Nuclear Decommissioning Authority

NDA RWMD Research & Development Strategy

NuSAC RG6 Meeting
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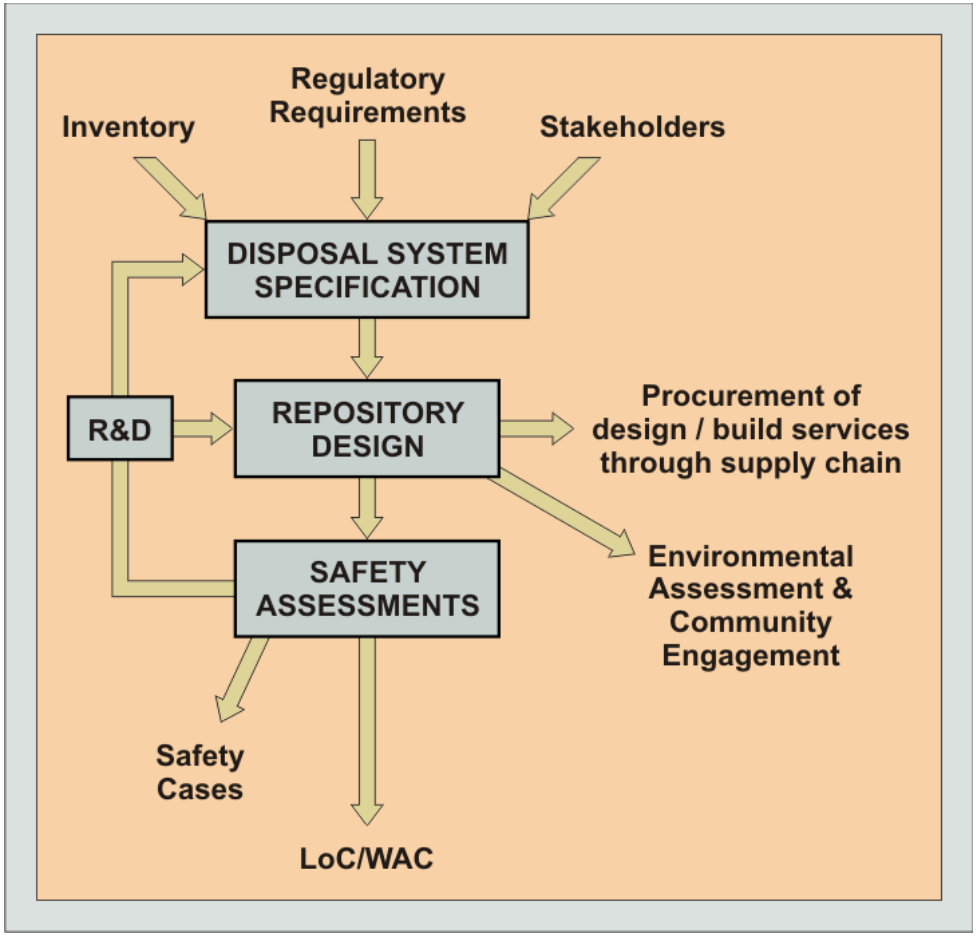
Outline

- 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



Research & Development

Research

Corrosion

Waste package

Wasteform

Near Field

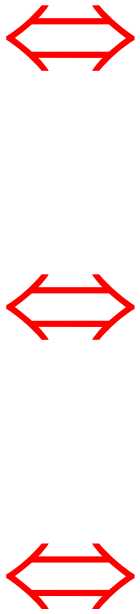
High-level Waste & Spent Fuel

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

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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

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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

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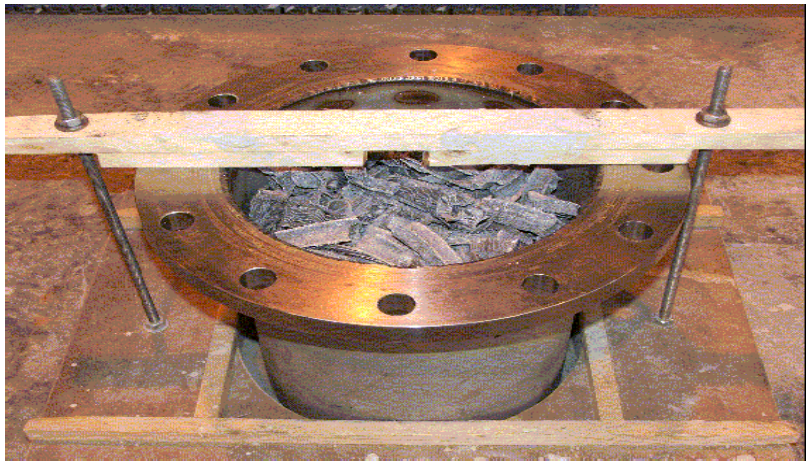
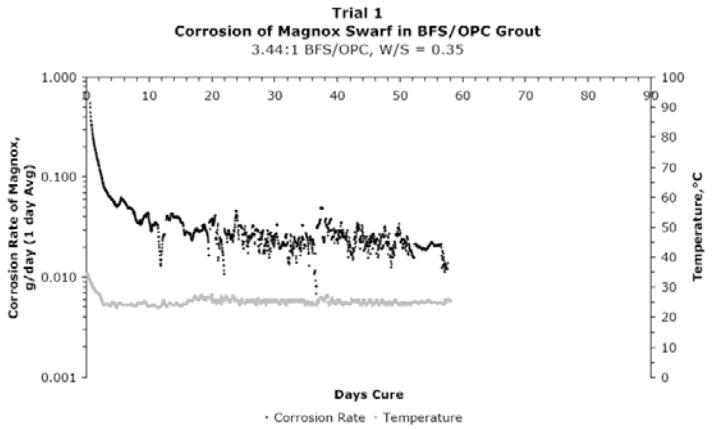
Package longevity

- 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

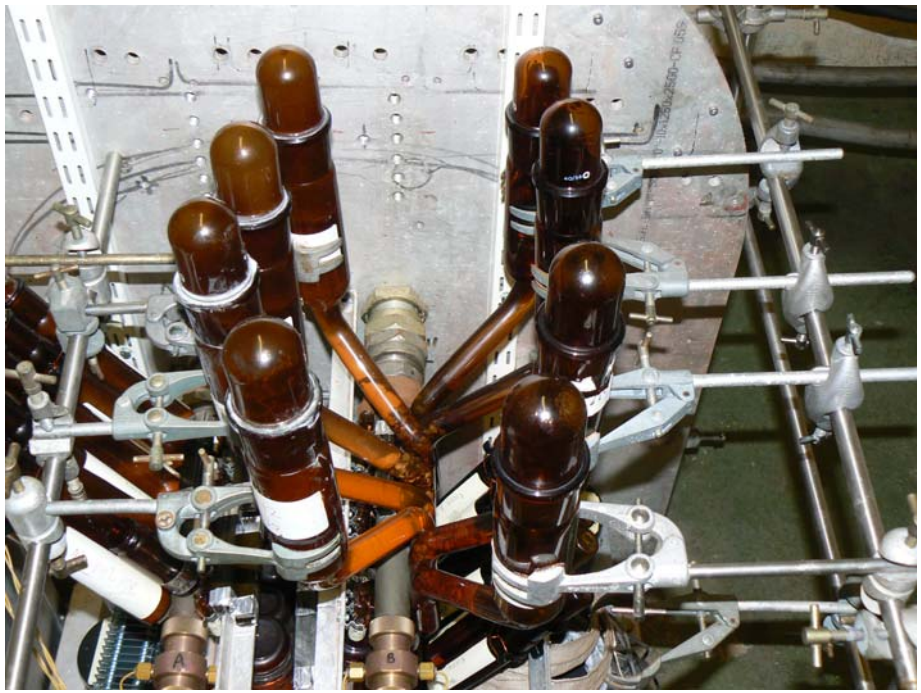
- New study of unirradiated Magnox swarf corrosion including measuring product expansion
- Measurement of corrosion rates in 5 year old drum of grouted Magnox swarf





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

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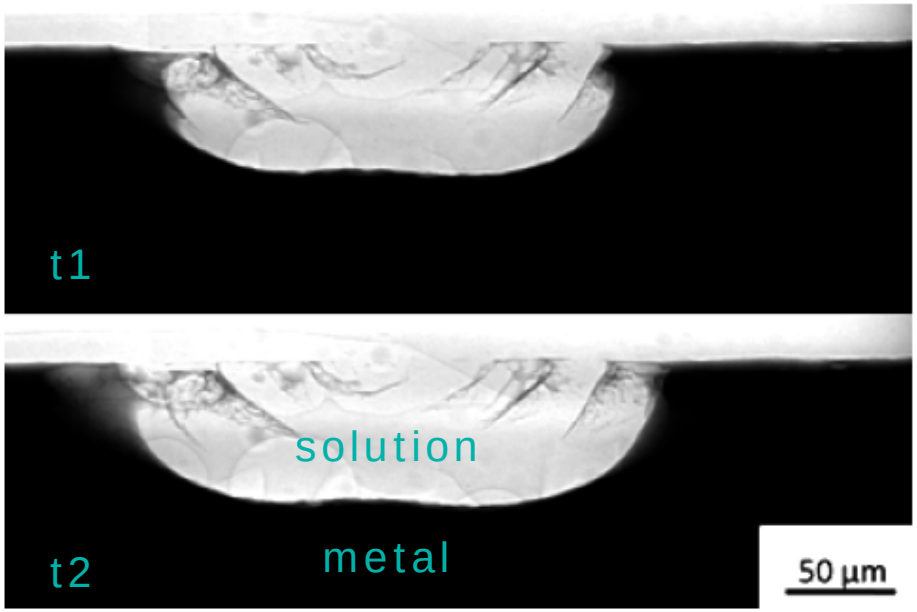
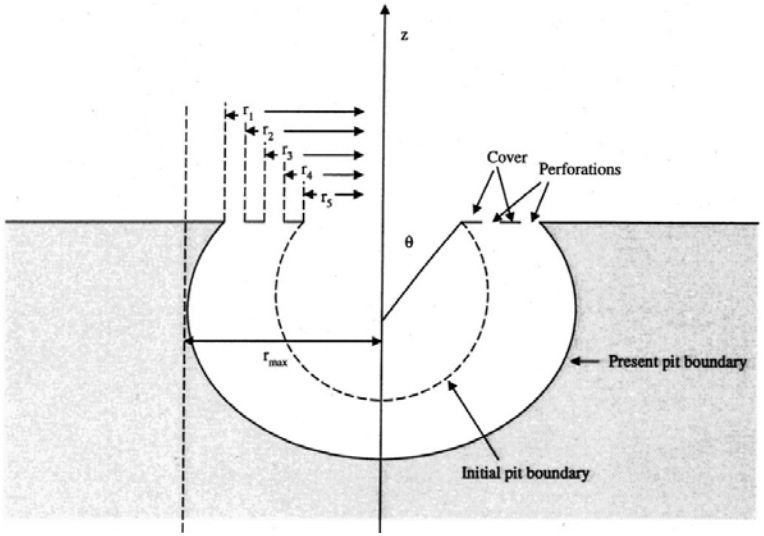
Example of R&D:
long-term propagation of pitting corrosion in atmosphere

Experimental



PhD study on mechanisms of pitting propagation in atmosphere

Modelling

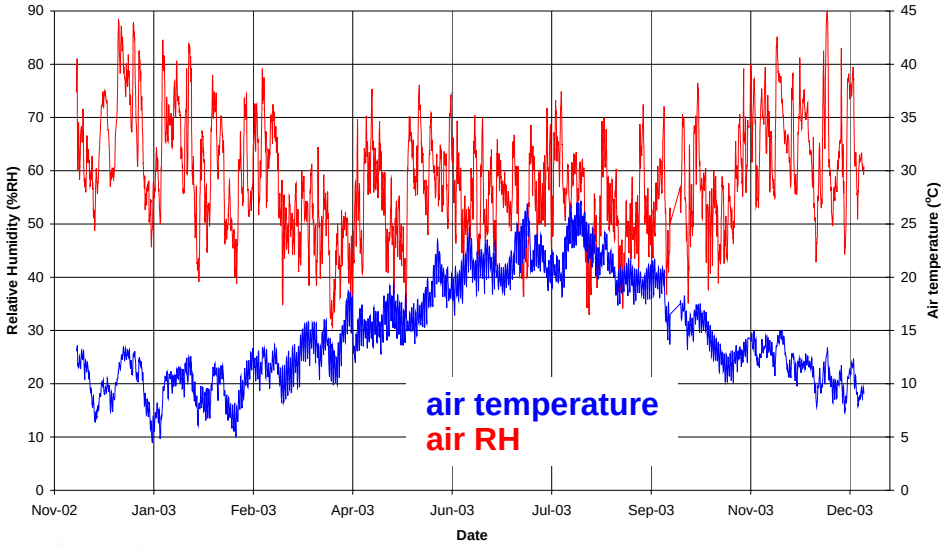


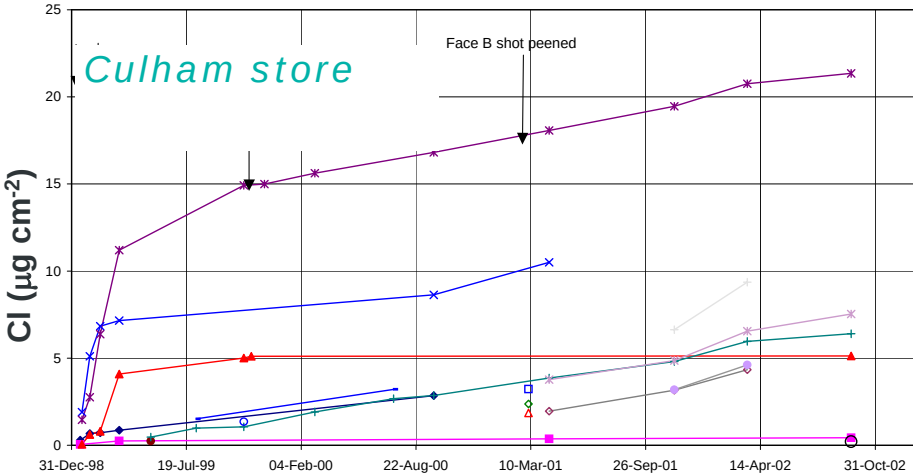
Modelling study of pitting propagation in atmosphere

Example of R&D
4 metre Box monitoring programme

Monitoring of environmental conditions including:

- Temperature
- Relative humidity
- Chloride deposition rate

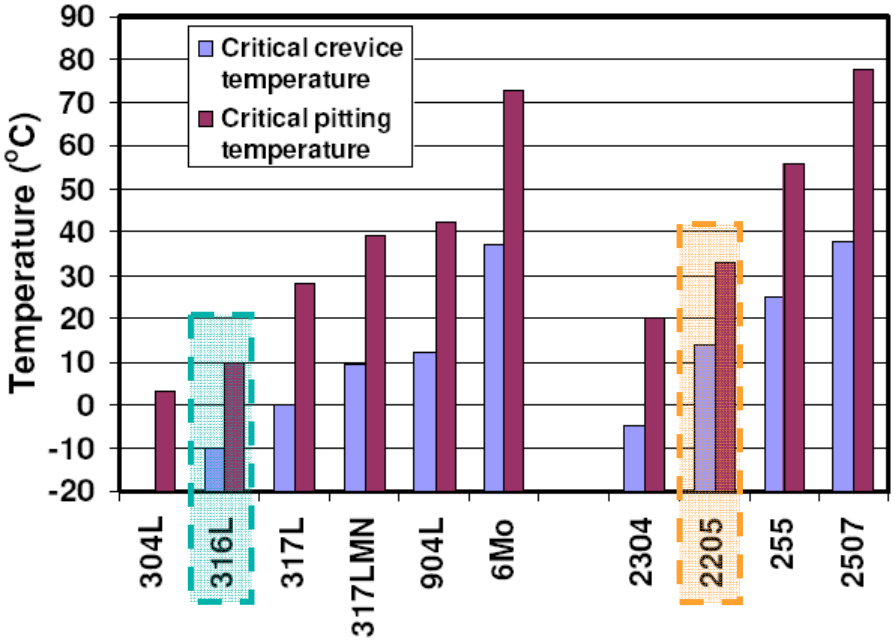




Monitoring of corrosion damage including:

- Pit density and depth
- Stress corrosion cracking

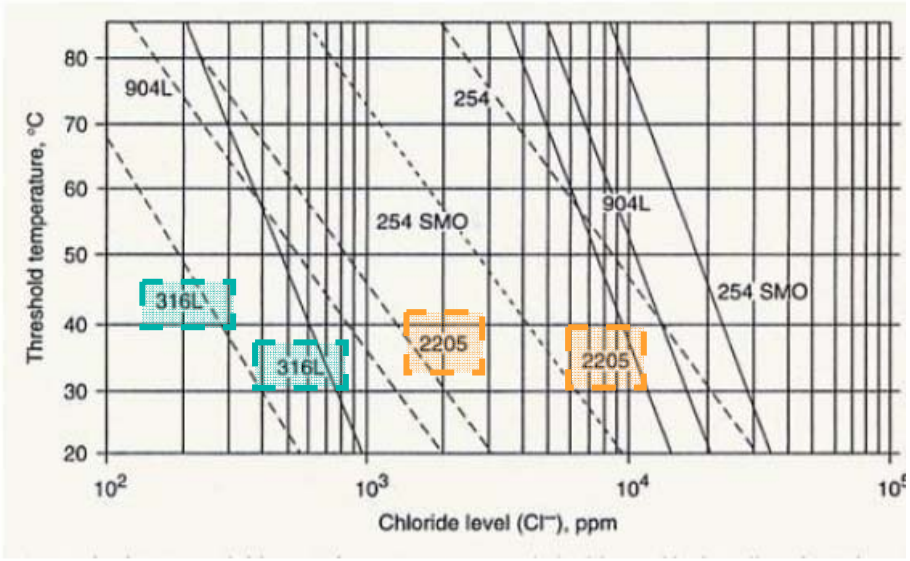
Example of R&D
duplex vs austenitic stainless steel



In 10 wt.% Ferric Chloride

Reference austenitic

Duplex currently considered

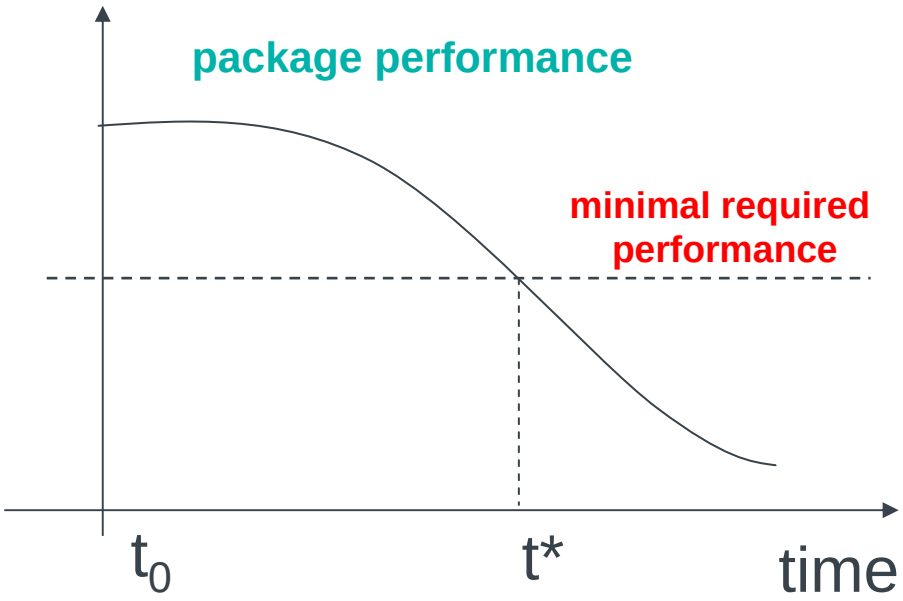


Pitting corrosion

Crevice corrosion

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

Development of failure criteria



Safety function	Evaluation criteria	Failure mechanism	Corrosion mode
Mechanical strength	Handling	Container deformation or breakage during lifting	General corrosion (wall thinning)
			Pitting corrosion (general damage)
			Crevice corrosion (base)
			Crevice corrosion (lid flange)
			SCC (susceptible areas)
		Damage to lifting features	General corrosion (wall thinning)
			Pitting corrosion (general damage)
			Crevice corrosion (lifting features)
			SCC (susceptible areas)
	Stacking	Container deformation during stacking	General corrosion (wall thinning)
			Pitting corrosion (general damage)
			Crevice corrosion (base)
			Crevice corrosion (lid flange)
			SCC (susceptible areas)

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