Hazards forum

The Hazards Forum Newsletter

Issue No. 67
Summer 2010

Web version

Hazards Forum Newsletter

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Contents

Edited by James Kearns

Views expressed are those of the authors, not necessarily of the Hazards Forum

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Hazards Forum Secretary: *Brian Neale*

June 2010

Hazards Forum AGM 2010

Brian Neale – Secretary, Hazards Forum

The Annual General Meeting this year was held on Tuesday 16th March at The Geological Society, Burlington House, Piccadilly, London, W1J 0BG, commencing at 17.00 hrs. The meeting was chaired by the Hazards Forum chairman, Sir David Davies, who welcomed the members attending.

The Annual Report of the Trustees for the Forum for 2009 was available. Sir David began by explaining that following the review of the Hazards Forum's objectives in 2008 the agreement not to change them was found to be appropriate during 2009 and that they would remain as they stood in the Annual Report for 2008. It was added further that the Hazards Forum was established to bring professionals together. The Hazards Forum did not claim to be an expert body itself, but more as a Forum for well informed professionals brought together to discuss and disseminate experiences for the mutual benefit of the professions.

He continued with a brief summary of some of the highlights from the year, including mention of the evening events of which there had been six and following with an outline account of the Forum's finances for the year. He stated that details were, of course, in the report now before the meeting. The independent annual reviewer (or examiner) of the accounts, Alexander Bierrum, had stated that from his review he was satisfied with the accounts and emphasised that although a qualified accountant, he did as required which was not an audit. He was duly thanked in his absence. The meeting signified it's satisfaction with the accounts. The Chair added that the signed report would be sent to the Charity Commissioners with the annual return for 2009 in due course.

Mentioning staff changes, he thanked Adam Kirkup in his absence, who had left the Secretariat towards the end of the year. In his place he welcomed Tim Fuller and took the opportunity to thank Jason Simpson who had completed his second year looking after the accounts.

The Chairman continued his report by mentioning the Executive Committee. He explained that his term had expired at this AGM as had the term of two other trustees. One of whom had sought re-election and one had not. There had thus been three trustee vacancies out of the available five to be filled for the 2010-11 year. This was put to the membership with the Notice for the AGM and no alternative suggestions were received to the three candidates put forward at that time. Hence the Executive Committee was pleased to agree in their meeting prior to the AGM that the new trustees would be Paul Thomas CB FREng, Dr Jean Venables OBE FREng and John Barber, with Paul Thomas being proposed and accepted as the new Chair of the Hazards Forum. It was reported that Executive Committee member Patrick McDonald had taken up the new position of HSE observer, having previously been a co-opted member. Stepping down from the Committee also were Dr Chris Elliott and Dr Robert Muir-Wood who were thanked for their contributions. Sir David mentioned that he had enjoyed his time as chair and had enjoyed the stimulating environment that the Forum offered.

To conclude his report, Sir David expressed the Hazards Forum's sadness at Dr John Bond passing which he linked to his appreciation of his editorship of the Newsletter for four editions from the Summer 2008 edition (No. 60). In addition Sir David expressed the Hazards Forum's thanks to the former editor, Dr Ian Lawrenson, who kindly stepped back into the role for the last two editions of the year and who is still involved with Forum

activities through both his membership and his continuing link with the Parliamentary & Scientific Committee. Sir David said that as an update, he was pleased to mention that the search for a new editor had been successful towards the end of the year when James Kearns stepped into the role.

Before a brief discussion, Sir David thanked the remaining members of the Executive Committee for their work during the year and also thanked the Hazards Forum Secretary, Brian Neale, for his continued support and hard work.
Before the meeting closed, Paul Thomas, on behalf of the members and Executive Committee, thanked Sir David for his enthusiastic leadership during the past seven years which had seen a variety of hazards issues being presented and debated with appreciation that the Forum was working on a reasonable financial footing.

The next Annual General Meeting was proposed for a date in spring 2011, yet to be determined. The meeting closed at 17.30 and was followed by refreshments which were in turn followed by the evening event on *Safe Operation of Decarbonised Fuel Schemes*.

New Hazards Forum Chairman

The Executive Committee is pleased to introduce the new Chairman of the Hazards Forum. He is Rear Admiral (retd) Paul Thomas CB who also became a trustee at the AGM in March, following his joining the Executive Committee as a co-opted member in 2009. As a brief introduction:

Rear Admiral (retd) Paul Thomas CB, FREng FIMechE HonFNucI

Paul's 35 year career in the Royal Navy was spent mostly in submarines and submarine related roles culminating in his appointment as Chief Strategic Systems Executive with responsibility for the procurement of the TRIDENT submarines, missile systems and nuclear warheads.

On leaving the RN in 1998, he joined AEA Technology Nuclear Engineering as Director Projects and in 2001 he moved to BNFL as Group Director Environment, Health, Safety & Quality. He is currently Chairman of RSSB and President of the Nuclear Institute. He was co-opted onto the Executive Committee of the Hazards Forum in 2009.

New Members of the Executive Committee

The Executive Committee is pleased to welcome two new members of the Committee. They are Dr Jean Venables, as a new Trustee, and Brian Wimpenny who has agreed to join as a co-opted member. As a brief introduction to each:

Dr Jean Venables OBE FREng CEng CEnv FICE MCIWEM

Jean is a Director of the Venables Consultancy, Chairman of Crane Environmental Ltd, Chief Executive of the Association of Drainage Authorities and Chairman of the Thames Estuary Partnership. She is also Immediate Past President, Institution of Civil Engineers and Past-Chairman, Independent Industry Panel, Thames Estuary 2100 Project.

Through Venables Consultancy and Crane Environmental, Jean has wide experience of and expertise in strategic flood risk assessment, facilitation and chairmanship, and works with

colleagues to assist the construction industry, its clients and suppliers to reduce environmental risk and the adverse environmental impact of its projects and operations, and to improve their environmental and sustainability performance.

A major Crane Environmental project has been to lead and manage the team that developed CEEQUAL, the ICE-initiated environmental assessment and awards scheme and now leads the team that operates CEEQUAL for the industry and profession. She holds Visiting Professorships at Southampton University, University of Strathclyde and Imperial College. For more about Jean please see http://www.venablesconsultancy.co.uk/directors.htm

Brian Wimpenny CEng FIMechE

Brian spent 37 years in Rolls Royce Marine on nuclear reactors for submarines. This included:

- Research and Development in heat transfer, fluid mechanics, noise and vibration and component testing
- System design for new generations of submarine
- Safety and reliability of operational submarines and support infrastructure.

When RR set up a competency matrix, he became the discipline head for all 200 RR safety and reliability engineers. This involved defining competencies and reviewing training. One outcome was that I set up an MSc at Loughborough with Prof John Andrews.

On leaving RR four years ago, Brian became an independent safety consultant and sit on MOD and BAE Systems safety committees. He is also a Visiting Professor in the Risk and Reliability Department at Loughborough University and remains an active member of the Safety and Reliability Working Group of the IMechE as past Chairman.

New Hazards Forum Newsletter Editor

The Hazards Forum is pleased to welcome **James Kearns** as the new editor of the Newsletter. James graduated in Physics from The University of Manchester with an MPhys (First Class Honours) in 2008. He then began a PhD at City University, London, under the supervision of Professor Philip Thomas. He is currently in his second year of research, which focuses on risk analysis and management, in particular, applying J-value techniques to assess the risks presented by nuclear power plants. The research is part of the SPRIng project, which seeks to assess the sustainability prospects of nuclear power in the United Kingdom, and is funded by EPSRC and ESRC. During the course of his research so far, James has had a paper published in a peer reviewed journal and had three papers published at conferences.

Sir Frederick Warner makes the Century

The first Chairman of the Hazard Forum was Sir Fredrick (Ned) Warner FREng FRS who celebrated his one hundredth birthday in March. The Executive Committee of the Hazards Forum sent him a birthday card wishing him well for his second century. He is a past President of the Institution of Chemical Engineers and led the first International team to examine the after effects of the Chenobyl meltdown (so much for the hazards of radiation). He was also a founder Fellow of the Royal Academy of Engineering - which was then called the Fellowship of Engineering. He has been a consultant since his retirement in 1980.

Sir David Davies, Immediate Past Chairman

Safe Operation of Decarbonised Fuel Schemes

James Kearns

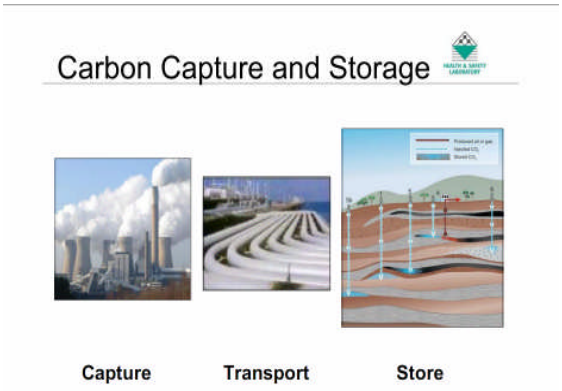
On **Tuesday 16th March 2010** the Hazards Forum and the Geological Society jointly hosted an **evening event** at the latter's premises at Burlington House, Piccadilly, London. The event was the third of three in the Hazards Forums energy series.

The event was concerned with safety issues presented by carbon capture and storage schemes, which are starting to receive much attention as both government and industry seek to mitigate their carbon dioxide emissions. The event began with **outgoing Hazards Forum Chairman Sir David Davies** introducing the **new Chairman Paul Thomas**, who thanked Sir David for the outstanding work he'd done for the Hazards Forum. Mr Thomas then introduced the **chair for the evening, Mr Adrian Collings**, who thanked the audience for attending, and the Geological Society for hosting and sponsoring the event.

The event had three presentations, which were subsequently followed by a brief session for questions from the audience and a reception for more informal discussions and networking opportunities. The first presentation was given by **Dr. Laurence Cusco, Head of Fire and Process Safety Unit** at the **Health and Safety Laboratory**, who gave a presentation titled "A Comparison of Hazard and Risks for CO_2 and Natural Gas Pipelines", in which Dr. Cusco described the work he had been carrying out in identifying and investigating the hazards presented by carbon capture and storage (CCS) systems. This was followed by a presentation from **Professor Haroun Mahgerefteh**, of **University College London**, titled "CO2 Pipelines Material and Safety Considerations". In this presentation, Professor Mahgerefteh discussed the research he has been carrying out looking at how transporting carbon dioxide affects the pressurised pipeline through which it is carried and the safety implications of such effects. Finally, **Dr. Murray Shearer of BP Alternative Energy** in his talk "Safe Design of a Pre-Combustion Capture Power Plant" discussed the safety issues which need to be considered in the design of a unique hydrogen power and carbon capture plant which is currently planned to be built in Abu Dhabi in the United Arab Emirates.

Dr. Laurence Cusco began his talk with a brief history of the Health and Safety Laboratory and how the HSL work relates to the Health and Safety Executive in ensuring that appropriate measures are taken to reduce the risks posed by carbon capture and storage technologies.

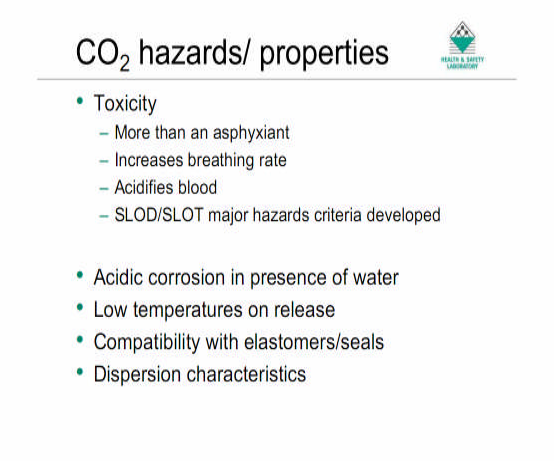
The CCS chain consists of three steps: capture, which takes place at the point of production in the power plant; transport, whereby the captured carbon dioxide is transported through a pipeline, and lastly, storage, which is deep underground. The work done at the HSL attempts to identify and quantify risks and hazards over the entire chain.



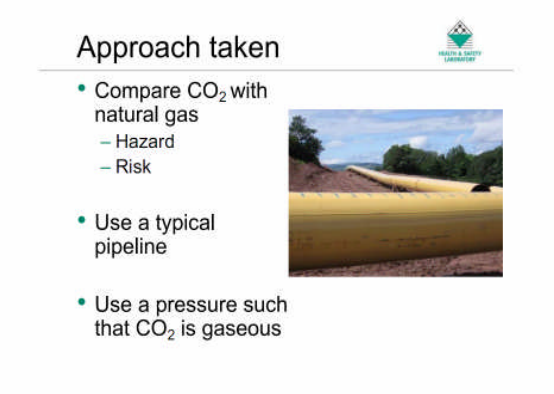
Dr. Cusco explained in detail the methodologies employed in hazard identification, and gave some specific examples of hazards created by carbon dioxide, such as hydrogen and oxygen

being present in a CO_2 pipeline combining to form water which then corrodes the pipeline. There were also instances whereby workers have been overcome by a build up of CO_2 from leaks in a pipe.

Dr. Cusco also made the point that there is uncertainty in how to regulate CCS pipelines. CCS is an important medium term strategy in mitigating climate change, and if it is to become more widespread, then it is necessary to clarify exactly how it will be regulated. The main point in this debate would be whether or not the existing Pipeline Safety Regulations should apply to CO_2 pipelines.

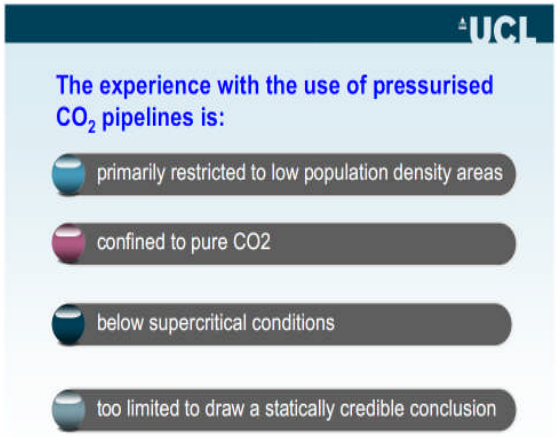


Dr. Cusco then elaborated on some of the hazardous properties of carbon dioxide. CO_2 is a toxic asphyxiant which acidifies blood and increases breathing rates. It can also cause acidic corrosion in the presence of water, and is very cold if released from a pipeline. The approach taken by the HSL is to compare the risks of CO_2 pipelines with natural gas pipelines.



The toxicity of CO_2 means it is a more dangerous asphyxiant than natural gas. Also, the higher pressures involved with CO_2 transportation means there are greater risks involved. These factors highlight some significant differences between CO_2 and natural gas pipelines which are important to consider when deciding on the appropriate regulations to implement.

Professor Haroun Mahgerefteh continued the theme of CO_2 pipeline safety in his presentation, in which he gave an overview of the most important factors that should be considered in the safe operation of CO_2 pipelines. Professor Mahgerefteh noted that most of the current research into CO_2 pipeline safety was limited to only studying the transportation of pure CO_2 in sparsely populated areas, whereas the proposed CCS systems will transport impure CO_2 in high density population areas, which introduces new significant safety issues.

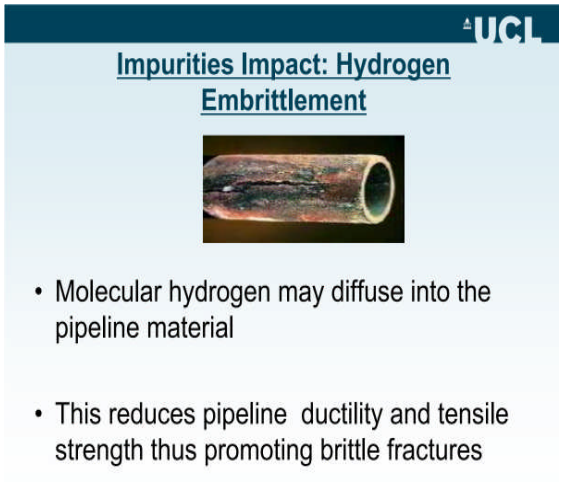


The CO_2 pipelines will carry impure carbon dioxide. The impurities are typically comprised of many other substances, the most prominent of which are methane, nitrogen and hydrogen sulphide. In some cases the impurities can comprise up to 10% of the mixture.

The presence of impurities alters the thermodynamic properties of the CO_2 mixture, and there is currently no equation of state which describes analytically the

variations introduced by impurities. The impurities also adversely affect the pipeline itself. One way in which it does this is through embrittlement, in which hydrogen present in the mixture diffuses into the pipeline material, causing it to become brittle and promoting the chances of a fracture occurring.

Another way in which impurities can affect the pipeline is through corrosion. If water is present in the pipeline, then it can either corrode the pipeline material directly or it can combine with the already present CO_2 and form carbonic acid, which is a more corrosive substance.

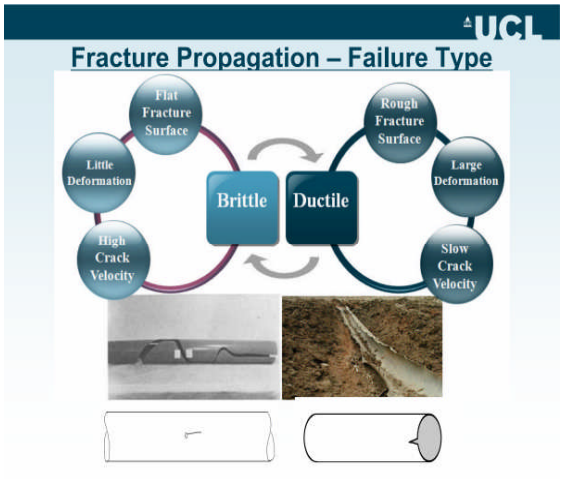


Professor Mahgerefteh then discussed some related research he had been carrying out in fracture analysis. There are two ways of classifying fractures: brittle fractures and ductile fractures.

In a brittle pipeline fracture, cracks will appear suddenly and travel quickly with little deformation of the pipe.

In a ductile pipeline fracture there is a lot of deformation to the pipe, which typically occurs over a prolonged time period, and the cracks move slowly compared to the brittle fracture cracks.

CO_2 pipelines are more susceptible to fast brittle fractures because of CO_2's prolonged phase transition and expansion during depressurisation.



Professor Mahgerefteh then explained the importance of accurately modelling the properties of the CO_2 as it disperses out of the pipeline following a fracture, as this would help in determining the level of harm to a receiving target as a function of distance from the pipeline.

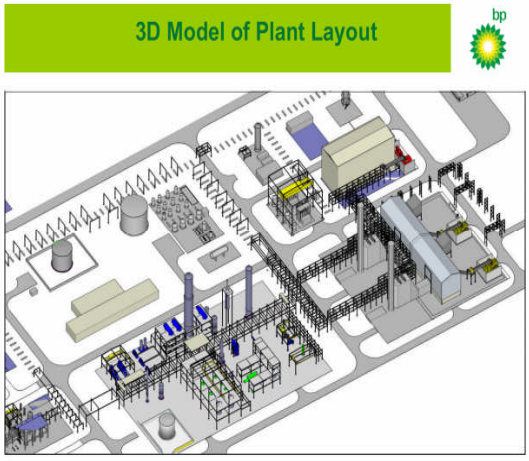
Dr. Murray Shearer gave the final talk of the evening in his presentation regarding how to design a novel "pre combustion power plant" safely. The power plant will convert natural gas into hydrogen and carbon dioxide. The hydrogen is then burnt for electricity production, whilst the carbon dioxide is first captured, and then pumped into depleted oil fields in an attempt to recover more oil.

The plant is to be built in Abu Dhabi, in the UAE, and is known as the "Hydrogen Power Abu Dhabi project". The project is a joint venture between BP Alternative Energy and MASDAR, an Abu Dhabi green energy company. The plant will

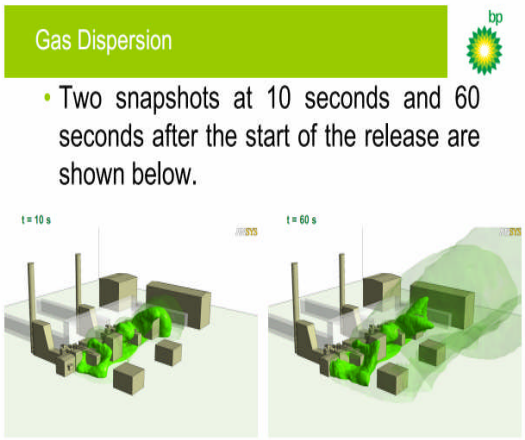
export 400 MW of clean power to power and water companies, and will capture 1.8 million tonnes of carbon dioxide each year.

Dr. Shearer then discussed the process flow for the plant. Hydrogen molecules are first removed from the natural gas. This leaves CO and CO_2 molecules. The entire CO is then converted into CO_2 by adding an extra oxygen atom from a supply of H_2O. The CO_2 is then compressed to a supercritical state and exported for oil recovery. Meanwhile, the hydrogen is sent to a gas turbine generator for combustion and subsequent electricity production.

Dr. Shearer went on to discuss some ways of designing the plant in such a way as to minimise the risk from the many hazards present in this sort of power station. The objectives of the design process are to first seek to limit releases, and second assume that a given accident occurs, and find ways to mitigate the consequences, such as minimise the event through good ventilation and detection systems, and to prevent escalation and harm to the immediate surrounding area.



Some models of methane and hydrogen dispersion following a release in the plant where then shown. The development of a cloud for each gas was shown in two scenarios, one in which the failing equipment was contained in a building, and one in which there was no building. The models showed that the building would lead to a much larger gas cloud, and would eventually cause the building walls to fail in the case of hydrogen, but would not fail in the case of methane. The scenarios shown suggested that it would be safer if there was no building.



Mr Collings thanked the speakers for their interesting and informative presentations, and invited all three speakers onto the stage for questions from the audience.

The ensuing discussion addressed a broad range of topics associated with the presentations. The discussion included some comments regarding research into thermodynamic modelling of impure substances and their equations of state, the psychology of risk and it's perception by the public, and the philosophy of bringing plant back to design conditions – rather than looking at failure rates. The speakers answered all questions succinctly and thanked the audience for their comments.

The chairman for the evening thanked the speakers for their answers to the questions and also those who commented during the discussion session. He then commented that this research helps in the understanding of the risks to workers and the general public that new technologies inevitably present so that it is not necessary to proceed via trial and error as has been done countless times before.

Mr Collings invited **Dr. Mike Considine, Head, Major Hazards and Fire, BP** to give some concluding remarks. Dr. Considine explained that the pipelines

present the greatest risks to the public in the CCS chain, but that these risks are not too dissimilar from those posed by standard natural gas pipelines, and hence one must always maintain perspective when assessing risks.

The Chair thanked Dr. Considine and invited all attendees to continue any discussions and network over the light refreshments which followed.

The Institution of Mechanical Engineers Safety and Reliability Group

Dick Vote

"Safe, Reliable Engineering cannot be left to chance"

The Institution places great emphasis on safety and reliability in engineering and strongly believes in proactive, structured assessment to verify that a product or service will work safely and reliably throughout its life. Unwillingness to manage risk, as veiled in statements such as "it has been safe to date" has been proved to be seriously mistaken and is increasingly likely to be treated as irresponsibility in court.

Proactive, holistic assessment, never simplistically prescriptive nor complex and unnecessarily erudite, steers the path to "***Dependability***" an overarching confidence in hardware, software and the human/machine interface. Purchasers should instigate (and suppliers should prompt for) a ***Dependability Strategy*** with quantitative criteria and clear, realistic definitions of "success" and "failure" especially when embracing new technology and in competitive tendering processes.

Evidence gleaned from relevant testing and feedback from operations will allow timely mitigation of risk within the whole life contractual process.

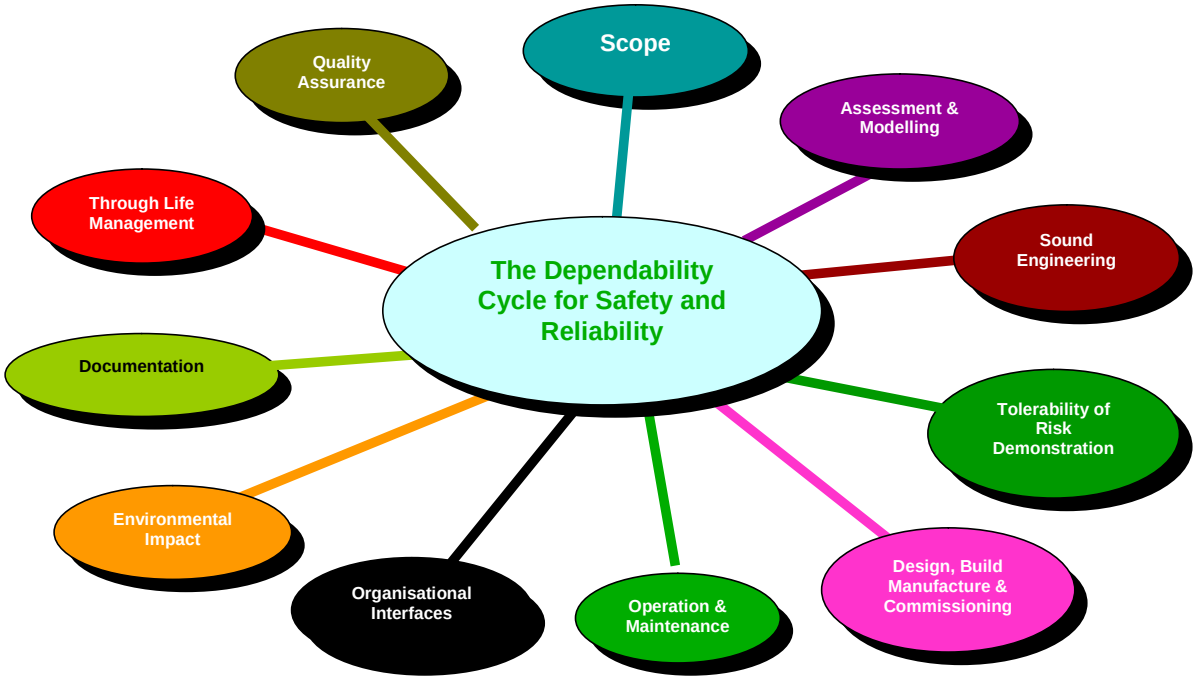
Dependability neither just "happens" despite the view of some who, by paying lip service with simplistic "right" data, "right" model and "right" answers, invariably guarantee poor performance, foreshortened useful life and breached financial containment. Imprecise objectives, unrealistic aspirations, uncontrolled changes or failure to take a realistic view and above all poor communication between and within purchaser and supplier increases risk but worst of all is dismissing the need to consider it.

The SRG recommend that Dependability should be invoked contractually – without exception and established in a "reasoned, auditable argument - **Dependability Case**" addressing the whole life cycle, gathering and analysis of evidence, to fine tune design, operations and maintenance and respond to change.

This brings greater confidence in integrity, delivery to specification and expectations, reduced costs with greater longevity and sustainability of resources. It also supports and verifies expectations by performance indicators and which can be demonstrated *contractually*.

Compromise or even complete re-appraisal is better than embarrassment after delivery.

The cycle of Dependability is described below in the ***"Ring of Confidence".***



[Diagram – Brian Wimpenny]

The SRG "Ring of Confidence"

- *Scope*

- *What is the product or service?*
- *What environment will it operate in?*
- *How will it be used?*

Rhys David

It is important to understand and document the system or product in terms of what it is and how and where it will be used. This will be used to scope the Safety and/or Dependability assessment of the product, so that people can appreciate it and understand whether it is relevant to their application. The definition should record the constituent parts, including hardware and software elements as well as how people and other systems interact with the system of interest. System functions, in all operating modes if relevant, should be listed, together with criteria for success and failure. The operating context of the product must be recorded, in terms of the environment and interfaces with other systems.

Any assumptions should be documented explicitly so that they can be understood and validated where necessary.

- *Assessment and Modelling*

- *What can go wrong?*
- *What effects will failure have?*
- *How robust can/will I make the product?*
- *What are the important features?*

Bill Wong

Assessments need to be made to ensure safety in the whole life cycle of design, manufacture, operation, maintenance and final disposal of any machine or system.

Published regulations require an assessment that all the essential health and safety requirements have been satisfied and certified to be in compliance. Depending on the type of equipment this can range from self certification to the need for independent third party assessment and verification of the design, materials and manufacturing processes. Examples are the Machinery Directive and the Pressure Equipment Directive.

Generally advice on the applicable regulations can be obtained from the HSE.

As well as being safe machines and equipment must be fit for purpose. A whole range of inspection and test procedures to verify this are published by the relevant industry authorities for this purpose. Examples are the American Petroleum industry standards for equipment for use in refinery services and the American Society of Mechanical Engineers Power Test Codes for mechanical equipment. ISO standards and codes of practice developed from these are also available. In the case of hazardous processes a safety case may be needed that must be assessed by an independent authority before operation can be allowed.

All machines and systems and their components have a limited life span. They fail due to material degradation and wear, and tear. Their life span and their consequences of failure need to be assessed. Techniques such as Failure Mode and Effects Analysis and Fault tree Analysis has to be used for this purpose. Where any failure is identified as safety critical the design is required to meet a safety performance level which is determined by the probability of failure and its attendant risk of harm. Measures are needed to give warning of incipient failure for maintenance action to avoid disaster. In some cases a Risk based inspection procedure may be applicable.

Machines or systems should only use and apply proven components in suitable operating environments for which reliability data is available. When a deviation from this is undertaken the assessment of its reliability, especially of safety critical components has to be dependent on life testing and field operation. This can be a long and expensive process.

- Sound Engineering

- *State key features of the design*
- *Demonstrate that the design is robust*
- *What key assumptions are carried forward?*

John Hopper

In recent years there has been a number of major disasters (and near disasters) of a technical or commercial nature where good sound engineering practice has either been ignored, and/or a company's priorities have become confused.

For products and equipment to operate safely and reliably it is essential that sound engineering practices are implemented throughout the product life cycle, especially during the Design phase. The major areas that need to be considered are Design, Manufacture, Operation and Maintenance but also to consider Disposal.

These notes focus on the Design phase, but much of what follows may also be applicable to other phases. During initial design, it is vital that such aspects as the intended use of the product or equipment is considered fully and understood. This will need to include the customer / user / operator's expectation. This may not always be achievable within the timescales and/or budget. Once this resolved, the detailed specification written and agreed and the detailed aspects of the design can be addressed.

These must include the intended operating environment, the use of appropriate materials, the level of technology (old, new or hybrid), the manufacturing sources and processes, and the models and testing to be employed in validating the product and verifying the design as 'fit for purpose'.

It is vital that any safety and/or reliability requirements are considered and included at this stage. Where the product or equipment must comply with mandatory or legal requirements, the must be complied with. Over the years a substantial knowledge base has been built up and this should always be referred to and used in an appropriate manner. This should include those instances where failures have occurred and safety compromised and / or reliability degraded, the root cause

of those failures and the corrective action(s) implemented to minimise the risk of further future occurrences.

Where design rules or guidance exist, these should be adhered to whenever possible. Where new technology is being introduced, the experience should not be ignored.

- Tolerability of Risk Demonstration

- *What are the risks in operating the plant, what features are fitted to prevent mitigate or contain them?*
- *Are they acceptable against safety & reliability targets?*
- *Have the risks been optimised?*
- *What further key assumptions need to be carried forward?*

Nicola Stacey

Definition

A tolerable risk is one that society as a whole is willing to live with so as to secure certain benefits in the confidence that the risk is one that is worth taking, is being properly controlled and subject to review to take into account new information about the nature and severity of the risk or better ways to control or manage it. This is not the same as a risk that everyone would agree, without reservation, to take upon themselves or have imposed on them.

Duty-Holder Actions

The person responsible (duty-holder) for operating the plant or equipment needs to understand what can go wrong, what the consequences could be and how likely they are. Or in other words carry out a risk assessment. For complex plants in high hazard industries this might take the form of a full quantitative risk assessment (QRA) or probabilistic safety assessment (PSA) as part of a safety report required for example under the control of major accident hazards regulations (COMAH). However for straightforward work equipment this may take the form of a simple qualitative assessment such as that described in HSE's 5-Steps guide. For further information on the management of health and safety see HSE's guide or approved code of practice.

HSE Framework

The HSE tolerability of risk framework recognises that there are some risks that are simply not tolerable to society such that a substance or process needs to be banned and that there are some which are broadly acceptable. However most risks fall in-between, requiring risks to be reduced "so far as is reasonably practicable". This requires a judgement to be made about what more could be done to control the risk. If there are relevant recognised good practices or standards that can be applied then the tolerability of the risk can normally be demonstrated by clearly showing compliance with those standards and that systems are in place to ensure that protective measures remain effective. The duty-holder needs to demonstrate that they have done all they can reasonably do to try to first eliminate the hazard and then reduce risk by design (by reducing the possible severity of harm, the exposure to harm, the probability of harm occurring) and finally failing all that to enhance the possibilities to avoid or limit harm should something go wrong. Any remaining or residual risk must then be managed through information, training, safe-operating procedures and as a last resort, and preferably only as a temporary measure, through personal protective equipment. For further information about how HSE judges whether duty-holders have done all they can to reduce risk as low as reasonably practicable see HSE's risk management web-pages on ALARP.

- Design Build manufacture and commissioning

- *What key assumptions need to be supported?*
- *How will this be achieved?*
- *How will they be supported?*
- *Confirmation of delivery*
- *Feedback and response*

Phil Godding

The process by which the overall project objectives are successfully achieved, avoiding all unacceptable risk, incorporating or exceeding acceptable safety factors, providing redundancy of hazard limiting controls and adequate warning devices to indicate failures or where conditions could cause an unacceptable level of risk to prevent or cease operation.

Failure mode analysis should be integrated into the concept phase of a design programme and revisited whenever significant changes to the project scope are identified. Design reviews should take place and include participants with sufficient product knowledge to effectively and correctly evaluate any new project content or conceptual ideas. Areas which include new concepts or carry significant risk should be included in the test programme, for thorough validation before proceeding.

General areas of review should include but not be limited to; structural integrity, mechanical components (including those for fluid or other power generation, control systems, operating environmental impact. Prototype testing or final commissioning should be specific to real world application of the machine or system, in accordance with appropriate design limits allowing for all anticipated working conditions and foreseeable system or operator-induced failures. Where failures in testing occur this information should be thoroughly investigated to determine if the original assumptions were correct and if other areas are impacted.

Testing should be carried out in accordance with the applicable standards and local legislation and whether required or not, preferably by an independent person. The best practice of prototype testing, pilot build validation and field feedback should all be incorporated into the project schedule to ensure a robust product.

Operations and Maintenance

- *Do the operating documents support the assumptions made in the design?*
- *Does the maintenance programme keep the product in an acceptable state?*

Norman Stewart

At the design stage of a product or process, consideration must be given to the potential hazards and reliability issues that could manifest themselves during normal and abnormal operation. To demonstrate a safe operation, the hazards that are identified must be risk assessed and controls stipulated to militate against these risks. Analysis must be provided on the projected performance levels taking into account human factors and equipment potential failure rates. This will enable development of controls to ensure an acceptable level of reliability/ dependability and fault tolerance are achieved.

An in depth knowledge of the product or process is necessary to enable the above assessments to be carried out. For complex processes the interaction between various operational parameters must be understood and the impact on safety and reliability comprehended.

By assessing potential consequences, both safety risks and reliability performance can then be classified on a ‘Tolerability’ sliding scale to enable a comprehensive benefits analysis. For those that are unacceptable then mitigating controls must be developed to make them tolerable.

Operations

From small consumer goods up to a large industrial complex a strategy must be developed to ensure that during their operation the design considerations are complied with. In the operating procedures the safe operating limits and performance levels must be specified to ensure a safe and reliable operation; that waste and environmental effects are minimised and that the process is energy efficient. Having trained and competent operators is a precursor to safe and reliable operations.

Maintenance

The designer must influence the maintenance strategy for a product or process to ensure that operating

standards and performance are maintained during its life cycle. Installed equipment must be designed to appropriate standards and have the necessary certification e.g. CE marking. The equipment must be cared for to ensure the original design requirements are fulfilled and not compromised due to lack of maintenance.

The operational requirements must be embedded in the maintenance strategy to optimise performance. This could range from having time based, condition based maintenance or just having a replacement policy.

Organisational Interfaces

- *Have other organisations involved in design, supply, support been identified?*
- *Do they know what is expected of them?*
- *Are processes in place to exchange the required data?*

Environmental Impact

- *Does the product design and through life operation need environmental assessment?*
- *What are the bases for that assessment?*
- *Environmental Impact*

Fred Pell

Any engineering undertaking will have an environmental impact, the magnitude of which depends upon the nature of the undertaking, and the design effort applied for its optimisation. The potential for environmental impacts exists throughout product life-cycle, as materials and energy will be consumed, and waste products and emissions produced during manufacture; during the operation and maintenance phase of its useful life; through to eventual decommissioning and disposal.

The responsible designer will identify environmental considerations, along with the primary product objectives of the project, to ensure that they are provided for from the proposal stage through to the delivery of the project, and the whole life cycle.

The strategy for minimising environmental impact needs to be established by assessment of the design at an early stage, so that it can be matched to the application. For example, the measures for a one-off major industrial installation will differ in many respects from those required for consumer goods produced in large volume.

Life-cycle assessment is an acknowledged technique for identifying the potential for environmental impact, used as an aid to design optimisation. Although there is much media exposure to “carbon footprint”, greenhouse gases and global warming, these are not the only factors to be considered.

The fundamental design considerations for environmental impact include:

- Depletion of resources – energy, raw materials, water, land
- Human health impacts (direct) – pathogenic, physiological
- Ecological impacts –fauna, flora, biodiversity, acidification, eutrophication
- Global impacts – ozone depletion, greenhouse gases, global warming
- Aesthetic degradation – spoiling areas of natural beauty

There are standardised methods for quantifying environmental impacts, if a formal declaration of the impact is required. Standards relating to Environmental management systems have been compiled under the auspices of ISO and published by BSI in the BS EN ISO 14000 series.

Documentation

- *Is the safety and reliability case presented in a useable manner?*

- *Are safety performance standards supported where required by quantified reliability assessment of safeguarding features and validated by operational feedback?*

Safety Case

The documentation referred to here is not the traditionally considered Safety Report or the Safety Case which would be considered the collection of safety or environmental documentation. The documentation suite would need to consider or draw from some or all of the other aspects of the Ring of Confidence. In this context the documentation required to support the Dependability Case will need to address but be not limited to the following aspects.

Composition

As a minimum the documentation should constitute the required components to cover all aspects of the full dependability case and these will include; descriptional, operational, discussional, justification and analysis reports/documents.

Adequate

In all aspects of the documentation there must be a demonstration of adequacy commensurate with the argument being presented. The documentation must be set in context by a defined scope against a defined set of agreed standards such that they are clearly linked and focussed on addressing the specific points within the scope and against the standards. Attempting to develop dependability related documents and a Dependability Case without this rigour will result in a much broader and unfocussed suite of documents with the associated and all too often increased cost.

Current

The documentation included in the case will need to be current and sufficiently flexible to allow their amendment following changes in circumstance or fundamental requirements. The need to allow and cater for updates and revisions may be driven by regulatory requirements or the essence of sound engineering following a managed change of function or additional functionality.

Comprehensive

The documentation within the case should be sufficiently comprehensive so as to demonstrate the adequacy of the argument successfully. There may be a need for documents covering all aspects of the Ring of Confidence.

Complexity

The complexity of the overall case will depend upon the application for which it is intended and the overall case complexity may change through the lifecycle of the facility or application being considered. It will also depend upon the defined scope as noted above.

Appropriate

In common with any complexity aspects of the case it must also be appropriate to the particular application being considered as one set of documents comprising a case will not necessarily satisfy all applications. In general the complexity of the case will depend upon the particular application, the nature of any regulatory involvement and the nature of any potential hazards or operations. The other aspect of appropriateness is that the case must be usable by those personnel responsible for providing compliance, the operators will need a suitable documentation suite to operate equipment or plant in their charge within the bounds of the overall case but they may only require a relatively high level version to demonstrate how operational constraints and management type arrangements have been developed. The appropriateness is also linked inextricably with the definition of the scope and the standards by which the overall case will be judged, this aspect is very closely associated with Adequacy.

Adaptable

As the lifecycle of the application develops it may be required to adapt the nature, content and complexity of the case documents to reflect the changing requirements. In regulatory controlled industry applications and where legislation is driving the requirement the case will

need to be adaptable to reflect changes in legislation or regulatory requirement. This aspect is also tied in with the concept of staged cases and that of appropriateness of the argument presented.

Staged

An adequate dependability case may well need to be planned to accommodate concept, design, construction, operation and decommissioning and the requirements and nature of the documentation will need to reflect these different requirements.

Through Life Management

- *Have design and procurement been based on a realistic view of performance?*
- *Is the organisation capable of delivering and maintaining that performance?*

Jeremy Lewis

Even in an environment of a well run and maintained facility or factory the deterioration of particular equipment items will continue through age and corrosion, and with the increasing production demands other items may be operating outside their design capability. Sustaining operations beyond the original design requires a level of strategic reinvestment. Understanding the particular plant items and systems which will need refurbishment or replacement allows the development of a Strategic Plan. This Plan provides the framework for the determination of appropriate layers of protection for the safety and reliability of equipment with maintenance policies and practice to provide the essential information needed in the normal budgetary and planning processes

Quality Assurance

- *How is compliance with safety processes demonstrated?*
- *Does reliability and stability meet the business aspirations?*
- *Do interfacing organisations have an acceptable QA process?*

Jeremy Lewis

The checks and balances of all QA processes must be underpinned by the competence of the Engineers who apply them. As manufacturing conditions and organisations change there is a need to maintain the safety, operability, and sustainability of the factory or facility. The QA processes must be kept relevant, valid and applied by appropriately competent Engineers. Where there is dependence on supplier organisation, then equivalent measures also need to be applied.

***Dick Vote** is Chair of the Institution of Mechanical Engineer's Safety and Reliability Group (http://www.imeche.org/)*

From the Secretary……

This edition of the **Newsletter is larger than usual**, as regular readers will have noticed. There are two main reasons for this, both of which are of particular interest.

The first is because of the **Annual General Meeting** held **in March** and the inclusion of an account of the meeting for members who were not able to attend, together with welcoming introductions of people who are either new to the Committee, or who have taken on a change of role within it. These include two new trustees, Paul Thomas and Jean Venables; and a new co-opted member, Brian Wimpenny. **A change in the Chair of the Forum this year** – an event that does not occur very often - saw Paul Thomas unanimously welcomed into that role. In this Newsletter, a couple of other people are mentioned also, where we are pleased to congratulate Sir Fredrick (Ned) Warner FREng FRS, the first Chair of the Hazards Forum, who celebrated his one hundredth birthday in March; and where we learn more about our new Newsletter editor, James Kearns.

Sir David Davies with some members of the
Hazards Forum Executive Committee
after his last meeting as Chair on 16th March 2010.
Also in the picture is the Hazards Forum Secretary. Photograph: Tim Fuller

The Hazards Forum Executive Committee following the AGM:

- Chairman: **Mr Paul Thomas** CB FREng CEng FIMechE HonFNucI
- **Dr Mike Considine** CEng FIChemE
- **Prof Richard Taylor** CEng CPhys FIET FInstP
- **Dr Jean Venables** OBE FREng CEng CEnv FICE MCIWEM
- **Mr John Barber** CEng FICE FCIArb MHKIE
- **Mr Richard Jones** CFIOSH FRSPH AIEMA MIOD
- **Mr Brian Wimpenny** CEng FIMechE
- **Mr Patrick McDonald** CEng CChem FIChemE FRSC FInstP (HSE Observer)
- **Prof William Bardo** FREng HonFInstMC FIET FInstP FPhysSoc (RAE Observer)
- **Prof Gordon Williams** FREng FRS (RS Observer)
- Secretary: **Mr Brian Neale** CEng FICE FIStructE HonFIDE

See the following Hazard Forum website page for the Executive Committee:

http://www.hazardsforum.org.uk/content/index.asp?CONTENT_ID=7

The second reason we are pleased to publish this larger edition of the Newsletter this time is that we welcome an **extended article from one the Forum's member organisations**. Readers will be aware that recent Newsletters have included, on a regular basis, an article per edition describing a member organisation and its interest in the hazards arena. On this occasion, the article about the Safety and Reliability Group (SRG) of the Institution of Mechanical Engineers is longer than usual and **provides an innovation** for such a piece. The article includes views on an approach to management of hazards and the competencies of those involved. This is timely as the principal author, Dick Vote (who is chair of the SRG) is scheduled to be one of the presenters at the Forum's Evening Event on 16th June 2010, where event title is "Avoiding Catastrophes: Are you Competent?". He has taken the opportunity to "trail", or anticipate, his presentation in the article so that members will have the **opportunity to gain some familiarity** with the SRG's thoughts and approach before attending the event.

As competencies has currently come more to fore in the hazards and risks community, the Forum is considering a further **Evening Event on the topic** which will built on the 16th June event and which will be of interest to the wider community of professionals. Please see the Forum's website for updated information as the event is developed.

The website continues to be updated, including information about the Executive Committee which now includes their professional qualifications and affiliations. The calendar continues to include some events from other organisations – and more are welcomed. It is thus worth visiting from time to time to what else might be of interest – that is, in addition to Hazards Forum events. As well as seeing developments in the events programme, a visit to the sponsor's page will show current and recent supporters of Hazards Forums events together with a link to their home page as a gateway for seeking further information about them and areas of business that may be of particular interest. The link is:

http://www.hazardsforum.org.uk/events/events_sponsors.asp .

Newsletters are usually **posted on the website** sometime after publication to members. Members will thus have the advantage of receiving their newsletter up to three months before they are posted on the website. Newsletters can be found on the Hazards Forum website at:

http://www.hazardsforum.org.uk/publications/publications_newsletters.asp

"Learning the lessons of the past is as important as understanding
the possibilities of the future."

A new addition to a member's Proceedings **suite of journals**, ***Forensic Engineering*** is due to launch its first edition in Spring 2011, although this follows a "pilot" edition in May 2009. It will focus on examining under-performance and non-compliance as well as other failures to help promote better understanding for future practice. The new journal is currently welcoming submissions from the practitioner and academic communities. To read more about the journal, visit the homepage http://www.forensicengineeringjournal.com/ where you can view the full aims and scope and also the editorial advisory panel. You can also download the details of the journal's call for papers in PDF format.

Are you interested in **effective communication** of risk and what constitutes state-of-the-art risk communication? If so, you will be interested to see news of a new HSE Research report on the following page.

Brian Neale

HSE eNews – some examples

++ RR785 - Improving health and safety: An analysis of HSE's risk communication in the 21st century ++
What constitutes state-of-the-art risk communication? Which practices may be considered anachronistic? Does HSE use the most effective means to communicate risks? Which theories and tools are most apposite for the appraisal of HSE's risk communication? What policy recommendations would help the Executive to improve its performance in this area? To answer these crucial questions this report develops an in-depth analysis of HSE's communication practices. The researchers explore HSE's risk communication in two specific cases: that of the Buncefield oil storage incident of 2005 and that of the proposed development at the Oval cricket ground in London. The researchers conducted face-to-face interviews of the critical actors involved in each case. These interviews support a robust qualitative analysis of current risk communication practices. The analysis employs the latest theoretical and empirical knowledge from the academic discipline of risk communication. The authors conclude that the HSE has engaged third parties successfully to develop a proactive risk communication when faced with a major incident. For most decisions, however, HSE still relies on communication practices derived from the consensual, expert-led model with which the Executive operates. The authors formulate five critical recommendations to adapt HSE's risk communication towards a more proactive model.

To download the full report, visit the following link:
http://www.hse.gov.uk/research/rrhtm/rr785.htm

++ **Workers Memorial Day – Wednesday 28th April** ++
On workers memorial day, the Bishop of Liverpool Reverend James Jones spoke on the 'Thought for the Day' slot on BBC Radio 4's Today programme. His talk can be heard at the following link:
http://www.hse.gov.uk/news/2010/radio4-tftd.htm

++ **Explosion at Buncefield Oil Storage Depot** ++
Three companies are on trial over the Buncefield Oil Storage Depot explosion in 2005. Information on the defendants and their charges can be found at the following link:
http://www.hse.gov.uk/news/buncefield/index.htm

++ **Award Winning "Hidden Killer" Campaign** ++
Asbestos is a hidden killer, so now's the time to get clued up on the facts, so that you, your workmates, your friends and family are protected.
http://www.hse.gov.uk/asbestos/hiddenkiller/index.htm

++ "True to your own values" ++
Judith Hackitt in Sunday Times
http://www.hse.gov.uk/news/2010/hackitt-sunday-times.htm?ebul=hsegen/24-may-2010&cr=2

++ HSE at Expo 2010 ++
Chief Executive - the challenges ahead
http://www.hse.gov.uk/news/2010/expo-2010.htm?ebul=hsegen/24-may-2010&cr=3

Calendar of Events

Please check the Events section of the Hazards Forum website for more information at **www.hazardsforum.org.uk** and to see any updates in the calendar. These may include additional events or perhaps amendments to the Events shown below.

Please note that attendance at Hazards Forum events is by invitation. If you are interested and do not receive an invitation, please contact as shown below.

Date	Event	Venue	Contact/further information
JUNE			
16	**Hazards Forum Evening Joint Event**: Avoiding Catastrophes: Are you Competent?	IMechE, 1 Birdcage Walk, London, SW1H 9JJ (Provisional)	Tim at hazards.forum@ice.org.uk
17	Safety and Reliability Society: Language of Safety	Royal Institution of Naval Architects, Upper Belgrave Street, London	www.sars.org.uk
28 - 29	Institution of Civil Engineers (ICE) Event:, HF Supported – Innovate to Survive: Engineers for One Planet Future ®	ICE, One Great George Street, Westminster, London, SW1P 3AA	www.ice-innovatetosurvive.com/
JULY			
15	Safety and Reliability Society Event: 21st Century Reliability - the First Decade	The Raddison Edwardian Hotel, Manchester	www.sars.org.uk
SEPTEMBER			
14	IMechE Event, HF Supported: Engineering Judgement - The Impact of Ethics	University of Leeds	http://events.imeche.org/EventView.aspx?code=s1556
21	**Hazards Forum evening event**: Provisional date	ICE, One Great George Street, Westminster, London, SW1P 3AA	Tim at hazards.forum@ice.org.uk
23	IMechE Event, HF Supported: Using Human Factors for Engineering Success	Austin Court Conference Centre 80 Cambridge Street Birmingham B1 2NP	http://events.imeche.org/EventView.aspx?code=S1541
OCTOBER			
14	Safety and Reliability Society Event: 30 Years of Risk Assessment	Royal Institution of Naval Architects, Upper Belgrave Street, London	www.sars.org.uk
27	IMechE Event, HF Supported: What is Reliability?	IMechE, 1 Birdcage Walk, London, SW1H 9JJ	http://events.imeche.org/EventView.aspx?code=s1526
NOVEMBER			
30	**Hazards Forum evening event**: Provisional date	ICE, One Great George Street, Westminster, London, SW1P 3AA	Tim at hazards.forum@ice.org.uk

The Hazards Forum's Mission is to enable government, industry, science, universities, NGOs and Individuals to find practical ways of approaching and resolving hazard and risk issues, in the interests of mutual understanding, public confidence and safety.

The forum was established in 1989 by four of the principal engineering institutions because of concern about the major disasters which had occurred about that time.

The Hazards Forum holds regular meetings on a wide range of subjects relating to hazards and safety, produces publications on such topics, and provides opportunities for interdisciplinary contacts and discussions.

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