KFKI Atomic Energy Research Institute

Decommissioning Activities of Budapest Research Reactor

RER3009/9019/01 Safety Assessment for Decommissioning of Research Reactors (R^2D^2P)

Gabor Toth gtoth@aeki.kfki.hu

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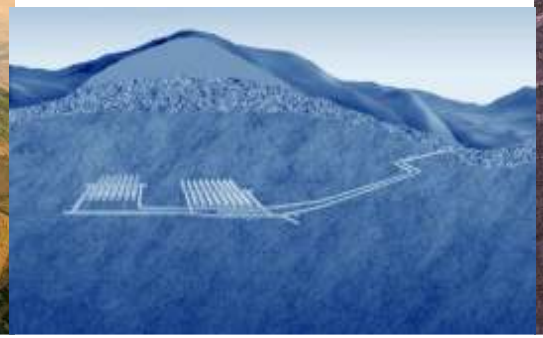
Hungarian Nuclear Palette

- 4 NPP's units in Paks ~2000 MW
  - Life time extension for 20 years
  - Planned enlarge 2 x 1000 MW
- 2 Research Reactors in Budapest
  - WWR-SM10 → 10 MW /1959 – 2023, renewed/
  - BUTE → 100 kW /1971 – 2027, Hungarian developed/
- 2 Radioactive waste repositories /low- and medium level/
  - Near surface repository near Budapest
  - Geological repository near Paks
- Interim spent fuel storage in Paks



Legislation, main acts, ministerial decrees and BRR documents

- Act on Atomic Energy No. CXVI (1996)
- Govt. Decree No. 89/2005 on the procedures of the HAEA in nuclear safety regulatory matters, with Nuclear Safety Codes
- Minister of Health Decree No. 16/2000 on the execution of certain provisions of Act on Atomic Energy associated with radiation protection
- Minister of Health Decree No. 47/2003 on certain issues of interim storage and final disposal of Radioactive Wastes
- Govt. Decree No. 240/1997 Legal requirements for funding
- Main BRR documents which approval by Hungarian RB
  - Final Safety Report → contents the decom. plan
  - Periodic Safety Report
  - Safety Analyses
  - Operational Limits and Conditions
  - Operational regulations
  - Emergency plan

Regulatory Independence

Legal background

Hungary`s national policy concerning the application of atomic energy is regulated by law. The basic purposes of Act CXVI of 1996 are those of protecting the health and safety of the population and protecting the environment. The requirements of the Act state that the use of atomic energy is

allowed only in a manner provisioned by law and under the permanent control of the competent authority. Regardless of what aspect of atomic energy is being considered safety enjoys priority. With regard to the governmental objectives stated in the Act these are executed by the Government

through the Hungarian Atomic Energy Authority (HAEA) and the competent Ministries, whose activities are coordinated by the Atomic Energy Co-ordination Council led by the Director General of the HAEA, within the scope of the safety of the application of atomic energy. *Supervision of the HAEA, on behalf of the Government, is performed by the designated member of the Cabinet, – at present the Minister of Justice – independently of his portfolio-related functions.*

Planned involvement in decommissioning 1

Decommissioning plan

- Initial plan from operating license to final shut down
  - First IDP in 2005, revision in 2010 (5 yearly)
- Final decom. plan before 1 year the final shut down
- Responsible the licensee (usually the operating organization)

Safety enclosure

- Practically 2 years at research reactors

Decommissioning

- According to § 40 of the Act on Atomic Energy upon the Public Limited Company for Radioactive Waste Management with the additional provision that the responsibility for the maintenance, surveillance and guarding of nuclear facilities from their closure to the dismantling shall be with RW company. The dismantling and the area's recultivation work shall also be within the scope of responsibility of the RW company.

Planned involvement in decommissioning 2

Basics of decommissioning

- Partial decommissioning at BRR in 1986
  - Archive diaries, 2000 photos, 8 hours video
- Dismantled reactors in Europe (final reports)
  - WWR-M10 reactor in Rossendorf, Germany
  - BR2; BR3 reactors in Mol, Belgium
  - DR2 reactor in Roskilde, Denmark
- Decommissioning plans
  - WWR-M10 reactor in Kiev, Ukraine
- Trainings, workshops, Technical meetings

Transition from operation to decommissioning

Operation in 1993-2023

- Plans
  - Initial → ongoing → final DP (before 1 year the final shut down)

Final shut down in 2023

Safety enclosure in 2023-2025

- Work preparedness
- Fuel transhipment from site
- Decontamination

Give out the work area to the decom. company

Decommissioning in 2025-2028

Site characterisation

Division of work area's

- Controlled area: An area where, in relation with the radiation protection and the potential radioactive contamination, specific protection measures and safety provisions apply and the access of which is controlled.

- Supervised area: It is an area which is under well-defined supervision for the purpose of protection against ionising radiation.
  Dose limit is 2,5 μSv/h on average of 2 hours.

- None supervised area: An area which the dose rate less than 1μSv/h.

Radiation protection measuring system

- Gamma dose rate measuring → 31 detectors on 26 place's
- Gamma and TL dosimeters
- 7 pc gas detectors
- 3 pc radio iodide measurement
- 2 pc. gamma spectrometer

	Measuring points	Reactor shut down	10 MW	Measuring instrument
1	Reactor cover ventilation grid		D_γ= 8,0 – 19,1 µGy/h	SSM-1
			D_n= 51 - 125 µSv/h	Berthold LB123
2	Breakthrough of servomotors		D_γ= 10 - 28 µGy/h	SSM-1
			D_n= 0,5 – 0,9 µSv/h	Berthold LB123
3	1st horizontal channel		D_γ = 0,18 µGy/h	SSM-1
			D_n = 0,2 µSv/h	Berthold LB123
4	2 – 9th horizontal channels		$D_\gamma \leq$ 0,2-0, 8 µGy/h	SSM-1
			$D_n \leq$ 0,2-0,3 µSv/h	Berthold LB123
5	10th horizontal channel left side		D_γ= 6 - 63 µGy/h	SSM-1
			D_n= 3 - 29 µSv/h	Berthold LB123
6	10th horizontal channel right side		D_γ= 0,2 – 6,0 µGy/h	SSM-1
			D_n= 0,7 – 1,0 µSv/h	Berthold LB123
7	Reactor cover		D_γ= 8 – 24 µGy/h	SSM-1
			D_n= 4 – 16 µSv/h	Berthold LB123
8	Reactor hall	$D_\gamma \leq$ 0,2-0, 8 µGy/h	D_γ= 2 – 4 µGy/h	SSM-1
		$D_n \leq$ 0,2-0,3 µSv/h	$D_n \leq$ 1 µSv/h	Berthold LB123
9	Primary pump room	D = 7-10 µSv/h	D = 1,4-1,5 mSv/h	SSM-1
10	Iodine filters	D = 1-4 µSv/h		SSM-1
11	Aerosol filters	D = 1-2 µSv/h		SSM-1

Cost estimates 1

Necessary human resource

	Stuff numbers	∑ work hour
1 – 104. week	15-20 people work part-time	40.000
105 – 128. week	15-20 people	16.500
129 – 165. week	15 people	21.600
166 – 173. week	5 people	1.400

Summary 79.500 hours

Expenses

	Denominating	Unit	Unit price [Euro]	Summary [Euro]
1	Spent fuels transport out	650 pc	590	383.500
2	Tools, single-purpose machines			285.000
3	Protective clothes	300 pc	90	27.000
4	Decontamination materials, wrapping			23.000
5	Inactive waste deposit	270 m^3	19/m^3	5.100
6	Active waste deposit	430 m^3	750/m^3	322.500
7	Dangerous waste deposit		610/m^3	6.100
8	Extractors	10.800 hours	32/hour	345.600
9	Stuff wages	79.500 hours	13.5/hour	1.085.000
10	Site overhead cost	173 week	2300/week	398.000
11	Documentation, PR activity			78.600

Summary 2.959.400 Euro

Cost estimates 2

Income

	Denominating	Unit	Unit price [Euro]	Summary [Euro]
1	Metal scrap	200 t	680/t	136.000
2	Machines, measurements, Tools			36.000

Summary 172.000 Euro

Financial balance

	Denominating	Cost [Euro]
1	Expenses	2.959.400
2	Spare (5%)	148.000
3	Summary expenses	3.107.400
4	Summary income	172.000

Cost of decommissioning: 2.935.400 Euro

Funding mechanism

According to Act of Atomic energy section 41: The licensee, or in the case of budgetary organisations, the central budget shall be liable to cover the costs of the final disposal of radio-active waste, as well as the interim storage and final disposal of spent fuel, and of the decommissioning of a nuclear facility.

Decommissioning activities

- Characterization of radioactive area's
- Spent fuels transhipment from active core to the AR storage
- Spent fuels transporting to the AFR storage
- Decontamination, work areas preparation
- Spent fuels transport out from site
- Emptying of reactor hall
- Demolishing of secondary loop
- Hot cells, laboratories
- Active core, CNS cold plug
- Reactor vessel lifting out, move out
- Gravity vessel lifting out, move out
- Primary loop
- Heavy concrete shelter demolition
- Demolishing of the AR storage
- Demolishing of the AFR storage vessel
- Dismantling of auxiliary systems
  - electric power supply
  - water desalinize system
- Reactor hall and basement cleaning and decontamination
- Partial demolishing of normal ventilation system
- Demolishing of radioactive waste storages
  - solid waste storages
  - liquid waste storages
- Dismantling of radiological surveillance measurement
- Demolishing of control room

Expected decommissioning technologies

Goal the minimal quantity of radioactive wastes and the secondary wastes

- 3 D laser scanning technology for the planning
- Electro-chemical decontamination device
- Cutting technologies
  - Hydraulic tube cutting devices (without secondary waste)
  - Underwater cutting technologies for core basket and reactor vessel fittings
  - Diamond surface wire for the heavy concrete shelter and steel parts
- Compress technology for the RW reduction (5-8 reduction factor)

Actual decom. work at BRR

- Revision of Initial Decommissioning Plan
- IAEA Expert mission in 2010
- Discussion with the RW repository factory the wastes receive conditions (wrapping, geometry, isotope inventory)

Issues, open questions

- Beryllium elements final disposal (poisonous and radioactive waste)
- RW wrapping → 200 l drums or bigger geometry
- Activation the biological shelter

  The maths calculation is uncertain around the horizontal channels

Thank you for your attention!