



Doosan Heavy Industries & Construction

Heavy Components Dismantle Technology and Replacement Experience in Doosan for the Preparation of Kori#1 Decommissioning



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Nuclear Decommissioning Technology
and Business Development Team
Nuclear Power Plant BG

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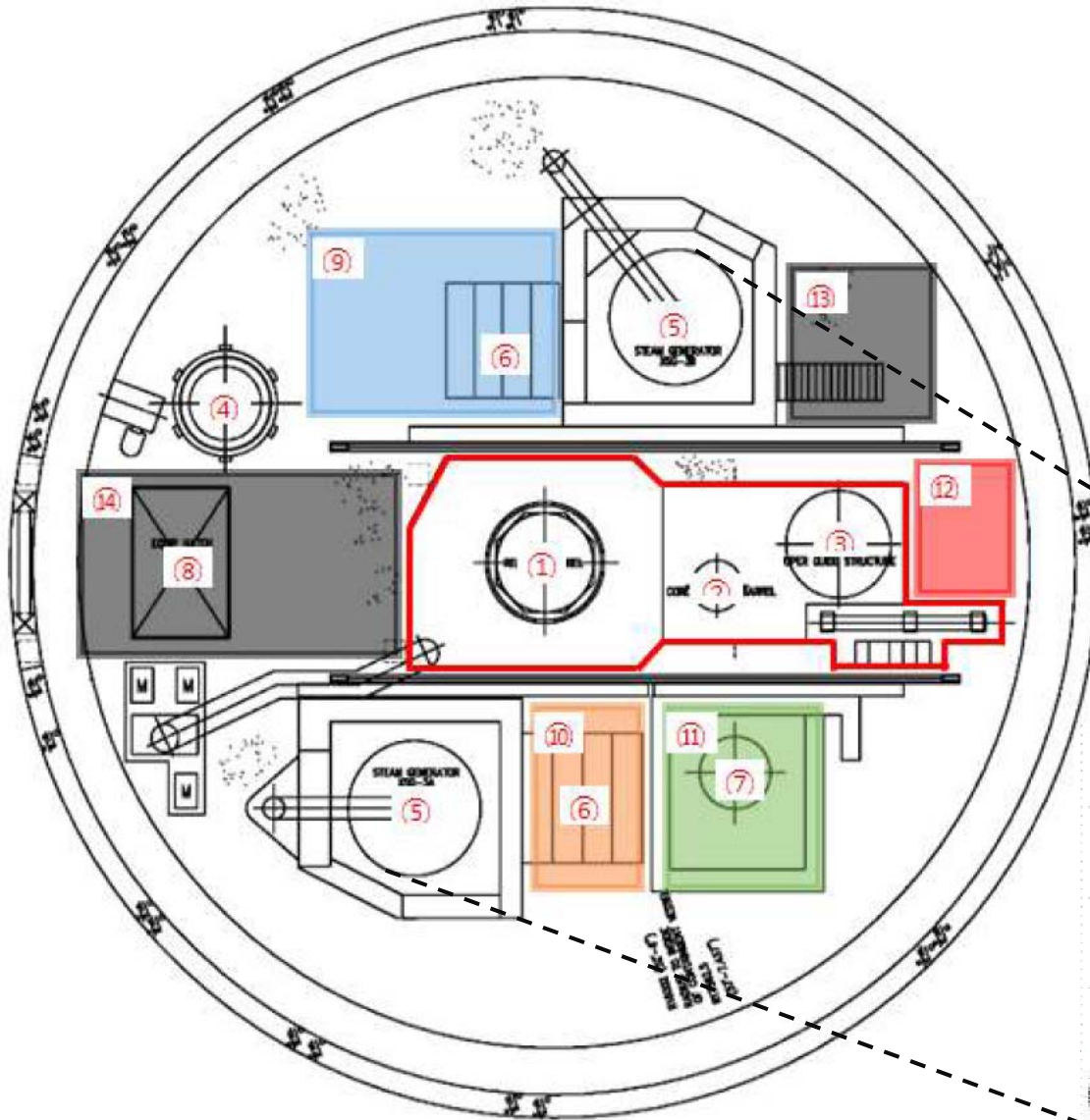


Doosan Heavy Industries & Construction

2017 Waste Management Symposium
Panel Session 96 - Korean Special Challenges
and Opportunities

- **Reactor Vessel and Reactor Vessel Internal Dismantle Technology**
- **Steam Generator Dismantle Technology**
- **Steam Generator Replacement Experience**
- **Spent Fuel Storage & Transportation Cask Development**
- **Conclusion**

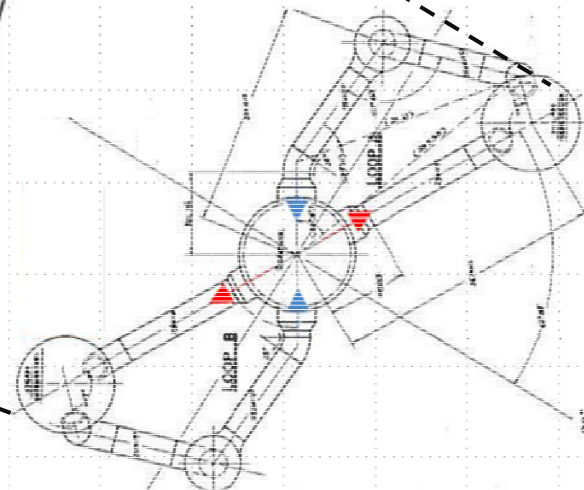
Kori unit 1 Overview – Containment Building



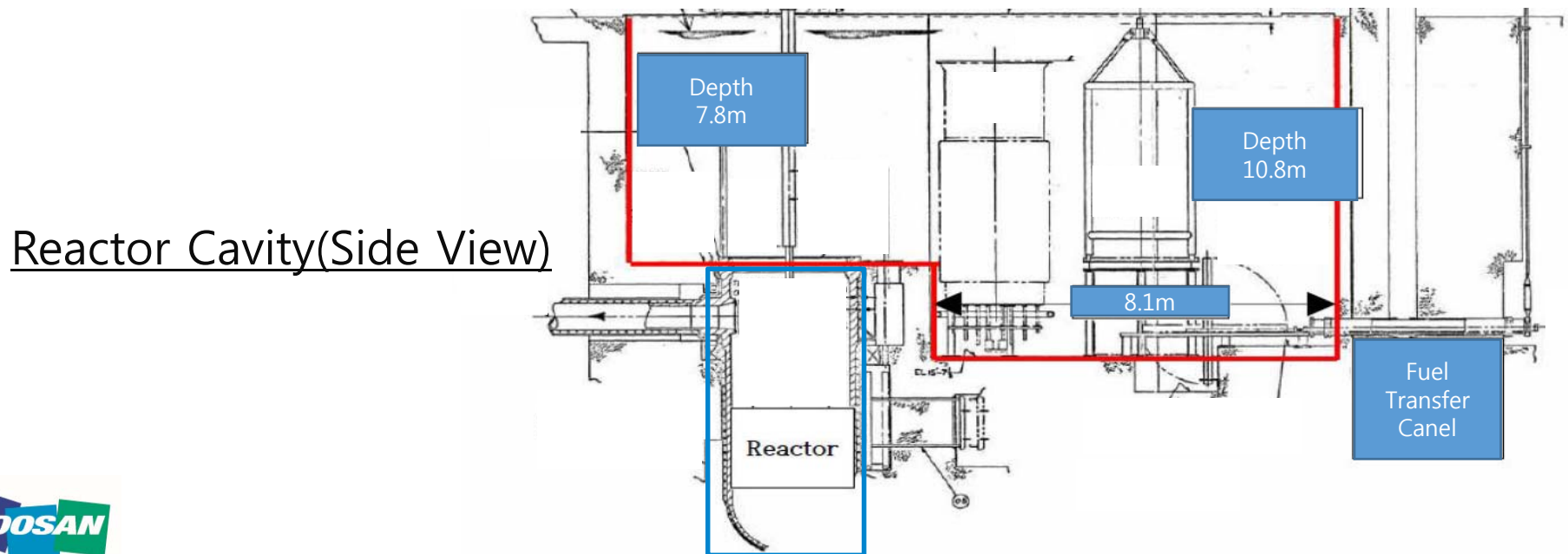
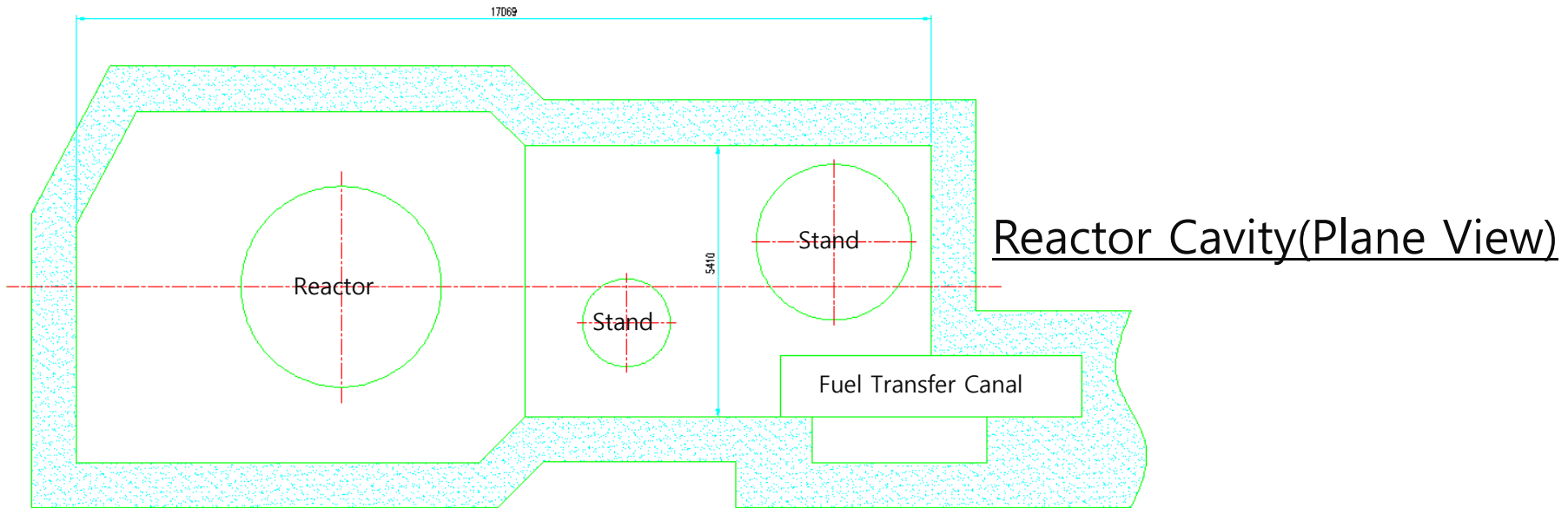
Kori unit 1 Containment Building

1. Reactor Cavity(Reactor Vessel)
2. (Core Barrel & Baffle Assembly)
3. (Upper Guide Structure)
5. Steam Generator
6. Reactor Coolant Pump
7. Pressurizer

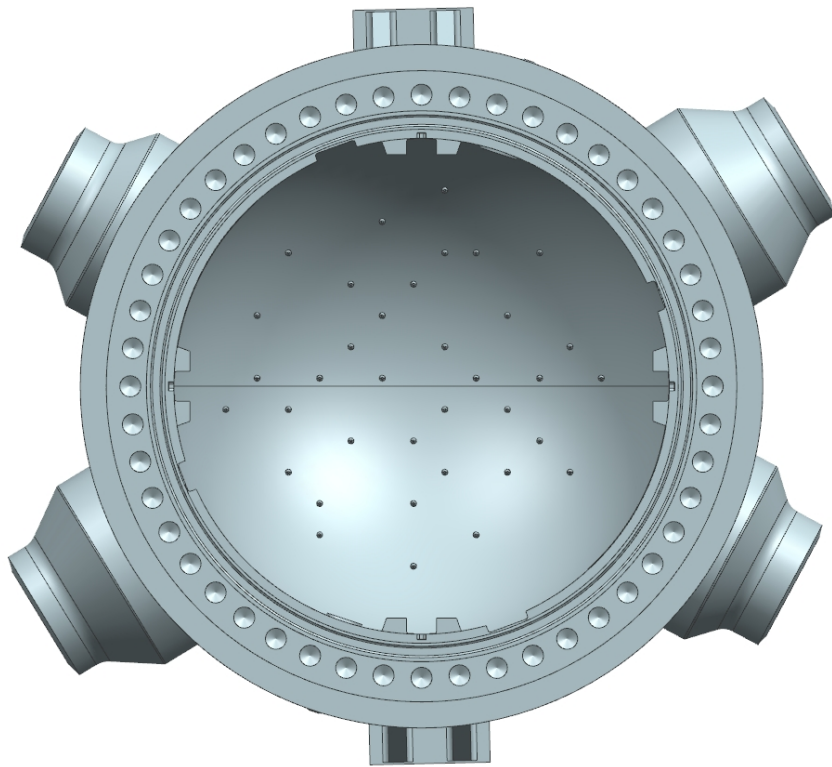
WEC 2-loop Type PWR NPP



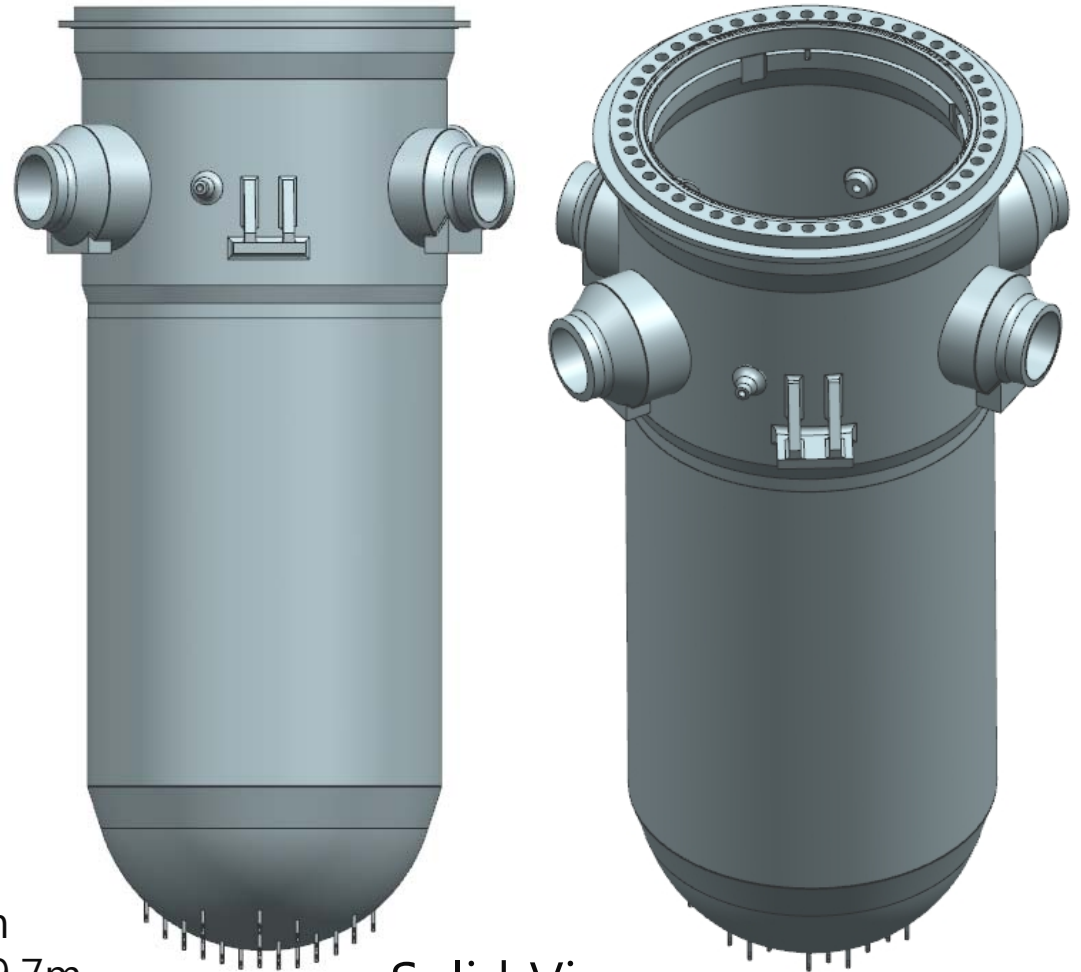
Kori unit 1 Overview – Reactor Cavity



Kori unit 1 Reactor Vessel Structure



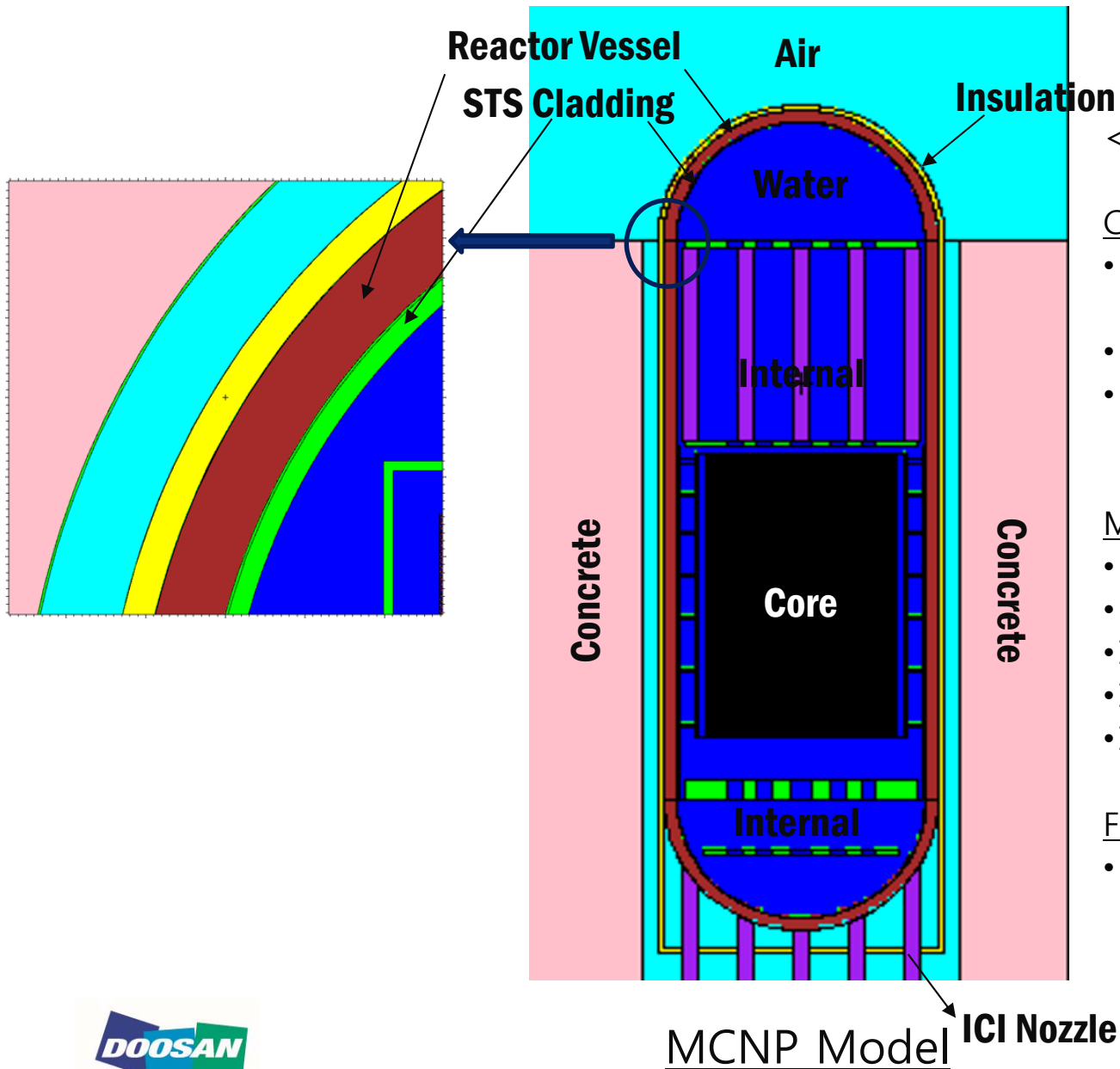
Plane View



Solid View

- I.D. : 3.4m
- Height : 9.7m
- Thickness : 168mm
- Weight : 187ton
- Material : SA 508
- Inner wall STS clad

Kori unit 1 RV/RVI/Bio-Shield Activation Evaluation



<Activation Evaluation Methodology>

Computer Program

- Source Term and Burn-up(Depletion) Calculation : SCALE/ORIGEN
- Flux Calculation : MCNP
- Material Activation Calculation : ORIGEN-S Flux Irradiation Method

Material Information

- Reactor Vessel : SA508 Gr.3
- Cladding : STS304
- Insulation : STS Clad + Al Foil
- Internal : STS304
- ICI Nozzle : Inconel

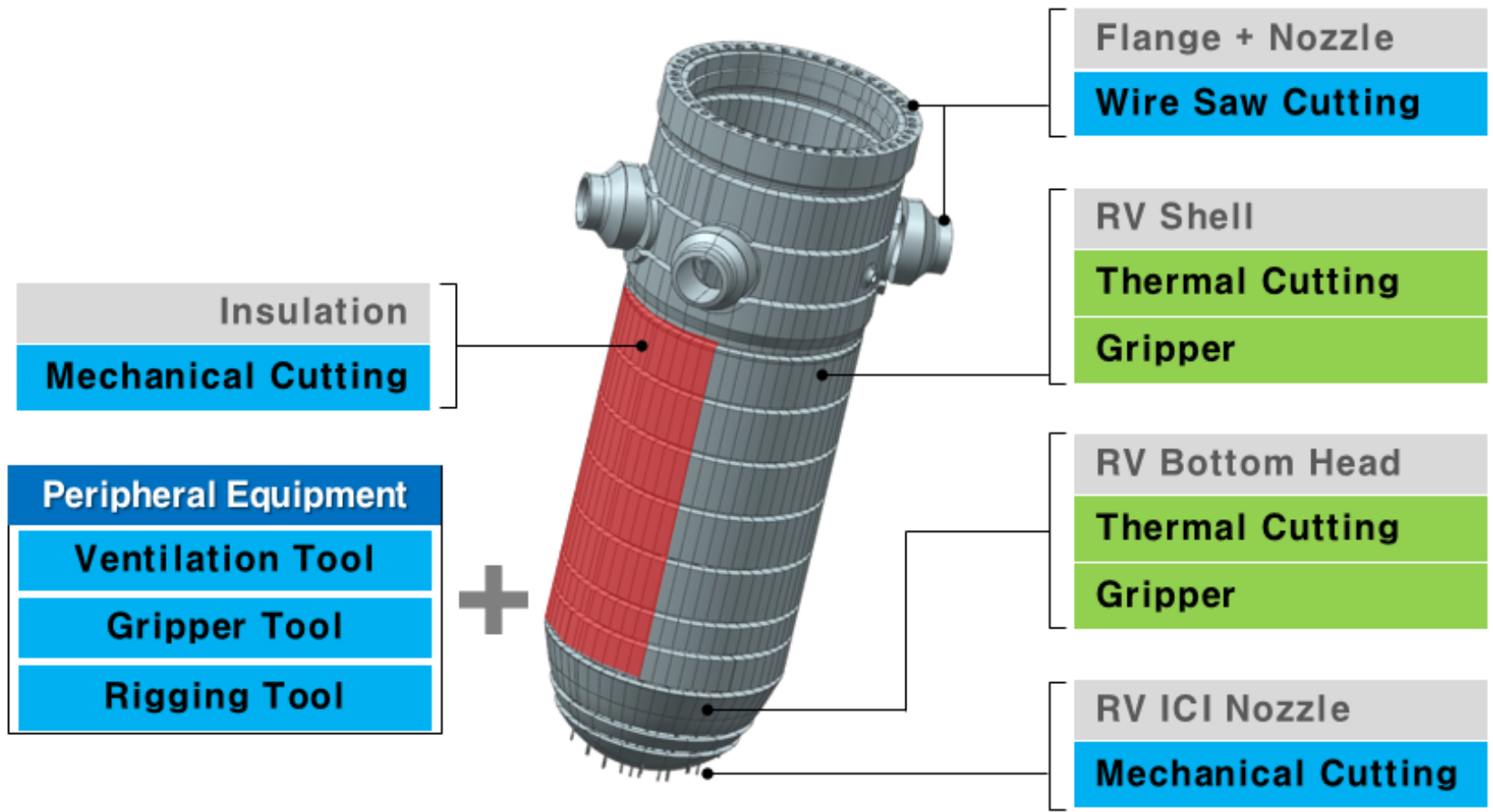
Flux

- Max. : $\sim \times 10^{11}$ #/cm²-sec neutron flux

Korean Regulations for the Clearance of Radioactive Waste

Classification	Criteria	Structure / Item
HLW	Spent Fuel	Spent Fuel
ILW	LLW Permissible Concentration Limit <	<i>RVI(Baffle + Former + Core Barrel + Thermal Shield)/Stellite Structure</i>
LLW	SPC x100 < LLW < LLW Permissible Concentration Limit	<i>RVI(Core Barrel + Thermal Shield + Support Structure)/RV</i>
VLLW	SPC < VLLW < SPC* x100	<i>RV/RVH</i>
Self-disposal	SPC <	

Kori unit 1 Reactor Vessel Dismantle Method and Cutting Plan

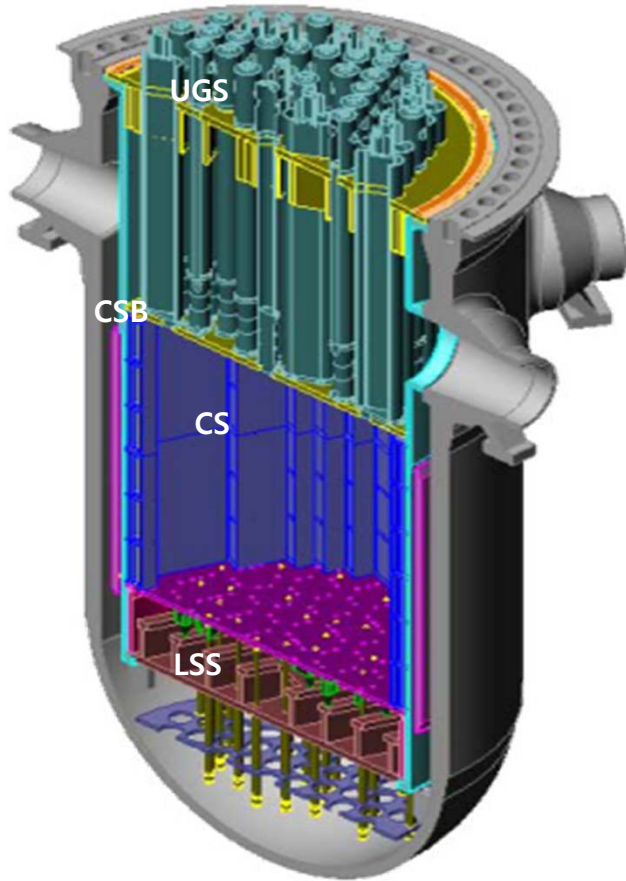


Items	Expected Value
Cutting Length	603 m
Number of cut-off piece	708 ea
Number of Drum	310 ea

- In-Situ on Air Environment
- Container for storage is 200 liter drum.
- Optimizing cutting plan based on the RV characterization result & size of container



Reactor Vessel Internal Dismantle Scenario(Under Water)



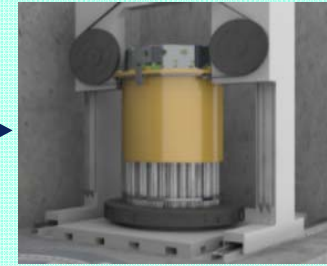
- UGS : Upper Guide Structure
- CSB : Core Support Barrel
- CS : Core Shroud
- LSS : Lower Support Structure



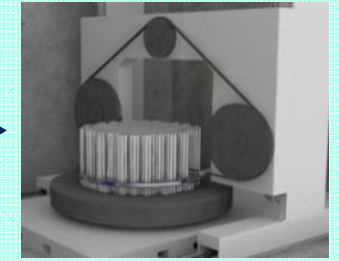
UGS



UGS lifting



Band saw installation

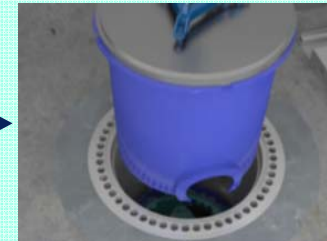


UGS cutting

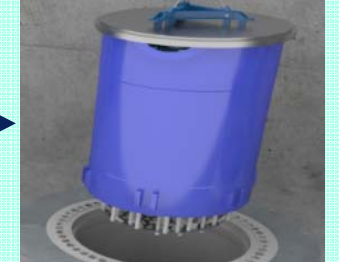
CSB



Upper CSB cutting



Upper CSB lifting



Lower CSB lifting

**CS/
LSS**



Lower CSB cutting



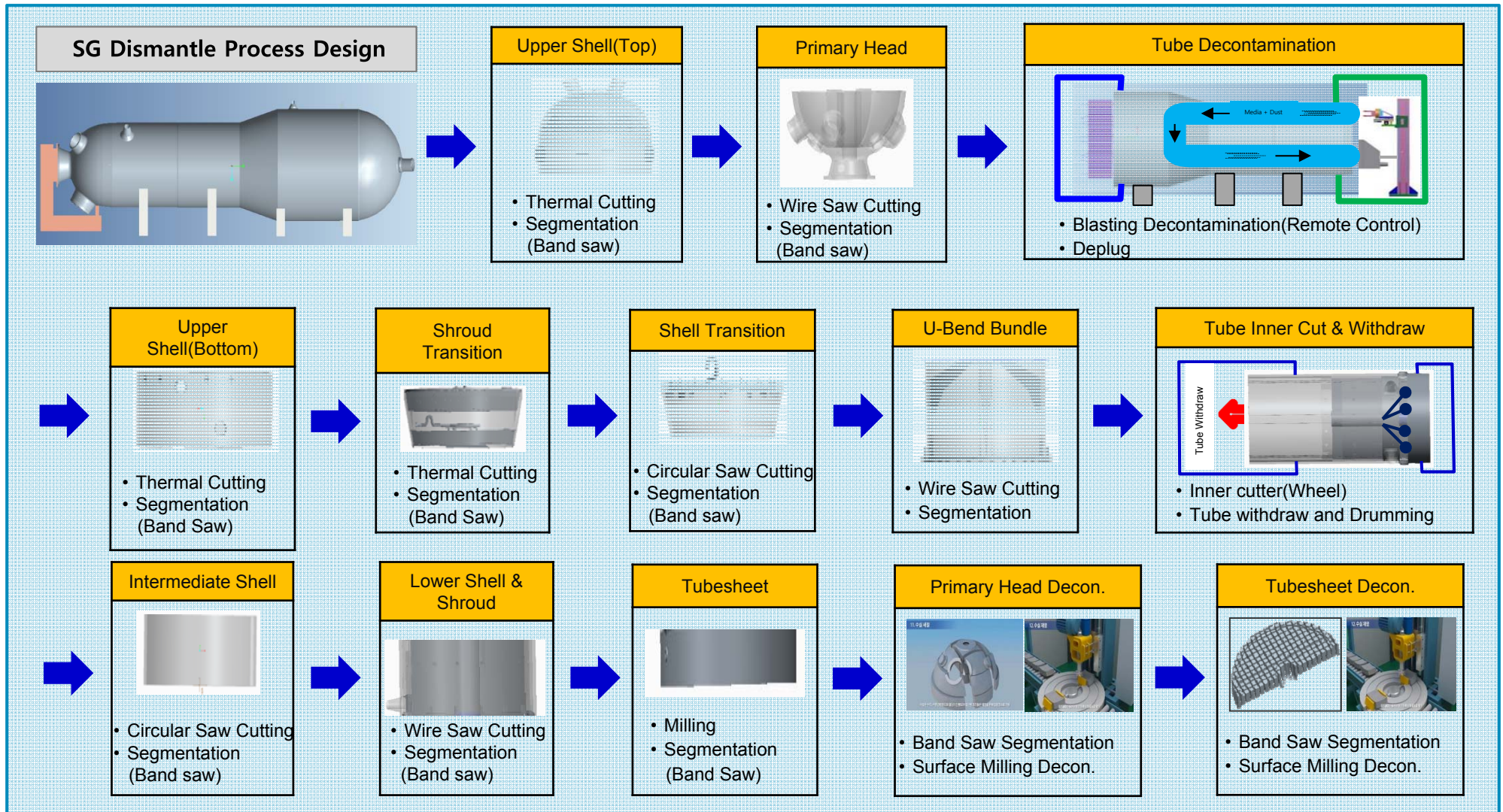
CS/LSS dividing



CS/LSS cutting

- **Reactor Vessel and Reactor Vessel Internal Dismantle Technology**
- **Steam Generator Dismantle Technology**
- **Steam Generator Replacement Experience**
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Steam Generator Dismantle – Process Design



Steam Generator Dismantle - Mockup Design

Mockup design & fabrication



[Shell Mockup]



[Channel head Mockup]

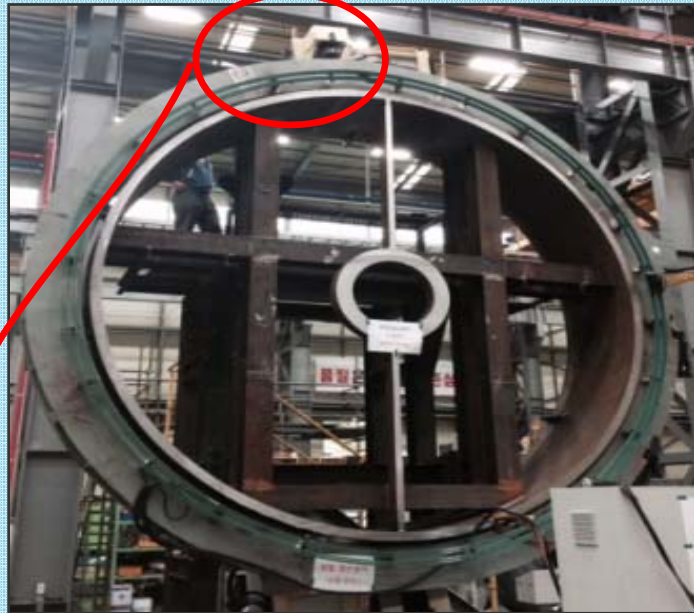


[Shroud Mockup]

Description	Shell Mockup	Channel Head Mockup	Shroud Mockup
Weight(Ton)	32	25	25
Dimension(mm)	4350(OD) × 2000(W)	4306(OD) × 1600(W) × 2762(H)	5088,3850(OD) × 7220(H)

Steam Generator Dismantle – Mockup(Shell)

Circular saw cutting Technology



[Cutting Head]



[Chip]



[View after cutting]

Characteristics

- Size : $\phi 6100(\text{OD}) \times 1300\text{W}$ mm
- Cutting Capability : max. 170 mm
- Cutting Process :
Endless Rotation
- Easy Installation/Disassemble

Steam Generator Dismantle – Mockup(Channel Head)

Diamond wire saw cutting Technology



[Diamond Wire Saw]



[Cutting]



[View after cutting]

Characteristics

- Size
 - 6,650L x 2,520W x 6,450H mm
- Cutting Capability :
 - max. 3,250 mm
- Easy Installation/Disassemble

Steam Generator Dismantle – Mockup(Segmentation)

Band saw cutting Technology



[Band Saw Equipment]



[View after cutting (Thickness 600 mm)]

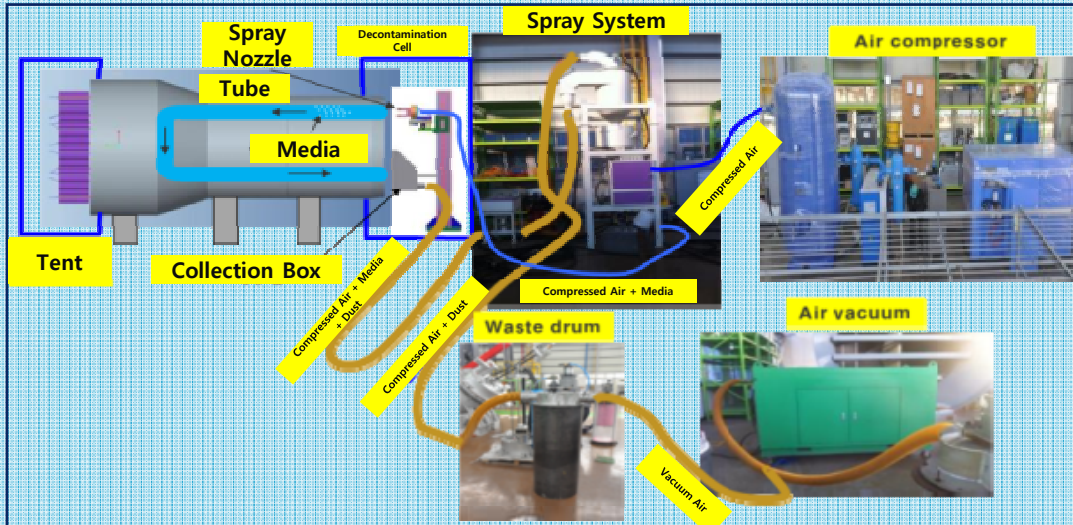


Characteristics

- Size :
 - 9,000L x 8,500W x 8,500H mm
- Cutting Capability :
 - max. 3,200 mm
- Vertical / Horizontal cutting
- Easy Work using the Turn Table

Steam Generator Dismantle – Mockup(Decontamination)

Blasting Decontamination Technology



[Layout of Equipment]



[Simulation]

Characteristics

- Medium circulation type
- Blasting Media : Grit
- Blasting Media Type:
Al Oxide or SiC
- Multi-operated work function

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VLLW	SPC < VLLW < SPC* x100	RV/RVH/SG Primary Part(Channel Head, Tube-sheet, U-Tube)
Self-disposal	SPC <	SG Secondary Part

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Steam Generator Replacement Experience

■ Purpose of SGR(Steam Generator Replacement)

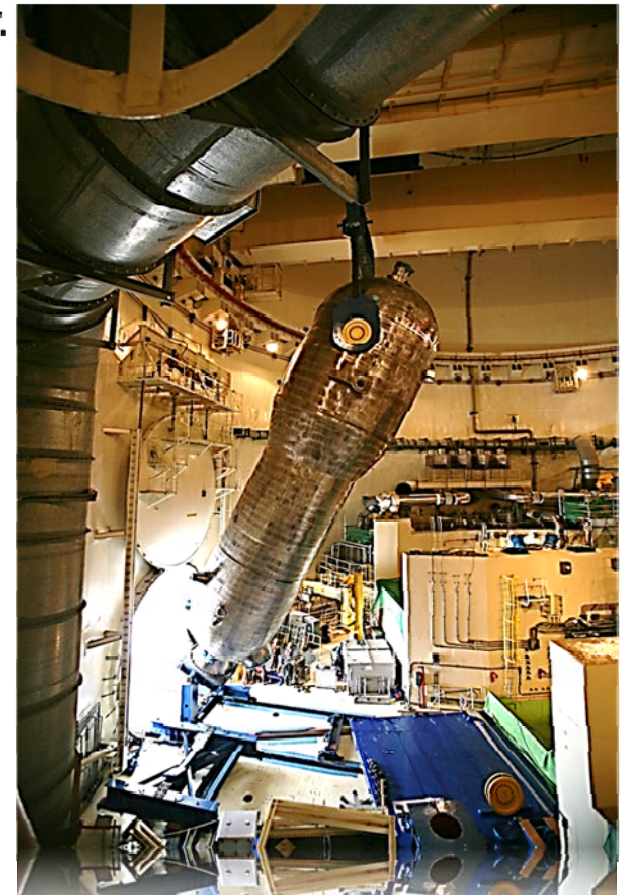
- Tube defects occurred due to long operation period, increased the rate of tube plugging.
- Minimizing radiation exposure with reducing maintenance activities and increasing effectiveness of operation and reliability of Steam Generator.

■ Applied Technologies

- NSSS Pipe Cutting & Beveling
- Templating
- Clamping & Supporting
- Decontamination
- Receiving, Handling, Storage & Rigging with Lifting Device
- Double Head Auto Welding System
- FOSAR(Foreign Object Search And Retrieval)
- Specialized Tools & Monitoring System

■ Scope

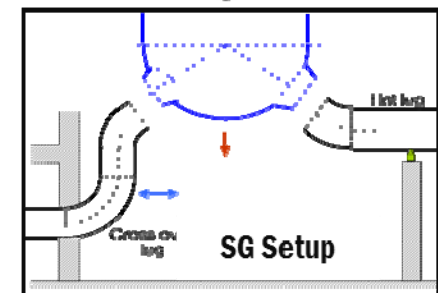
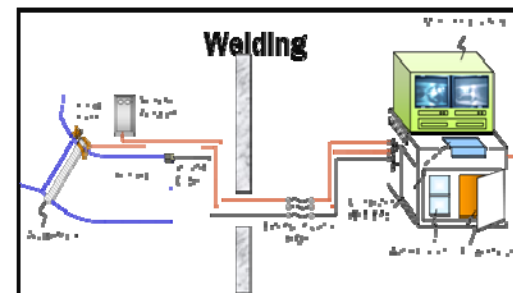
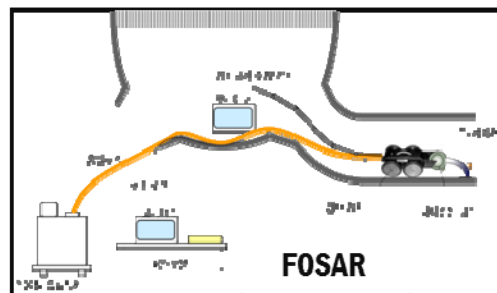
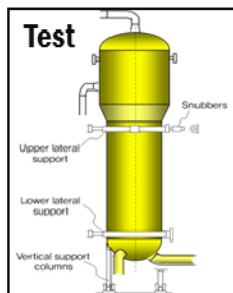
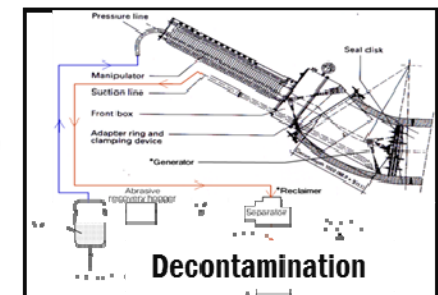
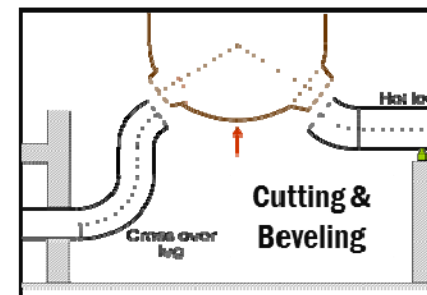
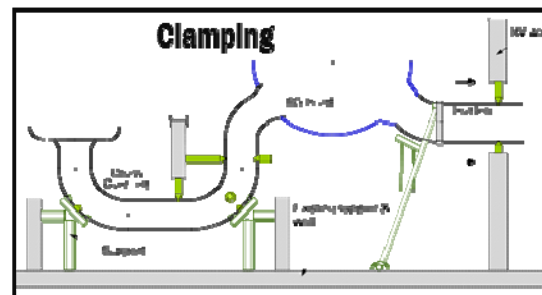
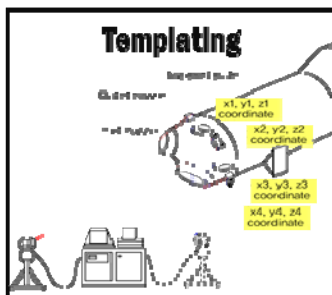
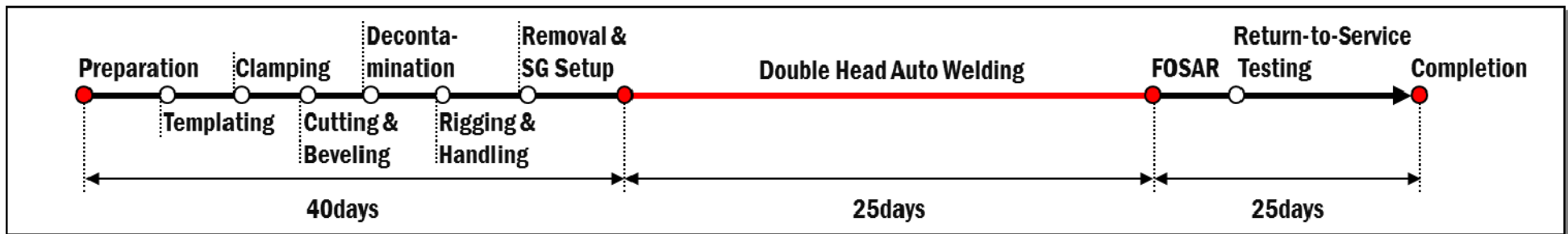
- Fabrication of Replacement SG(RSG) components
- Installation of SGR



Steam Generator Replacement Experience

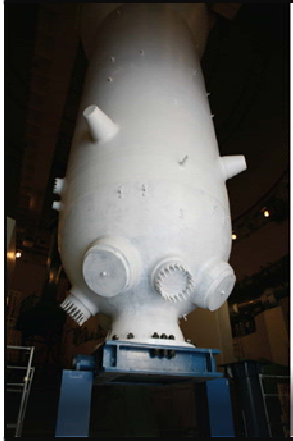
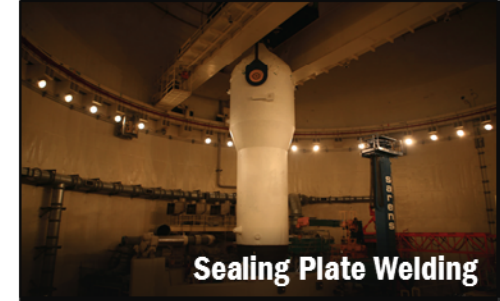
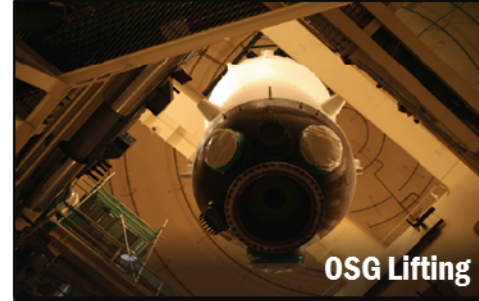
■ Schedule & Process

- Optimized replacement schedule : approximately 90 days (Actual site work : 45 days)
- Activities execution of the serial-parallel processes



Steam Generator Replacement Experience

■ OSG Lifting, Carrying out and Storage



Fixture Installation & OSG DOWN-ENDING



OSG DOWN-ENDING



Crane Setting



OSG Lifting



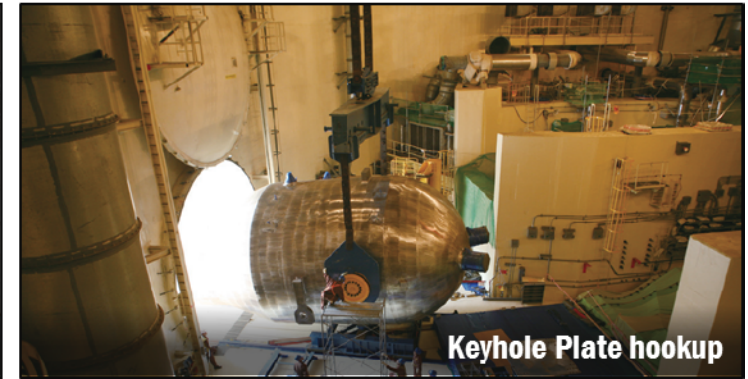
OSG Carrying



OSG Storage

Steam Generator Replacement Experience

■ RSG Lifting and Installation

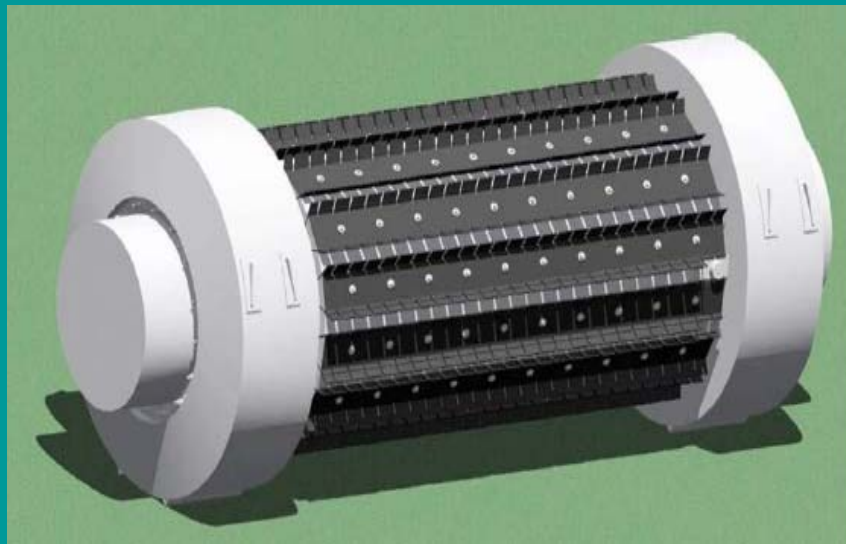


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CASK Development for Spent Fuel Storage

- Developing Korean Type Spent Fuel Storage & Transportation Cask with NAC
- Casks will be used to store the spent fuels from Korean NPPs

Spent Fuel Storage and Transportation Cask



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Self-disposal*	SPC <	SG Secondary Part

Conclusion

- **Heavy component replacement technology and experience are the basic one in decommissioning.**
- **Radioactive waste treatment technology is one of the important factors for the success of Kori unit 1 NPP decommissioning.**
- **Doosan has strong capability to develop, design and manufacturing of equipment for nuclear service and decommissioning business.**
- **Doosan would like to participate in Kori unit 1 NPP decommissioning business as leading company and in overseas decommissioning one as supplier.**



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