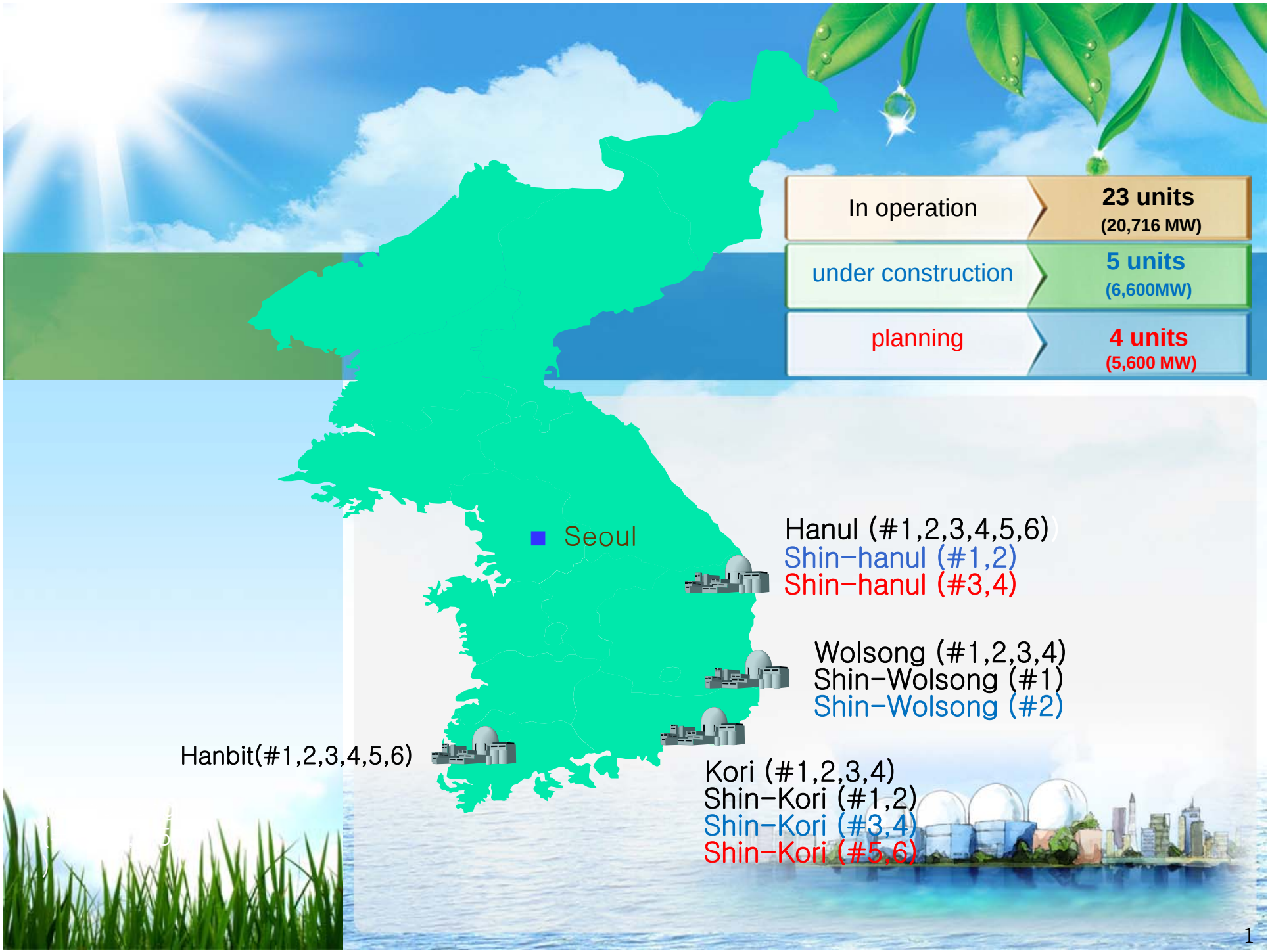
HANUL Unit4 Steam Generator Replacement

Radiation Safety Management

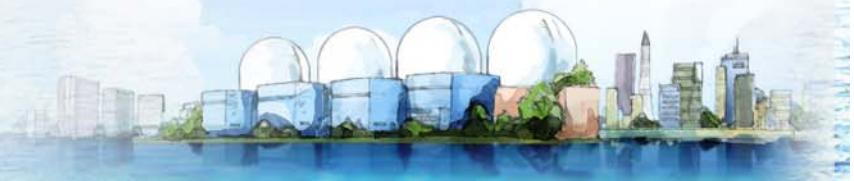
KHNP

Lee Eung-Il

KHNP


In operation
23 units
(20,716 MW)
under construction
5 units
(6,600MW)
planning
4 units
(5,600 MW)
Seoul
Hanul (#1,2,3,4,5,6)
Shin-hanul (#1,2)
Shin-hanul (#3,4)
Wolsong (#1,2,3,4)
Shin-Wolsong (#1)
Shin-Wolsong (#2)
Hanbit(#1,2,3,4,5,6)
Kori (#1,2,3,4)
Shin-Kori (#1,2)
Shin-Kori (#3,4)
Shin-Kori (#5,6)

CONTENTS



1. SUMMARY

Condition

- HANUL Unit 4
  - business operated day : 31, December, 1999
  - type : PWR(pressurized-water reactor)
  - reactor shutdown day : 9th, September, 2011
- Replacement Subject : two steam generators
  - reason : excess of acceptance rate of steam generator tube plugging
  - period of replacement : 2013. 5.10 ~ 8.14(97D)

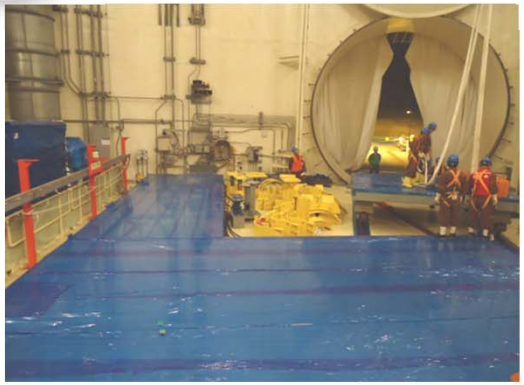
2. MAIN PROCESS

Work Item	MAY				JUNE				JULY					AUGUST	
	2	3	4	5	1	2	3	4	1	2	3	4	5	1	2
Preparation work(22d)					5.10 ~ 5.31										
• bringing equipment into RCB		5.10 ~ 5.12													
• installation of refueling pool cover		5.12 ~ 5.13													
• cutting pipes of MS & FW				5.16 ~ 5.27											
• installation of SG lifting equipment(HLU/TLD)				5.28 ~ 5.31											
SG replacement work(37d)											6.07 ~ 7.12 (RCS Critical Window)				
• cutting RCS pipes							6.07 ~ 6.09								
• taking out OSG from RCB						6.09 ~ 6.11									
• decontamination of RCS end pipes and processing cutting plane								6.07~ 6.16							
• bringing RSG into RCB and Fit-up									6.12 ~ 6.18						
• welding and NDE of RCS pipes										6.19 ~ 7.12					
Successive work & start-up(29d)									7.12 ~ 8.09						
• SG ECT											7.12 ~ 7.24				
• refueling operation											7.18 ~ 7.21				
• making a trial run													7.26 ~ 8.06		
• synchronization & connection														8.14	

2. MAIN PROCESS

1 supply cable

2 refueling pool cover



3 temporary auxiliary crane

4 & removal of insulation

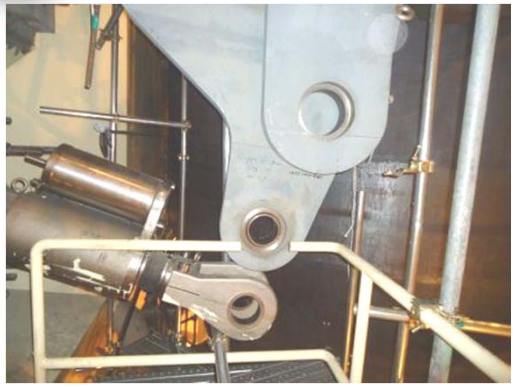
5 materials & fixing device

6 steam pipes

2. MAIN PROCESS

7 the PWR

8 SG upper fixture



9 part of RCS pipes

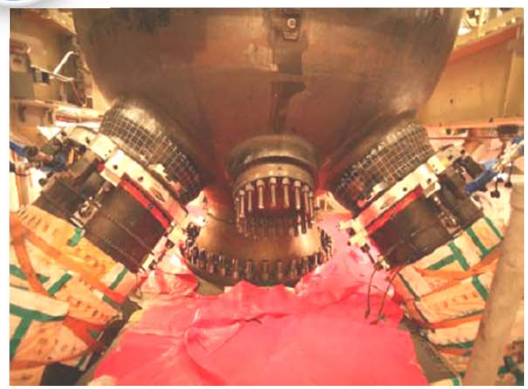
10 Installation of the rail

11 equipment(HLU/TLD)

12 SG lower fixture

2. MAIN PROCESS

13 cutting the RCS pipes

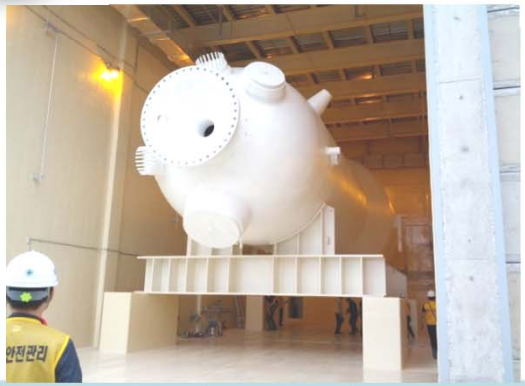


14 coating the SG surface

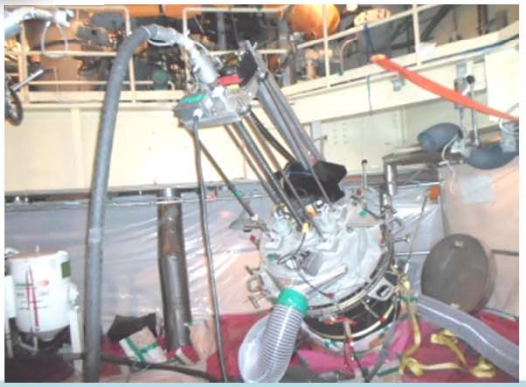
15 taking out SG

16 Taking out the SG

17 the SG into OSGSF



18 inside RCS end pipes



2. MAIN PROCESS

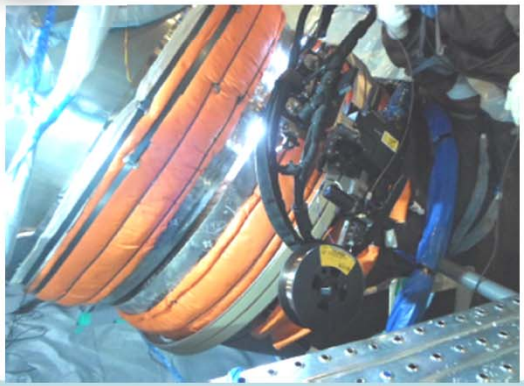
19 RCS pipes processing the cutting plane

20 new SG transportation

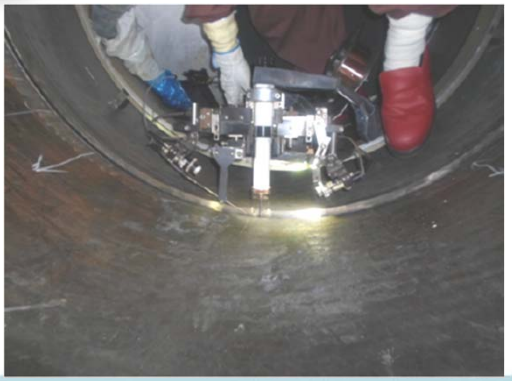
21 into RCB

22 SG on the RCS pipes

23 outside welding



24 welding



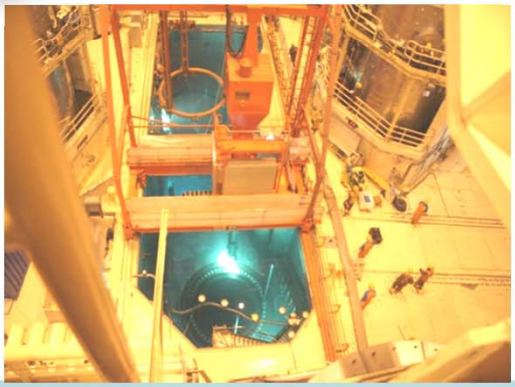
2. MAIN PROCESS

25 Inspection & removal of foreign materials

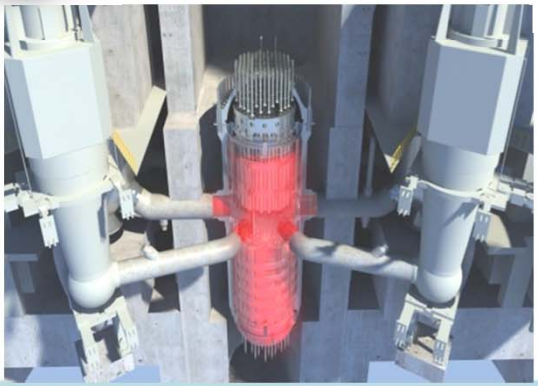
26 Welding of the MS/FW pipes

27 Installation of the insulation materials

28 Loading the nuclear fuel



29 reactor start-up



30 Synchronization & connection

3. RADIATION SAFTY MANAGEMENT

1) Woker exposure dose management

management goal

- collective dose
  - goal : 210 man-mSv, result : 177 man-mSv
- individual dose : 16 mSv/yr
  - unavoidable case of excess exposure: 20 mSv/yr
  - legal requirement : 50 mSv/yr, 100 mSv/5year

3. RADIATION SAFTY MANAGEMENT

○ Exposure dose of the major work

NO	Major work	goal	result
1	RCS pipes cutting, grinding, welding	120	106.6
2	RCS pipes clamping, supporting	15	14
3	RCS pipes inside decontaminating	10	7.6
4	SG support fixture, platform removal and installation	7	4.9
5	Shielding materials installation and removal	7	3.9
6	Heat insulation materials of SG, RCS pipes removal and installation	3	4.4
7	others	48	36.3
total		210	177.7

3. RADIATION SAFTY MANAGEMENT

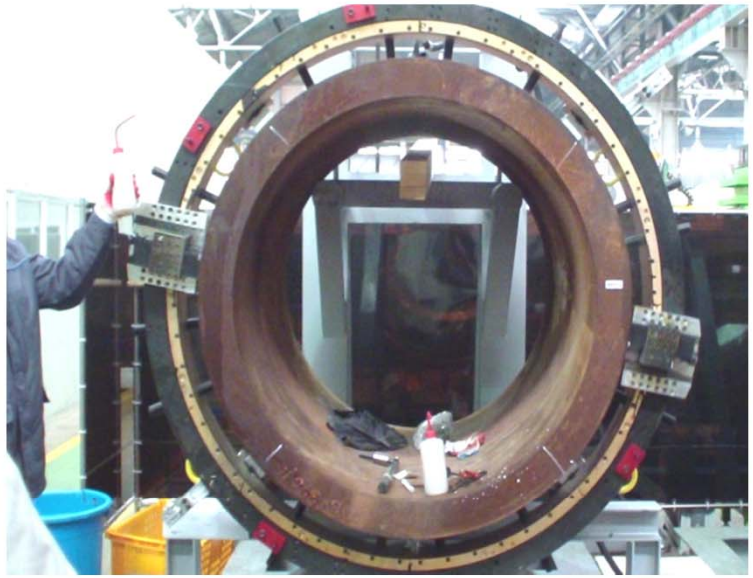
2) Method of reducing exposure radiation dose for worker

- delay the draining of SG primary and secondary coolant
- conducting pre-mock up training for major radiation work
- radiation shielding : installation of temporary lead shielding materials for RCS pipes and lead shielding structure for OSG
- installation of the movable air cleaning unit
- monitoring continually the air contamination level(movable continuous air contamination monitor)
- decontamination of the inside of RCS end pipes
- measurement of radiation and radioactivity for a day, of work

3. RADIATION SAFTY MANAGEMENT

○ Conducting pre-mock up training for major radiation tasks

cutting



RCS and MS/MW pipes cutting machine

welding

RCS pipes welding

3. RADIATION SAFTY MANAGEMENT

○ Conducting pre-mock up training for major radiation tasks

shielding

shielding plug

decontamination

pipe end decontamination(PED)

3. RADIATION SAFTY MANAGEMENT

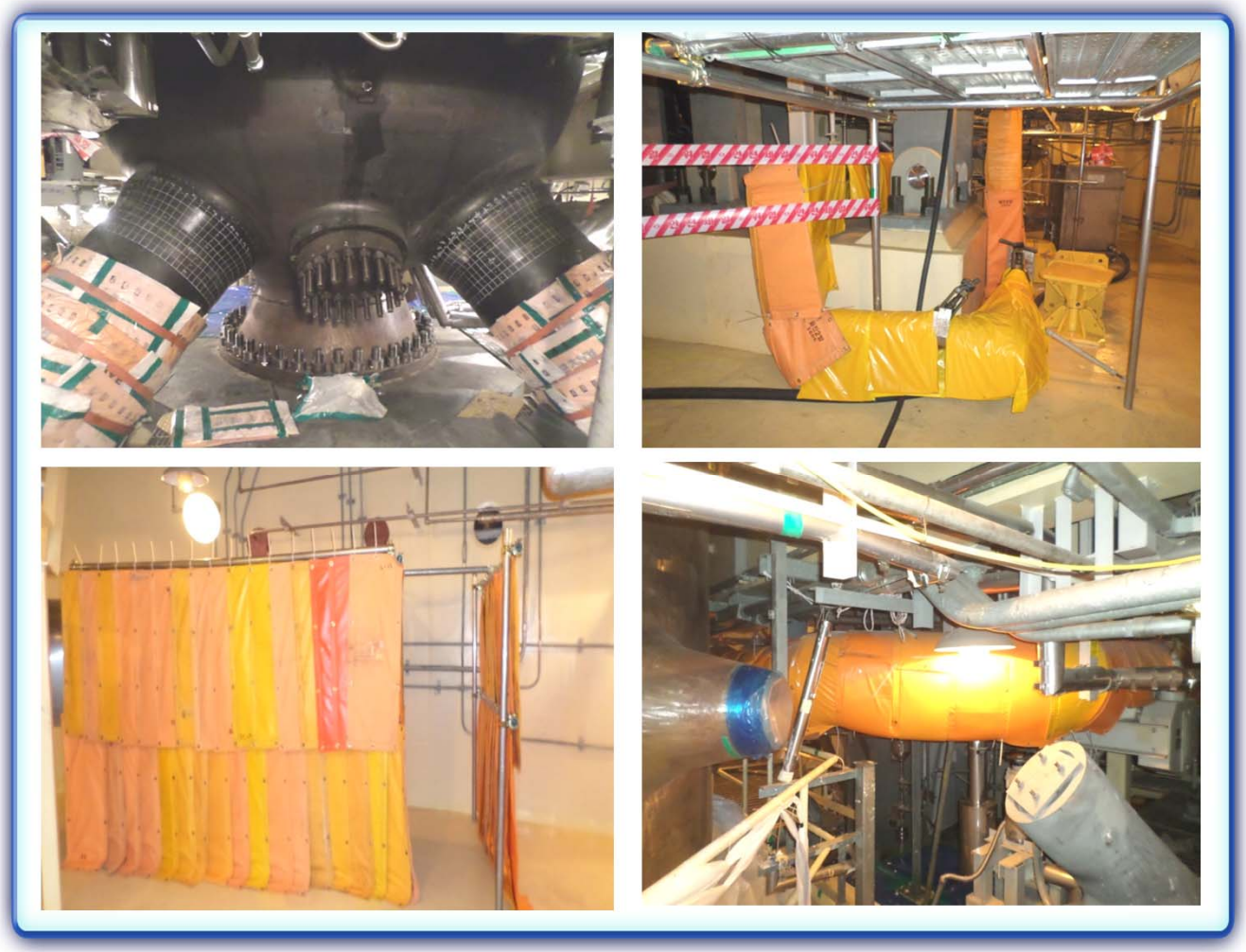
○ Conducting pre-mock up training for major radiation tasks

transportation

- SG weight : 546 ton, total weight : 637 ton(included saddle, lashing)
- Mock up weight : 730 ton

3. RADIATION SAFTY MANAGEMENT

○ Radiation shielding(pipes and object)



3. RADIATION SAFTY MANAGEMENT

○ Radiation dose rate after shielding (mSv/h)

location	Installation place	mSv/h	
		before	after
RCB 86'	Reactor drain pipe	0.2	0.08
	Refueling Pool drain pipe	12.5	5.5
RCB 100'	SG hot leg pipe	0.5	0.2
	SG cold leg pipe	0.25	0.15
	RTD pipe	0.25	0.1
RCB 116'	SG H/L→PZR Surge Line	0.15	0.08

※ total quantity needed of lead material : 1,150 sheets

3. RADIATION SAFTY MANAGEMENT

○ Radiation shielding(SG lead shielding structure)

3. RADIATION SAFTY MANAGEMENT

SG transportation terms

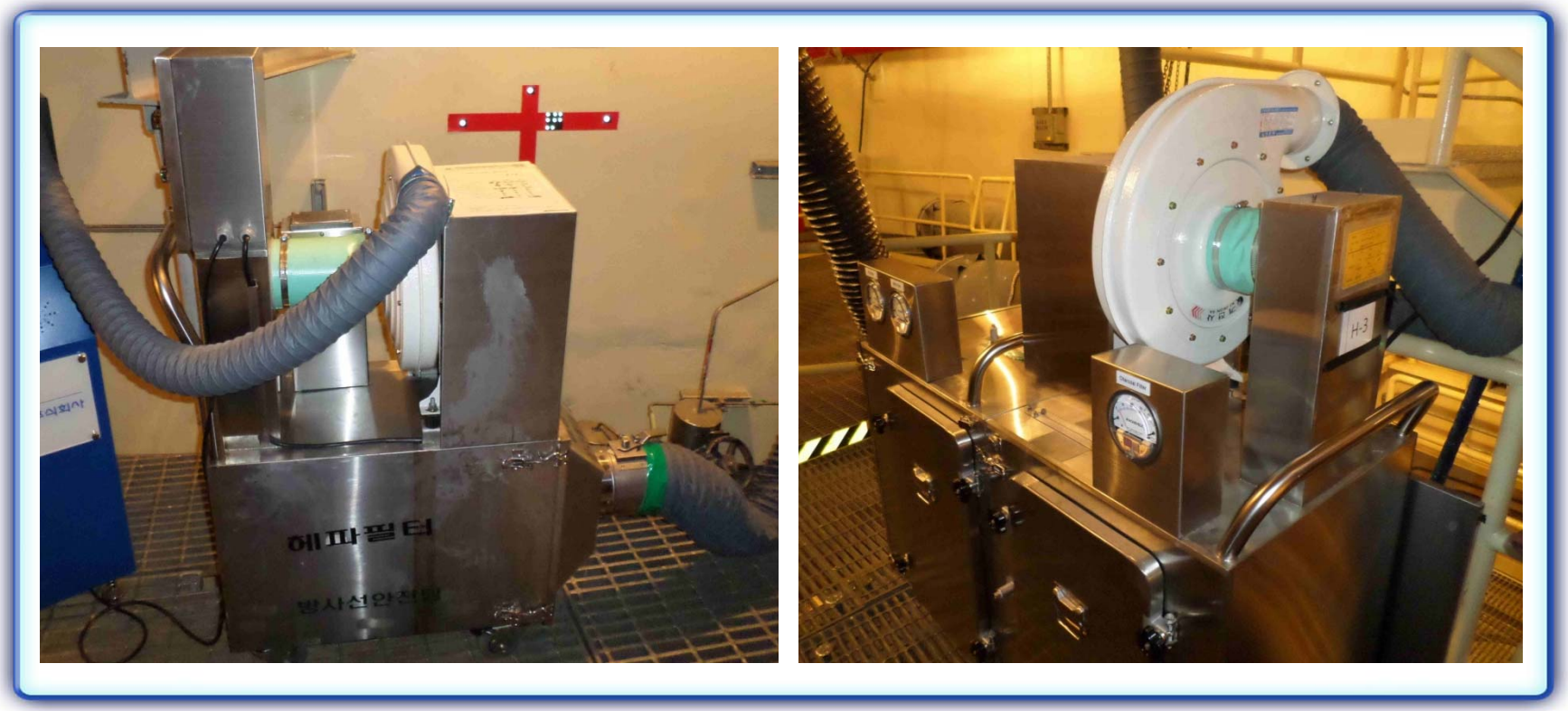
- outside surface of transporting object : 2 mSv/h
- outside surface of transporting vehicle from 2m : 0.1 mSv/h
- surface contamination : below surface contamination control limits
  - surface contamination control limits : 4 Bq/cm^2

Measured value

- outside surface of transport object : 3.1 uSv/h
- outside surface of transport vehicle from 2m
  : 2.84 uSv/h(→0.44 uSv/h)
- surface contamination : natural background radiation level

3. RADIATION SAFTY MANAGEMENT

○ Installation of the movable air cleaning unit



- capacity : 2,000cfm, 750cfm, 560cfm

3. RADIATION SAFTY MANAGEMENT

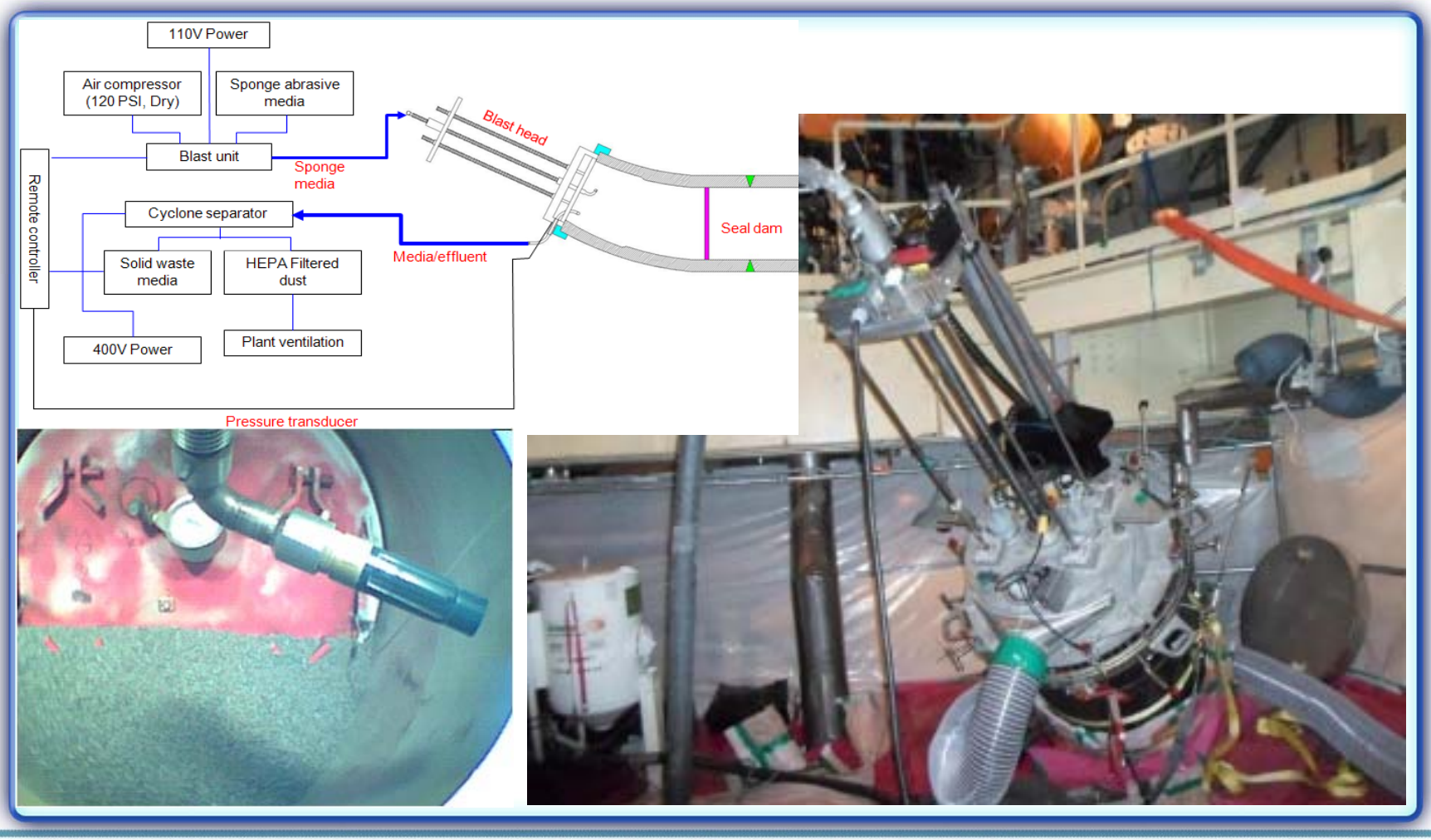
○ Monitoring continually air contamination

Continual air monitor

Grab sampler

3. RADIATION SAFTY MANAGEMENT

○ Pipe end decontamination(PED) of RCS



4. RADIOACTIVE WASTE MANAGEMENT

○ Generated amount of radioactive waste

unit : kg

type	iron	cotton	paper	vinyl	plastic	rubber	insulation
amount	9,416	1,094	937	1,543	163	1,073	2,100

○ Method of reducing radioactive waste

- iron
  - ➢ high level contamination : storage of 200 ℓ drum
  - ➢ low level contamination : disposal after long term storage
- rest of radioactive waste : storage of 200 ℓ drum


Thank you for your attention
Question?
e-mail : aop123@khnp.co.kr
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