The NDA group of Site Licensed Companies

Making a difference for future generations

Dounreay Magnox NTS Nuclear Transport Solutions Nuclear Waste Services Sellafield Ltd

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Our mission

We're charged with the mission, on behalf of Government, to clean up the UK's earliest nuclear sites safely, securely and cost effectively.

Doing this with care for our people, communities and the environment is at the heart of our work.

We're committed to overcoming the challenges of nuclear clean-up and decommissioning, leaving our 17 nuclear sites ready for their next use.

Our sites

Our work to clean up the UK's nuclear legacy is the largest, most important environmental restoration project in Europe.

Our mission is so long-term it spans the next century and beyond.

Our 17 sites are at different stages of decommissioning and all have unique challenges.

17
nuclear sites across the UK

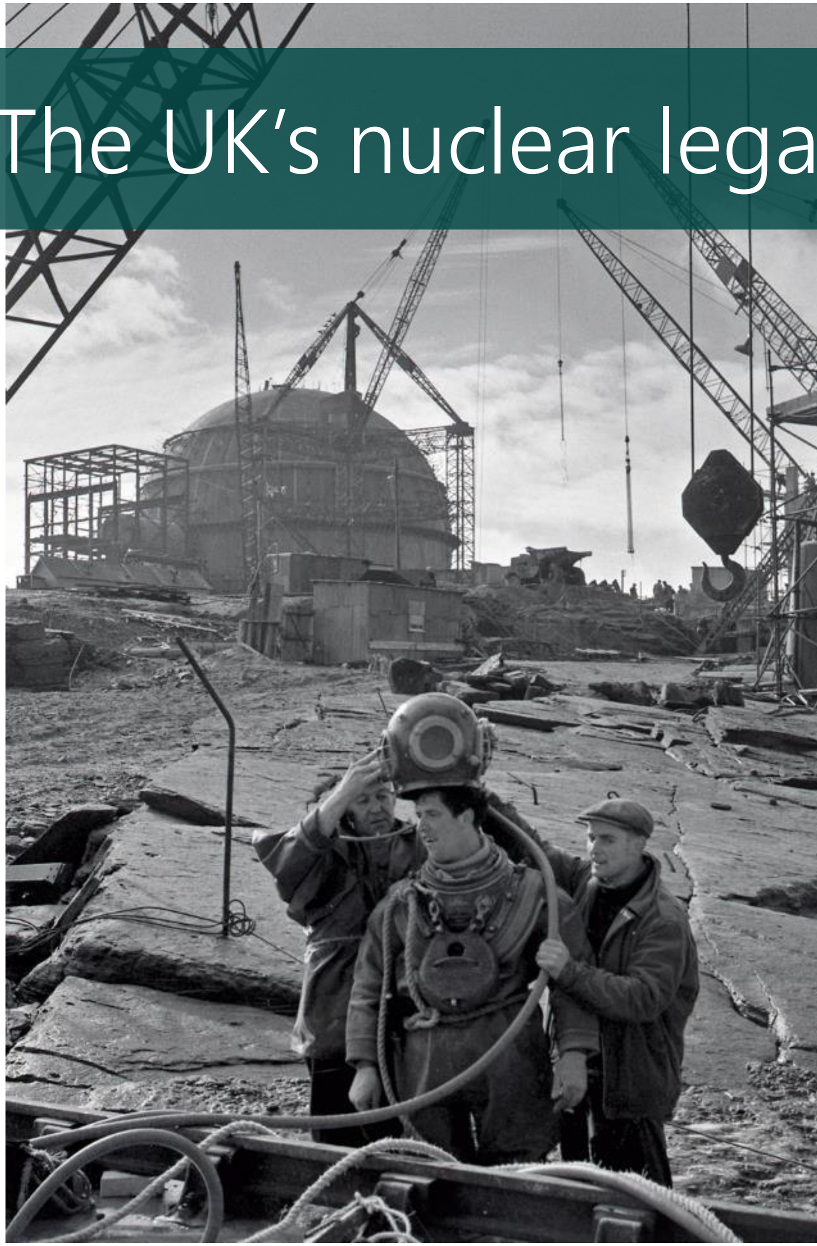
11
operating companies

15,000
employees across the group

1,043
hectares of designated land on nuclear licensed sites

800+
buildings to be demolished

The UK's nuclear legacy



The UK's nuclear landscape began to take shape in the post-war period and has evolved over many decades.

Our 17 sites reflect this and include the first fleet of nuclear power stations, research centres, fuel-related facilities and Sellafield, which has the largest radioactive inventory and the most complex facilities to decommission.

Current plans indicate it will take more than 100 years to complete our core mission of nuclear clean-up and waste management. The ultimate goal is to achieve the end state at all sites by 2125.

Innovation through research and development

The NDA collaborated on R&D projects with the wider nuclear sector and beyond, both in the UK and overseas.

- We're supporting more than 50 PhD projects at over 20 universities
- More than 70 supply chain organisations are involved with our R&D projects
- Around 80% of total R&D spending is targeted at Sellafield's technical challenges

We're doing more internationally

We place great importance on collaborating with international partners to share learning and best practice, helping us develop better solutions for the UK's most pressing technical challenges.

We're working closely with international committees such as the IAEA and the OECD NEA, and with decommissioning and waste management companies in France, USA and Japan.

We're also helping to identify opportunities for the UK's nuclear supply chain to work internationally.

Introduction

The presentation will include an example from the UK to present the challenge in managing higher activity waste following either accident scenario and where the records and provenance of the waste is poor

Sellafield Magnox Swarf Storage Silos

Briefly UK Radioactive Waste Characterisation Good practice guide (which is summarised in NEA Expert Group on Characterisation of Unconventional and Legacy Waste 2020 paper) will is now published

Sellafield

Current key activities

- Focus on high hazard risk reduction
- We have had a number of significant accidents at the site over the past 7 decades and have a number of facilities in a degraded condition which are a priority for us
- In order to make the progress needed to address those High Hazard facilities and reduce the risk they present in a priority manner we work very closely as part of G6 approach, with our government, our two key regulators (Office for Nuclear Regulation and Environment Agency)

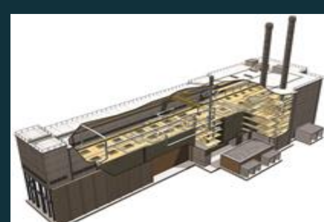
High Hazard programmes represent 90% of the nuclear hazard potential on the Sellafield site

1. Pile Fuel Storage Pond

2. Pile Fuel Cladding Silo

3. First Generation Magnox Fuel Pond

4. Magnox Swarf Storage Silos



Four Legacy Ponds & Silos

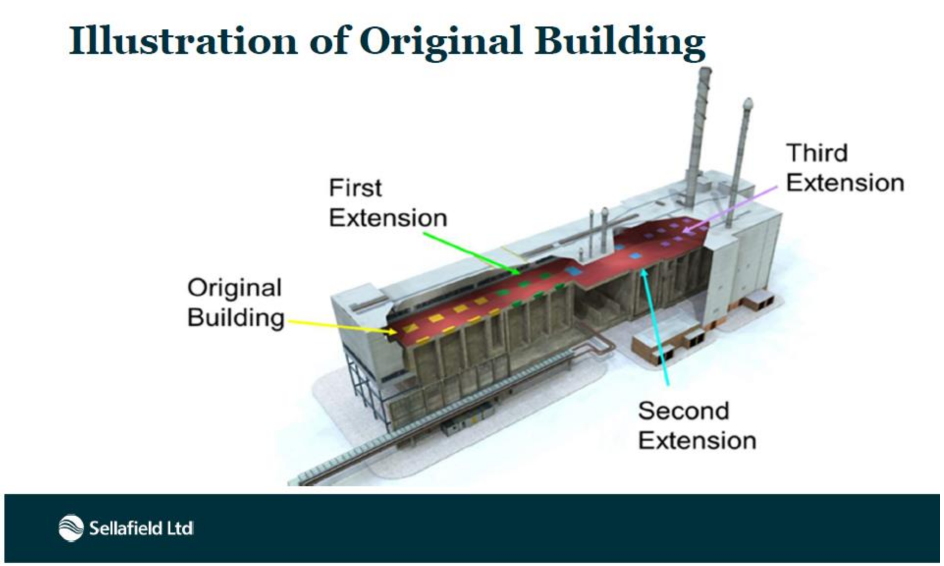
5. Highly Active Liquor (HAL)

6. Management of Plutonium

Discrete item retrievals now completely removed from the Pile Fuel Storage Pond at Sellafield

Magnox Swarf Storage Silo – balance between certainty and progress

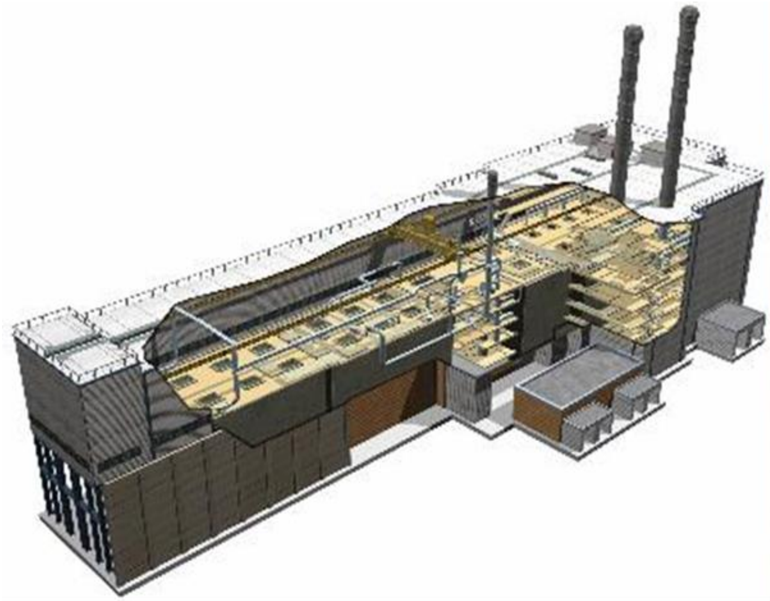
Credit to my colleague John Clifford, Head of Retrievals and Higher Activity Waste of Sellafield Ltd for content



Balancing uncertainty and progress

- A selected forward direction requires a certain level of confidence which is influenced by levels of risk, hazard, stakeholder requirements and legislation.
- Confidence can be gained through removal of uncertainty and tolerance or protection to uncertainty and there is an appropriate balance between elements which can be struck to allow progression.
- The appropriate balance is bespoke to the problem in hand.
- The role of characterisation is one means to provide data to inform decisions (utilising Data Quality Objectives principles) where the nature and extent of characterisation provides the level of confidence in that data.
- However, for certain scenarios characterisation activities that provide sufficient levels of quality and confidence may prove a significant challenge.
- The Magnox Swarf Storage Silo is one such case study where the driver to make progress in removal of its inventory is significantly important.

Magnox Swarf Storage Silo (MSSS)



There is a high hazard and risk reduction driver to remove the inventory from MSSS and store in a safer form under modern arrangements.

The outcome was the Alternative ILW Approach where the material was to be stored unconditioned in high integrity multi-barrier containers.

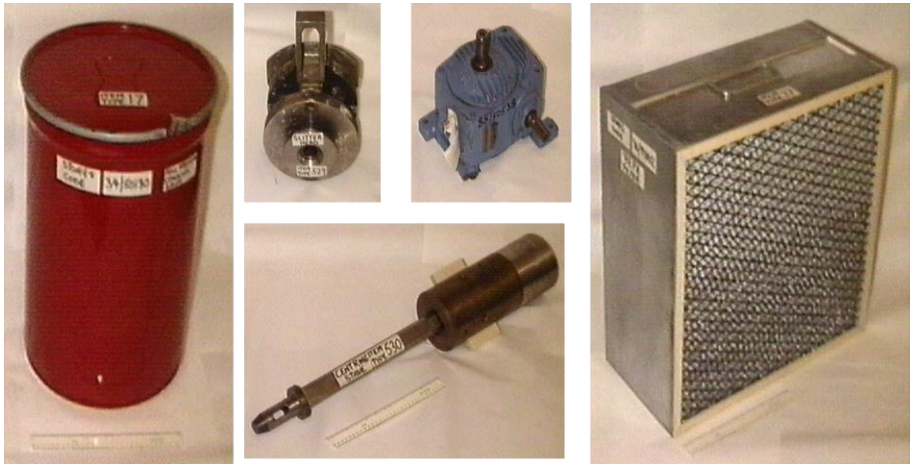
MSSS - Inventory Overview & Uncertainty

There are 22 compartments each approximately 600 m^3 containing a range of Intermediate Level Waste.

MSSS waste can be broadly categorised into five waste types which are of interest:

- Magnox swarf and its corrosion product magnesium hydroxide sludge;
- Uranium metal and its corrosion products e.g. uranium dioxide sludge;
- MBGW;
- Mixtures of the above three types.
- Stainless steel and Zircaloy hulls from reprocessing operations.

Majority of MBGW items consisted of general waste e.g. filters, cave items, graphite sleeves and distance pieces, drums of sludge, tins/drums of soft wastes, lead, pond tools.



MSSS – Inventory Overview – Swarf/Sludge

- Metal corrosion rate is temperature, pH and surface area dependent.
- Magnox wastes in the older compartments exhibit a specific set of behaviours identified by characterisation and are referred to as “**Type 1**” Magnox behaviour.
- Applying this Type 1 Magnox behaviour to the MSSS results in the prediction that most of the Magnox in all the Compartments of the MSSS has corroded during storage, with the waste now consisting of magnesium hydroxide sludge.
- In 2014 and during 2015 a series of video camera surveys were carried out in the MSSS. These showed that at least at the visible surface of the waste in the Second and Third Extensions the Magnox had corroded to a much lesser extent than would be expected if it had exhibited Type 1 behaviour. This Magnox waste, which has shown a lower corrosion extent than Type 1 behaviour Magnox is referred to as exhibiting “**Type 2**” behaviour Magnox.




Technical, Safety and Engineering Cases

Requirement to consider the lifecycle of the waste:

- In-situ inventory
- Retrievals and containerisation
- Safe interim storage
- Final disposal to the GDF

Undertaking characterisation is extremely challenging – difficult to access the waste, radiological considerations for handling and analysis, and to provide high levels of confidence significant numbers of samples would be required - uncertainty would always remain.

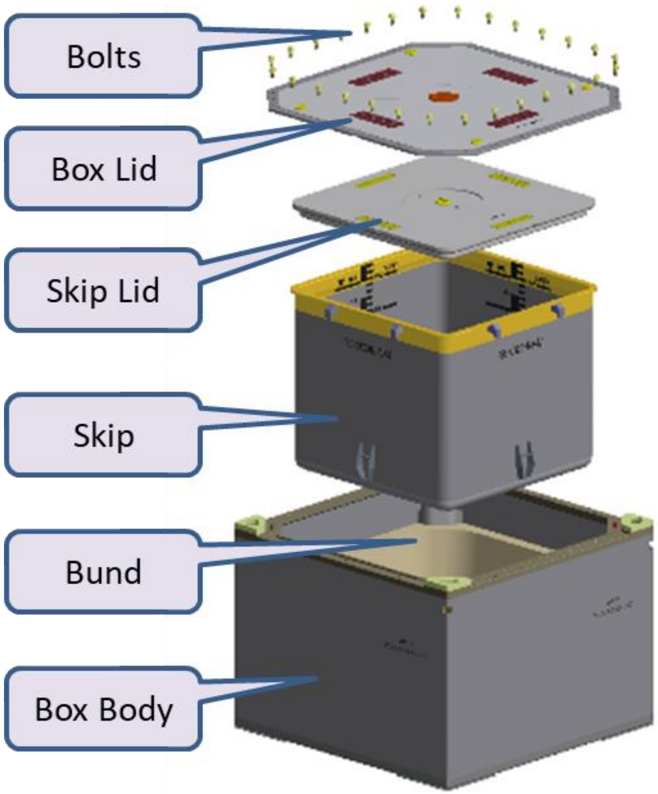
For all current adopted waste management processes and identified waste behaviours all available information has been used e.g Historic records and accounts, visual inspections and historic sampling data, On-plant measurement data.

Significant supplementary work was also undertaken to provide a sufficiently conservative basis and assumption set, through;

- Fundamental research and development related to waste behaviours,
- Demonstrations and predictive modelling

Where each element of uncertainty is duly considered to ensure that sufficient margins of tolerance are incorporated into the solution to protect people, process and plant.

Example - Robust Waste Containers



The $3m^3$ Box and internal waste storage skip provide significant robustness to a number of any adverse waste behaviours. This provides protection against a range of uncertainties.

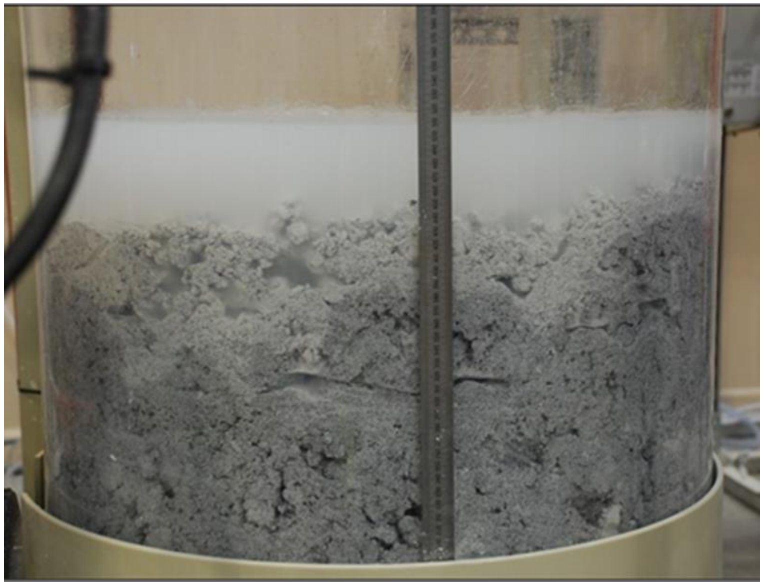
Key Box Features:

- Multi and diverse-barrier container robust to corrosion mechanisms induced by the waste or external environment.
- Filters to allow egress of hydrogen and retain particulate.
- Robust to impacts and deflagration


INACTIVE COMMISSIONING BOX

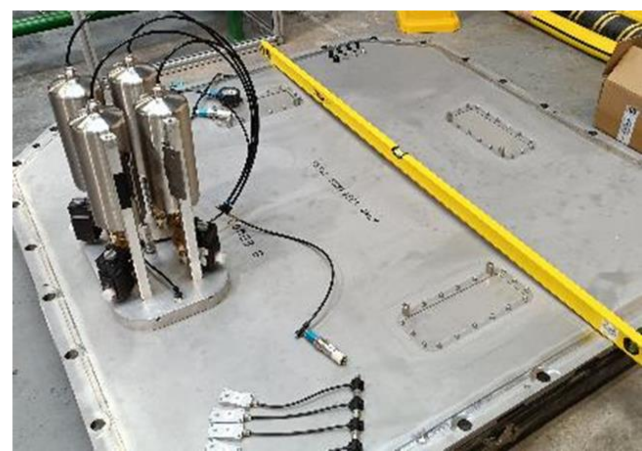
Example - Hydrogen Technical Arguments

- With respect to hydrogen generation the inventory of significance are those wastes that can generate hydrogen or retain and release hydrogen such that levels within the waste container exceed the lower flammable limit.
- Conservative skip filling has been adopted to ensure the rate of H2 generation is always manageable.
- Conservative waste behaviours have been assumed.



Assurance through Condition Monitoring and Inspection

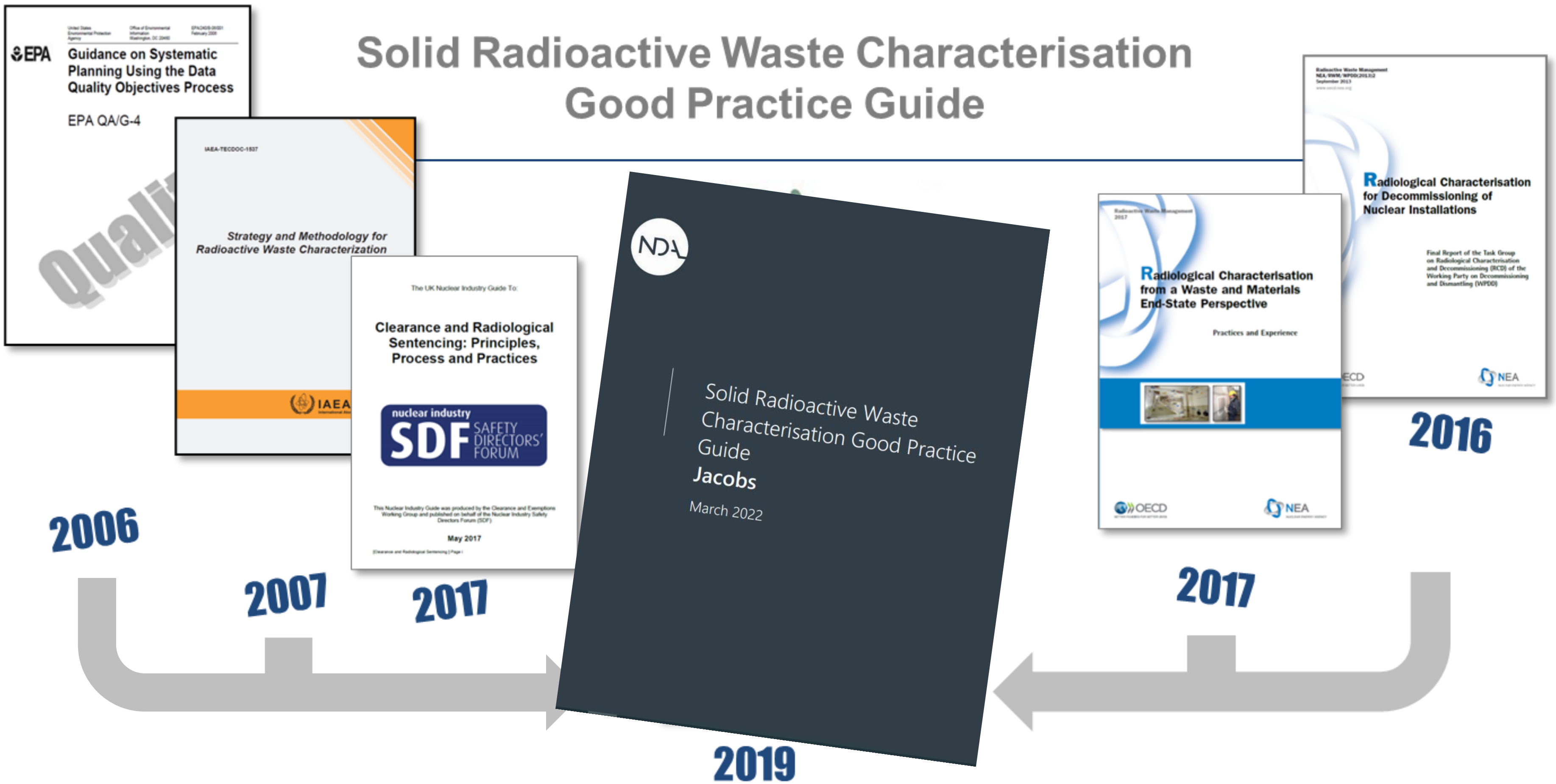
- Condition Monitoring and Inspection (CM&I) takes account of the technical risks, the potential waste evolution and the performance requirements of both the store and waste container.
- The approach provides reassurance that the overall performance of the storage system is protective of people and the wider environment.
- Monitoring of evolution of the waste packages will aim to understand any long-term risks that could complicate package retrieval, as well as supporting the understanding of the waste prior to finishing and disposal.
- The currently available and proposed future CM&I capabilities provide for wide ranging interrogation techniques.

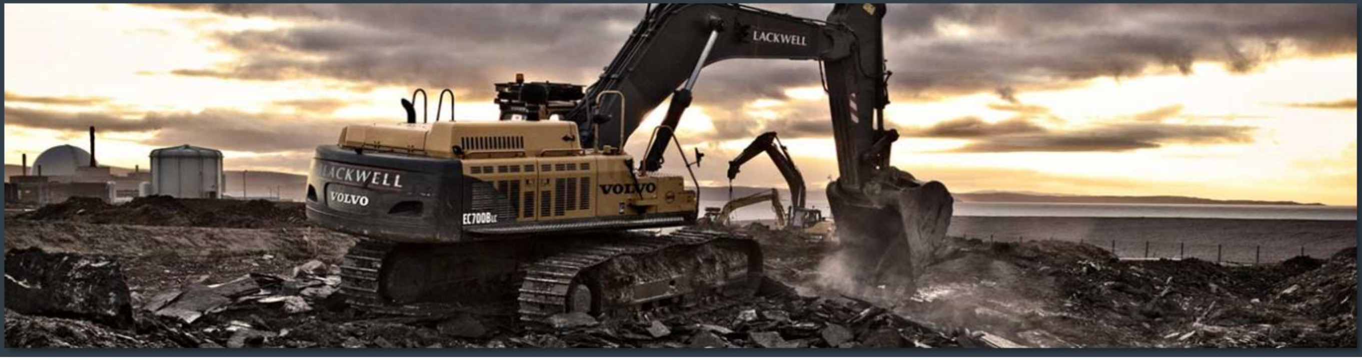


Conclusions : MSSS Optimisation, Continued Improvement and Learning

- Although a conservative basis has been adopted, it is understood where known uncertainties reside and conservatisms have been made.
- Tolerance and robustness has been built into the engineered systems and technical basis.
- Caution is adopted for the filling of skips and this means a sub-optimal case but allowed retrievals and storage to commence.
- Waste behaviour and the silos content will be better understood once it is retrieved and observed.
- Strategy is now to improve on this position to reduce conservatism through learning activities, further R&D, engineering optimisation and limited characterisation; whilst having considered means of responding to deviations.

NDA Solid Radioactive Waste Characterisation Good Practice Guide





Chapter 1 describes the aims, scope and intended readership of the GPG.

Chapter 2 describes the United Kingdom classification system for solid radioactive waste and introduces the UK regulatory framework for radioactive waste management.

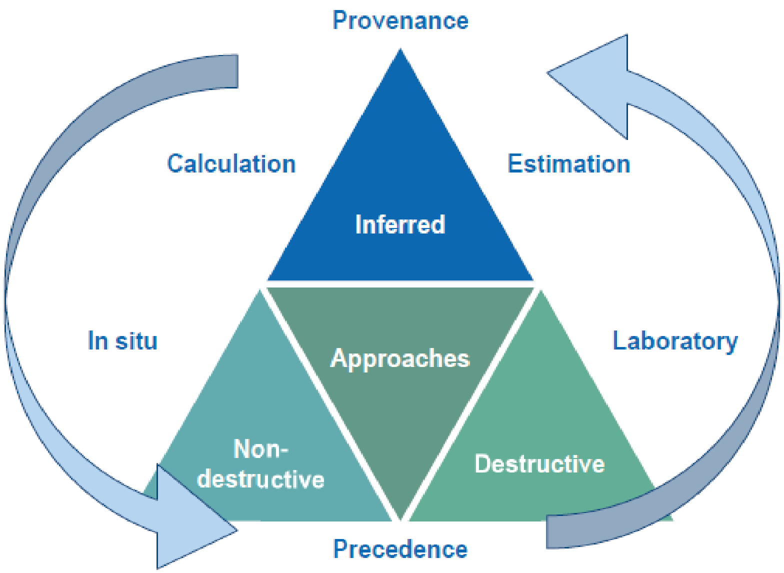
Chapter 3 describes the characterisation requirements of organisations responsible for treating or disposing of radioactive waste, the responsibilities of the waste producer.

Chapter 4 presents a systematic process for characterising solid radioactive waste and gives guidance on the application of this process.

Chapters 5 to 7 consider specific important aspects of the waste characterisation process

Chapters 8 to 10 describe and provide guidance on the three approaches to waste characterisation

Optimised Approach to Acquiring New Data



OECD BETTER POLICIES FOR BETTER LIVES
NEA NUCLEAR ENERGY AGENCY

Summary

There is a balance to be struck between making progress and managing uncertainty

If there is an imperative to make progress then uncertainty must be managed.

Where it is not feasible or characterise to the extent you might like, one can adopt conservative safety cases and robust engineered containers to provide the safety envelope and hence allow the progress.

Progress can best be made by developing and agreeing that strategy with key stakeholders, aiming for a shared and agreed outcome.

Progress may only be to the next interim step but this is still good and important progress as long as the end goal is kept in mind.

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