VINCA Institute of Nuclear Sciences

Decommissioning of the RA Reactor at the Vinča Institute

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Content

- The RA research reactor & History of the project
- LEGAL FRAMEWORK and LICENSING
  - Existing national legislation & status of the draft law
  - International recommendations & standards
- Current Decommissioning Project Status & Activities
  - The draft Decommissioning Plan
  - Survey of the RA hall inventory and removal
  - Dismantlement of experimental equipment
  - Material and waste management
  - Dismantlement Assistance in the SNF preparatory activities
- SUMMARY
- LESSONS LEARNED

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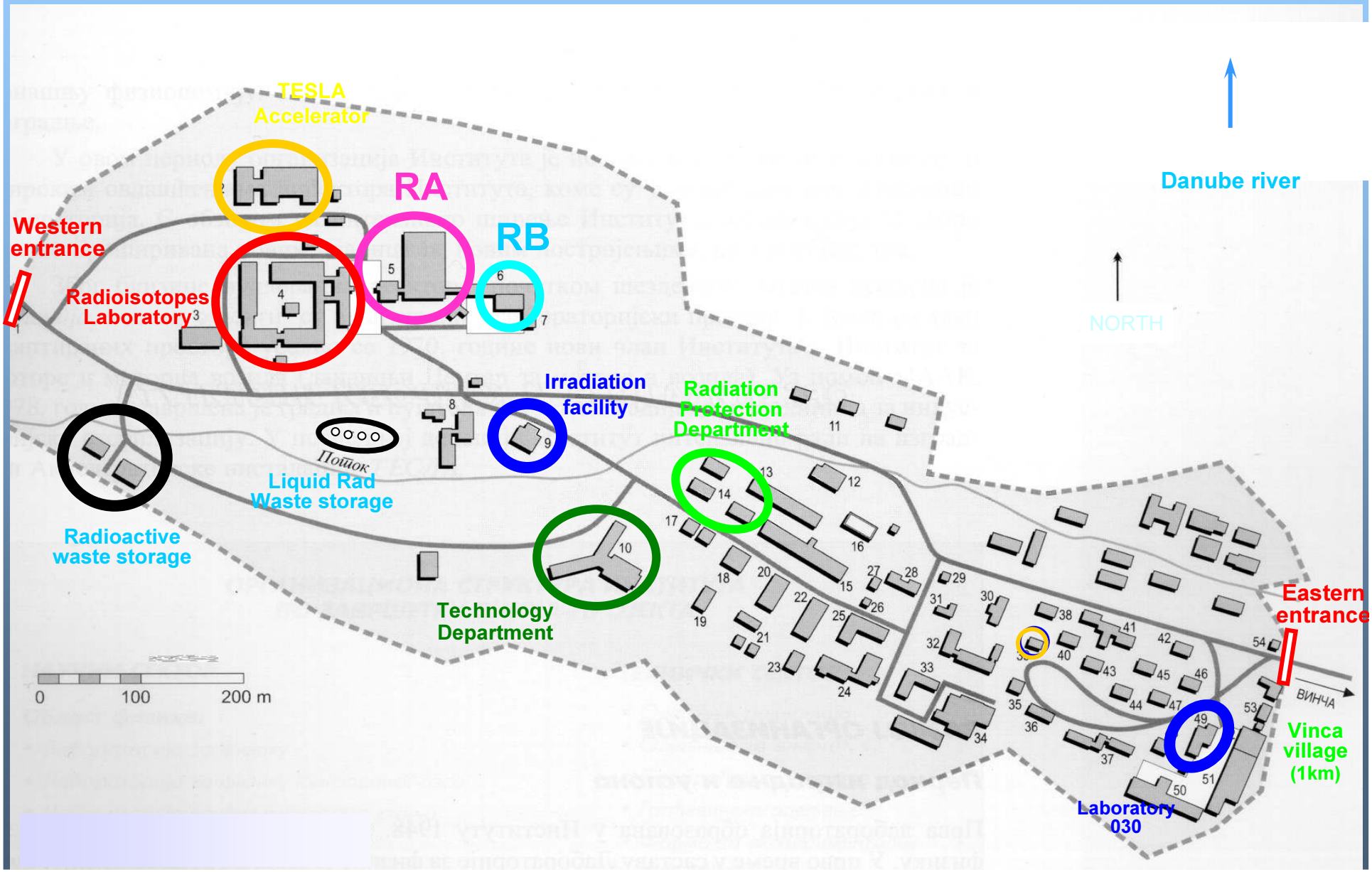
The site layout



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The RA research reactor

The RA research reactor

- The RA research reactor went critical in December 1959
- A tank type reactor using heavy water as the primary coolant and the moderator; the water from Danube river was used in the secondary cooling circuit
- Operated at nominal power of 6.5 MW , maximum power 10 MW
- From 1960 until 1975 the fuel was LEU (2% of ^{235}U)
- In 1976 the original fuel was gradually replaced by the HEU (80% of ^{235}U)
- Both types of fuel elements of the ex-USSR origin (known as the TVR-S type) and have the same shape, dimensions and approximately the same initial mass of ^{235}U
- The reactor was temporary shut down in 1984 to upgrade control and some utility systems

The RA Decommissioning Project History

- 1984 - 2002: Extended shutdown period (ES)
- July 2002: Final shutdown declared after 18 years of ES and decommissioning approved by the Government
- 2003: Start of the IAEA TC project "Decommissioning of the Vinča RA Research Reactor"
- 2004: Contract with the former Serbian MSEP; the VIND Program (Vinča Nuclear Decommissioning Program) was established

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Facts at the START of the RA Decommissioning Project

- **No decommissioning planning** for the RA reactor has ever been made during its operational life, nor after its final shut down
- No transition plan in place
- No feasibility study
- Spent fuel still located at the RA reactor building
- Absence national legislation for decommissioning
- Cost estimate not performed
- Decommissioning funds not allocated
- Absence of national strategy on waste management
- No final RW disposal in the country

LEGAL FRAMEWORK and LICENSING

- Absence of clear national policy and strategy on nuclear development, radioactive waste management and decommissioning;
- Inadequacy of the existing legal framework;
- Absence of nuclear and radiation safety regulatory authority competent to review and assess documents, grant authorisation, and carry out inspection and enforcement
- Absence of relevant environmental regulatory authority

Adopted clearance levels

Practices and Proposal in the Use of Unrestricted Release Criteria

Country	Mass activity [Bq/g]	Surface contamination [Bq/cm^2]			Dose rate [μSv/h]
		Loose	Fixed	Total	
USA research reactors		0.003 (α) 0.15 (β, γ)		0.015 (α) 0.8 (β, γ)	0.05[a]
Commission of the European Communities	1.0	0.4 (β, γ)	0.04 (α)		

* above the background level at that location

LEGAL FRAMEWORK and LICENSING (contd)

Approach adopted in the course of the preparation of documents:

- **The scope and the format of the Decommissioning Plan as specified by the IAEA**
- **The IAEA standards and recommendations implemented in planning**
- **The recommendations stipulated in the US regulations (NUREG) applied as well, especially those related to the particular chapters of the Decommissioning Plan and necessary supporting documents (e.g. Environmental Impact Assessment Study)**
- **To comply with existing national regulations that prescribe the basic nuclear and radiation safety requirements, and to utilize the scope and the format of the Safety Assessment Report as specified in the regulation**
- **To follow best practice in decommissioning planning**

IAEA Documents and Standards

Safety Standards, Technical Reports

- Standard format and content for safety related decommissioning documents, Safety reports series No. 45, IAEA 2005
- Safety Considerations in the Transition from Operation to Decommissioning of Nuclear Facilities, Safety Report Series No. 36, IAEA, 2004
- Quality Assurance for Safety in Nuclear Power Plants and Other Nuclear Installations, Safety Series No. 50-C/SG-Q, IAEA, 1996
- Predisposal Management of Radioactive Waste, Including Decommissioning, Safety Standards Series No. WS-R-2, IAEA, 2000
- Application of the concepts of exclusion, exemption and clearance: Safety guide RS-G-1, IAEA, 2004
- International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, 1996
- Occupational Radiation Protection, IAEA Safety Standards Series No. RS-G-1.1, IAEA, 1999
- EUROPEAN COMMISSION, Practical Use of the Concepts of Clearance and Exemption (Part I & 2), RP-122, EC, Belgium 2001 & 2002

Existing national regulations

1) **Law on Protection against Ionising Radiation** , ("Official Gazette of the FRY", No. 46/96)

Decrees

2) **Environmental Protection**

- **Law on Environmental Protection ("*Official Gazette of the RS*", No135/2004)**
- **Law on Environmental Impact Assessment Study ("*Official Gazette of the RS*", No135/2004)**
- **Law on the Strategic Environmental Impact Assessment Study ("*Official Gazette of the RS*", No135/2004)**
- **Law on Integrated Protection and Pollution Control of the Environmental ("*Official Gazette of the RS*", No135/2004)**

The NEW Law on Protection Against Ionising Radiation and Nuclear Safety

The draft of the new Law entered the procedure for adopting in Parliament

Provides basic legislative framework for the implementation of the Decommissioning

The new Law conceives:

a) the Government shall develop national programmes which are of multifold importance for the VIND Programme :

- Radiation Safety and Security Programme
- Nuclear Safety and Security Programme
- Radioactive Waste Management Programme

b) establishment of the regulatory body in Serbia - Agency for Radiation and Nuclear Safety and Security

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Code of Practice

- **Detail the principles, processes and practices that should be used when determining whether an article or material may be released from any further controls.**
- **This Code is not, in itself, a working level procedures document; it is aimed for developing working level procedures.**
- **The criteria to be adopted from the Basic Safety Standards and the good practice gained within the nuclear industry.**

Current Funding Mechanism for Decommissioning Project

- **2005: a three years contract for the VIND Program signed, to be confirmed by an annex each year**
- **Project based financing**
  - **workforce**
  - **excpenses**
  - **overhead**
  - **investments (reconstruction, construction)**

Current Funding Mechanism for Decommissioning Project

- Current cost estimate for the transition phase is based on:
  - ➔ existing model for project financing (labour costs and overhead)
  - ➔ expenses are estimated on the basis of the work plan and consumption
  - ➔ investments are determined through the bidding process
- Feedback
  - ➔ the overall model for financing is not adequate
  - ➔ only expenses paid are according to the current estimated costs

Expected Sources of Funding

- **Government funding (started since October 2004)**
- **Donations from foreign organisations - expected**
  - for spent fuel shipment
  - for RadWaste storage design & construction
- **The IAEA support - exists :**
  - Equipment through the IAEA TCP
  - Expert missions
  - Training

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Current Decommissioning Project Status and Activities

1) The daft Decommissioning Plan the RA reactor prepared and of the Documents
2) Survey of the RA Reactor hall and removal of the equipment and waste
3) Development of the additional instrumentation
4) Assistance in the preparation of SNF repackaging operation
5) Dismantlement of the experimental equipment at the horizontal channels
6) Maintenance of the RA reactor

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Content of the RA Decommissioning Plan

- Introduction
- Facility Description
- Decommissioning Strategy
- Project Management
- Decommissioning Activities
- Surveillance and Maintenance
- Waste Management
- Cost Estimate and Funding Mechanisms
- Health and Safety
- Quality Assurance
- Emergency Planning
- Physical Security and Safeguards
- Final Radiation Survey

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Content of the RA Decommissioning Plan (contd.)

- **Safety Assessment (preliminary)**
- **Environmental Impact Assessment**
  (stand alone document)

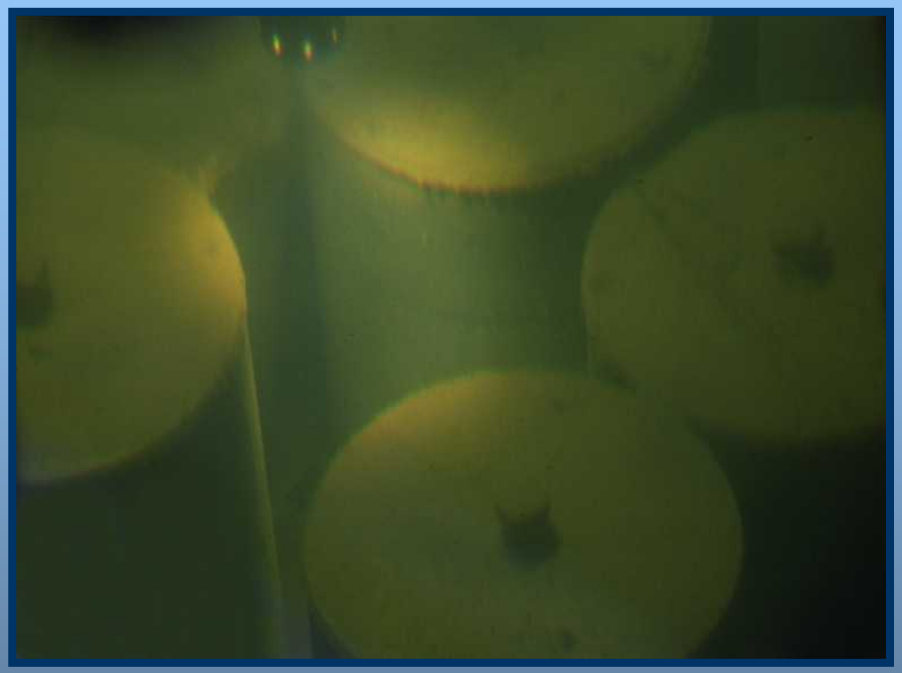
Related documents:

- **Characterization Plan**
  - Amendment of the Characterization Plan
  - Characterization Plan for the RA reactor Surrounding
- **Characterization Reports**

Spent Nuclear Fuel Removal Preparation

Period of storage

20 - 40 years



Packaging

- 304 tubular stainless steel containers
- 30 aluminium barrels

Spent fuel inventory

- **6656 LEU (2%) fuel elements (2.5 tones of metal uranium)**
- **894 HEU (80%) fuel elements (20 kg of UO2)**
- **480 HEU (80%) fuel elements remained in the RA reactor core**

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Spent Nuclear Fuel Removal Preparation

2 % UO_2 fuel element

- Dimensions:
- Outer diameter: 3.72 cm
- Height: 11.3 cm

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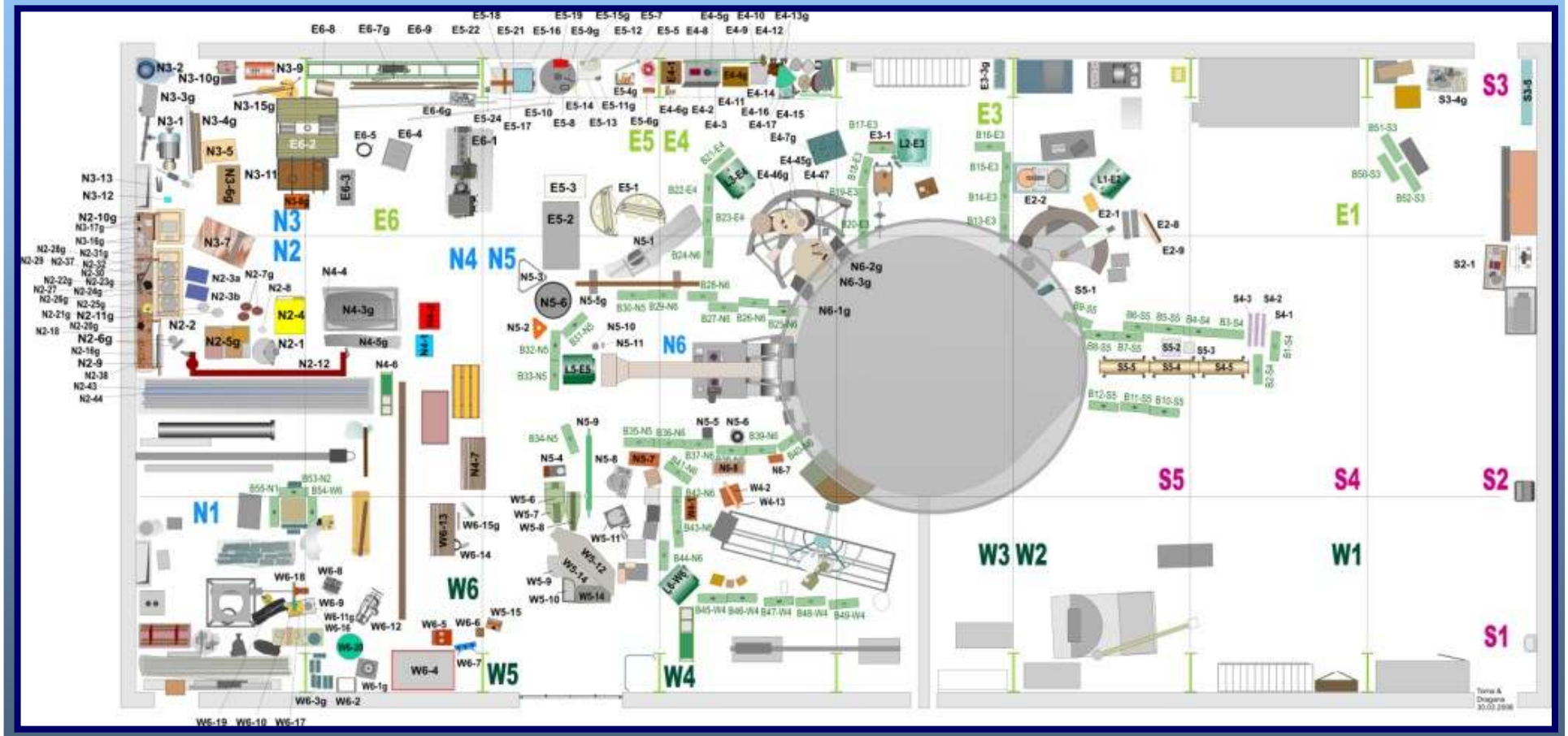
Equipment & components at the RA reactor hall surveyed until December 2008



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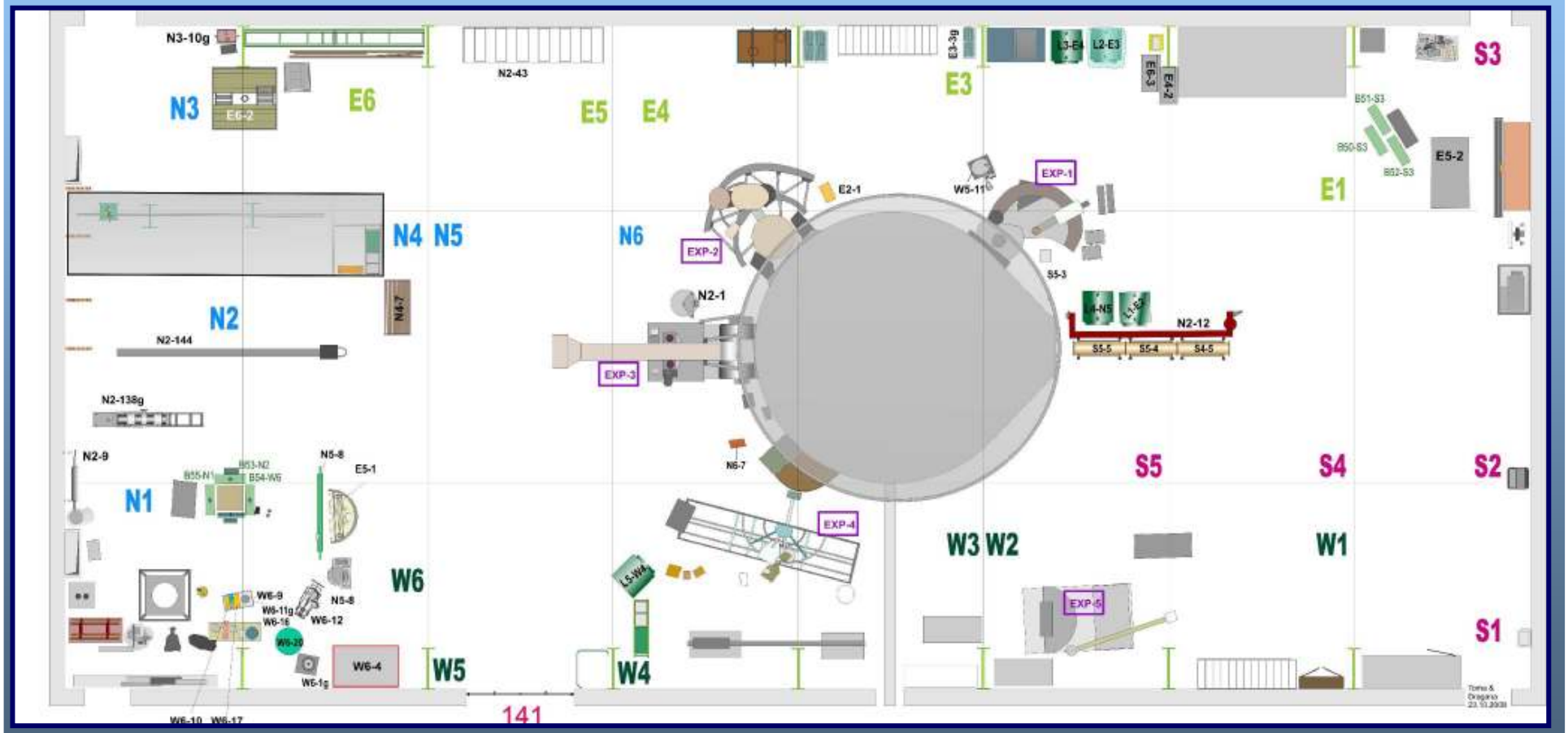
Status of the inventory located at the RA reactor hall in December 2008



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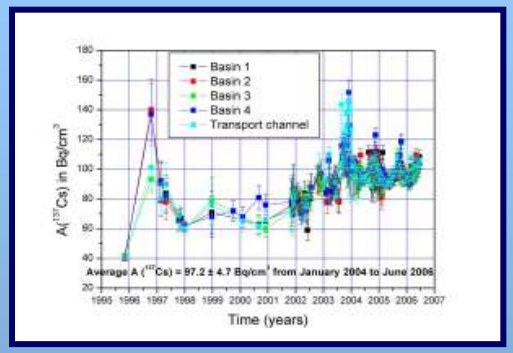
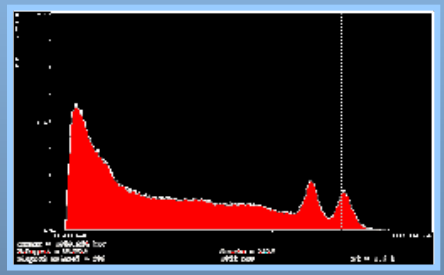
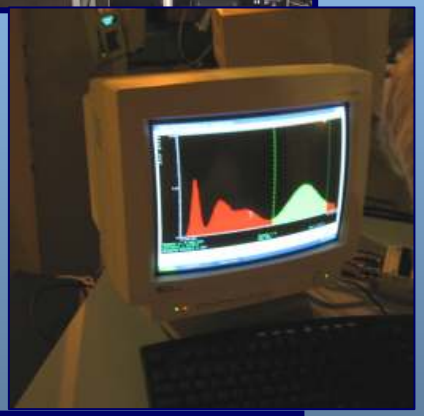
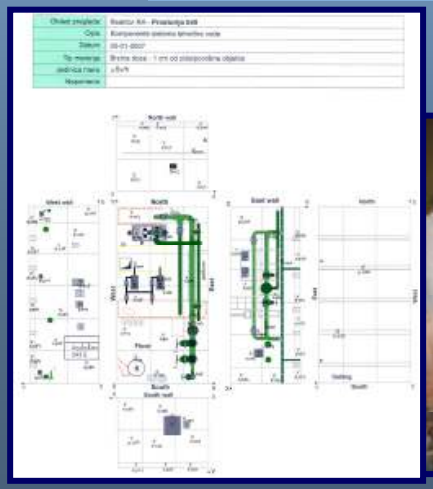
Activities of the RA Reactor Decommissioning Project









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Radioactive sources, equipment, instrumentation found in the RA hall

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QA – Documentation of the survey of reactor hall inventory

Obrazac za radiološki pregled opreme i objekata u hali reaktora RA

Obrazac: ZP.4.DEC.150.211
Broj: 0044_08

Naziv predmeta	Veliki plavi metalni blok
Šifra predmeta	E4 - 28
Materijal	Metal
Zapremina	
Datum: [illegible]	Vreme: [illegible]
Fotografija br.	
Lokacija (kvadrant)	RA hala – E4

Inventarski broj:

Tip merenja

Broj merne tačke	A: α fix [imp]	B: β/γ fix [imp]	C: Jač. doze [μSv/h]	D (brisevi on-site): Oznaka brisa	D: Merenje β/γ fix [imp]	D: S_p	E: Oznaka brisa	E: CH1 [imp]	E: CH2 [imp]	E: CH3 [imp]
1	2	50	[illegible]	[illegible]	30					
2	3	32	[illegible]	[illegible]	31					
3	2	49	[illegible]	[illegible]	31					
4	3	36	[illegible]	[illegible]	22					
5	7	34	[illegible]	[illegible]	36					
6	7	38	[illegible]	[illegible]	38					
7	3	32	[illegible]	[illegible]	25					
8	1	30	[illegible]	[illegible]	39					
9	12	32	[illegible]	[illegible]	38					
10	4	39	[illegible]	[illegible]	32					
11										
12										
13										
14										

$t_{merenja}$ = 1 min

A	Instrument	model	E-600
		serijski broj	[illegible]
	Sonda	model	SHP-380AB
		serijski broj	[illegible]
B	Instrument	model	E-600
		serijski broj	[illegible]
	Sonda	model	SHP-380
		serijski broj	[illegible]
C	Instrument	model	FH40G
		serijski broj	[illegible]
D	Instrument	model	E-600
		serijski broj	[illegible]
	Sonda	model	HP-210
		serijski broj	[illegible]
E	Instrument	model	E-600
		serijski broj	
	Sonda	model	SPA-3
		serijski broj	

Obrazac: ZP.4.DEC.150.211
Broj: 0044_08

α fix	
β/γ fix	
Jačina doze	
Merenje briseva	
Pomeranje objekata	
Upisivanje rezultata	
Overa rezultata	

Radiološki nalaz

Napomene:

	Institut za nuklearne nauke "Vinča" Centar NTI	Obrazac:	IZ.4.DEC.150.212
		Broj:	0002_07
	Dekomisija istraživačkog reaktora RA	Datum:	07.09.2007.

Zapisnik o iznošenju opreme i materijala iz hale reaktora RA

Oprema i otpadni materijal iz hale reaktora RA, nakon izvršenog radiološkog pregleda, premeštaju se na druge lokacije radi privremenog ili trajnog skladištenja.

R. br.	Naziv predmeta	Šifra predmeta	Foto br.	Materijal	Zapremina [cm³]	Lokacija (kvadrant hale)	Nova lokacija
1.	Drveni orman	S3-1		Drvo		S3	Centralno skladište
2.	Drveni orman	S3-2		Drvo		S3	Centralno skladište
3.	Drveni orman	S3-3		Drvo		S3	Centralno skladište
4.	Grupisani metalni predmeti za otpad	S3-4g		Metal		S3	Centralno skladište
5.	Peć na stalku	E1-1K		Metal		E1	Centralno skladište
6.	Pokretni orman sa mernom instrumentacijom	E1-2K		Metal, plastika, elek.-oprema		E1	Centralno skladište
7.	Metalni stalak	E1-3K		Metal			Centralno skladište
8.	Polica sa mernim segmentima (instrumentima)	E1-4K		Metal		E1	Centralno skladište
9.	Metalni kontejner	E1-5K		Metal		E1	Centralno skladište
10.	Teleprinter	E1-6K		Metal, plastika		E1	Centralno skladište
11.	Pokretni orman sa mernom instrumentacijom	E1-7K		Metal, elek.-oprema		E1	Centralno skladište
12.	Pokretni orman sa mernom instrumentacijom - Vinča nova	W5-1		Metal, elek.-oprema		W5	Centralno skladište
13.	Pokretni orman za mernu instrumentaciju	W5-2		Metal		W5	Centralno skladište
14.	Pokretni orman sa mernom instrumentacijom	W5-3		Metal, elek. - oprema		W5	Centralno skladište
15.	Orman sa mernom instrumentacijom	W5-4		Metal, elek. - oprema		W5	Centralno skladište
16.	Pokretni orman za mernu instrumentaciju	W5-5		Metal, elek. - oprema		W5	Centralno skladište

Izvršio
Vođa tima za radiološki pregled
Dragan Svrdlin, ing.

Odobrio
Rukovodilac projekta "Dekomisija nuklearnog reaktora RA"
Dr Dragana Nikolić

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Characterization at the RA reactor hall

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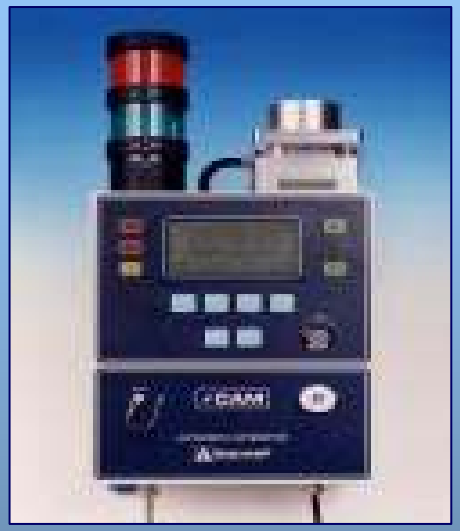
Measuring instrumentation ....

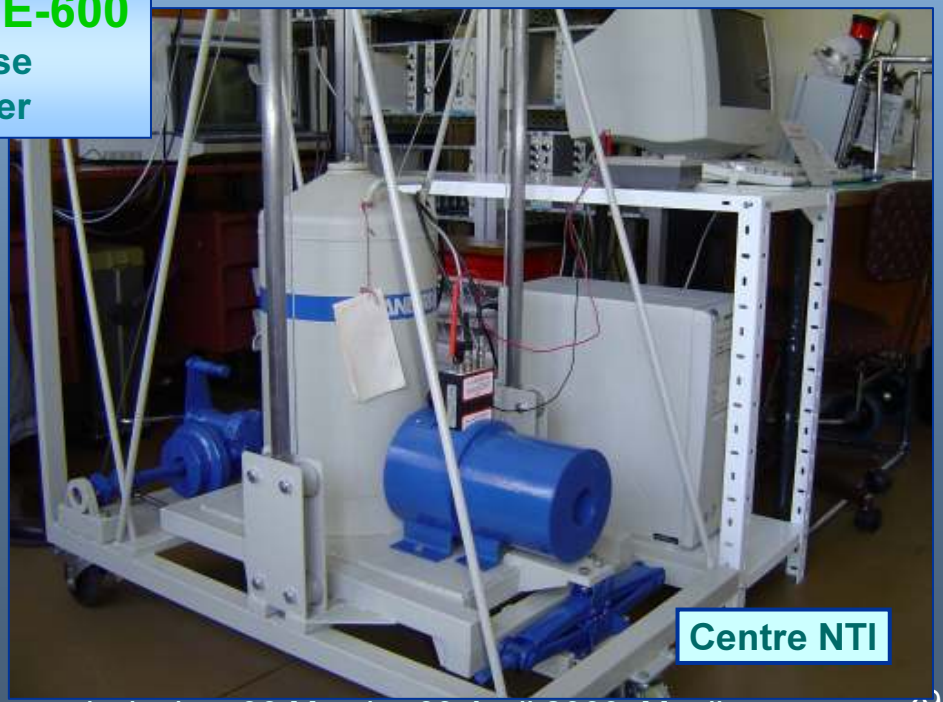
Scintillacion detector NaI
- 3.8 x 3.8 cm^2
- lead colimator 1.5 cm



Home-made ISOCS
- Ge detector with lead colimator

Eberline E-600
Multipurpose survey meter

CdZnTe
- 5 mm^3 volume
- Colimator wolframe



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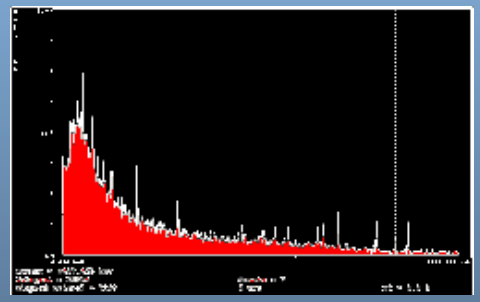
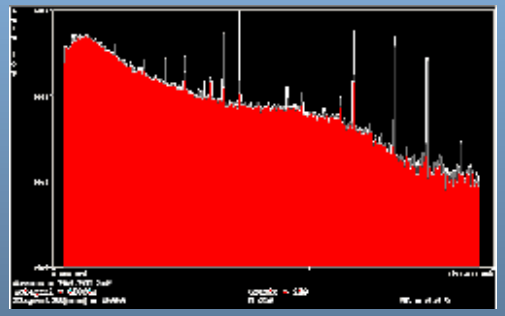
Spectrometry measurements and results

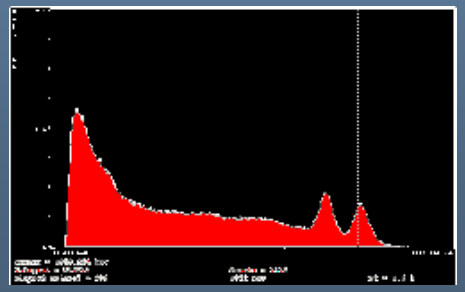
Measurements at the RA hall

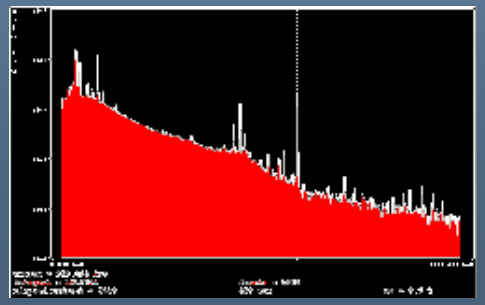
Laboratory measurements

•Samples from the RA reactor hall









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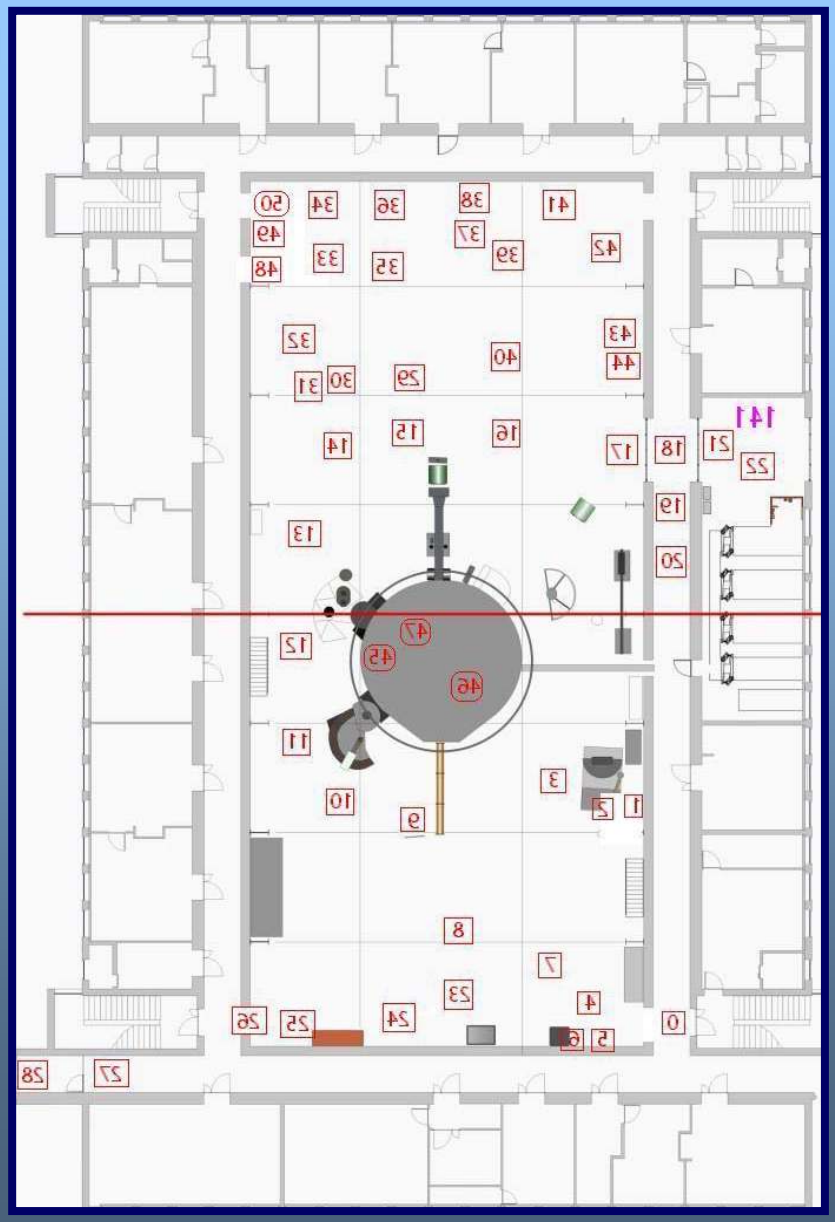
Characterization of the RA hall floor



"Wet smears" are taken from the surfaces of 300 cm^2

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Characterisation of the experimental equipment in the RA hall

No.	Smear location	Surface activity [Bq/cm^2]	
		^{137}Cs	^{60}Co
7	EXP-3	$5.3 \cdot 10^{-2}$ ±1.5%*	$9.7 \cdot 10^{-3}$ ±5.0%
8	EXP-3	$9.9 \cdot 10^{-2}$ ±1.1%	$1.3 \cdot 10^{-2}$ ±4.0%
9	EXP-3	$7.2 \cdot 10^{-2}$ ±0.4%	$5.1 \cdot 10^{-3}$ ±2.3%
10	EXP-3	$1.3 \cdot 10^{-1}$ ±0.9%	$1.1 \cdot 10^{-2}$ ±4.4%
11	EXP-3	$9.3 \cdot 10^{-2}$ ±0.4%	$5.8 \cdot 10^{-3}$ ±0.4%
12	EXP-3	$6.7 \cdot 10^{-2}$ ±1.1%	$7.9 \cdot 10^{-3}$ ±5.4%
13	Floor	$1.9 \cdot 10^{-2}$ ±2.6%	$1.0 \cdot 10^{-3}$ ±18.0%
14	EXP-3	$3.3 \cdot 10^{-2}$ ±1.9%	$4.0 \cdot 10^{-3}$ ±7.6%
15	Floor	$4.1 \cdot 10^{-3}$ ±0.6%	$1.0 \cdot 10^{-4}$ ±6.6%
16	Floor	$5.0 \cdot 10^{-2}$ ±1.5%	$9.0 \cdot 10^{-4}$ ±5.0%
17	Floor	$1.9 \cdot 10^{-2}$ ±2.6%	$1.0 \cdot 10^{-3}$ ±22.0%

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Dismantling of the experimental equipment EXP-3 in the RA hall

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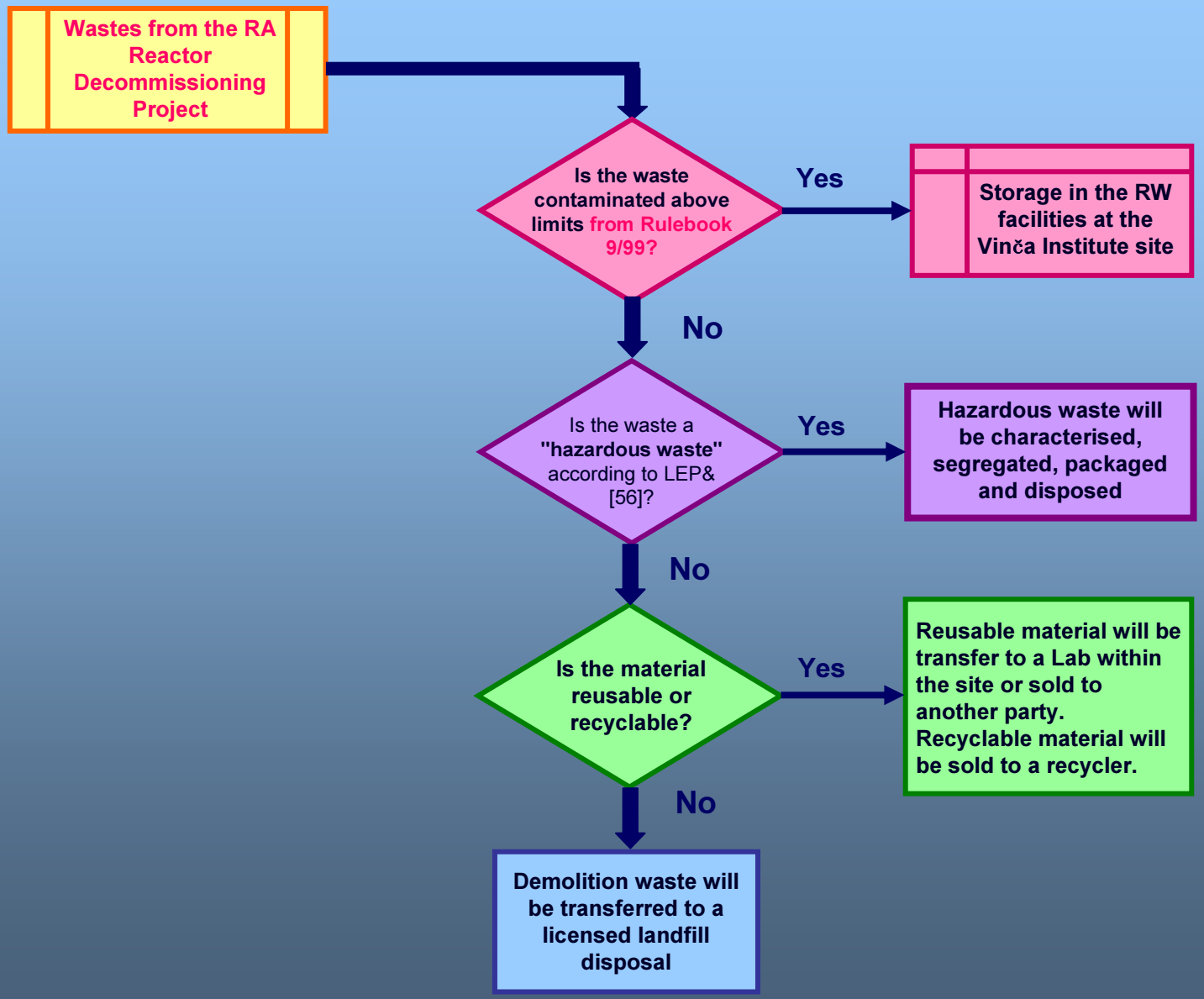
Dismantling of the experimental equipment EXP-5 in the RA hall

Waste and Material Management



Waste and Material Management (contd)

Material management

- Shielding blocks removal:
- 40 t of steel
- 16 000 l of water released





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Waste and Material Management (contd)

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SUMMARY

- The draft of the RA research reactor Decommissioning Plan has been completed according to the international standards and recommendation, in the absence of national regulation
- Further implementation of the RA Decommissioning Project is under consideration due to lack of funding
- The new law is in the procedure, giving only the basis for regulation of decommissioning
- Regulatory Body will be established in Serbia after enacting the new law

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SUMMARY

- **Major tasks remained in decommissioning planning**
  - to review and upgrade certain chapters of the draft RA research reactor Decommissioning Plan
  - to complete the feasibility study which comprises detailed estimate of all costs, involving anticipated project risks and providing justification for any provision these risks to be made in pricing the program;
  - to establish and implement QM system;
  - to perform adequately safety assessment for each stage of the decommissioning
- To provide stable funding of the Decommissioning Project
- To provide appropriate human resource management

LESSONS LEARNED

- Decommissioning Plan is a "living document"
- To ensure good prospects for the progress of the Decommissioning Project, it is necessary to provide rational planning and stable long term funding
- The necessary input is sufficiently detailed cost estimation of the project that should be carried out after a final shut down
- Organisation and co-ordination are the key success factors when multiple projects sharing the same resources are performed at the site
- In the absence of necessary regulations establish principles, processes and practices that should be used (i.e. Code of Practice)

LESSONS LEARNED

- **The appropriate planning and management of resources, including the human resources, is of major importance**

- **The IAEA assistance is necessary to:**
  - **Provide standards, recommendations and guidelines**
  - **Enable international co-operation with other institutions carrying out decommissioning projects in order to exchange experiences and practices**

Thank You