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Lessons Learned from a Review of International Approaches to Spent Fuel Management

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Overview

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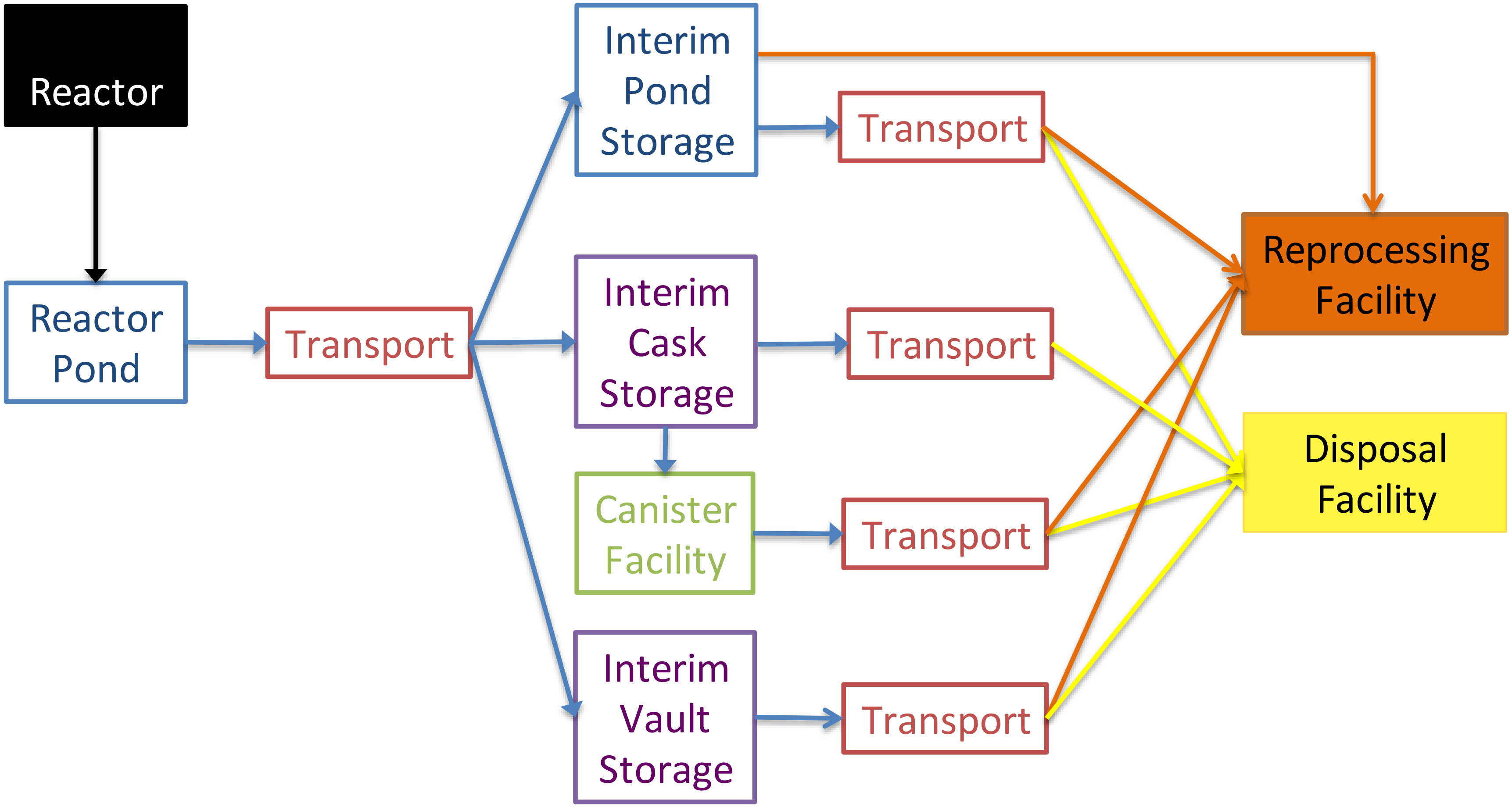
- Introduction
- Role of Spent Fuel Storage
- International Review
- Key Messages

Introduction

- Slow progress in the deployment of geological disposal facilities and reduced use of reprocessing has led to the need to extend storage periods for fuel and to store greater quantities of fuel.
- Internationally, different fuel cycle strategies have been adopted: closed, open and "wait and see".
- A wide range of technical options for storage have been developed and continue to be adopted, e.g. wet storage, dry cask storage, dry vault storage, which have potentially different implications for subsequent management activities.
- Approaches for management of accumulating fuel stocks also vary: e.g. decentralised or centralised storage.
- The costs and benefits of different options are not immediately apparent therefore this review was undertaken to seek to uncover any lessons for the long term management of spent fuel that could be derived from the experiences in a range of countries with different levels of nuclear power deployment.

Role of Spent Fuel Storage

Spent fuel storage is, and always has been, an essential part of the nuclear fuel cycle



International Review (1/2)

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Review of publically available information from 16 countries:

- Belgium,
- Canada,
- China,
- Finland,
- France,
- Germany,
- Hungary,
- Japan,
- Netherlands,
- Russia,
- South Korea,
- Spain,
- Sweden,
- Switzerland,
- United Kingdom
- United States of America.

covering:

- Strategy
- Data on Fuel in 2012
  - Reactor Type
  - Fuel Requirement (tHM/year)
- Data Storage in 2012
  - Storage Capacity (tHM)
  - Quantity in Storage (tHM)
  - Arisings (tHM/year)
  - Type
  - Location (AR/AFR)
- Disposal
  - Programme
  - Timelines

International Review (2/2)

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In-depth analysis of the development of spent fuel management policy, strategy and practices using case studies looking at:

- Impact of the ownership of fuel, facilities & liabilities on spent fuel management in Finland, Germany, United Kingdom, United States of America
- Strategic long term vision / programme and adherence to it
- Comprehensive fuel services for the back-end of the nuclear fuel cycle and closing
- Disposability of spent nuclear fuel: factors and influences

Lessons on Strategy (1/4)

- Overall cost effectiveness relies on spent fuel management strategies and frameworks being aligned with the national policy for the final dispositioning of the fuel.
- National policy decisions can constrain or incentivise particular forms of spent fuel management.
- National decision makers need to appreciate the factors affecting storage options and the financial, social and environmental effects of different strategies.

Lessons on Strategy (2/4)

- In most countries more than one organisation is responsible for spent fuel storage, disposal and any intermediate processing.
- The way in which liabilities are distributed affects the effectiveness of spent fuel management.
- Policy makers in setting the national policy framework and regulation should take organisational responsibilities in account when designing national approaches to spent fuel management so as to best incentivise all actors to provide efficient and effective storage & dispositioning of spent fuel.

Lessons on Strategy (3/4)

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- Timeframes associated with GDF site selection require a robust, consistent and resilient approach to fuel storage and disposition.
- Where public acceptance is important, clear separation between regulation and delivery of storage and dispositioning is associated with effective long term delivery.
- The greatest stability in back-end fuel management was associated with countries where governments had
  - set policy, strategy and regulation
  - placed the liability for storage and the development, licensing and implementation of disposal facilities with commercial companies.

Lessons on Strategy (4/4)

- At the end of storage an export facility may needed to ensure that fuel is exported in packages suitable for transport and interfacing with a reprocessing or disposal facility.
- Such a facility may need to include capabilities for some or all of the following:
  - fuel drying,
  - opening sealed dry-stored packages,
  - repackaging spent fuel in disposal containers and
  - remediating degraded packages.
- Storage option evaluations needs to take appropriate account of the need for such facilities

Lessons on Technology (1/3)

- Storage of spent fuel for over 100 years or more using existing technologies is feasible and credible.
- Over long timescales all types of storage system and supporting infrastructure will need to be refurbished or replaced due to ageing or changing regulatory requirements. Technologies to enable this are feasible and credible.
- Both wet and dry storage systems continue to receive regulatory approval and are acceptable in terms of safety and environmental impact and operational practicality.

Lessons on Technology (2/3)

- The use and continued evolution of multiple technologies for fuel storage indicates that there is no single best storage technology
- Technology selection is dependent on factors such as
  - national policies and regulations,
  - approach to fuel cycle management,
  - size of national spent fuel inventories,
  - existing infrastructure,
  - existing experience/capability,
  - geographical factors and
  - short-term cash flow considerations.

Lessons on Technology (3/3)

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- Wet storage has been successfully employed for many decades and is a mature technology.
  - Designs are evolving to increase the levels of passive safety and resistance to external and malicious events.
  - Wet storage provides easier monitoring of fuel conditions and greater flexibility in post-storage transportation and packaging.
- Dry storage is less mature than wet storage. Long term ageing effects are currently being addressed.
  - The transition to dry storage results in fuel experiencing higher temperatures, which may affect fuel performance.
  - Dry storage systems generally provide incremental storage capacity and lower short term cash flow requirements.
  - Operational costs during reactor operational phase are low, but increase substantially after reactor shutdown.

Conclusions

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- Spent fuel management activities should be aligned to the national policy for final dispositioning of the fuel.
- Spent fuel storage frameworks and regulation should ensure efficiency across all spent fuel management and disposition activities.
- The way in which liabilities are distributed between organisations affects the effectiveness of spent fuel management.
- Storage of spent fuel for over 100 years or more using existing technologies is feasible and credible.
- Wet and dry storage systems are acceptable in terms of safety, environmental impact & practicality.

Conclusions

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- There is no single best technology for spent fuel storage.
- Optimum technology options are dependent on a range of political, policy, technical and economic factors.

Courtesy of Sellafield Ltd.

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Courtesy of CRIEPI

Thank you for listening

any questions ?

About the Presenter

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- David Hambley works in the Spent Fuel Management Technology unit of the Fuel Cycle Solutions Business of the National Nuclear Laboratory.
- He is the laboratory's Research Fellow for Spent Fuel Management and Disposal at the National Nuclear Laboratory. In this role, he is responsible for leading NNL's activities to support the interim storage of spent oxide fuels and the remediation and interim storage of legacy, mainly uranium metal, fuels. He is also actively involved in research into the behaviour of the UK's Advanced Gas-Cooled Reactor fuels in repository environments. David has 30 years of experience working in the nuclear power industry, including positions in/with the UK Atomic Energy Authority, AEA Technology and the Australian Nuclear Science and Technology Organisation. He is a Research Fellow at NNL and is involved in international activities on spent fuel storage at IAEA and WNA.
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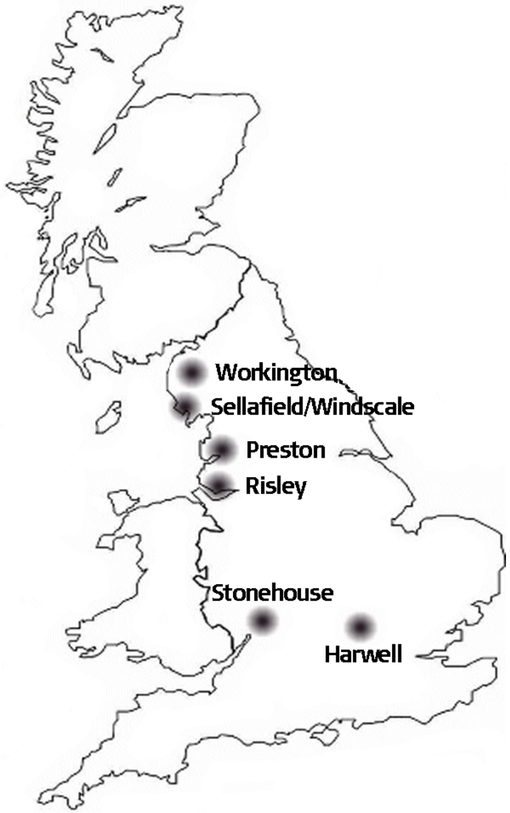
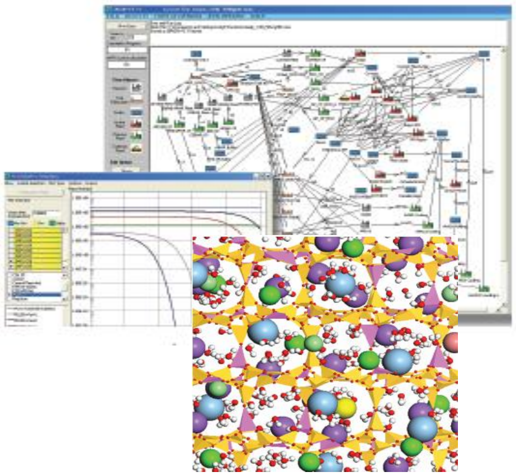
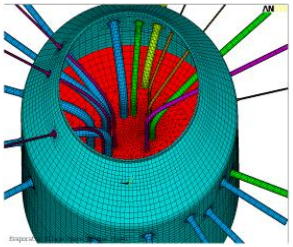
- Delivering a full range of research and technology to support the nuclear fuel cycle







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- National Laboratory for both UK Government and Industry
- Support to national R&D programmes
- Host and lead Nuclear Innovation Research Office