DECOM LFR EAN 2019

Not classified

Folkert Draaisma

11 maart 2019
DOSE ESTIMATION AND OPTIMISATION DURING DECOMMISSIONING THE LOW FLUX REACTOR
DOSE ESTIMATION AND OPTIMISATION DURING DECOMMISSIONING THE LOW FLUX REACTOR

30 kW
PROGRAM

1. Introduction
2. Permit
3. Preparations
4. Pictures
5. Clearance and Waste
6. Radiation Protection
7. Lessons learned
ARGONOUT TYPE REACTOR

Research reactor, mainly for education and training
First criticality, 28-09-1960
Maximal thermal power, 30 kW (1983)
Upgrade van 10 naar 30 kW in 1983
Uranium used, 11 gram
Last operation, December 2010
HEU Fuel and coolant (water) removed, Summer 2012
Permit for decommissioning in force, February 2015.
Clearance of the reactor hall, March 2018
Decommissioning complete, including removal of all radioactive material, Februari 2019.
TIME LINE

Preparations: 5 years
Decommissioning: 2.5 years
Final phase: 1 year
PREPARATION


Dose rate measurements → Zoning
Activation calculations
Sampling – degree of activation → ‘clean’ concrete or RA waste?
Lessons learned from decommissioning the same type of reactors
SHE plan
ALARA plan
Internal Permit with dose constraints
Activity break down – work plans
Hold points
DOSE RATE ZONES LFR (TOP VIEW)

<table>
<thead>
<tr>
<th>Dosistempo (μSv/uur)</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>x &lt; 10</td>
<td>Blauw</td>
</tr>
<tr>
<td>10 ≤ x &lt; 100</td>
<td>Groen</td>
</tr>
<tr>
<td>100 ≤ x &lt; 1000</td>
<td>Geel</td>
</tr>
<tr>
<td>1000 ≤ x &lt; 10000</td>
<td>Oranje</td>
</tr>
<tr>
<td>10000 ≤ x</td>
<td>Rood</td>
</tr>
</tbody>
</table>
SAMPLING REACTOR
MATERIAL ABOVE CLEARANCE LEVELS

150 cm
ACTIVITIES

Activity break down:
23 activities e.g

• Ventilation system
• Boot or Start source
• Biological shield (not active)
• Thermal column
• Graphite reflector
• Biological shield (active)
• Foundation plate (active)
• Clearance LFR hall
• Asbestos remediation
• Demolition LFR hall
• Clearance location
CLEARANCE MEASUREMENTS
LABORATORY ANALYSES

Gamma radiation
Gamma spectrometry

Beta radiation
For specific nuclides
- H-3
- C-14
- Fe-55
- Ni-63

Total costs per material per point on y-axis activation graph € 2000,
ACTIVATION GRAPH

Activiteitsconcentratie in beton

- Co-60
- Ba-133
- Eu-152
- Eu-154
- Fe-55
- H-3
HOUSEKEEPING
NEW AIR TREATMENT SYSTEM
REMOVING NEUTRON START SOURCE

Training in mock up
BIOLOGICAL SHIELD
REACTOR FOUNDATION
AVAILABLE PACKAGES

Konrad II
3300 liter
€ 60 – € 80 per liter

400 liter drum
200 liter
€ 40 – € 75 per liter

90 liter drum
96 liter
€ 70 – €150 per liter
CLEARANCE REACTOR HALL
CLEARANCE CRITERIA

Materials:
- Guideline for the clearance of materials during the decommissioning of a nuclear facility, TÜV Nord, Hamburg 30 juni 2012
- Uitvoeringsregeling stralingsbescherming EZ, 20 november 2013
- Besluit basisveiligheidsnormen stralingsbescherming, 23 oktober 2017

Building:
- Guideline for the clearance of buildings during the decommissioning of a nuclear facility. TÜV Nord, Hamburg, 30 juni 2012
- Uitvoeringsregeling stralingsbescherming EZ, 20 november 2013
- Besluit basisveiligheidsnormen stralingsbescherming, 23 oktober 2017

Location:
- Guideline for the clearance of sites during the decommissioning of a nuclear facility, TÜV Nord, Hamburg, 30 juni 2012.
- Strahlenschutzverordnung – StrlSchV, 20 juli 2001
# CLEARANCE LEVELS

<table>
<thead>
<tr>
<th></th>
<th>Co-60 [Bq/kg]</th>
<th>Eu-152 [Bq/kg]</th>
<th>Fe-55 [Bq/kg]</th>
<th>H-3 [Bq/kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bs*</td>
<td>1000</td>
<td>10.000</td>
<td>$1 \times 10^7$</td>
<td>$1 \times 10^9$</td>
</tr>
<tr>
<td>BbS</td>
<td>100</td>
<td>100</td>
<td>$1 \times 10^6$</td>
<td>$1 \times 10^5$</td>
</tr>
<tr>
<td>StrlSchV</td>
<td>30</td>
<td>70</td>
<td>6000</td>
<td>3000</td>
</tr>
</tbody>
</table>

* Until 6 February 2018
ASBESTOS REMEDIATION
# WASTE

<table>
<thead>
<tr>
<th>Material</th>
<th>conventional [*1000 kg]</th>
<th>COVRA [*1000kg]</th>
<th>% RA waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>concrete</td>
<td>260</td>
<td>37</td>
<td>14%</td>
</tr>
<tr>
<td>graphite</td>
<td>10</td>
<td>5</td>
<td>50%</td>
</tr>
<tr>
<td>lead</td>
<td>15</td>
<td>1,5</td>
<td>10%</td>
</tr>
<tr>
<td>metal</td>
<td>25</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>remainder</td>
<td>20</td>
<td>0,5</td>
<td>2,5%</td>
</tr>
<tr>
<td>total</td>
<td>330</td>
<td>46</td>
<td>14%</td>
</tr>
</tbody>
</table>
## RADIATION PROTECTION

<table>
<thead>
<tr>
<th></th>
<th>Result</th>
<th>Dose restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collective dose</td>
<td>1.46 man.mSv</td>
<td>20.5 man.mSv</td>
</tr>
<tr>
<td>Personal dose</td>
<td>0.68 mSv</td>
<td>5 mSv</td>
</tr>
<tr>
<td>External parties</td>
<td>0.25 mSv</td>
<td>0.1 mSv</td>
</tr>
</tbody>
</table>

Activities with an important contribution to the collective dose:
- removal of activated parts of the biological shield
- removal of core elements (reflector, frame and vessel)

Removal neutron start source 185 GBq AmBe: max task dose 10 micro.Sv
DOSE RATE

1 micro.Sv/h

- Kern componenten
- Biologisch schild
- Bestralingswagen
- Leegmaken kernruimte
- Beladen Konrad
- Funderingsplaats
LESSONS LEARNED

• Conventional safety is equal to radiation safety.
• Do not underestimate the costs for maintaining installations and facilities.
• The costs of working hours increase fast, but the costs of radiactive waste go faster.
• Bats can cause delay.
• Do not start before all critical parameters are known: characterisation, packages, transport.
• But don’t wait till all details are known.
• Availability of the work force is a critical success factor.
• Keep all stakeholders involved by the project.
RESULT
THANK YOU FOR YOUR ATTENTION!

about the decommissioning of the LFR: youtube.com/watch?v=SWMxIDQiB6A&t=6s