Preliminary Radiological Impact Assessment of Transport Options for a Dismantled Steam Generator

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1. Introduction

Various types of large metal components like S/Gs, RPVs etc. are generated into radioactive wastes during operation or from decommissioning of NPPs. However, treatment and disposal options of large metal components have not been already decided in Korea. Also, comprehensive studies about radiological impact resulted from treatment/transport for disposal are much insufficient these days. Therefore, radiological impact assessment of management options focusing on transport of large metal components like steam generators generated from NPPs in Korea is necessary.

2. Methodology

Methodology of evaluating exposure doses of workers from transport and treatment of large metal wastes is described.

2.1 Large Metal Wastes Transport Scenarios

Transport scenarios of large metal wastes can be determined by transport forms (land/sea), treatment forms (cutting/melting) and treatment facilities (On/off-site) [1].

Table I: Transport Scenarios

Transport Scenarios	
LT #1	One-piece Transport by Land
LT #2	Cutting in On-site Treatment facility & Transport by Land
LT #3	Melting in On-site Treatment facility & Transport by Land
LT #4	Cutting in Off-site Treatment facility & Transport by Land
LT #5	Melting in Off-site Treatment facility & Transport by Land
ST #1	One-piece Transport by Sea
ST #2	Cutting in On-site Treatment facility & Transport by Sea
ST #3	Melting in On-site Treatment facility & Transport by Sea
ST #4	Cutting in Off-site Treatment facility & Transport by Sea
ST #5	Melting in Off-site Treatment facility & Transport by Sea

2.2 Subject of Assessment

Subject of a large metal waste is a steam generator and the S/G of Shin Kori Unit 3, 4 is applied to specification of assessment.

Source terms which analyzed at 1998 when S/Gs of Kori Unit 1 were replaced are used for evaluation of exposure doses of workers [2]. Excluding Long-lived radionuclides (^{54}Mn, ^{60}Co, ^{65}Zn, ^{106}Ru, ^{144}Ce), impact of other nuclides is insignificant**.**

Table II: Source Terms of Kori Unit 1 Steam Generator

Radionuclide	Radioactivity[MBq]
^{54}Mn	3.50E+04
^{60}Co	1.13E+06
^{65}Zn	1.97E+04
^{106}Ru	1.85E+05
^{144}Ce	3.84E+04

2.3 Radiological Impact Assessment System

Micro-Shield is used to calculate dose rate at 1m from the package surface for main Input of RADTRAN that calculates risks of transporting radioactive materials [3]. RADTRAN is used to evaluate exposure doses of transport, loading and unloading workers of large metal wastes. RESRAD-RECYCLE is used to calculate exposure doses of treatment workers of large metal wastes including furnace operators, slag workers etc. [4]. By integrating results of these two tools, radiological impact per scenarios can be obtained. Assessment system of exposure doses of all workers is schematized in Fig. 1.

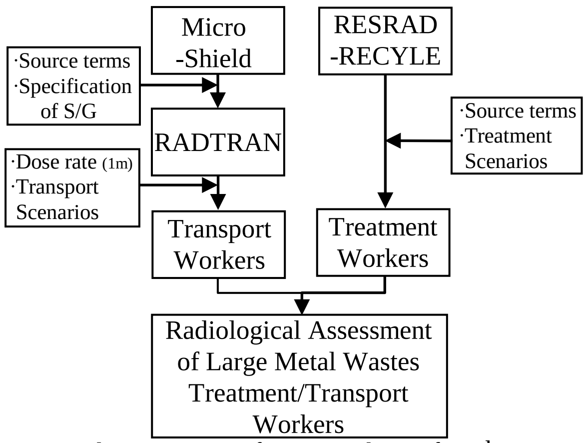

Fig. 1. Evaluation system of exposure doses of workers

3. Results

Individual dose of each treatment worker calculated by RESRAD-RECYCLE is presented in Fig. 2. Most dominant radionuclide to all workers excluding slag workers is ^{60}Co. In case of slag workers, impact of ^{54}Mn is highest. Most exposed workers among treatment workers are furnace operators, exposed about 3.13mSv/y and second most exposed workers are slag workers.

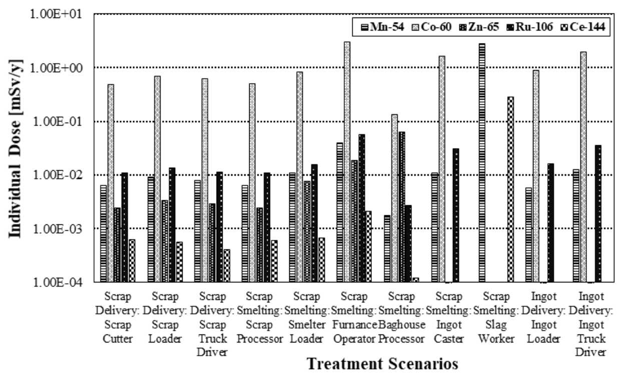

Fig. 2. Individual dose of treatment workers calculates by RESRAD-RECYCLE

Individual dose of each transport worker calculated by RADTRAN is presented in Fig. 3. Most exposed worker exposed about 5.87 mSv/y, who transports a dismantled steam generator from Hanbit NPP which is most far from the disposal site to Off-site treatment facility, from Off-site treatment facility to the disposal site by land.

For land transport, exposure doses of transport workers are same along treatment forms. Also for sea transport, exposure doses of transport workers are same along total length of the route.

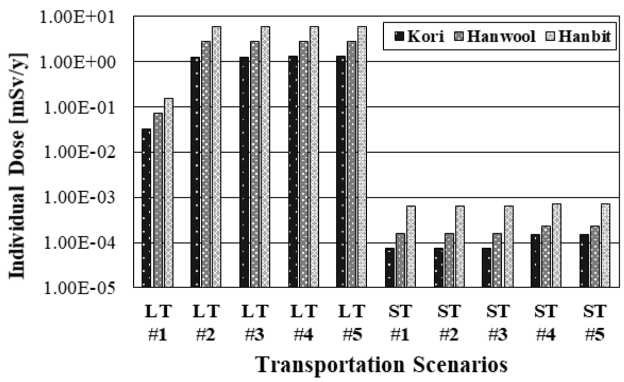

Fig. 3. Individual dose of transport workers calculated by RADTRAN

Collective doses of all workers including treatment, transport, loading and unloading workers calculated by RESRAD-RECYCLE and RADTRAN are presented in Fig. 4. Collective doses of land transport scenarios LT #1~ LT #5's workers depend on the length of the route from disposal site to each NPP. But in case of sea transport scenarios ST #1~ ST #5, doses of all scenarios except one-piece transport (ST #1) are almost same per each NPP.

One-piece transport scenarios, LT #1 and ST #1, all conditions are same but due to the length of the route from the disposal site to each NPP, exposure doses are different. All other scenarios excluding one-piece transports, treatment conditions are same but due to numbers of transporting (39 times when land transports and 1 time when sea transports), difference of exposure doses between land transport and sea transport workers occurred.

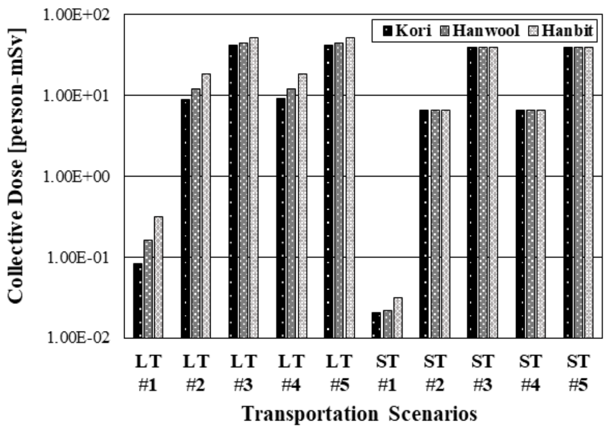

Fig. 4. Collective dose of all workers per transport scenarios

4. Conclusion

Kori unit 1 were permanently shut down in 2017 and decommissioning of Kori unit 1 will be planned. In Korea, under circumstances that treatment and disposal methods of large metal components generated during operation or from decommissioning of NPPs have not been decided yet, exposure doses of workers involved in management of large metal components focusing on transport who treat, transport, load and unload a dismantled steam generator were preliminary evaluated using computer tools, RADTRAN and RESRAD-RECYCLE. Most exposed treatment workers are furnace operators, exposed about 3.13mSv/y and most exposed transport worker exposes about 5.87 mSv/y. In terms of transport safety, it is almost 6 mSv/y, dose limit of transport workers [5], therefore exposure management of workers will be required.

In this study, subject of assessment is a steam generator but other large components including pressurizers, reactor heads whose characteristics are different each other exist. Thus considering characteristics of each large component, treatment and disposal options will be determined. It is judged that this study will be utilized as basic data for exposure dose assessment and exposure management of workers involved in the treatment, transport and disposal of large metal wastes.

5. Acknowledgement

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