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# Analysis on Radiation Exposure Dose of Radiation Workers in NPPs of Korea based on ISOE and KISOE Databases



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# 1. Commercial Nuclear Reactors in Korea

Date : October, 2018

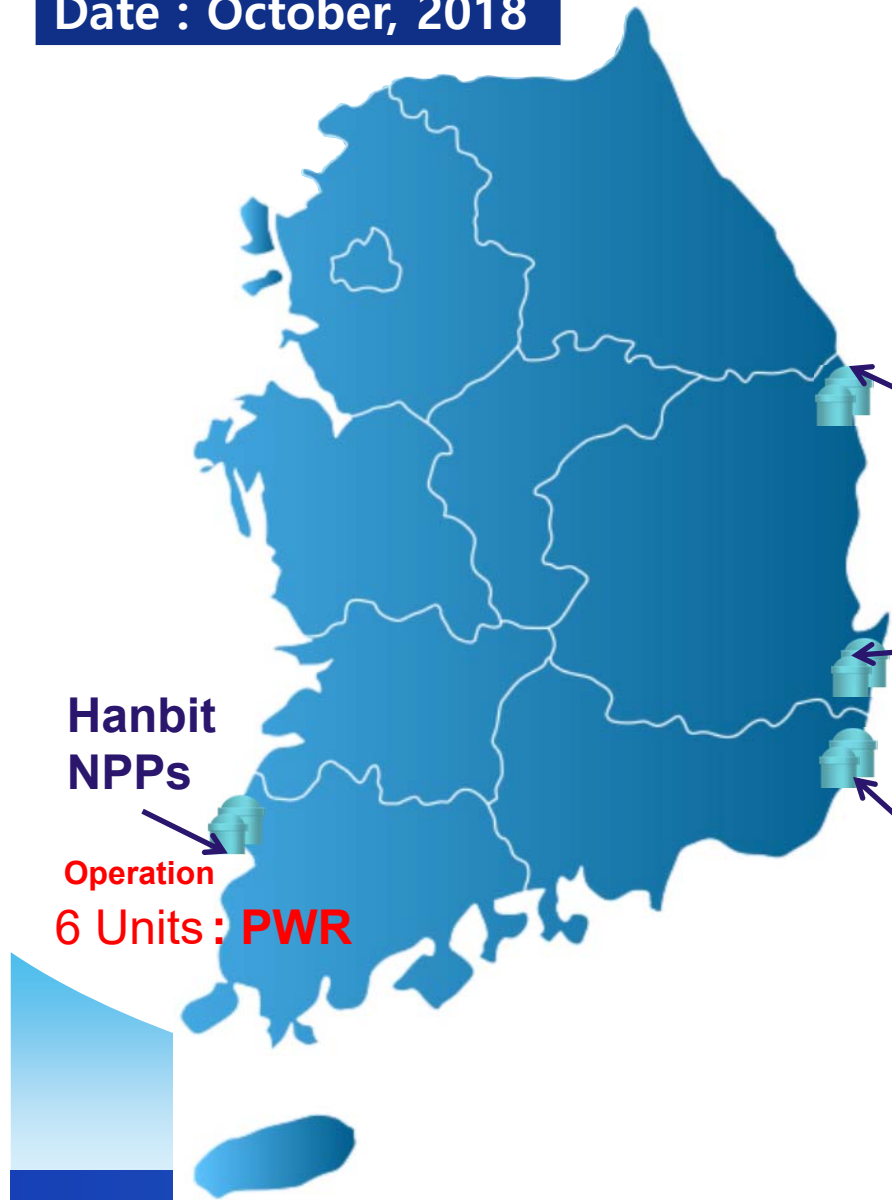
Commercial	Operation	Construction	Shutdown
30 Reactors	23	5	2

June 19, 2017 : Kori #1 (1st PWR) in shutdown

June 15, 2018 : Shutdown decision for

Wolsong #1 (1st CANDU)

June 15, 2018 : Plan for 4 New Units canceled.



**Hanbit NPPs**

Operation  
6 Units : PWR

**Hanul NPPs**

**8 Units : PWR**

Operation Construction  
6 Units 2 Units

**Wolsong NPPs**

**2 Units : PWR**

Operation Shutdown  
Permanent  
5 Units 1 Unit

**4 Units : CANDU**  
\* 1st CANDU : Shutdown (Wolsong #1)

**Kori NPPs**

**10 Units : PWR**

Operation Construction  
6 Units 3 Units  
Permanent Shutdown 1 Unit

\* 1st PWR : Shutdown (Kori #1)

## 2. Brief Introduction of ISOE & KISOE

### ISOE Database

#### **Establishment and Operation of KISOE**

- Information System on Occupational Exposure (ISOE)
- Established in 1992 by OECD/NEA and IAEA
- Exchange of information, data and experience on the optimization of ORP in the operation of NPPs, and for the compilation and analysis of the information, data and experience collected

### KISOE Database

#### **Establishment and Operation of KISOE**

- Korea Information System on Occupational Exposure (KISOE) in KINS, Korea
- Developed in 2002 ~ 2004 & Operated since 2005
- Evaluate Trends in Occupational Radiation Exposure to Assess Radiation Protection Programs (RPP) in Korea By using National Dose Registry

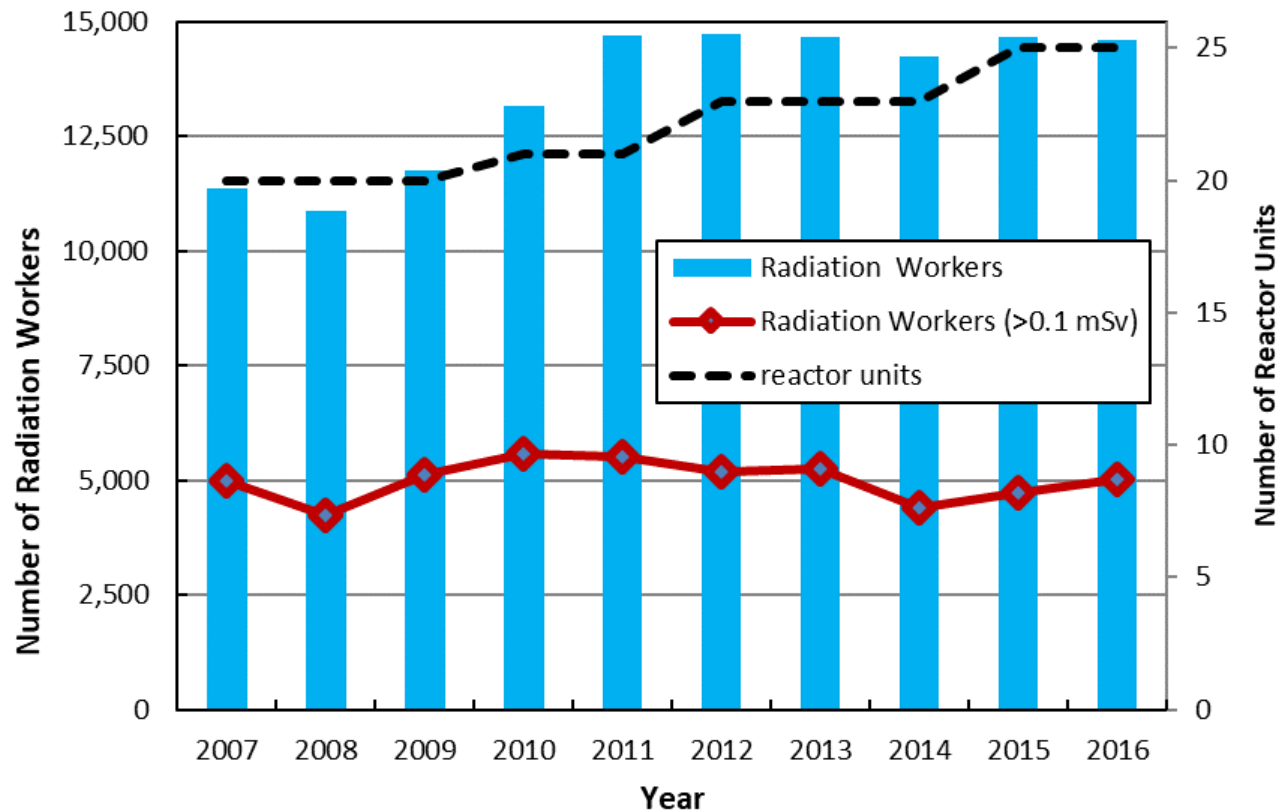
### This Presentation

#### **Analysis for NPPs based on ISOE & KISOE**

- In this presentation, analyses on occupational exposure of radiation workers in Korea NPPs are summarized for recent years.

### 3. Radiation Workers in Korea NPPs

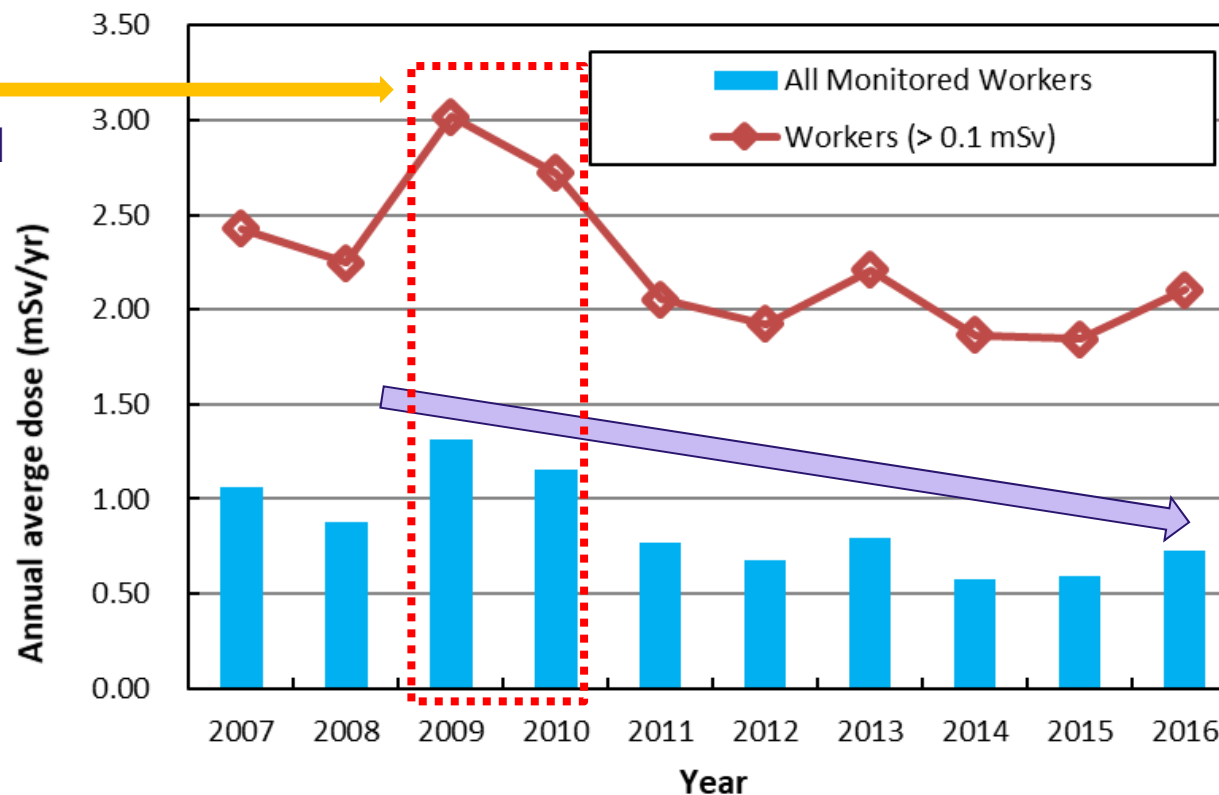
- Radiation Workers monitored in Korea NPPs are around 15000.
- Radiation Workers (dose > 0.1 mSv) are around 5000.
  - As reactor units increased, monitored workers increased. However, workers (>0.1 mSv) didn't increase, but was kept same for 10 years.



## 4. Annual Average Dose in Korea NPPs

- **Annual average dose for all radiation workers (monitored dose)**
  - 2007: around 1 mSv → Decrease below 1 mSv → 2016: around 0.7 mSv
- **Annual average dose for workers (> 0.1 mSv : measurable dose)**
  - 2007: around 2.5 mSv → continue to decrease → 2016: around 2 mSv
  - Measurable dose (>0.1 mSv) is 2~3 times Monitored dose (>0 mSv)

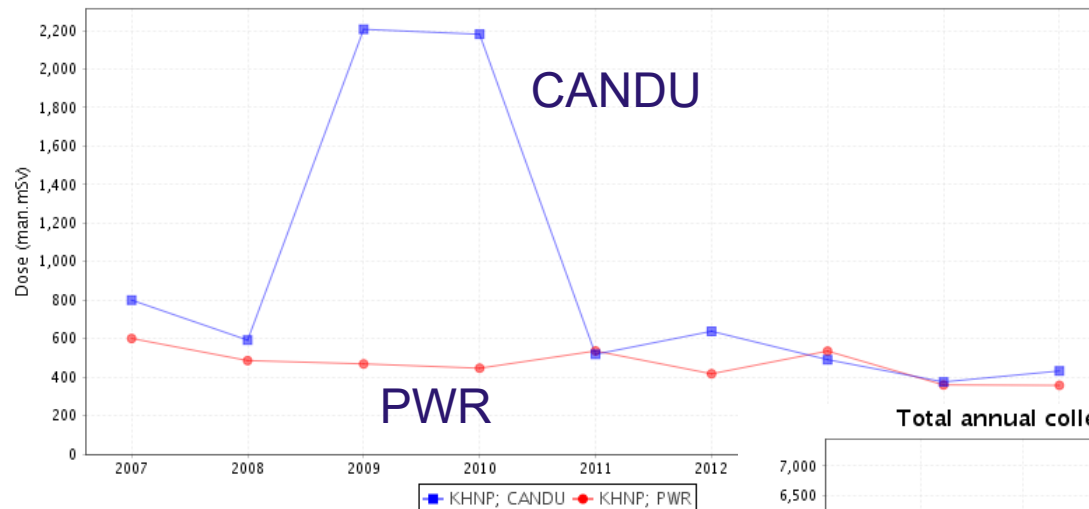
Dose increased  
due to Wolsong #1  
(1st CANDU)  
Refurbishment



# 4-1. CANDU vs. PWR in Korea

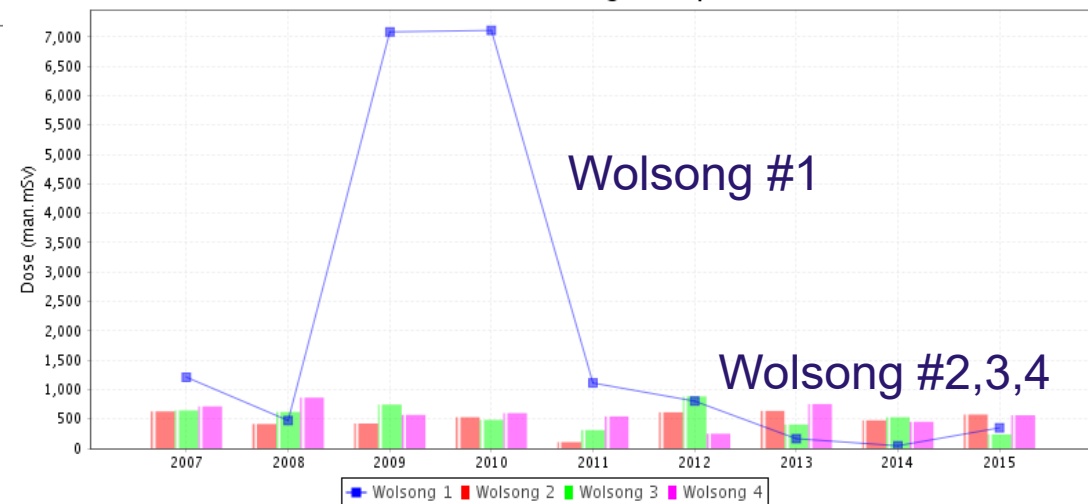
- This graph shows Trends of CANDU and PWR in Korea.
- CANDU dose is high in 2009 and 2010
  - due to Wolsong #1 (1st CANDU) Refurbishment

KHNP average annual collective dose per reactor by reactor type



#U-40

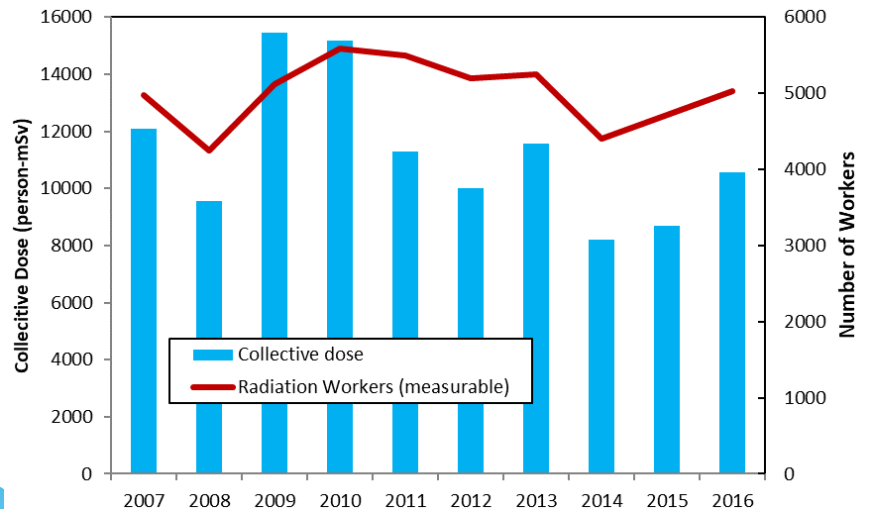
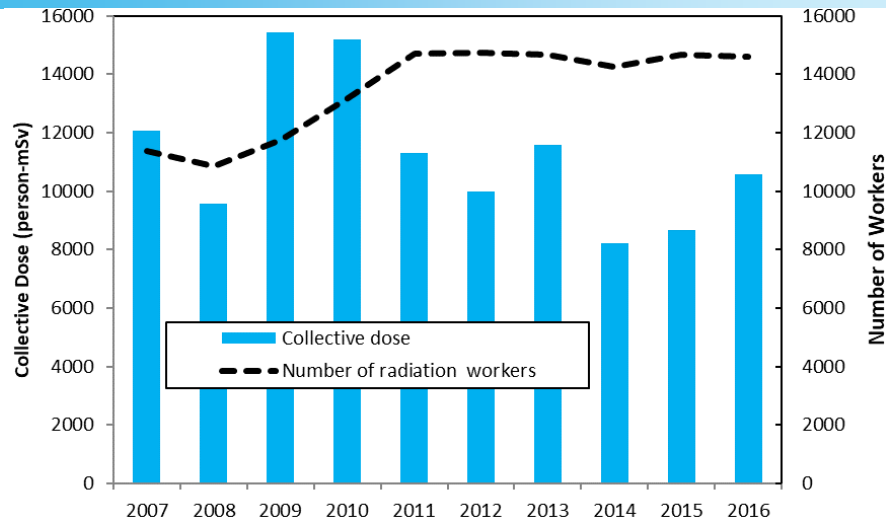
Total annual collective dose for Wolsong 1 compared with other units



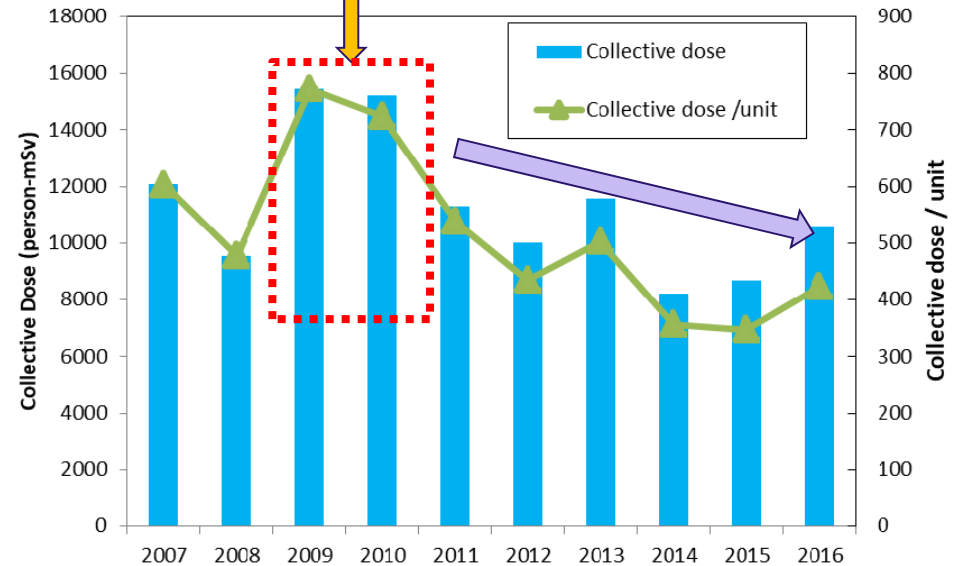
#U-01

Source: ISOE

# 5. Collective Dose in Korea NPPs



## Wolsong #1 Refurbishment



- Collective dose is now around 10,000 person-mSv
- Collective doses continued to decrease except the Wolsong #1 Refurbishment.
- (Collective dose/unit) is now around 500 person-mSv/ unit.

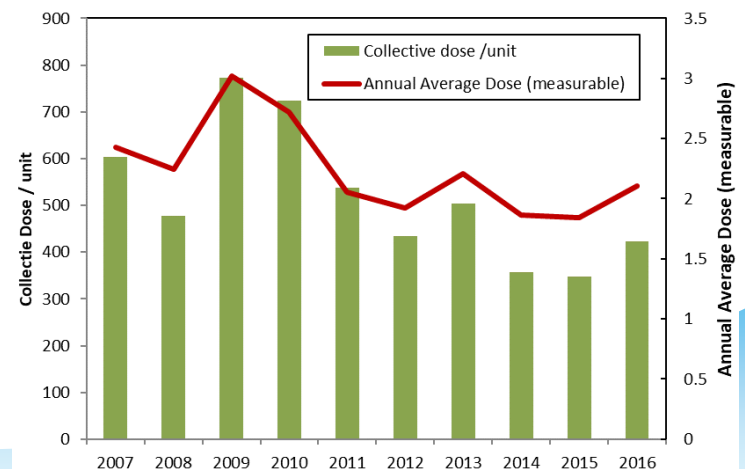
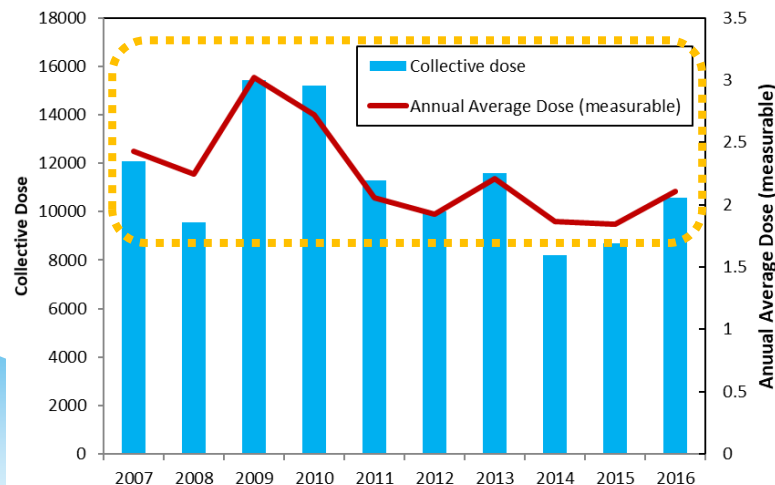
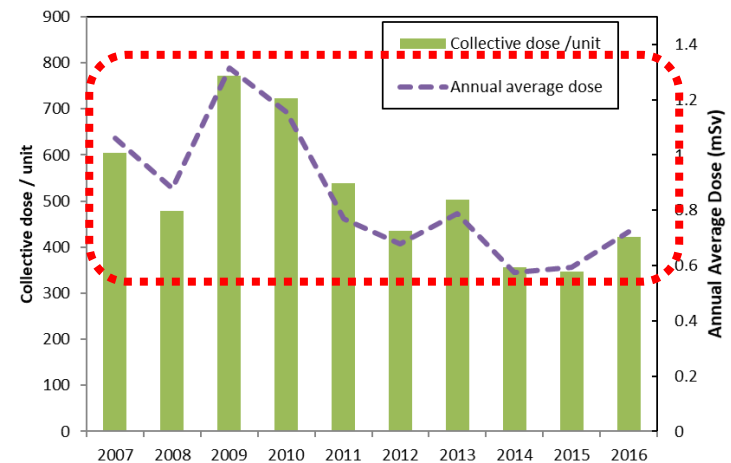
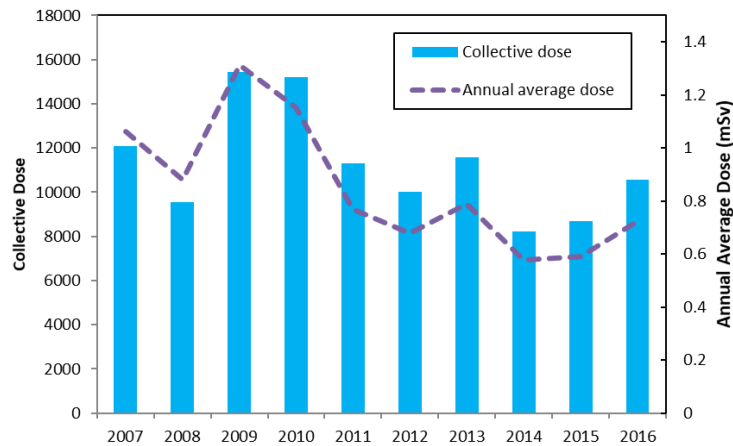
(Radiation Workers of measurable dose) follow trend on collective dose better than total radiation workers. → So, correlation of (workers of measurable dose) seems better than total workers. → They can estimate very roughly trend of each other ?



# 5-1. Collective Dose vs. Individual Average Dose

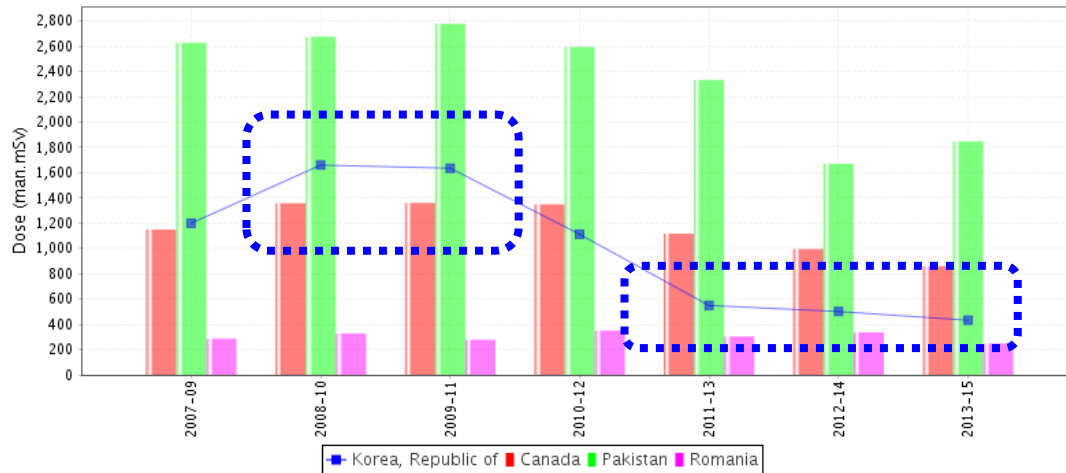
In the graph (Collective dose/unit vs. Individual Average dose), (collective dose / unit) follows trend on annual average dose better than the others.

- Correlation (collective dose / unit VS. average dose) very good → Trend Estimator?
- Correlation (collective dose VS. measurable dose) good → Trend Estimator?



## 5-2. Comparison with other countries

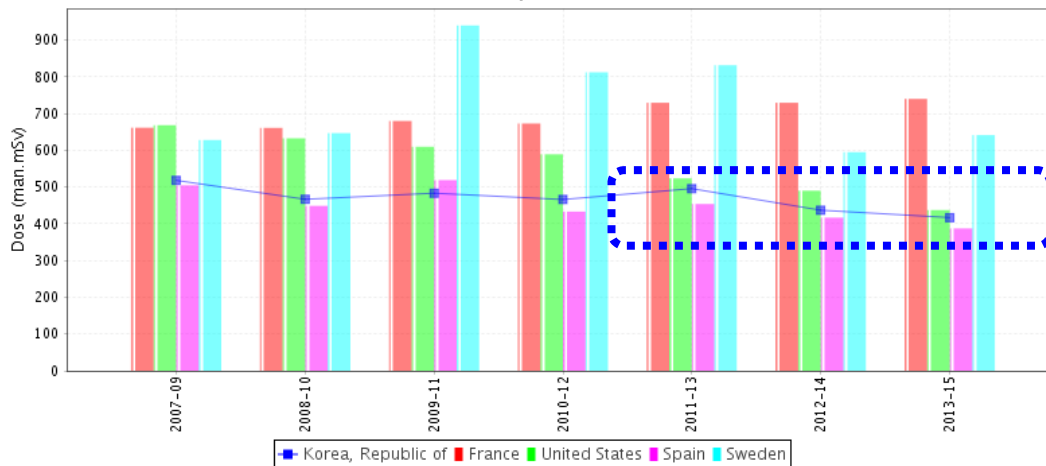
CANDU-Year rolling average collective dose per reactor for Korea compared with other countries for Republic of



#6-fy

Source: ISOE

PWR-Year rolling average collective dose per reactor for Korea compared with other countries for Republic of



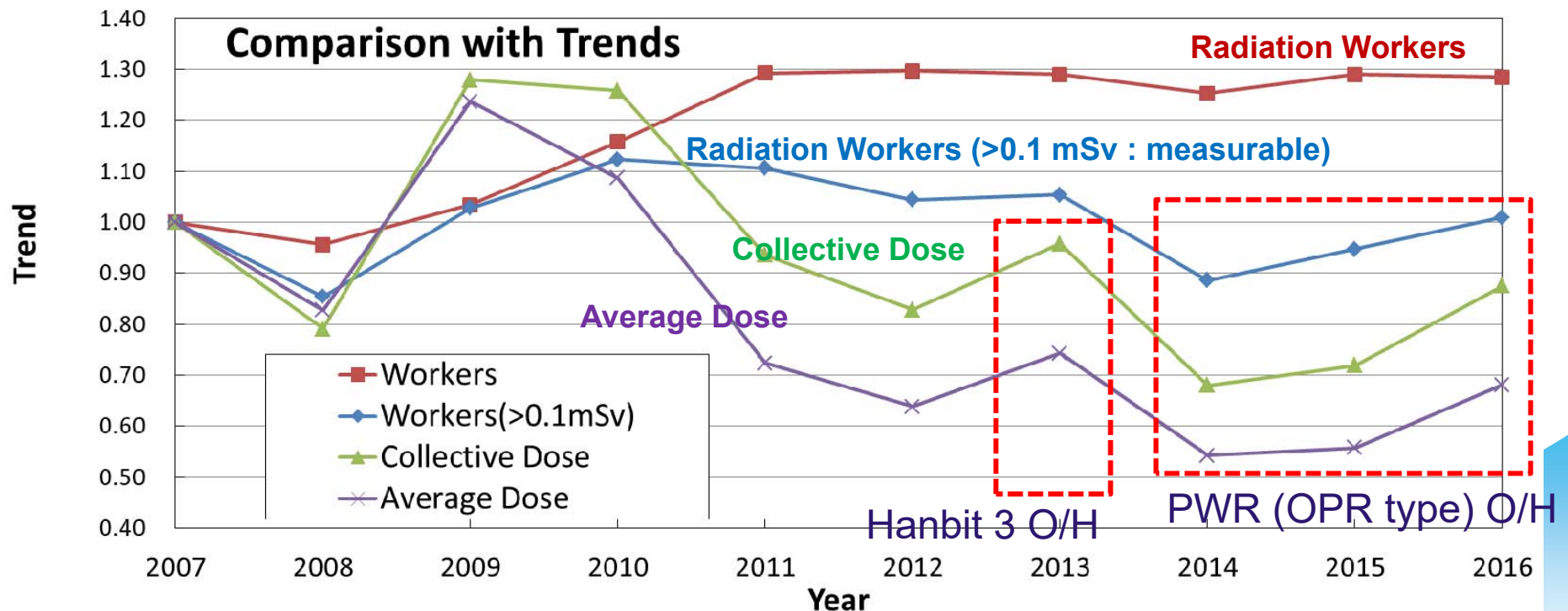
#6-fy

Source: ISOE

- Assume as in previous slide that (collective dose / unit) set as Trend Estimator for (individual average dose)
- CANDU : Doses was High During Wolsong #1 Refurbishment
  - Recently, Doses are in a lower group compared with other countries
- PWR : Doses are similar to Spain for many years.
  - Recently, doses are similar to US, too.

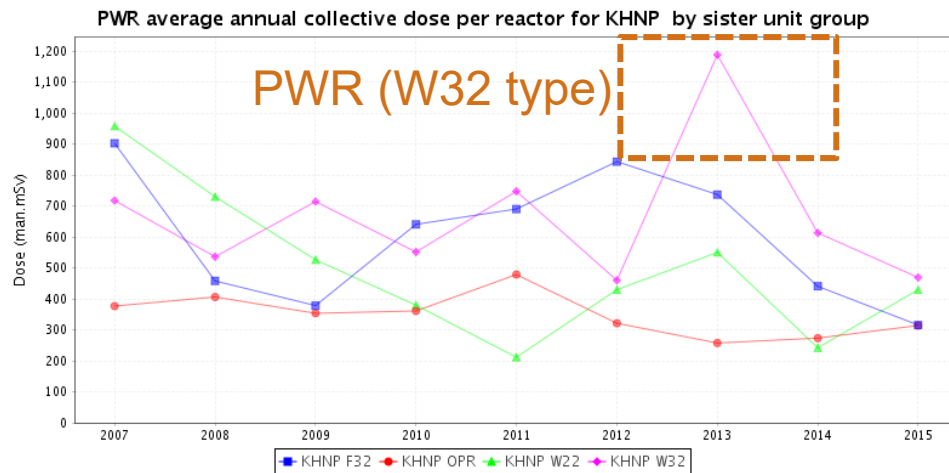
## 6. Overall Analysis on radiation protection program

- Number of Radiation Workers has been constant since 2011.
  - Radiation workers (>0.1 mSv) slightly decreased since 2011.
  - Collective dose and individual average dose decreased, too.
    - Average dose decreased more than collective dose.
  - Recently, radiation workers (>0.1 mSv), collective dose and average dose tends to increase. It may be due to extended O/H activities.



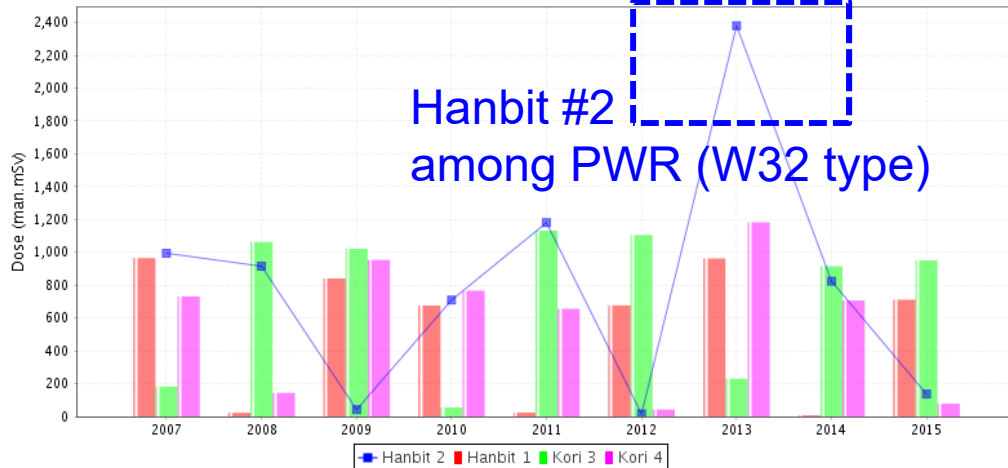
# 6.1 Analysis of Increment of Collective Dose

- Increment in 2013 is due to Hanbit #2 OH
- Increment in 2015 is due to many PWR (OPR type) OH activities



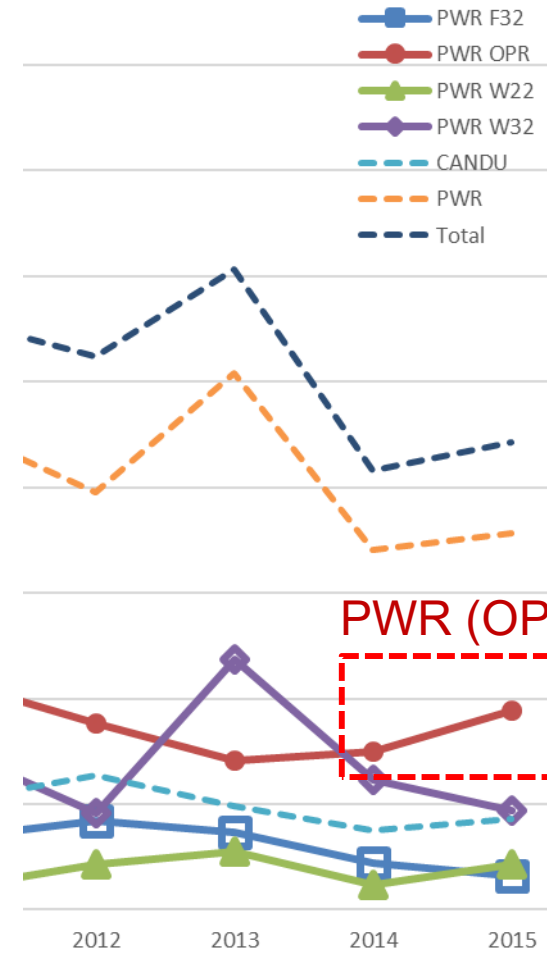
#U-72 Source: ISOE

Total annual collective dose for Hanbit 2 compared with other units in its sister unit group



#U-20

Source: ISOE



## 7. Conclusion

- **Analyses on Occupational Exposure of Radiation Workers in Korea NPPs were performed.**
  - By using **KISOE database** for Korea NPPs and **ISOE database** for other countries and similar NPP types.
- **Based on the analyses, it is implied that radiation protection programs for Korea NPPs have been continuously improved.**
  - Number of Radiation Workers has been constant since 2011.
    - Number of Radiation Workers (>0.1 mSv) has been constant for 10 years.
  - Collective dose generally continuously decreased.
    - Annual Average dose decreased more than collective dose.
  - However, Recently, Doses tend to increase due to strengthened and extended OH activities.
- **It is useful to perform analyses on occupational exposure by ISOE and KISOE databases,**
  - To get insight over the status of occupational exposure
  - To review the radiation protection programs implemented in NPPs



**Thank you for your attention.**