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Radiation Protection Culture in Context

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Introduction

It is absolutely essential for a nuclear company to operate to the highest standards of Environment, Health and Safety (EH&S), from a moral perspective, business viability and to ensure public acceptance. It is increasingly recognised that to deliver such high levels of performance it is necessary to engage with the workforce at the cultural level ie to seek to embed what is generally recognised as an excellent 'safety culture' leading to a professional management approach to safety at all levels of the organisation . The general consideration of safety culture is the subject of guidance produced by the IAEA since the review and analysis of the Chernobyl event, and the generic assessment and development principles apply equally to the four disciplines of safety applicable to a nuclear facility ie Nuclear, Radiological, Conventional including occupational, and Environmental.

In order to pursue this ambition within British Nuclear Group, a subsidiary company of the former BNFL which operated nuclear power plants, reprocessing plants and waste management facilities, a model was developed as an aid to training and communication of EH&S. The model involved four specific components of EH&S – nuclear safety, radiological protection, conventional safety and environmental protection. Each of these components has its own specific hazards, characteristics and controls, which can to some extent be at different levels of safety culture maturity within the same organisation. However, the four components are joined together by a set of common management factors, ie the cultural, leadership and management system factors, which are essential for the successful integration of the control of risks from all the hazards.

To deliver the highest EH&S standards there is a need to understand the differing characteristics and common management factors of the identified four main hazards on a nuclear site. It was recognised that the key role of the Leadership was to successfully develop management structures and processes to enable the leaders and supervisors in the company to manage the risks as an integrated whole. Essential to an organisation's success in doing this, continues to be the development and maintenance of a supportive safety culture which allows the attitudes and behaviours of workforce and managers to bring together a balanced approach in controlling their risk.

Radiation protection and nuclear safety form two of the essential disciplines which have to be integrated into the way an organisation manages its hazards, and radiation protection professionals have a key collaborative role in maintaining an organisation's safety performance and hence its reputation and business profitability and sustainability.

Safety Performance and 'loose coupling'

It is common to find in safety performance reports the assumption that a good performance in one sector of safety, eg conventional safety, is an indicator and influence on the other three sectors.

There is little literature relating directly to the distinction between radiological,[1]occupational, environmental and plant safety, but individual comparisons of specific types of safety eg review of safety performance by the aviation industry (air safety vs ground safety) and the off shore industry (loss of containment vs occupational safety) found little or no correlation between performance of plant safety and occupational safety. Also, NRC commissioned a large piece of work to identify leading indicators of nuclear plant safety and found no robust linkage between occupational indicators and the performance of nuclear safety. There is no recorded research into the differences and influences of radiological safety and conventional/environmental/nuclear.

Research associated with the TRIPOD audit system (similar to IAEA's ISRS) within a number of large high hazard organisations showed that differing aspects of safety performance may change independently of one another, and any change of performance was mostly associated with the amount of recent or lack of management attention. This is closely related to the 'Hawthorne effect' where attention to an aspect improves the performance whilst lack of attention leads to deterioration and failure. Leadership and management attention sets the focus of attention for the organisation.

Research into the common assumption that a good conventional safety performance would transfer its influence to nuclear safety was the subject of an overview [2]research project. The stark findings were those summarised below:

1. **There is no evidence to tightly correlate an organisation's conventional safety performance with radiological safety performance, nuclear safety performance, and environmental safety performance.**

2. **Indeed, fundamental differences exist between the different safety disciplines, with the exclusive factors being the dominant influence on performance.**

3. **A "Good" safety performance in one area should not be used as an indicator of "Good" safety performance in the others.**

4. **However, a falling safety performance in one discipline can impact on safety performance with another discipline as influenced by their common or dependant factors.**

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[1] Occupational safety also includes conventional safety, and Plant safety performance includes nuclear safety.

[2] HF/GNSR 5052 in 2001 joint Regulator/BNFL/BE research programme.

The research identified conventional and plant safety performance as a 'loosely coupled system' ie:

[3]*Loose-coupled systems have components that function together but evidence significant independence to one another.*

And there is good reason to believe that all four safety disciplines are 'Loose-coupled' systems

Review of events will reveal that there are different profiles of root causes of serious/major events, and each use different independent knowledge systems to achieve the performance, despite having common business drivers and in many cases integrated systems within organisations.

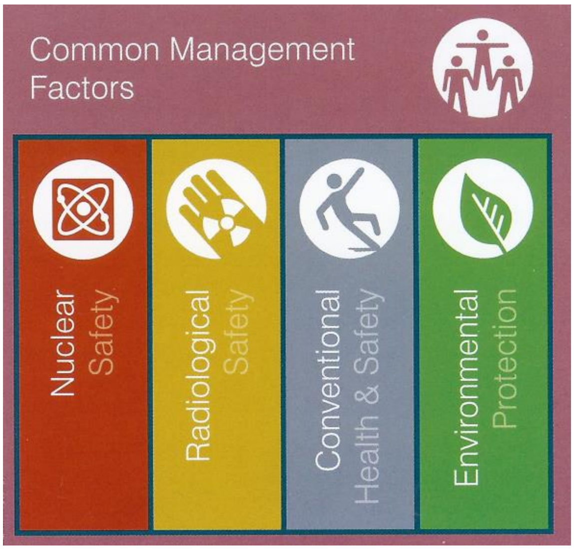
Experience within the nuclear chemical plants has demonstrated that good performance with the conventional safety side of a job does not guarantee nuclear and radiological safety. Putting to work a person into a radiological hazard area where they have no basic or refreshed training, or no experience, has led to some significant contamination events. Even putting to work a beta experienced person into an alpha risk task has also led to events characterised by lack of understanding of procedural hazard reduction techniques for the radiological conditions. So knowledge of cutting and grinding hazard reduction will not lead naturally to the reduction of hazard present in radiological/nuclear conditions. This is seen as self evident in the field but not necessarily carried forward when analysing performance indicators or deciding on safety performance measures and improvements.

This analysis can be extended to include approaches to chronic health protection and environment protection measures, and the Tokai criticality event demonstrated that good QA culture will not guarantee a good safety culture.

The Communication Model for EH&S

As part of a business drive to make visible the nature of the underpinning safety disciplines, British Nuclear Group developed a model to assist its leadership to develop the company's activities set by its safety goal. The model recognises the four components of safety, ie Nuclear, Radiological, Conventional and Environmental, but emphasises that these are joined together by the Common Management Factors. This is shown diagrammatically below.

[3] as described by work carried out by Glassmen 1973 & Weik 1996



To deliver the necessary EH&S standards, an understanding of the different characteristics and common management factors was communicated across the company. The following sections describe these communications.

<u>Common Management Factors</u>

Leadership

Leadership have to set clear standards, expectations and accountabilities for safety as practiced their facility. This has to be backed by their behaviour showing a clear commitment to the integration of risk management alongside clear communication and coaching where necessary.

Leadership Implications

The visible commitment and expectation of standards from the leadership is crucial to maintain safety performance in all four areas. The assumptions of *too difficult to train*, *too complex to understand*, or *being overwhelmed with information*, must be addressed urgently to prevent the standards of any safety discipline degrading, and should be considered unacceptable in a professionally-run nuclear facility.

Culture

The culture has to be supported by the leadership and management systems to achieve:

- Intolerance of degraded plant and equipment condition, ie plant operates as designed.
- Compliance with instructions, but with a questioning attitude
- Conservative decision making
- Supporting the development of EH&S competencies
- Instilling 'Right first time' and 'Continuous Improvement' attitudes

Management Systems

Management systems must structure and encompass:

- Work control, with a process to identify hazards, carry out risk assessment and put in place hierarchy of controls.
- Advance planning, preparation and training
- Pre-task one minute risk assessment eg STAR, STOP etc
- Operational Experience Feedback – including both internal events and those of others.

Safety Disciplines individual characteristics

The loose coupling is such that in the majority of cases nuclear, radiological, environmental and occupational safety performances may rely on the conduct of persons using the equipment, and so human factors and human performance knowledge can be used to improve safety performance in all safety disciplines. However, by appreciating the differences in the safety disciplines, improvement methods may be targeted. For example:

- **Nuclear safety** performance rarely gives first hand learning experience with a serious consequence event; hence learning is 'second' or 'third hand' and therefore less effective in both assimilation and retention. Many of the built-in protection measures through design and management for plant safety are not necessarily visible, and in the case of criticality can be counter intuitive.

- **Radiological safety** hazard is easily measured by instrument but the hazard perception is not 'direct', ie the person cannot feel the harm, and the application and maintenance of developed protection protocols rely on specialist advice. This means that training has to be on 'second hand' learning, as the harm related to over exposures is rarely seen or is not seen immediately by the workforce and management.

- **Occupational and conventional safety** is usually able to be visualised, within the individual's experience, and in many cases even minor consequences have an immediate effect. This is 'first hand' learning which is the most effective and enduring. Many of the built-in protection measures through design and management for occupational and conventional safety are immediately visible, even if persons choose to bypass them.

- **Environmental safety** measures can often be solely dependant on an organisation's permits, and the direct personal harm is seldom part of the consideration. It may depend solely on enforcement of limits, ie completely divorced from harm perception, and needs an organisation to develop a culture of environment awareness. This is often third hand learning and similar to criticality training.

A more detailed consideration can be seen in Table 1.

Implications for training and Coaching

Training can be tailored to suit the characteristics of the nature of the hazard ie:

- 1st hand learning can be achieved through standard and experiential learning methods and with local examples used to illustrate the standards and hazards.
- 2nd hand learning can be achieved with the discussion of the underpinning science behind the rules and standards, with some of the hazards illustrated (if not with local examples the harm could be illustrated with worldwide examples). Risk assessment should be trained with live examples.
- 3rd hand learning should be with discussion of the hazard and illustrated with worldwide examples. Discussions should also attempt to illustrate attitudes towards the hazards and how complacency can develop leading to a fall of standards and bypassing of the 'rules'. Key to this type of hazard is the development of nuclear professionalism.

Nuclear professionalism is a concept that helps workers and leaders on a nuclear facility to understand the expectation of them from the nuclear industry. This includes safety culture aspects of 'conservative decision making' and the demonstration of 'questioning attitude'. The attitudes and behaviours developed by the adoption of the nuclear professional helps to maintain safety, and differentiates their skills from other industries, but also connects them to High Hazard Industry working.

Conclusion

By understanding the nature of the four safety disciplines an organization can tailor its communication, training, management and leadership of an integrated risk management system. They will also be able to successfully develop a safety culture that strongly maintains the organisation's capability to meet standards and expectations of society.

Table 1 Individual Nature of the 4 disciplines of Safety on Nuclear facilities

Nuclear	Radiological	Conventional (plus Occupational)	Environmental
Hazards Unplanned criticality Major release of radioactivity Degradation of reactor core and nuclear fuel integrity Degradation of chemical plant (Nuclear safety is given overriding priority)	**Hazards** External radiation exposure Internal radiation exposure Contamination control	**Hazards** Typically – slips trips and falls, electricity, machinery, lifting, working at height, asphyxiation,/confined spaces, stored energy, fire, display equipment, driving, lasers. Occupational health typically – chemicals and substances hazardous to health, noise, stress, individual fitness for tasks, substance abuse.	**Hazards** Release or disposal of unauthorised or noxious substances into the environment giving: Health effects, damage to flora and fauna, loss of amenity, other long term effects eg climate change. Inappropriate or unsustainable use of natural resources eg water, energy, raw materials Other effects on quality of life eg noise, transport
Characteristics High consequences/low probability events – loss of control and/or containment Defence-in-depth – no single error results in major event. No obvious and immediate threat; remoteness from 'end event'; difficult to make the connection – beware complacency. No personal health consequence of a single error (unless it breaches final barrier) Equivalent to plant safety or process safety in other High Hazard industries.	**Characteristics** Routine hazard directly present in our active plants Presence can only be made visible using specialised instrumentation Not part of normal consciousness – particular training need Health consequences at normal occupational level are indirect, delayed and stochastic. Exposure to a very high dose can lead to burn, organ damage, and death.	**Characteristics** Routine hazards directly present in the workplace. Most threats generally obvious, evident and well understood. People have direct experience, can use common sense. These mainly have directly and immediate health consequences.	**Characteristics** Consequences can range from immediate and obvious eg oil spillage, to long term and indirect. Sometimes a complex relationship between plant and environmental effect. Underpinning environmental science sometimes open to debate and reliant on precautionary approach to uncertainty. Societal and political importance of environmental issues has been raised in recent years, and strong differences of view can exist on some issues.
Controls Emphasis on containment and and control of energy sources. Requires knowledge of, and compliance with, safety case via rules, procedures, and instructions. Requires strong emphasis on compliance, attention to detail and conservative decision making. Extra importance of management of change and learning from experience. Requires underpinning technical understanding and ongoing refresher training and management re-enforcement – need for SQEPS. Lagging indicators are useless, a basket of leading indicators are more useful.	**Controls** Emphasis on containment of radioactivity and protecting people from the hazard. Control by use of engineered features , management systems, and personal protective equipment. Local individual knowledge and awareness can greatly influence your dose. Radiological protection is a branch of occupational health and safety – similar control systems to asbestos, chemicals, mutagens, carcinogens.	**Controls** Seek to eliminate the hazard where feasible, but then reduce, isolate and control by use of systems and PPE. Inspections, hazard logs, near miss logs.	**Controls** Controls and indicators cover a combination of those for nuclear, radiological, and conventional since such events can also result in environmental impact Control hierarchy: avoid, reduce, reuse, recycle, lastly minimise disposal. Prevention and minimisation of releases and disposes must comply with BPEO (best practical environmental operation), BPM (best practicable means), and BAT (best available technology). People need fundamental understanding of environmental impact of each task and knowledge of local plant significant environmental effects: requires specific operator training.