

# LOSS CONTROL NEWSLETTER

2013 – EDITION 2



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# FOREWORD

Welcome to the second edition of the *Loss Control Newsletter (LCN)* for 2013, issued to coincide with Marsh's global energy risk engineering (GERE) events for the energy insurance market in both Dubai and London.

Shortly after the publication of the last edition of the *LCN*, we saw events unfold in the fire and subsequent detonation at an ammonium nitrate (AN) fertilizer storage facility in the town of West, Texas, requiring action from US authorities. In August, US President Barack Obama issued an executive order to improve US chemical safety security, and a US advisory document was released in an effort to share lessons learned from past accidents involving AN. These, and other recent safety developments, can be found in the "Safety news from around the world" section of this edition.

Twenty-five years after the Piper Alpha oil product platform disaster in Scotland, Jasper Clark of Marsh's Energy Practice in London looks at the impact that the Cullen Reports — one of three reports of public inquiries prompted by the disaster — have had on onshore operations today. On the topic of pipeline losses, London-based risk engineer Nigel Cairns reflects on the risks involved with pipeline operations, a subject on which he presented on at the recent UK Onshore Pipeline Operators' Association technical conference.

Ryan McGovern, a risk engineer based in Dubai, looks at the dramatic changes in the terrorism insurance arena and outlines Marsh's position on developing loss estimates for terrorist attacks on energy installations. From our Singapore Energy hub, risk engineer Jon Wilkinson reports on his attendance at the Hazards Asia Pacific Symposium held in Malaysia earlier this year.

In another article, Michael Eason, a risk engineer based in London, talks of the benefits of risk mapping applied to construction projects, and how Marsh has helped clients use the process to quickly obtain an overview of a venture's risk profile.

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 six new risk engineers who joined Marsh in 2013 — part of a growth plan that further increases our global 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](mailto:LCN.editor@marsh.com).

# INSIDE THIS ISSUE

## SAFETY NEWS FROM AROUND THE WORLD

Latest global safety news.

## HAZARDS ASIA PACIFIC SYMPOSIUM 2013

The second Hazards Asia Pacific Symposium was held in April 2013 and covered several themes, such as asset integrity and learning from major hazards incidents. In this article, Jon Wilkinson, a risk engineer in Marsh's Energy Practice in Singapore, reports on his visit to the event in Kuala Lumpur.

## PIPER ALPHA: 25 YEARS ON

This year marks 25 years since the Piper Alpha disaster, which caused the most significant loss of life in the history of offshore operations. In this article, Jasper Clark, risk engineer and engineering hub leader in Marsh's Energy Practice in London, explores the lessons learned from Piper Alpha and the subsequent *Cullen Reports*, and how these are relevant for onshore operations today.

## PROJECT RISK MAPPING

Major oil, gas, and petrochemical construction projects are exposed to a myriad of risks which, if not properly managed, can lead to cost increases, schedule delays, advanced loss of profits, and are often damaging to the reputations of the organizations involved. In this article Michael Eason, a risk engineer in Marsh's Energy Practice in London, examines how risk mapping can be applied to these projects, giving improved understanding of those critical risks that threaten the success of a venture.

## PIPELINE LOSSES

Of all the options available to clients for moving flammable or toxic hydrocarbons between sites, pipelines have long been acknowledged as providing an efficient and relatively low-risk form of transportation. In this article, Nigel Cairns, a risk engineer in Marsh's Energy Practice in London, addresses the risks involved with operating pipelines, the implications of these on the insurance industry, and what clients should be doing to prevent potential losses.

## TERRORISM LOSS ESTIMATES

The landscape has changed dramatically in the terrorism insurance arena, leaving critical questions within the industry — how bad and how likely? Ryan McGovern, a risk engineer in Marsh's Energy Practice in Dubai, outlines Marsh's position on developing loss estimates, as a result of terrorist attacks on energy installations.

## FROM THE ARCHIVES... CORROSION UNDER INSULATION — OUT OF SIGHT, OUT OF MIND

Corrosion under insulation (CUI) poses particular problems for operators of pressure-containing equipment and piping, which is insulated for fire-proofing reasons. In this article, first published in 2003, Iain Clough, a risk engineer in Marsh's Energy Practice in London, discusses some of the losses, mechanisms, and detection methods associated with CUI.

## MARSH NEWS

The latest updates from Marsh's Energy Practice, including an introduction to new engineers and Marsh's new Energy hub in India.

## MARSH ENERGY TRAINING COURSES 2014

Marsh's Energy Practice offers courses at three different levels at various locations around the world. Here is some further information on each of the courses.

## LOSSES

A summary of incidents of interest from recent months.

## FURTHER READING

A list of publications from Marsh's global energy risk engineering (GERE) team, as well as full URL destinations for all resources referenced within this edition of the *LCN*.



# SAFETY NEWS FROM AROUND THE WORLD



## US PRESIDENT ISSUES EXECUTIVE ORDER TO IMPROVE CHEMICAL FACILITY SAFETY

On August 1, 2013, President Barack Obama issued an executive order to regulatory authorities to improve US chemical facility safety and security.

The executive order specified that additional measures can be taken by executive departments and agencies with regulatory authority to further improve chemical facility safety and security, in coordination with owners and operators. Improvements will be achieved by:

- The establishment of the Chemical Facility Safety and Security Working Group.
- Improving operational coordination with state, local, and tribal partners.
- Enhanced federal coordination.
- Enhanced information collection and sharing.
- Policy, regulation, and standards modernization.
- Identification of best practices.
- General provisions.

All US presidents, since George Washington, have issued executive orders, which are official documents through which the President of the United States manages the operations of the federal government. This particular order was partly brought about by the reminder of past and recent chemical facility disasters seen in the US.

For the full executive order visit [www.whitehouse.gov](http://www.whitehouse.gov).<sup>1</sup>



## NEW FABIG TECHNICAL NOTE: VAPOR CLOUD FORMATION

This note from the Fire and Blast Information Group (FABIG), describes how to

calculate the rate of vapor cloud volume increase during overfilling, giving the concentration of hydrocarbons, and guidance on cloud spread in a typical tank farm.

This technical note is an extension of the scope of the recent *UK Health and Safety Executive (HSE)* report on vapor cloud formation experiments and modeling, published in 2012. Assessment of vapor clouds for a range of fuels and solvents commonly stored in large volumes is possible. Preliminary guidance is given on extending the assessment to low-wind speeds and to calculate the rate at which a cloud may accumulate in the case of spray releases, such as flange failure or pipe rupture.

For a free copy of the *HSE* report, visit: [www.hse.gov.uk](http://www.hse.gov.uk).<sup>2</sup>

The technical note is free to FABIG members and can be purchased by non-members at: [www.fabig.com](http://www.fabig.com).<sup>3</sup>



## LEES' PROCESS-SAFETY ESSENTIALS: HAZARD IDENTIFICATION, ASSESSMENT, AND CONTROL

December 13, 2013, will see the publication of the first edition of *Lees' Process-Safety Essentials*.

This single-volume book presents practical content from the definitive three volume reference — *Lees' Loss Prevention*, used by energy insurance risk engineers and safety professionals worldwide for more than 30 years.

This compact edition covers topics including; engineering for sustainable development; plant location and layout; fire, explosion, and toxic release; human factors and human error. It also includes the latest standards and information on recent incidents, such as Texas City and Buncefield.

It is intended as a guide to navigate common safety and loss prevention challenges faced by those in the industry.

## US FEDERAL AMMONIUM NITRATE ADVISORY DOCUMENT ISSUED

Following the fire and subsequent detonation of an ammonium nitrate (AN) fertilizer storage facility in the town of West, Texas in April 2013, an advisory document was issued to help prevent similar incidents occurring in the future.

In August 2013 the US Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), and Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) issued an advisory containing information on recent and past accidents involving AN, the hazards of AN, how to manage such hazards, appropriate steps for community emergency planning, and proper emergency response.

The advisory is intended to share lessons learned from recent incidents involving AN so that such events can be prevented in the future. Also included is a list of information resources, such as relevant codes and standards, industry publications, and applicable statutes and regulations that will help first responders and facilities handling AN better understand the hazards so they can effectively manage the risks.

For a copy of the full advisory visit: [www.epa.gov](http://www.epa.gov).<sup>4</sup>

## EUROPEAN PROCESS-SAFETY CENTRE (EPSC) MAKES REPORTS AVAILABLE TO PUBLIC



In August 2013 the EPSC selected a series of process-safety reports from their archive for public release. These EPSC reports reflect the efforts of working groups, who discuss process-safety topics and share experience between members.

Six reports deemed to be of value for public release were chosen, dealing with a wide range of topics from high-level organizational safety barriers, such as skills and competence management, or risk management systems, through to specifics of process-safety work, such as systems for protecting pressurized flammable gas vessels. Other reports made available cover subjects, such as process safety in shared facilities, and ensuring against misidentification of chemicals.

EPSC has seen considerable interest in the project globally, with requests coming in from process industry professionals, students, educators, and researchers. The most requested report has been *How to Set up a Process-Safety Competence Management System*, a guidance report for an organization on the management of skills, experience, and training to ensure continued safe operations.

To see a full list and request a copy of the reports visit: [www.epsc.org](http://www.epsc.org).<sup>5</sup>



## EU OFFSHORE OIL AND GAS PLATFORM STANDARDS

On June 10, 2013, the EU adopted a directive on the safety of offshore oil and gas operations.

The new rules (initially proposed to take the form of a regulation) will ensure that the highest safety standards are followed at every oil and gas platform across Europe and that there is an effective and prompt reaction should an accident occur. This will help minimize possible damage to the environment and the livelihood of coastal communities. The new directive sets clear rules that cover the whole lifecycle of all exploration and production activities from design, to the final removal of an oil or gas installation.

The new regulatory framework aims to reduce the number of major accidents related to offshore oil and gas operations, as well as to limit their impact. It establishes minimum conditions for safe offshore exploration and exploitation, and improves response mechanisms in the event of a major accident.

The new law applies to existing and future installations and operations. Offshore oil and gas operations will only be conducted by operators appointed by licensees or licensing authorities. The directive contains provisions ensuring the independence and objectivity of the competent authority. To prevent conflicts of interest, member states should ensure a clear separation between regulatory functions relating to offshore safety and environment, and economic development, including licensing and revenues management.

In addition, the directive also provides rules for transparency and sharing of information, cooperation between member states, emergency response plans and trans-boundary emergency preparedness and response.

For the full directive visit: [eur-lex.europa.eu](http://eur-lex.europa.eu).<sup>6</sup>





# HAZARDS ASIA PACIFIC SYMPOSIUM 2013

Singapore-based Jon Wilkinson, a risk engineer in Marsh's Energy Practice, reports on his visit to the second Hazards Asia Pacific Symposium held in April 2013.

The second Hazards Asia Pacific Symposium was held on April 16-18, 2013 in Kuala Lumpur, Malaysia. The event was hosted by joint organizers, the Institution of Chemical Engineers (IChemE), and the Chemical Industries Council of Malaysia (CICM). The symposium covered several topics, including asset integrity, operational safety, process-safety management, and learning from major hazards incidents. The event was well attended by more than 230 delegates and speakers from across the world, representing several major oil, gas, and petrochemical companies, such as DuPont, BASF Petronas, and Phillips 66.

Judith Hackitt, chair of the UK Health and Safety Executive (HSE), opened the morning session on day one with a cautionary speech entitled "Complacency to Anxiety – the Road to Process-Safety Leadership." She referenced Marsh's *100 Largest Losses* publication early on in her speech, highlighting it as an excellent source of material for learning from losses, although judging from the significant number of losses in the publication this implied that the industry was still not getting it right.

Several possible causes of complacency were cited, such as assuming problems are fixed, having too much faith in technology, memory loss in an organization with demographic shift, and a company culture that seeks reassurance rather than assurance. Simply put, complacency can be dangerous. She went on to outline that there was a "need for unease" in the

industry, and that process-safety management is a continuum — not a one-off fix and that the "journey never ends." Hackitt then posed the question: "Is regulation the best way to achieve change?" It has been demonstrated in many countries that regulation is good at setting minimum standards, but tends to externalize the issue rather than making safety integral to doing business. In her opinion, goal setting is a better approach. However, she concluded that a voluntary approach requires real commitment and delivery, and needs a much greater level of reporting by companies, and between companies on process-safety management performance indicators, to understand what is happening "below the water line."

The concept of the "need for unease" in an organization was a common theme throughout the symposium with a similar speech by John Bresland, former chairman of the US Chemical Safety Board. He shared lessons learned from his many years working in the industry and on the US Chemical Safety Board, discussing how a company can improve their process-safety programs. He suggested there are three categories of companies:

1. Companies that do not understand process safety.
2. Companies that truly understand process safety.
3. Companies that have the right systems and are trying to achieve good safety standards, but still suffer serious incidents.

Bresland used examples of companies focusing more on personal safety than process safety, illustrating that it is possible for a company that has worked with a hazardous chemical or product for many years to not appreciate the safety issues. He suggested companies do the following to improve process safety:

- Hire the right people. It is vital to hire people who understand how to design, build, operate, and maintain the plant. Education and process-safety knowledge are essential for all staff.
- Ensure leadership committed to process safety. It is important for managers to spread the message and regularly visit the plant to check that everyone is adhering to systems and procedures.
- 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.

**"Excellence in process safety is the key to the overall success of a company."**

He also advocated learning from other sectors such as the aviation and nuclear industries, and concluded his address by stating that: “Excellence in process safety is the key to the overall success of a company.” Therefore, companies should always opt to take the long view on safety.

Another key theme of the symposium was the importance of people in process safety. Research by several companies suggested that more than two thirds of safety incidents were caused by human error. Yang Soo Lee, vice president SHE at SK Innovation, presented a paper on how to improve safety culture in SK Innovation. He focused on how the company has recently set up a safety task force, which spent 10 months reviewing its safety management systems and has since reinvigorated them. For example, he highlighted how the near-miss reporting system had

become both discredited and under-utilized within the organization. The company, therefore, set about promoting the near-miss reporting system to gain the maximum benefit of the information generated from it. Other notable examples of initiatives to improve safety culture include providing safety bulletins to employees and establishing a set of mandatory golden safety rules. He concluded that it had not been easy to change the safety culture in SK Innovation, and that simply trying to follow best practices was not a guarantee for success. However, he felt that there was an opportunity for the company to benefit from sharing best practices with other companies. Overall, his presentation was warmly received by the other delegates who commented that it was very open, and provided good recommendations that other companies could implement to improve their own safety culture.

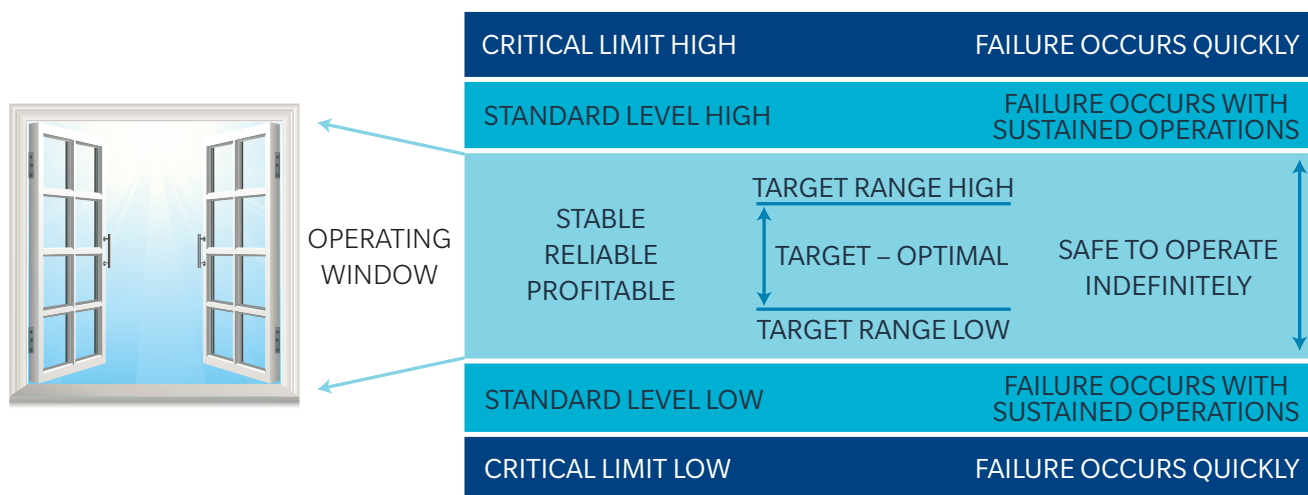
Ian Hamilton, head of the Global Human Factors team at ERM — a leading environmental, health, and safety (EHS) consultancy practice — presented a paper titled *Controlling Human Error for More Effective Process Safety Management*. He first outlined the interactions between people, machines, and systems within an organization. When carrying out a process hazard analysis, such as a “bow tie” study, the biggest component of risk are human factors — yet the main focus is usually on technical risks. He introduced a methodology known as “safety critical task analysis,” which is used to identify all the critical human factors using a team of subject-matter experts. The objective is to measure success (leading indicators) not failure (lagging indicators), for example, how effectively someone is actually carrying out a task, such as an operator monitoring alarms on a distributed control system (DCS) console, or a maintenance technician taking vibration analysis data for a pump.

Wijnand Moonen, the Downstream Market Sector leader at Lloyd’s Register, gave a presentation that was rather controversially titled “Are We Waiting for the Next Texas City? Plant Safety and Our Understanding of Risk.” He opened by presenting several examples of major incidents that have occurred over the last two years that were similar in scale to the 2005 British Petroleum (BP) Texas City incident. He continued to outline some of the factors that are currently affecting the refining and petrochemicals industries, such as the emergence of newer, larger plants with cheaper feedstocks, particularly in the Middle East. This has meant that older, smaller plants without access to advantaged feedstocks have had to become much more flexible and efficient in their operating models.

Previously, the focus of plant operations was to run a steady operation, with stable feedstock. However, we are now



seeing the use of opportunity crudes and plant rates dependent on optimizing products based on fluctuating market forces. Moonen introduced various industry recommended practices such as the *American Petroleum Institute Recommended Practice (APIRP) 584 – Integrity Operating Windows (IOWs)*. This is a new guidance document that highlights the importance of IOWs for process-safety management and demonstrates that moving outside a “safe” operating window can affect the risk of running a plant. This document also aims to guide users on how to establish and implement IOWs for refining and petrochemical process units for the express purpose of avoiding unexpected breaches of containment.



On day three, Hans Volkmar Schwarz, a vice president with group-wide responsibility for process safety at BASF, gave a keynote speech on the firm’s approach to process safety in Asia. He opened his address by sharing some background on BASF’s historical incidents, which are very much part of “corporate memory.” In 1921 an explosion at an ammonium nitrate factory in Oppau, Germany resulted in 560 fatalities, and widespread destruction of the BASF site and adjacent township. He then provided a summary of how process safety has

hugely improved since the early days of BASF, and how organizing the health and safety executive (HSE) under the framework of industry initiatives such as “responsible care” has made BASF a world leader in safety performance. The company takes a holistic approach to safety with the philosophy that prevention is better than dealing with incidents. BASF has developed process-safety management systems that are systematic and binding. There is a dedicated process-safety organization following global rules, and BASF recently established a new center

in Asia, headquartered in Shanghai, China, to build a team of experts to support its developments in the region. However, he did note that many companies are experiencing problems in recruiting people with good experience in process safety.

In conclusion, the symposium provided a useful platform for speakers and delegates to explore process-safety management themes, and share lessons learned from losses within the oil, gas, refining, and petrochemical industries.

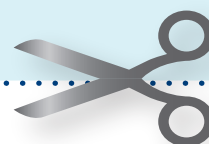
## Safety

Snippet

### USE OF ULTRASOUND INSPECTION ON HIGH-VOLTAGE (HV) SWITCHGEAR TO PROTECT AGAINST FAILURES CAUSED BY UNDETECTED CORONA AND TRACKING

Electrical discharge in the form of corona and tracking is a cause of numerous shutdowns and serious damage in metal-clad switchgear. Because corona and tracking conditions are voltage problems that rarely produce heat, they go undetected during a typical infrared inspection.

Recognizing this risk, one company complements its thermographic survey program with ultrasound scanning, and consequently has observed an increased ability to locate problems and take necessary corrective action.





# PIPER ALPHA 25 YEARS ON STILL RELEVANT FOR ONSHORE OPERATIONS

Jasper Clark, a risk engineer and engineering hub leader in Marsh's Energy Practice based in London, explores the lessons learned from the Piper Alpha disaster and how these are relevant for onshore operations today.

The Piper Alpha disaster, in which 167 people died, caused the most significant loss of life in the history of offshore operations. It was also the cause of an insurance loss well in excess of US\$1 billion. This year, 25 years on, the event has rightly been commemorated in a number of ways, including the "Piper 25" event held in Aberdeen, Scotland in June.

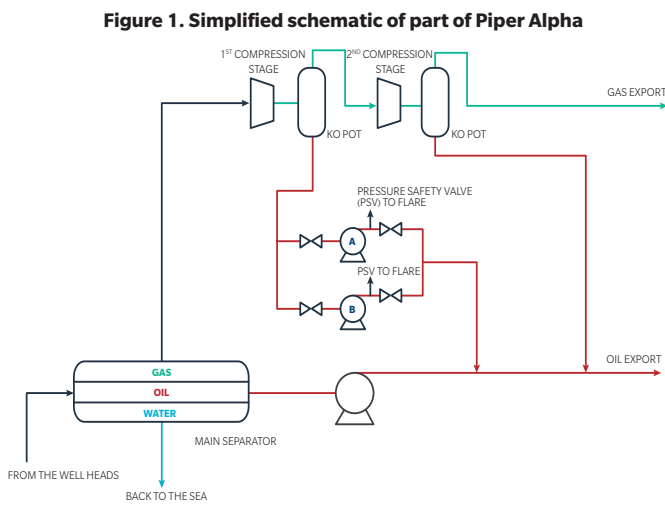
The Cullen investigation, and subsequent reports that followed Piper Alpha, led to many fundamental changes in the way UK offshore platforms are designed, operated, and managed.

However, although many of the improvements following Piper Alpha were offshore specific, a number of the learning areas were just as relevant for onshore process plant operations. The aim of this article is to highlight and remind us of some of those key areas.

## BACKGROUND

Piper Alpha was an oil production platform operated by Occidental Petroleum, located in the North Sea around 110 miles northeast of Aberdeen, Scotland. Originally designed as an oil production platform, it was also a hub, exporting gas from other areas, including the nearby Tartan platform. At the time of the incident, the platform was producing approximately 120,000 barrels of oil per day (bbl/d), and exporting around 33 million cubic feet of gas per day (MMscf/d) from Tartan.

A simplified schematic illustrating part of the process plant on Piper Alpha can be seen in Figure 1. The main separator vessel on the platform took in the produced oil fluids, separating them into gas, oil, and water. The gas was compressed for export, and the produced oil pumped away. Condensate liquids produced as a part of the compression process were added to the oil export via condensate pumps A and B.



## OVERVIEW OF THE INCIDENT

Some of the key events that occurred at Piper Alpha on July 6, 1988, are outlined below:

<b>DAY SHIFT</b>	Planned overhaul on condensate pump A – work completed during shift. Additional/emergent work on the relief valve on pump A. Additional work incomplete – loosely fitting blank put onto relief-valve flange. Permitry for/status of additional work not handed over to night shift.
<b>NIGHT SHIFT</b>	Fire pumps on platform switched to manual operation due to diving activity around the platform.
<b>21:45-21:50</b>	Operational problems with condensate pump B; pump B trips, leading to increases in knock-out (KO) pot level and risk of having to shut down compressors.
<b>21:45-21:55</b>	Attempts to restart pump B fail. Permit for overhaul of pump A found, but not relief valve permit. Blank on relief-valve flange not seen (located several meters higher). Operators prepare pump A for running.
<b>21:55</b>	Condensate pump A started. Gas leak from pump A relief-valve flange heard by a number of people. Gas detectors alarm due to gas leak. Initial ignition and explosion on the platform. Fire deluge system not fully available.
<b>22:00 ONWARDS</b>	Mayday messages broadcast from Piper Alpha. Gas production from Tartan platform continues. Control room on Piper Alpha partially destroyed and abandoned.
<b>22:20</b>	Gas pipeline from Tartan ruptures, causing further explosion.
<b>22:50</b>	Further pipeline ruptures and explosions.
<b>23:20</b>	Structure of platform starts to collapse.

## THE KEY ISSUES

Process operators typically have a number of hardware, software, and emergency management systems in place to manage the risks associated with their operations. These may, at times be called layers of protection or risk control systems (RCS).

In keeping with James Reason's "swiss cheese" failure model, there were multiple causes behind the Piper Alpha disaster. RCS failures occurred in many places during the initiation and escalation of the incident. Here, we will focus on the three that are most applicable to onshore operations:

### CONTROL OF WORK SYSTEM

- The overhaul permit for condensate pump A did not reference the additional work that occurred on the relief valve.
- It is understood that the engineer in charge of the relief valve overhaul did not convey the status of that work to the lead operator as he appeared to be busy.
- Hence, when the overhaul permit was examined on the night shift the operators believed that pump A was ready to use.

### SHIFT HANDOVER SYSTEM

- The shift handover did not fully convey the status of condensate pump A, making it clear that there was relief-valve work occurring in addition to the overhaul.

### EMERGENCY MANAGEMENT SYSTEMS

- The fire deluge pumps were set to manual and so did not operate automatically, contributing to the escalation of the fire.
- An evacuation command was never given during the incident, which resulted in many people losing their lives in the accommodation block.

“it can be useful to test systems against serious incidents such as Piper Alpha, as they give meaning to the everyday processes we use.”

- Emergency scenarios had not been sufficiently designed and practiced prior to the Piper disaster. During the incident other nearby platforms remained in operation, continuing to transmit large amounts of gas to Piper even though it was visibly on fire.

## QUESTIONS FOR AN ONSHORE PROCESS PLANT OPERATOR

Based on the Piper Alpha experience, it is suggested that any onshore operator could test themselves by asking the following questions:

### CONTROL OF WORK

- On your site(s), when a piece of equipment is taken out of service for one type of maintenance work, but further or opportunity work is done, how does your control-of-work system recognize and manage this?
- When maintenance work is completed, or when work finishes for the shift, how is the status of this work communicated to the operating team? Do you believe your current practice is adequate?

### SHIFT HANDOVER

- Do you have specific, written handover expectations?
- How much variation in quality of handover do you believe there is?
- Is this variation in quality accepted, or is something being done about it?
- Have operations management ever audited your shift handover processes?
- How else does senior leadership demonstrate commitment to the handover process?

### EMERGENCY MANAGEMENT – HARDWARE SYSTEMS

- How well do you manage impairments to your emergency management hardware (fire pumps, fire and gas detectors, etc)?
  - How is it risk assessed and what approval is needed?
  - Where are records of impairments kept?
  - How is site leadership made aware of impairments?

### EMERGENCY MANAGEMENT – SCENARIO TRAINING

- Do you have a written emergency management plan?
- Does it contain a clear definition of the different roles within your emergency management process?
- Have you determined the most likely emergency scenarios for your plant?
- As an organization, do you drill or practice these key scenarios?
- Do you feel what you do is adequate?

While these questions are not rigorous tests of the risk control systems listed above, it can be useful to test systems against serious incidents such as Piper Alpha, as they give meaning to the everyday processes we use.

Finally, you should ask yourselves:

- As a site or organization, are you clear on what your key risk-control systems are?
- What are the key auditing processes you use for each RCS?
- What key performance indicators (KPIs) do you use to monitor the performance of your RCS?



# PROJECT RISK MAPPING

Michael Eason, a risk engineer in Marsh's Energy Practice in London, examines how risk mapping can be applied to energy construction projects, lending improved understanding to those critical risks that threaten the success of the venture.

**“No construction project is risk free. Risk can be managed, minimized, shared, transferred, or accepted. It cannot be ignored!”**

SIR MICHAEL LATHAM, 1994.

Michael Latham's words provide the perfect backdrop to the subject of project risk mapping in the field of energy construction projects. Major oil, gas, and petrochemical construction projects are some of the highest financial-value ventures globally. With inherent process hazards, inhospitable locations, and scaled up and new technologies, these projects are exposed to a myriad of risks which, if not properly managed, can lead to cost increases, schedule delays, advanced loss of profits, and are often damaging to the reputations of the organizations involved.

Despite the large number of projects that have been undertaken over many decades, and the use of experienced constructors, project management consultants, and project owners, a surprisingly high proportion of projects still suffer the impacts of risks that may have been mitigated had effective project risk mapping been undertaken early on in the project lifecycle.

Although project risk management almost always features within the structure of organizations, the understanding, techniques, rigor, and discipline of the actual practice varies considerably. Project owner organizations may be familiar with risk management across their operational businesses, using techniques such as quantified risk analysis, and safety integrity level studies, as well as the risk improvement recommendations received through operational insurance underwriting surveys. However, risk management during a construction project is far more dynamic and its success is highly dependent upon commitment throughout the whole of an organization — right to the top. Started early in the project's lifecycle, risk mapping involves the systematic and comprehensive identification, evaluation, and control of those critical risks that threaten the success of the project.

**Marsh has been helping a number of clients use risk mapping to quickly get an overview of a venture's risk profile. Risk mapping forms the “front end” of the project risk management process as shown below:**



**Working intensively with the project team, Marsh employs different techniques and, depending upon the situation to identify risks, these can typically include:**

- Brainstorming.
- Interviewing.
- Assumptions analyses.
- Utilization of sabotage teams.

**The captured risks are then analyzed to quantify them against categories such as:**

- Engineering.
- Project management.
- Transport.
- Construction.
- Ready for start up.
- Procurement.
- Financial.
- Commercial.
- Political.
- Regulatory.

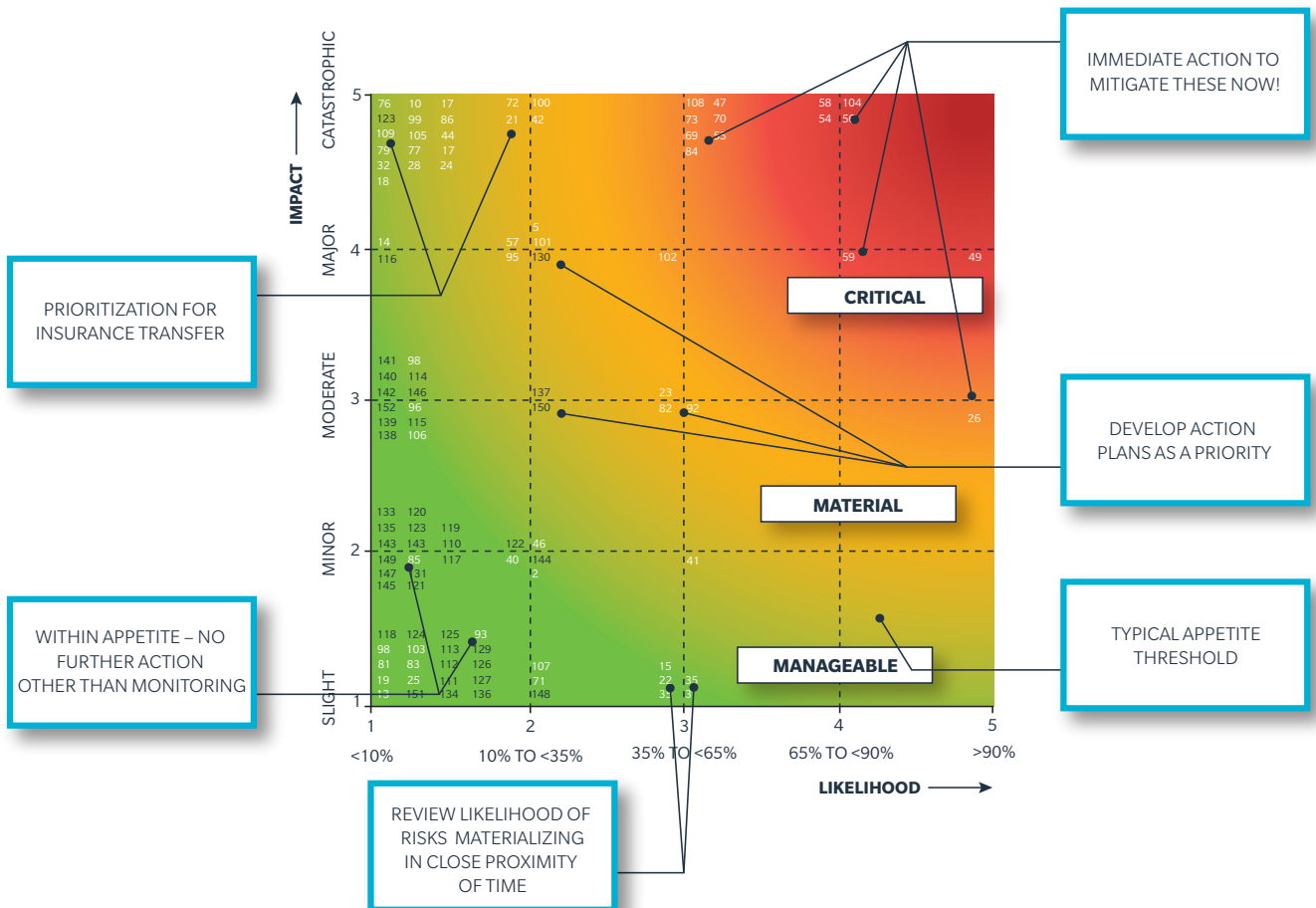
Risk quantification is achieved through the consideration of the risk impact and the likelihood of the risk occurring. Importantly, Marsh develops the criteria for impact and likelihood up front in the process, in close collaboration with the client, and specifically for the project under review. In terms of the safety, financial, schedule, and reputation categories, it is the project director who will reveal what constitutes the definition of “high impact” in relation to their project. Conversely, likelihood definitions are best brainstormed with the wider project team to harness their valuable collective experience. Severity scores from one to five are then assigned against the different levels of impact and likelihood, with the risk score being a multiple of the likelihood and highest scoring impact.

It is vitally important to understand the risk tolerance of a project. Working closely with the client, Marsh identifies risk classes, against which the required assessment and prioritization of actions should be undertaken. An example of such a risk-tolerance definition for a project is shown to the right:

RISK CLASS	RATING ASSESSMENT AND PRIORITIZATION
<b>CRITICAL</b>	<p><b>HIGH RISK:</b> should be brought to the attention of the project director.</p> <ul style="list-style-type: none"> <li>- <b>Severe discomfort at carrying this risk.</b></li> <li>- Insufficient controls in place to address the cause or risk.</li> <li>- If this risk materializes – unable to recover.</li> <li>- Action is required immediately, and if required, funds for mitigation must be made available now.</li> </ul>
<b>MATERIAL</b>	<p><b>MATERIAL RISK:</b> outside of the risk appetite; further mitigation required; bring to the attention of the project manager.</p> <ul style="list-style-type: none"> <li>- <b>Uneasy about carrying this risk.</b></li> <li>- There may be some controls in place that partly address the cause of the risk.</li> <li>- The consequences of the risk could be severe.</li> <li>- Action plans should be prepared.</li> <li>- Status of the risk should be monitored continuously.</li> </ul>
<b>MANAGEABLE</b>	<p><b>LOW RISK:</b> within the risk appetite. No further action other than monitoring is required.</p> <ul style="list-style-type: none"> <li>- <b>Comfortable about carrying this risk.</b></li> <li>- The risk is small; there are sufficient controls in place.</li> <li>- The status of the risk should be reviewed from time to time.</li> </ul>

Typical Project Risk Tolerance

With the impacts and likelihood definitions in place, together with an understanding of the risk tolerance, a project risk map can be drawn up. Using this process, after just a few days of working with the project team, Marsh can identify typically upwards of one hundred risks. The figure below is an example of a risk map produced for a petrochemical complex construction project.



Typical Project Risk Map



The numbers denote unique identifiers that align to the risks captured in an associated risk register; also annotated on the risk map is commentary based on the risk tolerance. The different colored numbers on the map in this case denote those risks scored by the project management organization (in black text) and by Marsh (in white text). In this case, a low perception of risk amongst the project team was revealed, which was at odds with the history and current status, where material risks were actually starting to occur on the project.

“Risk mapping involves the systematic and comprehensive identification, evaluation and control of those critical risks that threaten the success of the project.”

Through the risk-mapping process, Marsh was able to work with the client to develop immediate action plans against those risks that were critical, and also made a number of recommendations relating to project risk management opportunities.

For a project to fully harness the benefits of risk management, the risk map and risk register delivered under

the risk-mapping exercise should be treated as live documents. Throughout the project, significant focus should be applied to the continued identification, analysis, and mitigation of changing or new risks deemed to be material or

high. Regular reporting should focus on those high risks, ensuring the existence, progress, and effectiveness of mitigating action plans.

In summary, project risk mapping applied early on in the project lifecycle will help identify and improve understanding of critical risks.

With support from the top of the organization, continued application of formal project risk management techniques, during the life of the venture, will help mitigate those risks. Additionally, alongside these real benefits are often intangibles, such as enhanced project team leadership, informed decision making and higher confidence across the project stakeholder groups.

## Safety

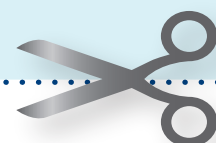
Snippet

### SHARING DATA USING A CUSTOMIZABLE DASHBOARD

In an effort to share key safety-related data, one refinery site has maximized user access to over 15 databases. Users are able to pull data into a single read-only Java-based portal providing secure access to the source databases. Within the portal, users can map real-time data views from the sources into a customizable dashboard. There are various dashboard views including:

- Process safety.
- Personnel safety.
- Quality.
- Leadership accountability.
- Health.
- Environment.
- Road safety.
- Fire and emergency.
- Refining.
- Downstream.

Other features of the portal include links to the laboratory, training records, maintenance teams, and equipment performance, such as turbine trips, hours since last loss time, number of disabled alarms, and number of alarm floods. Roll out has included employee training on the full use of the system.





# PIPELINE LOSSES

Nigel Cairns, a risk engineer in Marsh's Energy Practice in London, was recently asked to present on the topic of pipeline losses at the annual technical conference hosted by the United Kingdom Onshore Pipeline Operators' Association (UKOPA). He addressed the risks involved with operating pipelines, the implications of these on the insurance industry, and what clients should be doing to prevent potential losses.

Of all the options available to clients for moving flammable or toxic hydrocarbons between sites, pipelines have long been acknowledged as providing an efficient and relatively low-risk form of transportation.

However, they are, of course, not without their risks, and we have recently seen a number of high-profile media reports of third-party pipeline interventions in Africa leading to extensive environmental damage and ensuing court activity.

But are these incidents unique? How prevalent are pipeline losses in general? And, how can we best advise our clients in planning to prevent or mitigate pipeline losses?

The European-wide organization Conservation of Clean Air and Water in Europe (CONCAWE), which includes most of Europe's oil producers within its membership, recently published figures on the scale of pipeline losses from 40 years of European pipeline operations. They revealed that third-party activity (such as accidental pipeline damage through excavation, or intentional damage by theft or vandalism) accounted for approximately 37% of all losses of containment; this was the single-biggest factor, followed by pipeline losses, as a result of corrosion (at 28%). However, in terms of actual volumes spilled, such losses are typically smaller than those suffered from mechanical losses (for example, as a result of design and construction faults), or from natural hazards (such as landslides, earthquakes, and flooding).

For the insurance industry, the fact is that pipeline losses continue to occur, and a number of unique factors can often increase loss exposure when compared to process plants such as

refineries. Beyond potential third-party effects and the vulnerability to natural hazards, there could be potentially significant effects related to the time to reach a remote pipeline installation after a loss. These can present challenges when considering estimated maximum loss (EML) scenarios and insurance coverage for property damage, business interruption, or third-party liability policies.

Indeed, it is the third-party angle that has been generating the most recent interest in the matter. While the above figures demonstrate that the issue is of great concern within Europe, losses due to third-party activity can be highly

influenced by geography and local economic conditions, and it could be argued that theft from pipelines might be more prevalent in poorer economic climates where organized crime might be more active. In these cases, wider action across governments and international organizations is required to reduce pipeline losses, beyond the mere application of industry "good practice." In these areas, pipeline losses due to third-party intervention (line taps) can have significant economic and environmental effects, as well as high levels of (bad) publicity for the operators.

Although these losses might generate some spectacular media coverage, the resulting financial losses (from either property damage or loss-of-business revenue) from illegal tapping have mostly been below the respective oil company policy deductible

**"Pipeline losses due to third-party intervention can have significant economic and environmental effects."**



retentions. And, of course, in territories that have a prevalence of such illegal activity, such losses are generally excluded under the policy and thus do not constitute insurance claims. Therefore, claims following a pipeline loss as a result of third-party intervention are more likely to occur from unintentional events, such as the damage inflicted on a pipeline during excavation work, which has not been properly managed.

To try and reduce losses from such third-party intervention we can advise our clients in a number of areas of good practice. Of course, preventing any loss in the first place, by having well-managed software systems, is a good start, communication with and awareness of landowners and



communities is vital, as is a strong work management process to grant approval for any work taking place in proximity to client pipelines (for example, to allow maintenance of municipal utility systems). Pipeline operators should also be well trained in dealing with abnormal operational situations that might arise as a result of third-party intervention.

Good hardware-related systems are vital for keeping hydrocarbons “inside the pipe” for example, ensuring that the pipe is located with the correct depth of cover and natural barriers (rock strata, for example) to limit susceptibility to external interference. Additional barriers, such as concrete encasement might also be used where illegal tapping is a concern. We would advise robust mass-balance monitoring and leak detection facilities to pick up any loss quickly, supporting well-maintained emergency shutdown and isolation systems to limit the consequence of any loss.

If all else fails, then it’s the emergency response plan (ERP) that takes the spotlight. Has the client planned and practiced its response to loss of containment scenarios, and involved local communities in developing the ERP? We would expect the answer to this question to be “yes.”

## “If all else fails, then it’s the emergency response plan that takes the spotlight”

However, as mentioned earlier, although third-party activity has been the leading cause of pipeline losses of containment (certainly within Europe), in terms of actual volumes spilled, mechanical failure, and natural hazards have had a greater overall impact in the last 40 years. In these areas, too, we can offer our clients advice on how to mitigate such events.

In preventing mechanical failure, we would look to the clients’ understanding of potential corrosion and failure mechanisms within their systems, and to ensure that regular inspection and maintenance activities are carried out to ensure pipeline mechanical integrity. Inspection can be carried out in a number of ways, including visual (though this may require physically exposing the pipeline if buried) or through the use of “intelligent pigs”, which gather inspection data from within the line itself.

In limiting potential losses, as a result of natural hazards, again we would look to ensure that the correct design basis has been used for construction of the pipeline (for example, that the correct

hydrological data had been used to determine a pipeline’s resistance to scouring in flood waters). However, it may be that in areas of heavy rainfall, additional work is required, such as land remediation, to improve stability, and additional pipeline monitoring and geotechnical inspections to ensure the pipeline has sufficient resistance to periods of extreme weather.

In summary, pipeline losses continue to occur for a number of reasons, and although unintentional and intentional third-party activity accounts for approximately 37% of all losses of containment, mechanical factors and natural hazards generally have a greater significance in terms of giving greater overall loss volumes. Also, although losses due to intentional intervention tend to create high-profile media interest, financial losses due to such events have mostly been below policy deductible retentions, resulting in few policy claims.

Although pipeline systems can exhibit a number of unique exposure factors when compared to process plants, we can typically offer clients the same level of advice on industry good practice to try and mitigate these risks.

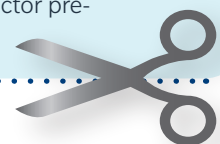
## Safety

### USE OF FLAWED SPECIMENS TO TEST CONTRACT-INSPECTOR CAPABILITY BEFORE ENGAGEMENT

Prior to engaging contract inspection services, one company stipulates that all inspectors undergo a test to demonstrate their ability to practically identify flaws. The company uses test specimens with purposely induced real flaws that are accurately sized and located. The specimens are presented to candidate inspectors, whose task it is to successfully identify the flaws using their own equipment in controlled conditions.

This quality-control step has proven to be a positive addition to the overall inspection contractor pre-engagement procurement process.

Snippet





# TERRORISM LOSS ESTIMATES

Ryan McGovern, a risk engineer in Marsh's Energy Practice in Dubai, outlines Marsh's position on developing loss estimates, as a result of terrorist attacks on energy installations.

Prior to the attacks on the World Trade Center in New York in September 2001, terrorism was not considered a potential risk in major single-loss incidents. Indeed, it took a few more years for it to be considered a major risk for the energy industry, with industrial sites in the Middle East experiencing the first large-scale attacks from international terrorist groups, while oil tankers and pipelines came under attack with increasing frequency. The landscape has changed dramatically in the terrorism insurance sphere, and there is a need to "sharpen the pencil" on the perennial questions within the industry — how bad and how likely?

The sad reality is that terrorist attacks predominantly aim to hurt people rather than damage property, as the perceived threat to life and livelihood is a powerful psychological weapon against the target community. The attack on the In-Amenas gas plant in Algeria in January 2013 was executed with the intention to capture and kill foreign workers and, despite being in control of the site for almost four days, the militants did not succeed in causing significant damage to the plant. When militants attacked the Iraq Baiji Refinery in 2011, five employees were killed and explosives were set off within the plant. However, the refinery was partially restarted within two days and the damaged units repaired within six weeks. Arguably, the most important energy-related terror attack was the attempt by Al-Qaeda to detonate car bombs in the huge Abqaiq oil-processing facility in Saudi Arabia in 2006 — the first direct assault of its kind by the group. Despite the fact that the attackers were stopped prior to reaching the plant itself, oil prices immediately rose by US\$2/bbl, showing just how well Al-Qaeda had selected their target — and hinting at

the potential economic repercussions should the attack have been successful.

So, how do the above examples, the frequent pipeline attacks in Yemen, the marine assaults on oil tankers in the Gulf region, and the invasions of offshore Nigerian platforms help us in quantifying the impact of terrorist attacks on energy installations? The answer is...not much. But they do serve to underline the complexity of understanding terrorism risk in the 21st century.



Terrorist groups have used a wide range of weapons and attack techniques to achieve their objectives, exploring ever-more diverse methods of attack in the last decade as security awareness and defense technologies have improved. Acquisition of a commercial aircraft or a highly technical, scarce weapon (thermonuclear, for example) would be very difficult for a terrorist group to achieve and, therefore, the target for an attack with such a weapon is likely to be something more spectacular; for example, the central business district (CBD) of a major city, government, or military building, or a high-density residential area. Excluding these from the list of "credible" attacks opens up the possibility to determine an estimated maximum loss (EML), which is not simply a "total loss scenario."

While the use of self-propelled or projected devices, like rocket-propelled grenades (RPGs) and mortar bombs present a terrorist group with the opportunity to attack an energy installation without breaching the perimeter fence, the likelihood of catastrophic damage is typically lower than that from the strategic placement of a bomb or other explosive device. The use of maritime craft to carry a bomb to attack a jetty or (more likely) a vessel moored at, or close to, an energy installation presents a realistic scenario, and is something which has been carried out before on moored military vessels (USS Cole, Yemen, 2000) and on oil tankers in transit (Limburg, Gulf of Aden, 2002; M Star, Straits of Hormuz, 2010). However, it is the conventional, home-made bomb that presents the most probable and, frequently, the most damaging type of attack. Small bombs can be carried by an attacker and placement at the site can be through undercover means or by force. Car bombs are among the most frequently

used weapons by terrorists, having the ability to carry a reasonably sized, hidden payload. Larger explosive devices can be carried in rigid body trucks, as has been the case in some of the most devastating terror attacks (Alfred P. Murrah Federal Building in Oklahoma City, 1995; Khobar Towers in Saudi Arabia, 1996, for example).

Having identified three credible attack scenarios, including delivery methods, the nature of the explosive material and the weight used in the bomb must be determined. Based on the history of terrorist-made bombs, maximum vehicle payloads and view of experts in the field of counterterrorism, Marsh has developed maximum credible bomb TNT/ammonium nitrate-fuel oil equivalent models for:

- A bag bomb.
- A feasible car bomb.
- A truck bomb, based on the typical realistic maximum payload.

Placement of the bomb is the next consideration. It can be realistically assumed that a bag bomb can be smuggled into a facility undetected, and therefore can be placed anywhere on the plant, including business interruption (BI) sensitive areas as well as those locations representing the property damage (PD) EML.

## “It is the conventional, home-made bomb which presents the most damaging type of attack.”

The car bomb is also assumed to be smuggled in covertly, therefore allowing it to be placed in any location on the plant which is normally accessible by road. If security checks are performed on trucks accessing the site, then it is not considered credible that a truck bomb can access the site. In this scenario the bomb is placed at various points just outside from the site perimeter fence which is accessible by vehicle from nearby roads. The bombs are modeled in

Marsh’s proprietary explosion modeling program, SLAM®, to yield a property damage loss estimates to identify the PD EML case. Bespoke scenarios are considered for other installations where these attack scenarios

are deemed inappropriate, for example, pipelines, offshore platforms, and marine terminals.

Thankfully the type of attacks discussed in this article have been infrequent, however the significant variability in geography, motivating ideology and political stability in our increasingly unpredictable world warrant consideration of these as real threats.



## Safety

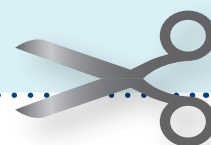
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### “SUBTLE CHANGES” RECOGNIZED BY MANAGEMENT OF CHANGE PROCEDURE

A large company operating in petrochemicals and power has developed its management of change (MoC) procedure to recognize “subtle” changes – aspects of change in the process industries that are often missed.

In dealing with “subtle” changes in the MoC procedure, it was important not to unnecessarily slow down the process — something that could deter users from capturing such changes. Hence, a streamlined flow chart for risk assessment and approval was developed, which did not mandate a process hazards analysis (PHA), nor require all disciplines to attend the MoC meeting.

An example MoC that was seen to be well-managed as a “subtle change” in the MoC database included an improvement to gas turbine efficiency on winter mornings when air can be thick with mist. A fine mesh supported by scaffolding was installed in front of the air intake to coalesce water droplets. This is a classic “subtle” and temporary change, the kind that is often missed from the MoC process, as it involved no obvious existing equipment modification.



# FROM THE ARCHIVES...

In this article, first published in 2003, Iain Clough, a risk engineer in Marsh's Energy Practice in London, discusses some of the losses, mechanisms, and detection methods associated with corrosion under insulation (CUI).



# CORROSION UNDER INSULATION (CUI)

## OUT OF SIGHT, OUT OF MIND

Corrosion, as a whole, costs the UK about 4% of GNP, which is similar to figures identified for Japan and the USA. Corrosion under insulation, while only a subset of the wider topic, poses particular problems for operators of pressure-containing equipment and piping (together with associated supports), which is insulated for thermal or fire-proofing reasons.

### WHAT IS IT?

CUI is a specific case of atmospheric corrosion and is mainly due to the ingress of water or moisture under the insulating or protective layer where it can attack the metal-pressure containing envelope. It can occur on installations, on structures, and under supports and clamps. Additionally, while not insulated for fire proofing or thermal reasons, similar corrosion mechanisms can occur on buried pipelines used for the transmission of oils and gases, where visual examination is not possible due to the nature of the installation.

### LOSSES

Most cases of CUI on processing plants will result in a leak of process fluid that is detected, inspected, and analyzed to determine whether a repair or replacement is the appropriate course of action.

Problems can arise when it is believed that the leak is symptomatic of a problem caused by deterioration of the protective system. For one operator, the concern over the state of systems due to external stress chloride cracking, meant that some facilities were shut down for 11 months in the 1980s.

The corrosion of structures can be even more catastrophic, as there is no leak to identify that the metal underneath the lagging is being weakened by

corrosion. This can lead to a sudden collapse of a structure, either under its own weight, or when loadings are changed due to wind or filling operations.

Corrosion of long-distance underground pipelines can also lead to sudden failure, resulting in the loss of large amounts of oil or gas. Official estimates of oil pipeline leaks in the area of Usinsk, Russia suggest around 68km<sup>2</sup> of land was polluted with oil up to 15 cm thick in places, due to a series of spills, amounting to several hundred thousand tonnes of oil.

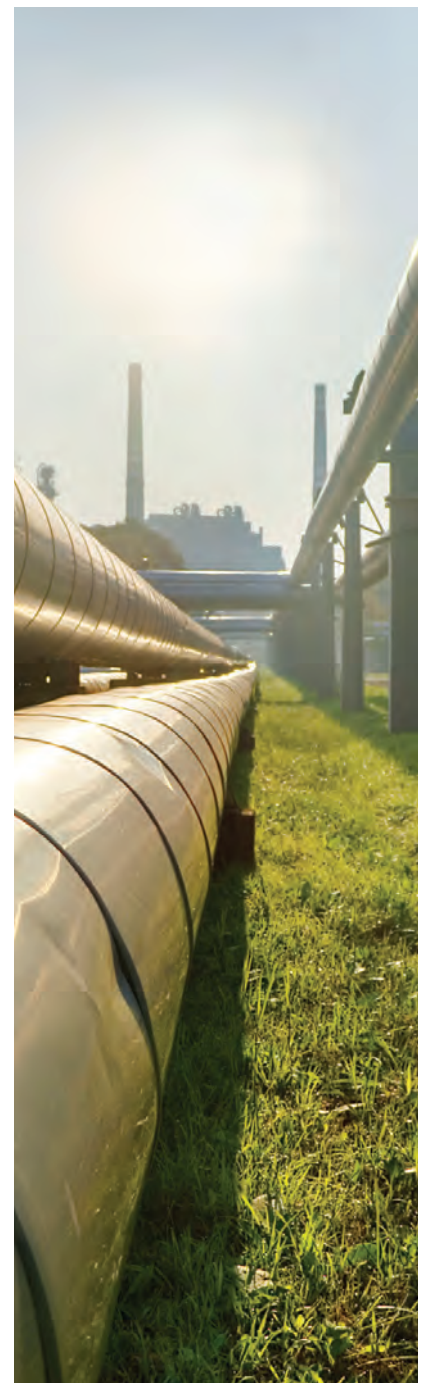
### CORROSION MECHANISMS

There are a number of different mechanisms depending on the situation and the equipment/pipeline material.

#### CARBON STEEL CORROSION

Corrosion of carbon steel systems under insulation is mainly caused by the ingress of water under or through the protective coating, which then attacks the metal and is seen as a non-uniform general attack, localized pitting, or both. Coating failure can be caused by a number of factors:

- Age: A gradual deterioration of the protective coating over time.



- **Repair:** Where the new section of coating does not seal or overlap the older coating sufficiently, allowing moisture to attack the carbon steel through the gap.
- **Temporary Repair:** Where a clamp is used on a pipeline, the gap between the clamp and the pipe can form a crevice, allowing water to enter.
- **Maintenance:** Where a coating is renewed, a failure to either remove all traces of rust or remove pipe supports and hangers can leave the protective coating incomplete and areas unprotected.
- **Others:** Corrosion can also occur where other items have been attached to the linework, most notably direction stickers.

Corrosion rates will be increased by:

- The presence of mineral salts from the insulation material, water ingress, or surrounding earth (for buried pipelines).
- Absorption of water by hygroscopic insulating materials.
- Entrapped water within the insulation caused by water entering via a fault in the cladding, or outer layer of the insulation, and being unable to escape again.
- Elevated temperatures (between 60°C and 100°C).
- Low temperatures, where any moisture or vapor is frozen, creating a driving force for more water ingress.
- Poor-quality coatings installed prior to insulation.
- Intermittent operation or units shut down for extended periods.
- Marine or chemical (chloride) atmospheres, exacerbating all of the above points.

Alternatively, corrosion rates can be reduced by:

- Good surface preparation and coating installation.
- A non-hygroscopic or water-resistant insulation material with a waterproof outer layer.
- The installation of drain points to allow entrapped water to escape, to eliminate “wells” where water can accumulate.

## STAINLESS STEEL CORROSION

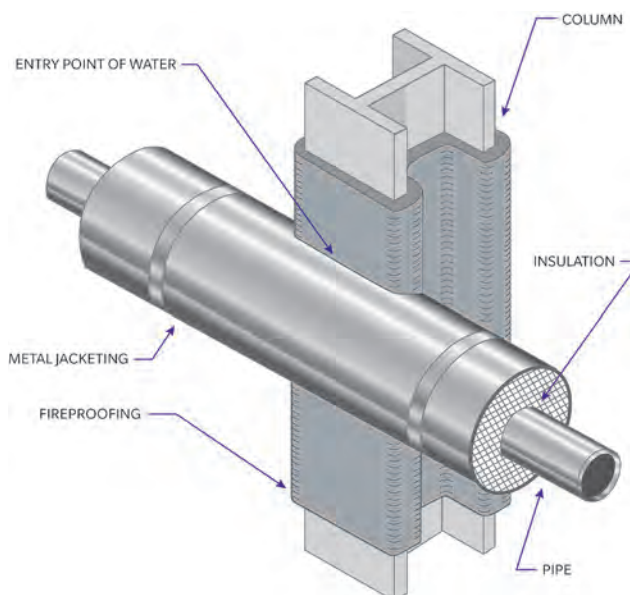
The most common cause of corrosion of austenitic stainless steel under insulation is by chloride attack (stress chloride cracking). Chlorides can be found in the insulation material itself (even those marked as low chloride) and the problem can be exacerbated by warm lines, which allow the water to evaporate and hence, concentrates the chloride ions.

## PREVENTION

The most effective method of prevention is to provide a barrier at the metal-insulation interface. Paint, bitumen, or plastic coating systems are the most common forms, although other solutions, such as wrapping in aluminum foil, can also be used successfully.

This should be coupled with the exclusion of water. The use of a non-hygroscopic or water-resistant insulation, in conjunction with a water-shedding outer layer, can effectively stop water reaching the pipe coating described above.

For structures with insulation for fire protection, water caps should be well designed, fabricated, and installed to prevent water ingress. A common example is illustrated below where an insulated and clad line is too close to a fire-proofed column:



For stainless steel, in particular, care should be taken to avoid chlorides being present.

Underground pipelines can be protected by cathodic protection. This is an active protection system that works by altering the electrical potential between the ground and the pipe. In all cases, a good maintenance routine, ensuring the integrity of the insulation and the protective barrier pipe-coating, can prevent corrosion occurring at all. Some studies suggest that preventative costs can be 20% of the repair costs associated with a failure that would otherwise occur.

## INSPECTION

Any protective barrier system installed to minimize CUI will degrade with time, and an effective inspection regime is needed to ensure that repairs are undertaken at the appropriate time. Risk-based schemes can be more effective

than blanket schemes, as the scope of blanket schemes can be so large they are rarely completed.

Risk-based inspection should focus on the following areas:

- Wherever water is present, or has been present, and there is no acceptable protective coating.
- Older insulations — although younger ones are not immune.
- Where surface or pipework temperatures are between 60°C and 100°C (internal temperatures up to 160°C).
- Plants in intermittent service or subject to prolonged periods of shutdown.
- Low temperatures, where freezing can effectively draw water to the pipework surface.

As with all inspections, the inspectors must be competent and good records should be retained to ensure that the corrosion history of the area under consideration can be monitored. Typical points to note during inspections are:

- Wall thickness compared with the original and design condition.
- Surface-coating condition.
- State of the insulation cladding.

The major problem when inspecting for CUI is that of the insulation itself. For a visual inspection to be realistic, a considerable area of insulation may have to be removed,

although risk-based inspection regimes should identify specific areas that can often be accessed with “windows” cut into the insulation. If there are no suitable inspection points, or the linework is generally inaccessible (such as long lengths of underground pipeline) then visual inspection techniques cannot be used. However, various non-invasive techniques can be employed, that include:

- Thermography: identifies where liquids are present, which may indicate corrosion.
- Real-time imaging: detects external corrosion under insulation.
- Long-range ultrasonics: detects internal and external metal loss at long range (20-40 m from the probe).
- Pulsed-eddy current: detects general thinning over a sample area without removing the insulation, but cannot detect pitting.
- Magnetic-flux leakage: detects general metal loss, and is particularly useful when employed on an ‘intelligent pig’ in lengths of underground pipework.

## CONCLUSIONS

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.



# MARSH NEWS

## NEW ENGINEERS

Since the last edition of the *LCN*, Marsh's GERE team has welcomed six new risk engineers:



### DAVID ADAIR – LONDON

Since graduating as a chemical engineer in 1979, David has worked at major operational sites within the downstream oil and petrochemical industries in Bahrain and the UK. His experience includes safety case preparation, operations management, control of work, and process-safety management, including management of organizational change. Prior to joining Marsh, David was a refinery HSE Manager. He joins the GERE team in London and is responsible for downstream underwriting surveys and providing risk management advice.



### EMMA WHITWORTH – LONDON

Emma graduated from Oxford University in 2006 and is a mechanical engineer. She started her career with the Royal Air Force (RAF) and has been based at RAF Benson, RAF Cranwell, and RAF Waddington. She then worked for four years as a risk engineer for a commercial property underwriter, conducting engineering surveys in a variety of industries, with a focus on locations exposed to severe natural hazard perils and protecting buildings with large volumes of flammable liquids and gases. Emma joins the GERE team in London, and is responsible for carrying out business interruption, third-party liability, and terrorism reviews.



### SANJEEV SUBHRA – DUBAI

Sanjeev graduated in chemical engineering from the University of Nottingham, UK in 2001. He started his career providing technical support on piping systems, valves, and automation for ABB in the UK. He then spent 10 years specializing in instrumentation and process control for Yokogawa and ABB, where his responsibilities included, technical support, commissioning, training, research and development, and key account management. Sanjeev is an associate member of the IChemE. He joins the GERE team in Dubai and is responsible for supporting underwriting surveys in energy and power.



### MARC JOSEPH – DUBAI

Marc graduated in chemical engineering from the University of KwaZulu-Natal, South Africa in 1998, and went on to do a master's in chemical engineering in 2000. He started his career as process engineer at Sasol Technology, where he was responsible for process design and plant optimization of a wax plant in South Africa. In 2007 Marc joined Sasol Synfuels as senior process engineer, responsible for the optimization of a gas reforming plant and managed a team of process engineers. Marc then transferred to Sasol Technology as principal process engineer. Marc joins the GERE team in Dubai and is responsible for downstream underwriting surveys and providing risk management advice.



### GRAEME MCMILLAN – DUBAI

Graeme graduated in chemical engineering from the University of Strathclyde in 2006. His career, to date, has been with ExxonMobil Refining and Supply in the UK, starting as a process engineer working on improvement projects and technical support for the cat-cracking complex. He then moved to refinery optimization where he first scheduled and optimized the refinery gasoline production, then crude oil. Graeme went on to become the refinery economist before moving on to be operations supervisor for the reforming and isomerization complex at the Fawley refinery. He is an associate member of the IChemE, and joins the GERE team in Dubai, where he is responsible for downstream underwriting surveys and providing risk management advice.



### PETER BARRALET – LONDON

Peter graduated in mechanical engineering from Loughborough University, England, in 1994. Prior to joining Marsh, Peter worked for BP and has 17 years of international operational and project experience. Most recently, he worked on BP's deepwater subsea developments offshore of Angola. He is a chartered engineer with the Institution of Mechanical Engineers. Peter joins the GERE team in London and will be carrying out insurance surveys, with a particular focus on upstream and construction projects.

## MUMBAI ANNOUNCED AS 12TH GLOBAL ENERGY HUB

December 11-12, 2012, marked the launch of Mumbai, India as Marsh's 12th global Energy hub. Arun Negi, a risk engineer in Marsh's Energy Practice based in New Delhi, attended Marsh's India Energy Conference (IEC), which provided the perfect platform to launch the new hub.

The event attracted 150 delegates from over 30 reinsurers, and approximately 70 Indian oil and gas clients and was attended by some of Marsh's senior management, including Jim Pierce, Andrew George, and Guy Bessis.

The central theme of the conference was *Securing Future – Managing Risks in Energy Domain* with a view to encompassing both the insurance and risk management aspects of the oil and gas industry. The two-day seminar served as an opportunity for detailed discussions on recent developments, like deepwater drilling and the globalization of Indian oil and gas companies.

Marsh's Energy Practice in India has grown in strength and expanded its geographic presence to Delhi, in addition to



the main base in Mumbai. The team now consists of 12 full-time dedicated energy colleagues, including a full-time offshore risk engineer, part of Marsh's GERE team, providing risk engineering expertise dedicated to this new global Energy hub.

# MARSH'S ENERGY TRAINING COURSES 2014

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: July 7-11, 2014

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 12-16, 2014

October 6-10, 2014

JOHANNESBURG: April 7-10, 2014

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 1-5, 2014

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.

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To access the energy insurance courses 2014 brochure please visit [www.marsh.com](http://www.marsh.com).<sup>7</sup>



# LOSSES

JANUARY – AUGUST 2013



## CHEMICAL

LOSS NO.	9767	Instability in the product process for mercaptan resulted in a release, which led to an odor spreading from the site that extended for hundreds of kilometers (km). Although the chemical is not toxic it resulted in numerous reports of natural gas leaks. The reactor neutralization process took over six days to complete.
DATE OF LOSS	01/21/2013	
COUNTRY	France	
LOCATION	Rouen	
MATERIAL	Mercaptan	
EVENT TYPE	Release	
CAUSE	Process upset	

LOSS NO.	9779	About five million liters of ethanol were consumed by a fire in a tank at a plant that produces sugar and ethanol. The fire was thought to have been caused by a lightning strike. The force of the explosion was so great the roof of the tank was thrown 15 meters (m), and the lightning caused the burning structure to fall on the tank, causing the explosion. No one was injured.
DATE OF LOSS	01/06/2013	
COUNTRY	Brazil	
LOCATION	São Paulo	
UNIT TYPE	Storage	
MATERIAL	Ethanol	
EVENT TYPE	Explosion, fire	
CAUSE	Storm	

LOSS NO.	9826	An explosion and subsequent fire at a chemical plant in an industrial park prompted the evacuation of at least 1,200 people. Early reports indicated that the explosion could have been generated by a short circuit. Nearby residents were evacuated from their homes due to the environmental risk from the toxic cloud that caused the fire.
DATE OF LOSS	04/07/2013	
COUNTRY	Mexico	
LOCATION	Pachuca, Hidalgo	
EVENT TYPE	Explosion, fire	
CAUSE	Short circuit	

LOSS NO.	9887	A flash fire injured up to 16 people on a production unit of a polyethylene plant. Injuries included smoke inhalation and serious burns.
DATE OF LOSS	05/02/2013	
COUNTRY	United States	
LOCATION	Point Comfort, Texas	
MATERIAL	Ethylene	
UNIT TYPE	Polyethylene	
EVENT TYPE	Fire	

LOSS NO.	9897	One person was hospitalized with a chemical burn after a leak of a mixture of hydrofluoric acid and butane. The minor leak of toxic material led to the closure of the main railway line that runs through the site.
DATE OF LOSS	07/11/2013	
COUNTRY	France	
LOCATION	Donges, Loire-Atlantique	
UNIT TYPE	Alkylation	
MATERIAL	Hydrofluoric acid	
EVENT TYPE	Release	

LOSS NO.	9902	Two people were killed and 76 injured in an explosion and fire at a petrochemical plant that produces ethylene and propylene. The explosion is thought to have originated in the propylene fractionator. Piping, heat exchangers and the reboiler were badly damaged by the explosion and subsequent fire that burned for more than three hours. Large portions of electrical cabling and control wiring, as well as support structures and piping were damaged and approximately 300 people were evacuated due to the explosion. Restart is expected in April 2014, incorporating an expansion of the capacity of the unit by about 50%.
DATE OF LOSS	06/13/2013	
COUNTRY	United States	
LOCATION	Geismar, Louisiana	
UNIT TYPE	Ethylene	
MATERIAL	Propylene	
EVENT TYPE	Explosion, fire	

## DISTRIBUTION

LOSS NO.	9825	Marine fuel leaked from a refueling pier in São Paulo, Brazil soiling four beaches along the coast. Clear-up operations involved 27 ships and approximately 300 workers removing oil from the beaches, as well as a canal. The company was ordered to pay a fine of US\$5 million as a result of the oil spill.
DATE OF LOSS	04/05/2013	
COUNTRY	Brazil	
LOCATION	São Paulo	
UNIT TYPE	Storage	
MATERIAL	Diesel	
EVENT TYPE	Release	

LOSS NO.	9830	An oil pipeline stopped pumping after rebels used dynamite to blow up a portion of the line. 72 bombings have occurred on this pipeline during the first three months of the year — nearly twice as many as the 38 registered during that period of 2012.
DATE OF LOSS	05/22/2013	
COUNTRY	Colombia	
LOCATION	Norte de Santander	
UNIT TYPE	Pipeline	
MATERIAL	Crude oil	
EVENT TYPE	Explosion	
CAUSE	Terrorism	

LOSS NO.	9833	A landslide damaged a major pipeline in Ecuador, causing a spill of about 10,000 barrels of crude oil, some contaminating a river travelling downstream. An estimated 11,480 barrels entered the river, polluting the water and affecting the drinking water of about 80,000 people.
DATE OF LOSS	05/31/2013	
COUNTRY	Ecuador	
LOCATION	River Coca	
UNIT TYPE	Pipeline	
MATERIAL	Crude oil	
EVENT TYPE	Release	
CAUSE	Landslide	

LOSS NO.	9854	A company estimated 750 barrels of light synthetic crude oil had spilled onto the ground, forcing it to shut down its pipeline and install booms to contain the spill. All other pipelines in the area were also shut down. The leaking pipe is a 12-inch diameter line that runs for 17km. The release occurred in a remote area only accessible by helicopter or all-terrain vehicles. A temporary road was constructed using rig mats. No injuries or evacuations occurred as a result of the spillage and no potable water wells were affected.
DATE OF LOSS	06/22/2013	
COUNTRY	Canada	
LOCATION	Alberta	
UNIT TYPE	Pipeline	
MATERIAL	Crude oil	
EVENT TYPE	Release	
CAUSE	Spill	

LOSS NO.	9856	A gas pipeline exploded in a rural area, prompting evacuations and road closures near the site. Fifty-five people were evacuated, but there were no fatalities or injuries. The incident knocked out power to 10,000 residents. An approximate 80-foot segment of the pipeline was blown away, causing nearly 300 feet of heavily wooded radius to be completely leveled. The pipeline that ruptured was a 30-inch natural gas line.
DATE OF LOSS	06/18/2013	
COUNTRY	United States	
LOCATION	Washington Parish, Louisiana	
UNIT TYPE	Pipeline	
MATERIAL	Natural gas	
EVENT TYPE	Explosion	
LOSS NO.	9860	A leak occurred in a pipeline, spilling 50-70 tonnes of crude oil into the sea, while a tanker moored offshore was transferring crude oil to the pipeline for delivery to a refinery. The ship's crew immediately shut off the pipeline valve to prevent further spills and cooperated with the navy and the marine department to contain the damage.
DATE OF LOSS	07/26/2013	
COUNTRY	Thailand	
LOCATION	Map Ta Phut, Rayong Province	
UNIT TYPE	Pipeline	
MATERIAL	Crude oil	
EVENT TYPE	Release	
CAUSE	Leak	
LOSS NO.	9872	A train spilled more than 20,000 US gallons of crude oil onto frozen ground after 14 tankers of a 94-car train derailed. One 26,000-gallon tanker drained out onto both sides of the track, while two other tanks leaked smaller amounts. The rail line reopened the following day after track repairs and inspections.
DATE OF LOSS	03/27/2013	
COUNTRY	United States	
LOCATION	Parkers Prairie, Minnesota	
UNIT TYPE	Rail	
MATERIAL	Crude oil	
EVENT TYPE	Release	
CAUSE	Derailment	
LOSS NO.	9874	Thirty houses were evacuated for two hours when a 24-inch diameter methane pipeline ruptured. The pipeline typically transports 120 million cubic feet per day of natural gas. There was no ignition.
DATE OF LOSS	03/22/2013	
COUNTRY	United States	
LOCATION	Wheeling, Wyoming	
UNIT TYPE	Pipeline	
MATERIAL	Natural gas	
EVENT TYPE	Release	
LOSS NO.	9875	A pipeline reception terminal was shut down following failure of a connection on a pump on the gas-heating system. A connection to a pump on the hot water system that heats the gas before it enters the national distribution network failed, resulting in a steam release and consequent shutdown of terminal operations. The terminal returned to full capacity of 76 million m <sup>3</sup> /day, after operations were interrupted for approximately eight hours.
DATE OF LOSS	03/22/2013	
COUNTRY	United Kingdom	
LOCATION	Bacton, Norfolk	
UNIT TYPE	Gas processing	
MATERIAL	Natural gas	
EVENT TYPE	Production loss	
CAUSE	Mechanical failure	

LOSS NO.	9885	A total of 25 people died when a gas tanker, hauling two gas tanks on tandem trailers, exploded. The tractor hit a center divider and broke apart; one tank flew into a house and exploded, while another hit a different house. One piece of the truck's tank was blown 50m by the blast, landing on the wall of a house and cars parked outside. At least 20 homes were damaged and 15 vehicles burned.
DATE OF LOSS	05/07/2013	
COUNTRY	Mexico	
LOCATION	San Pedro Xalostoc	
UNIT TYPE	Road	
MATERIAL	Propane	
EVENT TYPE CAUSE	Explosion Road accident	
LOSS NO.	9886	More than 50 cars of a 71 car-long freight train derailed in a station, setting at least 10 tank cars on fire. One of the tank cars containing diesel fuel started the fire that engulfed an area of 1,500 square meters. One of the cars released propane that fuelled the fire. At least 27 people were injured with burns and 3,000 people were evacuated from the nearby area.
DATE OF LOSS	05/08/2013	
COUNTRY	Russia	
LOCATION	Belaya Kalitva	
UNIT TYPE	Rail	
MATERIAL	Diesel	
EVENT TYPE CAUSE	Fire Derailment	
LOSS NO.	9892	A freight train of 74 crude oil tank wagons ran away from an overnight parking location and derailed, causing the tank cars to catch fire and explode. More than 30 buildings were destroyed and the explosion caused damage up to one kilometer from the incident. Approximately 150 firefighters were deployed to the scene of the derailment. After 20 hours, the center of the fire zone was still inaccessible to fire-fighters and five pools of fuel were still burning. Fire-fighting foam was supplied from a nearby refinery to aid in fire-fighting. Two rail tank cars were still burning 36 hours after the derailment. The engine on the freight train was shut down while it was parked up after reports of a fire on the locomotive, which may have disabled the compressors required to maintain the pressure in the air brakes. Approximately 1,000 people were evacuated after the derailment and an additional 1,000 later due to the threat from toxic fumes.
DATE OF LOSS	07/06/2013	
COUNTRY	Canada	
LOCATION	Lac Megantic, Montreal	
UNIT TYPE	Rail	
MATERIAL	Crude oil	
EVENT TYPE CAUSE	Explosion, fire Derailment	
LOSS NO.	9899	A landslide caused by heavy rainfall damaged an underground oil pipeline. Oil leaked into a nearby river when the pipeline cracked due to the severe impact of the landslide. Rescue teams built nine protective dams in the river to stop the spill from flowing downstream.
DATE OF LOSS	07/15/2013	
COUNTRY	China	
LOCATION	Zichang, Shaanxi Province	
UNIT TYPE	Pipeline	
MATERIAL	Crude oil	
EVENT TYPE CAUSE	Release Landslide	

LOSS NO.	9905	A tug boat pushing a barge carrying crude oil hit a 16-inch LPG pipeline in shallow coastal waters resulting in failure of the pipeline and a major fire. Pipeline operators shut off supply to the 19-mile long pipeline. The crew of the tug boat suffered burns and were transferred to hospital.
DATE OF LOSS	03/12/2013	
COUNTRY	United States	
LOCATION	Bayou Perot, Louisiana	
UNIT TYPE	Pipeline	
MATERIAL	Propane	
EVENT TYPE CAUSE	Explosion, fire Collision	

## E&P OFFSHORE

LOSS NO.	9773	Hydrocarbons were detected at one of the legs of an offshore oil production platform. The company removed all non-essential crew from the installation. Pipeline connections to the platform and all associated pipeline infrastructure was shut down as a precaution.
DATE OF LOSS	01/14/2013	
COUNTRY	United Kingdom	
LOCATION	Cormorant Field, North Sea	
UNIT TYPE	Crude distillation	
MATERIAL	Crude oil	
EVENT TYPE	Release	

LOSS NO.	9796	A pipe linking two platforms ruptured and released crude oil into the sea. A crude oil slick about one kilometer long and ten meters wide was reported. The platforms were out of service for several months.
DATE OF LOSS	02/01/2013	
COUNTRY	Algeria	
LOCATION	Skikda	
UNIT TYPE	Platform	
MATERIAL	Crude oil	
EVENT TYPE	Release	

LOSS NO.	9810	A platform and pipelines were shut down as a precaution following the discovery of a leak into one of the platform's legs during maintenance work. Hydrocarbons were flushed through with sea water, and the release was contained within the leg meaning no hydrocarbons were released into the environment. (See loss 9773 earlier in 2013).
DATE OF LOSS	03/02/2013	
COUNTRY	United Kingdom	
LOCATION	North Sea	
UNIT TYPE	Platform	
MATERIAL	Crude oil	
EVENT TYPE CAUSE	Release Leak	



LOSS NO.	9819	<p>A power failure on-board an offshore gas field center occurred while well operations were under way, causing a gas leak from the well. The facility was shut down in accordance with procedures, the emergency response organization was mobilized, and the personnel were sent to the lifeboat stations. Power was restored, the gas leak was stopped and the situation was gradually returned to normal. During the subsequent startup of the facility, gas detectors indicated that gas was still present and the alarm was triggered again. The facility was depressurized and personnel were again sent to the lifeboats. The gas detectors quickly returned to normal levels, and the situation was resolved without further mobilization of the emergency response organization. Following this, the field experienced another power failure, with the loss of the main power supply. During this period the emergency power units supplied the emergency preparedness systems, lights, and limited communications, measures were also initiated to safeguard the personnel on board, as the heating unit was not operating.</p>
DATE OF LOSS	03/14/2013	
COUNTRY	Norway	
LOCATION	North Sea	
UNIT TYPE	Well	
MATERIAL	Natural gas	
EVENT TYPE	Release	
CAUSE	Explosion	
LOSS NO.	9850	<p>Two workers died and one was injured in an explosion on a natural gas platform. The incident occurred when a heat-exchanger exploded during a pressure test. The platform was not producing at the time. No one was evacuated and 13 workers remained on the platform. The men who died were both contractors.</p>
DATE OF LOSS	06/14/2013	
COUNTRY	Netherlands	
LOCATION	North Sea	
UNIT TYPE	Gas processing	
EVENT TYPE	Explosion	
CAUSE	Leak	
LOSS NO.	9867	<p>Natural gas flowed uncontrolled from a well after a blowout that forced the evacuation of 47 workers aboard a drilling rig. The water depth of the rig was reported as 154 feet. The incident occurred near an unmanned offshore gas platform that was not producing natural gas — the workers were aboard a jack-up rig. The well ignited after the evacuation and the rig partially collapsed after catching fire because of a ruptured natural gas well and failure of beams supporting the derrick and rig floor. The jack-up rig also crumpled over the rig structure. No injuries were reported.</p>
DATE OF LOSS	07/23/2013	
COUNTRY	United States	
LOCATION	Gulf of Mexico, Louisiana	
MATERIAL	Natural gas	
EVENT TYPE	Fire	
CAUSE	Blow-out	
LOSS NO.	9878	<p>A leak occurred from a holding tank on an offshore platform. The tank contained more than 300,000 gallons of medium crude oil floating on more than 150,000 gallons of water. The company arranged for an oil barge to remove the oil and water to minimize the leakage.</p>
DATE OF LOSS	05/02/2013	
COUNTRY	United States	
LOCATION	Matagora Island, Gulf of Mexico, Texas	
UNIT TYPE	Offshore platform	
MATERIAL	Crude oil	
EVENT TYPE	Release	

LOSS NO.	9888	A jack-up sank after the sea bed collapsed under one of the three legs. The rig sank while being positioned for drilling operations in approximately 40m of water. One hundred and three workers were on-board the rig when it suddenly tilted, causing the rig to take on water and capsize. One crew member was reported missing and six others received minor injuries.
DATE OF LOSS	07/01/2013	
COUNTRY	Angola	
LOCATION	Atlantic Ocean	
UNIT TYPE	Drilling	
EVENT TYPE	Mechanical damage	
CAUSE	Collapse	

## E&P ONSHORE

LOSS NO.	9804	A company was forced to drill a relief well to control the flow of natural gas that began to flow underground while a well was being drilled. They shut in the well after it experienced a kick due to higher than anticipated pressures encountered while drilling. Non-essential personnel were evacuated from the jack-up drilling rig and no oil or gas was reported to have been released. The well was reported to have been killed approximately one month after the initial loss of control. The bottom of the well was plugged and cemented, and the migration of gas into another sand formation stopped.
DATE OF LOSS	02/05/2013	
COUNTRY	United States	
LOCATION	Gulf of Mexico, Louisiana	
MATERIAL	Natural gas	
EVENT TYPE	Release	

LOSS NO.	9818	At least eight workers were injured in an explosion at a natural gas field on the Yamal Peninsula in Russia. The explosion was reportedly due to an uncontrolled blowout of natural gas.
DATE OF LOSS	03/13/2013	
COUNTRY	Russia	
LOCATION	Yamal Peninsula	
UNIT TYPE	Gas processing	
MATERIAL	Natural gas	
EVENT TYPE	Explosion	

LOSS NO.	9820	A drill malfunction at a natural gas well caused thousands of gallons of hydraulic fracturing fluid to be released, and the well was shut down. At one time, 800 gallons of fracking fluid were flowing out every minute. The drill was repaired and workers were able to contain the fluid in a nearby retention pond — allowing only a small amount to reach a public road nearby.
DATE OF LOSS	03/14/2013	
COUNTRY	United States	
LOCATION	Tunkhannock, Pennsylvania	
UNIT TYPE	Drilling	
MATERIAL	Fracking fluid	
EVENT TYPE	Release	
CAUSE	Blow-out	

## FERTILIZER

LOSS NO.	9807	A major deflagration occurred in a phosphate fertilizer plant. It was reported that this was caused by the failure of a compressor. Toxic fumes, reported to be ammonia, spread offsite, resulting in some panic among local residents.
DATE OF LOSS	02/04/2013	
COUNTRY	Tunisia	
LOCATION	Gabes, Chatt Salem	
MATERIAL	Ammonia	
EVENT TYPE	Release	
CAUSE	Mechanical failure	

LOSS NO.	9906	An explosion occurred on a small fertilizer storage and distribution facility located close to a small rural community. The explosion occurred while emergency services personnel were responding to a fire at the facility. Fifteen people were killed, more than 160 were injured and over 150 buildings were destroyed as a result of the explosion. The explosion had the effect of a 2.1 magnitude earthquake and caused a crater that was 28 meters wide and 3 meters deep. Debris was found four kilometers away. The source of the explosion was thought to be stocks of ammonium nitrate fertilizer, stored in a wooden bin in a seed store. The cause of the original fire was not determined, however, it is understood the fertilizer storage area was not equipped with firewater sprinklers, but there were fire extinguishers in the building. Investigators determined that between 28-34 tons of ammonium nitrate exploded in two blasts that were milliseconds apart, and were caused by the heat of the fire and the impact of falling debris. An additional 20-30 tons of fertilizer in the building, and 100 tons of fertilizer in a rail wagon outside the building, did not explode. The blast was the equivalent of an explosion of 6,800 to 9,000 kilograms of TNT.
DATE OF LOSS	04/17/2013	
COUNTRY	United States	
LOCATION	West, Texas	
MATERIAL	Ammonium nitrate	
EVENT TYPE	Explosion, fire	
CAUSE	Fire	

## GAS PROCESSING

LOSS NO.	9778	A terrorist attack on a desert gas-processing facility resulted in at least 40 fatalities to plant personnel. Terrorists linked to Al-Qaeda kept over 800 workers hostage in the gas plant. The national army ended the siege by force, killing 29 of the attackers. Production was shut down for the duration of the crisis, but threats to blow up the facility were not carried out. Limited production on the facility was restarted about one month after the incident.
DATE OF LOSS	01/16/2013	
COUNTRY	Algeria	
LOCATION	Algiers	
MATERIAL	Natural gas	
EVENT TYPE	Production loss	
CAUSE	Terrorism	

LOSS NO.	9835	An explosion occurred at a gas compressor station during the commissioning phase of the process. A sensor in the compressor building detected a fire in a 4,000 horsepower compressor and the building went into emergency shutdown by isolating incoming and outgoing lines along with the facility's two other compressor units. The fire and explosion caused moderate damage to the station.
DATE OF LOSS	05/14/2013	
COUNTRY	United States	
LOCATION	Brooklyn, Pennsylvania	
UNIT TYPE	Gas processing	
MATERIAL	Natural gas	
EVENT TYPE	Explosion, fire	
CAUSE	Fire	

LOSS NO.	9838	An explosion in a fuels and lubricants storage facility resulted in a major fire that spread over the entire block, consuming nearby homes. There was a second larger explosion followed by multiple explosions of liquefied petroleum gas (LPG) storage vessels.
DATE OF LOSS	05/23/2013	
COUNTRY	Brazil	
LOCATION	Duque de Caxias, Rio de Janeiro	
UNIT TYPE	LPG	
MATERIAL	Propane	
EVENT TYPE	Explosion, fire	
CAUSE	Explosion	

## REFINERY

LOSS NO.	9770	Refinery and local firefighters spent over six hours battling a fire on a large oil refinery. A warning was issued to local residents because of thick non-toxic smoke generated from a stack on the site. The fire is thought to have broken out in a furnace. No injuries were reported.
DATE OF LOSS	01/12/2013	
COUNTRY	United Kingdom	
LOCATION	Stanlow, Cheshire	
UNIT TYPE	Distillation	
EVENT TYPE	Fire	

LOSS NO.	9774	A fire broke out following a release of gas from equipment adjacent to a refinery's delayed coker unit. The fire burned for almost two hours, while the refinery firefighters cooled the affected equipment and isolated the fire. No one was injured.
DATE OF LOSS	01/16/2013	
COUNTRY	United States	
LOCATION	Cheyenne, Wyoming	
UNIT TYPE	Coking	
MATERIAL	Crude oil	
EVENT TYPE	Fire	
CAUSE	Release	

LOSS NO.	9800	A fire in a coking unit used for processing asphalt caused an explosion sending flames 24m high. The fire lasted approximately one and a half hours. Some workers were moved to standby points for their safety, but were not evacuated off site. This was the third fire at the refinery in 16 months.
DATE OF LOSS	02/11/2013	
COUNTRY	Canada	
LOCATION	Saskatchewan, Regina	
UNIT TYPE	Coking	
MATERIAL	Asphalt	
EVENT TYPE	Explosion, fire	
CAUSE	Fire	

LOSS NO.	9812	A leak in the pumping system of a distillation tower at a 370,000 barrels per day (bpd) refinery caused a fire in the vacuum distillation unit. The fire was extinguished after 15 minutes and there were no casualties.
DATE OF LOSS	03/09/2013	
COUNTRY	Kuwait	
LOCATION	Kuwait	
UNIT TYPE	Vacuum distillation	
MATERIAL	Heavy oil	
EVENT TYPE	Explosion	

LOSS NO.	9814	A fire broke out in a wet gas scrubber of a refinery while heavy maintenance was being carried out on a unit. Personnel were evacuated from the site and there were no injuries. The site was conducting a planned shutdown and maintenance of the plant equipment including the polypropylene plant.
DATE OF LOSS	03/11/2013	
COUNTRY	Oman	
LOCATION	Sohar	
MATERIAL	Propylene	
EVENT TYPE	Fire	
LOSS NO.	9822	A fire broke out in a 188,000 bpd refinery, caused by flashfloods during heavy rain. The rain overwhelmed the storm drainage system on the refinery, resulting in hydrocarbons being washed out of the drains and around the site. An explosion was reported in the crude distillation unit (CDU). There were two fires in the CDU, one in the coking plant and two in the topping distillation plant. The government agency said the incident had been caused by hydrocarbons exploding in one of the coke manufacturing furnaces. The furnaces had been shut down but were still hot enough to ignite the hydrocarbon. It took eight hours to extinguish the fire and 10 hours before the incident was under control. The oil company reported no fatalities or injuries.
DATE OF LOSS	04/02/2013	
COUNTRY	Argentina	
LOCATION	La Plata District, Ensenada	
UNIT TYPE	Coking	
MATERIAL	Mixed hydrocarbons	
EVENT TYPE	Explosion, fire	
CAUSE	Flood	
LOSS NO.	9834	A fire broke out in the crude distillation and vacuum distillation units of a refinery, but the fire was contained within an hour. No casualties were reported. Four firefighters from the refinery and three others from the district administration fought the fire, which was doused with fire water. The two plants were shut down, and the other units of the refinery were later shut down in a phased manner as a precautionary measure.
DATE OF LOSS	05/31/2013	
COUNTRY	India	
LOCATION	Golaghat, Assam	
UNIT TYPE	Crude distillation	
MATERIAL	Crude oil	
EVENT TYPE	Fire	
LOSS NO.	9841	Two workers were seriously injured and two others were reported missing after an explosion and subsequent fire at an oil refinery. There were 18 tanks on the site, used to store ethylbenzene and other materials. The tanks that were used to store tar and other materials were undergoing maintenance, and four workers were replacing the instrument platform on one of the tanks when there was a sudden explosion. Two workers were injured and later died, when two tanks containing residual diesel exploded. Nearly 100 firefighting vehicles and more than 300 fire-fighters responded to the incident.
DATE OF LOSS	06/02/2013	
COUNTRY	China	
LOCATION	Dalian	
UNIT TYPE	Storage	
MATERIAL	Diesel	
EVENT TYPE	Explosion, fire	
CAUSE	Explosion	
LOSS NO.	9843	A leak at a refinery catalytic-cracking unit forced the shutdown of the refinery. A weld seam failed on a line on the refinery's fluidized catalytic-cracking unit. The leak released slurry, light-cycle oil, heavy-cycle oil, and fluid catalytic cracking (FCC) gasoline, among other components. No one was injured in the accident, but the 451,000 bpd plant was forced to shut down.
DATE OF LOSS	06/07/2013	
COUNTRY	United States	
LOCATION	Texas City, Texas	
UNIT TYPE	Catalytic cracking	
MATERIAL	Gasoline	
EVENT TYPE	Release	
CAUSE	Leak	

LOSS NO.	9858	There was a gas explosion at a furnace on a refinery during preparation to restart the refinery after maintenance had damaged one of the walls of a furnace. The fire department ordered all operations at the refinery to be suspended. Refinery management said that the incident had no impact on the 100,000 bpd crude distillation unit. Restart was undertaken after one or two days of inspection of the CDU.
DATE OF LOSS	07/19/2013	
COUNTRY	Japan	
LOCATION	Okinawa	
UNIT TYPE	Furnace	
MATERIAL	Light hydrocarbons	
EVENT TYPE CAUSE	Explosion, fire Mechanical failure	
LOSS NO.	9865	A distillation column exploded in a heavy crude oil upgrading plant, sparking a fire that was brought under control. The plant that produces 200,000 barrels of crude oil a day, reported no collateral damage or injuries.
DATE OF LOSS	07/30/2013	
COUNTRY	Venezuela	
LOCATION	Barcelona	
UNIT TYPE	Crude distillation	
MATERIAL	Crude oil	
EVENT TYPE CAUSE	Explosion, fire Leak	
LOSS NO.	9866	A contractor died in an explosion while performing maintenance on a level indicator. The company said the explosion at the refinery was caused by a hydrogen sulfide release inside the refinery's hydrodesulfurization plant. At least three people were taken to hospital with injuries.
DATE OF LOSS	07/31/2013	
COUNTRY	Chile	
LOCATION	Valparaiso	
UNIT TYPE	Hydrotreating	
MATERIAL	Hydrogen sulfide	
EVENT TYPE	Explosion	
LOSS NO.	9881	A power loss at the 145,000 bpd refinery caused units to shut down, resulting in emissions due to problems at the sulfur recovery unit.
DATE OF LOSS	05/13/2013	
COUNTRY	United States	
LOCATION	Anacortes, Washington	
EVENT TYPE CAUSE	Production loss Power failure	
LOSS NO.	9883	A major explosion occurred on the 3 million tonnes per year (t/y) crude distillation unit of an 8 million t/y refinery. Three hundred workers close to the unit were evacuated, but no deaths or injuries were reported. The fire was triggered by a pump failure and was brought under control within one hour. The emergency protection systems worked as designed, and firefighters reached the site within 30 minutes. All other production units were working normally.
DATE OF LOSS	05/16/2013	
COUNTRY	India	
LOCATION	Vishakhapatnam, Andhra Pradesh	
UNIT TYPE	Crude distillation	
MATERIAL	Crude oil	
EVENT TYPE CAUSE	Explosion, fire Mechanical failure	
LOSS NO.	9895	A fire broke out in a refinery following a series of explosions. The plant was being restarted after six months shutdown of production. The fire was reportedly caused by the collapse of a pump in a heat exchanger in the desulfurization plant. This resulted in the release of a jet of burning product from a flange. Firefighters brought the fire under control after six hours. A second fire occurred the following day, but this was brought under control by refinery staff. No injuries were reported.
DATE OF LOSS	07/08/2013	
COUNTRY	Italy	
LOCATION	Ancona	
UNIT TYPE	Desulfurizing	
EVENT TYPE	Explosion, fire	
CAUSE	Mechanical failure	

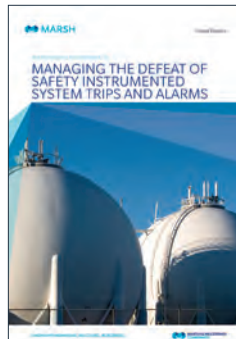
# FURTHER READING

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



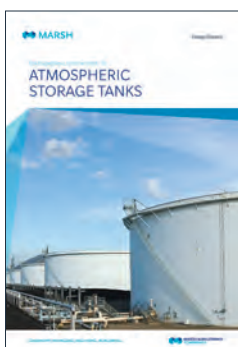
## THE 100 LARGEST LOSSES<sup>8</sup>

The 22nd 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<sup>11</sup>

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<sup>9</sup>

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<sup>12</sup>

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<sup>10</sup>

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<sup>13</sup>

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](http://www.epa.gov/emergencies/docs/chem/AN_advisory.pdf)
5. [http://www.epsc.org/contact.aspx?Group=products&Page=request\\_reports](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. <https://usa.marsh.com/NewsInsights/ThoughtLeadership/Articles/ID/20660/The-100-Largest-Losses-1972-2011-in-the-Hydrocarbon-Industry.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>

For further information, please contact your local Marsh Energy office or visit our website at: [www.marsh.com](http://www.marsh.com)

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