

EUNDETRAF



DECONTAMINATION (INDUSTRIAL APPLICATION)

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EUNDETRAF

Decontamination / Industrial Application



Reference to the PHARE Project

Technical Design for Decommissioning
Kozloduy NPP Units 1&2

➤ Task 2

Decontamination and Cleaning
Operations



- Primary Circuit
- Nuclear Auxiliary Systems
- Reactor and Spent Fuel Pools
- Thermal Insulation Sheathing Materials



Primary Circuit Components

- The pipe works
- The SGs tubes and collectors
- The pressuriser
- The reactor vessel with the internals
- The main coolant pumps and isolation valves
- The hot portion of the SV01 circuit



Two steps

- Soft Pre Decontamination
- Hard Decontamination



Preference to the APCE process

- pH must be > 5.5 due to absence of stainless steel cladding in the RPV and in the pressuriser
- The type of secondary waste
 - APCE : liquid waste processed by SV03 system
 - CORD: highly active IERs
- APCE process already used
- Experience of the staff and Availability of the chemical dosing systems



Main Guidelines considered

- Objective to achieve the EU free release levels
- Regenerative Cerium process selected as proven technology currently available

3 Options considered for the primary circuit



1. On-line hard decontamination of the 6 loops during the SE preparatory phase
2. No-Hard decontamination; at the end of the SE the components are dismantled, immobilised without decontamination
3. Hard decontamination in batches in an auxiliary unit on the dismantled components at the end of the SE phase



- Must be performed during the SE preparatory phase (operability and tightness of the circuit)
- Must have a reasonable assurance to reach the free release levels for most equipment
- !! In the case of KNPP, too much plugging rate of the SGs tube's and too difficult to remove (or to drill) the plugs on an economical basis
- Option abandoned



$$C_j = A_j + N_j \cdot V \cdot X$$

- C_j = overall cost of option j
- A_j = total cost for the process
- N_j = number of final packages
- V = volume of the final package
- X = final disposal unit cost



- Investment fixed costs
- Consumable costs
 - Chemical reagents
 - Final packages
 - Products for final conditioning (cementation)
 - Steam, electrical energy, auxiliary fluids
- Manpower costs (for decontamination and waste conditioning)
- Personnel radiological exposure costs



- Total weight criteria
 - Internal concrete shielding
 - Maximum weight (licensing and handling)

- Chemical concentration
 - Limit for total salts content (240 gr / l)

- Contact dose rate (handling and transportation)

- Activity inventory
 - WAC for critical nuclides



Direct dismantling after SE, and conditioning the cut equipment

For SGs tubes, two cases

- Without supercompaction
- With supercompaction



| Equipment | Nj | Criterion |
|--------------------------|-----------|-----------------------------|
| 6 loops | 6 | Weight |
| 6 SGs tubes bundles | 20 to 25 | α activity, geometry |
| 12 SGs collectors | 12 | weight |
| 1 pressuriser | 10 | weight |
| 6 Main coolant pumps | 10 | Weight |
| 12 Main isolation valves | 7 | weight |
| Total | 70 | |



With supercompaction Δ cost = - 7%

- Less volume
- Additional costs
 - More operations for cutting in small lengths
 - More handling operations
 - More secondary waste
 - More Manpower and Man.Sv exposure costs



- Hard Decontamination in batches
(segmented components)

Compared to option 1

- 2X more reagents
- Volume of liquid waste is lower
- Volume of sludges is unchanged

- SGs tubes :cutting, conditioning with or not SC



Significative increase of the surfaces

- Increase of the size and the capacity
 - of the decontamination unit
(50 m² / batch in place of 10-20 m² / batch)
 - of the waste conditioning unit



| Option | Nj |
|--|----------|
| Soft pre decontamination before SE | 19 |
| No-hard decontamination | 65 to 70 |
| Hard decontamination (all equipment, ex SGs tubes) | 25 to 30 |
| Hard decontamination (all equipment) | 19 |



Result (cheapest option)

- Soft decontamination after Reactor Final Shutdown
- Hard decontamination (all equipment) during the deferred dismantling (at the end of the SE)
- Batch process applied on segmented components

SGs decommissioning alternate options



- SGs melting option
(Yankee Row, Kewaunee, Obrigheim NPPs)
- SGs entombment option
(Loviisa NPP)



Cold portion of following systems

- SV 01 Purification system of the primary circuit
- SV 02 Liquid waste collecting system
- SV 03 Liquid waste processing system
- SV 04 Spent fuel storage pools cooling down and purification systems



No APCE Soft Pre Decontamination

- Technical reasons

- Need to circulate solutions at high temperature (110 – 160 °C)
- ≠ Systems operated at low temperature and not provided with thermal insulation
- Complexity of the pipework circuits, difficulty to arrange circulation decontamination loops



No APCE Soft Pre Decontamination

- Radiological reasons

- Internal β - γ and α surfacic contamination is low

- (1 to 2 order of magnitude than the primary circuit at the Reactor Final Shutdown)



Selection of the decontamination process

- Chemical
 - Too large volumes
 - Unfavourable geometry for recirculation

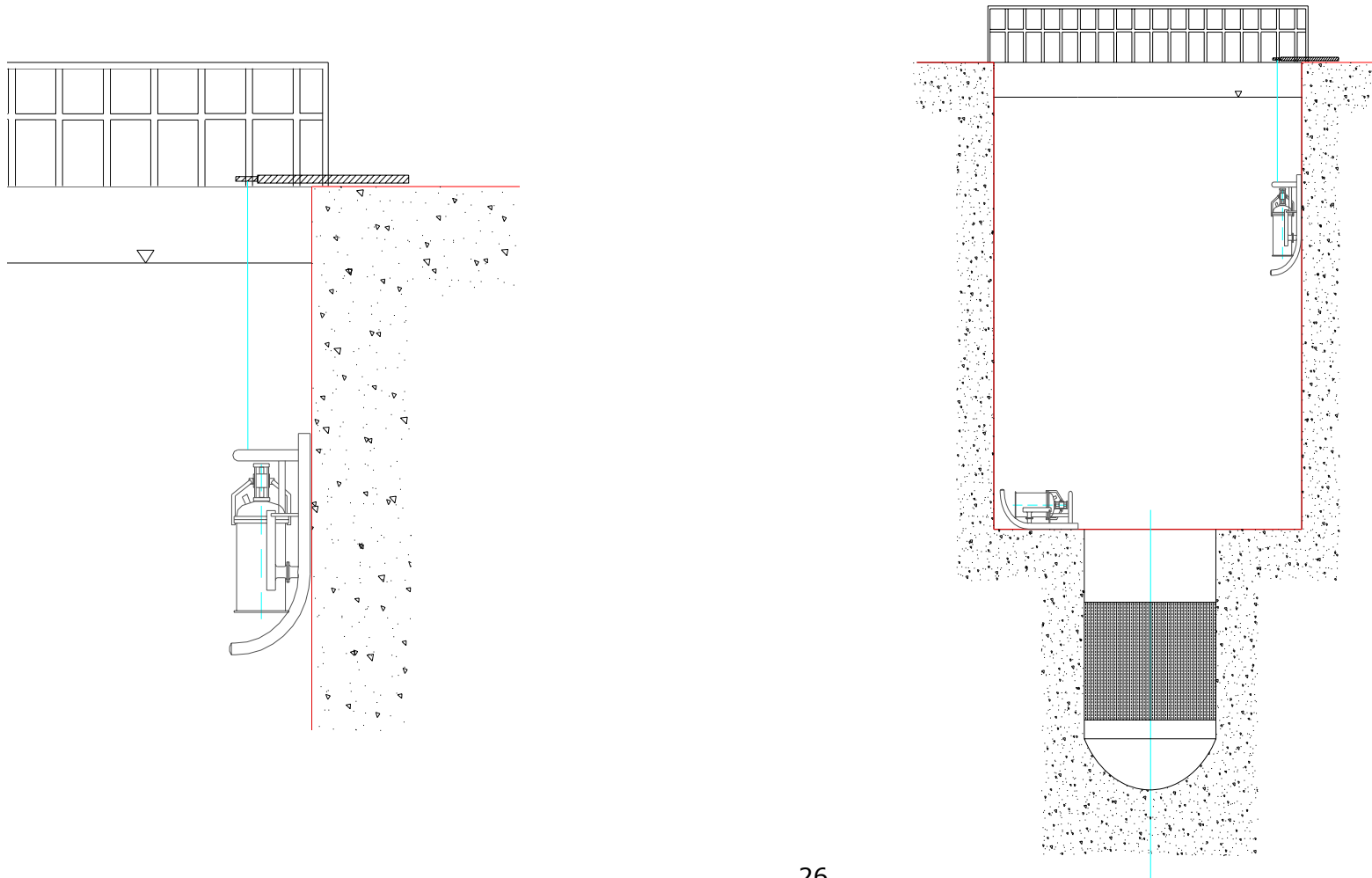
- Ultra-sonic
 - Industrial experience in western PWRs
 - Easy to be implemented
 - Removal of crud with immersed filter cartridges
 - DFs in the range of 5 to 50



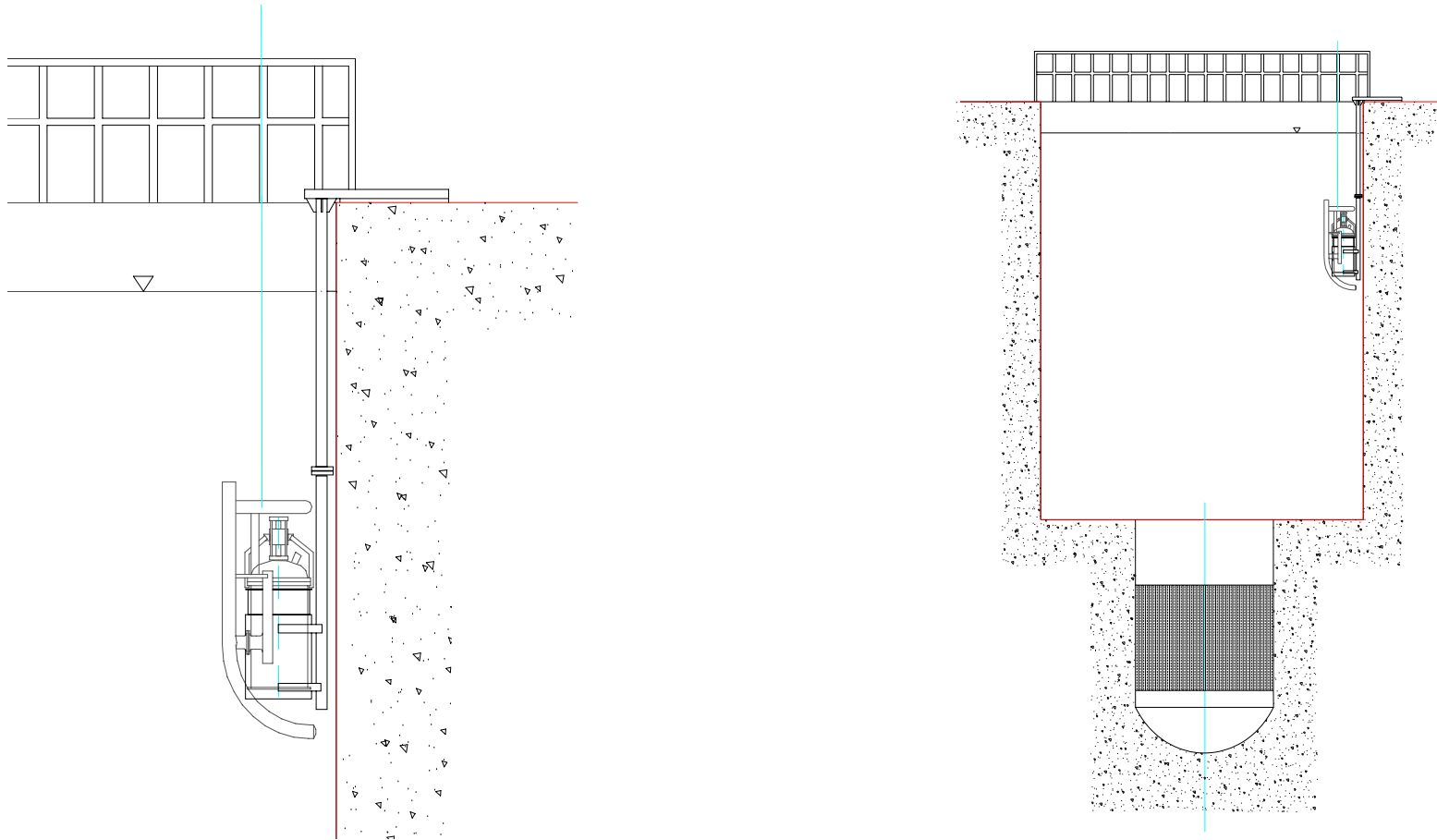
- Patented submerged filter system UWF 120-4
- Reactor vessel pool and spent fuel pool
- Reduces activity and turbidity
- Outage time reduction



UWF Working Position



UWF Filterelement Change Out

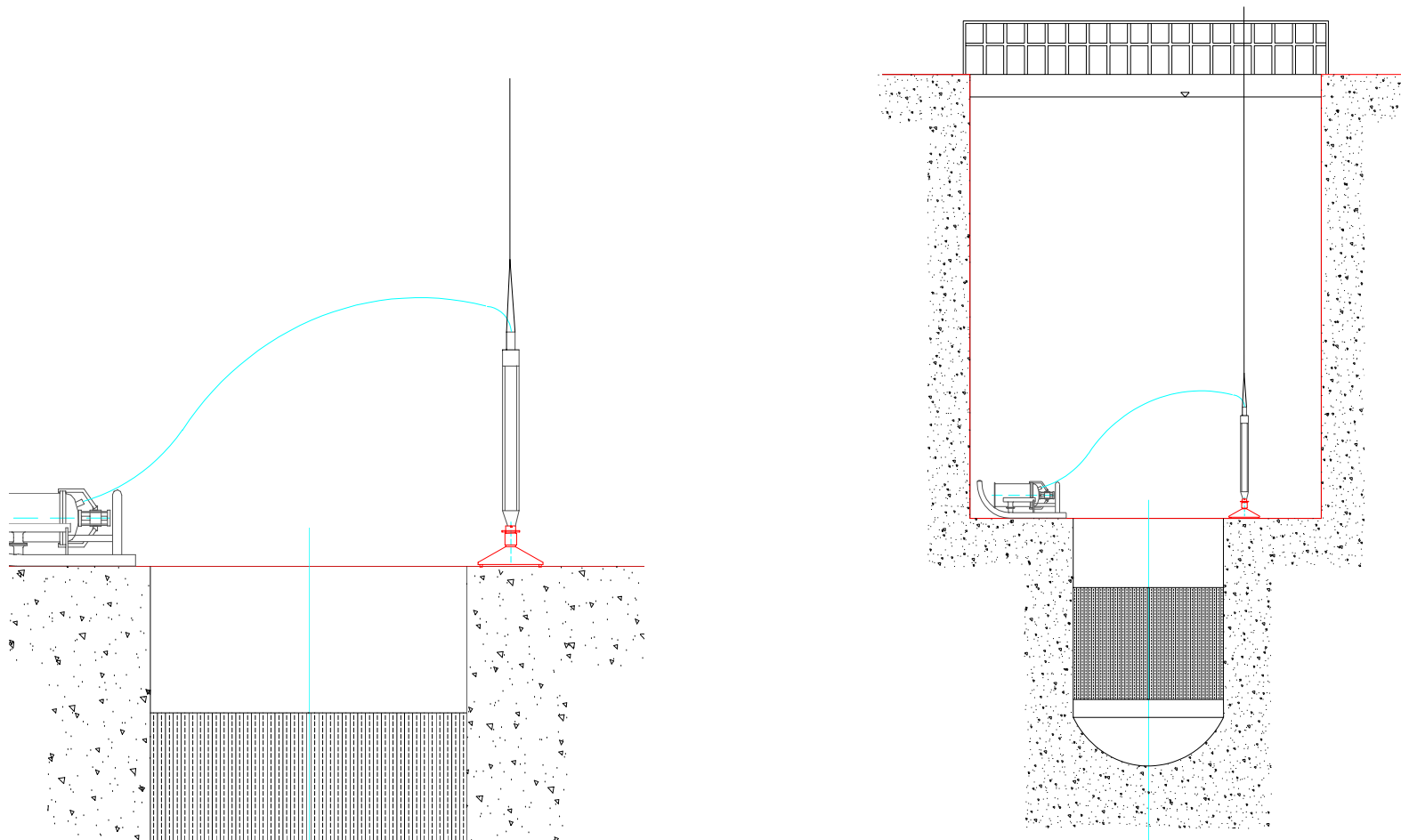




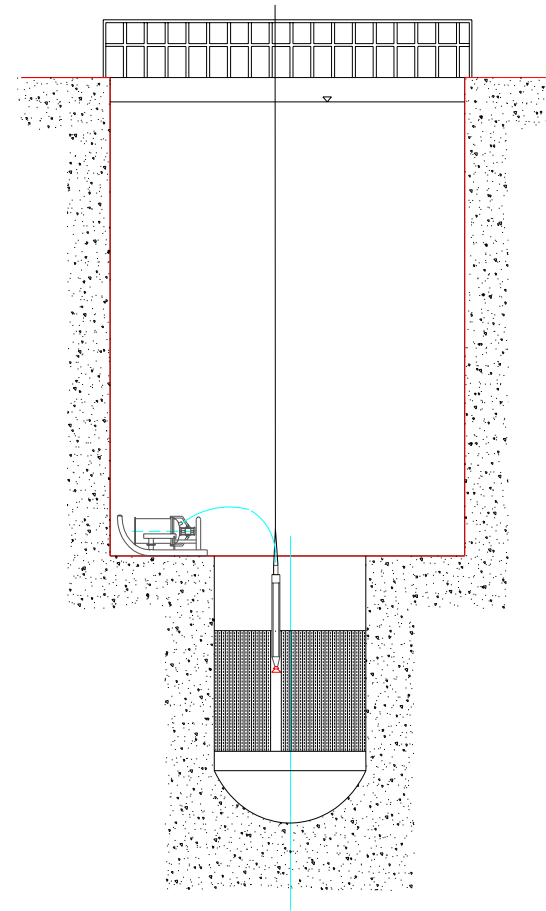
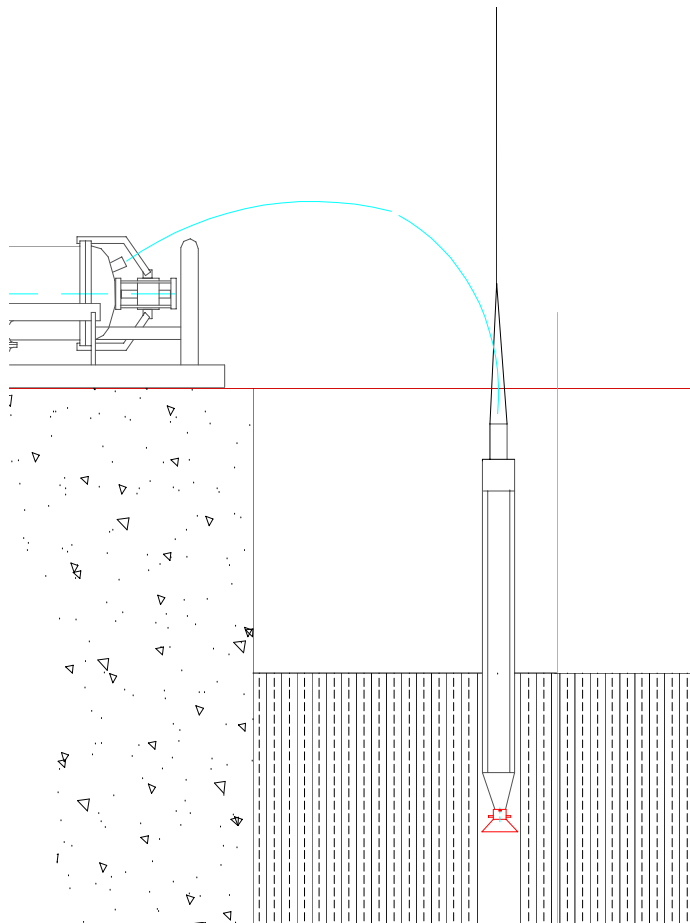
- Suction installation as a water jet pump
- Handling: dimension as a fuel assembly
- Suction direct at the machine



Bottom- and Wall Cleaning



Cleaning of the Reactor Vessel





Immediate Removal

(after decontamination of the primary circuit)

- Not suited for long term conservation
- Corrosion of sheathing materials
- Generation of dust and aerosols from glass wool materials



- Thermal insulation material

- Precompaction (50 t) into drums
(110 kg / 210 l drum)

- Supercompaction (910 t)
Height reduction factor of 3

- Immobilisation with concrete in the final package

Overall volume reduction factor = 4.7



- Sheathing materials

Two options

- Pre compaction, supercompaction, immobilisation (!! aluminium)
- Decontamination to reach free release levels