



FULL SYSTEM DECONTAMINATION

UNDER ALARA POINT OF VIEW

Dr. Michael Knaack

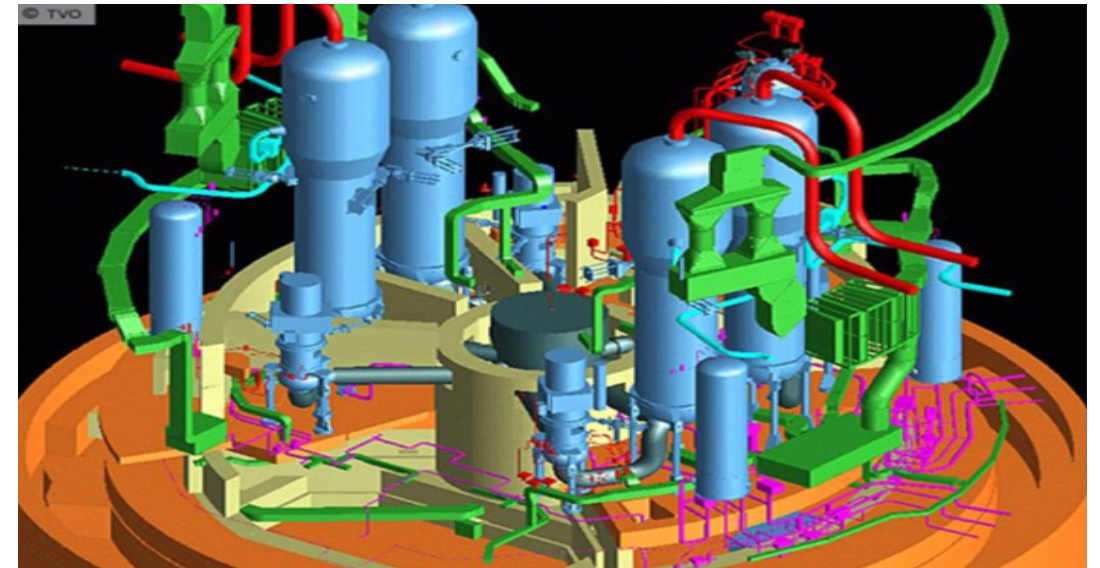
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FULL SYSTEM DECONTAMINATION

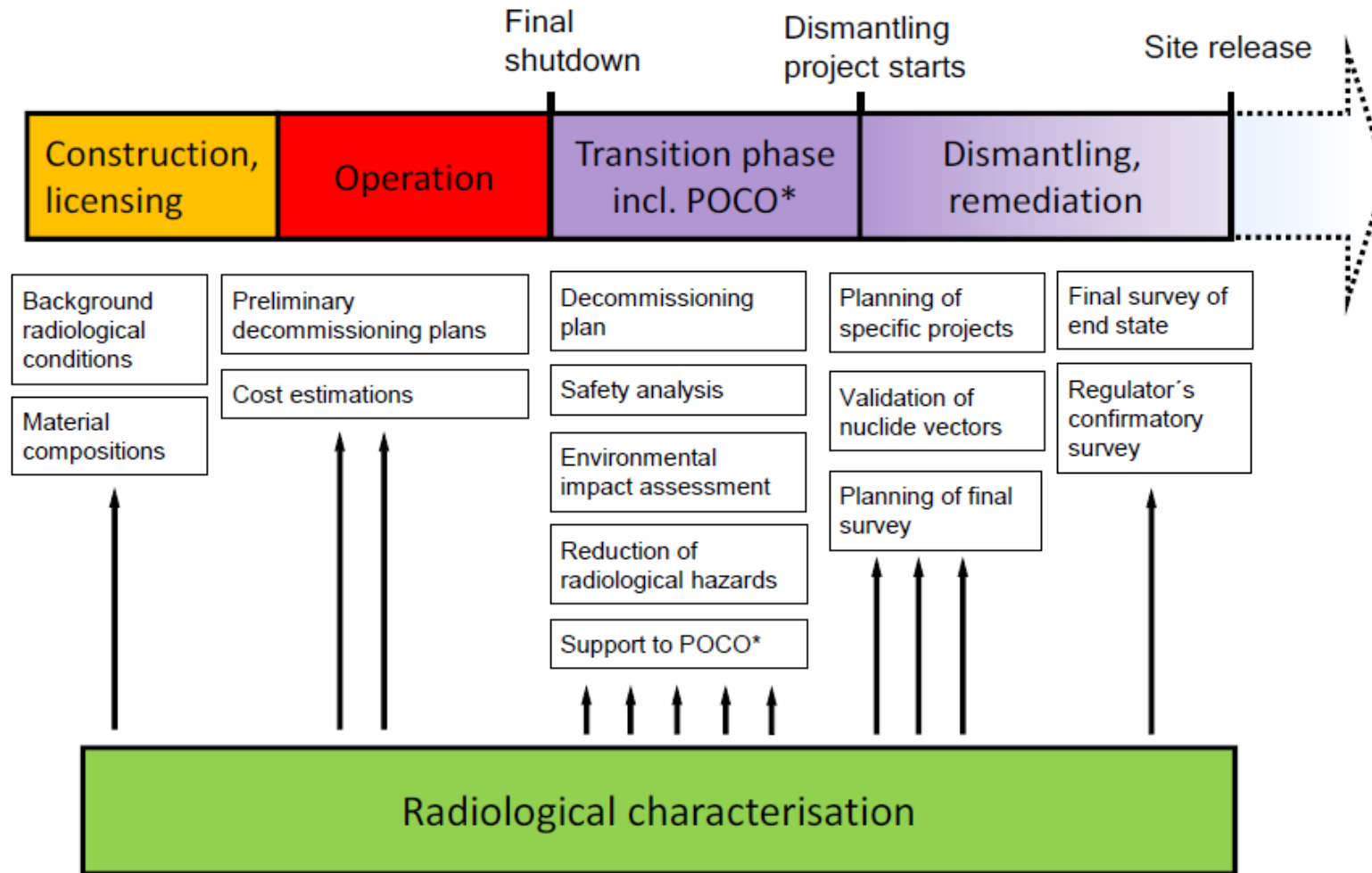
A brief introduction in the topic of
Full System Decontamination (FSD)

- Why?
 - Where does the dose come from?
- How?
 - FSD – procedures
 - How does the FSD work?
 - Where does the dose end up?
 - Range of different FSD
- Supervision
- Results



FULL SYSTEM DECONTAMINATION

LIFE CYCLE

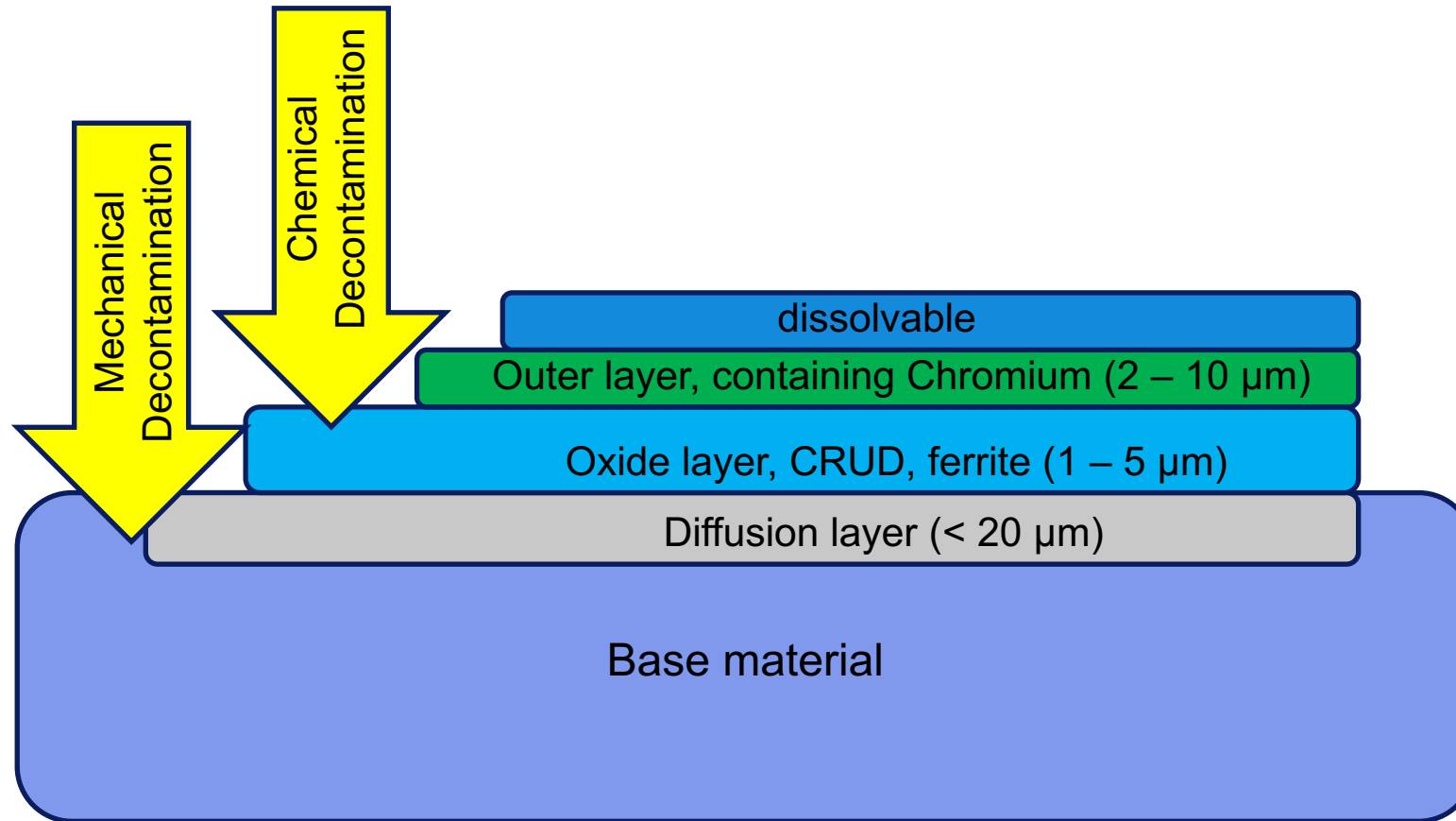


*POCO = post-operational clean-out removal of operational waste etc.

(Source: NEA/RWM/WPPD(2013))

FULL SYSTEM DECONTAMINATION

- How to decontaminate?



FULL SYSTEM DECONTAMINATION

Different procedures:

- HP Cord UV
- ASDOC_D-Mod
- NITROX-E
- Lomi, CITROX, DfD...

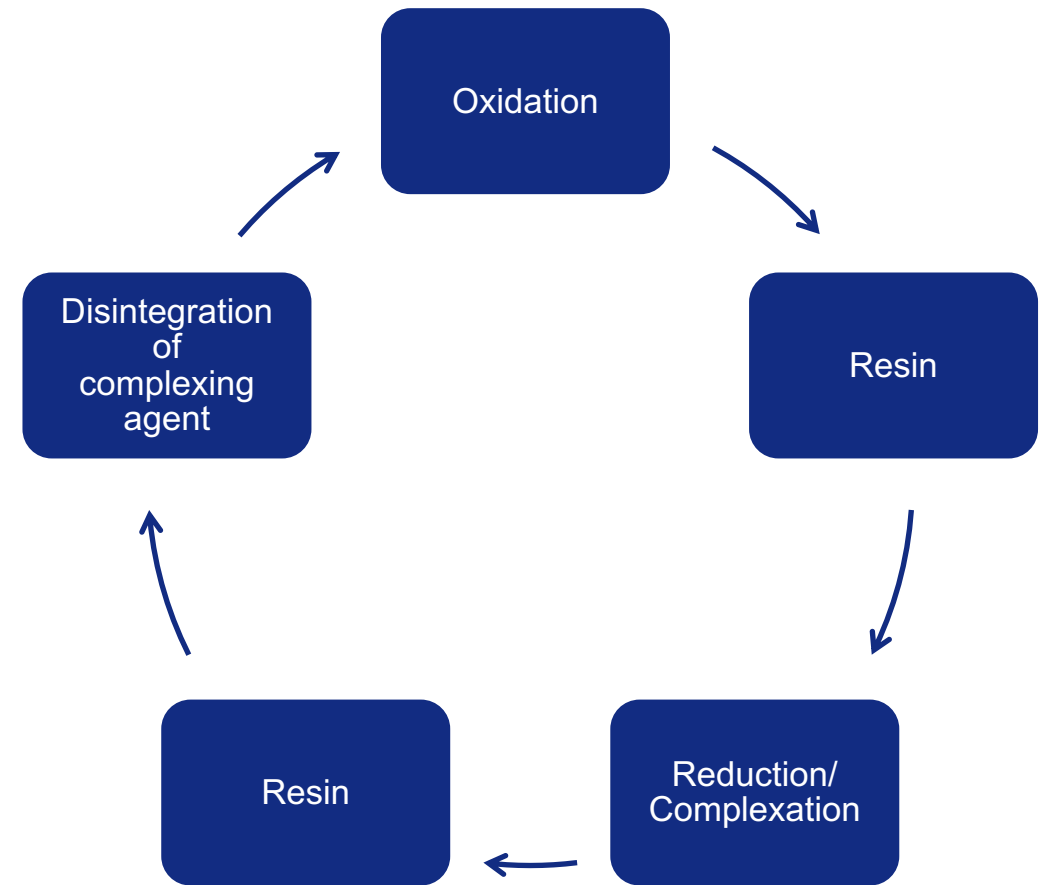
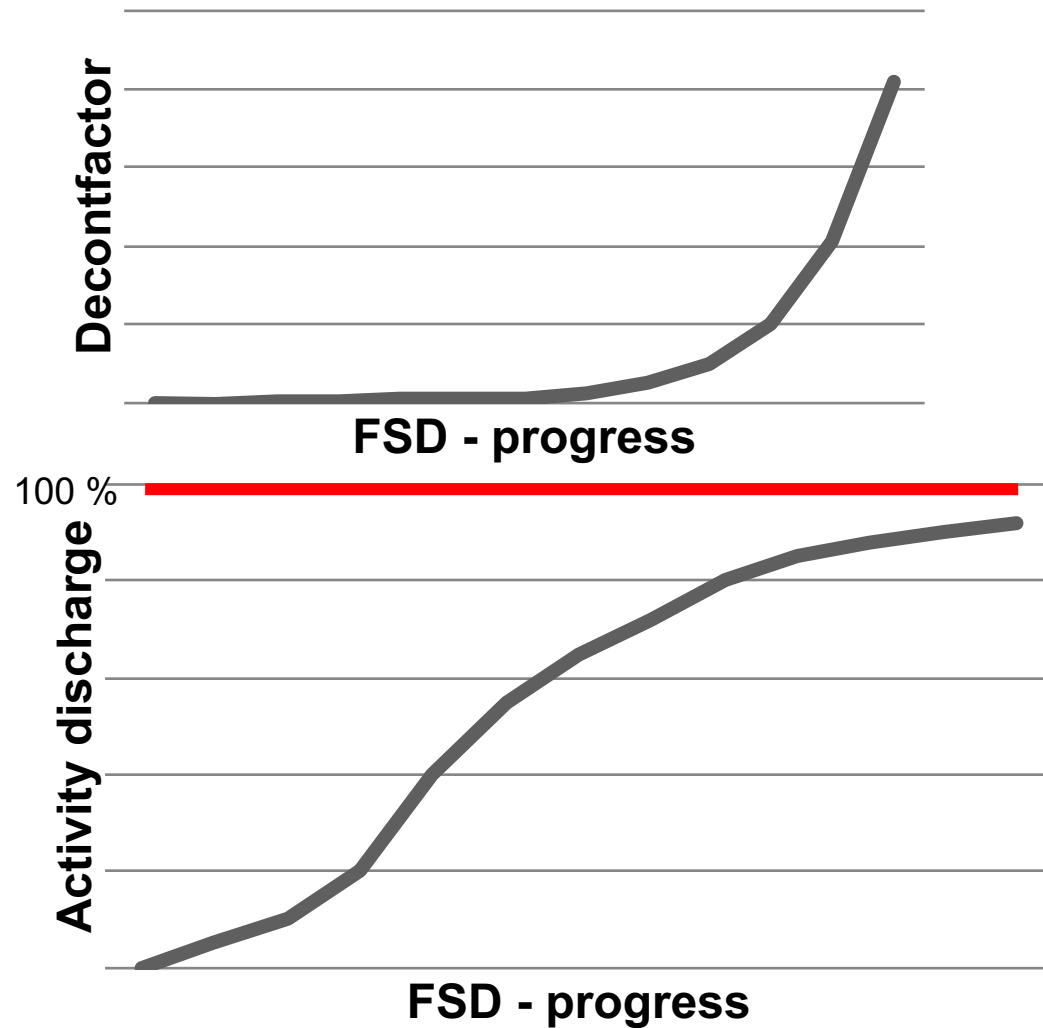
all these with many variations

Chemical shopping list for FSD:

- Permanganic acid
- Oxalic acid (Tartaric acid, Ascorbic acid)
- Methylsulfonic acid, Nitric acid (Sulphuric acid)
- Hydrogen peroxide
- Cationic exchange resins
- Anionic exchange resins
- α -Carrier (if necessary), Ni-Carrier (if necessary)



FULL SYSTEM DECONTAMINATION



FULL SYSTEM DECONTAMINATION

What remains?

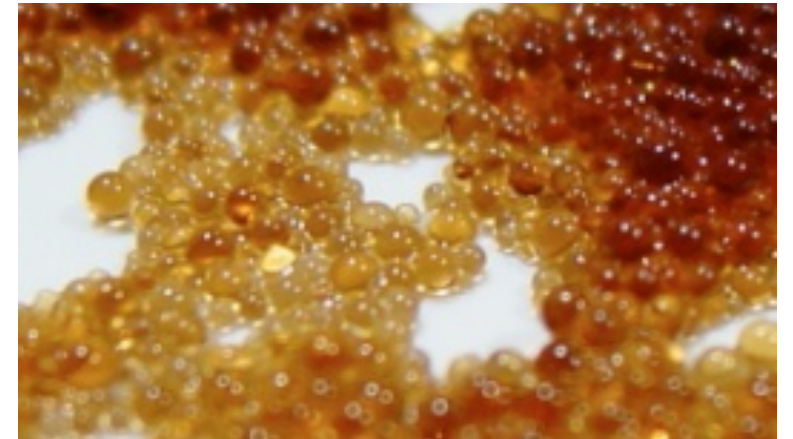
Since the chemicals fully decompose during the process, the radioactive waste consists of filters and resins. It is to mention that besides the radioactive ^{60}Co -ions, high amounts of inactive metal-ions get disposed on the resins.

Depending on the chosen process, each cycle generates between 0.2 and 4 m³ of loaded resins.

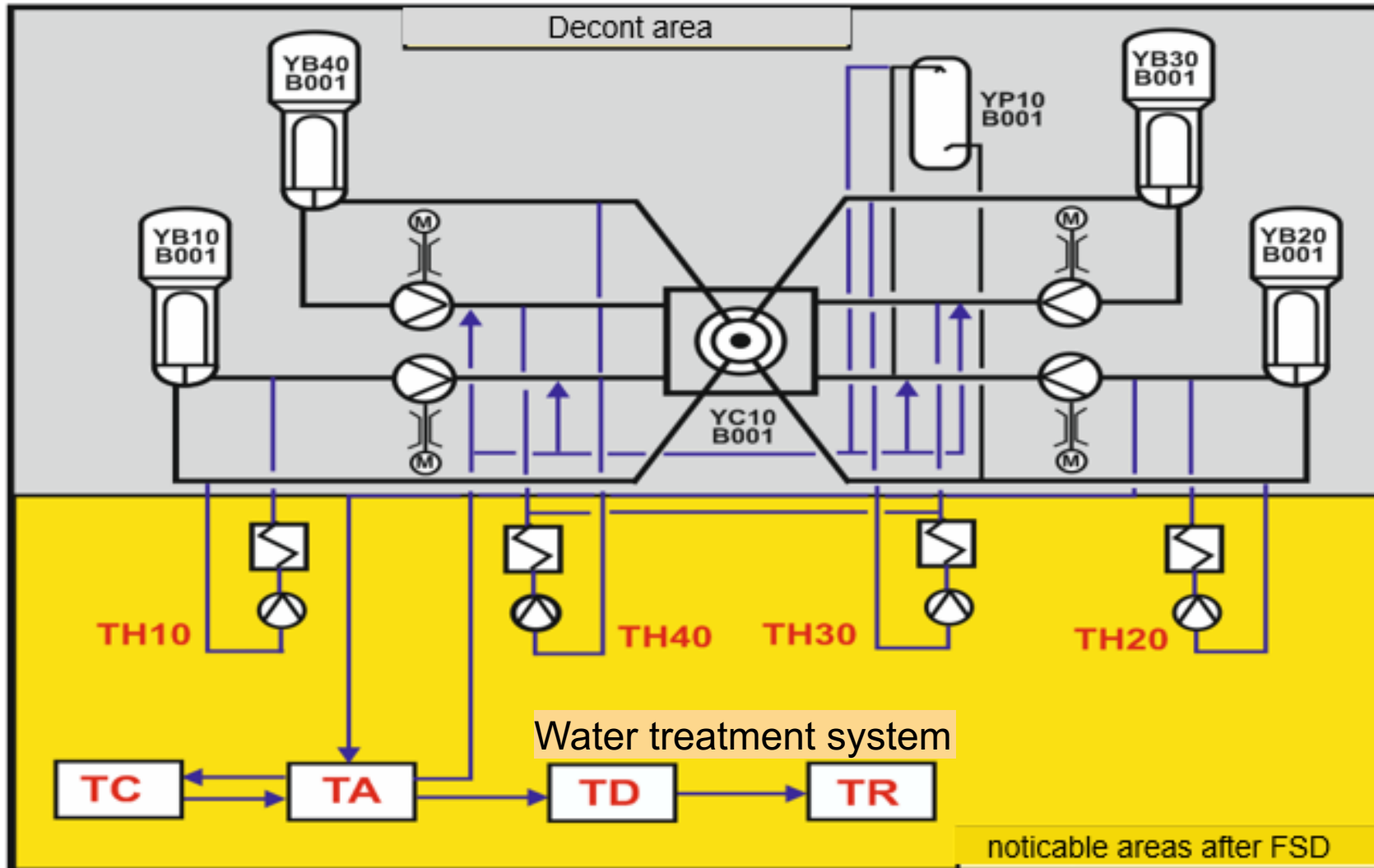
The resins are usually treated like operational ion exchangers. Due to the limited capacity of the spent resin buffer tanks, a parallel conditioning is preferable.

Generation and treatment of gases (CO_2 , H_2) is to be expected.

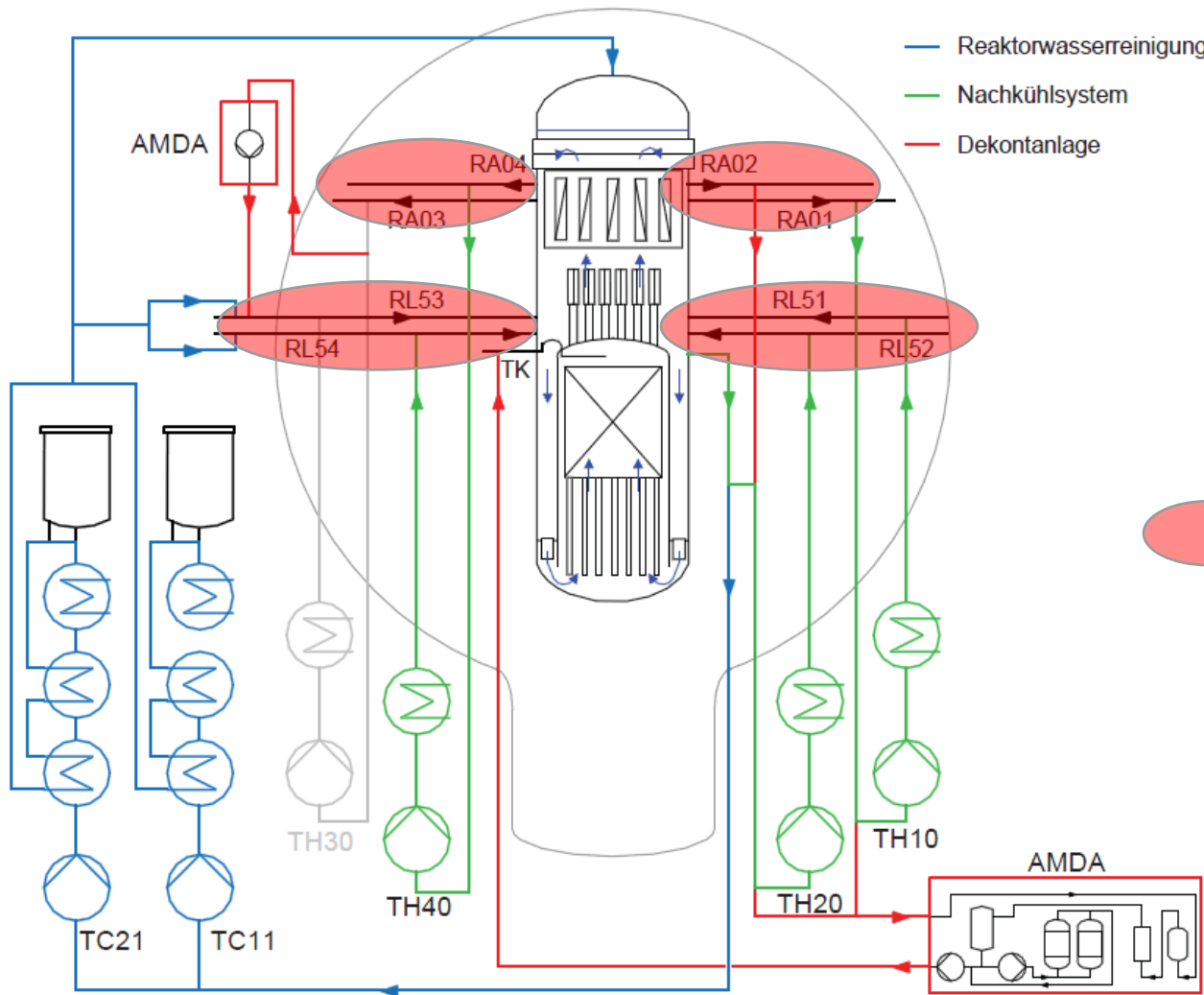
Conditioning the resins and the filters must be done under radiation protection measures.



FULL SYSTEM DECONTAMINATION DECONT AREA PWR



FULL SYSTEM DECONTAMINATION DECONT AREA BWR



 = **Ferritic steel areas RA/RL**

Schematic of FSD in a BWR (KKI, KKK)

SUPERVISION

BEFORE START (PAPERWORK)

TSO can provide valuable input for every step of the decontamination project. Consultation work:

- Planned commissioning and checks
- Planned pressure safeguarding
- Planned monitoring, measurements and decontactor
- Handling of gas and hazardous liquids
- Planned waste management
- Check the planned radiation protection measures
 - Shieldings
 - Off-limits areas
 - Remote handle
- Examination of possible failure
 - Material compatibility
 - Pipe burst
 - Contamination of other areas
 - Release of activity
 - Chemicals in other areas



SUPERVISION

DURING FSD

- Start up checks
- HF: communication between all actors?
- Other resources
- Radiation protection
- Collective dose
- Changes in the dissolved nuclides
- Commissioning



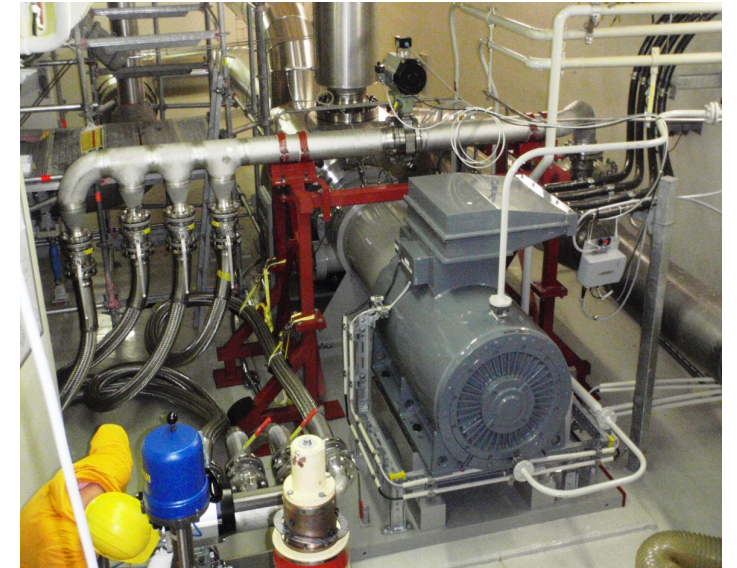
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AMDA-commission

SUPERVISION

AFTER FSD

- Set back of valves, armatures and accessories
- Dismantling of flexible hose
 - Radiation protection
 - Spread of contamination
- Rinse cycles
- Chemicals in other systems
 - Are there any?
 - And how to treat them?
- Check the Nuclide Vector
- Review the Final report
 - Decont factors
 - Removed activity
 - Displacement of NV
 - Waste produced
 - Collective dose



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AMDA-intake from TH40-System

FULL SYSTEM DECONTAMINATION

MAIN DRIVER: RADIOLOGICAL PROTECTION

But of which amount of activity inventory we talk?

Activity inventory without nuclear fuel:

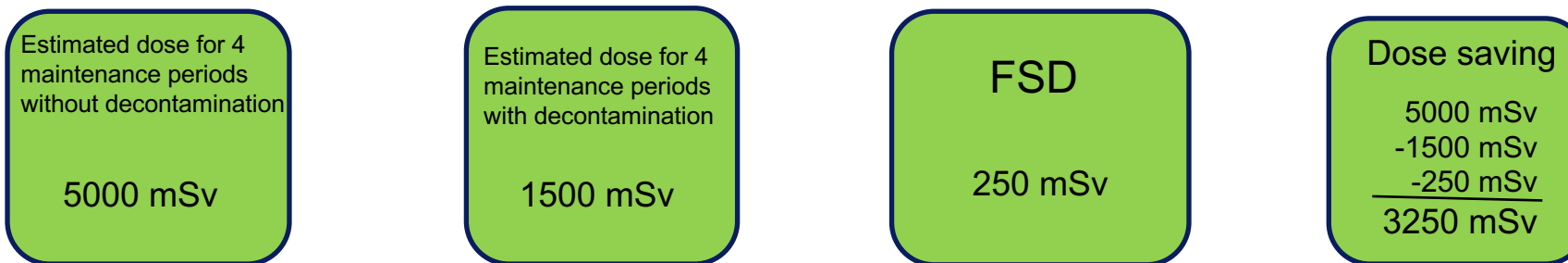
ca. $1 \text{ E } 17 \text{ Bq}$, more than 95 % from activation

Cleanout per FSD:

ca. $1 \text{ E } 14 \text{ Bq}$

Appreciation and justification of dose values

- In case of long-term operation for some maintenance periods



- In case of dismantling: 10.000 working hours in a radiation field decrease from $120 \mu\text{Gy/h}$ to $20 \mu\text{Gy/h}$:

Savings about 1000 mSv collective dose

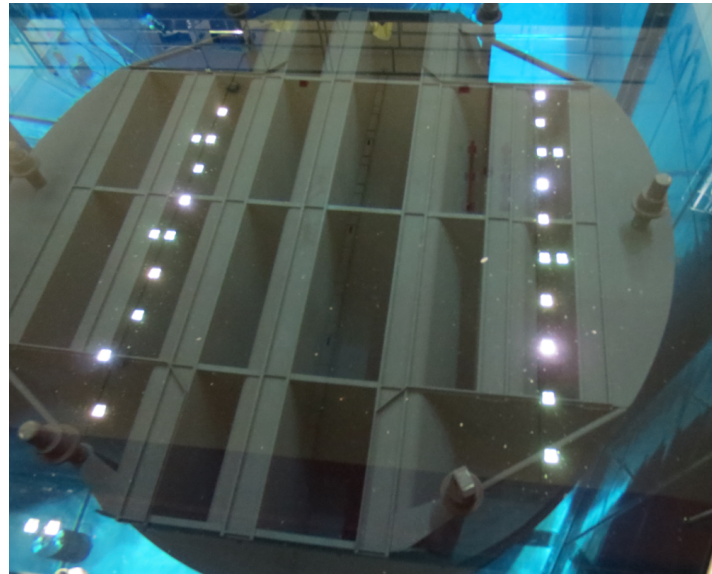
FULL SYSTEM DECONTAMINATION MAIN DRIVER: WASTE MANAGEMENT

Dismantling of big components



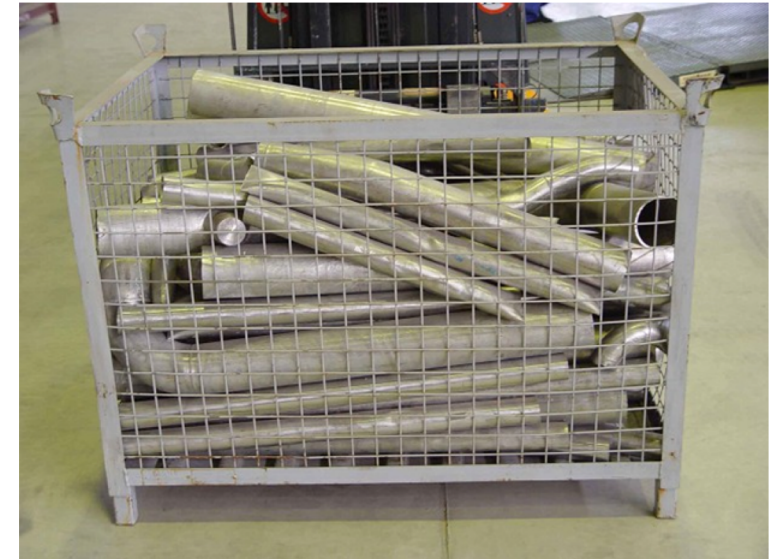
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Easier dismantling possibility
without water shielding



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More material could be
prepared for clearance



FULL SYSTEM DECONTAMINATION RESULTS

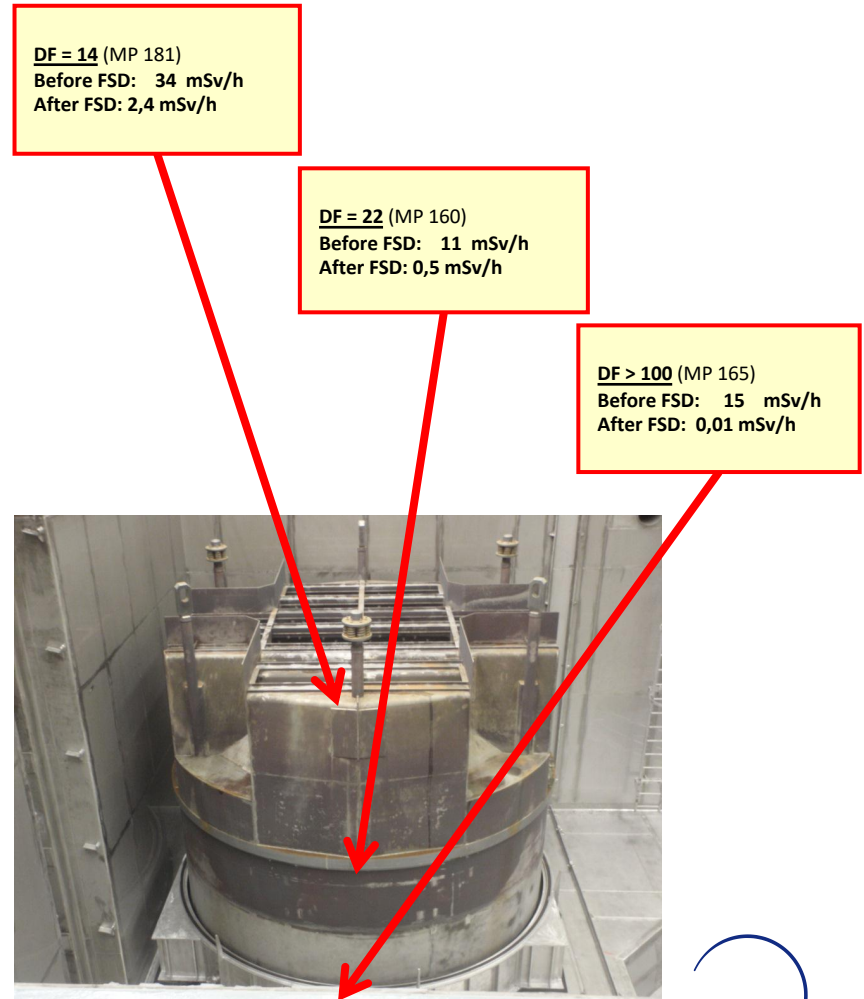
Which are the results?

The success of the decontamination is described by the decontactor:

$$\frac{\text{Dose rate prior decontamination}}{\text{Dose rate after decontamination}}$$

Typical decontactors are between 10 and 50 (in some cases over 100), this depends on different factors like the operation, the material, the surface, the flow...

A decontactor of 10 means a 90% discharge of the contamination!!



FULL SYSTEM DECONTAMINATION RESULTS

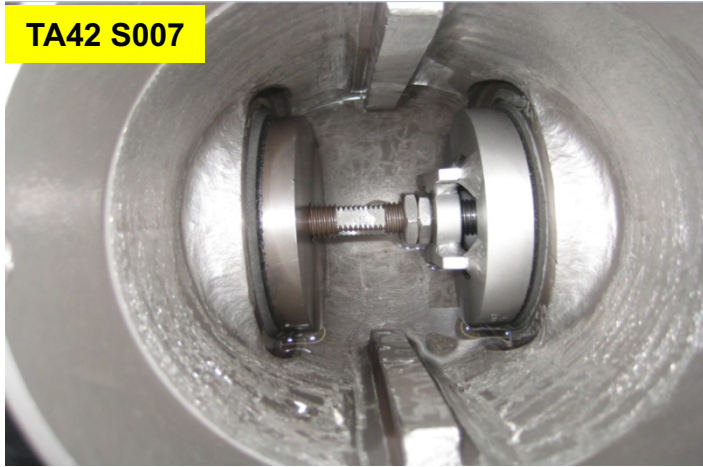


Doserate in the middle of the primary chamber
before: 150 mGy/h → after: 3 mGy/h

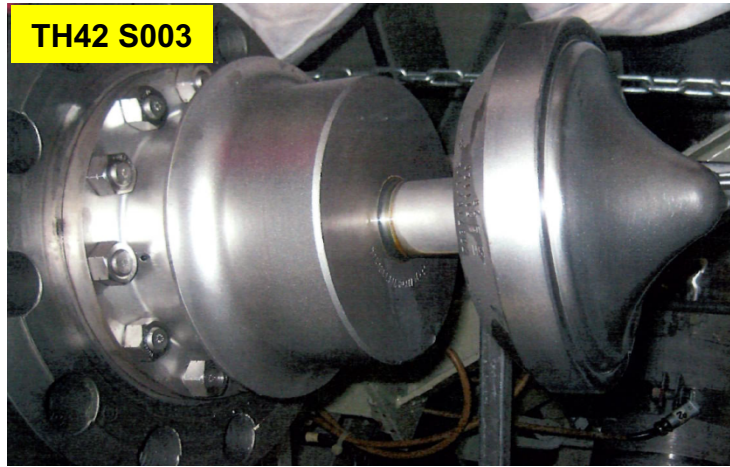
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FULL SYSTEM DECONTAMINATION RESULTS

TA42 S007



TH42 S003



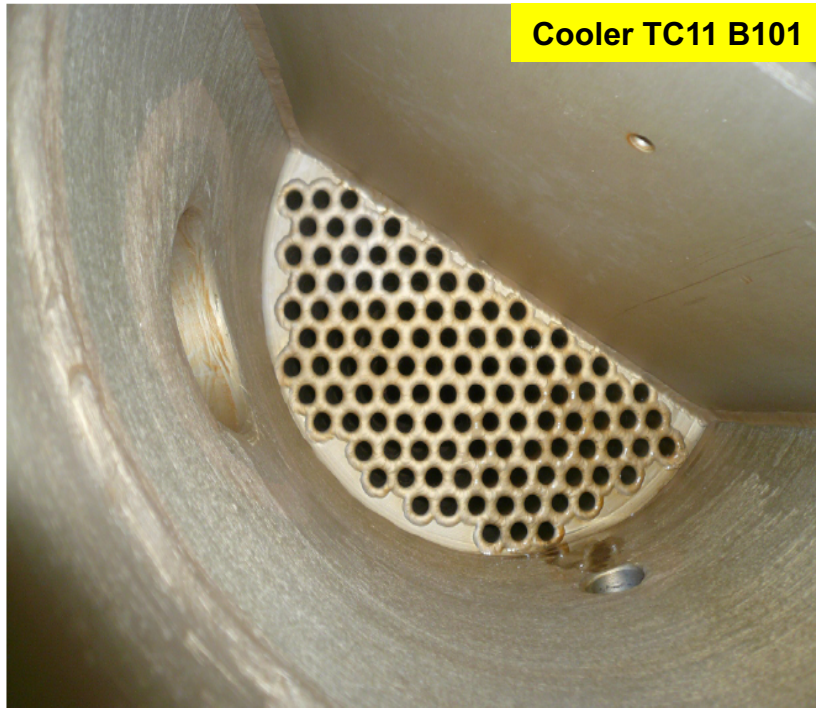
TH40 D001



- No base material corrosion

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FULL SYSTEM DECONTAMINATION RESULTS



before: 200 Bq/cm² ± 50%



after: 20 Bq/cm² ± 50%

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FULL SYSTEM DECONTAMINATION

And always remember:
The dosage makes the poison!

Thank you for your patience !

