

## Decommissioning of DFR An Overview

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## DSRL Mission for DFR

To safely, compliantly and efficiently decommission DFR facilities.



### Mission for Today

1. Brief History
2. The Strategy
3. Current Status
4. Fuels – Challenges
5. Alkali Metals Treatment – Challenges
6. Reactor dismantling – Challenges
7. Demolition – Challenges
8. Questions

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## DFR History

- Construction on DFR began 1955, reactor critical 1959
- 60MW NaK cooled Fast Reactor (15MW electrical)
- Shut down 1977
- Secondary NaK removed, Majority of primary NaK removed, Removed all steam and electrical generation plant
- Facility upgrades took place to support decommissioning



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## The Decommissioning Strategy

### Fuels

- Out of Reactor fuel packaging is taking place in BFR
- 977 breeder elements yet to be removed from the Reactor Vessel(RV)

### NaK Treatment

- Majority of the Bulk NaK has been destroyed (7 hot traps remain)
- Residual NaK contaminated with Caesium in RV and primary circuits to be treated before the RV can be dismantled.
- Dump tanks behind the facility, left with nitrogen pad gas, all have tank heels of NaK that is to be destroyed and the tanks removed.
- Other alkali metal wetted items stored in various locations (Mortuaries, D1115, D7628, etc.) Some are LLW or ILW

### Vessel Dismantling

- Removal of the contaminated vessel (RV) and 9 km of associated piping (24 Circuit loops)

### Decommissioning challenges

- Abundant oils, petrol / diesel, asbestos need to be removed for deposal prior to demolition
- Several large facilities that need to be "Decommissioned" once operations are complete.

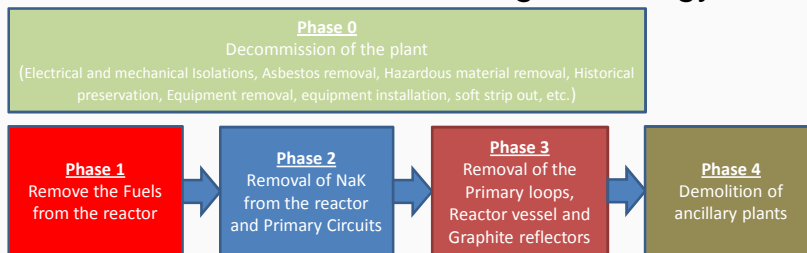
### Building Demolition

- Demolition of the remaining structures (Sphere and other buildings)

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## DFR Reactor Decommissioning – Strategy

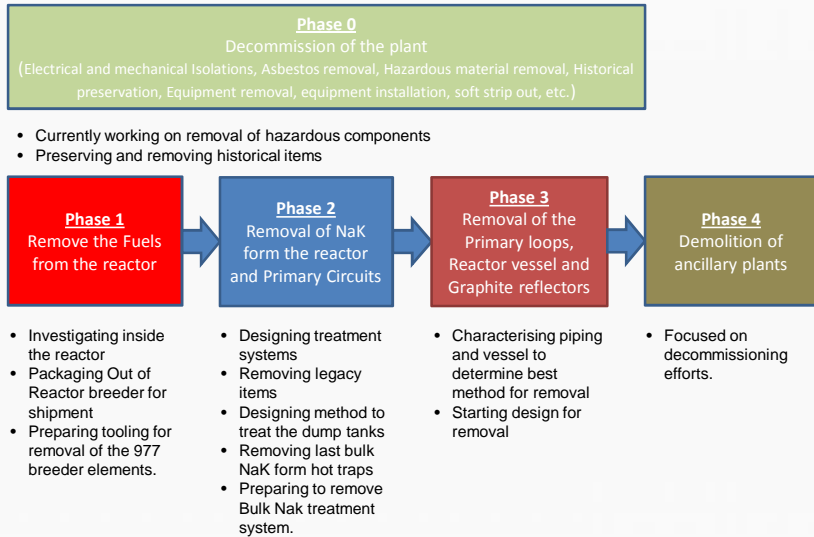


- Removal of remaining 977 breeder elements.
- Surveying in the vessel and lots of characterisation taking place during this timeframe.
- NaK is highly reactive.
- NaK will be treated using alkali metal treatment process primarily in-situ.
- Some equipment will be removed to be treated ex-situ
- Removal of the loops will mainly be done using conventional techniques.
- Reactor vessel to be removed in sections due to radiation dose.
- Characterisation to inform demolition method as breeder and NaK is removed
- Reactor building is planned to be dismantled using water jet cutting techniques and conventional demolition.

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## DFR Reactor Decommissioning – Current status

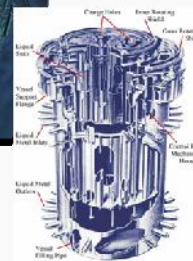
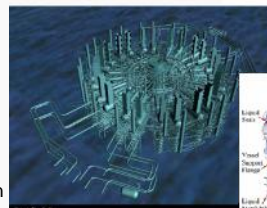
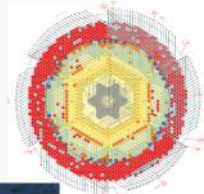


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## Technical Challenge - Key Areas

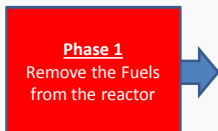
- Breeder Element Removal**
  - Stuck and damaged elements have to be remotely cut from the internals of the vessel.
- Alkali Metal Residue Removal**
  - NaK burns if exposed to air and moisture
  - Employ a range of cleaning techniques to remove NaK residues from vessels and 9 km of piping.
  - Complicated loops and piping configurations
- Reactor Vessel Dismantling**
  - Dismantling in a very tight space with high radiation and contamination.
- Demolition of the DFR Sphere**
  - Difficulties in bringing down the sphere



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## DFR Reactor Decommissioning – Strategy



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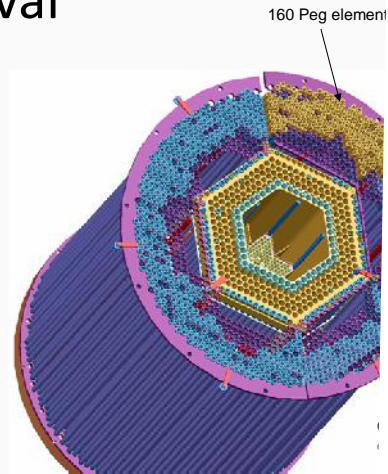
## Fuels –Challenges

- Damaged breeder elements
- Damaged / shifted top plate
- Tight working area in reactor
- Tight Working space in the Sphere
- Tools have to be multi-functional, capable of working in high dose and with NaK
- Unknowns as we work our way into the reactor
- Knowledge retention-
  - Ageing work force
  - Highly talented work force is very attractive to other employers
- Throughput is not just controlled by Dounreay on fuel transport

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## Breeder removal

- **977 breeder elements present**
  - 929 in outer breeder region
  - 46 in gagging skirt
  - 2 in the inner breeder
- Reactor and Breeder Fuel condition
  - BFR project assumption 10% fuel stuck
  - Revised project estimate 60% stuck, following inspection



## DFR Reactor Inspection Results

- Damage to fuel more extensive than assumed- unexpected failure modes, cladding corrugation and element head/body separation.
- Removal by cutting top plate then use modified external grab or manipulator



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## Element Removal Strategy Way Forward

- In reactor preparation (cutting top plate) in advance of BFR commissioning– combination of hydraulic shears and “rotabroach” cutters access via 9” port, as reactor inspection
- Alternative simpler tooling for reactor prep work - consultation with Reactor dismantling project
- Modify existing Retrieval Facility(RF) tooling to remove ALL fuel (intact, stuck, headless, rippled, fuel fragments, core element)
  - Internal Grab - free elements
  - External Grab - stuck elements
  - Manipulator – stuck elements



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## Element Retrieval Facility

- 14 tools plus 2 cameras, 4 can be held in RF Carousel, remainder in Tool Maintenance & Storage Glove Box (TM&SGB) or storage bins
- Internal and External Grabs for fuel removal, remainder for cutting and removal of element support structure
- RF operation through rotating shield 2'9" port, element removal through rotating shield 9" port
- Cutting tools require maintenance in Tool Maintenance & Storage Glove Box



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## Inside the vessel

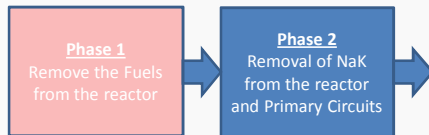


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## DFR Reactor Decommissioning – Strategy



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## Alkali Metals – Challenges

- Small diameter piping treatment.
- Isolation of the loops from the vessel for treatment
- Vault containing 24 circuits is high dose
- Tight working space inside of the sphere – Difficult for people interactions and equipment use
- Unknowns – Not on Drawings, Plugs in the systems,
- “Fire” Stigma
- As it is a hazardous facility there is a high level of regulatory interface
- Knowledge retention- as for fuels
  - Ageing work force
  - Highly talented work force is very attractive to other employers

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## Alkali Metal Residues Hierarchy / Strategy

The intent of a hierarchy for treatment of components is to minimize potential impacts to the personnel and the environment. Every time an item is handled the risk exposure to people (Radiological and industrial) and the environment is considered.

1. Inspect and dispose
2. Treat in-situ
3. Clean and dispose
4. Size, clean and dispose

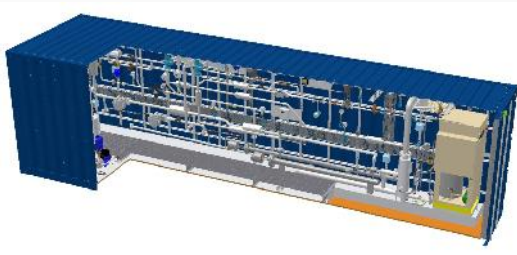


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## Alkali Metal Critical Activities

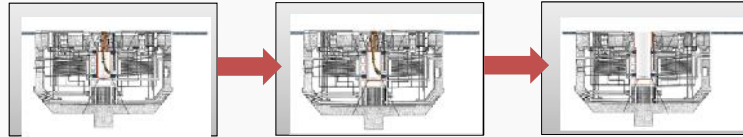
- Design treatment skids to be used at multiple locations on site.
  - Treatment delivery
  - Neutralization (Chem dosing, ion exchange, effluent)
  - Off gas (Chiller, Ventilation)
  - Treatment vessel
- Identify and treat all of the remaining alkali metals (~140 Tonnes)
  - DFR Reactor Vessel and Loops (3Tonnes)
  - DFR Other (2 Tonnes)
  - PFR (60 Tonnes)
  - PFR KNK (75 Tonnes)







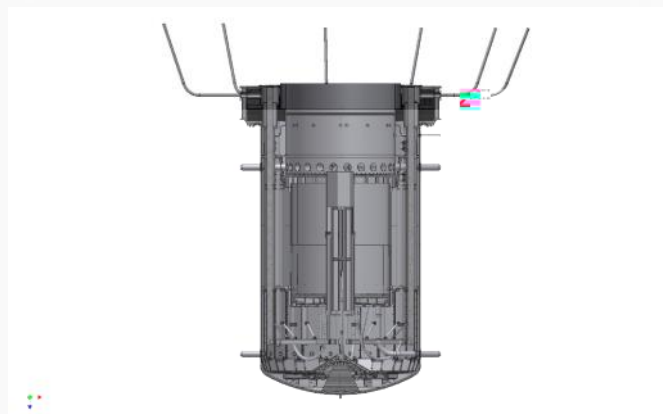
### DFR – Pulling Components and/or Sizing in Place



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### Reactor Vessel



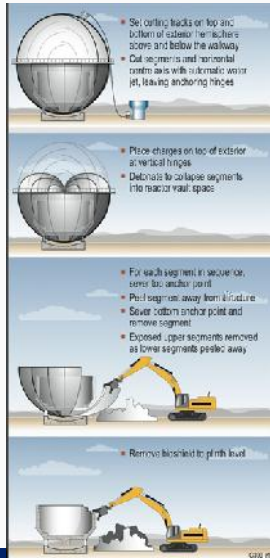
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### DFR – Building demolition



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# Questions??



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