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A Nuclear Management Partners company
operated under contract to the NDA

Sellafield Ltd – R&D and the future

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Sellafield Ltd

The Sellafield site has more than 60 years of history

1940s/50s

- Nuclear build begins
- Initially a military
- programme
- Later civil programme begins
- Calder Hall on line

1960s/70s

- Waste stored safely – pending treatment
- Storage capacity extended incrementally
- Coarse segregation of waste arising from process
- Magnox reprocessing starts

1980s

- Main expansion of site
- Major waste treatment focus
- Environmental impact substantially reduced
- Decommissioning programme started
- Thorp construction starts

1990s

- True commercialization of reprocessing—Thorp online
- Waste arising from processes treated in ‘real time’
- Product waste forms compatible with disposal concepts
- Health and safety executive reports

2000s/10s

- Decommissioning gathering pace
- Sellafield landscape changing forever
- NDA formed
- NMP become PBO

Sellafield Today

- The world's most complex and compact nuclear facility and is the location for
  - 3 reprocessing plants
  - several current and legacy fuel storage ponds
  - several current and legacy raw waste storage facilities – silos, stores etc
  - 7 reactors
  - several fuel fabrication plants
  - A vitrification plant with three lines
  - 4 ILW encapsulation plants
  - PCM, LLW and other processing plants and
  - a combined heat and power plant
- In excess of 1300 buildings, 290 active facilities consisting of 1 million m^3 concrete above ground, 1 million m^3 concrete below ground, 37km road, 15km railway, 120km sewers and 65km water pipes all within a ~2.6Km^2 boundary
- Costs £1.5bn per year to operate

Sellafield Focus for the Future

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Overview of Site programme phases

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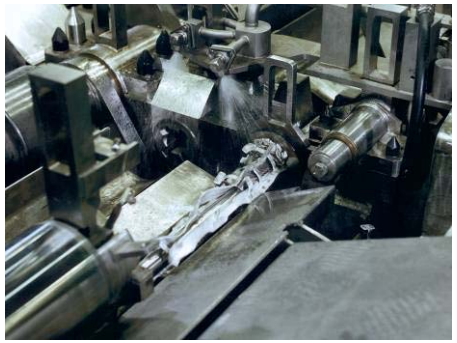
What does this mean

- Work planned over the future recognises a reduction in operational programmes and increases in site restoration programmes
  - Reprocessing facilities operate to circa 2018 then move into post operational cleanout
  - Waste treatment plants generally operational for decades
  - Legacy ponds and silos – currently in retrieval phase until 2030's
  - New waste treatment plants from 2020s onwards for several decades
  - Broad front cross site decommissioning commences mid 2020s with subsequent demolition activities
  - Land – ongoing protection and remediation after building demolition

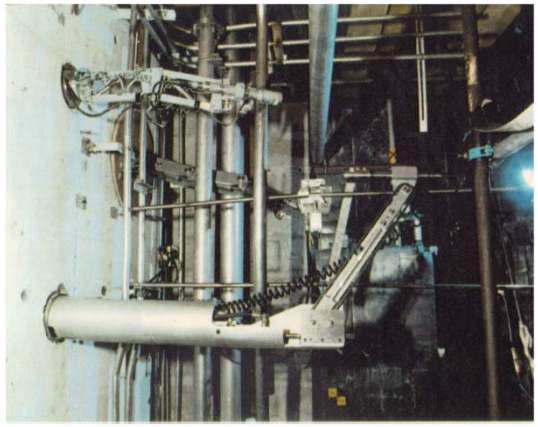
Sellafield R&D programme

Support to existing operational plants



Preparation for post operational clean out

Preparation for decommissioning

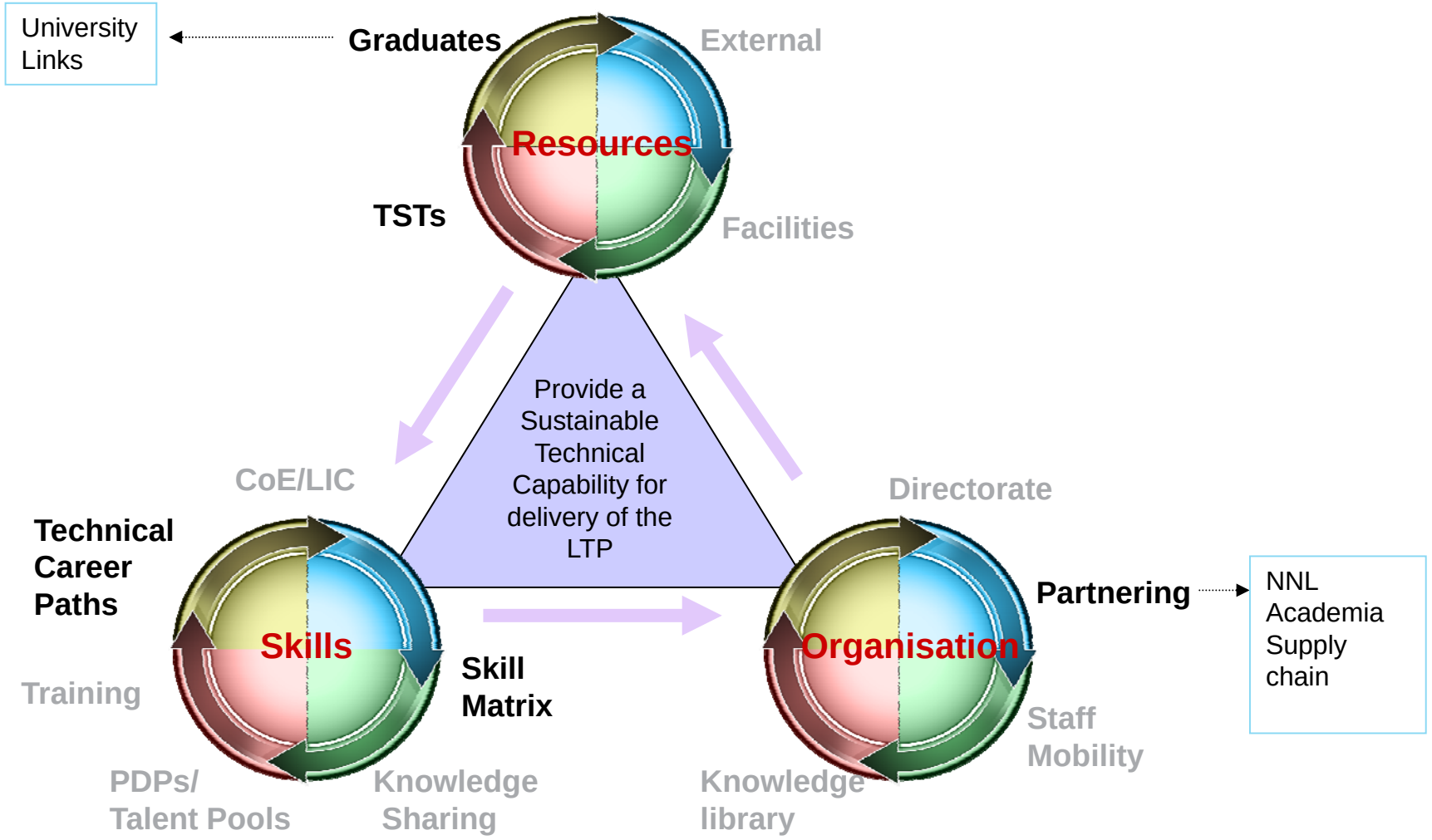


Strategic game changers

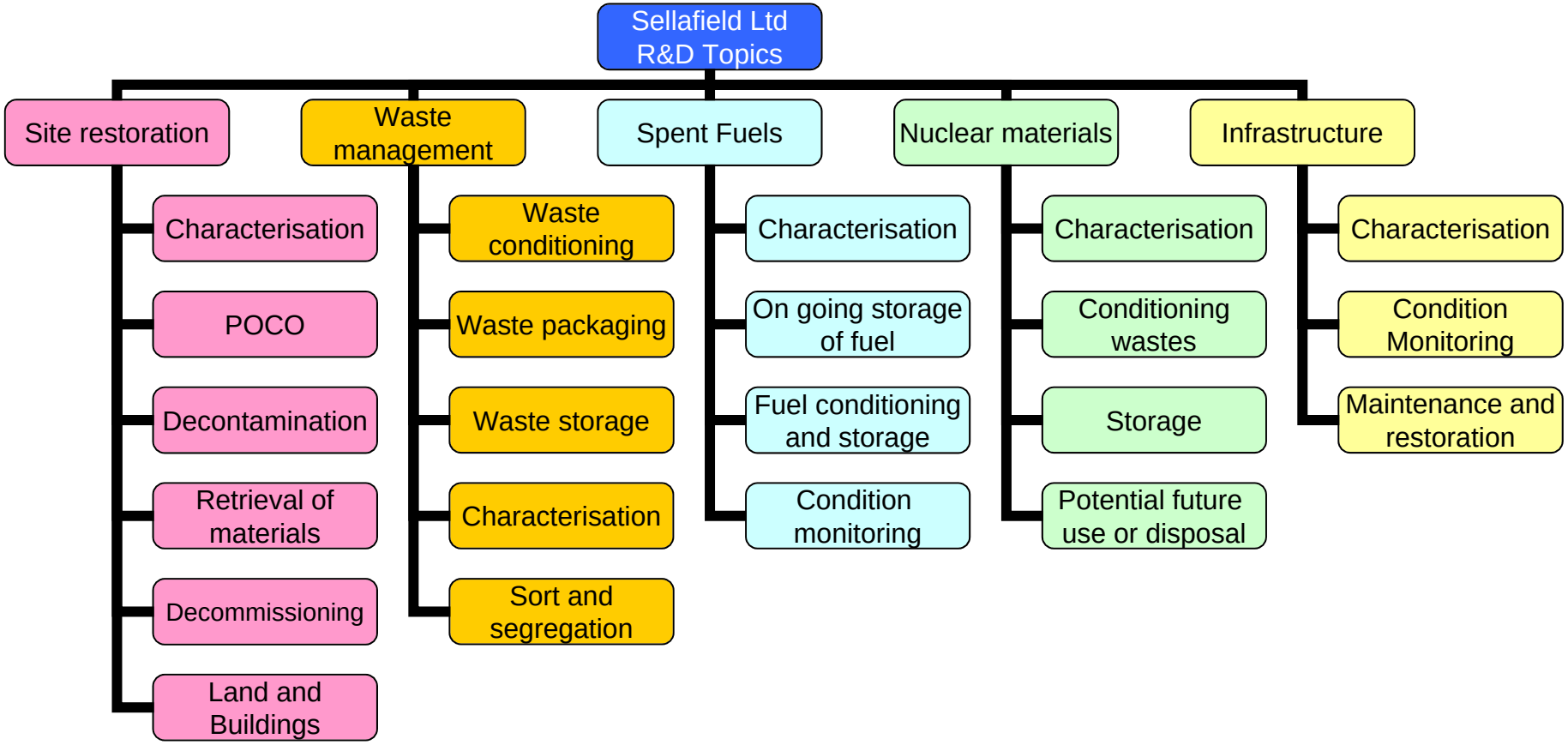
People – our key asset

- Future needs are changing as we move from operational work to decommissioning work resulting in more complex one off challenges requiring higher skill levels in Sellafield Ltd and our supply chain
- Sellafield current recruits technical and engineering people through a variety of routes and our current technical focuses are
  - Technical Specialist Trainees
  - Graduate level recruitment across science, engineering and business areas
  - Specialist recruitment for experienced STEM professionals
- http://www.sellafieldsites.com/careers/vacancies/

Technical Capability Improvements

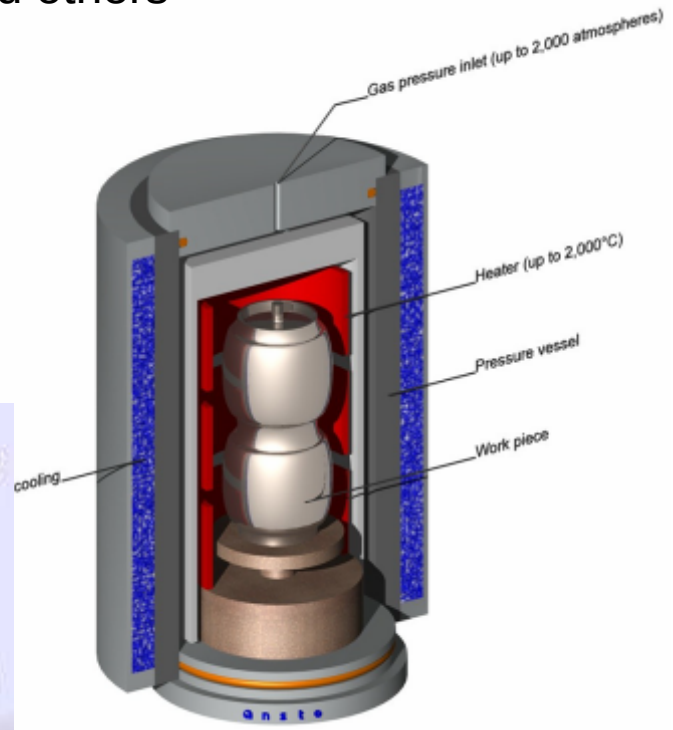


Target Areas for future R&D activities



Examples of current technology development

Ceramic Disposal of Pu Residues using Hot Isostatic Pressing (HIP) – NNL, ANSTO, U of Sheffield and others



Examples of current technology development

- ILW package inspection
  - Collaboration with RIs (NPL) and SMEs
  - Cenosphere grout formulation
  - White light scanning
  - Magnetic permeability
  - Lock in thermography
  - Coarse ground cement formulation
  - Infra red imaging

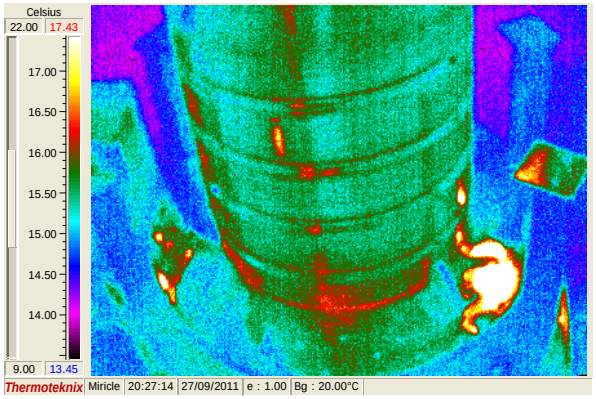


Figure 3: Demonstration of active thermography (lock-in) system. Left – back face of test artefact, Middle – front face of test artefact, right – phase (processed thermal) image taken from analysis of front face

Broad front decommissioning

NO MARKING REQUIRED

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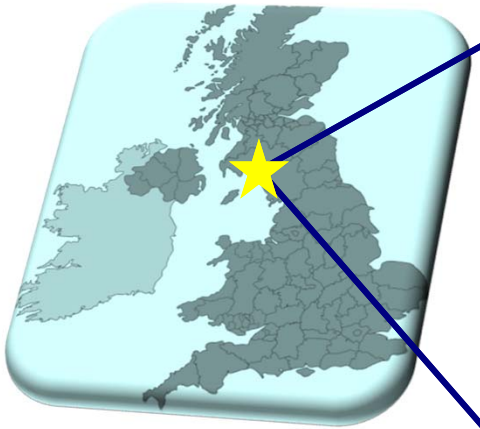
Technical challenges, needs and opportunities in decommissioning of the Sellafield Site

NO MARKING REQUIRED

First Generation Reprocessing Plant: Challenges, Opportunities & Needs

	Challenges	Opportunities	Needs
Characterisation	Considerable volumes of material may assumed to be LLW or exempt, through insufficient characterisation this may lead to delays in retrievals should levels exceed LLW threshold.	To demonstrate efficient, reliable identification of ILW, LLW and free release.	Imaging techniques to locate α, β/γ hot spots. Reliable, fast imaging, in-situ characterisation methods to differentiate waste categories.
	Limitations on man access to carry out characterisation may limit the amount of data that can be collected without remote capabilities being available.	Opportunity to develop "Through the wall" techniques to assess plant status for future projects.	Fibre optic techniques / small radiation imagers Radiochemical analysis Remote handling
Decontamination	Limitations on man access to carry out characterisation may limit the amount of data that can be collected without remote capabilities being available.	Opportunity to develop faster, more efficient decontamination for future projects.	Remote application and better targeting of decontaminants.
	Assumption that scabbling will be sufficient to remove hot spots within cells to the assumed desired levels is correct, if not these areas may require additional techniques incurring additional costs.	Opportunity to prove Scabbling of cell walls to remove hot spots from HA cells.	Potential to consider alternative decontamination techniques.
	Ability to deploy required decontamination technique may not be achievable requiring alternative methods of decommissioning/shielding to be required.	Opportunity to develop decontamination techniques which generate less effluent for future projects.	Understanding of the behaviours of substrates to be decontaminated to inform future projects.
Remote	Limited as-built data may lead to additional decommissioning work if plant configuration is not as thought.	Better remote characterisation and domain modelling	Development of long reach remote deployment systems for existing wall penetrations. In-situ real time sampling and analysis tool heads. Laser scanning technology that will pass through existing wall penetrations.
	Use of slow tele-operations may lead to additional time and cost issues for the project.	Move towards the use of selectable autonomy control system architectures	Develop common autonomous system architectures
	Working in high active congested space may restrict use of remote equipment.	Use of snake like manipulator systems that can work reliably in congested spaces.	Develop reliability and active deployment experience, develop maintenance decontamination methodologies.
	Use of labour intensive tele-operations on multiple work fronts.	Use of universal / common HMI for a variety of deployment systems.	Develop common HMI and robot control interfaces that can be used on a range of off the shelf robot systems.

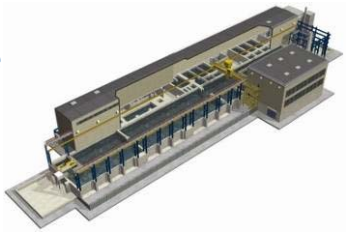
Decommissioning at the Sellafield Site



Legacy Ponds & Silos

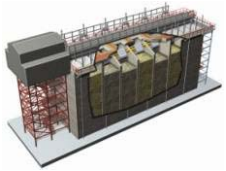
Magnox Swarf Storage Silo

Pile Fuel Storage Pond



Magnox Storage Pond

Pile Fuel Cladding Silo



Remediation Portfolio

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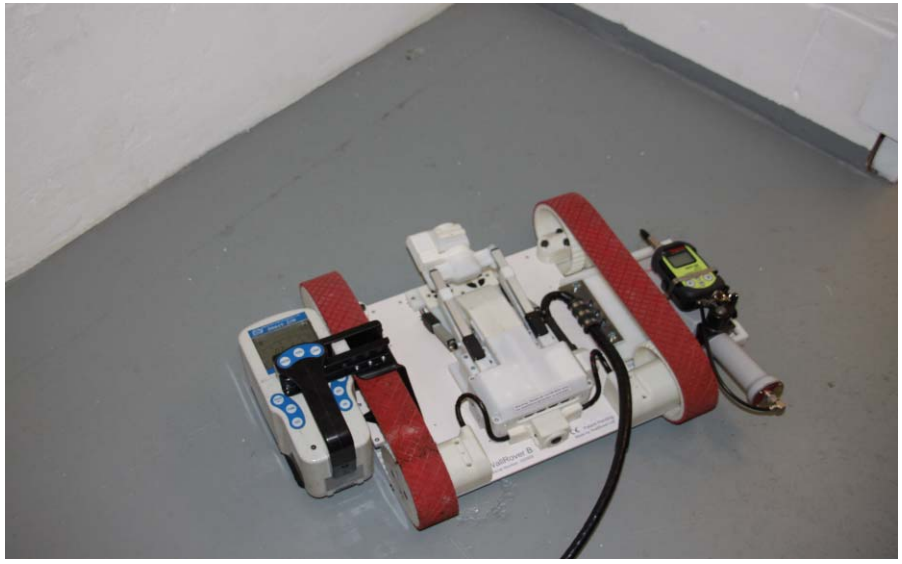
Examples of current technology development

- Robotics
  - Collaboration with Academia, NDA, TWI and specialist SMEs

Examples of current technology development

- Mobile delivery platforms
  - WallRover - Collaboration with local specialist supply chain



Strategic R&D

- Imagine the deactivation of plants being carried out using “intelligent chemicals” that work their way through the building collecting and retrieving all radioactivity as they go.
- Imagine mobile effluent treatment plants capable of collecting and separating all radioactive constituents including tritium.
- Imagine remote “moles” being deployed to target ILW deep underground, to extract it and return it to the surface.
- Imagine workers wearing protective clothing no heavier than a cloth overall but which reduces their exposure to radiation be a factor of 10, 100 or a 1000 fold.
- Imagine a technology which harnesses gamma and neutron emissions and converts them into electricity.
- Imagine a thriving technical and engineering supply chain in West Cumbria and exporting across the World.
- Imagine the Sellafield site being rapidly decommissioned at a fraction of the current time and cost.

Enablers

- **R&D Alliance** linking Sellafield Ltd with NNL, Academia, Supply Chain and others using local gateways to facilitate the delivery of R&D
- **University Links** on key technical themes
- Linking with UK Research Councils, TSB and others
- Developing innovation commercial framework to support project delivery
- Multi-million pound investment into research, development and deployment through academia, supply chain and national laboratories

What do we want from academia?

- Stream of high quality scientists and engineers with awareness or experience of working life
- Underpinning and applied R&D
- Awareness of issues at Sellafield to focus R&D on real issues
- Support transition through valley of death from research to deployment
- We encourage you to develop partnerships and collaborations
- Join us through the R&D Alliance

What can we offer academia?

- Summer placements for students (10 – 20 per annum)
- Industrial placement students (15 per annum)
- Job opportunities for graduates from university (50 – 80 per annum)
- Source of knowledge, industrial expertise, collaboration with academia and ideas for future research
- Support through “in kind” and financial (we already invest some £5M)

Concluding Remarks

- Sellafield has over 60 years of experience of nuclear operations and over 70 years of future operations
- Time is right – national strategy, opportunities for trade and clean up programme accelerating at Sellafield
- The site is about to enter the broad-front decommissioning phase
- Significant technology development is required to support ongoing operations, waste treatment and decommissioning
- Delivery of technology development will be achieved by partnering with the supply chain, academia, national institutions and research institutions
- How can we partner to deliver the nuclear clean up programme?

- **Thank you**

- Any questions..??