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Analysis on Occupational Exposure of Radiation Workers in Korea based on KISOE Database (2007~2016)

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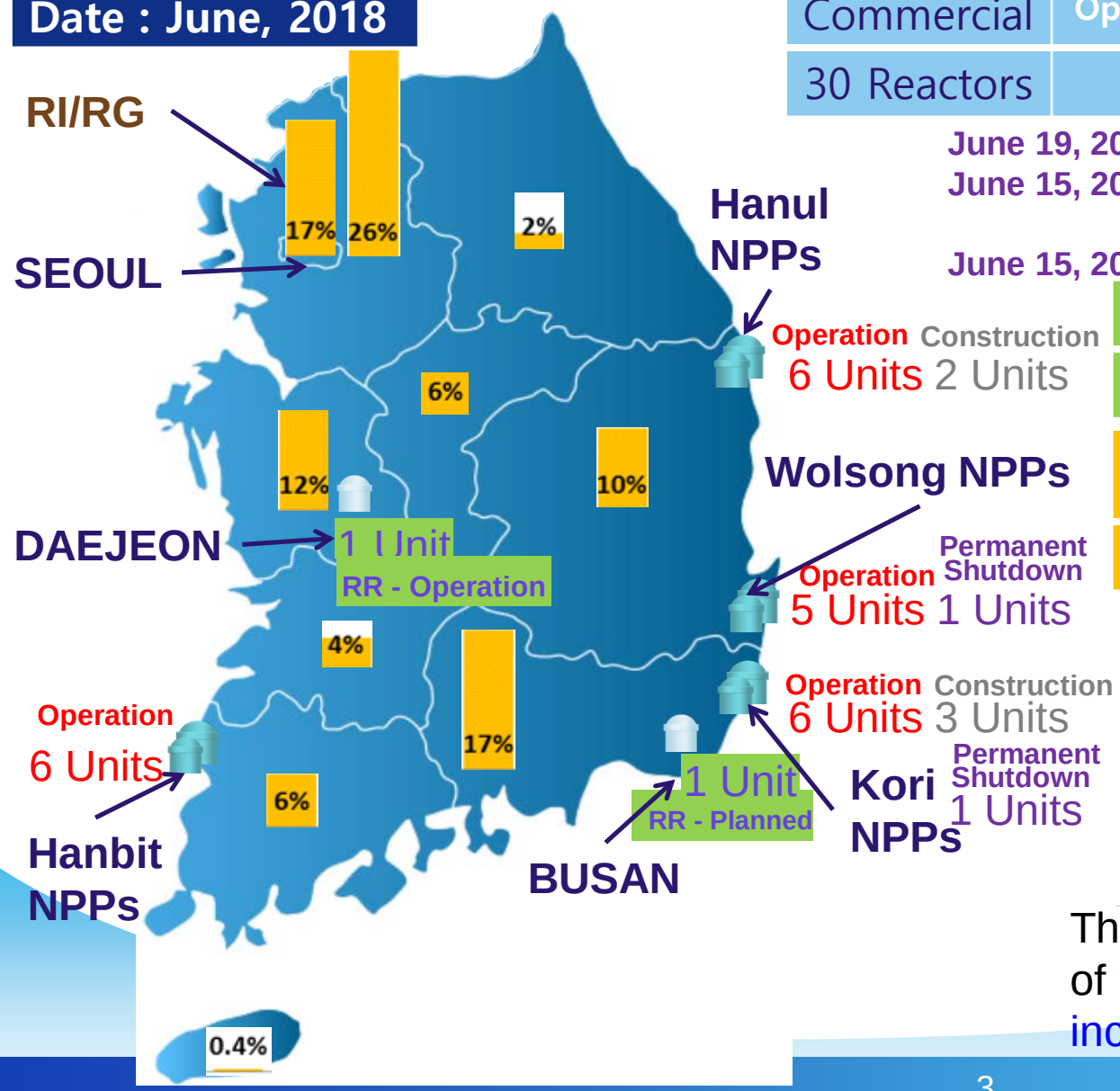
1. Nuclear Reactors & Licensees of Radiation Sources in Korea

Date : June, 2018

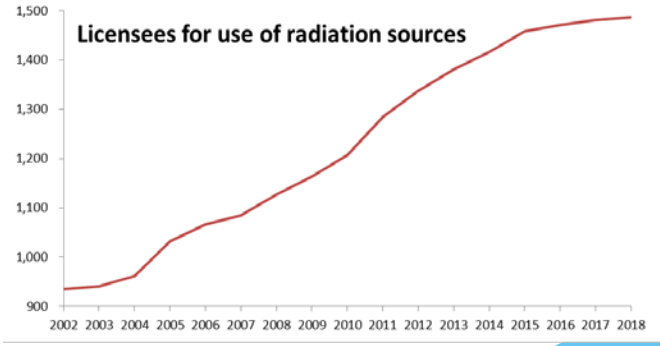


Commercial	Operation	Construction	Shutdown
30 Reactors	23	5	2

June 19, 2017 : Kori #1 (1st PWR) in shutdown
June 15, 2018 : Shutdown decided for Wolsong #1 (1st CANDU)
June 15, 2018 : Plan for 4 New Units canceled.

Research	Operation	Planned
2 Reactors	1	1

Licensees for Use of Radiation Sources	Total Facilities
	1487



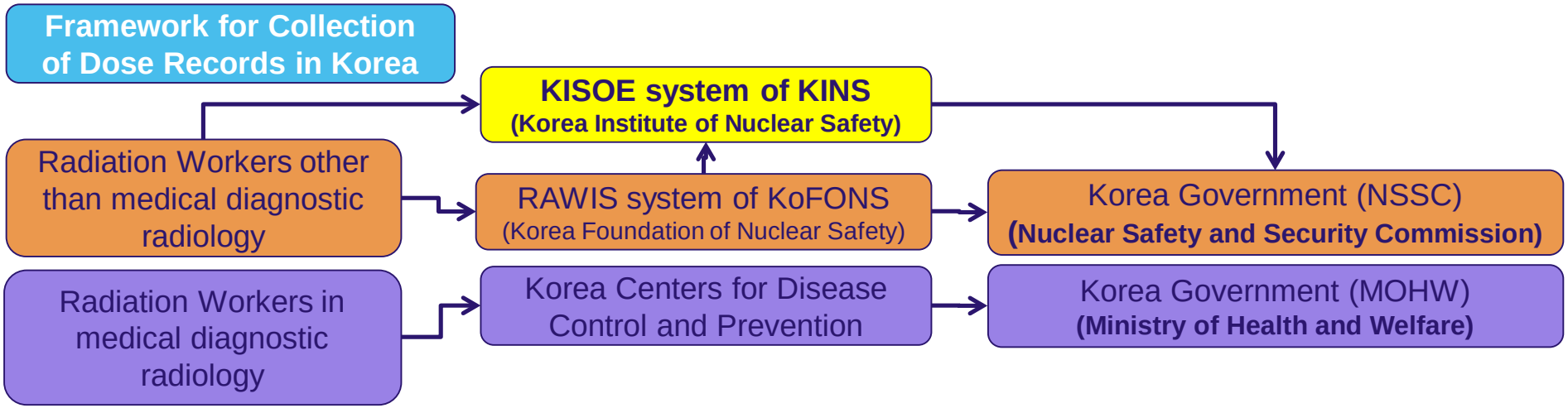
The number of licensees for use of radiation sources in Korea is increasing gradually every year.

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 Evaluate 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 last 10 years from 2007 to 2016.

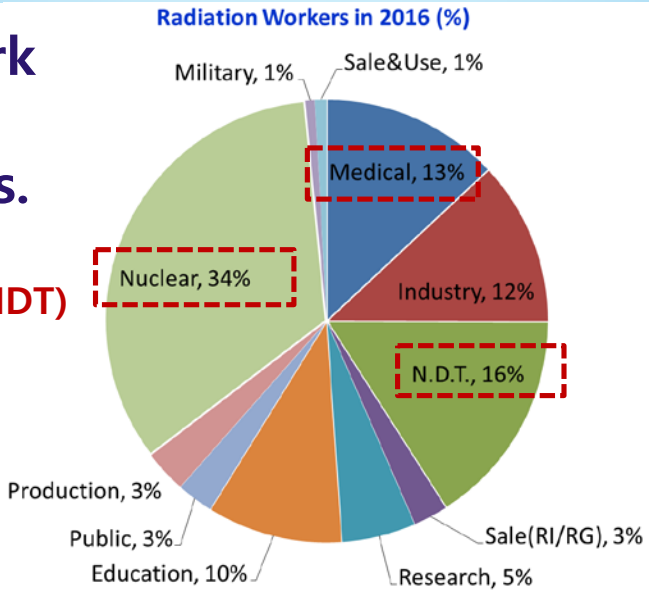
3. Radiation Workers in Korea (2007~2016)

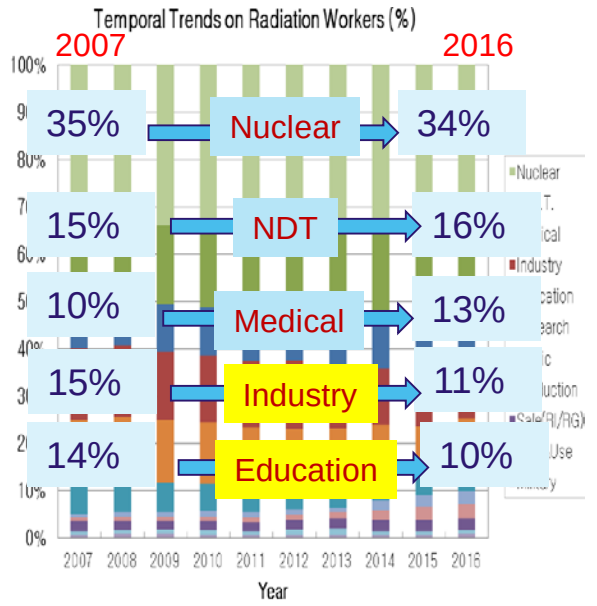
- **Radiation workers work for Licensees that are classified into 11 types.**

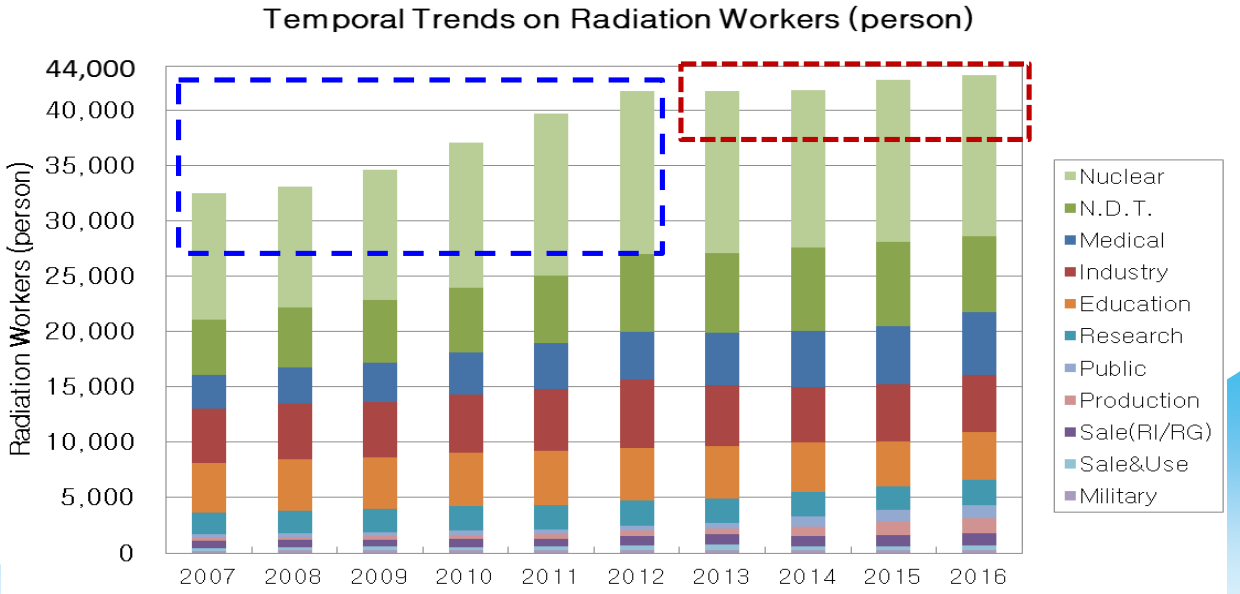
Top1 ▪ **Nuclear energy**
Top2 ▪ **Non-Destructive Testing (NDT)**
Top3 ▪ **Medical Use**

- General Industry
- Education institute
- Research institute
- Public institute
- Production (RI/RG)
- Sale (RI/RG)
- Sale & Use (RI/RG)
- Military activity

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

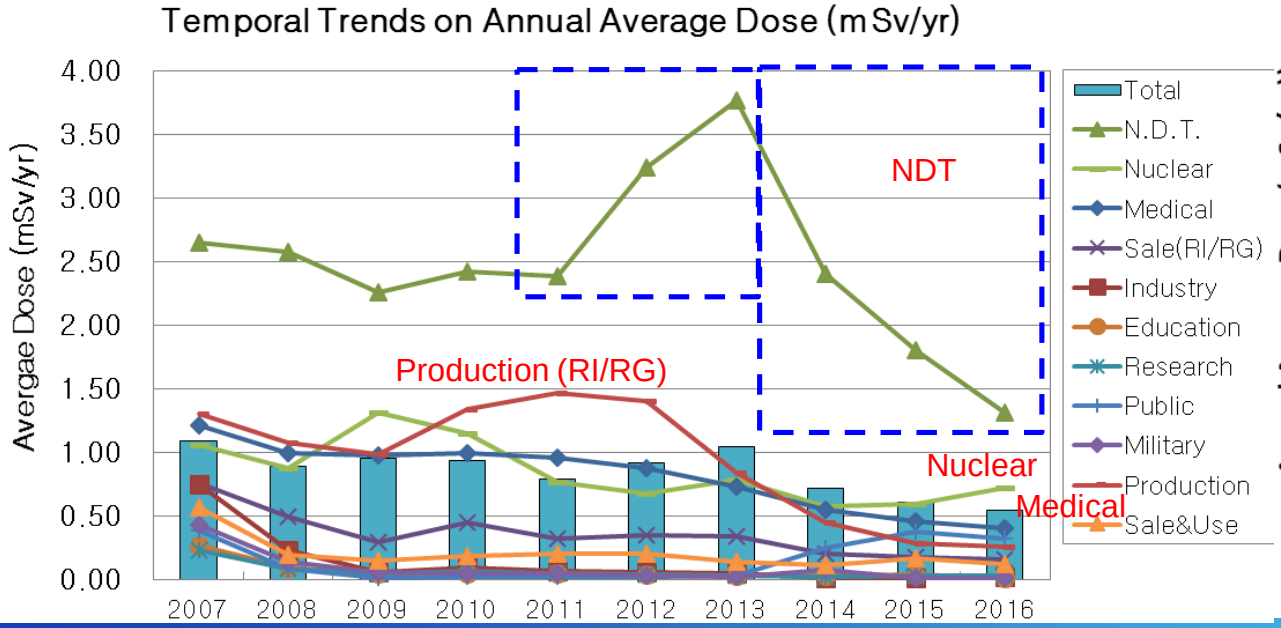


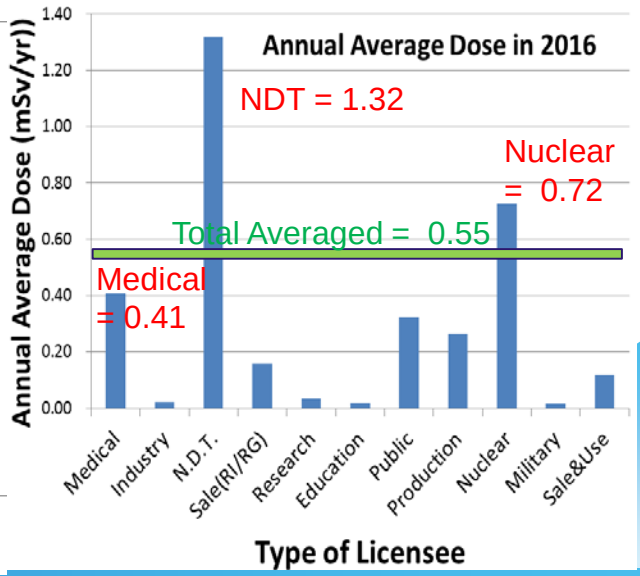




4. Annual Average Dose (2007 ~ 2016)

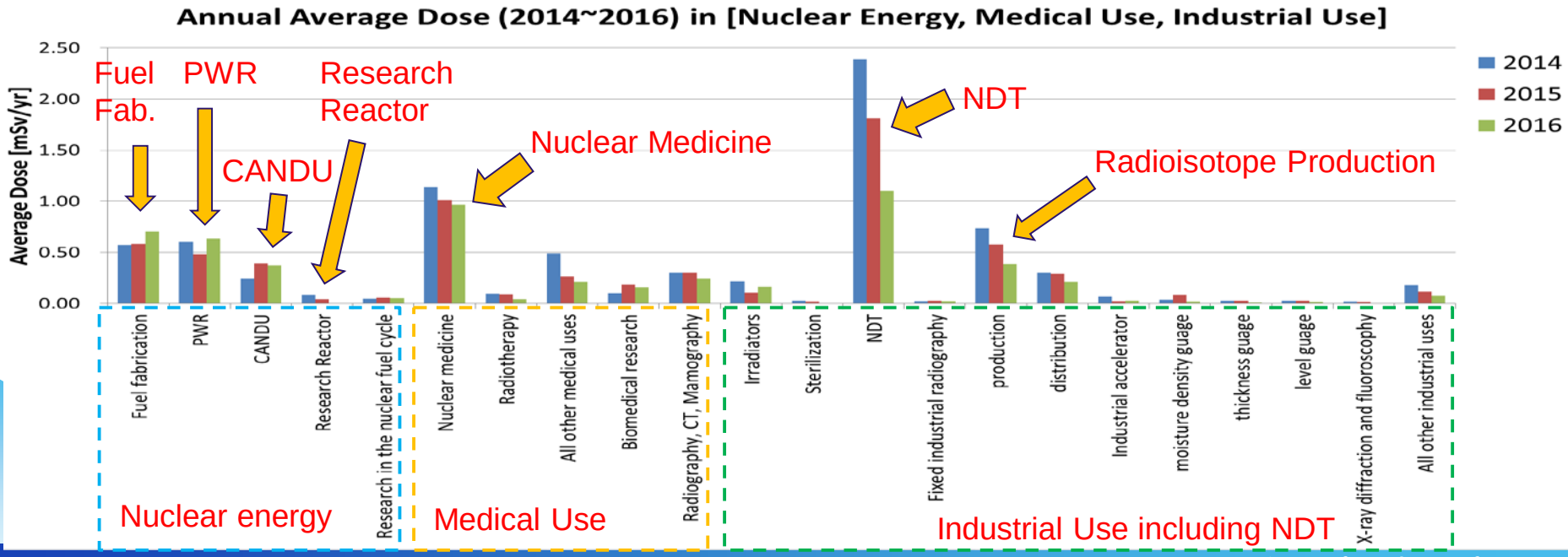
- **Top 3 : NDT > Nuclear > Medical**
  - The HIGHEST average dose is from NDT.
    - NDT during 2007 ~ 2016 is in the range of 1.32~3.77 mSv/yr.
    - NDT is 2~4 times higher than Total Averaged dose (0.55~1.10 mSv/yr)
    - NDT doses increased VERY HIGH in 2012 & 2013. (3.40 ~ 3.77 mSv/yr)
    - From 2014 NDT decreased & reached at minimum so far in 2016 (1.32 mSv/y)
- **Nuclear energy is above the Total Averaged dose**
- **Medical use is below the Total Averaged dose.**





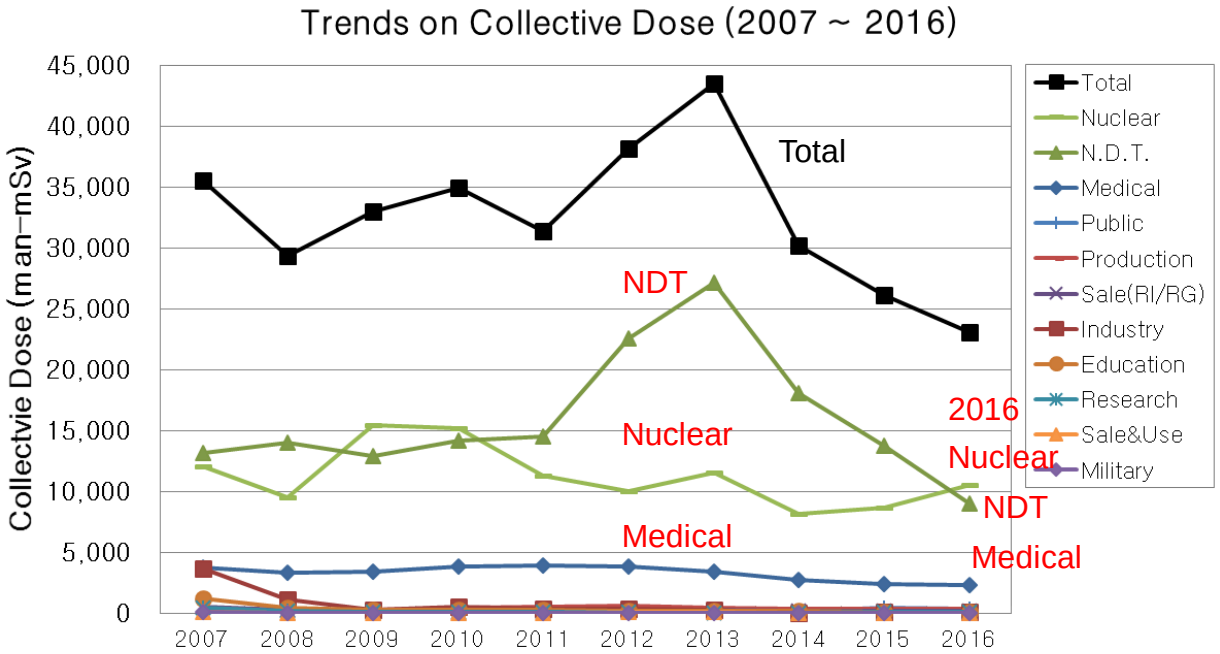
4.1 Detailed Annual Average Dose (2014~2016)

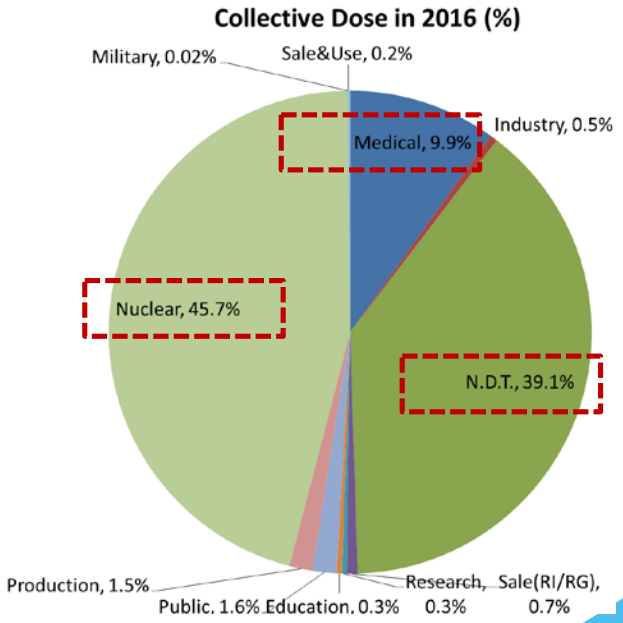
- **Higher than 1 mSv/yr : NDT : the highest dose in Industrial Use area**
  - The 2nd highest dose in Industrial use is from Radioisotope Production.
- **Around 1 mSv/yr : Nuclear Medicine : the highest dose in Medical**
  - Nuclear Medicine (0.97 mSv) is 2 times higher than overall Medical (0.41)
- **Nuclear energy areas are Below 1 mSv/yr**
  - Above 0.5 mSv/hr : PWR and Fuel fabrication
  - Below 0.5 mSv/hr : CANDU, Research Reactors



5. Trends on Collective Dose (2007 ~ 2016)

- **Top 3 (Nuclear Energy ≒ NDT > Medical Use) constitute the most part of collective doses (about ~95%).**
  - Many Workers in the above Top 3 (34%, 16% & 13%, respectiveley).
  - High Annual average doses (0.72, 1.32 & 0.41 mSv/yr, respectively)
  - Recently NDT continued to decrease; became less than Nuclear (2016)

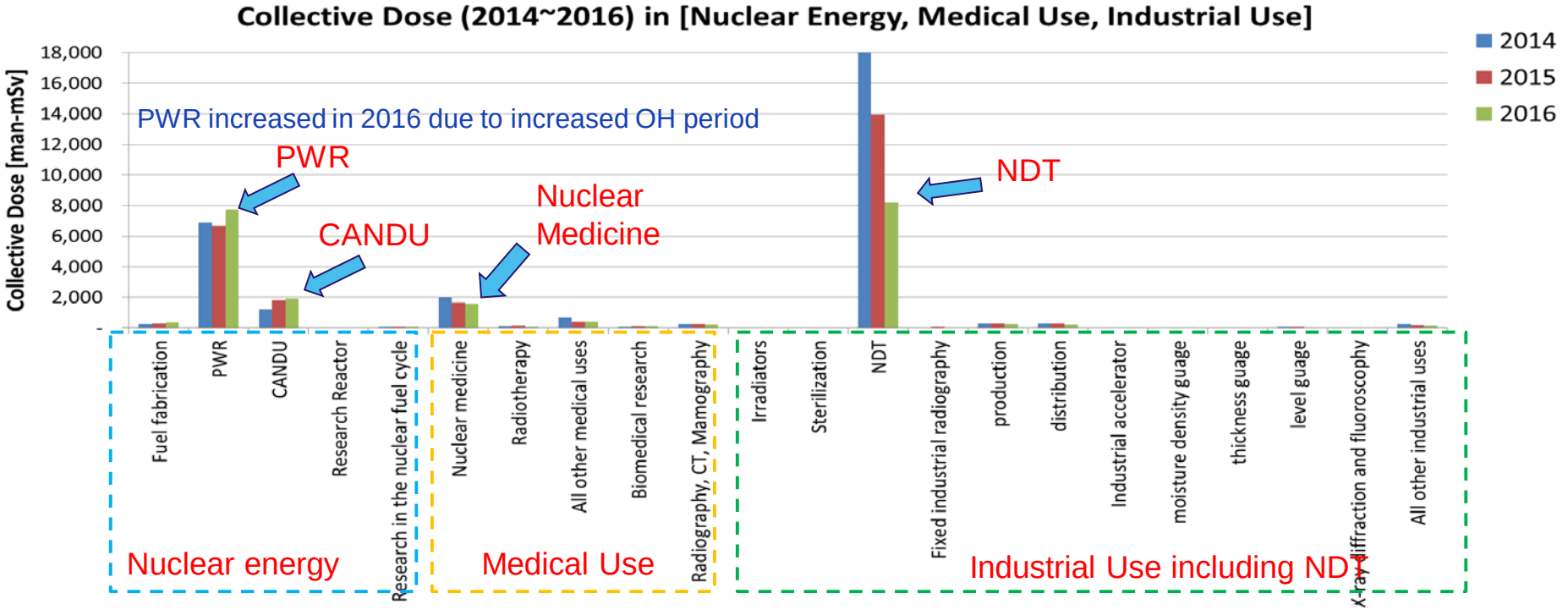




- **Collective doses of other types of licensees are very small (below 5%) due to much lower annual average doses (<0.2mSv), although the total number of workers is not small (~37%).**

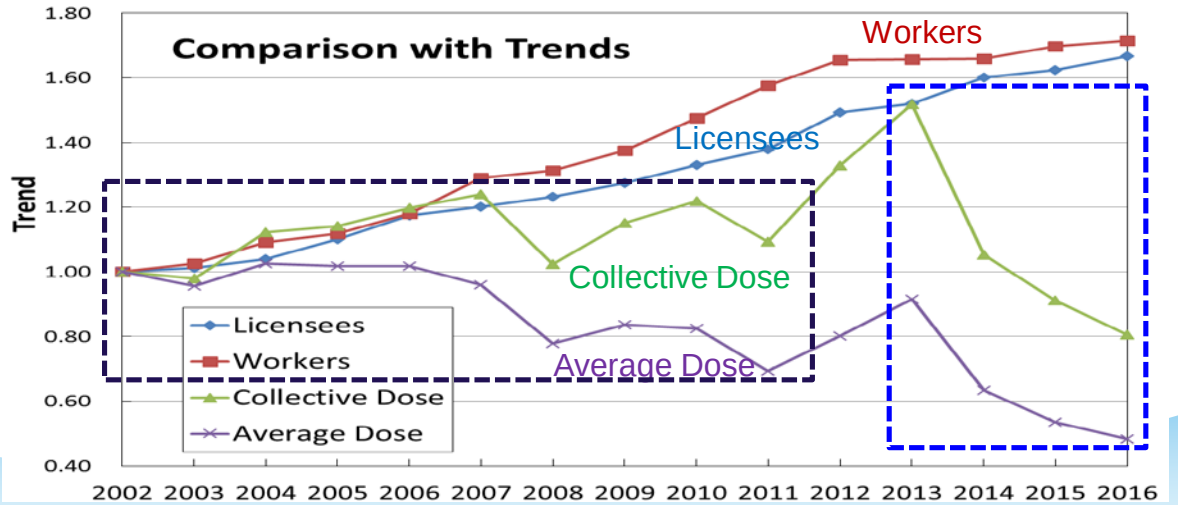
5.1 Detailed Collective Dose (2014 ~ 2016)

- **Top 4 (NDT > PWR > CANDU ≒ Nuclear Medicine) in 2016**
  - In the past, NDT was very higher than PWR.
    - Recently NDT decreased so fast. Now, NDT became similar to PWR.
  - Nuclear Medicine continued to decrease and became less than CANDU.
- **Collective dose in CANDU(Wolsong) and PWR increased in 2016.**
  - Increased OH to deal with various issues such as PWR Cont. Liner Plates
  - Increased Followup actions after Earthquakes(M5.8) near Wolsong Sep.2016



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, from 2014 to 2016, doses decreased into the minimum so far.**
  - Enhanced regulation & strong enforcement in NDT to protect NDT radiation workers from over-exposure incidents.
  - Economic depression, especially in ship makings, which accelerated decrement of overall NDT activities.
- **Overall Trends imply the continuous improvement of RPP in Korea.**



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 (2007~2016), it is implied that radiation protection programs have been continuously improved in Korea.**
  - In comparison with the increased radiation workers,
    - Annual average dose has continuously decreased
    - Annual collective doses have been kept at same level or decreased
  - Nonetheless, specific fields such as NDT need more enhanced regulation and strong enforcements.
    - Because, over-exposure incidents still happen in NDT fields.
- **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 for your attention.