Best practices for preparing vessel internals segmentation projects

Joseph Boucau, Per Segerud, Moisés Sanchez

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Agenda

• Introduction
• Experience from similar projects
• Jose Cabrera preparatory works
• Chooz A preparatory works
• Lessons learned
• Q&A
Introduction

• Successful decommissioning relies on careful and organized planning and decision making based upon factual data and information.

• A good upfront characterization of the vessel and internals is key for an accurate waste packaging and acceptance for waste transportation and final disposal.

• A detailed cutting and packaging plan, based on a 3-D model, is needed for facilitating the segmentation operation on site.

• In old plants, some plant functions do not exist or do not fit the specific needs anymore: e.g. electricity, compressed air, water filtration, working bridge.

• The optimum dismantling strategy sometimes requires significant civil work modifications.
# RVI segmentation – Mechanical cutting references

## Segmentation Performed

<table>
<thead>
<tr>
<th>Location</th>
<th>Component</th>
<th>Year</th>
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<tbody>
<tr>
<td>Forsmark 2</td>
<td>Core Shroud</td>
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<td>Forsmark 2</td>
<td>Core Support Grid</td>
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## Segmentation Contracted

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<td>RPV, Upper &amp; Lower Internals</td>
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<td>All reactor vessel internals</td>
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<td>Philippsburg 1</td>
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<tr>
<td>Neckarwestheim 1</td>
<td>Upper &amp; Lower Internals</td>
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**José Cabrera**

- **Upper & Lower Internals** - 2013
- **Reactor Pressure Vessel** - 2015
RVI segmentation projects ... Not just cutting

Band Saws with Stands

Turn tables

Disc Saws

Lifting Tools

Shearing Tools

RVI segmentation projects require also a good upfront preparation ... let us review two examples.
José Cabrera plant (Zorita): Reactor Vessel dismantling

- One loop reactor: 160 MWe
- First PWR built in Spain
- Located 100 km east of Madrid
- In operation from 1968 till 2006
- Scope of work: segmentation and packaging of reactor internals, operational waste and reactor vessel
- Contractual dates: September 2010 & June 2013
- Project completion: May 2013 & April 2015
Reactor vessel and internals

- Reactor vessel
- Upper internal
- Lower internal
Upper internals

Drive shaft
Shroud tubes

Top support plate

Deep beam

Support column

Upper core plate

Guide tube assembly

Weight: ~ 9.5 T
Lower internals

Upper core barrel

Baffle plate

Lower core barrel

Lower core plate

Lower plenum

Weight: ~50.5 T
Characterization of lower internals

A good characterization is essential for waste container acceptance
Tooling design

- Extensive 3-D modeling
- Adaptation of proven mechanical cutting technology
Zorita mock-up testing (June 2011)
Plant configuration

- Turbine building
- Reactor building
- Reactor cavity
- Spent Fuel Pool
José Cabrera reactor cavity & spent fuel pool

Water depth:
- Reactor pool: 5.597 m
- Spent Fuel pool: 11.722 m

Protection plates
New working bridge
Wall removal
Sealing of leakages
Grouting of reactor cavity floor

Reinforced concrete slab of 15 cm thickness
Spent fuel transfer channel enlargement

Diamond wire cutting:
24 blocs of 1.7x1.7x1.7 m
New spent fuel bridge
Sealing of leakages

Vessel Sealing

Instrumentation wells

Preferential pathways of releases interfaces between steel liner and asphalt impermeabilization

Deficiencies in the upper part of impermeabilization

Liner punctures
Repair of previous liner damages
Contingency pumps and SFP protection plates

Contingency pumps

Vessel protection plates
Retrieval of spent fuel racks
Cutting and packaging of operational waste

Flow diffuser

Primary Source

Secondary source

Cut thimbles ... 30 Sv/h!

Visual inspection and radiological inventory
Waste packaging in the pool

Thanks to a good preparation, the segmentation work has been performed according to the initial plan.
Packing of RVI cut pieces - CE-2B container

Efficient packaging is achievable by CAD modelling
Reactor Vessel removal scenario
RV Nozzle cutting with diamond wire

Equipment testing in Vasteras (Nov.2013)

Equipment installation on site (March 2014)
Reactor Vessel lifting equipment with jacking system

Equipment delivery

Vessel lifting (June 4, 2014)

Installation on site
José Cabrera Lessons Learned

• Good preparatory work is essential – needs to be planned thoroughly.
• Many plant functions, such as compressed air and water were shut down, making the preparation more complicated.
• The amount of debris (sludge etc.) at starting point was far more than anticipated.
• An additional filtration system was needed to clean the water from the initial state.
• Thanks to the good preparatory work for the internals segmentation, the reactor vessel and internals cutting project has been implemented perfectly.

✓ RV Internals: 418 meters of cutting, 432 cut pieces, total weight = 59.5 T
✓ RV: 240 meters of cutting, 140 cut pieces, total weight segmented = 114 T
Chooz A: RV internals segmentation

- Located in France close to the Belgian border
- 4-loop, 305 MWe PWR
- Unique feature: built in two caves
- In operation from 1967 till 1991
- Scope: segmentation and packaging of reactor vessel, reactor internals and operational waste
- Consortium Westinghouse/Nuvia
Chooz A – RV/RVI segmentation scope

- Upper internals (M=19 T)
- Vessel with thermal insulation (M=177 T)
- Operational waste stored in the vessel (M=16 T)
- Lower internals (M=27 T)
Enlargement of reactor cave entrance

- Needed for introducing large equipment (e.g. RV stand ~6 m OD) and evacuating large waste containers
Grouting of 3 Steam Generator pits
Closure of Steam Generator #2 pit

• Provides base for future construction of the reactor cave hot cell
New reactor cave workshop

To create space for building reactor cave workshop for dry cutting and waste processing

Three concrete beams and two columns have to be cut

SG3 pit closed

SG3 pit closed
Modifications to create valuable work space

- Closure of cable trace to create a working area and support future electrical cabinet installation
Upgrade of electrical power distribution

- Strategically placed to support dismantling work
- Eight such cabinets have been installed
- About 2 km of new cables and trays

Installation of new electrical cabinets (~ 400KVA)
Studs de-tensioning

Original plant studs tensioning machine had to be re-conditioned
Conclusions

• Reactor dismantling is not just cutting internals and a vessel.
• A detailed study of the optimum dismantling scenario must be done taking account of the available plant systems and infrastructure.
• Especially for old plants, significant plant modifications need to be considered for meeting the project goals, including civil work modifications, new water filtration system, new power supply, new HVAC system, …
• Specific waste management constraints may also require installation of dedicated equipment.
Questions
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