Research Centre Rez Ltd.

HOT CELL FACILITY

Test of Biological Shielding and Commissioning

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Since 2002, R&D organization developing ideas, technologies and solutions in power generation industry particularly focused on nuclear technologies

Member of the UJV Group
Layout of the hot cells

- 8 gamma hot cells, 2 alpha hot cells and 1 semi-hot cell

Thickness of steel shielding:
- perimeter shielding 500 mm
- ceiling shielding 400 mm
- floor shielding 300 mm

- Max. source activity up to 300 TBq $^{60}$Co
Dose Equivalent Rates $\gamma = 1.38 \mu$Sv/h
Limits of DER were established by comparison:

predictable spent time/ shielding

### Table: Thickness of the shielding [cm]

<table>
<thead>
<tr>
<th>Area</th>
<th>Workplace</th>
<th>Thickness of the shielding [cm]</th>
<th>DER with source inside hot cell [µSv]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under hot cells</td>
<td>Occasionally</td>
<td>30</td>
<td>2950</td>
</tr>
<tr>
<td>Operator room</td>
<td>Permanent</td>
<td>50</td>
<td>1,38</td>
</tr>
<tr>
<td>Adjacent box</td>
<td>Occasionally</td>
<td>30 up to 50</td>
<td>2500</td>
</tr>
<tr>
<td>Ceiling of hot cells</td>
<td>Temporary</td>
<td>40</td>
<td>20,5</td>
</tr>
</tbody>
</table>

### Table: t₀ - the presence of an operator relative to its total working time

<table>
<thead>
<tr>
<th>Workplace</th>
<th>t₀ - the presence of an operator relative to its total working time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent</td>
<td>20% &lt; t₀ ≤ 100%</td>
</tr>
<tr>
<td>Temporary</td>
<td>1% &lt; t₀ ≤ 20%</td>
</tr>
<tr>
<td>Occasionally</td>
<td>t₀ ≤ 1%</td>
</tr>
</tbody>
</table>
Shielding walls

- During construction of the shielding occurred inaccuracies of welded steel blocks
- Spaces between modules of shielding
- The largest width of gap was 12 mm
- Gap over the entire length of the weld, narrowed in some places

- Solutions of penetration
- Mix of steel pellet
- Fraction S460 (1 – 1,180 mm)
- Fraction S280 (0,81 – 1 mm)
- Overall used approx. 600 kg
Preparations for active source

- After completing all of the shielding elements (walls, windows, manipulators)
- Risk analysis
- It was necessary to made a prototype components
- All operations were backed up
- Nonactive training started 14 days before performing of the active test
During the test was used two active sources

- $^{60}$Co - 60 GBq for semi-hot cell
- $^{60}$Co - 300 TBq for hot cell and dry pool

Sealed source – no active ventilation

Preliminary calculations of DER was done by MCNP
Shielding test - Calculations using MCNP

Hot cell

Source
300 TBq $^{60}$Co

Operator room
DER = 1,4 uSv/h

DER = 118 uSv/h

DER = 4,2 uSv/h

DER = 3960 uSv/h

Concrete

Reinforced concrete

Lead glass

Grommet filled with steel pellets

Steel
Shielding test – Receiving source
Shielding test – Active test

Opening of transport cask →

← Ready to start

← Source $^{60}\text{Co}$ - 300 TBq

← Measurement of each point
Shielding test – camera system
Shielding test – changing of box

← Inserting of a hermetic box in to the shielding.

Cask with source → was inside Box.

← Inserting of manipulators

← Closing of the shielding
Shielding test – empty chambers

Moving shielding plugs
Shielding test – Active test – each welding
Shielding test – Comparison of values

The maximum measured values of all the cells

<table>
<thead>
<tr>
<th>Measured point</th>
<th>Hot cell – 300 TBq</th>
<th>Semi – hot cell – 60 GBq (Extrapolated for 250 GBq)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Calculated</td>
<td>Measured</td>
</tr>
<tr>
<td>Operator room</td>
<td>1,4 µSv/h</td>
<td>0,4 µSv/h</td>
</tr>
<tr>
<td>Under operator room</td>
<td>4,2 µSv/h</td>
<td>42 µSv/h</td>
</tr>
<tr>
<td>Under cell</td>
<td>118 µSv/h</td>
<td>300 µSv/h*</td>
</tr>
<tr>
<td>Under cable grommet</td>
<td>3960 µSv/h</td>
<td>2758 µSv/h</td>
</tr>
<tr>
<td>On the ceiling of cell</td>
<td>54 µSv/h</td>
<td>14,3 µSv/h</td>
</tr>
</tbody>
</table>

*Missing floor shielding, only lead plugs
Most important is transportation device.

Detail design is finished and some parts are already install

In the end of this year shielding properties will be tested
Installation of technologies in hot cells
Received instrumentation
Non-active testing – docking bay

- Difficult technologies were tested in docking bay
- Easier accesses to equipment
- Better for training of crew
Non-active testing
In the end of this year the facility will receive approval from authorities and active testing process will start.
Next step – active run

- It will be done by low-active materials.
- All systems (principles, decontamination, all procedures) will be tested from security point of view.
- Monitoring systems and decontamination procedures will be improved based on contamination spreading.
- Train, train, train
Timeline

2013
Beginning

2014
Basic design

2015
Building part

2016
Everything in place

2017
Active testing

First picture of HK

Detail design of shielding

Manipulators

First equipment
Year 2017 and on

New hot cells complex is ready, but has to prove itself in operational in 2017.

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Thank you for your attention