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# Westinghouse Experience in Reactor Vessel Dismantling Projects

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# Agenda

- Introduction
- Latest reactor internals segmentation projects across Europe
- Graphite plant dismantling expertise
- Waste storage and disposal facilities
- Conclusions

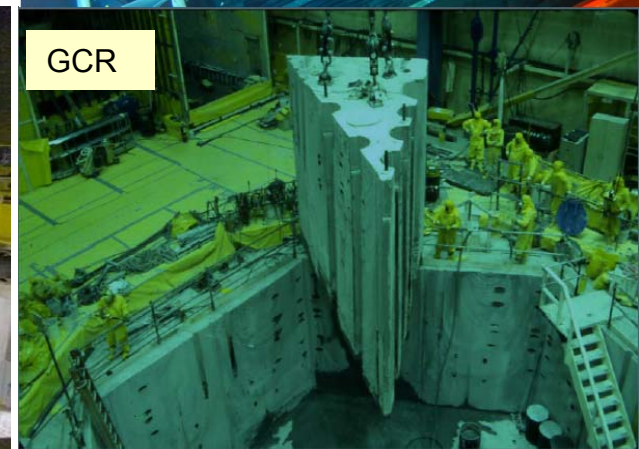
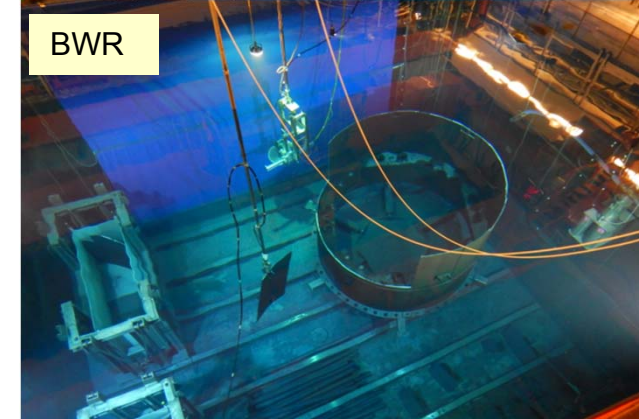
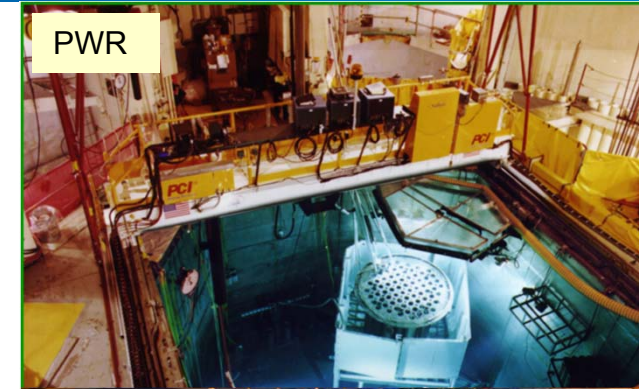
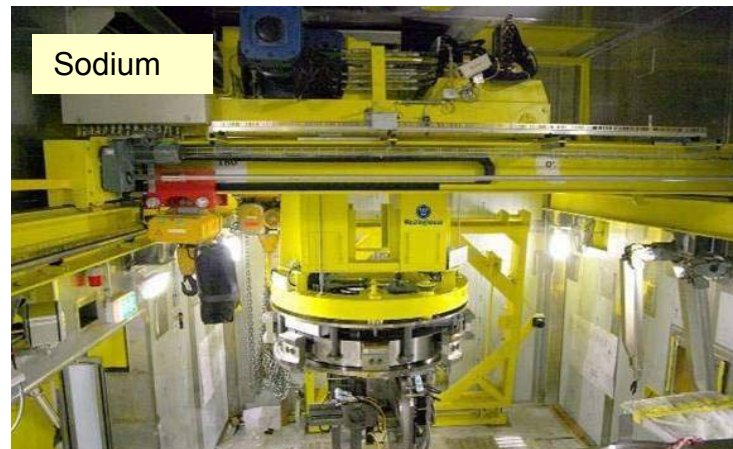
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# Reactor Vessel Internals Segmentation

- Scope: project management, cutting and packaging plan, tooling design, manufacturing & testing, on-site activities (cutting, packaging, handling, cleaning, ...)
- Proven experience since 1985 on all types of reactors: PWR's, BWR's, GCR's, Sodium
- Used all types of cutting tools: PAC, AWJC, MDM, mechanical

More than 30 year experience in dismantling different types of reactors worldwide with various cutting techniques



# Latest Segmentation References (Mechanical)

## 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
● Olkiluoto 1	Core Spray Riser Pipes	2005
● Olkiluoto 1	Test Channels	2005
● Olkiluoto 1	Core Shroud Cover	2005
● Olkiluoto 2	Core Support Grid	2005
● Olkiluoto 2	Core Shroud Cover	2005
● Olkiluoto 2	Core Spray Riser Pipes	2005
● Olkiluoto 2	Test Channels	2005
● Forsmark 3	Control Rod Shafts, 62pcs	2010
● Forsmark 2	Steam Dryer	2010
● Forsmark 2	Core Shroud Cover	2010

## Segmentation Performed

● 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
● Peach Bottom 3	Steam Dryer	2015
● Mühleberg	Fuel channels	2016

## Segmentation Contracted

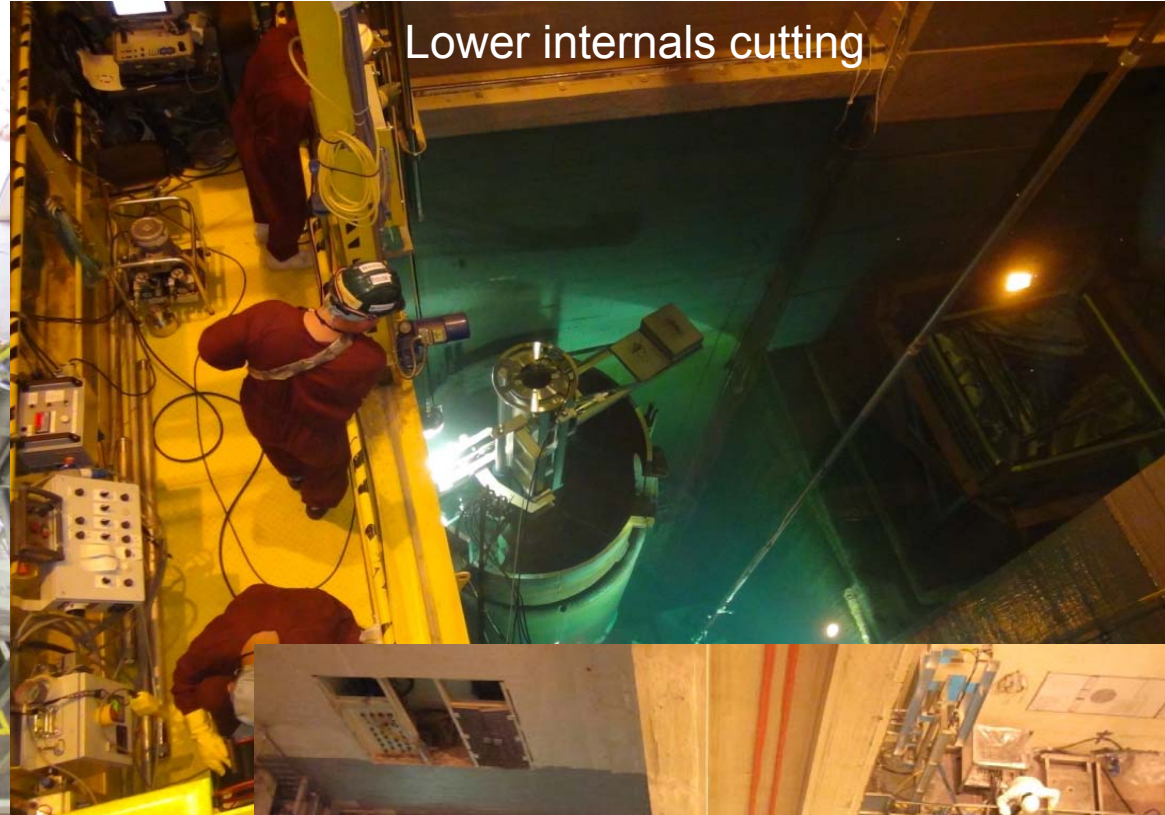
● Chooz A	RPV, Upper & Lower Internals	2016
● Barsebäck 1 & 2	All Reactor Vessel internals	2016
● Philippsburg I	All Reactor Vessel internals	2017
● Neckarwestheim I	Upper & Lower Internals	2017
● Bohunice V1 (2 units)	Full Primary System	2019
● Unterweser	All Reactor Vessel internals	2019
● Grafenrheinfeld	All Reactor Vessel internals	2021
● Gröhnde	All Reactor Vessel internals	2023
● Isar 1	All Reactor Vessel internals	2022
● Isar 2	All Reactor Vessel internals	2024
● Brokdorf	All Reactor Vessel internals	2027

13 reactors currently under contract

# José Cabrera plant (Zorita): Segmentation and Packaging of Reactor Internals



Mock-up testing



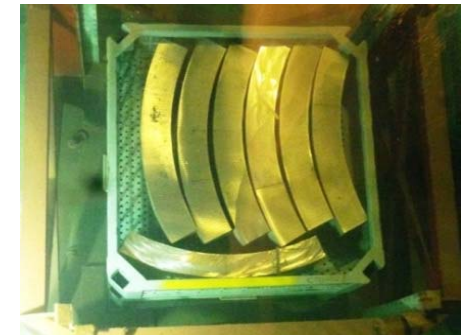
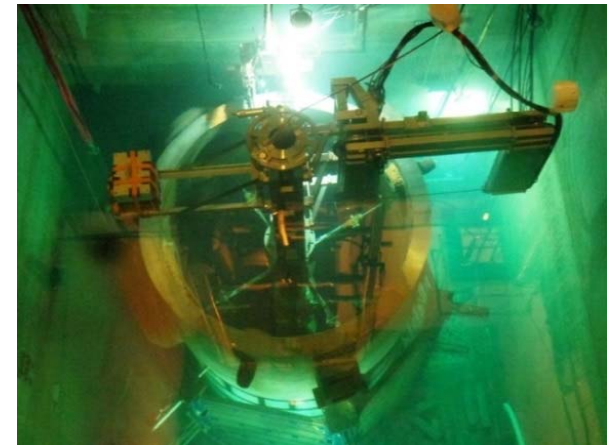
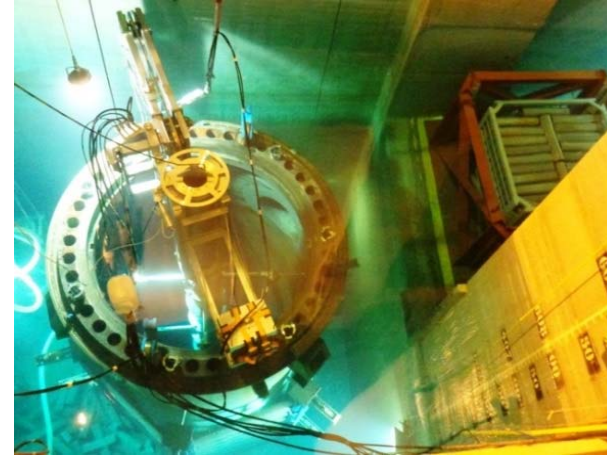
Lower internals cutting



- 418 meters of cutting, 432 cut pieces, total weight = 59.5 T



# Zorita Reactor Vessel removal from the pit and segmentation

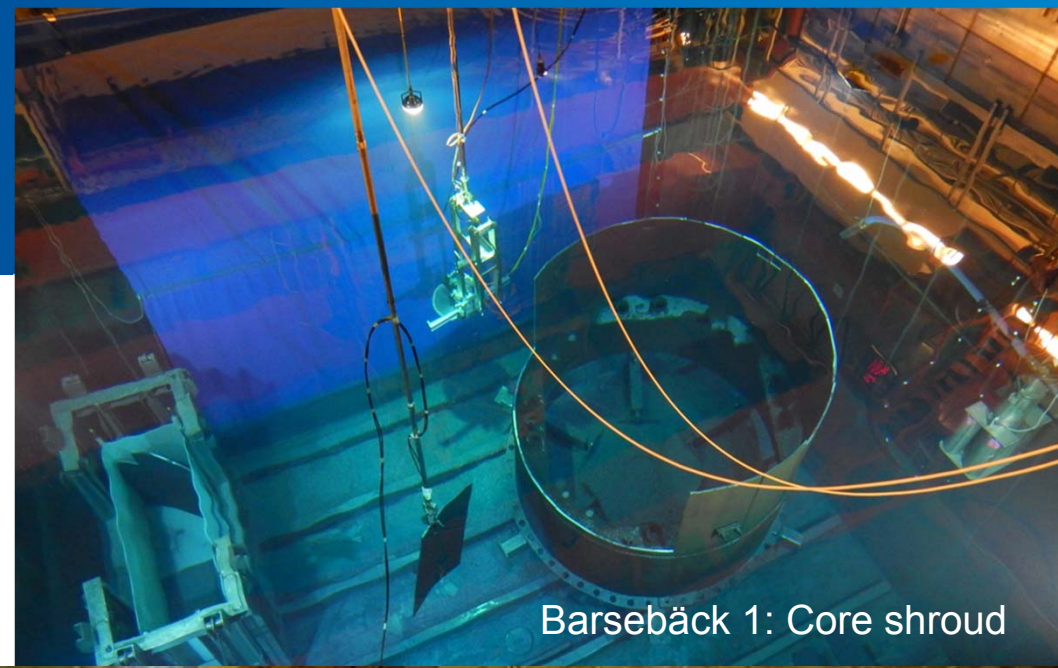
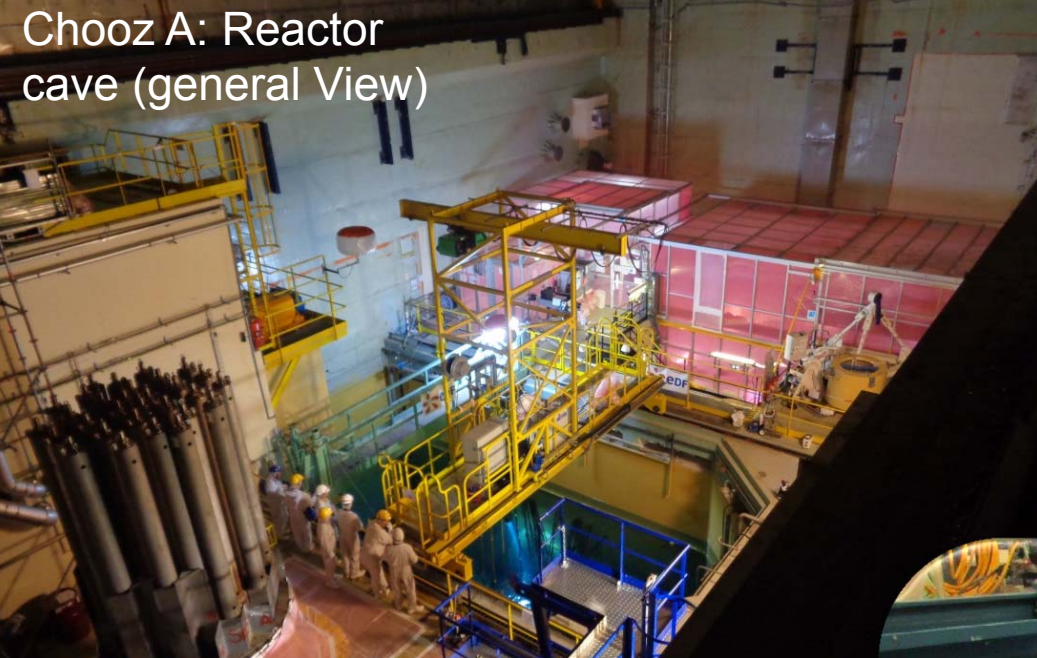


- 240 meters of cutting, 140 cut pieces, total weight segmented = 114 T
- Project completed in May 2015



# On-going cutting activities

Chooz A: Reactor  
cave (general View)

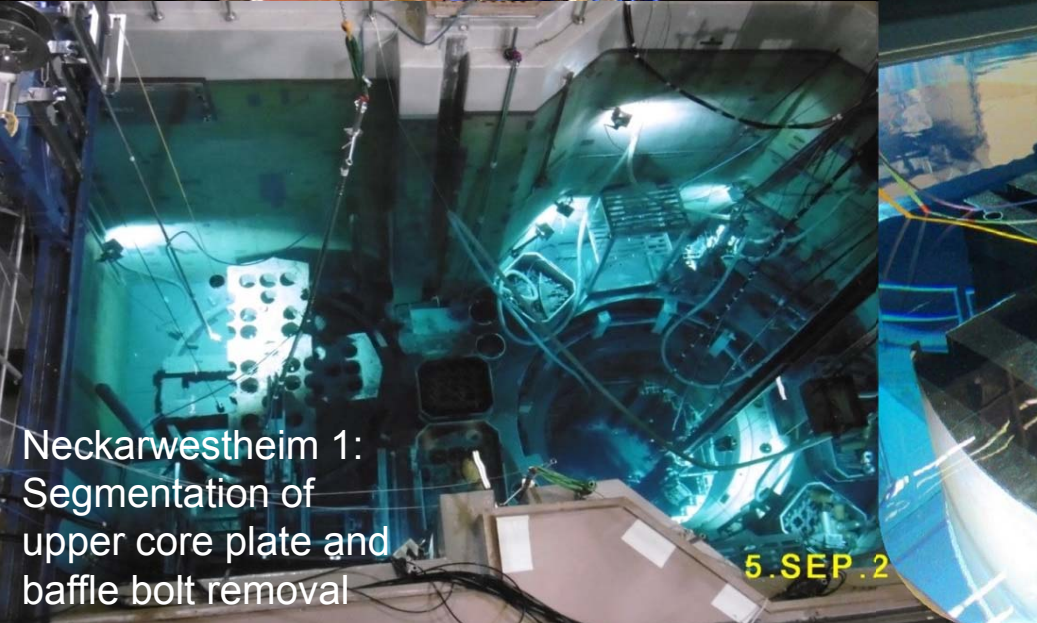


Barsebäck 1: Core shroud

Bohunice V1: Reactor Shaft  
Protection Lid Handling



Neckarwestheim 1:  
Segmentation of  
upper core plate and  
baffle bolt removal



# Agenda

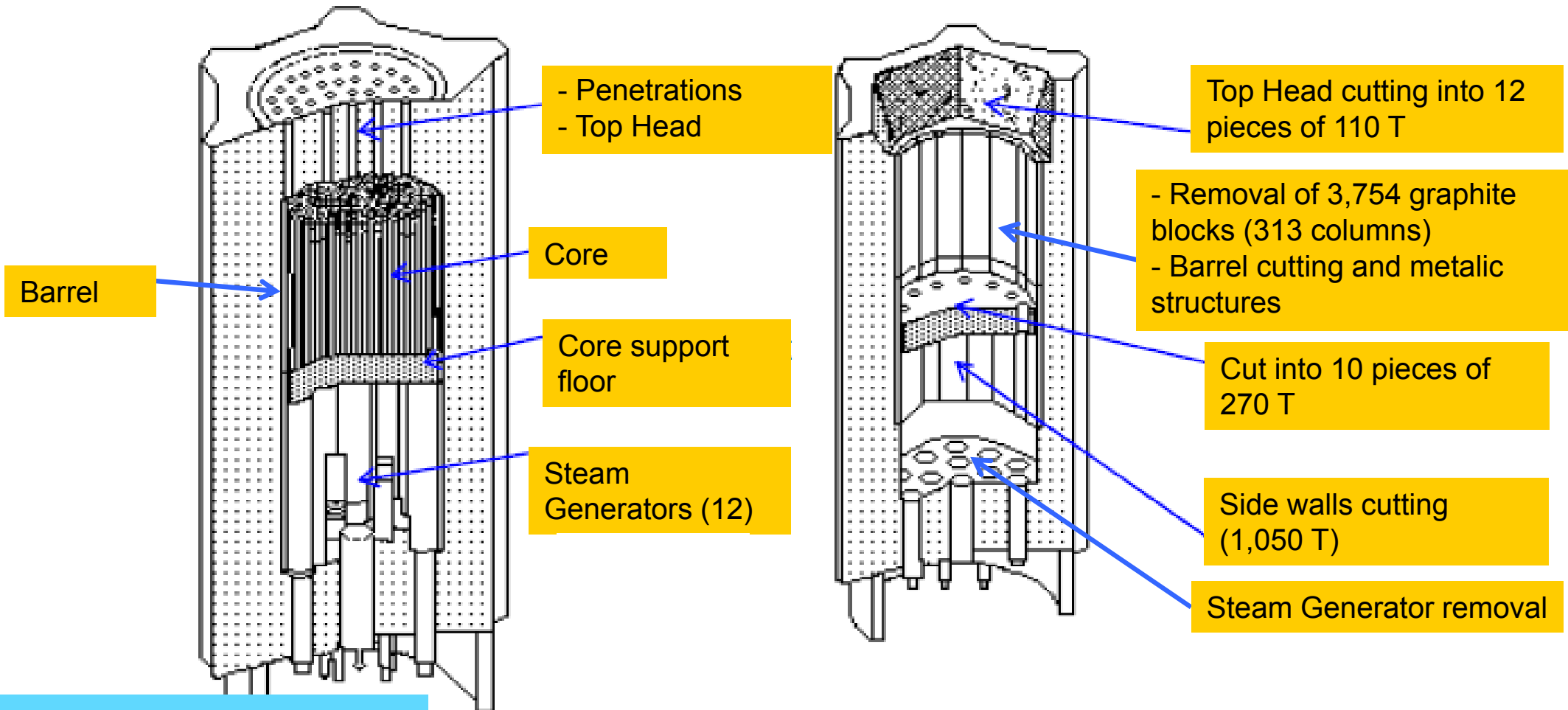
- Introduction
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- **Graphite plant dismantling expertise**
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# Fort St Vrain Nuclear Power Plant

- Power: 330 MWe
- Construction: 1968-1976
- Operation: 1976-1989
- Decision for final shutdown: August 29, 1989
- Reasons: technical problems, low capacity factor (15%)
- Consortium W/MK selected for reactor dismantling: June 26, 1990
- Total project duration: 6 years (4 years on site)



# Fort St Vrain Reactor Structure

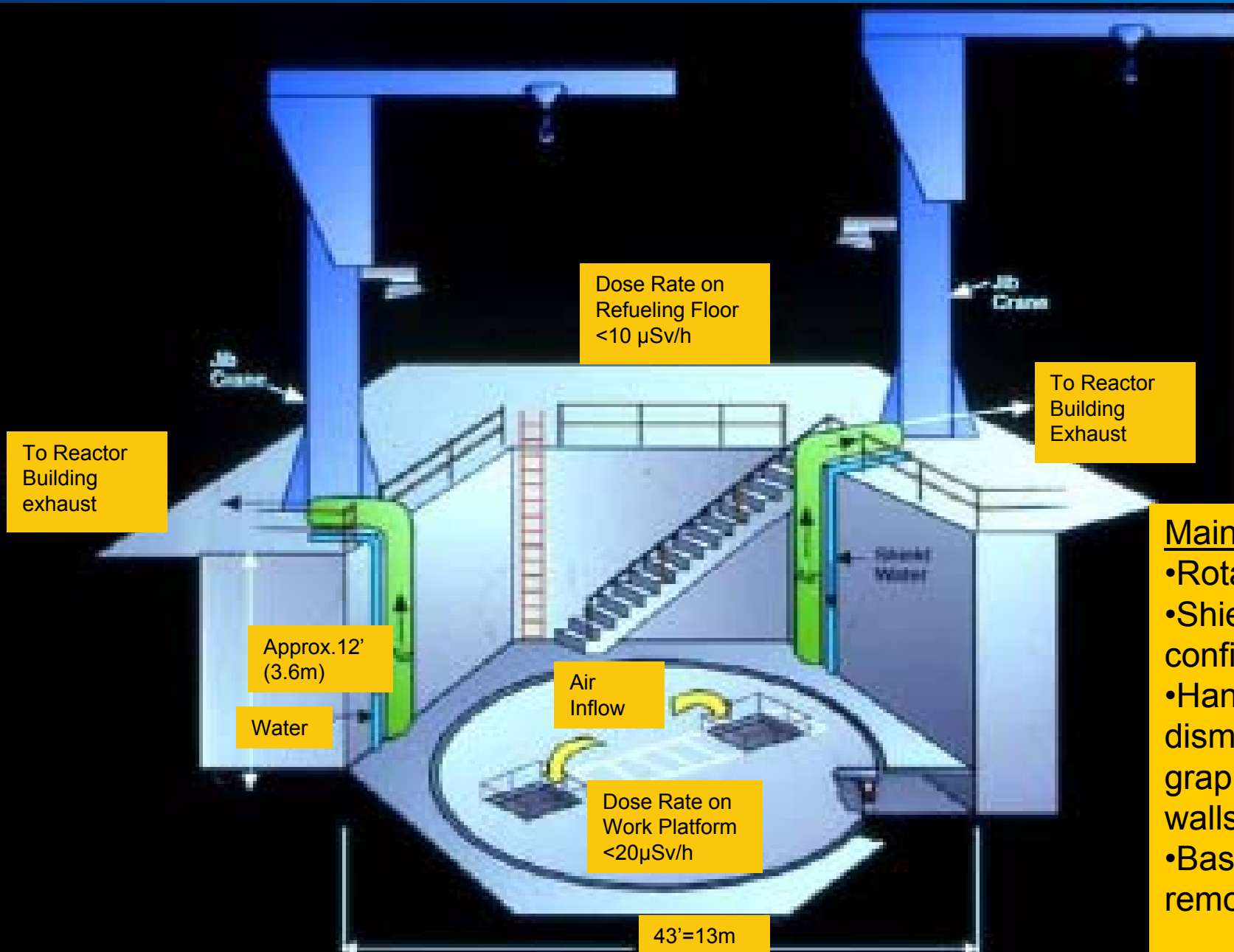


## Fort St Vrain reactor

- 32 m high
- 15 m diameter
- Cavity: 9.5 x 23 m
- 2.75 to 4.7 m wall thickness

- Underwater dismantling
- Short planning
- Proven techniques from reactor services

# Installation of a Rotary Platform

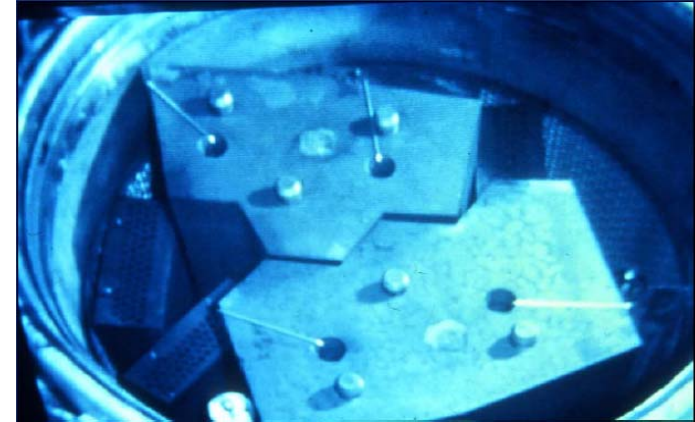
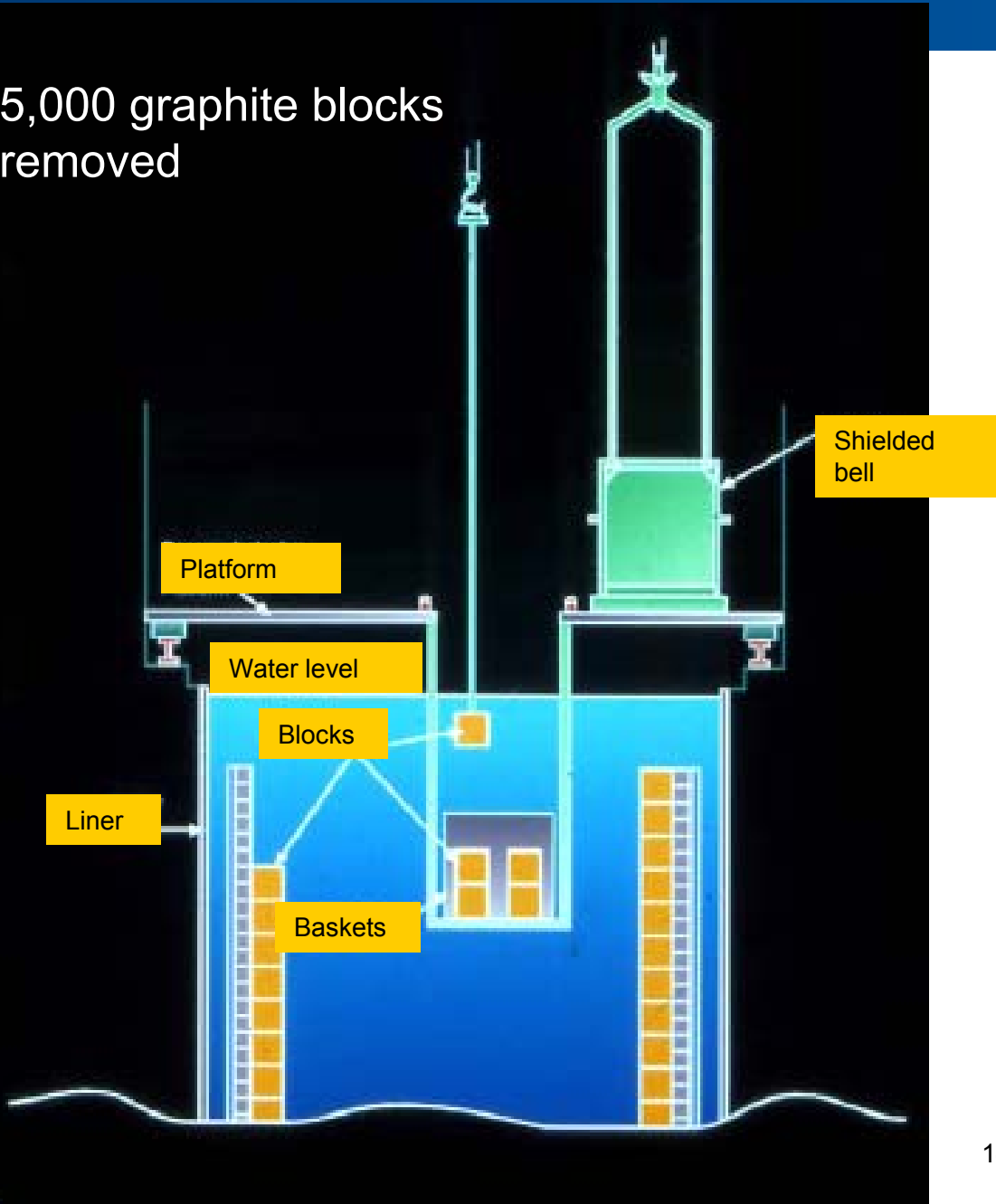


## Main Functions:

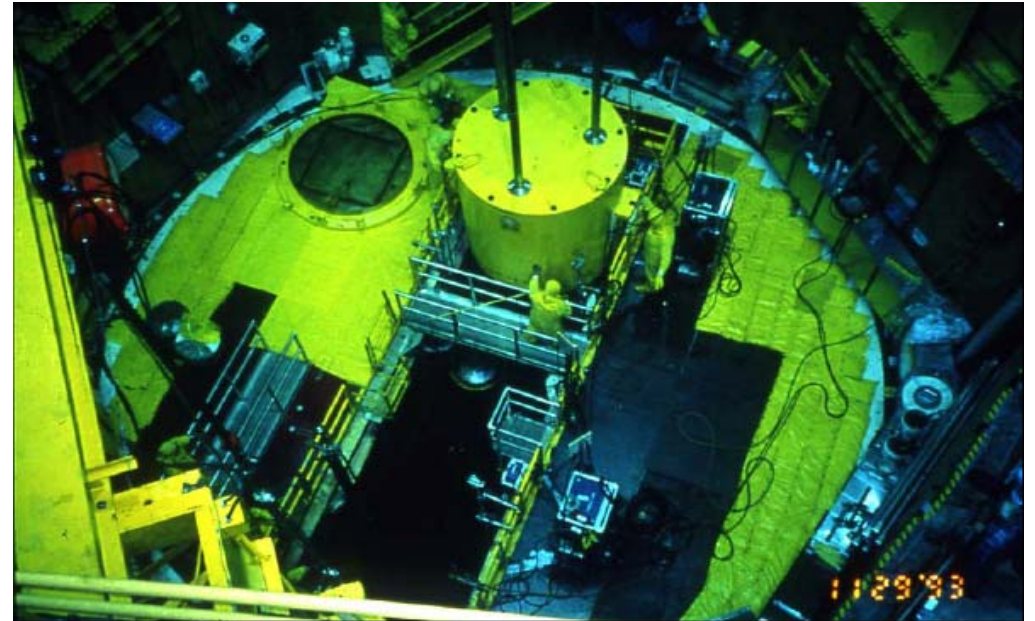
- Rotation
- Shielding and confinement
- Handling during reactor dismantling (internals, graphite, concrete side walls)
- Basket filling and waste removal

# Graphite Block Removal

5,000 graphite blocks removed

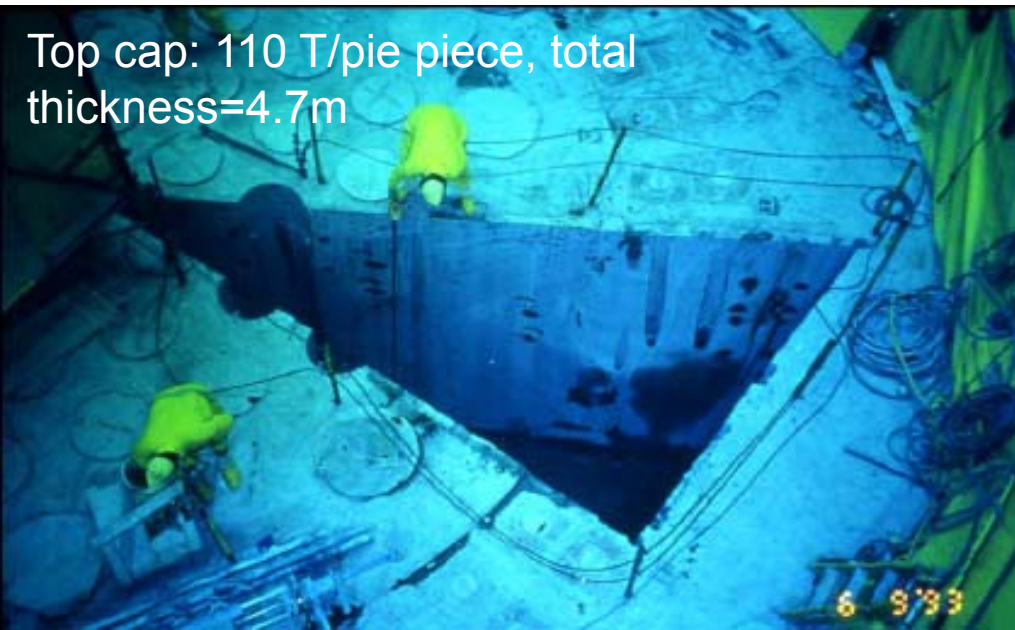


Baskets

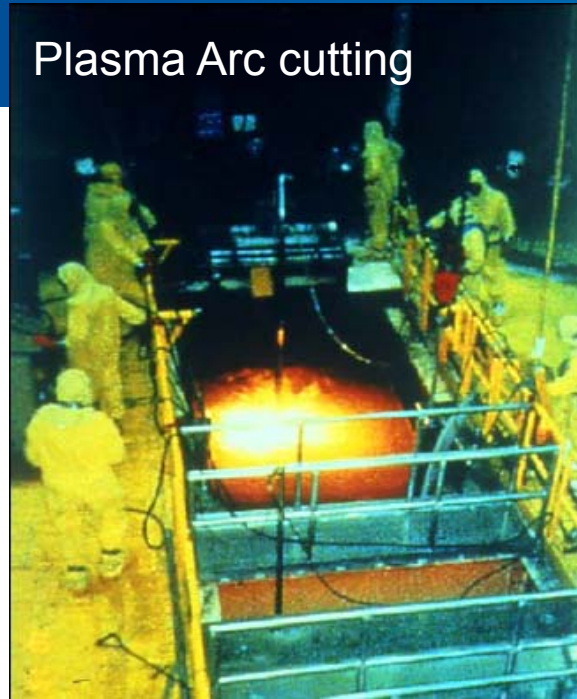


# Reactor Dismantling

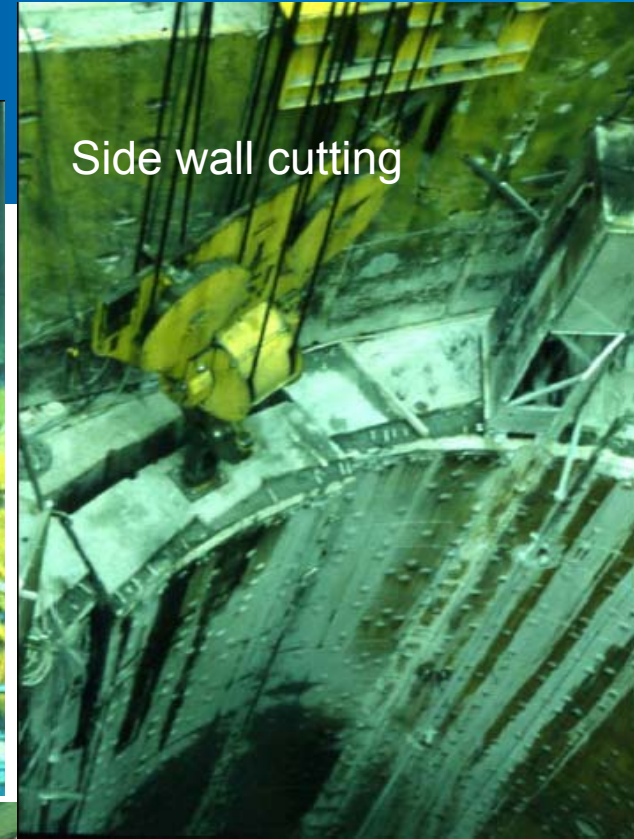
Top cap: 110 T/pie piece, total thickness=4.7m



Plasma Arc cutting



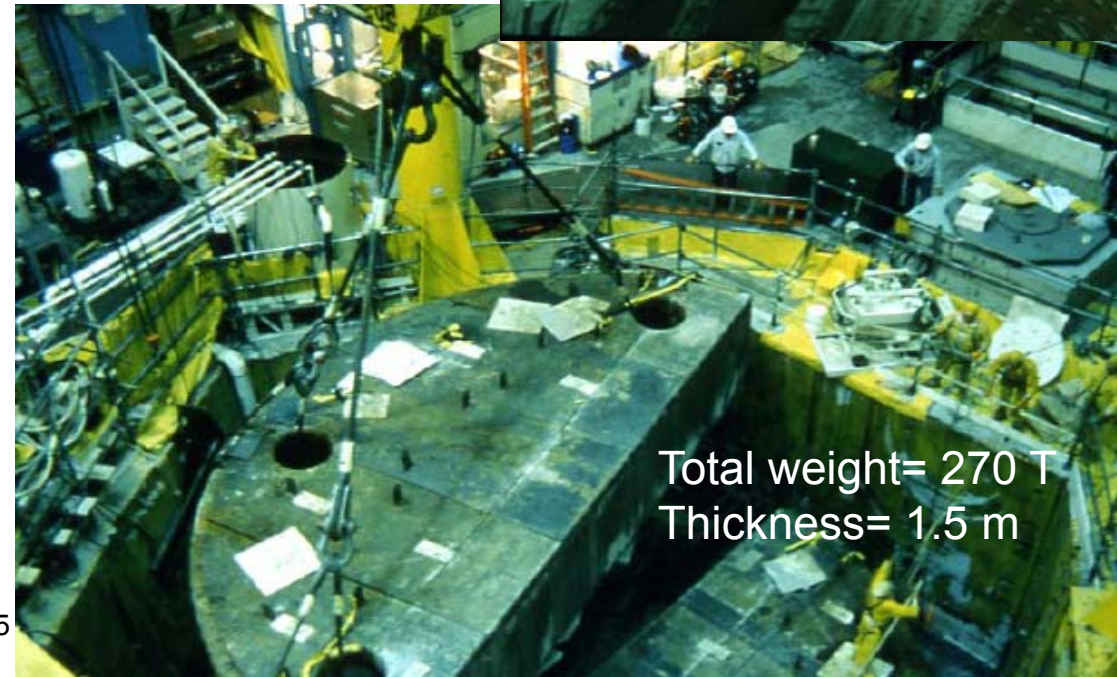
Side wall cutting



Heat Exchangers dismantling



Total weight= 270 T  
Thickness= 1.5 m



# Bugey 1 Reactor Dismantling



- Westinghouse prepared a detailed offer, including a conceptual design for dismantling the Bugey 1 reactor.
- After removal of the top cap, the innovative solution was underwater dismantling by using a floating platform that was naturally lowered while lowering the water level.
- The Westinghouse proven mechanical cutting technology was proposed for dismantling the reactor.

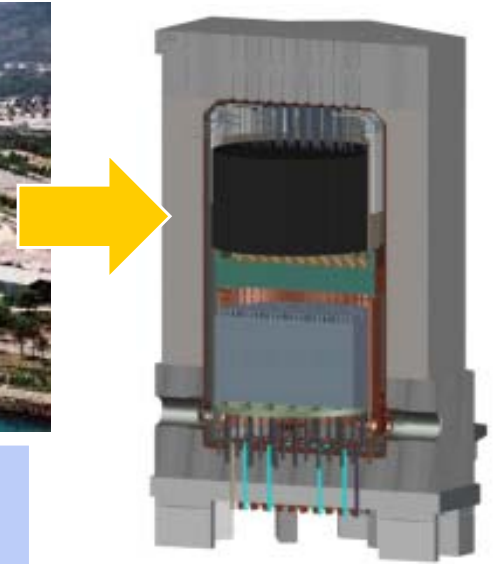
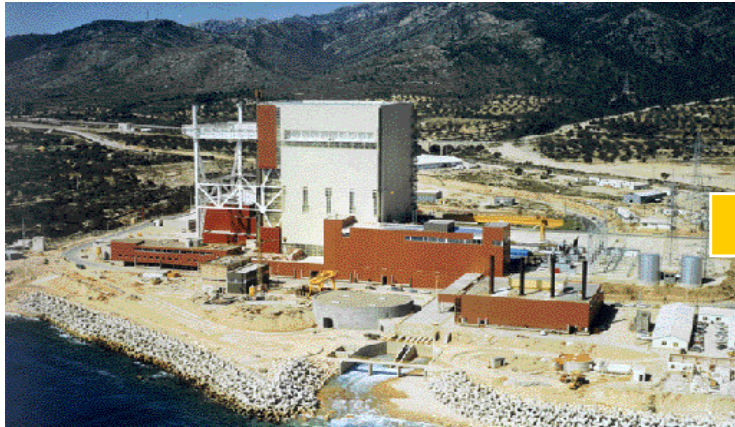


# Vandellós I Nuclear Power Plant



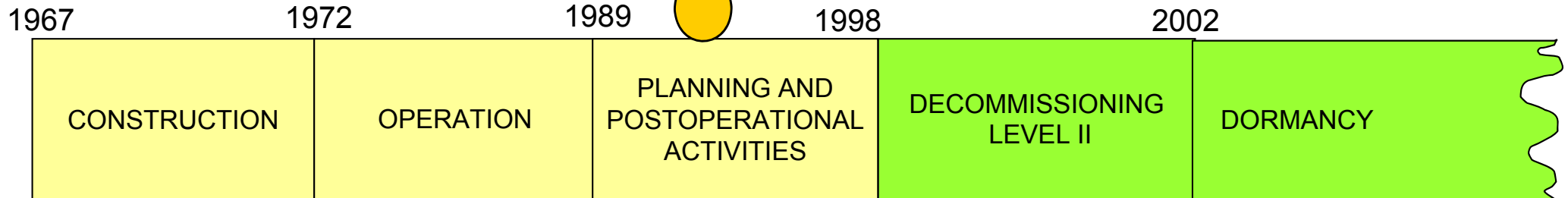
- 508 MWe plant located in Vandellós (Spain), operated by Hifrensa
- Carbon dioxide gas cooled reactor based on Saint Laurent A NPP (EDF)
- Shut down on July 31, 1990, following a fire in one of its two turbo-generators in October 1989

# Westinghouse Involvement at Vandellós I



1993-1996: Retrieval of operational waste

Westinghouse involvement



Westinghouse involvement

Engineering and Licensing

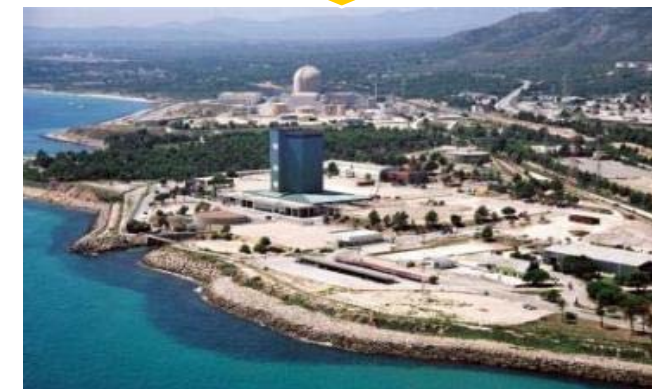
Supervision of D&D activities

Engineering support and Level III Concept



# Westinghouse activities at Vandellós I

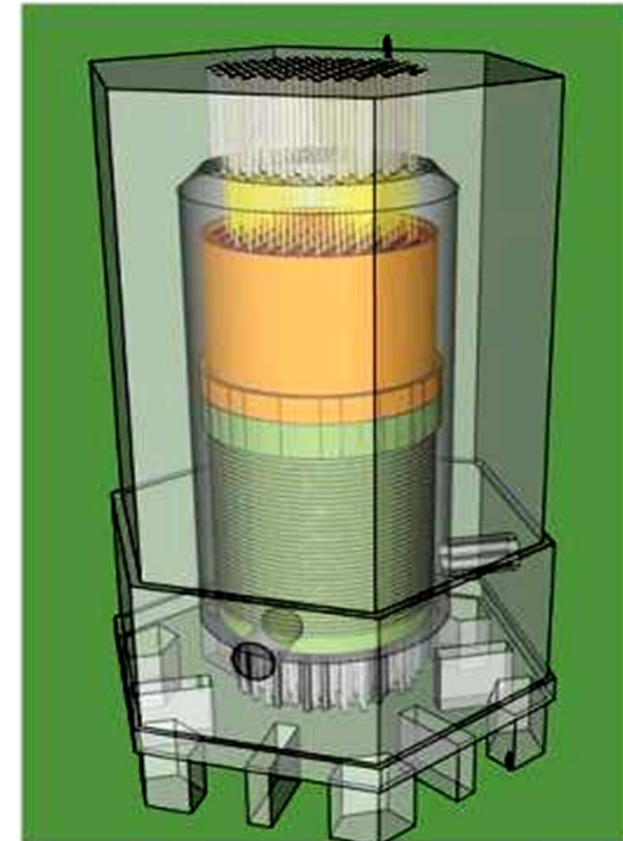
- 1994 to 1997: Graphite silos retrieval (together with other partners):
  - Civil design
  - Integration
  - Works supervision
  - Licensing documentation
- 1992 to 1997: Decommissioning Plan and licensing documentation
  - Decommissioning plan
  - Licensing documentation
  - Environmental impact report
  - Application for the Euratom Art. 37
  - Engineering project for works license
  - Health and Safety plan
  - Project scheduling
- 1998 till 2003: Level 2 dismantling
  - Works supervision
  - Licensing support
  - On-site engineering support
- 2003 till now: Care and Maintenance
  - Systems update and as built documentation
  - Surveillance
  - Licensing support and update of licensing documentation
  - Site Restoration Plan
  - Preparatory activities for Level 3 dismantling



# Preparatory activities for Level 3 dismantling

## ➤ Optioneering, based on:

- Caisson characterization
- Activation calculation model
- Model calibration with sampling results
- Integrated model for level 3
  - Structural
  - Activity inventory
  - Level 3 design

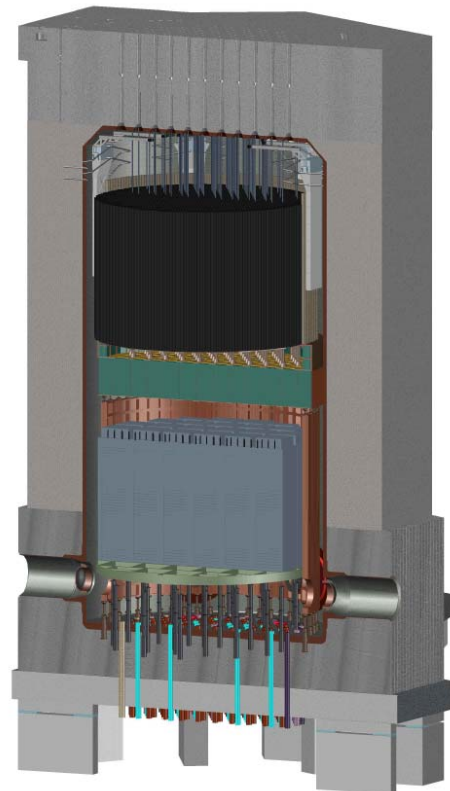


## ➤ Optioneering: three stage process

# Optioneering for Level 3

## 1st stage:

- Multi-attribute qualitative analysis of five alternatives (wet, dry top/lateral/bottom openings, ex-vessel wet cutting)



# Optioneering for Level 3

2nd stage: quantitative assessment of 2 selected alternatives (top opening dry, and wet)

- Alternatives activities list
- Identification of differentiating or exclusive activities
- Quantitative assessment
- Several cutting techniques

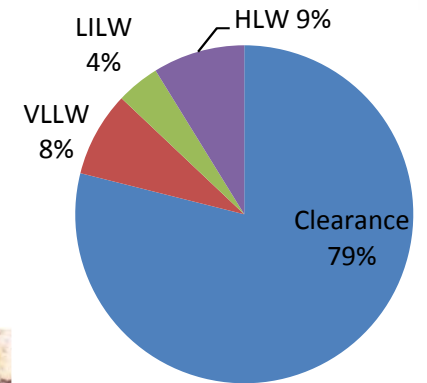
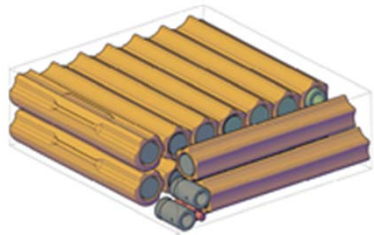
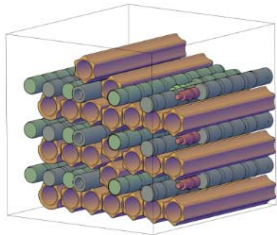


# Optioneering for Level 3

## Selected: dry alternative (top opening):

- Dry takes slightly longer and is a bit more expensive than wet
- Operational doses are smaller in dry (use of teleoperated tools)
- Secondary wastes are higher in wet
- Uncertainties and accident risks are higher in wet

# Optioneering for Level 3: conceptual design

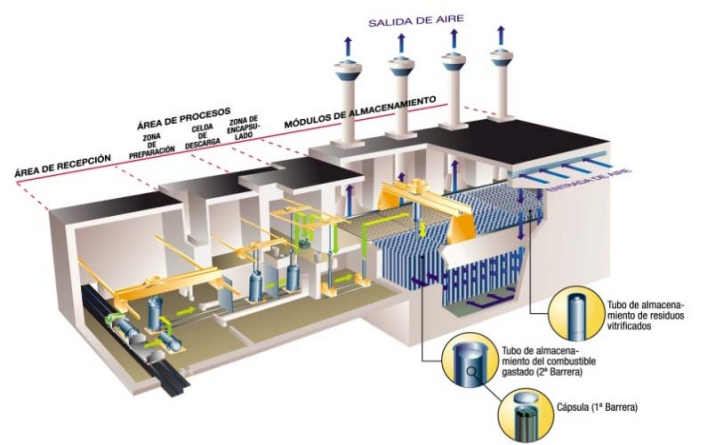




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- **Waste storage and disposal facilities**
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# Westinghouse Experience in Interim Waste storage and Disposal facilities



Centralized Interim Storage for SNF, Spain



Comanche Peak SNF storage facility, USA



El Cabril LILW Repository, Spain

- ✓ Detailed facility design, licensing support, safety analysis report
- ✓ Engineering and construction for a mile long heavy haul road and on-site SNF storage facility at the two unit PWR located in Texas
- ✓ Design, licensing, construction supervision and operational support

# Conclusions

- Westinghouse brings more than 30 years of proven experience in reactor dismantling on different types of reactors (PWR's, BWR's, GCR's, Sodium).
- Westinghouse has currently on-going segmentation contracts on 13 reactors in Europe.
- Westinghouse has dismantled the first graphite plant (Fort St Vrain) and continues to be involved in other similar reactors (e.g. Vandellós I).
- Westinghouse has developed skills for performing optioneering studies and selecting the optimum dismantling scenario.
- Westinghouse has also a deep knowledge in designing interim waste storage and disposal facilities.
- Westinghouse is used to collaborate with local partners.

# Thank You for your Attention... Any Questions?

