HOT TOPIC REPORT OF
BOTTOM HEADER DEFECTED
,YGN PLANT 5 IN 2003

KOREA HYDRO AND
NUCLEAR POWER COMPANY

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Ⅰ. General Description

During the One cycle life of outage at Young Gwang nuclear power plant 5, The Mechanical department found that three of eight thermal sleeves was separated from the Safety Injection nozzle at Bottom Header as a result of inspection.

The One among these thermal sleeves was located at the Bottom of Rx V-
essel, occurring impact against the surface of Bottom Header and damaged two location against the surface of Rx Bottom. Fortunately There is no problem in process of safety operation according to the result of test which associated with Rx vessel integrity in consideration of the long term safety operation during the periods of design life time.

We intend to provide other plants with result data of two aspects regarding Bottom Header damaged. The one is the assesment of radiation dose that these data were conducted by the radiation safety department for the condition of surrounding area at Bottom Header damaged in preparation of repair in the future.

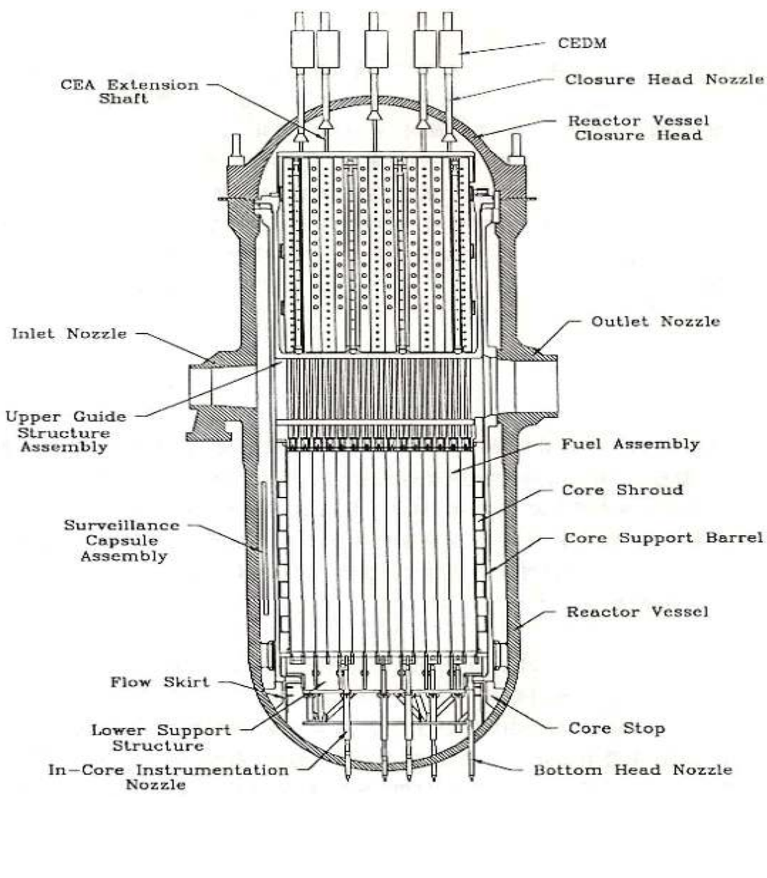
The other is the scheme of repair that at first two company such as GENE(General Electric Nuclear Energy Company) and UCC(Underwater Construction Corporation) were scheduled to be performed in order to recover the Bottom Header damaged although these schemes had beeen delayed by several reasons of our plant. We hope to attribute to other plants by introducing above case not only the reduction of radiation dose but also the radiation safety control.

Ⅱ. The Size and location of the Damaged Bottom Header

1. The design of Rx Vessel

The Rx Vessel consists of fuel assembly, CEA and Internal Structure to be needed supporting Rx Core which covered with the minimum depth of S/S<1/8"> and made of Mn metal including Mo metal. It is divided into two parts such as the upper header part and the lower part. The ICI with fourty five guide nozzle is locationed through the lower header part to monitor the of neutron inside Rx and prevent from moving toward the radius direction of the core support barrel and core stop inside the upper Rx Header part restricts to moving toward the vertical direction of core support barrel.

The upper closure head consists of CEDM housing with seventy three, Rx Header vent line with one, Heated junction thermo couple system with two, including upper closure head with eighty four, in addition the material of Rx Vessel is made of carbon SA S08 and the material of cladding is made of S/S 318, 319.

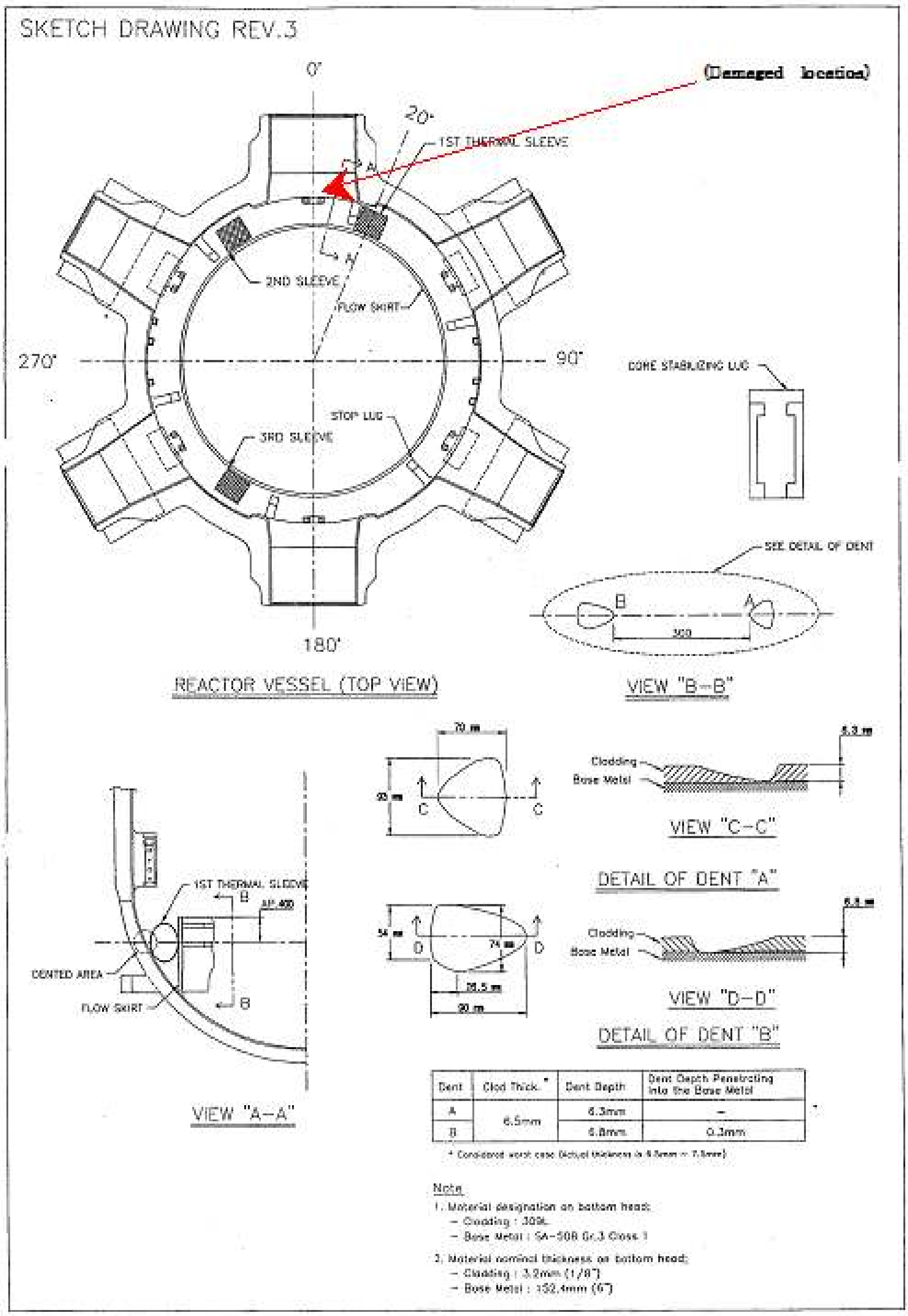


[Picture 1)] The Design of Rx Vessel

2. The size and location of Bottom Header defected

1) Location of Bottom Header Defected

Two locations to the side of the lower flow skirt within a radius of 2° and 347° angle at Rx Vessel



[Picture 2)] The location of internal cladding defected at Rx Vessel

2) The size of Bottom Header defected [Refer to picture 2]

Location of Defect	Size of Defect(㎜)			Remarks
	Length	Width	Maximum Depth	
# A	70	93	6.3	-
# B	90	74	6.8	-

[Table 1)] The size of Bottom Header Defected

[Picture 3)] The Photography for Bottom header defected at Rx Vessel

Ⅲ. The Monitoring of Radiation Dose Level

1. Objective of Monitoring

The condition of job area has accomplished by effective plan and schedule for monitoring the radiation Dose for Bottom Header and Internal Rx Vessel and the objective of monitoring was based on the assumption that the process of these job's above mentioned ensured compliance with the goal of appropriate radiation protection as well as principle of ALARA.

2. The Area of Monitoring

○ Eight locations within a radius of 300°, 0°, 60° angle at the center of bottom header damaged in the Rx vessel

○ Eight locations between the center of Rx Vessel and Internal Rx Ve- ssel

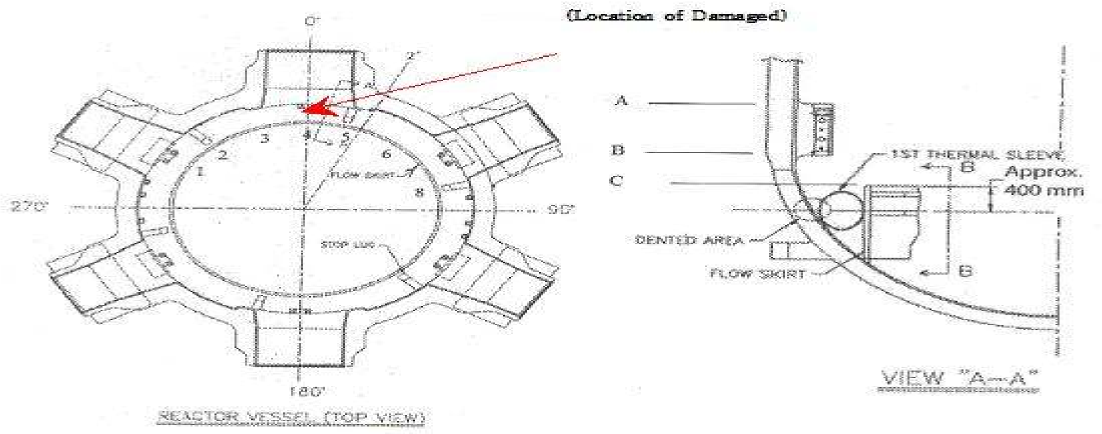
○ The monitoring of the radiation dose at the Rx cavity

3. Radiation Dose Survey for the Bottom Header defected

1) Method of Survey

Radiation dose survey has been conducted at 3 locations such as 30cm, 60cm and the upper location of stabilizing lug within a radius of 300°~60° at bottom header damaged in using radiation monitoring instrument

2) Result of Survey related to Location of Bottom Header Damaged



[Picture 4)] Location of Bottom head defected

[Unit: mSv/hr]

Survey Location	A				B			C		
	Contact	Distance 30 cm	Distance 60 cm	Upper stabilizing lug	Contact	Distance 30 cm	Distance 60 cm	Contact	Distance 30 cm	Distance 60 cm
1(300°)	1,630	80	6	1,630	100	50	4	20	15	2
2	100	-	-	-	100	-	-	20	-	-
3	200	-	-	-	100	-	-	20	-	-
4(0°)	1,890	70	5	1,902	200	40	5	20	15	2
5	200	-	-	-	70	-	-	20	-	-
6	120	-	-	-	10	-	-	20	-	-
7(60°)	1,160	-	-	1,160	100	-	-	20	-	-
8	200	70	5	-	50	30	2	20	3	5

[Table 2)] The Data of Radiation Dose survey for the Bottom Header defected

4. The Radiation Dose survey at both internal Rx Vessel and Center of Rx Vessel

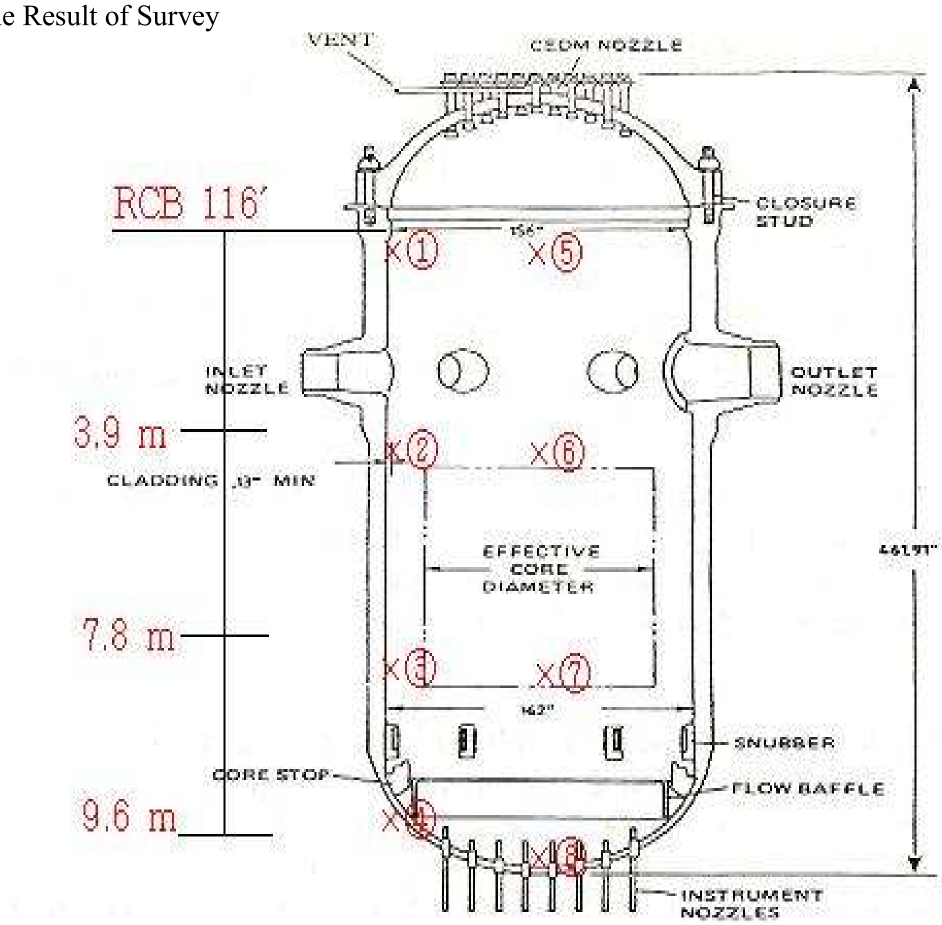
1) Method of Radiation Dose evaluation

Radiation Dose Evaluation has precisely monitored by using Hi-Hi Teletector, TLD and ADR for Rx internal wall and center of Rx Vessel damaged according to the elevation level.

[Picture 5)] Hi-Hi Teletector

[Picture 6)] ADR and TLD

2) The Result of Survey



[Picture 7)] Survey points of Vessel

[Unit : mSv/hr]

Section	TLD	ADR	Hi-Hi teletector	Section	TLD	ADR	Hi-Hi teletector
①	5	5	0.2	⑤	0	0	0
②	1	1	3	⑥	0	0	0
③	206	165	275	⑦	0	0	0
④	62	64	238	⑧	5	5	1

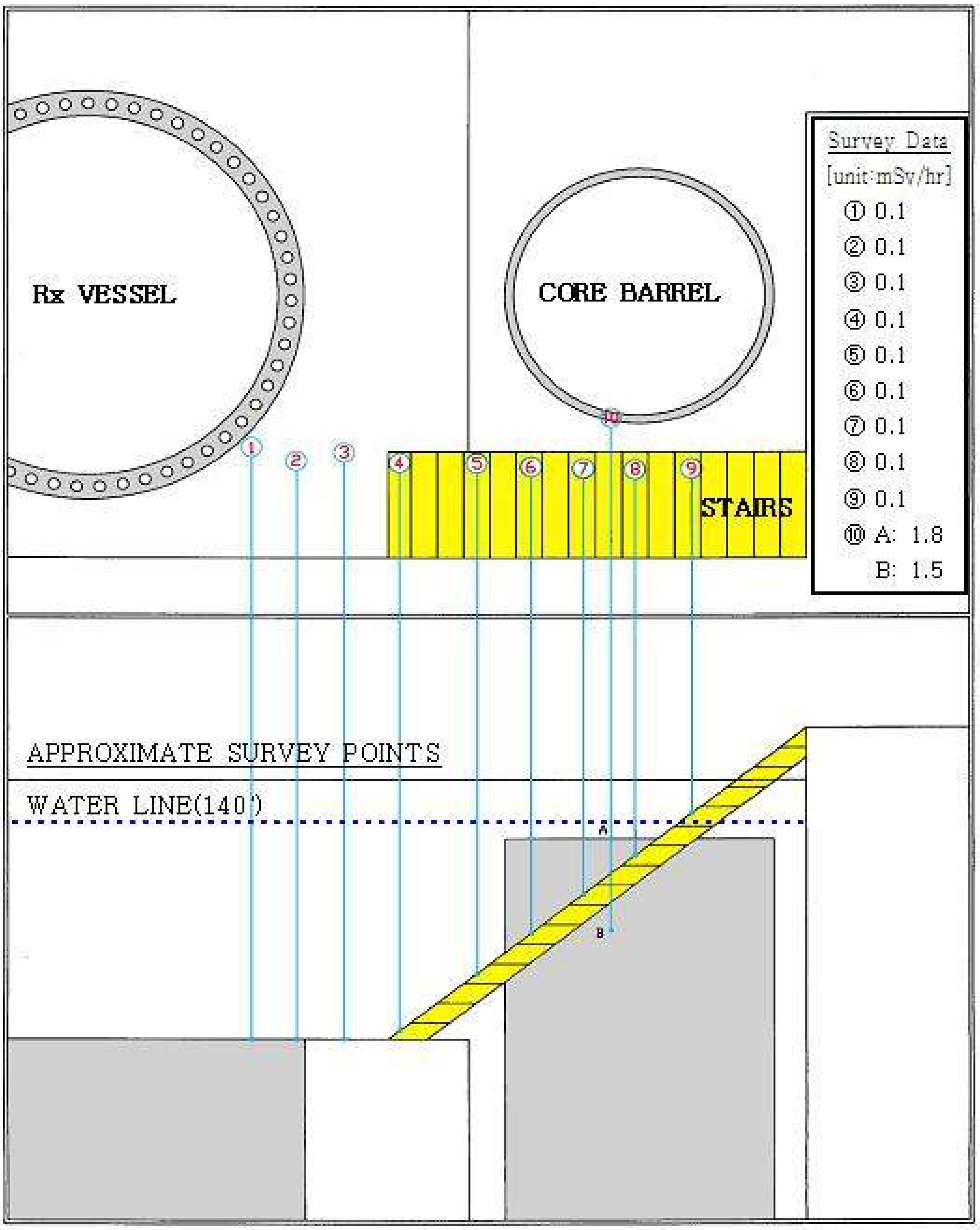
[Table 3)] The Data of Radiation Dose survey at Both internal Rx vessel and center of vessel

5. Radiation Dose Survey for Rx cavity

1) Method of Radiation Dose monitoring

When transferring to the job area or conducting these job's, job area such as at Rx cavity and around the accessible area needs to be established to prevent and minimize the risk through monitoring precisely the level of radiation by using Hi-Hi Teletector.

2) The Radiation dose rate for accessible corridor at the Rx Cavity with full water

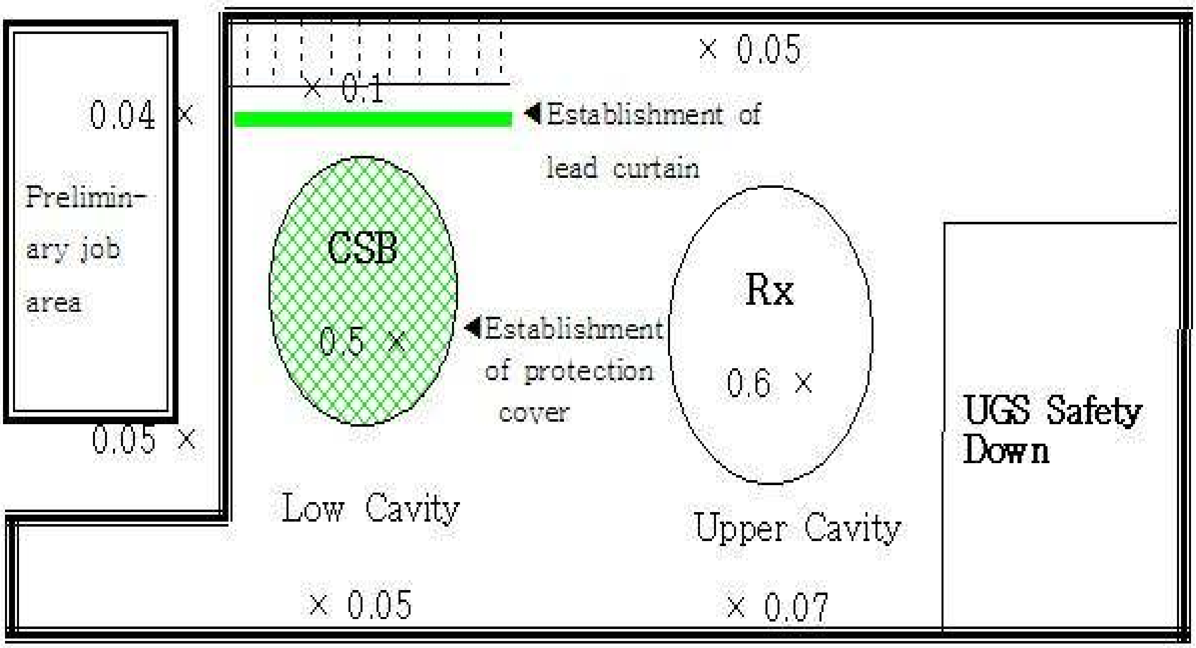


[Picture 8)] Reactor Cavity Survey Map

width

3) Surface Radiation dose rate at the Rx cavity with full water (Elevation 140ft)

[Unit :mSv/hr]



[Picture 9)] Radiation dose rate of Rx cavity area

user\LOC

6. Maximum Radiation Dose Rate for job area

Monitoring area	Monitoring location	Maximum Dose Rate (mSv/hr)	Remarks
Within a radius of 300° ~60° at bottom header damaged	0° Surface point the upper stabilizing lug	1,902	Position of Defect
Inside wall and height at Rx vessel	7.8m height point from the inside bottom header	275	Position of Defect
Rx Cavity	Aside stair at CSB	1.80	Route for job's worker

[Table 4)] Survey point and Maximum Radiation dose rate for job area

The Location of maximum radiation dose rate exists within radius of the 0° angle from core stabilizing and within the range of bottom head damaged which affects chiefly as the main radioactive source term.

It seemed probably that core stabilizing lug had been more activited with radioactive source term than others of why it located within the least range from the fuel assembly.

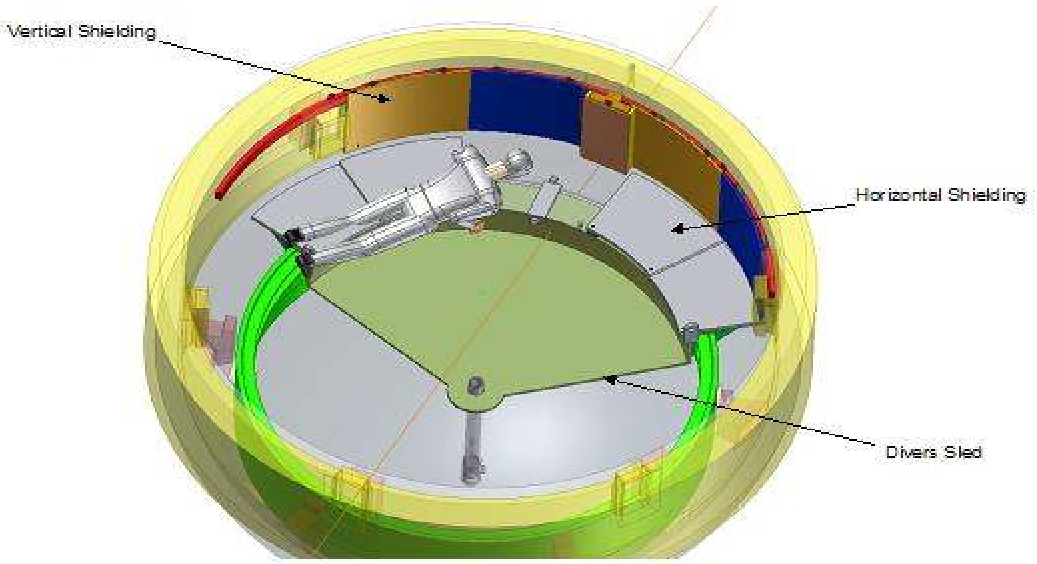
Ⅳ. The Assesment of shielding for bottom header defected

The Assesment of shielding should be estimated in reducing the maximum radiation exposure dose below 1.0mSv/hr for technicians related to bottom defected by means of establishing shielding barrier prior to conducting the job.

1. The Manufacture of Shielding Materials

The Shielding Material for diver sled and shielding was made of tungsten metal taking into consideration various features such as the density of shielding material, strength, the thickness and effects

1) Materials : Density 10 with tungsten metal
2) Shielding Thickness : over 14cm(it maintains below 1.0 mSv/hr after shielding)
3) Height : over 1m
4) Shielding Range : 120°~360°



[Picture 11] Diver Sled and the Establishment Status of Shielding

2. The Assessment of Shielding

1) Precondition

Section	Mass attenuation coefficient(μ) [㎠/g]	Density(ρ) [g/㎤]	Linear attenuation coefficient(μ) [cm]	Half Life(T) [cm]
Water	0.0707	1	0.0707	9.8
Tungsten	0.0654	10.0	0.654	1.059
Iron	0.0599	7.86	0.471	1.47

[Table 5)] A Comparison of water, tungsten and iron within the range of gamma energy with 1Mev

2) The Calculation of Build up factor for Water, Tungsten and Iron within range of gamma energy with 1Mev

Section	Mass attenuation coefficient(μ) [cm]	Thickness of Shielding(x) [cm]	μ.χ	B(μ.χ)
Water	0.0707	30	2.121	3.95
Tungsten	0.654	14	9.156	4.58
Iron	0.471	22	10.36	18.16

[Table 6)] A Comparison of water's Build Up factor

** The Value of Build up related to tungsten and iron at the range of Gamma Energy with 1Mev.*

3) The Effects of Shielding.

Determining the maximum radiation dose rate as main source term based on the upper core stabilizing lug with 0° angle which located higher 1m than bottom Header.

① Radiation Dose rate Calculation after finishing shielding

◦ I : Radiation dose rate after finishing shielding

◦ $I_{\circ}$: Radiation dose rate before finishing shielding

◦ : the thickness of shielding

◦ μ : Linear Atteareation coefficient [unit]

◦ : Build up factor

② Radiation Dose rate Between before shielding and after shielding

Section	Before shielding [mSv/hr]	After shielding [mSv/hr]	Thickness of shielding [cm]	Reduction rates
Water	1,902	900.9	30	1/2.1
Tungsten		0.9197	14	1/2,068
Iron		1.09	22	1/1,745

[Table 7)] Radiation Dose rate Between before and after shielding

Ⅴ. The Estimated Collective Dose.

The Estimated collective dose is carefully evaluated on the assumption that the materials of Diver shielding sled needs to be established in consideration into the level of radiation dose rate concerning Rx Cavity Bottom Header damaged, Rx Cavity, Rx Vessel and surrounding areas under influence of two life cycles at Young Gwang unit 5.

1. The Periods of job's termination and number of technicians

1) The periods of job termination : seven days in total

2) Number of technicians

① GENE/UCC : twenty two people in number

◦ Engineer and technician

◦ QA, QC : eleven people in number

◦ Diver : eleven people in number

② KHNP company(mechanical department : 3, QA : 2, Radiation Safety department : 8, Operational department : 4)
: Seventeen people in number.
③ Others : thirty three people in number

2. The Assessment of total estimated collective Dose during the repair of bottom Header defected

1) Precondition of Calculation

① The Estimated collective Dose is evaluated in two aspects both without shielding material and with shielding material, the upper core stabilizing lug within a radius of 0° angle as Known the maximum radiation dose with 1,902 mSv/hr

② The Estimated working time for Diver : 11 man-hr the total time of this job was represented by GENE/UCC company

③ The Estimated working time for Assistant worker : 448man-hr

<7day × 8man × 8hr>

※ *These 448men-hr are estimated in consideration into two process, one process is the preliminary job in relation with welding job at the bottom Header damaged and the another is to support the Auxiliary process to be needed essentially in performing the welding job.*

④ The Estimated collective dose in Both the aspect of withouting Diver shielding sled and the aspect of with Diver shielding

Section	Situation of withouting diver shielding sled			Situation of with diver shielding sled		
	Dose rate maximum (mSv/hr)	Estimated time (man-hr)	Total collective dose (man-mSv)	Dose rate maximum (mSv/hr)	Estimated time (man-hr)	Total collective dose (man-mSv)
Main worker	주 1) 900.9	11	**9,909.9**	주 3) 1.0	11	**11**
Aux worker	주 2) 0.1	448	**44.8**	주 2) 0.1	448	**44.8**
Total collective dose	-		**9,954.7**	-		**55.8**

[Table 8)] The comparison of estimated collective dose following on whether shielding or with shielding

※ Explanatory above items

① *When performing the welding job under water, the main location of estimated radiation dose rate was applied to area which located within a radius of 30cm length from the accessible job area<refer to table 7>*

② *The surrounding Radiation Dose Rate will also be applied to the technician who are handle with the several Aux job when establishing the preliminary job area around Rx Cavity<refer to picture 9>*

③ *The Estimated Radiation Dose Rate applied after establishing the Diver shielding sled (material: density with tungsten, thickness : more than 14cm, height : more than 1m, the Rang of shielding : 120° ~ 360°, refer to table 7)*

Ⅵ. The Repair schedule of bottom Header defected.

1. The Scope of Job

1) The Management of critical job : GENE company
2) The Performance of welding under water : UCC company

2. The Procedure of Maintenance

The bottom Header defected will be conducted in accordance with the sealing welding under water and NDE procedure equipped with attaching seal plate after processing smoothly with Ring shaped

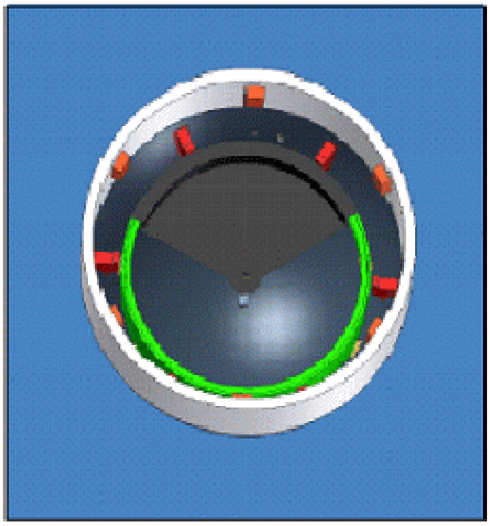
3. The Total job's man applied : twenty two people in number

1) project manager and supervision : three people in number
2) Engineer and Technician : six people in number
3) QA and QC : two people in number
4) Diver : eleven people in number

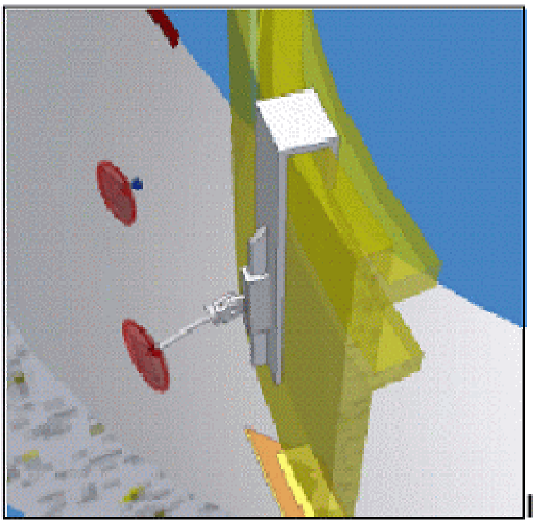
4. The Procedure of Job

1) The visual Inspection and cleaning for maintenance location
○ withdraw of the Internal Rx structure fuel, water<below 90°F> temperature of Rx cavity and maintenance of water elevation<below 123ft>
○ the establishment of Diver shield sled
2) The comparison of initial measurement Data and figure of bottom Header defected
3) The establishment of seal plate with material of seal plate(316L)
4) The execution of EDM(=Electro-Discharge Machine)
5) The Welding of seal plate under water at bottom Headed defected
○ Method of welding is performed by using two kinds such as CMAW and wet under water welding
○ Welding Rod is performed by using E 316L which is one kind of welding rod
6) The execution of clearing for welding location.
7) The execution of NDE for welding spot
8) The internal venting from the seal plate and seal welding for the venting line
9) The inspection of QA

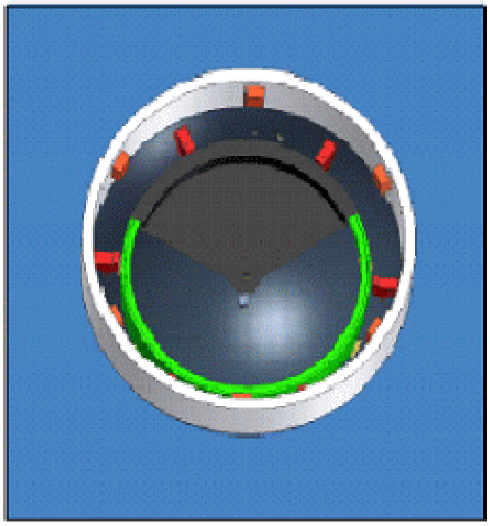
5. The Status of Diver shield establishment and the process of the job schedule



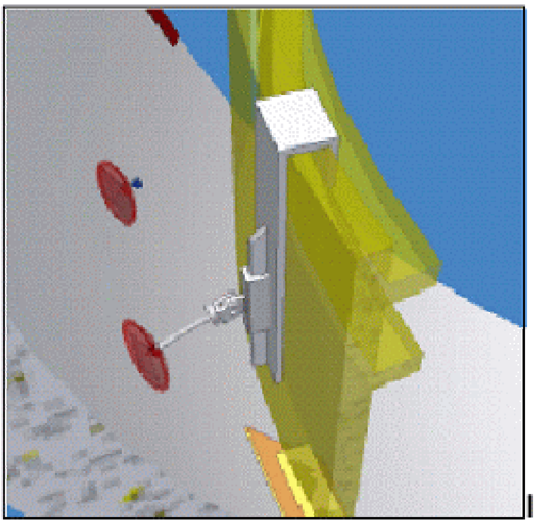
[Picture 13] The Establishment of diver shield



[Picture 14] The Establishment of seal plate

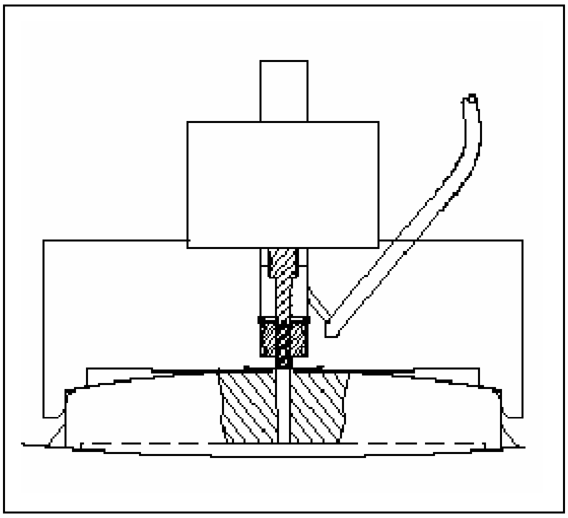


[Picture 13] The Establishment of diver shield

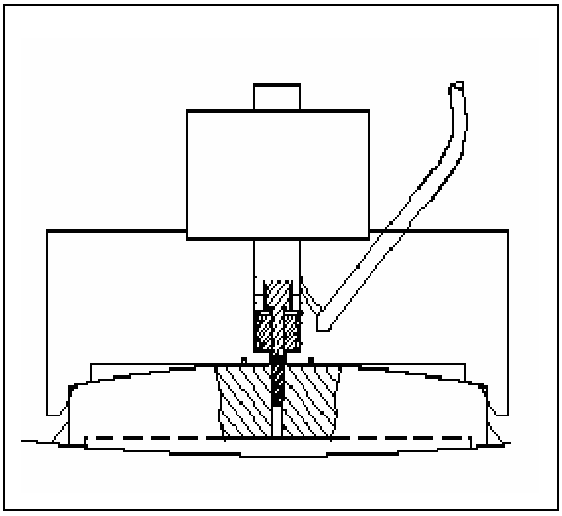


[Picture 14] The Establishment of seal plate

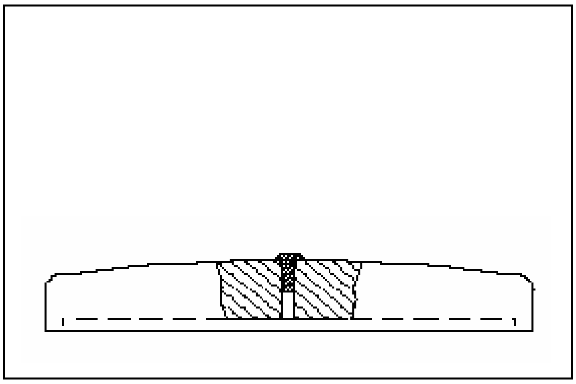
[Picture 17] The status of taking on a Diving suit



[Picture 18] The execution of lear test



[Picture 19] The establishment of sealing pin



[Picture 20] The status of job termination

Ⅶ. Conclusion

It was possible to evaluate concretely for the first time the radioactive dose of Rx vessel by monitoring the radiation dose rate at both the internal Rx vessel and the bottom header damaged during two cycle life

There is no problem in any aspect regarding Rx vessel integrity as the result from the data of assesment.

We hope that these data will be attributed to the other plants in handling with the similar problems such as the Bottom header damaged reference.