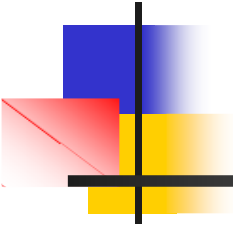


Decommissioning Plan of VVR-S Research Reactor at Magurele –Bucharest-



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Outline

- Basics of decommissioning plan
- Presentation of decommissioning process;
- Radiological Characterization
- Wastes resulted from decommissioning



Basics of decommissioning plan

- IFIN-HH-operator and licensee, responsible for decommissioning VVR-S
- Ownership: state owned
- Principal characteristics of the research reactor VVR-S:
 - thermal neutrons research reactor, moderately, cooled and reflected by distilled water, fueled with enriched uranium 10% and then 36 %;
 - thermal power: 2,000 kW;
 - total thermal (supply) energy-9.59 GWd;
 - flux of the thermal neutrons (n/cm-2.s) : 2×10^{13}
 - number of thermal column-1
 - number of horizontal experimental channels:9
 - number of vertical experimental channels: 16
 - number of biological channels: 3
 - number of circulating pumps: 5
 - number of heat exchangers: 2

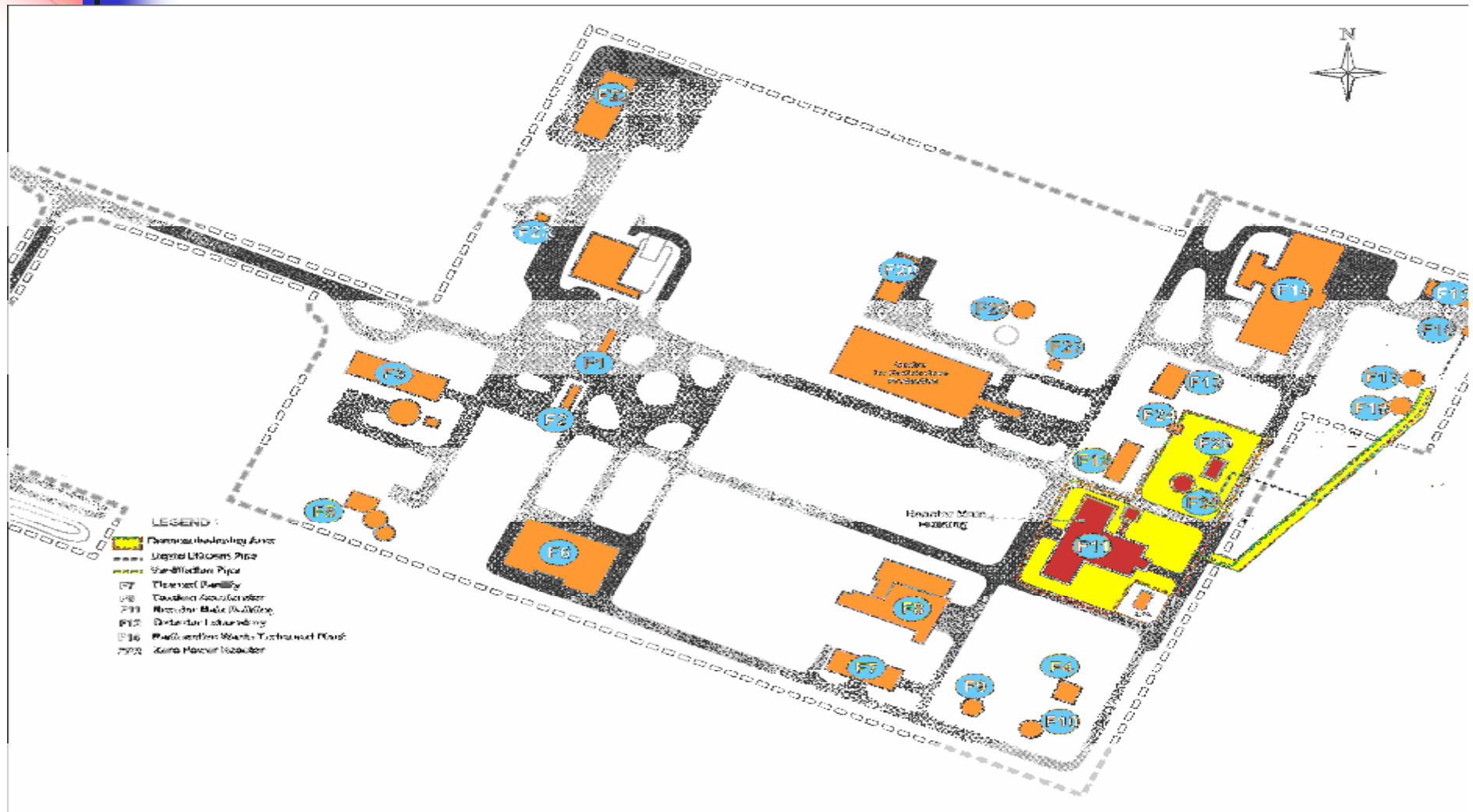
Basics of decommissioning plan (cont-1)

- VVR-S reactor is composed of the following systems and equipments:
 - 1. Reactor block
 - 2. Primary cooling system
 - 3. Secondary cooling system
 - 4. Instrumentation and control system
 - 5. Distilled water system
 - 6. Heating and ventilation system
 - 7. Radioactive leakage drainage, overflow and collecting system
 - 8. Central dose system
 - 9. Electric system
 - 10. Auxiliary equipments and systems
 - -Hot cells
 - -Hot cells decontamination installation
 - -Storage for spent fuel elements
 - -Hoisting and transport equipment
 - -Water supply system
 - -Industrial and domestic drainage water system
 - -Compressed-air and natural gas system.

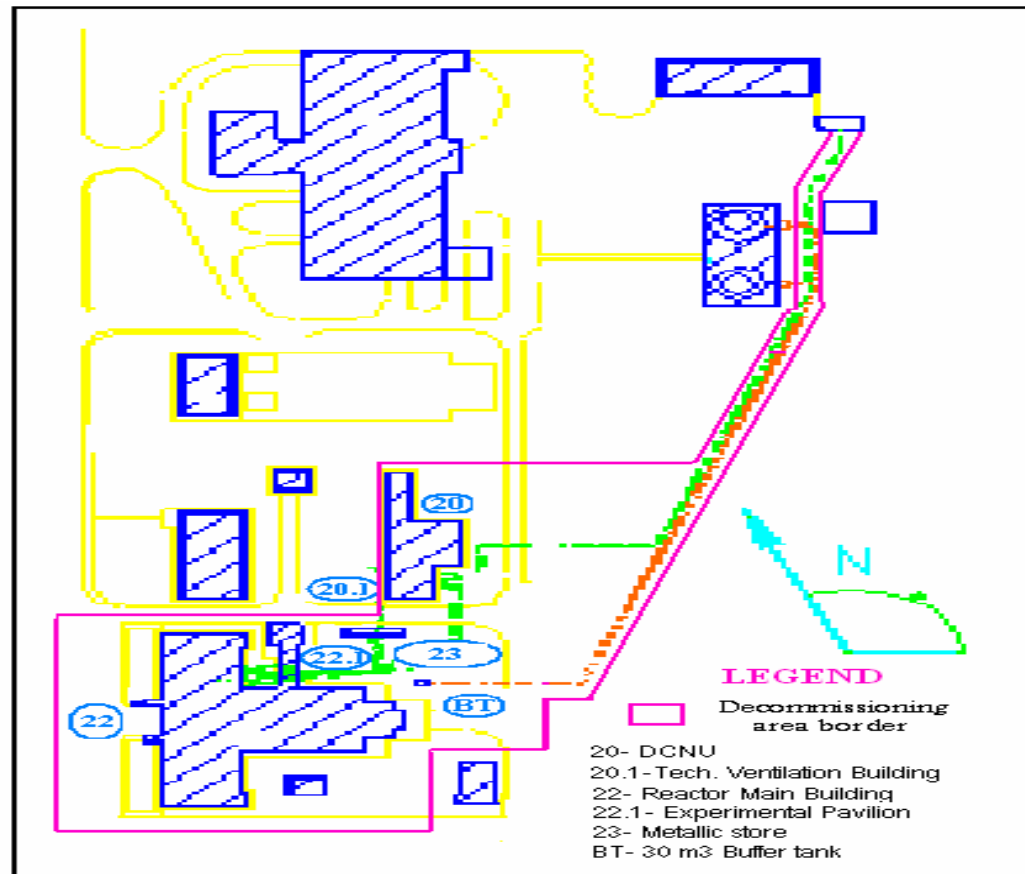
Basics of decommissioning plan (cont-2)

- References documents for elaboration of decommissioning plan: IAEA SRS-45/2005
- Immediate dismantling strategy for decommissioning of VVR-S
- Duration of decommissioning project: 12 y
- WBS- 7 phases, 5 work packages
- Radiation dose for release of VVR-S from regulatory control : 0.3 mSv/year
- End use: Industrial application , R&D in the material sciences, radiological facility-linear accelerator

Site of IFIN-HH, Group I

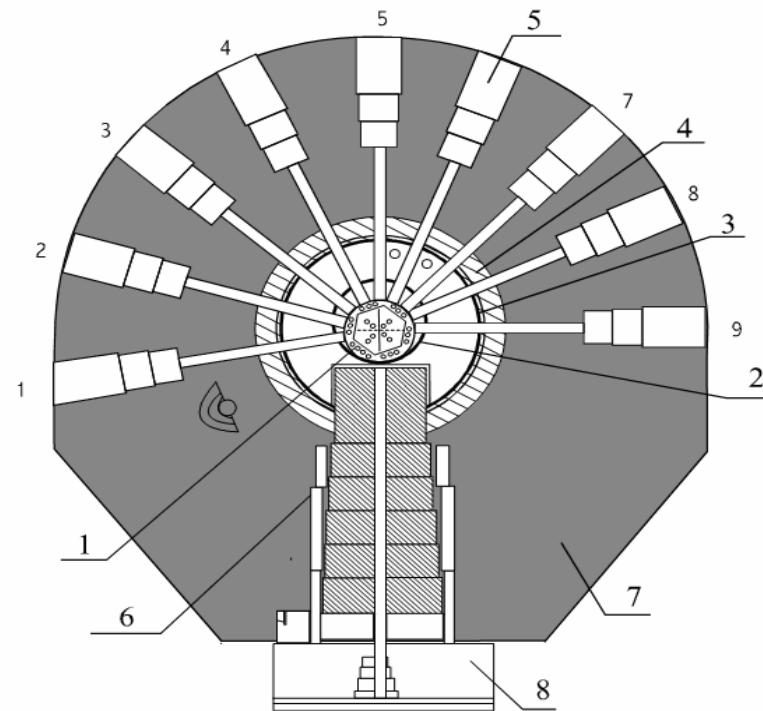


Borders of decommissioning



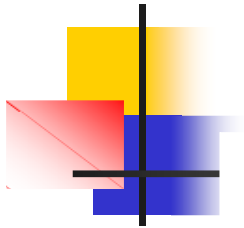
Decommissioning Area

Reactor Block VVR-S- Horizontal cross section

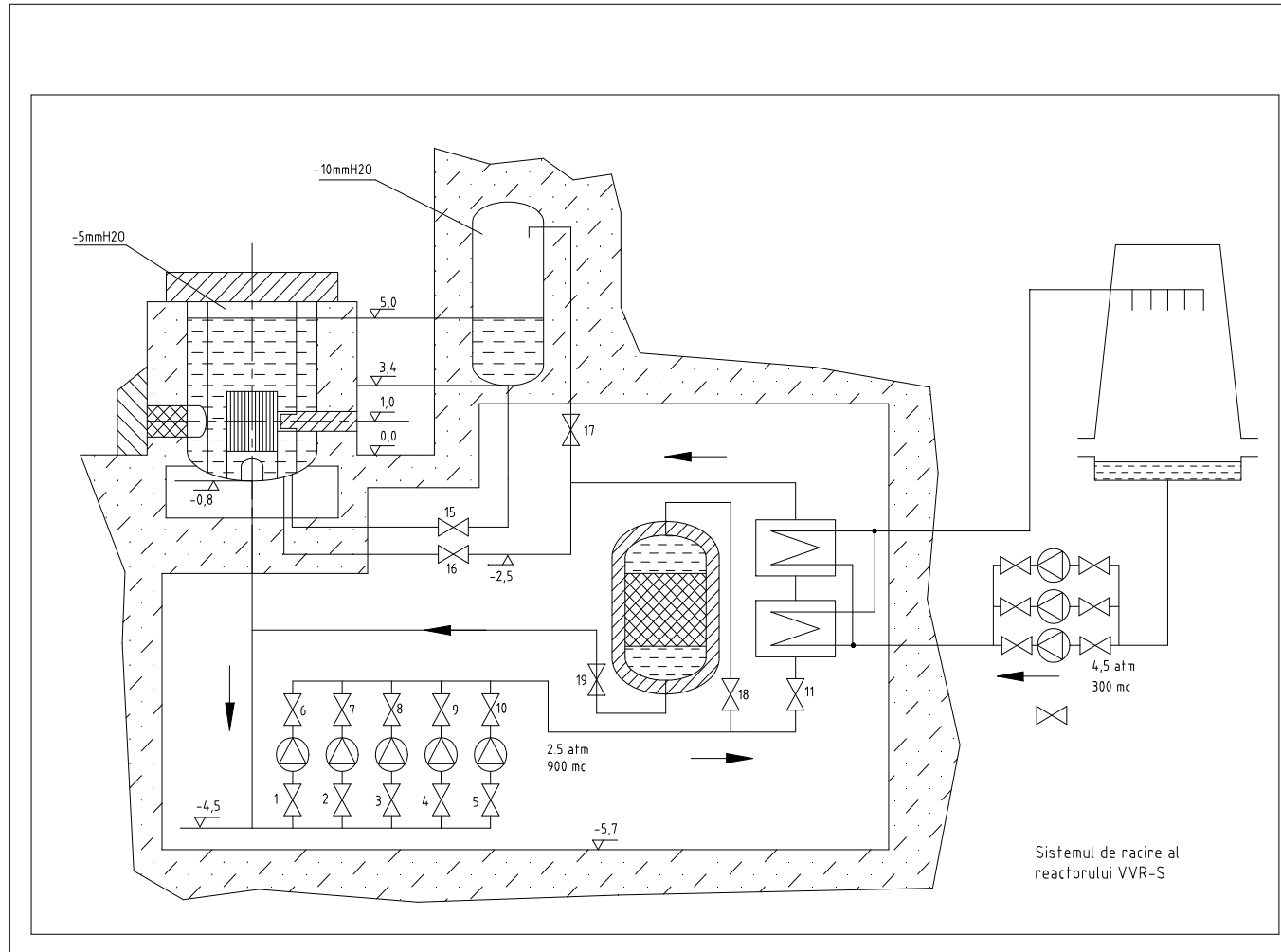


- | | |
|-----------------------------|------------------------------|
| 1. Reactor core | 2. Median cylindrical vessel |
| 3. Outer cylindrical vessel | 4. Cast-iron rings |
| 5. Beam tubes | 6. Mobile thermal column |
| 7. Concrete shielding | 8. Thermal column shielding |

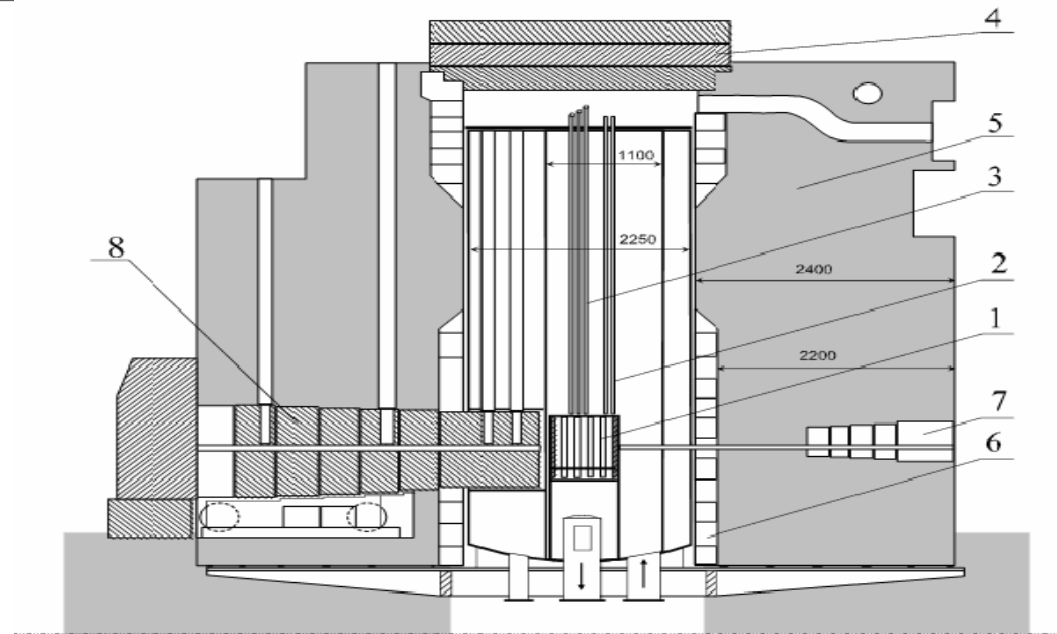
VVR-S REACTOR HORIZONTAL CROSS-SECTION



Cooling system of VVR-S



Reactor block vertical cross-section



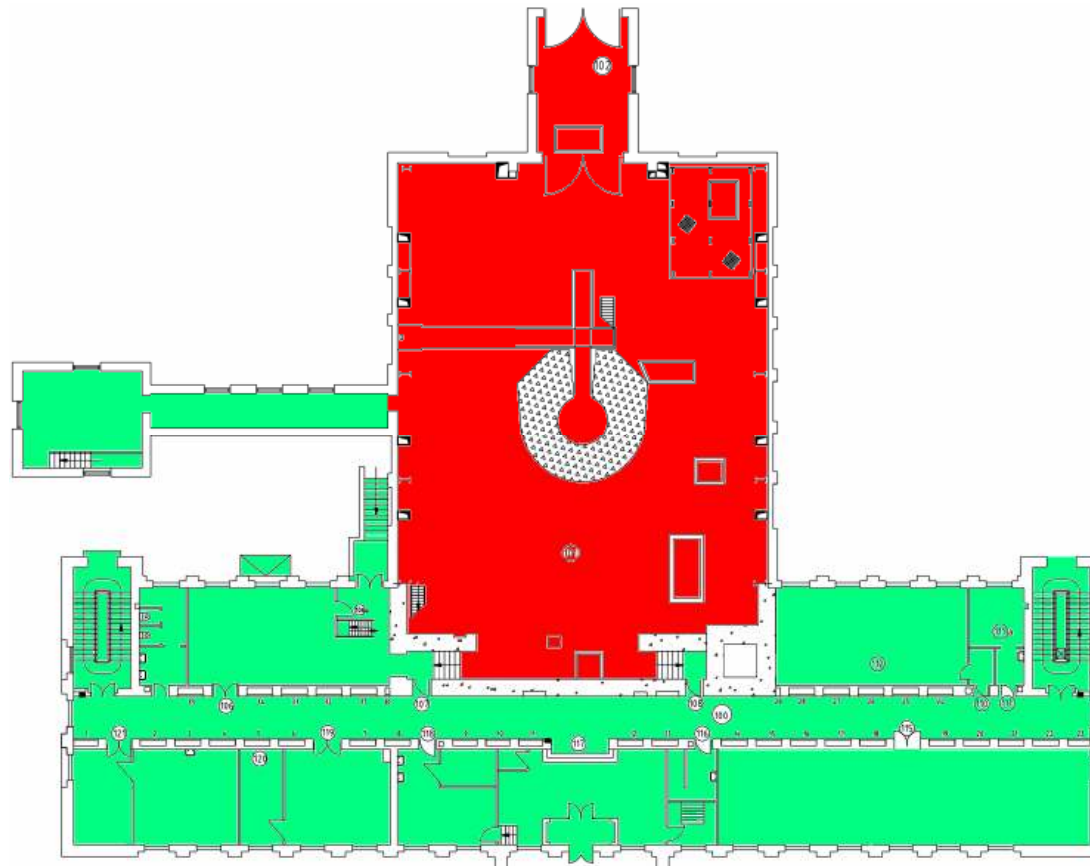
- | | |
|--------------------------|------------------------------|
| 1. Reactor core | 2. Vertical channels |
| 3. Control rods channels | 4. Cast-iron rotating lids |
| 5. Concrete shielding | 6. Cast-iron shielding rings |
| 7. Horizontal channels | 8. Mobile thermal column |

VVR-S REACTOR VERTICAL CROSS-SECTION

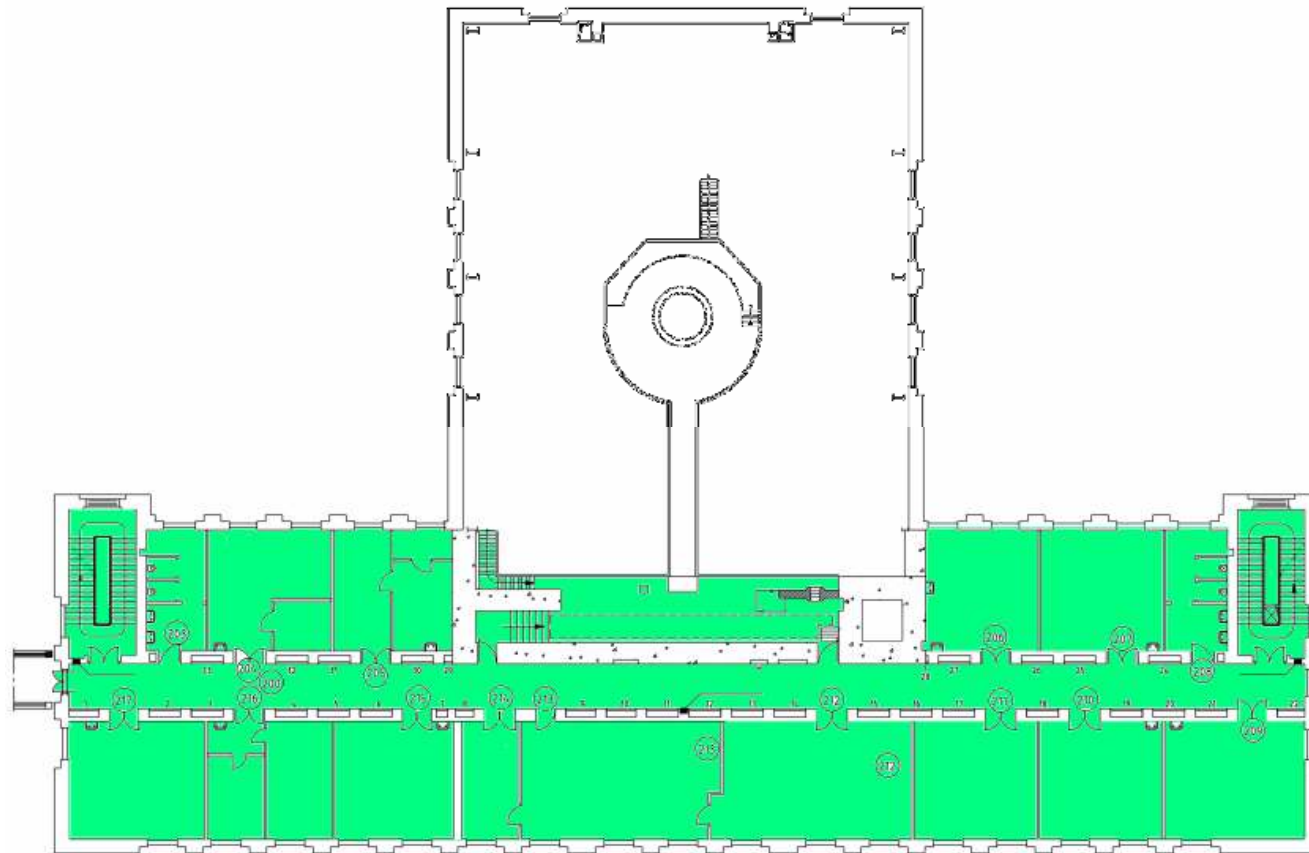
Rooms from basement contaminated three classes



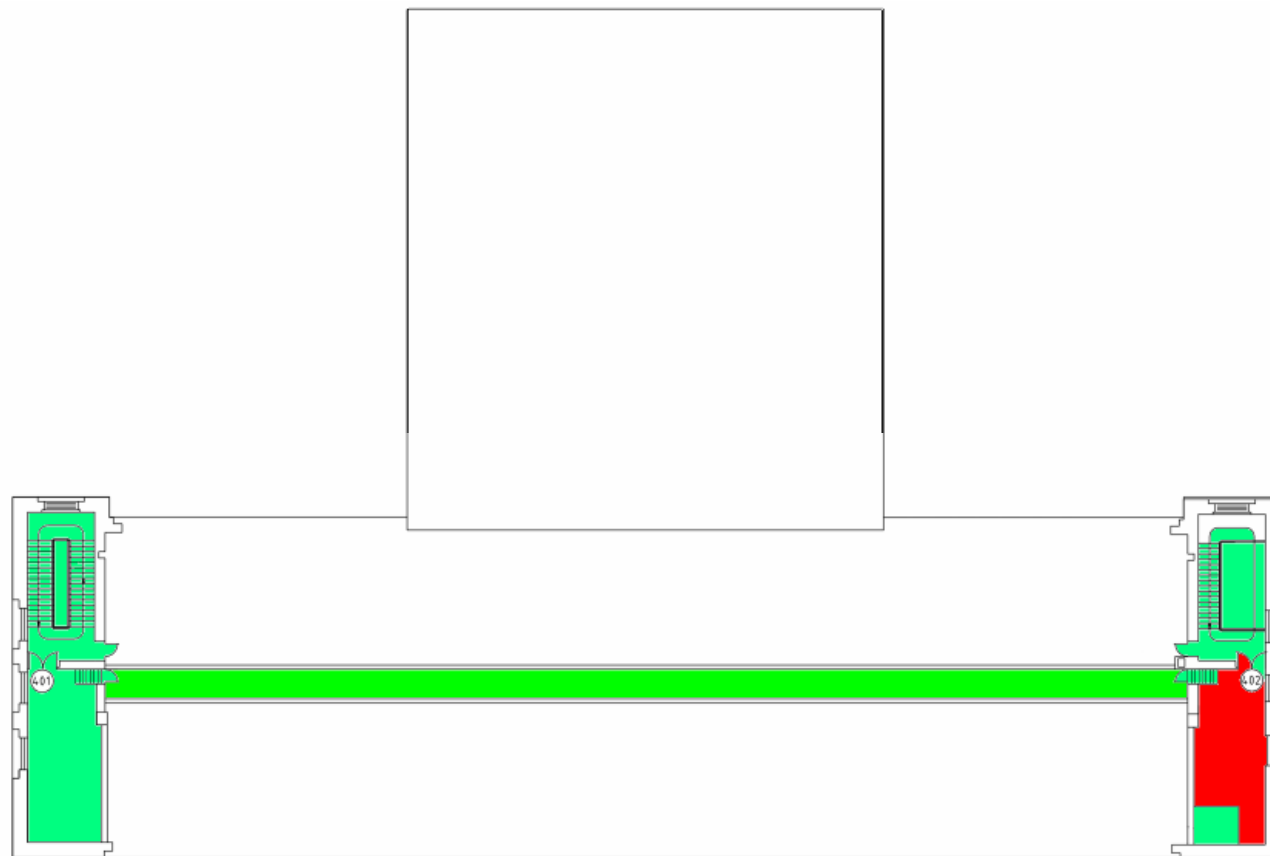
Ground floor of VVR-S



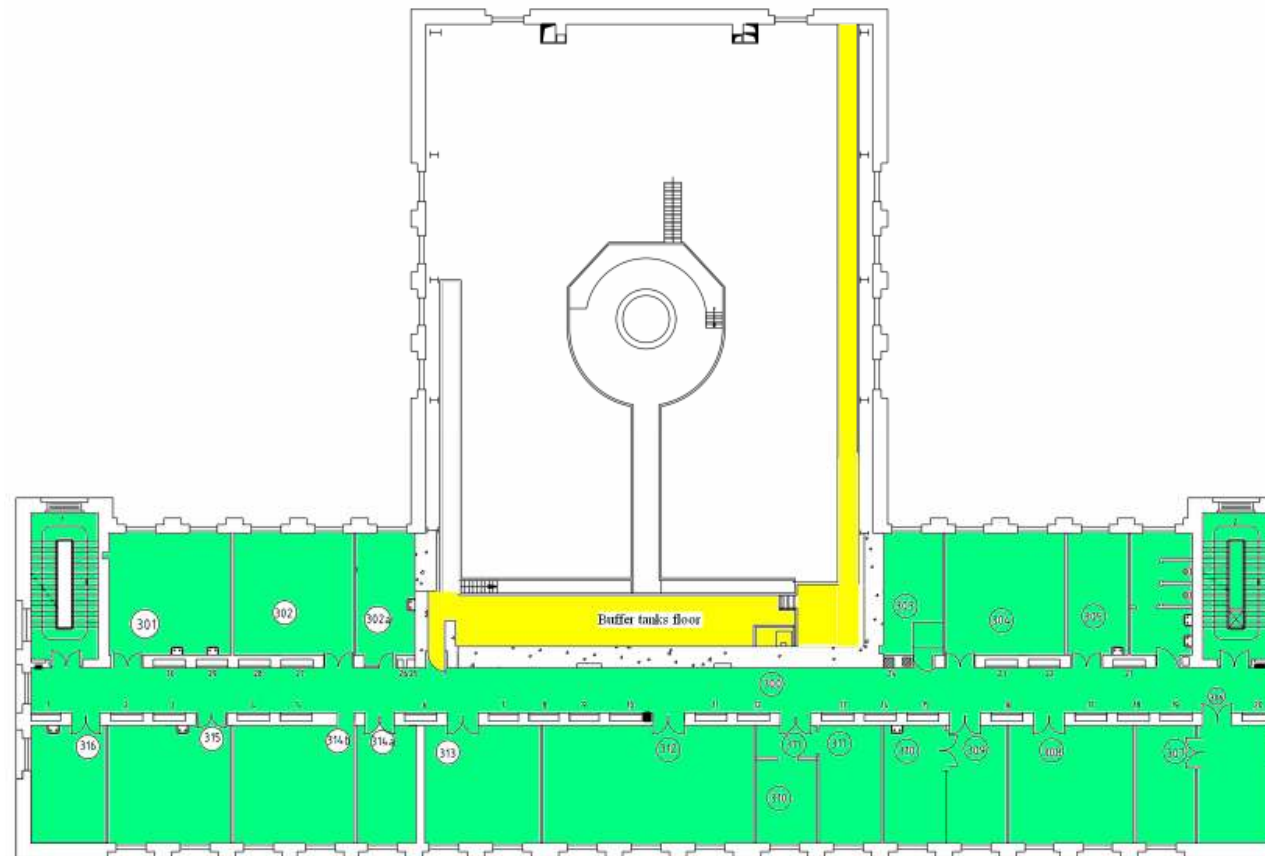
The first floor of VVR-S



The third floor of VVR-S



The second floor of VVR-S





Radioactive Inventory from Reactor Block

Material	Mass (Mg)	Activity (Bq)							Total (Bq)
		Co-60	Fe-55	Ni-63	Ni-59	Eu-152	Eu-154	Eu-155	
Aluminum	4.78	2.06E+10	2.22E+11	3.40E+11	3.67E+09	0	7.00E+08	2.88E+08	5.87E+11
Cast iron	143	5.23E+09	2.10E+09	3.10E+08	0	0	0	0	7.64E+09
Concrete	550	6.50E+08	2.9E+07	0	0	3.20E+08	0	0	1.00E+09
Graphite	5.3	-		-	-	-	-	-	4.00E+09

Contamination of reactor systems

No	Reactor systems	Contamination level [Bq/cm ²]	Radionuclide vector	Remarks
1	Components of the reactor block	100....1000	Co-60, Cs-137	Components of the reactor block are also highly activated.
2	Primary cooling circuit	10....1000	Co-60, Cs-137	Filter of the primary circuit is highly contaminated having a total activity of about 10 ⁹ Bq.
3	Secondary cooling circuit	0	-	This system is clean.
4	Ventilation system	0....1000	Co-60, Cs-137, Am-241	-Laboratory ventilation system is contaminated with Am-241. - Technological ventilation system for hot cells is highly contaminated but the part connected to the other rooms is slightly contaminated.
5	Radioactive leakage drainage, overflow and collecting system	0....1000	Co-60, Cs-137, Cs-134	This system is highly contaminated with isotopes from hot cells.
6	Instrumentation and control system	0.....1000	Co-60, Cs-137	Control rods and ionization chambers are also highly activated.
7	Hot cells	inaccessible area	Co-60, Cs-134, Cs-137, Eu-152, Ir-192, Am-241	Hot cells are highly contaminated and contain inside a lot of radioactive sources.
8	Storage for spent fuel elements	inaccessible area	Cs-137	It contains spent fuel elements. Water is clean.
9	Other systems of the reactor	0	-	These systems are clean or very slightly contaminated.



Presentation of decommissioning process;

- Work Breakdown Structure
- Decommissioning Process in 7 phases during 12 years and 5 work packages



Presentation of decommissioning process;

- Work Breakdown Structure-
- Dismantling primary circuit up to reactor block (non activated parts)
- Dismantling core/absorber rods, drive assembly, core components, other internal components, thermal column, cooling pond
- Demolition of deaerator, hot cells, biological shield of reactor block
- Dismantling underground structure: secondary circuit, connected pipes between Reactor and effluents buffer (30 m³) tank
- Dismantling technological ventilation, active drainage, electrical for equipment used in decommissioning, air services
- Dismantling ancillary buildings (temporary structures for material storage)
- Final radiological survey for building and site



Presentation of decommissioning process;

Work Breakdown Structure- Work Packages (WP)

- **WP.1. Pre-decommissioning activities**
- **WP.2. Dismantling activities**
- **WP.3. Decontamination activities**
- **WP.4. Demolition activities**
- **WP.5. Radiological characterization, packaging, transportation, disposal, storage, free release, final survey, archiving**



Presentation of decommissioning process;

Work Packages (WP)

- **WP.1. Pre-decommissioning activities**
- Spent Nuclear Fuel management – removal from site;
- Up-grading Radioactive Waste Treatment Plant and National Repository for Radioactive Waste;
- Commission the Radiological Characterization Laboratory & Free Release of materials for initial planning, packaging, storing, conditioning and un-conditioning release;
- Dose-meter system in site;
- Equipment for environmental protection and monitoring systems in/off site;



Presentation of decommissioning process;

- **Work Packages (WP)**
- **WP.1. Pre-decommissioning activities**
- Commission mechanical workshop for cutting and light decontamination in Reactor Hall
- Funding mechanism;
- Elaboration of documentation: organizational, QMS, H&S, Safety & Security & Safeguards, Technical, Packages and Transport Specifications, Radiation Protection;
- Worker route in site;



Presentation of decommissioning process;

- **Work Packages (WP)**
- **WP.1. Pre-decommissioning activities**
- Material route in/off site;
- Removal from site of equipment and materials resulted from research activities and radio-isotopes production;
- Drainage of water from primary & secondary circuit, cooling pond
- Authorization from regulatory bodies: in nuclear, environmental, industrial;
- Maintenances of SSC in transition period and during decommissioning;
- Training of workers, public relation plan, definition of stakeholders;



Presentation of decommissioning process;

- **Work Packages (WP)**
- **WP.2. Dismantling activities**
- Remove control/absorber rods, drive assembly, I&C system;
- Remove primary heat exchangers and piping, pumps, water purification system;
- Remove core components and internal vessels from reactor block;
- Remove control room equipment;
- Remove secondary circuit, buffer tank, pipes from active drainage, including underground part,
- Remove cooling pond
- Remove active drainage
- Remove ventilation system,



Presentation of decommissioning process;

- **Work Packages (WP)**
- **WP.3. Decontamination activities**
- Decontamination of primary circuit (by washing with water and filtered in close circuit)
- Decontamination of liner from hot cells with dry methods
- Decontamination of walls, floors
- Decontamination of tools and equipment used in decommissioning
- Other large pieces will be transported in Radioactive Waste Treatment Plant for decontamination in special room



Presentation of decommissioning process;

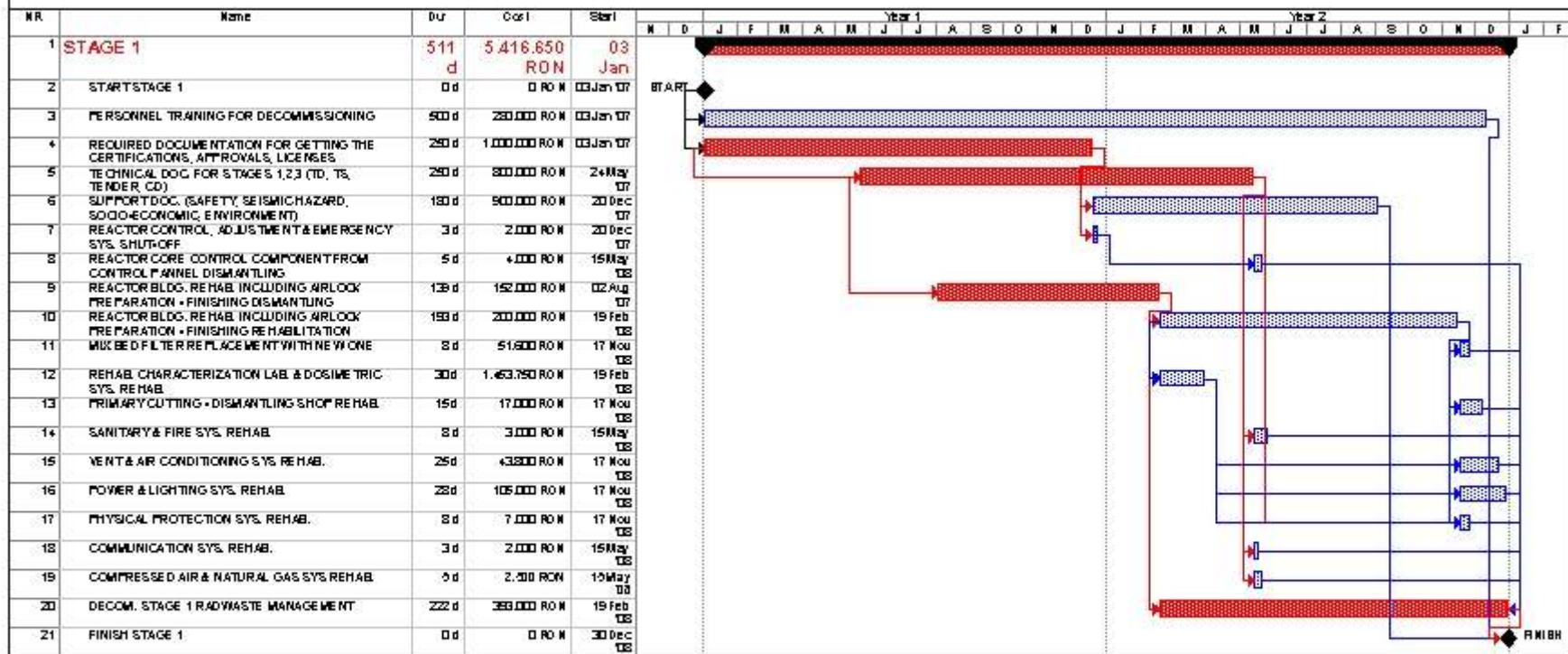
- **Work Packages (WP)**
- **WP. 4. Demolition activities**
- Demolition of biological shield from reactor block, hot cells, deaerator, stack

- **WP.5. Radiological characterization, treatment, conditioning, packaging, transportation, disposal, storage, free release, final survey, archiving**

Presentation of decommissioning process

10 May '06

VVR-S - IFIN-HH NUCLEAR REACTOR DECOMMISSIONING, STAGE 1



Date: 10 May '06

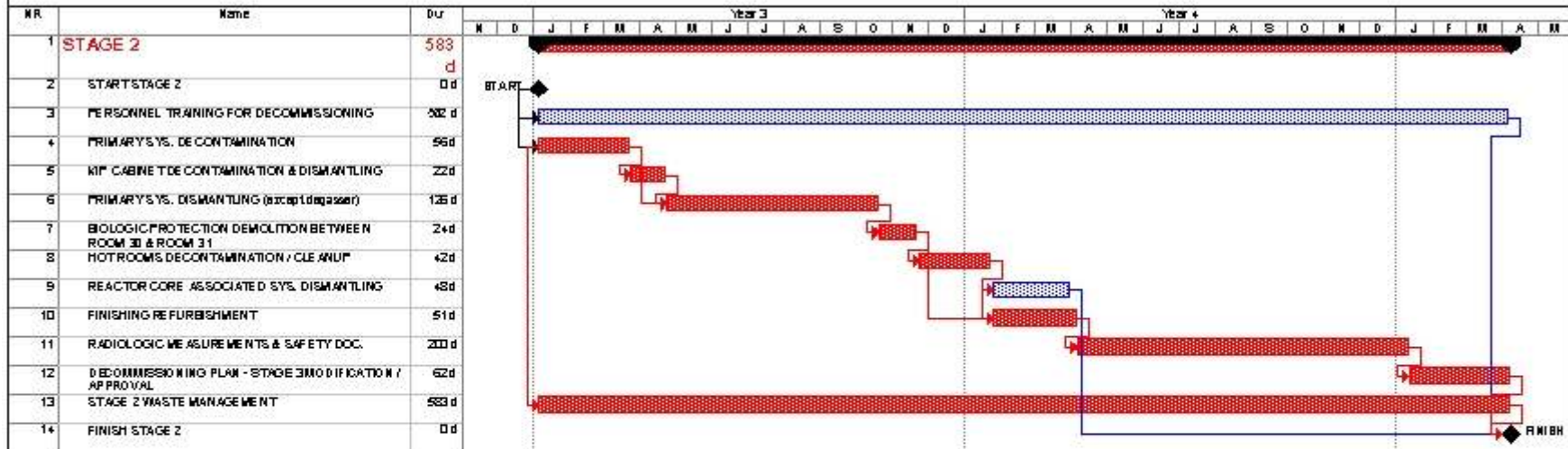
R.A.A.N. - CITON

█ Critical
 █ Noncritical
 Progress
 ◆ Milestone
 Summary

Presentation of decommissioning process;

10 May '06

VVR-S - IFIN-HH NUCLEAR REACTOR DECOMMISSIONING, STAGE 2

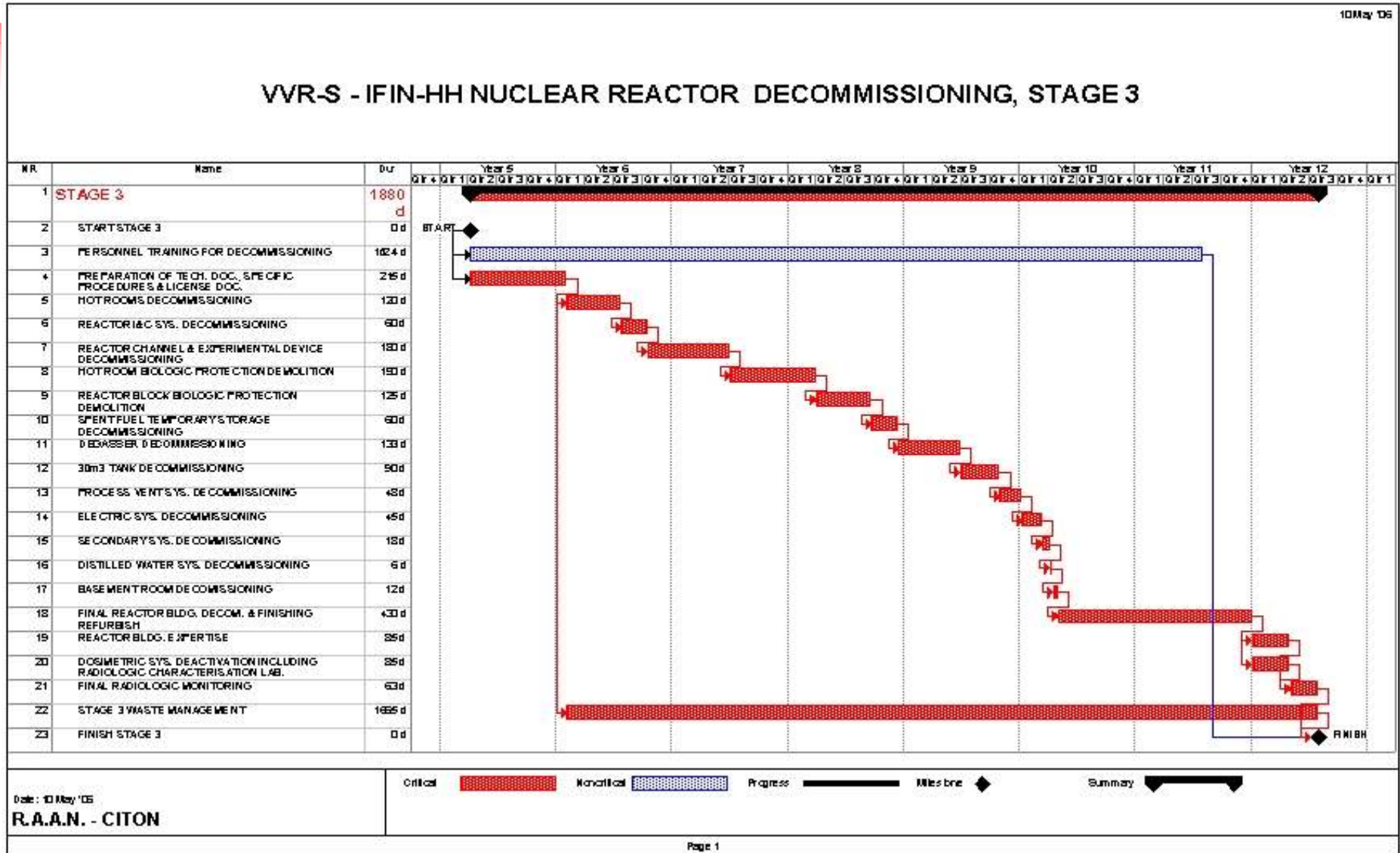


Date: 10 May '06

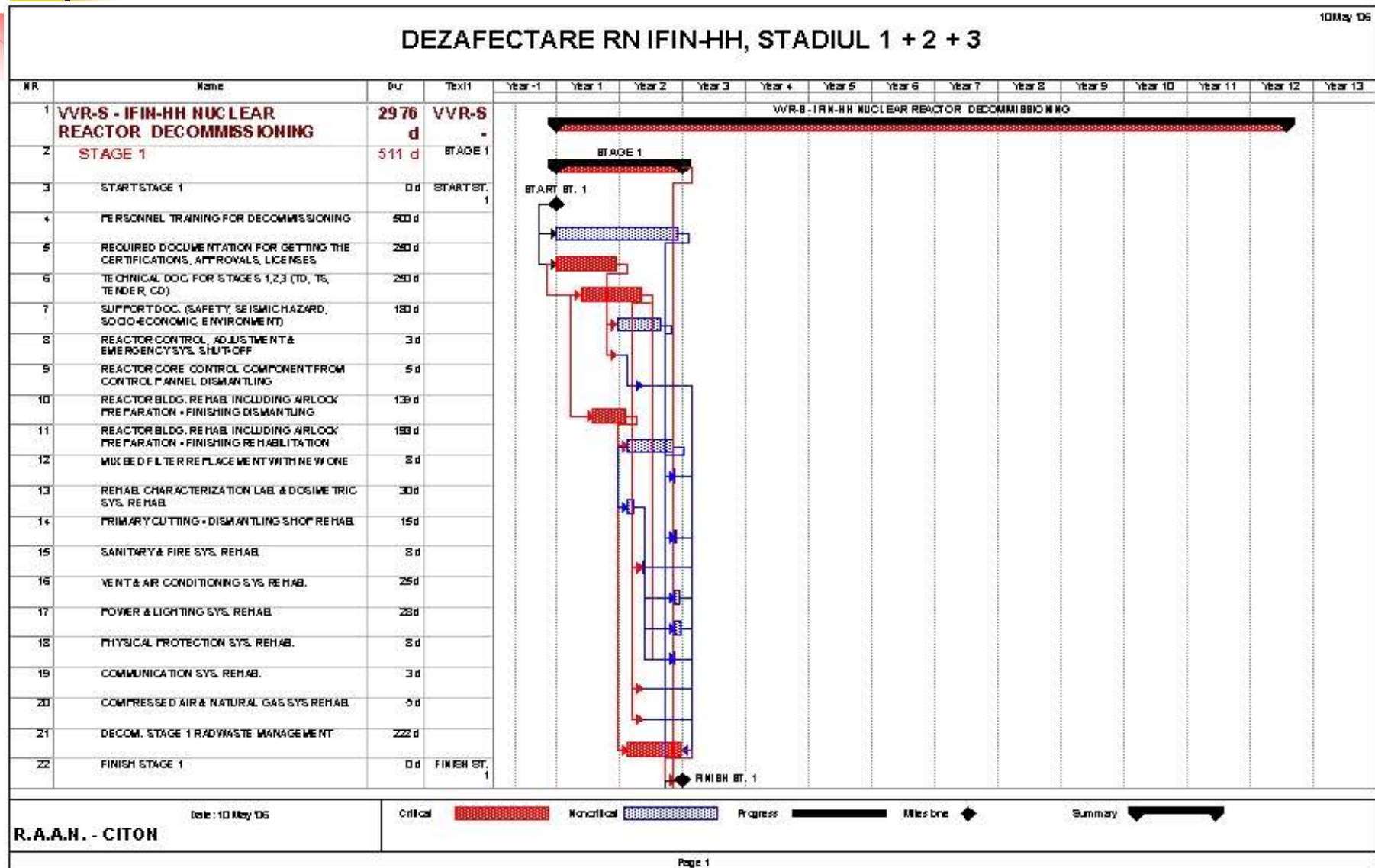
R.A.A.N. - CITON

Critical Noncritical Progress Milestone Summary

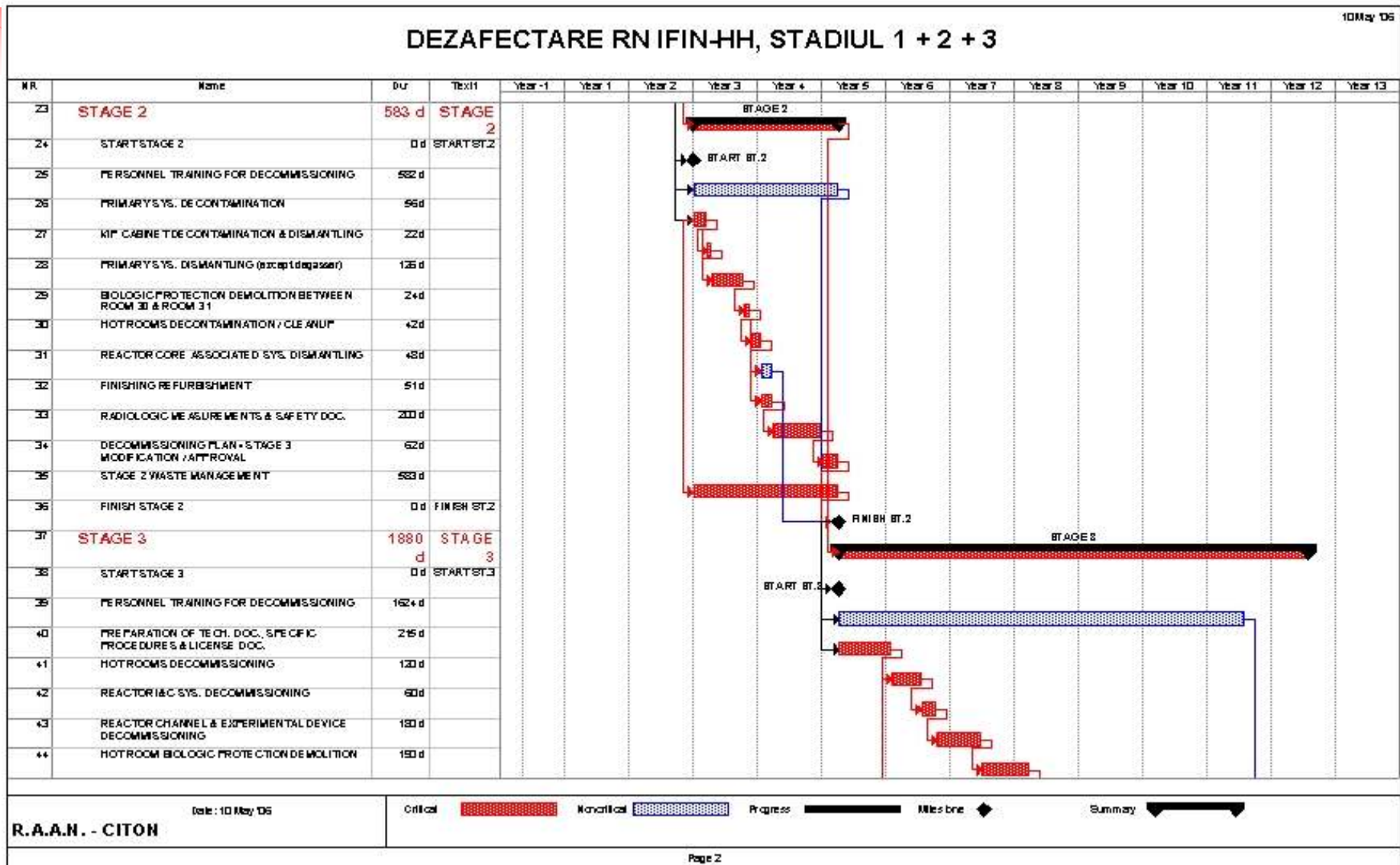
Presentation of decommissioning process;



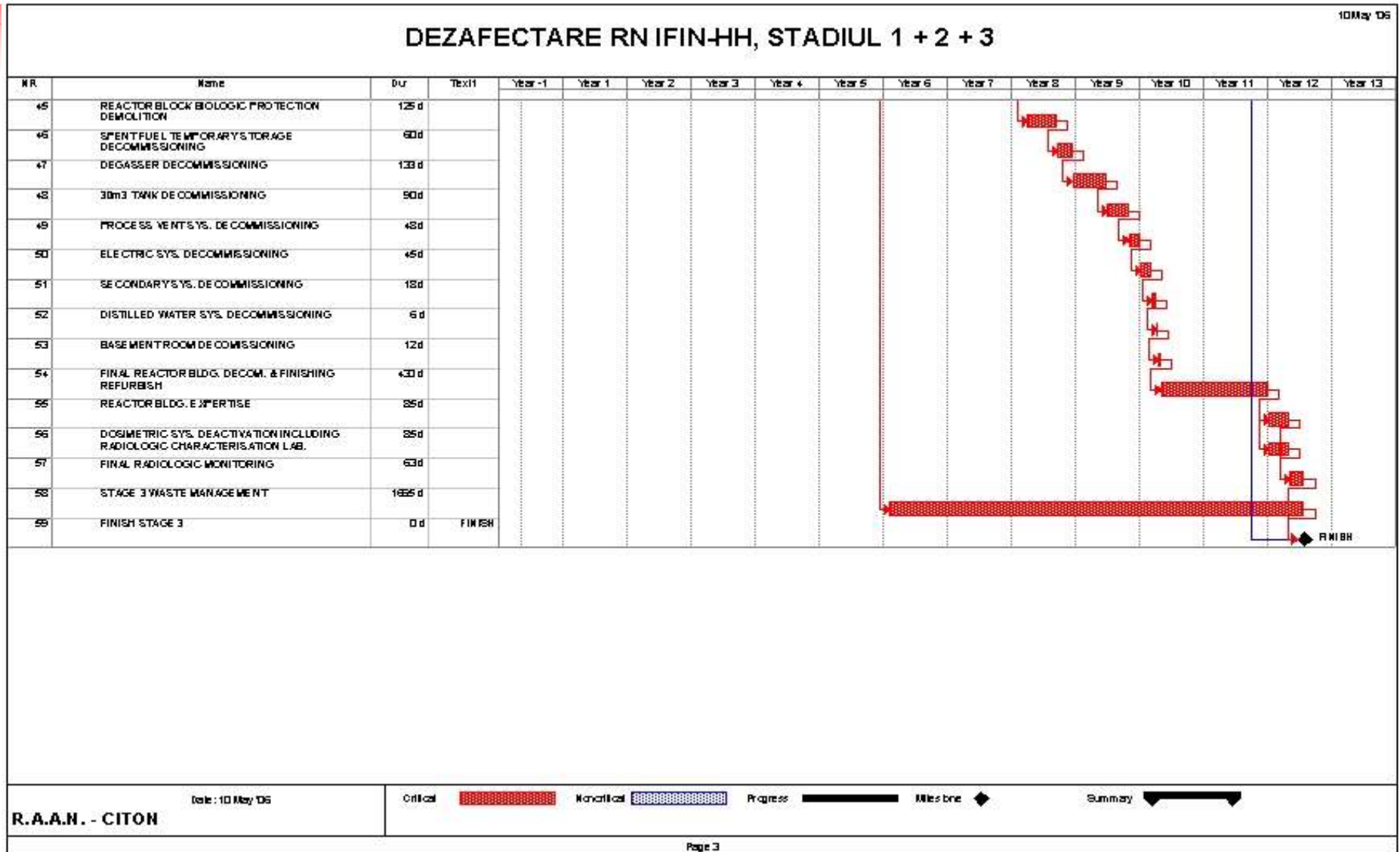
Presentation of decommissioning process



Presentation of decommissioning process;



Presentation of decommissioning process





Wastes resulted from decommissioning

- Activated waste:
 - concrete: 35 500 kg
 - Aluminum alloy: 650 kg
 - Graphite: 4 700 kg

Contaminated waste:

- Aluminum alloy: 2 865 kg
- Cast iron: 131 700 kg
- Stainless steel: 6 620 kg
- Concrete: 5 000 kg
- Water : 500 000 liters
- Resins: 1 100 kg
- Textile and plastics: 5 000 kg