

British Nuclear Group

Reactor Sites Chemistry Issues

NuSAC SCR Meeting - April 4th 2006

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- Magnox Station Chemistry Organisation and Support
- Chemistry and Radiochemistry “Intelligent Customer” Role
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 - Magnox Fuel Cladding Corrosion
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 - Submersible Caesium Removal Units
 - Aqueous Filtration

...application of technical solutions and targeted research to optimise safety and plant performance over the full life cycle of the station

Station Chemistry Organisation and Support

- Station Chemist – Examples of Duties
 - Plant Operations – all Chemistry Issues
 - Plant Monitoring and Control – Generation Standards
 - Environmental Co-ordination, Chemical Safety (COSHH), WANO
 - Support to Site Based Plant Improvement or Decommissioning Projects
- Magnox Electric Generic Support and R & D
 - E&TS Provide Technical Integration and act as Intelligent Customer
 - Supply Chain - Nexia Solutions Ltd via Framework Agreement
 - Other suppliers Involved Including Universities

Engineering and Technical Services – Intelligent Customer (IC) Support

- IC definition – requirement to:
 - Specify, interpret and manage work by contractors that could have an impact on safety (nuclear, radiological or industrial) or environmental protection.
 - Skills and knowledge to: understand safety case implications; nuclear site licence issues and discharge authorisations.
- IC topic categories include:
 - Chemistry
 - Radiochemistry
 - Decontamination

Chemistry is also involved with some of the other IC areas, e.g. Structural Integrity, Graphite, Radioactive Waste Strategy, Contaminated Land.

Chemistry IC – Breadth of Issues

- Magnox fuel corrosion and spent fuel pond chemistry
- Plant water chemistry control
- Corrosion protection – boilers, turbines, waste containers
- Chemical instrumentation
- Ion exchange
- Aqueous filtration
- Waste immobilisation, Nirex Letters of Compliance (LoC)
- Gas chemistry

Issues cover generating plant and decommissioning plant

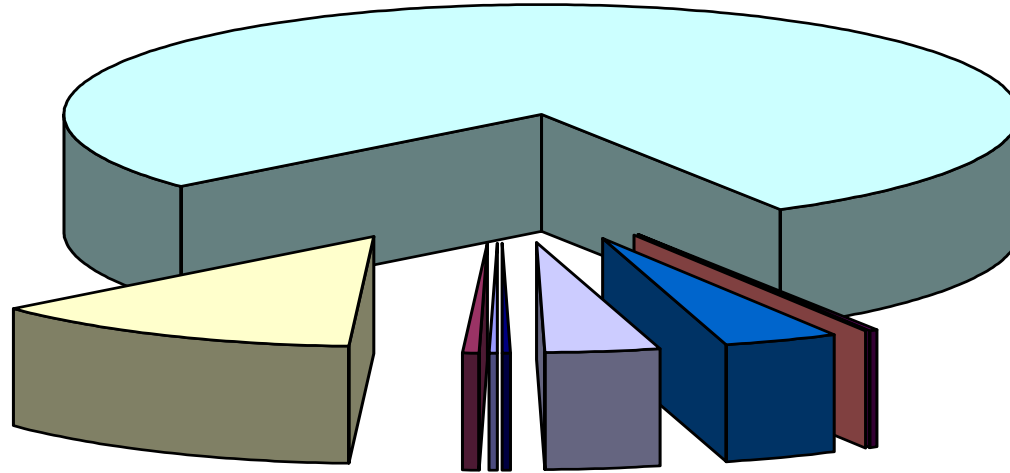
Magnox Fuel and Ponds



Pond Caesium Issues - Introduction

- Late 1970s - Problems with corroding fuel clad and Cs-137 release - removal systems installed on most sites - most using Lewatit DN- phenol formaldehyde resin - "Lifetime" stock ordered in 1988
- Late 90s Increase in Cs-137 Arisings at Hinkley Point A and Dungeness A - Issues over Lewatit stocks and spent resin storage capacity
- Research into alternative ion exchange resins – Duolite ARC 9359 as substitute for Lewatit and IONSIV IE-911 as a high capacity resin
- 1999/2000 Optioneering Studies - led to feasibility study for submersible plant using IONSIV IE-911

Typical “Operational” Magnox Pond Water Inventory



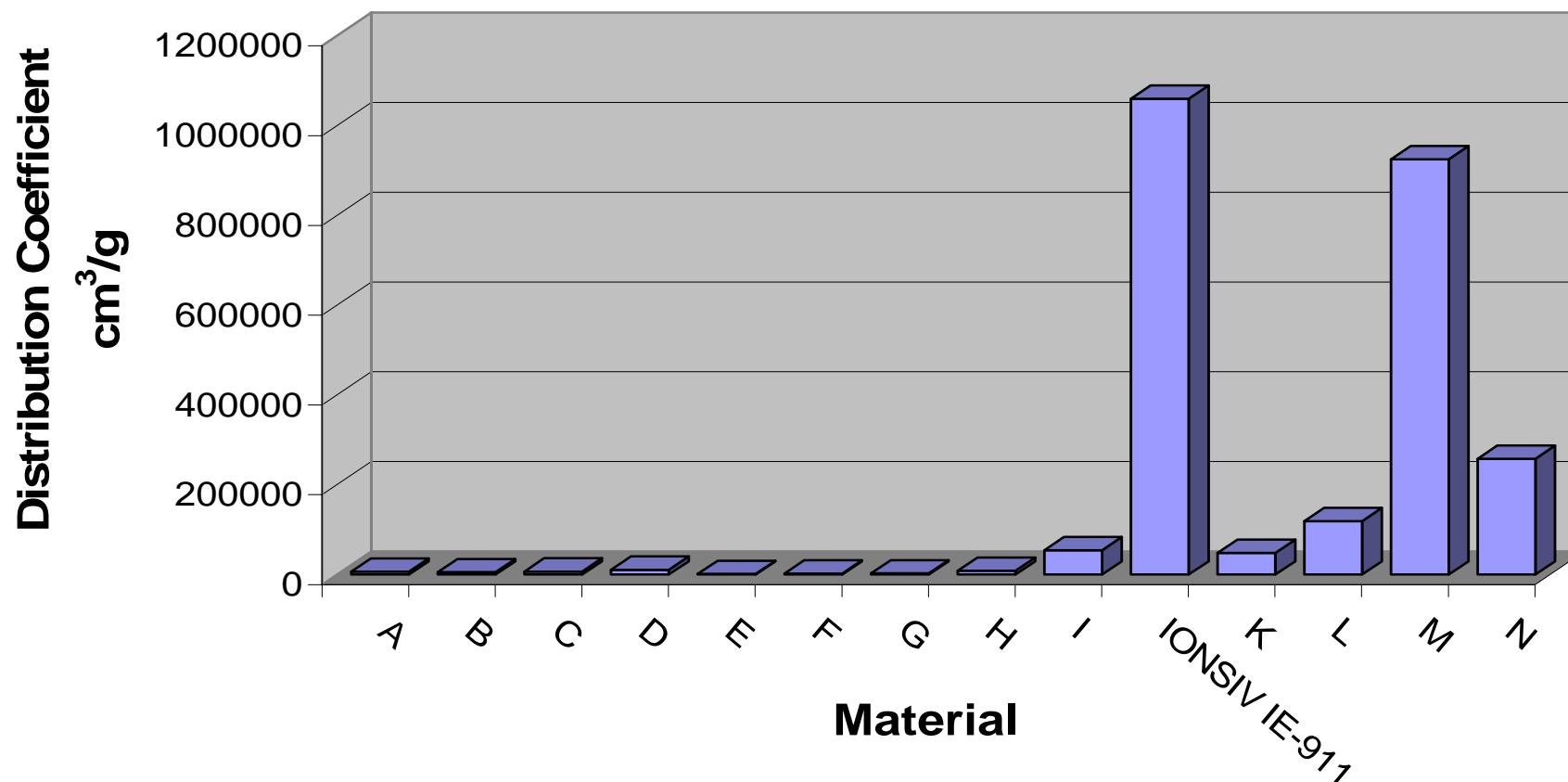
■ Ru-106
■ Cs-137
■ Sr-90
■ U/Pu/Am/Cm-alpha

■ Sb-125
■ Ce-144
■ Y-90
■ Other beta/gamma

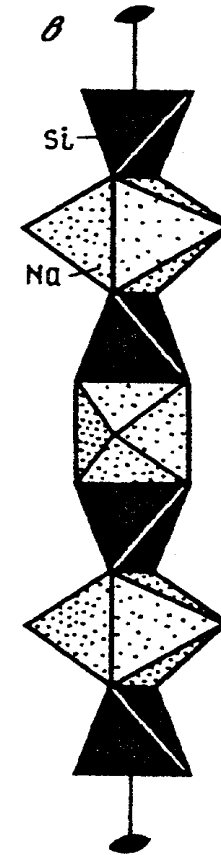
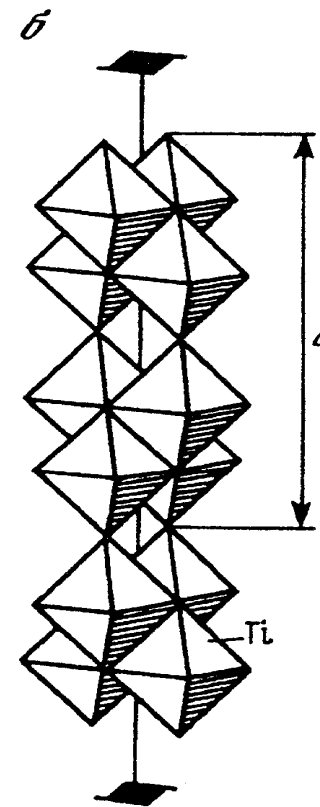
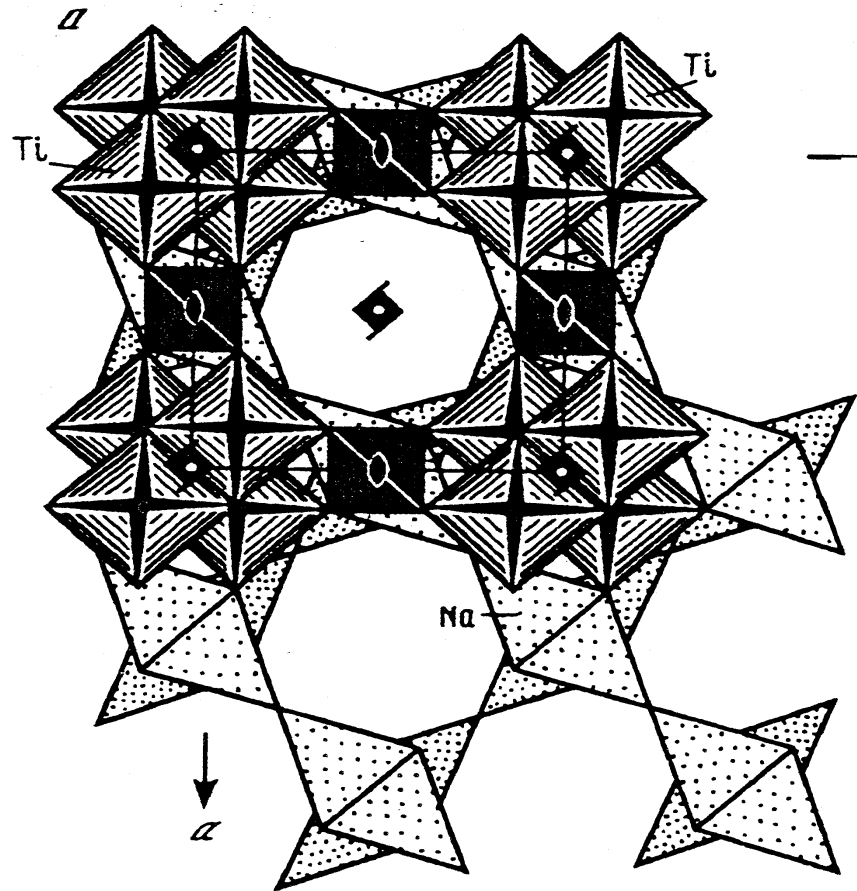
■ Cs-134
■ Pr-144
■ Pm-147

Candidate Ion Exchange Materials

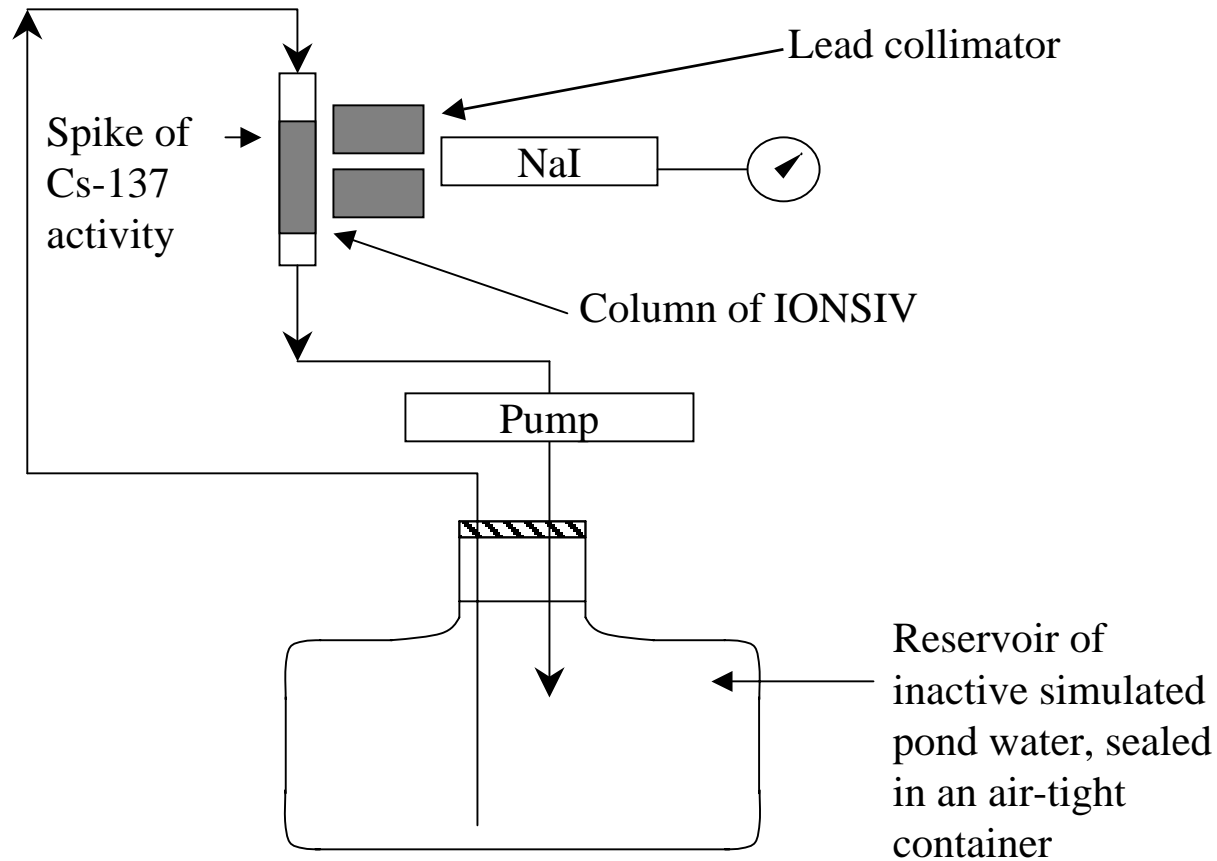
Distribution Coefficient of Test Materials at Optimum Pond Conditions.



Crystalline Silicotitanates



Experimental Set-up

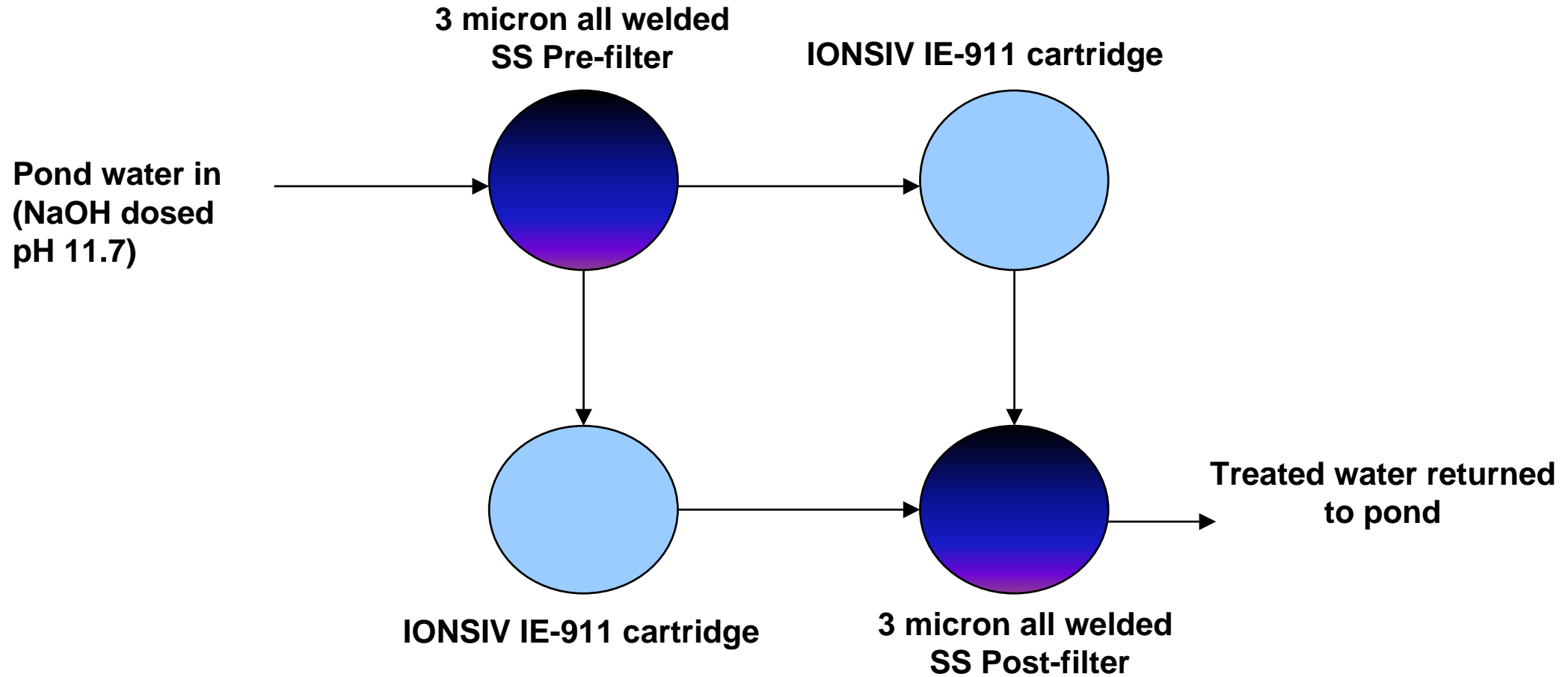


Submersible Caesium Removal Unit (SCRU)



nexasolutions
Nuclear expertise intelligently applied

Flow Schematic of Standard SCRU



IONSIV SCRUC Enhancement Project (1)

- Premature “blinding” of SCRUC pre-filters at some plants
- Extensive programme completed to successfully understand the chemical filter blinding mechanism
- Application of laboratory and pilot plant rig studies
- Ameliorative measures deployed on plant include;
 - (i) Optimisation of caustic concentration & pond water treatment plant (PWTP) operation
 - (ii) Methods of reducing pond water [Mg²⁺]
- *Waste volume and Operator dose minimisation (ALARP)*

IONSIV SCRUC Enhancement Project (2)

- Daily technical support to plant operations
- Technical Working Group established to share best practice in
Safety, Operations, Training
- Filter design specifications and cleaning
- IONSIV IE-911 cartridge and filter dose rate analysis
- Caesium removal efficiencies
- Further optimised use of IONSIV IE-911 technology

Work to be presented at the International Conference on Water Chemistry of Nuclear Reactor Systems, October 23-26 2006, Korea

Spent Fuel Cooling Pond Operations

Caesium Abatement

Pond Water
Chemistry

IONSIV SCRUB
Enhancement
Project

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Support to
Magnox
Operating Plan

Fuel Skip
Issues

General Technical
Support

Pond Water Chemistry

- Station pond water particulate measurement and data analysis
- Magnox fuel cladding corrosion support*
- Post-aqueous storage regimes for Magnox fuel elements
- Monitoring/Analysis of pond water chemistries and activity levels (e.g. *nuclear site licence condition linked to environmental discharges*)

** Work presented at the IChemE DECOMM '05 Conference,
September 4–9 2005, Glasgow, UK*

Caesium Abatement Issues

- Identification and mitigation of current and future chemistry risks & threats to Magnox power station cooling ponds
- Revision of spent fuel pond post-defuelling storage guidelines (*e.g. consideration of potential impact on associated plant such as wet vaults*)
- Development of radionuclide behaviour pond model
- Support to station BPM/BPEO assessments as required
- Opportunities, acceleration and innovation via chemistry applications

Fuel Skip Issues

- Call-off technical support on generic fuel skip issues to cover;
- *Decontamination*
- *Fuel skip corrosion*
- *Transport flask chemistry etc.*

Ion-Exchange Technology



Experimental IONSIV
IE-911 Studies

Experimental AW500
Studies

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AW500 Literature
Survey

Optimised
(lifetime) ion-
exchange plant
operation

Lifetime
decommissioning
and waste issues

- AW500 is a molecular sieve type resin used by MEL at some stations for Cs-137 abatement;
- There are “Orphaned” fuel skips containing spent AW500 resin awaiting a identification of a suitable disposal process
- Experimental programme at Nexia Solutions Ltd. active facilities at Springfields to consider the Cs⁺ desorption effects on loaded AW500
- Parameters studied - pH, [Na⁺] and Temperature
- Results help to dictate optimum pond decommissioning strategy

Generic Technical Support

- Engineering Documentation
- Revision of Generation Standards (*e.g. Post-Operational Safety Case - Off-load steam/water circuit storage during defuelling/decommissioning*)
- Best Practice Reviews (*e.g. Aqueous filtration plant peer reviews*)
- Participation in Optioneering Workshops and BPEO Studies
- Station Chemists Meetings
- Input to Training
- External Liaison

Collaborations and Benchmarking

- University Research Alliances (URA's)
- EPRI Workshops
- Participation in WANO Reviews
- Westinghouse technology exchanges
- Utility Benchmarking Visits – PWR, BWR, VVER

Vattenfall Ringhals, OPG Darlington, GKN Neckarwestheim, Temelin

- International Conferences (NACE, EUROCORR, Water Chemistry)
- National collaboration – NPL, universities etc.

Overall Summary

- Chemistry and Radiochemistry Support to Magnox Stations covers:
 - Operational needs
 - Research – fundamental studies
 - Application of technology
- Chemistry issues change - new issues emerge, continued support required
- Chemistry skills key to Plant Performance and Station Operations
- Chemistry and Radiochemistry skills key to Radioactive Waste and Radioactive Discharge issues
- Overall requirements kept under review through consideration of chemistry risks, threats and opportunities
- Important to maintain external links and learn from experiences elsewhere