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Analysis on Occupational Exposure of Radiation Workers in Korea based on KISOE Database (2005~2014)

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Byeongsoo KIM

한국원자력안전기술원
KOREA INSTITUTE OF NUCLEAR SAFETY

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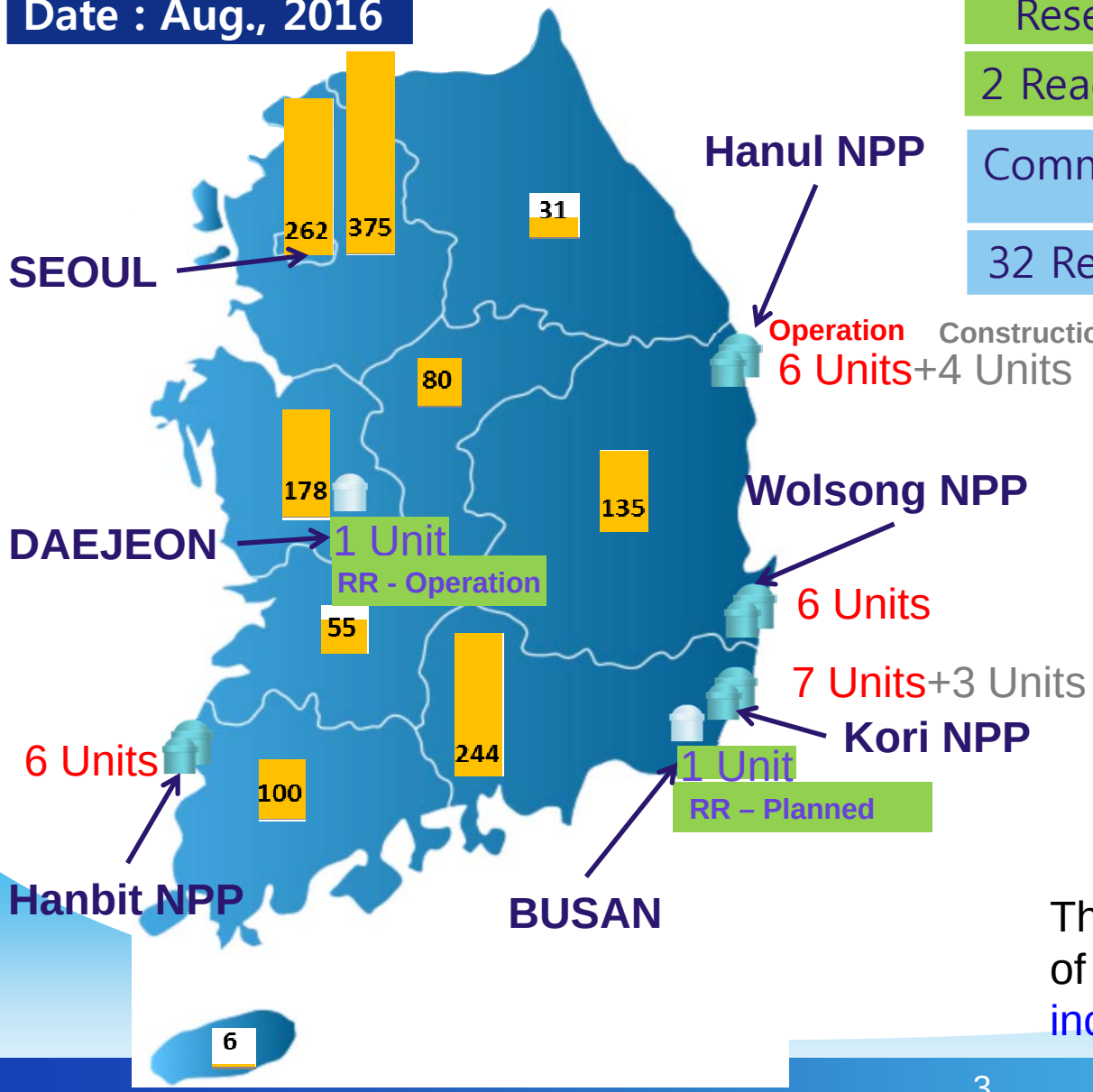
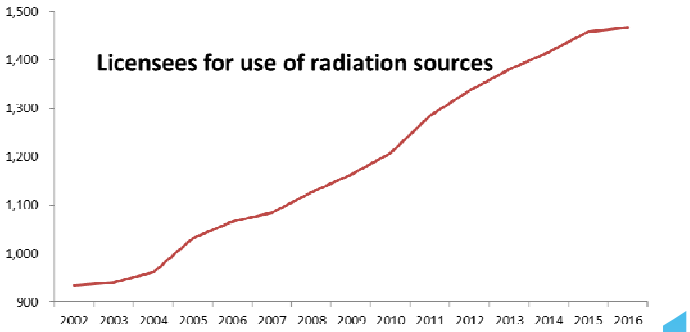
1. Nuclear Reactors & Licensees of Radiation Sources in Korea

Date : Aug., 2016



Research	Operation	Planned
2 Reactors	1	1
Commercial	**Operation**	**Construction (or planned)**
32 Reactors	25	7

Licensees for Use of	Total Facilities
Radiation Sources	1466



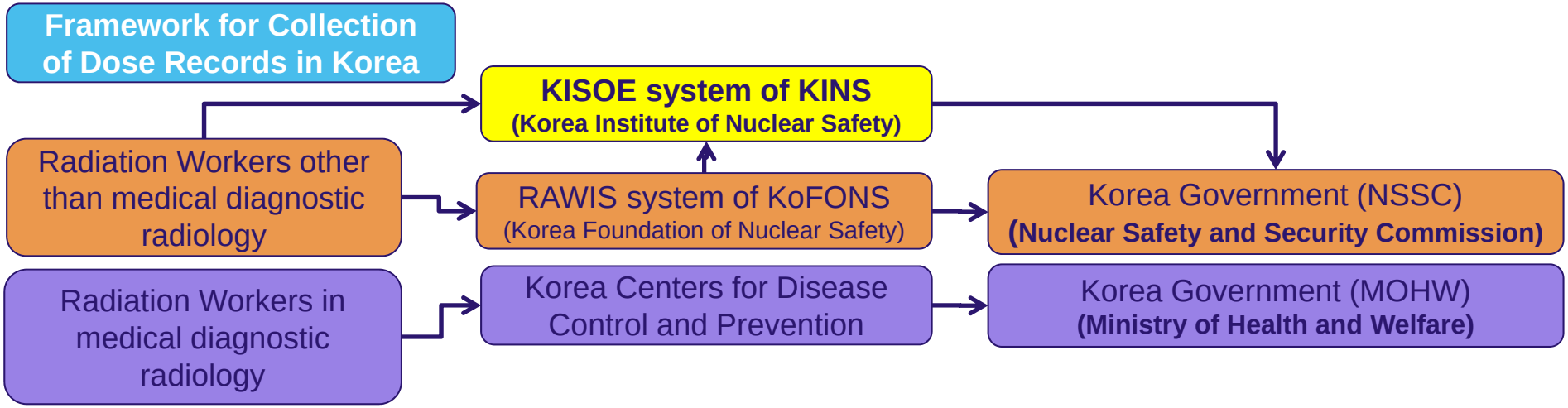
The number of licensees for use of radiation sources in Korea is increasing gradually every year.

2. Brief Introduction of KISOE

KISOE Database

Establishment and Operation of KISOE

- Korea Information System on Occupational Exposure (KISOE) in KINS
- Developed in 2002 ~ 2004 & Operated since 2005
- Collect Exposure Doses and Evaluation of Trends in Occupational Radiation Exposure to Assess Radiation Protection Programs (RPP) in Korea



This Presentation

Analysis for 10 years based on KISOE database

- In this presentation, analyses on occupational exposure in Korea are summarized for 10 years from 2005 to 2014.

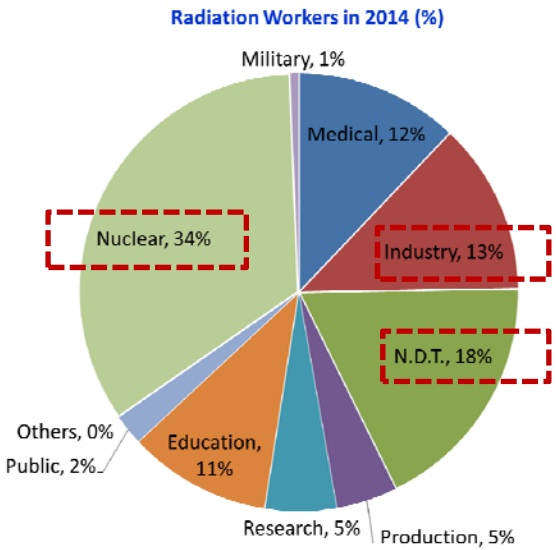
3. Radiation Workers in Korea (2005~2014)

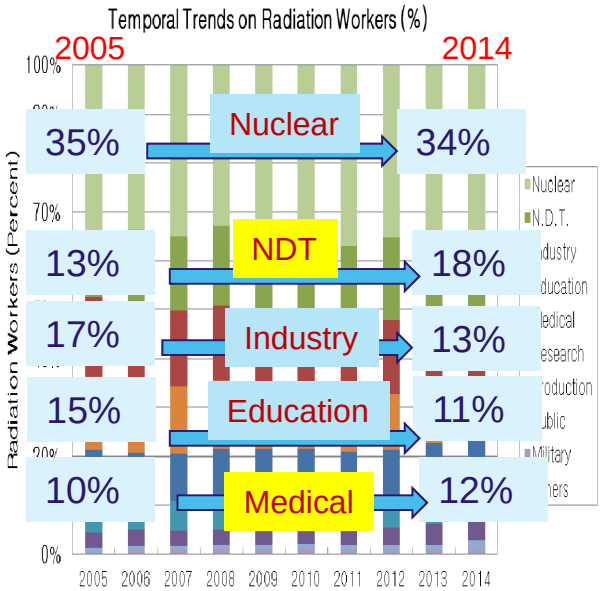
- **Radiation workers work for Licensees that are classified into 10 types.**

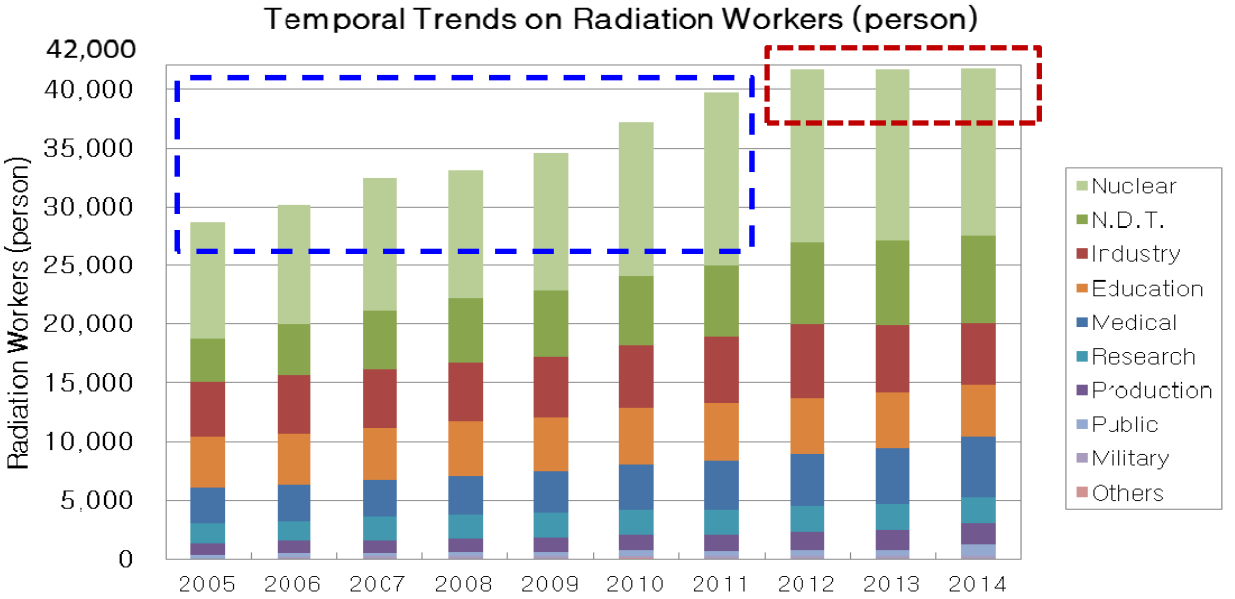
Top1 ▪ **Nuclear energy**
Top2 ▪ **Non-Destructive Testing (NDT)**
Top3 ▪ **General industry**

- Education institute
- Medical Use
- Research institute
- R.I. Production and distribution
- Public institute
- Military activity
- Others

- **Number of Radiation Workers**
  - Until 2012, increased about 5% annually.
  - After 2013, however, remained steady.

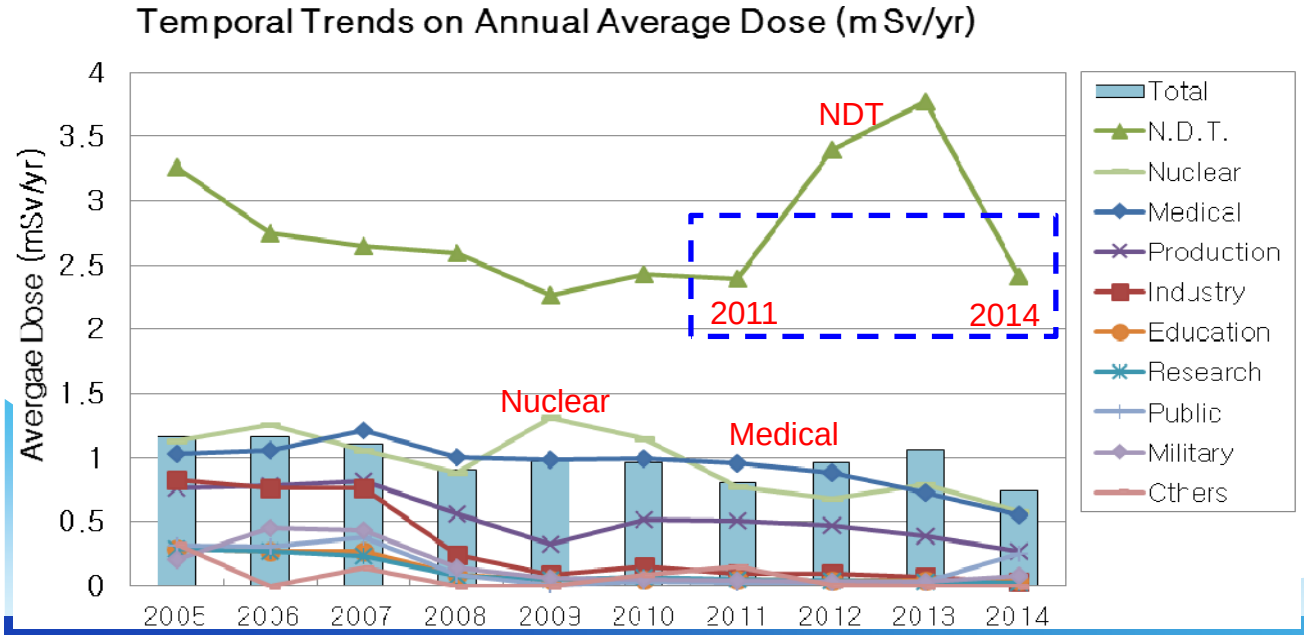


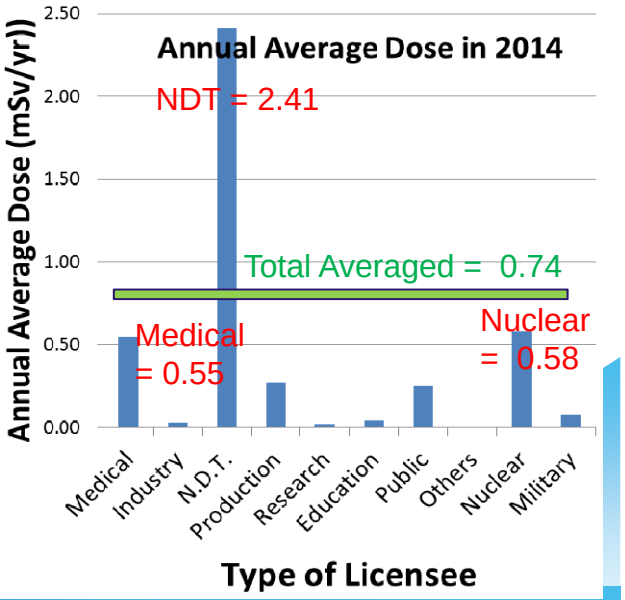




4. Annual Average Dose (2005 ~ 2014)

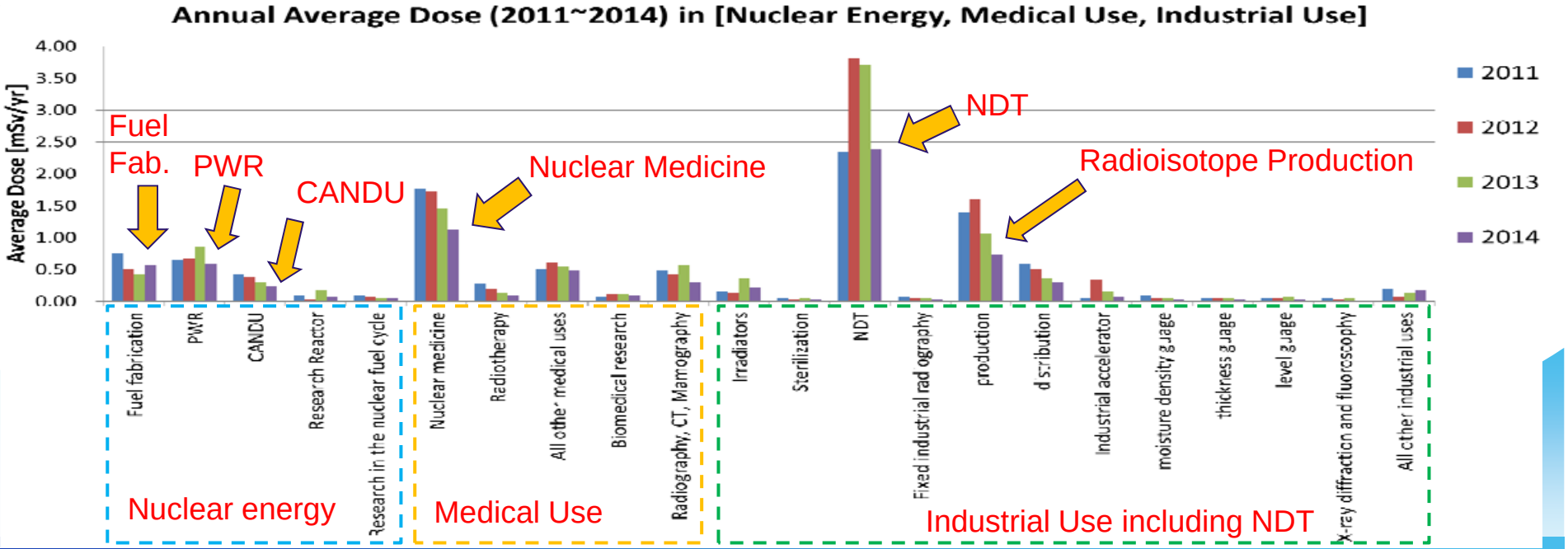
- **Top 3 (2014) : NDT >> Nuclear ≒ Medical**
  - The HIGHEST average dose is from NDT.
    - NDT during 2005 ~ 2014 is in the range of 2.26~3.77 mSv/yr.
    - NDT is 2~4 times higher than Total Averaged dose. (0.74~1.16 mSv/yr)
    - NDT doses increased VERY HIGH in 2012 & 2013. (3.40 ~ 3.77 mSv/yr)
    - In 2014, NDT doses decreased into the previous 2011 level. (2.41 mSv/y)
- **Nuclear energy & Medical use are around the Total Averaged dose.**
  - Trends between Nuclear Energy and Medical Use are similar.



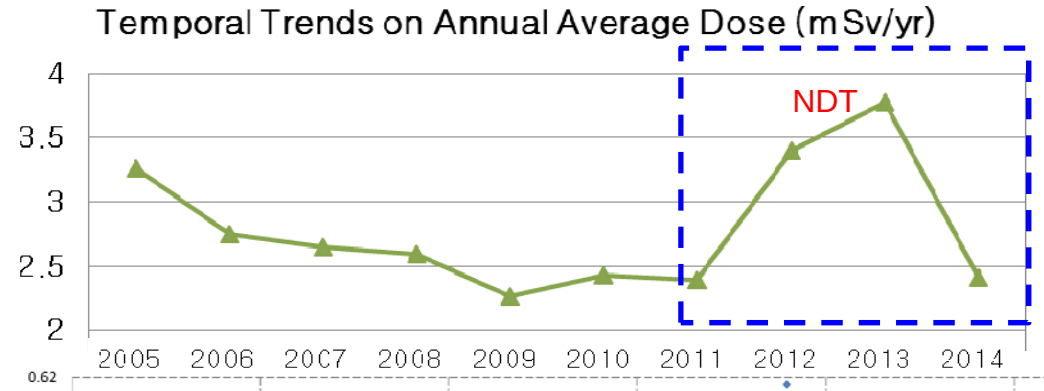


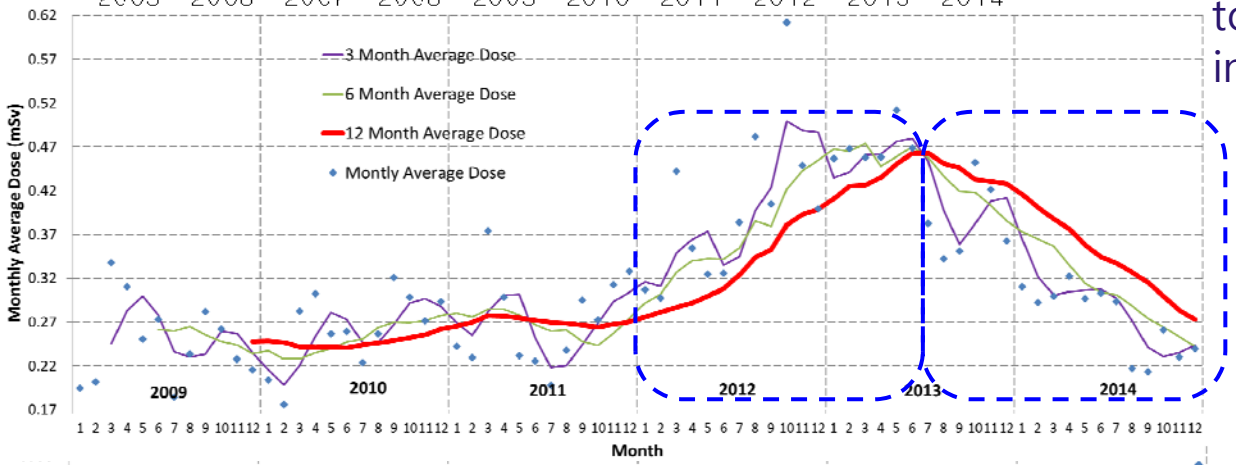
4.1 Detailed Annual Average Dose (2011~2014)

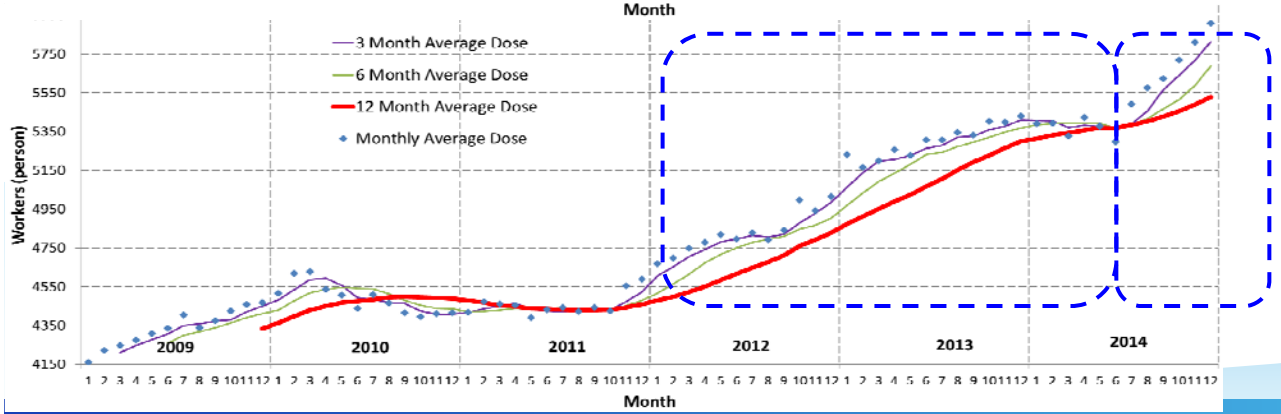
- **Higher than 1 mSv/yr during (2011 ~ 2014)**
  - Nuclear Medicine : the highest dose in Medical Use area.
  - NDT : the highest dose in Industrial Use area
  - RI. Production : the 2nd highest dose in Industrial Use area
- **Nuclear energy areas are Not HIGHER than 1 mSv/yr (2011~2014)**
  - PWR and Fuel fabrication is above 0.5 mSv/yr
  - CANDU is below 0.5 mSv/yr



4.2 Trends on NDT by using Moving Average



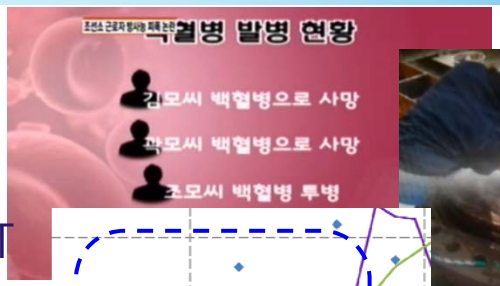


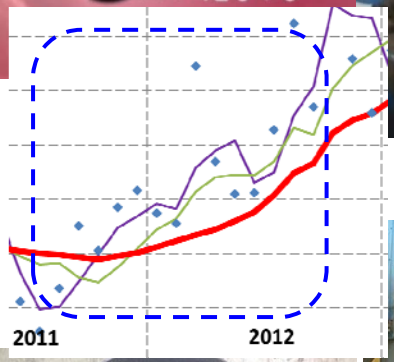


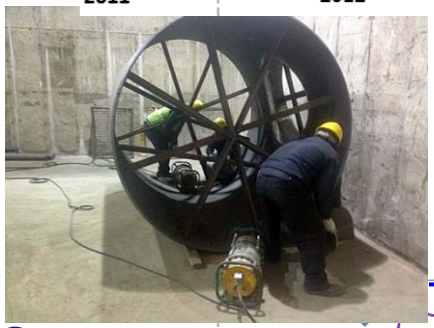
- Annual Average Dose for NDT (Radiographic Testing)
  - increased very high (2012~2013)
  - Decreased in 2014
  - Additional analyses by using Moving Averages which are useful to identify overall trends without interruption of data fluctuations.
    - This is Moving average trends of monthly doses.
    - In the end of 2011, trends began to increase until Mid-2013.
    - However, since Mid-2013, trends began to decrease.
    - Numbers of monthly NDT workers began to increase in the end of 2011 ~ 2013.
    - Workers increased faster in 2014.

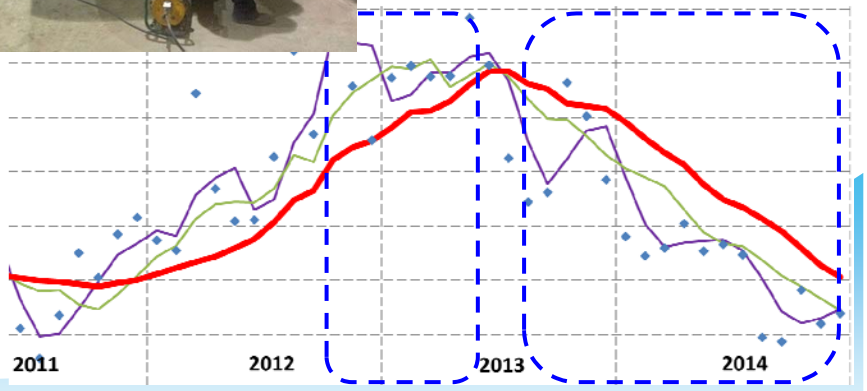
4.3 Reasons of increment and decrement in NDT

- **Over-exposure and Death of 3 NDT workers (Mid 2011 ~ 2012)**
  - The accidents were broadcasted by the public news and many NDT Workers got to know radiation risks REALLY.
- **Dose began to increase in end-2011.**
- **Strong enforcements to enhance RPP of NDT by regulatory body**
  - Thorough compliances of Radiation protection programs (RPP), Improvement of RT room where NDT activities are done
- **Increasing and Decreasing of Doses**
  - Doses kept increasing, as RPP began to be applied strongly.
  - Began to decrease, as RPP were settled down and safety facilities such as RT rooms were enhanced.



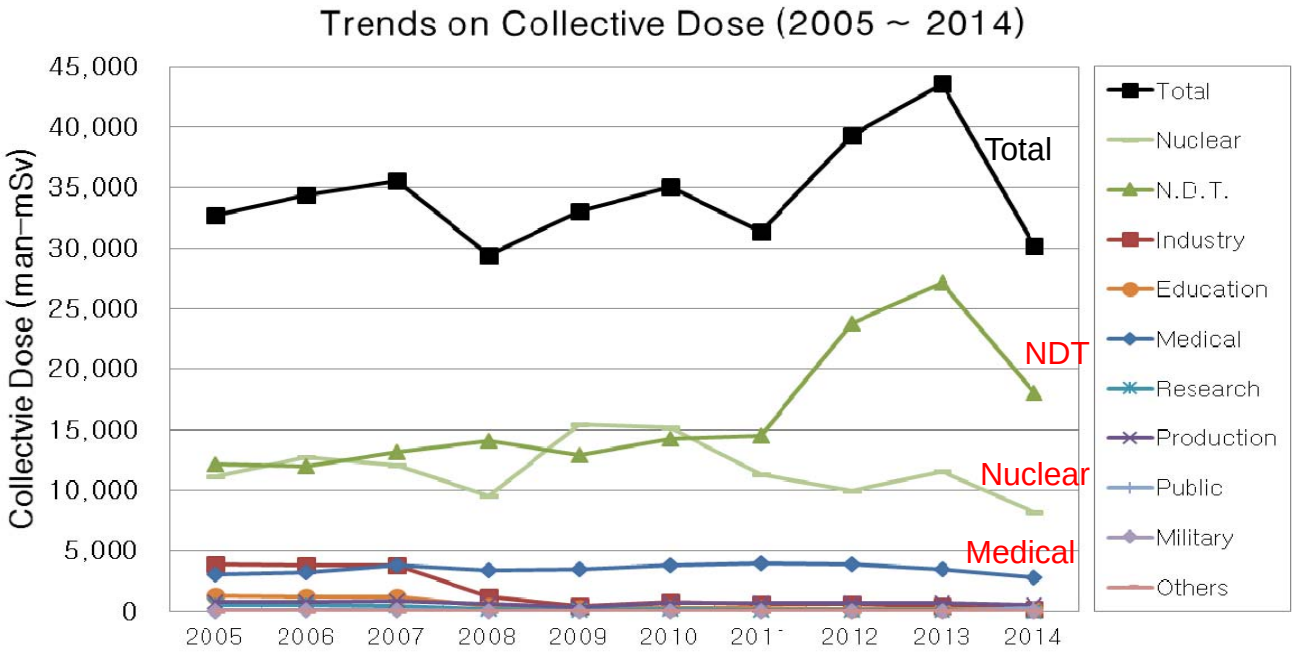


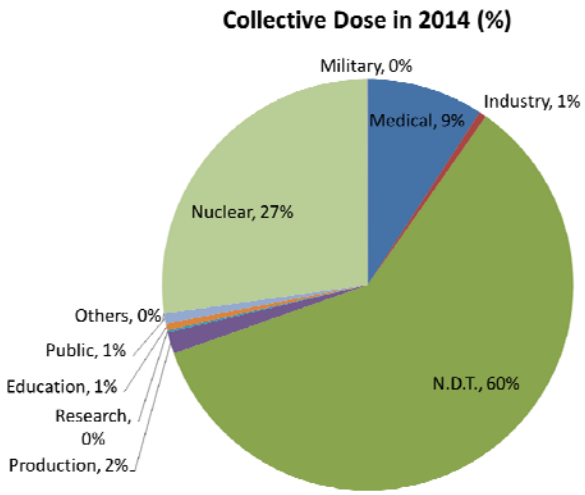




5. Trends on Collective Dose (2005 ~ 2014)

- **Top 3 (2014) (NDT > Nuclear Energy > Medical Use) constitute the most part of collective dose (about ~96%).**
  - Many Workers in the above Top 3 (18%, 34% & 12%, respectivley).
  - Higher Annual average doses (2.41, 0.58 & 0.55 mSv/yr, respectively) than other types of licensees.

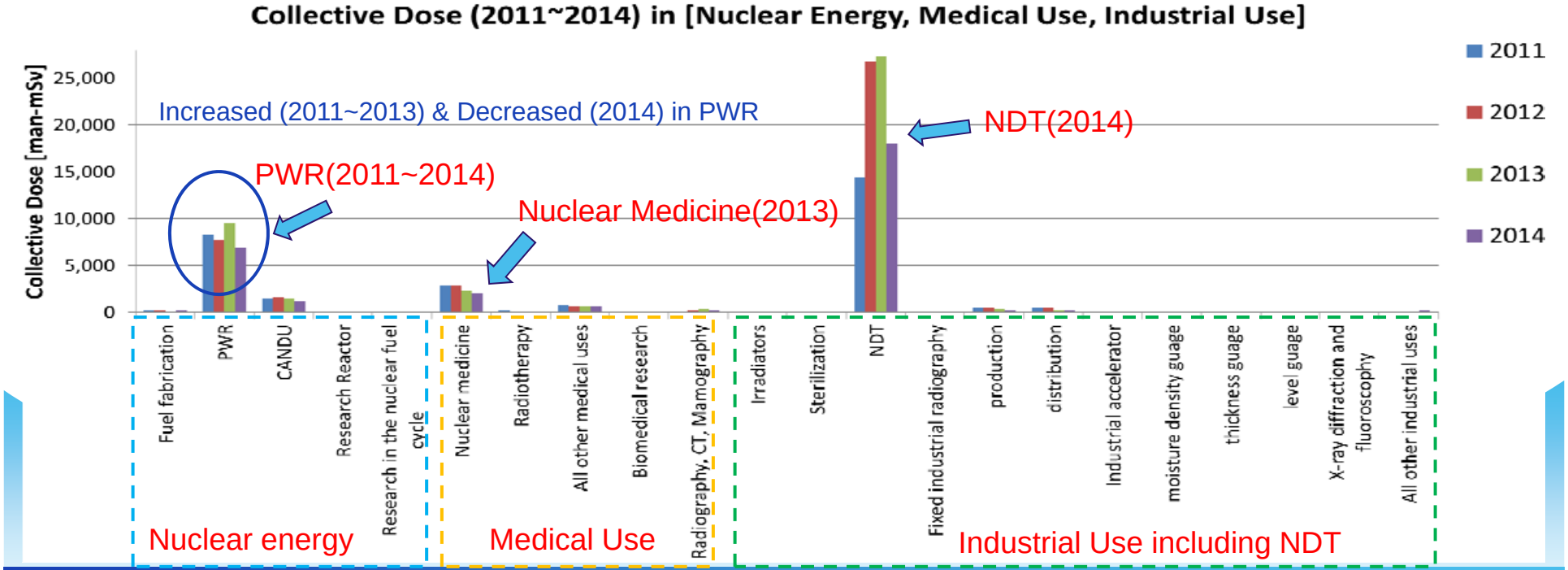




- **Collective doses of other types of licensees are very small (below 5%) due to the low annual average doses (<0.3mSv), although workers are not a few (~36%).**

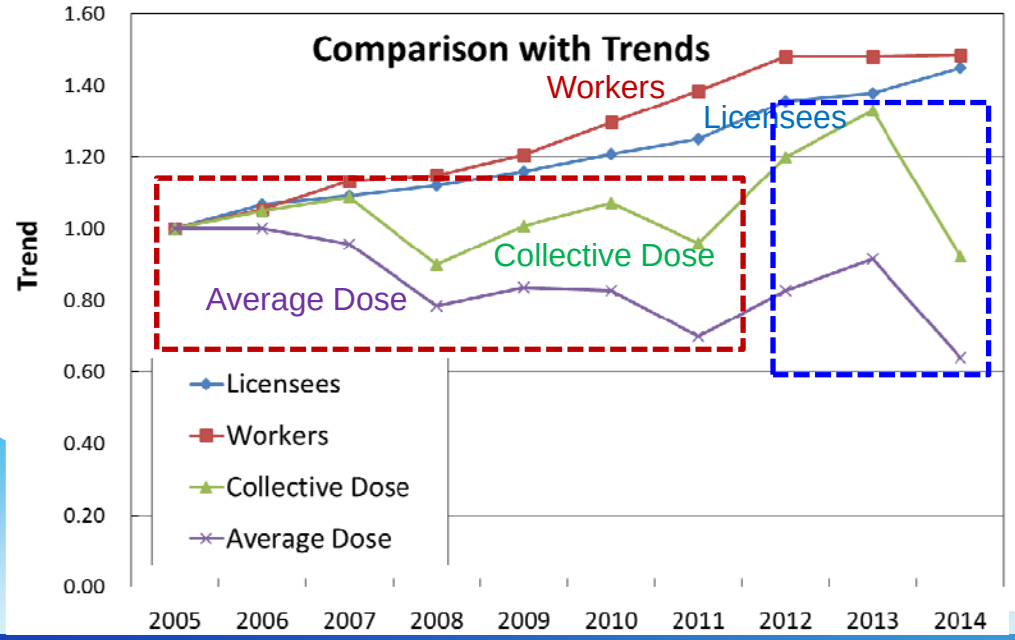
5.1 Detailed Collective Dose (2011 ~ 2014)

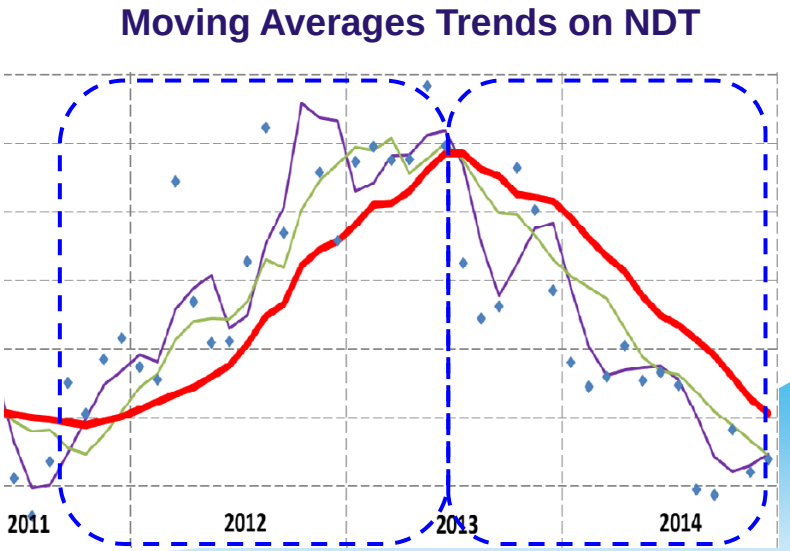
- **Top 3 (NDT > PWR > Nuclear Medicine) collective doses in 2014**
  - NDT and Nuclear Medicine workers are FEWER than PWR.
  - Average doses are 4 TIMES and 2 TIMES HIGHER than PWR, respectively.
  - So, NDT is Top 1 and Nuclear Medicine Top 3.
- **Collective dose in PWR increased till 2013 but increased in 2014.**
  - Due to an increase of job tasks after Fukushima accident
  - Due to an increase of workers in new PWRs that began operation.



6. Overall Analysis on radiation protection program

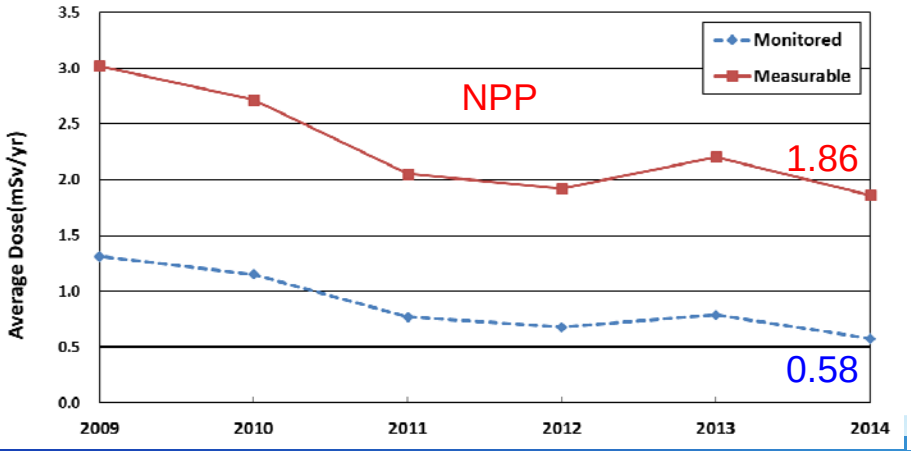
- **Numbers of licensees & radiation workers have increased.**
  - Collective doses have been kept at the same level until 2011.
  - Average doses have continuously gradually decreased until 2011.
- **In 2012 & 2013, doses increased very high due to NDT. However, in 2014, doses decreased into the level of 2011.**
  - By the strong enforcements and thorough application of RPP, trends decreased since Mid-2013 ~ 2014 in NDT areas.
- **Trends imply the continuous improvement of RPP in Korea.**

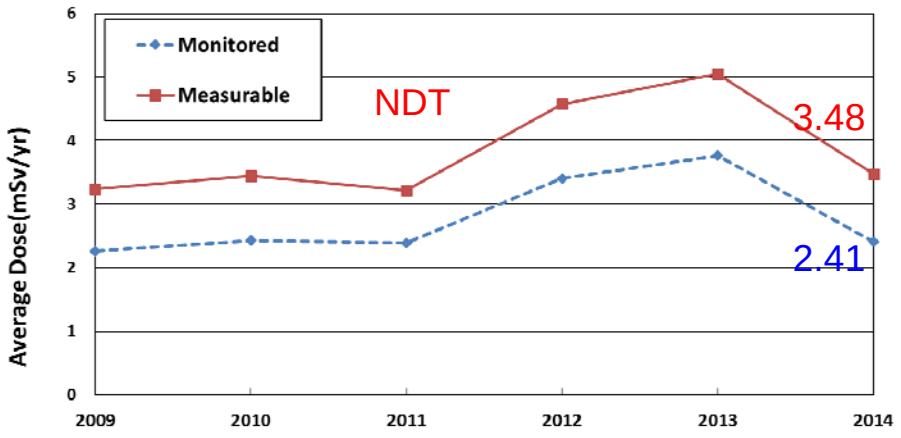




6.1 Trends of Measurable Dose

- **Previous analyses based on Monitored dose (all radiation workers)**
- **Monitored Dose (all workers) vs. Measurable Dose (above 0.1 mSv)**
  - Monitored Dose includes all range of dose including ZERO doses.
  - ZERO could mean that the workers might NOT be in actual exposures.
  - To see the trends of radiation workers with actual occupational exposures, it is Meaningful to utilize Measurable Dose (>= 0.1 mSv)
- **Measurable Dose in NPP and NDT (2014)**
  - NPP : Measurable is 1.86 mSv, About 3.2 times Higher than Monitored.
  - NDT : Measurable is 3.48 mSv, About 1.4 times Higher than Monitored.
- **Workers with actual occupational exposures have doses of several times higher than doses analyzed based on all the workers.**





7. Conclusion

- **Analyses on Occupational Exposure of Radiation Workers in Republic of Korea were performed.**
  - By using KISOE database that collects dose records of radiation workers in various fields in Republic of Korea.

- **Based on the analyses for (2005~2014), it is implied that radiation protection programs have been continuously improved in Korea.**
  - Number of radiation workers has increased about 5% annually.
  - Nonetheless, annual average dose has continuously gradually decreased and annual collective doses been kept at the same level.
  - By strong application of RPP in NDT areas since 2012 ~, NDT doses began to decrease in Mid 2013.
    - In 2014, The doses returned back into the previous 2011 level.

- **It is necessary to continue to improve KISOE system,**
  - By collecting more detailed data about jobs of radiation workers.
  - By developing more useful method for data analysis.

Thank you.

Q & A