Energy & Power Practice

LOSS CONTROL NEWSLETTER

2016 – EDITION 1

SOLUTIONS...DEFINED, DESIGNED, AND DELIVERED.

CONTENTS

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FOREWORD

Welcome to the first edition of the Loss Control Newsletter (LCN) for 2016. This publication follows the successful conclusion of Marsh's sixth National Oil Companies (NOC) conference which took place in Dubai, March 22 – 24, 2016.

MARSH BLAST LAUNCHED

During this biennial conference, titled "Insights for a New Era in Energy Risk," Marsh launched our next generation explosion modelling tool. Marsh BLAST, powered by MaxLoss™, assists energy companies to calculate estimated maximum loss (EML) values following a vapor cloud explosion (VCE) across their global assets as they undertake insurance risk assessment surveys - turn to page 14 for more detail.

NEW MARSH INSIGHTS PUBLISHED

We also launched a number of insight papers during the conference. The 24th edition of the *100 Largest Losses* report examines the costliest disasters in the global energy market over the past four decades. Losses can be influenced by the oil price environment, a point explored in a new briefing, *Can Energy Firms Break the Historical Nexus Between Oil Price Falls and Large Losses?*

The event also saw the launch of our *Engineering Position Paper: Pre-startup Safety Review* which offers clients a guide to best practice methodologies of this key safety process. It is these best practices that we have used to establish our proprietary risk-ranking system which provides an absolute measure of risk quality when compared against a defined set of criteria. From these rankings, Marsh developed its benchmarking tool during the conference we published two new benchmarking reports, *Benchmarking the Middle East Onshore Energy Industry: Strengths and Opportunities of an Energy Superpower and Benchmarking the Asian Energy Market: Strengths and Opportunity*, which examine how operators in Asia and the Middle East measure up to their global peers. For many of our clients, Marsh's benchmarking reports have already proved to be a catalyst for change. Turn to page 20 to read more on each of these papers.

BUNCEFIELD: LESSONS TO LEARN

The LCN provides articles that address numerous safety topics including a review of the Buncefield incident, ten years on, reflecting on a report issued by the UK Health and Safety Executive. An article by Marsh risk engineer Marc Joseph looks at what happened at Buncefield, why it happened and in particular what learnings should be taken away by operators of similar assets, together with suggested resources (Page 10). The Buncefield investigations led to significant changes in the way high hazard onshore installations operate. This, and other recent safety developments, can be found in the "Safety news from around the world" section of this edition (Page 22).

ASSET INTEGRITY

In late 2015, Marsh was invited by Gassco to present on the subject of asset integrity at their HSE&Q summit in Norway. This provided another platform for Marsh to highlight the unique insurance perspective of asset integrity in a presentation delivered by London-based risk engineer, Nigel Cairns – a regular speaker on loss prevention at client and industry events. In an article here in this LCN Nigel summarizes his presentation and those of other key presenters at the Gassco event.

SAFETY CRITICAL DEVICES

The concept of safety critical devices (SCDs) as a designated equipment category is not widely adopted by the onshore oil, gas, and petrochemical industry. Loss experience suggests that the argument "we have good equipment maintenance programmes; why do we need to define SCDs?" does not hold and hence an increased level of rigor and focus in SCD management is justified. In this edition of the LCN Andy Goddard, a risk engineer with Talbot Underwriting, examines how the failure to identify and manage safety critical devices (SCDs) has played a contributing factor to many industry losses.

WHAT VALUE DO INSURANCE SURVEYS DELIVER?

What does insurance have to do with engineering? Well, in fact a significant amount of value and loss prevention advice can be derived from risk engineering surveys. Dubai-based Marsh risk engineer, Adrian Louis looks at how to get the most out of the survey process by setting out clear upfront objectives.

ARE WE REALLY LEARNING FROM INCIDENTS?

The creation and distribution of "Learnings From Incidents" (LFIs) is widely recognized as a key activity in managing process safety. Yet selecting LFIs for distribution, getting the quality right, and delivering the "story" on site can be a challenge. A paper by Marsh & McLennan company Oliver Wyman on this subject was presented at the American Institute of Chemical Engineers 11th Global Congress on Process Safety.

Laurence Pearlman and Susie Scott of Marsh & McLennan Group company Oliver Wyman presented a paper on Learnings From Incidents (LFIs) at the American Institute of Chemical Engineers 11th Global Congress on Process Safety in April 2015. In this LCN, Marsh risk engineer, Will Chaffin gives a précis of this fascinating paper.

DO LUBE OIL FIRES REALLY HAPPEN?

Our "From the archives" article featured in this edition of the LCN in which we explore the phenomenon of lubricating oil fires within lube oil skids and whether they can really occur when the oils are handled below their flash points.

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 the Marsh GERE team in 2015 bringing significant upstream and downstream experience with them — part of a growth plan that further increases our global risk engineering capability.

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

INVESTING IN OUR ENGINEERING CAPABILITIES

Our engineers' provide risk managers and underwriters with the essential information they need to determine the right limit and scope of cover and the right price. Given the challenges facing the industry today— with moderate growth, high volatility, oil prices at record lows, and a soft insurance market — this can have a meaningful impact on your total cost of risk. This is why Marsh continue to invest so heavily in this service; since we last published we have employed another eight new engineers who between them speak six languages – helping to further breakdown the barriers between the complex workings of facilities and the underwriting process.

SAFETY CRITICAL DEVICES (SCDs)

Andy Goddard, a risk engineer with Talbot Underwriting Ltd based in London, considers the importance of identifying safety critical devices (SCDs) and how a systematic and holistic management approach is essential to ensuring the availability of SCDs.

The failure to identify and manage safety critical devices (SCDs) is a contributing factor to many industry losses, yet the concept of SCDs as a designated equipment category has still not been widely adopted by the onshore oil, gas, and petrochemical industry. Incident investigation findings normally address SCD specific failures but rarely is there recognition of the need to implement a more holistic and systematic SCD management system. Sometimes the argument "we have good equipment maintenance programs; why do we need to define SCDs?" is put forward but loss experience would suggest this does not hold and that an increased level of rigor and focus in the management of SCDs is warranted.

KEY CONCEPTS

The first step, and often one of the main problems faced by operators, is developing a suitable definition of a SCD. The concept of last line of defense is sometimes used, which would be the final layer of protection that must function effectively to prevent or mitigate a major accident in the event of failure of all other layers of protection.

As the name suggests, SCDs refer to devices that perform a specific safety-related action. These devices could be mechanical, pneumatic, hydraulic, electrical or electronic. It is important that operators do not fall into the trap of designating everything as safety critical as the management system would become diluted and lose the original intent of increased focus. For instance, the inclusion of static equipment within the designation can be problematic and this is often best handled through a separate and dedicated static equipment inspection program.

The term major accident above must also be defined by operators as some choose to have subsets of safety classification including process safety, occupational safety, environment, and security.

Also, some management systems differentiate on the level of criticality. For example, prevention devices may be considered more important than mitigation. Also, for example, a safety integrity level (SIL) 2 rated protective instrument may be classified as more critical than a flammable gas detector, where redundancy considerations may also come into play.

IDENTIFICATION

There are various methodologies that can be used to identify SCDs but in all cases the exercise should be undertaken by an experienced multi-discipline team with clear sight of the prevention and mitigation of major accidents. Use of a barrier technique such as "bowtie" is becoming increasingly popular which lends itself very well to the identification process. Generic SCD equipment classes should be used to aid the process such as "safety instrumented functions (SIFs)", "overpressure protection", "fire protection", etc.

The criticality assessment of equipment for maintenance purposes normally includes safety considerations and, depending on the methodology, SCDs may therefore end up being classified as high criticality. While this may provide the desired maintenance priority, this process does not normally result in a specific classification of equipment as safety critical and hence the wider benefits of such a classification are not realized. A separate and specific SCD identification process should be considered with a pure focus upon the prevention and mitigation of major accidents without having to also consider production availability issues.

Once identified through a risk evaluation method, SCDs should be:

- Registered in a dedicated database.
- Designated within the computerized maintenance management system (CMMS).
- Referenced within standard and emergency operating procedures (SOPs and EOPs).
- Identified on the piping & instrumentation diagrams (P&IDs).
- Clearly identified in the field.

In fact SCDs should permeate through all process safety systems and procedures including process hazard analysis (PHA), management of change (MoC), pre start-up safety review (PSSR) and so forth.

Insurance survey experience would suggest that most SCDs are recognized for their safety importance, however, there are sometimes gaps where particular equipment items do not receive the correct level of attention. Examples would include critical non-return valves (NRVs), uninterruptible power supply (UPS) systems, and emergency isolation valves (EIVs) (EIVs are not generally part of a SIF).

INSPECTION, TESTING, AND PREVENTATIVE MAINTENANCE (ITPM)

All SCDs should have a suitable ITPM plan developed and implemented through the CMMS. ITPM plans should be based upon the original equipment manufacturer (OEM) guidelines and further developed using reliability techniques to ensure degradation mechanisms are identified and mitigated (as might be done for production critical equipment). This process should also consider the necessary spare parts holding (how often is the availability of SCDs reduced whilst waiting for spare parts?).

For each ITPM activity, there should be a documented procedure which stipulates the actions to be taken and the test performance criteria.

SCD test performance should be reported, monitored and any failures on test investigated appropriately. The latter point is important as failure on test represents a fail-to-danger probably at some unknown point in time during operation. Reliability improvement plans should be developed for any SCD failing on test (or demand).

In the same way it would be expected to have an inspection deferral procedure for static equipment, there should be an equivalent deferral procedure in place for the maintenance and testing of SCDs.

Again, insurance survey experience would suggest gaps in this area. How often would one or more of the bulleted items below be found to be inadequate when applied, for example, to pressure relief devices (PRDs), safety instrumented functions (SIFs), and firewater pumps?

- Test procedure documented and adequate.
- Test performance criteria stipulated.
- Failure on test reported and investigated.
- Maintenance and testing deferral procedure in place.

TEMPORARY IMPAIRMENT MANAGEMENT

The temporary impairment of SIFs is *generally* understood and managed by operators but there is no reason why the same general steps below could not be broadened to apply to the temporary impairment of all SCDs.

1. Risk assessment including temporary mitigations.
2. Authorization including time validity and escalations.
3. Escalation to MoC (if not reinstated in stated timeframe).

Visibility of temporary impairments could be improved through a control room SCD temporary impairment board and a SCD temporary impairment section in the shift handover log.

ASSURING IN-SERVICE AVAILABILITY

Certain valves (normally manually operated) must be maintained in specific positions for SCDs to function as intended. Whilst there is often recognition of the need to control PRD isolation valves and sometimes specific firewater valves, there is not always recognition of the need to control all the necessary valves associated with all SCDs. A valve "car seal" system accompanied with routine field verification should be implemented.

PERFORMANCE MONITORING

The availability and performance of SCDs should be monitored through a suitable set of process safety performance indicators (PSPIs). Some of these could appear on the plant's overall performance dashboard but all could, and arguably should, be monitored somewhere within the organization and regularly reviewed at the process safety committee.

- Number of demand activations (#).
- Number of failures on demand (#).
- Number and proportion of overdue corrective maintenance (# and %).
- Number and proportion of overdue ITPM (# and %).
- Number and proportion of failures on test (# and %).
- Number of temporary impairments with durations (#).
- Overall unavailability (%).

Whilst maintenance backlog (or more importantly overdue) is generally monitored, without a SCD designation it is not possible to break out safety critical maintenance status.

CONCLUSION

None of the above should be considered "rocket science" yet industry losses continue as do recurring insurance survey recommendations associated with aspects of SCD management. Often, it is specific elements of SCD management on particular equipment types which is less than adequate and this is where a holistic and systematic approach would be beneficial.

Perhaps one of the issues has been the lack of a single and widely accepted industry standard, although there are numerous guidance documents available. The UK Energy Institute published its "High Level Framework for Process Safety Management[1]" in 2010 with specific guidance on meeting "Element 16: Management of Safety Critical Devices" recently published in September 2015. This latter document may fill this gap with a consensus standard.

For many years, the management of safety critical elements (SCEs) has been regulated within the UK offshore industry through "The Offshore Installations (Safety Case) Regulations 2005[2]" and perhaps the onshore industry could learn from this approach. Certainly the more progressive international oil companies (IOCs) and large multinationals have implemented SCD management systems.

Surely, it is not beyond the realm of imagination that a plant manager could log on in the morning and have a dashboard with a simple overview of the status of SCDs, providing a health check of the plant's final and critical layers of protection.

REFERENCES

1. Energy Institute,
   'High Level Framework for Process Safety Management', 1st Edition 2010.
   https://www.energyinst.org/technical/PSM/PSM-framework

2. Health and Safety Executive,
   'A Guide to the Offshore Installations (Safety Case) Regulations 2005'.
   http://www.hse.gov.uk/pubns/books/l30.htm

LOSS CASE STUDIES:

CANADA - UPGRADER - 2011

Local field bypass of a permissive instrumented system allowed the online process vessel to be opened resulting in a major loss of containment, explosion, and fire with extensive damage and ensuing business interruption.

IMPAIRMENT OF A SCD

PORTUGAL - REFINERY - 2009

Failure of a critical non-return valve resulted in back flow of steam and total destruction of a steam turbine generator.

FAILURE ON DEMAND OF A SCD

BRAZIL - ETHYLENE PLANT - 2011

Loss of external power supply to the site resulted in emergency shutdown of the process unit but the uninterruptible power supply (UPS) system failed to operate contributing to the loss. Major damage to the cracking furnaces resulted.

FAILURE ON DEMAND OF A SCD

THAILAND - POLYOLEFIN PLANT - 2011

High temperature trip instrumentation was not reinstated after maintenance on a high pressure ethylene reactor. A high temperature runaway reaction occurred resulting in extensive damage to reactor piping and loss of containment.

SCD NOT REINSTATED AFTER MAINTENANCE

UK - STORAGE DEPOT - 2005

Failure of an atmospheric storage tank overfill protection device resulted in major loss of containment, explosion, and ensuing fire with extensive onsite and offsite damage.

FAILURE ON DEMAND OF A SCD

WHAT VALUE DO INSURANCE SURVEYS DELIVER

Adrian Louis, a risk engineer in Marsh's Energy Practice in Dubai, gives a personal perspective of initial impressions of energy insurance and overviews a Marsh workshop for clients titled: "Preparing for an Insurance Survey"

Some time ago, when I was still working in the industry, insurance risk engineers visited the site I was working at. Coincidently, they worked for Marsh. When I first heard that these "surveyors" were planning to tour the site and ask me questions, I was intrigued, but quickly, curiosity gave way to confusion and then annoyance. What does insurance have to do with engineering, I thought to myself. Clearly, insurance is important to provide cover in the event of damage but that would be something for the finance team to deal with. What I was told, at that time, is that in order to obtain insurance, we would have to let these "surveyors" on site.

What I did not appreciate was the nature of insurance — where one would insure on the full value when purchasing consumer insurance, say, a car; however, in the context of a chemical plant, it is all about buying the right amount of insurance, that is, the worst-case scenario to optimize one's investment. Therein lies the first objective of insurance surveys: to determine insurable limits. I was also surprised by the surveyors' knowledge of chemical processes. I was expecting "bean counters" and not chemical engineers who proceeded to share best practices with us and where we strayed from them. Needless to say, I developed a new-found respect for insurance surveys. Where I thought the process could have been improved was for a short session to set out the objectives of the visit prior to the visit itself, so that expectations could be managed accordingly.

I am sure that my initial experience of energy insurance, as described above, is not uncommon among our clients, and for that very reason, Marsh has in place, a "Preparing for an Insurance Survey" workshop that aims to put everything into perspective.

We have carried out sessions for clients such as SATORP, Yasref, Tasnee, and the article today describes the session that we carried out for SABIC in Al-Khobar, KSA in March 2015. The half-day workshop was jointly conducted by Ryan McGovern and me for approximately 70 SABIC colleagues who hail from SABIC affiliates located in Jubail, Yanbu, and Riyadh.

The objective for the half-day workshop was simple: we wanted to improve the overall effectiveness of the survey process by:

- Outlining the "need" for insurance, the process, and what it means for each site.
- Providing the client with an understanding of the insurer's objective and his/her focus when assessing risk.
- Guiding each site on how to "articulate" their best practices to the surveying team.
- Providing example slides of best practices, the information expected by the survey team, and the format to optimize sharing.
- Describing the profile of a successful client's survey coordinator, a key person who can make or break the process.
- Sharing with the site as to how they can benefit above and beyond insurance requirements, such as a "cold eyes" review of the client's work practices/standards and obtaining best practices from risk engineers who have a varied and thorough knowledge of loss prevention.

As part of the workshop we have, examples of slide presentations for the various discipline meetings we conduct. This includes the main opening meeting and meetings with operations, maintenance and reliability, inspection, engineering, safety etc. These templates outline key information that insurers look for.

The quantum of loss attributed to business interruption is around three-to-four times the initiating property damage event and, therefore, the workshop aims also to increase clients' awareness of business dependencies, supply chain management, and contingencies so that the essential information is available for discussion during the survey.

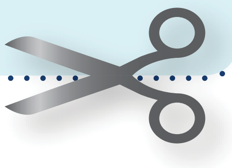
It was certainly a diverse crowd during our session with SABIC. We had survey coordinators, finance executives, as well as site risk managers attending. Survey coordinators are typically from technical backgrounds, such as: operations, engineering, or, reliability, given their understanding of a process plant and its interdependencies. One interesting point which was raised during the event was the need to expand our slide templates for non-chemical processing business units such as Hadeed (steel mill), and compounding plants (SABIC Innovative Plastics), etc.

Based on participant interaction and feedback, the session with SABIC was certainly a success, and Marsh will be conducting similar sessions for SABIC affiliates in other jurisdictions, including North America, Europe, and the Far East. We are also planning to conduct refresher sessions every three-to-four years as best practices, insurance requirements, and people continue to change. As a client, should you wish Marsh to carry out a similar workshop at your site, please get in touch with your Marsh client manager or email adrian.louis@marsh.com.

Safety Snippet

SIMPLE LEAK BOXES DETECT SMALL RELEASES FROM FLANGES

One site has installed some 500 leak boxes on flanges in high pressure (200 barg) syngas and ammonia gas applications. Flanges are sealed within a box with a breather tube feeding a bottle of colored inert liquid. Small leaks are observed by presence of bubbling liquid. Large leaks are evident through the loud noise and accompanying fire/toxic gas cloud!



ASSET INTEGRITY

On 22 October 2015 the annual Gassco HSE&Q summit took place in Haugesund, Norway. Marsh's Risk Engineer Nigel Cairns gave a presentation on the importance of asset integrity, here we summarize his presentation and those of other key presenters.

Asset integrity is often viewed solely as a maintenance or inspection activity but, in fact, it encompasses the management of assets for the entire life cycle, from process selection and design, through to construction and operation, and ultimately, to decommissioning. Asset integrity clearly has an impact on safety, cost, operability and reliability and, as risk engineers, we have a particular interest in its impact on process safety incidents, which can result in property damage losses, or have reliability implications for machinery breakdown and business interruption exposures.

Asset integrity is one of the many factors that we consider when it comes to assessing the quality of a risk. In discussions with underwriters it always comes out as being one of the most important, if not the most important consideration. It is, after all, something over which the client can have a direct influence and to which it can choose to give more or less attention and resources to manage. Improving a plant's risk profile by having a strong inspection program is far easier, for example, than trying to achieve a comparable improvement in risk rating by moving a plant outside a windstorm or earthquake zone.

IDENTIFYING THE CRITICAL LOSS CONTROL ELEMENTS

Every asset has its loss control elements, or "barriers" that stand between a potential risk being managed and a loss. It is only when these barriers fail that incidents happen. Many people are familiar with this concept as the "swiss cheese" model – though, of course, in Norway, Jarlsberg is a perfectly good alternative. The first job of any good asset integrity management system is to identify what these critical loss control elements are for the site. Each one of these then needs a defined, structured, and appropriate procedure for managing and maintaining its effectiveness, which can only be done if there is committed and competent resource allocation to implement the control; and whilst risk engineering surveys have become quite skilled at identifying these (or at least identifying where they are missing), the industry, as a whole, can always become better at assessing or improving the level of implementation and performance monitoring.

KEY PERFORMANCE INDICATORS (KPIs)

One very effective way of performance monitoring is to use key performance indicators (KPIs). Although there is no "one size fits all" for KPIs, and they should be developed to be client-, industry-, and site-specific. It's important to note also that KPIs are but one means to drive asset and risk improvement, and not a means in and of themselves. Suffice it to say that we would typically expect sites to have a mix of both leading and lagging indicators, to measure, for example, process-safety incidents, overdue equipment inspections, safety-critical element failures or the effectiveness of a site's management of change (MoC) process.

ASSET INTEGRITY STRATEGY IMPLEMENTED DURING THE DESIGN PHASE

As asset integrity is a "cradle-to-grave" process, the earlier the process and methodology can be implemented on a site, the better. An asset integrity strategy

> In discussions with underwriters it always comes out as being one of the most important, if not the most important consideration.

implemented during the concept selection and design phase of a plant will reduce the need for "bolt on" solutions to asset integrity issues later on in the design and construction phase, when costs can escalate. This early implementation will involve the identification of potential risks and hazards, the establishing of "integrity operating windows" for the plant (i.e. defining the boundaries of safe operation), and the use of inherently safe-design principles. If risks are still present after this thorough review, then is the time for defining additional barriers or controls, such as trip systems or work procedures.

INDUSTRY LOSSES TRENDS

When 515 individual onshore losses between 2000 and 2013 were analyzed by Liberty Specialty Markets (excluding Nat Cat), some 60% by value occurred in refining (excluding tar sands refining), with gas plants the next industry type at 7%. Further analyses of this data states that the main contributing factor in all refining losses was a lack of mechanical integrity (64%), with poor operations practice (such as training, manning etc.) at 13%; and poor isolation and work permit practice was next at 6%. When Swiss Re looked at the primary causes of losses across all energy sectors over the last 15 years, 53% of all losses came as a result of a lack of mechanical integrity.

While there may be many causes that contribute to a loss, many barriers which have to fail for an incident to happen, asset integrity continues to present one of the greatest risks to clients in maintaining their layers of protection. The number of industry losses even over the last 15 years bears testament to the importance of a strong asset integrity management process. But remember, asset integrity is more than just a good maintenance or inspection program, it's a "cradle-to-grave" process, from process selection and design, through construction and operation and ultimately decommissioning.

INSIGHTS FROM OTHER PRESENTERS

AGEING ASSETS

PTIL highlighted some challenges faced in Norway concerning ageing assets. Maintaining the integrity of ageing assets, both onshore and offshore, can be a real challenge particularly in the current environment of reduced oil revenues, depleting wells, and increased cost and regulatory challenges.

LEARNING FROM LOSSES

Stephen Flynn discussed how BP learned from the Macondo loss, and how it changed its learning strategy as a result. One of the outcomes of Macondo was that BP employed full-time investigators, travelling globally to all BP's assets to ensure a consistent methodology for focusing on the management of safety barriers. A single companywide risk management framework was established to ensure better and more consistent communication between different areas of the company, and best learning practices were gathered from discussions with the aviation industry, the military, and intelligence services.

IMPROVING HSE PERFORMANCE IN SPITE OF EFFICIENCY MEASURES

Aibel presented on how their HSE management has stood up in times of increasing cost-efficiency drives in the contractor sector. The firm has had to go through an exercise in manning reduction and restructuring in order to improve efficiency and productivity yet, despite this, has continued to improve its HSE performance (for example, its total recordable injury rate). This has been as a result of close cooperation between Aibel and its customers in working better together, and closely following performance through the use of lagging and leading KPIs.

IMPROVING THE CULTURE OF CARING

Total was the last to present on how it has tried to improve the culture of caring at the St. Fergus site. The diagnostic tool it used to try and assess the site's culture was based on the established personal safety culture ladder assessment process (defining safety culture on a scale from pathological (i.e. reactive) through to generative) through a process of audits, observations, and focus groups. Following the results, there was then a defined action plan to close the gaps, including improving communication, leadership, and workforce engagement, and better auditing (for example, ensuring compliance to work permit procedures).

Safety Snippet

QUICK VISUAL GUIDES USED TO DENOTE STAGES OF PROCESS ISOLATIONS

Marsh recently noted an example of good practice at a refinery employing quick visual guides using stickers to denote stages of the mechanical isolation. A yellow sticker is applied by operations to show where a blind or isolation is required to be installed. A red sticker is then applied by the executing party to denote that the isolations have been made and are in force, while a green sticker is then applied for one week after the isolations have been removed and the system returned to normal. This final green sticker aims to support field operators when carrying out walkthroughs for verification that no post-work leaks have developed.

BUNCEFIELD: LESSONS TO LEARN

A decade has passed since a massive explosion occurred at the Buncefield complex in the UK. In this article Dubai-based risk engineer Marc Joseph looks at what happened at Buncefield, why it happened, and in particular what learnings should be taken away by operators of similar assets.

WHAT HAPPENED AT BUNCEFIELD?

The Buncefield Complex, located in Hemel Hempstead in Hertfordshire, began operations in 1968 . It was a large tank farm occupied by Hertfordshire Oil Storage Limited, UK Oil Pipelines Limited, and BP Oil UK Limited.

On December 10, 2005, Tank 912 and Tank 915 were being filled with gasoline. Both tanks were fitted with an automatic tank gauging (ATG) system which measured the tank level. These levels could be displayed on a single screen in the control room along with all other tanks in the facility. Each tank was also fitted an independent high-level switch (IHLS), which was the final layer of overfill protection to stop the filling process and also to activate an audible alarm.

On December 11 at 03:00, Tank 912's level measurement failed and the level reading in the control room "flatlined." This was unnoticed by operations and the tank filling continued. As the level in the tank increased above the ATG alarm settings, no alarm was activated because of the measurement failure. The IHLS also did not work and thus the "final alarm" did not sound and the automatic shutdown was not activated. Eventually, large quantities of gasoline overflowed from the top tank, causing a loss of primary containment. After the failure of the primary containment, there was reliance on a bund retaining wall around the tank (secondary containment) and a system of drains and catchment areas (tertiary containment). Both forms of containment failed, which resulted in fuel contaminating the groundwater.

Around 185 tonnes of gasoline[1] was released over a period of about 40 minutes prior to ignition. A large, low lying vapor cloud[2], developed over a wide area extending significantly offsite. At approximately 06:00, the vapor cloud ignited, probably due to a spark from starting the firewater pumps located close to the tanks.

This caused a massive explosion, large overpressures (> 2 bar), further loss of containment and subsequent fires that lasted for five days. Further details on the vapor cloud explosion mechanism, which includes the impact of the undergrowth and trees along Three Cherry Trees Lane can be found in the 2015 Marsh *Loss Control Newsletter*[3]. Total costs arising from the Buncefield incident were estimated as GBP1 billion.

WHY DID THIS HAPPEN AT BUNCEFIELD?

After four years of investigation, the causes of the Buncefield incident were published by the Competent Authority for the Control of Major Accident Hazards (COMAH) in 2011.

LOSS OF PRIMARY CONTAINMENT:

- **Failure of Tank 912's ATG system:** At least 14 other similar failures with Tank 912's level gauge occurred prior to the incident, but no effective action was taken to correct the issue.
- **Failure of Tank 912's IHLS:** The switch, which needed a padlock, was installed just over a year prior to the incident. The use of a padlock was not clearly communicated by the supplier or understood by the site and thus the padlock was not fitted.

Provision of suitable primary containment can be attained via suitable design, construction, and maintenance in accordance with international standards. Further guidance can be found in UK HSE RR 760[4].

LOSS OF SECONDARY AND TERTIARY CONTAINMENT:

- This is not considered as a direct contributor to the explosion.
- **Failure of bund retaining wall (secondary containment):** The bunds failed at the joints and walls where pipes penetrated them.

  Any concrete structure that is used for the retention of liquids should be designed to minimize the risk of crack formation. Bunds should also be inspected regularly and repaired

1 Steel Construction Institute (SCI) (2014). Dispersion & Explosion Characteristics ofLarge Vapour Clouds, Volume I & 2.www.fabig.com/video-publications/OtherPublications

2 Atkinson, G, Gant, S, Painter, D, Shirvill, L, & Ungut, A. Liquid dispersal and vapour production during overfilling incidents. IChemE symposium series 154, Hazards XX University of Manchester, UK, 14e17 April 2008

3 Joseph, M. The Buncefield Vapor Cloud Explosion Mechanism. Marsh Loss Control Newsletter. Edition 1, 2015 http://uk.marsh.com/NewsInsights/Articles/ID/43902/Loss-Control-Newsletter-Learning-From-Shared-Experiences.aspx

4 Health and Safety Laboratory (2009). Mechanical integrity management of bulk storage tanks. HSE. Research Report (RR) 760.http://www.hse.gov.uk/research/rrpdf/ rr760.pdf

accordingly. Guidance on limiting crack formation is provided in BS 81102 and BS 80073.

- **Failure of tertiary containment:** The drainage was designed for rainwater and minor spills, not for any large-scale release from bunds.

  Tertiary containment should ensure that a spillage of hazardous liquids can be contained and thus pollution confined to the site.

DESIGN AND MAINTENANCE ISSUES:

- **Monitoring screen:** Using a single screen to display all tank levels made it difficult to see all tank levels at once. It is probable that, just prior to the incident, Tank 912's level was not clearly visible on the single screen.

  The system used for the monitoring of safety critical instrumentation should be robust, simple, and designed so that the status of such instrumentation is readily available to the operator at all times. Management should also conduct appropriate risk analyses to determine if the system in place is suitable for all operation and emergency scenarios. EEMUA 201 provides guidance on the design of human- computer interfaces, which includes a discussion on screen allocation that allows for complete access to the necessary information and controls under various operational scenarios.

- **Bunds:** Bunds were not treated as safety critical equipment. Bunds were not impermeable (poor joint design, poor pipe-wall penetration design), not fire resistant and unable to handle the large volumes of firewater involved in the incident.

  Bunds should be subjected to an adequate inspection and maintenance regime. There should be periodic reviews of the bunds' characteristics compared to up-to-date standards and guidance.

- **Site layout:** The firewater pumps were not located in a designated non-hazardous zone and were located too close to the tanks, which meant they were vulnerable to damage from tank incidents.

  Consequence modelling and relevant due-diligence should be done to determine the placement of firewater pumps. The location should also ensure easy access and effective operation at all times. Tank spacing must consider the spread of the fire from a neighboring tank.

- **Instrumentation:** Redundant instrumentation was not considered to protect against overfilling.

- **Design codes:** The designers, manufacturers, installers, and those involved in maintenance did not have sufficient knowledge of the environment for which the equipment was to be used. They were unable to make the correct decisions about the standards they needed to apply to their work. For example, National Fire Protection Agency (NFPA) 30 (Flammable and Combustible Liquids) with regard to overflow prevention and avoidance of fires spreading to adjacent tanks was not consulted.

MANAGEMENT ISSUES:

- **Contactors/suppliers:** Systems for control of contractors/suppliers were not effective. Compliance with the COMAH regulations and international standards such as IEC 615088 (Functional safety of electronic safety related systems) and IEC 61511 (Safety instrumented Systems) were not made clear to contractors.

- **Management of Change (MoC):** Poor application of MoC in terms of replacement of the IHLS on Tank 912 and during bund projects.

  Further information on MoC can be found in the MoC Marsh Risk Engineering Position paper. Reference: Marsh Risk Engineering Position Paper – 05 (2015)[7].

- **Resources:** The Operations Manager and the Terminal Co-ordinator were overloaded. There was insufficient engineering support to Hertfordshire Oil Storage Limited (HOSL).

- **Management of gasoline filling:** The systems were deficient and not fully implemented.

- **Process safety and promotion of a safety culture:** The safety management system focused more on personal safety and not on control of major hazards, particularly in relation to primary containment. No process safety performance indicators were in place. Previous bund failures were not treated as "near misses". There was a lack of effective process safety studies such as Hazard and Operability (HazOp) and Safety Integrity Level (SIL) studies.

7 Marsh Risk Engineering Position Paper – 02 (2011). Fire pre-plans.https://uk.marsh.com/NewsInsights/Articles/ID/5014/Risk-Engineering-Position-Paper-Fire-Pre-plans.aspx.

- **Training:** Lack of adequate training for employees.
- **Auditing:** Effective auditing systems were not in place. There was no evidence of any recent auditing of the performance of the contractor and delivery of their technical expertise. Reference: Howard, C (2013). The Buncefield Incident – 7 Years on: A Review. Measurement and Control. Vol 46, No.3, pp 76-82.

EMERGENCY ARRANGEMENTS:

- **On site emergency plan:** Adequate emergency plans and arrangements were not in place. Operators were not prepared for a multiple tank fire event following an explosion.
- Fire pre-plans: Pre-plans to combat a multiple tank fire were not in place. Further information can be found in the Marsh *Risk Engineering Position* paper on fire pre-plans[5].
- **Spill response:** There were no contracts for spill response in place.

WAS THE BUNCEFIELD INCIDENT UNIQUE PRECEDING 2005?

In 2004, the Swedish National Testing and Research Institute identified an alarming figure of 480 global tank fire incidents since the 1950s[6]. In fact, at least two (Pernis Netherlands, 1968 and New Jersey USA) of these incidents were very similar to Buncefield *(Mannan et al 2007)*[6]. Our inability to learn from the past: Is Buncefield another example? IChemE Symposium Series No. 153. Additionally, some of the Buncefield shortcomings listed here were also identified in the March 2005 Texas City Refinery and the 1998 Longford Esso Gas Plant Incidents. Reference: Competent Authority for the Control of Major Accident Hazards (COMAH) (2011). Buncefield: Why did it happen? HSE.

Buncefield was certainly not unique and previous learning should have been considered.

TEN YEARS AFTER BUNCEFIELD – WHAT HAS HAPPENED WITHIN THE INDUSTRY?

Following the Buncefield Root Cause Analysis, technical recommendations were proposed and the importance of process safety management was reaffirmed as follows:

- The UK Health and Safety Executive (HSE) endorsed the classification of Buncefield type sites as high-hazard facilities and that these need to be compliant with the requirements of the COMAH regulations.
- A greater understanding of the explosion mechanisms associated with gasoline type material has been gained in order to better understand the consequences (*2015 Marsh Loss Control Newsletter*).
- The UK HSE Process Safety Leadership Group (PSLG) was formed in 2006 to progress with the implementation of the 2008 Buncefield Major Incident Investigation Board (MIIB) recommendations[8]. These recommendations for COMAH complaint Buncefield type sites[9] were:
  - Reassess SIL requirements.
  - Use of automatic high integrity systems against loss of primary containment.
  - Engineer against escalation of loss of primary and secondary containment.
  - Engineer against loss of secondary and tertiary containment.
  - Operation with high reliability organizations.
  - Deliver high performance through culture and leadership.
- The American Petroleum Institute (API) made changes to the Tank Overfill Prevention Standard (API 2350) addressing risk assessment (*CAPECO, CSB, 2015*). Note further comments later.

The MIIB, Reference: Buncefield Major Incident Investigation Board (BMIIB) (13 July 2006). Initial report to the Health and Safety Commission and the Environment Agency of the investigation into the explosions and fires at the Buncefield oil storage and transfer depot, Hemel Hempstead, on 11 December 2005.

HSE. Executive, and PSLG reports were made freely available to the public and it would be satisfying if the oil industry was able to report that no further Buncefield type incidents had occurred. Unfortunately, at least two similar incidents, namely, Caribbean Petroleum (CAPECO) in 2009 and Gladieux Trading and Marketing Huntington in 2010 have occurred. The June 2015 US Chemical Safety and Hazard Investigation Board (CSB) report, Reference: US Chemical Safety and Hazard Investigation Board (CSB) (June 2015). Caribbean Petroleum Tank Terminal Explosion and Multiple Tank Fires. http://www.csb.gov/caribbean-petroleumrefining-tank-explosion-and-fire/ on the CAPECO incident clearly shows how analogous the CAPECO incident was to the Buncefield incident. This 2015 CSB report indicated the following as areas of improvement to NFPA 30, Occupational Health and Safety Administration (OSHA) flammable and combustible liquids standard 29 and API 2350:

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5 Marsh Risk Engineering Position Paper – 02 (2011). Fire pre-plans.https://uk.marsh.com/NewsInsights/Articles/ID/5014/Risk-Engineering-Position-Paper-Fire-Pre-plans.aspx.

6 Persson, H and Lönnermark, A (2004). Tank Fires Review of fire incidents 1951-2003. SP Swedish National Testing and Research Institute.

7 Mannan, M. S, Meneses, M, Zhang Y and Wang, Y (2007). Our inability to learn from the past: Is Buncefield another example? IChemE Symposium Series No. 153.

8 BMIIB. (December 2008). The Buncefield Incident 11 December 2005. The final report of the MIIB. HSE

9 Process Safety Leadership Group (2009). Safety and environmental standards for fuel storage sites. Health and Safety Executive. http://www.hse.gov.uk/comah/buncefield/response.htm

- NFPA 30 does not provide a requirement for an independent or redundant level alarm or an automatic overfill prevention system.

  The installation of such protection systems could have been a key contributor in minimizing or even preventing the Buncefield incident.

- A high level alarm system or high- integrity overfill prevention system is not required by OSHA's 29 CFR 1910.106.

  Plant installations should be subjected to appropriate risk studies such as Hazardous Operability (HazOp) and Safety Integrity Level (SIL) studies to determine the adequate level of instrumentation. It is expected that if these studies are executed correctly, an overfill protection system would be mandated for a tank processing hazardous or flammable substances.

- API 2350 does not require implementing an automatic overflow prevention system for all tank terminals. It leaves the decision to the owner/operator of the facility.

- API 2350 does not offer sufficient guidance on conducting a risk assessment that considers the complexity of site operations, the type of flammable and combustible liquids stored or proximity to nearby communities when considering the safeguards to protect the public.

  Facility owners look to these international standards for guidance and consequently critical decisions are enforced. It is imperative that these standards are reviewed and assessed regularly by a suitably qualified panel. This team must be comprised of experts who able to render an unbiased analysis of the standards, thus ensuring that there is the requisite oversight function of quality control. To assist in the prevention of similar incidents like Buncefield, it is vital that appropriate changes to these international standards are made.

CONCLUSION

December 11, 2015 signified the tenth anniversary of the Buncefield tragedy, which has left an indelible mark on the lives of so many people. Despite the extensive recommendations and advancements in risk management, Buncefield type incidents continue to occur. Storage Tank Operators should conduct a gap analysis of their installation against the Buncefield learnings and the best practice indicated in the following documents:

- Marsh Position Paper on Atmospheric Storage Tanks Reference: Marsh Risk Engineering Position Paper – 01. Atmospheric Storage Tanks[10]. This defines standards that would be expected of a good atmospheric storage facility in the oil, gas and petrochemical industry.

- The 2009 PLSG report.

- The CSB CAPECO 2015 Investigation report.

Proactive implementation of risk mitigation strategies and lessons learnt from past incidents would limit the likelihood of such catastrophes in the future.

10 Marsh Risk Engineering Position Paper – 01. Atmospheric Storage Tanks. http://uk.marsh.com/NewsInsights/Articles/ID/5015/Risk-Engineering-Position-Paper-Atmospheric-Storage-Tanks.aspx

NEW INDUSTRY LEADING EXPLOSION MODELING SOFTWARE

Explosions account for the greatest frequency of losses, by far, in the energy sector[1]. These are typically vapor-cloud explosions (VCEs) that occur following the loss of containment of light hydrocarbons, which consequently form a cloud, engulf a congested or confined area, and find a source of ignition.

To assist energy firms in modelling the financial impact of explosions, Marsh launched Marsh BLAST powered by MaxLossTM (Marsh BLAST). Developed with leading engineering consultants Baker Engineering and Risk Consultants Inc. (BakerRisk), Marsh BLAST is powered by BakerRisk's MaxLossTM technology, and for the first time in the insurance industry, employs the advanced Baker-Strehlow-Tang (BST) explosion model. Energy companies can use Marsh BLAST to calculate the maximum property damage loss across their global assets, as they undertake insurance risk assessment surveys.

Where the maximum foreseeable property damage loss is less than the total value of the asset (due to there being no foreseeable credible accident that has the potential to result in the catastrophic loss of the whole asset), it may be appropriate to link the insurance purchased to the foreseeable maximum loss, rather than the total value of the asset. For this purpose, risk engineers will determine an estimated maximum loss (EML) value for the property loss value associated with the largest foreseeable property damage accident scenario.

It is therefore hugely valuable to have EML values when setting the limits for insurable physical damage. The accuracy of such modeling is dependent on an understanding of the physical layout of the asset, the distribution of property value, the physical and chemical properties of the hydrocarbons being processed, and the congestion and confinement of the plant structures. Marsh BLAST can be used to calculate an estimate of the property damage loss associated with an explosion event. This vital information can be used to prioritize risk reduction and control measures, and to support decision-making with respect to risk mitigation and risk transfer.

1 100 Largest losses Marsh Insight Paper

ARE WE REALLY LEARNING FROM INCIDENTS? A DISCUSSION OF BEST PRACTICES AND COMMON MISTAKES

Laurence Pearlman and Susie Scott of Marsh and McLennan company Oliver Wyman presented this paper at the American Institute of Chemical Engineers 11th Global Congress on Process Safety in April 2015. A précis of the paper is given here by London-based Marsh risk engineer, Will Chaffin.

Creation and distribution of Learnings From Incidents (LFIs) is widely recognized in industry as a key activity in managing process safety. Many companies now dedicate significant organizational capability to these communications which can instantly reach targeted audiences of thousands faster and more easily than ever before.

Using LFIs effectively to avoid future incidents, as this paper explains, requires more than simply counting the number of emails or alerts issued. The following are a series of common pitfalls or best practices observed in the area:

SELECTING WHICH INCIDENTS TO DISTRIBUTE

Given the level of information overload that most people experience, even the best written LFIs run the risk of not being read. For that reason, only incidents that have, or could have, resulted in a significant consequence (for example, risk of fatality or permanent injury) and that could occur at multiple locations should be prioritized and communicated system-wide. For more specialized or obscure events, the appropriate audience should first be identified and then sent a specific alert.

Some operators are observed to prioritize distribution of new or novel learning points over incidents where similar issues have been shared in the past. It must be cautioned that almost all process safety incidents stem from barrier failures which are well known to the industry but may not be fully appreciated by individual sites or operating groups. The positive contribution to safe operations to be gained by distribution of LFIs referencing classic learnings to should not be underestimated.

CREATING THE LFI

Too often LFIs are written in engineering speak by the individual or team who conducted the investigation. Overuse of technical jargon and including long passages on timing, condition, and actions leading up the event obscure key learnings and put off widespread adoption.

Safety communications should be as simple as possible so that learnings and recommendations are clear. They should:

- Be written for their audience, that is supervisors who need to explain information to their teams.
- Make the LFI visually appealing and clear, illustrating the "wrong" and the "right" way.
- Identify the immediacy of the problem up front.
- Quickly get to the incident details and learnings.
- Be clear on recommendations.

Adopting the language of barriers and listing non-technical failings such as breakdown of management systems or failures of audit, verification, and assurance can make the LFI more relevant to the reader's own work place.

Liability and reputational concerns often delay and degrade LFIs that might otherwise capitalize on the freshness of the incident to generate energy to animate discussions and close out actions. An example of best practice observed is the rapid distribution of an anonymized single page PowerPoint within a short time of the incident. The operating company in this instance agreed to forgo legal checks to achieve this.

DISCUSSION ON SITE

When the sole distribution of LFIs involves site management reading aloud flyers in town halls or locker room briefings much of the potential value of the alert can be lost. In-depth team discussion involving leaders is key to ensuring full understanding of what happened and agreeing relevant team-specific takeaways. Leading questions such as "what should we be doing here to ensure this doesn't happen (again)" and "what aspects of our operation need to be modified as a result" are useful prompts to achieving this.

A best practice performed by an international oil major is a monthly leadership team meeting in which a nominated employee is tasked with presenting on an LFI selected from the company database. A 30 minute discussion follows, during which time contributing factors and preventative measures are examined and recommendations reviewed. At the end of the session, the team agrees on a timeline for cascading the LFI learnings and recommendations throughout the organization.

STORYTELLING:

Proximity theory in relation to incidents is quoted to assert that there is a strong relationship between an individual's reaction or response to an incident and their distance from the incident. Reading about an event at another site is not as impactful as having it happen to a friend or family member.

The techniques of storytelling and story based learning are a powerful way to humanize an incident, effectively bringing it closer to its audience and avoiding them drawing the conclusion that "it couldn't happen here" or "we're different'."

One such example is the recommended practice of adding short narratives to operational procedures to remind users why a specific step is required. Addition of a note such as "this check was included following an incident in 1999 at X site in which Y people were injured" not only supports completion of the appropriate action but avoids the step being bypassed or removed years later after organizational memory of the incident has been lost

CLOSING THE LOOP

Perhaps the most poorly fulfilled aspect of learning from incidents is closing the loop on modifications to plant, process, or procedure to prevent recurrence.

It is observed that incident root causes are often well defined but no plan of action is agreed at the corporate level before the learning is released. This failing leaves a somebody should void due to lack of leadership delegation.

When the required actions are likely to be too site-specific to adequately define on distribution of LFIs consideration should be given to how to assure suitable close out. The varying degree to which companies rely exclusively on positive corporate culture to assure sub-organizations do the right thing is acknowledged as a key differentiator in corporate LFI policy.

Some operators are observed to require site managers to sign off generic statements that the issues contained in the alert have been examined and addressed locally while some mandate further measures. In the latter case identified actions are often captured in a company-wide safety management action tracking system, which might be visible to all employees. It has been argued that this can aid the creation of company memory and can ensure that all aspects of incident causation are tackled including modifications to training programs, operating procedures and engineering standards.

SHARING ACROSS COMPANIES

The paper concludes with a call to action to create an industry wide database of incidents and related learnings.

The nuclear and commercial aviation industries are noted as leading the way in this regards. The latter sector, through the Federal Aviation Administration, operates the Aviation Safety Information Analysis and Sharing system. This enormously successful program enables users to perform integrated queries across multiple databases, search an extensive warehouse of safety data, and display information in an array of useful formats.

There is a conspicuous absence of any equivalent database serving the energy industry. It is observed that legal teams increasingly limit potentially defamatory details about an incident being circulated outside the organization and sometimes even internally. There would be much to be gained, both in terms of injury prevention and cost avoidance, if these objections could be overcome and regular incident information sharing instigated.

Original authors: Laurence Pearlman and Susie Scott of Oliver Wyman.

Presented at the American Institutes of Chemical Engineers 2015 spring meeting: 11th Global Congress on Process Safety, Austin, Texas, April 27-29, 2015

FROM THE ARCHIVES: DO LUBE OIL FIRES REALLY HAPPEN?

Corporate memory is often said to extend no further back than 10 years or so. With this in Mind, we have included here an article written by Adrian Louis, a Risk Engineer in Marsh's Energy Practice based in Dubai, which appeared in an edition of the Loss Control Newsletter in 2012. Here, Louis explores whether lube oil fire can really occur when the oils are handled below their flash points.

We have learned a lesson, albeit a very expensive one, from our colleagues in the power sector of losses due to lubricating oil fires occurring at machinery lube oil consoles. In the last 15 years, there have been more than US$400 million in property losses alone[1] due to lubricating oil fires.

It is not uncommon for fires originating at the consoles to then escalate to surrounding equipment, and typically, the associated main machine – compressor, pump or turbine. The subsequent loss of the main machine has the potential for far greater consequence when looked at in a business interruption scenario as major machines can take up to 30 months to replace.

One can sympathize with the difficulty in understanding how lubricating oil can catch fire. The usual responses heard include "It's not flammable!" and "It is operating below its auto ignition temperature", however, fires at lube oil consoles still occur.

Past examples on process plants include:

- 1978, Propylene Plant, Spain – fire at lube console which escalated to surrounding equipment.
- 1988, Refinery, Scotland – leak of lube oil at power station generator causes fire and subsequent refinery shutdown.
- 1989, Refinery, USA – leak of lube oil resulted in a fire and spreads to main hydrogen compressor and surrounding area.
- 1996, Ammonia Plant, Canada – cracked three-quarter inch line on seal oil pump discharge resulting in fire which destroys syngas compressor.
- 2005, Ethylene Plant, Scotland – fire at lube console which escalated to the cracked gas compressor.

Lubricating or mineral oil is used to reduce friction and wear on rotating parts and is traditionally hydrocarbon-based. Lube oil consoles are typically located close to the main rotating equipment. It is quite common for lube oil consoles to be located at grade underneath the elevated compressor or next to the pump or generator. This is typical to minimize lube oil pumping head as well as to conserve plot space and is favored by Engineering, Procurement, and Construction (EPC) contractors.

The very nature of lubricating oil systems sets the scene for a perfect storm; take high energy fluid, pumped under pressure from a large reservoir, operating at elevated temperatures and in close proximity to "hot" surfaces and then throw in a leak – not unusual given that rotating equipment is synonymous with vibrations.

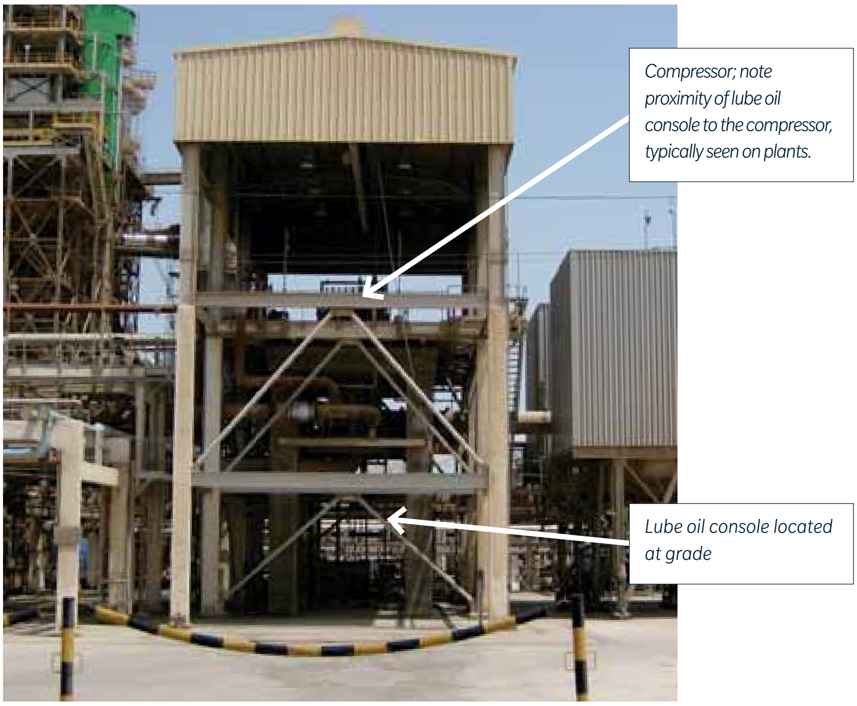
1 FM Global

Safety Snippet

ADVANCED TECHNIQUES DETECT CORROSION UNDER INSULATION (CUI)

The day when it will no longer be necessary to remove insulation to confirm if CUI is present may be a step closer thanks to this Low Intensity X-ray (LIXI) profiler which can provide instantaneous real-time information on thinning of material. The assembly is a U-bend type detector put in place around the pipe and then progressed through the pipe's length without the need to remove insulation.

More information can be found at: http://www.ndt.net/article/ndt-canada2010/papers/Lukose.pdf



Fire detectors

Given this perfect storm scenario and the associated context – the presence of a rotating machine handling a large quantity of flammables in close proximity to other potentially critical (and unspared) equipment – one would assume that installing fire detection and fixed fire protection for consoles would be an industry norm. However, there is no industry norm and best practice is not being applied consistently, a shortcoming that continues to cause loss. The installation standard is often set by a licensor or contractor with wide variations in facilities seen, even amongst new build equipment at the same site.

Marsh recommends that in the context of lube oil consoles, a risk assessment to understand the likelihood and consequences of a lube oil fire should be determined, especially where these consoles are located close to business-critical, unspared equipment.

This is particularly vital during the design phase, where suitable provisions for fire detection and suppression are much more cost effective than potentially expensive retrofits.

For areas where the inherent risk is deemed unacceptable then, as a minimum, fire detection systems should be installed. Examples of fire detectors include infra-red (IR) or ultra-violet (UV) sensors which are linked to the overall site's distributed control system.
For reliability purposes two different types of fire detector are recommended. A more economical alternative is to use a linear heat detector in combination with a fire detector on an instrumentation-voting basis. Moreover, fire detectors should be appropriately located in order to realize the benefit. Line-of-sight type (UV/IR) detectors (as shown on the right) should be focused on areas prone to leaks, such as flanges and joints.

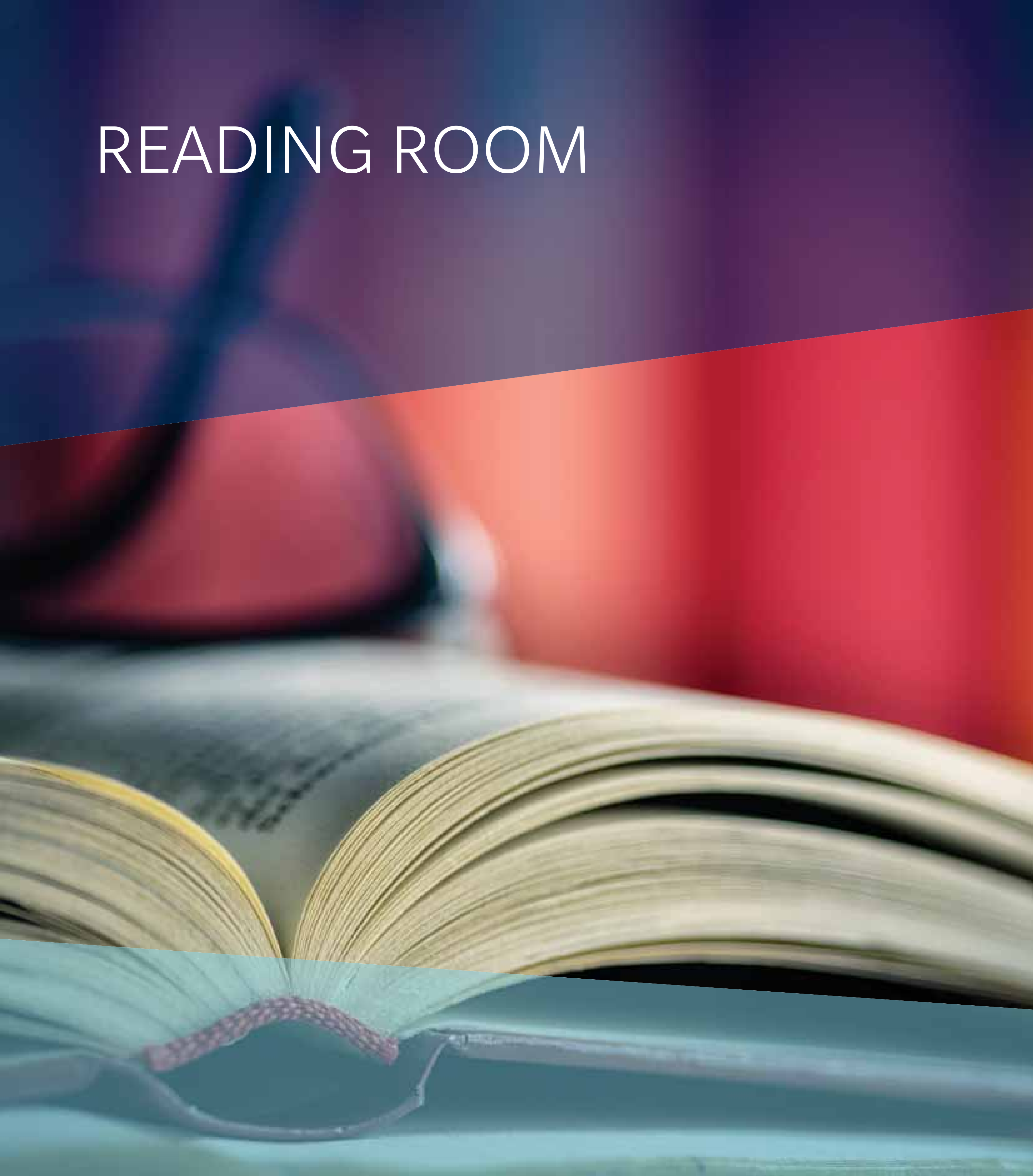
Detectors are the first line of defense and support the subsequent fire-fighting effort. In addition, a well-defined pre-plan specifically tailored for fire-fighting at the lube console and the surrounding area is then required. The pre-plan must be concise, specific, and easy to understand and should be practiced as part of the site's drill schedule. More guidance on fire pre-plans can be found in Marsh's position paper on the subject.

Depending on the nature of the process materials handled, the surrounding equipment, and the capabilities of the first intervention team, consideration should be given to installing fixed fire protection systems. Examples of these include deluge systems or inert gas suppression systems which either provide cooling, reduce the level of oxidants in the atmosphere, or inhibit the fire chain reaction.

The application of fixed systems is site and unit-specific and should be considered as part of the risk assessment. Particularly in older units, the space and access to allow effective intervention by fire fighters can be sorely compromised. There may also be cases where water deluge systems may be detrimental as water damage could render machines inoperable.

The risk engineering team at Marsh continues to observe and review various practices at sites globally and is well placed to provide support and advice to meet clients' individual needs.

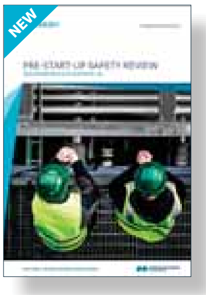
READING ROOM



INSIGHT PAPERS PUBLISHED BY MARSH

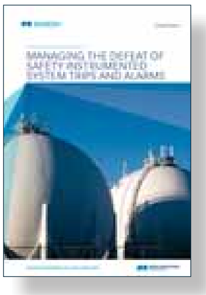
ENGINEERING POSITION PAPERS

Marsh's engineering position papers leverage our knowledge on best practices to establish standards that don't currently exist. These papers define the key attributes that we would define as being "very good."



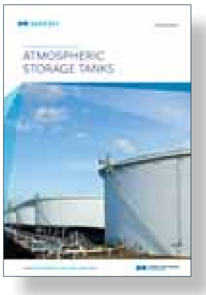
PRE-START-UP SAFETY REVIEW

These recommendations can be used to support and define risk improvements and also provide detailed advice to clients seeking to improve their management systems.



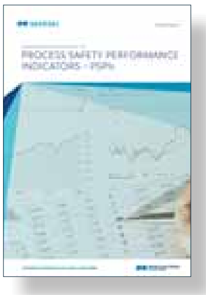
MANAGING THE DEFEAT OF SAFETY-INSTRUMENTED SYSTEM TRIPS AND ALARMS

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.



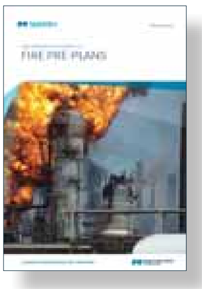
ATMOSPHERIC STORAGE TANKS

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.



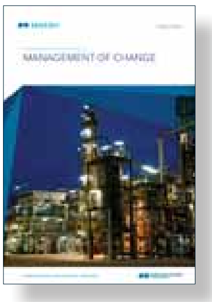
PROCESS-SAFETY PERFORMANCE INDICATORS

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.



FIRE PRE-PLANS

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.



MANAGEMENT OF CHANGE

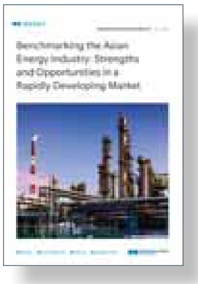
During the lifetime of an operating process plant, many changes will occur, including to the physical hardware of the plant, control systems, business processes, and/or to the organization running the plant.

BENCHMARKING

Marsh uses a proprietary risk-ranking system to provide an absolute measure of risk quality when compared against a defined set of criteria. From these rankings, Marsh developed its benchmarking tool to provide a proactive risk-improvement approach based on current standards and best practices, in sharp contrast to improvement plans that are based on historical performance. For many of our clients, Marsh's benchmarking reports have already proved to be a catalyst for change.

ENERGY RISK QUALITY BENCHMARKING IN THE MIDDLE EAST

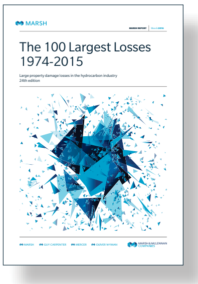
This paper contextualizes risk quality in the Middle East and explores regional trends to gauge the comparative risk quality of oil, gas, and petrochemical facilities relative to more than 500 similar facilities worldwide.



BENCHMARKING THE ASIAN ENERGY INDUSTRY: STRENGTH AND OPPORTUNITY IN A RAPIDLY DEVELOPING MARKET

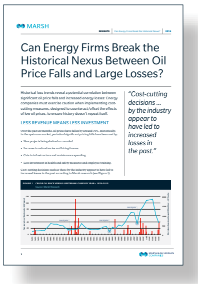
A benchmarking study to gauge the comparative risk quality of Asian onshore oil, gas, and petrochemical facilities relative to more than 400 similar facilities worldwide.

DATA-DRIVEN INSIGHTS



THE 100 LARGEST LOSSES 1974-2015. LARGE PROPERTY DAMAGE LOSSES IN THE HYDROCARBON INDUSTRY

The 24th 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.



CAN ENERGY FIRMS BREAK THE HISTORICAL NEXUS BETWEEN OIL PRICE FALLS AND LARGE LOSSES?

This new insights paper analyzes the historical sequential correlation between oil price falls, which led to energy firms cutting costs, including safety training and education, which in turn, led to an occurrence of significantly larger insured losses in the following period.

NATIONAL OIL COMPANIES CONFERENCE (NOC) SUMMARY 2016

In this summary of insights from Marsh's sixth NOC conference we provide our esteemed speakers' perspectives on the complex and evolving risks energy companies face today.

Visit www.marsh.com/UK to download these reports

SAFETY NEWS FROM AROUND THE WORLD

INVESTIGATION REPORT FROM 2009 EXPLOSION AND FIRE AT CARIBBEAN PETROLEUM TERMINAL FACILITY

The report finds inadequate management of gasoline storage tank overfill hazard and is released alongside a safety video about the incident.

In October 2015 the CSB voted on the final investigation report into the massive explosion in 2009 at the Caribbean Petroleum (CAPECO) terminal in Puerto Rico.

The incident occurred when gasoline overflowed and sprayed from the vents of a large aboveground storage tank, forming a vapor cloud that ignited. While there were no fatalities, the explosion damaged some 300 nearby homes and businesses and petroleum leaked into the surrounding soil, waterways, and wetlands.

The investigation found that the tank level measuring devices at CAPECO were poorly maintained and frequently were not working. Electronic equipment to relay level measurements to the control room was out of service, so operators were required to manually record the hourly tank level readings. When that system failed, the facility did not have additional layers of protection in place to prevent the incident.

A new safety video called "Filling Blind" chronicles how the incident unfolded at the terminal. It is a powerful resource that could serve as a good introduction to safety committee meetings, training on the override of safety critical devices, etc.

See the "Filling Blind" video at: http://www.csb.gov/videos/

TECHNOLOGY OUTLOOK 2025

Over the next ten years we're likely to see many technological advances that will revolutionize industrial processes.

As an example, additive manufacturing – or 3D printing – is dramatically changing where and how things are made. The digitization of information flows will spur the automation of existing processes and functions, and have a positive impact on safety and environmental performance.

When it comes to the production of energy, large generating plants and passive components still dominate today's power system. But, According to **DNV GL's Technology Outlook 2025**, that time is over. In the next 10 years, the new energy landscape will be a hybrid of large and small scale elements: large scale renewable generating plants and super grids which move power over long distances, and micro grids and energy producing buildings where consumers have an active role.

https://www.dnvgl.com/news/dnv-gl-s-technology-outlook-2025-explores-technology-likely-to-be-taken-up-in-the-next-ten-years-60983

STUDY REVEALS TOP 10 CYBER THREATS TO OFFSHORE OIL AND GAS OPERATORS

The international survey of 1,100 business professionals found that although companies actively manage their information security, the majority adopt an ad-hoc management strategy and only one in four set concrete goals.

The study focused on Norwegian Continental Shelf operations, however DNV GL believes that the issues apply equally to oil and gas operations across the globe. The top ten cyber security vulnerabilities cited in the report are:

1. Lack of cyber security awareness and training among employees.
2. Remote work during operations and maintenance.
3. Using standard IT products with known vulnerabilities in the production environment.
4. A limited cyber security culture among vendors, suppliers, and contractors.
5. Insufficient separation of data networks.
6. The use of mobile devices and storage units including smartphones.
7. Data networks between on-and offshore facilities.
8. Insufficient physical security of data rooms, cabinets, etc.
9. Vulnerable software.
10. Outdated and ageing control systems in facilities.

Read more and download the report here:
https://www.dnvgl.com/oilgas/download/lysne-committee-study.html

This study comes as Reuters report a US government cyber security official warning that authorities have seen an increase in attacks that penetrate industrial control system networks over the past year, which are vulnerable because they are exposed to the internet.[1]

Marsh has previously warned of the cyber- attack threat to industrial control systems in our 2014 report Advanced Cyber Attacks on Global Energy Facilities.

https://www.marsh.com/uk/insights/research/advanced-cyber-attacks-on-global-energy-facilities.html

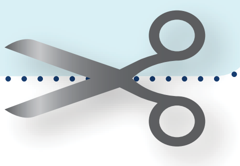
1 http://www.reuters.com/article/us-usa-cybersecurity-infrastructure-idUSKCN0UR2CX20160113

Safety Snippet

SAFETY SYSTEM FOR MONITORING STORAGE TANK FLOATING ROOFS

Marsh has observed sites making use of an additional layer of protection against storage tank floating roof failure. A Floating Roof (FR) Tracker from Syscor boasts the ability to detect risks associated with water/snow accumulation, sticking roof seals, roof mis- alignment, etc. The end-to-end wireless product has an expandable roadmap to include gas detection, in-tank camera, and video.

More information can be found at: http://syscor.com/



INTERNATIONAL ASSOCIATION OF OIL AND GAS PRODUCERS (IOGP) 2014 SAFETY PERFORMANCE DATA

Continuing IOGP's Safety Committee initiative to feedback learnings from events to help organisations to categorise process safety events, a new report has been published.

IOGP has been collecting safety incident data from its member companies since 1985 and boasts the world's largest database of safety performance data in the exploration and production industry.

Following the publication of IOGPs complete set of fatal incidents and high potential events for 2014, December 2015 saw the publication of a separate report of those incidents that were identified as process safety-related, and those that were process safety events.

Each event in the report is detailed in the form of a narrative, explaining what went wrong, plus lessons learned and recommendations. This is a rich source of learning for those organizations operating across the energy industry.

The report can be downloaded for free at: http://www.iogp.org/pubs/2014pfh.pdf

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COST MANAGEMENT CHALLENGES FOR THE OIL AND GAS INDUSTRY

Highlighting the current cost pressured environment, a recent report from DNV GL considers the priorities for senior executives in 2016 in the "lower-for-longer" oil-price conditions.

Now in its sixth year, the outlook for the oil and gas industry in 2016 benchmark study titled *A New Reality* delivers an assessment of industry sentiment, confidence, and priorities, in addition to expert analysis of the key pressures facing the industry in the year ahead.

Failing to learn from the past is seen as a key risk, with a finding that over half of the respondents to the survey underpinning the report saying that the oil and gas industry is repeating many of the same mistakes made in prior price downturns.

Worries that there are already some early signs that costs have been cut in the wrong areas by some companies highlight the requirement to make sure assets continue to operate safely. A focus on safety barriers is needed to ensure that cuts being made are sustainable, with a reminder that any cost savings being considered would be dwarfed by the costs associated with a major accident.

Download the full report for free here: https://www.dnvgl.com/oilgas/industry-outlook-report/a-new-reality.html

THE GERE TEAM NEWS

GERE NEW STARTERS:

Continuing to add new talent to the GERE team, since the last edition of the LCN we have welcomed eight new members:

WILL CHAFFIN – LONDON

Will is a Chartered Mechanical Engineer and joined the oil industry in 2007. Prior to joining Marsh in 2015 Will gained experience with super-major and independent operators in the North Sea, primarily based in Aberdeen. He has worked with many aspects of offshore technology including subsea, pipelines, corrosion, and integrity works but specialized in topsides facilities alternative selection, engineering, construction, and commissioning. He has varied offshore experience including significant time working on dive support vessels, subsea construction vessels, mobile offshore drilling units, and fixed and floating platforms.

ARUN NEGI – INDIA

We are very pleased to report that Arun Negi has re-joined the Marsh GERE team. Arun has a wealth of experience from his previous spent time with Marsh as a risk engineer on both upstream and downstream risks. Arun has a B.Tech from IIT Roorkee and Executive MBA in Petroleum Management from School of Petroleum Management, Gandhinagar. Prior to re-joining Marsh, Arun was working with Cairn India Ltd. as a Field Delivery Manager.

Arun joins the GERE team in India and is responsible for upstream and downstream underwriting surveys and providing risk management advice.

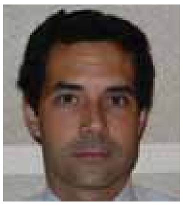
KENG SIANG CHAN – SINGAPORE

Keng graduated from the National University of Singapore as a Chemical Engineer. He began his career in 2005 as a Process Engineer, he went on to work on to hold various MEG plant operations management positions. Keng has also served as an LNG Operations Service Engineer and developed the basic design engineering package for the Abadi FLNG project.

RUBEN GARCILAZO – MEXICO

Ruben is a graduate in Mechanical Engineering from Universidad de Oriente, Venezuela and has a Master's degree in Reliability & Risk Engineering from Universidad de Las Palmas, Spain. He started his career as a project engineer with oil and gas consulting company, APOYO.C.A. before joining Pequiven S.A. as a Risk Engineer in the HSE department. During his time at Pequiven he also undertook a role in maintenance planning, before joining Pequiven's corporate headquarters. As a corporate risk engineer he carried out inspections and technical evaluations of safety and risk engineering on new projects and plant operations.

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



PABLO BARRENA – ARGENTINA

Pablo holds both a degree in Mechanical Engineering (Universidad de Buenos Aires) and an MBA (Centro de Estudios Macroeconómicos de la Argentina). Pablo joined Marsh in 2007, managing the Risk Consulting Department in Argentina covering technical and consulting activities. Prior to Joining Marsh Pablo worked as risk manager for YPF and also worked in energy risk engineering for both Willis and Zurich.

In 2015, Pablo was appointed as Regional GERE Team Leader in Latin America and the Caribbean. In this role he is responsible for developing and strengthening the Energy and Power engineering capabilities in the region and maintaining client service excellence.

GAURAV KANODIA – INDIA

Gaurav graduated with Bachelor's degree in Chemical Engineering in 2007 from IIT-BHU, India. His experience includes working as a shift in charge with BG Group E&P, India and as assistant manager – process with Bharat Oman Refineries Limited. Prior to joining Marsh, Gaurav was a risk engineer with AIG.

Gaurav joins the GERE team in India and is responsible for upstream and downstream underwriting surveys and providing risk management advice.

GONZALO FIGUEROA – COLOMBIA

Gonzalo joins the risk-engineering team as Engineering Manager for Power companies in Latin America and the Caribbean. With a degree in Mechanical Engineering from the America University of Bogota, and with more than 20 years' international experience in the Power-generation sector, Gonzalo has worked as the chief operation engineer and plant manager for leading power firms in Colombia, Brazil, Panama, the US, the Dominican Republic, Iraq and, most recently, as engineer AIG Latin America's PowerGen practice.

JASON SHIRLEY – DUBAI

Dr Jason Shirley is a chartered process engineer who graduated with a first class Master's degree in Chemical and Biochemical Process Engineering and a Process Engineering Doctorate. Within industry his experience has comprised of substantive roles within operations management, process engineering, commissioning, project management and performance and risk management.

Jason joined the GERE team, based in Dubai, UAE, his main responsibilities involve conducting underwriting surveys and the provision of risk management. advice for energy clients.

A FOND FAREWELL

DICK BARTON

Dick Barton "Special Agent" recently retired after more than 20 years with the Marsh GERE team. During his tenure with Marsh, Dick made a great contribution to risk engineering to the benefit of our clients and the energy insurance market at large. Working out of both the London and Singapore offices, he covered all the key areas in depth including upstream, downstream, operational, and construction risks.

However, Dick has not hung up his hard hat and overalls for good just yet, so you may see him working as an independent contractor for Marsh in the not too distant future!

HILARY McGRATH

Hilary has retired after 17 years working as a team secretary in the Marsh London GERE team. Hilary's ability to pack up Marsh engineers with travel visas, flight tickets, hotel bookings and send them off around the world to far flung destinations is unsurpassed. She has been the backstop behind Marsh underwriting report quality and has helped us develop a rich database for benchmarking of risk quality.

Well known to both Marsh and market risk engineers alike, we will all miss her great sense of humor and classic one-liners in the office! Wishing Hilary a long, healthy, and fun retirement!

Safety Snippet

QUICK VISUAL GUIDES USED TO DENOTE STAGES OF PROCESS ISOLATIONS

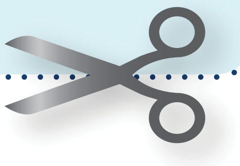
How do you know that a piece of equipment that you intend to put into service is actually ready for use? For example:

- Routine start-up of a process pump, such as switching from the on-line pump to the spare.
- Transferring material into a different tank or other process vessel.
- Introducing material into a piping system which has been out of service for maintenance.
- Starting up new equipment following a plant modification (which should be covered by your plant management of change and pre start-up safety review procedures).

Any time that you introduce material or energy into equipment that is not currently being used, it is essential that you confirm that the equipment is ready. Are all of the parts of the equipment actually there and properly installed, or is something missing? Are all the valves that are supposed to be open actually open, and all the valves that are supposed to be closed actually closed? Is everything else ready to use?

- When you change the status of a piece of equipment, know where material and energy comes from, where it can go, and how that will change when you change the equipment status.
- Complete a field assessment of a system before changing its status.
- Make sure all components of the system are properly installed, and that everything is in the correct position.
- Be careful when putting equipment back into service following maintenance or any other activity where equipment was taken apart.
- Make sure that it has been properly re-installed, that all temporary isolation devices such as blinds have been removed, and that all valves are in the right position.
- Set a personal goal of zero equipment setup errors.
- **"Walk the line"** and encourage your colleagues to do so as well!

The above is an extract from a useful Process Safety Beacon published by the AIChE. See the full document at: http://www.aiche.org/sites/default/files/beacon/201508beaconenglish.pdf



LOSSES

JANUARY – DECEMBER 2015

The 24th edition of Marsh's '*The 100 Largest Losses*' was recently published to provide you with the most up to date information on the largest losses that have occurred in the energy industry. To complement this, here in the LCN we provide a selection of recent losses of interest from around the world, including a mixture of those that grabbed the headlines as well as those that have not been so widely publicized.

MAJOR ENERGY INDUSTRY LOSSES		
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	05/04/2015 Bomb Attack Distribution Colombia	An oil pipeline was shut down following a bomb attack. Armed forces secured the area so that workers could carry out repairs. There was minimal oil spillage or impact to oil export.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	11/08/2015 Explosion Distribution Mexico	An explosion occurred on a 24 inch gas pipeline when an excavator working in the area struck the line. There were five fatalities amongst the workers; it was reported that they were installing power lines near the pipeline.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	28/07/2015 Explosion Distribution Turkey	An act of sabotage caused an explosion on a pipeline carrying natural gas from Iran. No injures were reported and the ensuing fire that was swiftly extinguished.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	03/07/2015 Explosion Chemical Korea	An explosion occurred during hot work carried out by contractors on a waste water treatment facility of a chemical plant. There were six fatalities.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	06/04/2015 Explosion Distribution Colombia	An oil pipeline was shut down following a bomb attack. Armed forces secured the area so that workers could carry out repairs.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	16/03/2015 Explosion Gas Processing Australia	An LNG plant was shut down after a drilling rig was torn from its moorings in a cyclone and drifted close to flowlines at the offshore field. The rig had been shut down and secured in advance of Tropical Cyclone Olwyn's approach. The rig broke from its mooring lines and drifted some three nautical miles. The flowlines were not damaged. Production restarted once the rig had been relocated.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	11/03/2015 Explosion E&P Offshore Brazil	An explosion on an FPSO off the coast of Brazil resulted in nine fatalities and multiple wounded. The accident happened as the vessel was anchored in the Atlantic 120 km from the coast of southeast Brazil The FPSO was a converted VLCC. It is understood that a condensate leak during a fluid transfer operation released a cloud of flammable vapor into the engine room resulting in an explosion in the machinery space. The majority of fatalities were believed to be part of the emergency response team. The FPSO took on water, but the explosion did not result in a breach of the hull of the vessel.

MAJOR ENERGY INDUSTRY LOSSES		
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	18/02/2015 Explosion Refinery United States	An explosion and fire damaged a refinery gasoline processing unit, injuring four workers and shattering windows of surrounding buildings. Firefighters and refinery crews also contained a gasoline leak caused by the blast. A structure at the refinery was visibly damaged. Shutdown of the unit could extend to six months.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	06/01/2015 Explosion E&P Onshore United States	An explosion and fire at an oil rig killed two workers and injured three others, two of them critically. The fire was extinguished.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	24/12/2015 Explosion, fire Distribution Nigeria	A release of butane at a domestic cylinder filling facility resulted in an explosion and fire while customers were queuing to fill cylinders. It is thought the release was from an unloading road tanker.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	20/12/2015 Explosion, fire Distribution China	A major landslide buried buildings and damaged a major natural gas distribution pipeline resulting in a major explosion.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	03/12/2015 Explosion, fire Gas Processing United States	More than 250 workers escaped after a release of gas from a gas processing facility resulted in an explosion and fire. Two workers received minor injuries. People within a 10 mile radius of the plant were evacuated. The fire continued to burn on the plant for one week.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	24/11/2015 Explosion, fire Refinery Mexico	An explosion occurred on the alkylation unit of a refinery, resulting in serious injuries to eight workers and evacuation of some 2,000 refinery workers. The fire was put under control by the refinery fire- fighting team.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	13/11/2015 Explosion, fire Distribution United States	A natural gas pipeline was struck by heavy equipment resulting in an explosion and 200 foot long jet fire. The operator of the heavy equipment was killed. Two other people were injured and a house was destroyed.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	07/10/2015 Explosion, fire Gas Processing United States	An explosion occurred on a gas plant during a shutdown for routine maintenance.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	13/08/2015 Explosion, fire Chemical Czech Republic	A short interruption in the supply of cooling water to a separation column downstream of a steam cracker resulted in the need to open relief valves from the column to flare. Subsequent manual choking back of the relief line to flare resulted in the Pressure Relief Valves opening. These valves vibrated excessively resulting in failure of the bolted flanges and the release to atmosphere of the propylene-rich column overhead line. The resultant explosion led to the failure of utility lines to the cracker requiring a crash shutdown. The lack of process steam due to the interruption to the utility supply resulted in the failure of furnace tubes and the release of quench oil. There was subsequently a pool fire from the released quench oil under the cracker resulting in damage to four of the ten cracker furnaces.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	16/07/2015 Explosion, fire Chemical China	There was an explosion at a petrochemical plant following a fuel leak amongst four pressurized storage spheres. The facility had stopped operating some 18 months earlier and no staff were injured.

MAJOR ENERGY INDUSTRY LOSSES

DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	14/07/2015 Explosion, fire Chemical France	Two tanks caught fire at a petrochemicals site, one containing gasoline and the other naphtha. The cause was believed to be explosive devices, detonated near simultaneously. Firefighters dealt with the gasoline fire quickly but took several hours to extinguish the naphtha fire. There were no injuries.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	09/07/2015 Explosion, fire Distribution Nigeria	A pipeline was struck by a vehicle while the team were investigating a clamp that had been fitted following previous damaged by sabotage. The resulting explosion caused 12 fatalities.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	21/04/2015 Explosion, fire Chemical China	An explosion occurred in the ethylene oxide distillation tower of an Ethylene Glycol Facility on an Olefin plant, injuring an operator. During firefighting on a re-boiler, an explosion occurred followed by a secondary explosion inside the tower. An investigation found that pressure gauge piping was distorted and blocked resulting in under-reading of the actual column pressure. The safety valve lifted and there was a leak of ethylene oxide.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	17/04/2015 Explosion, fire Distribution United States	An explosion and fire occurred on a crude oil storage facility. Oil and salt water tanks were engulfed and fire fighters let the tanks burn themselves out. No injuries were reported. It was thought that a lightning strike may have been the cause of ignition.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	10/01/2015 Explosion, fire Refinery United States	A major explosion and fire occurred on the isocracker unit of a refinery. The isocracker was being restarted after maintenance. There was extensive damage.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	04/12/2015 Fire E&P Offshore Azerbaijan	A major fire broke out on an offshore platform. Rescue was hampered by poor weather conditions. Strong winds reportedly damaged gas pipework on the platform. There were eight fatalities and 33 workers were rescued. Some 22 workers were reported still missing after one month. The fire was still burning a month later whilst well control specialists worked to control the fire.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	14/10/2015 Fire Chemical Brazil	A fire occurred on a cracker unit of an integrated petrochemicals site resulting in injury to six workers. The ethylene, propylene and benzene units were shut down for one month.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	21/09/2015 Fire Refinery Mexico	A fire occurred on the heater of a hydrocracking unit of a refinery. The fire lasted one hour and one worker was injured. There was limited damage.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	20/09/2015 Fire Refinery United States	A fire occurred during the restart of a coker unit following maintenance. A failure of a line in the area above the coke drums released material that was ignited on the hot drums. The unit was shut down for three weeks to repair electrical wiring damaged in the fire.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	17/08/2015 Fire Refinery Kuwait	A refinery was shut-down and evacuated after a large fire broke out. The fire on the heavy oil cracking unit was brought under control and no injuries were reported.

MAJOR ENERGY INDUSTRY LOSSES

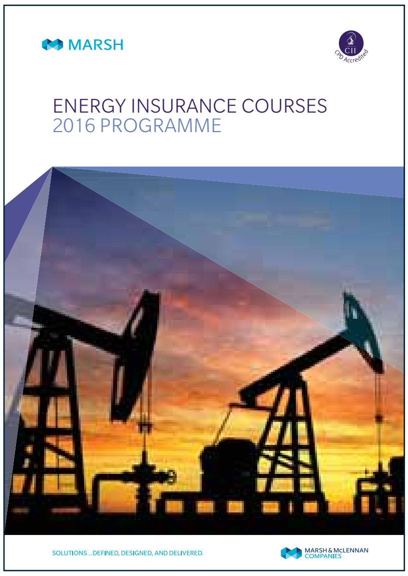
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	12/08/2015 Fire Distribution Russia	A pipeline failed under a river close to a refinery and released oil which burned on the surface. Some local residents were injured. Refinery operations were unaffected.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	06/08/2015 Fire Distribution United States	A natural gas pipeline caught fire following impact by a third-party carrying out excavation work. There were no injuries following the incident. An exclusion zone of 2 miles was established around the leak and people within the area were evacuated.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	17/07/2015 Fire Refinery Turkey	A malfunction in the refinery's electrical systems caused a fire and explosion impacting the oil tanks at the facility. Production operations were not affected.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	14/07/2015 Fire Refinery Yemen	A missile attack by rebels on an oil refinery resulted in a storage tank fire that escalated to other areas of the refinery.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	05/07/2015 Fire Distribution United States	A train of 107 cars of crude oil derailed. 10 cars caught fire and it was estimated that some 34,000 gallons of crude oil burned and another 60,000 gallons were spilled. There were no injuries reported.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	10/05/2015 Fire Refinery Greece	Five workers were seriously injured following a fire on a refinery while during maintenance work. The fire is reported to have spread across dry grass in the surrounding area.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	26/04/2015 Fire E&P Onshore United States	A fire started after lightning struck a storage tank, spreading to other flammable materials at the site. Homes near the site were evacuated, no injuries were reported.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	20/04/2015 Fire E&P Onshore India	A fire broke out at a gas well during maintenance, injuring 12 people. Non-essential persons were evacuated. A relief was directionally drilled to the well sub surface to stop further gas flow. Water was continuously sprayed over the affected well-head to keep the area cool.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	19/04/2015 Fire Refinery South Africa	A worker died and two were injured following a flash fire after a pipeline failure at the 172,000 barrel a day plant.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	18/04/2015 Fire Distribution United States	A pipeline was struck by a backhoe, resulting in a fireball injuring construction workers and a prison inmate crew nearby.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	10/04/2015 Fire Refinery Russia	One worker was killed after a fire broke out during maintenance on the pipeline of a refinery pipeline.

MAJOR ENERGY INDUSTRY LOSSES

DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	08/04/2015 Fire Chemical China	Six people were hospitalized and hundreds of firefighters deployed to fight a hydrocarbon fire following an explosion at a paraxylene plant. Three gas tanks caught fire after the explosion. Nearby residents were evacuated.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	01/04/2015 Fire E&P Offshore Mexico	A major fire occurred at a complex of six platforms located in 30 m of water in the Gulf of Mexico. The fire originated on the lower decks of the Production Platform resulting in major damage to the platform, radiation and fire damage to an adjacent compression platform, plus damage of bridge links and pipelines. A root cause investigation identified corrosion of a small bore pipe as the cause of the initial failure.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	30/03/2015 Fire Chemical United States	A vapor release from a propylene line resulted in a fire in the unit which forced the shut down of the entire chemical plant. No injuries were reported.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	09/03/2015 Fire Distribution Canada	An incident associated with a train of 94 cars carrying crude oil resulted in the derailment of 38 cars. A bridge over a waterway was damaged and five tank cars entered the water and leaked oil. Booms were deployed to contain the oil.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	16/02/2015 Fire Distribution United States	A freight train carrying crude oil derailed and caught fire. 14 cars were affected and one plunged into the river. One person was treated for smoke inhalation; no other injuries were reported. The accident resulted in the shut down a local water treatment plant an hour after derailment.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	23/01/2015 Fire E&P Offshore United States	An unmanned platform was damaged which led to gas bubbles surfacing nearby. Damage was possibly due to impact by a vessel leading to a fire on the platform which was extinguished by firefighting by nearby vessels. Three wells were producing oil at the time; an emergency shutdown was successful and production was shut in.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	05/01/2015 Grounding Distribution Nigeria	A fully loaded LNG tanker grounded when leaving an LNG plant. The ship was not positioned to block the shipping channel to the terminal.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	05/07/2015 Mechanical Damage E&P Offshore Qatar	A jack-up accommodation rig keeled over into the water and partially sank following a punch-through incident. All crew escaped in lifeboats following the incident and there was no damage to the adjacent rig.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	05/05/2015 Mechanical Damage E&P Offshore Mexico	An accident occurred on a jack-up rig during positioning ready for maintenance on a production platform. The rig tilted due to a fault in one of the legs. Two workers were killed.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	16/03/2015 Mechanical Damage E&P Offshore United Kingdom	A platform in the North Sea was shut after being hit by a supply vessel. Workers were taken off the platform and transferred to a nearby platform following the collision. There was no leak of hydrocarbons.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	23/10/2015 Release Distribution United States	A leak of odorized gas occurred at an underground gas storage facility in a depleted oil field. Some 60,000 kg of gas per hour was estimated to have leaked. A no-fly restriction in the vicinity was set up and 5,000 households were evacuated. The well was temporarily plugged on 11 February 2016, four months after the initial release.

MAJOR ENERGY INDUSTRY LOSSES		
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	27/09/2015 Release Refinery United States	Heavy rain caused the failure of the floating roof of a nearly full storage tank containing 4 million gallons of gasoline on a major oil refinery. The failed roof sank to the bottom of the tank. During emptying of the tank a leak in the tank base released 4,200 gallons into the bund which was then covered with foam.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	20/07/2015 Release Chemical Netherlands	Following the sinking of a roof of an atmospheric storage, foam was applied to reduce vapor emissions.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	17/07/2015 Release Distribution United States	A breach in a pipeline was not picked up by automatic detection systems resulting in the spillage of 31,500 barrels of an emulsion of bitumen, water and sand. The leak spread across an area of 16,000 square meters. The pipeline, which connects a 9,000 barrel-per day oil sands project to processing plant was shut down until the pipeline was repaired.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	24/04/2015 Release E&P Onshore Brazil	Four oil platforms off the coast of Brazil halted production after a leak of 7,000 liters of oil was detected from an associated pipeline. The platforms together produce 400 barrels of oil and 60,000 cubic meters of natural gas per day.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	06/04/2015 Release Distribution India	Two workers were killed and three others injured following failure of an LPG pipe during pigging operations. The fatalities and injuries were due to the impact from a release of energy. There was no fire or explosion.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	19/01/2015 Release E&P Offshore United Kingdom	A release of gas was detected near a FPSO. Non-essential personnel were evacuated while investigations were carried out which found that a line between the FPSO and a station keeping vessel had become snagged on the subsea infrastructure.
DATE OF LOSS EVENT TYPE SITE TYPE COUNTRY	04/04/2015 Terrorism Distribution Nigeria	A gunmen killed nine people and, separately, militants blew up a gas pipeline apparently to draw attention to their exclusion from pipeline protection contracts with the state oil company.

MARSH'S ENERGY INSURANCE TRAINING COURSES 2016



Marsh's Energy Practice offers energy insurance training courses at different levels at various locations around the world.

THE ENERGY INSURANCE DIPLOMA COURSE

BEGINNERS' LEVEL

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 which 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.

LONDON:

11-15 July 2016

THE ENERGY INSURANCE AND RISK MANAGEMENT COURSE

INTERMEDIATE LEVEL

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 role. Topics covered during the course include business interruption, risk identification and evaluation, drilling risks, control of well, and delay in start-up.

LONDON:

3-7 October 2016

DUBAI:

22-25 October 2017

SINGAPORE:

28 November - 1 December 2016

THE ENERGY RISK MANAGEMENT COURSE

ADVANCED LEVEL

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.

LONDON:

5-9 September 2016

Visit www.energytraining.marsh.com to download the brochure or register for a course.

LOSS CASE STUDIES:

UK - STORAGE DEPOT - 2005

Failure of an atmospheric storage tank overfill protection device resulted in major loss of containment, explosion, and ensuing fire with extensive onsite and offsite damage.

FAILURE ON DEMAND OF A SCD

CANADA - UPGRADER - 2011

Local field bypass of a permissive instrumented system allowed the online process vessel to be opened resulting in a major loss of containment, explosion, and fire with extensive damage and ensuing business interruption.

IMPAIRMENT OF A SCD

PORTUGAL - REFINERY - 2009

Failure of a critical non-return valve resulted in back flow of steam and total destruction of a steam turbine generator.

FAILURE ON DEMAND OF A SCD

BRAZIL - ETHYLENE PLANT - 2011

Loss of external power supply to the site resulted in emergency shutdown of the process unit but the uninterruptible power supply (UPS) system failed to operate contributing to the loss. Major damage to the cracking furnaces resulted.

FAILURE ON DEMAND OF A SCD

THAILAND - POLYOLEFIN PLANT - 2011

High temperature trip instrumentation was not reinstated after maintenance on a high pressure ethylene reactor.
A high temperature runaway reaction occurred resulting in extensive damage to reactor piping and loss of containment.

SCD NOT REINSTATED AFTER MAINTENANCE

The information contained herein is based on sources we believe reliable and should be understood to be general risk management and insurance information only. The information is not intended to be taken as advice with respect to any individual situation and cannot be relied upon as such.

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