High level guidance for the electricity sector highlighting the link between asset management, process safety and the successful management of health and safety risks to both workers and members of the public

1. Introduction/background

In line with HSE's strategy*, The Health & Safety of Great Britain: Be Part of the Solution*, the electricity industry has developed its own 5 year strategy, *Powering Improvement*.

Vision

The UK Electricity Industry will be a world leader in health and safety performance by 2015.

Strategy

ENA and Energy UK member companies and trade unions commit, with the support of HSE, to build on our partnership approach to bring about continuous improvements in the management of safety and occupational health in the electricity sector in the 5 years leading up to 2015. We will do this by supporting the priorities in the HSE strategy, in particular the themes of leadership, worker involvement and improving competence, and by proactively managing the risks that cause real harm and suffering.

In addition to the three over-arching themes that run throughout the lifespan of *Powering Improvement,* namely leadership, improving competence and worker involvement, each year the strategy will focus on a specific topic which has been identified as a priority area for our sector. Each topic will be led by a senior industry champion.

- 2010 Leadership
- 2011 Occupational health/wellbeing
- 2012 Asset management/maintenance
- 2013 Behavioural safety/personal responsibility
- 2014 Beyond 2015 – Next steps

The topic for 2012 is asset management & maintenance. The intention is to focus on the "softer" aspects of asset management and to produce sector-specific high level guidance that will include a competency framework for asset management and maintenance within the electricity sector. The delivery plan for the year comprises 4 outputs and this guidance supports Output 2:

Output 2

The National HESAC Powering Improvement Asset Management sub-group will develop high-level guidance for the electricity sector highlighting the link between asset management, process safety and the successful management of health and safety risks, to both workers and members of the public.

2. Definitions

Asset management

Systematic and organised practices through which an organisation optimally manages its physical assets and their associated performance, risks and expenditures over their life cycles for the purpose of achieving its organisational strategic plan.

BSI PAS 55-1 requires organisations to establish, implement and maintain an asset management policy, strategy, objectives and plans. It then describes in some detail the typical elements that are expected within each category. However, the scope of PAS 55 is primarily focussed on the management of physical assets and asset systems. It recognises that the management of physical assets are at the 'heart' of the business and are inextricably linked with human assets, information assets, intangible assets and financial assets. As far as human assets are concerned, PAS 55 recognises that human factors such as leadership, motivation and culture are not directly addressed, in the document, but that they are critical to the successful achievement of asset management and require due consideration. This focus on human assets mainly relates to issues of skills and competence but there are other factors to bear in mind.

Process safety

Process safety for the electricity sector means making sure the whole electricity system from generation through transmission to distribution is well designed, safely operated and properly maintained. The application of management systems for the identification, understanding, and control of process hazards to prevent process-related injuries and incidents is designed to prevent incidents of high consequence but low frequency.

Process safety in the electricity sector, however, is not just concerned with the quality of pipe-work and/or valves at power stations and the effects of corrosion, and metal fatigue. It is also concerned with human factor issues and the types of factors that could lead to errors and influence people's behaviour and similarly lead to an unintentional release of dangerous substances at a power station or the catastrophic failure of a transformer at a substation.

A common tool used to explain the various different but connected systems related to achieving Process Safety is described by the Swiss Cheese model. In this model, barriers (Risk Control Systems) that prevent, detect, control and mitigate a major accident are depicted as slices (each having a number of holes (measured and known as Lagging Indicators) The holes represent imperfections in the risk control system. The better the barrier is managed, the smaller the holes will be. When a major accident happens, this is invariably because all the imperfections in the barriers (the holes) have become significant and have lined up. It is the multiplicity of the barriers (which may be physically-engineered containment or behavioural controls dependent on people) that provide the protection.

Process safety programmes focus on design and engineering, maintenance of equipment, effective alarms, effective control points, procedures and training. It is sometimes useful to consider Process Safety as the *outcome* or *result* of a wide range of technical, management and operational disciplines coming together in an organised way.

Effective process safety is the by-product of two distinct activities – excellence in asset management as portrayed by adherence to standards such as PAS 55, and through the development of performance indicators to give improved assurance of control over major hazard risks (e.g. as documented in the HSE's HSG 254 guidelines, *Developing Process Safety Indicators*). Although the principles of process safety are particularly applicable to large single-site complexes such as generating stations, the same procedures are equally applicable to, for example, the DNO or transmission network operator.

Personal safety

Occupational health and safety primarily covers the management of Personal Safety (incidents of low consequence but high frequency). However, well developed management systems will also address Process Safety issues. The tools, techniques, programs etc. required to manage both Process and Occupational safety can sometimes be the same (for example a Work Permit system) and in other cases may have very different approaches.

Personal versus process safety

The distinction between personal and process safety is a distinction between different types of hazards. Process safety hazards are those arising from the processing activity in which a plant may be engaged. Typical process safety incidents involve the escape of toxic substances, or the release flammable material which may result in fires or explosions. Many process safety incidents either damage the plant or have the potential to damage the plant. Moreover, they have the potential to generate multiple fatalities and harm members of the public. Personal safety hazards, on the other hand, affect individuals but have little to do with the processing activity of the plant. Typically they give rise to incidents such as falls, trips, crushings, electrocutions and vehicle accidents.

Injury and fatality statistics tend to reflect how well an organisation is managing personal safety hazards rather than process safety hazards. Any organisation that seeks to assess how well it is managing process safety hazards cannot therefore rely on injury and fatality data; it must develop indicators that relate specifically to process hazards. (Hence the need to measure leading and lagging indicators.)

Safety on major hazard sites is frequently measured by Lost Time Injuries (LTIs). However, a number of such sites that have suffered major accidents have also demonstrated good management of personal safety, based on measures such as LTIs. How can this be when they have managed LTI rates to such low levels? The reason why companies with good LTI records still have major accidents is that the causes of personal injuries and ill-health are not the same as the precursors to major accidents. Measures of injury or fatality rates do not provide an indication of how well major accident risks such as major fires and explosions are managed. Measures such as LTIs are not an accurate predictor of major accident hazards and sites may thus be unduly complacent in this respect. Although a focus on personal injuries is important, there must be the correct balance between resources addressing personal health and safety and those addressing process safety. Too much focus on measures such as LTIs can draw attention away from those aspects relating to major hazard safety.

3. Key Principles

3.1. Link between physical asset management and safety

Duty holders need to ensure that equipment is constructed, installed, protected, used, maintained and decommissioned in such a way as to prevent danger, so far as is reasonably practicable. There is a duty, so far is reasonably practicable, to inspect assets with sufficient frequency to ensure awareness of any action needed to ensure compliance. The "stewardship" of the assets is therefore risk-based and asset owners have to factor this into their whole business process.

This stewardship is shown in diagrammatic form in Figure 1. Here, the asset database is populated with information from new assets as well as data from the condition of in-service assets. The database itself drives the inspection and preventive maintenance processes, both of which have a policy foundation. For example, many asset owners have moved away from traditional time-based preventive maintenance regimes in favour of condition-based or reliability-centred approaches. The results from such fieldwork, including from day-to-day operations and failures in service are then fed into the decision-making process labelled "Operations Management" in which various decisions are needed to be made regarding the remaining life of the asset. Underpinning this is the policy which should assist in the decision-making process, for example in simple terms whether to do more work at the time or to defer further work and organise more testing. Above all, the central management function must provide guidance on prioritising remedial work based on the criticality of the asset and/or network. Apart from the asset database routinely issuing work orders for inspection and maintenance, much of the rest of the process is human-driven. Those involved in this process need to have the necessary skills to drive the process and competence to understand and act on the results.

Although much of the process shown in Figure 1 is automated, much is human-driven and there is considerable scope for errors to occur. Three examples come to mind, in one instance, a scaffolder received severe electric-shock injuries while manoeuvring a pole under an 11,000-volt overhead line which oversailed his depot yard. In this case, although the overhead line circuit had been in existence for many years and patrolled, the significant use of the land had not been prompted by the asset database system - nor therefore recorded - so the inspector incorrectly classified the risk of danger. Neither did the inspector have the opportunity to "manually override" the inspection report, for example to alert the network planners of a scaffold yard under an 11,000-volt overhead line circuit; and this practice had perpetuated over more than one cycle of inspections. Other instances (involving accidents) have arisen involving the use of non-standard equipment which had failed. For example (i) the inspector was unfamiliar with the equipment, (ii) the equipment had not formed part of the training, (iii) the equipment did not form part of a "drop-down menu" for recording and (iv) there was no consequent risk rating – therefore the asset database was not 'aware' of the equipment.

In other cases, accidents have happened as a result of a combination of incidents involving for example: incorrect application of switchgear interlocks, failure of the safety management system, incorrect procedures and a fatigued operator. Reason, states that it has become fashionable to claim that human error is implicated in 80 – 90% of all major accidents. Bates, more recently looked at 162 major electrical and control system incidents over 9 years and

found that the human error proportion to be 91%. So with this large proportion of possible human error in mind, it is vital that the asset owner considers human asset management.

However good the asset database is, as well as the operations management process (i.e. applying company procedures etc), the successful management of physical assets is largely dependent on human intervention and decision making. Some of the aspects of this are highlighted in the following section.

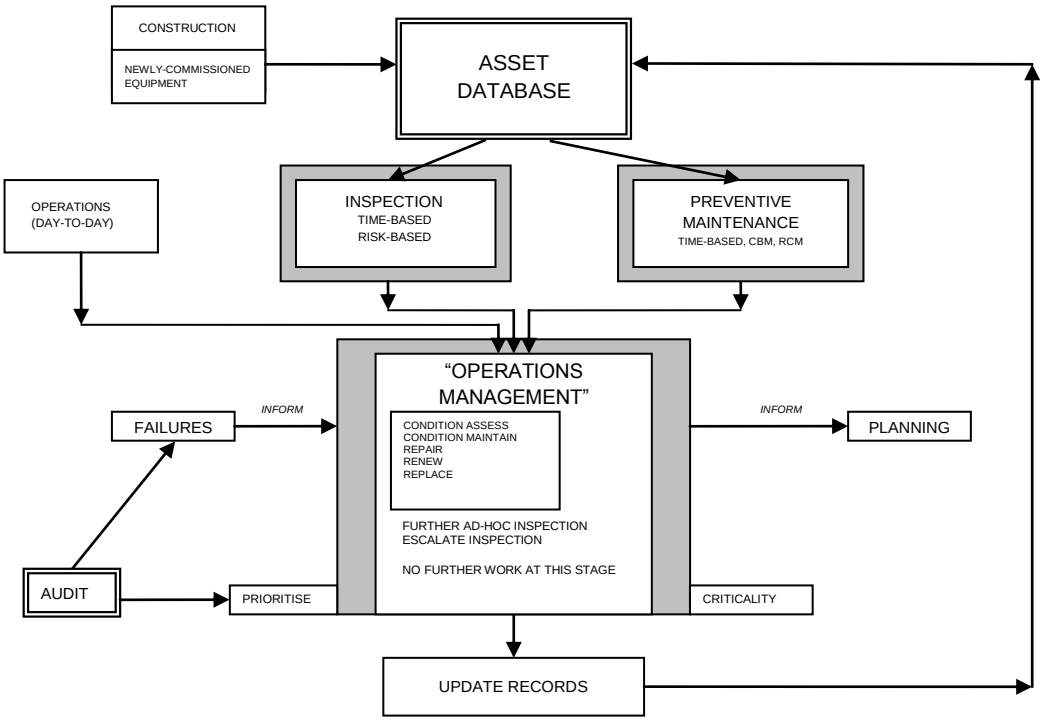

Figure 1 The asset management process

3.2. Link between process safety and personal safety

The link between process and personal safety leads back to the three main themes of Powering Improvement: leadership, competence and worker involvement, supported by effective management systems.

Cultural or behavioural interventions will only be successful if engineering, technical and systems aspects are in place and adequately managed. Companies should:

- Ensure that all hazards have been identified;
- Ensure that human performance issues have been identified and managed - particularly in relation to safety critical roles and activities;
- Ensure that the "hierarchy of control" has been applied to prevent the realisation of identified hazards, or minimise their consequences should they occur;
- Ensure that the specific asset (from power plant level to switch gear) has the required engineering, operating and maintenance resource and experience (including appropriate staffing levels;

- Ensure that accurate operating procedures are available for all eventualities, including process upsets and emergencies;
- Ensure that operators are fully prepared to deal with all conditions, including process abnormalities. This will include identification of training needs, training, assessment, rehearsal and re-assessment. This training should include underlying knowledge of the process, so that operators can 'troubleshoot' - identify and respond to abnormal situations as they develop – it should not just provide the minimum knowledge required to operate the plant. This will help to manage 'residual risk' arising from hazards that were not identified, or effectively addressed;
- Ensure that lessons have been learnt from site, company and industry experience;
- Ensure that succession planning ensures that corporate knowledge is retained;
- Ensure that safety management arrangements and risk control measures are regularly reviewed to ensure that they remain usable and relevant.
- Set high level goals on process safety and demonstrate top level leadership on process safety.
- Establish an integrated and comprehensive process safety management system.
- Ensure that appropriate process safety knowledge and expertise is present at all levels of the organisation, including contractors.
- Develop an open, trusting, positive process safety culture.
- Define management and supervisory accountabilities and set expectations on process safety.
- Provide suitable support for line management on process safety.
- Establish a set of leading and lagging process safety performance indicators and regularly monitor performance against them. Consult with regulators and industry groups to establish the best indicators.
- Implement an effective process safety audit system.

Once engineering and technical and systems issues have been addressed, personal safety issues can be addressed. Companies should ensure that:

- there is visible and real management of health and safety;
- there is management commitment and the resources to see it through;
- there is a high level of trust between management and employees.
- the focus is not just on what can be easily measured;
- management understand the principles of process safety;
- the importance of asset integrity and maintenance is recognised at all levels within the company;
- There is visible process safety leadership.

Principles to note:

- Process safety is never fixed – it requires constant attention
- "Safety in design" requires follow-up with "safety in operation"
- Process automation and management systems have bring huge benefits but may also create a false sense of security;
- There is usually a lack of practice and experience in dealing with unusual situations;
- The impact of changes to a process may take some time to manifest themselves;
- Asset integrity, maintenance and inspection become increasingly important as plant ages.

4. Further Information

J Reason, "Managing the Risks of Organizational Accidents", Ashgate, 1997

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