Hazards forum

# The Hazards Forum Newsletter

## Issue No. 80
## Autumn 2013

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## Issue No. 80 - Autumn 2013

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***Edited by Dr. Neil Carhart***

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


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*September 2013*

# Risk Proportionality – Measuring 'True' Risk

Neil Carhart

On **Wednesday 19th June 2013** the Hazards Forum hosted an **evening event.** The event, sponsored by E.ON and the Institution of Mechanical Engineers, was held at the Institution of Mechanical Engineers at One Birdcage Walk, Westminster, London.

Part of the Hazards Forum's mission is to promote the public understanding of risk and to provide a forum for high level debate. A key element of communicating and assessing risk is in the application of 'proportionality'. This Hazards Forum event looked at proportionality with leading figures giving regulatory, legal and academic perspectives.

The event began with a few brief words from **Hazards Forum Chairman** Rear Admiral (retd) **Paul Thomas CB**, who welcomed the audience and thanked the sponsors and hosts for the event. He then introduced the **chair** for the evening**, Professor Dick Taylor**, a Fellow of the IET and IOSH and until recently a member of the Executive Committee of the Hazards Forum. He also chairs the Inter-Institutional Group on Health and Safety.

Prof. Taylor introduced the three speakers for the evening. The first speaker was **Dr David Painter**, a Principal Specialist Inspector in the Hazardous Installations Directorate of the Health and Safety Executive. He started his career in British Gas and has twenty years' experience of working for HSE concentrating on on-shore non-nuclear hazards. Major hazard risk assessment is the area David has specialised in for many years and exercising judgement is a core element of that work. David presented on the approach of the regulator in applying proportionality to on-shore non-nuclear hazards.

The second speaker was **Professor Philip Thomas**, Professor of Engineering Development and Director of the Risk Management, Reliability and Maintenance ($RM^2$) Group within the School of Engineering and Mathematical Sciences at City University. In his talk '*The role of the J-value in determining best use of resources*', Philip presented the J-value framework which provides recommendations to decision makers in high hazard industries on how much ought to be spent to protect both humans and the environment.

The final talk of the evening '*Health protection at the World Trade Organisation: The 'J-value' as a universal standard of reasonableness of regulatory precautions*' was delivered by **Dr David Collins** who teaches and researches in the field of international economic law specializing in the law of the World Trade Organization and international investment law. He is reader at the City Law School of City University and a Fellow of the Institute for Globalisation and International Regulation at Maastricht University, a frequent Visiting Professor at Esade Law School and a current development editor for the Manchester Journal of International Economic Law.

**Dick Taylor** set the scene for the three talks with a brief overview of some of the issues relating to proportionality in decision making in reducing health, safety and environmental risks. In so doing, he emphasised that this was a personal view and not necessarily those of either the HSE of which he is a non-executive director or the City University team with whom he carries out research.

He introduced some of the concepts under discussion, starting with what is meant by proportionality. He explained that it is important to strike a good balance between the cost of safety provisions and environmental performance, and the benefit we get from them. He suggested

that proportionality was about getting this balance correct. However, this is not a simple process. In terms of regulatory decision making there is also a requirement to achieve reasonable practicability. The regulations require the 'balance' to err on the side of safety, or in other words, to introduce a disproportion into that balance. There are then issues over the scale of that disproportion. In practice, and where appropriate, quantitative assessment is a useful aid to decision making, but many other aspects can come into play such as good practice and standards.

Guidance developed by the Better Regulation Executive of the late 90s led to the Five Principles of Better Regulation. In the UK a lot of work has gone into developing Regulatory Impact Assessments (RIAs) so that when we look at new regulation, there is a very careful attempt to make sure that costs and benefits are properly taken into account. But that has not always been the case.

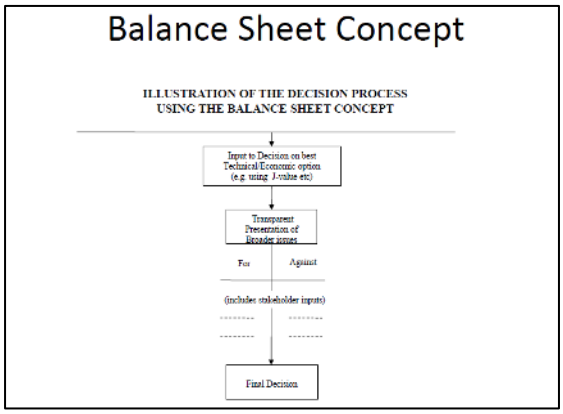

There have been a number of studies into disproportion in regulations. In particular, in the USA and Sweden, there were major academic studies of the cost effectiveness of regulation in the 1990s. These looked at health and safety regulation of various types, through to environmental regulation. It is interesting that both in the USA and Sweden there were variations of many orders of magnitude in cost to benefit ratio and the implied value of saving a life. These studies highlighted very clearly that if we don't think about these issues and try and get them right, there is a real danger that we may be inadvertently wasting scarce resources. We may be spending money on the wrong interventions, and not reducing risk in a balanced and holistic way. While the RIAs attempt to address these issues for new regulations, there are potentially still issues with individual decisions which implement them.

If we accept that quantitative assessment of cost and benefit is important, we then have to think about the options that are available for doing that. Most people are aware of the well tried process of Cost Benefit Analysis (CBA). It is a very simple and useful process, but we do have to bear in mind that it does have some down sides. First of all, it is necessary to impute the value of a life. This can be done by a variety of techniques, many of which rely on extrapolation from the results of willingness to pay surveys. The numbers thus have to be used with caution and are not cast in stone. Secondly, if we use conventional CBA, we don't actually look at loss of life expectancy. Particularly if we are looking at long latency effects, such as the exposure to radiation or certain chemicals, it's very important that we have a technique that allows us to look at this. So while CBA may be simple, we should not forget that there are other tools available, such as the J-value - a relative newcomer. This presents another option for looking at cost effectiveness and does not require 'the value of a life' to be assumed. It also allows us to deal with the loss of life expectancy issue.

When we have addressed the balance between cost and benefit, whichever technique used, there may sometimes be a strong indication in terms of the quantitative scientific and engineering analysis that we should not proceed with an activity. However, there is a wider spectrum of concerns, broadly referred to as socio-political issues, which often need to be addressed. For this Dick advocated the use of a 'balance sheet concept'. One of the Five Principles of Better Regulation is Transparency. It is quite proper that as a society we may wish to spend more resources to address particular risks which are of special concern but it is important that this is done transparently. Examples

include the need to meet international treaties on radioactivity in the environment (e.g.OSPAR), particular views held by stakeholder groups, and particular concerns about multiple fatality events (e.g. railway accidents). These issues will be important for duty holders as well as regulators. The balance sheet attempts to address these concerns openly and transparently.

Dick concluded that, to put it simply, engineering and scientific analysis are very important inputs to judgement and to ensure that resources are to be used effectively. An approach like the balance sheet, however, then forces us to present in a transparent way the broader factors which have influenced the decision (and which may not otherwise be apparent) and how these may lead us to deviate from the conclusions of the engineering and economic analysis.




Dick then introduced **Dr David Painter** who began by describing his role within the Health and Safety Executive. David works within a unit that gives advice to land use planners about the risks associated with major hazard installations, in the context of siting them, as well as developments in the vicinity of them. In his talk, he set out to give an idea of the scope of onshore, non-nuclear major hazards and the regulatory process that the HSE takes across that range of different hazard industries.

The range of hazards can include fires that happen very suddenly or go on for a long time; solid phase explosions and vapour cloud explosions; toxic gas releases, and; microbiological hazards. As well as this range of hazards and risks, there is an extraordinary range of different types of operators that have the duty of managing these risks. While some are very large multinational companies which understand their duties for managing hazards very well and utilise very sophisticated techniques, the range extends down to much smaller organisations that might not have the same capabilities or resources in-house. Many of the operators are traditional oil or chemical companies, but there are increasing numbers of asset management companies who don't have the same background or tradition of managing these hazards. Other companies, particularly chemical distribution companies, are essentially logistics operators. The fact that some of the materials they are handling are hazardous is an additional concern for them to manage. Some organisations see themselves as fuel providers or retail companies. Then there are other major employers that happen to have major hazard dimensions to their activities, such as manufacturers and utilities companies. There are also some more unusual outliers such as paper mills, turkey farmers, sugar processors and brickworks.

The work also covers a range of different sectors: mining; explosives manufacturing and storage; microbiological hazards (human and animal pathogens, GMOs etc.); chemical manufacturing and distribution, and all aspects of onshore fuel production and distribution.

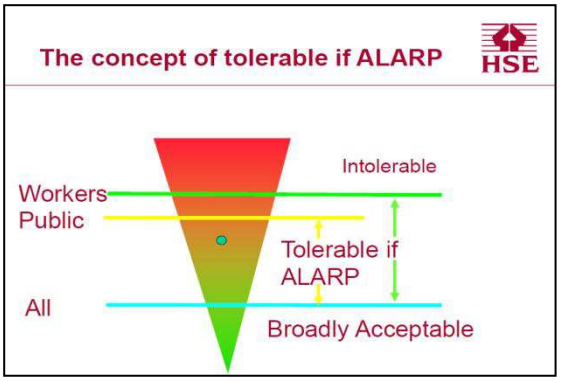
What this means is that different types of organisations and different types of hazards lend themselves to different regulatory approaches. In some areas the approach is largely prescriptive. This is because legislation has been developed that is very specific to a particular industry or a particular hazard. Mines are an example of this, as are some aspects of explosives licensing, and the containment regimes of microbiological hazards. In these examples, the regulation can be made very specific because the hazards can be tightly defined. Other hazard

activities are managed through a goal-setting risk-assessment regime, such as sites subject to the Control of Major Accident Hazards (COMAH) regulations.

David then moved on to talk in more detail about COMAH and the range of regulatory approaches used depending on the size of the risk, in other words the proportionality aspect. COMAH covers a wide range of sites and operators. It is a risk-informed approach to decision making. COMAH covers refining, all aspects of fuel distribution, traditional chemical and petrochemical manufacturing, and all aspects of natural gas supply from where it lands on the beach to above and below ground storage and distribution right up to where it is delivered to the user. This makes it quite a wide ranging sector in itself. COMAH also covers LPG providers, some of which, as mentioned previously, consider themselves to be fuel retailers and not necessarily part of a major hazard industry. They range from very large facilities to smaller tanks in garages or cylinder providers. Some larger explosives manufacturing sites, which although covered by their own legislation, are also covered by COMAH. Large fireworks and ammonium nitrate fertiliser sites are similarly covered by COMAH. Water treatment sites are not generally thought of as being major hazard sites, but they can be if they are using substances such as Chlorine, and as such are also covered by COMAH. Logistics companies which deal with chemical warehousing and distribution as well as pharmaceuticals manufacturing, metal production and processing, some aspects of nuclear fuel processing and power stations are also covered. More unusual installations include whisky maturation warehouses, flavours and fragrance manufacturers, paint production, metal finishing, waste recycling and MOD sites.

At the heart of COMAH lies a proportional approach to risk management. In its simplest sense this is driven by controlled quantities of hazardous substances. Thresholds determine whether COMAH applies or not. If it does, these quantified thresholds determine whether it is considered in terms of Lower Tier duties (around 600 establishments) or Top Tier duties (around 350 establishments).

Amongst other things Top Tier sites have a duty to produce a Safety Report. They must make a demonstration that "all measures necessary" (AMN) have been taken to prevent and mitigate major accidents. AMN equates to 'so far as is reasonably practicable' in UK legislation and 'as low as is reasonably practicable' or ALARP. What this means is that we can think about a quantum of risk, and see whether it is deemed to be intolerable, broadly acceptable or if it can be shown to be tolerable only if it as low as is reasonably practicable.




Relevant good practice is the starting point to demonstrating that a risk is ALARP. The duty holder, if in the 'tolerable if ALARP' region, is required to address two further questions:

- What more could be done to reduce risk?
- Why has it not been done?

The first part is a hazard identification process and thinking about risk reduction methods, the second part is very much the judgement about reasonableness, and this comes down to cost.

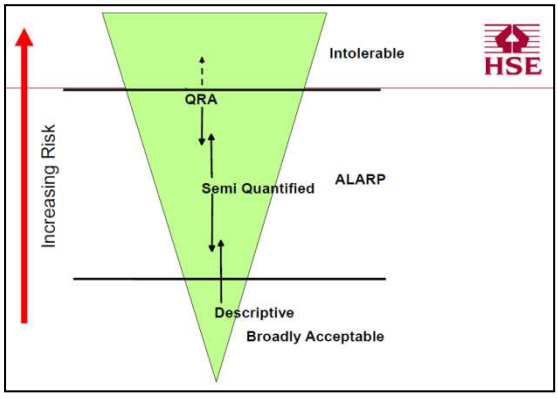
HSE's focus is on potential for acute harm to people from this wide range of hazards. The COMAH regulations also address major accidents to the environment, but this is covered by the HSE's colleagues in the Environment Agencies. Clearly these are risks that the duty holders must also take into account.

The level of detail required to answer the ALARP questions is determined by the proportionality. The greater the risk, the greater the detail and degree of rigour required in carrying out the risk assessment and ALARP demonstration, and the greater the time and trouble appropriate for managing those risks. The greater the risk, the more a Duty Holder would be expected to consider paying to reduce those risks.

The risk may be dependent on the type of material, the quantities stored and the process involved, but one of the factors that really drives the HSE's approach is where this risk is located and its consequences in terms of the surrounding population. They also take into account the nature of that surrounding population: is it a group of people who can be trained to deal with the risks and hazards, or is it a group residing nearby who are not trained in such a way.

The starting point for an ALARP decision may be 'common sense', engineering judgement or professional judgement. In the high proportionality cases it can often come down to a Cost/Benefit Analysis (CBA).

Another way of looking at this in the COMAH context is in terms of what the Duty Holder needs to do to demonstrate they are managing risk depending on the scale of the quantified risk.




For low risk a descriptive approach may be appropriate, but as the risk increases the level of quantification and understanding also increases. When getting to the top end of the 'ALARP tolerability diagram' the approach moves more and more to a fully quantified assessment and CBA.

The CBA can involve a degree of 'Gross Disproportion' in the ratio between the sacrifice and the benefit of avoiding the risk. But there is a great deal of debate about what this disproportion is. The HSE has done some research into this. Based on Gross Disproportion factors inferred by regulatory impact assessments it can be found that there is some loose correlation with the number of people that might be affected by a single accident. A number of different factors have been deduced from a number of different regulations over the years, and these are published as part of the HSE's internal guidance and COMAH information on the HSE website[1]. Ultimately this is not set down in law, but is decided by cases. One such example can be seen in Edwards vs. National Coal Board (below).

**Gross Disproportion** HSE

Edwards vs. National Coal Board
a computation must be made in which the quantum of **risk** is placed on one scale and the **sacrifice**, whether in money, time or trouble, involved in the measures **necessary to avert the risk** is placed in the other; and that, if it be shown that there is a **gross disproportion between them**, the risk being **insignificant** in relation to the sacrifice, the person upon whom the duty is laid discharges the burden of proving that compliance was **not reasonably practicable**.

In many instances we are looking to make decisions about risk reduction measures; weighing the 'cost' of a risk reduction measure against its benefit in terms of the change of harm averted with some degree of disproportionality.

CBA can be beneficial in terms of its transparency and consistency, and the way in which costs and benefits are expressed in a common currency. It can be a powerful tool for comparing risk reduction options and useful for considering retrospective improvements. It is not without its drawbacks though. There is a lot of uncertainty in predicting

both consequences and frequency, it can be difficult to obtain an equivalent level of detail on both sides of the balance (the costs and benefits), there is uncertainty over what makes an appropriate disproportion factor and uncertainty over what is an appropriate lifetime for plant or installations

David concluded that CBA was a very powerful technique but should never be used to argue against compliance with established good practice, or remove existing risk reduction measures.

The second speaker, **Prof Philip Thomas**, began his talk on the J-value[2] by acknowledging the commonalities with the previous presentation, specifically in terms of addressing the wide range of areas that need to be covered by risk assessment and risk management. The J-value can play a role in this potentially daunting task.

HSE enforcement policy talks about reasonable practicability, the exercise of judgement and good practice. These concepts are held as part of the foundations to the policy. In terms of reasonable practicability it could be said that the law is relatively simple, in that you make additional safety improvements if it is *common sense* to do so. But this brings out one of the problems of this area in that common sense is not necessarily transportable from one person to another and views change. It therefore has a subjective element. There is also historic evidence or relevant good practice, but where this doesn't exist or where there are conflicting good practices it is necessary to have a **paradigm** to help make decisions.

Following the 1974 Health and Safety at Work Act the law states that an employer has a duty to control risks so far as is reasonably practicable (SFAIRP). This gives the UK a very sensible and logical basis for looking at the regulation and risk in industries across the board. It requires a comparison of the sacrifice (e.g. money, time and trouble) of improving safety with the detriment of not doing so, such that to not implement improvements the sacrifice would need to be "grossly disproportionate". At nuclear inquires the sacrifice was quoted as a factor of 2 to 10 higher than the expected detriment in relation to the public. In practice the US law seems to take a similar line.

There are particular difficulties in valuing a human life. Market valuations are not straight forward and we need to go back to fundamentals. What benefit is conferred when a safety system allows a person to continue to live the rest of their normal life? They benefit in the sense that they are allowed to carry on, but if they don't get killed or injured how do we value that benefit? The benefit can be thought of as the restoration of that person's life to come.

So far the HSE's method for valuing a life has come from the Department for Transport's studies. However, there is a problem with this in that it makes the assumption that there is a single-valued "value of a prevented fatality" (VPF). The current value in the UK comes from the preferences of about 170 people, as stated 16 years ago, and updated assuming that VPF is proportional to Gross Domestic Product (GDP) per head. There are a number of problems with this approach logically, ethically, and in the actual measurement of it.

We can do better by looking at each person's life in reality as a random, if finite, variable. We certainly can't predict this precisely in advance, but we can predict with accuracy the expected life to come for a person of a given age and a given gender using actuarial tables. It is thus life expectancy that we may reasonably choose to value. An overall average for the population at risk may be found. This interpretation is used in the Life Quality Index and the judgement value, or J-value.

The Life Quality Index, devised by a group of Canadian academics, is analogous to the dimensional analysis of pumps. An individual's quality of life $Q_1$ is modelled as a function of income, $G$, and expected free time from now on, $F$:

$$Q_1 = \alpha_1 G^{\beta} F^{\gamma}$$

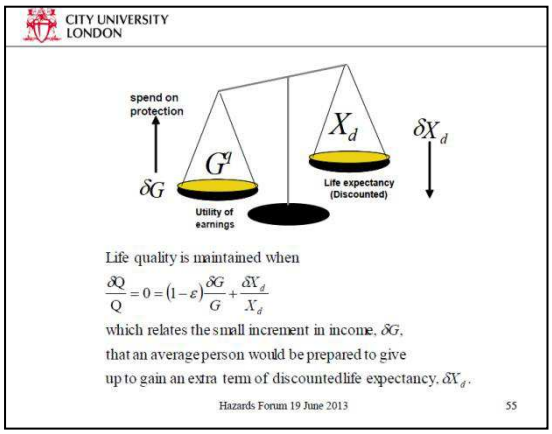
This is, in fact, a standard Cobb-Douglas utility function, used in empirical economics, which can be developed into the Life Quality Index:

$$Q = G^{1-\varepsilon} X_d$$

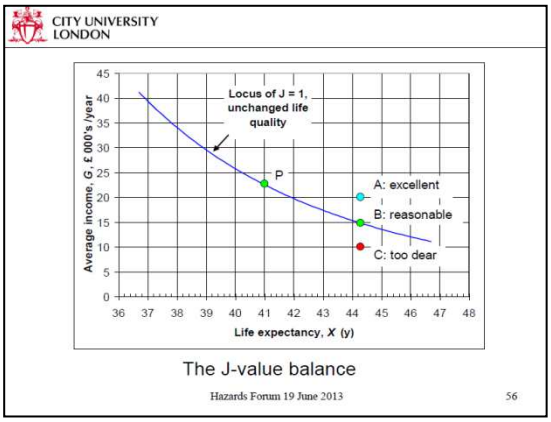
where $X_d$ is the discounted life expectancy and ε is the risk-aversion. Population averages are used for $X_d$ and ε. G is taken to be the GDP per head for ethical reasons. By using a utility function it becomes not just about how much money you earn, but what the money is worth to you.

Risk aversion, ε, is a very important and powerful parameter. Someone with a positive risk-aversion will tend to prefer a certain outcome to an uncertain one, even when the uncertain outcome has a somewhat higher expected monetary value. For example, they tend to be prepared to pay more in insurance premiums and for safety.

Philip returned to the idea of a balance discussed by Dick Taylor and David Painter. The balance in this case is between the discounted life expectancy and the utility of earnings.




If we plot where we stand in terms of averages (life expectancy on average being around 41 years and income in GDP per head of around £23,000 per annum) we can draw a locus where the J value equals 1, and therefore the quality of life is unchanged. This is shown in the slide below. Moving from a point P on this graph to point A would be considered a successful undertaking as life expectancy has increased. This has been achieved at a cost, but one that is deemed to be outweighed by the benefits. Alternatively, if the movement is to point C then you can be said to have overpaid for the same beneficial change in life expectancy.




The J-value is then the ratio of the amount actually spent on protection or a safety system to the maximum that is reasonable or sensible to spend. Hence J=1.0 corresponds to the limiting condition where the actual expenditure on protection is justified by the gain in discounted expectancy. If J is less than 1, then you could afford to spend some more, if it is significantly greater than 1, then you may be spending too much.

The J-value's valuation of different effects fits neatly into the ALARP framework which constitutes the basic legal framework of the UK. The concept of gross disproportion can be very easily addressed by increasing the minimum required J-value. In addition, it is possible in principle to adjust for injuries rather than deaths by using fractional multipliers.

Large industrial accidents can cause major environmental damage as well as human harm, as seen in incidents such as Seveso, Chernobyl BP Macondo and Fukushima. Environmental effects can also be addressed within the J-value framework though the Total J-value, $J_T$, which preserves the objectivity of the J-value.

The J-value allows us to move away from problems of subjectivity present in “stated preference” valuations of life to a totally objective and transparent approach. Every single assumption and calculation can be examined. It is also important to note that the J-value incorporates what has been referred to as the ‘democratic principle’ that the next hour or day of life is the same for all regardless of age or income. Recent work has allowed for the examination of WHO actuarial data and World Bank statistics such that the J-value can now be applied across all nations in the UN.

Philip then presented examples of the application of the J-value. The first concerned the effect of the Regulatory Impact Assessments (RIAs), introduced by the Better Regulation Executive in 2007. These were intended to introduce proportionality into the decisions over safety made by UK Government bodies. The J-value was used to examine the published results of this. He reported that the evidence is not particularly reassuring. They looked at four areas: HSE limits for respirable crystalline silica; schemes to reduce radiation risks associated with CT scans; schemes to reduce MRSA infections, and; Highways Agency junction and roundabout improvements. It is clear from looking at the inconsistency in these areas that the important messages do not appear to be getting through.

The HSE is setting sensible and strict regulation limits with a J value of 1.3 for silicate, while Department of Health sanctions some spending where J=0.6 but not when J=0.55. The Highways Agency can be seen to be spending on schemes with a J-value of 0.01 and not when J = 0.02, but it is not clear why not. The hazard was not reduced as much as it could have been.

The second example arises from the Management of Nuclear Risk, Environmental, Financial and Safety (NREFS) Project, where City University leads a consortium that also involves the Open University, Manchester University, Warwick University and the Atomic Energy Commission of India. The project's aim is to apply objective methods such as the J-value to the management of risk, under the UK-India Civil Nuclear Power Collaboration. The focus is on large nuclear accidents and how to best respond to them. Preliminary results are beginning to emerge from a study of the Chernobyl incident. These early results, looking at health effects and agricultural remediation measures, indicate that while some of the responses were sensible, some were not. The CLEARE program has shown that the evacuated members of the public, who received the highest dose, lost 9.3 days of life expectancy; in the UK 2.7 hours were lost. Using the J-value technique it is possible to conclude that neither of those figures is a negligible loss, so that we should be prepared to spend something to prevent that loss. It was highlighted that these losses in life expectancy are much less than the difference in life expectancy between areas of North England compared to the South of England (which is around 3 years on average).

Philip concluded his talk by reiterating that both the J-value and the $J_T$-value provide objective metrics that can be used as a consistent guide for decision makers. They do not rely on any one person to do the calculations. They are based, in the case of the J-value, on data gathered by the ONS or equivalent in other countries, based on the behaviour, or revealed preferences of millions of people. They have a very good provenance for their data and provide a useful guide. Their use does not preclude the decision maker from spending more money than would be implied by these measures, indeed they might be inclined to do so in consideration of wider socio-political concerns. It provides a consistent platform on which to base your decision, and very importantly, to explain those decisions if necessary.

The final talk of the evening was given by **Dr David Collins**, on the application of the J-value to international law, with particular focus on health protection at the World Trade Organization and international investment law. The law relies on the

ambiguous concept of "reasonableness" which can lead to inefficient and unpredictable judicial outcomes. The J-value potentially provides a more sophisticated and transparent universal standard for reasonableness.

Legal scholars tend to acknowledge the inadequacy of the vague notion of "reasonableness", but while it is not intellectually rigorous, its biggest problems lie in the unpredictable outcomes in which it results. If the law is unpredictable it does not function properly as a means for ordering society. One academic, Richard Posner, asked whether we could supplant reasonableness with something more objective, leading him to come up with the idea of efficiency. He found that judges had been using this all along. They had been using cost benefit analysis only they hadn't been calling it that. Then, in a famous case, *US v Carroll Towing* Co. (1947) the judge actually mentioned cost benefit analysis. The case involved a barge that sank in New York harbour and set out to establish whether the owners of the barge had been negligent or whether they had taken sufficient care. The judge, Judge Learned Hand, said that the injurer will be found negligent in law if the burden of the protection against the harm (B), is less than or equal to the resulting benefit. The benefit being a product of the magnitude of the injury (I) multiplied by the likelihood of it occurring (P):

$$B \leq IP$$

This, known as the Learned Hand formula, is the first time in common law that a judge explicitly set out a cost benefit analysis to supplant the vague notion of "reasonableness". The UK courts have taken the same approach. For example health risks faced by employees should always be reduced unless the responsible body can demonstrate that there was a gross disproportion between the costs and the benefits, meaning that the risk was insignificant in relation to the sacrifice that was required. The US has really led the way in terms of law and economics, it is taught in English law schools, but is nowhere near as advanced as you would find in North America.

The J-value is really a more sophisticated way of applying the Learned Hand cost benefit formula for assessing the reasonableness of health and safety precautions that may be implemented. Just as the J-value can inform law makers that a certain regulation asks too much, and is commercially destructive, it can also act as a tool for judges who are deciding over lawfulness, reasonableness or efficiency. As it applied on a case by case basis, as one judge uses a particular logic or ratio, another can use the same.

The J-value can be useful in international judicial situations. David explained how he had been applying it at the World Trade Organization (WTO). The WTO is an international body, composed of 157 countries, which aims to ensure the liberalized trade and free flow of goods and services across international borders. Its stated purpose is to raise living standards worldwide. Russia joined in 2012 meaning all of the largest countries in the world are now represented in the WTO. It supervises the application of several international treaties, minimising regulations that impact on trade. It is recognised that illegitimate national health and safety laws can be used as a disguised form of protectionism, unfairly distorting the market for the trade of certain goods. A country could impose a regulation and claim that it serves to protect the health of its citizens, when in fact it is being done to protect the sale of a product against international competition. This raises the price of goods artificially, and in so doing can lower the global standard of living. An important function of the WTO is in dispute settlement. It contains a Dispute Settlement System to resolve disputes between Member states as to their legal rights, ensuring security and predictability. This acts like a court, with a panel of judges sitting in effect at trial level hearings as well as appeals. A Member (meaning a country) can bring a claim through the WTO Dispute Settlement System against another Member on the basis of an allegedly

protectionist implementation of a measure. It is an adjudication as to whether an agreement has been broken or whether or not actions are justified.

Article 3.2 of the Dispute Settlement Understanding, which is the set of procedural rules governing the dispute settlement body, states that the dispute settlement system of the WTO is an essential element in providing the security and predictability of the multi-lateral trading system. It serves to preserve the rights and the obligations of the members and the treaties, and to clarify the meaning of those agreements. The WTO panels and appellant body decide on whether the national law is reasonable or unreasonable.

There are two main spheres of WTO law that are relevant for considering the application of the J-value as a tool for unpacking the reasonableness concept: the GATT General Exceptions and the Sanitary and Phytosanitary Agreement. The General Agreement on Tariffs and Trade dates back to 1947. It prohibits discrimination against foreign products. Generally, in addition to this it encourages Members to lower their tariffs on international trade, stick to their commitments and avoid quantitative restrictions. If a member imposes a health regulation on a particular product, for example fruit coming from a particular country has to be sprayed with a certain pesticide, and this isn't imposed on fruit grown domestically, this could be a violation of GATT.

A member is allowed to breach this, and discriminate against foreign products, under the General Exception to Article XX of the GATT "Subject to the requirement that such measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries" and it is "necessary to protect human, animal or plant life or health". Although the GATT makes no explicit reference to a scientific methodology, case law shows that measures that are purportedly necessary to protect lives or health under Article XX should be grounded in evidence. However, there is not much guidance on what constitutes scientific evidence with respects to risks to health. Assessing a regulation under this provision is indeterminate because of ambiguity of the terms 'necessary', 'arbitrary' and 'unjustifiable'.

The J-value may provide a means of objectively evaluating the economic costs and benefits of a measure in a clear and predictable way. It could provide the WTO panels and Appellate Body with a transparent method of interpreting the ambiguous concepts by assessing whether the amount that would be spent on the safety measure, in terms of the testing of products as well as the lost trade, are proportional to the risks to life and health. If the J-value reveals a measure to be unreasonable then it may be a disguised restriction on international trade.

The Sanitary and Psytosanitary (SPS) Agreement is a further area of WTO law that may derive a benefit from the application of the J-value. The SPS Agreement is a compulsory rule, agreed to by all members of the WTO, which covers national regulations concerning international food trade in relation to human, animal and plant health. Providing the national law is based on "scientific principles" then it can be enacted. Once again, the J-value can help illustrate whether the science used by a Member of the WTO to inform the national law is rationally linked to the outcome in terms of health protection, or if it is a disguised barrier to international trade.

Unlike trade, international investment law isn't governed by a particular treaty. Instead there are thousands of Bilateral Investment Treaties (BITs) protecting foreign investors from harmful actions by host governments, and instead of one particular court, there are many different ad hoc arbitration tribunals around the world to resolve disputes. These international arbitration decisions have to answer similar questions to the WTO. In

particular, they have to resolves disputes involving regulatory expropriation. If, for example, a nation says to an investor that to operate within their borders they have to enact some kind of environmental protection, and the precautionary health and safety measures imposed by that host state are excessively burdensome, they can be viewed as a form of expropriation. The J-value can be used again here, and in particular the $J_T$-value looking into environmental harm. If the precaution required by the host is seen by the foreign investor as unreasonable, or it is seen that no rational decision maker within the investing organisation would voluntarily chose to enact that health and safety measure, then it may be expropriation. The company may be being asked to do more than it should, making their investment less and less valuable to the point where they won't derive any commercial value from it at all. Arbitration tribunals can use the J-value to make decisions based on the reasonableness of the interference.

David summarised his talk by concluding that world trade law and international investment law both rely heavily on the concept of reasonableness in resolving crucial questions of legal entitlements. This undermines the predictability of adjudication and can have a damaging effect on trade and investment. If there is no way of predicting what 'reasonable' means, then there is no way of understanding the legal obligations. At the same time, health and safety precautions are key components of a state's sovereignty and must be treated cautiously so as not to encroach on rights in this area. The J-value can operate as a useful tool in judicial decision-making by indicating that in the trade context unreasonable spend is a proxy for protectionism and in the investment context unreasonable spend looks like expropriation. While just a tool, it gives an objective means of dealing with otherwise vague concepts.

**Prof Dick Taylor** thanked the speakers, noting the multi-disciplinary nature of the evening's talks. He then introduced the discussion period and invited questions for the panel from those in attendance. The first question related to international trade and investment laws. The audience member asked how many cases were brought for arbitration each year, how often countries were asked to change their regulation as a result, and what level of compliance was seen in practice. Dr David Collins responded that around 12 cases are brought per year to the WTO. Although technically the WTO panels make recommendations, compliance with these is quite good. With the exception of a small number of cases, the losing countries have usual implemented a change to their laws within the allowed time period. This time period is usually less than a year. SPS cases are a particularly vibrant area, and this is likely to increase.

The second question related to the J-value. The audience member explained that while they could see the benefit of having an objective measure to inform decisions, there was a risk that it was being promoted beyond its real value such that it trumps regulation, law, politics and everything else. They asked, if the J-value is a measure based on the economic valuation of life expectancy, was there a risk of it suggesting dangerous facilities should be placed in poorer communities with less highly valued life expectations, or worse regulated countries? Prof Philip Thomas replied that he would be very careful to communicate that the J-value is only one factor in a decision, albeit a potentially very useful one. He added that the J-value takes the ethical stance that it regards the next person's hour of life to be of equal value regardless of their wealth or age. This is done by assuming that the person's income is equal to the national GDP per head. Thus there would be no incentive from the J-value to site a more hazardous facility in an area in this country with a lower than average income. He acknowledged that the notion of different countries was certainly an interesting and important question. When applying the J-value to a country with a lower GDP per head then the suggestion might be that

less should be paid on protection. Economists might argue that this is entirely sensible as the country has fewer resources to spend on protection. Prof Thomas and his team are looking at this issue, comparing countries with different GDP per head and life expectancies. He has discussed this issue with students from across the globe who have pointed out other issues such as lower labour rates, which mean installing protection systems may be cheaper, and a reluctance to be forced into installing safety features based on a standard the country can't afford. For the companies that operate in less wealthy countries there is an ethical choice to be made over how much should be spent on protecting safety and the environment. Should they use one value worldwide? It is undoubtedly a challenging question. It is of particular relevance to companies operating in countries with a lower GDP per head than those in which they are based .There are a large number of ethical questions that need to be resolved, but they are problems whether you are applying the J-value or any other tool.

A third question asked whether local trade regulations concerning encapsulated asbestos could be challenged using the J-value, allowing countries to import such products into the UK. Prof Thomas first described investigations into radiation models and life expectancy change. He described the complex link between the two, and how the same principles could theoretically be applied to asbestos although his team has not yet done so. Dr Collins highlighted that there was a WTO case involving asbestos in which the then EC had banned asbestos imports. This was challenged by a number of other countries who won, meaning that the ban had to be removed. It was felt that they had been applying the ban in a discriminatory and illogical fashion. Certain types of asbestos from certain countries were prohibited while others weren't. They couldn't show a scientific reason or evidence for this distinction.

Another comment relating to the J-value highlighted the potential benefit in benchmarking the decisions made by different people in different environments. They asked whether the real difficulty in applying the J-value in a proactive way emerged from the lack of data or uncertainty in the risk estimates relating to high consequence, low frequency events. They also asked whether the data used for the J-value would result in a different Value of a Prevented Fatality (VPF) than is commonly used in Cost Benefit Analysis. Prof Thomas responded that it suggests only a 25% VPF using Treasury discount rates, although the figure would be significantly higher if a zero discount rate were used. However, he said that, the J-value is more soundly based. There are problems of logic, provenance and measurement with the VPF figure, and there is an increasing sense that those in high-hazard industries are not satisfied with it. The J-value can give a more level playing field across all industries, from high-hazard industries and beyond. There may be many under-regulated areas where we are taking risks, because we are concentrating on high-hazard industries. He added that with the J-value, the intrinsic uncertainty is actually very low. You need to estimate the consequences, and there is uncertainty there, and the starting frequency. As long as you have a safety system which can reduce that by a factor of 10 or 100, then the final frequency becomes less important in the J-value calculation.

The final question asked about the normative value of the J-value approach and how it might be affected by the different politics, cultures and approaches to risk and acceptance of CBA around the globe. Dr Collins replied that the German courts had embraced CBA and the Italian's were leaders in the field. At the international stage, the EU is a member of the WTO as a unit, rather than its individual countries. International trade law at the WTO is a hybrid of largely an American approach, but with aspects of the European system and, with China's entry, Asian influences. The methodology of dispute settlement is somewhat adversarial, but diplomatic and focused on reaching agreement in a non-

confrontational manner. The J-value, and things like it, will come into their own in international law as we see increasing deference to science. Lawyers and judges are increasingly more comfortable with scientific methods, evidence and formulae. This is becoming the norm. In the more ad hoc investment arbitrations, scientific formulae are used as and when they are tendered by the lawyers. And when they are used they are often found to be very persuasive. The J-value is also only a tool and guidance, and judges will still make the decision as humans.

Prof Taylor thanked the speakers before passing to **John Armstrong** who closed the session by thanking the speakers once more for their contributions, the event's sponsors, and the audience for its engagement in the concluding discussions. He encouraged any guests to consider joining the Hazards Forum and invited all those in attendance to continue their discussions over refreshments.

[1] http://www.hse.gov.uk/comah/

[2] More information on the J-value can be found at http://www.jvalue.co.uk

## Chemical Engineering Matters

Judith Hackitt, IChemE president, quoted in her presidential address:

"During my Presidential year and thereafter my focus will be helping prepare the next generation of engineers and leaders to deliver against the IChemE's report *Chemical Engineering Matters*."

*Chemical Engineering Matters* outlines IChemE's broader thinking on the areas where the profession creates, maintains or improves quality of life.

This document is intended to provoke debate and stimulate activities and engagement with a long-term view rather than short-sighted thinking.

This revised technical document addresses the challenges faced across four areas of society and the world today. Across each of these four areas there are underlying chemical engineering principles that must also be addressed.

*Chemical Engineering Matters* can be downloaded from: http://goo.gl/bCy7Ft

If you have any comments, questions, or wish to discuss any aspect of *Chemical Engineering Matters* in further detail email us at chemengmatters@icheme.org

# From the Secretary.....

Many Member organisations have taken advantage of the opportunity to submit events for the Hazards Forum website Events Calendar. This can be seen at http://www.hazardsforum.org.uk/events/index.asp. Those displayed on the page as the Newsletter goes to press are then included in the Diary page (Page 20). On this occasion readers can see something a little different, which is a Call for Papers for a major conference and thus provides the opportunity for the potential for more pan-discipline transfer of knowledge amongst those in the hazards community. As mentioned in the previous Newsletter, the Forum is happy to consider including events of Member organisations and welcomes invitations to "support" such events.

An advance date for the diary is Tuesday 18th March, when the 2014 AGM is scheduled to take place, with an evening event to follow.

Brian Neale

# Risk Communication and Professional Engineers

Prof Dick Taylor
Chairman of the Inter-Institutional Group on Health and Safety

## 1. Background

The effective communication of health and safety risks by engineers is of vital importance if government and society are to be able to make sensible, balanced judgements about risks – from major projects and new technology, through to day-to-day health and safety issues. This is reflected in the Engineering Council's document 'Guidance on Risk for the Engineering Profession'[1] where one of the six principles to guide and motivate professional engineers and technicians in dealing with risks is to 'contribute to public awareness of risk'.

In 2012, the Inter-Institutional Group on Health and Safety (IIG), following a workshop with the HSE, established a working group to consider the key issues further. The group comprised nominees from professional bodies, the Hazards Forum and the HSE. As a result, a paper has recently been published by the IIG[2]: which summarises recent developments involving professional bodies and government, and makes recommendations on what might be done to promote appropriate action to improve risk communication.

## 2. The Issue

The IIG paper makes the point that in order to express the issues relevant to particular risks to the wider public, engineers have to bridge a potentially significant culture gap. In many cases engineers regard the need to address risk satisfactorily as primarily an issue of meeting 'objective' criteria often expressed in statistical terms. This process of risk assessment and optimisation provides an important basis in ensuring that scarce resources are employed cost effectively in minimising the risks to which individuals and society are exposed. It is important that this 'objective' element in risk management is not neglected. However, society generally does not see the issues as simply as this. Unless engineers understand what lies behind the sometimes complex public attitudes and perceptions and take account of them, they will be unable to communicate effectively with the wider public about the issues involved in identifying, assessing and managing risks. As a result there is a danger that they will not be able to gain acceptance for important technological advances or improvements in our capability to minimise the risks to which we are exposed or create.

Much research has been carried out on the topic and the paper briefly reviews some of the important findings. One particular issue that has been identified by the research is that of 'trust'. The paper points out that where the public or those affected perceive something to be of high risk, trust in those responsible for introducing the risk and those controlling it, can help to mitigate concerns. Conversely, a lack of trust can lead people to oppose a development even where scientific evidence indicates that the risks are low. It is suggested that to achieve trust, five characteristics are required:

- competence (those communicating know what they are talking about);
- objectivity (this frequently means a view that the source of information is independent);
- consistency (a track record in dealing competently with similar matters);
- openness (a willingness to disclose information and not to appear secretive); and
- empathy (willingness to accept the validity of concerns and to listen and consult).

Recently the Chair of the HSE, Judith Hackitt, in a paper to the IMechE[3], emphasised the importance of building public confidence and made the point that this will not come from telling people that 'we know best'. What will help to deliver it is:

- acknowledging justifiable fear or apprehension of the new and unknown;
- explaining innovations in terms of benefits and risks;
- being honest about what can be done to reduce but not eliminate risk; and
- constantly reminding people that inaction is, itself, not risk free.

### 3. Response of the Engineering Profession and Government

Against this background, the IIG paper reviews what has been done by the engineering profession to equip engineers to deal with this important issue. For example, in addition to the Engineering Council's Guidance referred to above, the Royal Academy of Engineering produced a report on 'The Societal aspects of Risk' and published the proceedings of a debate entitled 'Trust me, I'm an engineer'[4]. The Report contained the clearly expressed statement that ':.the conventional separation between the technical (the province of engineers) and the social (the province of managers, politicians and the public) cannot survive scrutiny. Engineering decisions are inevitably shot through with social considerations, just as many apparently political decisions depend on technical judgements. Indeed it is often hard to tell just where the 'technical' ends and the 'social' begins'. Given this, it concluded that 'Engineers need to be as adept at functioning in a wider political environment as they are in a technical one'. It recommended that the following guidelines should be considered in all engineering activities:

- at an early stage, identify the interest groups that might have a stake in the project;
- define the boundaries of the system under consideration and ensure that decisions about the appropriate boundaries are understood and accepted by interest groups;
- aim to quantify the risks with as much precision as is relevant and achievable;
- do not attribute a greater degree of precision to risk assessments than deserved;
- recognise the social, political and economic implications in any risk assessment and acknowledge them publicly;
- stimulate public debate on the perceived risks and benefits; and
- establish a consultation and feedback process about risks with stakeholders, including the public and local community.

Several practical steps have been taken by professional bodies to develop this agenda. In addition to the Hazards Forum series of evening meetings on risk communication reported in previous editions of Hazards Forum newsletters[5], IOSH has championed the need to create a more risk intelligent society, RoSPA has proposed ways in which understanding about health and safety and broader risk issues might be strengthened in the school curriculum and the IIG has promoted the production of core teaching materials for undergraduate engineers which is now being picked up as part of an HSE funded project being led by the Health and Safety Laboratory with backing from professional bodies, academe and industry.

The IIG paper also summarises the many recent attempts that government has made over the last decade or so to strengthen government's handling of risk and its communication, providing a timeline of initiatives. The considerable activity reflects an appreciation that handling risk effectively - both in terms of opportunity and threat - is increasingly central to government in its role as a regulator, steward and manager of risks at the strategic, programme and project/operational levels. In particular, that the accelerating pace of change in science and technology and greater societal connectedness are creating new responsibilities and demands on government. The issue was also brought out in the 2011 Löfstedt Report which concluded that there needs to be a shared understanding of risk and how it should be regulated, and that a mechanism is needed to bring together Parliament, policy makers, academics and the public

to achieve this. Recent HSE initiatives such as the 'Myth Busters Challenge Panel' also highlight efforts to generate better understanding and to assess whether sensible and proportionate decision making is taking place by those responsible for considering health and safety risk management.

### 4. What More Might be Done

The IIG paper concluded that more needs to be done in this important area and that the engineering professional bodies could play an important role in this. In particular, attention was drawn to four specific issues where action would make a difference.

1. It is important that risks continue to be objectively and transparently assessed in order to ensure that resources are used as effectively as possible in minimising risks, but it is also vital that 'socio-political' concerns are addressed and transparently weighed in decision making. A suitable balance has to be struck between understanding and using engineering, scientific and economic analysis and taking proper account of societal perceptions and concerns.
2. There is a need to examine what barriers prevent engineers and engineering organisations communicating more effectively about risks and how these can be overcome. For example, do they recognise and accept the importance of managing and communicating about risk; are they aware of the guidance and tools which exist and the conclusions of research from the social sciences; and are they sufficiently encouraged and supported to communicate about risk and challenge 'bad science'?
3. Engineers and scientists may sometimes require help to become more aware that if they do not pay attention to, and develop expertise in, building trust and meeting the needs of stakeholders, they are unlikely to be successful in gaining acceptance for developments and, indeed, trust in the profession may be undermined. It is therefore vital that the current thinking and recommended good practices, many of which have been summarised in the discussion above, and covered more fully in the IIG paper, become better embedded in the training and continued professional development of engineers at all levels. This does not imply that all engineers should engage in risk communication, as some may not find it easy to engage with the subjective judgement involved. However, it is important that the need is understood by both individual engineers and the organisations in which they practice, and that those with the necessary skills are encouraged to participate in wider stakeholder communication where this is judged necessary and appropriate.
4. The public are faced with increasing challenges in judging the relative importance of the risks they face. Their understanding is not always helped by poor communication and potential bias from those creating the risk, from pressure groups with a particular 'angle' on an issue, and by some parts of the media, which may on occasions exaggerate risks or scare people in order to provide 'a story'. It is thus important that a more 'risk intelligent' society is created and that sources of information are developed which are seen by those with interest and/or concerns about issues to be sources of objective and trusted information.

As a result, three recommendations have been made in the report. Individual engineering professional bodies and the profession as a whole are being asked to consider these:

**Recommendation 1:** A group representing the professional bodies is established to provide good practice guidelines to engineers and safety professionals to improve awareness and facilitate improved analysis of the issues and communication, drawing on existing material and promoting the development of any further tools which may be required, including advice on the circumstances in which wider communication about risks might be appropriate.

**Recommendation 2:** Initiatives to develop innovative and engaging

teaching material (such as the HSE/IIG work to teach risk concepts to undergraduate engineers in a health and safety context) should continue to be endorsed and supported by the professional bodies and used, where appropriate, in ensuring that such issues receive due attention in accreditation. As a broader objective, support should be given to drawing together current developments to provide a portfolio of materials which can be presented to a wider audience in education, industry (and potentially more broadly) as an input to developing a more risk intelligent society.

**Recommendation 3:** The professional bodies, both individually and collectively, should further consider how they can play a role in the wider debate on risk issues which has been proposed in the Löfstedt Report and elsewhere. In particular, they may wish to consider whether the engineering and safety community can be more effective in challenging claims which are at odds with the evidence and, where appropriate, in supporting those in the engineering community who attempt to challenge such claims.

**In conclusion**, although much has been done in recent years in relation to this important issue, the various strands of past work need pulling together and further progress made in the light of the above recommendations whilst recognising the needs of each engineering discipline.

**Your views** and input are welcome through your own professional bodies and through the pages of the Hazards Forum Newsletter.

[1] Engineering Council, 'Guidance on Risk for the Engineering Profession'
http://www.engc.org.uk/ecukdocuments/internet/document%20library/Guidance%20on%20Risk.pdf

[2] Inter Institutional Group on Health and Safety, 'Risk Communication and Professional Engineers'
http://www.theiet.org/factfiles/health/risk-comms-page.cfm?type=pdf

[3] 'Engineering safe sustainable solutions - from build to decommissioning', A speech by Judith Hackett CBE to the Institution of Mechanical Engineers, 11th June 2012:
http://www.hse.gov.uk/aboutus/speeches/transcripts/hackitt110612.htm

[4] Royal Academy of Engineering, The Risk Debate: 'Trust me, I'm an engineer':
http://www.raeng.org.uk/news/publications/list/reports/RAE_risk_debate.pdf

[5] Hazards Forum Newsletter Nos. 76, 77 and 78:
http://www.hazardsforum.org.uk/publications/publications_newsletters.asp

**Members of the Working Group**

| | |
|---|---|
| Dick Taylor (Chairman) | Chairman of the Inter-Institutional Group on Health and Safety |
| Beverley Bishop | Principal Research Officer, Economic and Social Analysis Unit, Health and Safety Executive |
| Andrew Petrie | Chairman of the Institution of Engineering and Technology Policy Panel on Health and Safety |
| Nicola Stacey | Member, Safety and Reliability Group, Institution of Mechanical Engineers and Health and Safety Laboratory |
| Paul Thomas | Chairman of the Hazards Forum |
| Luise Vassie | Director of Policy, Institution of Occupational Safety and Health |
| Graham Barber | Secretariat, Institution of Engineering and Technology |

# HSE eNews – An Example

**++ Successful health and safety management (HSG65) is changing ++**
A new edition of *Successful health and safety management (HSG65)* will be published later this year by HSE. Until the new edition is produced as a hard copy publication, this refreshed HSG65 guidance has been made available by HSE online, as a series of webpages: http://www.hse.gov.uk/managing/index.htm.

# Parliamentary and Scientific Committee

The latest issues of "Science in Parliament", the journal of the Parliamentary and Scientific Committee of which the Hazards Forum is a member, has among its contents the following articles. Any member who would like any further information on any of the articles below should visit the PSC website www.ScienceInParliament.org.uk

| | |
|---|---|
| WIND FARM NOISE ASSESSMENTS | David Unwin and Richard Cox |
| UNDERGROUND COAL GASIFICATION | Dr Michael B Green |
| PHYSICS AND CHEMISTRY SHOW THEIR WORTH | Dr Beth Taylor |
| DO QUALITY, INNOVATION AND PERFORMANCE COMPETE OR COMPLEMENT | Professor Sa'ad Medhat and Dr Sarah Peers |
| ENGINEERING TOMORROW'S WORLD | Professor David Delpy |
| HOW MUCH FOOD TESTING DO WE NEED? | Addresses to the P&SC by Dr Duncan Campbell, Elizabeth Moran and Dr Patrick Miller |
| 100 YEARS OF THE BRITISH ECOLOGICAL SOCIETY | Julie Hodgkinson |
| SUPPORTING EXCELLENCE IN EDUCATION | Dr Mark Jones |
| SPEED | National Science and Engineering Week Seminar: Addresses to the P&SC by Dr Michael de Podesta, Dr Andrew Spence and Professor Alistair Fitt |
| AN OASIS IN THE DESERT | Dominic McAllister |
| EQUIPING THE YOUNG FOR LIFE IN WORK | Ian Morris |
| SKILLS | Address to the P&SC by Dr Julian Braybrook |
| WATER PURITY | Addresses to the P&SC by Clive Haward, Kevin Prior and Professor Helen Jarvie |
| HOW WELL IS WATER? | Dr Dan Osborn |
| WATER PURITY: MICROBIAL ASPECTS, ESPECIALLY CRYPTOSPORIDIUM | Professor Rachel Chalmers |

# 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 to Hazard Forum events is by invitation.

| Date | Event | Venue | Contact/further information |
|---|---|---|---|
| September | | | |
| 24 | >> Hf Evening Event: The Crossrail major infrastructure project – high-end risk management at work | Institution of Civil Engineers, One Great George Street, London, SW1P 3AA | Tim Fuller at admin@hazardsforum.org.uk |
| October | | | |
| 3 | SaRS Event, Hf Supported: SaRS2013 – Metamorphosis: Safety and Reliability in Times of Change | Friends House, 173 Euston Road, London NW1 2BJ | info@sars.org.uk |
| 7 | IChemE Event, HF Supported Hazards 24 Call for papers deadline | Please visit: www.icheme.org/hazards24 | conferences@icheme.org |
| 8 | IMechE Event, Hf Supported: Managing competence – using human factors methods to develop skills and experience | Institution of Mechanical Engineers, 1 Birdcage Walk, London, SW1H 9JJ | Rhiannon Stuart-Jones SRG@imeche.org |
| 15 | IMechE Event, Hf Supported: Software Reliability 2013 | Institution of Mechanical Engineers, 1 Birdcage Walk, London, SW1H 9JJ | Jason Williams at: J_Williams@imeche.org |
| 16 | ICE Event: ICE BIM 2013 – Making BIM Work for You | Grange Tower Bridge Hotel, 45 Prescot Street London E1 8GP | events@ice.org.uk |
| 16 | IMechE Event, Hf Supported: Carbon Capture & Storage 2013: Reporting One Year On | Institution of Mechanical Engineers, 1 Birdcage Walk, London, SW1H 9JJ | Taz Khatun at: T_Khatun@imeche.org |
| November | | | |
| 13 | IMechE Event, Hf Supported : Reliability – managing loss or retention of empirical knowledge | Institution of Mechanical Engineers, 1 Birdcage Walk, London, SW1H 9JJ | Rhiannon Stuart-Jones SRG@imeche.org |
| 26 | >> Hf Event: Supply chain reliability – managing risks for successful outcomes (provisional title) | Institution of Mechanical Engineers, 1 Birdcage Walk, London, SW1H 9JJ | Tim Fuller at admin@hazardsforum.org.uk |

The Hazards Forum's Mission is to contribute to 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 events 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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