Issue 31 / Spring 2017

RISKworld

The Newsletter of Risktec Solutions

In this issue

Welcome to Issue 31 of RISKworld. Feel free to pass it on to other people in your organisation. We would also be pleased to hear any feedback you may have on this issue or suggestions for future editions.

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New look, same ethos

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"Never forget where you came from. Never forget where you want to go."
Gurbaksh Chahal, Internet Entrepreneur

Welcome to the latest issue of RISKWorld. You will have noticed that we've had a bit of a facelift. It's over three years since Risktec became part of the TÜV Rheinland Group, and our new branding firmly positions Risktec at the centre of risk and safety management across the group.

Whilst our branding has changed, our commitment to delivering very high quality services to our clients remains the same. We are therefore delighted that the results from our latest client survey show that we continue to achieve very high levels of client satisfaction. Feedback shows that 100% of clients are satisfied with the service they received from us and would recommend us to other organisations or other parts of their organisation.

We recognise that controlling risks requires understanding of engineered and technological systems, management systems and organisational, cultural and behavioural factors. The articles in this issue of RISKworld encompass these risk reduction enablers.

The features on pages 2 and 4 look at equipment reliability and availability at different stages of a project lifecycle and how these can be optimised by smart asset management and tailored maintenance programmes.

The article on page 6 introduces the wider concept of Enterprise Risk Management and some of its benefits, both in terms of risk prevention and value creation. Page 8 develops this theme by exploring the different psychological biases that can have an impact on risk-based decision-making.

We conclude with an overview of Small Modular Reactors (SMRs), which present the nuclear industry with an intriguing set of new challenges.

We hope that you find these topics interesting and thought provoking. As always, we welcome your feedback and look forward to your continued support.

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Launched: Sept 2001 **Projects:** 5,227 **Clients:** 1,178
Employees: 250 **Offices:** 14

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Improving equipment reliability through smart asset management

Of all the factors with the potential to adversely affect safety and optimal commercial performance of an asset, poor equipment reliability is recognised as one of the most significant.

In compliance with the relevant legislative requirements and good practice in the civil nuclear sector, safety systems are designed and installed with defence in depth, including sufficient redundancy and diversity, to ensure a single component failure does not result in an unsafe state – thus ensuring that risks are 'As Low as Reasonably Practicable' (ALARP). However, for other systems, the inclusion of similar levels of redundancy and diversity, whilst technically feasible, is often logistically and financially impracticable. Thus the reliability of certain components, which may be categorised as Single Point Vulnerabilities (SPV), becomes critical to maintaining the anticipated output throughout the life of the asset.

BLIND COMPLIANCE

Traditionally, operators of newly commissioned facilities adopt planned maintenance (PM) and spares strategies from the plant designers who, in turn, adopt recommendations from equipment manufacturers. However, many systems utilise components not exclusively designed for the asset's function.

For example, many civil nuclear power stations in the UK employ diesel generators as a means of generating essential electrical supplies should normal grid supplies become temporarily unavailable. These machines are usually marine diesels designed to power an ocean-going vessel. Accordingly, the recommended PM routines, frequencies and spares holding advice are based on an anticipated operating cycle of thousands of hours per year. At a nuclear power plant, these engines run for significantly fewer hours each year, typically only one hundred or less, often rendering the manufacturer's advice on PM routines, frequencies and spares inappropriate.

PROACTIVE ASSET MANAGEMENT

The solution is to ensure that the design of a new asset includes the production of an Asset Management System (AMS) that identifies and disseminates knowledge and data associated with all components, especially those upon which safety and commercial performance depend.

The AMS should apply for the entire anticipated operational life and use of the asset, and crucially, should tailor its requirements such as equipment health monitoring, PM, spares, etc. accordingly.

Best practice is now seen as bringing together all the elements of ageing management, preventive maintenance, knowledge management and business decisions. The most prominent example, the Institute of Nuclear Power Operations' INPO AP-913 Equipment Reliability Process (Ref. 1), is being embraced by more and more power utilities in North America, the UK and, more recently, Europe. However, the underlying principles of AP-913 are not specific to civil nuclear utilities or indeed the wider power generation industry. These include the coordination of equipment reliability, availability and maintainability activities into one process for plant personnel to evaluate important equipment, development of long-term equipment health plans, monitoring of performance and condition, and making continuing adjustments to PM tasks based on equipment operating experience.

Power utilities that have previously implemented INPO AP-913 via a well-designed AMS have reported significant benefits, not only in the equipment reliability but also within the context of continuous improvement informing better plant management; maintenance is targeted specifically at those items categorised as commercially 'critical'. Similarly, strategic spares holding is better informed and, for those utilities with multiple power stations of similar design, the exchange of operating experience has proven invaluable in reducing recurring issues. For example, where AP-913 has been implemented by civil nuclear utilities, they typically achieve above 90% of their maximum continuous power output.

CONCLUSION

Whilst the link between equipment reliability and asset performance is clear at a high level, use of a proactive asset management system leads to an improved understanding of critical components and delivery of bespoke upkeep requirements to achieve greater availability.

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References: 1. Equipment Reliability Process, INPO AP-913, Rev.1. Institute of Nuclear Power Operations, 2001.

EMIT Optimisation – Getting more out of existing equipment for less

A key challenge facing operators is to optimise their preventive maintenance regimes such that the safety of the plant is maintained, the availability of the plant is maximised and disruptive corrective maintenance or replacement of equipment is minimised.

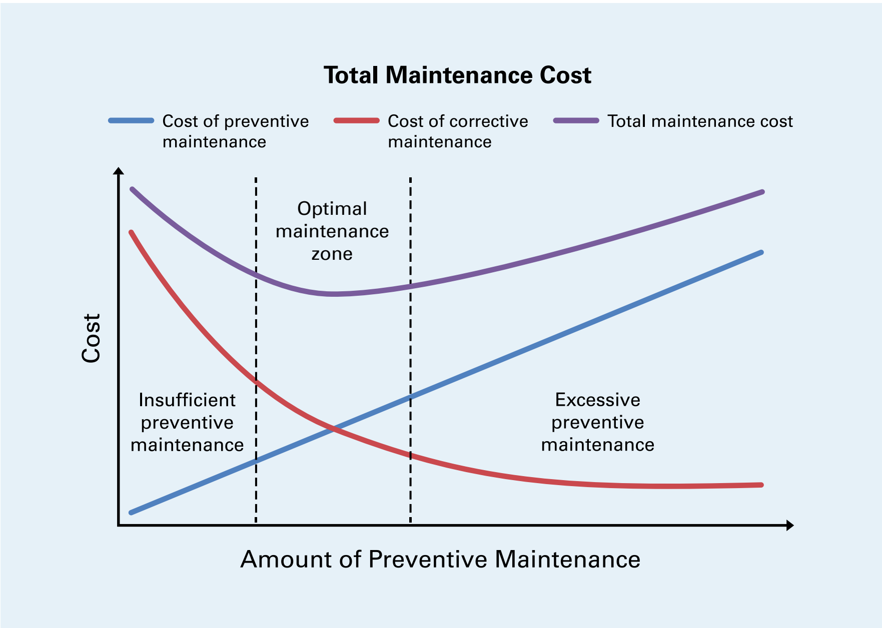

Figure 1 – Optimising the cost of maintenance

Traditional preventive maintenance is often initially prescribed by original equipment manufacturers on the basis of generic operating cycles, rather than adjusted for operator specific usage, system location or online condition monitoring.

The Examination, Maintenance, Inspection and Testing (EMIT) optimisation process seeks to understand the plant or system function, highlight the significant equipment items, review the current EMIT regime and reduce the associated workload while maintaining plant safety and improving plant availability.

WHY CONDUCT AN EMIT OPTIMISATION STUDY?

The total cost of maintenance is the sum of the cost of preventive and corrective maintenance. The optimal maintenance zone is where these two costs are balanced, as illustrated in Figure 1. Locating this balance is an age old problem and this is where an EMIT optimisation study helps. The study aims to establish a cost and plant availability benchmark for the existing maintenance regime, by combining data from current maintenance planning with operating and replacement/repair costs, and then proposing improvements to the maintenance regime to reduce the maintenance burden and improve availability.

Ideally, the EMIT optimisation process should be embedded within the design phases of projects, where maintenance and access requirements can be considered along with the other system requirements; however it is also very effective at any stage of a system lifecycle.

HOW IS EMIT OPTIMISATION UNDERTAKEN?

The EMIT optimisation process can be broken down into five stages:

1. Identify critical plant

Identify plant items that critically affect the safety function or availability of the plant, through lack of redundancy for instance. All other components can potentially be considered as ‘run to failure’ items, although this may be influenced by other factors.

2. Understand the failure modes and effects

Conduct a Failure Modes and Effects

Analysis (FMEA) or an equivalent means of identifying failure mechanisms, and consequential effects.

3. Evaluate existing maintenance

Review the existing maintenance regime (or the proposed regime if new plant is being considered) to establish:

- Difficulty (specialist equipment, training, etc.)
- Location of plant (access arrangements, confined space issues, etc.)
- Downtime (periodicity, maintenance workload, preparation time, etc.)
- Operating experience (condition of plant, maintenance observations, failures, etc.)
- Associated risk (impact on adjacent plant, exposure of personnel, etc.)

4. Apply predictive maintenance techniques

Consider applying predictive maintenance techniques such as corrosion, thermography and vibration analysis, taking into account the associated implications, including costs and manpower.

5. Recommend changes to the maintenance regime

On the basis of the findings and industry best practice, recommendations can be made to adjust the current maintenance regime toward an optimised state.

TOO FAR TOO FAST?

The conclusions of any EMIT optimisation study are influenced by uncertainties in data and assumptions used. A staged approach to recommended reductions in proactive maintenance should therefore be taken to guard against a spike in failures and reactive maintenance costs which would ultimately negate any realised benefits. Further reductions in maintenance burden can be delivered in subsequent iterations where supported by operational experience or condition monitoring trends.

CONCLUSION

The EMIT optimisation process can better balance the plant maintenance burden by focusing resources on critical plant to achieve safety and availability goals in a continuous and proactive manner.

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Legends of Risktec No.31

Enterprise Risk Management: How to prevent losses and create value

Organisations create value by taking risks and lose value by failing to manage them. Effective Enterprise Risk Management (ERM) is about ensuring that the organisation knows what risks it is taking, that these are the right ones and that they are appropriately managed. ERM provides the processes to help organisations protect and enhance value.

What risks are we talking about? The answer is simple in concept: ERM is about managing all risks that can impact the organisation's objectives, whether financial, infrastructure, marketplace or reputational (see Fig. 1, from Ref. 1).

ERM focuses not only on the downside of risk but the upside as well. Traditionally, risk management focuses on the negative consequences, for example losses from currency movements in financial markets, losses caused by a disruption in a supply chain, or losses from a fire at a production plant.

In thinking about the upside consequences, organisations consider competitive opportunities and strategic advantages from taking well thought out risks. New business plans incorporate a focus on risk - for example, where to locate a plant abroad based on an analysis that would consider all political and economic risks in a country.

In this way ERM moves risk management from simply protecting enterprise value to enhancing value as well. It seeks to make the best bets in pursuit of new opportunities for growth and returns; ERM is top-down, portfolio wide and strategic.

ERM encourages a balance between both the risk-taking entrepreneurial activities of the organisation and the risk-avoidance control activities so that one is not disproportionately stronger than the other. This balance is important. Unrestrained

FINANCIAL RISKS	INFRASTRUCTURE RISKS	MARKETPLACE RISKS	REPUTATIONAL RISKS
Accounting standards	Communications	Mergers and acquisitions	Brand extensions
Interest rates	Transport links	Research and development	Board composition
Foreign exchange	Supply chain	Intellectual property	Control environment
Funds and credit	Terrorism	Contracts	Product recall
Internal control	Natural disasters	Economic environment	Corporate social responsibility
Fraud	Pandemic	Technology developments	Public perception
Historical liabilities	Recruitment	Competition	Regulator enforcement
Investments	People skills	Customer demand	Competitor behaviour
Capex decisions	Health and safety	Regulatory requirements	
Liquidity and cash flow	Premises		
	IT systems		

Figure 1 – ERM is about managing all risks

and unfocused entrepreneurial activity leads to excessive risk taking and unethical behaviour. An overemphasis on control leads to stifling risk averse behaviour. Neither of these extremes is as desirable as a reasonable balance.

HOW MUCH RISK CAN BE TAKEN?

An organisation may define its risk appetite as the amount of risk that it is willing to accept in pursuit of value (Ref. 2). This should underpin an organisation's ERM philosophy, and in turn influence the culture and operating style. Many organisations consider risk appetite qualitatively, others quantitatively, trading-off goals for growth, return and risk.

A company with a higher risk appetite may be willing to allocate a larger portion of its capital to high-risk areas, such as newly emerging markets. In contrast, a company with a low risk appetite might limit its risk of large losses of capital by investing only in mature, stable markets.

Risk appetite is a signpost in strategy setting and every organisation has an inherent risk appetite whether it acknowledges it explicitly or not.

WHAT PROCESSES ARE APPLIED?

ISO 31000 Risk Management was established in 2009 to bring consistency to global risk management understanding and practice. Since then, it has become acknowledged as the international risk management standard. It sets out the principles, framework and process for effective risk management. One limitation of the standard is that there is a perceived lack of recognition of interdependent ERM controls such as risk appetite, business planning and risk culture. Whether this will be addressed when the standard is next updated remains to be seen.

WHAT ARE THE BENEFITS OF ERM?

The benefit of ERM in protecting value by preventing losses seems clear but how does ERM create value? Some reasons include:

- Better understanding of aggregate risks across the enterprise, providing a more objective basis for resource allocation
- Better understanding of the risk-return relationship at board level, with decision-making based on clear risk-return trade-offs
- Better risk transparency, which reduces costs of regulatory scrutiny and external capital

Whilst there is a general lack of empirical evidence, research on 300 publically listed companies has shown that organisations exhibiting mature ERM practices realise a valuation premium of 25% (Ref. 3).

CONCLUSION

At less than two decades old, ERM is a relatively new management discipline that helps organisations identify and manage all risks to provide reasonable assurance that the organisation will achieve its objectives. In doing so, ERM can create value as well as prevent losses.

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References: 1. A Structured Approach to Enterprise Risk Management (ERM), IRM, 2010.
2. Enterprise Risk Management – Integrated Framework, COSO, 2004.
3. The Valuation Implications of Enterprise Risk Management Maturity, Farrell & Gallagher, 2014.

Thinking power: Avoiding mental traps in risk-based decision making

In his international bestseller *Thinking, Fast and Slow,* Daniel Kahneman (winner of the Nobel Prize in Economics in 2002) describes mental life by the metaphor of two agents, called System 1 and System 2.

System 2, the slow thinker, is deliberate. It is in charge of self-control. It is much too slow and inefficient at making routine decisions. But it can follow rules, compare several attributes and make deliberate choices between options. It is capable of reasoning and it is cautious.

System 1 on the other hand is the fast thinker, it is impulsive and intuitive. It is more influential than your experience may suggest and is the secret author of many of the choices and judgments you make. It operates automatically and quickly, with little or no effort. It executes skilled responses and generates useful intuitions, after adequate training, but is the source of many mental traps or 'biases'. Despite what you might believe, high intelligence does not make you immune to these psychological biases and there are many biases which can have a profound impact when making risk-based decisions. This article briefly introduces just three of these.

GROUPTHINK BIAS

Groupthink is the desire for harmony or conformity within a group which results in an irrational or dysfunctional decision-making outcome – very few people like to be the 'odd one out'. Groupthink was a significant contributor to the Deepwater Horizon oil well blowout in 2010 (Ref.1). The culture of drillers is of a group of highly skilled, opinionated technicians taking a personal interest in every well. They take on a leadership role, in practice if not in definition. The complexity of drilling operations is typically reflected in an obscure language with extensive use of technical slang and acronyms. What is more, peer pressure is extensive, with widespread use of teasing and competitive humour. 'Dumb' questions are not well received.

So it is perhaps no surprise that when one of the drillers proposed the 'bladder theory' as an explanation for the failed pressure test of the well integrity – a theory with no credibility in hindsight – the first and then eventually the second of the two company men in charge agreed despite initial scepticism. The failed test was 'reconceptualised' and the operations continued.

CONFIRMATION BIAS

Confirmation bias is the unconscious tendency of preferring information that confirms your beliefs – a tendency to selective

PROBLEM A	PROBLEM B
• In four pages of a novel (about 2,000 words), how many words would you expect to find that have the form __ __ __ __ ing (seven-letter words that end with ing)? • Indicate your best estimate by circling one of the values below: 0 1-2 3-4 5-7 8-10 11-15 16+	• In four pages of a novel (about 2,000 words), how many words would you expect to find that have the form __ __ __ __ __ n __ (seven-letter words that end with n _)? • Indicate your best estimate by circling one of the values below: 0 1-2 3-4 5-7 8-10 11-15 16+

Figure 1 – The availability bias in action

use of information, while giving disproportionately less consideration to alternative possibilities. Put more simply, we see and hear what fits our expectations.

The Lexington aircraft crash in the USA in 2006 is a case study in confirmation bias (Ref. 2). A regional jet took off from the wrong runway in darkness and failed to get airborne in sufficient time to clear trees at the end of the runway, causing the deaths of 49 passengers and crew. Multiple cues were missed by the pilots that should have alerted them to the fact that they were on the wrong runway. Instead, it is believed that the crew talked themselves into believing they were in the correct position. For example, in response to a comment about the lack of runway lights, the first officer said that he remembered several runway lights being unserviceable last time he had operated from the airfield.

AVAILABILITY BIAS

Availability bias means you judge the probability of an event by the ease with which occurrences can be brought to mind. You thus implicitly assume that readily-available examples represent unbiased estimates of statistical probabilities.

Try the simple test in Figure 1 before reading on.

If you answered a higher number for Problem A then you are in good company – most people do. But all words with seven letters that end in ing also have n as their sixth letter. Your fast thinking System 1 has fooled you. Ing words are more retrievable from memory because of the commonality of the ing suffix.

The availability bias can create sizeable errors in estimates about the probability of events and in relationships such as causation and correlation. Be aware, your risk analysis assumptions may not always be right, especially when they are backed by quick judgements.

SO WHAT'S THE REMEDY?

Think slow! Engage your System 2. Control your emotions and the desire to jump to conclusions. Take your time to make considered decisions and be ready to ask for more evidence, especially when pushed to make a fast decision. Request explicit risk trade-off studies. Challenge groupthink, and base your opinion on facts. Never be afraid of speaking up, you could save the day.

Consult widely and generate options. Involve a diverse group of people and don't be afraid to listen to dissenting views. Seek out people and information that challenge your opinions, or assign someone on your team to play 'devil's advocate'. Learn to recognise situations in which mistakes are likely. Try harder to avoid mental traps when the stakes are high. And finally, practice, refine, practice.

CONCLUSION

It is human nature to think in short-cuts, which bring with them a host of associated psychological biases. When making risk-based decisions it is essential to slow down our thinking, and apply formalised processes backed by science and data.

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References: 1. Disastrous Decisions: The Human and Organisational Causes of the Gulf of Mexico Blowout, Andrew Hopkins, 2012.
2. Accident Report, NTSB, AAR-07/05, 2007.

Small but mighty: An introduction to Small Modular Reactors

The size of civil nuclear power reactor units has steadily grown from 60 MWe in the 1950s to today's 1600+ MWe, driven by economies of scale. So too has the capital investment required, to the extent that funding new nuclear power stations is becoming prohibitively expensive for many nations.

Throughout the same period there have been many hundreds of smaller power reactors built for naval use and research purposes (up to 190 MW thermal), so the engineering of small power units is well established. The concept of applying this technology for commercial use in modular form has provoked international interest and spurred a second renaissance in the nuclear industry. Small Modular Reactor (SMR) development is progressing worldwide, together with a shift towards private investment, particularly in countries such as Canada, the USA and the UK, often led by entrepreneurs with a strong desire for carbon dioxide-free energy generation.

TECHNOLOGICAL RICHNESS

There are estimated to be over 40 SMR concept designs on the drawing board, covering a wide range of technologies – light water reactors, fast neutron reactors, graphite-moderated high temperature reactors and molten salt reactors, to name but four. In a recent competition launched last year by the UK government to identify 'best value SMRs', for example, there were over 30 applicants.

The various SMR designs typically share the following common safety features:

- A compact architecture of reactor systems with far fewer components that can fail.
- Inherently safe or passive safety concepts (e.g. natural circulation), with less or no reliance on active safety systems, cooling water or AC power for accident response.
- Claims on high integrity or reliability of passive components.
- Reduction of radioactive inventory (smaller reactors) which might be released in an accident.
- Sub-grade (underground or underwater) location of the reactor unit providing more protection from natural or man-made hazards, e.g. aircraft impact.

INNOVATION

There are also plenty of innovative ideas, such as:

- Mobile floating SMRs.
- Liquid fuel.
- Near atmospheric pressure reactor vessel.
- Integrated primary cooling circuit (within the reactor vessel).
- Extended time between refuelling (5+ years).
- The ability to remove and replace an entire unit rather than refuelling.
- Short unit lifetimes (e.g. 7 years), eliminating ageing issues.
- Combined heat and power output.
- Road/rail transport-friendly modular design.

NOT-SO-SMALL BENEFITS

The SMR has two main advantages over conventional reactors: affordability and grid independence.

The combination of comparative simplicity and smaller size means that units can be manufactured in a central factory, and then transported whole to a site for installation, with little on-site construction. Units would be produced continuously over a number of years to provide and then replace reactors at multiple sites. This production model reduces the capital cost of each unit as well as making the overall capital cost

per MWe more attractive than a traditional nuclear power plant.

SMRs are also much less demanding in terms of local infrastructure requirements, most notably power grid connectivity. This coupled with their intrinsic scalability makes them ideal for remote locations where there is a significant power demand, such as mining towns or large isolated conurbations.

CHALLENGES AHEAD

Whilst it is refreshing to see so much diversity and innovation in the nuclear industry by so many potential vendors, these two factors might work against SMRs, at least in the short term.

Only the light water reactor variants, which are scaled down versions of current, proven nuclear technology, are likely to receive regulatory approval without considerable research and assessment, both by vendors and regulators alike.

Moreover, with so many competing designs in the marketplace and limited regulatory resources, there is an inevitable requirement for short-listing preferred vendors, which may take time.

CONCLUSION

With SMRs coming into view, it's an exciting time to be part of the nuclear industry. Although both their need and benefits are clear, it remains to be seen whether the enthusiasm of vendors and markets is sufficient to overcome the challenges ahead.

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About Risktec

Risktec is an established, independent and specialist risk management consulting and training company. We help clients to manage health, safety, security, environmental (HSSE) and business risk in sectors where the impact of loss is high.

OUR SERVICES ENCOMPASS:

CONSULTING

Specialist risk management services, delivering packaged and proportionate solutions to help reduce and manage risk.

TRAINING & EDUCATION

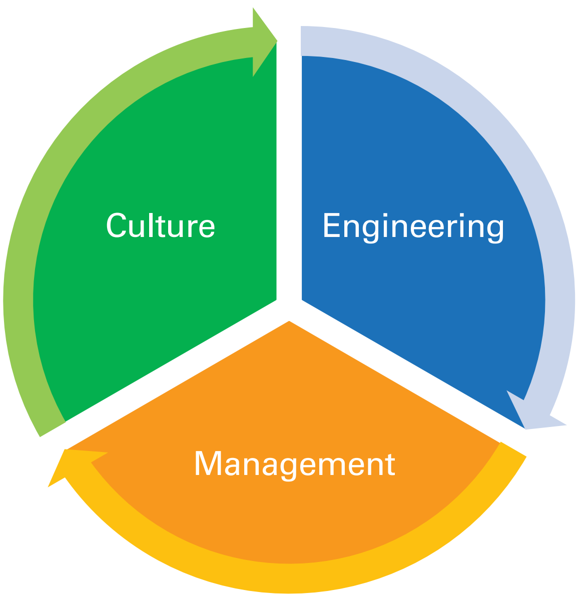
Online and classroom training and postgraduate education to help develop competent risk management professionals.

RESOURCE SOLUTIONS

Specialist risk, HSSE and engineering associates to work at client locations to help fill resource and skills shortages.

Consulting

Our experience ranges from delivering small self-contained work packages to managing complex multi-disciplinary projects with a large number of stakeholders.



Our services recognise that controlling risk requires understanding engineered and technological systems, management systems and organisational, cultural and behavioural factors.

ENGINEERING
Identifying, analysing, evaluating and reducing the risks associated with facilities, operations and equipment to acceptable levels.

MANAGEMENT
Identifying, developing and implementing effective policies and procedures to maintain control of risks and minimise loss.

CULTURE
Accelerating cultural and behavioural improvement, and ensuring a solid foundation for building sustainable improvements in risk control.

Training and Education

We provide a unique training and education service, from a single training course to a Risktec professional qualification or a tailored master's programme in Risk and Safety Management, all developed and taught by our experienced consultants. Our courses encompass the breadth and depth of our consulting services.

- Postgraduate Certificate, Diploma or Master's Degree (MSc) in Risk and Safety Management
- Degree Apprenticeship in Risk and Safety Management
- Risktec Professional Qualification (RPQ) in Risk and Safety Management
- Training courses from single modules to multi-year programmes for corporate clients
- Game-based learning
- Computer-based training
- Delivery via face-to-face, distance or blended learning
- Accredited by professional engineering institutions and industry bodies
- Our whole approach is flexible to meet client needs

Resource Solutions

We provide resource to support our clients' activities by working at their main offices, project locations or industrial sites, anywhere in the world. The support is delivered by our professional resource solutions business, ASTEC, which has access to a huge pool of professional associates.

We provide associates who:

- Are well known to us.
- Are suitably qualified and bring the required specific skills and experience.
- Have many years' experience and hence can make an immediate and positive impact on projects.
- Can be supported by work packages from consultants in our own offices.

TÜV Rheinland

As part of the TÜV Rheinland Group we have access to a very large range of services via the group's 20,000 employees in over 65 countries worldwide, including:

Testing, inspection and certification services to ensure the safety, reliability and regulatory compliance of assets and components throughout their lifecycle; as well as technical consulting and training to industrial, transportation and healthcare sectors.

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