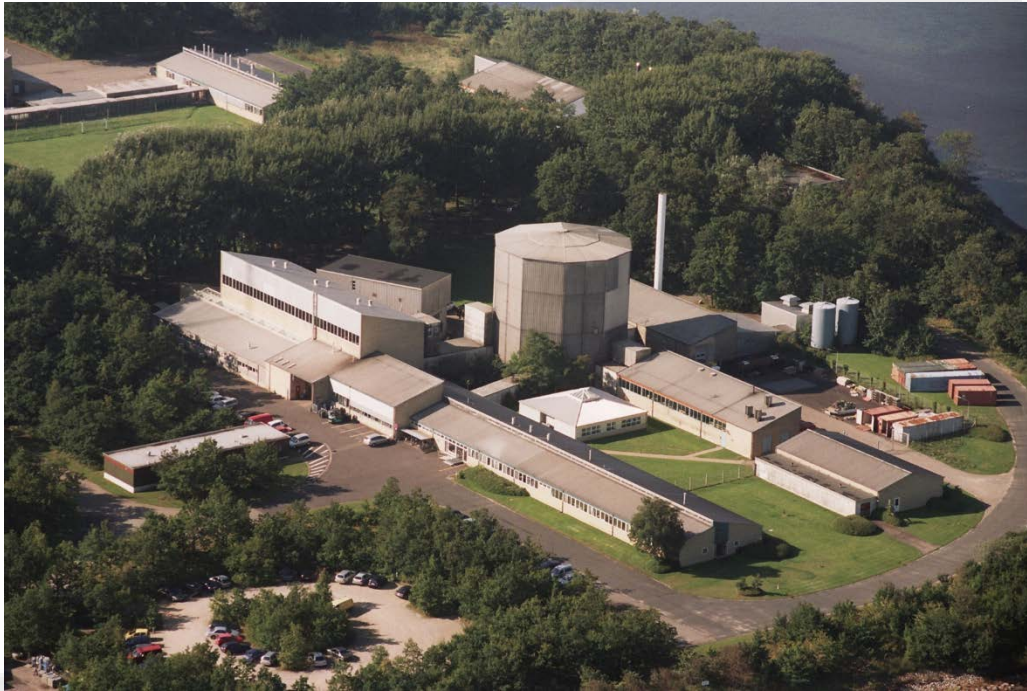


The start of the decommissioning of the inner parts of the DR3 reactor.



*Jens Søgaard-Hansen,
Haraldur Hannesson and
Per Hedemann Jensen*

**Section of Radiation and
Nuclear Safety**

Danish Decommissioning

www.dekom.dk

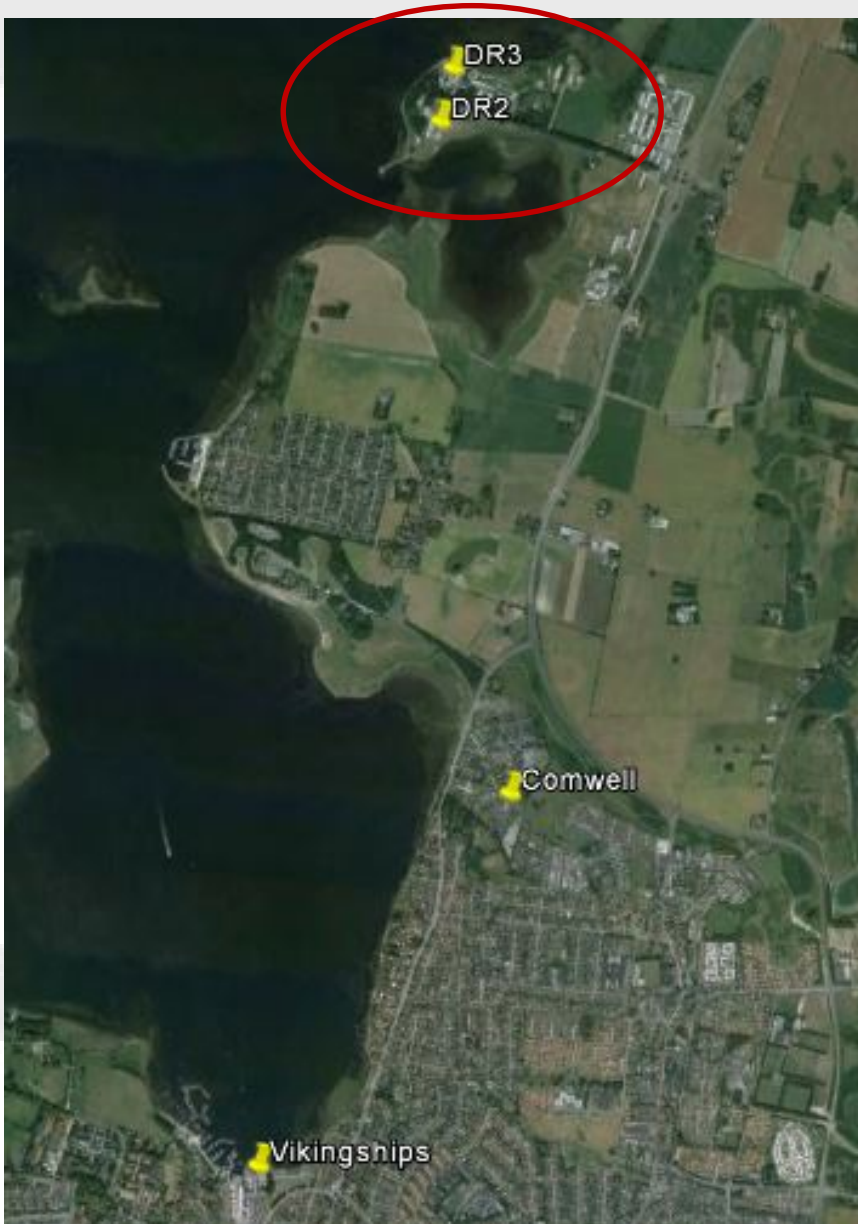


Nordic Society for Radiation Protection, Denmark, 2015.



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Status for the decommissioning of the nuclear facilities at Risø:



DR1 ✓

DR2 ✓

Hot Cells: ongoing

Fuel fabrication plant ✓

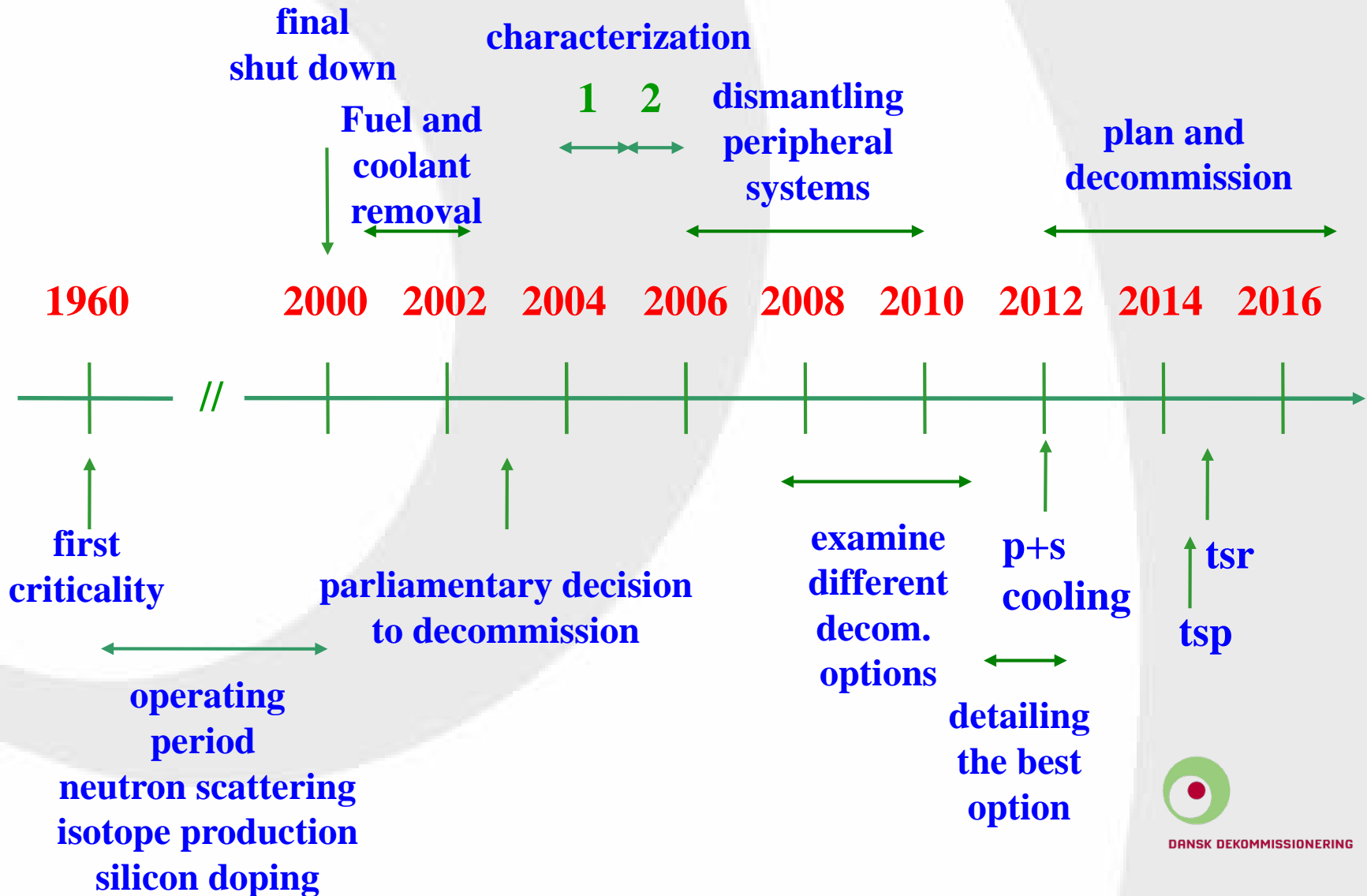
Waste treatment plant: not started

Emptying of storages: started

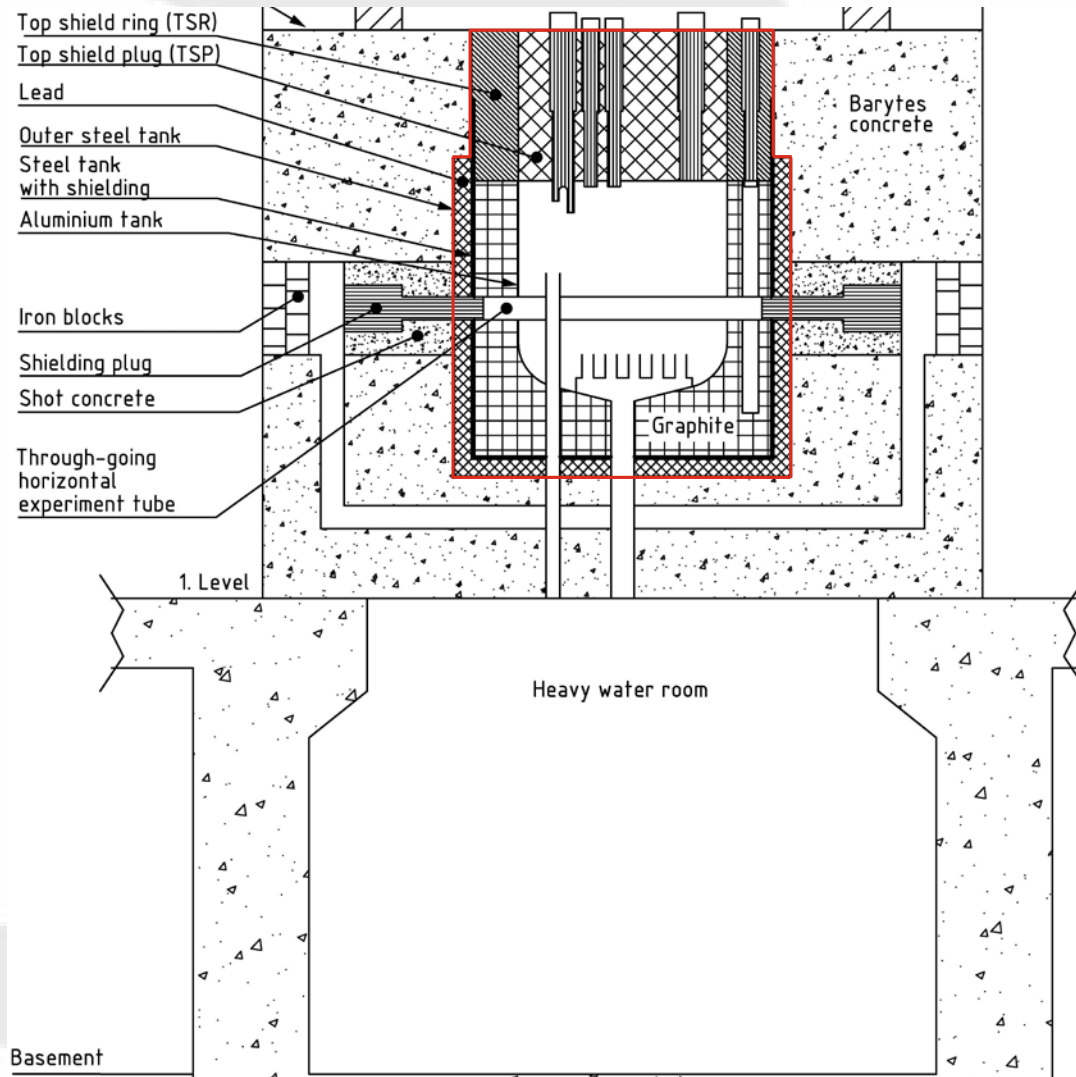
DR3: ongoing



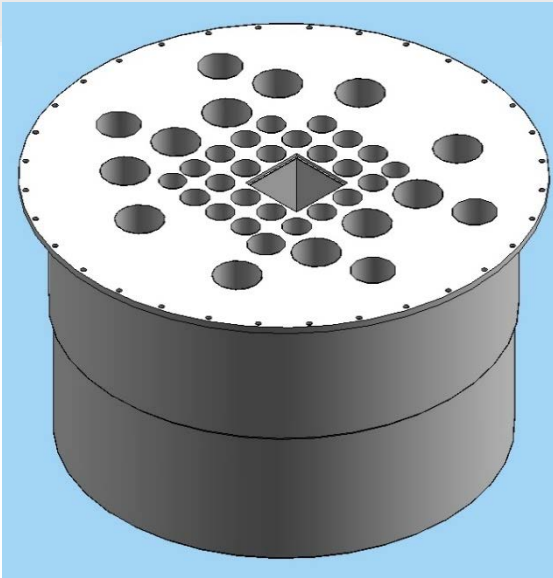
DR3 time line



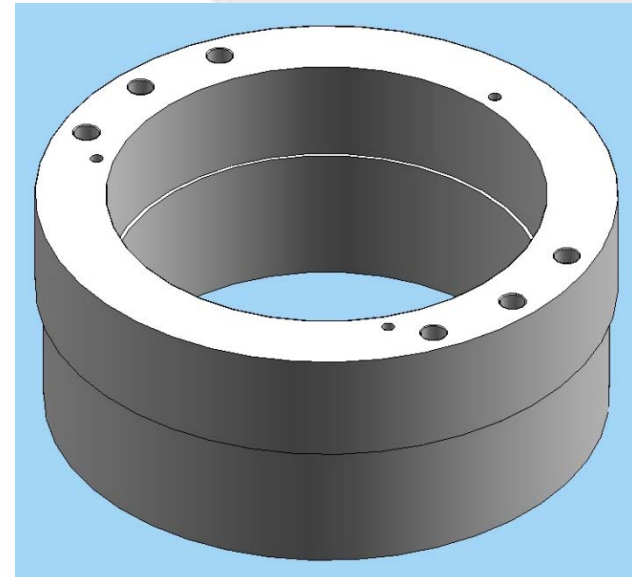
Inner and outer parts of DR3 reactor block



TSP and TSR



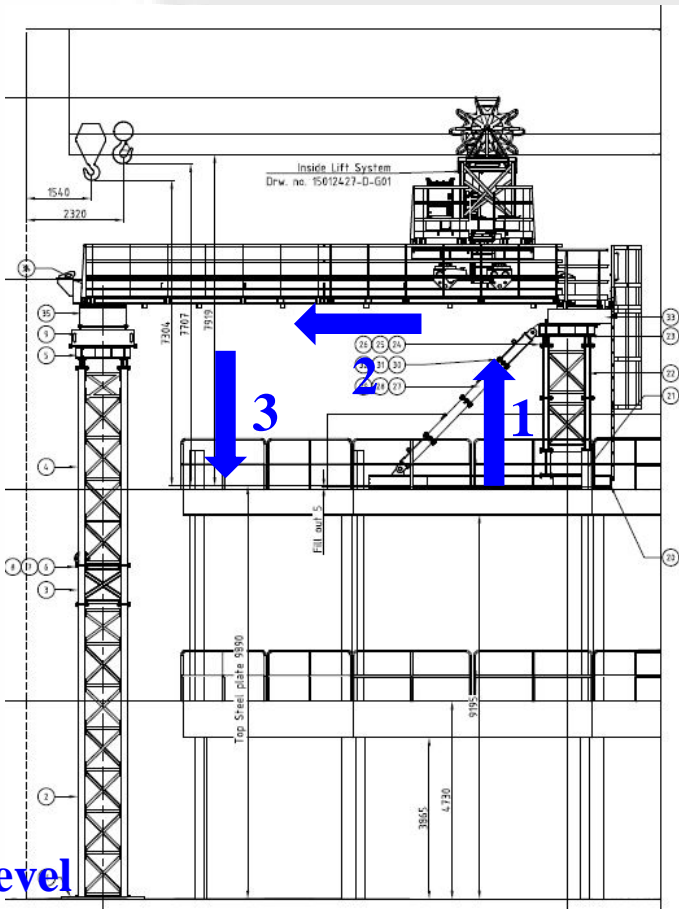
Mass ~ 22 tons
Outer diameter ~ 197 cm
Estimated activity ~ 4.5 TBq ^{60}Co (2012)



Mass ~ 17 tons
Outer diameter ~ 270 cm
Estimated activity ~ 0.4 TBq ^{60}Co (2012)



Method for removal of TSP and TSR



1. Vertical hydraulic wire lift (strain jack)
2. Horizontal displacement by hydraulic pistons, while moveable top shield (MTS) covers opening
3. Vertical lowering down



Preparations for removal of the TSP (and TSR)

Limitations on doses and radiation levels

Calculations of expected radiation fields

Shielding calculations

Work planning

Expected doses

Setting no-go criterion



Limitations on doses and radiation levels

Dose constraint on individual effective dose for the DR3 project: 5 mSv/y

Dose constraint on individual effective dose for removing TSP/TSR: 1 mSv

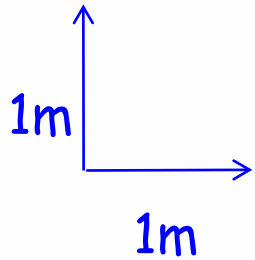
Maximum dose rate on surface of TSP/TSR shielding casks: 2 mSv/h (design)



Monte Carlo calculation of radiation fields



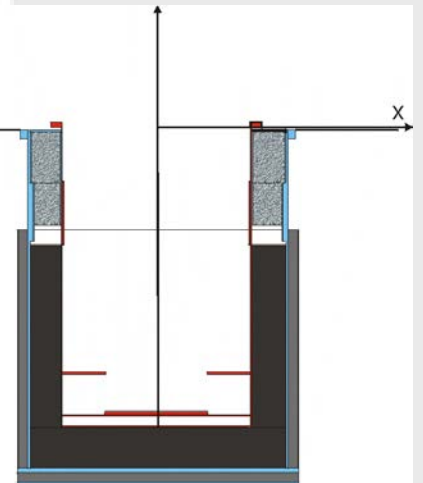
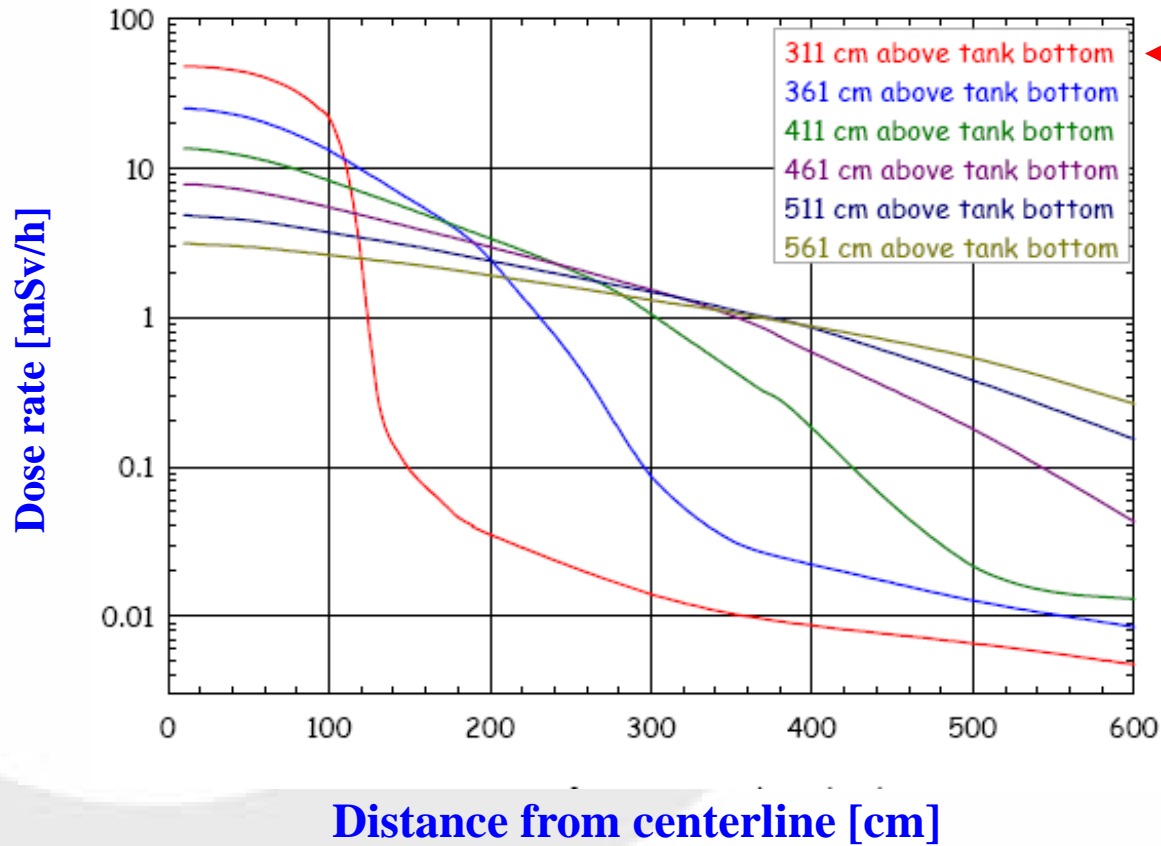
| | | | | | | |
|------|------|-----|-----|----|----|----|
| 3200 | 1400 | 185 | 60 | 20 | 8 | 5 |
| 1600 | 890 | 390 | 175 | | | |
| 775 | 520 | 330 | 200 | 60 | 23 | 12 |
| 250 | | | | | | |
| 125 | 110 | 100 | 85 | 80 | 38 | 20 |
| 70 | | | | | | |
| | 45 | 45 | 35 | 60 | 40 | 29 |



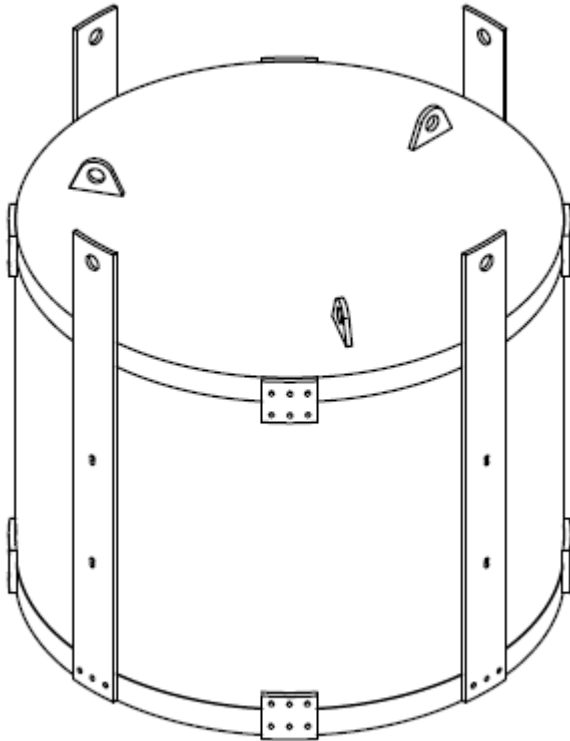
mSv/h \pm ~50-200%



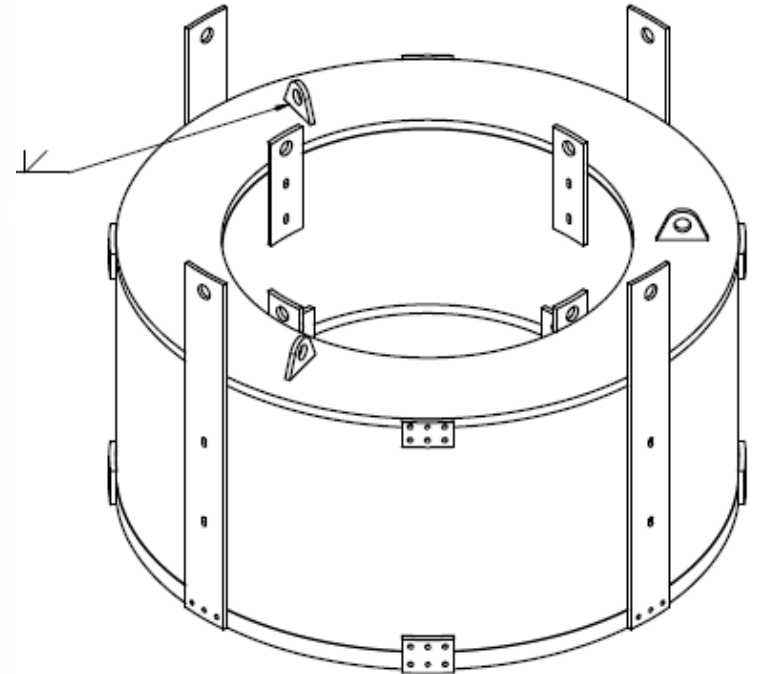
Monte Carlo calculation of radiation fields



Shieldings



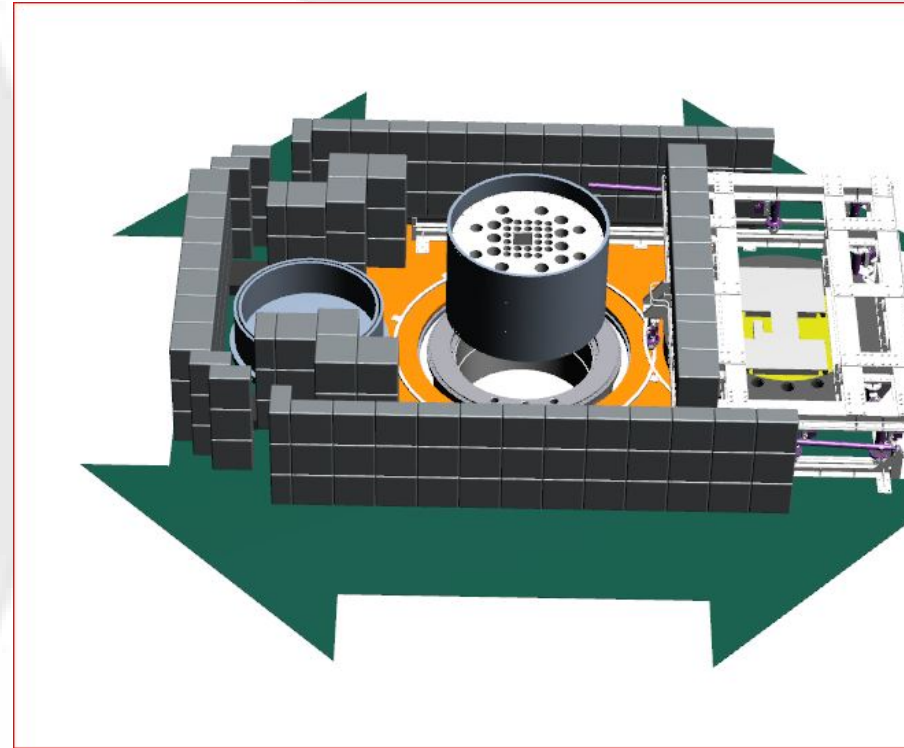
17 cm iron bottom



13 cm iron bottom

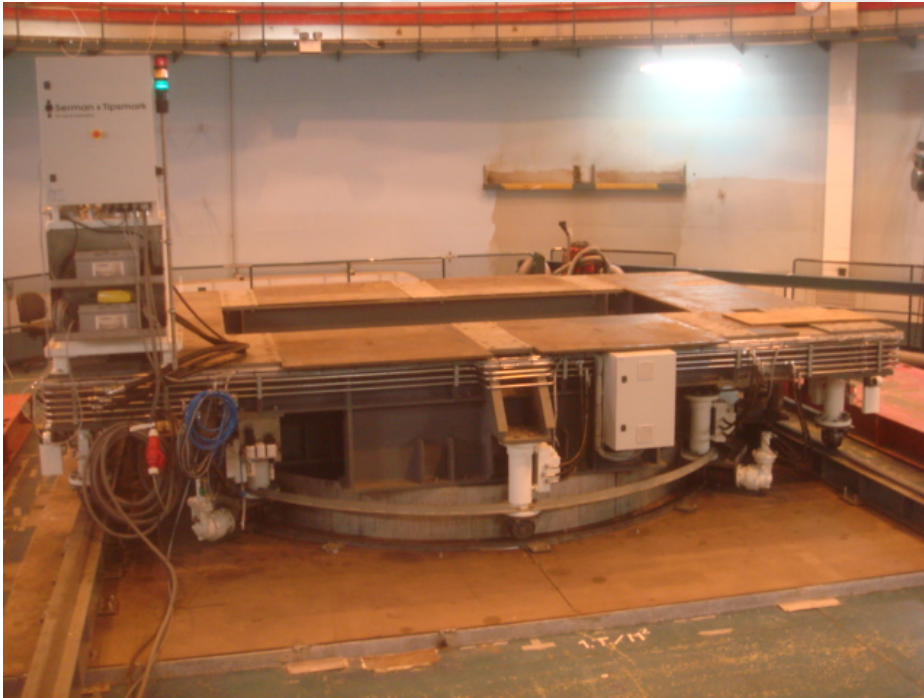


Shieldings



Shieldings

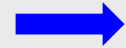
(moveable top shield, MTS)



No-go criteria (TSP)

Max estimated individual effective dose in sub tasks:

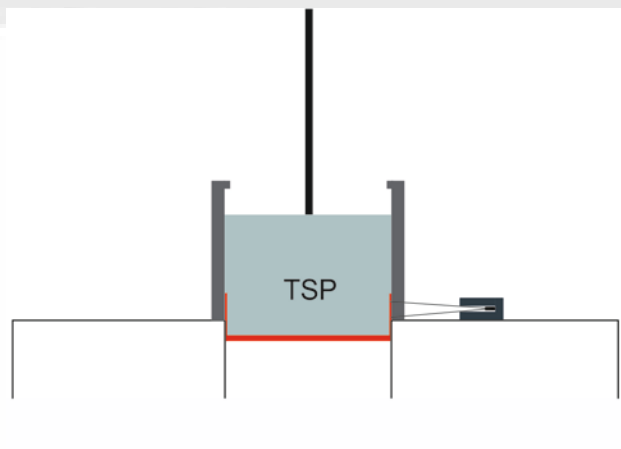
~ 1/4 of max acceptable dose of 1 mSv



up to 4 times higher (than estimated) activity in bottom and side of casing can be accepted.



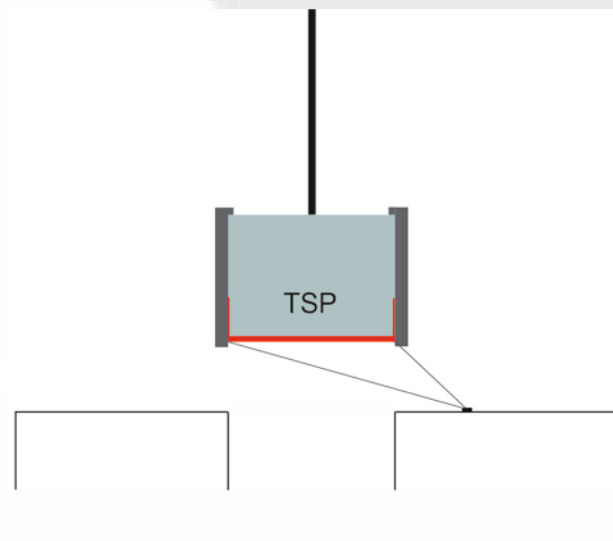
No-go criteria (TSP)



Measurements of activity in small part of side casing viewed by two collimated detectors:

Relation: 0.035 mSv/h pr. GBq (^{60}Co)

No-go: > 1.3 mSv/h



Measurements of bottom activity by two un-collimated detectors:

Relation: 44 mSv/h pr. TBq (^{60}Co)

No-go: > 700 mSv/h



Condensed video of the removal of TSP



Effective doses [μSv] (TSP removal)

| 8 May | DD | MM | DD and MM |
|--|------------|------------|------------------|
| Mean effective dose (for those >0) | 15 | 14 | 14 |
| Maximum effective dose | 31 | 36 | 36 |
| Collective effective dose | 177 | 111 | 288 |
| 9 May | | | |
| Mean effective dose (for those >0) | 8 | 9 | 8 |
| Maximum effective dose | 26 | 19 | 26 |
| Collective effective dose | 109 | 37 | 146 |
| Total collective effective dose | 286 | 148 | 434 |



Effective doses [μSv] (TSR removal)

| 13 October | DD | MM | DD and MM |
|--|------------|------------|------------------|
| Mean effective dose (for those >0) | 6 | 5 | 5 |
| Maximum effective dose | 12 | 8 | 12 |
| Collective effective dose | 13 | 19 | 32 |
| 14 October | | | |
| Mean effective dose (for those >0) | 12 | 16 | 13 |
| Maximum effective dose | 54 | 36 | 54 |
| Collective effective dose | 202 | 98 | 300 |
| Total collective effective dose | 215 | 117 | 332 |



Internal doses

Air at reactor top monitored continuously for gaseous and particulate activity gave no measurements above background.

Smartests from the floor at the reactor top gave no measurements above background

→ no air or area contamination →
no internal doses



Activity contents (at time of removal)

| Part | Measured during removal | Estimated from characterization project |
|-----------------|---|---|
| TSP bottom | 2.89 ± 0.41 TBq | ~ 3 TBq |
| TSP side casing | 0.104 MBq/g \pm 0.015 MBq/g (22 cm from bottom) 0.81 MBq/g \pm 0.12 MBq/g (7 cm from bottom) | ~0.8 MBq/g (22 cm from bottom) ~4 MBq/g (7 cm from bottom) |
| TSR bottom | $0.28 \text{ TBq} \pm 0.15 \text{ TBq}$ | 0.29 TBq |



2015-08-21



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Thank you for your attention

