ALARA Program and RP Activities for the Reactor Vessel Head Replacement in Vandellòs II NPP

Anna Prim-Pujals, Radiation Protection, Vandellòs II NPP

2015 ISOE International ALARA Symposium, Brussels
Content

1. Vandellòs II NPP: why RHVR?
2. Reactor vessel head dose rate evolution
3. Project description and dose planning
4. Dose Results Summary
5. Information and procedures
6. Learned lessons
1. Vandellòs II NPP: why RHVR?

- **Owners**: ANAV
- **Technology**: Westinghouse 3 loop Pressurised Water Reactor (PWR)
- **Cooling**: Mediterranean sea and aircoolers. Forced draught cooling towers and safeguards pool recently implemented (2009)
- **Power**: 1,087.14 Mwe
- **Start-Up**: March 1988
- **Date of Current Operating Permit**: 2010
- **Spent Fuel Pools Saturation**: 2020
1. Vandellòs II NPP: why RHVR?

Operative international experience: PWSCC in NPP with Inconel 600 /82 /182 in the pressure barrier

Inconel 600 in the CRDM penetrations, thermocouples columns

Possible wear in thermal sleeves (specific Westinghouse issue)

Successive inspections: no cracking problems detected

Preventive measure: replacement of the vessel head by a necover with an improved design with Inconel 690 /52M / 152M
2. Reactor vessel head dose rate evolution

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2013</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.73 mSv/h</td>
<td>1.2 mSv/h</td>
<td>3.3 mSv/h</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2013</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.2 mSv/h</td>
<td>0.5 mSv/h</td>
<td>0.5 mSv/h</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2013</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.42 mSv/h</td>
<td>1 mSv/h</td>
<td>3.5 mSv/h</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2013</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.28 mSv/h</td>
<td>0.4 mSv/h</td>
<td>0.5 mSv/h</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2013</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.85 mSv/h</td>
<td>1 mSv/h</td>
<td>3.2 mSv/h</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2013</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.85 mSv/h</td>
<td>1 mSv/h</td>
<td>3.2 mSv/h</td>
</tr>
</tbody>
</table>
### 3. Project description and dose planning

#### PLANT MODIFICATIONS
- New platform at Containment hatch
- New gate for the entrance to the Fuel Building
- Conditioning of the Waste Storage Building

#### ACTIONS ON THE NEW HEAD
- CDRM installation in the new vessel head in the Fuel Building
- Transport of the new vessel head to the Containment Building
- Assembly of the reusable items on the new head

#### ACTIONS ON THE OLD HEAD - PHASE 1
- Disassembly of the reusable items from the old vessel head
- Transfer of the old vessel head to the Fuel Building
- Storage of the old vessel head in the Fuel Building

#### ACTIONS ON THE OLD HEAD - PHASE 2
- CDRM disassembling and conditioning in the Fuel Building
- Transport of the old vessel head and the CRDM to the Waste Storage Building
ALARA Program and RP Activities for the RVHR at Vandellòs II NPP

3. Project description and dose planning

**ACTIONS ON THE NEW HEAD**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Man-hours</th>
<th>Man-(\text{mSv})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverted</td>
<td>1091</td>
<td>3</td>
</tr>
<tr>
<td>Estimated</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Re-estimated</td>
<td>1</td>
<td>1,271</td>
</tr>
</tbody>
</table>

**CDRM installation in the new vessel head in the Fuel Building**

**Transport of the new vessel head to the Containment Building**

**Assembly of the reusable items on the new head**

No significant radiological concerns
3. Project description and dose planning

<table>
<thead>
<tr>
<th>Activity</th>
<th>Man·hours</th>
<th>Man·mSv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverted</td>
<td>Estimated</td>
<td>Re-estimated</td>
</tr>
<tr>
<td>Partial disassembly of insulation</td>
<td>35</td>
<td>10</td>
</tr>
<tr>
<td>Disassembly of the reusable items</td>
<td>594</td>
<td>34</td>
</tr>
<tr>
<td>Scaffolding</td>
<td>621</td>
<td>8</td>
</tr>
<tr>
<td>Shielding</td>
<td>54</td>
<td>1</td>
</tr>
</tbody>
</table>

The shroud is the last reusable part to be removed. Opportunity to install additional shielding.

Dose re-estimation
3. Project description and dose planning

**ACTIONS ON THE OLD HEAD-PHASE 1**

- Disassembly of the reusable items from the old vessel head
- Transfer of the old vessel head to the Fuel Building
- Storage of the old vessel head in the Fuel Building
3. Project description and dose planning

### ACTIONS ON THE OLD HEAD - PHASE 1

- **Disassembly of the reusable items from the old vessel head**
- **Transfer of the old vessel head to the Fuel Building**
- **Storage of the old vessel head in the Fuel Building**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Man·hours</th>
<th>Man·mSv</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inverted</td>
<td>Estimated</td>
<td>Re-estimated</td>
</tr>
<tr>
<td>Preparation and Decontam.</td>
<td>119</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Transfer to the Fuel Building</td>
<td>1180</td>
<td>41</td>
<td>22</td>
</tr>
</tbody>
</table>

*Head vessel transfer much faster than expected (36 h estimated / 8 h inverted)*
3. Project description and dose planning

**ACTIONS ON THE OLD HEAD-PHASE 1**

- Disassembly of the reusable items from the old vessel head
- Transfer of the old vessel head to the Fuel Building
- Storage of the old vessel head in the Fuel Building
- 134 smear samples before the vessel head exits out of the Containment Building (all < 0.4 Bq/cm²)
3. Project description and dose planning

**ACTIONS ON THE OLD HEAD-PHASE 1**

- Disassembly of the reusable items from the old vessel head
- Transfer of the old vessel head to the Fuel Building
- Storage of the old vessel head in the Fuel Building

**Affected outside areas:**

- Yellow: $> 25 \mu Sv/h \leq 1 mSv/h$
- Green: $> 3 \mu Sv/h \leq 25 \mu Sv/h$
- Gray: $> 0.5 \mu Sv/h \leq 3 \mu Sv/h$
3. Project description and dose planning

**ACTIONS ON THE OLD HEAD - PHASE 1**

- Disassembly of the reusable items from the old vessel head
- Transfer of the old vessel head to the Fuel Building
- Storage of the old vessel head in the Fuel Building

**Teledosimetry**

- 16 remote monitoring DLD + 6 additional transmitters
- 1 personal computer
- 6 TLD
3. Project description and dose planning

- **Disassembly of the reusable items from the old vessel head**
- **Transfer of the old vessel head to the Fuel Building**
- **Storage of the old vessel head in the Fuel Building**

**Actions on the Old Head - Phase 1**

**RP checkpoints (entrance to the restricted area)**

Maximum dose-rate measured with the remote monitoring system

8 ALARA Technicians + 2 RP coordinators (inside/outside containment) + 4 RP for teledosimetry control + RP managers
3. Project description and dose planning

**ACTIONS ON THE OLD HEAD-PHASE 1**

- Disassembly of the reusable items from the old vessel head
- Transfer of the old vessel head to the Fuel Building
- Storage of the old vessel head in the Fuel Building

**Remote monitoring system:**

<table>
<thead>
<tr>
<th>Crane</th>
<th>Accumulated dose (µSv)</th>
<th>Maximum dose rate (µSv/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crane 1</td>
<td>32</td>
<td>159</td>
</tr>
<tr>
<td>Crane 2</td>
<td>239</td>
<td>231</td>
</tr>
</tbody>
</table>
3. Project description and dose planning

**ACTIONS ON THE OLD HEAD - PHASE 1**

- Disassembly of the reusable items from the old vessel head
- Transfer of the old vessel head to the Fuel Building
- Storage of the old vessel head in the Fuel Building
3. Project description and dose planning

Almuerzo Program and RP Activities for the RVHR at Vandellòs II NPP

ACTIONS ON THE OLD HEAD-PHASE 1

May 2015- October 2015

- Forbidden access to the old vessel head
- Shielding to reduce the radiological impact in outer areas
- Work-management: minimization of jobs in the influenced area of the Fuel Building
- Temporal change of the affected area monitors threshold

Disassembly of the reusable items from the old vessel head

Transfer of the old vessel head to the Fuel Building

Storage of the old vessel head in the Fuel Building
3. Project description and dose planning

<table>
<thead>
<tr>
<th>Activity</th>
<th>Man-hours</th>
<th>Man·mSv</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inverted</td>
<td>Estimated</td>
</tr>
<tr>
<td>Scaffolding</td>
<td>178</td>
<td>12</td>
</tr>
<tr>
<td>CRDM cutting</td>
<td>1465</td>
<td>26</td>
</tr>
<tr>
<td>Decontam.</td>
<td>290</td>
<td>1,7</td>
</tr>
<tr>
<td>Shielding</td>
<td>47</td>
<td>1,5</td>
</tr>
</tbody>
</table>

**ACTIONS ON THE OLD HEAD-PHASE 2**

**CRDM disassembling and conditioning in the Fuel Building**

**Transport of the old vessel head and the CRDM to the Waste Storage Building**
ALARA Program and RP Activities for the RVHR at Vandellòs II NPP

3. Project description and dose planning

### ACTIONS ON THE OLD HEAD-PHASE 2

- **CDRM** disassembly and conditioning in the Fuel Building
- Transport of the old vessel head and the CRDM to the Waste Storage Building

### Table: Man-hours and Man·mSv

<table>
<thead>
<tr>
<th>Activity</th>
<th>Man·hours</th>
<th>Man·mSv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfer to the Waste Storage Building</td>
<td>1983</td>
<td>37.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15,388</td>
</tr>
</tbody>
</table>
3. Project description and dose planning

**ACTIONS ON THE OLD HEAD-PHASE 2**

- CDRM disassembly and conditioning in the Fuel Building
- Transport of the old vessel head and the CRDM to the Waste Storage Building

**Teledosimetry**

- 16 remote monitoring DLD + 3 additional transmitters
- 1 personal computer
- 6 TLD

**RP team**

- 4 ALARA Technicians + 1 RP coordinator + 2 RP for teledosimetry control + RP manager
3. Project description and dose planning

**RP checkpoints (entrance to the restricted area)**

Maximum dose-rate measured with the remote monitoring system

- 6 µSv/h
- 104 µSv/h
- 58 µSv/h
- 48 µSv/h
- 41 µSv/h
- 48 µSv/h
- 3 µSv/h

**ACTIONS ON THE OLD HEAD-PHASE 2**

- CDRM disassembly and conditioning in the Fuel Building
- Transport of the old vessel head and the CRDM to the Waste Storage Building

**Fuel Building**

**Waste Building**
3. Project description and dose planning

**ALARA Program and RP Activities for the RVHR at Vandellòs II NPP**

**ACTIONS ON THE OLD HEAD-PHASE 2**

- CDRM disassembly and conditioning in the Fuel Building
- Transport of the old vessel head and the CRDM to the Waste Storage Building
- 12 hours for the head vessel movement - saturday

<table>
<thead>
<tr>
<th>Remote monitoring system:</th>
<th>Accumulated dose (µSv)</th>
<th>Maximum dose rate (µSv/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver 1</td>
<td>9</td>
<td>34</td>
</tr>
<tr>
<td>Driver 2</td>
<td>18</td>
<td>51</td>
</tr>
</tbody>
</table>
3. Project description and dose planning

**ACTIONS ON THE OLD HEAD-PHASE 2**

- CDRM disassembly and conditioning in the Fuel Building
- Transport of the old vessel head and the CRDM to the Waste Storage Building

2 days /12 hours per day for the CRDM containers movement

Final disposal
3. Project description and dose planning

Contamination control surveillance after each movement

Zero personal skin contamination events

**ACTIONS ON THE OLD HEAD-PHASE 1 and 2**

- Transfer of the old vessel head to the Fuel Building
- Transport of the old vessel head and the CRDM to the Waste Storage Building
## 4. Dose Results Summary

<table>
<thead>
<tr>
<th>Activity</th>
<th>Man·hours</th>
<th>Man·mSv</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity</strong></td>
<td><strong>Inverted</strong></td>
<td><strong>Estimated</strong></td>
</tr>
<tr>
<td>Assembly of the reusable items</td>
<td>1091</td>
<td>3</td>
</tr>
<tr>
<td>Disassembly of the old vessel head and auxiliary activities</td>
<td>1304</td>
<td>53</td>
</tr>
<tr>
<td>Preparation and transference of the old vessel head to the Fuel Building</td>
<td>1299</td>
<td>49</td>
</tr>
<tr>
<td>Assembly of the reusable items on the new head</td>
<td>1091</td>
<td>3</td>
</tr>
<tr>
<td>CDRM disassembling and conditioning in the Fuel Building</td>
<td>1980</td>
<td>41.2</td>
</tr>
<tr>
<td>Transfer to the Waste Storage Building</td>
<td>1983</td>
<td>37.9</td>
</tr>
<tr>
<td>Plant modifications</td>
<td>2440</td>
<td>1.65</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>10097</strong></td>
<td><strong>185,75</strong></td>
</tr>
</tbody>
</table>
5. Information and procedures

**Before**

- 2 reports describing specific RP activities: to the regulatory body
- Emission of specific RP procedure describing the preparation and radiological control of the vessel head cover during transport
- Presentation to the ALARA Committee (dose estimation and main RP activities)
- Information to the entire organization (areas with forbidden access)

**After**

- 2 reports summarizing the obtained results: to the regulatory body
- 2 reports with the remote monitoring system results
- Presentation to the ALARA Committee (dose results and main RP activities)
- Information to the entire organization
ALARA Program and RP Activities for the RVHR at Vandellòs II NPP

6. Learned lessons

- Good ALARA performance
  - Dose planning
  - Specific procedures
  - Shielding
  - Remote monitoring
  - Contamination control
  - Effective communication
  - RP involvement
THANKS