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VUJE experience in NPP decommissioning and radwaste (RAW) treatment

JRC - Slovakia
Conference
Bratislava

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June 10, 2014
www.vuje.sk
A1 NPP Decommissioning

• A1 NPP - CO₂ cooled, HW moderated, metallic natural uranium; now owned by JAVYS

• Serious core accident (INES 4) occurred during operation of reactor on 22nd Feb 1977.

• Consequences – partial core damaged, cladding of fuel assemblies damaged, severe contamination of primary systems and spent fuel handling systems, generation of large quantities of specific liquid RA waste, contamination of civil structures

• Status at start of A1 NPP decommissioning – no experience, techniques, legislation, funding, RAW treatment; everything was solved by own effort of the Slovak Republic

• 1980-1994: Governmental tasks of science and technology development, dominant participation of VUJE in development of RWM technologies.
• **1996–1999:** Management of damaged spent fuel assemblies and construction of the LLW/ILW disposal facility at Mochovce site. VUJE as a general contractor.

• **1999-2008:** A1 NPP Decommissioning Project – Stage I; specific radiation safety tasks, environmental protection, partial D&D, RAW management, technical support. VUJE as a general contractor.

• **2009-2016:** A1 NPP Decommissioning Project – Stage II; decommissioning of outer active objects, RAW management, contaminated soil management, technical support and environmental protection tasks. VUJE as a general contractor.

• **2016-2033:** Next three licensed phases planned.
Since 1996 VUJE is the general contractor of the most important and complex A1 NPP Decommissioning projects. This position consists of:

- Management and coordination of the projects,

- Development of databases, radiological characterisation and physical characterization of installations by laser scanner and as-built documentation for preparation of decommissioning plans, cost estimations and licensing procedures.

- Elaboration of documentation - feasibility studies, investment intents, project and design documentations in the field of decommissioning and RAW management.

- Development, testing, delivery and application of technological procedures and technical tools for decontamination and dismantling of technological and civil parts of NPP including remotely controlled manipulators and 3D models and task simulations,
VUJE experience in A1 NPP decommissioning - continue

• Pre and post decontamination radiation characterisation, development of method and devices for sorting and free release of materials (soils, concrete, bulk material),

• R&D of procedures for treatment, conditioning and disposal of RAW,

• Development, delivery and operation of RAW treatment facilities (cementation, bituminization, vitrification) for conditioning of various RaW - concentrates, sludge, spent resins, chrompik etc.

• Assessment of radiological impact of operation of various nuclear installations on the environment, safety analyses and reports.
One the most challenging activities was the retrieval of damaged spent fuel from the long term spent fuel store, preparation of the spent fuel for the transport and transport of the re-packaged spent fuel to Russian Federation (Mayak facility).

Principal scheme of the damage spent fuel management:

- Drainage
- Encapsulating
- Refueling machines
- Transport cask
- Drainage equipment
- Long term store
- Transport container

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Fixation of Liquid RAW and RA sludge from underground tanks into inorganic matrixes:

• Movable, autonomous, remotely controlled, in-drum mixing in 200 l drums
• Embedded activity in drum $1 \times 10^{11}$ Bq
• Dose rate on drum’s surface up to 30 mGy/hour
• Since 2005 produced cca 1 000 drums

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In-situ Cementation Facility for Liquid RAW
Based on shielded twin LaBr 1.5”x1.5” detectors mounted above moving belt and a tensometry scale (LaBr detectors replaced by NaI(Tl) with temperature stabilisation in 2013),

- Automatic sorting into 3 adjustable categories (< , 300 Bq/kg to 10^4 Bq/kg, <)
- Monitoring capacity: cca 10 t / shift
Equipment & software used:
- 3D scanner MENS1 (SOISIC) and CALLIDUS CP3200
- consolidation and modeling software 3Dipsos
- CAD software EUCLID, AutoCAD, AutoPLANT
- Development, analysing and simulation software IGRIP etc.

real room and equipment 3D scanner output as built model Cutting simulation

VISIPLAN Decontamination simulation Dec. Mock-up tests Cutting Mock-up tests
✓ Planning and performing of decommissioning based on individual licensed phases provides some advantages

✓ Effective and transparent funding is needed

✓ Systematic approach in waste management is the prerequisite for effective decommissioning

✓ Detailed physical and radiation characterisations are demanded for planning and safe implementation of decommissioning

✓ NPP decommissioning after accident requires development and delivery more extensive range of technological procedures and application of advanced techniques

✓ Post accidental and/or non-standard decommissioning projects can be also managed effectively
Close cooperation among all involved parties - NPP operator, Nuclear regulatory authority, Repository operator and Contractor - is needed.

Stable, responsible, reliable and flexible system of subcontractors focused on nuclear, radiation and conventional safety is essential for timely and safe delivery of decommissioning project.

Preparation of legislation in advance for foreseen decommissioning activities and management of RAW is essential.

Decommissioning planning and costing required always substantial radiological characterization, but due to accident it is required to be more extensive and detailed.

It is advisable to apply common approved technical solutions and approaches (it save time and resources), however not all of them it is possible to apply directly and they required adoption to specific conditions for each decommissioning project (NPP conditions).
Development of special technologies and techniques is required for decommissioning of NPP shut down after accident (e.g. retrieval of damaged fuel, remotely operated manipulators).

Due to high level of contamination and dose rate many operation must be performed remotely and therefore adequate techniques must be developed, manufactured, delivered, tested and operator must be thoroughly trained to operate them, so it takes much more time to perform given decommissioning tasks - focus must be given to planning of related and concurrent tasks.

For NPP shut down after accident amount of waste is much higher, its radiological, chemical and physical characteristic are more complex and thus unique treatment and conditioning facilities with sufficient capacity must be developed and put in operation that accumulated waste doesn’t halt the decommissioning process.

Multiple site decommissioning put higher requirements on planning and implementation of decommissioning project as well as on overall RAW management - concurrent demand on decommissioning resources e.g. RAW treatment and temporary storage/disposal capacity.
Thank you for your attention