Strategy 4: Spent Fuels and Nuclear Materials

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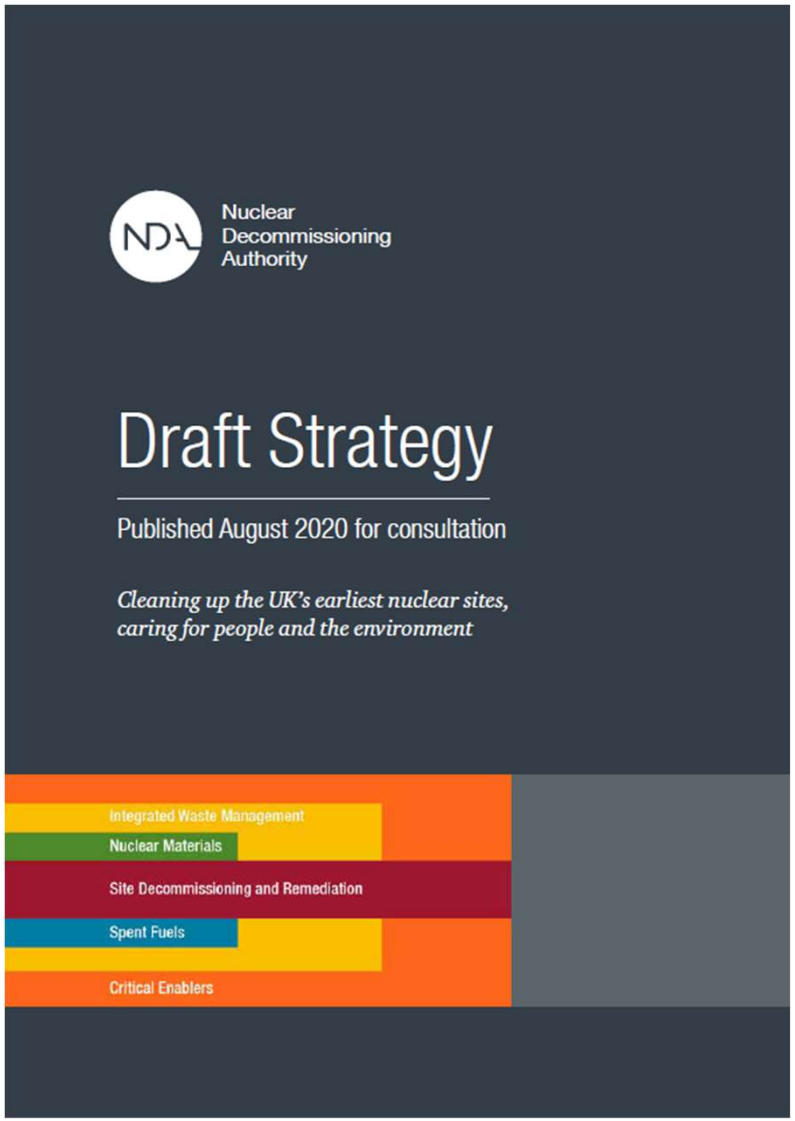


- The NDA regularly reviews its Strategy to ensure it has the right approach to decommissioning its 17 nuclear sites and benefits from the latest learning, best practice and can continue to deliver value for the taxpayer.
- The 12-week public consultation started on 17th August and closes on the 8th November 2020
- Today's virtual brief is on the themes of spent fuels and nuclear materials
- The final Strategy will be submitted for approval to UK and Scottish Government for publication April 2021

https://www.gov.uk/government/consultations/nuclear-decommissioning-authority-nda-draft-strategy-for-consultation

Themes, topics and strategic outcomes

	BUSINESS DELIVERY OF STRATEGIC OUTCOMES	Sellafield	Magnox	Dounreay	LLWR	RWM	INS	DRS	Capenhurst	Springfields
SPENT MAGNOX FUEL	1 All Magnox sites defueled	✓	✓					✓		
	2 All legacy Magnox fuel retrieved	✓								
	3 All Magnox fuel reprocessing completed	✓								
	4 All remaining Magnox fuel in interim storage	✓								
	5 All remaining Magnox fuel disposed	✓				✓				
SPENT OXIDE FUEL	6 All EDFE oxide fuel received	✓					✓	✓		
	7 All legacy oxide fuel retrieved	✓								
	8 All oxide fuel reprocessing completed	✓								
	9 All remaining oxide fuel in interim storage	✓								
	10 All remaining oxide fuel disposed	✓				✓				
SPENT EXOTIC FUEL	11 All exotic fuel defueled	✓		✓						
	12 All exotic fuel consolidated	✓		✓			✓	✓		
	13 All exotic fuel reprocessing completed	✓								
	14 All remaining exotic fuel in interim storage	✓								
	15 All remaining exotic fuel disposed	✓				✓				
PLUTONIUM	16 All plutonium produced	✓								
	17 All plutonium consolidated	✓		✓			✓	✓		
	18 All plutonium repacked	✓								
	19 All plutonium in interim storage	✓								
	20 All plutonium reused or disposed	✓				✓				
URANICS	21 All uranium produced	✓								
	22 All uranium consolidated	✓	✓				✓	✓	✓	✓
	23 All uranium treated								✓	✓
	24 All uranium in interim storage	✓							✓	
	25 All uranium reused or disposed	✓				✓			✓	

The theme of Spent Fuels includes the topics of;

- **Spent Magnox Fuel**
- **Spent Oxide Fuel**
- **Spent Exotic Fuel**

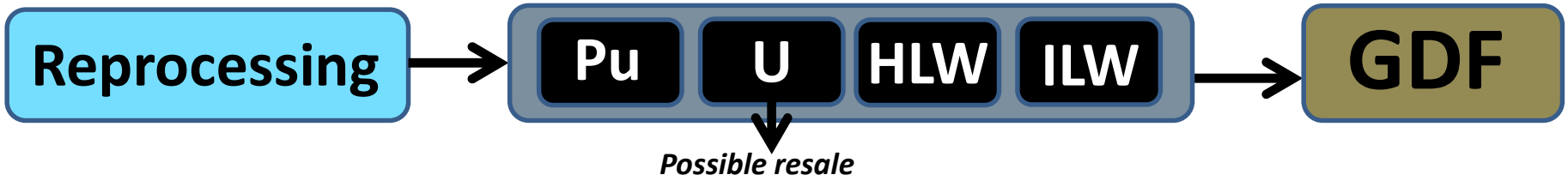
The theme of Nuclear Materials includes the topics of;

- **Plutonium**
- **Uranium**

- Strategic outcomes “SOs”– the key steps that we need to achieve in order to complete our mission for spent fuels and nuclear materials
- SOs 1, 7, 8 and 17 have all been completed since Strategy 3 published in 2016

- Our spent fuels consists of large quantities of oxide fuels, along with smaller quantities of Magnox fuel and non-standard and diverse fuel types which we refer to as ‘exotic fuels’.

- One approach is to reprocess, separating the spent fuel into its component parts of uranium and plutonium, various waste streams and authorised discharges.



- An alternative approach is to interim store the spent fuels, potentially for several decades, until they can be declared as waste, conditioned and disposed of in a Geological Disposal Facility (GDF).

- We consider the lifecycle of spent fuels, their products, wastes and discharges and all of the existing or potential facilities

Spent Oxide Fuel (1)

"Our strategy is to consolidate all spent AGR fuel from the EDF Energy AGR stations in a single pond in the THORP facility at the Sellafield site, and interim store all oxide fuels pending a future decision on whether to declare the fuel as waste for disposal in a GDF"

- Strategy covers spent AGR fuel and small amounts of other oxide fuels
- We are contractually committed to receive and manage all of the AGR spent fuel arising from EDFE's seven AGR power stations
- The management of AGR spent fuel is a major source of our commercial income
- By the time defueling of the AGR power stations finishes we expect to hold over 5,000 tonnes

Heysham 2 and Heysham 1

Spent Oxide Fuels (2)

- THORP reprocessing programme – contracts successfully completed: last commercial oxide fuel sheared November 2018
- Remaining AGR spent fuel committed to long-term pond storage
- We have created sufficient space to manage all AGR fuel from the EDFE power stations, avoids building more storage capacity
- To ensure its safe storage, spent fuel is stored under water in carefully managed conditions to prevent or minimise corrosion
- We are preparing to store spent fuel for several decades
- For planning purposes we are assuming that spent oxide fuel is disposed of in a GDF and work closely with RWM

- Based on EDFE's plans we expect that by the early 2030s all the AGR power stations will have ceased generating
- Following shutdown there will be an increased demand to move the spent fuel from the power stations to Sellafield
- The NDA Group is working closely with EDF Energy to ensure defuelling is done safely, efficiently and cost-effectively
- Collaborative AGR Operating Programme launched in 2016

THORP reprocessing

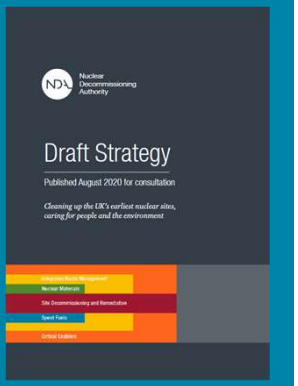
Fuel handling operations

Oxide fuel in storage

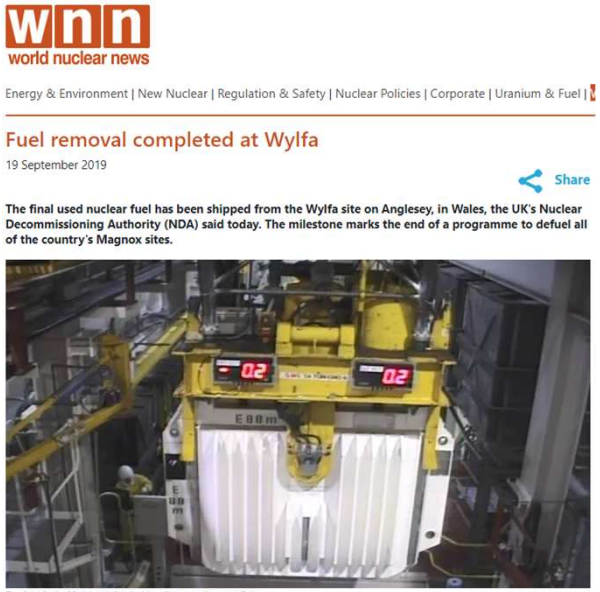
Spent Magnox Fuel (1)

"Our current strategy is to reprocess as much of the spent Magnox fuel as is practicable, in line with the Magnox Operating Programme (MOP), and to complete reprocessing as soon as is practicable"

"Any remaining fuel is expected to be transferred into dry storage pending a future decision on whether to condition and dispose of it in a GDF"



- Includes Magnox fuel from the commercial powers stations and a range of metal fuels from the legacy ponds at Sellafield
- The consolidation of spent fuel at Sellafield for reprocessing results in a significant reduction in radioactivity and hazard at the reactor sites.
- All 26 reactors now defueled!
- All fuel at Sellafield as of September 2019



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Fuel removal completed at Wylfa

19 September 2019

Share

The final used nuclear fuel has been shipped from the Wylfa site on Anglesey, in Wales, the UK's Nuclear Decommissioning Authority (NDA) said today. The milestone marks the end of a programme to defuel all of the country's Magnox sites.

The final flask of fuel in Wylfa's fuel handling area (Image: NDA)

https://world-nuclear-news.org/Articles/Fuel-removal-completed-at-Wylfa

Spent Magnox Fuel (2)

- Around 500 tonnes left to reprocess out of 55,000 tonnes and we were on track to finish around the end of 2020
- In March 2020 operations at the Magnox reprocessing plant were suspended due to the COVID-19 pandemic
- Now expect to complete Magnox reprocessing in mid 2021. This will mark the end of reprocessing in UK after 70 years

Magnox Reactors are located across the UK

Fuel was moved by rail

All of the spent fuel has been moved to the Sellafield site in the north west of England

Where it is reprocessed

- There is some heavily degraded fuel recovered from the legacy ponds which is not suitable for reprocessing
- We expect to transfer this fuel from wet storage to dry storage over the next decade. Following a period of dry storage for several decades we expect to condition and dispose of as waste in a GDF
- We now have sufficient confidence that this approach could be used to manage any remaining spent Magnox fuel at the end of the MOP

Spent Exotic Fuels

- *"Our strategy is to consolidate all our exotic fuels at Sellafield and store them safely and securely"*
- *"This strategy optimises the use of facilities, skills and capabilities at Sellafield and provides better value to the UK taxpayer"*
- *"The strategy is to transfer all of the DFR material to Sellafield and reprocess as much of this fuel as practicable before the Magnox reprocessing plant ceases operations"*

- We also manage a small inventory of non-standard fuels, commonly referred to as "exotics"; they include metallic, oxide and carbide materials
- They are a legacy from earlier nuclear industry activities such as the development of research, experimental and prototype fuels and reactors
- The individual nature of exotic fuels means that the approach for managing each fuel type is made on a case by case basis
- We are also contracted to receive and store irradiated fuels from the MOD arising from the development and operation of the UK Defence Nuclear Programme

Spent Exotic Fuels

Dounreay Fast reactor

DFR – metal fuelled, sodium cooled fast reactor

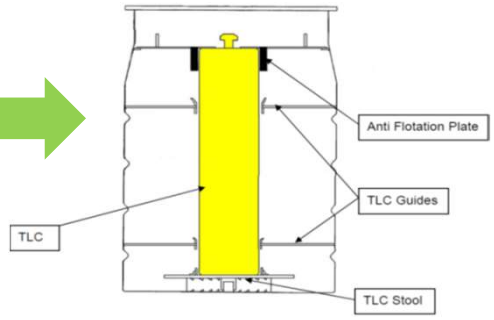
1959 → 1979

DFR – driver fuel reprocessed following shutdown but breeder remained

We continue to consolidate all of the DFR material at Sellafield
In the event that not all of this material can be reprocessed, we will develop an alternative option so that it can be managed at Sellafield
Over half of the 44 tonnes of material has already been transferred

DRAGON fuel

Dragon reactor was a high temperature test reactor at Winfrith.



- Fuel mainly carbon/graphite pucks containing small spheroidal particles (kernels) made of oxides of HEU surrounded by pyrolytic carbon and silicon carbide.
- Fuel being transferred from Harwell to Sellafield
- We have decided to encapsulate Dragon fuel in cementitious grout in the Magnox Encapsulation Plant.
- Plan to dispose of to a GDF

PFR fuel

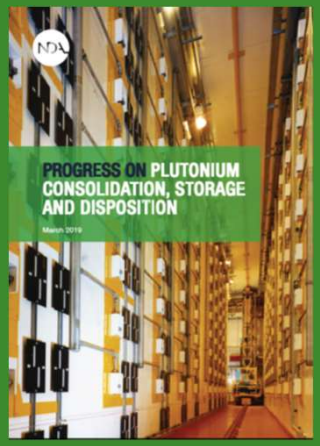
- The PFR fuel will be transferred to Sellafield from Dounreay within the next ten years
- It is expected that most of the PFR fuel will be stored alongside AGR fuel in the THORP facilities because it is compatible with the storage conditions, but bespoke storage arrangements may be needed for some types of this fuel.

- NDA manages large stocks of civil uranium and plutonium arising from fuel cycle activities such as reprocessing and enrichment

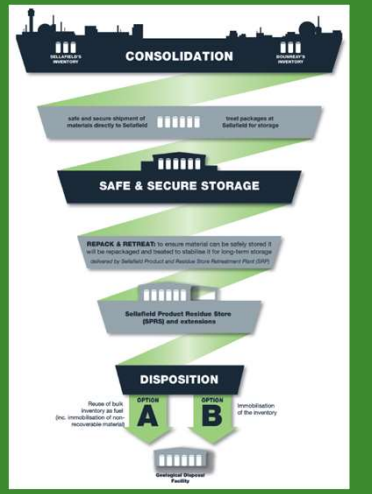
- Our strategy is to safely and securely store our nuclear materials
- We will develop and implement effective lifecycle solutions for their management in accordance with applicable UK government policy and international good practice

- Some of our nuclear materials have the potential to be reused in nuclear fuel for generating electricity while others are likely to be unsuitable for reuse and ultimately will need to be treated as waste for disposal.
- Our nuclear materials are held at a number of sites in the UK. We have taken a number of decisions to consolidate nuclear materials at sites which we consider are best suited to their safe, secure and cost-effective management

Plutonium (1)



- *"Consolidation of material at Sellafield, which is now complete"*
- *"Long-term safe and secure storage"*
- *"Disposition: working with the UK government to determine the right approach for putting this nuclear material beyond reach."*



- This is one of the most complex challenges facing the NDA.
- At the end of reprocessing there will be around 140 tonnes of plutonium.
- Continued, indefinite, long-term storage leaves a burden of security risks and proliferation sensitivities for future generations to manage.
- The NDA is working with the UK government to identify and implement a disposition solution that puts the UK's plutonium beyond reach.
- This is where the material is placed in a form which reduces the enduring security risks and burden during storage, and is aligned with its ultimate disposal in a GDF.
- Due to the size of the plutonium inventory and the complexity of developing and implementing the options, any long-term management solution will take many decades to fully implement.

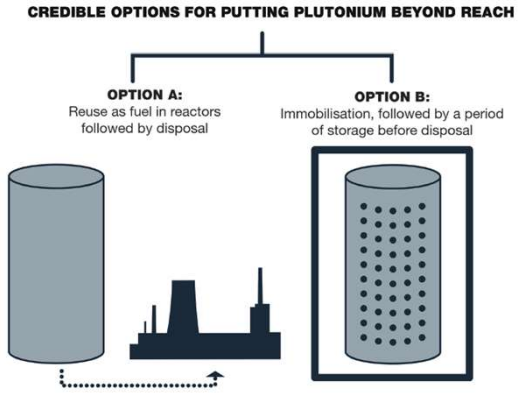
https://www.gov.uk/government/publications/progress-on-plutonium-consolidation-storage-and-disposition

Plutonium (2)

- Safe and secure storage: the plutonium packages will be repackaged for long-term storage.
- A new plant will be built at Sellafield to repack and, where appropriate, retreat all of the material. This plant is expected to start operations 2027.

Storage facility

- Continuing to progress the development of the reuse as MOX and immobilisation options.
- Work focussed on demonstrating and developing each of the technical options under consideration, including the potential for them to be licensed in the UK.
- Options for reuse as MOX in light water reactors (LWRs) can be shown to be the most mature from a technical and licensing perspective.
- Part of our future work is developing immobilisation to improve confidence in their potential for successful deployment.
- The UK government position: decision can only be taken when underpinned with sufficient evidence and has potential interactions with national security and other investments including nuclear new build and geological disposal.



Reuse or Immobilisation

THORP can system

Uranium (1)

- *Continued safe and secure storage pending either:*
  - *Sale for reuse where practicable*
  - *Conditioning to an appropriate form for disposal*
- *The sale value of our inventory can change markedly over time*
- *It may not be possible to reuse the entire inventory and some will need to be disposed of as waste*

Drums of uranium in storage at THORP

- The uranium we manage has been produced from nuclear fuel cycle operations such as enrichment, fuel fabrication and reprocessing since the 1950s.
- We own most of the uranium on our sites; the remaining material is owned by our customers e.g. MOD, EDF Energy and overseas utilities.
- We manage customers' materials in accordance with our contracts with them.
- Our inventory comprises ~54,000 tonnes of uranium, over 95% of which is at Capenhurst with the remainder at Dounreay, Sellafield, Springfields and Harwell.
- Our uranium is predominantly:
  - Magnox Depleted Uranium (MDU), a product of Magnox fuel reprocessing and
  - "Hex", a by-product of uranium enrichment

Uranium (2)

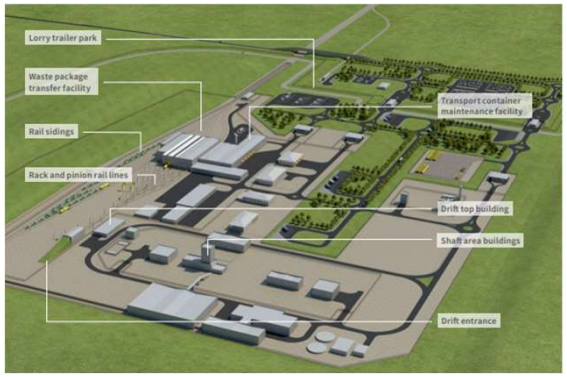
- Most of our uranium is in a form suitable for storage over several more decades.
- Our Hex is not because it is chemically reactive and some of the storage cylinders are showing signs of local external corrosion.
- Our strategy is to transfer our Hex into modern cylinders and then deconvert it into a form of uranium oxide, more suitable for long-term storage.

HEX cylinders in storage at Capenhurst

- We have a small quantity of uranium contained in residues of low uranium concentration.
- We are evaluating these residues to identify viable, cost-effective and environmentally responsible routes to either recover the uranium or condition the material for disposal.

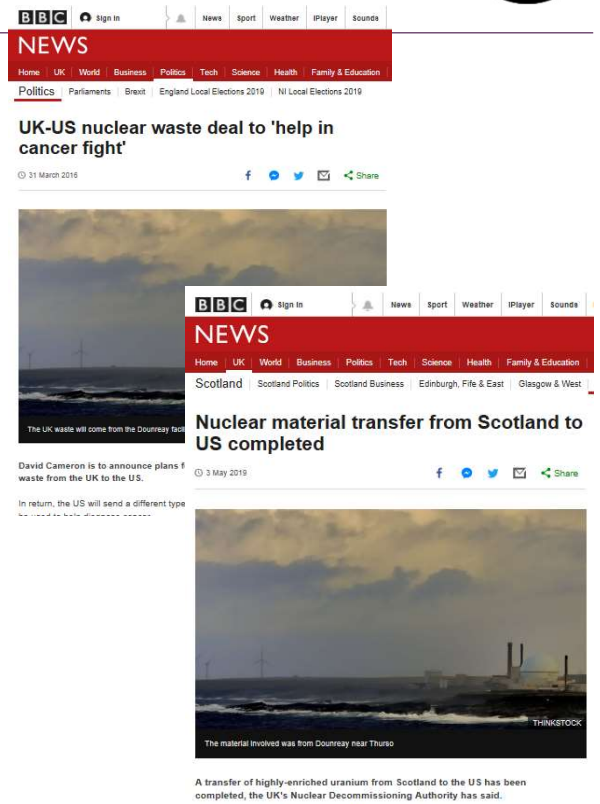
some will need to be disposed of as waste

- We have worked with Radioactive Waste Management Limited (RWM) to determine that bulk quantities of uranium held in England could, **in principle**, be disposed of in a GDF in the event that these materials, if not reused, were to be declared waste.



Case Study: Export of HEU in Support of Medical Isotope Production

- In 2016 at the Nuclear Security Summit the British Prime Minister announced that the UK will transfer around 700kg of Highly Enriched Uranium (HEU) to the United States.
- In return, the United States will provide enriched uranium for use in European reactors to produce medical isotopes used in the diagnosis and treatment of cancers.
- Material was located at the Dounreay site in the far north of Scotland, which was where the UK fast reactor programme operated until the late 1990s.
- More than a dozen U.S. and U.K. organizations participated in the removal programme led by the US DOE National Nuclear Security Administration and the UK's Nuclear Decommissioning Authority.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UK-US nuclear waste deal to 'help in cancer fight'

31 March 2016

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The UK waste will come from the Dounreay facil

David Cameron is to announce plans f waste from the UK to the US.

In return, the US will send a different type

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Nuclear material transfer from Scotland to US completed

3 May 2019

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The material involved was from Dounreay near Thurso

A transfer of highly-enriched uranium from Scotland to the US has been completed, the UK's Nuclear Decommissioning Authority has said.

- In May 2019 we announced the successful completion of the project.
- The removal of this HEU is an important milestone in the NDA's programme of work to decommission and clean-up the Dounreay Site.


Aircraft loading at Wick airport

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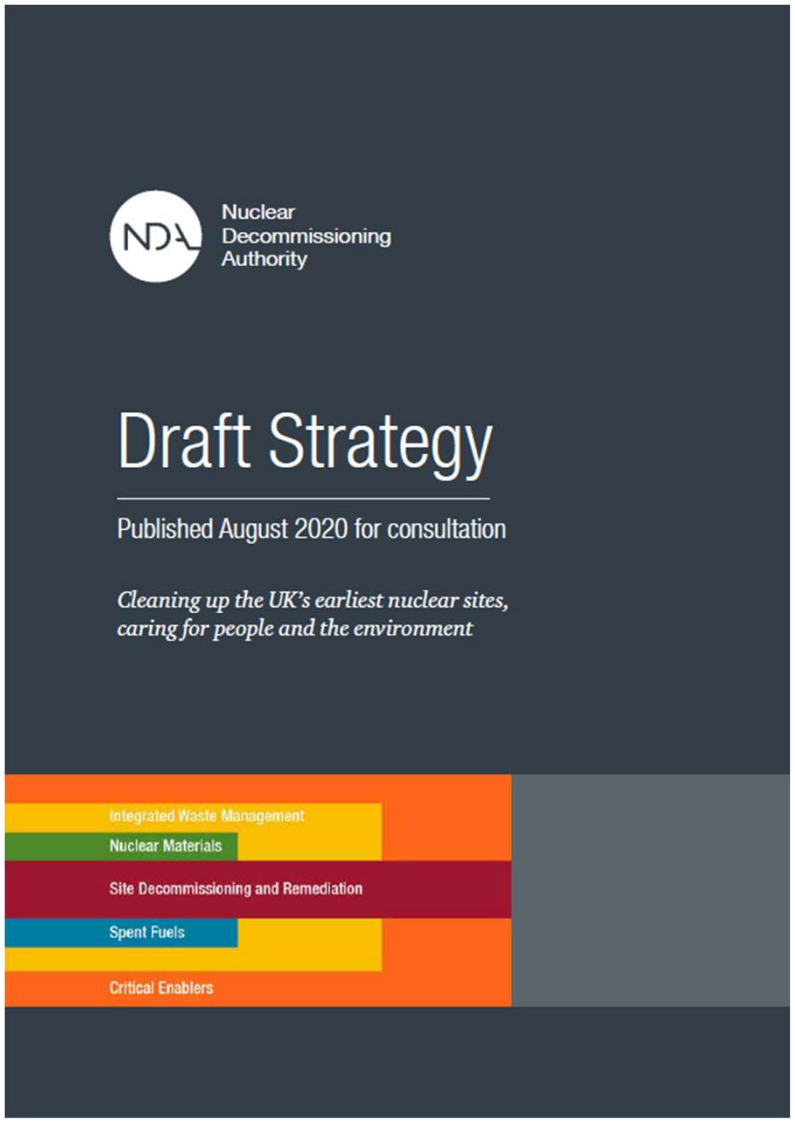

- The 12-week public consultation started on 17th August and closes on the 8th November 2020
- The final Strategy will be submitted for approval to UK and Scottish Government for publication April 2021
- Questions please?

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