# Overview of Used Nuclear Fuel R&D in the UK

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Nuclear Decommissioning Authority

# How NDA delivers R&D

- **NDA R&D role:**
  - Promote and, where necessary, fund generic research relevant to nuclear decommissioning and clean-up

- **Current R&D strategy:**
  - SLCs carry out R&D in conjunction with the supply chain, with an NDA led strategic R&D programme being carried out by the supply chain. NDA provide overall leadership in order to deliver the NDA's mission

| | | FY08-09 |
|---|---|---|
| NDA Research & Development | Indirect: SLCs and Supply Chain | ~£90M |
| | Direct: Supply Chain | £11M |

# Direct NDA-funded Research

- **Key objectives:**
  - Inform strategy / policy
  - Innovation – Generic needs / risks / opportunities
  - Maintain / develop key technical skills
  - Promote link to SLC

| **Direct Research Portfolio (DRP)** | **Concepts** | **Technology Demonstration Project** |
|---|---|---|
| Lot 1 – University Interactions<br>Lot 2 – Waste Processing<br>Lot 3 – Material Characterisation<br>Lot 4 – Actinide & Strategic Materials | Multiple<br>< £50k | Single<br>< £1million |
| Framework Contractors<br>Competed via OJEU | Supply Chain<br>Competed via Open Calls | |

# DRP: Lot 4 – Actinide & Strategic Materials

- **Framework Contractors**
  - NNL and UKAEA Consortium

- **Three main areas of investigation**
  - Plutonium
  - Uranium
  - Spent-fuel: Magnox, Oxide, Exotic

- **Examples from FY08-09**
  - Radiolysis and Surface Reactions during the Storage of Plutonium Oxide - UKAEA with ITU
  - Immobilisation of Plutonium in a Ceramic Wasteform – NNL

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# Babcock - Nuclear Business Unit

Client Update

July 2010

# Organisation

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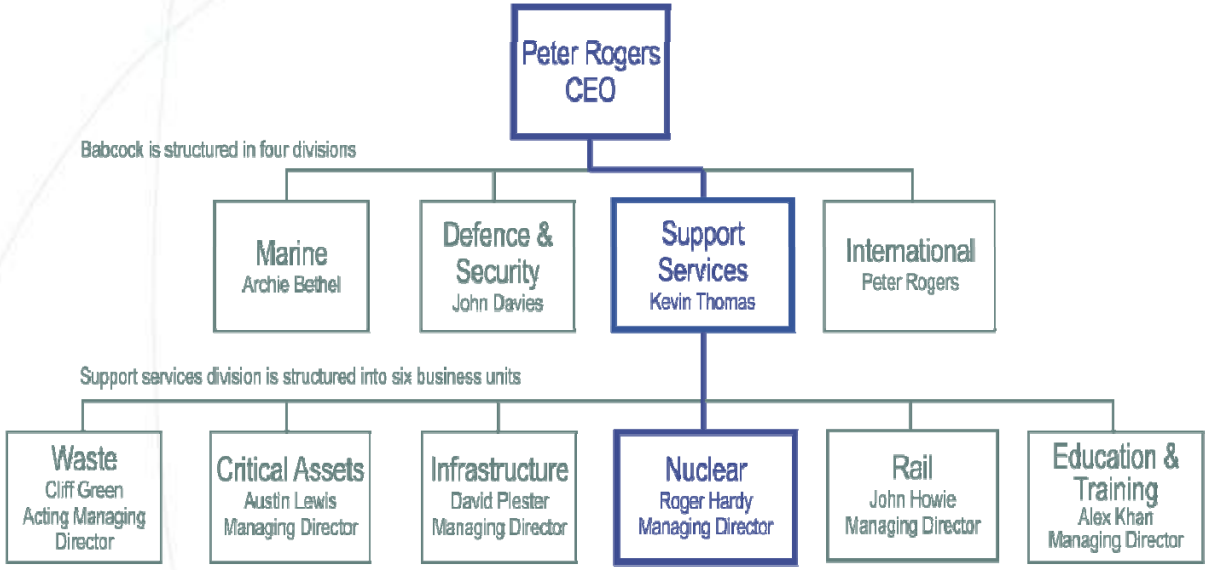


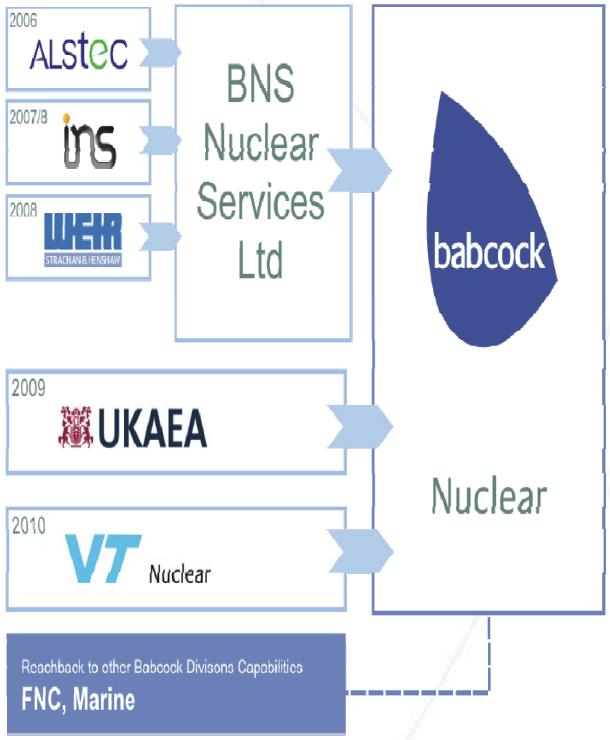


Babcock is the largest nuclear engineering and support services organisation in the UK.

£350M revenue, 3500 people

# NDA funded fuels management research

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- Technical underpinning for long term management of oxide, magnox and exotic fuels
  - Technical solutions for life extension of wet storage facilities
  - Dry storage options for varying fuel types
  - Fuel Co-location potential
- Peer review of macroeconomic model to underpin decision making for strategic materials
- Encapsulation options for plutonium oxide
- Treatment options for UF6 storage with technical options and high level economic case for deconversion products

# NNL Spent Fuel R&D

National Nuclear Laboratory

Date: 15/09/10

# NNL R&D Projects

- NNL undertakes a wide range of R&D for the NDA
- Ranges from reviews of international SF management techniques to assessing innovative storage techniques for legacy metallic fuel

## Proliferation resistance assessment

- Review all of the internationally available proliferation resistance assessment methodologies
- Recommend how best to measure proliferation resistance in the UK fuel cycle
- Use the chosen methodology to assess UK spent fuel management options

# NNL R&D projects

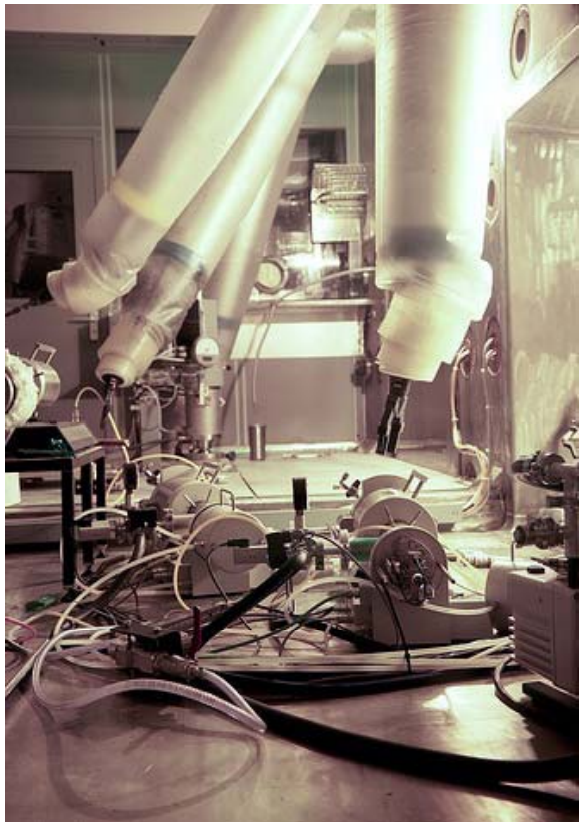
## Spent Fuel Disposability Studies

- Consideration of metal, oxide and exotic fuel
- Assessed viability of different key process steps for treatment, storage and geological disposal
- Understanding of how fuel's history affects storage and disposal behaviour
- Identification of knowledge gaps and key risks

# NNL R&D projects

## Options for treating UK exotic fuels

- Categorised current inventory
- Evaluated compatibility of existing reprocessing facilities (e.g. THORP)
- Proposed modifications to expand their operating envelopes
- Produced outline for a new, dedicated small-scale fuel dissolution and treatment facility

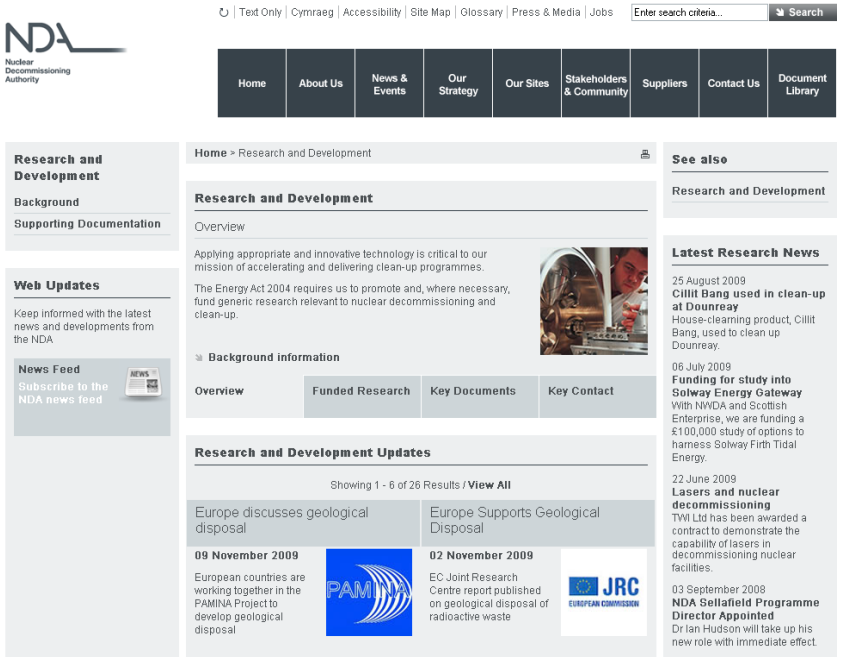


# Dissemination of information

- **R&D area on NDA website launched (www.nda.gov.uk/research)**
  - Applying appropriate and innovative technology is critical to our mission of accelerating and delivery clean-up programmes
  - Sharing innovative thinking across estate and supply chain
  - Commitment to openness and transparency

- **Contact details**

  **research@nda.gov.uk**



# DRP Spent Fuel Programmes This FY

**The following are projects either underway or expected to be initiated this year**

- **Immobilisation of plutonium in a ceramic wasteform**
  - Preparation of ceramic wasteforms for the immobilisation of plutonium.
  - Developing the attrition milling process for the titanate-based wasteforms and involves a systematic evaluation of key processing parameters (e.g. mill speed and duration) in order to develop the Hot Isostatic Pressing (HIP) process.

- **Plutonium radiolysis – Phase 2**
  - This project involves investigating the radiolytic production of hydrogen and oxygen on the surface of moist plutonium oxygen. The results of this project will be used to underpin the extended storage of plutonium oxide.

# DRP Spent Fuel Programmes This FY

- **Uranics encapsulation**
  - Experimental work to develop encapsulants to immobilise the uranium.

- **Behaviour and Implications of Magnox fuel in pond storage environments**
  - Technical options for extending Magnox fuel storage in either the Fuel Handling Plant or reactor ponds.
  - Down selection of the options is currently underway as discrete pieces of work
    - Impact of long-term pond storage on Magnox spent fuel degradation
    - Control of chemical and physical parameters to prolong the storage life of spent Magnox fuel under aqueous conditions
    - The management options and implications of processing corroded fuel within FHP
    - The behaviour and implications of adverse observations from forthcoming MEP swarf bins and Drum Inspections

# DRP Spent Fuel Programmes This FY

- **Proliferation resistance factors associated with nuclear materials**
  - Proliferation resistance is becoming an increasingly important aspect of the nuclear fuel cycle. Following the Global Nuclear Security Summit held in Washington DC in April 2010, aspects of proliferation resistance are taking higher priority as nations consider future nuclear power opportunities.
  - The project summarises the current methods used to measure proliferation resistance and make recommendations on how the NDA (and potentially UK Government) could measure proliferation resistance in the UK nuclear fuel cycle. In particular the methodology will be used in the strategic credible options studies on oxide fuels, Magnox fuels, exotic fuels and uranics due to be completed during 2011.
- **Options for Dragon fuel**
  - The NDA is currently investigating the options for managing Dragon fuel (Dragon was a high temperature gas cooled reactor at Winfrith in England operated by UKAEA). This project will investigate the technical options for managing this fuel.

# DRP Spent Fuel Programmes This FY

- **Strategic Options Development for Uranics**
  - The NDA uranics inventory has potentially significant value associated with it, but further characterisation of the material will be required to realise such value. Many of the non-disposal options are immature and need to be worked up to an improved state of technical development before the strategic options can be appropriately underpinned. The following sub-options are being taken as discrete pieces of work:
    - The treatment and management of hydrogen fluoride by-product (HF) resulting from Hex deconversion: quantification of uranium etc., in the feed to the neutralization process.
    - The implications of interim and long-term storage of uranic materials throughout the UK: material, package and store evolution. Review of material stability, package performance, store condition.
    - Disposability of cementitious wasteforms containing U

# DRP Spent Fuel Programmes This FY

- **Strategic Options Development for Oxide fuels / THORP**
  - The following sub-options are being taken as discrete pieces of work:
    - Consequences of AGR station lifetime extensions.
    - Residual asset value of THORP
    - Generic work on the dry storage of AGR fuels as a contingency to continued wet storage and reprocessing.
    - Co-storage of oxide fuels in dosed media.
    - Implications of high burn up fuel on wet and dry spent fuel storage
    - Impact of decay heat and cooling time on options for dry storage
    - Lifecycle economic impacts on long term storage and disposal of spent oxide fuels

# DRP Spent Fuel Programmes This FY

- **Reuse of plutonium**
  - Technical projects to underpin the development of Plutonium Topic Strategy with respect to the reuse of plutonium (*e.g.* reactor reuse of MOX).
  - The isotopic properties of the plutonium (e.g. americium in-growth) on ageing with regard to their potential value in future reuse scenarios over several decades.
- **Future Management Option Development for the UK's Exotic Fuel Inventory**
  - The following sub-options are being taken as discrete pieces of work:
    - Concepts for small scale "specialist" fuel processing facilities
    - Lifecycle management model development for exotic fuels
    - Concepts for specialist fuel storage and immobilisations