ALARA on the Radioactive Waste Management Activities at NPP in Korea – 15189

Sungil Kim *, Hongtae Kim*, Byeongsoo Kim*, Daesik Yook*, Byungsoo Lee*
* Korea Institute of Nuclear Safety , 62 Gwahak-ro, Yuseong-gu, Daejeon 305-338, Republic of Korea, sikim@kins.re.kr

ABSTRACT

This study examined and analyzed on-site experience to investigate the effect of the 'as low as reasonably achievable' (ALARA) principle on the level of radiation exposure management during NPPs' radioactive waste management activities. In particular, the ALARA principle was observed by various activities of radioactive waste management. According to 2012 data, workers' radiation exposure due to radioactive waste management activities in one light water reactor (LWR) unit amounted to a collective dose of 14.8 man-mSv, and this value corresponded to approximately 3.5% of the radiation exposure due to the NPP's total activities. The present study is expected to contribute to the reduction of workers' radiation exposure by analyzing and synthesizing field experience from the perspective of the ALARA principle during radioactive waste management, and transmitting the results to other NPPs.

INTRODUCTION

Ever since it began operating commercial nuclear power plants (NPPs) in 1978, South Korea has consistently endeavored to reduce workers' exposure to radiation. NPPs have established radiation protection programs and made efforts to reduce workers' radiation exposure such as airborne pollution management and etc. within radiation controlled areas. The licensee incorporates the following radiation protection principles in the design and construction of nuclear facilities, for assuring ALARA and maintaining the radiation doses to workers and the general public are exposed within the applicable limits. The operator establishes and operates target values for reducing occupational radiation exposure according to the classified categories, such as annual collective dose, collective dose during the planned preventive maintenance period, and job-specific collective dose. It is provided that any radiation work should be conducted following the plan, as established before undertaking the work, and causal analysis for excesses over the expected dose, if any, should be performed through ALARA post-examination after the work is completed, so that its result can be applied to any similar work in the future.

Although radioactive waste management doesn't occupy the major part of collective dose during normal operation of NPP, radioactive waste management plays very important role to NPP safety. When radioactive waste management is well practiced, radioactive waste management is not the major part in radiation protection program and it is a good indicator to NPP safety. If radioactive waste management is poor and leaks of radioactive waste happens, it would be an incident and influence a bad impact to NPP safety.

VARIOUS ACTIVITES OF RADIOACTIVE WASTE MANAGEMENT FOR ALARA

In order to achieve the status of "as low as reasonably achievable (ALARA)" at nuclear power plants, each and every equipment and component must be designed to be easily disassembled and assembled with the aim of reducing any exposure to workers during maintenance activities.

- Efforts for ALARA when storing radioactive wastes
  - Removing moisture when storing in a drum (using dehumidifiers or installing the HVAC system)
  - How to store drums of waste: Placing higher-dose drums at the inner walls and lower-dose drums towards outer walls (drawings required)
  - For large components such as old S/G, separate storage buildings with sufficient shield walls are planned to be constructed, and packaging for disposal are scheduled to be implemented after sufficient decay of radioactivity

Figure 1. Storage of old Steam Generator

- Drums of spent resin and spent filters that have relatively high levels of radiation must be loaded with waste first before conducting remote decontamination of the drum surfaces
- The solidification system for relatively high activity waste at newly constructed nuclear plants must be remotely controlled by means of conveyer belts
- With regard to protective coating of inner walls, floors, and equipment surfaces within nuclear power plants, the coated surfaces must be maintained in a smooth state so that contaminants can be easily removed. The walls in hallways and rooms must be coated to the height that workers can reach

Figure 2. Coated wall to the height that workers can reach

- The inside of nuclear power plants must be kept clean. Dust around pipes, equipment, and wire trays must be thoroughly removed
- Efforts for ALARA from the perspective of drainage facilities of each building: Particular care is required for drainage facilities because failure of drainage is likely to cause area dose rates within buildings to increase
  - Drainage holes must be protected to prevent ingress of construction waste during construction (seal during construction)
  - The floors within buildings must be flat and oriented toward floor drains for unobstructed drainage
  - The tank rooms or sump rooms accommodating liquid waste or radioactive materials must be equipped with embankment at the entrance, so that any liquid waste overflowing in the event of failure of the tanks or sumps cannot spread to another area
- Maintaining sumps clean: Construction debris must be kept from entering sumps during construction. Should any liquid flow in during construction, it must be removed entirely before loading nuclear fuels, and the sump surfaces must be thoroughly cleaned
- For air cleaning units (ACU) using activated carbon, it is necessary to install post filters at the rear of activated carbon and thereby prevent exposure to workers that might occur when activated carbon dust contaminated by radioactivity is deposited within the ducts
- Cautions for ACU design

  The tank room Interior lights must be designed to be replaced from outside ceilings

Figure 3. Interior lights that can be replaced from outside ceilings

  - For performance tests, manifolds to collect samples of test gases must be installed so that tests can be conducted without entry into the insid
  - Sufficient space must be secured between the ACU and building walls to facilitate smooth performance tests or maintenance (reducing work time)
    - At least 4 ft between building walls and the ACU
    - At least 3 ft between the ACU ceilings and ducts, wire trays, or building ceilings
  - Determining air volume based on ALARA requirements: Determining ALARA air volume to ensure that the airborne radioactive concentration of each compartment within the radiation zones does not exceed a threshold (0.1-1.0 DAC)
- ETC.
  - Containers incorrodible by organic waste fluids
  - Troughs with sufficient capacity must be installed in order to prevent spread of liquid waste when containers are breached
  - It is prescribed that waste subject to meet clearance level must be stored at a designated place separate from radioactive waste

RESULTS OF RADIATION PROTECTION ACTIVITES

According to 2012 data, workers' radiation exposure due to radioactive waste management activities in one light water reactor (LWR) unit amounted to a collective dose of 14.8 man-mSv, and this value corresponded to approximately 3.5% of the radiation exposure due to the NPP's total activities. The present study is expected to contribute to the reduction of workers' radiation exposure by analyzing and synthesizing field experience from the perspective of the ALARA principle during radioactive waste management, and transmitting the results to other NPPs.

Table 1. Collective Dose of Radiation Workers

2012	LWR	CANDU
[Collective dose / unit]	[man-mSv/unit]	[man-mSv/unit]
Total dose for all activities	417	637
Radiation protection practices	33.5 (8 %)	45.7 (7.1%)
Radioactive Waste Management	14.8 (3.5%)	18.9 (3.0%)

The radioactive waste management is practiced well according to radiation protection program. The radioactive waste management collective dose is about 3.0% ~ 3.5 % compared with total. Although radioactive waste management doesn't occupy the major part of collective dose during normal operation of NPP, radioactive waste management plays a very important role to NPP safety. Keeping radioactive waste management well practiced is important to radiation protection program & NPP Safety.

When radioactive waste management is well practiced, it is not the major portion of radiation exposure and it is a good indicator of NPP safety. If radioactive waste management is poor and leaks of radioactive materials happen, it would be an incident and influence a bad impact on NPP safety.

CONCLUSION

This study examined and analyzed on-site experience to investigate the effect of the 'as low as reasonably achievable' (ALARA) principle on the level of radiation exposure management during NPPs' radioactive waste management activities.

In particular, the ALARA principle was observed by various activities of radioactive waste management. This was accomplished by installing dehumidifiers or heating, ventilation, and air conditioning (HVAC) units where solid radioactive waste is stored and by stacking high-dose drums inside and low-dose drums closer to the outer walls. In addition, when designing air cleaning units (ACUs), internal lighting was designed so that it could be replaced from the external ceiling. Ample space was also placed between ACUs and the building wall for the easy implementation of performance tests or repair and maintenance, thus reducing and minimizing workers' radiation exposure. Furthermore the solidification system, for high activity waste , is operated remotely by using conveyor belts and surfaces of spent resin or filter drums are remotely decontaminated after the drums are filled with radioactive waste. The coating on walls in aisles or rooms is done to the height of worker's reach in order to easily remove contaminated materials from surfaces. Although radioactive waste management doesn't occupy the major part of collective dose during normal operation of NPP, radioactive waste management plays very important role to NPP safety. When radioactive waste management is well practiced, radioactive waste management is

not the major portion of radiation exposure and it is a good indicator of NPP safety. If radioactive waste management is poor and leaks of radioactive waste happens, it would be an incident and influence a bad impact to NPP safety.

According to 2012 data, workers' radiation exposure due to radioactive waste management activities in one light water reactor (LWR) unit amounted to a collective dose of 14.8 man-mSv, and this value corresponded to approximately 3.5% of the radiation exposure due to the NPP's total activities. The present study is expected to contribute to the reduction of workers' radiation exposure by analyzing and synthesizing field experience from the perspective of the ALARA principle during radioactive waste management, and transmitting the results to other NPPs.

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REFERENCES

1. Annual Report of Radiation Management, KHNP, 2013
2. Korean National Report of the Joint Convention, 2014
3. ASME AG-1, Code on Nuclear Air and Gas Treatment, 1997
4. Nuclear Regulatory Commission, Regulatory Guide 1.52, Design, Testing and Maintenance Criteria for Post-Accident Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants, 1978
5. Nuclear Regulatory Commission, Regulatory Guide 1.52, Design, Inspection and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants, 2001
6. Nuclear Regulatory Commission, Regulatory Guide 1.140, Design, Testing and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants, 1979
7. Nuclear Regulatory Commission, Regulatory Guide 1.140, Design, Inspection and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants, 2001