PREDEC 2016 International Symposium on PREparation for DECommissioning

Best practices for preparing vessel internals segmentation projects

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Agenda

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

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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.

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RVI segmentation – Mechanical cutting references

Segmentation Performed

Forsmark 2	Core Shroud	2000
Forsmark 2	Core Support Grid	2000
Forsmark 1	Core Shroud	2001
Forsmark 1	Core Support Grid	2001
Oskarshamn 2	Core Shroud Cover	2003
Oskarshamn 2	Core Support Grid	2003
Oskarshamn 2	Feed Water Spargers	2003
Oskarshamn 2	Core Spray Riser Pipes	2003
Oskarshamn 2	Test Channels	2003
Oskarshamn 2	Core Shroud Cover	2004
Oskarshamn 1	Core Support Grid	2004
Oskarshamn 1	Core Spray Riser Pipes	2004
Oskarshamn 1	Test Channels	2004
Olkiluoto 2	Steam Separators, 19 pcs	2004
Olkiluoto 2	Core Support Grid	2004
Olkiluoto 2	Core Shroud Cover	2004
Forsmark 3	Core Spray Piping & Support	2005
Olkiluoto 1	Steam Separators, 19 pcs	2005
Olkiluoto 1	Core Support Grid	2005
Olkiluoto 1	Core Shroud Cover	2005
Oskarshamn 3	Control Rod	2006
Olkiluoto 1	Steam Dryer	2008

Segmentation Performed

Olkiluoto 1	Control Rod Shafts, 120pcs	2009
Olkiluoto 2	Control Rod Shafts, 81pcs	2009
Forsmark 3	Control Rod Shafts, 46pcs	2009
Forsmark 2	Steam Dryer	2010
Forsmark 2	Core Shroud Cover	2010
Forsmark 3	Control Rod Shafts, 62pcs	2010
Forsmark 1	Steam Dryer	2011
Forsmark 1	Core Shroud Cover	2011
Forsmark 3	Core Shroud Cover	2012
Grand Gulf	Steam Dryer	2012
Olkiluoto 2	Steam Dryer	2013
Oskarshamn 3	Control Rod Shafts, 27 pcs	2013
Studsvik R2	Iodine Rigs	2013
José Cabrera	Upper & Lower Internals	2013
Oskarshamn 3	Core Shroud Cover	2013
Oskarshamn 3	Steam Dryer	2014
Peach Bottom 2	Steam Dryer	2014
José Cabrera	Reactor Pressure Vessel	2015

Segmentation Contracted

Mühleberg	Fuel channels	2016
Peach Bottom 3	Steam Dryer	2015
Chooz A	RPV, Upper & Lower Internals	2016
Barsebäck 1 & 2	All reactor vessel internals	2016
Philippsburg 1	All reactor vessel internals	2017
Neckarwestheim 1	Upper & Lower Internals	2017

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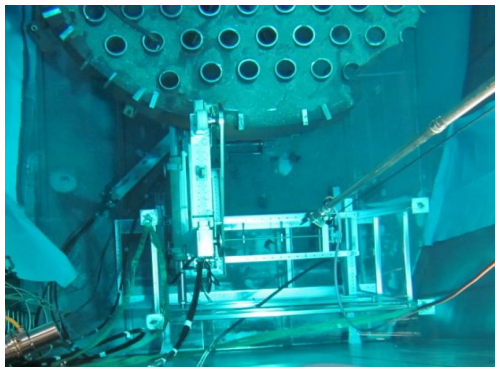
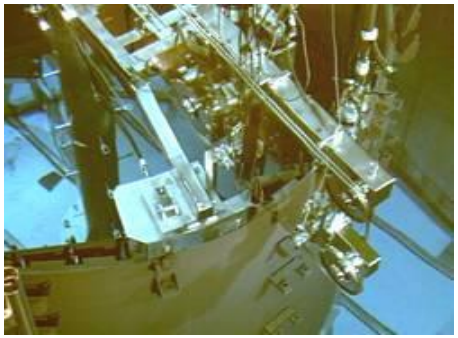
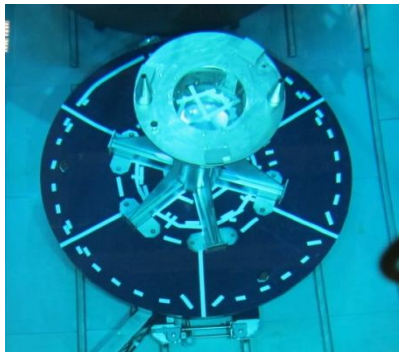
RVI segmentation projects ... Not just cutting

Band Saws with Stands

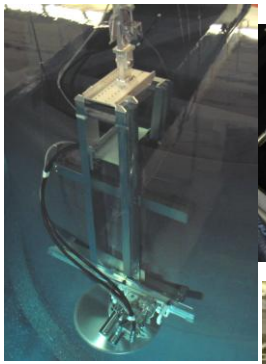


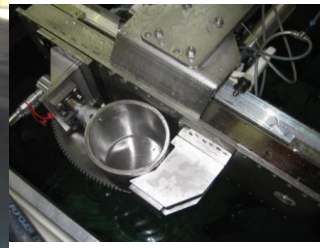


Turn tables



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

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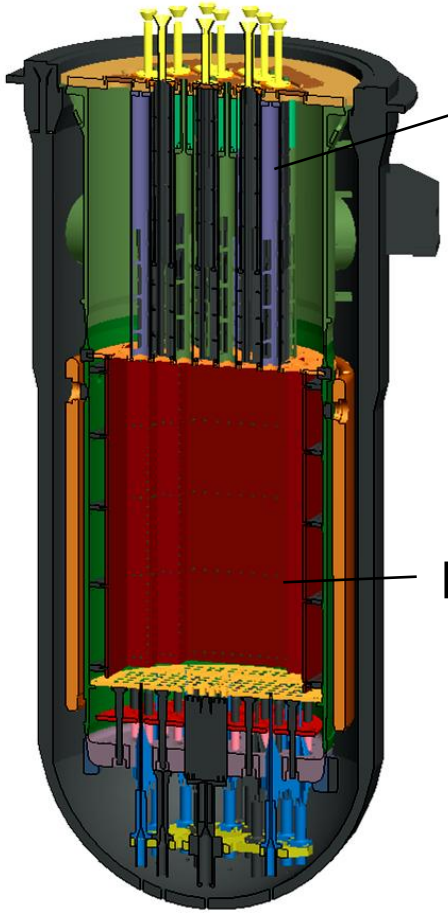
Reactor vessel and internals

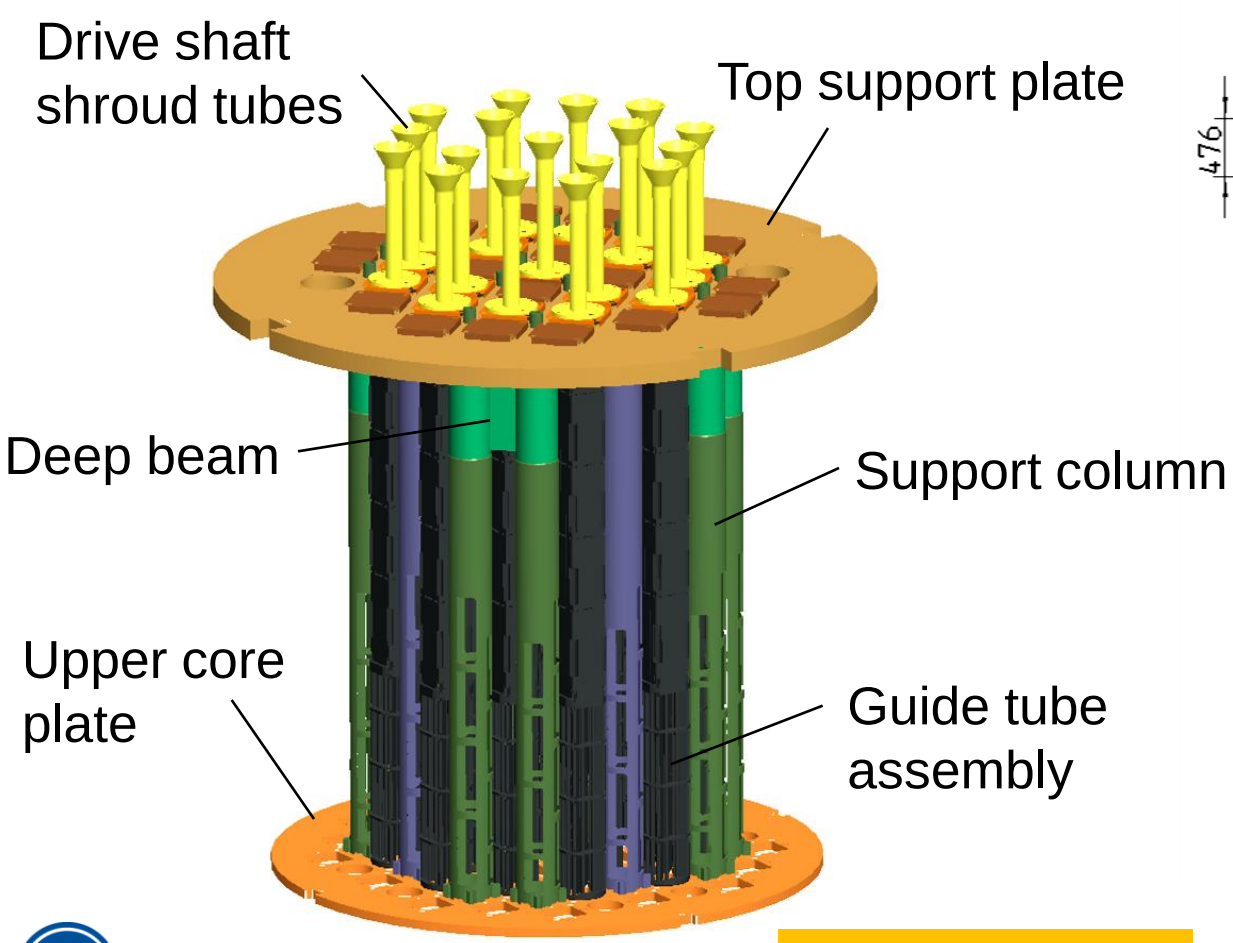
Reactor vessel

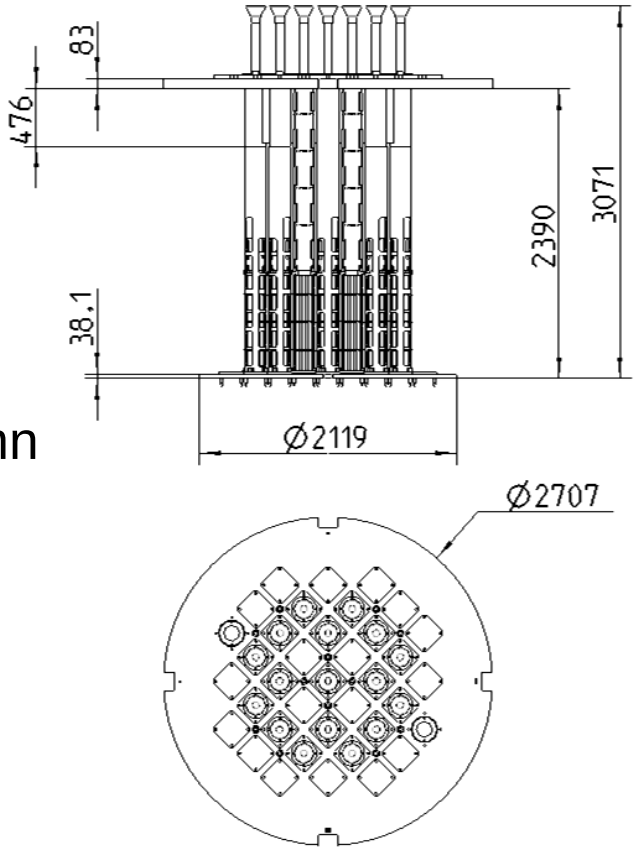


Upper internal

Lower internal

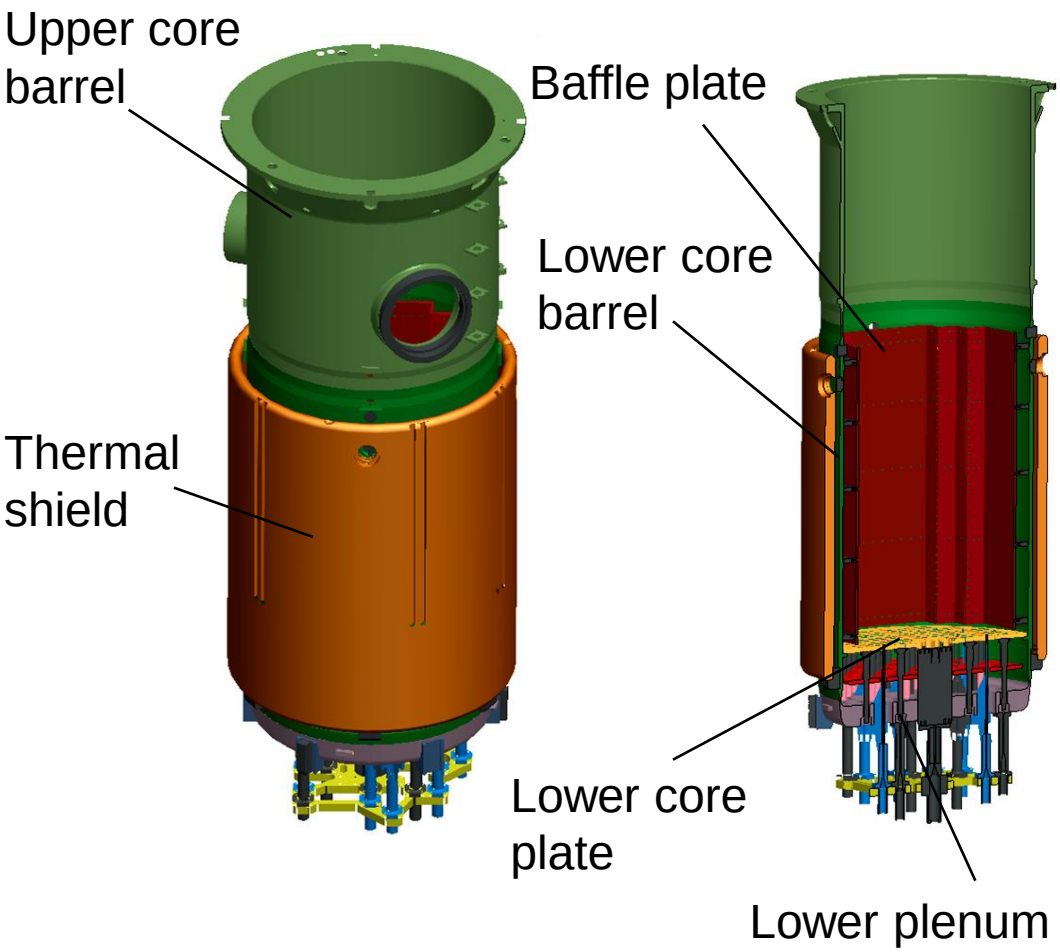
Upper internals

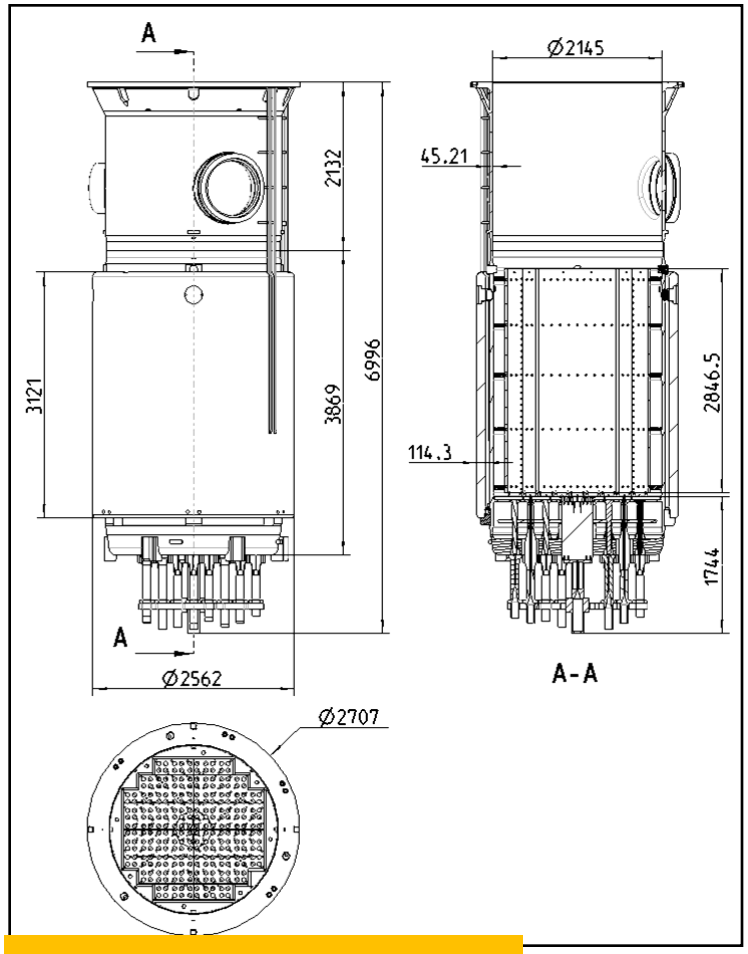




Weight: ~ 9.5 T

Lower internals

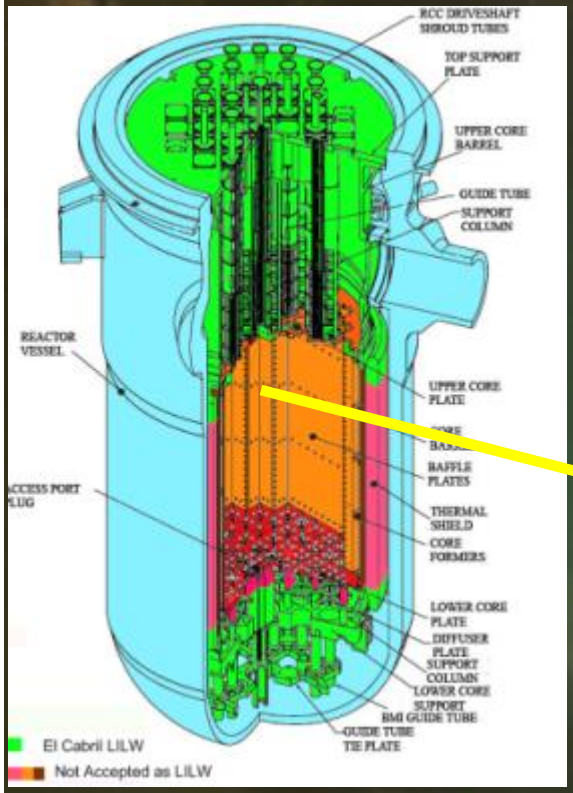




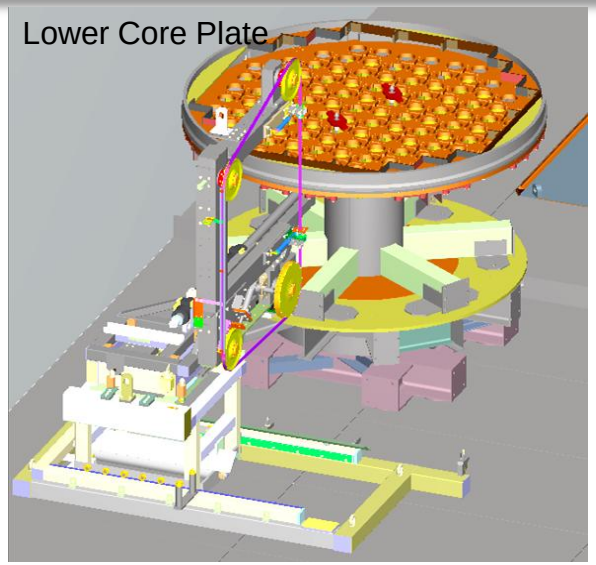
Weight: ~50,5 T

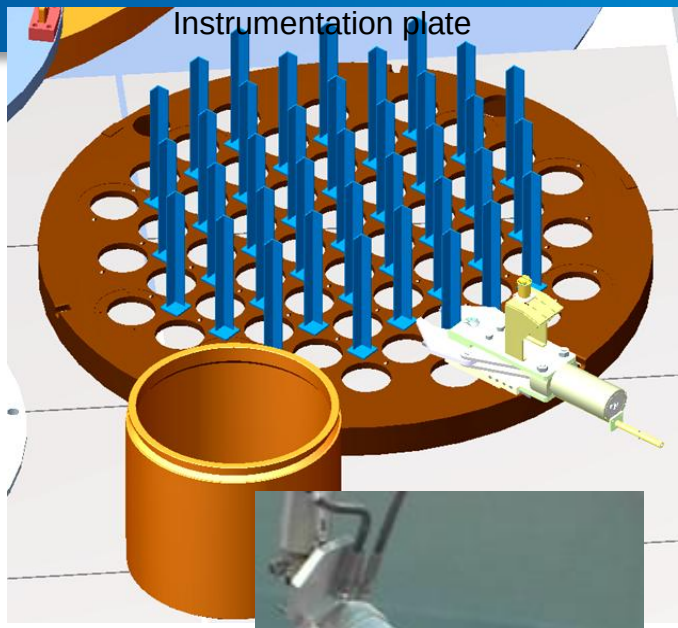
Characterization of lower internals

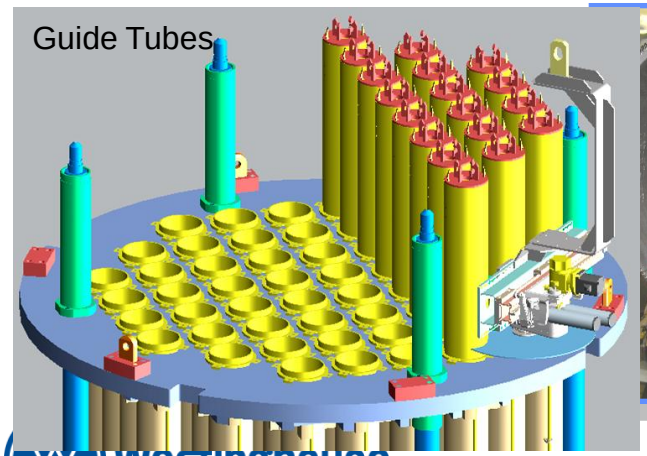
A good characterization is essential for waste container acceptance



Tooling design



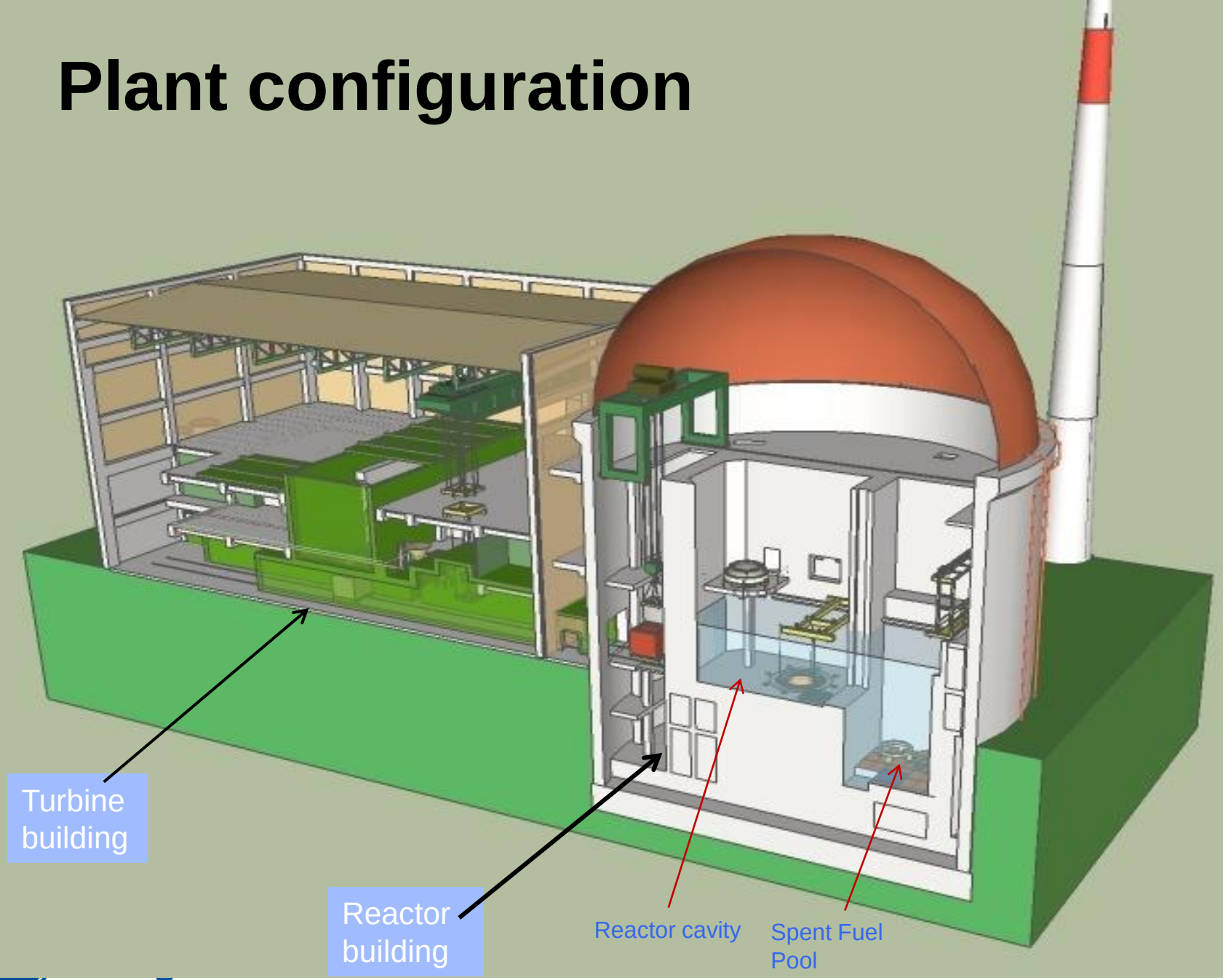




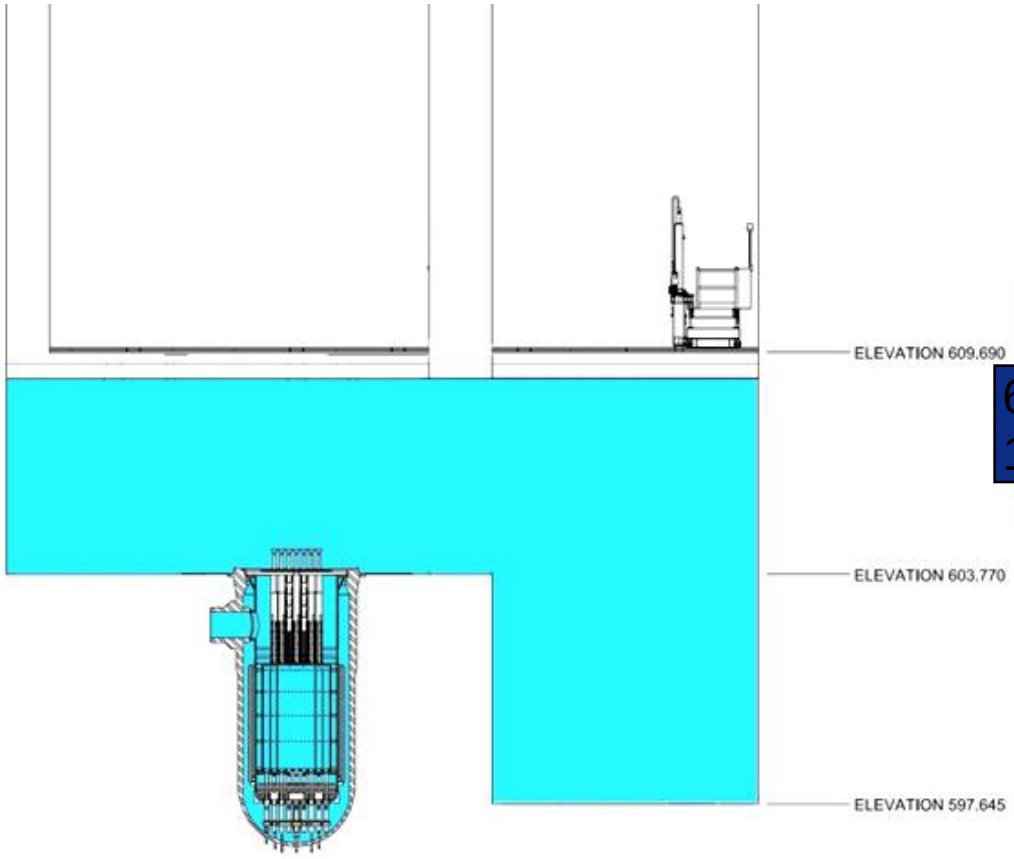
- Extensive 3-D modeling
- Adaptation of proven mechanical cutting technology

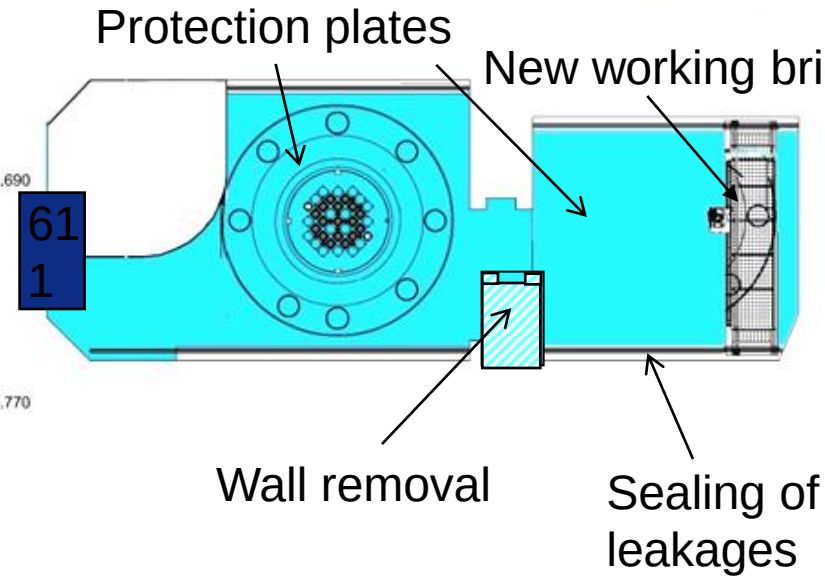
Zorita mock-up testing (June 2011)

Plant configuration



José Cabrera reactor cavity & spent fuel pool

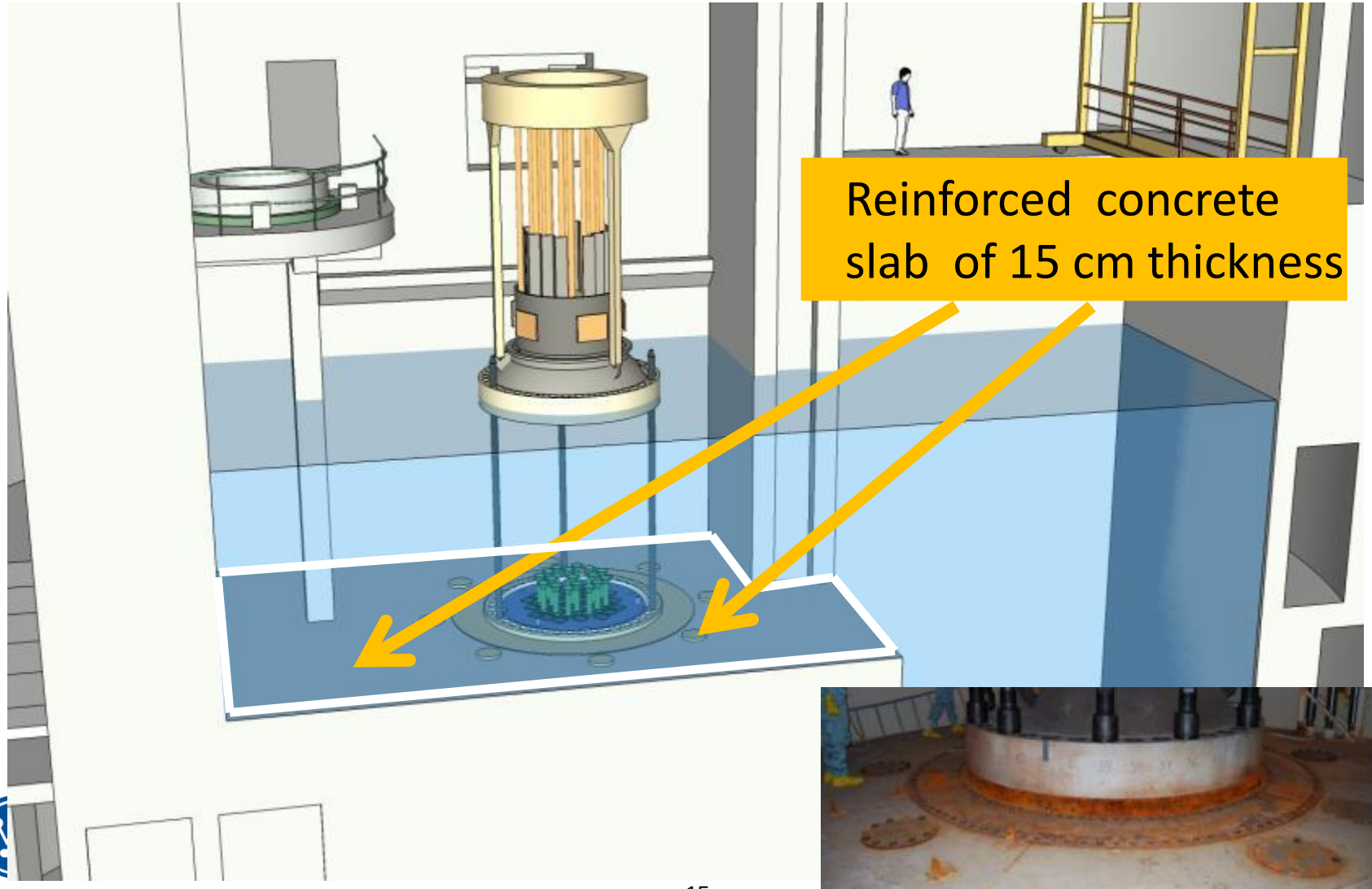




Water depth:

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

Grouting of reactor cavity floor

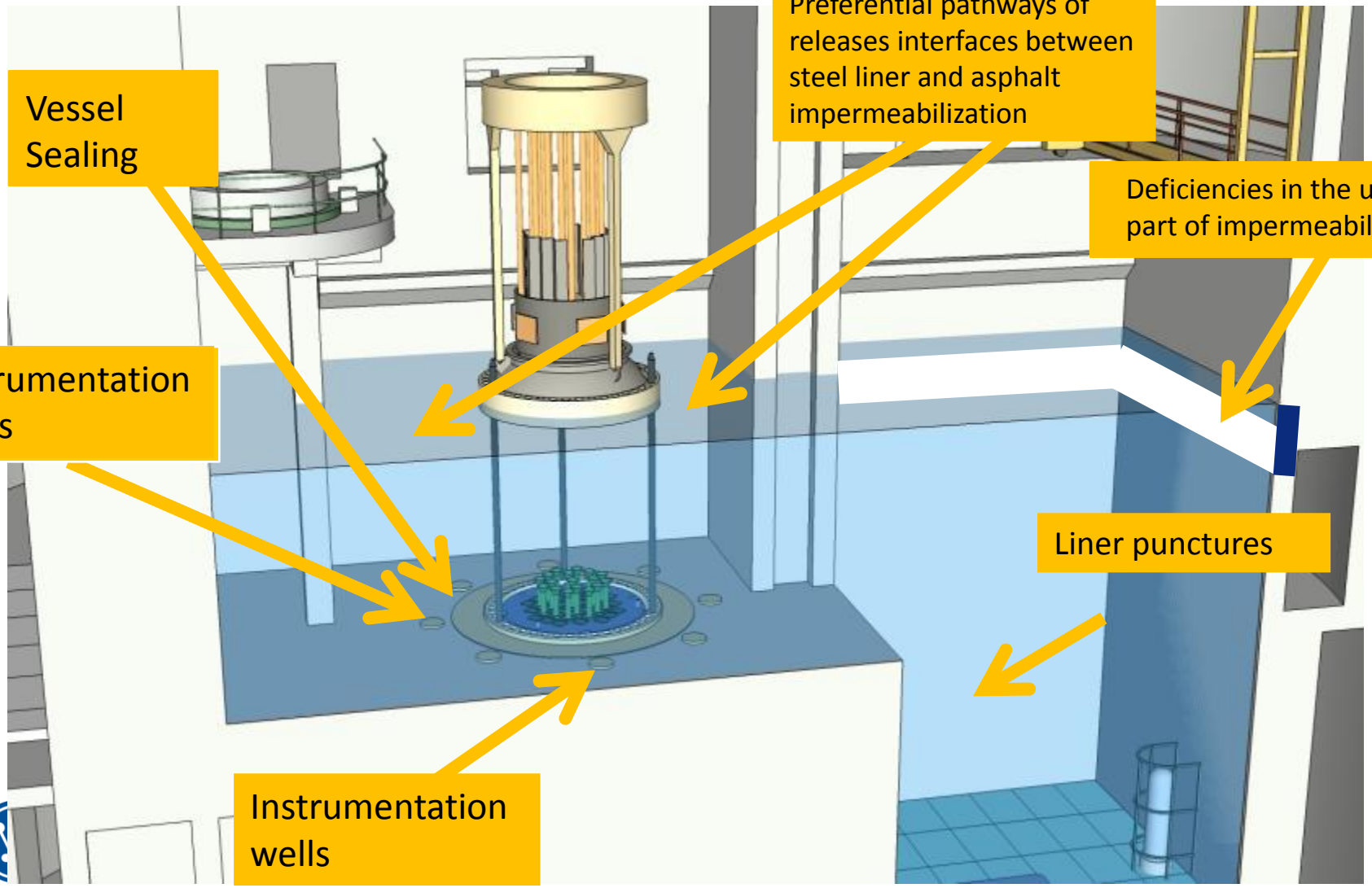


Spent fuel transfer channel enlargement

Diamond wire cutting :
24 blocs of 1.7x1.7x1.7 m

New spent fuel bridge

Sealing of leakages



Repair of previous liner damages

Contingency pumps and SFP protection plates

Contingency pumps

Vessel protection plates

Retrieval of spent fuel racks

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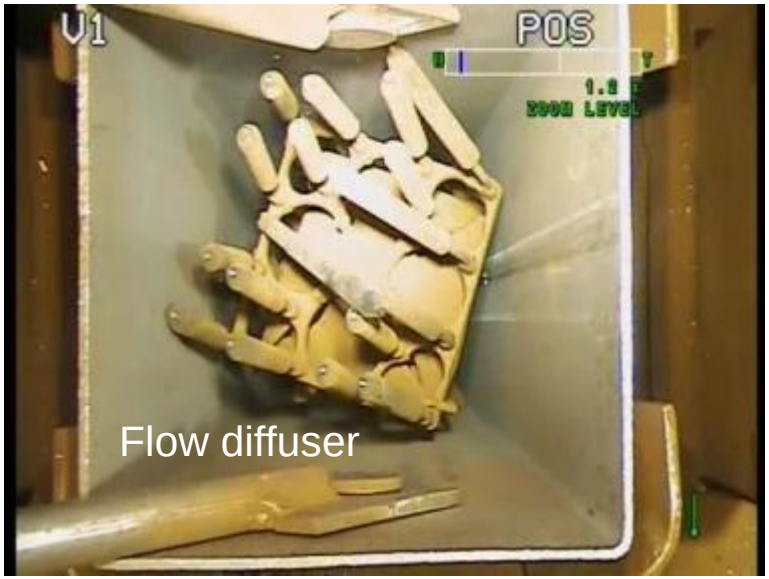
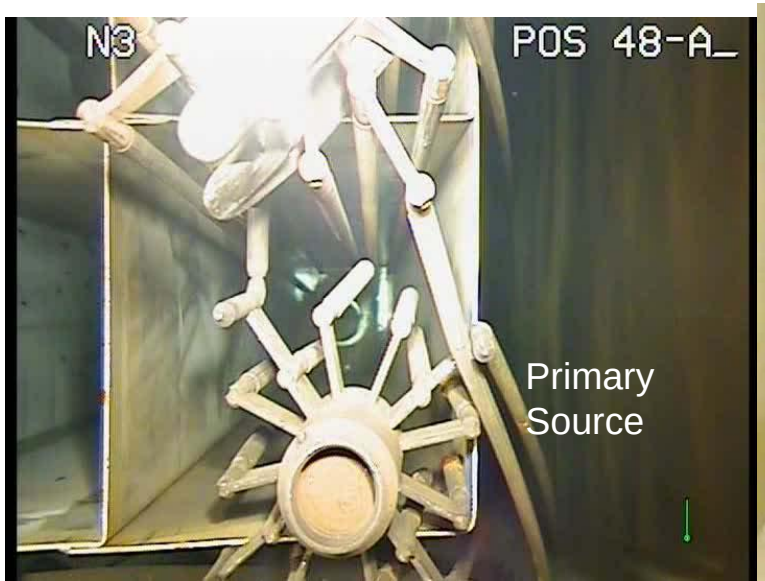
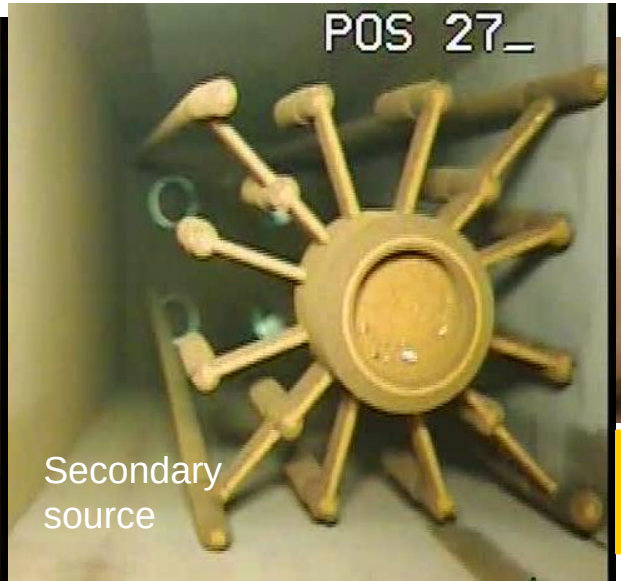
Cutting and packaging of operational waste

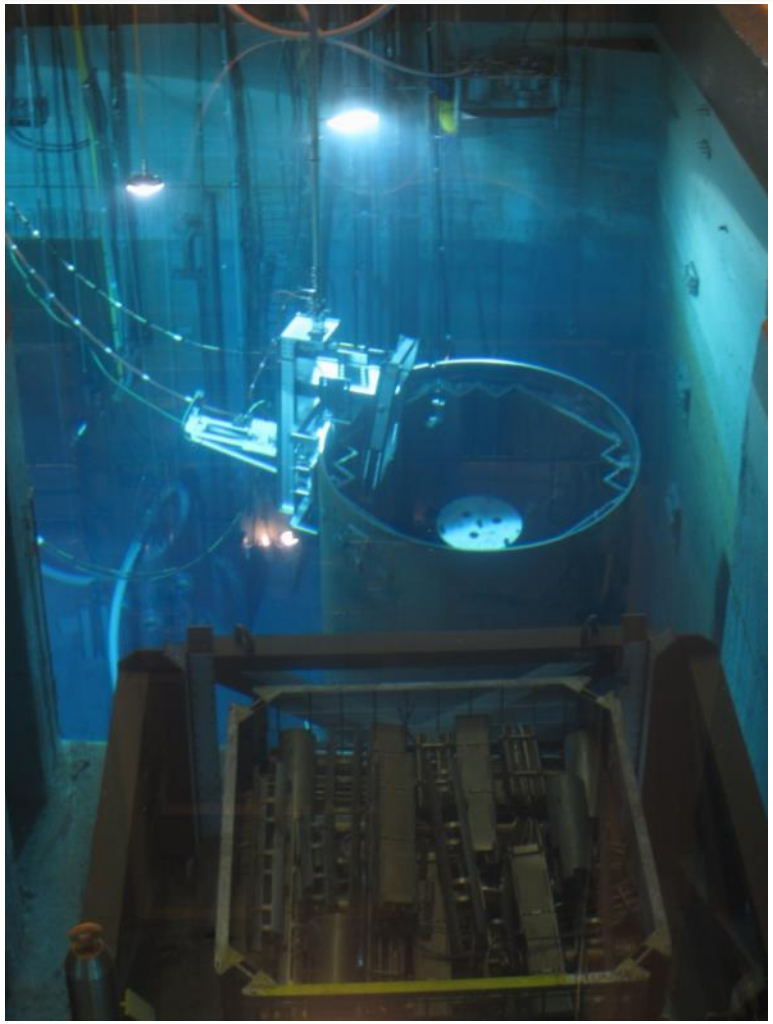






Visual inspection and radiological inventory

Waste packaging in the pool



Thanks to a good preparation, the segmentation work has been performed according to the initial plan.

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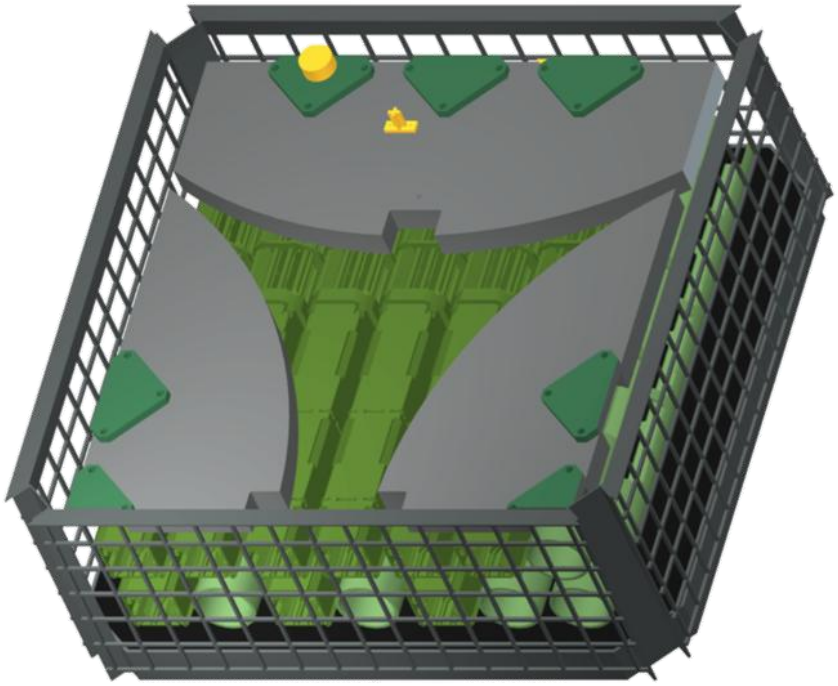
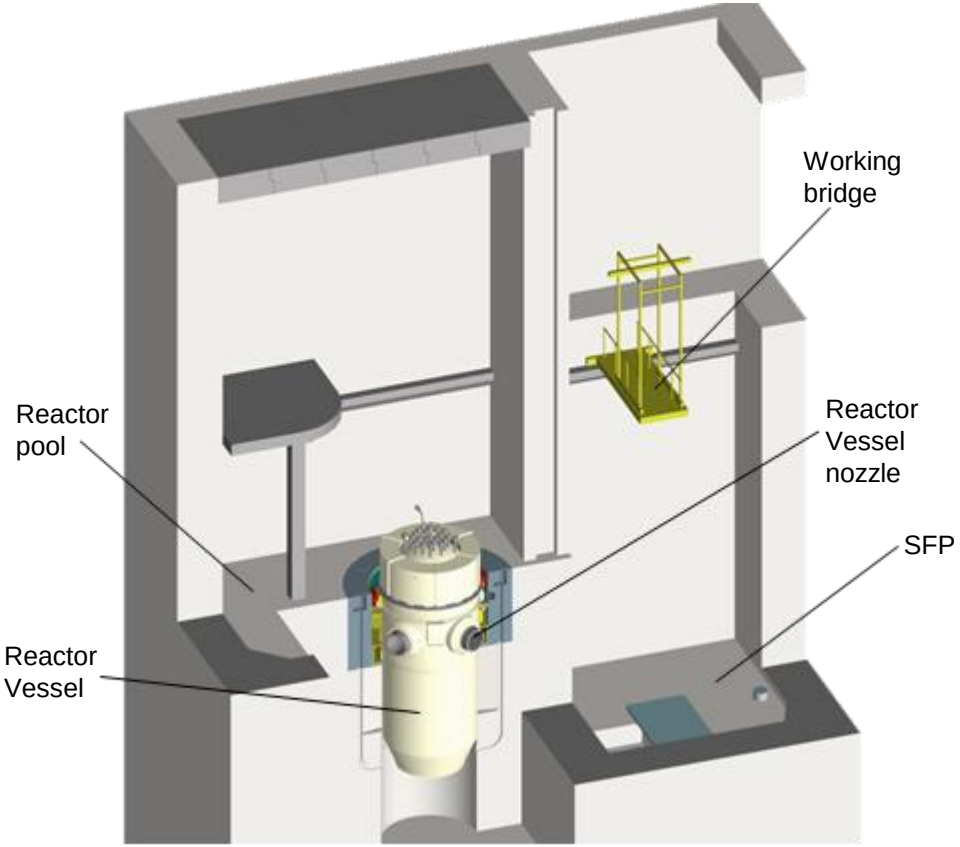
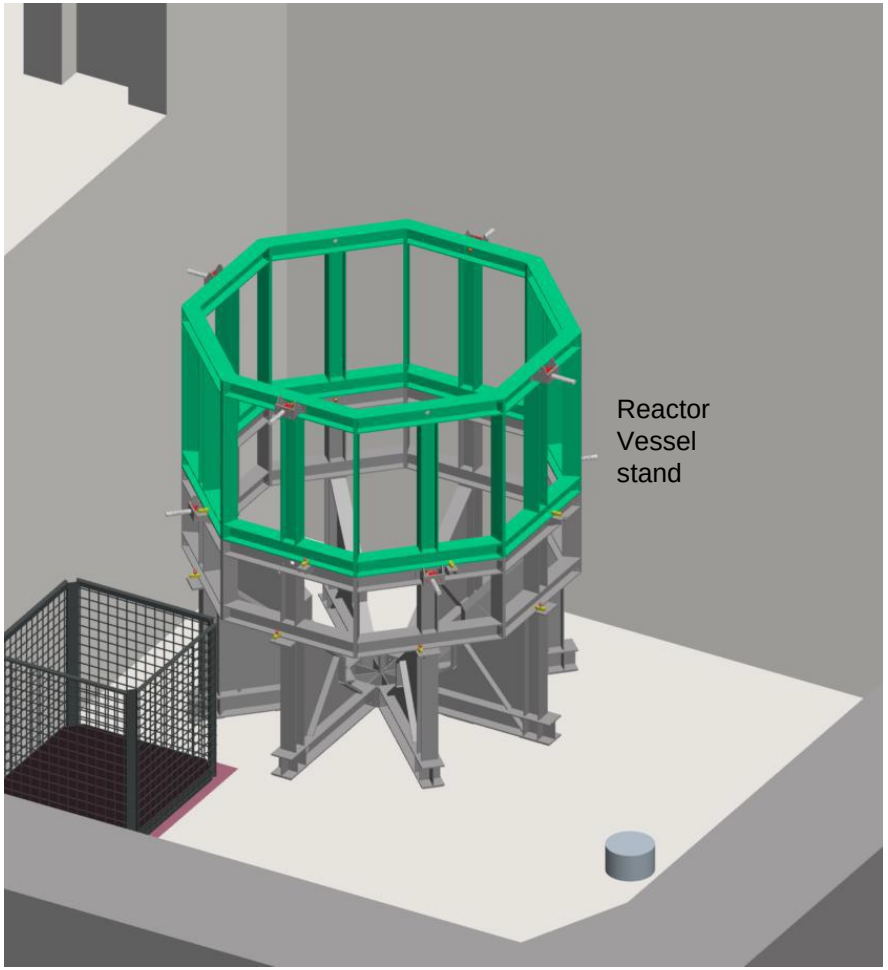
Packing of RVI cut pieces - CE-2B container



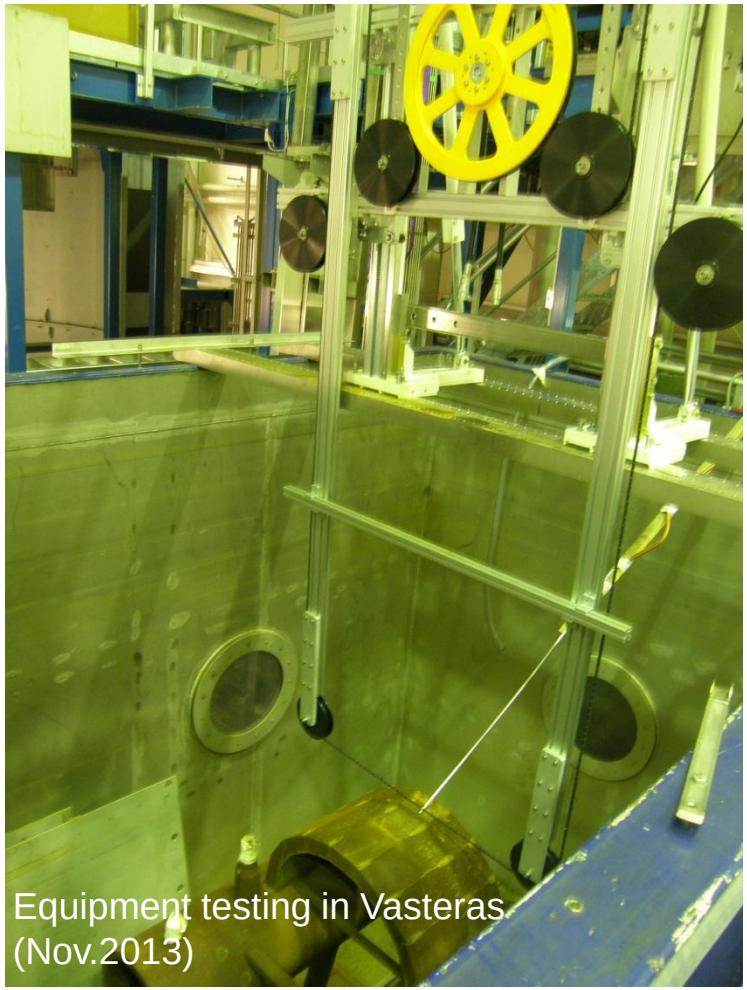
Efficient packaging is achievable by CAD modelling

Reactor Vessel removal scenario





RV Nozzle cutting with diamond wire



Equipment testing in Vasteras (Nov.2013)

Equipment installation on site (March 2014)

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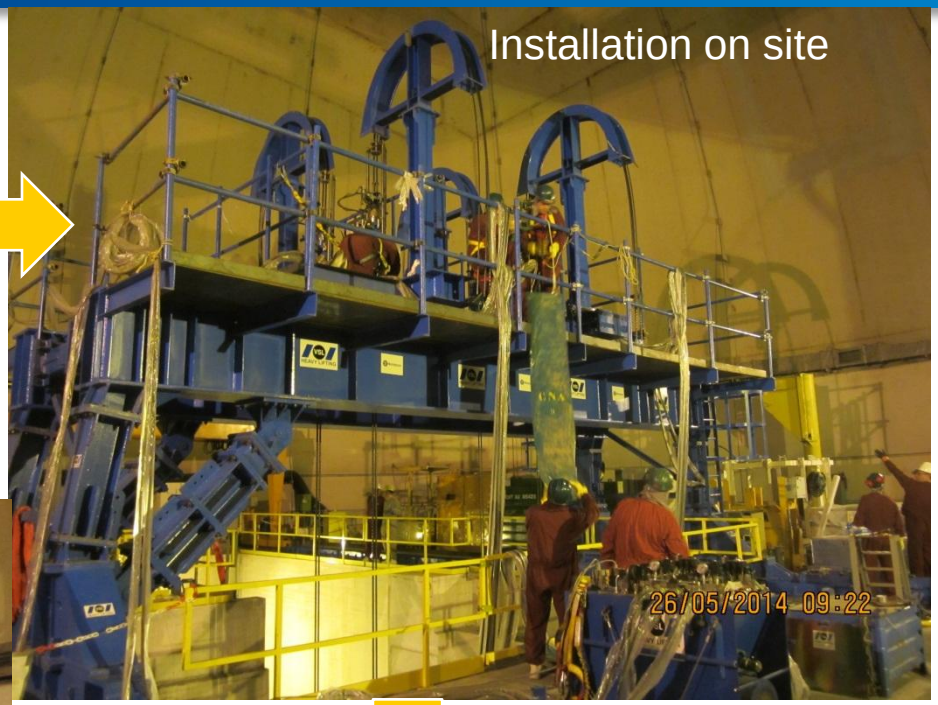
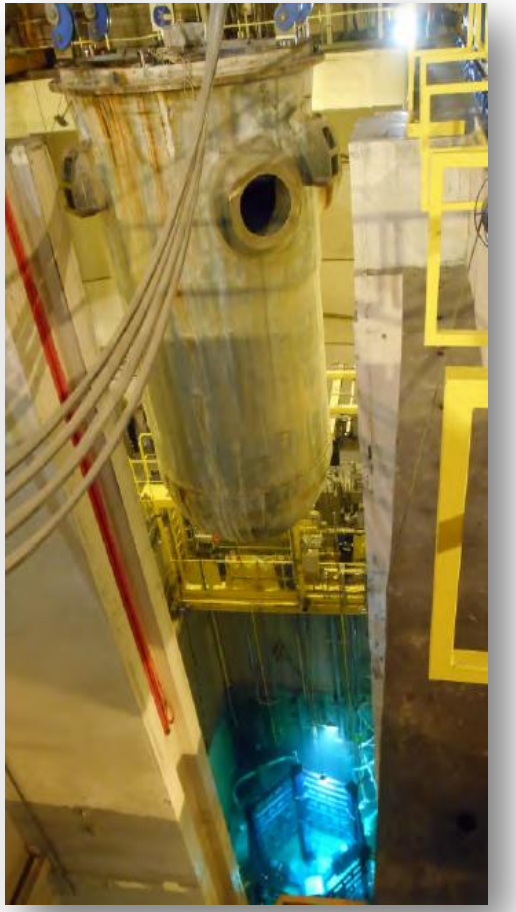
Reactor Vessel lifting equipment with jacking system



Reactor Vessel lifting and transfer to SFP



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RV lifting out of the pit occured on June 4, 2014

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**

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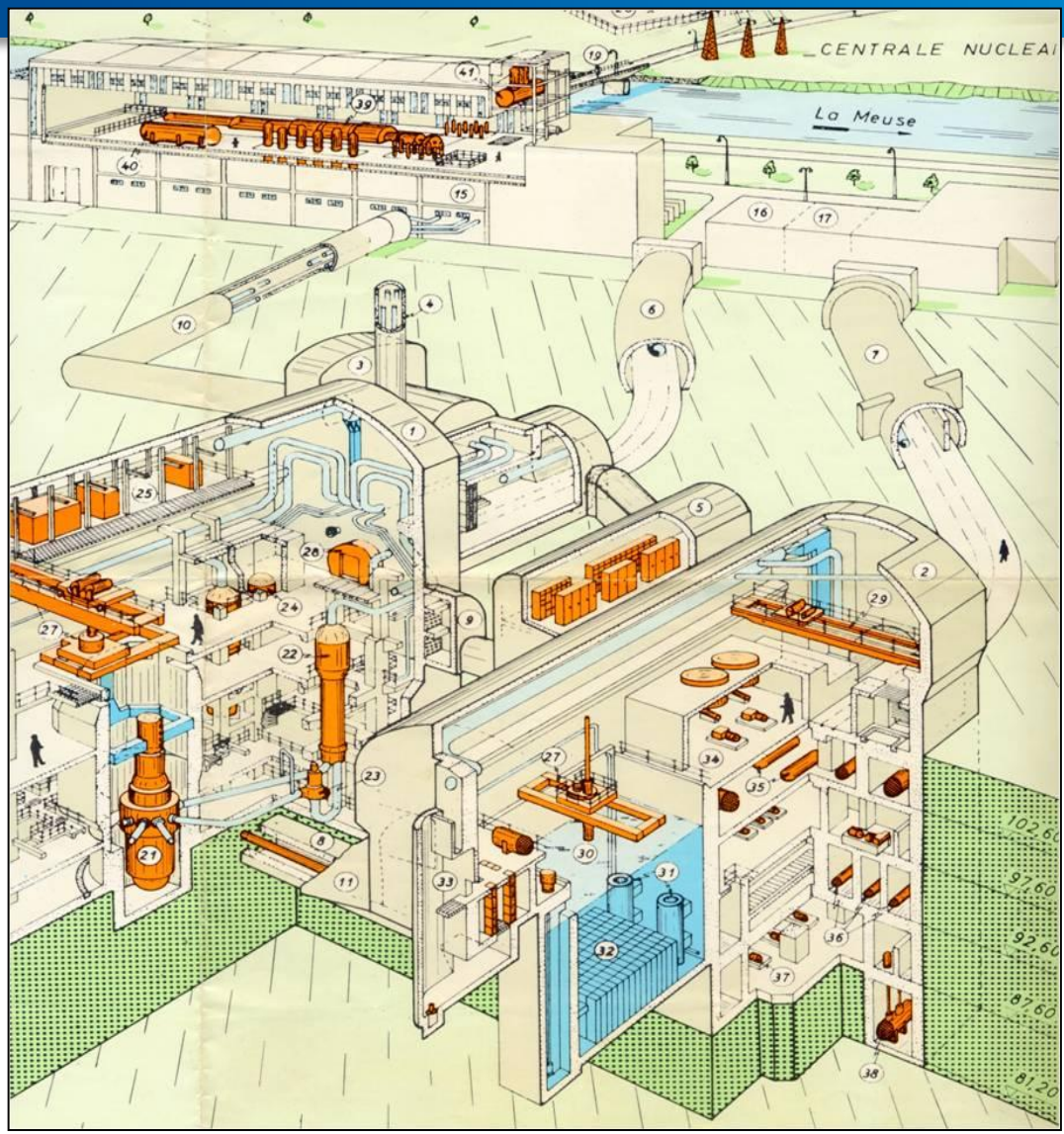
Chooz A : RV internals segmentation

- 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



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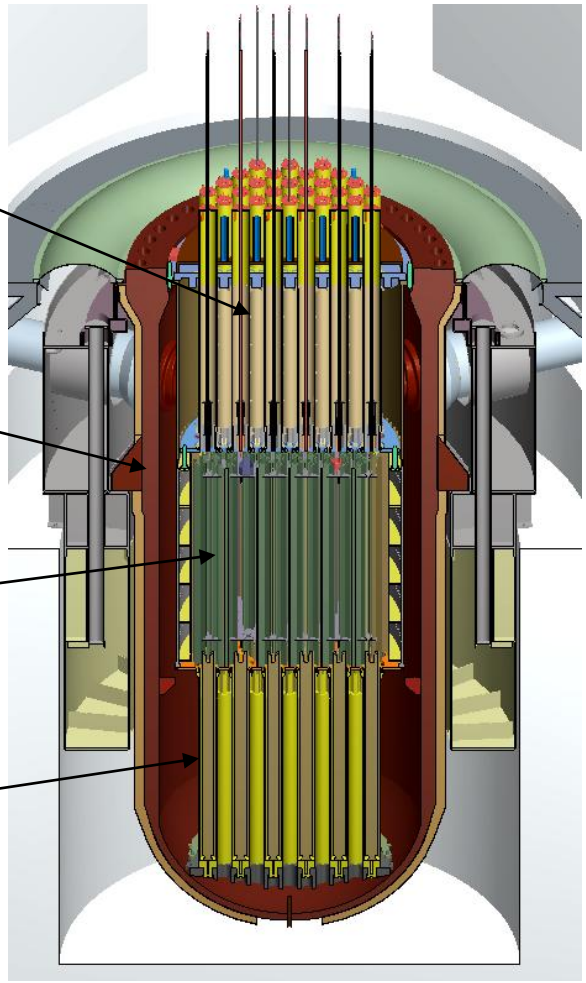
Chooz A – RV/RVI segmentation scope

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)



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Enlargement of reactor cave entrance

- Needed for introducing large equipment (e.g. RV stand ~6 m OD) and evacuating large waste containers

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Grouting of 3 Steam Generator pits

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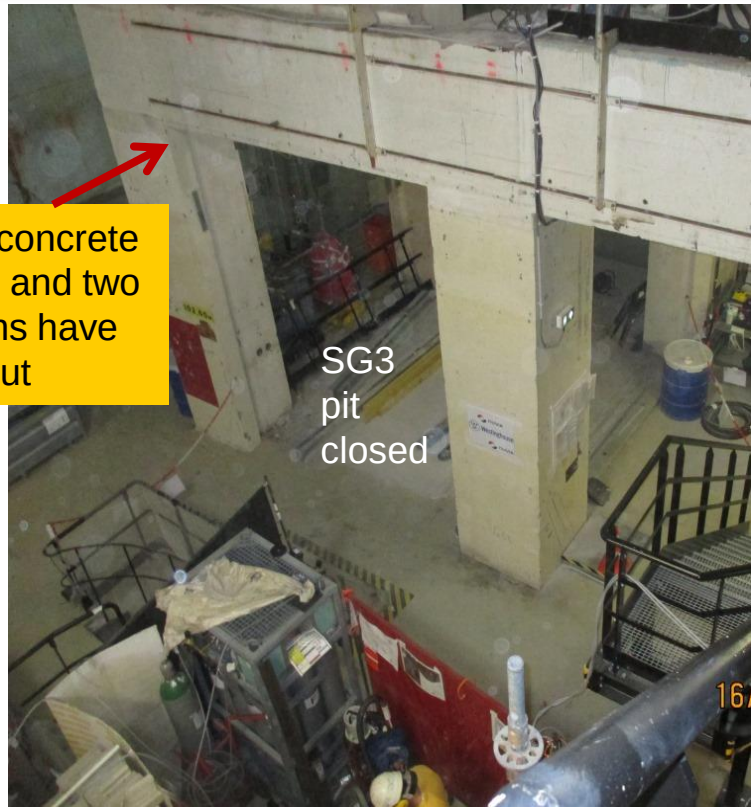
Closure of Steam Generator #2 pit

- 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

Modifications to create valuable work space

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

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Upgrade of electrical power distribution

Installation of new electrical cabinets (~ 400KVA)

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

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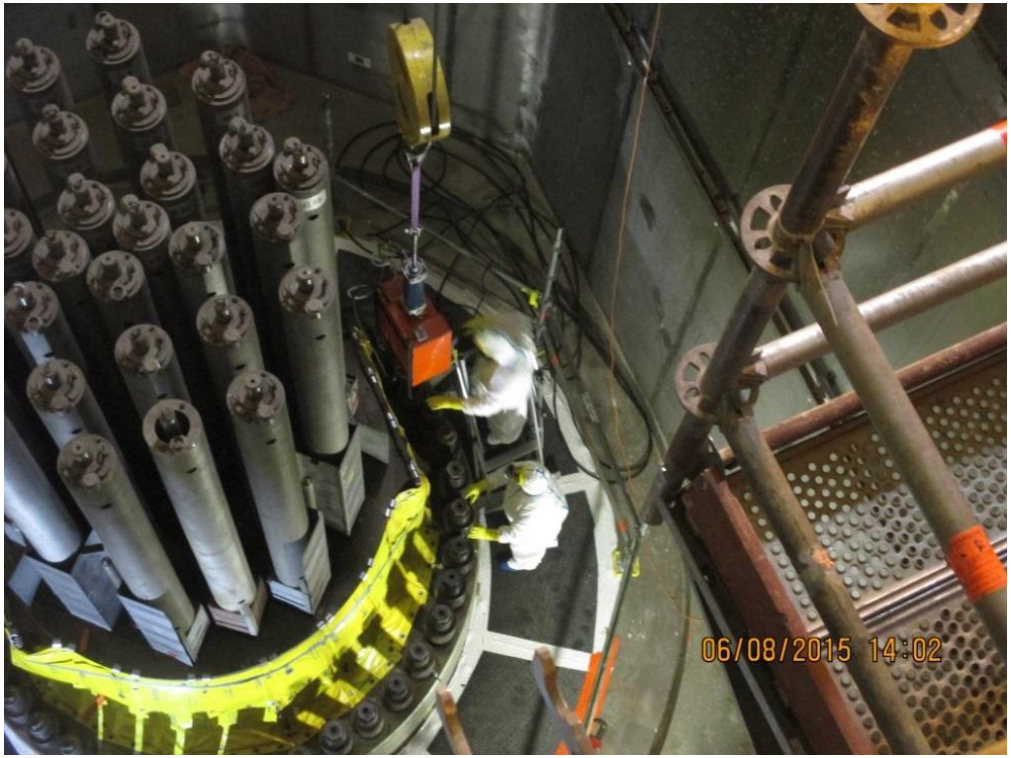
Studs de-tensioning



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.

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Questions