

**Ensuring Enhanced Nuclear Safety at Sellafield during the Remediation of Legacy Facilities - 10057**

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**ABSTRACT**

The Sellafield nuclear site has operated in West Cumbria, UK, since the 1940's. Since this time, the site has been home to all phases of the nuclear fuel cycle, from commercial power production and fuel manufacture through to reprocessing operations, waste management and the current site focus, Decommissioning.

Today the key priority for the site is Hazard and Risk reduction, particularly in relation to the numerous legacy facilities. Many of these facilities are significantly degraded despite being under continuing care and maintenance regimes and their decommissioning presents a number of challenges, ranging from a requirement to upgrade the facility and equipment even before access can be achieved to having to devise remote decommissioning tools and techniques in areas where the radiological conditions preclude human operations.

This paper will focus on the decommissioning of the legacy facilities at Sellafield, looking at why decommissioning activities need to take place at Sellafield and using specific examples from across the Decommissioning Directorate to identify the key elements of nuclear safety.

The author will then review and provide feedback on the leadership and safety initiatives that have been introduced at Sellafield to help enhance nuclear safety as well as those which previously existed and have been reviewed. This will include an overview and discussion of the work that has been carried out to achieve the buy in and commitment of the site workforce to achieving and maintaining the increasingly high safety standards being imposed on them.

Finally, the paper will discuss and analyse the impact and influence of these initiatives on safety culture across the site as well as their impact against the existing nuclear safety benchmark, so that the learning and improvements from them can be shared across the industry for the future benefit of all.

**SELLAFIELD OVERVIEW**

Sellafield Decommissioning is one of the most complex, demanding and challenging programmes worldwide. Linking all these challenges is one underlying key imperative: to ensure that high standards of nuclear safety apply at all times and through all stages of operations.

To achieve this imperative, an extensive programme of work has been carried out across the organisation since the appointment of new parent body organisation Nuclear Management Partners in November 2008. This has ensured that there is a detailed understanding of the current safety culture on site and a benchmark against which to measure progress.

This paper will discuss the challenges facing the Decommissioning team at Sellafield, the importance of ensuring that nuclear safety is embedded and how we improve safety standards and culture on site

## **RANGE OF CHALLENGES**

The range of Decommissioning Challenges at Sellafield is enormous. Inter-connected with the Site Operational Facilities, the lifetime cost for the decommissioning portfolio is in excess of £25 billion. Decommissioning spend for the year 2009/10 was over £530 m.

Management of legacy facilities and their preparation for retrieval and treatment of inventories is a major part of the High Risk / High Hazard reduction priority for the site.

Within Decommissioning there are six major delivery programmes to deliver this, which are divided into three main areas – Legacy Ponds and Silos, Site Remediation and Decommissioning Projects and Windscale.

Legacy Ponds and Silos include –

- Pile Fuel Storage Pond
- First Generation Magnox Storage Pond
- Magnox Swarf Storage Facility
- Magnox Swarf Storage Silo

Site Remediation and Decommissioning Projects is subdivided into three areas–  
High Hazard Stack removal  
General Decommissioning  
Land Remediation

Finally, the Windscale site covers decommissioning of the pile reactors and the Advanced Gas Reactor, and the Waste Examination facility.

Many of the plants are aging, bringing with it inevitable deterioration. This requires a major programme of asset care and restoration which in turn has nuclear safety issues such as ensuring safe containment that must be managed.

One example of the challenges faced is the First Generation Magnox Storage Facility. Comprising of buildings, ponds, transfer bays and pipework systems, the facility has a high inventory of fuel, sludge and pondwater. These result in a high background dose, in turn creating challenging working conditions that require high levels of personal

protective equipment to be worn. In order to decommission the facility, an extensive maintenance programme had had to be carried out, replacing or refurbishing much of the retrievals machinery. At the same time, the condition of the aging structure also presents a further challenge, to ensure the building integrity is maintained.

These challenges are typical of a number of facilities on the Sellafield site, however significant progress is being made on accelerating decommissioning at Sellafield.

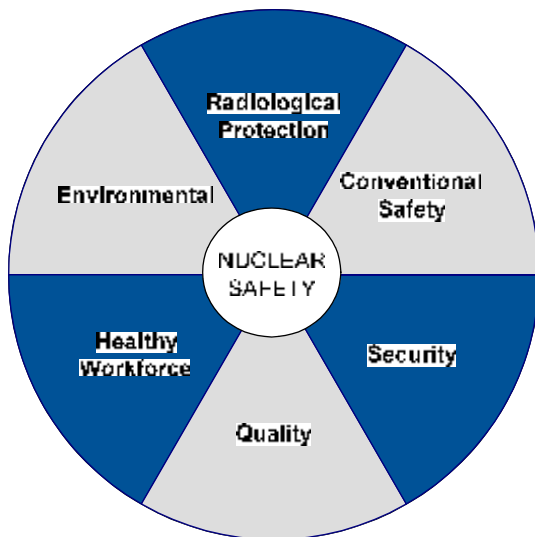
## **FOCUS ON NUCLEAR SAFETY**

Nuclear Safety is a fundamental focus for Sellafield and encompasses the prevention of major events, protection of the workforce and public and protection of the environment.

Our responsibilities to deliver nuclear safety require us to provide -

- Containment of Nuclear Materials
- Care and maintenance of Assets
- Construction of new treatment and storage facilities
- Retrieval and treatment of wastes
- Safe, secure storage
- Decommissioning and demolition

In addition to Nuclear Safety, we must also include all aspects of conventional safety as well as environmental and security issues.

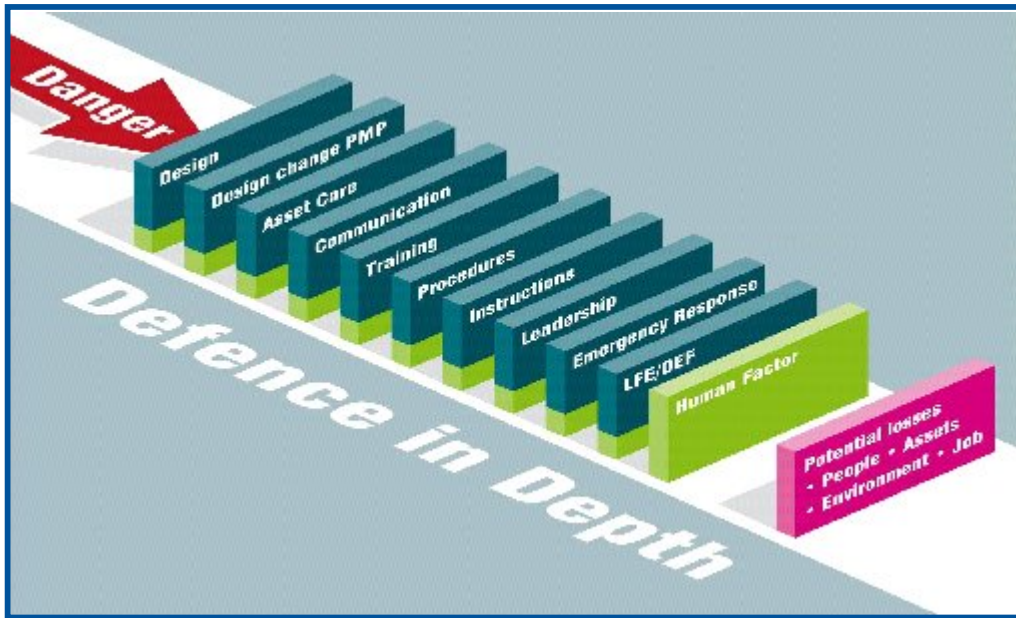


One way of increasing nuclear safety is to build in multiple layers of defence against a major incident or event status at the design, or even conceptual stage.

At Sellafield there are a number of defensive layers we aim to build in order to prevent incidents, detailed in the diagram below.

Human Factors/Human Intervention should always be the final line of defence, however when examining events, it is easy to blame individual performance, when often there should have been more investment in defence in depth.

Utilising the 'Developing Process Safety Indicators' (PSI) from the UK Health and Safety Executive [1] we have carefully chosen a small number of safety indicators, which provide us with assurance that the hazard risks in our plants are under control. Using 'Leading Indicators' we can determine if our safety barriers (defence in depth) are starting to deteriorate, allowing us to respond before event occurs. PSI helps us understand our process safety risks, ensuring they are effectively controlled.



A number of radiological safety improvements have also been implemented to support nuclear safety. Two key aspects to Radiological Safety are the Control of exposure, and the control of contamination.

Control of Contamination sets standards for behaviours at Barriers into controlled areas, as well as standards for dress in Active Areas. Control of Radiation Exposure is managed by dose management strategies and the use of monitoring devices such as electronic personal dosimeters which enable improved prediction and ownership of doses.

## **EMBEDDING NUCLEAR SAFETY**

Our aim is to embed nuclear safety at all stages of the nuclear lifecycle –

- Concept
- Design
- Safety case preparation and approval
- Procurement
- Construction
- Commissioning
- Operations
- Post Operational Clean Out
- Decommissioning, and
- Demolition

With over 75% of its annual budget spent in the Supply Chain, partnership and cooperation between Sellafield Ltd and the Supply Chain are vital to the embedding of nuclear safety standards. Many of the safety initiatives in place reflect this, such as:

ZEW (Zero Event Workplace scheme), which has been jointly developed by Sellafield and Supply Chain Partners and applies a Behavioural Safety approach which encompasses the best from our Supply Chain Experience and from our Behavioural Safety Background. ZEW incorporates features from our contractors own Company Schemes and recognises that Attitude drives behaviour, and that this must be addressed effectively in order for Zero accidents to be achieved.



Safety recognition schemes, where Projects reward safe performance by the awarding of money to charity. Example of this include the project team working on Sludge Packing Plant 1, currently under construction to process waste from the first generation storage ponds, which has completed over 5 years accident free without any reportable events and made over 30 donations totalling over £10,000, as well as the Sellafield Product and Residue Stores project team, who have now passed 1.66 million man hours (27 months) without a lost time accident or days away case making 73 awards to charity, totalling £55,000.

Members of the Decommissioning Executive Team carry out regular Leadership tours and Friday Street meetings, during which they spend time looking around one of the decommissioning projects and learning about the project, the challenges the team are facing and what is being done to overcome them. Extending this, a similar process has also been applied to the Supply Chain, and a buddying system enables members of the supply chain to visit projects and share learning.

Sellafield is the only non operational site in the world to be a member of WANO, the World Association of Nuclear Operators. This provides benefits and learning through peer assist and technical assist visits to Sellafield and visits to other facilities. Developed from this, a Decommissioning WANO coalition team was established in April 2008. 16 Supply Chain companies participate in monthly workshops which aim to share experiences and raise awareness of the importance of applying good and consistent standards across all activities at Sellafield.

Finally, also being rolled out across the site is a new Disciplined Operations manual [2]. Disciplined Operations is quite simply ‘the right way to do business.’ It involves the setting of clear standards and expectations for safe performance of operational activities and the rigour required in applying those standards. The disciplined operations standards are based on well developed industrial operations practices such as the IAEA Conduct of Operation standards [3], WANO Performance objectives [4], criteria and guidance and the US Department of Energy Guidance [5] and are written to be flexible so that they encompass a wide spectrum of facilities.

## **IMPROVING SAFETY STANDARDS AND CULTURE**

One of our biggest challenges from a safety aspect is raising awareness and reinforcing standards. To do this, a number of techniques are applied, including –

- Risk perception workshops
- Human Performance training
- Use of Human Performance tools such as the phonetic alphabet, 3-way communications, peer checking, 1 minute risk assessments before all tasks, and applying a challenging attitude.
- Nuclear Safety dashboards & focus boards – existing plants, task based & new plants
- Local and Programme level nuclear safety focus meetings where the health of the barriers ensuring safety are discussed and any shortfalls challenged
- Error reduction courses, which teach techniques to spot and reduce errors

This is supported by the setting of standards. At Sellafield we publish our ‘Standards and expectations for the Sellafield Site’ in a pack to all employees. This highlights twelve basic standards:

1. Leadership
2. Maintaining Safe Conditions
3. Workforce committed to Safety
4. Achievement of Goals and Targets

5. Rules, Procedures and Instructions
6. Workforce committed to Quality
7. Training and Development
8. Audit and Improvement
9. Support and Equipment
10. Personal Conduct
11. Working Together
12. Environment

These are supported by recommendations and examples of suggested behaviours, together with guidelines for how to carry out effective safety checks and briefings.

Demonstrating strong leadership and leading by example also plays an important role in embedding an effective safety culture on site. Leadership means communicating the standards we expect and being visible.

Leadership at all levels is central to Safety Culture, and the highest standards we can expect of our people are the lowest we exhibit ourselves. If we ignore low standards we are approving them, and one of the biggest challenges of the culture change process is moving people from a state of Blind Compliance to Caring about why the standards exist.

This is addressed through education - extensive Nuclear Safety training is provided for all new staff, including agency supplied workers and contractors, and regular refresher training courses are provided for existing employees.

Embedding Nuclear Safety in design and construction arena presents different challenges, as it is perceived as less relevant to facilities which have not been actively commissioned yet. One of the challenges is changing the mindset of design and construction workers who come to work at Sellafield from a non nuclear background. Running design and construction focussed Process Safety Indicator workshops including supply chain and design, construction and commissioning disciplines, helps raise awareness of how design and construction can effect nuclear safety, for example concrete pour quality has to be to a standard to ensure containment and longevity on a nuclear facility, whereas a slightly lower standard may be perfectly acceptable in a similar non nuclear facility.

## **ENVIRONMENTAL PERFORMANCE**

As well as the obvious benefits of embedding nuclear safety, many of the measures being put into place have a positive impact on environmental performance.

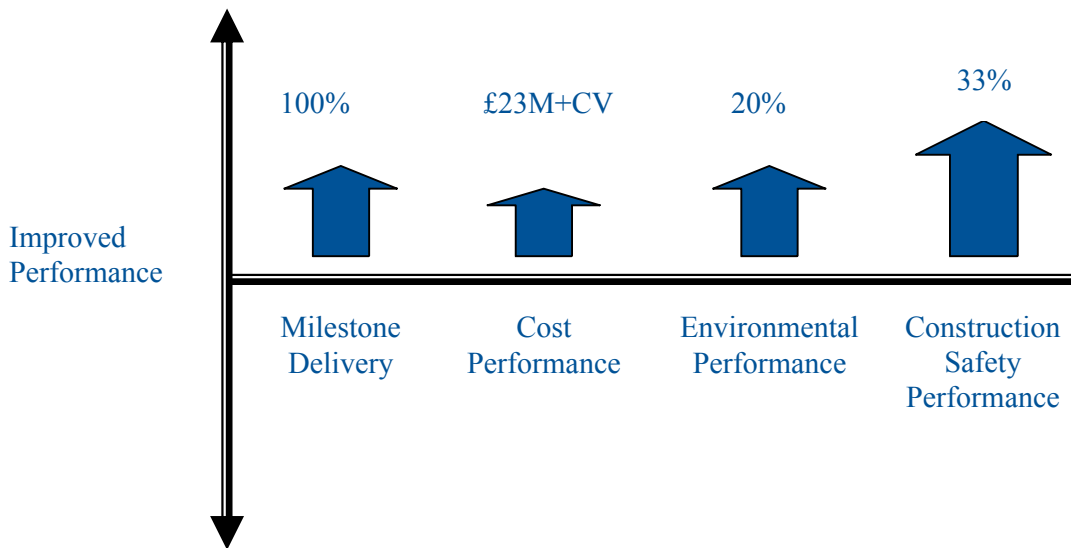
A Local Effluent Treatment Plant (LETP) has been installed and is currently being commissioned to control the activity of the pond liquor using an ion exchange process. The LETP is proving effective at removing beta activity from Pile Fuel Storage Pond water, which would otherwise have been discharged to sea. The effectiveness of the LETP means that the activity concentration the pond water is reduced and marine discharges are significantly reduced.

Shot blasting of steel surfaces to remove layers of contamination, rust, paint to leave a clean surface has resulted in over 1,150 tonnes steel being processed and free released.

600 tonnes of concrete has also been recycled as hardcore for contractors' and company compounds. Concrete waste is also being used as infill on Calder cooling towers basins and investigations underway into re-use of crushed concrete as aggregate in new concrete.

## OUTCOMES

Thanks to the emphasis that has been placed on improving safety at Sellafield and the initiatives that have been introduced, there has been a definite trend of improvement in safety performance on site.



Over the last four years there has been an overall reduction in the number of RIDDOR (Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995) reportable incidents and also a reduction in the number of INES events that have occurred on site.

## CONCLUSION

The increased focus on Nuclear Safety and the improvements in Nuclear Safety Culture have already demonstrated a real benefit at Sellafield, however world class leadership of safety means not only setting and establishing standards, but also continually reinforcing them.



We need to continue to raise awareness and find ways to improve Safety Culture throughout our workforce and this includes our Supply Chain partners and our Contractors. We are at pains to embed nuclear safety considerations at all stages from Design, Construction, Commissioning, Operations, then into Decommissioning/Demolition however we must continue to make Nuclear Safety our top priority across the entire nuclear industry, not just on the Sellafield site, so that we prevent major events such as Chernobyl happening again in the future.

A Zero Event Workplace is achievable through partnership and learning from each other. Leadership, compliance and ZEW/IIF combine to drive down injuries, however there are still too many near misses. Accidents are still happening, and in some cases, only luck and personal performance have prevented serious injuries occurring.

We have not fully changed the culture yet but by continuing to work together to ensure Nuclear Safety remains our over-riding priority, we will achieve the high standards expected from the nuclear industry.

## REFERENCES

- [1] Health and Safety Executive, "Developing Process Safety Indicators: A step by step guide for Chemical and Major Hazard Industries." HSG254, [www.hse.gov.uk](http://www.hse.gov.uk).
- [2] Sellafield Ltd, 'Disciplined Operations Manual – Standards for Sellafield Ltd Facilities', September 09, Issue 2.
- [3] IAEA Safety Standards for protecting people and the environment, Conduct of Operations at Nuclear Power Plants, Safety Guide No. NS-G-14, International Atomic Energy Authority ISSN 1020-525X
- [4] World Association of Nuclear Operators, 2008 Performance Indicators, 04/2009. [www.wano.org.uk](http://www.wano.org.uk)
- [5] [www.energy.gov/safetyhealth](http://www.energy.gov/safetyhealth)