2012 ISOE Asian ALARA Symposium

Development of Cyber ALARA Program

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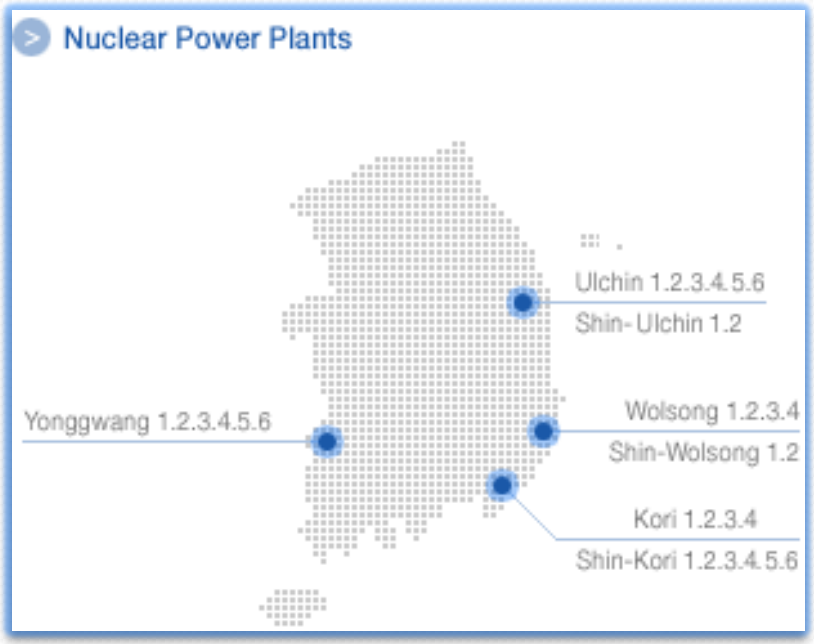
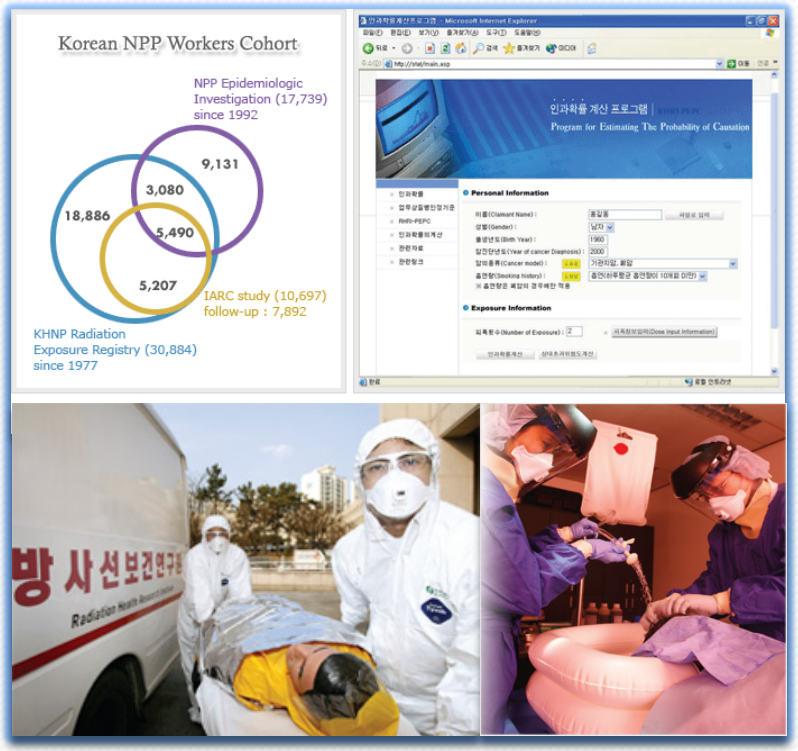
Overview of KHNP



- KHNP is the largest among the six power generating subsidiaries that separated from Korea Electric Power Corporation (KEPCO) in April 2001
- accounting for approximately 25% of electricity producing facilities, hydro and nuclear combined(21 operating NPPs).
- KHNP also operates nuclear power plants in Kori, Yonggwang, Ulchin and Wolsong, and several hydroelectric power generation facilities in the Hangang system, providing approximately 40% of the national power supply.

About RHRI(Radiation Health Research Institute)



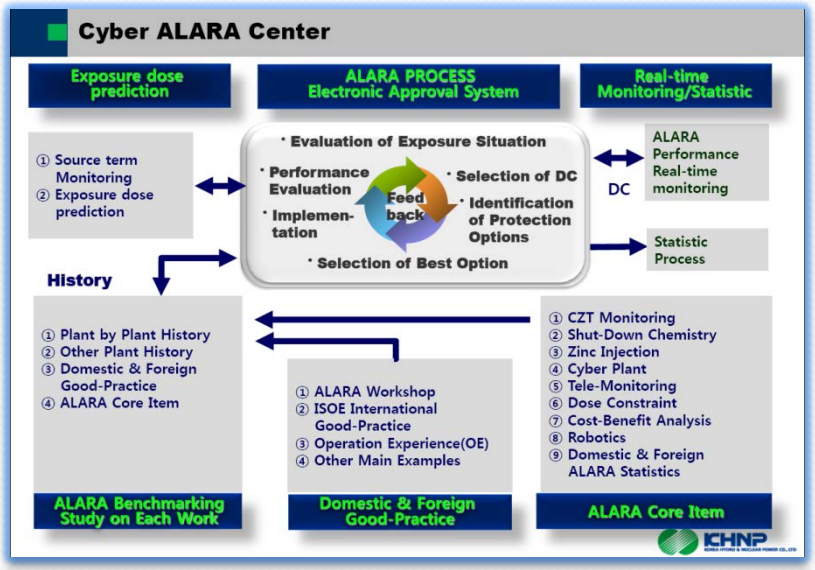
- RHRI was established in 1996 to evaluate and conduct research on effects of low dose radiation exposure on human and to provide immediate medical assistance in case of radiation exposure accident

- So far, we have made effort in studying dosimetry method, constructing international-scale radiation emergency medical networks, and poviding health care for radiation workers

Cyber ALARA Center in Information system for KHNP

- Cyber ALARA Center was already presented as a part of Radiation Management of information system in “2012 International ISOE ALARA Symposium” early this year
- Cyber ALARA Center will be functioned as critical contents for actual radiation management system
- Detailed information about ALARA Center would be presented in this presentation, especially from history and cause of planning Cyber ALARA Center

Background Study for Cyber ALARA Center

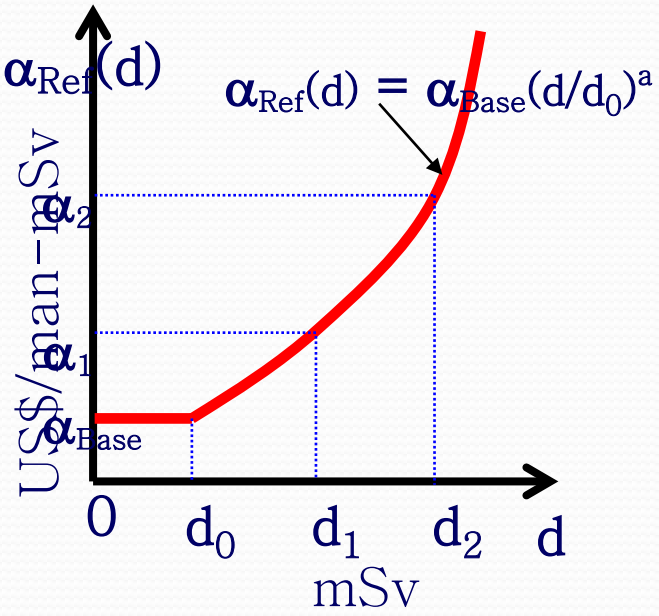


- For "ALARA PROCESS" of Cyber ALARA Center , two research project was already implemented by RHRI

  First one is "Analysis of the radiation field at the major working places in NPP(2008. 3 – 2011.2)"

  Second is " The study on NPP's Application and Countermeasure of IAEA Basic Safety Standard(2009. 3 – 2011. 8)"

Criteria for Selection of Best Option



- Monetary Value of the Man-mSv for Korean NPP radiation workers assessed by "Radiation Aversion Factor" was included as one section of Second research project " The study on NPP's application …"
- All three part would be contents of "ALARA PROCESS" and it will be presented here one by one

Contents for ALARA PROCESS

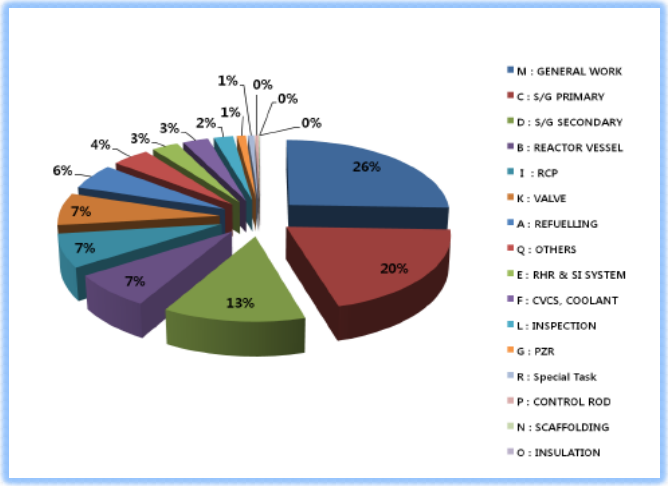
1. Analysis of the radiation field for "Evaluation of exposure situation"

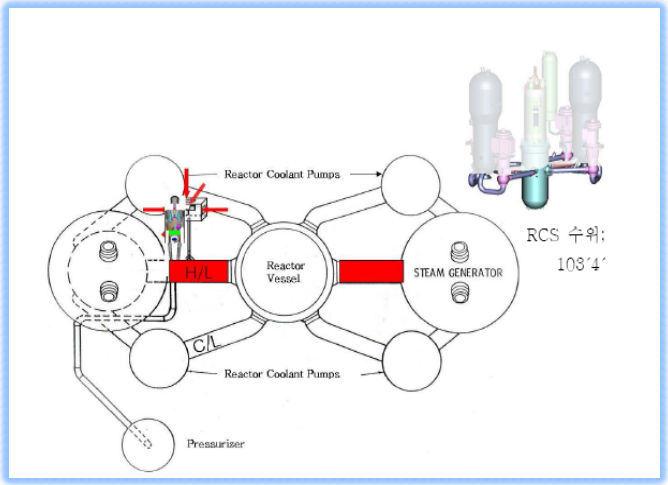
2. Review of "Revised Dose Constraint and dose limit"

3. Monetary value for "Selection Of Best Option"

Analysis of the radiation field for “Evaluation of exposure situation”

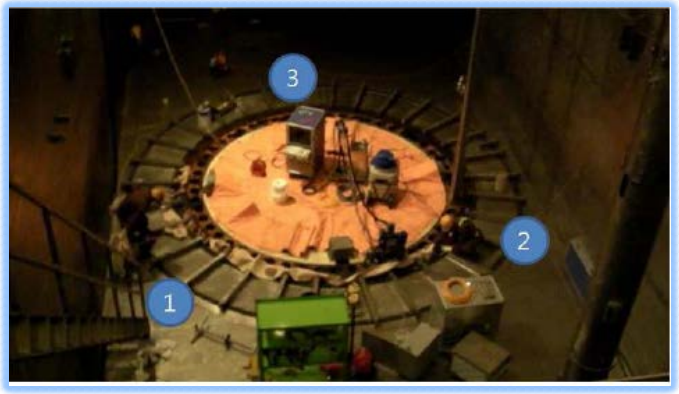
Analysis of the radiation field for “Evaluation of exposure”

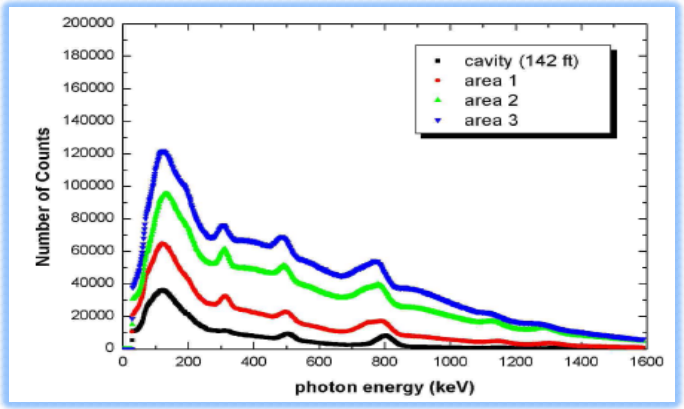




- Job type analysis and classification in NPP was implemented and gathered past exposure data, thus developed “ data base of radiation exposure” for major working places
- For “identification of protection option”, Establishment of analyzing methods for exposure environment of each jobs
- Irradiation experiments and radiation transport simulations for radiation fields analysis at interesting working places were done using TLD and other systems

Analysis of the radiation field for “Evaluation of exposure”



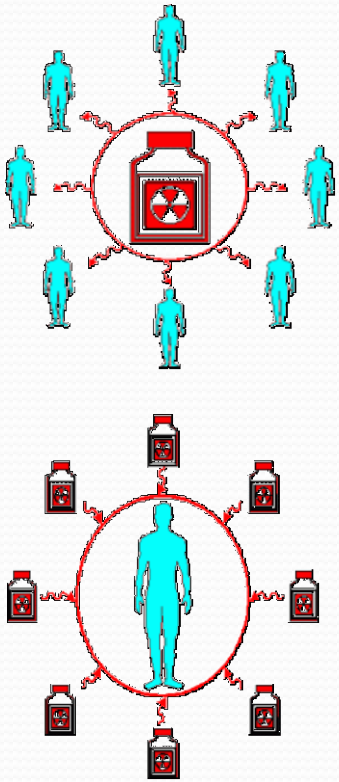


** Measurement points over reactor at the time of stud hole test(upper) and Energy spectrum of gamma rays(lower)*

- “Effective dose” analysis by job types and equivalent dose reconstruction
- Analysis of shielding effects to the dose reduction and optimization
- Making a final reports on radiation fields analysis at the major working places and quality analysis of the effective doses
- Development of a guideline for equivalent dose estimation and it’s data base

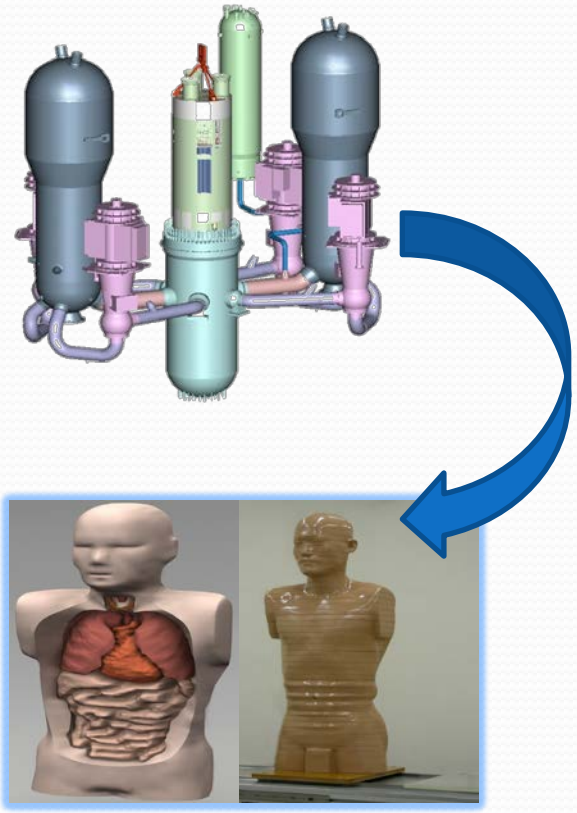
Review of
“ Dose Constraint and dose limit”

Review of “Dose Constraint and Dose limit”



- ICRP issued new recommendation in 2007 : ICPR 103
  - dose constraint in occupational radiation protection
- One of purpose of research project was optimal countermeasure against the applying of revised IAEA BSS to the safety measurement of NPP

Review of “Dose constraints and dose limits”



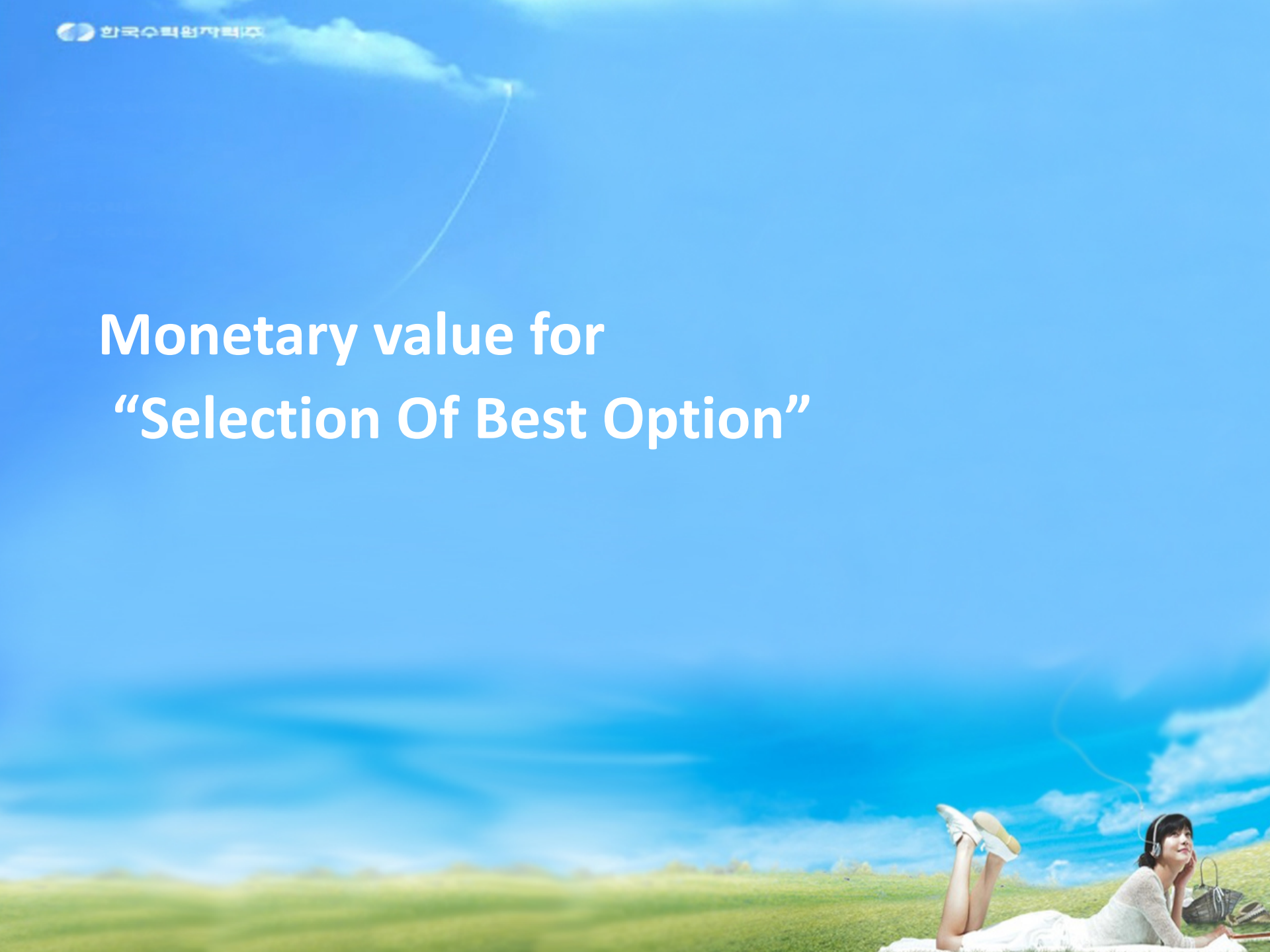
- Dose constraints is the source-related values of individual dose used to limt the range of options considered in the procedure of optimisation : concept was first introduced in ICRP 6o

- For planned exposure situations, occupational exposures should be below the dose constraints for particular source

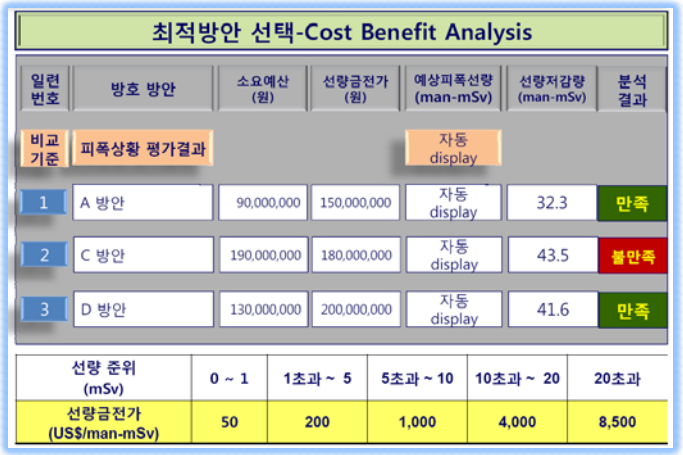
Review of “Dose constraints and dose limits”

- As a result of study, requirement of “ALARA CENTER” to satisfy the equity of distribution of exposure for individual workers
- Reflection of “good practice” and “optimisation of radiation protection” needs ALARA S/W or Program development
- Application of Dose Constraints :
  - No big change of radiation protection system

Monetary value for “Selection Of Best Option”



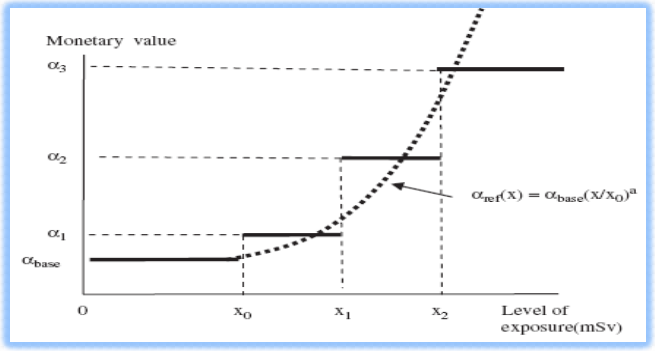
Monetary value for “Selection Of Best Option”



최적방안 선택-Cost Benefit Analysis

일련번호	방호 방안	소요예산 (원)	선량금전가 (원)	예상피폭선량 (man-mSv)	선량저감량 (man-mSv)	분석결과
비교기준	피폭상황 평가결과			자동 display		
1	A 방안	90,000,000	150,000,000	자동 display	32.3	만족
2	C 방안	190,000,000	180,000,000	자동 display	43.5	불만족
3	D 방안	130,000,000	200,000,000	자동 display	41.6	만족

선량 준위 (mSv)	0 ~ 1	1초과 ~ 5	5초과 ~ 10	10초과 ~ 20	20초과
선량금전가 (US$/man-mSv)	50	200	1,000	4,000	8,500

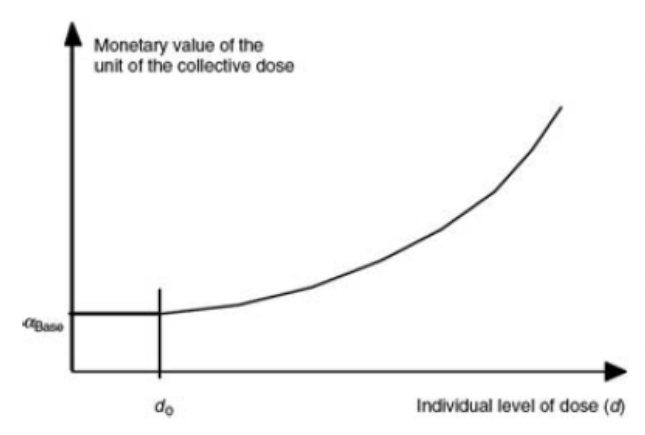


- Monetary value of man-mSv for operators of Korean nuclear power plant(NPPs) was calculated in 2011*
- Aversion factor based on a survey of NPP workers was used for estimation (2,157 surveys were obtained, 2010)
- Discrete stepwise model, monetary values according to different levels of exposure, was used for study**

The monetary value of the Man-mSv for korean NPP radiation workers assessed by the radiation aversion factor (B Lee etal, RPD, 2011)

** A step function model to evaluate the real monetary value of man-sivert with real GDP(Seong H. Na,2009)*

Monetary value of “Selection Of Best Option”



Dose level (mSv)	0–1	1–5	5–15	15–50
a	1	1.2	1.6	1.75

* *Model of monetary values of the man-mSv incorporating radiation aversion and equity consideration(upper) and radiation aversion factor ‘a’ value by dose level(CEPN)(lower)*

- 10 Korean NPPs(Kori 1-2, Yeonggwang 1-3, Ulchin 1-3 and Wolseong 1-2) were selected as subjects

- Radiation aversion coefficient : degree of radiation aversion of the radiation workers was surveyed a scale of 1 – 5 for each man-mSv level and converted to a 1 – 2 scale and averaged

Monetary value of "Selection Of Best Option"

Surveyed company	Profession	No. of respondents	Percentage
KHNP KEPCO KPS[a]	Operation Machine/ electricity-inspection and maintenance	1115 469	51.7 21.7
Radiation contractor	Radiation management service	312	14.5
Samchang	Instrumentation-inspection and maintenance	161	7.5
The rest		100	4.6

[a]KEPCO Plant Service and Engineering Co., Ltd.

$$\alpha_{\text{ref}}(d) = \alpha_{\text{base}} \quad \text{for } d < d_0$$

$$\alpha_{\text{ref}}(d) = \alpha_{\text{base}} \left(\frac{d}{d_0}\right)^a \quad \text{for } d \geq d_0$$

* *The basic model equation presented in ICRP Publication 101 and IAEA SRS No. 21(lower)*

- In August 2010, with the cooperation of KHNP and partner compaies, about 2500 survey questionnaires were distributed to currently deployed radiation workers in 10 NPPs
- $\alpha_{ref}(d)$ is the monetary value of the man-mSv according to the individual exposure level d
- α_{base} is the basic monetrary value of the health detriment due to a unit dose
- The d is the annual level of individual exposure and a is the radiation aversion factor

Monetary value of "Selection Of Best Option"

Life expectancy in population (A)	79.4 y[6]
Average age of cancer occurrence (B)	60.0 y[7]
Loss of life expectancy induced by radiation exposure ($C=A-B$)	19.4 y
Average annual wage for an electric worker (W)	56 000 \$ y^{-1}[8]
Nominal risk coefficient induced by radiation (P)	$4.2E^{-5}$ mSv[9]
Basic monetary value ($\alpha_{base}=C\times W\times P$)	45.6 \$ mSv^{-1}

	Dose level (mSv)				
	0–1	1–5	5–10	10–20	>20
α_{ref} (\$)	50	200	1000	4000	8500

** Korean specific factors and basic monetary value as of 2009(left) and KHNP's radiation aversion factors and monetary values by dose level(upper)*

- These radiation aversion factors were used as an important basis in determining the monetary value of the man-mSv by the NPP operators

Thank you !


ICHNP RHRI
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