2018 ISOE International Symposium
Kyoto, 24-26 October 2018

Review on Radiation Area Zoning of NPPs in Korea

25 Oct, 2018

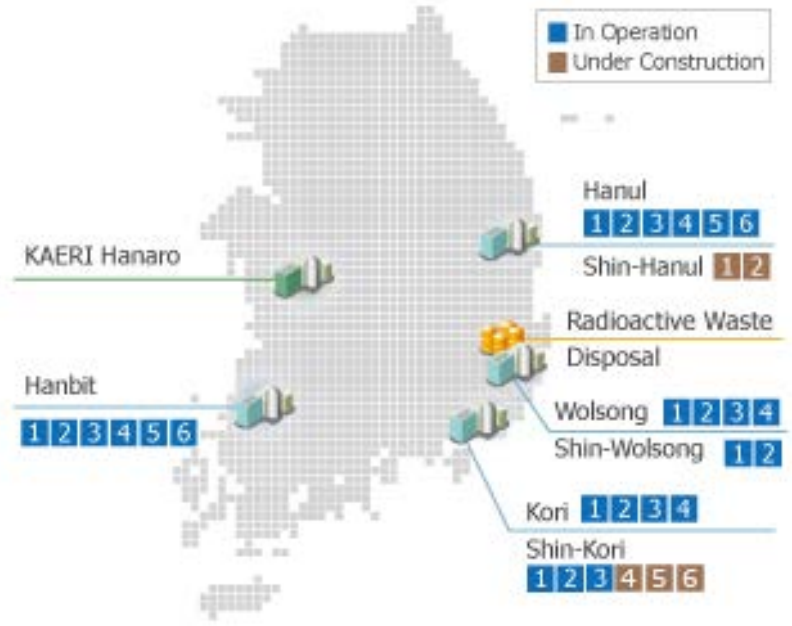
Youngkyun KIM

KINS 한국원자력안전기술원
KOREA INSTITUTE OF NUCLEAR SAFETY

Contents

1. Radiation Area Zoning of Korea NPPs

- **There are 30 commercial reactors in Korea. (October, 2018)**
  - 25 reactors in operation
  - 5 reactors under construction



Kori #2 (1983)	Kori #1 (1972)	Shin-Kori #3 (2015)
Zone 1	Zone 1	Zone 1
Zone 2	Zone 2	Zone 2
Zone 3	Zone 3	Zone 3
Zone 4	Zone 4	Zone 4
Zone 5	Zone 5	Zone 5
	Zone 6	Zone 6
		Zone 7
		Zone 8

- **Radiation Area Zoning is one of radiation protection programs.**
  - Radiation Area Zoning plays a **key role to** prevent radiation workers from over-exposure and keep the exposure **ALARA**.
  - It is improved from early 5 or 6 zones to recent 8 zones.

2. Comparison of Structures of Radiation Zones

- **3 Zones : CANDU (Wolsong #1, #2, #3, #4) (op. permit 1978-1999)**
  - Very different structures from radiation zones of PWR reactors
- **5 Zones (A type) : PWR (WH) (Kori #2 : op. permit 1983)**
- **5 Zones (B type) : PWR (Framatome) (Hanul #1,#2 : 1987, 1988)**
- **6 Zones (A type) : PWR (WH) (Kori #1 : operation permit 1972)**
- **6 Zones (B type) : PWR (CE) (operation permit 1984~1995)**
  - Kori #3,#4 , Hanbit #1,#2, Hanbit #3,#4
- **8 Zones : PWR (Korea) (2001 ~ 2018 current)**
  - Hanbit #5, #6, Hanul #5, #6, Shin-Kori #1, #2, #3 : in operation
  - Shin-Kori #4, #5, #6, Shin-Hanul #1, #2 : under construction

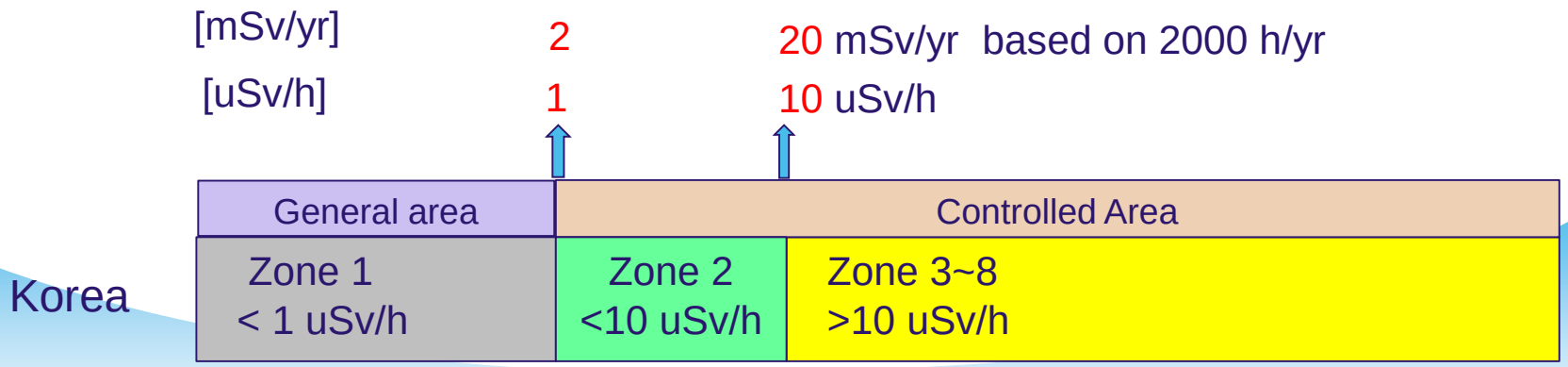
2. Comparison of Structures of Radiation Zones

- **Radiation Zone Structures are improved**
  - Recent structures are getting more complicated than the early
    - from early 5 or 6 zones to recent 8 zones
  - **Zone 1** upper dose is **lowered** into 0.001 mSv/h (= **1 uSv/h**)
  - High radiation zones (above 1 mSv/hr) are more classified

Operation permit	1983	'87~'88	1972	'84~'95	2001~
Zone Type [mSv/hr]	5 zones (A) max. level	5 zones (B) max. level	6 zones (A) max. level	6 zones (B) max. level	8 zones max. level
Zone 1	0.0025	0.0075	0.005	0.005	0.001
Zone 2	0.025	0.025	0.025	0.025	0.01
Zone 3	0.25	2	0.25	0.05	0.05
Zone 4	1	100	1	0.2	0.2
Zone 5	>1	>100	>1	1	1
Zone 6			>>1	>1	10
Zone 7					5000
Zone 8					>5000

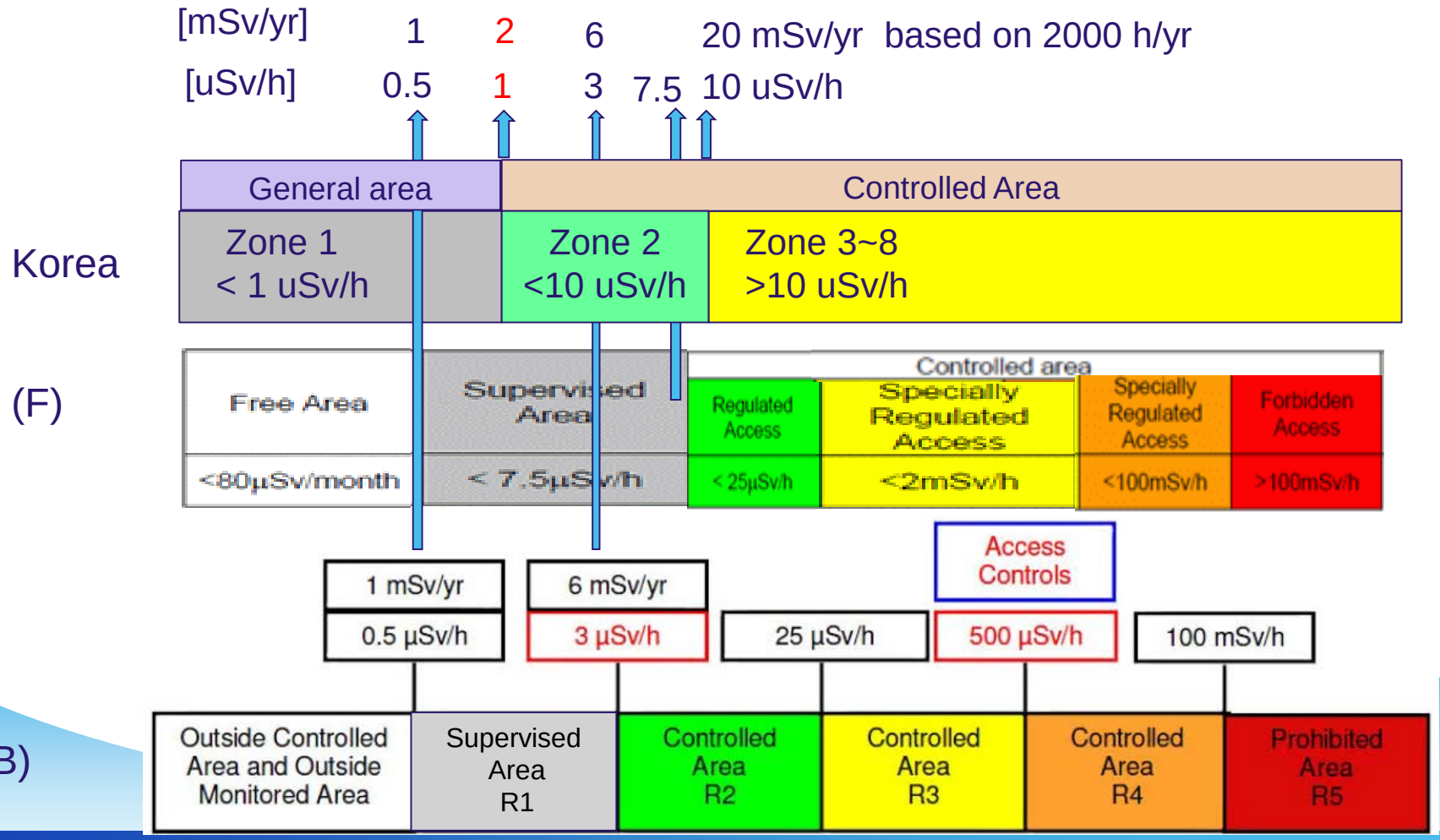
3. Bases of Upper Level of Radiation Zone 1 & 2

- **Zone 1 is called a general area. It is not a controlled area.**
  - Zone 1 is below 1 uSv/h (< 1 uSv/h)
- **From Zone 2 to Zone 8 are controlled areas (It is above 1 uSv/h)**
  - Zone 2 is between 1 uSv/h and 10 uSv/h (1 ~ 10 uSv/h)
- **Upper value of Zone 2 is 10 uSv/h.**
  - It is from ICRP-60 dose limit (annual averaged dose 20 mSv/yr)
    - 10 uSv/h = 20 mSv/yr divided by 40 hrs/week * 50 weeks/yr
- **Upper value of Zone 1 is 1 uSv/h.**
  - It is from 10 % of radiation workers dose limit.
    - 1 uSv/h = 10 uSv/h * 10% (or 2 mSv/yr = 20 mSv/yr * 10 %)



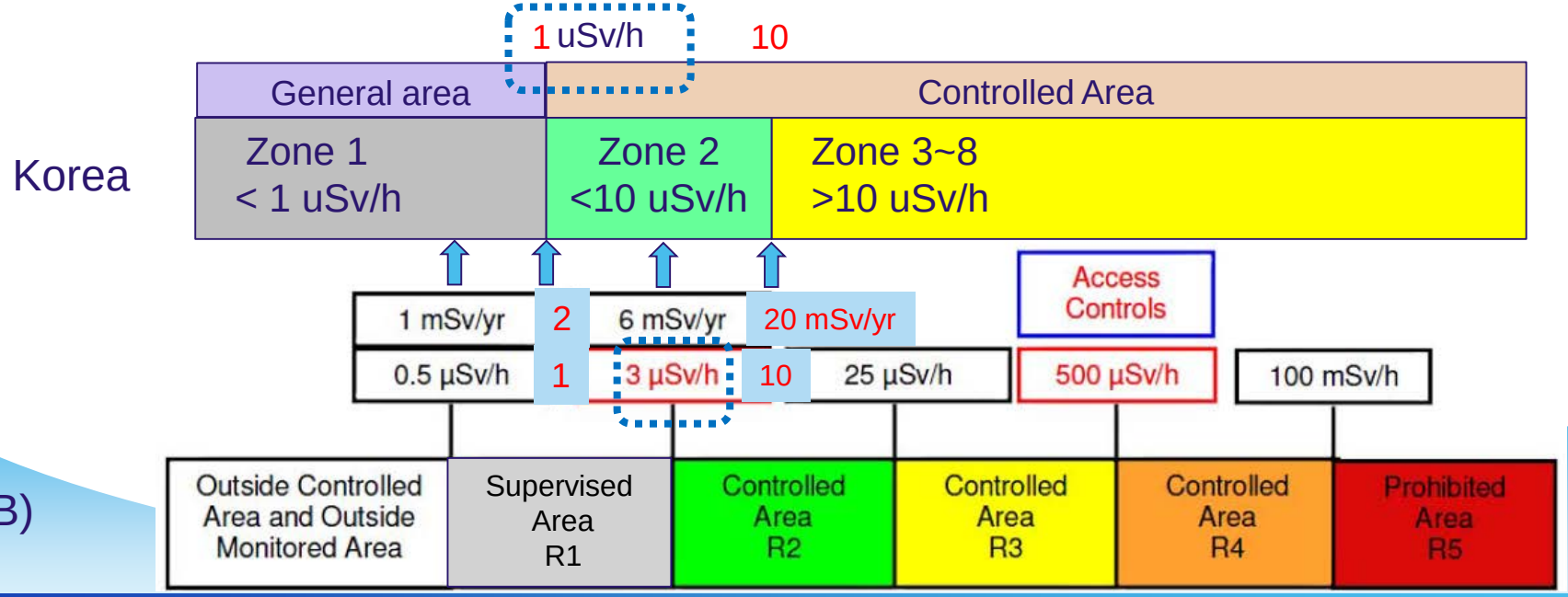
4. Comparison with NPPs of other countries

- **Minimum level of controlled area (Zone 2) of Korea NPPs is lower than other countries. Zone 2 of Korea NPPs starts from 1 uSv/hr, whereas Zone 2 of other countries starts from 3 or 7.5 uSv/hr.**



5. Comparison with Upper value of Zone 1

- **In Korea, Zone 1 is a general area, not a controlled areas.**
  - So, free entrance for NPP workers is allowed.
- **Controlled areas are from Zone 2 to Zone 8.**
  - So, the entrance for NPP workers should be controlled.
  - Decision of Lower value of Zone 2 (or Upper value of Zone 1) is important, because it is the criterion for controlled area.
- **By the way, there is no supervised area in Korea regulation.**



6. IAEA IRRS Recommendation on Supervised Area

- **IAEA IRRS(Integrated Regulatory Review Service) in December 2014 recommended that**
  - NSSC should introduce in the regulatory framework the **concept of the supervised areas** in addition to the controlled areas and ensure they are implemented consistent with GSR Part 3.
    - * NSSC is Nuclear Safety and Security Commission in charge of nuclear regulation in Korea.
- **Supervised Area in Requirement 24 of IAEA GSR Part 3**
  - Employers, registrants and licensees shall establish and maintain organizational, procedural and technical arrangements for the designation of **controlled areas** and **supervised areas**, for local rules and for monitoring of the workplace, in a radiation protection programme for occupational exposure.
  - 3.91. Registrants and licensees shall designate as a **supervised area** any area not already designated as a controlled area but for which occupational exposure conditions need to be kept under review, even though specific measures for protection and safety are not normally needed.
- **There is no numeric guide for supervised area in GSR Part 3.**
  - However, there is a numeric guide (30% rule) for supervised area that have commonly been set.

7. Numeric Guide for Supervised area

- **Paragraph 252 of ICRP 60**
  - The **dividing line** between controlled areas and supervised areas, if the latter are used, **has commonly been set** with the aim of ensuring that the doses to workers in the supervised areas can confidently be predicted to be less than **3/10 of the occupational dose limits**. The Commission now regards **this definition** as being **too arbitrary**
  - and recommends that the **designation** of controlled and supervised areas **should be decided** either at the design stage or locally by the operating management **on the basis of operational experience and judgement**. This judgement has to take account of the expected level and the likely variations of the doses and intakes, and the potential for accidents.
- **30 % rule for dividing line between controlled & supervised areas**
  - **Although** it is **too arbitrary** according to ICRP 60,
  - As it is not easy to consider operational experience & judgement,
  - 30 % rule is **still useful** for cases of designating **supervised areas**.
  - So, 30 % rule is **still implemented** and applied in NPP design stages.

8. Impacts on the introduction of supervised areas

- **To implement IAEA IRRS recommendation on supervised areas,**
  - The concepts of **supervised areas** will be introduced to the **regulatory framework** of Korea sooner or later.
- **At the time of introduction of supervised areas,**
  - **(1) In case of its implementation according to IAEA GSR Part 3**,
    - According to IAEA GSR Part 3, supervised areas don't demand strict numerical dividing with controlled areas, but demand that occupational exposure conditions need to be kept under review.
    - Zone 1 can be designated as supervised areas with additional survey activities.
    - In these cases, it is expected that there will be **no significant impacts** on the structure of radiation area zones.
  - **(2) In case of numerical regulation such as 30 % rule**,
    - Most of Zone 1 meet this regulation and Zone 1 can be designated as supervised areas with additional survey activities.
    - For a few NPPs that don't meet this regulation, restructure of Zone 1 will be necessary
    - So, **some impacts** can exist due to Zone 1 restructure for a few NPPs.

9. Conclusion

- **Radiation Area Zoning is a key role to ALARA in NPPs.**
  - It has been improved from early 5 or 6 zones to recent 8 zones.
  - Upper value (1 uSv/h) of Zone 1 of Korea NPPs is low enough to keep occupational exposure ALARA.

- **According to IAEA IRRS recommendation on supervised areas,**
  - The concepts of supervised areas will be introduced to regulatory framework sooner or later.
  - It is expected that impacts of supervised areas on Korea NPPs will be no significant or only a little to a few NPPs.
  - However, it is expected that impacts of supervised areas (if in case of numerical regulation such as 30 % rule) on other areas such as medical field, or industrial field where RI/RG are utilized, may not be small, because additional radiation area zoning will be necessary to them.
- **In summary, it could be concluded that Radiation Area Zoning has been effective and contributed to radiation protection for radiation workers in Korea NPPs.**

Thank you for your attention.