



Hazards forum



The Hazards Forum Newsletter

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

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September 2016

New Members of the Hazards Forum Executive Committee

As part of a review of the membership of the Executive Committee, the Committee is delighted to announce that three new members have agreed to join the Committee. This is seen as part of a revitalisation, which will continue to the 2017 AGM, when four of the five Trustee positions will become available for nominations and subsequent election if there are more than four nominations. (Please see *From the Secretary* for more on this at Page 14). All retiring members have been thanked individually.



Eur Ing Bill Hewlett, CEng

Eur Ing Bill Hewlett, MA CEng FICE FIET is welcomed to the Executive Committee as a co-opted member. Bill's career started with an industrial placement year at Sheerness, working in a marine piling gang. His degree at Cambridge, in Engineering Sciences, followed. He held a QUEST Scholarship from the ICE.

Returning to Costain and contracting in 1984, Bill developed his career over a series of major civil engineering projects in the highways, nuclear defence and oil sectors. Highlights included floating concrete structures for the MoD and BP in Scotland, and the Avonmouth Viaduct Refurbishment, near Bristol.

From 1999-2006, Bill was Chief Engineer of O'Rourke (later Laing O'Rourke) leading the design office. The portfolio was more focussed towards construction. The company expanded during this period and addressed many projects of significant innovation and complexity.

In 2006 Bill returned to Costain as Group Technical Director. In this role he oversees engineering in all disciplines and leads the key technical functions. Engineering safety and the health of the engineering community in the firm are key responsibilities.

Bill takes a keen interest in the professions, activity which Costain supports as a contribution to the engineering community and to society at large. From 2010-2013 Bill served as a Vice President of the ICE, since 2009 he has built up the Temporary Works Forum, in 2015 he was elected to the Board of the Engineering Council and in 2016 he became the Chair of SCOSS, the Standing Committee on Structural Safety. He takes a close interest in the education and formation of engineers, both within universities and as a lifelong pursuit throughout careers in industry.



Prof Stephen J Garwood, FEng CEng

Prof Stephen J Garwood BSc (Eng), ACGI, PhD, DIC, FEng, CEng, FWeldI, FIMechE, FIMMM is welcomed to the Executive Committee as the Royal Academy of Engineering's Observer. Steve studied Mechanical Engineering at Imperial College, graduating in 1973, followed by a PhD in Applied Mechanics. He developed his early career at the Welding Institute where he became Head of Engineering in 1989 and subsequently Head of Structural Integrity.

Steve joined Rolls-Royce in 1996 as Technical Director of Rolls-Royce and Associates, becoming Director of Engineering & Technology for Marine Power in June 1998. He took up the corporate position of Director of Technology at Rolls-Royce plc in January 2000 and then joined Operations as Director of Materials in January 2002 before returning to the re-organised Rolls-Royce Marine business as Director, Engineering and Technology – Submarines in April 2006. In 2013, Steve directed the research activities for the Nuclear Sector in particular links with Rolls-Royce's Nuclear UTC's at Imperial College and Manchester.

Steve is a Chartered Engineer; a Fellow of IMechE, IOM3 and TWI and was elected to the Royal Academy of Engineering in 2002. He was principal author of the RAEng report on 'Industrial Systems' published in 2012. He became a visiting Professor in the Department of Mechanical Engineering, Imperial College, in December 2006. Following retirement from Rolls-Royce in Dec 2013, Steve joined the Mechanical Engineering Department at Imperial College, London as Professor of Structural Integrity. He is also a Non-Executive Director of the Transport Systems Catapult and serves on a number of Nuclear Advisory Committees.



John Steed, CEng

John Steed BSc (Eng), ACGI, CEng, FIET, DipEM, CMIOSH is welcomed to the Executive Committee as a co-opted member. John is a retired HSE Specialist Electrical Networks Inspector. Before spending 15 years as a regulator in which he carried out a number of high-profile investigations and enforcements, John held a variety of posts in the electricity supply industry for 26 years. These comprised all aspects (policy and delivery) of operations, control, design, construction, installation and maintenance of all power system equipment up to and including 132,000 Volts.

In his career, John was particularly interested in asset management, reliability, safety management, condition monitoring and maintenance and has published around 15 papers to IET conferences and colloquia on these topics. In addition to this, John has chaired some national and local professional committees within the IET and has been a member of several international conferences on the reliability of transmission and distribution networks, chairing one of the conferences.

His interests in health and safety together with attendance and support at very many Hazards Forum events has furthered his interests in all aspects of risk associated with the energy sector; including human factors and the vital role that human asset management plays towards successful physical asset management.

John has now set up his own consultancy – jsriskmanagement that will offer advice and support to amongst others, those duty holders who have licenced or unlicensed electrical networks.

Procedural Compliance: What works and why?

Neil Carhart

On **Tuesday 14th June 2016** the Hazards Forum hosted an **evening event** at the Institution of Civil Engineers, One Great George Street, Westminster, London.

The final defence against major hazards are the people who have the necessary skills, competences and diligence to never take unacceptable risks. This would be nice, but since the very nature of people is to err, this last defence is at best unreliable. It is not always possible to engineer hazards out of the equation or substitute non-hazardous alternatives. Add to that the fact that despite its importance, rule and procedure development often doesn't receive the care and thought it deserves. This event is designed to provide a forum to hear and discuss these issues based on studies carried out across a number of environments and to examine what works and why.

Dr Luise Vassie welcomed all those present to the event on behalf of the Hazards Forum. Following an expression of thanks to the evening's sponsors, Lloyd's Register and the Institution of Civil Engineers, she introduced the chair for the event: **Sir John Armitt CBE, FREng, FICE**. Sir John is currently Chairman of the National Express Group, the City & Guilds Group and Deputy Chairman of the Berkeley Group. He is President of the Institution of Civil Engineers and a member of the Board of Transport for London. Sir John was awarded the CBE in 1996 for his contribution to the rail industry and received a knighthood in 2012 for services to engineering and construction.

The first speaker of the evening was **Professor Andrew Hale**, Emeritus Professor of Safety Science at Delft University of Technology and Chairman of HASTAM Ltd. Drawing on recent studies on the effectiveness of safety rules, he discussed the need to accommodate the two faces of rules – an essential element

in safety management, with education and disciplinary action as their handmaidens, aiming to achieve as close to 100% obedience as possible and, on the other hand, guidance to be flexibly interpreted in accordance with circumstances, with compliance being defined in terms of meeting goals and not of following detailed rules.

The second presentation, '*Changing culture in a technical workforce: How do you improve compliance?*' was given by **Garry Moon**, Principal Consultant in the Human Factors team at Lloyds Register. Garry presented a case study set in a mature oil and gas production organisation that identified the need to combat complacency, improve operational discipline and set new standards of behaviour. He described a multifaceted approach to support workers in developing baselines for acceptable behaviour, removing the perceived barriers and developing a desirable 'chronic sense of unease' to combat complacency.

The final talk came from **Elaine Vinton**, Principal Inspector for Nuclear Safety and Professional Lead for Human Factors in Office for Nuclear Regulation. Set in the context of the nuclear sector, Elaine addressed some key questions, including: What is the legal position for procedures and operating instructions and what does this mean in practice. What do we mean when we talk about procedural compliance, 'fit for purpose procedures' and how can procedure quality, use, and adherence be improved? What does a licensee need to have in place to deliver these requirements and associated expectations? She also outlined good practices across the nuclear industry and explained why an integrated and systematic approach is important.

Sir John set the scene for the talks by emphasising the responsibility of engineers to manage risk and eliminate

hazards. Those undertaking major engineering projects must do everything they can to live up to the trust the public places in them. The UK has a proud history of undertaking rigorous risk assessment processes, despite criticisms from some of the burden they can create. When looking at past disasters - be they in the nuclear, rail, oil and gas or construction sector – time and time again the role of human action is evident. The human action is itself a product of the environment and processes created by the organisation. It is therefore important to reflect on, and improve, the organisational systems that can influence and shape human behaviours.

The first speaker of the evening, **Professor Andrew Hale** then began his talk '*Rules – Sound Foundations?: Working to rule and/or working safely?*' during which he described the lessons drawn from a recent study into the academic literature on the dilemmas associated with rules and procedures.

Well-designed situations should be self-explanatory and avoid the need for written rules. However, even when the rules are clear, examples of people violating them may not be hard to find. Some rules are meant to be followed all the time to the letter, while others may be advisory as a baseline in case better methods are not available.

This leads to two contrasting paradigms on rules, the first being one in which rules or procedures are seen as the essential and obligatory foundation for safety. Under this worldview procedures are required as a 'user manual'. They are seen as a central focus for instilling the attitudes valued as part of a safety culture. The failure to follow the rules is often cited as one of the most common causes in accident investigations.


Andrew described how in the past certain industry regulators had been caricatured as having an approach whereby investigations were conducted until someone who broke a rule was identified and declared the cause of the event. If

someone did not break a rule, then a rule was created to stop the event from reoccurring.

This is a top-down paradigm with its roots in scientific management. It is methodologically rationalist, prescriptive and static. This paradigm holds that rules can cover all eventualities and embody the single best way of accomplishing a task. The rules are worked out in advance by experts who to provide protection from the fallible operators who lack the time, motivation or knowledge to create their own rules. These rules are imposed and enforced on the operators. Any deviation from the rules is looked down upon and suppressed.

This paradigm is aligned with the classical approach of engineering, where people are essentially treated as analogous to machines. It fits those with an authoritarian style of management. Behavioural safety and behavioural economics are based on this sort of top-down paradigm. Auditors, regulators and compensation claimants often adopt a version of the paradigm in their search for non-conformity, rule breaking and breaching the law as it can make prosecution easier. The media frequently adopt this paradigm for similar reasons. Those who desire off-the-shelf safety manuals and 'old fashioned' accident investigators are also adherents of this paradigm.

There is research evidence to support the value of this perspective. The literature shows that if you have simple, observable behaviours with no acceptable exceptions or deviations then this rule-based structure can be implemented. Compliance can be monitored and measured. Feedback, both praise and discipline, can be given to improve compliance and create a virtuous cycle. There is extensive research about the correlates and indicators of non-compliance and situations that will increase rule violation including: *the perception of low risk*, *the inconsistency in sanctions from management* and *conflicts between rules*.



PARADIGM 1: Non-compliance

<p>Individual factors</p> <ul style="list-style-type: none"> • Perceived low risk/consequence • Habit of non-compliance • Low level of knowledge, training, experience • High value on macho ways to work, self-image & status among peers • Sees ways to make short cuts, or save energy: high self-efficacy/powerfulness • Male & young in driving (not in other arenas) 	<p>Organisational or safety climate factors</p> <ul style="list-style-type: none"> • Management turns blind eye or inconsistency in sanctioning • Poor cooperation/cohesion between workers & supervisors • Subjective group norm to violate: 'a skilled person can violate this way with impunity' • Conflicting demands: productivity, time pressure, workload, incentive pay
<p>Hardware/activity factors</p> <ul style="list-style-type: none"> • Complicated, difficult or changed design • Design/layout making violation necessary to achieve objectives: • Compensation for poor equipment 	<p>Rule related factors</p> <ul style="list-style-type: none"> • Difficult to understand/comply, • Out dated rule, or conflicting rules, • Rule seen as not appropriate for the organisation/activity • Too many rules

Research also indicates a clash of cultures in the perception of rule violation. Data shows Senior Managers agreeing with the statement that “people don’t have to break safety rules to get jobs done” more strongly than the Operators.

The second paradigm believes that procedures are generated through experience. They are socially constructed patterns of behaviour emerging from those undertaking the relevant tasks codified into a repository of organisational memory. In this sense, it is a bottom-up view of rules. The creation and continual development of the rules needs to involve those enacting them. This paradigm recognises that the rules can never cover all eventualities except in very simple situations. The rules often take the form of heuristics which include ways to work out what to do when the rules no longer fit. This viewpoint sees the operators as the real experts; their ability to adapt defines their competence and is essential.

Rules are seen as generic and underspecified in that some situation will be unanticipated. The rules are a resource that can be offered to people to help them do the right things.

This tends to be the dominant paradigm within the schools of ethnography, sociology, organisational studies, and increasingly, within the domain of resilience engineering. The operators and their immediate supervisors ascribe to this paradigm. It is particularly common among professional ‘operators’ such pilots, surgeons, maintenance fitters, air traffic controllers etc. as they find themselves

undertaking complex, diverse, dynamic and uncertain tasks. The complexity is such that even if you could prepare procedures and rules for every eventuality it would be impossible to get all of the information into people’s heads. The volume of rules required would be counter-productive as operators might be less likely to look for the relevant rules.

As with the first paradigm, there is research evidence to support the efficacy of this bottom-up approach. There has been a lot of research comparing the views of designers and rule makers with those of the operators. This suggests that those creating the rules have inadequate models of the operations they are attempting to make rules for and inadequate models of the operators themselves. There is a lot of literature suggesting that while rule following helps if you are a novice, experts outgrow the rule and learn to adapt them. Professionals can be observed to resist proceduralisation, seeing it as a barrier to innovation.

Andrew suggested that these two paradigms can be reconciled if rule management is seen as a continual process. It is not a one-off task that rule managers can leave behind. The rules should not be static. They have to be monitored and optimised. Removing rules is an essential task, but something that organisations often overlook. The challenge can also be approached by developing a hierarchy of rule types to match the variation in the complexity of different operations. Some may require performance goals, some may need decision processes and others still might require rigid, detailed prescribed actions. Some situations warrant compulsory rules while others will be better suited to guidance. The most important element is to establish a continual participatory dialogue on rule making, monitoring and improvement. People need to be trained to take a role in the cycle of evaluating, adapting and improving the rules that should be built into all organisations¹.

The second speaker of the evening, **Garry Moon** continued the discussion from his perspective as a psychologist working on a unique project. He set the scene by describing his background working in the on-shore and off-shore oil and gas sector. The project in question was different from the norm, which is often motivated by reaction to a specific unwanted event. In this example the client organisation had identified what they felt was an over-reliance on procedural compliance. Any deviation from the procedures presented a significant risk. The facility involved was not in the UK, but was staffed by 40% British staff and 60% nationals of the country in which it was located. The organisation was interested in the cultural differences between the ex-pats, who were familiar with the experience and lessons of events such as Piper Alpha, to those from the host country that was relatively unfamiliar with the oil and gas industry. The management were very supportive and provided resources to investigate and address these issues.

The first stage of addressing such a concern involves benchmarking and gap analysis. For this, Lloyds Register Consulting has a number of tools.



This involves an Organisational Integrity Framework through which important formalised organisational systems concerning *leadership* and *workload management* can be assessed to give a view of the organisation's behaviour. Safety Culture sits at the middle of this framework. This framework was applied to a specific team at the client organisation who worked with a particular piece of equipment that was of interest.

This only gives a partial picture. It was necessary to establish whether the observations of that team were specific to them, or were general to whole organisation or even the region. In order to assess this Lloyds Register Consulting implemented their Safety Climate Assessment tool. Garry explained that this is somewhat different to other safety climate tools in that it incorporates an awareness scale. This seeks to identify how familiar people are with the processes of safety management (e.g. risk assessments, root cause analysis, hierarchies of control etc.). Such information is useful in identifying groups who both understand safety management and see improvement areas in their organisation. Also, non-experts tend to have a lower baseline of what a good safety culture looks like which can lead to organisations receiving overly positive results.

Using these tools it was possible to devise a series of interventions. This forms the second stage of the process. One such intervention was to provide training on *behaviours in emergency response*. This was in order to address the fact that people were not responding appropriately to incidents that fell between emergencies and routine operations. This set out to create a set of rules for situations where operators were unsure how to react. Other interventions included Human Factors Incident Analysis, leadership support and cultural reassessment.



There was a particularly significant issue concerning procedural compliance. To address this, the team first sought to understand the reasons why people were not using procedures. The staff members

were observed in the course of conducting their responsibilities, they were interviewed and the systems they used were analysed. The procedures themselves were sampled and assessed. Everyone knew that the procedures existed for certain tasks, and normally there was something of value in the written procedures. In other words the procedures were not redundant for the tasks they were intended.

Garry grouped the drivers of procedural compliance around three themes related to process, people and plant. With regards to process there were issues around the clarity of expectations. People were using the procedures in order to train others how to conduct a task, but they would not use them themselves in practice. So prevalent was this perception that procedures were there to aid training that they were not being used in practice even for critical tasks. Additionally it was unclear within the organisation which procedures were mandatory and which provided optional guidance.

The second theme, concerning people, was motivation. While it is necessary to look at the written procedures themselves, if people are not actually looking at them then the quality is moot. Within the organisation in question there were issues around the motivation to actually pick up the procedures in the first place. To address this, the culture of teams within the organisation was investigated. The aim is for 4 out of 5 people within a team to always use the procedures. This is generally sufficient to motivate the 5th person to change. This was the same when scaled up to the workforce of local people. If 80% of the workforce were committed to always following procedures then the remainder and any new members of staff would start behaving like the majority. Achieving this required management support.

The final theme concerns the procedure's ease of use. This relates to the accessibility, readability, clarity and logic of the procedures.

Using Edgar Schein's model, Garry discussed how culture cannot be changed by direct attempts to change the culture. Explicitly challenging people's beliefs can make them defensive and result in their beliefs being reinforced. Instead, changing the culture requires changing the artefacts, and positively changing the artefacts requires knowledge of the team interacting with them.

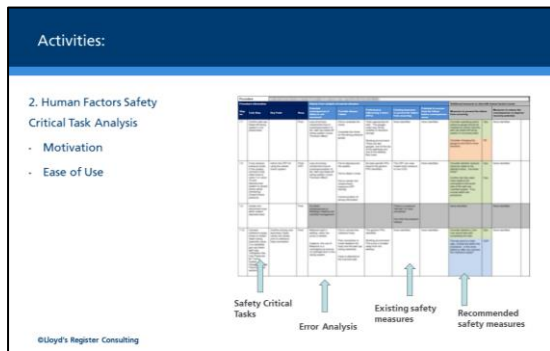
In this case, every member of the team had a degree in engineering. The project was well resourced, meaning there were lots of opportunities to spend time with the team. One challenge was that while the procedures had to be written in English that was the second or third language of many of the team members. There was no shortage of effort from the team though, who were set to be the future leaders at the facility due to a policy of nationalisation.

A procedure was established for how to change procedures. This was a standard that really made the organisation think about involving broad representation in this process. This is important as, at the core of the task, is the need for those following the procedures to feel a sense of ownership over them, rather than view them as something that had just been given to them.

A good practice guide was issued in an attempt to ensure that the procedures were clear and easy to use. This set out how procedures should be written and what they should look like.

People within the organisation needed to understand that mistakes were possible. A process known as '*Human Factors Safety Critical Task Analysis*' was used to achieve this. It asks experts how others could make mistakes in conducting a task, and how they themselves could make mistakes. This leads them to consider why others would make those mistakes but they would not. It also reveals a large number of possible situations that could lead to a major accident. It can be an arduous task, but it provides the motivation for people to accept that

mistakes were possible, and uncovers potential improvements to the procedures and equipment. For example, it may reveal changes to labelling of equipment that could lead to less mistakes being made.



This was followed by the task of re-writing the procedures. This implemented certain formats that have a recognised history of success in terms of their clarity and ease of use. One such format involves the requirements for the user to write on the procedure itself. For each use the individual would print a copy of the procedure and sign each step as they went along. If there were two people involved then both of them would sign each step.

Drafts of the re-written procedures were then discussed and analysed in workshops with the experts. Front line production technicians, engineers, supervisors and others were asked for feedback on whether the procedures reflected the way the tasks should be performed. By the time these workshops had been completed around 80% of those who would ever need to use the procedure in any way had been through the process of reviewing it. This included both desk reviews and reviewing the procedure on site. This developed a sense of ownership.

The next stage involves monitoring. There is no point in re-writing the procedures if people do not do the things that are required of them. This required some changes to the protocol relating to the way the supervisors and other senior staff undertook their monitoring. It is very easy to see someone with a procedure in their

hand and use this as confirmation that the procedure is being used. This is why techniques such as dual sign-off can be so useful. There are two approaches to dual sign-off. The first is where one person reads the procedure aloud while the other enacts it. This actually creates a risk as it introduces the potential for communication issues. The second involves action and confirmation. For example the first person reads the procedure and confirms with the second that they have understood what they must do; the first locates the relevant component and checks with the second that it is correct; the first person enacts the procedure and confirms with the second that they are doing it correctly, and so on. This second approach was the level the staff were operating at after three years of the project to improve the procedures. Any deviation from this can be picked up and corrected. In one case a supervisor witnessed workers operating under the first approach, leading to the whole team being called together to discuss whether this was the agreed method.

Under the old system, the printed procedures were disposed after they had been used. To improving auditing, the new system asked that procedures were scanned or placed into a folder after they had been signed-off so that the supervisor could later audit them.

Under the previous system procedures indicated at the start how many competent people were required. However, the notion of competence was not always clear. Competence was commonly interpreted as people with a particular degree of experience, overlooking the fact that competence can go down as well as up. To address this a list was produced each week of everyone in the team formally recorded within the system as currently having competence to perform the different tasks. At the end of the project there was a greater understanding of what competence was, that it could change and be verified, and that anybody on the list was competent to follow the procedure.

The project challenged a ban on paper procedures. A critical task was analysed and the process of accessing the emergency procedures mapped. If a mistake was made in managing a particular machine it was likely that they could not recover within fifteen minutes. The process of getting the team together, getting the emergency procedure and taking it back to the machine was timed. This took twelve minutes, giving three minutes to resolve the situation. Placing a printed version of the procedure in a weatherproof case next to the machine and assigning a senior person with responsibility for updating the procedure, five minutes could be saved.

Unfortunately, around two years into the project a climate survey revealed that over time the workers became more complacent. Human Factors awareness training was introduced for front-line roles. This training was designed to counter this complacency and reintroduce an awareness for the things that could go wrong, and an appreciation for the fact that mistakes could happen. The training also looked at ways in which these mistakes could be managed from a Human Factors perspective.

Garry concluded by summarising the motivation behind the intervention he had described as understanding and managing the cultural perceptions that underlined the behaviours of the group.

Elaine Vinton from the Office for Nuclear Regulation (ONR) gave the final talk of the evening on '*Procedural Compliance – regulatory expectations*'. Elaine set the scene for her talk by describing the legal framework for the nuclear industry. ONR is now a public body operating under the Energy Act 2012, having separated from the Health and Safety Executive. The Nuclear Installations Act 1965 is also a relevant statutory provision. The industry must also work to the Health and Safety at Work Act (HASWA) 1974 and other related UK regulation. These provide the main basis for regulation by ONR on British nuclear sites, and related activities and sites.

The UK has a goal-setting rather than prescriptive regulatory regime, although there are some exceptions. This means that it sets out what must be achieved, but not the means by which it must be done. The ONR sets out expectations and requires the Licensee to determine and justify how best to achieve them. This allows operators to be innovative and to achieve the required high levels of nuclear safety by adopting practices that meet their particular circumstances. The Licensee must demonstrate that they are achieving the goals and controlling risks. It encourages continuous improvement and the adoption of good practice to ensure risks are reduced to as low as reasonably practicable (ALARP).

Elaine then posed the question: why do we need procedures? Firstly, it is a legal requirement. The Management of Health and Safety at Work Regulations (MGSWR) 1999, Regulation 3(1) places a legal requirement for a risk assessment, and (4) require the production of a preventative and protective measures to control risk. The assessments may identify procedures as a part of providing such measures as part of the hierarchy of control. HASWA refers to necessary instruction and information, clearly pointing to the need for procedures. Nuclear operators must also adhere to the conditions of their licence to operate. Licence Conditions (LC) 23 and 24, dealing with Operating Rules and Operating Instructions respectively, are also relevant to this legal necessity for procedures.

ONR lays out its expectations at three levels. The first relates to the Licence Conditions 23 and 24; the second relates to the Technical Inspection Guides that support the Licence Conditions and provide guidance for ONR inspectors, and; the third are the Safety Assessment Principles and their supporting Technical Assessment Guides. While these Inspection and Assessment guides are aimed at the community of regulatory inspectors, it is understood that the industry will also utilise them.

LC 23(1) says that “The licensee shall, in respect of any operation that may affect safety, produce an adequate safety case to demonstrate the safety of that operation and to identify the conditions and limits necessary in the interests of safety. Such conditions and limits shall hereinafter be referred to as Operating Rules.” There are a whole hierarchy of rules from low hazard to high hazard events.

LC 23(3) says “The licensee shall ensure that operations are at all times controlled and carried out in compliance with such Operating Rules.” In other words, once the limits and condition have been set, the licensee has to make sure they are actually being delivered in practice. Licence Condition 24 looks at Operating Instructions themselves as shown below.

LC24 Operating Instructions

- 24(1) The licensee shall ensure that all operations which may affect safety are carried out in accordance with written instructions hereinafter referred to as operating instructions.
- 24(2) The licensee shall ensure that such operating instructions include any instructions necessary in the interests of safety and any instructions necessary to ensure that any operating rules are implemented.
- 24(4) The licensee shall make and implement adequate arrangements for the preparation, review and amendment of such operating instructions.
- 3,5 and 6 concerned with regulatory powers

These Licence Conditions therefore set out very clear and strong expectations for licensed operators in terms of procedure, presenting challenges in how these expectations can be best met.

Beneath these Licence Conditions are Safety Assessment Principles that provide guidance to the inspectors who will seek to identify whether or not these conditions, and others, are being met. These provide specific guidance on assessing procedures. For example, they say “Procedures should be produced to support reliable human performance during activities that could impact on safety”. Furthermore they should be accurate and designed and presented in a format that is compatible with the needs of the end user. They should be suitable for the task that they are designed to support.

From the Human Factors perspective, the focus is on the role of procedures in providing task support to reduce risks to as low as reasonably practicable. They should aid operators in carrying out their tasks.

In addition to these legal requirements, procedures are also necessary to implement the limits, conditions and administrative controls. They act as an error reduction tool and to mitigate the limits of human memory. We cannot hold all task steps in memory, regardless of experience. Procedures also standardise working practices across facilities and act to alert operators to any departure from expectations, and guide them in the correct responsive actions. In other words, to warn operators that something hasn't gone to plan, and provide them with sufficient information to bring the situation back to a safe position.

Elaine reflected on these elements representing two sides to the provision of procedures: as both a legal requirement and for error reduction. This can lead to a tension between the compliance related requirements that ensure all task steps are represented and followed, and the requirement to suitably support those enacting the tasks. In order to deliver both elements there is an increasing emergence of Procedure Quality Use and Adherence (PQU&A) programmes.

Operators can feel de-skilled by the requirement to use procedures, particularly for frequently performed tasks that they perform as part of a routine. The key to avoiding this is to provide *fit for purpose* instructions, though this is itself a challenge. This can be viewed in terms of the quality and usability of the procedures, both in terms of the content and the format through which it is delivered. This in turn requires an understanding of why procedures are not followed, as discussed in the previous two talks. Issues such as inaccuracy, availability, difficulty of use, real or perceived easier methods, poor risk perception and culture can all play a role.

The ONR's expectations try to address these issues. Instructions should reflect all operator actions identified as necessary to ensure the safety and operability of plant and ability to influence a safety function, including design and safety case requirements, equipment qualification requirements and manufacturers recommendations. Procedures should be accurate, straightforward, designed and presented in a format compatible with the needs of the end-user and suitable for the task that they are designed to support. They should take into account who will be using them and the sort of tasks they will be using them for. The ONR expects that procedures take into account the need to demonstrate 'active' real-time compliance with conditions and limits necessary in the interests of safety; detect non-compliance and facilitate the successful performance of recovery actions. This means that systems should support immediate notification if something uncompliant is witnessed. If the safety case claims independent checking will take place, then the operating instructions should reflect those requirements. This could be through independent instrumentation or separate checklists.

In addition to this, the procedures should be consistent with conservative actions, and provide information necessary to recover from malfunctions, faults or failures during operations. Personnel should have the necessary instructions at the task location and in an appropriate format. There is an expectation for evidence that they are being used appropriately.

Procedures are only one of the factors affecting the reliability of operator action associated with the implementation of administrative controls. Other key factors need to be inspected such as human-machine interfaces, task design and the demands it places on individuals, the environment, supervision and training. There shouldn't be too much reliance on procedures as a control mechanism.

Elaine then turned to look at procedure management. The production of the

procedures should be considered including the corporate style to ensure consistency. Task analysis should be used to inform the content and to understand what activities the operator needs to undertake and the challenges they may encounter. The procedures should also be validated and the level of use taken into account. The procedures should be maintained and revised proactively and on the basis of use, checking that they are delivering their intended purpose. Review and amendment should be linked to any modification processes, but should also be periodic.

Amendment of procedures should be responsive and flexible to the concerns and comments of operators. If the processes do not welcome or react appropriately to suggestions for improvement then operators may lose trust. Version control is essential, as are records of compliance and training.

While the ONR has many expectations on procedure use it is important to remember that this does not necessarily mean there must be a procedure in hand, followed step by step for every part of the task. It must be based on the nature of the task, its potential consequences, its complexity, its safety significance, the potential for error, the frequency with which it is conducted, and the experience of the user.

The experiences of the ONR have highlighted some common areas where licensees can go wrong. Sometimes they can respond to events by simply revising the procedures or adding new ones. There can be an excessive focus on achieving compliance through behavioural aspects. A one-size-fits-all philosophy can produce negative consequences as opposed to assessing the procedures' fitness for purpose. There can be a focus on increasing responsibility, that is to say the dogmatic apportioning of blame based on failure to adhere to procedures. Some organisations use the wrong people to develop the procedures, in particular failure to involve the user or having no Human Factors involvement. Licensees

can also go wrong if they fail to link procedures with training.

Elaine concluded by discussing procedural improvement, stating that it should be based on a risk-based review to produce a prioritised programme of the identification and resolution of risk gaps. There should be a central body to 'own' the issues and provide governance. Importantly, users should be involved in the process of improvement.

Sir John Armitt thanked the speakers for their talks before opening the session up to questions from the audience. The first question highlighted the behaviours of engineers, and asked what one thing the panellists would like to see done within engineering degree programmes to make a difference to future outcomes.

Elaine suggested that an awareness of Human Factors could make a valuable contribution to the education and performance of engineers. There should be an emphasis on both the operability and functionality of design. Andrew added that we need to teach engineers to be less optimistic about the things that they design. There should be increased awareness of what could go wrong and what could be done at the design stage to make those failures less likely.

The second question asked whether the panel members had looked at the mechanisms behind the degradation of procedures and whether these could be countered in the design of procedures. Garry described the difficulty in balancing the need for users to be able to amend and update the procedures with the need for appropriate oversight to make sure that those amendments are appropriate. The length of time this oversight takes can be important, the shorter it is the more likely people will follow the correct amendment processes. Andrew added that the process of degradation needs to be visible. The organisation and staff must accept that the degradation of procedures is somewhat inevitable. If approached correctly it can create opportunities to improvement. Elaine explained that there

are a number of ways to identify whether a procedure is no longer fit-for-purpose. Some of the common human performance tools, such as pre-job briefs, toolbox talks, and post-job reviews should provide opportunities to identify the degradation of procedures and reinforce the expectation to amend and improve them.

The third question asked the panel what single piece of information they would like to see implanted in the minds of the board. Garry suggested that it should be the realisation that good safety performance leads to good performance in all dimensions. Elaine recommended that any board should understand the role they play in setting expectations, both explicitly and implicitly through their actions. Andrew reflected on the difference of opinion between operators and senior management. Senior managers need to realise that there can be a gap between the model of the system as they understand it and the one used by the operators. This is a result of the challenge of communications between these two different groups. Sir John added that a company's culture can be an important factor in promoting good communications and therefore an important issue when trying to close gaps in understanding between the different organisational layers.

The fourth question asked whether the panel had any thoughts on the differences in culture and approach to safety across different engineering sectors. Garry suggested that some industries may seem better than others by virtue of the differences in the likelihood and consequences of the hazards they face. Andrew added that another important factor to consider is when the industry opened up to consider the lessons from other industries. The oil and gas industry, for example, did this much earlier than rail industry.

The final question reflected on what was perceived by the audience member to be the short-term view of the Construction Design and Management (CDM) Regulations, and asked to what extent

rules and procedures could be used to establish the long-term development of safety, particularly in relation to learning from best practice. Elaine highlighted that it had been some time since the nuclear industry had embarked on any significant construction activities, and indeed the alignment of expectations between the construction and nuclear sectors, as embodied in regulations and rules, was an important issue.

Sir John reflected on each of the talks and concluded that a key lesson from his own experience, and articulated by the speakers, was that for rules and procedures to be truly effective, those at the operational level tasked with following them had to feel valued within the organisation. Their expertise should be recognised and their concerns addressed. Everybody should be supported to engage in the process of improving the procedures and improving safety. He thanked the speakers once more before handing over to Luise Vassie to close the event. Luise thanked Sir John Armit for chairing the event, the panel for sharing their

knowledge, the ICE for hosting the event and finally the audience for their participation. Those in attendance were invited to continue their discussions over refreshments.

¹Further information on Andrew's work can be found at www.iosh.co.uk/rulesandprocedures and in the following publications:

Hale, A., & D. Borys, 2013, Working to rule, or working safely? Part 1: A state of the art review. *Safety Science*, 2013, v55 pp207-221

Hale, A., & D. Borys, 2013, Working to rule, or working safely? Part 2: The management of safety rules & procedures. *Safety Science*, 2013, v55 pp222-231

Hale, A., D. Borys & M Adams, 2015, Safety regulation: the lessons of workplace safety rule management for managing the regulatory burden. *Safety Science*, 2015, v71 pp112-122

From the Secretary...

In the Summer Newsletter (NL 91), the last paragraph of the write-up of the Hazards Forum 2016 AGM included the announcement that the **next Annual General Meeting** is planned to be held at the Institution of Civil Engineers on **Tuesday 28th March 2017**. As mentioned on Page 2 of this edition of the Newsletter (NL92) in the introduction to the announcement of the three new members of the Executive Committee, the revitalisation of the committee will continue to the 2017 AGM, when **four of the five current trustee positions** will become available for nominations beforehand, with subsequent election at the 2017 AGM if there are more than four nominations. **The new chair of the Hazards Forum** will need to be one of that revitalised group of trustees. The trustee's position that does not conclude at the 2017 AGM, will do so at the AGM in 2018.

It is thought that **Member organisations** will appreciate knowing this well in advance of the official notice for the 2017 AGM, which is due in January, and which will include the official call for nominations for the four trustee positions. This gives the opportunity for **early consideration of potential candidates**, especially as the **new Hf chair** will come from the trustees, once they are all known **at the AGM**.

As background, Trustees, have traditionally been chartered members of (one or more of) the four founding engineering institutions. The latter are still the principal stakeholders of the Forum, of course. **Hf Chairs**, to date, have thus been similarly qualified, although usually FREng as well. At the last intake, someone from a different professional discipline was welcomed as a trustee. The professional diversity of ExCom has also widened. *Brian Neale*

Royal Academy of Engineering Elects Top Engineers as Fellows at its 40th Anniversary AGM

The Royal Academy of Engineering is today proud to welcome 50 of the UK's finest engineers as new Fellows on the day of its 40th annual general meeting.

Newly elected Fellows include Professor Sarah Hainsworth of the University of Leicester - the engineering forensic expert who recently helped establish the fate of King Richard III, Chris Dulake – former Chief Engineer for Europe's largest infrastructure project, Crossrail, Dr Barbara Lane - Arup fire safety engineering pioneer, Dr Peter O'Hearn – engineering manager at Facebook, and Sir David Higgins – Chairman of HS2, who led the London 2012 Olympics build as Chief Executive of the Olympic Delivery Authority.

The Academy is also pleased to welcome Thomas Heatherwick CBE RDI as an Honorary Fellow. As the founder of Heatherwick Studio, Thomas' unique designs are recognised the world over – from the iconic cauldron of the 2012 London Olympic Games to the Routemaster-inspired New Bus for London, in addition to acclaimed buildings in Singapore, Hong Kong, Shanghai and beyond that have made creative use of materials to combine engineering, architecture and sculpture.

Professor Dame Ann Dowling OM DBE FREng FRS, President of the Royal Academy of Engineering, said: "For 40 years the Academy has gathered the wisdom, ingenuity and expertise of the nation's finest engineers to advance and promote excellence in the profession. I am delighted to welcome to our Fellowship 50 more of today's very best engineering minds. From life-changing equipment revolutionising our hospitals to new tools that are enabling high-tech businesses to flourish, their work has delivered great value to society. We are very much looking forward to working with all our new Fellows as we continue to make the UK a leading nation for engineering innovation."

“The father of Process System Engineering” – founding Fellow receives Sir Frank Whittle Medal

Roger Sargent FREng, Emeritus Professor and Senior Research Fellow at Imperial College London, who has been advancing the field of process systems engineering since the 1950s, has been honoured with the Royal Academy of Engineering's Sir Frank Whittle Medal. He received the Medal at the Royal Academy of Engineering's Annual General Meeting on 8 September, 40 years since the inaugural meeting of the Academy at which he was a founding Fellow.

Professor Sargent was among the first to recognise the need for a branch of chemical engineering concerned with the issues of how to design and operate processing facilities, leading the way in developing an approach based on mathematical techniques and developing the first commercially-available simulation software for the industry, SPEEDUP. He went on to found the Centre for Process Systems Engineering (CPSE) in 1989 at Imperial College London.

On receiving the award, Professor Sargent said: "I am proud to follow in the tradition set by Sir Frank Whittle".

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 is by invitation to Hf Events.

Date	Event	Venue	Contact/further information
September			
20 th	Hf Event: The Nuclear Legacy - Progress with Hazard Reduction at Chernobyl & Fukushima and Regulation of the Legacy in the UK	IMechE, 1 Birdcage Walk, Westminster, London SW1H 9JJ	admin@hazardsforum.org.uk
25 th -29 th	SaRS Event: ESREL 2016, Glasgow UK	Conference Centre of the Technology and Innovation Centre (TIC), Glasgow, UK	http://www.sars.org.uk/events/esrel-2016-glasgow-uk/
26 th	IMechE Event: High Speed Rail Technologies	IMechE, 1 Birdcage Walk, London SW1H 9JJ	http://events.imeche.org/ViewEvent?e=6390
October			
4 th	IET Event: Critical Infrastructure Safety	Bromley Central Library, Bromley, UK	http://www.theiet.org/events/local/240291.cfm?nxtId=241306
6 th	SaRS Event: SaRS2016 – Don't stop thinking about tomorrow: tools and techniques for managing an uncertain future	HSE's Foresight Centre, Health and Safety Laboratory, Buxton.	http://www.sars.org.uk/events/sars-2016/
11 th	IMechE Event: Rail Sustainability: Planning for the Future	IMechE, 1 Birdcage Walk, London SW1H 9JJ	http://events.imeche.org/ViewEvent?e=6412
11 th -13 th	IET Event: SSCS –System Safety and Cyber Security Conference	IET: Savoy Place, 2 Savoy Place, London WC2R 0BL	http://conferences.theiet.org/system-safety/?nxtId=237427
25 th	IChemE Event: Piper Alpha: What happened and what can we learn?	Department of Chemical Engineering, Imperial College London, SW7 2AZ	http://www.icheme.org/communities/member%20groups/uk-member-groups/london%20and%20south%20east/events/2016.aspx
28 th	IET Event: NATO's Submarine Emergency Response Team & Russia's Kursk Disaster	IET: Savoy Place, 2 Savoy Place, London WC2R 0BL	http://www.theiet.org/events/local/237427.cfm?nxtid
28 th	ICE Event: ICE Transport Asset Management 2016	Institution of Civil Engineers, One Great George Street, Westminster, London, UK, SW1P 3AA	https://www.ice.org.uk/events/ice-transport-asset-management-2016
November			
8 th	ICE Event: From Risk to Resilience: Practice made perfect	Pugsley Lecture Theatre, Queens Building, University Walk, University of Bristol, Bristol, UK, BS8 1TR	https://www.ice.org.uk/getattachmen t/eventarchive/brunel-international-lecture-2016-london/11th-Brunel-International-Lecture.pdf.aspx
15 th -16 th	IMechE Event: International Rail Accident Investigation Conference	IMechE, 1 Birdcage Walk, London SW1H 9JJ	http://events.imeche.org/ViewEvent?e=6404
25 th	IET Event: The Ethics of Acceptable Safety	IET: Savoy Place, 2 Savoy Place, London WC2R 0BL	http://www.theiet.org/events/local/240587.cfm?nxtId=237426
December			
7 th	Hf Event: Design Safety – The inherently safer way (Provisional)	IChemE hosting, Central London (TBC)	admin@hazardsforum.org.uk
8 th -9 th	IET Event: Safety Integrity Levels (SIL) Determination	IET: Savoy Place, 2 Savoy Place, London WC2R 0BL	http://events.theiet.org/sil/index.cfm?nxtid
12 th	ICE Event: frontiers in Green Materials	Institution of Civil Engineers, One Great George Street, Westminster, London, UK, SW1P 3AA	https://www.ice.org.uk/events/frontiers-in-green-materials

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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