Outline

- How does R&D fit into the programme to develop the geological disposal facility
- Drivers for the R&D programme
- Background to the R&D strategy
- Approach to undertaking the programme
  - E.g. Planning, review
- Overview for the areas covered
The Work of the Radioactive Waste Management Directorate

Diagram:
- Inventory
- Regulatory Requirements
- Stakeholders
- DISPOSAL SYSTEM SPECIFICATION
- R&D
- REPOSITORY DESIGN
- SAFETY ASSESSMENTS
- Procurement of design/build services through supply chain
- Environmental Assessment & Community Engagement
- Safety Cases
- LoC/WAC
Research & Development

Research

- Corrosion
- Waste package
- Wasteform
- Near Field
- High-level Waste & Spent Fuel
- Criticality
- Geosphere
- Biosphere
- Geosphere Characterisation

Development

Disposal System Specification
- Requirements
- Optioneering
- Optimisation

Engineering Development
- Container design
- Transport
- Facility design

Disposal System Safety Case
- Transport
- Operations
- Post-closure
Disposal System Safety Case

- Main vehicle for demonstrating safety of geological disposal
- Different documents within the suite aimed at different stakeholders
- Numerical assessments and fundamental safety arguments including natural analogues, role of the different barriers in the system
- Scope of documentation being developed with input from external advisory panel, regulators and stakeholders
- Covers transport, operations and post-closure
Research Drivers

- Prepare for future phases of MRWS
  - Ensure the R&D is in place to deliver the programme
- Build confidence in the concept
  - Address key technical uncertainties
  - Examining alternatives for packaging and encapsulating wastes
  - Contribute to optioneering studies
- Provide inputs into the Disposal Safety System Case
  - Understanding processes
  - Provision of data
  - Provision of wider safety arguments
- Develop R&D for the disposal of HLW and spent fuel
  - UK concept currently less mature than work on ILW
  - Build on wider international experience
- Support current and proposed waste packaging processes
Scrutiny of the Programme

- At different levels
  - Programme, topic, task
- Regular reviews of the R&D programme will be undertaken at key points of the programme
  - NDA Research Board and Nuclear Research Forum
  - CoRWM Research Group
  - Periodic reviews by international expert panels e.g. NEA or IAEA groups
- Focused peer reviews of parts of the programme
- Advisory panels on aspects of the programme
- Peer preview where appropriate
- Completed tasks are peer reviewed
- Regulatory engagement and scrutiny
Implementing the Programme

- Procurement
  - OJEU competition
    - Much through framework contracts
- Relationships with universities
  - URA and specific projects
- Relationships with overseas waste management organisations
  - Collaboration on joint projects
    - NEA, EU framework contracts
- Links to industry R&D
- Gearing up the programme
  - Increased the size of the in-house research team
  - Increasing spend
  - Building confidence in the supply chain
Key Scientific and Technical Uncertainties

- Package longevity
- C-14 labelled gases
- Organic complexants, colloids, non-aqueous phase liquids
- Coupling of gas and groundwater flow
- Long-term demonstration experiments
  - E.g. Build confidence in chemical containment, build confidence in package performance
- Criticality safety
- Demonstrate understanding of the values of key parameters
  - Ensure future assessments are on firm foundations
Package longevity

- Development of spreadsheet model to screen qualitatively waste packages for longevity issues based on UK National Inventory
- Modelling study of wasteform expansion and effect on waste package for drum and box geometries for mild steel and Magnox waste
- Modelling of fate of chloride from supercompacted PCM and effect on internal container corrosion
Magnox corrosion

- New study of unirradiated Magnox swarf corrosion including measuring product expansion
- Measurement of corrosion rates in 5 year old drum of grouted Magnox swarf
Alternative wasteforms

• Work on stability and degradation of organic polymers
  • close liaison with Windscale Piles project
  • vinyl ester styrene and epoxy resin systems being studied
• Tenders being evaluated for study on interactions of vitrified ILW in high pH systems
Carbon-14

- Measuring release of volatile C14 from irradiated BEPO graphite at high pH
- Obtaining samples of Oldbury Magnox graphite for future studies
- Tenders being evaluated for study of release of volatile C14 from irradiated steels
Outline of current knowledge and R&D relevant to material performance

Research aims:

To consolidate our understanding of the corrosion behaviour of ILW packages and evaluate/maximise their longevity

Current knowledge:

- Main degradation mechanisms in relevant conditions
- Key factors in controlling/affecting degradation mechanisms
- Partly, degradation rates (e.g. general corrosion)

Current R&D:

- Long-term corrosion rates and performance
- Definition of failure criteria
- Environmental storage regimes to limit degradation
- Alternative materials (for container and wasteform)
- Effect of radiation and risk of microbiologically influenced corrosion
Example of R&D: long-term propagation of pitting corrosion in atmosphere

**Experimental**

PhD study on mechanisms of pitting propagation in atmosphere

**Modelling**

Modelling study of pitting propagation in atmosphere
Example of R&D
4 metre Box monitoring programme

Monitoring of environmental conditions including:
- Temperature
- Relative humidity
- Chloride deposition rate

Monitoring of corrosion damage including:
- Pit density and depth
- Stress corrosion cracking
Example of R&D
duplex vs austenitic stainless steel

Reference austenitic
Duplex currently considered

Duplex grades offer benefits in terms of
localised corrosion and SCC resistance
Development of failure criteria

<table>
<thead>
<tr>
<th>Safety function</th>
<th>Evaluation criteria</th>
<th>Failure mechanism</th>
<th>Corrosion mode</th>
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<tbody>
<tr>
<td>Handling</td>
<td>Container deformation or breakage during lifting</td>
<td>General corrosion (wall thinning)</td>
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<tr>
<td>Mechanical strength</td>
<td>Damage to lifting features</td>
<td>Pitting corrosion (general damage)</td>
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<td>Crevice corrosion (base)</td>
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<td>Crevice corrosion (lid flange)</td>
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<td>SCC (susceptible areas)</td>
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<tr>
<td>Stacking</td>
<td>Container deformation during stacking</td>
<td>General corrosion (wall thinning)</td>
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<td>Pitting corrosion (general damage)</td>
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</tr>
</tbody>
</table>
Summary

• R&D strategy is being prepared
  • Sets out the key drivers for R&D
  • Describes the short and long-term R&D programme
  • Welcome review from key stakeholders
• Key priorities
  • Gear up the programme
  • Make progress on key technical uncertainties
  • Be ready for future phases
  • Focus on ensuring needs of DSSC and options studies are met