Radioactive Waste Management

The use of Scientific Readiness Levels SRLs™ in the Planning of Waste Disposal RD&D

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Overview

- Why? What and Who? Where and When? and How? (and What's next?)
- Start off by understanding the benefits and limitations of Technology Readiness Levels (TRLs)…

I keep six honest serving-men
(They taught me all I knew);
Their names are What and Why and When
And How and Where and Who.

Rudyard Kipling: Just So Stories (1902)

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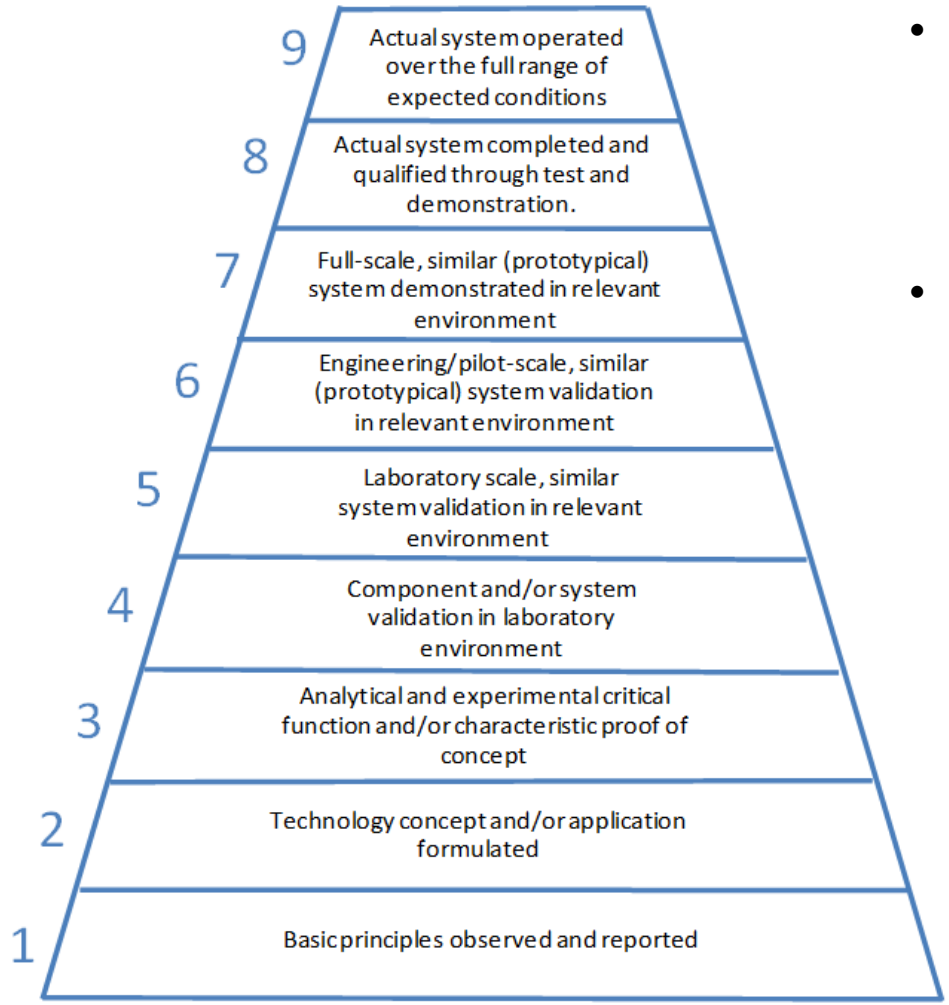
Technology Readiness Levels

The 'Why?'



- Technology Readiness Levels – widely used as a risk mitigation tool – immature technology is a prime cause of cost growth and schedule delay.
- Invented by NASA in 1974; widely used across defence and technology, including nuclear decommissioning in the UK.
  - Provide a common understanding of technology status.
  - Key driver is risk management.
  - Used to make decisions concerning technology funding.
  - Used to make decisions concerning transition of technology.

Comanche helicopter: TRL at start of programme: 3-5

Cost growth: 101%
Schedule delay120%

http://www.gao.gov/assets/680/679006.pdf

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Application of TRLs to Geological Disposal?

The 'Why?'

- TRLs are still a useful tool where Siting has progressed, a disposal concept has been agreed and the site has been characterised.

- However:
  - Readiness does not necessarily fit with appropriateness of technology.
  - Without a site, and with purely illustrative concepts and designs our need was to develop understanding, not technology.
  - For the purposes of calibrating the scientific maturity of underpinning science, identifying the requisite level of scientific maturity and plotting a route to attaining that robustness in understanding, TRLs have proven intractable.

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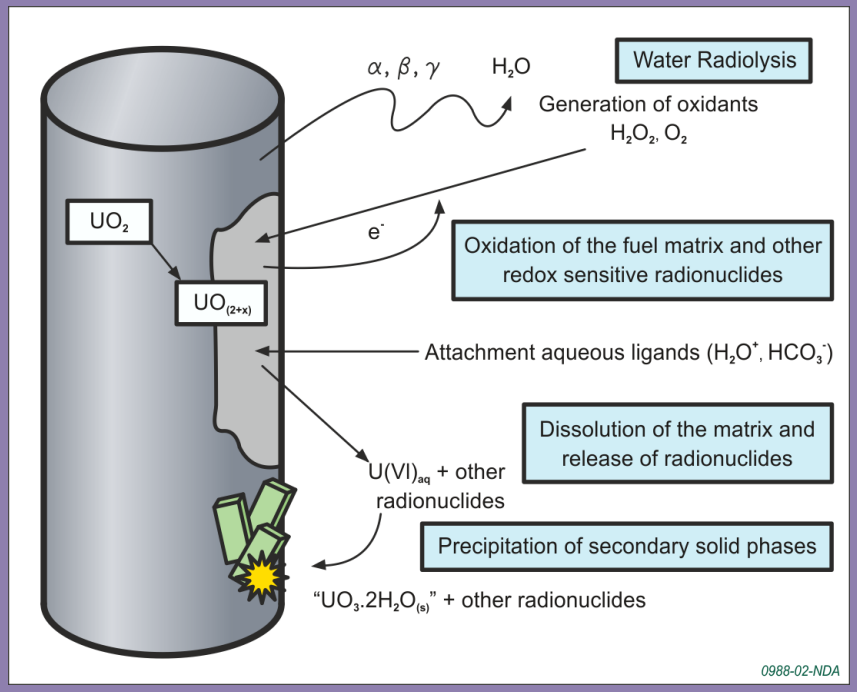
An example

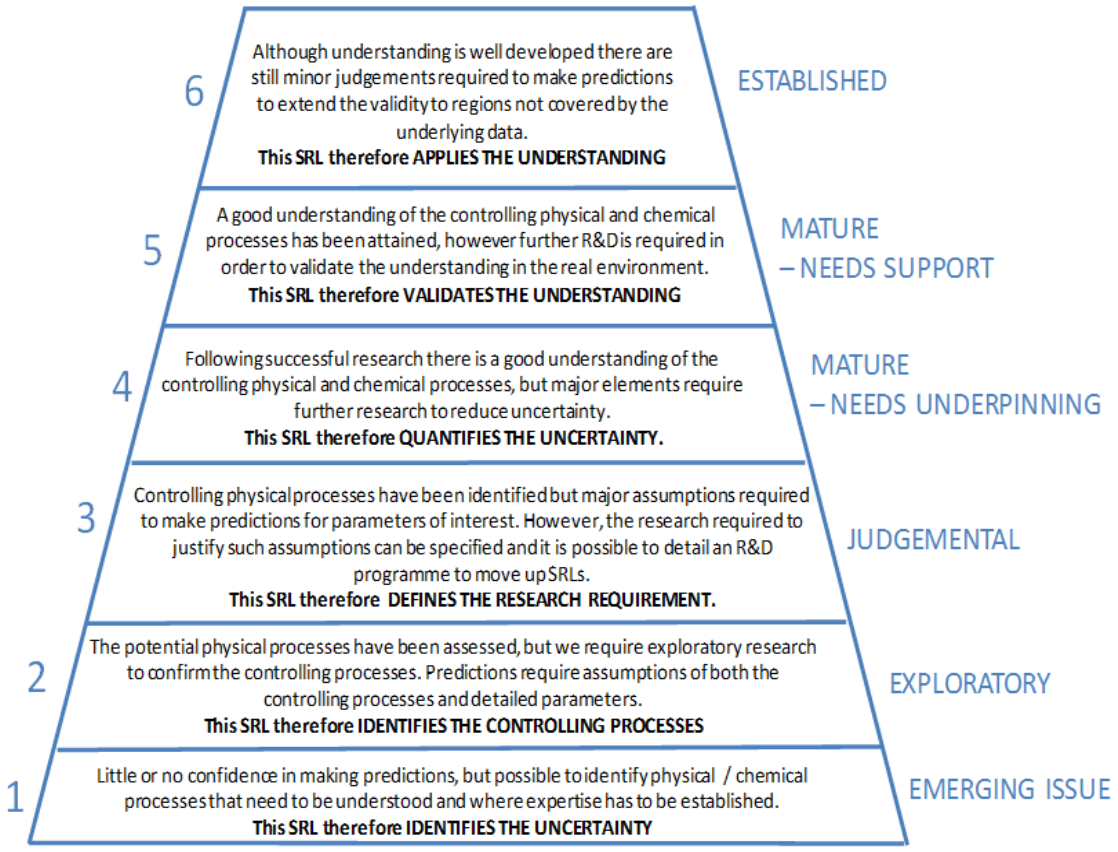


A ceramic spent-fuel matrix is a part of the multi-barrier system.

- It therefore provides a safety function.
- Need to identify whether further research is required on the dissolution of radionuclides from spent fuel.
- TRLs cannot be applied at this level.
- Need a means of calibrating scientific understanding.

Scientific Readiness Levels™

The 'What?' and the 'Who?'



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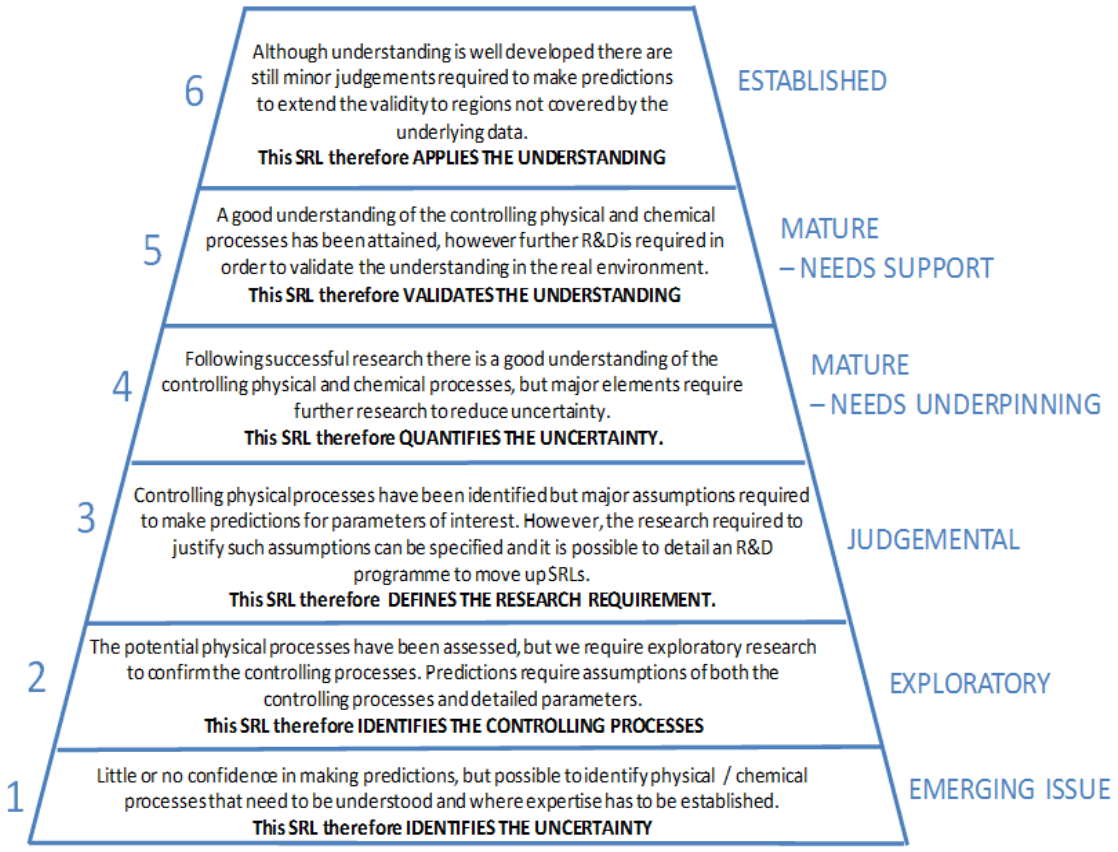
- Developed by UK's National Nuclear Laboratory – looking at Gen IV new build technology.
- A useful tool for assessing:
  - Our current understanding.
  - What understanding is required / sensible at the generic stage.
  - Identification of success…

    …but a tool, not an end in itself.
- SRLs™ can support Governmental policy development and WMO research planning and prioritisation.
- Help to challenge the adequacy of current plans.
- Don't always need to go to SRL™ 6.

Scientific Readiness Levels™

More of 'the Why?'



- SRLs™ provide focus on real needs by examining our level of understanding.
- Assist our Regulators in understanding critical knowledge gaps.
- Defend the WMO from the "search for all knowledge" (at infinite cost and taking forever).
- Assist the dialogue with academia / Research Councils by explaining when sufficient understanding has been gained to bound an uncertainty
  - Focussing their efforts on real needs.

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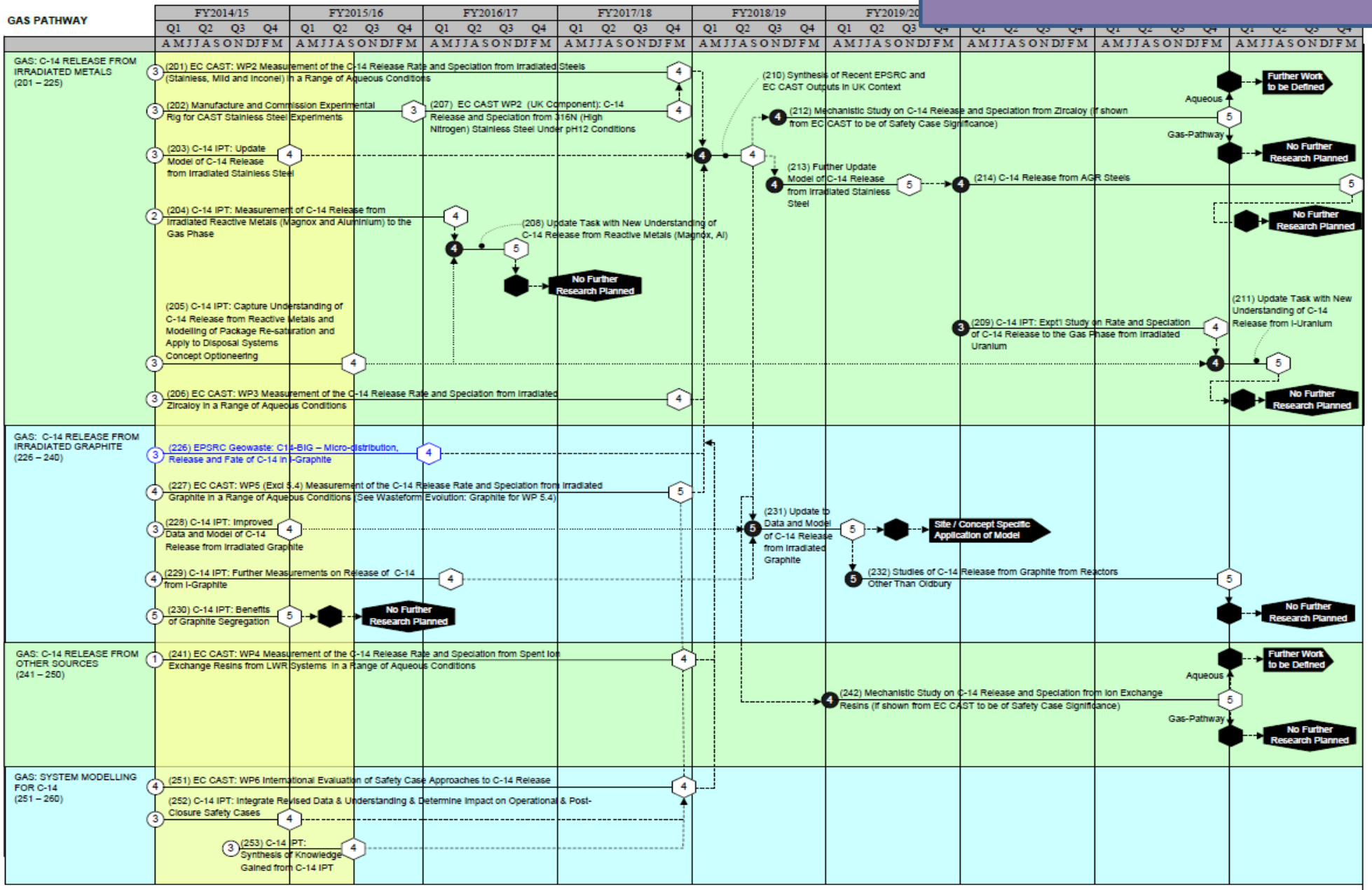
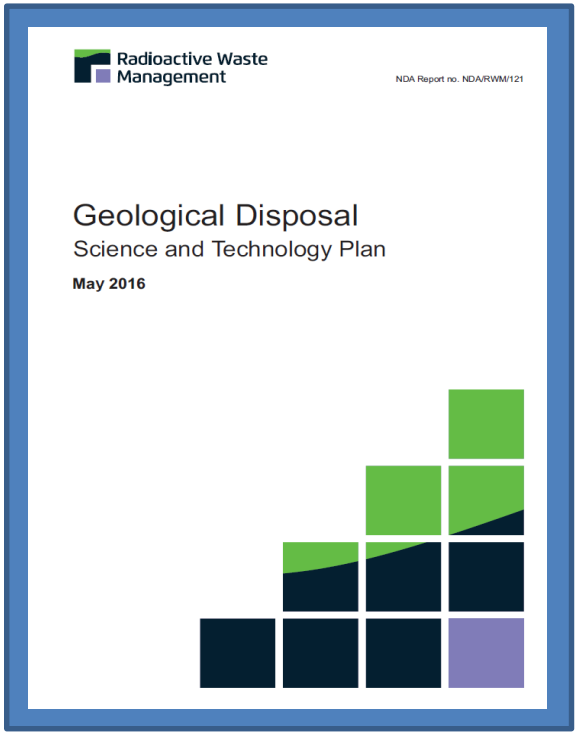
Long-range Planning (continued)

The 'Where and the When?'



Documentation & Communication



https://rwm.nda.gov.uk/publication/science-and-technology-plan-2016/

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The 'How?'

Task Number	227	Status	Ongo
PBS level 4	Gas Pathway		
PBS level 5	C-14 Release from Irradiated Graphite		

Title

EC CAST: WP5 (Excl 5.4) Measurement of the C-14 Release Rate and Speciation from Irradiated Graphite in a Range of Aqueous Conditions (See Wasteform Evolution: Graphite for WP 5.4)

Background

Carbon-14 (C-14) is a key radionuclide in the assessment of the safety of a GDF for radioactive waste because of the calculated radiological consequences of gaseous C-14 bearing species. RWM has established an Integrated Project Team to develop an holistic approach to C-14 management in the disposal system. Using the current modelling basis, but ignoring any potential benefits from the geosphere in retarding or preventing gas from reaching the surface, the calculated release of C-14 is dominated by:

- Corrosion of irradiated reactive metals (in the operational and early post-closure time frame).
- Corrosion of irradiated stainless steel and leaching of irradiated graphite (in the longer term).

Work has shown that better understanding could reduce the calculated radiological consequences for these wastes. Alternatively, it may be possible to mitigate the impact of these wastes through alternative treatment, packaging or design options. While only a minor component of the C-14 inventory of irradiated graphite is thought to be labile, graphite comprises the largest inventory of C-14 associated with irradiated material in ILW in the UK.

Research Need

To support the development of the environmental safety case by determining the release of C-14 from irradiated graphite (this may also support the transport and operational safety cases).

Research Objective

To determine the inventories and release rates of C-14 from a range of irradiated graphites to the solution and gaseous phases in simulated post-closure conditions.

Scope

The scope comprises the:

- Collation of existing information on the C-14 inventory in irradiated graphite, its form and leaching behaviour and treatment and packaging for geological disposal.
- Development of approaches to the characterisation of the C-14 inventory of irradiated graphites and studies on the release of C-14 from irradiated graphites to solution and gas.
- Development of an interpretation of C-14 behaviour in, and release from, irradiated graphites.

SRL at task start	4	SRL at task end	5	Target SRL	5
End point	No Further Research Planned				
Customer	Disposal System Safety Case				

Further information

This task forms part of the CAST (Carbon-14 Source Term) project (Work Package 5), which is an international collaboration co-funded by the European Commission

Relevant publications include:

NDA/RWMD, December 2012. Geological Disposal: Carbon-14 Project – Phase I Report. NDA Report No. NDA/RWMD/092. ISBN 978-1-84029-476-7.

www.projectcast.eu

Full Integration into our Evolving Safety Case?

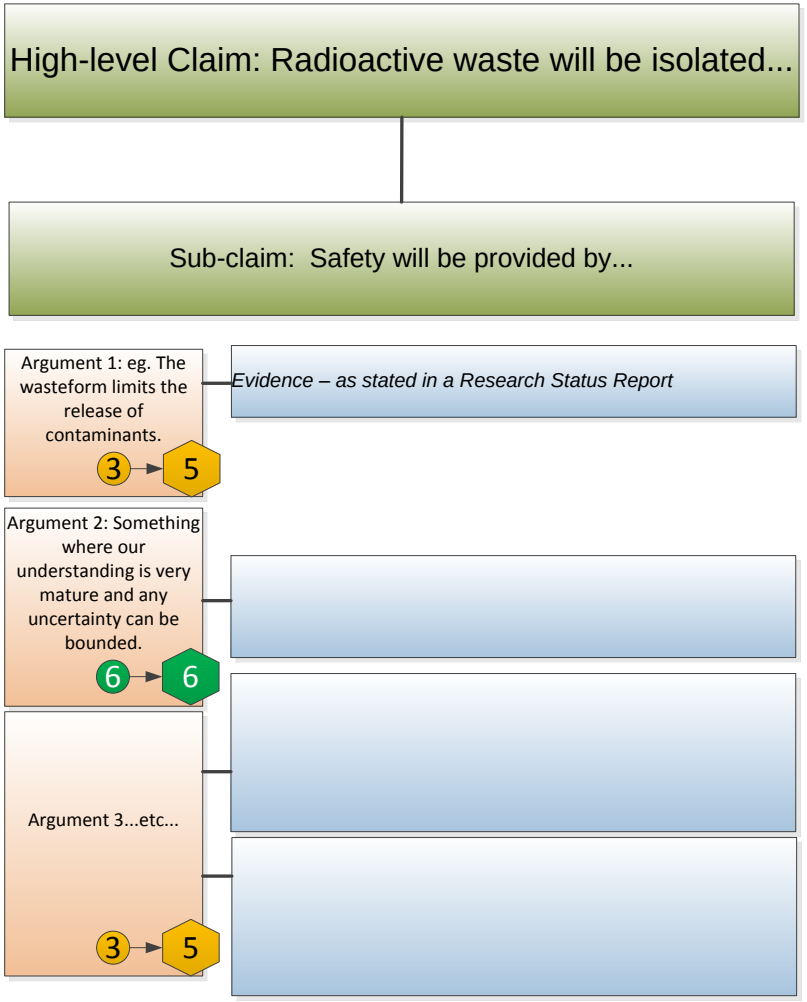
The 'What's next?'

An environmental safety case is a set of claims concerning the environmental safety of disposals of solid radioactive waste, substantiated by a structured collection of arguments and evidence.

Geological Disposal Facilities on Land for Solid Radioactive Wastes: Guidance on Requirements for Authorisation

February 2009; Environment Agency and Northern Ireland Environment Agency

- SRLs™ could facilitate rapid evaluation of the maturity of scientific understanding in support of key safety case arguments.
- Enhance transparency.



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Concluding remarks

• SRLs™ and TRLs both have their place in a Geological Disposal Programme.

• SRLs™ address understanding, TRLs address maturity / deployability of technology.

• SRLs™ are now clearly integrated in our generic research plans.

• Potential for further clarity, focus and transparency by integration with the safety case?

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