

A REVIEW OF THE NUCLEAR INTEGRATED WASTE STRATEGIES AND THE DRIVE FOR NATIONAL SOLUTIONS[†]

Neil Blundell¹ and D.A. Goodill²

¹HSE Nuclear Directorate, Bootle, Merseyside, L20 7HS

²TGF Ltd, The Towers, Lorton Road, Cockermouth, CA13 9EB

UK's Health and Safety Executive's Nuclear Installations Inspectorate (HSE/NII) has required Nuclear Licensee's for some time to produce strategies for management of their nuclear matter and the radioactive waste deriving from it. The concept of an integrated waste strategy was initiated between the HSE/NII and the Environment Agency (EA) at the Sellafield site in 2004.

This concept was later formalised in conjunction with the Nuclear Decommissioning Authority (NDA) such that it became a specification of their contracts with their new Parent Body Organisations that were brought in to deliver remediation of the UK's nuclear Legacy. A number of years have passed on the development of deliverable Integrated Waste Strategies and recent Joint Guidance on the Management of Higher Activity Radioactive Waste has expanded the influence of IWS on Licensee's outside the NDA estate.

HSE's ND has now carried out a series of reviews of developing IWS's and has formed additional informal guidance on what may be considered good practice from this review. Those reviews and that additional informal guidance has been shared and discussed with a small number of nuclear Licensees and other regulators.

The purpose of this paper is to present the output of that review, to share the developing guidance and to consider what part IWS's may have in improving the delivery of a national IWS and national solutions for radioactive waste as well as influencing the delivery of the EA's EPP requirements on non-nuclear Licensee's to produce an Environmental Management Plan.

These reflections are also of value to industries and organisations with volume or specialist waste generation where either the disposal cost impacts on their operations or where the existence of a specialist disposal route is essential to continue them. The capacity of disposal routes is becoming a premium and in some instances limiting the challenge to that capacity early will prevent their loss.

INTRODUCTION

UK's Health and Safety Executive's Nuclear Installations Inspectorate (HSE/NII or NII) has required nuclear Licensee's for some time to produce strategies for management of their nuclear matter and radioactive waste deriving from it.

These are wrapped up primarily in Licence conditions (LC) 4 and 32 (Reference 1) respectively entitled, 'The control of nuclear matter' and 'Minimisation of the accumulation of radioactive waste'.

The two are interlinked as the source of radioactive waste within the nuclear industry is the management of nuclear matter and thus avoidance or minimisation of the generation of radioactive waste is achieved by effective management of the nuclear matter which produces it. This principle of effective nuclear matter management extends from nuclear fuel production to spent fuel management and reuse of nuclear materials.

Integrated waste management is also of significant importance to NII's fellow regulators, the Environment Agency (EA) and Scottish Environmental Protection Agency (SEPA), as it is this which affects the level of aerial or aqueous discharge or volume of solid waste disposal from a nuclear Licensee's site. As a result it is this which has

led the EA to include the delivery of radioactive waste management plans within the nuclear sector plan (Reference 2) and an environmental management plan within the EPP regulations on non-nuclear Licensee's.

The mutual interest of the regulators also enables the partial fulfilment of a desire to adopt better regulation practice to reduce the burden on the Licensees and the work of the regulators. Thus the history of IWS development has been a joint regulator, NDA and Licensee initiative and remains so.

The purpose of this paper is to draw together a history of Integrated Waste Strategy (IWS) development, the current status of IWS within nuclear site Licensee's and the process of developing a review process against regulatory guidance and reflections from results of early reviews. We will also share the outcomes of that review process and provide our reflections for Licensee's on the production of their IWS's. Finally, we outline the future work of the regulators to move IWS's into good practice delivery of radioactive waste management that is owned and delivered by the managers of nuclear matter.

These reflections are also of value to industries and organisations with volume or specialist waste generation where either the disposal cost impacts on their operations

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or where the existence of a specialist disposal route is essential to continue them. The latter could be considered to be outside an organisations control but the capacity of such routes is becoming a premium and unless voluntary efforts are made to limit the challenge to that capacity early they will either cease to exist, become very expensive or be subject to additional legislative control.

This paper reports on the development of integrated waste management guidance for the UK's Health and Safety Executive (HSE) and this does not currently represent its final regulatory view.

DEVELOPMENT OF GUIDANCE FOR GOOD PRACTICE INTEGRATED WASTE STRATEGY

Waste strategies have been required by Government policy (cm 2919) and have been enforced by the NII for many years (Reference 3) and delivered on an individual basis by Licensees for particular streams.

However, certain nuclear sites within the UK are multistream and multi-discharge in nature. Most particularly, the Sellafield site in West Cumbria which is a significant component of the UK's aqueous discharges to sea (Reference 4).

In 2004, the EA in their Certificate of Authorisation BX9838 for the disposal of radioactive waste from the Sellafield site required (within Schedule 9) BNFL to develop and maintain an integrated waste strategy and HSE paralleled this with a letter SEL75903R in October 2004 excerpts of which are below that underlined that: -

"[HSE had] requested for some time integration of waste treatment methods on the Sellafield site in order to meet the criteria set down in Cm2919"

That from inspection it was evident from

"...the [Sellafield] Overall Effluent Strategy and other work that integration of waste treatment is minimal on the Sellafield site and in terms of solid wastes does not exist at all."

And that although

"... there are a number of separate focussed strategies in existence for management of waste [from] the inspectorates review of the Life Cycle baseline data and the early interactions concerning waste strategies for the early retrievals project it has become apparent that the underpinning information related to the current non-integrated waste treatment strategies lacks transparency."

Knowledge of the current status is essential to develop an understanding of the task and development required to fully integrate waste treatment across the Sellafield site to ensure optimised waste minimisation."

In late 2004 joint HSE/EA/BNFL discussions were initiated on the delivery of an integrated waste strategy for the Sellafield site and BNFL set up a team of 6–8 individuals to work with regulators to deliver the first combined strategy for that site.

The baseline philosophy for an IWS and the questions that Sellafield at that time needed to address were determined by the joint regulator/Licensee group to be:

- What is the current position?
- Where would we like the site to be?
- What do we need to do to move from where we are to where we want to be?

There was an understanding within the group that the vision for the Sellafield site would be for it to be demonstrating good practice waste management.

BNFL (now BNG) indicated that there was a need for further guidance on "What did this good practice IWS look like?" or simplistically "What is the shape of the rock you want me to deliver?"

Consequently, the NII and EA issued a guidance note in the form of a letter that set down expectations (Reference 6). The letter established the link between IWS and the adequate demonstration of waste minimisation.

The letter presented a generic methodology that was based on existing guidance at that time and linked it to the waste management hierarchy, which the joint regulators believed could contribute significantly to the objective of minimised waste generation.

The fundamental principle that guides the use of a Waste Management Hierarchy (WMH) is:

'Application of the WMH should achieve the waste minimisation required under the nuclear site licence, the Radioactive Substances Act 1993 Authorisation and other legislation.'

The methodology that was developed was "a step-wise approach to achieving waste minimisation to promote sustainability that considers the life cycles of both the processes that create waste and the waste that is produced from them."

Other considerations were:

- A WMH applies at all levels – from strategic to plant level – wherever possible a Site Licence Company (SLC) should take account of the effect of WMH decisions on the wider picture as well as the impact of wider decisions such as government policy
- The WMH should consider all of the waste i.e. radioactive and non-radioactive.
- Licensee should understand the process that may create the waste and the problems that may be incurred from handling, treating and disposing of that or any other waste associated with the process. This was an important fundamental requirement
- Integrated Waste Strategy (IWS) should incorporate a general understanding of the waste challenges, the aims and objectives to improve the problem and the context for the process.

The WMH was presented in simple key words which are laid down in Government policy:

1. Avoid
2. Reduce
3. Reuse
4. Recycle
5. Dispose

A consequence analysis approach was recommended similar to a safety case approach that would define all possible routes for waste creation and the defences that would be needed to prevent that waste creation. (*Later work carried forward by the HSE in conjunction with Aston University is presented as paper 136 in this conference that demonstrates how such a methodology can be applied.*)

If good practice is used it could in most circumstances be considered ALARP.

The application of the methodology can be considered to be similar to the deterministic approach in safety case methodology. The methodology is compiled of five stages, each aiming to build understanding of the waste generation and potential actions to avoid waste:

1. Stage 1: Understand the way waste could be created in a facility and its behaviour following creation. E.g. corrosion mechanisms or contamination.
2. Stage 2: Apply each of the keywords of the WMH against normal operations in the form of a consequence analysis and derive a series of safeguards that align with the fundamental principle stated above.
3. Stage 3: Apply the keywords of the hierarchy against reasonably foreseeable deviations from normal operations in the form of a consequence analysis and derive a series of new safeguards or strengthen those derived from stage 2.
4. Stage 4: Monitor the waste production to confirm the fundamental principle is adhered to. It is important to choose the appropriate measure for individual wastes as volume, activity and concentration can all be acceptable, independent measures of waste arisings.
5. Stage 5: Ensure a system of fundamental and programmed review that takes account of changes in policy, strategy, process, infrastructure, and emerging information on the waste challenge or new techniques.

Some of the elements of this concept were later formalised in conjunction with the NDA such that it became a specification of their contracts with their new Parent Body Organisations that were brought in to deliver remediation of the UK's nuclear legacy. The first such specification was issued in 2005 as ENG01 (Reference 9).

British Nuclear Group expended significant effort in bringing together by October 2005 the first draft document that described the Waste and Waste management strategies within the Sellafield Site. It was an incomplete draft but following further interaction and work by BNG the First complete IWS was delivered for the Sellafield site in June 2006. It stated that it utilised the NDA guidance and

the guidance revealed from interactions with HSE/NII and EA.

The document was constructed to the NDA format and primarily focussed on identifying strategic issues with respect to waste and to help develop appropriate waste management plans. The result was a document of over 1000 pages in size and took a number of weeks of effort within the HSE/NII to review the document and compare it with the internal guidance of T/AST/024 (Reference 7) and the 2006 Safety Assessment Principles (SAPs) (Reference 8).

As an appropriately sized proportionate targeted approach HSE/NII employed a contractor, TGF Limited to directly deliver a review of all of the IWS's of NDA Licensee's against the same principles and guidance.

It is important to note at this point that the TGF assessments are always taken as regulatory advice and it is the HSE/NII who directly interact and respond to Licensee's on all matters involving regulation.

A project officer was appointed to manage and act as an intelligent customer for the TGF reviews of a series of significant IWS's across the UK.

Sellafield's IWS was again reviewed during 2007 against the original assessment criteria but additionally in terms of overall impressions, the content of the documentation with particular emphasis on the auditability of claims made and conclusions stated in the documentation.

Only by 2008 were sufficient mature IWS's available across the UK NDA sites to deliver a review of the NDA estate that would inform both the Licensee's and the developing Joint Regulatory Guidance on the Management of Higher Activity Waste on Nuclear Sites (Reference 11).

During 2008 the following IWS's were reviewed: Sellafield, Dounreay, Sellafield-Capenhurst, Windscale and Springfields. The significant outputs of these were communicated to the Licensee's to where possible help with the development of their future IWS's. In addition the outputs were input where relevant into the Joint Guidance.

The Joint Guidance was issued for trial during 2009 and essentially repeats the philosophy proposed in the original discussions with Sellafield Ltd in a more comprehensive manner.

It expands the regulatory expectations on the use of relevant good practice in waste avoidance, minimisation, management and disposal. The guidance seeks to see effective use of waste minimisation, characterisation and segregation. It emphasises the need to be transparent, systematic and optimised.

Significantly the guidance aims to inspire ownership of the IWS by the Licensee as not being a regulatory tool but a device that enables a dutyholder to understand and control its waste from cradle to grave and thus deliver safety at a minimised cost.

By restating some of the guidance in simplistic terms the similarities with the guidance stated in SEL76251R can clearly be seen:

1. An IWS should define a structured approach which is consistent with relevant good practice

2. Apply to the management of all the wastes over the whole lifecycle of the site
3. Comply with the law
4. Be consistent with Government policy and regulatory expectations
5. Apply Waste Management Hierarchy
6. Adequately control hazards of wastes and act to reduce them
7. Identify all radioactive wastes on and assigned long-term management and/or disposal routes.

Of these, Point 1 is significant in demonstrating the decision making process that a Licensee or dutyholder has used to deliver its IWS.

2009 IWS REVIEW

Following the success of the 2008 review in providing an overarching understanding of the status of IWS's across the part of the NDA estate it was decided within NII to repeat the exercise using the 2009 edition of IWS on key NDA sites (the Sellafield site was excluded due to the significant emphasis that had been placed on it for a number of years).

The sites covered were: Dounreay, Sellafield Capenhurst, Springfields, Magnox North and South. The choice of sites includes a complex multiplant significantly radioactive site, operating and decommissioning reactor sites, chemical and fuel manufacture related sites.

The 2009 review was against the Joint Guidance and additionally the following criteria:

- Identify changes between 2008 and 2009 where possible and check progress on actions listed in the 2008 documents.
- Identify those sections of the IWS which remain unchanged in comparison to 2008.
- How are all nuclear materials, which can generate radioactive waste or which themselves may become radioactive waste in the future, considered.
- Is there a clear and systematic method to underpin decisions on strategies to reach a desired state and is it evident how this has been used?
- Whether best practice is apparent.
- Whether drives for improvement are framed in terms of defined goals and milestones to measure progress.
- Is it clear what value the Licensee places on the IWS.
- Does the IWS drive the site strategies which form the Lifetime Plan rather than the other way round?
- What level of effort has the Licensee devoted to the IWS – is the team size and source evident and is it appropriate?
- Are there strategic goals set and on what basis?
- Does the IWS tend to focus on waste treatment rather than waste avoidance and minimisation?
- Are segregation, containment and passivation strategies evident, which will minimise waste?
- Is there adequate description of the current status of the wastes, storage containers and waste stores?
- Are any safety case implications brought out, e.g. inherent hazards, limiting factors on waste storage life?
- Is there an appropriate Electrical and Instrument Maintenance & Testing strategy developed from the waste/stores status and safety case issues, e.g. care and surveillance, monitoring, sampling?
- Are secondary containment issues covered?
- Are buffer storage arrangements described for material awaiting processing or disposal?
- Is the inventory comprehensive, accurate and relate to the national inventory.
- How good are the current waste management arrangements.
- Are the available routes and methods to reach a desired state clearly identified?
- How does the IWS link to those external projects which affect it, e.g. R&D?

SIGNIFICANT RESULTS OF THE REVIEW

Across the sample of IWS that we have reviewed these observations have been made:

GOOD PRACTICE

- Most Licensees have now spent significant efforts in producing an IWS that can be reviewed and that meets with the outline of the NDA specification.
- Infrastructure requirements are beginning to be acknowledged, e.g. flasks, intersite transfer issues, characterisation support.
- Inventories have been drawn together and predicted.
- Techniques that help develop characterise IWS's have been developed e.g. Sankey diagrams, site wiring diagrams.
- Uncertainties and risks have begun to be identified.
- One Licensee has recognised the IWS as a vehicle to drive change in its lifetime plan.

POINTS FOR IMPROVEMENT OR CHALLENGES

- Ease of reading is variable. Many are very long and appear "padded out", particularly with re-statements of the Law or Guidance. We consider that a strategy documents would benefit by being concise.
- Approach to describe wastes, processes and plant interactions are variable.
- *Often the source term for the waste is placed outside the IWS which limits the visibility for waste avoidance.*
- Often not enough description of the current status of wastes and what really drives the strategy – hazards, radionuclides, chemical forms.
- IWS's often appear to be driven by the lifetime plan (or business model) than driving the business.
- There was limited evidence of real challenge against waste management hierarchy principles.
- Inventory information of variable quality, often inconsistent and with little indication of its accuracy. Estimated volumes often vary significantly from one year to the

next. For instance some IWS's declare future waste predictions often in tonnes to the second decimal place.

- BPEO is often used to underpin strategy but these BPEO studies are usually waste stream-specific and thus not integrated.
- No targets set for solid radioactive wastes.
- Routes to achieve strategic aims often overstated e.g. notional waste processing plants.
- Fallback and contingency plans often not well-developed.
- Longer-term Electrical, Instrument and Mechanical Technology strategies rarely mentioned.
- Record management strategies rarely mentioned.
- Teams are often small and composed of experts who integrate information from a wide variety of sources, working offline.
- Some teams are inconsistent with the size of a site. The expectation would be to have a team size proportional to the challenge and complexity of a site.

CONCLUSIONS

The paper has argued that over the period of six years regulatory guidance has developed and matured sufficient to inform Licensees in the construction of IWS's for the NDA estate. However the quality and ownership of the IWS's is variable and inconsistent. Some significant good practice exists and this should be shared amongst all Licensees and dutyholders and particularly those who are outside the direct control of the NDA.

Only following improved integration and consistency will it be possible to deliver a national plan that is an important part of the UK's position within Europe and the United Nations.

FUTURE DEVELOPMENT

Integration of IWS's should be sought via a consistency of approach and output at the site level.

To develop a national radioactive waste management plan it is important that not only the NDA owned sites but other Licensees and duty holders demonstrate that they can deliver adequate consistent integrated waste strategies.

In order to improve the delivery, ownership and output of IWSs, the HSE/NII (in conjunction with the EA) plan to hold a national workshop in Manchester (UK) in January 2011 to share experience of current IWSs and their development. In addition, work is progressing to understand the challenge that Licensees face when they produced their IWS. This work aims to help regulators to form reasonable expectations of Licensee's, given the challenges they face. The results of this workshop and future work will be reported at the conference.

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