RISKworld

issue 12 autumn 2007

the newsletter of risktec solutions limited

In This Issue

Welcome to Issue 12 of RISKworld. If you would like additional copies please contact us, or visit www.risktec.co.uk, and feel free to pass on RISKworld to other people in your organisation. We would also be pleased to hear any suggestions you may have for future editions.

Contact Steve Lewis (Warrington)

Contents

Diversity and Delivery

Risktec's diversity of activities, helping to deliver risk controls where they are needed

In our previous RISKworld we announced the change in Risktec's ownership to make us a fully employee-owned company. We are pleased to report that this transition has happened smoothly and we look forward to developing Risktec and welcoming new employee shareholders into the company.

Managing Director, Alan Hoy comments, "We believe that our ownership structure, which is designed to attract and retain personnel, is ideally suited to the modern consulting environment. With the added incentive of a real stake in the business, our high quality and motivated people are very focused on adding value to our clients."

This issue of RISKworld aims to illustrate the diversity of activities we are involved in and the importance of delivering risk controls to where they are needed.

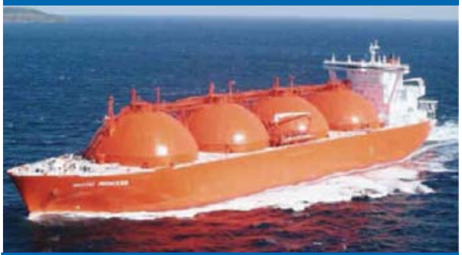
Alan Hoy explains further, "The articles presented in this issue reinforce one of our key aims - to provide an integrated service which helps our clients understand the risks they face, implement practical and appropriate systems to manage these risks and maintain these systems throughout the operational cycle. This will remain a major challenge as complexity and the pace of change increases in the modern world."

This issue of RISKworld is dedicated to Andy Reynolds, who died on 5th May. Andy, who was never without a smile, was a founding member of Risktec and a friend to many. His positive attitude and willingness to tackle new ventures sets a great example to us all. He is dearly missed.

For further information, contact Alan Hoy (Warrington)

The Rise and Rise of Liquefied Natural Gas

New LNG production facility at Melkøys, Norway



Spherical Moss design of LNG tanker

LNG receiving terminal at Niiata, Japan

What is LNG?

Natural gas comprises methane, ethane, propane and heavier hydrocarbons, plus small quantities of nitrogen, helium, carbon dioxide, sulphur compounds and water. Liquefied Natural Gas, or LNG, is produced by cooling natural gas to -160°C, once impurities such as water and carbon dioxide have been removed, which would otherwise solidify.

At this temperature, purified natural gas is a liquid at atmospheric pressure, occupying about 600 hundred times less volume than its gaseous form at room temperature. LNG is a clear, non-toxic, non-corrosive liquid with a density about half that of water.

Although cryogenic temperatures are required, LNG's intrinsic properties make it a viable means of transporting natural gas across long distances by sea. As a result, LNG facilities fall into one of three categories: liquefaction plant, shipping and regasification plant.

Economic Importance

Today, natural gas meets over 21% of the world's energy needs, and growth in gas consumption is forecast to outstrip that of oil over the first quarter of this century reaching 26% by 2030 [Refs 1 & 2]. In OECD countries, gas-fired power generation is largely responsible for this growth, given the improved efficiencies of closed-cycle gas turbines and their cleaner emissions, compared to coal, for example. At the same time, countries once rich in gas reserves, such as the UK and US, are struggling to meet demand, while others, such as Nigeria and Qatar, are tapping into vast reserves. With rising gas prices, LNG offers an increasingly attractive method of transporting gas to market.

LNG already supplies about 7% of the global gas market, the majority of which goes to Japan and South Korea. This is set to rise, with investment in LNG facilities predicted to double in 2008 to over $20 billion per annum.

In the UK, for example, two major new LNG terminals are under development at Milford Haven (Dragon LNG and South Hook LNG). Similarly, in the US a new LNG terminal in New Jersey (Crown Landing) is planned to come on line at the end of 2007.

LNG Hazards and Safeguards

LNG has been used worldwide for about 40 years. As such, there is a mature understanding of its associated hazards, gained in part from extensive operational experience [see Table 1]. Hazards fall into the following categories:

Extreme cold - Direct contact with LNG will cause immediate freezing of plant or people. Widespread exposure can cause serious injury and death. Secondary containment systems around LNG storage tanks are designed to contain tank contents, and in hazardous areas, personnel wear protective clothing and may have access to emergency showers.

Vapour cloud explosion - As uncontained LNG warms, it evolves methane gas. As this gas itself warms it disperses, mixing with air. Explosion occurs if a vapour cloud is confined and an ignition source is encountered within the range of flammability.

To prevent leakage, primary containment structures are designed from low temperature-resistant materials, such as high nickel content steel alloys, aluminium, stainless steels and reinforced concrete. Secondary containment limits leaks to areas where ignition sources are excluded or strictly controlled. Most modern facilities employ a full second containment structure capable of withstanding cryogenic temperatures, while older facilities use dikes, berms or dams. LNG ships are designed with double hulls to prevent leaks caused by grounding or collision.

Table 1 Major LNG Incidents*

1944, Cleveland, Ohio
An LNG tank fabricated from low-nickel steel suffered low temperature brittle failure and spilled its contents into the street and storm sewer system. The resulting explosion and fire killed 128 people.

1971, LNG Ship Esso Brega
First documented LNG rollover incident. A storage tank developed a sudden increase in pressure. LNG vapour was discharged from the tank safety valves and vents. The tank roof was slightly damaged.

1972, Montreal East, Canada
During defrosting operations at an LNG liquefaction and peak shaving plant, overpressurisation of the compressor caused natural gas to enter the control room, followed by an explosion when an operator tried to light a cigarette.

1973, Canvey Island, UK
A small amount of LNG was spilled onto rainwater causing a flameless vapour explosion known as a rapid phase transition.

1977, Arzew, Algeria
Aluminum valve failure on contact with cryogenic temperatures caused LNG release, but no vapour ignition. One worker died of extreme cold.

1979, Cove Point, Maryland
An LNG pump leaked natural gas into an electrical substation, leading to an explosion that killed one plant employee and seriously injured another.

1983, Bontang, Indonesia
A rupture in an LNG plant occurred as a result of overpressurisation of the heat exchanger caused by a closed valve on a blowdown line.

2004, Skikda, Algeria
A steam boiler that was part of an LNG production plant exploded, triggering a second, more massive vapour-cloud explosion and fire.

*Source: Refs 3 & 4

Leak detection methods include monitoring of vapour pressure, temperature and liquid level, as well as direct sensing of gas outside primary containment. Upon leak detection, emergency shutdown systems can be called upon to limit leaks due to loading, unloading or process operations.

Multiple trains of cryogenic plant control LNG temperature. However, should a plant fail, pressure relief devices prevent a catastrophic loss of containment.

In the unlikely event of a release, the layout of LNG facilities seeks to minimise confinement and incorporates sufficient separation distances from the surrounding area to minimise loss of life and property.

Pool fire - Liquid leaks of LNG, when accompanied by an ignition source, can result in a pool fire similar in nature to other liquid hydrocarbon fires. In addition to containment and leak detection systems, smoke and fire detection is fitted, together with automated fixed fire fighting systems.

Rapid phase transition - If LNG is released onto water it floats and vapourises rapidly. In large amounts, with mixing between LNG and water, a rapid phase transition can occur capable of causing light structural damage. This hazard is particularly relevant for LNG ships, and is managed by using double hulls.

Rollover - When stored in large volumes LNG may become stratified in layers of different densities. For example, if bottom layers are warmed by natural heating, they become lighter than upper layers. The resulting liquid rollover of tank contents can result in substantial vapourisation above the capacity of pressure relief devices. To counter this, LNG tanks have rollover protection systems, which include distributed temperature detection and pumped mixing systems.

Roundup

LNG is clearly set to continue and expand its role as an important global energy commodity. While not without its hazards, they are well understood and there are technologically mature solutions available to manage the associated risks.

For further information on our experience in this area, contact Andy Harding (Warrington).

References:

1. International Energy Agency, Natural Gas Review 2006.
2. Douglas-Westwood, The World LNG & GTL Report 2007-2011.
3. University of Houston Law Center, Institute for Energy, Law & Enterprise, LNG Safety & Security, October 2003.
4. California Energy Commission (www.energy.ca.gov/lng).

Integrated Safety and Security

Breaking from Tradition

Historically, the disciplines of safety and security have often been isolated from one another, including separate regulation, practitioners and documentation. Nuclear safety cases, for example, still explicitly exclude events caused by war, terrorism and sabotage, tacitly invoking a plea that such events are unpredictable.

Perhaps as a result of the rising prominence of global terrorism, there are signs that this position is beginning to change.

The introduction of modern Health, Safety & Environmental Cases throughout much of the international oil and gas industry during the middle to late 1990s also saw the initial consideration of security threats such as piracy and sabotage, especially in more volatile regions. Following the events of 9/11, the industry has placed a much greater emphasis on security and now many operators produce Health, Safety, Security & Environmental Cases. These fully integrate security threats with conventional hazards, making use of similar techniques for analysing consequences and assessing risk (e.g. using the same risk matrix for personnel hazards).

In a separate development, the UK's Office for Civil Nuclear Security has recently been transferred from the Department of Trade and Industry to the Health & Safety Executive, which acts as the government's nuclear safety regulator. So far, this has not resulted in a move to integrate security and safety regulation, but this may well be one of the possible motives for this reorganisation.

Following this early trend, Risktec has recently acquired IMS, based in Kent, UK. This group currently focuses on maritime security, but through a network of specialists also advises on security in other sectors such as civil nuclear and oil & gas.

Implications of Integration

In many ways the extension of safety cases to incorporate security threats is quite natural. The assessment techniques to identify hazards, consequences, controls and risks to people, plant and the environment are similar in principle, if not in detail. The key differences are:

- Limited published historical data from which to derive security threats to facilities.
- The involvement of security experts in identifying and postulating security threats and measures.
- Analysis of the effects of explosives, weapons or nuclear, biological or chemical attack.
- The dynamic nature of the security threat. Typically, this means that the likelihood of security hazards can vary, sometimes on a daily basis, and should be matched by a varying set of security measures.
- The sensitivity of related documentation, which for obvious reasons should be strictly controlled.

In Conclusion

As industries move towards greater integration of Health, Safety, Security and Environmental aspects, issues will inevitably arise where a balance needs to be struck. In this respect, a common, systematic approach will help greatly to inform the decision making process.

For further information on safety & security integration, contact Alan Hoy (Warrington).

For security advice, contact Geoff Greaves (IMS, Kent).

IMS SECURITY AT SEA

Blown Away: The End of Chapelcross Cooling Towers

At 9am on Sunday 21st May 2007, the quiet of the Solway Firth was awakened by the sound of approximately 15,000 explosive charges detonating in staggered phases. In just ten seconds, the four 90 metre high cooling towers, which had dominated the skyline for almost 50 years, were levelled, leaving an estimated 28,000 tonnes of rubble. As well as marking the end of the Chapelcross power station [see Table1], this graphic demolition belied a wealth of necessary technical assessment.

A Balance of Risk

Cooling tower design employs the hourglass shape to reduce incident wind loadings and minimise tensile forces. In the UK, however, a number of factors meant that the dynamic effects of winds were underestimated, culminating in the collapse of three cooling towers within an hour at the Ferrybridge coal-fired power station in 1965. In a separate incident in 1973, a cooling tower collapsed at the Ardeer Nylon Works in Ayrshire, largely due to geometric imperfections.

Shortly after, a degree of structural asymmetry was uncovered in one of the cooling towers at Chapelcross. As a result, the Chapelcross cooling towers were reinforced in 1977 by the addition of an external layer of reinforced concrete. However, even after these strengthening works, the cooling towers fell short of modern design codes. In planning the decommissioning of Chapelcross, the decision was therefore taken to demolish the cooling towers as soon as practicable to minimise the risk to nearby reactor buildings associated with inadvertent collapse.

Big Bang is Best

After a detailed investigation, it was concluded that the best practicable means of demolishing the cooling towers was by rapid implosion, rather than piecemeal demolition.

Dismantling each tower bit-by-bit would have involved considerable risk to people working at height and would have reduced the structural integrity making the tower more vulnerable to inadvertent collapse.

On the other hand, assessing the use of explosives on a nuclear licensed site was novel. The principal potential hazards to the reactor buildings were identified as:

- Flying debris
- Ground vibration
- Air overpressure
- Dust blocking of dry air filters
- Inadvertent detonation of explosives during handling

To address the first of these, for example, the explosive charges were placed to remove approximately two thirds of the circumference and the shell legs, causing a controlled collapse away from the reactor buildings, with the resulting rubble designed to fall largely within the footprint of the cooling towers.

There was also initial concern that the ground vibrations caused by tower debris hitting the ground would be similar to a major earthquake and could cause loss of reactor support. However, the safety case showed that ground vibrations would not induce a significant response in the foundations.

Before demolition could take place a number of regulatory submissions were produced by the operator, BNG, with support from Risktec, including:

- A Best Practicable Environmental Option report
- An environmental risk assessment
- The nuclear safety case

Aftermath

Witnessed by hundreds of onlookers and broadcast over the internet, the cooling tower demolition proceeded as planned. The only damage sustained was two broken windows in the reactor buildings.

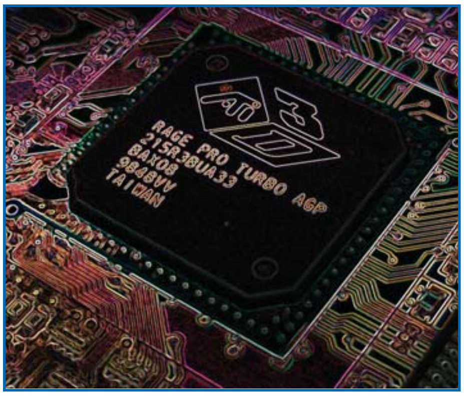
For further information contact Davy Howie (Glasgow).

Table 1 Chapelcross Facts*

- Chapelcross is home to four Magnox-type reactors currently being decommissioned.
- The first reactor came on line in 1959, with the others following within 15 months.
- The reactors powered 8 steam turbines, each capable of generating 30MW.
- The station produced enough electricity to supply every home in South West Scotland, the Borders and Cumbria.
- Each cooling tower was constructed from 6,400 tonnes of concrete and 600 tonnes of re-bar.
- Chapelcross was closed in 2004 after 45 years of operation.

*Source: www.chapelcrosscoolingtowers.com

Affordable Software Safety - More for Less



Software, Software, Everywhere

Software is increasingly being used within systems which perform functions important to safety, both for new facilities and in the replacement of existing hardwired systems which are coming to the end of their life. Such systems include fire control and reactor control panels.

This transition from hardwired to software based equipment, fuelled by cheaper processing power, is often accompanied by improved functionality or flexibility. The knock-on effect is that hardwired components typically required for safety system functionality, such as simple closed loop control, alarm and indication functions, are uneconomic to produce.

Software Safety Headache

From the safety perspective, hardwired components offer the advantage that they have a limited number of predictable failure modes and there are widely accepted techniques for estimating their likelihood of failure. This is good news for those tasked with producing the safety justification.

Box 1 IEC 61508

IEC 61508 deals with functional safety and advocates the application of a safety process during system development, the rigour of which is directly related to the required Safety Integrity Level (SIL) of the system. Four SILs are recognised, designated SIL 1 (low integrity) to SIL 4 (high integrity).

In the case of an equivalent software based safety system, it is usually more difficult to produce an equally robust safety justification following the requirements of IEC 61508 (Refer to Box 1).

This is particularly true if software is partially or wholly proprietary, when the source code and specification are normally unavailable. Very often, the implied time, cost and project risk of producing a safety case may force designers to adopt a costly bespoke hardware solution, even though this may provide inferior functionality. More worryingly, in some instances software may be implemented without proper safety justification.

Testing, Testing

When software safety cases are produced, they typically comprise a number of legs (see Box 2), one of which is verification and validation (V&V) testing. This may take the form of functional testing which is applied to provide product safety assurance evidence, but is often poorly targeted. Furthermore, this V&V testing may ignore any additional functionality provided as a feature of the proprietary software, which, while unused in the safety system, could result in its hazardous failure.

A New Approach

A new approach, developed by Risktec, makes software safety justification a more practical and affordable proposition. The key is to adapt classical safety techniques such as HAZOP and Functional Failure Analysis, to derive the safety requirements for software in its specific safety application.

As this approach is applied at the functional level, it does not necessarily rely upon access to the source code, and also takes into account any effects on system functionality when the software is integrated with hardware. The result is a comprehensive and auditable set of safety requirements.

Box 2 Software Safety Case

The certification of a software based safety system relies on a combination of the following types of evidence:

Process Evidence - Evidence produced during the software development process, which demonstrates compliance with the appropriate safety process (e.g. software specification, design documentation).

Operational Experience - Previous operational experience with the system or with one or more of the software components, where shown to be directly relevant in terms of the software version and operational envelope.

Independent Certification Safety - Certification performed by an independent third party.

Product Evidence - This may include formal proofs or functional V&V testing, in addition to that undertaken during system development.

When V&V testing is focused by these safety requirements, the outcome is a compelling demonstration that the requisite level of safety can be achieved. This, coupled with the ever increasing speeds of testing, means that a comprehensive evaluation can be undertaken in realistic timescales.

Affordable Software Safety

As the use of proprietary software continues to grow and the option to use hardwired systems diminishes, the desire for affordable software safety justification begins to strengthen. At the same time the amount of available process evidence is substantially lessening. Offsetting a lack of evidence of sound safety process during development with a much greater emphasis on safety-led testing offers a practical means of assuring product safety.

For further details, contact Kevin Charnock (Warrington).

Master Class in BowTieXP

The next generation bow-tie methodology tool

14th - 16th Nov 2007 Amsterdam

Risktec is a leading authority on applying the complete bow-tie method for assessing and managing health, safety and environmental (HSE) risks. BowTieXP, developed by our partner, Governors BV, is the most advanced software available enabling rapid application of the bow-tie methodology. Risktec and Governors will be jointly holding their 2007 Master Class in using BowTieXP to meet the recent HSE Case Guidelines issued by the International Association of Drilling Contractors (IADC). The Master Class will be held on 14th to 16th November, 2007 in Amsterdam.

The 3-day course will comprise presentations, case studies and hands-on exercises to gain practical experience of bow-tie analysis, including an appreciation of the pros, cons and best practice solutions, together with the implications of meeting the HSE Case Guidelines. It introduces the bow-tie method, from risk identification, assessment and control, to critical tasks, systems, responsibilities, procedures and competencies.

The Master Class has been designed specifically for people seeking to implement practical risk management within the oil and gas drilling and well services sector.

For further details, email andy.lidstone@risktec.co.uk

Launch of the Management Toolbox

In 2005, as a result of a demand for broader advice, Risktec created a dedicated management systems team with a focus on gathering and applying best practices from across industries and disciplines. In a more recent development, the management systems team has been joined by Professor Simon Burtonshaw-Gunn of the Salford Business School. Having previously worked for BAE SYSTEMS, Simon holds two Masters degrees and a PhD in management, and is a fellow of four professional institutes in the UK including the Chartered Management Institute and the Institute of Business Consulting.

Based on personal experience and academic research, Simon has collated a comprehensive suite of top business models on topics ranging from marketing to operations to risk management. According to Simon, "The purpose is to provide easy access to a toolbox of tried and tested management approaches which can be used in a practical way."

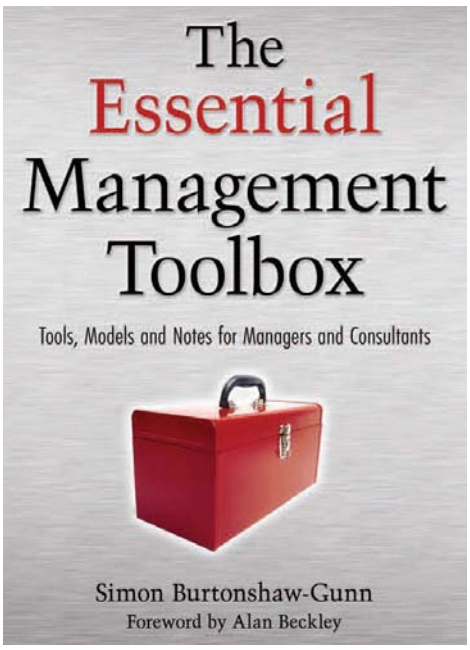
This Management Toolbox is set to become the gold standard for managers and management consultants. His accompanying book, which is due to be launched in January 2008, has received high praise from the London School of Marketing and the Institute of Business Consulting who consider it to be recommended reading for their management consulting courses.

The European Centre of Corporate Governance concluded, "This is a no-nonsense guide to using real business management tools and provides the reader with a comprehensive arsenal of practical diagnostic tools and shows you how to use them effectively."

For more details on how the Toolbox can be applied to your business, contact Simon Burtonshaw-Gunn (Warrington)

Did you know…?

- Risktec's 6th birthday was on 3 September 2007.
- Since starting, the company has completed 242 projects and currently has 365 active projects.
- Risktec now has 77 employees and 26 associates, including 8 Steves and 4 Davids.
- Risktec operates from 8 offices in 5 different countries (if you count Scotland as a country that is).
- Collectively, Risktec personnel have visited 41 different countries (allegedly on business) and speak 12 different languages (not including Scouse and Glaswegian).
- Legends of Risktec has been voted least funny cartoon 6 years running.



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