Decommissioning Session
The Belgian experience: main achievements and future challenges

International Seminar
Nuclear decommissioning: an opportunity for global and sustainable development
Milan, 11-12 December 2014

Marnix Braeckeveldt  ONDRAF/NIRAS

Belgian Agency for Radioactive Waste and Enriched Fissile Materials
Contents of the Presentation

• Role of ONDRAF/NIRAS

• Remediation and Decommissioning: Nuclear Liabilities

• Other Decommissioning projects

• Challenges for the future

• Conclusion
Legal framework ONDRAF/NIRAS

• **ONDRAF/NIRAS** is a public body in charge of the management of all radioactive waste on Belgian territory (transport, processing & conditioning, storage & disposal)

• **Specific mission ONDRAF:**
  • Approval of decommissioning plans
  • Management of nuclear liabilities

• **Belgoprocess since 1986, subsidiary company of ONDRAF/NIRAS**
  • Operating, under the control and responsibility of ONDRAF/NIRAS, the agency’s facilities for
    • Processing and conditioning
    • Interim storage on the central management site of Dessel/Mol
Approval of dismantling plans

- Nuclear operators submit a decommissioning plan of their facilities for approval to ONDRAF/NIRAS
- Decommissioning plans have to be reviewed every five years (by agreement between ONDRAF/NIRAS and nuclear operator)
- Final decommissioning plan has to be submitted three years at latest before ending operation
- Follow up of decommissioning activities with focus on 'cost to complete'
- Remark: FANC issues decommissioning licence (radiological safety and environmental impact)
Remediation and Decommissioning: Nuclear Liabilities

ONDRAF/NIRAS entrusted by the Belgian State with managing three main nuclear liabilities in application of one of the competencies of ONDRAF defined by the Royal Decree of March 30, 1981

- BP1 (ex-Eurochemic and related facilities) in 1986 and BP2 (ex-Waste department of SCK·CEN) in 1989
- SCK·CEN in 1991
- IRE (Fleurus) in 1998

=> Operational activities entrusted by ONDRAF/NIRAS to Belgoprocess: for nuclear liabilities BP1/BP2
SCK·CEN: for nuclear liability SCK·CEN
IRE: for nuclear liability IRE

- ONDRAF/NIRAS recently (August 2012) charged with the management of a new nuclear liability: remediation and decommissioning of nuclear facilities of Best Medical Belgium S.A. in Fleurus (through bankruptcy)
Decommissioning former reprocessing plant Eurochemic (site BP1)

- pilot reprocessing plant - consortium of 13 OECD countries
- operated from 1966 to 1974
- reprocessing of 180 tons natural and low-enriched uranium fuel, and 30 tons HE fuel
- start of decommissioning 1989
Decommissioning former reprocessing plant Eurochemic (site BP1)

- **Relevant data:**
  - Length 90 m, width 27 and height 27 m
  - Volume: 56,000 m³
  - Concrete volume: 12,500 m³
  - Concrete surface: 55,000 m²
  - Metal: 1,500 ton
  - 7 floors, 40 large cells

- **Strategy developed to minimize radioactive waste production by appropriate D&D techniques**

- **Methodology and installations for clearance, depending on the material and its history (potential contamination): recycling > 90%**
Decommissioning strategy

- Rinsing program
- Removal of systems and components
- First decontamination of the structure
- Removal of embedded piping
- Decontamination of the structure
- Release measurements
- Demolition of the structure
- Brown field
Decommissioning former reprocessing plant Eurochemic (site BP1)

Concrete crushing, milling and sampling facility

- Length 48 m, width 10 m, height 9 m
- Current nominal capacity set at 240 Mg per week
Decommissioning former reprocessing plant Eurochemic (site BP1)

Concrete crushing and sampling unit

<table>
<thead>
<tr>
<th></th>
<th>Eurochemic [Mg]</th>
<th>Rest [Mg]</th>
<th>Total [Mg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processed</td>
<td>9 069</td>
<td>4 767</td>
<td>13 837</td>
</tr>
<tr>
<td>Unconditionally released</td>
<td>9 006</td>
<td>4 763</td>
<td>13 769 ±100%</td>
</tr>
</tbody>
</table>
Decontamination for recycling and reuse of metal

![Decontamination diagram]

<table>
<thead>
<tr>
<th>METAL</th>
<th>Total [Mg]</th>
<th>Free Release [Mg]</th>
<th>% tot</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989-1994</td>
<td>394</td>
<td>243</td>
<td>62%</td>
</tr>
<tr>
<td>1995-1999</td>
<td>554</td>
<td>383</td>
<td>69%</td>
</tr>
<tr>
<td>2000-2004</td>
<td>375</td>
<td>261</td>
<td>70%</td>
</tr>
<tr>
<td>2005-2009</td>
<td>279</td>
<td>218</td>
<td>78%</td>
</tr>
<tr>
<td>2010-2014</td>
<td>160</td>
<td>134</td>
<td>84%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1762</strong></td>
<td><strong>1239</strong></td>
<td><strong>70%</strong></td>
</tr>
</tbody>
</table>
Remediation and decommissioning nuclear liability SCK•CEN

Decommissioning BR3

- BR3 reactor, first pressurized water reactor in Western Europe
- Commissioned in 1962 and ended operation in 1987
- Decommissioning activities on the BR3 reactor started in 1989
- Selected by the European Commission as pilot dismantling project within the framework of the European Union’s 5-year research program on the decommissioning of nuclear installations
Decommissioning BR3: main achievements

• 1989 Start of the BR3 decommissioning project
• 1991 Full System Decontamination of the primary loop
  Dismantling of the Thermal Shield
• 1995 Dismantling of the two sets of internals
  Dismantling of primary and auxiliary loops
• 1999 Commissioning of the MEDOC and ZOE
• 2000 Dismantling of the Reactor Pressure Vessel
• 2002 Dry Storage of the Spent Fuel
  Decontamination of the Steam Generator and the Pressurizer
• 2004 Decontamination of the Fuel Transfer Tank
• 2005 Dismantling the Steam Generator and the Pressurizer
  D&D of cellars in Auxiliary buildings
• 2007-2011 Remote dismantling of the NST
• 2012-2014 Hands on dismantling of the NST
Decommissioning BR3: the strategy is to cut it in-situ -> 400 liter drum
Decommissioning BR3: development of underwater cutting techniques RPV & internals

- Underwater remote EDM cutting, mechanical cutting and plasma arc torch have been compared
- Remote controlled underwater cutting has been extensively used
Decommissioning BR3

MEDOC process: chemical wet decontamination of metallic materials on SCK\textendash CEN site
Decommissioning Best Medical Belgium

May 14, 2012: bankruptcy of Best Medical Belgium S.A (Fleurus)

Belgian law provides that ONDRAF/NIRAS is charged with remediation and decommissioning in case of bankruptcy or failure of a nuclear operator.

August 1, 2012: ONDRAF/NIRAS was charged by its supervisory authority to undertake remediation and decommissioning operations of Best Medical Belgium S.A. facilities.

September 28, 2012: ONDRAF/NIRAS submits an operating licence application to the Federal Agency for Nuclear Control (FANC).
Decommissioning Best Medical Belgium S.A.

October 5, 2012: licence granted - ONDRAF/NIRAS becomes nuclear operator

Licence covers all activities required to:
• restore the safety standards and maintain proper safety levels
• collect the waste, radioactive sources or materials
• release the materials and the buildings from radiological surveillance

ONDRAF/NIRAS currently prepares dismantling strategy, dismantling plan and licence application for decommissioning
Other decommissioning projects in Belgium

Decommissioning Belgonucleaire (Dessel)

• For more than 20 years, Belgonucleaire (Dessel) produced MOX fuel for nuclear reactors
• 2005: Belgonucleaire decides to close down its facility in Dessel
• Last production campaign ended on August 15, 2006
• 2008: licence for decommissioning
• 2009: start decommissioning activities
• 2016: unconditional release
Other decommissioning projects in Belgium

Decommissioning Belgonucleaire (Dessel)
Glove boxes: cleaning->removal of internals before GB separation from line-> “in situ” cold cutting in „glove tent“
Other decommissioning projects in Belgium

Decommissioning FBFC International (Dessel)

• Produced uranium oxide and MOX nuclear fuel elements for nuclear power plants
• December 2010 : licence for decommissioning
• Dismantling started in September 2011
• 2016 : “brown field”
Other decommissioning projects in Belgium
Decommissioning reactor Thetis University of Ghent

- In operation from 1967 until December 2003 (max. 250 kW)
- 2010: final decommissioning plan, drawn up by SCK•CEN, approved by ONDRAF/NIRAS
- 2010: fuel elements removed from reactor core and transferred to Belgoprocess (Dessel) for treatment and conditioning in PAMELA facility (cementation of the elements in a 400l drum)
- 2012: licence for decommissioning granted by the Federal Agency for Nuclear Control (FANC)
- Beginning of 2013: a team of Belgoprocess started the work under supervision of SCK•CEN
- Decommissioning activities expected to be completed in 2015 ("brown field")
Challenges for the future
Time Frame Shut Down of the 7 Belgian NPP: D1&2 in 2015; D3&4-T1&2&3 2022-2025

Decommissioning power reactors Doel1 and Doel 2
July 2013 : first discussions between nuclear operator (Electrabel) and ONDRAF/NIRAS to determine a dismantling strategy taking into account all logistic aspects from waste generation (dismantling) to disposal
Challenges for the future
Radioactive Waste from Decommissioning of the 7 NPP: quantities and categories

- Cat A-waste (low and intermediate level short lived waste): 21% total cat –A waste to be managed by ONDRAF
- Cat B- waste (low- and intermediate level long lived waste): 20% total cat –B waste to be managed by ONDRAF
Challenges for the future cAt Project: Surface Disposal in Dessel

- Planning:
  - License introduced: 2013
  - To obtain license: 2016
  - Construction: 2017-2020
  - Operation: from 2020
Challenges for the future
Decommissioning D1&2

Following actual planning:
  • disposal Cat-A in operation from 2020
  • dismantling D1&2 from 2019

⇒ respect of planning major importance
BUT

new Federal Government: intention to approve extension of lifetime for units Doel 1 & 2 with 10 years, but this under investigation
Challenges for the future
Remote decontamination of vessels in building 105X/122X at site BP1

horizontal vessels: former storage 50 m³ HLLW(LEWC); vertical vessels: former storage of 850 m³ HLLW (HEWC)
Challenges for the future

• Nuclear liability SCK·CEN : Decommissioning research reactors BR1 and BR2 > 2025
  • the BR1 : a uranium/graphite reactor;

  • the materials test reactor BR2 : fuel assemblies with highly enriched uranium placed in a beryllium matrix shaped as an hyperbolic paraboloid, which ensures at the same time a high neutron flux and an easier access to the experiments from the top and the bottom of the reactor;
Conclusions

- ONDRAF/NIRAS central role decommissioning activities in Belgium due to:
  - management of different nuclear liabilities
  - decommissioning plan and follow up during decommissioning

- Belgoprocess and SCK•CEN have built up a large industrial experience in decommissioning nuclear facilities (former Eurochemic pilot reprocessing plant, reactor BR3, other installations)

- Specific decontamination and dismantling techniques have been developed by Belgoprocess and SCK•CEN and are available for further use

- The availability of a disposal site for cat A-waste is crucial for the decommissioning of the 7 NPP