewpub.cfm?frmPubID=805

CSB HIGHLIGHTS ISSUE OF PSM IN A VIDEO TO MARK 30TH ANNIVERSARY OF BHOPAL DISASTER

The video chronicles how a violent runaway reaction in a tank containing 40 tons of methylisocyanate occurred at the Union Carbide plant in Bhopal, India, and led to a massive release of toxic gas, with some 3,800 immediate fatalities.

The CSB has highlighted the issue of PSM in a video issued in December 2014 to mark the 30th anniversary of the Bhopal disaster in India. The video, "*Reflections on Bhopal*," chronicles how the incident unfolded at the Union Carbide plant, the aftermath that followed and the PSM challenges still faced today.

In the wake of the Bhopal incident, the US Congress enacted laws requiring operators to develop process safety and risk management programs. It also set up the CSB to independently investigate major accidents and recommend measures to prevent them. "Despite these actions in the 1990s, the US continues to experience serious chemical accidents," the CSB notes.

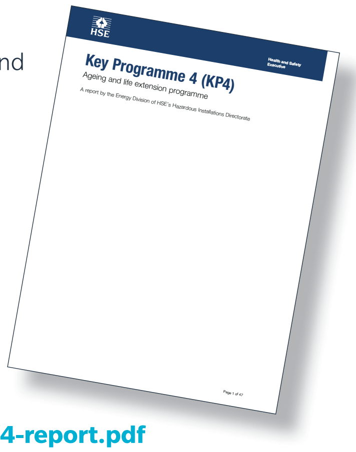
"Process safety management regulations are in need of reform," CSB chair, Dr. Moure-Eraso, says in the video. "There must be more emphasis on preventing the occurrence of major chemical accidents through safer design. Responding to emergencies and punishing people after the fact are not enough."

This is another poignant video from the CSB; it is a powerful resource that could be used as an introduction to safety committee meetings, serving to remind all of the PSM challenges ahead.

See the video at: **http://www.csb.gov/videos/**

OFFSHORE OIL AND GAS - HSE PUBLISHES ITS REPORT INTO THE FINDINGS OF THE KP4 AGEING AND LIFE EXTENSION PROGRAM

The report identifies industry strengths and areas for additional focus that will deliver long-term improvements for UK Continental Shelf installations.



The HSE has published its report into the findings of the Key Program 4 (KP4) – The Ageing and Life Extension Program. KP4 is a key element of HSE's Energy Division major hazard work priorities, with the aim of the program being to promote awareness and the management of the risks associated with ageing plant in the offshore oil and gas industry. The program was launched to the offshore industry in July 2010, followed by three trial inspections in December 2010. KP4 ran to December 2013, involving both onshore and offshore inspection of duty holders' management systems. The program determined the extent to which asset integrity risks associated with ageing and life extension are being managed effectively by duty holders, and places emphasis on the development and promotion of good practice in the industry to ensure continued safety.

Download the report free of charge here: **http://www.hse.gov.uk/offshore/ageing/kp4-report.pdf**

MANAGING PROCESS SAFETY: ADDRESSING THE DIFFERENCES BETWEEN PROCESS SAFETY AND WORKPLACE SAFETY

Trevor Hughes, a risk engineer in Marsh's Energy Practice in London, examines ways in which process safety differs from workplace safety, with some consequences for the management of high hazard processes.

"Tragedies can occur even in companies with a highly regarded safety culture," John Bresland – former chairman, US Chemical Safety and Hazard Investigations Board (2011).

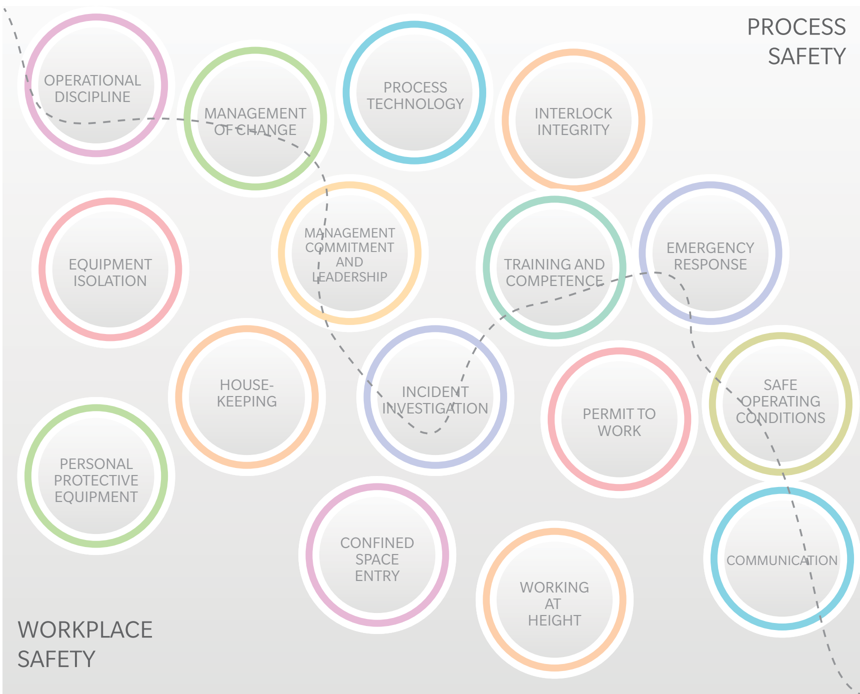
REASON FOR CONCERN

Equating workplace safety with process safety is a seductive philosophy, with parallels to the idiom "look after the pennies, and the pounds will look after themselves". So why is this not a valid conclusion? This article focuses, not on the technical content of process safety management (PSM) implementation, but on the different cognitive challenges of PSM as a possible explanation.

Process safety focuses on the prevention of fires, explosions, and chemical releases that can result in substantial financial loss, multiple fatalities, and long-term damage to the business. By contrast, workplace safety is focused on injuries to employees resulting from accidents such as falls, chemical splashes, or limbs getting trapped in machinery.

In insurance, we consider the potential causes of significant financial loss, and their mitigation. The attention here is focused on process safety issues.

Historically, success in workplace safety was considered a good indicator of process safety. There are sound reasons to view both as interlinked, with their overlaps and common tools. Both workplace safety and process safety require some common features, such as strong operational discipline, clearly demonstrated management commitment, and learning from incidents and near misses.



PROCESS SAFETY AND WORKPLACE SAFETY - SOME COMMON AREAS OF OVERLAP

In the past 20 years, a number of incidents have highlighted that good process safety does not necessarily follow from excellent workplace safety. Some striking examples include the following:

- Exxon Longford (1998) – two workers died in a gas plant explosion. Exxon was considered to have a strong safety management system, well implemented throughout its facilities.
- BP Texas City (2005) and Deepwater Horizon (2010) – 26 fatalities in total. Many with experience of BP would support the view that the company has had excellent commitment and achievement in workplace safety; however, tragically, that performance has not extended to process safety.
- Du Pont Belle Plant (2010) – although the company is admired for its safety culture and practices, a process safety-related incident at this plant resulted in one fatality.

COGNITIVE DIFFERENCES AND THEIR CONSEQUENCES

Process safety is concerned with reducing the risk of low probability, high impact events. By contrast, workplace safety is concerned with reducing the likelihood of lower impact, higher frequency events. This key difference has consequences in terms of management approach, such as injuries cause pain and emotional impact. As a trailing indicator, employees pay attention to injury performance. An absence of catastrophic events says nothing about their potential. Here, the use of leading indicators is appropriate, but employee impact is less.

VISIBILITY OF ACTIONS

Good or poor workplace safety is generally visible, at least to organizations and individuals with developed risk awareness skills. Safe and unsafe acts are identifiable during safety observations, audits, and management walkarounds. Observing process safety is difficult since risky behavior is seldom visible.

COMPLEXITY

Process safety situations are generally highly complex; hence distinguishing right from wrong in these situations can be difficult. Consider a management walkaround where a control room operator is observed acknowledging an alarm. The observer has little opportunity to evaluate and understand whether the operator takes the right action or whether the alarm level is correct. Even during a formal audit, we have the same problem of complexity. We can audit to see that a process hazard analysis (PHA) has been done; we can even review the methodology. But can we tell if it is a good PHA or a poor one?

COMPETENCE

Process safety requires high levels of education, training, and competence to understand complex problems. It also requires soft skills to work in teams with diverse membership.

DIFFUSE RESPONSIBILITY

PSM can suffer from diffuse responsibility. PSM responsibility is an amalgamation of inputs from design engineers, process engineers, operators, safety specialists, managers, contractors, and construction workers. Safety is seen as a line management responsibility. However, the line manager may not have the competence, resources, or time to fully integrate the PSM task; hence there is dependence on support departments.

VULNERABILITY TO CONFIRMATION BIAS AND GROUPTHINK

With "diffuse responsibility" comes a danger of "confirmation bias" and "groupthink". Confirmation bias is the tendency to interpret ambiguous evidence as supporting an existing position. Groupthink can arise from a desire for harmony or conformity in a group, resulting in an irrational outcome. Individual creativity, independent thinking, and uniqueness are diminished.

Process safety issues are highly dependent on the work of diverse teams of professionals with a desire for projects to be successful; hence the vulnerability to these psychological consequences.

CONCERN ABOUT GIVING RISE TO MORE WORK AND EXPENSE

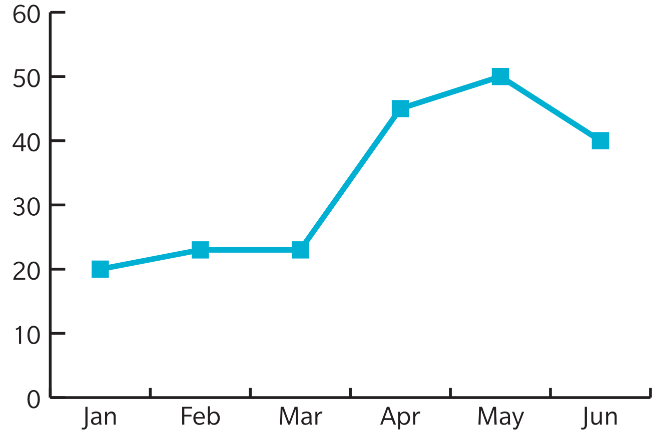
Typically, a PHA will result in the need for additional precautions, instrumentation, and/or equipment. These ultimately incur cost. Initial reaction to such well-meaning recommendations may not be welcoming. A PHA may call into question the basic philosophy of the process. Speaking out and being heard when fundamentals are being questioned, requires confidence. For example, it would have been a brave engineer who spoke up about the potential consequences of a tsunami hitting a nuclear reactor on the coast of Japan.

SOME MANAGERIAL ACTIONS TO ADDRESS THESE CONSEQUENCES

PROCESS SAFETY PERFORMANCE INDICATORS (PSPIS)

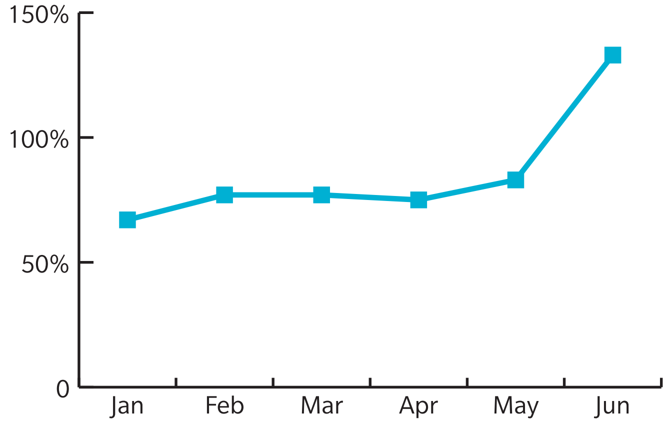
PSPIs can be effective at bringing responsible parties together to drive improvement. PSPIs must be carefully selected to focus where the organization needs to improve: Good or bad trends should be clearly identified and interpreted. Consider the following graphs representing inspection activity. The first graph of an increasing number of inspections could be viewed as a good or bad trend. This is clearer in the second graph showing the percentage of plan accomplished. In this hypothetical example, a unit turnaround doubled the number of inspections planned for April/May. At first sight, the trend is improving. In the final graph, the number of overdue inspections reveals a concerning trend.

NUMBER OF INSPECTIONS



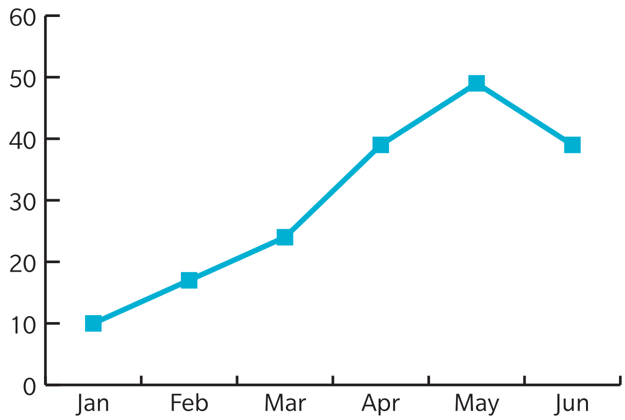
TREND:
GOOD OR BAD?

% INSPECTION PLAN ACCOMPLISHED



TREND:
IMPROVING?

NUMBER OF INSPECTIONS OVERDUE



TREND:
CONCERNING?

COMMUNICATION

More than just promoting the importance of process safety, it is far better is to educate the plant community in understanding PSM basics, goals, and achievements. This would drive plant-wide awareness of major PHA recommendations.

INCLUDE PROCESS SAFETY CONSIDERATIONS IN BEHAVIORAL AUDIT AND MANAGEMENT WALKAROUNDS

Although requiring advance thought and preparation, PSM considerations can form safety conversations, especially in control room situations.

BE PREPARED TO "STOP THE JOB"

"Stop the job" is an admirable philosophy, often applied in personal danger situations. "Stop the job" in these circumstances rarely has significant financial considerations. Are you prepared to "stop the job" when process safety issues are at stake? Do your people genuinely display this sort of commitment?

MODIFY ORGANIZATIONAL STRUCTURE

A review of organizational structure may be appropriate; however, there is no "one size fits all solution". The optimum solution depends on the complexity of PSM challenges for the organization, its current structure, and the background and competencies of the management. Organizational changes should recognize that PSM can be harmed if responsibilities become too diffuse. Accountability for PSM should be clear, well recognized, and appropriately resourced.

DEVELOP A HIGH RELIABILITY CULTURE

The organization should feel that efforts to identify and highlight process safety issues are valued at all levels of management. Much has been written about high reliability cultures and their key attributes, including, for example, a pre-occupation with avoiding failure, a reluctance to simplify, and respect for expertise. The philosophy of "challenging the green and embracing the red" may not be an easy transition for management.

SINGLE PERSON ACCOUNTABLE

Assigning a single person accountable (SPA) is an important step, especially for the management of change issues. The assigned SPA will solicit expertise from those having their own responsibilities. The SPA must gather these contributions and is ultimately responsible for the combined efforts.

The level of the SPA needs to be carefully considered. Too high, and the issue will not get the attention intended; the higher level manager is already surrounded by many other accountabilities. Too low, and the individual may not have the soft and hard skills to fulfil the task. Assignment of a sponsor for the SPA can help overcome this.

IN SUMMARY

Good process safety is not a natural consequence of good workplace safety. It requires special attention and additional tools beyond those of workplace safety. However, it does not follow that good process safety can be achieved without a foundation in workplace safety. There are strong common foundations in management commitment, operational discipline, and safety culture.

THERE'S MORE ONLINE:

High reliability organizations – A review of the literature - HSE RR 899– **www.hse.gov.uk/research**

Incidents at BP Texas City, Deepwater Horizon, and Du Pont Belle – **www.csb.gov**

PSPI POSITION PAPER

Marsh's Risk Engineering Position Paper: Process Safety Performance Indicators (PSPIs) defines the standards rated by Marsh as "very good" for a set of process safety performance indicators in the oil, gas, and petrochemical industry. These standards are incorporated in Marsh's energy risk ranking criteria and can be used to support and define risk improvement recommendations. The standards may also provide detailed insights for clients seeking to better understand and improve their process safety performance.

http://uk.marsh.com/NewsInsights/Articles/ID/29372/Risk-Engineering-Position-Paper-Process-Safety-Performance-Indicators-PSPIs.aspx

Don't get complacent. Never relax and forget about the potential hazards of a plant.

Concentrate on details, details, details. One detail, if incorrect, can be catastrophic. A company should not let deviation in procedures become the norm, and should also be measuring and reporting a set of process-safety performance metrics.

API RELEASES NEW FIRST EDITION STANDARDS

Graeme McMillan, a Marsh risk engineer based in Dubai, outlines some new standards designed to enhance refinery safety and inspection programs.

INTRODUCTION

The American Petroleum Institute (API) recently issued three new first edition standards to enhance refinery safety and inspection programs.

As reported by the API newsroom: "These new practices will enhance safety, helping companies prevent accidents whilst also helping to respond to those incidents that may occur," said API Director of Standards David Miller. "The new standards achieve this through guidance on reducing corrosion, improving process safety inspections, and outlining steps for proper incident investigations."

The API traces its beginning to World War I, when the American oil and gas industry agreed to work with the government to ensure that vital petroleum supplies were rapidly and efficiently deployed to the armed forces.

The API was established after the War on March 20, 1919, in order to:

- Afford a means of cooperation with the government in all matters of national concern.
- Foster foreign and domestic trade in American petroleum products.
- Promote in general, the interests of the petroleum industry in all its branches.
- Promote the mutual improvement of its members and the study of the arts and sciences connected with the oil and natural gas industry.

Offices were established in New York City, and the organization focused its efforts in several specific areas. One such area was standardization. During World War I, drilling delays resulting from shortages of equipment at the drill site were common. The industry attempted to overcome the problem by pooling equipment. The program reportedly failed because there was no uniformity of pipe sizes, threads, and coupling. Thus, API took up the challenge of developing industry-wide standards, with the first being published in 1924.

The three new first edition standards add to more than 500 such standards and recommended practices maintained by API today. They cover all segments of the oil and gas industry to promote the use of safe, interchangeable equipment, and proven and sound engineering practices. This article will summarise the key purposes of the new standards.

RP 583, CORROSION UNDER INSULATION AND FIREPROOFING

This standard will assist with industry inspection and allow maintenance personnel to fully understand the complexity of corrosion under insulation and fireproofing, as well as the subsequent ways to reduce its occurrence at refineries.

It begins with an introduction to the causes of damage, reminding users that corrosion under insulation (CUI) is defined as the external corrosion of piping and vessels that occurs when water gets trapped beneath insulation. CUI damage occurs on carbon and low alloy steel when exposed to moisture and oxygen. This occurs when moisture is allowed to penetrate the insulation and contact exposed steel at metal temperatures between 0°C and 100°C. The standard suggests a much broader operating temperature range should be considered, typically from -12°C to 175°C due to fluctuations in operating temperature, ineffective insulation maintenance, temperature gradients within the equipment considered (long pipe runs, fractionation columns, heat exchangers, etc.), and various operating modes. The standard also notes that CUI also occurs in austenitic and duplex stainless steels, most commonly in the range of 60°C to 175°C, and also on aluminum piping.

The API advises that localized corrosion due to corrosion under fireproofing (CUF) on fireproofing systems tends to occur in highly industrialized areas with high SO_2 levels in the atmosphere, or marine environments when water penetrates the fireproofing when operating either continuously or intermittently in the temperature range between -4°C to 121°C. As well as causing corrosion to the affected equipment, the corrosion products resulting from CUF can promote cracking or spalling of the fireproofing itself, reducing its effectiveness in a fire.

The standard also advises that under the right temperature conditions, CUI or CUF damage can occur at any location that is insulated or fireproofed, and it is not uncommon to find CUI/CUF damage in locations remote from the more predictable and susceptible locations. However, there are some areas within facilities that experience has shown have a higher susceptibility for damage. In general, areas with severe CUF damage are easier to identify visually than those with CUI damage due to cracks and staining of the fireproofing. The standard describes certain areas and types of equipment that have a higher susceptibility for CUI damage.

It continues by detailing the commonly used types of insulation and fireproofing, and gives the advantages and disadvantages with regard to CUI and CUF for each. In many situations, users may apply coatings to the surface of equipment before insulating or fireproofing, and the standard describes the factors to consider when choosing a coating, as well as surface preparation.

The API also discusses inspection for CUI and CUF damage. Some general advice given is that before performing CUI inspections, the purpose of the insulation on equipment and piping should be well understood. This will help establish priorities, highlight what hazards may exist, determine if insulation can be removed while equipment/lines are in operation, and conclude if insulation can be permanently removed. Having conducted such a study on my plant while in industry, I was surprised to find how much insulation was completely unnecessary. This is an excellent discovery, as permanent removal results in 100% elimination of CUI risk. Of course, a management of change (MOC) process should be used when considering the modification or removal of any insulation or fireproofing. If insulation is required, there are various inspection methods available, and the standard describes the advantages and disadvantages of each.

The standard continues with guidance on how to incorporate CUI and CUF assessments into a risk-based inspection (RBI) program. It advises that, due to the highly localized nature of damage, CUI and CUF assessments lend themselves to a qualitative assessment approach to assess the likelihood of failure and an example of such a system is given.

The document then considers design practices to minimize CUI and CUF. Such practices include coating systems, choice of insulation, and jacketing design for CUI. A general rule of thumb is that complicated designs are difficult to insulate and therefore should be avoided. Design practices for CUF include coatings and choice of fireproofing material.

The standard concludes with a description of maintenance and mitigation of CUI/CUF issues. Generally, it advises that properly designed and installed insulation systems should normally require little maintenance. However, failing insulation systems are very often detected only in poor shape and require significant repair. The API advises that routine maintenance practice should be extended by periodic scheduled inspections, preventive maintenance, and can include a long-term strategy based on RBI principles. It also advises on several approaches that are used to mitigate CUI damage. These include approaches to protecting the surface of the metallic piping (that is, organic coatings, TSA, and aluminum foil for stainless steel), the installation of protective cages in locations where piping is insulated solely for personnel protection, and performing periodic maintenance on the insulation system.

Of course, CUI is not new to the world of risk engineering, with Marsh's senior risk engineer, Iain Clough, first publishing an article in Marsh's Loss Control Newsletter in 2003, which preempted many of the practices discussed in the new API standard. Iain's article concluded:

"Corrosion under insulation is a recognized problem that can result in large or catastrophic losses. Good specification and construction standards can protect the installed pipework and can be very effective when coupled with a risk-based inspection regime, utilizing one of a number of inspection methods."

RP 584, INTEGRITY OPERATING WINDOWS

The second new API standard is RP 584, Integrity Operating Windows (IOWs). Inspection programs are not generally designed to look for unanticipated impacts of processes that are not adequately controlled. Thus, a well-designed inspection program depends on IOWs to avoid exceedances having an unanticipated impact on mechanical integrity.

The purpose of the new standard is to explain the importance of IOWs for process safety management, and to guide users in how to establish and implement an IOW program for refining, and petrochemical process facilities for the express purpose of avoiding unexpected equipment degradation that could lead to loss of containment.

Within the standard, the API advises that IOWs should be classified into different levels, distinguished by risk, in order to set priorities on notifications and timings of actions to be implemented when IOWs are exceeded. The standard defines three levels, namely critical, standard, and informational, with the primary difference between a critical and a standard limit being the reaction time allowed to return the process to within the IOW limits.

RP 585, PRESSURE EQUIPMENT INTEGRITY INCIDENT INVESTIGATION

The third standard describes how an effective investigation can be structured so that organizations can learn from each incident, and use this knowledge to reduce the likelihood of future incidents.

Through this standard, the API is aiming to provide users with practices for developing, implementing, sustaining, and enhancing an investigation program for pressure equipment integrity (PEI) incidents.

Within the standard, the API gives guidance on determining PEI incident causes, and PEI incident investigation theory, as well as information on how to conduct PEI incident investigations.

USE OF API STANDARDS DURING UNDERWRITING SURVEYS AND PROJECT REVIEWS

International standards such as API are powerful tools for individual sites, or for companies to use to prepare their own standards. Such standards are regarded as the minimum requirements during underwriting surveys and project reviews, and sites can differentiate themselves by demonstrating both an awareness of the standards themselves and how their site has considered and implemented the standards. Class-leading sites continually push for further improvement and find ways to better the standards.

Safety Snippet

STEAM REFORMER TUBE CRAWLER INSPECTION TECHNOLOGY DEVELOPMENTS

Marsh has observed sites with steam reformers making use of advances in non-intrusive reformer tube inspection by using external tube crawlers with an innovative eddy current application. The MANTIS^{TM} tube crawler by Quest Integrity is being used to inspect approximately 700 tubes in 20 hours without the need to empty out catalyst.

More information can be found at: **http://www.questintegrity.com/technology/steam-reformer-integrity-management**

PLANT PROPERTY VALUATION FOR ENERGY INSURANCE

Michael Eason, a Marsh risk engineer based in London, considers the importance of establishing accurate plant values, and the careful considerations to be taken when embarking on a valuation exercise.

BACKGROUND

In the event of a property damage loss on a plant, the insured would expect reinstatement back to a condition enjoyed prior to the loss. It follows then that this principle of "new for old" coverage relies on declaring plant property values that accurately reflect those required for reinstatement. This is also vital when considering the risk of being "under-insured" (that is, the application of "average clause").

Arriving at an accurate value is not easy. A common basis is to use the contract value for the original plant construction project. This seems reasonable as those values will include the costs of fabrication and erection. However, alongside these, a "turnkey" project contract value will typically include a raft of other items such as:

- Feasibility study.
- Basic engineering.
- Land purchase.
- Detailed engineering.
- Geological and ecological studies.
- Site preparation (earth movement/ rock blasting/dredging/ reclamation).
- Procurement, erection, and commissioning costs.
- Cost increases from delays (industrial disputes, prolonged bad weather, etc.).
- License fees.
- Training costs.
- Capitalized interest.

In addition, there will be the client's own costs, adding up to the total project value. But there are variables too that may compromise this simplistic view of the project value. For example, fast-tracking a project, contractors working in an uncompetitive market, exotic material upward price trends, and multiple projects in a particular region may all escalate the contract price. Conversely, others may serve to reduce contract values such as: Competitive markets, exotic material downward price trends, contractors seeking work from a valued client, etc.

WHAT'S INSURED?

Property damage policies provide cover under two different forms; "all risks" with specified exclusions, or fire and named perils. Property exclusions (for example, jetties, underground structures, foundations, reservoirs, etc.) may be covered on payment of additional premium. However, unless such items are specifically insured, these should be excluded from the declared values.

There are key project items which should not be included in the insurable value, as, following a major loss they may not be incurred again (these are known as "non-recurring costs"). These can include feasibility studies, geotechnical, ecological or topographical studies, basic engineering, land purchase, site preparation, license costs, and even detailed engineering (depending on the age of the plant/technology).

NEW TECHNOLOGY AND CONSTRUCTION METHODS

New technology and/or construction methods can present challenges when considering values. Modern technology with cheaper equivalent plant replacements may be available. Construction method developments, such as pre-assembled units, large crane barge availability, and heavier lift capacities, may allow a facility to be re-built at a lower cost than, say, thirty years ago. In this instance, what should the owner declare as an insurable value? This is particularly relevant in the offshore environment.

MODIFICATIONS AND REVAMPS

Over the course of the operating lifecycle, many plant changes will be made and maybe two or three major revamps will be undertaken, often costing tens of millions of dollars. Is it realistic to simply add these costs to the sum insured, and then escalate the total from year to year? Often, the cost of the revamp does not significantly increase the reinstatement value as significant cost was actually incurred dismantling and modifying existing plant in a live operational environment rather than a construction environment. These costs would not be repeated if the plant was completely reconstructed. Also, what about any decommissioned/obsolete plants? Has it been removed from the declared values? This is not an uncommon mistake.

USING COST INDICES

For older installations, or where revaluations have been carried out irregularly, perhaps without expert appreciation of trends in design and construction practice, and their associated costs, it is likely that valuation costs will be considerably out of line. Even when values have been regularly reviewed, under/over-estimation of replacement costs can occur unless an accurate account is taken of market conditions.

Cost indices are available covering different industrial groups, in various parts of the world. These are dimensionless numbers used for updating the cost required to construct a plant from a past date to a later time. They take into consideration changes in the value of money due to inflation and deflation. There are several energy industry indices; the two commonly used published indices are the Chemical Engineering's Plant Cost Index (CEPCI) and the Nelson-Farrar Refinery Cost Index.

CEPCI was first published in 1963 and is published monthly in Chemical Engineering magazine[1]. Multiple sub-indices monitor material and commodity price movements, with further sub-indices monitoring labor costs.

The Nelson-Farrar Index was established in 1946 and is published monthly in the Oil & Gas Journal[2]. Accurate use of Nelson-Farrar is restricted to the petroleum industry in the US Gulf coast region; therefore care must be taken when applying this index to non-US locations due to variable labor rates, exchange rates, import duties, and local taxes. Conversion from a US location to other parts of the world can be made via a "location factor". This means that costs calculated using the US-based indices require uplifting to generate an equivalent plant value in another location. These location factors are not generally publicly available, being developed by oil majors for internal use in estimating the cost of their own projects in various parts of the world.

Ultimately, great care must be taken when applying cost indices. They can be used effectively within certain constraints to adjust values; however, their use should be limited to five-year periods. Beyond that, price differences in equipment and labor between actual costs and those predicted using indices can cause significant deviations. So, the blind application of cost indices to original plant costs, while always yielding a numerical result, will very often produce an inappropriate valuation.

PROFESSIONAL VALUATIONS

Professional valuations can produce accurate data for insurance purposes. Such valuations should take a systematic approach based on data collection, with a full cross reference to the assets register. Simple "walk-through" type valuations, with no detailed checking of the asset register, but merely a superficial inspection, are not a comparable substitute.

A credible valuation invariably involves a professional team visiting the site to obtain detailed information of major equipment including vessels, columns, pumps, fin-fan coolers, utilities, pipework, water towers, etc. This data is used as a basis, after which various factors such as location, labor costs, procurement, etc. are taken into account.

There are a number of consultants providing plant valuation services. When selecting a provider, clients should review the experience and knowledge that the consultant has of working in the energy field, and also their experience of particular asset types and locations.

ALTERNATIVES

A professional valuation is by far the most accurate means of establishing the value at risk. However, where this is not possible, other alternatives exist. Clients wishing to carry out their own valuations could apply a careful methodology to arrive at an approximate asset value for insurance purposes.

For example, where a plant is to be insured on a reinstatement basis, a method of establishing the values at risk can be based on the original contract value minus those non-recurring costs, plus consideration of additions/deletions arising from plant changes. The contract value should be adjusted using an appropriate national or international construction cost index to reflect a current replacement value at policy inception. It should also be noted that a professionally produced valuation can also be indexed to a present value; the original valuation provider would likely offer this as a service, providing that the physical valuation survey was within say, the last three or so years.

SUMMARY

Knowing the true value at risk is vital to ensure that a fair premium is paid and to mitigate against the risk of under-insurance. Marsh considers that a professional valuation carried out by experts in the energy field is by far the best means of establishing an accurate valuation. There are alternatives, such as the use of plant cost indices to update the cost to construct a plant at a later time, but in doing so, careful attention should be paid to those non-recurring costs in the original project, as well as the influence of geographical location. Ultimately, beyond five years, the accuracy of a desk-top valuation can result in significant deviations.

REFERENCES:

1. http://www.chemengonline.com

2. http://www.ogj.com

Safety Snippet

DETECTION OF CORROSION UNDER INSULATION USING SNIFFER DOGS

One company is exploiting the highly sensitive noses of trained dogs to detect the presence of corrosion under insulation on gas plants. This interesting and innovative project is on-going at two sites and is showing positive results.

THE BUSINESS INTERRUPTION CENTRE OF EXCELLENCE

AN INTERVIEW WITH CAROLINE WOOLLEY BY CHRIS PRICE-KUEHNE

Caroline Woolley is the EMEA Property Practice leader and heads up Marsh's Global Business Interruption Centre of Excellence (BICoE). Chris Price-Kuehne is a senior risk engineer, specializing in business interruption (BI) in Marsh's Energy Practice.

CHRIS: Caroline, we've both been working on business interruption (BI) issues for many years, albeit in different business areas. You're now leading Marsh's BICoE. What is the BICoE and why was it formed?

CAROLINE: It was formed because BI strikes fear into most people; a fear of the unknown. We aim to change this through training, knowledge sharing, and by providing our clients with access to Marsh's BI experts.

The BICoE consists of a core council, supported by a network of BI experts across the world. We have regional leaders tasked with spreading BI messages and helping to create comfort around BI risks for clients, colleagues, and insurers.

CHRIS: There are a number of groups within Marsh that already focus on BI risks for their business areas. For instance, the Engineering Specialties team within the Energy Practice carries out comprehensive BI studies for oil, gas, and petrochemicals clients around the world. How is Marsh's existing BI knowledge being brought to bear by the BICoE?

CAROLINE: Our aim is to draw on best practice from around the business and ensure that it is shared effectively. We want to improve everyone's understanding of the risk, starting with property damage BI. We act as a connector between geographies and businesses to share ideas and provide templates to ensure continuous improvement.

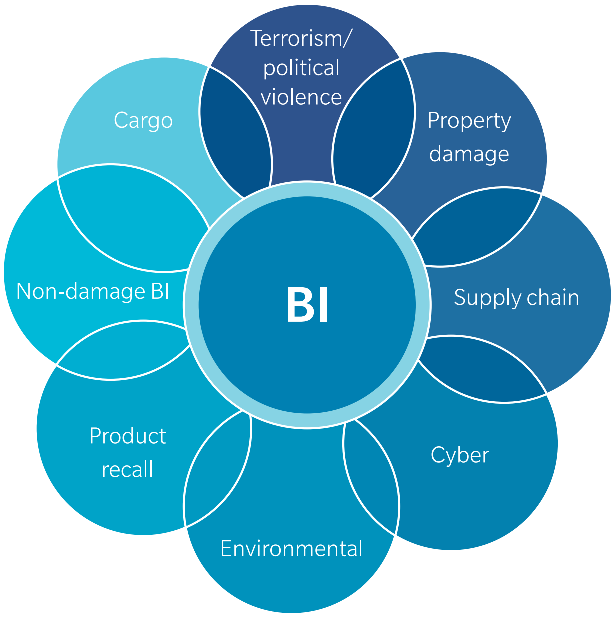
Everything we do is subject to local interpretation and adoption; we aren't dictating what is required. What we are doing is providing sufficient tools to allow each region to improve the level of understanding around BI. This will be of value to colleagues and clients, and will develop a strong value proposition around BI risk.

CHRIS: BI claims in the energy sector are typically triggered by an insured, physical loss. In other industries, a wide range of incidents may cause a business to suffer an interruption. Are you focusing on BI following property damage (PD) incidents?

CAROLINE: Initially yes, but we view BI through the client lens. We are interested in anything that may interrupt a client's business. Many such incidents don't necessarily fit neatly into existing insurance categories: this is something we've illustrated using the "BI bubbles" concept (illustrated overleaf).

We are currently looking at a variety of policies that have an element of BI. For these policies, we are improving and aligning cover, identifying gaps, and, where appropriate, filling those gaps.

For example, areas of particular interest include supply chain BI and non-damage BI. Many policies place restrictions on suppliers' extension clauses, typically either by reducing limits or by cutting cover from all-risks to FLEXA (fire, lighting, explosion, aircraft). Policies often only cover first tier (direct) suppliers, and are usually limited to being triggered only by damage. We have therefore worked with insurers to develop policies to address some of the standard limitations by introducing cover for multi-tier and non-damage BI events. Such policies are now readily available, and we are striving to establish their place in the market. Having addressed this issue, we will now work on the next gap.



We take a holistic view of BI and are encouraging insurers to do so too.

CHRIS: This sounds like quite an innovation for the traditional BI policy structures. Is this an internal Marsh exercise or can clients also get involved?

CAROLINE: We have a real opportunity to change the way the industry views BI just now. The move towards a more holistic approach gives much more scope for innovation and there is a real interest from clients in this.

We have been holding various brainstorm sessions around the world in 2014, both internally and with insurers and clients. Clients are very keen on contributing, particularly those that have suffered major loss.

We have a fact sheet available that assists clients with starting their own BI deliberations. After an initial discussion has taken place, we can work with the client to determine how it would be most appropriate to proceed. We can assist and support as much as required.

CHRIS: Many of the items that the BICoE is working on are applicable to a broad range of Marsh's clients. What opportunity does this present for energy clients specifically?

CAROLINE: The enormity of the project could be rather intimidating. We are taking bite-size chunks and working hard to make a tangible difference; starting with improvements to PD/BI policies in-line with industry special requirements. For our energy colleagues, this means using the full global weight of Marsh in a coordinated fashion, to influence and change the norms while drawing on best practice and establishing a framework for energy BI policies.

The BICoE will also be working to see if alternative risk transfer solutions can be established for BI risks that might already be covered under existing policies. However, it's not just about risk transfer; the BICoE will be looking to develop risk management solutions too.

The integration of BI concepts, and making the connections between placement and claims, is essential for continuous improvement of BI risks.

CHRIS: What are the plans for the BICoE in 2015? If readers are interested in getting involved, how can they best participate?

CAROLINE: We have started out by looking at issues surrounding PD/BI policies. In 2014, we focused on the development of tools and templates to improve the efficiency and effectiveness of value collection, the placement process, and the transfer of PD/BI risk.

In 2015, we will be focusing on the improvement of policies other than PD/BI that have an element of BI. We will be seeking innovations to fill gaps in BI cover and will be drawing this together under the overall umbrella of the BICoE. We are happy to help set up brainstorming sessions on BI issues for clients and insurers that are interested in learning more.

CHRIS: Thank you, Caroline. The BICoE is clearly a great vehicle for making clients and insurers more comfortable with business interruption risks.

THE VALUE OF A MARSH RISK ENGINEERING SURVEY REPORT

The following email received from a loss adjuster, highlights how a risk engineering survey report can be a useful aid when investigating a loss:

Dear All,

I think most would agree that risk survey reports are primarily geared towards the underwriter and the placement of a risk. However, the risk survey report also has a part to play in the event of a loss, which can sometimes unfortunately be overlooked. I would like to change this. The reason for wanting to do this is explained by way of example.

Integra was recently appointed to investigate and adjust a refinery fire loss. The risk engineers that drafted the underwriting report on this refinery did a superb job of providing sufficient detailed background information about the insured risk and the plant and processes employed at the refinery, which allowed the adjusting team to hit the ground running when the all clear was given to get on site.

We issued a comprehensive 23-page draft report to the lead reinsurer less than 72 hours after the time/date of ignition. The only way that we were able to fly to site, carry out the site survey work, and issue a detailed report in such a short space of time was because the building blocks of our report were partly to be found in the detail of the underwriting report.

On this occasion, we had the opportunity to review in detail, a good, well-thought-out underwriting report prior to the first site visit. Certainly for me, this rammed home the vital importance of the work that you chaps do at the front end before the risk is placed.

I look forward to working more closely with you all in the future, as it can only serve to enhance the insurance industry value chain (and keep me on my toes).

Thanks and keep up the good work!

Angus Bradley
Regional Manager Middle East, Integra Technical Services Middle East Limited

FROM THE ARCHIVES...

KEY LESSONS TO REDUCING RISK DURING HOT WORK

Corporate memory is often said to extend no further back than 10 years or so. With this in mind, we include here an article written by Nigel Cairns in an edition of the Loss Control Newsletter back in 2011, from which lessons can still be drawn today.

A review of Chemical Safety Board safety information in relation to hot work activities at facilities handling hydrocarbons provides some key lessons.

INTRODUCTION

Of all the maintenance activities that operators may carry out as part of day-to-day energy operations, none has quite the risk exposure as carrying out hot work. Hot work can be considered as that which involves burning, welding, or a similar operation (such as cutting, brazing, grinding, and soldering) that is capable of initiating fires or explosions.

Like many such operational activities, its risks are generally well understood and can be mitigated by use of the correct management of change procedures and inherently safe operational and maintenance techniques. However, risk-awareness is often greatest where the hazard potential is well known, resulting in those activities being perceived as significantly less hazardous. This may give rise to a lower quality of risk awareness and mitigation, and ultimately a greater exposure.

The Chemical Safety Board (CSB) in the US recently produced a paper that highlighted the learning from a number of hot work incidents on storage tanks, representing some of the 60 or so fatalities which have occurred over the past 20 years in this area of the energy industry. This article looks at two of those incidents and the learning from the CSB's investigation.

STANDARDS

As you might expect, such an activity has a number of relevant standards which instruct and guide operators on good practice. Of course, the most inherently safe operation is one which eliminates the potential for fire and explosion by removing the heat element altogether (for example, by the use of "cold cutting"), but often this is neither practical nor possible. In such situations, an awareness of potential flammable in ventories is imperative, and while the OSHA hot work standard 29 CFR 1910.252 prohibits hot work in an explosive atmosphere, it does not explicitly require the use of a combustible gas detector. However, other good practice guidance documents from the National Fire Protection Association (NFPA), American Petroleum Institute (API), and FM Global stress the need for gas monitoring to prevent fires and explosions. Indeed, NFPA 326 is very specific about the flammability levels at which any hot work must be stopped and the flammable atmosphere either eliminated or controlled.

It is true to say that while each of the incidents investigated has unique features, all resulted from an ignition source created by welding or cutting that was performed in, on, or near tanks that contained flammables. In some cases, the presence of a flammable material was completely unknown to the workers affected.

INCIDENT #1

At the Partridge-Raleigh Oilfield in Raleigh, Mississippi, in June 2006, three workers were killed and one seriously injured when, as contractors were installing a new pipe between two oil tanks, sparks from a welding torch ignited flammable hydrocarbon vapor venting from one of them.

This was a rural oilfield, containing "satellite" storage tanks that would ultimately feed a refining operation some distance away. One would imagine it to have little residual risk when compared to carrying out a maintenance procedure in the middle of an operating refinery or hydrocarbon processing plant.

All the tanks damaged by the explosion were interconnected by piping, and one of the tanks contained crude oil, which was the source of the vapor that fuelled the explosions; this tank was not isolated prior to the work starting. Crucially, no gas monitoring tests were carried out either prior to or during the hot work, and neither the contract nor operating company required written hot work permits for this kind of work. The only testing that was carried out was the use of a lit welding torch to check one of the tanks for flammable vapor.

INCIDENT #2

The second incident took place at the Motiva Enterprises Refinery, Delaware City, Delaware, in July 2001. A massive explosion destroyed a large storage tank containing a mixture of sulphuric acid and flammable hydrocarbons. One contractor was killed, eight others were injured, and sulphuric acid from collapsed and damaged tanks polluted the Delaware River.

With similarities to the incident at Partridge-Raleigh, the explosion occurred during welding operations above the tank, when flammable hydrocarbon vapor was ignited by welding sparks. This tank, however, was not part of a rural "'satellite" operation, but part of a major refinery; there was a hot work program that included written permits, and a requirement to do combustible gas testing prior to starting work. However, there were fundamental deficiencies in managing the operation's risk. Although gas testing was carried out at the start of the job, in the five hours leading to the explosion, the air temperature warmed by about eight degrees Celsius, increasing hydrocarbon evaporation inside the tank.

The hot work was allowed to be carried out near tanks that contained flammables, and on top of one that had known holes due to corrosion. The vapor escaped through these holes to find a source of ignition; continuous atmospheric monitoring and the control of welding sparks were not required. In this incident, the inadequate control of hot work was compounded by a poor maintenance program.

LESSONS

There are a number of key lessons to be learned from this study, namely:

1. Whenever possible, try to avoid hot work by using alternative methods.

2. Before starting hot work, carry out a hazard assessment to identify the scope of the work, potential hazards, and methods of control.

3. Remove all flammable materials from the work area by draining, purging, or isolating prior to starting work.

4. Conduct gas monitoring in the work area before and during hot work activities using a properly calibrated combustible gas detector. This should include areas where a flammable atmosphere is not anticipated.

5. Train and validate personnel on hot work procedures, and the use of monitoring and safety equipment. Ensure personnel are familiar with the specific site hazards.

6. Authorize all hot work using a written permit system that identifies the work to be conducted and the required precautions.

7. Provide safety supervision for outside contractors and inform contractors about site-specific hazards, including the presence of flammable materials.

It is clear that there are many common themes and causes in the incidents studied, and that potential incidents are often made worse where there is a coincident lack of effective operational, maintenance, and inspection procedures for the assets concerned.

All the incidents studied by the CSB resulted not only in either serious injury or loss of life, but also in significant property damage, and in some cases environmental damage and liability issues. They highlight that hot work-related fires and explosions continue to occur, despite the fact that the hazards are well established, usually predictable, and that there are a number of relevant standards which instruct and guide operators on good practice.

Safety Snippet

SPRAYED ALUMINIUM COATINGS PROTECT AGAINST CORROSION UNDER INSULATION

Marsh has recently seen two clients benefitting from the use of sprayed aluminium coatings on equipment/ piping where the surfaces can be exposed to a salt/marine environment. Quick to apply, these coatings help to reduce corrosion under i13nsulation (CUI).
Further information can be found at: **http://www.flamesprayusa.com/flame-spray-coating.php**


COMBUSTION
AIR DUCT

THE BUNCEFIELD VAPOR CLOUD EXPLOSION MECHANISM:

Marc Joseph, a Marsh risk engineer based in Dubai, reviews the research carried out on vapor cloud explosions (VCE) in the light of investigations undertaken into the Buncefield incident in 2005. Areas are highlighted that have helped our understanding of the vapor cloud explosion mechanism, which will assist tank farm owners and operators with managing risks at such sites.

In July 2014, the Fire and Blast Information Group (FABIG) made available the final report by the Steel Construction Institute (SCI) on the “dispersion and explosion characteristics of large vapor clouds” as observed in the 2005 Buncefield incident.

The project’s objectives were to understand vapor cloud development following large losses of primary containment, the characteristics of explosions involving large, flat flammable vapor clouds, and the explosion mechanisms that can give rise to high overpressures over a large area, as observed in the Buncefield incident.

In this article, we review the research into VCE characteristics, with reference to the Buncefield incident and the investigations that were undertaken over the past few years.

THE BUNCEFIELD INCIDENT

The Buncefield Complex commenced operations in 1968 and was a large tank farm occupied by Hertfordshire Oil Storage Limited (HOSL), UK Oil Pipelines Limited, and BP Oil UK Limited.

At approximately 6.00 a.m. on the December 11, 2005, a series of explosions occurred at the Buncefield complex. The main explosion resulted from the ignition of a vapor cloud emanating from tank 912 in bund A in the HOSL west site. This explosion resulted in very large overpressures (>2 bar) that, in turn, caused further loss of containment and subsequent fires.

Tank 912 was being filled with gasoline; the level gauge remained unchanged, overfill protection was inoperative, and the filling continued unchecked. Around 185 tonnes of gasoline (SCI report, 2014) was released over a period of about 40 minutes prior to ignition. A very large, low lying and relatively shallow (2-3 m) vapor cloud, of which the main constituents were possibly butane and pentane (Atkinson et. al., 2008), developed over a wide area extending significantly offsite.

Two other explosions occurred and a large fire engulfed 23 tanks; the fire burned for five days. There were no fatalities, but 43 people were injured and significant damage occurred to surrounding properties. Total damage was of the order of US$1.5 billion.

Figure 1: Buncefield December 2005 Fire and Damage to Site

WHAT IS A VAPOR CLOUD EXPLOSION?

A VCE is basically the result of a release and dispersion of flammable material into the atmosphere, which ignites upon contact with an ignition source, following the formation of a cloud or plume of pre-mixed fuel and air. VCEs are of key interest to the insurance industry as they often represent the estimated maximum loss (EML) to which an insurance underwriter is exposed.

WHAT IS THE MECHANISM FOR A VCE?

When a flammable vapor cloud (gas/air mixture) is ignited, combustion in any part of the mixture requires contact with the flame front. When the flame front contacts part of the mixture, it generally burns, becomes hot, and expands by a factor of around eight in volume. The chemical energy released is used to heat the gas and to push away nearby gas to make room for the extra volume. A small amount of the energy is also released as radiation.

If the expansion flow from the combusting part of the vapor cloud pushes an unburnt part of the vapor cloud past an obstacle, the unburnt gas is forced to accelerate in order to keep enough gas flowing away from the flame front. When this flow reaches the far side of a particular obstacle, it can slow down and its kinetic energy is quickly converted to turbulence. This improves local air mixing and results in a rapidly increased combustion rate, forcing a faster flow through future obstacles, and increasingly storing energy as pressure. If there is a high level of congestion, which can be generated by obstacles such as pipe racks, tanks, trees/vegetation, and multilevel process structures, then the flame speeds generated can reach in excess of 100m/s. As indicated by Puttock (1995), high pressures may be generated by congestion.

The faster the flame travels, the higher the pressure generated ahead of it. If very high flame speeds are produced, a transition from deflagration to detonation[1], which involves a very high shock wave, can occur. The combustion of the gas/air mixture then provides the energy to sustain the shock wave. As a result, the detonation is self-sustaining as long as the concentration of the gas is within certain limits. In a detonation, the flame front and shock waves are coupled and travel at a speed of approximately 2000m/s, and very high overpressures (in excess of 20 bar) can result (Naturalhy, 2008). Beyond the region that contains obstacles, the flame speed will decelerate rapidly, with a resulting decay in overpressure.

THE BUNCEFIELD INVESTIGATION FINDINGS RELATED TO THE VCE MECHANISM

Buncefield Major Incident Investigation Board (BMIIB) 2008 Report

The BMIIB, which was formed in 2006, released its final report in December 2008, which presented an explanation on the formation and ignition of vapor clouds, and why the formation of a large vapor cloud from gasoline was not envisaged at Buncefield.

Before Buncefield, the worst design event associated with a tank farm was thought to be a large pool fire following the failure of a tank. The rationale behind ignoring the possibility of an open flammable cloud explosion is that gasoline is a "stable liquid" at ambient temperatures and pressures. At Buncefield, it seems likely that much higher rates of evaporation of the spilled gasoline were achieved as a result of the manner in which the liquid was discharged from the tank.

Initial studies in 2007 by an advisory group failed to identify a single scenario that could explain all aspects of the explosion mechanism, and in the 2008 report, the BMIIB recommended that further work was needed to research the actual VCE mechanism. The advisory group therefore recommended that a joint industry project (JIP) be initiated to complete the assessment.

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1. A deflagration is a propagation of a combustion zone at a velocity less than the speed of sound in the unreacted medium. A detonation is a propagation of a combustion zone at a velocity greater than the speed of sound in the unreacted medium.

HSE 2009 Report by Steel Construction Institute (SCI)

The JIP was initiated in May 2008. Its main objective was to provide an understanding of the explosion mechanism. In June 2009, the results of the JIP investigation were published by the UK's Health and Safety Executive (HSE). The findings were as follows:

- Dense vapor dispersion in low wind speed conditions led to a cloud build-up over an area of 120,000m^2. The volume occupied by the cloud was estimated to be 240,000m^3 (Figure 2).
- In order to generate an explosion, there must be either confinement of the gas cloud or congestion. The two lanes adjacent to the depot were bordered by dense, wide verges containing trees and very dense undergrowth which could in fact have as strong an influence in generating explosion overpressure as the plant piping congestion. Note that the paper describing British Gas research and technology tests at Spadeadam, Harris & Wickens (1989), identified trees as potential congestion to cause high flame speeds. Geiger (1983) also supports this theory regarding trees.

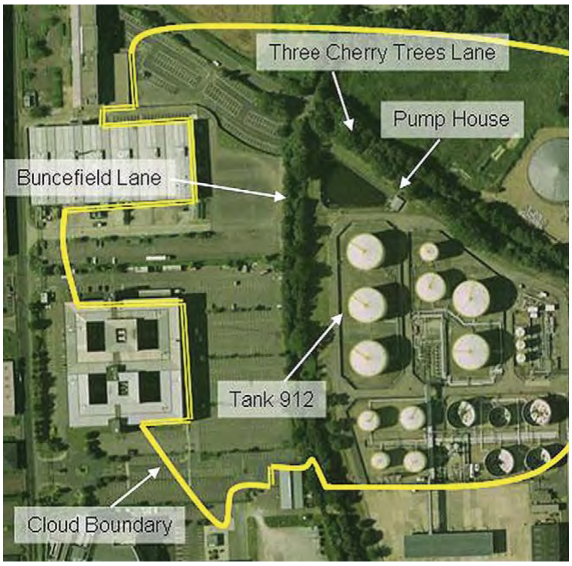

Figure 2: Area of the site indicating the cloud boundary as per the BMIIB reports.

The two most commonly known explosion mechanisms, deflagration and detonation, were assessed. The deflagration scenarios were modelled using the computational fluid dynamics (CFD) code EXSIM. Detailed modeling of the area immediately surrounding the emergency pump house supports the proposition that the trees and undergrowth caused flame acceleration to high speeds such that a transition to detonation is considered possible (Figure 3).

- Ignition occurred at the emergency pump house; the collapse of the pump house structure was followed by a deflagration outside the pump house.
- The overpressure within the cloud was generally greater than 2 bar, but the maximum overpressure was probably much higher.
- Detonation of a part of the remaining gas cloud took place. There was evidence indicating that a deflagration to detonation transition in the vapor cloud was credible. The deflagration to detonation transition mechanism is also supported in the paper by Johnson (2010).
- Overpressure diminished rapidly with distance away from the edge of the cloud. This was substantiated by the detonation modeling (Kingston CFD Modeling).

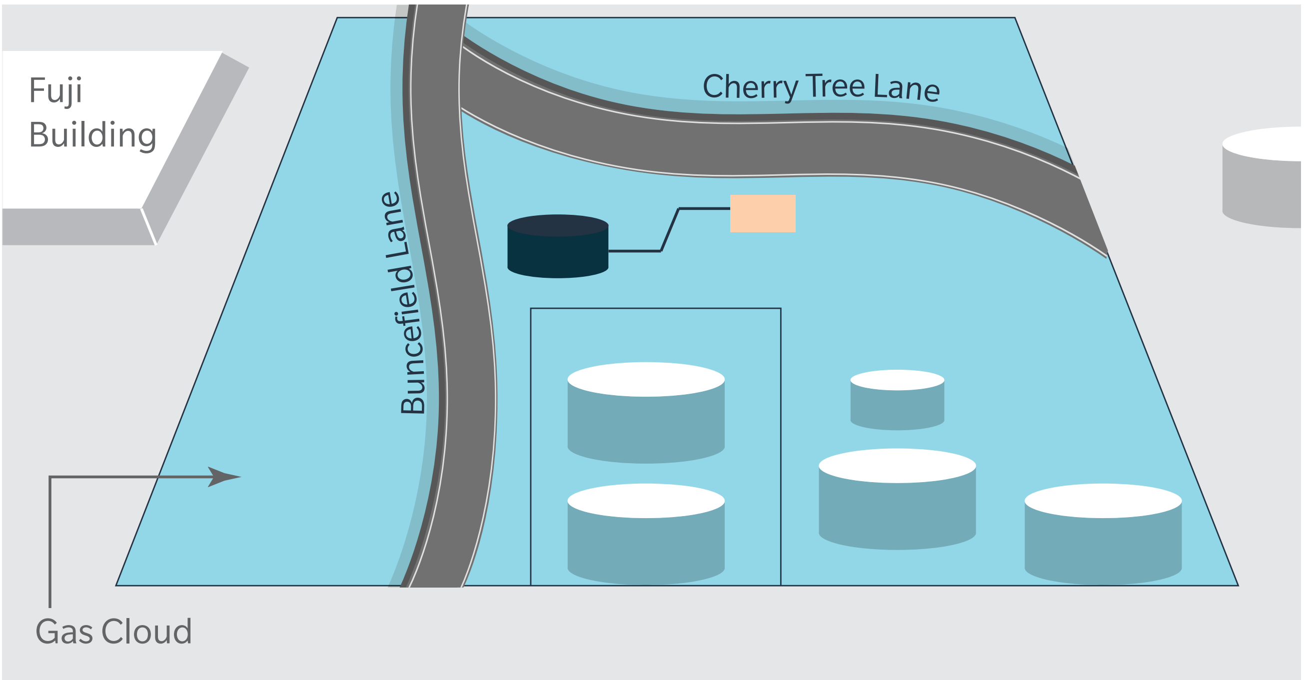

Figure 3: EXSIM simulation of the Deflagration scenario.

SCI 2014 Report

The JIP recommended further work to better understand the dispersion and explosion characteristics of large vapor clouds from primary containment, with test programs running from July 2010 to December 2013. The results were as follows:

- Flammable cloud formation:
  - Tests focused on vapor dispersion were done by the HSE. Seven full-scale over-spill tests were performed using a 10.4m-high model tank shown below.
  - It was found that an atmospheric storage tank overfill incident in still conditions can lead to the development of a large shallow vapor cloud, as per the 2009 report.

Figure 4: Liquid spills facility showing the test in progress (left) and the 1500 mm wide chute (right).

- Effect of vegetation on explosion overpressure
  - These tests were conducted by Gexcon (Norway) and DNV.
  - Types of vegetation studied were Norway spruce, Silver Birch, and Thuja.
  - It was found that:
    - All the tests showed that there was little influence of vegetation type. Types of vegetation studied were Norway spruce, Silver Birch, and Thuja.
    - The presence of vegetation always resulted in increased flame speed.
    - Two tests with a 4.5m-wide row of vegetation resulted in detonations.
    - The tests justify the BMIIB hypothesis of vegetation causing the congestion which increased the flame speed.

Figure 5: Large scale test set-up for effect of vegetation on explosion overpressure

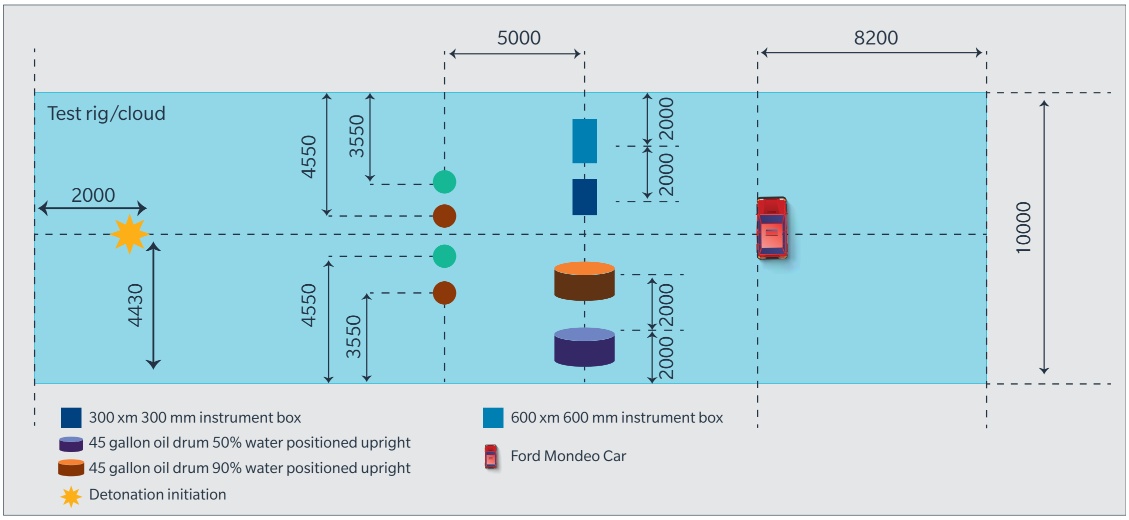

Figure 6: Obstacles used in test

- Detonation characteristics of large flammable vapor clouds
    - Various obstacles were placed at different locations in the test facility (see Figure 6). Six tests were undertaken; using nominally stoichiometric propane/air mixtures.
  - It was found that:
    - Explosions involving large shallow unconfined vapor clouds can cause very high overpressures.
    - The overpressure outside the cloud diminishes rapidly with distance from the edge of the cloud.
    - Overpressures exceeding 3 bar were found to cause significant damage to cars and instrument boxes. Minor damage occurred when the pressure was ≤1 bar. Oil drums were found to sustain damage at an overpressure >2 bar.
    - These tests justified the 2009 report regarding high explosion overpressures and the reduction in overpressure outside the cloud with increasing distance.
- Investigation of alternative explosion mechanisms
  - An alternative mechanism known as “episodic deflagration” has been investigated. It was found that it was not possible, on a large scale, to initiate “episodic deflagrations”.

CONCLUSION

Prior to the 2005 Buncefield incident, the formation of a vapor cloud from gasoline in such an installation would not have been considered a credible scenario for consideration.

A unique feature of the Buncefield explosion was the lack of on-site obstacles that could cause rapid turbulence and flame speeds that produce high overpressures. The explosion mechanism can clearly be explained using current knowledge of VCEs and literature.

The 2014 report documented a justification of the VCE explosion mechanism postulated in the 2009 report via large scale experiments. This mechanism was as follows:

- Dense vapor dispersion in very low wind speed conditions leading to a large vapor cloud.
- Ignition, followed by a deflagration and flame propagation to the undergrowth and trees.
- Flame acceleration in the undergrowth and trees along Three Cherry Trees Lane gave flame velocities to several hundred m/s, followed by a transition to detonation.
- Detonation of part of the remaining gas cloud.
- Overpressure diminished rapidly with distance away from the edge of the cloud.

In addition, it should be noted that the detonation would not have occurred if very high flame speeds had not been generated in the deflagration, which is due to the congestion created by the trees/vegetation.

The series of investigations into Buncefield and the subsequent testing have greatly helped our understanding of the vapor cloud explosion mechanism, which should assist tank farm owners and operators in managing the risks at such sites. While important to the development of risk management, we should also be aware of the rarity of such an incident at a tank farm.

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MARSH NEWS: NEW ENGINEERS

Since the last edition of the LCN, Marsh's engineering team has welcomed five new members.

PAUL COLEMAN - LONDON

Paul is a Chartered Chemical Engineer and MBA with 27 years' experience gained in the petrochemicals industry. His career has been with Hydro, EVC and INEOS, working on sites in the UK at Newton Aycliffe, Runcorn and Barry. His former roles have been as a plant process engineer, maintenance manager, plant manager and manufacturing manager. Latterly his role was as the site manager at the Ineos Newton Aycliffe site. Paul has a breadth of experience in engineering and operations management.

Paul joins the GERE team in London and is responsible for downstream underwriting surveys and providing risk management advice.

TREVOR HUGHES - LONDON

Trevor is a chemical engineer with over 35 years' experience in industry. He has spent the majority of his career in Du Pont, working in many different locations in Western Europe, Eastern Europe, the FSU and the Middle East. He has held many different positions in operating businesses, up to and including plant manager roles. In recent years Trevor has been working for Du Pont's consulting arm, helping upstream and downstream oil and gas clients improve safety, process safety management, and capital projects management.

Trevor joins the GERE team in London and is responsible for both downstream and upstream underwriting surveys and providing risk management advice.

SAMANTHA NELSON - LONDON

Samantha's technical background is in Instrumentation and Control. She joins Marsh from Talisman-Sinopec where she was most recently Montrose Area Redevelopment (MAR) Project Offshore Installation Manager (OIM) providing Operations experience and leadership within the Greenfield design team. Samantha brings with her a depth of operational management experience having commenced her career in power generation with National Power, prior to working in the North Sea offshore oil and gas industry for 22 years with Shell, Elf Enterprise and Talisman-Sinopec. Through her career, Samantha has fulfilled many operations, maintenance and production positions through to OIM during assignments associated with Brent Bravo, Claymore, Talisman house, Piper 'B', Saltire, Auk, Clyde & Montrose.

Samantha joins the GERE team in London and is responsible for upstream underwriting surveys and providing risk management advice.

JERRY MCKENNA - DUBAI

Jerry is a Mechanical Engineer with over 30 years' experience in the electricity generation industry. He has extensive experience in the management of all aspect of the operations and maintenance of power plants. The majority of his career has been with ESB in Ireland. The various positions he has held include Shift Charge Engineer, Technical Services Engineer, Operations Manager, Maintenance Manager and Plant General Manager working in oil fired, coal fired and peat fired generating stations. He was a member of the board who commissioned, reviewed and approved internal engineering standards produced by ESB's technical specialists.

IVAN CORONADO - MIAMI

Ivan is a Chemical Engineer with international experience working for EPC contractors including MW Kellogg (London) and Inelectra (Venezuela). He held process and project engineering positions and was involved in all stages of project execution including conceptual engineering, basic and detail Engineering, FEED, construction, commissioning and start up. Prior to joining Marsh, Ivan spent six years as a risk engineer for Liberty International Underwriters working across a broad range of technical industry classes including oil, gas, petrochemicals and power generation.

Ivan joins Marsh as a risk engineer representing GERE in Miami, carrying out risk evaluations of oil, gas, petrochemical and chemical facilities, as well as providing loss prevention consultancy.

MARSH'S ENERGY TRAINING COURSES 2015

Marsh's Energy Practice offers courses at three different levels at various locations around the world. For details on booking a place please contact Carol-Joan Smart.

THE ENERGY INSURANCE DIPLOMA COURSE

Beginners' Level

LONDON: February 23-27, 2015
July 6-10, 2015

This foundation-level course provides an introduction to the fundamental principles of insurance, such as insurable interest, indemnity, subrogation, and contribution. It also offers an insight into the workings of the insurance market. The first three days of the program are led by a chartered insurance practitioner from the Chartered Insurance Institute (CII), who takes delegates through the principles of insurance in relation to the Insurance Foundation 1 (IF1) syllabus – a module that forms part of the CII Certificate in Insurance. The remainder of the course provides an overview of the types of insurance relevant to the energy industry. As part of the course, delegates are also taken on a tour of Lloyd's of London.

THE ENERGY INSURANCE AND RISK MANAGEMENT COURSE

Intermediate Level

LONDON: May 11-15, 2015
October 5-9, 2015

LAGOS, NIGERIA: March 9-12, 2015

JOHANNESBURG: April 13-16, 2015

DUBAI, UAE: October 25-28, 2015

This intermediate-level course provides delegates with a broad understanding of energy insurance and how it is placed in the insurance market. As well as exploring the risk management aspect of the energy industry, delegates gain a broader understanding of the subject within their present roles. Topics covered during the course include business interruption, risk identification and evaluation, drilling risks, control of well, and delay in start-up.

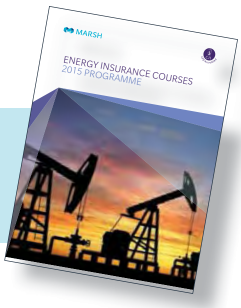
THE ENERGY RISK MANAGEMENT COURSE

Advanced Level

LONDON: September 7-11, 2015

This advanced-level course is designed to broaden delegates' knowledge in all areas of risk identification and analysis, and protection of revenue and assets. The course combines theoretical and practical training, and includes a site visit and risk assessment exercise. The site visit is carried out at an onshore plant where delegates will be instructed on, and carry out, a risk-assessment survey. The knowledge, skills, and processes learnt are transferable to all types of business, enabling delegates to conduct a similar survey on their return to work.

CONTACT: carol-joan.smart@marsh.com
To access the energy insurance courses 2015 brochure please visit www.marsh.com



Safety Snippet

USING SOCIAL MEDIA FOR POSTING INFORMATION DURING A SITE EMERGENCY

It's common these days for companies to have a site emergency response webpage to inform neighboring sites on its emergency status. One site recently visited by Marsh had taken this further by setting up a dedicated Facebook page to post information during a site emergency in order to inform local residents of what was happening.

LOSSES

JANUARY – DECEMBER 2014

CHEMICAL

LOSS NO.	10023	A major urea manufacturing project start-up will be delayed as a result of a fire on a ship delivering equipment to the plant site. The incident caused the disruption to the delivery of critical equipment to be used in the project, consequently leading to potential project execution delays.
DATE OF LOSS	07/02/2014	
COUNTRY	Indonesia	
LOCATION	Borneo	
UNIT TYPE		
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Fire	
CAUSE		

LOSS NO.	10030	Fire broke out in a xylene furnace, probably as a result of a puncture in a xylene tube in the combustion section. The fire was quickly extinguished by company employees after isolating the furnace resulting in no injuries or environmental release.
DATE OF LOSS	07/03/2014	
COUNTRY	Israel	
LOCATION	Haifa Bay	
UNIT TYPE	Xylene	
EQUIPMENT TYPE	Furnace	
MATERIAL	Xylene	
EVENT TYPE	Fire	
CAUSE		

LOSS NO.	9995	Fire broke out at a refinery and petrochemicals complex. It was put out with no casualties. The fire was triggered by a leak of propylene at a 300,000 tons per year (tpy) air separation unit. The fire lasted for about five hours before being extinguished.
DATE OF LOSS	04/08/2014	
COUNTRY	China	
LOCATION	Lanzhou Air	
UNIT TYPE	Separation unit	
EQUIPMENT TYPE		
MATERIAL	Propylene	
EVENT TYPE	Fire	
CAUSE		

LOSS NO.	10017	Emergency response team responded to a fire at a metering station outside the petrochemical plant. The fire was on the hydrocarbon line that feeds the site. the emergency response team blocked the feed line and depressurized and flared the gas. No one was injured in the fire and minimal damage was reported. The fire occurred during a thunderstorm, so was thought to be due to lightning or static electricity.
DATE OF LOSS	26/08/2014	
COUNTRY	United States	
LOCATION	Point Comfort, Texas	
UNIT TYPE	Offsites	
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Fire	
CAUSE	Storm	

LOSS NO.	10049	An explosion in a chemical facility resulted in injury to 66 people. Two were reported to be in a serious condition. The explosion caused serious material damage to the facility. Police and fire fighters were injured in the blast. There may also have been a release of chlorine gas associated with the accident.
DATE OF LOSS	07/11/2014	
COUNTRY	Argentina	
LOCATION	Cordoba	
UNIT TYPE		
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Explosion, fire	
CAUSE		

LOSS NO.	10054	Four workers were killed and a fifth hospitalized after a chemical leak. It was reported that workers were carrying out routine maintenance of a manufacturing facility when methyl mercaptant started to leak. Investigations are underway to identify the cause of the leak and subsequent fatalities.
DATE OF LOSS	15/11/2014	
COUNTRY	United States	
LOCATION	La Porte, Texas	
UNIT TYPE	Methyl mercaptant	
EQUIPMENT TYPE		
MATERIAL	Methyl mercaptant	
EVENT TYPE	Release	
CAUSE		

LOSS NO.	10059	Maintenance work was being carried out on a styrene monomer/ propylene oxide plant when an explosion and fire ripped through the plant. The explosion was thought to have originated in the unit reactor. Two workers were slightly injured in the blast. There was reported to be extensive damage to the production unit resulting in a substantial interruption to the operation of the unit.
DATE OF LOSS	03/06/14	
COUNTRY	Netherlands	
LOCATION	Moerdijk	
UNIT TYPE	Styrene	
EQUIPMENT TYPE	Reactor	
MATERIAL	Styrene monomer	
EVENT TYPE	Explosion, Fire	
CAUSE		

DISTRIBUTION

LOSS NO.	9911	An explosion occurred on a major oil pipeline. About 10.000 barrels of crude were released, caused by works in connection with the enlargement of autoroute between the south of Tunisia and the town of Gabes.
DATE OF LOSS	01/01/2014	
COUNTRY	Tunisia	
LOCATION		
UNIT TYPE	Pipeline	
EQUIPMENT TYPE	Pipe	
MATERIAL	Crude Oil	
EVENT TYPE	Explosion	
CAUSE	Explosion	

LOSS NO.	9916	A train with 5 cars full of crude oil and four LPG tankers derailed, resulting in 17 out of 19 cars igniting. 50 homes were evacuated and a one mile radius of an evacuation zone was enforced. The cause is suggested to be from a wheel at the front of the train with a crack caused the wheel to loosen from the axle. A broken rail was also found at the site. On January 11th residents were allowed to return to their homes.
DATE OF LOSS	07/01/2014	
COUNTRY	Canada	
LOCATION	New Brunswick	
UNIT TYPE	Rail	
EQUIPMENT TYPE	Rail tanker	
MATERIAL	Crude oil	
EVENT TYPE	Fire	
CAUSE	Derailment	

LOSS NO.	9922	A gas pipeline ruptured just before 4 pm. An explosion occurred and subsequently a fire started. The fire was extinguished at 5:35 pm. Several vehicles were reported to be on fire near the scene. Two businesses and several homes suffered heat damage. Upon inspection of the pipeline on January 13, a section of it had suffered surface damage during the installation of a smaller pipeline that runs parallel to it. This damage led to the rupture and subsequent explosion.
DATE OF LOSS	10/01/2014	
COUNTRY	United States	
LOCATION	North Carolina	
UNIT TYPE	Pipeline	
EQUIPMENT TYPE	Pipe	
MATERIAL		
EVENT TYPE	Explosion, fire	
CAUSE	Explosion	

LOSS NO.	9956	Pipeline company shutdown their 450,000 barrels per day (bpd) cross-country pipeline following an oil spill at the a pump station. The spill is estimated at 125 barrels and was mostly limited to the pump station.
DATE OF LOSS	18/01/2014	
COUNTRY	Canada	
LOCATION	Saskatchewan	
UNIT TYPE	Pipeline	
EQUIPMENT TYPE	Pump	
MATERIAL	Crude oil	
EVENT TYPE	Oil Spill	
CAUSE		

LOSS NO.	9961	An explosion and fire occurred at a pipeline valve station. The company shut down a portion of the natural gas pipeline system and was venting gas. Residents of nearby towns were without natural gas for up to 72 hours.
DATE OF LOSS	25/01/2014	
COUNTRY	Canada	
LOCATION	Manitoba	
UNIT TYPE	Pipeline	
EQUIPMENT TYPE	Valve	
MATERIAL	Natural gas	
EVENT TYPE	Explosion, fire	
CAUSE		

LOSS NO.	9969	Terrorists planted explosive near a 24-inch diameter gas pipeline. The explosive destroyed a large portion of the pipeline and suspended gas supply to a power plant. Due to suspension of gas supply a shortage of 586 MW of electrical power occurred in the system, causing power shortages.
DATE OF LOSS	03/02/2014	
COUNTRY	Pakistan	
LOCATION	Naseerabad	
UNIT TYPE	Pipeline	
EQUIPMENT TYPE	Pipe	
MATERIAL		
EVENT TYPE	Explosion	
CAUSE	Terrorism	

LOSS NO.	9948	An 88,000 ton freighter collided with an oil tanker off South Korea's largest port, spilling an undisclosed amount of oil. The two ships where trying to come close together because the tanker was going to transfer 1,500 tons of oil to the freighter. Emergency actions were taken to stop the spill, but an oil slick about 800 meters wide was found on the water. Officials believe the collision was caused by high waves.
DATE OF LOSS	15/02/2014	
COUNTRY	South Korea	
LOCATION	Busan	
UNIT TYPE		
EQUIPMENT TYPE	Ship tanker	
MATERIAL	Fuel oil	
EVENT TYPE	Oil spill	
CAUSE	Collision	

LOSS NO.	9946	A 36 inch diameter gas pipeline from a gas field caught fire after a huge explosion. Two people died and two more were injured. This occurred due to a leak of gas. Following the explosion, the supply of gas was suspended to various cities and towns of Punjab.
DATE OF LOSS	19/02/2014	
COUNTRY	Pakistan	
LOCATION	Sindh, Ghotki district	
UNIT TYPE	Pipeline	
EQUIPMENT TYPE	Pipe	
MATERIAL		
EVENT TYPE	Explosion, fire	
CAUSE	Gas leak	

LOSS NO.	9935	A 65 mile stretch of the Mississippi River was closed due to an oil spill that resulted from a barge striking a towboat. There were no injuries and all barges remained secure; the oil that did not spill into the river was pumped into another barge the following day. About 31,500 gallons of light crude oil spilled into the river.
DATE OF LOSS	22/02/2014	
COUNTRY	United States	
LOCATION	Louisiana	
UNIT TYPE		
EQUIPMENT TYPE		
MATERIAL	Crude Oil	
EVENT TYPE	Spill	
CAUSE	Impact	

LOSS NO.	10024	A landslip resulted in dislodging a valve of a tank storing diesel resulting in the spilling of fuel into the tank catchment area. Operations were established to transfer the leaked fuel into tanks. It was estimated that over one million liters of fuel was released. Engineers also had to assess the damage to the adjacent hillside. Another tank was reported as damaged by the landslip but this did not result in a release.
DATE OF LOSS	04/03/2014	
COUNTRY	New Zealand	
LOCATION	Lyttelton	
UNIT TYPE	Atmospheric storage	
EQUIPMENT TYPE		
MATERIAL	Diesel	
EVENT TYPE	Release	
CAUSE	Landslide	

LOSS NO.	9981	A construction crew pierced a section of crude oil pipeline resulting in a spillage of about 364 barrels. The pipeline was immediately shut down and isolated. Emergency crews were deployed and used absorbent booms to contain the spilled oil.
DATE OF LOSS	06/03/2014	
COUNTRY	United States	
LOCATION	Port Neches, Texas	
UNIT TYPE	Pipeline	
EQUIPMENT TYPE		
MATERIAL	Crude oil	
EVENT TYPE	Release	
CAUSE	Impact	

LOSS NO.	10021	A 5 inch crack in a 20 inch diameter crude oil transport line resulted in a release of about 500 barrels of crude oil into a dry creek bed and pond. The pipeline was shut during the recovery operation but reopened after five days.
DATE OF LOSS	18/03/2014	
COUNTRY	United States	
LOCATION	Cincinnati, Ohio	
UNIT TYPE	Pipeline	
EQUIPMENT TYPE		
MATERIAL	Crude oil	
EVENT TYPE	Release	
CAUSE		

LOSS NO.	10056
DATE OF LOSS	31/03/2014
COUNTRY	United States
LOCATION	Plymouth, Washington
UNIT TYPE	Storage
EQUIPMENT TYPE	Refrigerated tankage
MATERIAL	Natural gas
EVENT TYPE	Explosion
CAUSE	Material failure

A pressure vessel rupture on a LNG storage site expelled a piece of shrapnel that punctured the outer wall of one of the two cryogenic storage tanks on the site. The failure of the wall resulted in the loss of containment of some of the tank insulation and resulted in the slow release of LNG. It was reported that the tank was one third full. Residents within a two mile radius of the site were evacuated for more than one day as a precautionary measure. Natural gas from the damaged tank was transferred to the second undamaged tank. It was reported that it cost US$69 million to repair.

LOSS NO.	9975
DATE OF LOSS	07/05/2014
COUNTRY	Ghana
LOCATION	Accra
UNIT TYPE	Pipeline
EQUIPMENT TYPE	
MATERIAL	Naphtha
EVENT TYPE	Explosion, fire
CAUSE	

An explosion on a pipeline linking an oil refinery in the industrial hub to a nearby port was reported. The 5 km pipeline was transporting naphtha when it began to leak around midday. Passers-by had started to collect the spilled liquid when a fire broke out. The fire was brought under control in around three hours. It was reported that output from the refinery would not be affected.

LOSS NO.	9973
DATE OF LOSS	16/05/2014
COUNTRY	United States
LOCATION	Los Angeles, California
UNIT TYPE	Pipeline
EQUIPMENT TYPE	Valve
MATERIAL	Crude Oil
EVENT TYPE	Release
CAUSE	Leak

A major release of crude oil from a transfer pipeline occurred in a residential area. A geyser of crude oil shot 20 feet into the air and spread over half a mile. Four people reported breathing difficulties and two went to hospital. Street maintenance department used sand to block the spill and recover the spilled oil. It was reported that 10,000 gallons were spilled. The release was reported as coming from a pumping station due to a faulty valve.

LOSS NO.	10033
DATE OF LOSS	27/06/2014
COUNTRY	India
LOCATION	East Godavari, Andhara Pradesh
UNIT TYPE	Pipeline
EQUIPMENT TYPE	
MATERIAL	Natural Gas
EVENT TYPE	Explosion, fire
CAUSE	

14 people were reported dead following a huge blast on a gas pipeline close to a refinery gas connection station. The fire occurred on an 18 inch diameter pipeline. The blast occurred in the early morning and the fire was brought under control by emergency responders.

LOSS NO.	10037
DATE OF LOSS	01/07/2014
COUNTRY	China
LOCATION	Dalian
UNIT TYPE	Pipeline
EQUIPMENT TYPE	Pipe
MATERIAL	Crude Oil
EVENT TYPE	Fire
CAUSE	

A leaking oil pipeline caught fire forcing the evacuation of nearly 20,000 residents. The pipeline was reported as being damaged by construction work, allowing oil to flow into sewerage pipes where it caught fire. It was said that the fire burned for 25 minutes before being extinguished. No deaths or injuries were reported.

LOSS NO.	10057
DATE OF LOSS	31/07/2014
COUNTRY	Taiwan
LOCATION	Kaohsiong
UNIT TYPE	Pipeline
EQUIPMENT TYPE	Pipe
MATERIAL	Propylene
EVENT TYPE	Explosion, fire
CAUSE	

Explosions occurred just before midnight in urban area of a Taiwanese city following the release of propylene from a buried pipeline. It was reported that there were at least five separate explosions across the city. Explosions ripped up roads, overturned cars and fire trucks and caused blackouts on the electrical grid. The failed pipeline was a 4 inch diameter line and was found to be at high pressure for a period before the release. It was estimated that 3.8 tons of propylene was released from the pipe. There was some confusion over the ownership and responsibility for the pipeline. It was reported that the pipelines had not been inspected for 24 years, since their installation in 1990.

LOSS NO.	10003
DATE OF LOSS	13/08/2014
COUNTRY	United States
LOCATION	New Orleans, Loiusiana
UNIT TYPE	
EQUIPMENT TYPE	Tank barge
MATERIAL	Fuel oil
EVENT TYPE	Release
CAUSE	

A ship lost power and steering and collided with another ship and barge docked on the river. The crew of a towing vessel was transferring fuel oil from the barge when it broke free causing some oil to be discharged into the river from a hose. The hose was immediately shut off. Coast guards implemented one-way traffic around the terminal.

E&P OFFSHORE

LOSS NO.	9968
DATE OF LOSS	30/01/2014
COUNTRY	United States
LOCATION	Gulf of Mexico
UNIT TYPE	
EQUIPMENT TYPE	
MATERIAL	Natural gas
EVENT TYPE	Release
CAUSE	Blowout

Workers lost control of an underwater well where a rig was drilling off the Louisiana coast. No workers injured and no pollution resulted. The personnel from the jack-up rig and a platform were evacuated. the flow of natural gas was stopped by pumping weighted drilling fluids into the well. Monitoring was conducted to ensure flow did not resume. The adjacent platform that was producing oil and gas was shut-in.

LOSS NO.	10022
DATE OF LOSS	22/03/2014
COUNTRY	Mexico
LOCATION	Cantarell field
UNIT TYPE	Platform
EQUIPMENT TYPE	
MATERIAL	
EVENT TYPE	Fire
CAUSE	

Fire occurred on a platform, part of an extensive complex in shallow water. 42 workers on the platform were evacuated but production was not affected. Three people were injured but the fire was reported to be have been totally controlled.

LOSS NO. DATE OF LOSS COUNTRY LOCATION UNIT TYPE EQUIPMENT TYPE MATERIAL EVENT TYPE CAUSE	9993 09/08/2014 United Kingdom North Sea Platform Generator Fire 	A small fire broke out on an offshore platform in the North Sea. The platform was shutdown for maintenance at the time of the fire. A small fire was detected in one of the emergency generator enclosures which was promptly extinguished and the situation brought under control. There were 122 personnel on board at the time who were called to muster and all accounted for.
LOSS NO. DATE OF LOSS COUNTRY LOCATION UNIT TYPE EQUIPMENT TYPE MATERIAL EVENT TYPE CAUSE	10009 03/09/2014 Norway North Sea Platform Fire 	A platform was shut down after an electrical fire, resulting in the mustering of the personnel on-board. The fire started on a switch on an instrument panel in an electrical room resulting in the room filling with smoke. Production was immediately stopped and the 67 personnel on-board were gathered into lifeboats, though not evacuated. The fire was quickly extinguished and the panel disconnected.
LOSS NO. DATE OF LOSS COUNTRY LOCATION UNIT TYPE EQUIPMENT TYPE MATERIAL EVENT TYPE CAUSE	10010 04/09/2014 United Kingdom North Sea Platform Fall 	A worker died on a normally unmanned offshore platform while carrying out routine maintenance.
LOSS NO. DATE OF LOSS COUNTRY LOCATION UNIT TYPE EQUIPMENT TYPE MATERIAL EVENT TYPE CAUSE	10014 19/09/2014 United States New Orleans, Louisiana Pipeline Natural gas Fire 	A contractor was killed and two others were injured during maintenance of a natural gas pipeline. They were working on an offshore platform when the accident occurred. The other two workers were taken by helicopter to hospital. The platform and pipeline were shut in after the accident. A small amount of natural gas condensate was released to water.
LOSS NO. DATE OF LOSS COUNTRY LOCATION UNIT TYPE EQUIPMENT TYPE MATERIAL EVENT TYPE CAUSE	10008 28/09/2014 United Kingdom North Sea Platform Production loss 	Non-essential personnel were evacuated from a platform and a pipeline was depressurized after mechanical failure of a crane resulted in a large container fall into the sea. The incident occurred during the operation to winch the container from a support vessel. The container ended up dangerously close to a mass of subsea pipelines, dangling from a rope 20 feet below the sea surface.

LOSS NO.	9972	An explosion and fire occurred at a natural gas well. The heat of the fires and risk of further explosions forced fire-fighters to move back to safe areas. A large propane truck on the well pad caught fire an exploded. The well team was attempting to connect it to a gathering line, which involves putting pipe down the well. There were two other pads on the same well that were unaffected by the fire and explosion. Wild Well Control were brought in to extinguish the burning gas well after the blast.
DATE OF LOSS	11/02/2014	
COUNTRY	United States	
LOCATION	Greene County	
UNIT TYPE		
EQUIPMENT TYPE		
MATERIAL	Natural gas	
EVENT TYPE	Explosion, fire	
CAUSE		

GAS PROCESSING

LOSS NO.	10016	An explosion on a natural gas processing plant resulted in injury to four workers. The blast occurred as the maintenance crew were cleaning out the tank. Fire fighters quickly put out the flames. It was reported that the ignition was due to static electricity. Not all the crew were wearing fire retardant clothing.
DATE OF LOSS	25/09/2014	
COUNTRY	United States	
LOCATION	Western Wyoming	
UNIT TYPE	Atmospheric storage	
EQUIPMENT TYPE		
MATERIAL	Natural gas	
EVENT TYPE	Explosion, fire	
CAUSE		

REFINERY

LOSS NO.	9919	A tank containing toluene caught fire and exploded. Local residents were told to close doors and windows and stay inside until further notice. The fire was brought under control within 90 minutes. No one was injured.
DATE OF LOSS	09/01/2014	
COUNTRY	Germany	
LOCATION	Nordrhein - Westfalen	
UNIT TYPE	Aromatics	
EQUIPMENT TYPE		
MATERIAL	Toluene	
EVENT TYPE	Explosion, fire	
CAUSE	Fire	

LOSS NO.	9958	A fire in a substation injured two people. The incident occurred during maintenance work on a group of electrical motors, under substation number 1, driving pumps for loading railway tank cars at the refinery, which caused an explosion and fire.
DATE OF LOSS	17/01/2014	
COUNTRY	Mexico	
LOCATION	Veracruz	
UNIT TYPE		
EQUIPMENT TYPE	Substation	
MATERIAL		
EVENT TYPE	Explosion, fire	
CAUSE	Maintenance work on electrical motors	

LOSS NO.	9959	Three refineries with a combined capacity of 930,000 bpd shut down following a power failure. The three refineries interrupted operations, with the exception of the gas plants, following a power failure.
DATE OF LOSS	22/01/2014	
COUNTRY	Kuwait	
LOCATION	Al-Ahmadi	
UNIT TYPE		
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Production loss	
CAUSE	Power failure	

LOSS NO.	9980	The CCR on a 775,000 bpd refinery was shut down following a small fire. The unit was restarted after five days.
DATE OF LOSS	05/02/2014	
COUNTRY	South Korea	
LOCATION	Yeosu	
UNIT TYPE	Catalytic reforming	
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Fire	
CAUSE	Fire	

LOSS NO.	9966	A fire, that started at the truck park of a refinery, consumed two tankers. It was swiftly controlled and did not affect the production and distribution at the factory.
DATE OF LOSS	06/02/2014	
COUNTRY	Nigeria	
LOCATION	Kaduna	
UNIT TYPE		
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Fire	
CAUSE		

LOSS NO.	10028	The alkylation unit of a 166,000 bpd refinery was shut following a release of sulphuric acid injured two workers. It was estimated that there was a release of about 84,000 pounds (lb) of sulphuric acid. A similar incident occurred on the same refinery less than one month later.
DATE OF LOSS	12/02/2014	
COUNTRY	USA	
LOCATION	Martinez, California	
UNIT TYPE	Alkylation	
EQUIPMENT TYPE		
MATERIAL	Sulphuric acid	
EVENT TYPE	Release	
CAUSE		

LOSS NO.	9938	Several rail cars decoupled from a locomotive and rolled into a refinery, sparking a fire. Output was halted for 6 days and the refinery was put into recirculation mode, but all units in the refinery were returned to normal working. The train involved had 14 rail cars; 7 empty and 7 loaded. 11 rail cars caught fire. The fire lasted for about 11 hours before it was fully extinguished. A firefighting train was used in the fire response.
DATE OF LOSS	14/02/2014	
COUNTRY	Russia	
LOCATION	Ryazan City	
UNIT TYPE		
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Fire	
CAUSE	Derailment	

LOSS NO.	9939	A fire broke out in an oil refinery due to overheating of a hydrocracking unit. The fire started during the start-up of the unit. As the temperature increased one of the heaters caught fire.
DATE OF LOSS	16/02/2014	
COUNTRY	Indonesia	
LOCATION	Riau province, Dumai	
UNIT TYPE	Hydrocracking	
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Fire	
CAUSE	Equipment Failure	

LOSS NO.	9940	A fire started at the 235,00 bpd refinery which was under control shortly after crews arrived on scene. The fire was under control in less than an hour and no one sustained any injuries. The fire was on the H2U2 hydrotreater unit. The unit was shut down for 12 days following the fire.
DATE OF LOSS	24/02/2014	
COUNTRY	United States	
LOCATION	St. James Parish, Louisiana	
UNIT TYPE		
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Fire	
CAUSE		

LOSS NO.	9942	An accident happened in a refinery. It is believed to be a result of an explosion in the compressor plant for the production of gasoline and the chemical that was burned was hydrogen. It produced flames that were 30 meters high, but no deaths or injuries.
DATE OF LOSS	26/02/2014	
COUNTRY	Italy	
LOCATION	Priolo Gargallo, Sicily	
UNIT TYPE		
EQUIPMENT TYPE	Compressor	
MATERIAL	Gasoline	
EVENT TYPE	Explosion, fire	
CAUSE		

LOSS NO.	10026	Several workers were injured when fire broke out in the residue hydrocracking unit of the refinery during cleaning work. The fire was reported to have originated from the unit reactor. The fire was brought under control by pumping nitrogen into the unit. the fire did not spread to other units. Normal operations were able to be maintained on the crude distillation and other secondary units on the refinery. There was no impact on refinery production reported.
DATE OF LOSS	01/03/2014	
COUNTRY	Japan	
LOCATION	Kawasaki	
UNIT TYPE	Hydrocracking	
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Fire	
CAUSE		

LOSS NO.	10025	Refiner shut down all the units of the 120,000 bpd refinery after a strong earthquake. The earthquake had a magnitude of 6.3. The ethylene units caught fire more than two hours after the quake but were soon extinguished.
DATE OF LOSS	13/03/2014	
COUNTRY	Japan	
LOCATION	Tokuyama	
UNIT TYPE		
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Fire	
CAUSE	Earthquake	

LOSS NO.	10006	Fire destroyed part of a building on the refinery. The building houses offices in the west area maintenance block. There were no injuries and the fire did not threaten the major plant installations.
DATE OF LOSS	14/03/2014	
COUNTRY	Trinidad and Tobago	
LOCATION	Pointe a Pierre	
UNIT TYPE	Building	
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Fire	
CAUSE		

LOSS NO.	10029	A spill of crude oil occurred on an oil refinery when a hose used to transfer from an atmospheric storage tank to a pipeline burst. Initial estimates were that 8,000 gallons could be released. No oil was released outside the refinery site.
DATE OF LOSS	15/03/2014	
COUNTRY	United States	
LOCATION	Anacortes, Washington	
UNIT TYPE	Atmospheric storage	
EQUIPMENT TYPE	Hose	
MATERIAL	Crude oil	
EVENT TYPE	Release	
CAUSE		

LOSS NO.	9979	A malfunction caused crude oil to enter the refinery cooling system and to be discharged into the lake. It was reported that a 820 m stretch of the lake shore was affected by the spilled crude oil. A boom was used to contain the spill and a clean-up crew was deployed.
DATE OF LOSS	24/03/2014	
COUNTRY	United States	
LOCATION	Chicago, Illinois	
UNIT TYPE		
EQUIPMENT TYPE		
MATERIAL	Crude oil	
EVENT TYPE	Release	
CAUSE		

LOSS NO.	10047	A fire occurred on an oil storage tank following an explosion on an oil refinery. The fire was extinguished after five hours but later re-erupted. No casualties were reported.
DATE OF LOSS	10/06/2014	
COUNTRY	China	
LOCATION	Nanjing	
UNIT TYPE	Atmospheric Storage	
EQUIPMENT TYPE		
MATERIAL	Crude oil	
EVENT TYPE	Explosion, fire	
CAUSE		

LOSS NO.	10038	An explosion and fire on a remote oil refinery resulted in the death of seven workers with more missing and injured. The explosion and fire occurred on the fractionation unit of the refinery which has an operating capacity of 140,000 bpd. The plant had been shut down for regular maintenance for about one month. The fire burned for around three hours before it was brought under control.
DATE OF LOSS	15/06/2014	
COUNTRY	Russia	
LOCATION	Achinsk, Siberia	
UNIT TYPE	Crude distillation	
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Explosion, fire	
CAUSE		

LOSS NO.	10034	A major fire broke out after an early morning explosion on the vacuum gas oil treating unit of a major oil refinery. No casualties were reported but it took fire responders more than four hours to extinguish the fire. There was panic among residents if nearby villages. The fire spread to cover the whole of the vacuum gas unit.
DATE OF LOSS	20/06/2014	
COUNTRY	India	
LOCATION	Kankwal	
UNIT TYPE	Vacuum distillation	
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Explosion, fire	
CAUSE		

LOSS NO.	10036	There was a small fire while the company was repairing the heat exchanger equipment of the No. 3 crude distillation unit. The fire was not expected to have an impact on the restart of the CDU. There was no impact on the operation of the refinery's other CDU and no injuries reported.
DATE OF LOSS	03/07/2014	
COUNTRY	Japan	
LOCATION	Yokkaichi	
UNIT TYPE		
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Fire	
CAUSE		

LOSS NO.	9996	Fire broke out on a 5,000 cubic metre oil storage tank resulting in injury to three employees. The local fire department responded to extinguish the fire and prevent escalation to other storage tanks for gasoline and fuel oil. The injured workers were transported to hospital. The fire burned for about five hours before it was extinguished.
DATE OF LOSS	16/07/2014	
COUNTRY	Kazakhstan	
LOCATION	Aktobe Oblast	
UNIT TYPE	Atmospheric storage	
EQUIPMENT TYPE		
MATERIAL	Crude oil	
EVENT TYPE	Fire	
CAUSE		

LOSS NO.	10001	Two people were injured in a fire that broke out at a petroleum oil refinery in an industrial area south of Jeddah. Civil defense fire fighters doused the fire before it spread to oil storage tanks and warehouses. One plant worker suffered burns and a fire fighter suffered minor injuries.
DATE OF LOSS	17/07/2014	
COUNTRY	Saudi Arabia	
LOCATION	Jeddah	
UNIT TYPE		
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Fire	
CAUSE		

LOSS NO.	10000	Nine workers were injured as a result of a fire on a gasoline storage tank on a 190,000 bpd refinery. Two suffered minor burns and seven were treated for dehydration and exhaustion. The internal emergency response plan of the refinery was implemented to control and extinguish the fire. Families living near to the refinery were evacuated.
DATE OF LOSS	22/07/2014	
COUNTRY	Mexico	
LOCATION	Ciudad Madero	
UNIT TYPE	Atmospheric storage	
EQUIPMENT TYPE		
MATERIAL	Gasoline	
EVENT TYPE	Fire	
CAUSE		

LOSS NO.	10007	Fire occurred on the refinery coking plant during maintenance activity resulting in four fatalities and the hospitalization of a further seven.
DATE OF LOSS	11/08/2014	
COUNTRY	Mexico	
LOCATION	Ciudad Madero	
UNIT TYPE	Coking	
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Explosion, fire	
CAUSE		

LOSS NO.	9989	Fire reported in the primary distillation area of a refinery. The fire was reported as being due to the failure of a pump in the unit. There were no injuries or environmental impact, and no disruption to fuel deliveries to market.
DATE OF LOSS	24/08/2014	
COUNTRY	Croatia	
LOCATION	Rijeka	
UNIT TYPE	Distillation	
EQUIPMENT TYPE	Pump	
MATERIAL		
EVENT TYPE	Fire	
CAUSE		

LOSS NO.	10019	An explosion and following fire occurred on an oil refinery as a result of a release from a compressor unit on a process plant. One worker received minor injuries. The fire was extinguished by the refinery fire brigade within two hours. In addition, it was reported that 500 lb of sulphur dioxide was released as a result of the incident.
DATE OF LOSS	27/08/2014	
COUNTRY	United States	
LOCATION	Whiting, Indiana	
UNIT TYPE		
EQUIPMENT TYPE	Compressor	
MATERIAL		
EVENT TYPE	Explosion, fire	
CAUSE		

LOSS NO.	10045	Fire broke out on a synthetic oil plant resulting in injury to 23 people. The fire was contained to a relatively small part of the plant ad all personnel were evacuated from the area.
DATE OF LOSS	07/10/2014	
COUNTRY	South Africa	
LOCATION	Secunda	
UNIT TYPE	Synthol	
EQUIPMENT TYPE		
MATERIAL		
EVENT TYPE	Fire	
CAUSE		

LOSS NO.	10042	A fire occurred on the process furnace for the feed to the catalytic cracking unit of a refinery. The fire was reported as being localized to the unit and was quickly extinguished. The fire did not reduce the overall processing capacity of the refinery, but reduced the production of lighter hydrocarbons. Production from the refinery was restored to full capacity after about one month.
DATE OF LOSS	25/10/2014	
COUNTRY	Kazakhstan	
LOCATION	Pavlodar	
UNIT TYPE	Catalytic cracking	
EQUIPMENT TYPE	Furnace	
MATERIAL	Crude oil	
EVENT TYPE	Fire	
CAUSE		

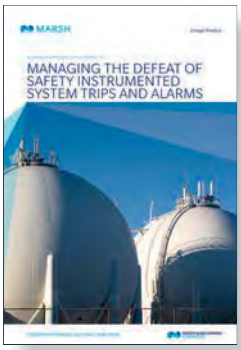
LOSS NO. DATE OF LOSS COUNTRY LOCATION UNIT TYPE EQUIPMENT TYPE MATERIAL EVENT TYPE CAUSE	10044 05/11/2014 Curacao Gas processing Explosion, fire 	An explosion on the 335,000 bpd refinery gas plant resulted in injury to two contractors. In addition a fire fighter was injured. It was reported that the incident took place as workers were preparing to carry out planned maintenance at a butane unit. The refinery had been operating at low utilization rates due to insufficient power and other resources.
LOSS NO. DATE OF LOSS COUNTRY LOCATION UNIT TYPE EQUIPMENT TYPE MATERIAL EVENT TYPE CAUSE	10051 13/11/2014 United States Norco, Louisiana Furnace Fire 	Fire occurred on the furnaces of an integrated refinery and petrochemicals complex resulted in a shutdown of the furnace unit and flaring at the plant. operations on other parts of the complex remained as normal. The unit was subject to a damage assessment and work to restart commenced the next day. The refinery has a processing capacity of 235,000 bpd.
LOSS NO. DATE OF LOSS COUNTRY LOCATION UNIT TYPE EQUIPMENT TYPE MATERIAL EVENT TYPE CAUSE	10052 04/12/2014 Oman Mina la Fahal Gas processing Explosion, fire 	A major fire broke out on a refinery gas treatment unit resulting in injuries to three people. The incident forced the evacuation of hundreds of refinery employees from the site. This was reported to hinder the civil defense response to the refinery. The incident lasted about two hours before it was brought under control.
LOSS NO. DATE OF LOSS COUNTRY LOCATION UNIT TYPE EQUIPMENT TYPE MATERIAL EVENT TYPE CAUSE	10053 05/12/2014 United States Rawlins, Wyoming Alkylation Fire 	A fire on the alkylation unit of a 80,000 bpd refinery burned for about seven hours before it was brought under control. No injuries were reported. The fire did not affect product on other units of the refinery.

FURTHER READING

All position papers and publications produced by Marsh's GERE team can be found at www.marsh.com. Here is a list of some of our papers:

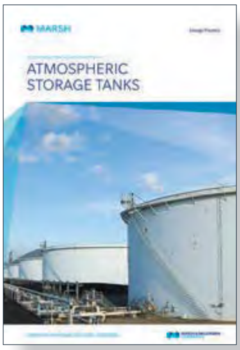
THE 100 LARGEST LOSSES[8]

The 23nd edition of *The 100 Largest Losses* reviews the 100 largest property damage losses that have occurred in the hydrocarbon processing industry since 1972. This review is based on Marsh's energy loss database, which compiles information gathered in the course of our interactions with the industry, as well as from the public domain.



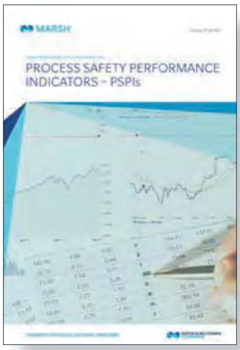
MANAGING THE DEFEAT OF SAFETY INSTRUMENTED SYSTEM TRIPS AND ALARMS[11]

Whenever a safety instrumented system (SIS) is defeated, the risk exposure is increased to an extent that depends on the nature of the hazard involved. This paper discusses what would be expected of an SIS trip and alarm defeat system rated as "very good" by Marsh.



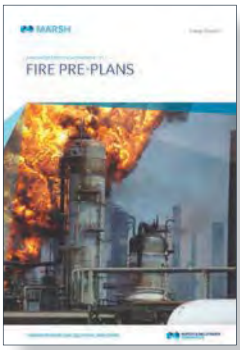
ATMOSPHERIC STORAGE TANKS[9]

Following numerous incidents involving atmospheric storage tanks, data has been compiled indicating that overfilling of atmospheric storage tanks occurs once in every 3,300 filling operations. This paper defines what would be rated by Marsh as a "very good" atmospheric storage facility.



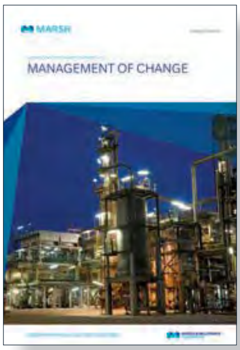
PROCESS SAFETY PERFORMANCE INDICATORS[12]

The process industry has a long history of major incidents that are well-publicized. The underlying causes of major incidents are often related to failures in process-safety management. This paper defines what would be rated by Marsh as a "very good" set of process safety performance indicators.



FIRE PRE-PLANS[10]

There have been numerous large damaging fires over the years, including tank fires. These involve massive product losses and process unit fires that cause major plant damage and process interruption. This paper defines what would be rated by Marsh as a "very good" level of fire pre-plans.



MANAGEMENT OF CHANGE[13]

During the lifetime of an operating process plant, many changes will occur, including to the physical hardware of the plant, control systems, business processes, or to the organization running the plant. This paper defines what would be rated by Marsh as "very good" for a management of change (MoC) system.

Listed below are the full URL destinations of resources suggested for further reading throughout this publication:

1. http://www.whitehouse.gov/the-press-office/2013/08/01/executive-order-improving-chemical-facility-safety-and-security
2. http://www.hse.gov.uk/research/rrpdf/rr908.pdf
3. http://www.fabig.com/video-publications/TechnicalGuidance
4. http://www.epa.gov/emergencies/docs/chem/AN_advisory.pdf
5. http://www.epsc.org/contact.aspx?Group=products&Page=request_reports
6. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:178:FULL:EN:PDF
7. http://usa.marsh.com/ProductsServices/MarshSolutions/ID/21384/Energy-Insurance-Training-Courses.aspx
8. http://usa.marsh.com/NewsInsights/ThoughtLeadership/Articles/ID/37477/The-100-Largest-Losses-in-the-Hydrocarbon-Industry-1974-2013.aspx
9. https://usa.marsh.com/NewsInsights/ThoughtLeadership/Articles/ID/21490/Risk-Engineering-Position-Paper-Atmospheric-Storage-Tanks.aspx
10. https://usa.marsh.com/NewsInsights/ThoughtLeadership/Articles/ID/21491/Risk-Engineering-Position-Paper-Fire-Pre-plans.aspx
11. https://usa.marsh.com/NewsInsights/ThoughtLeadership/Articles/ID/21492/Engineering-Position-Paper-Managing-The-Defeat-Of-Safety-Instrumented-System-Trips-And-Alarms.aspx
12. https://usa.marsh.com/NewsInsights/ThoughtLeadership/Articles/ID/29433/Risk-Engineering-Position-Paper-Process-Safety-Performance-Indicators-PSPIs.aspx
13. https://usa.marsh.com/NewsInsights/ThoughtLeadership/Articles/ID/33445/Risk-Engineering-Position-Paper-Management-of-Change-MoC.aspx

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