

Speaker Series

Decommissioning and legacy remediation in the UK – Progress and Challenges

Mark Foy – Chief Nuclear Inspector

21 November 2018

Overview

1. The UK nuclear waste management and decommissioning challenge – a National Overview
2. UK Regulatory Framework and Approach
3. UK Spent Fuel & Higher Activity Waste Strategy
4. Low Level Waste Management – Improved use of Waste Hierarchy
5. Case Studies:
 - Sellafield
 - Bradwell Care & Maintenance
 - Berkeley
 - Sizewell B Dry Store
 - New Build



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A National Overview

Sellafield



Sellafield, image copyright of Sellafield Limited

- Large, complex fuel cycle site – operations are critical to other parts of the nuclear sector
- Large inventory of radioactive materials
- Ageing and degrading facilities
- Clean-up will take decades but there has been recent progress
- New facilities needed to support remediation and for safe long-term waste storage
- Change of mission and organisational transformation

Shutdown Magnox Power Stations

Berkeley, copyright Magnox Ltd



- 26 reactors on 11 sites
- Built 1956 -1971
- Gas cooled - natural uranium fuel with graphite cores
- All ceased operation and most are defuelled



Dungeness A, copyright Magnox Ltd



Trawsfynydd, copyright Magnox Ltd



PWR Power Station – Sizewell B



Sizewell B, Copyright of EDF Energy

- Operational since 1995
- Owned by EDF Energy
- Output 1.2 Gw
- Spent fuel is stored on site in a purpose built dry store – US Holtec Design
- 60 year and 80 year lifetime extension ambitions



Sizewell B Control Room, Copyright of EDF Energy



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Research Sites



Harwell, Copyright Magnox Ltd



CONSORT,
copyright
Imperial College London



Dounreay, Copyright Dounreay Site Restoration Limited



Winfrith,
Copyright Magnox
Ltd

- Dounreay
- Harwell
- Winfrith
- Imperial College
CONSORT
- All in
decommissioning

Low Level Waste Treatment and Disposal



- Dedicated engineered disposal facilities at LLW Repository and Dounreay
- Conventional landfill disposal
- Metal treatment
- Incineration
- Trans-Frontier Shipments (eg for metal smelting)



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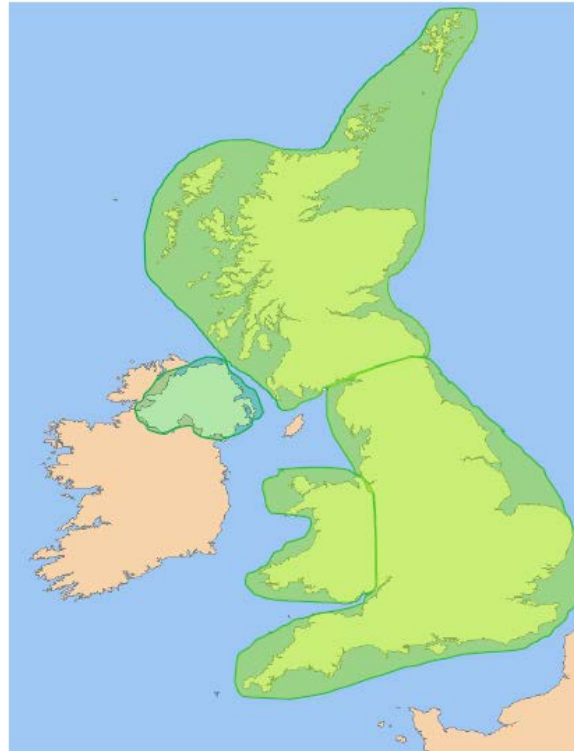
UK Regulatory Framework and approach



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UK Regulatory Bodies

Protection of People & the Environment



Safety, security, safeguards and inland transport:
Single UK-wide regulator



There are no licensed nuclear sites in Northern Ireland



Department for Business, Energy & Industrial Strategy

ONR legal responsibilities

- **ONR** regulates nuclear safety, civil nuclear security, transport and conventional health and safety
 - With respect to handling, treatment and storage of nuclear matter upon the licensed site
 - Conditions of the site licence
- **Environment Agencies** regulate protection of people and the environment from the use of radioactive substances and disposal of radioactive wastes
 - grant permits or authorisations for the discharge and disposal of radioactive wastes (including VLLW)



UK Regulatory Philosophy

- Site operators are responsible for safety and environmental protection
 - Regulation is non-prescriptive and goal setting
 - Risks should be reduced so far as is reasonably practicable
 - Adequate Arrangements

- Delivering clarity of regulatory expectations
 - Graded approach
 - Open and transparent guidance
 - Routine and targeted stakeholder engagement – ‘Early Engagement’

Relevant Conditions of site licence

- Nuclear matter is stored in accordance with adequate arrangements.
- All operations that may affect safety need a safety case to demonstrate safety & identify limits and conditions of operation.
- Adequate arrangements for minimising the rate of production and total quantity of radioactive waste accumulated.
- The licensee is to ensure that radioactive waste is at all times adequately controlled or contained.
- The licensee is to have adequate decommissioning programmes, divided up into stages.

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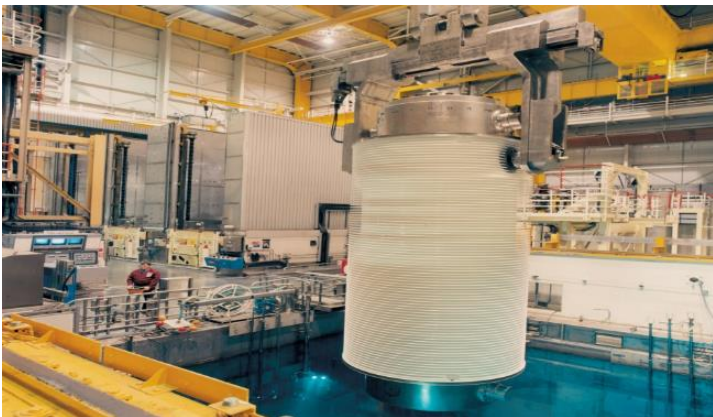


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Spent Fuel and Higher Activity Waste Policy



Spent Fuel Policy



- Spent fuel is not considered to be a waste while the option of reprocessing remains open
- Present assumptions are:
 - Magnox fuel reprocessing at Sellafield to end in 2020
 - Oxide fuel reprocessing at Sellafield to end in 2018
 - PWR and future reactors – Government policy is not to reprocess but to interim store pending geological disposal

THORP Receipt and Storage, images copyright of Sellafield Ltd

HAW Policy



Demonstration of HAW conditioning, copyright NDA



*High Level Waste Canisters at Sellafield,
copyright Sellafield Limited*

- HAW = Intermediate Level Waste and High Level Waste
- Safe interim storage followed by Geological Disposal - policy in England since 2006:
- Welsh policy is Safe interim storage followed by Geological Disposal (2015)
- Scottish policy is for long-term management in near-surface facilities near to the nuclear site where it is produced (2011)



HAW Future Disposal

Government policy is for:

- long-term management of higher activity radioactive waste (HAW) via geological disposal
- GDF to require a nuclear site licence
- No intent for ONR to regulate disposal of LLW or VLLW

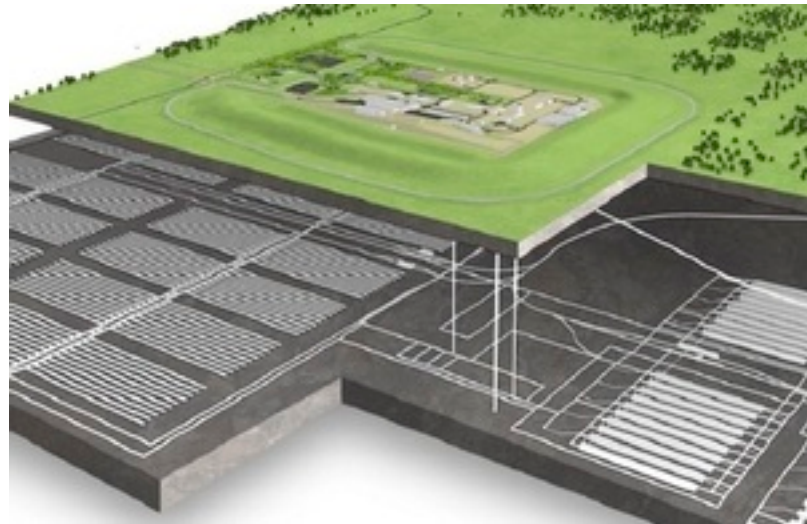


Image source – the Nuclear Decommissioning Authority



HAW Future Disposal



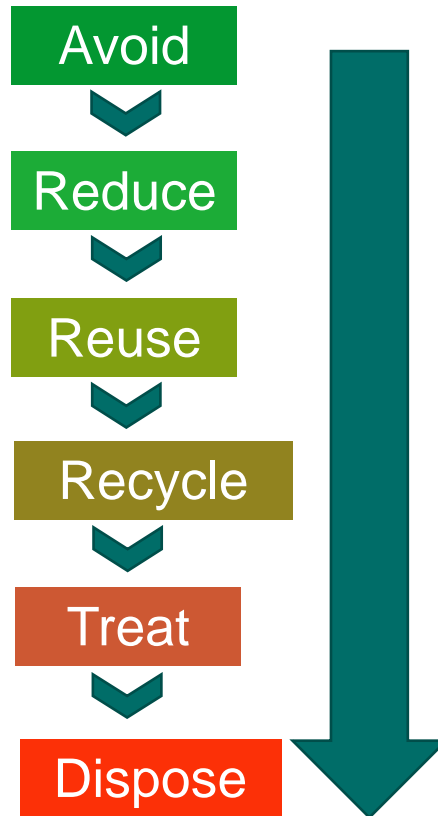


Low Level Waste – Waste Hierarchy



Low Level Waste Policy

Waste Hierarchy



0055-02-NDA

Drummed LLW at Dounreay, copyright of NDA

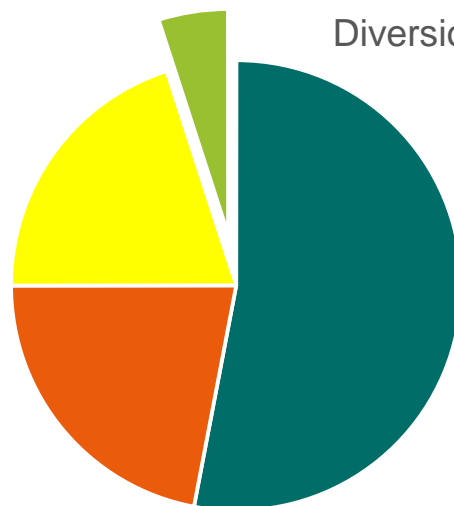
- LLW is defined as waste with radioactive content not exceeding 4GBq/te of alpha, or 12GBq/te of beta/gamma
- Current policy was established in 2007
- The Waste Hierarchy is embedded in UK legislation
- Policy is implemented through:
 - Strategies for each LLW producing sector
 - National Nuclear LLW Programme

LLW – Effective application of waste hierarchy

Recognised Joint
Convention 'Good
Practice

One of only 6 countries

Extends lifetime of
LLWR by 100 years



Diversion of wastes from LLWR FY 2017-18

- Landfill
- Combustion
- Metallic treatment
- LLWR





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Berkeley Boilers enroute to Sweden





Decommissioning strategies in the UK:

Prompt versus Deferred



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UK Strategy

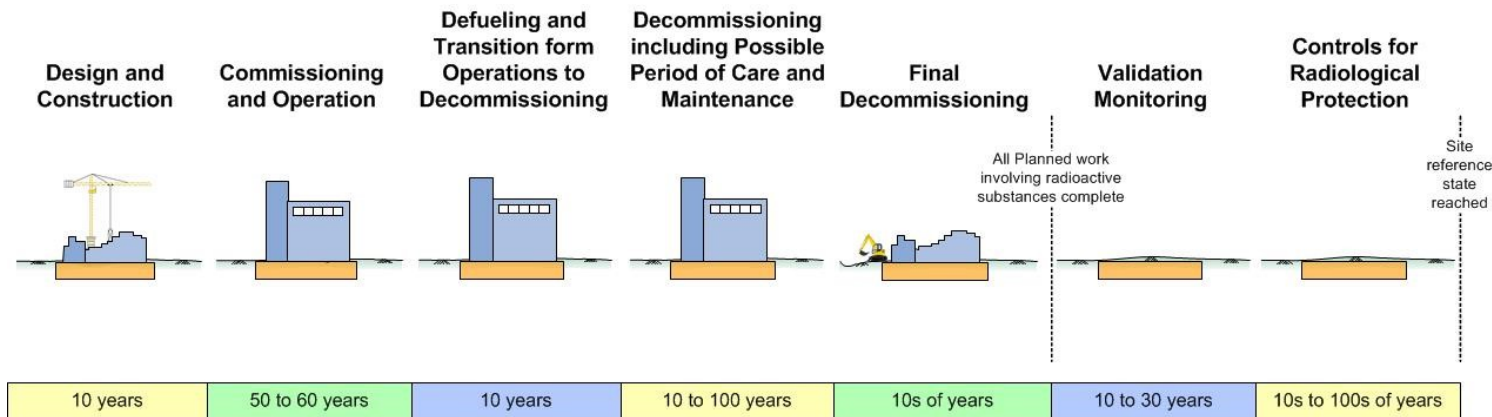


- As soon as reasonably practicable, taking into account all relevant factors
- A safe, progressive and systematic reduction of hazards
- NDA owns the UK's civil public sector nuclear liabilities and is obliged to refresh its strategy every 5 years with full consultation



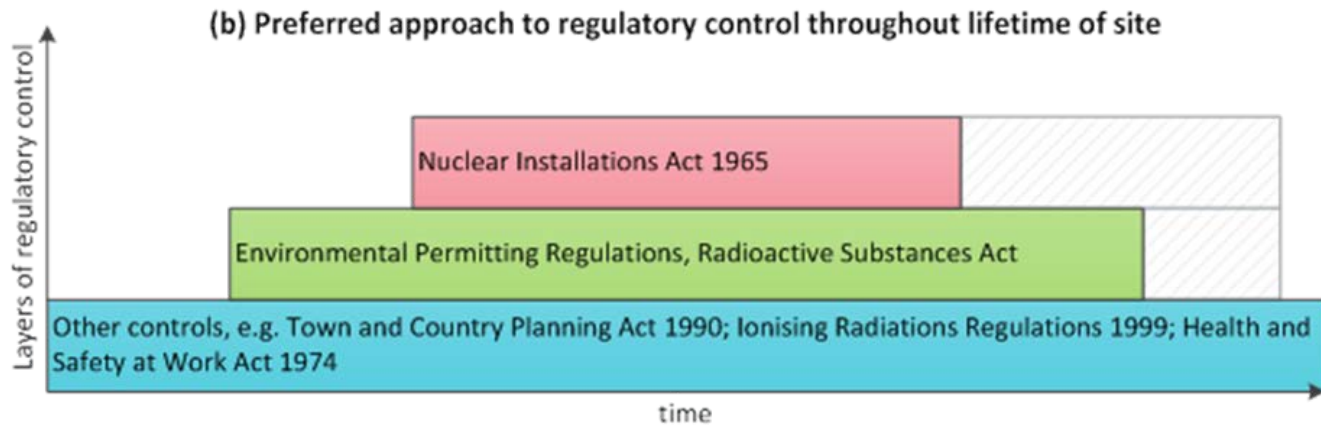
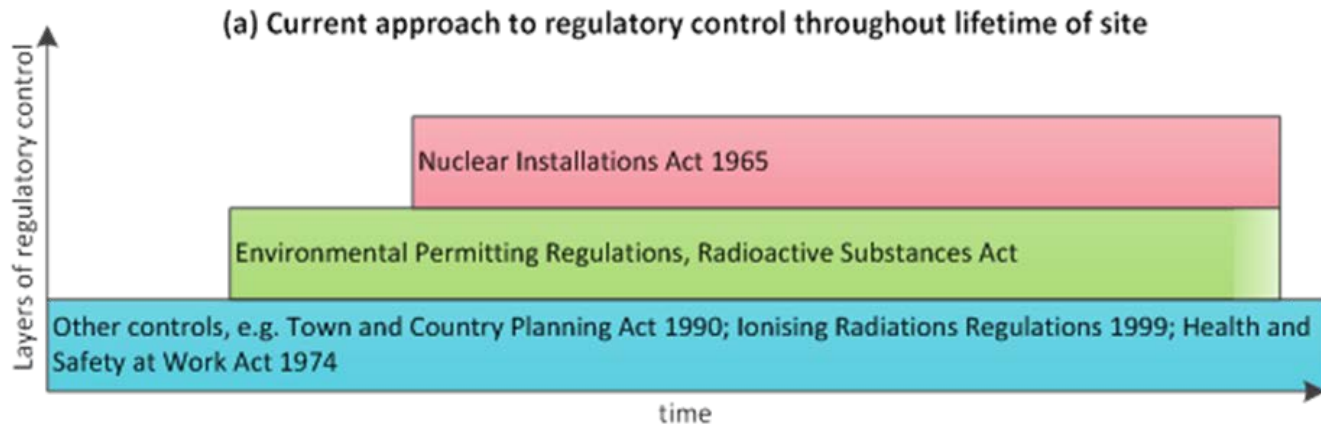
Guidance on the Requirements for Release from Regulation (GRR)

- GRR has a dual role: it defines the standard for radioactive waste management and final site clearance – both now (during the period of regulation) and in the future (after all regulatory controls have been removed)
- GRR is about identifying optimised solutions for waste management & the clean up of nuclear sites





Proportionate Regulatory Controls





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Case Studies



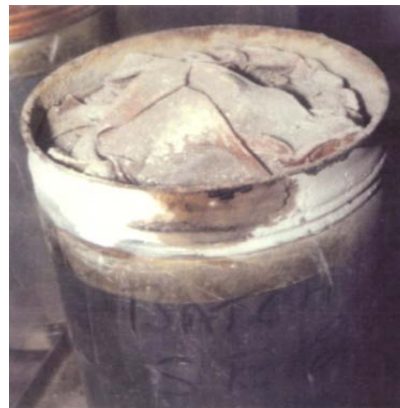
Hazard & Risk reduction at Sellafield

- Legacy ponds & silos – LP&S (legacy spent fuel, liquids, sludges)
- Plutonium management facilities (plutonium oxide powder)
- Nuclear fuel reprocessing and storage (spent fuel, highly active liquor)



*Intermediate level waste
inside a legacy silo*

Degraded plutonium storage cans



*Irradiated fuel and
sludge in a legacy pond*

Sellafield – ONR’s TOP Priority

Following stagnation in Sellafield’s remediation, ONR instigated **a new strategy** to enable acceleration & progress.

Key principles are:

- Fostering alignment and co-operation between key stakeholders;
- Prioritisation – *agreeing and communicating priorities with key stakeholders*
- Removal of Barriers /unnecessary Bureaucracy;
- Avoidance of Distractions and Diversions;
- Encouraging incentives aligned with Sellafield’s main mission;
- Application of fit-for-purpose solutions;
- Balance of risks and risk appetite



Hazard & Risk reduction at Sellafield



Pile Fuel Cladding Silo



Magnox Swarf Storage Silo

- Pile Fuel Cladding silo (PFCS)
- Pile Fuel Storage Pond (PFSP)
- Magnox Swarf Storage Silo (MSSS)
- First Generation Magnox Storage Ponds (FGMSP)

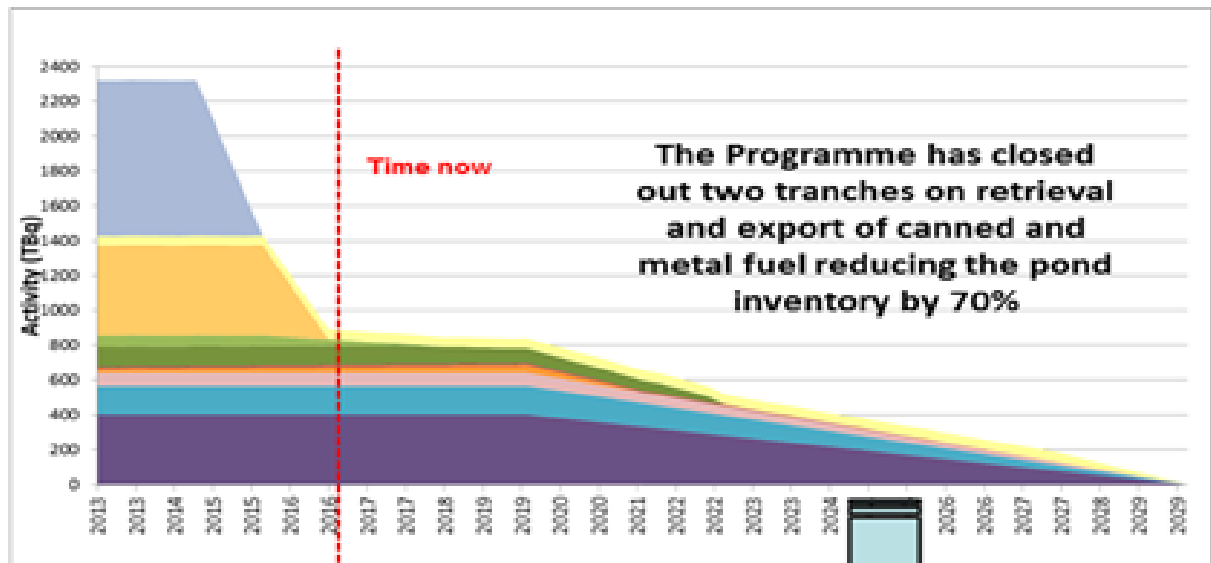


Example: Pile Fuel Storage Pond

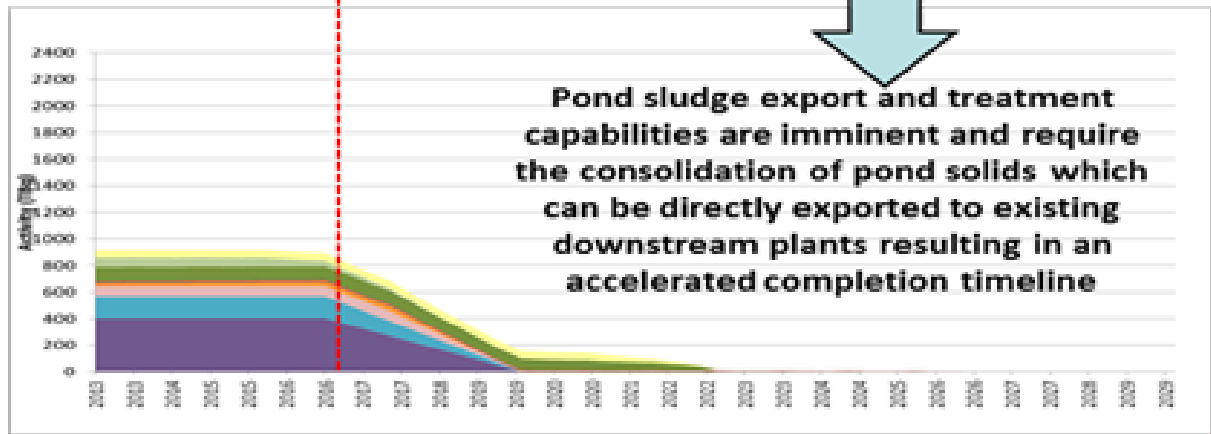




Example: Pile Fuel Storage Pond



- Bulk canned fuel
- Residual metal fuel
- Bulk metal fuel
- Bulk Sludge
- Residual Sludge
- Residual Solids
- Ionsiv
- Isotope Cartridges
- Support Struts
- Control Rods
- Other Activated Items (tins, HDW)
- Swarf
- Bulk waste (LLW)



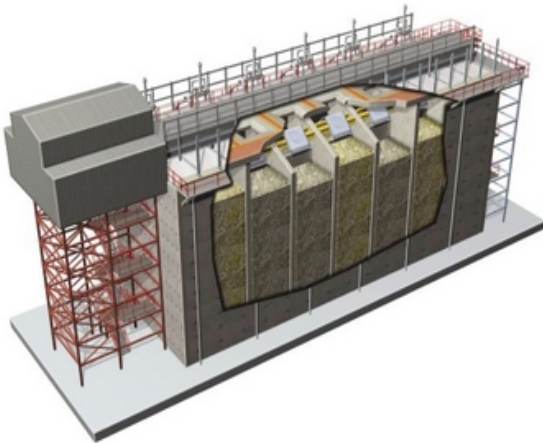


Example: Cutting holes in the Pile Fuel Cladding Silo

- Revised, simplified solution introduced - A necessary step to retrieve the waste - involved accepting (controlled) heightened short-term risk (major structural changes to a **vulnerable building with a large, flammable radioactive waste inventory**).

We:

- assessed SL's proposals, inspected their arrangements and preparatory work, secured improvements in emergency preparedness
- granted permission when satisfied that **all reasonable steps** had been taken to control the risks
- are regulating construction of **new facilities** to secure their timely availability for safe storage of waste



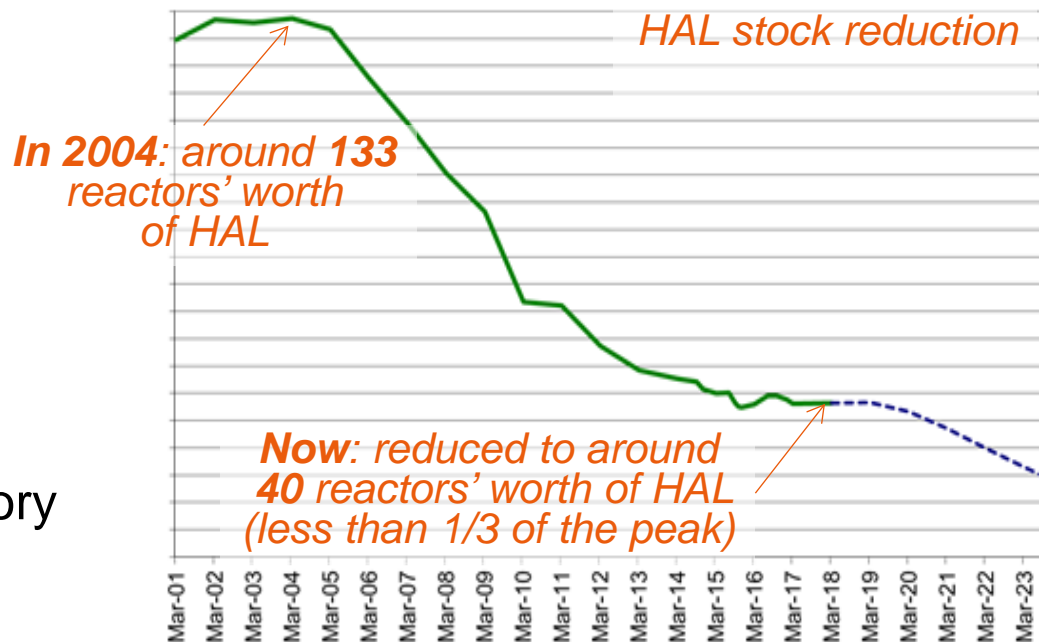


Example: Evaporation & “highly active liquor” stocks

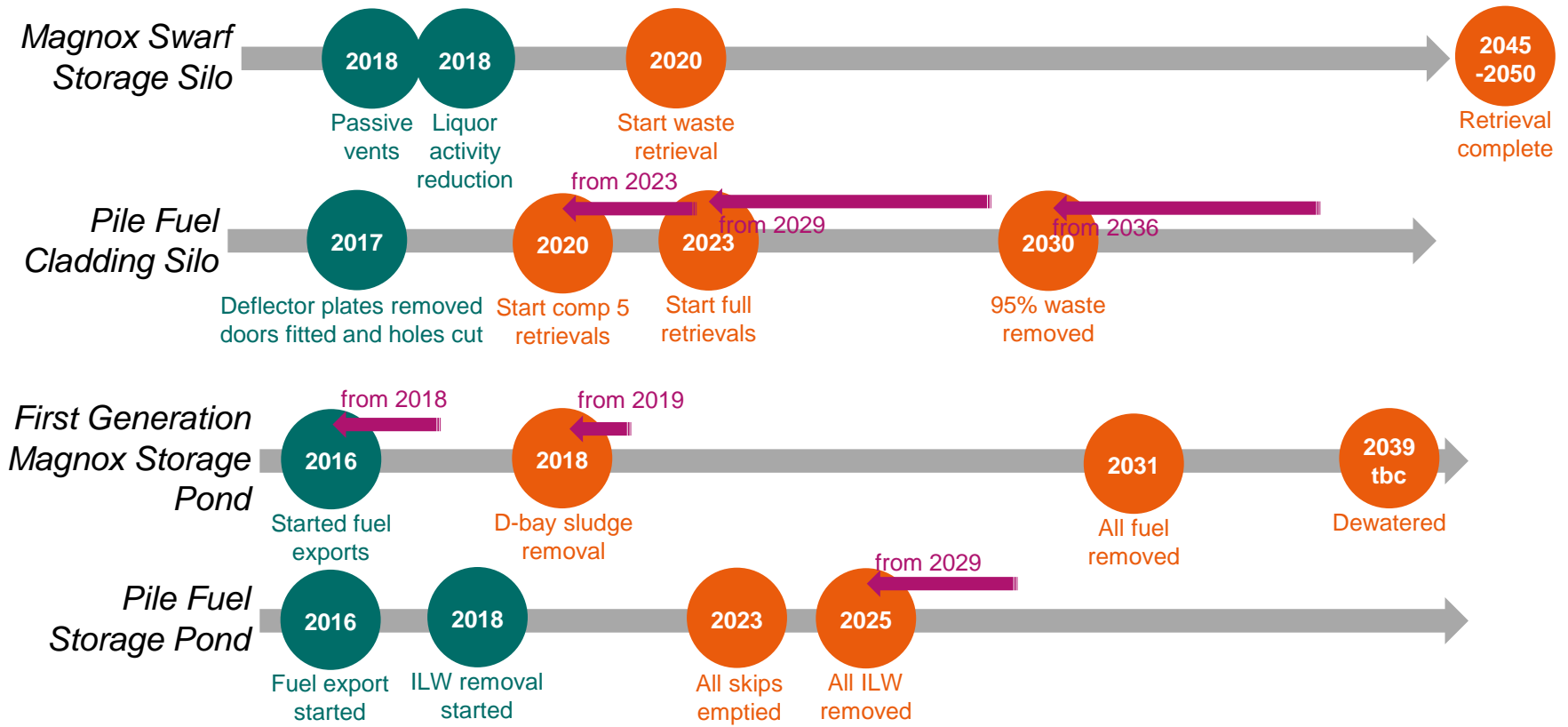
- **Highly active liquor** (HAL) is a by-product of spent fuel reprocessing and must be concentrated (**evaporation**)
- Evaporation produces HAL; extremely hazardous, stored on site before being turned into glass for safer longer-term storage (**vitrification**)

Regulation focused on **control of hazard**:

- new evaporative capacity (Evaporator D) to support continued reprocessing
- Securing better control measures on HAL stocks to enable sustainable reduction in the stored inventory



Enabling progress in legacy ponds & silos



Comparison of old vs current plans

Summary

- Sellafield will continue as ONR's top priority;
- Following a period of stagnation in SL's remediation, ONR's new strategy stimulated hazard and risk reduction with notable achievements
- Timely retrieval of hazardous legacy waste into modern facilities is essential. Undue delays increase risk and reduce options for intervention
- Remediating the legacy hazards at Sellafield are long-term projects, necessitating intrusive intervention and inevitable (controlled) increases in short-term risks
- Our regulatory strategy for Sellafield is dynamic, goal setting and continues to be effective achieving; accelerated safe remediation, securing compliant operational safety and robust emergency response capability

Bradwell Care & Maintenance



- Reactor buildings Clad for ‘Safestore’
- For 70-year period of Care & Maintenance to commence 2018
- Safety benefits are from radioactive decay



Retrieval of Fuel Element Debris at Berkeley



Beginning of FED removal

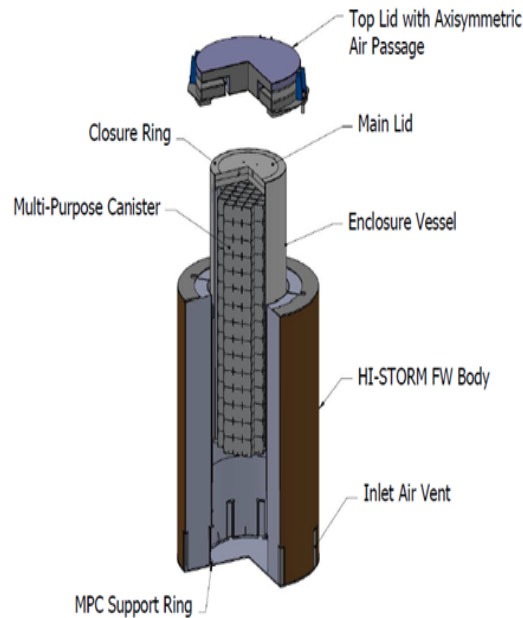


After 88 Te of FED removed

- Mixed FED/ILW contained in 3 underground vaults
- Retrieve-Process-Store pending a GDF
- Vault 1 - 270 Te FED
- Vault 2 – 350 Te FED retrieval commenced June 2016
- Vault 3 – 1400 sludge cans



Sizewell B Dry Store



Construction of the Sizewell B Dry Fuel Store, Copyright of EDF Energy

- Spent fuel is presently wet stored in the station pond
- Construction of a dedicated building for dry storage of spent fuel on site started in 2014
- Active commissioning took place in February 2017
- Spent fuel will be held in an inert atmosphere within metal casks
- Spent fuel may be stored on site for many decades after station closure, pending disposal to a Geological Disposal Facility



Generic Design Assessment



Hinkley Point C site, copyright of EDF Energy

- ABWR, AP1000, EPR & HPR1000
- GDA has included regulatory assessment of:
 - How spent fuel and radioactive wastes will evolve over the envisaged storage period;
 - Data and records management;
 - Disposability of spent fuel and Higher Activity Wastes;
 - Implications for the national disposal strategy, and;
 - Adequacy of the provided storage capacities.



Plans for new nuclear power stations



Hinkley Point C, copyright of EDF Energy



Wylfa Newydd, copyright of Horizon



Sizewell C, copyright of EDF Energy

- UK Government identified candidate sites for new nuclear power stations in England, Hinkley Point C, Sizewell C, EDF Energy and Wales, Wylfa Newydd, Horizon
- The Energy Act 2008 requires operators to cover all liabilities; management of spent fuel, radioactive wastes and decommissioning
- Funded Decommissioning Programmes are independently scrutinised and approved by the Secretary of State