

PROGRESS IN DECOMMISSIONING IN SERBIA

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Reactor Facility

Reactor name: RA
Design: former USSR
Location: Vinča (outskirts of Belgrade)
Operator: Public Company Nuclear Facilities of Serbia
Regulator: Serbian Radiation Protection and Nuclear Safety Agency
Type: tank – graphite reflector
Power: 6.5 MW
Moderator: heavy water
Primary coolant: heavy water
First start-up: December 1959
Date of shut-down: August 1984
Final shut-down: July 2002 – preparation for decommissioning

Fresh fuel shipment in August 2002

5046 HEU fresh fuel elements (app. 48 kg of enriched uranium) were sent to the Russian Federation in August 2002. This shipment was the first actual step in implementation of the RRRFR Programme.

Radiological Characterization Plan in 2003

Contract: Initial Planning for the Decommissioning of the RA Research Reactor

METHODS AND TECHNIQUES FOR RA REACTOR CHARACTERIZATION

- Development of the 3D geometrical models for the detailed Monte Carlo calculations
- Development of 1D geometrical radial and axial models for the 1D transport calculation
- Development of the calculation procedures
- In situ measurements
- Sampling and analyses
- Sampling and analytical programme methodology
- Quality Assurance

February 2004

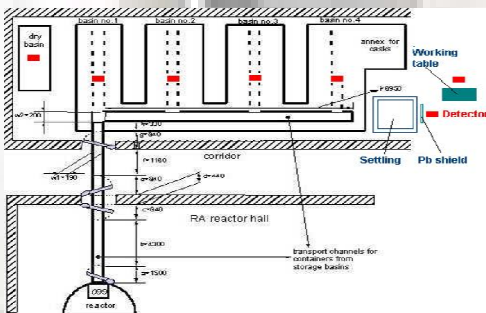
Government of Republic of Serbia and Ministry of Science, Technology and Development made a decision to repatriate the RA reactor's spent nuclear fuel to the Russian Federation.

September 2006 Contract for the transport of the RA reactor's spent nuclear fuel to the RF was signed by: International Atomic Energy Agency; Research and Development Company "Sosny"; Federal State Unitary Enterprise PA "Mayak"; Joint Stock Company "Tenex"; Vinča Institute of Nuclear Sciences.

November/December 2010 After 8 years of preparation on November 19th 2010 spent nuclear fuel from RA research reactor left Vinča. On December 22nd, after more than a month in transit, spent nuclear fuel arrived to Russian Federation, to facility for further treatment.

May 2011 Government of Republic of Serbia approved new regulations in the field of nuclear safety.

Radiological characterization of room 141



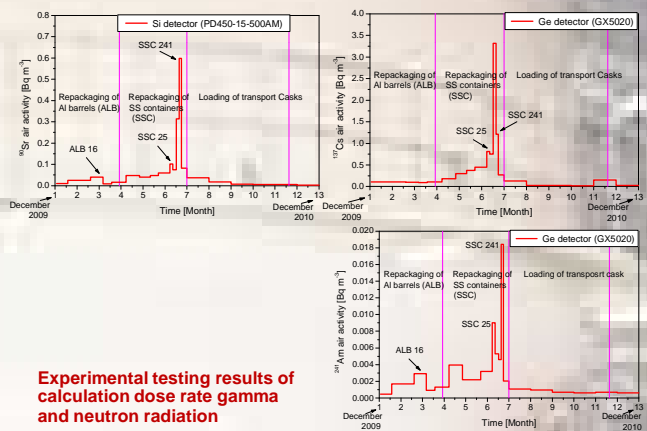
Equivalent gamma rays dose rate [$\mu\text{Sv}\cdot\text{h}^{-1}$] in the room 141 (before covering dry pool)

Detector position	Source1 Settling	Source2 Dry pool covered with Pb shield					Source3 Spent Fuel & Water	MCNP-4C calculation without Pb shield	AD2 measured without Pb shield
		0 cm	1 cm	2 cm	3 cm	0 cm			
Working table	0.43	0.22	0.02	0.00	0.00	0.33	1.0	1.0	
Behind Pb shield	$\pm 0.6\%$	$\pm 11\%$	$\pm 30\%$	$\pm 50\%$	$\pm 10\%$	$\pm 10\%$	$\pm 1\%$	$\pm 10\%$	
Basin 4	3.10	0.17	0.05	0.01	0.00	0.30	3.5	3.3	
Basin 4	$\pm 0.3\%$	$\pm 19\%$	$\pm 30\%$	$\pm 50\%$	$\pm 10\%$	$\pm 10\%$	$\pm 0.3\%$	$\pm 10\%$	
Basin 4	0.49	0.33	0.07	0.02	0.01	5.80	6.6	6.5	
Basin 4	$\pm 0.6\%$	$\pm 11\%$	$\pm 30\%$	$\pm 40\%$	$\pm 50\%$	$\pm 1\%$	$\pm 4\%$	$\pm 10\%$	
Basin 3	0.23	0.66	0.13	0.09	0.05	7.00	7.9	8.1	
Basin 3	$\pm 0.8\%$	$\pm 5\%$	$\pm 22\%$	$\pm 30\%$	$\pm 40\%$	$\pm 3\%$	$\pm 4\%$	$\pm 10\%$	
Basin 2	0.12	1.40	0.40	0.19	0.08	11.0	12.5	13.0	
Basin 2	$\pm 1.2\%$	$\pm 6\%$	$\pm 15\%$	$\pm 22\%$	$\pm 34\%$	$\pm 3\%$	$\pm 3\%$	$\pm 10\%$	
Basin 1	0.08	4.90	2.70	2.00	1.60	8.00	13.0	13.2	
Basin 1	$\pm 1.5\%$	$\pm 4\%$	$\pm 6\%$	$\pm 7\%$	$\pm 9\%$	$\pm 3\%$	$\pm 3\%$	$\pm 10\%$	
Dry basin (1m)	0.02	160.0	33.6	13.7	5.90	5.00	165.0	160.0	
Dry basin (1m)	$\pm 2.0\%$	$\pm 1\%$	$\pm 2\%$	$\pm 3\%$	$\pm 5\%$	$\pm 3\%$	$\pm 1\%$	$\pm 10\%$	
Dry basin (floor)	0.01	302.0	63.7	25.1	10.1	4.00	306.0	300.0	
Dry basin (floor)	$\pm 4.0\%$	$\pm 1\%$	$\pm 1\%$	$\pm 3\%$	$\pm 4\%$	$\pm 5\%$	$\pm 1\%$	$\pm 10\%$	

Equivalent gamma rays dose rate [$\mu\text{Sv}\cdot\text{h}^{-1}$] in the room 141 (after covering dry pool with 2.5 cm thick iron plates)

Detector position	Source-2 Dry pool with 2.5 cm of iron shield	Source-3 Spent Fuel & Water	MCNP-4C calculation	AD2 measured
Working table	0.06	0.33	0.8	0.8
Working table	$\pm 20\%$	$\pm 10\%$	$\pm 1\%$	$\pm 10\%$
Behind Pb shield	0.07	0.30	3.5	3.3
Behind Pb shield	$\pm 20\%$	$\pm 10\%$	$\pm 0.3\%$	$\pm 10\%$
Basin 4	0.10	5.80	6.4	6.8
Basin 4	$\pm 15\%$	$\pm 4\%$	$\pm 4\%$	$\pm 10\%$
Basin 3	0.30	7.00	7.5	9.5
Basin 3	$\pm 10\%$	$\pm 3\%$	$\pm 4\%$	$\pm 10\%$
Basin 2	0.6	11.0	11.7	11.0
Basin 2	$\pm 8\%$	$\pm 3\%$	$\pm 3\%$	$\pm 10\%$
Basin 1	8.7	8.00	16.5	22.0
Basin 1	$\pm 5\%$	$\pm 3\%$	$\pm 3\%$	$\pm 10\%$
Dry basin (1 m)	49.5	5.00	54.5	60.0
Dry basin (1 m)	$\pm 1\%$	$\pm 4\%$	$\pm 1\%$	$\pm 10\%$
Dry basin (floor)	98.5	4.00	102.5	100.0
Dry basin (floor)	$\pm 1\%$	$\pm 5\%$	$\pm 1\%$	$\pm 10\%$

Radiological measurements during repacking and transporting of the RA reactor spent fuel elements

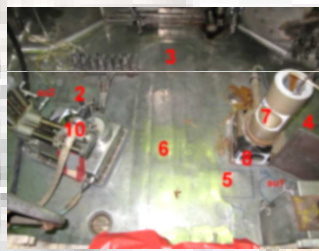


Experimental testing results of calculation dose rate gamma and neutron radiation

Škoda VPVRM cask (Number of elements 2% ²³⁵ U/80% ²³⁸ U)	Average fuel burnup [MWD·t ⁻¹]	Average contact dose rate of gamma radiation [$\mu\text{Sv}\cdot\text{h}^{-1}$]		Average contact dose rate of neutron radiation [$\mu\text{Sv}\cdot\text{h}^{-1}$]	
		Measurement (FHT40G)	Numerical simulations	Measurement (Au & Zr foil)	Numerical simulations
VPVRM 009 cask (391/0)	6194.9 \pm 370	0.92 \pm 0.15	0.97 \pm 0.06	0.65 \pm 0.06	0.75 \pm 0.06

Radiological survey of hot cell No 11

Losses activity of ⁶⁰Co in hot cell No. 11 before decontamination



Smear	Smear position	Loose activity of ⁶⁰ Co [Bq·cm ⁻²]
1	From wall	0.134 \pm 0.006
2	From wall	0.299 \pm 0.012
3	From wall	0.185 \pm 0.008
4	From floor	1152.3 \pm 46.3
5	From floor	8319.6 \pm 333.0
6	From floor	678.4 \pm 27.0
7	From floor	371.6 \pm 14.8
8	From floor	446.1 \pm 17.8
9	From floor	1570.1 \pm 62.9
10	From floor	47205.1 \pm 1870.0

Smear	Smear location	Loose activity of ⁶⁰ Co [Bq·cm ⁻²]
1	From floor	3.0 \pm 0.1
2	From floor	5.8 \pm 0.2
4	From floor	10.9 \pm 0.4
5	From floor	48.5 \pm 1.9

Losses activity of ⁶⁰Co in hot cell No. 11 after second decontamination

References

M.J. Milošević, V. Ljubenov, "Radiological Characterization Plan for the Purpose of Decommissioning of the RA Research Reactor," IAEA TC project, DECOMMISSIONING OF THE RA RESEARCH REACTOR IN VINČA INSTITUTE, Contract: (YUG4028-92441A), Vinča Institute of Nuclear Sciences, Vinča, 2003.

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