Occupational Radiation Protection in Radioactive Waste Management
1. More Concern for RW in Korea

- **Distance from Fukushima-1 NPP to Republic of Korea**
  - Seoul, the Capital City: 1250 km

- **Korea is geographically nearer to Fukushima than other countries.**
  - Korean society has a lot of concern for Fukushima accident.

- **Also, More concern for Nuclear Facilities & RW in Korea**
2. Status of Nuclear Facilities in Korea

- **Nuclear Power Plant (NPP)**
  - 23 in Operation and 5 under Construction

- **Research Reactor (RR) / Education Reactor (ER)**
  - HANARO (RR)
  - KRR 1 and 2 (RR, under decommissioning)
  - AGN (ER)

- **Nuclear Fuel Cycle Facility (FC)**
  - Fuel Fabrication Plant for NPP
  - Fuel Fabrication Facility for RR
  - Post-Irradiation Examination Facility
  - Uranium Conversion Facility (released from regulation due to completion of decommissioning)

- **Radioactive Waste Management Facilities (RW)**
  - RI Waste Management Facility
  - LILW Disposal Facility (under construction)

(As of July 2014)
2-1. Framework for LILW management

Nuclear Power Plants (KHNP)

Most RI Users
(Hospitals, Industries, etc.)

Commercial Fuel Fabrication Plant (KNF)

Research Complex (KAERI)

(KRR1 and 2)

On-site Storage (10)

Centralized Storage (1)
RI Waste Management Facility (KORAD)

On-site Storage (2)
On-site Storage (2)

On-site Storage (1)

End Point
LILW Repository (KORAD)
Under Construction

On-site Storage

Under Decommissioning

However, end point of high Level wastes and spent fuels is not yet decided.
3. General Methods for Radiation Protection

- **Radiation exposure = External exposure + Internal exposure**

- **Control of external exposure**
  - **Time**: Double the time, Double the dose
  - **Distance**: Double the distance, quarter the dose
  - **Shielding**: Shielding the radiation, reducing the dose
    - Work Planning, Training & Mock-up, Remote control, Shield tools, APD

- **Control of internal exposure**
  - Preventing radionuclides from entering the body by inhalation, ingestion & absorption
    - Eating, drinking, smoking prohibited in radiation areas
    - If airborne radioactivity exists, protective breathing apparatus used
    - Derived air concentrations (DACs) for airborne radionuclides
    - Wear appropriate protective clothing

- **Radiation Protection Program (RPP) established to all workplaces**
  - Organization, Local rules & task-specific procedures, Monitoring, Training,
  - Protective equipment, Classification of areas, Emergency plan, RWM, etc.
4. Specific Consideration for RP in RWM

**Characteristics of workplace for RWM**

- Dust, Powder
- Radioactive waste drums
- Large amount of radioactive waste
- High intensity of radiation
- Feasibility of leak of contaminated materials (liquids, gas)
- Cutting and repackaging of solid radioactive waste
- Possibility of contamination & exposure

**Typical task related to RWM**

- RWM during normal operation of NPP
  - Process of radioactive waste, Drum storage work, etc.
- Large-scale Project
  - Large Equipment Replacement (S/G, Heat Exchanger), HLW (such as spent fuel) Disposal & Management
- Decommissioning
  - Nuclear Reactor, Nuclear Fuel Cycle Facilities, Accelerator

**Careful consideration is necessary to establish RPP**
5. Decommissioning of research reactors

- Decommissioning of nuclear facilities
  - Uranium conversion facility (to produce UO2 powder): 2001 ~ 2011
  - Daegu Tech. (TIG welding rod including thorium): 2004 ~ 2005
  - Taegwang Industrial co. Ltd. (Use of catalyst including uranium): 2006
  - Cyclotron (to produce RI for medical diagnosis): 2012

- Difficulties in decommissioning
  - Identification & removal of activated materials
  - Identification & removal of contaminated soils & concretes
  - Methods to treat or dispose the large amount of radioactive waste
  - Set-up for criteria & various procedures related to decommissioning

- Safety activities to assure safe & thorough decommissioning
  - Safety review on decommissioning application & plan documents.
  - Inspection on the facilities during decommissioning
  - Periodic inspection on the storage of RW from decommissioning until the disposal of them
5-1. Decommissioning of KRR-1 & 2

KRR-1

decommissioning

The Inside of KRR-1

KRR-2

decommissioning

Large amount of RW
5-2 RWM in decommissioning of KRR-1 & 2

- Keep dust from spreading
- Reclassification of RW
- Solidification
- Cutting metals
- Reclassification of Metals
- Repackaging

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5-3 RP in decommissioning of KRR-1 & 2

- **Establishment of RPP**
  - Organization, Local rules & task-specific procedures, Monitoring, Training, Personal Protective equipment, Classification of areas, Emergency plan, RWM, etc.

- **Operation of ALARA committee & Work management**
  - ALARA review for some specific tasks
    - Considered as a task with risk of high radiation
    - e.g.: Re-classification of casks (metal-type RW)
    - Work control by SRWP (Specific Radiation Work Permit)
  - Estimation of collective doses (man-mSv) & Feedback
  - Work management by RWP (ERWP, RRWP, SRWP)

- **Air Monitoring and Wearing Masks**
  - Possibility of contamination in air by dusts
    - Monitoring of radioactivity in air in the workplace
    - Wear personal protective equipment such as masks
6. Lessons-learned from experience of RWM

- **RWM is being practiced according to RPP established for NPP**
  - Long-term experiences in RWM produce feedback items to improve RPP

- **From feedback items, Useful to reduce exposure in RWM**
  - **Easily disassembling and assembling** of equipment and component parts
    - Useful to reduce exposure of workers at the time of maintenance
  
  - **Securing stability of radioactive waste storage** is done by
    - Removal of moisture in storage of drums (running dehumidifier or HVAC)
    - High-radiation drums inside the storage & low-radiation drums near outer walls
    - Large-scale RW (old S/G) in the storage with sufficient shielding walls
  
  - Surfaces of spent resin drums or spent filter drums are **remotely decontaminated** after the drums are filled with RW.
  
  - Solidification system, where radioactivity of the surface is relatively high, is operated remotely by using conveyor belts.
  
  - **Keep protective coating** of wall, floor and equipment surface **smooth**. The coating of walls in aisles or rooms is done to the height of worker’s reach.
    - To easily remove contaminated materials from surfaces of wall or rooms.
6-1. Lessons-learned from experience of RWM

• Keep the inside of NPP clean. Especially clean dusts of pipes & cable trays.
  – To easily remove contaminated materials from the coated surfaces

• Keep the sump clean. Especially prevent construction waste from going into sump at NPP construction.

• Keep drainage facilities of each building well performed to reduce dose
  – Protect drainage hole at NPP construction
  – Keep floors on a slight slope to facilitate drainage easily
  – Build banks (or hills) in front of tank rooms or sump rooms where liquid RW is stored to prevent overflows of tank or sump from spreading into other regions.

• Install a post filter at the end part of active charcoal of ACU (Air Cleaning Unit) which uses active charcoal
  – to prevent charcoal dust from the duct deposition that could result in exposure

• Items of consideration for ACU (Air Cleaning Unit) design
  – Capable of replacing the interior light on the outside ceiling surface
  – Installing manifolder to sample testing gas, which lets performance test be done without going into the inside of ACU
  – Securing sufficient space between ACU & building wall (reducing working time)
7. Summary

- After Fukushima accident, more concern for Nuclear Facilities & Radioactive waste management (RWM) than any other times in Korea.
  - So, radiation risk and radiation exposure are often hot keywords to people.

- To minimize radiation exposure, radiation protection program (RPP) should be established and being operated in all nuclear facilities & Radioactive waste management.

- In addition, consideration of specific characteristics in RWM
  - Dust, High radiation, Possibility of RW leak, etc.
  - Necessary to establish RPP to minimize occupational exposure in RWM

- Korea has experiences in RWM of NPP, decommissioning, large-scale project such as S/G replacement.
  - Much effort to assure radiation protection and ALARA in these fields.
  - Continued effort is necessary to feedback the experiences to improve RPP.
Thank You.