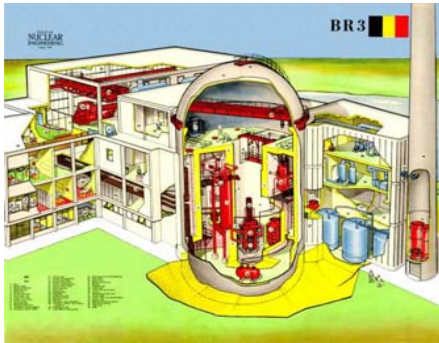




The BR3 Decommissioning project

J. Dadoumont

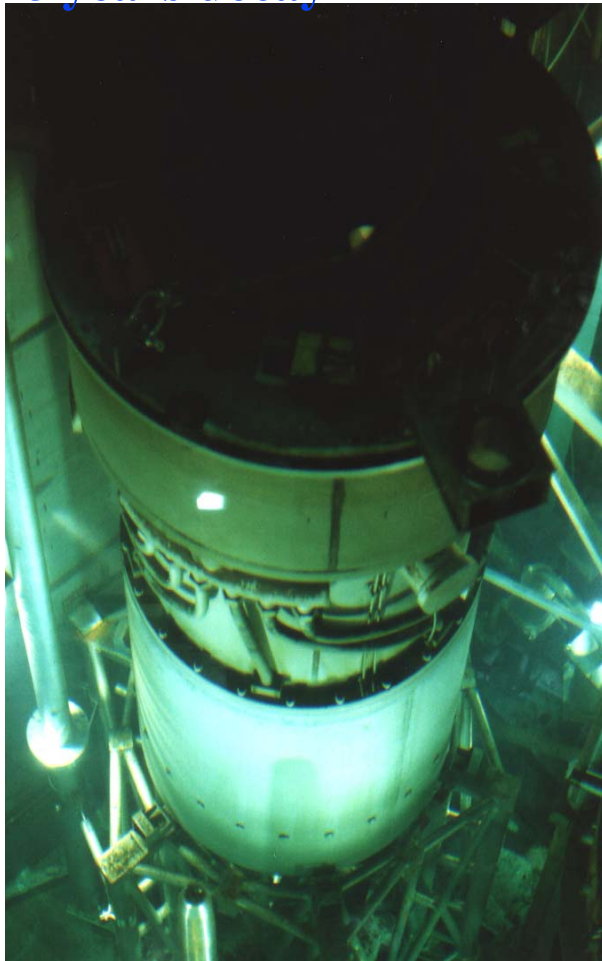
BR3: First PWR in Europe, First to be dismantled



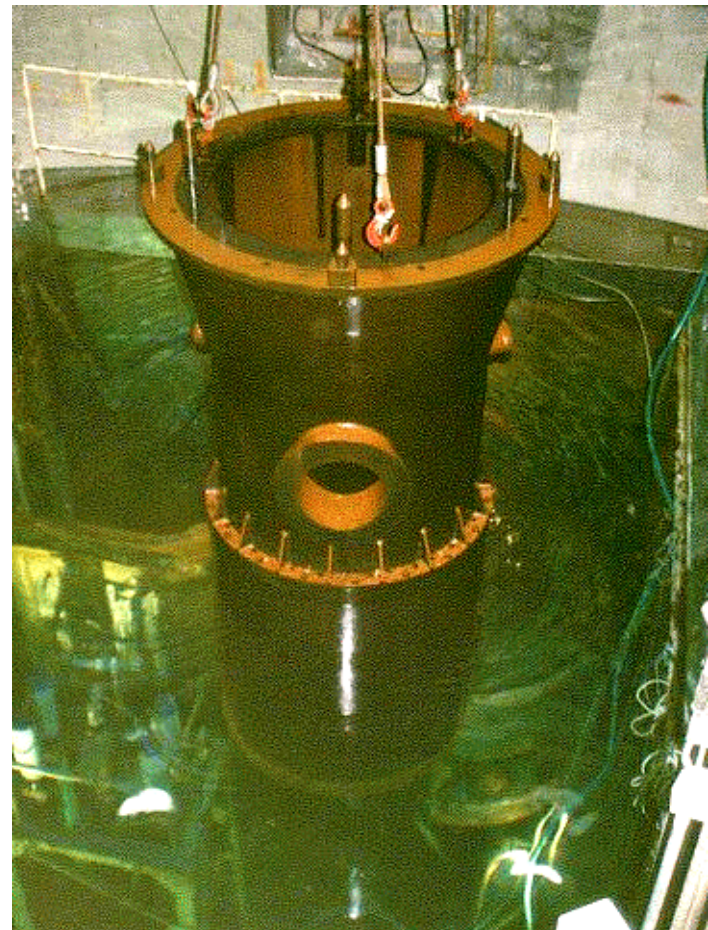
- **Type:** Pressurized Water Reactor (Westinghouse)
- **Power:** 40.9 MW_{th}, 10.5 MW_e (net)
- Started in 1962, shut down in 1987, i.e. a working life of 25 years
- 3582 EFPD in 11 operating campaigns
- Primary loop = 1.5 loop (1 SG, 2 pumps)
- Served as training center for future NPP operators and as test bench for advanced PWR fuel

Two sets of Internals were dismantled
This allowed to compare D&D strategies

**The "Vulcain" Internals:
8 years decay**

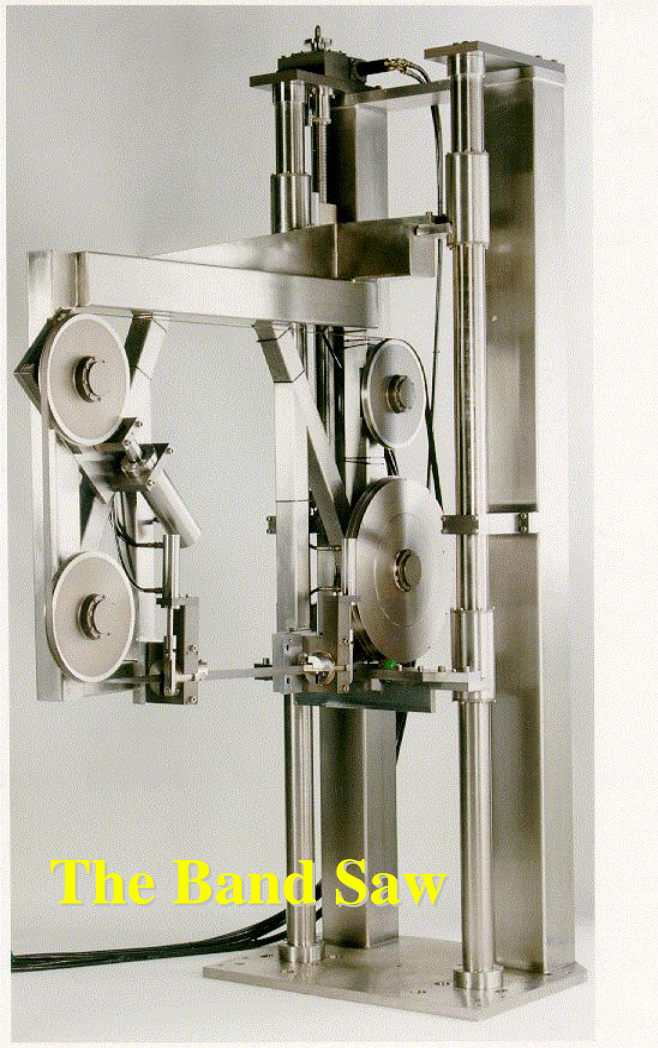
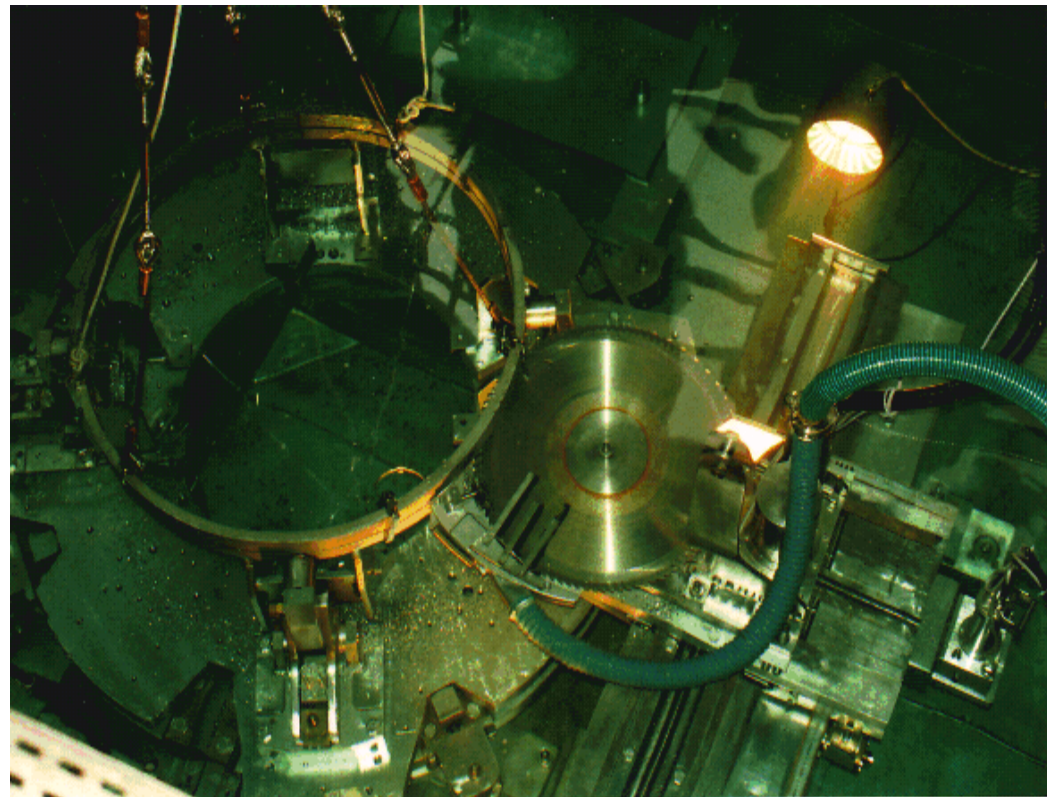


**The "Westinghouse" internals :
30 years decay**



Remote controlled underwater mechanical cutting has been extensively used

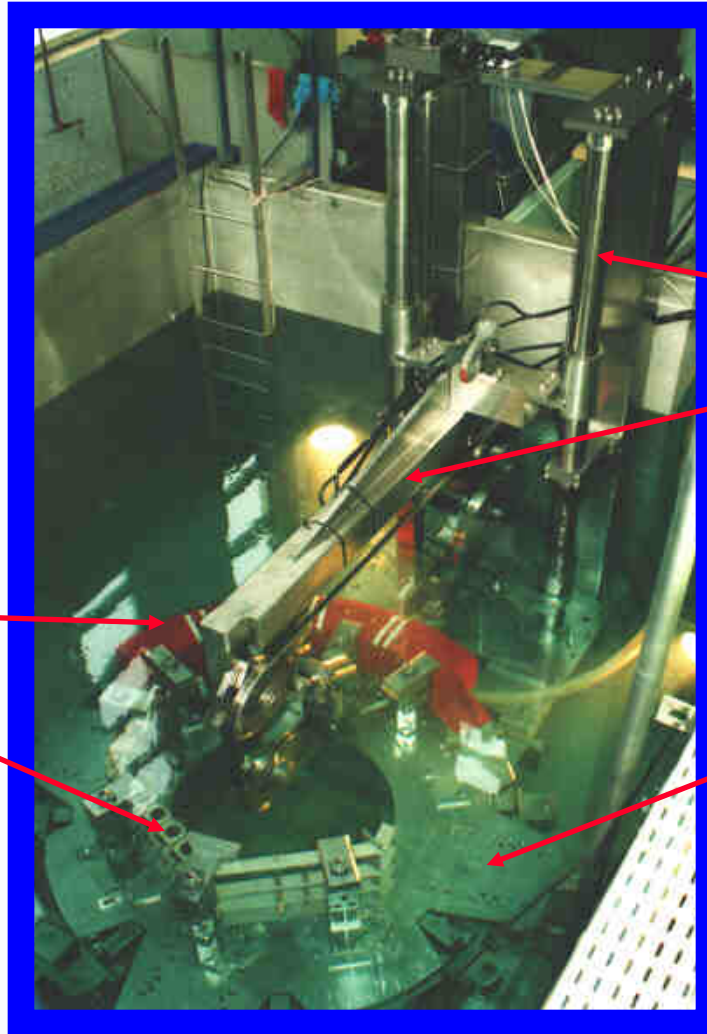
The Circular Saw



The Band Saw

All important operations started with: cold testing in a test tank

Models



Bandsaw

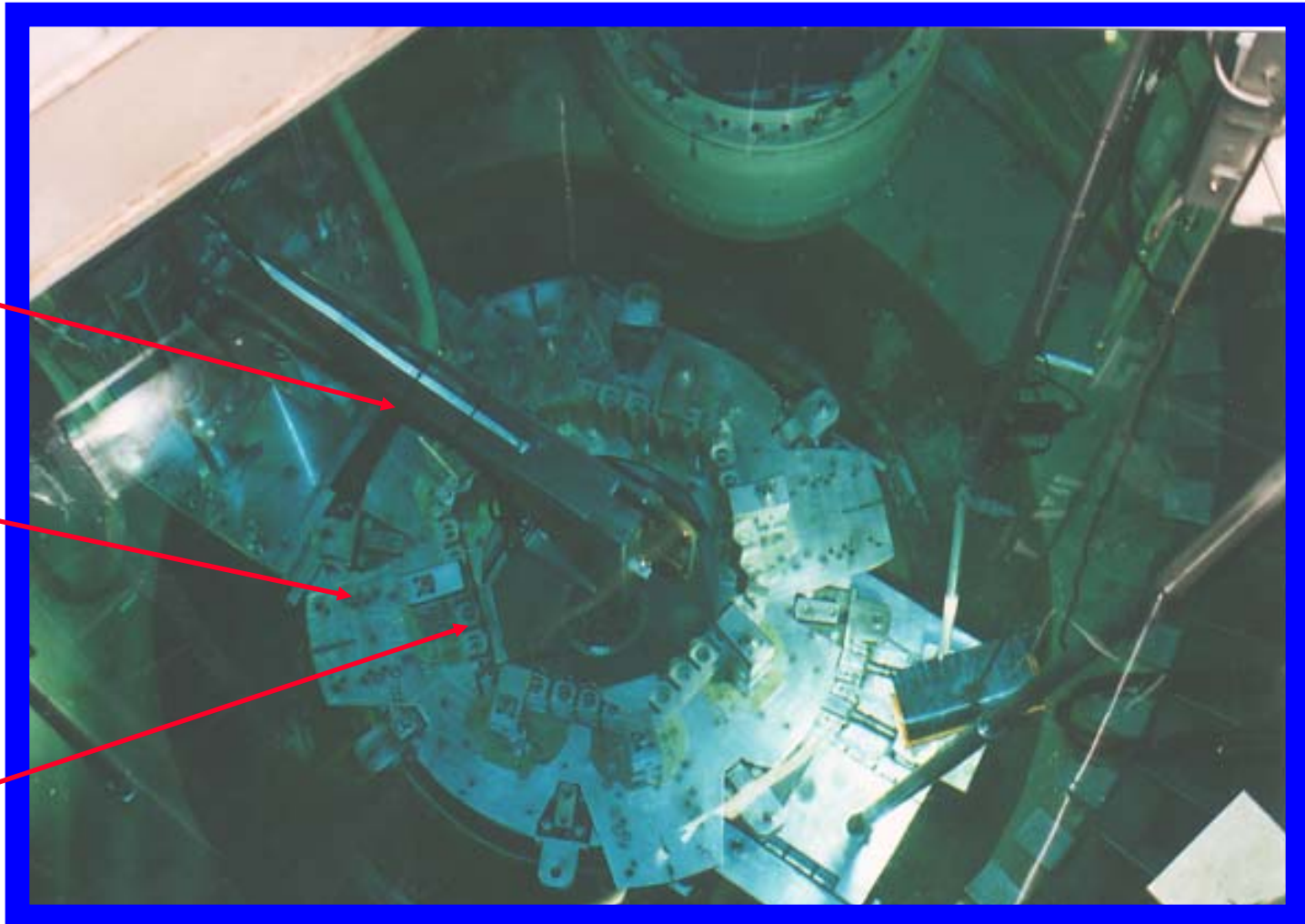
Turntable

...followed by application in the reactor pool

Bandsaw
frame

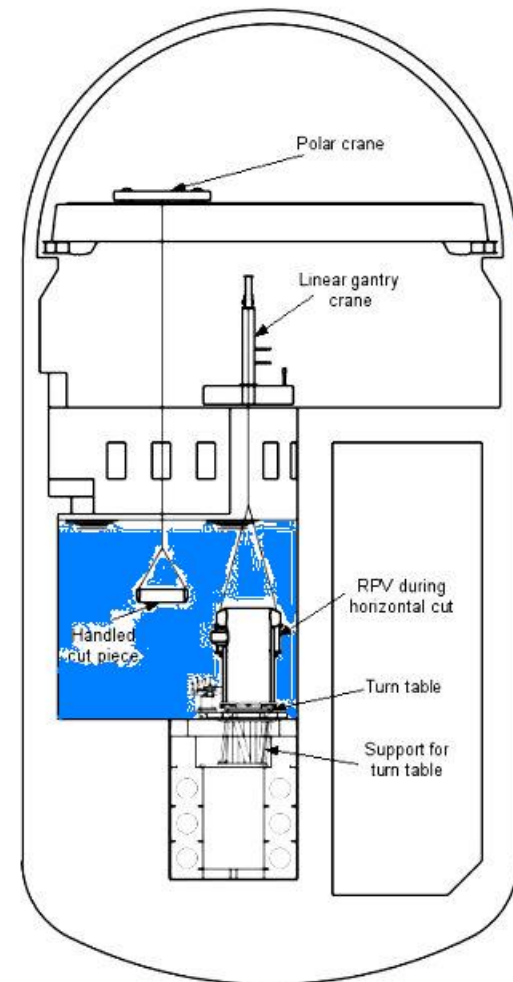
Turntable

Workpiece
(core baffle)

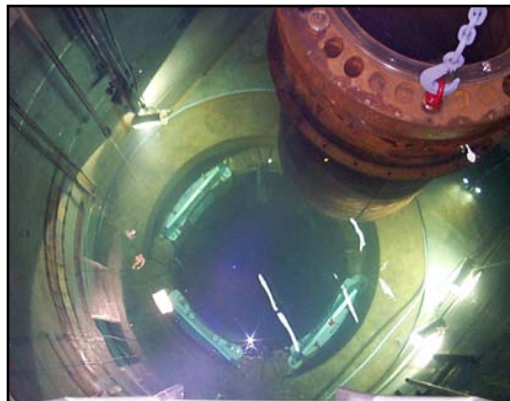
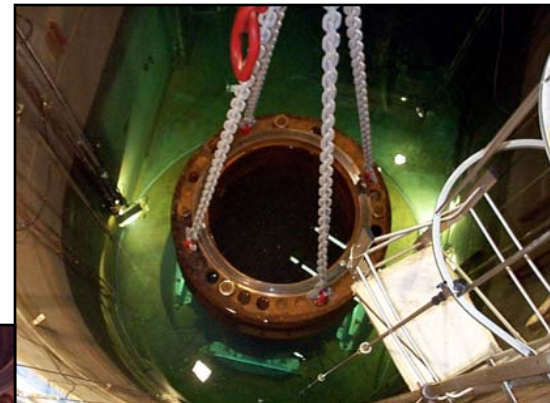


Reactor Pressure Vessel Removal

- Disconnect RPV from primary loop
- Lift RPV into refueling pond
- Re-instate pond integrity
- Cutting of RPV



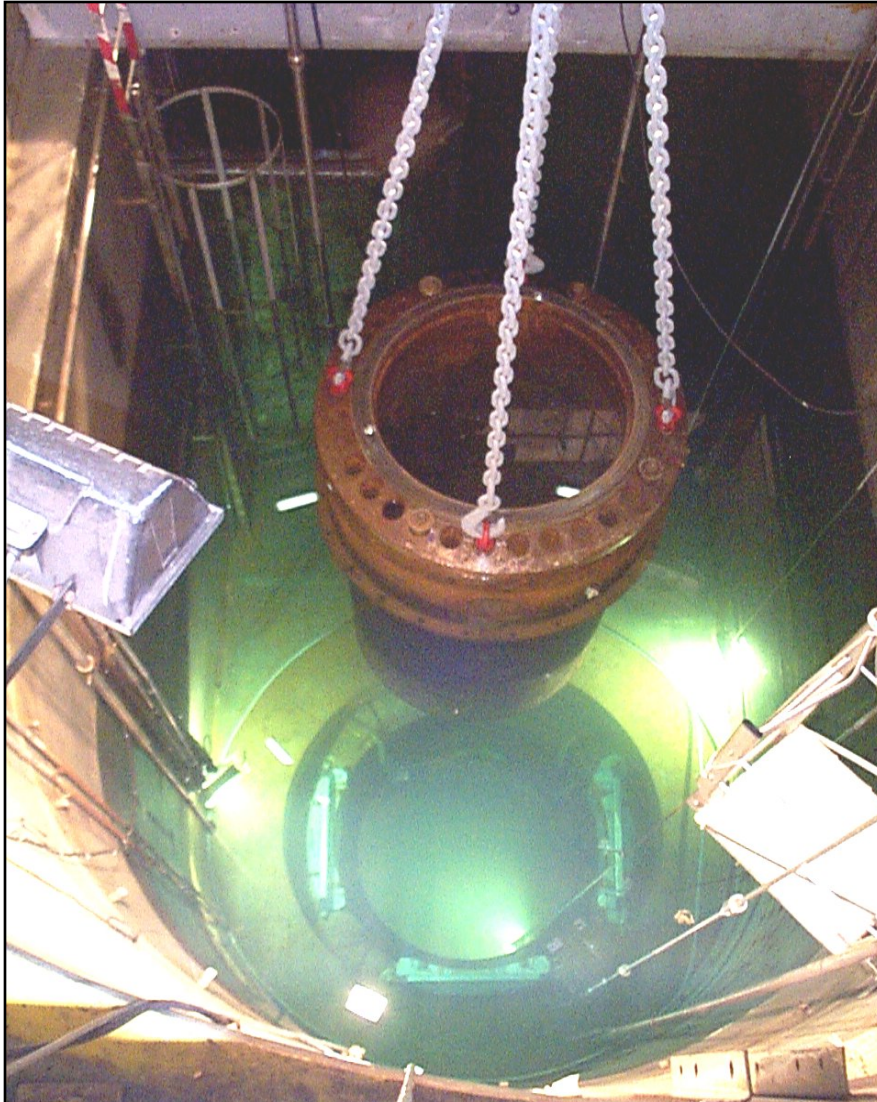
After one year preparation work, the RPV could be lifted





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...without any problem!



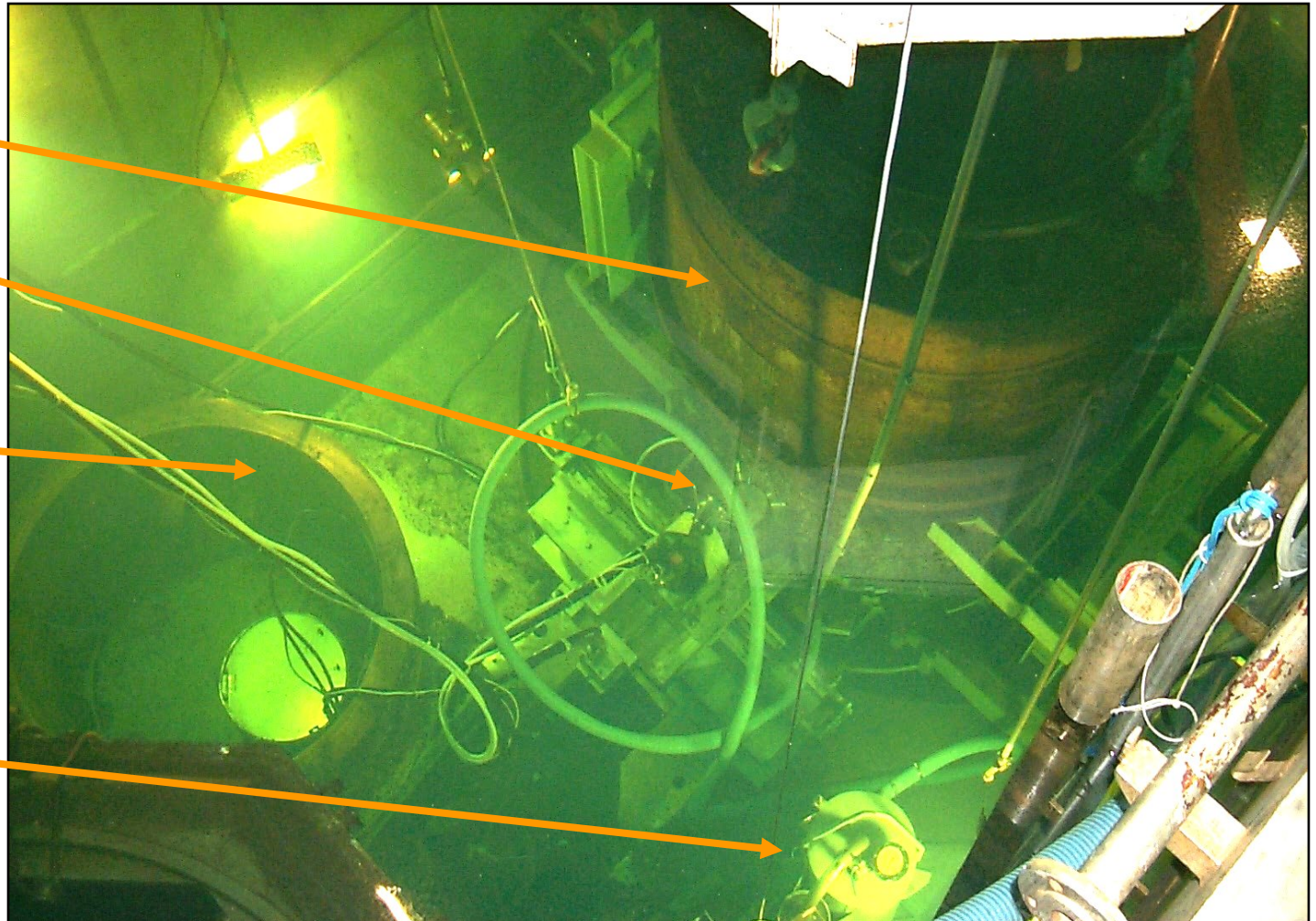
General view of the RPV dismantling yard in the pool

RPV

Circular saw

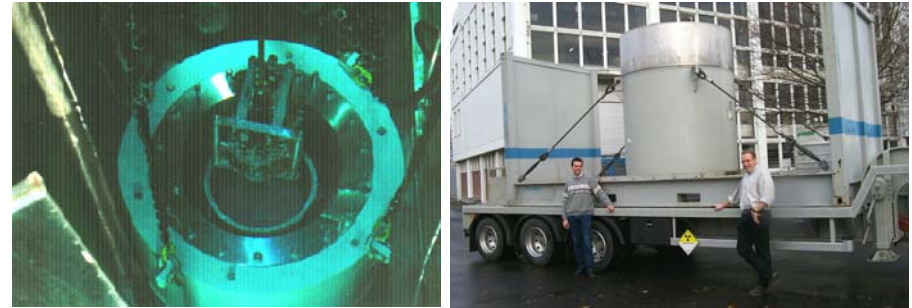
Cut rings
storage

Swarf filtration
pumping station

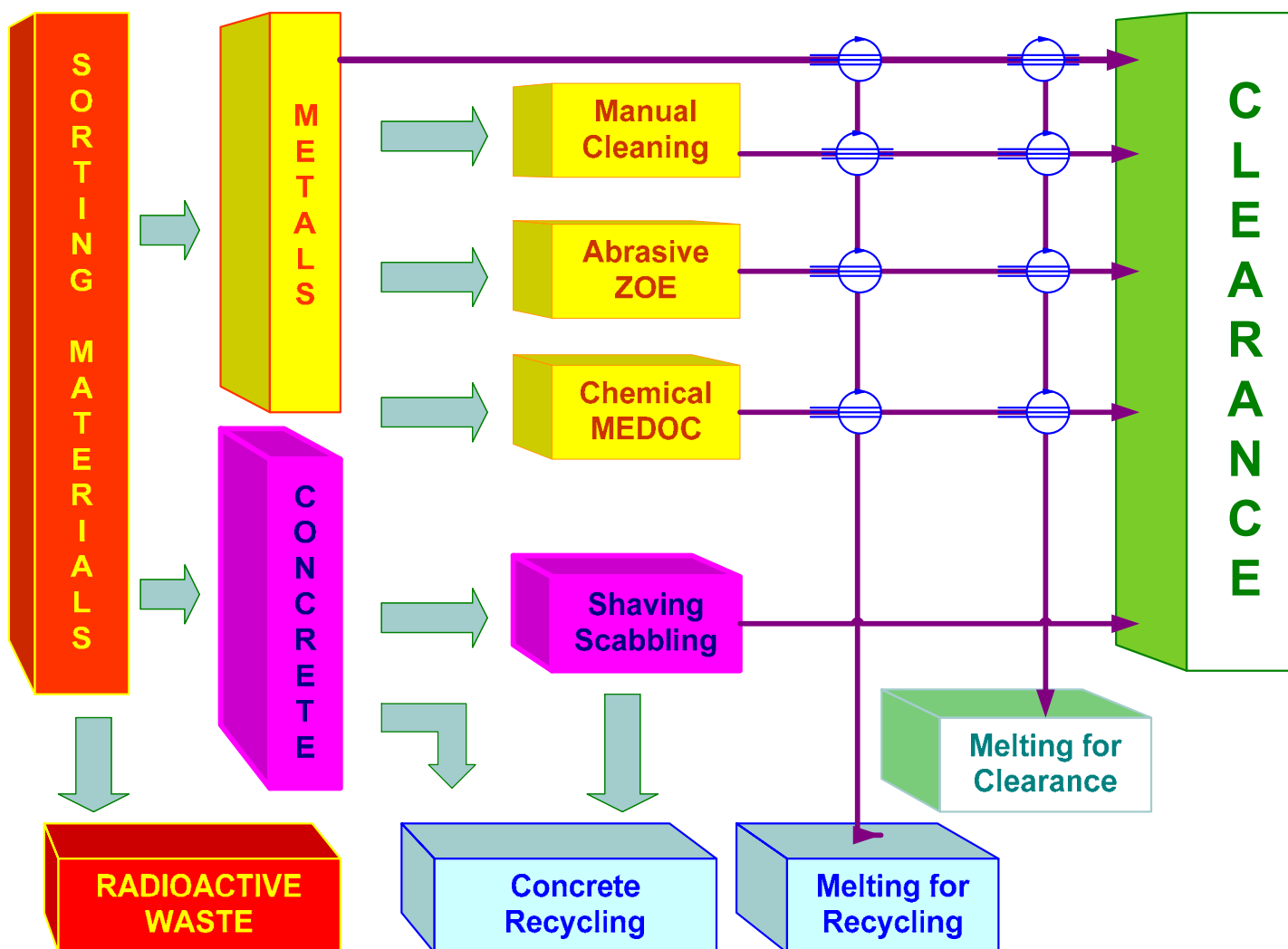


The waste management varies from one category to the other:

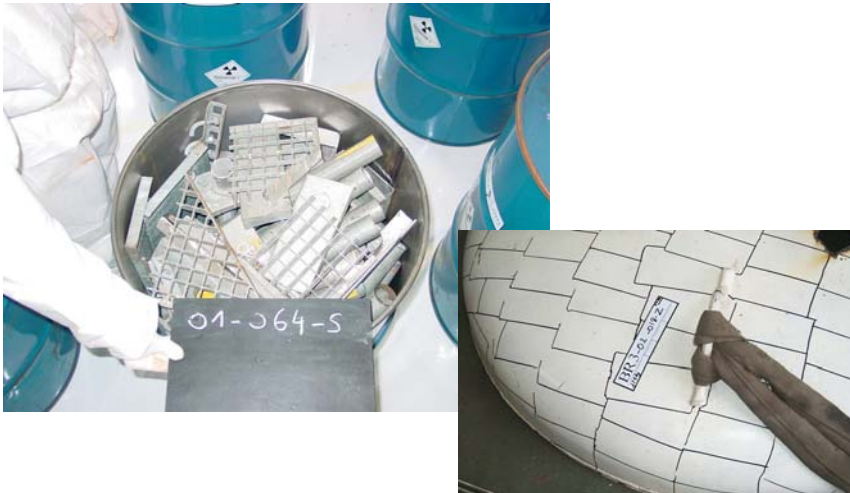
- The HLW and ILW (contact dose rate $>2\text{mSv/h}$): require radiological protection and special evacuation ways & procedures.
- The LLW (important volume: about 5000m^3): most of them can be decontaminated up to a "free release" level, or can be reused or recycled.
- The VLLW, representing the largest volume and including the decontaminated LLW, are intended to be free released.



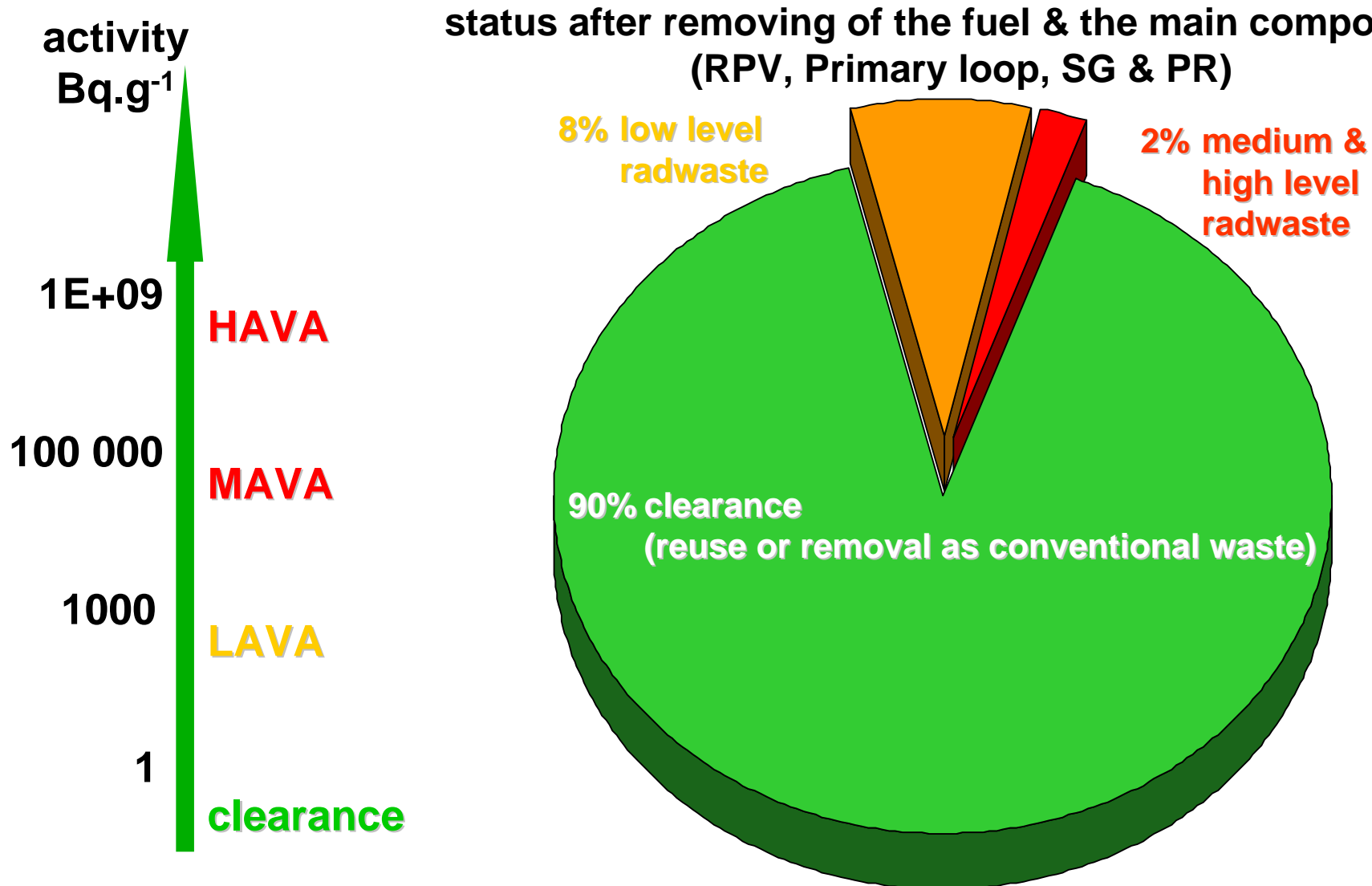
Removal routes BR3



...all the material
management is carried
out under a QA system
conform to ISO-9002

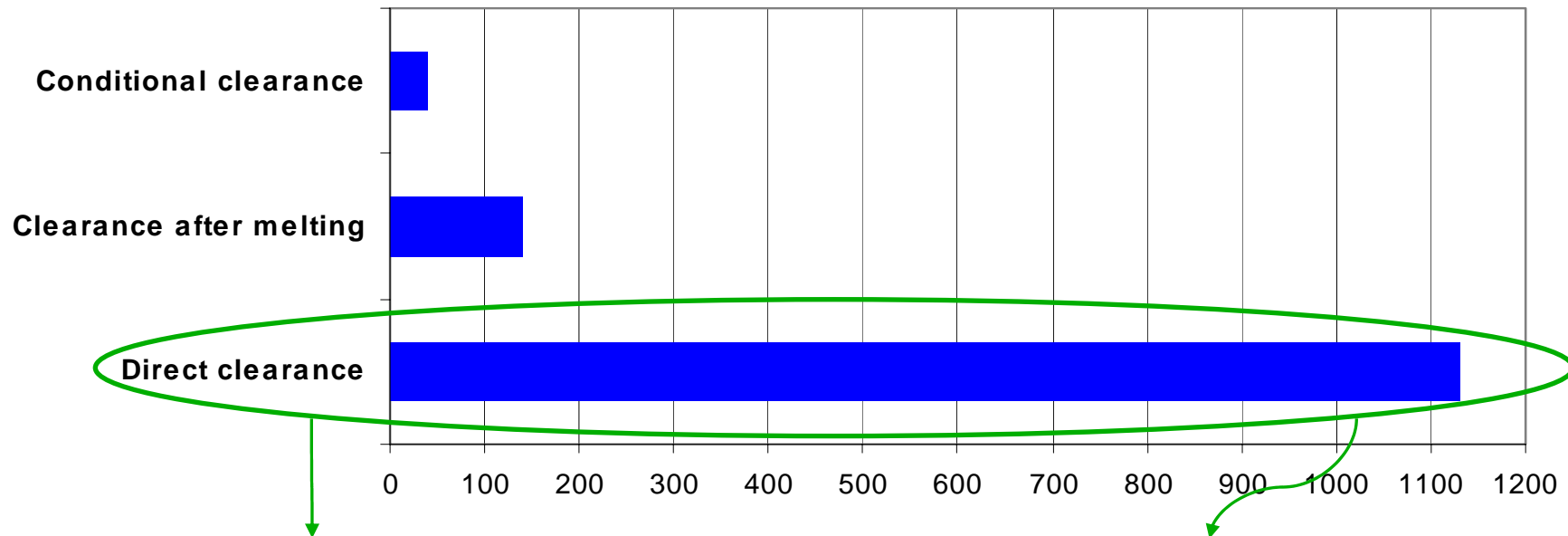


Up to now radwaste generated has been economically and safely reduced to a minimum

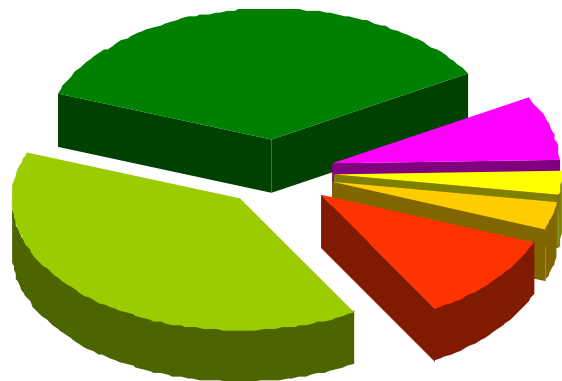


Component clearance practices

clearance methodologies used: from simple to more complex

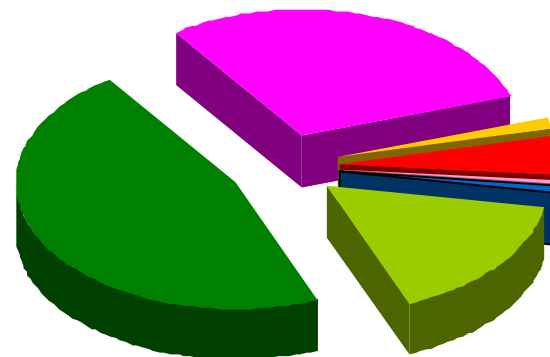


about 450 tons of metals



- History (Hand Held)
- Hand Held
- Hand Held+Sampling
- Hotspot+Q²
- Hand Held+ISOCS
- Hotspot+ESM+Q²

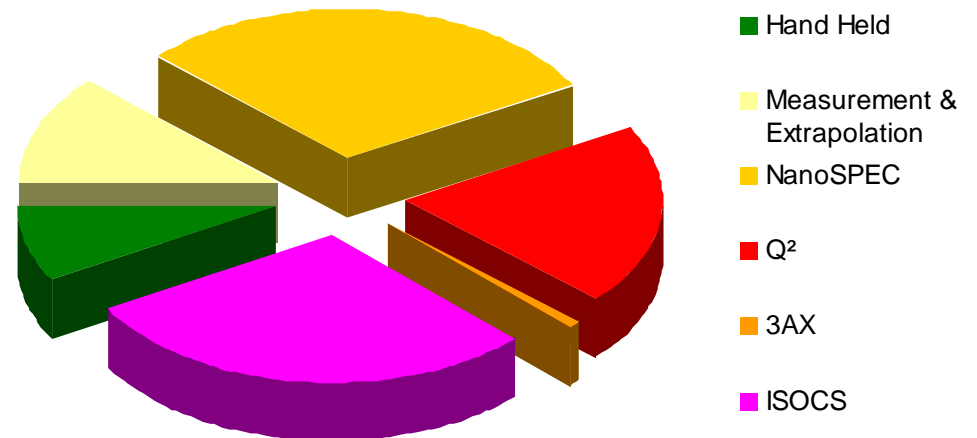
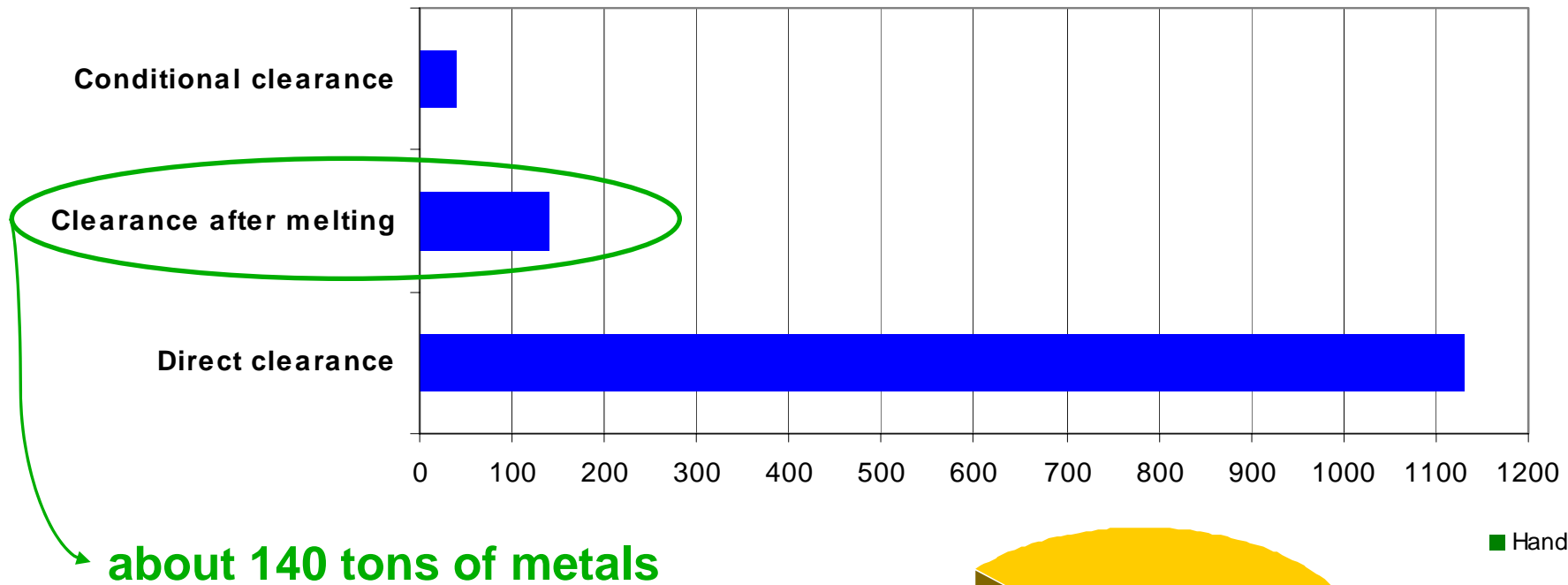
about 700 tons of other materials



- History (Hand Held)
- Hand Held
- Hand Held + Sampling
- Hotspot + ESM
- Q²
- Hotspot+ESM+Q²
- Sampling+Q²

Component clearance practices

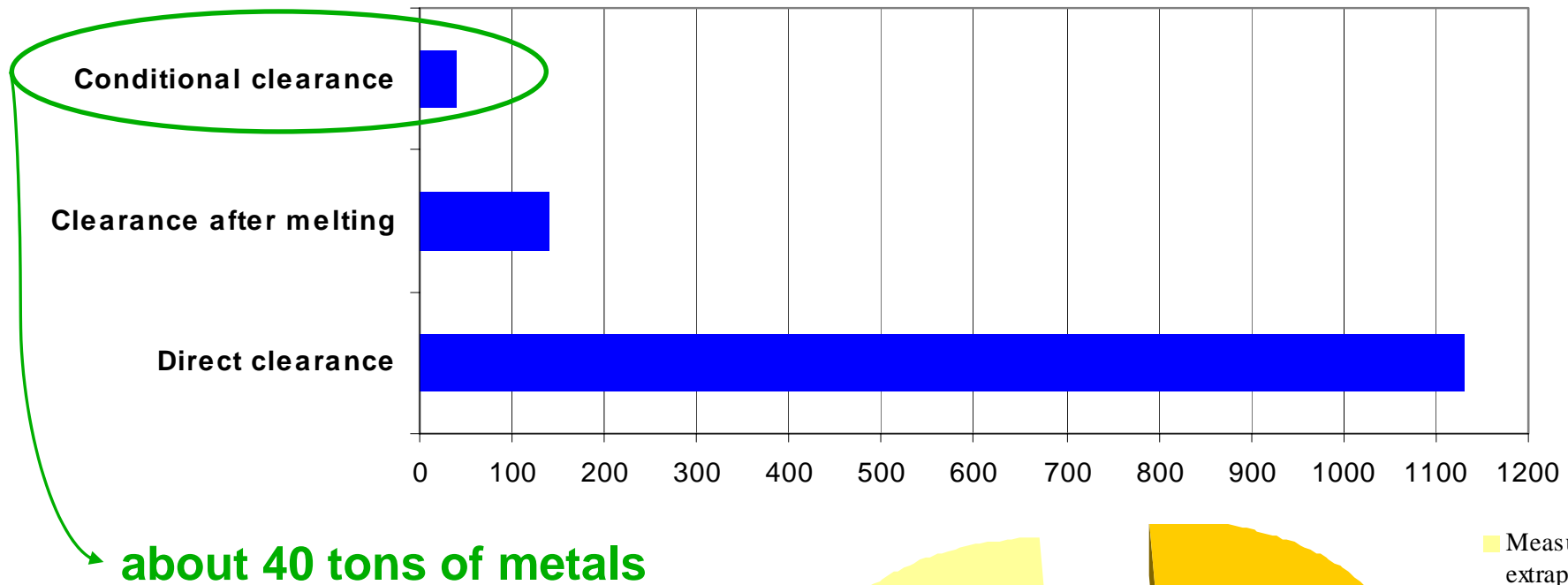
clearance methodologies used: from simple to more complex



clearance measurement based on sampling & analyses by Studsvik (S)

Component clearance practices

clearance methodologies used: from simple to more complex

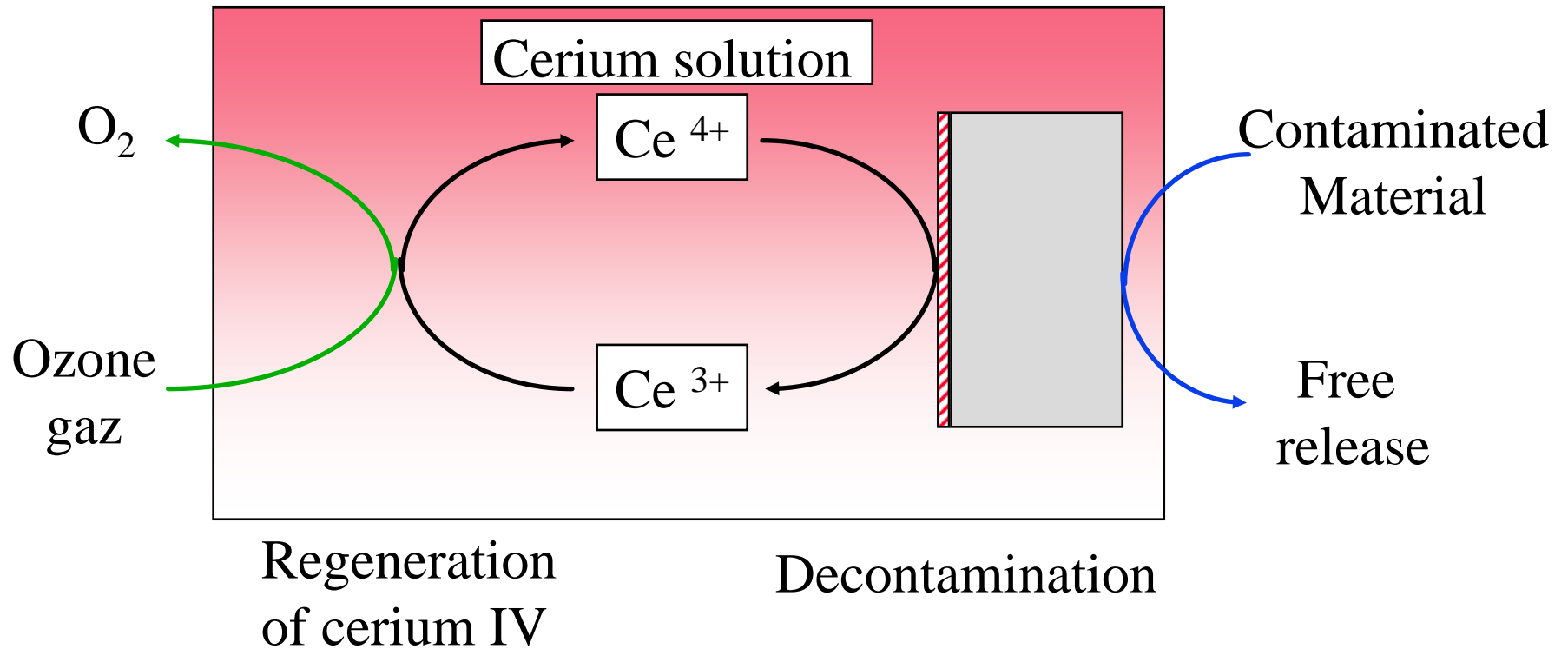


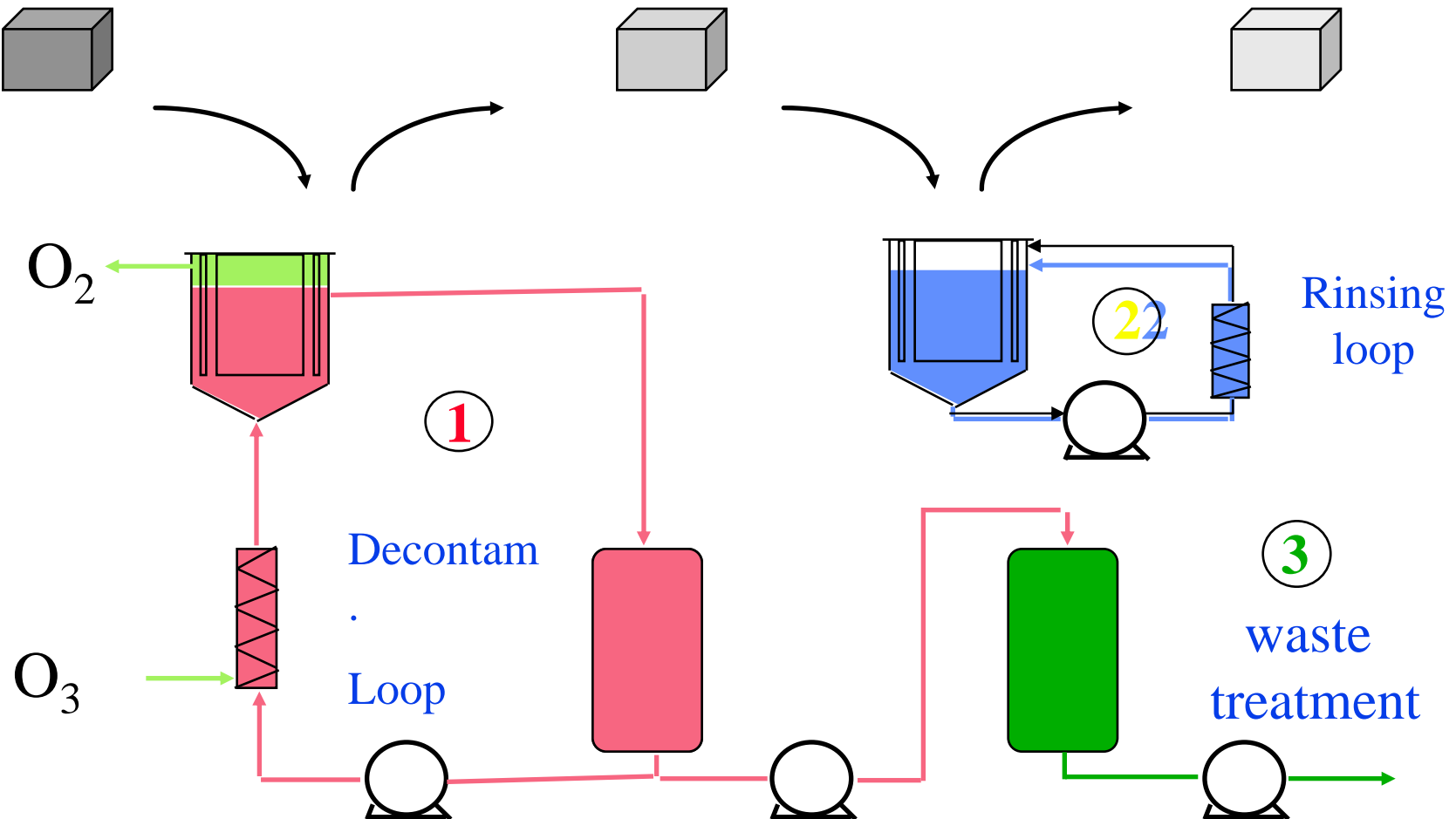
Clearance measurements & Reuse in the nuclear sector by Duratek (USA)

The decontamination processes

- We use mainly three decontamination processes on-site:
 - hand wash and cleaning (for very slightly contaminated parts)
 - wet sand blasting process and polishing (in a confined and ventilated booth)
 - hard chemical decontamination (using the Cerium-IV process, called MEDOC (patented))

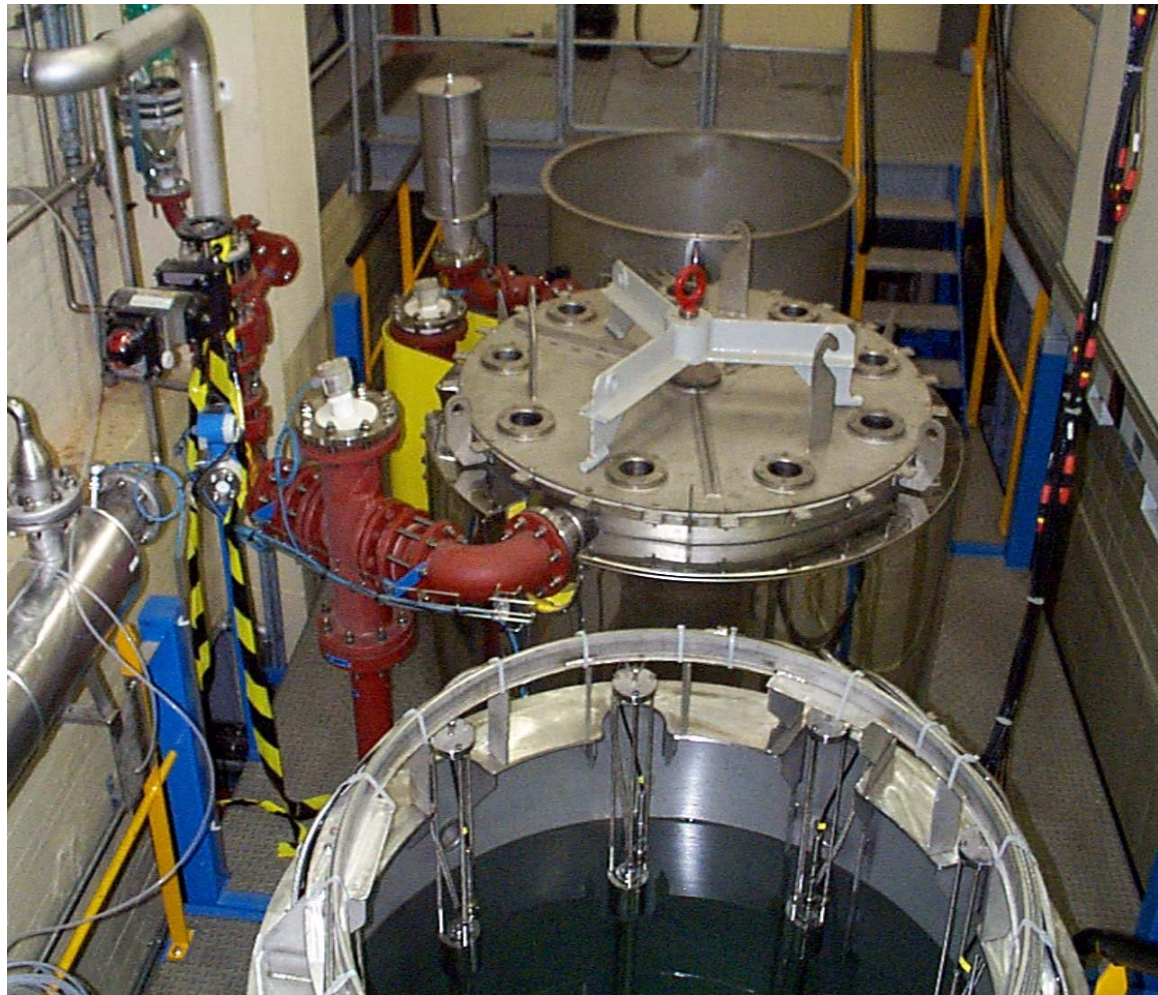
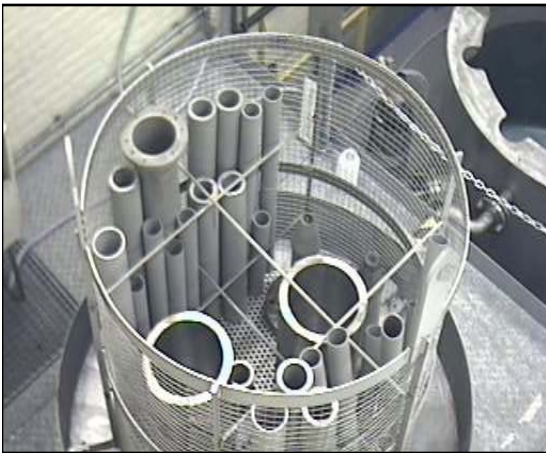
MEDOC hard decontamination: Only **one step** treatment



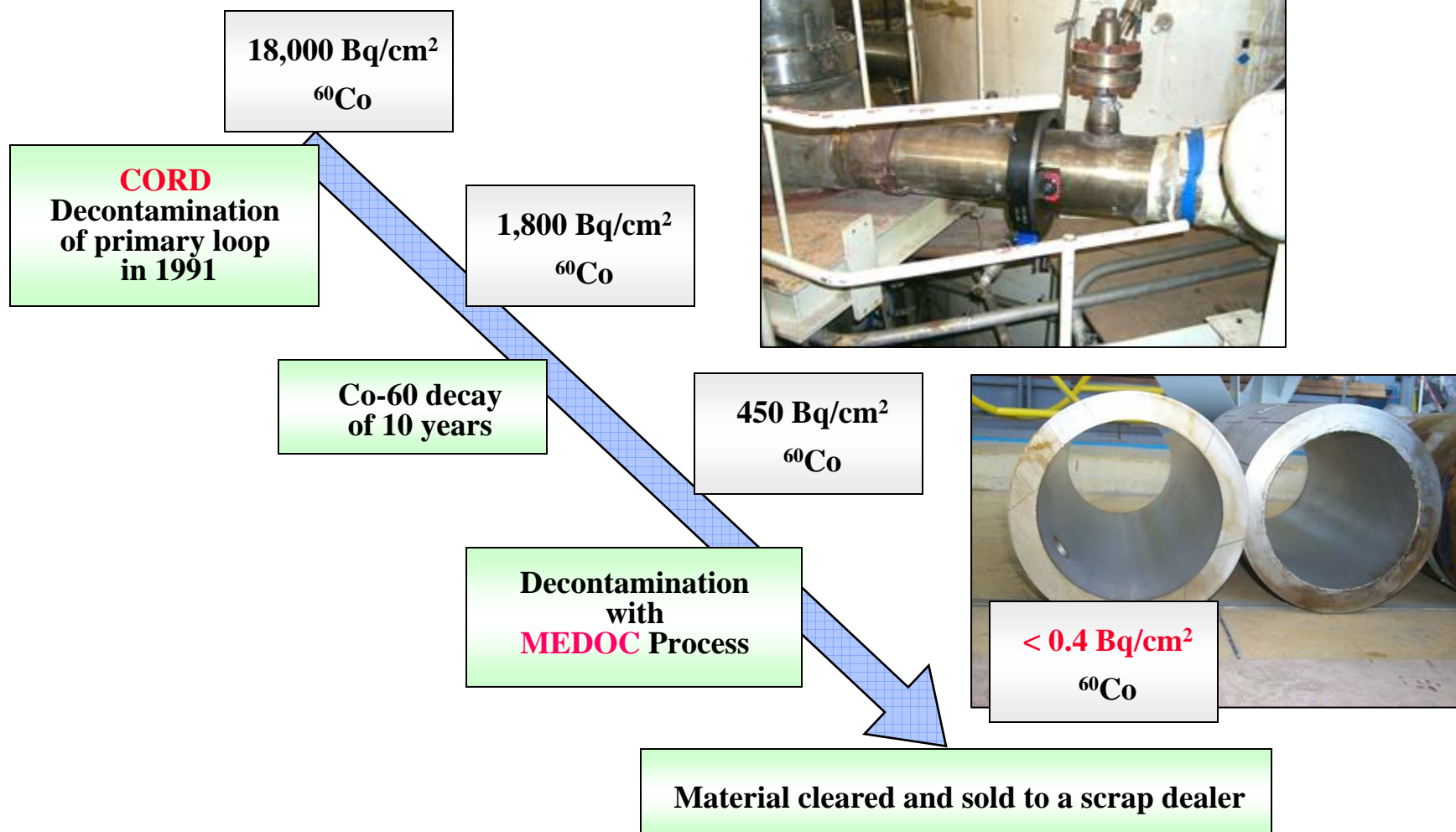


View of the MEDOC Installation Thorough chemical decontamination

Results:
More than 85% free
Waste reduction ~95%



Clearance of the BR3 primary pipes

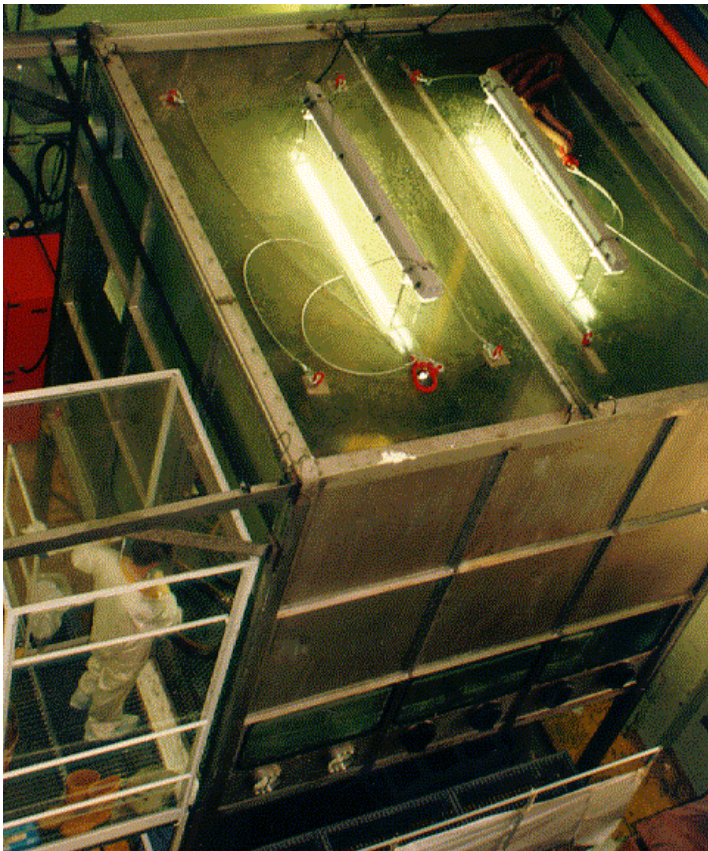


BR3 Primary pumps decontaminated with MEDOC



Wet Sand Blasting decontamination in a ventilated booth: the ZOE unit

Roof opening for large pieces



Walk-in Booth



Operator at work

Decontamination of Building structures (mainly concrete)



Concrete decontamination : heavy manual operation



All surfaces...



Building structure clearance practices element categorisation

0
"Cold"

- Location: outside controlled area
- Contamination risk: excluded
- Decontamination (& Characterization): not required

0 mm

1
"Suspected"

- Location: inside or outside controlled area
- Contamination risk: aerosols or dust (not confirmed)
- Decontamination: coating or base material removal

1 mm

2
"Contaminated"

- Location: inside controlled area
- Contamination: aerosols or dust (confirmed), no migration
- Decontamination: base material removal

~5 mm

3
"Severely Cont."

- Location: inside controlled area
- Contamination risk: liquids, possible migration
- Decontamination: case by case

~20 mm

4
"Activated"

- Location: close to RPV
- Contamination: activation
- Decontamination: case by case

several dm

building structure clearance practices equipment & clearance methodology



Categorie	Surface Control Measurements (α , β/γ)		Bulk Control Measurements (γ)		Drilled Holes Control Measurements (β/γ)	
	% Surface	Equipment	% Surface	Equipment	% holes	Equipment
0	0	-	0	-	0	-
1	25 - 100	Electra 600 (or ISOCS)	-	-	0	-
2	25 - 100	Electra 600	50 - 100	ISOCS	100	GM
3	100	Electra 600	100	ISOCS	100	GM

2 “interesting” cases:

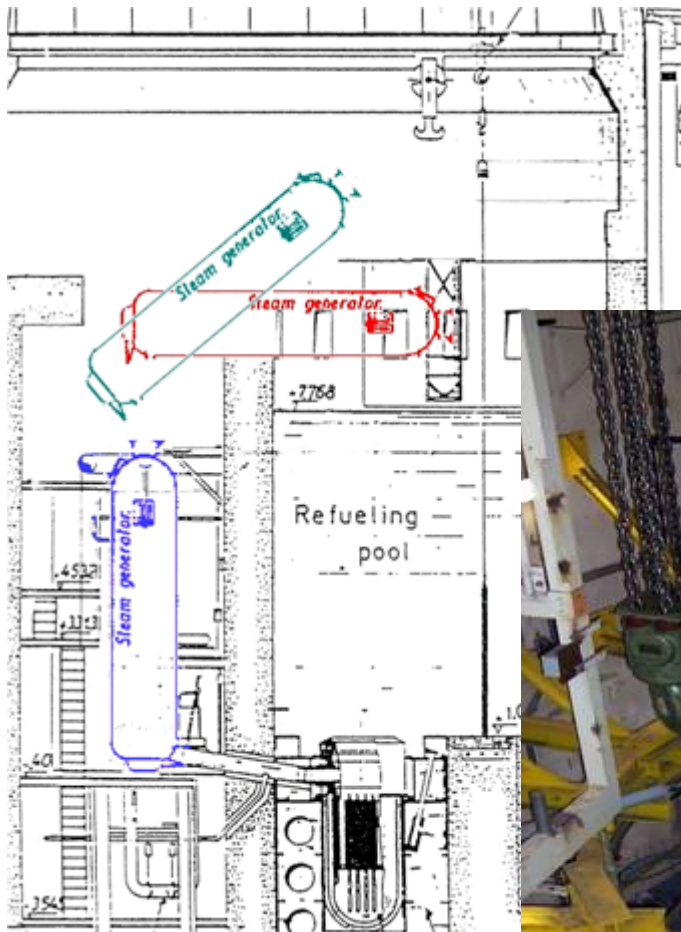
1) the BR3 SG removal/dismantling/decontamination

2) encapsulated lead melting

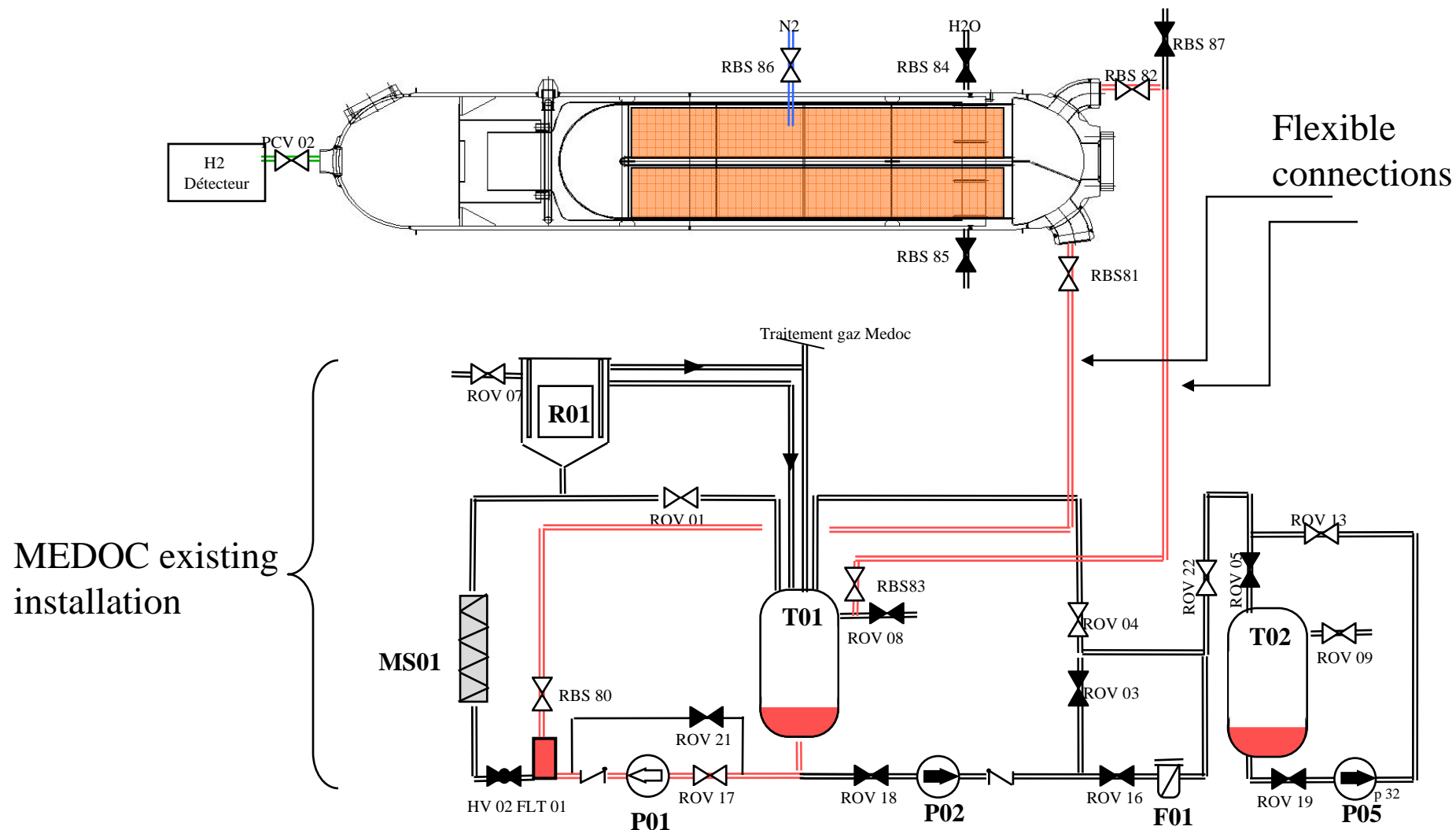
Objectives: economical material management and safe clearance by technology combination

Handling of the SG before decontamination

The SG has been lifted and placed horizontally to allow complete filling of the primary side



A quick view on the used installation (connection to the MEDOC loop)



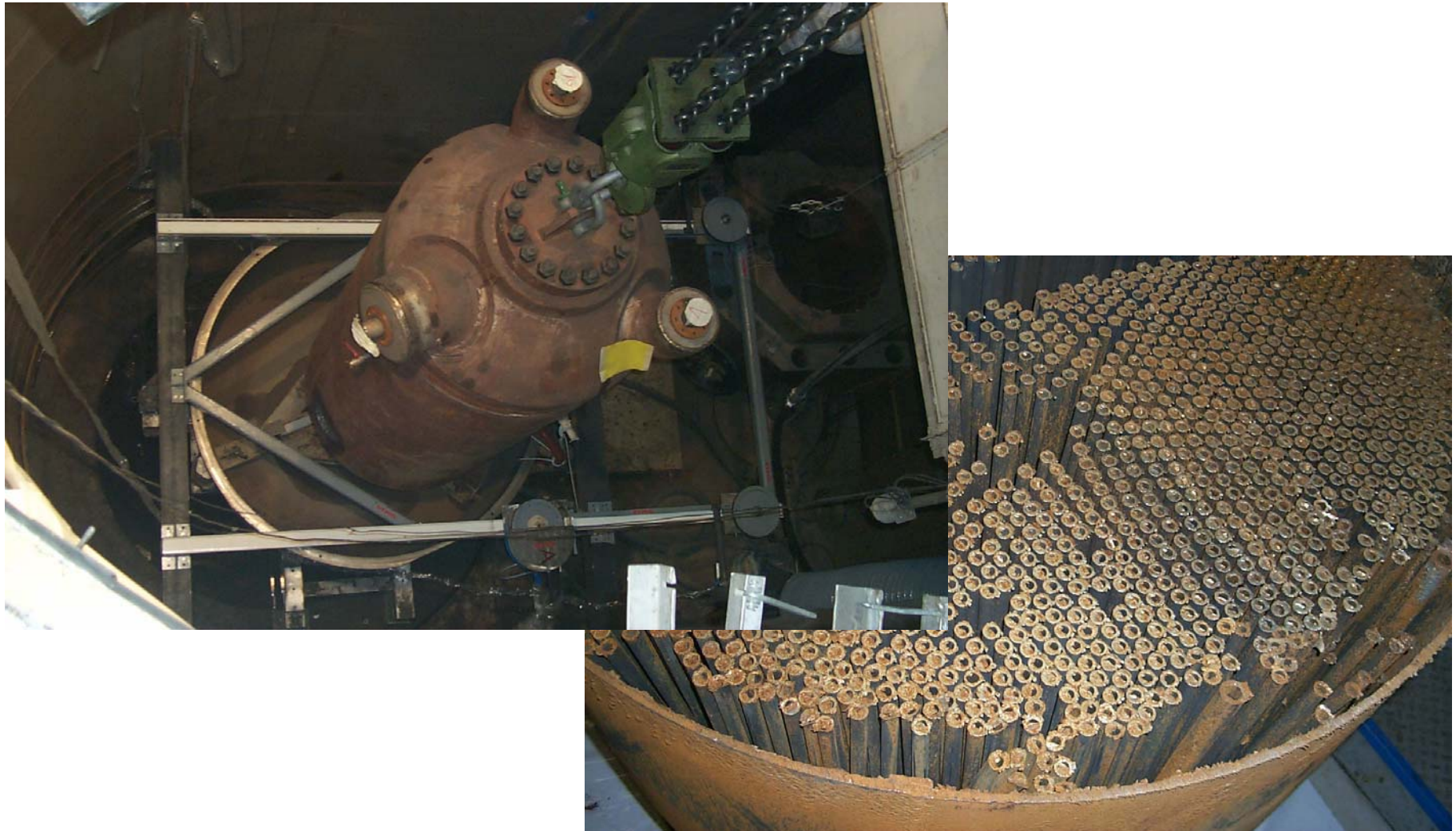
SG cutting using AWJC





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SG cutting using Diamond wire



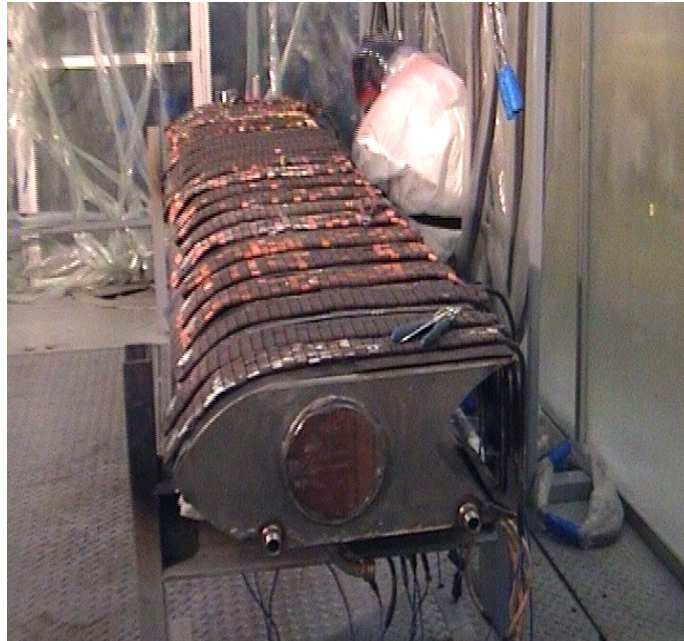
Lead melting

- 34 ton of lead
- 10 shielding pieces : Cs or SS shell filled up with lead
- Radiological resuming description: not contaminated lead inside contaminated containment
- “Separation technology” required

First piece being placed horizontally



Heating components (third preparatory operation)



Insulation installation (last preparatory operation)



Heating (few hours)



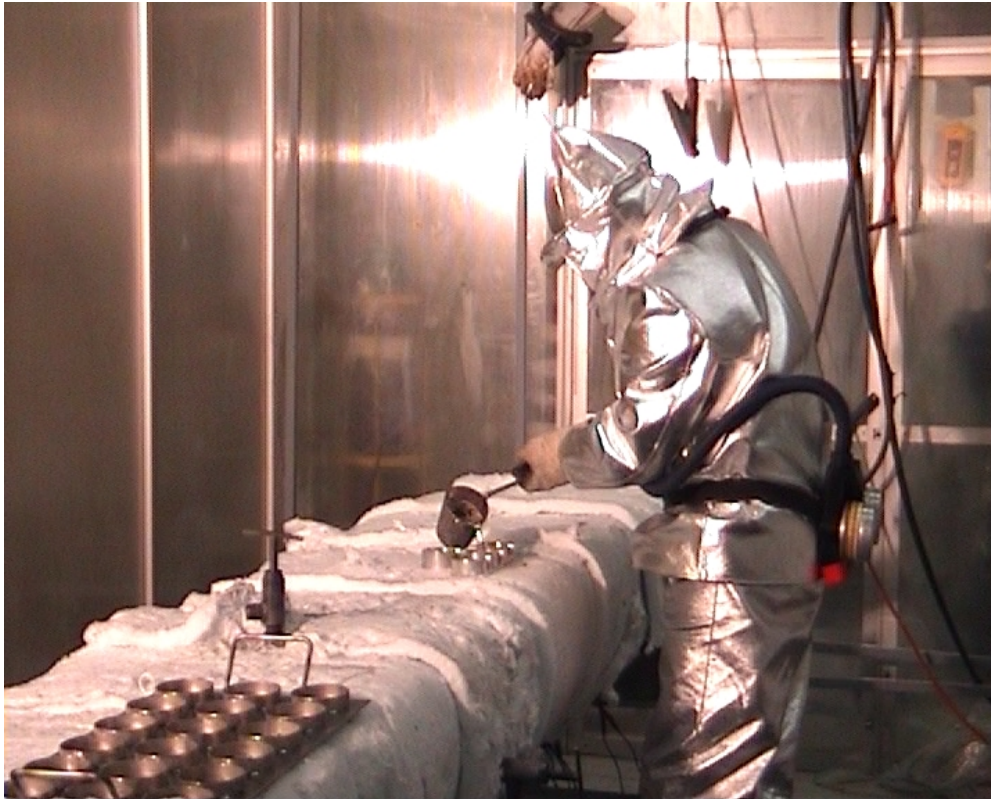
Melting operation almost ready



The melting



Sampling during operation



One sample
per melted
block



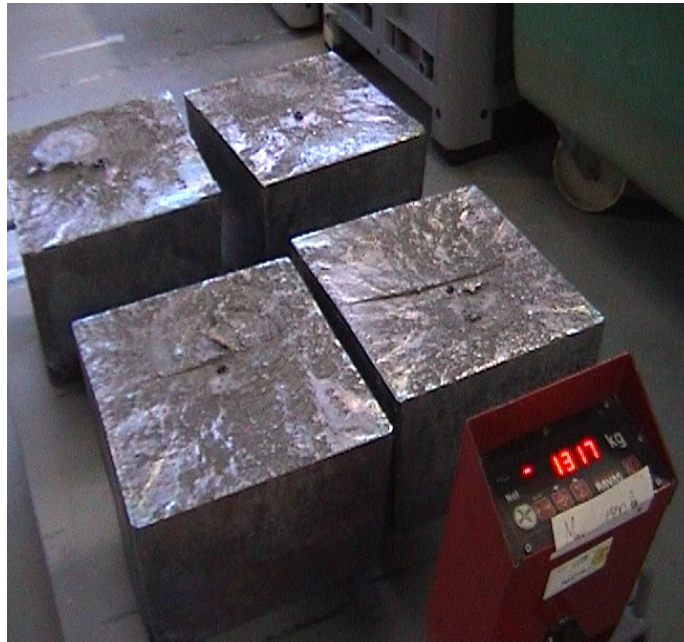
Cooling area



Removal of lead block



Final check of quantities



Measurements

- 10 pieces (7 with SS shell; 3 with CS shell)
- About 12 blocks for each piece
- One sample for each block
- One sample every two sent to gamma and alpha spectrometry
- Each last three samples of each piece also sent to spectrometry (top of liquid lead)
- 100% external surface lower than clearance limit
- 100% of lead can be cleared

Conclusions

- With this project, SCK•CEN acquired a quite broad know-how on D&D operations, technique, management, safety and costs
- Specific developments were carried out for optimizing the operations and reduce
 - the generated **radwaste**
 - the **dose** uptake and the **environmental** impact
 - the **duration** of specific operations
 - the **costs**
- Our experience is available for future project:
“WE CAN DO IT !” because “WE DID IT”