CRITICALITY SAFETY ACROSS THE FUEL CYCLE
A Review of Key Issues and Serco Experience

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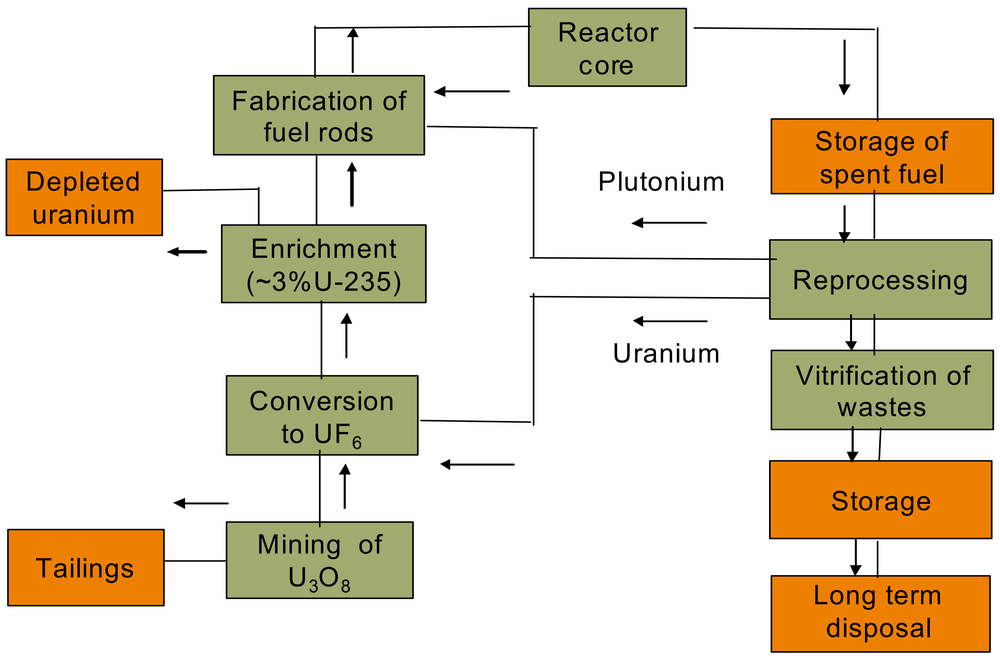
- The demonstration of criticality safety for many fuel cycle operations and facilities over the lifetimes of the facilities is a key requirement. The operations cover diverse technologies and processes.
- In the UK, licensees operating facilities including fissile materials' must demonstrate criticality safety in their plants against the requirements of the UK regulator's Safety Assessment Principles (SAPs). There are separate requirements for transport of fissile materials .
- Serco has carried out methods development, and broad ranging technical and safety case assessments in support of criticality safety assurance over all the stages of the fuel cycle for a wide range of clients in the UK industry.

Regulatory Requirements

- UK: Health and Safety at Work Act (HASW) 1974 & Nuclear Installations Act 1965. Safety Assessment Principles (SAPs) for Nuclear Facilities 1992, Revised 2006 (www.hse.gov.uk/nuclear/**saps**/)
- Criticality Safety Principles around Engineering, Radiation protection, fault analysis, waste management ……
- E.g. Engineering Principles
  - Where significant amounts of fissile materials may be present, SAPs require a system of safety measures to minimise the likelihood of unplanned criticality:
    - Engineering Principles set out a hierarchy of controls for all stages of a facility's life-cycle.
  - A criticality safety case should incorporate the double contingency approach:
    - Requires that unintended criticality cannot occur unless at least two unlikely concurrent changes in the conditions originally specified as essential to criticality have occurred.
- UK requirements for the safety of fissile transport operations are provided for by IAEA RAM Transport Regulations

Stages of the Fuel Cycle



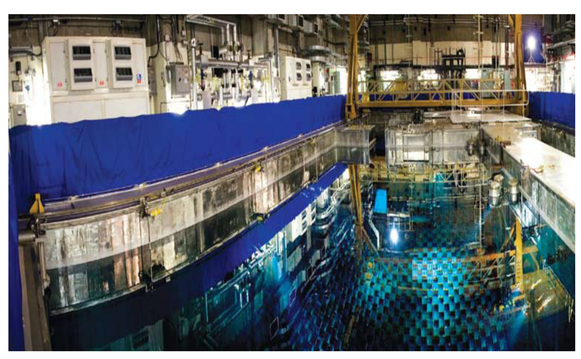
Areas of Criticality Support

- Operational criticality safety (main focus of presentation)
  - All aspects of the fuel cycle, also:
- Nuclear science
  - Criticality safety handbooks e.g., development of Improved Critical and Safe Parameters Algorithm (ICASPA);
  - Contribution to experimental data-base for criticality safety e.g. DIMPLE, ZEBRA data;
  - Computer code development (ANSWERS MONK Monte Carlo code).
- Safety methodology
  - Participation in ICSBEP activities;
  - Development of assessment methods (e.g. burn-up credit and ALARP).
- Emergency planning
  - Review of Criticality Incident Detection Systems (CIDAS).
- Professional development
  - Training of criticality assessors.

Operational Criticality Safety

- Examples of Serco activities include:
- Support to fuel fabrication activities at the Sellafield MOX plant;
- Sizewell-B fuel ponds safety case;
- Transport assessments for spent fuel from UKAEA sites to storage locations in the UK;
- Support to reprocessing operations at the Thermal Oxide Reprocessing Plant (THORP);
- Criticality assessments in regard to ILW waste storage in a Geological Disposal Facility.

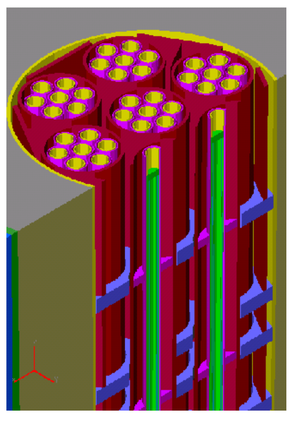
Fuel Ponds (Sizewell-B)
(Courtesy of British Energy Group plc)



Criticality Assessments

- COSR safety case production for major facilities.
- Criticality safety case review.
- Criticality safety studies in support of decommissioning operations.
- Fissile material transport assessment.
- Design and assessment of fissile material waste storage facilities.
- Criticality incident detection system advice and assessment.
- HAZOP studies.

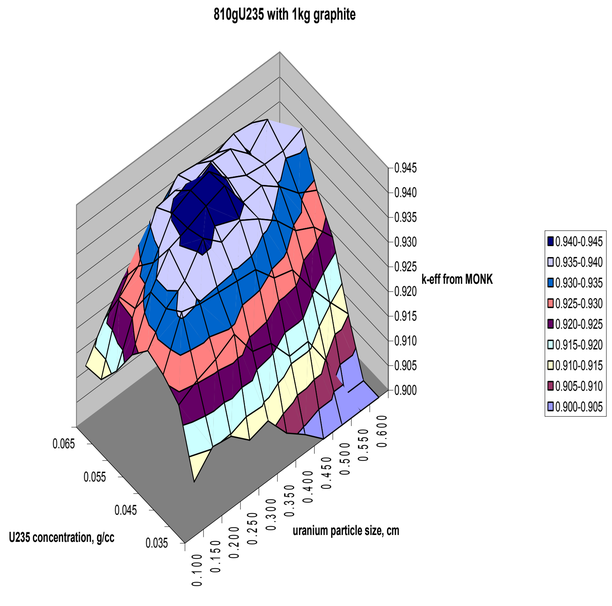
MONK model of fuel elements in a transport container



Transport containment

Geological Disposal

- Application of the Serco ANSWERS Monte Carlo MONK code to the calculation of safe fissile material limits for intermediate level waste (ILW) packages.
- Scope covered Pu Contaminated Material, Irradiated Natural U, Low Enriched U and High Enriched U and more specific wastes, e.g. from decommissioning activities.
- Calculation of both lower and upper fissile limits for waste packages.



Intermediate Level Waste (ILW) Package