Radiological Impact Assessment for the New Radioactive Isotope Wastes Land Transportation Route Using RADTRAN

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1. Introduction

Since the operation of Wolsong Low and Intermediate level Radioactive Waste Disposal Center had been approved in 2014, the operation of the disposal facility began. From 2015, Korea Radioactive Waste Agency (KORAD) carrys out transporting the radioactive isotope wastes temporarily stored in the 'radioisotope (RI) waste management facility' to the disposal facility.

This study concerns Radiological Impact Assessment using the RADTRAN program, and will predict the estimated dose rate to workers and the publics around the transportation vehicles by applying the new land route transportation scenario for transporting RI wastes to the disposal facility, and compare the results with the legal standards of the Enforcement Decree of the Nuclear Safety Act [Presidential Decree No. 28987] for evaluation.

2. Transportation system

2.1 Wastes to be transported

The study assumed that RI wastes are transported, and the nuclides and amounts of radioactivity used for Radiological Impact Assessment are shown in [Table 1].

Table 1. Amount of radioactivity of each nuclide

Nuclide	Amount of radioactivity	Nuclide	Amount of radioactivity
H-3	1.076E+06	I-131	0.0
C-14	4.063E+07	Cs-143	3.214
Cr-51	0.0	Co-57	1.945
Co-58	1.804E+00	Fe-59	3.195E+01
Sr-90	0.0	Ca-45	7.248
P-32	5.606E-02	Y-90	0.0
S-35	8.527E+01	Cd-109	0.0
I-125	8.580E-01	Rb-86	0.0
Co-60	6.491	Ga-67	0.0
Cs-137	9.550E+06	Am-241	0.0
Pm-147	3.137E+02		

2.2 Setting the transportation route

The new land transportation route for transporting RI wastes to the disposal facility consists of expressways and general national roads. Using the new transportation route setting conditions to minimize transportation time and thus minimize exposure time and transportation accident rates was considered.

The main route of the new transportation route, applied to this study, includes Honam Expressway, Gyeongbu Expressway, Dangjin Yeongdeok Expressway, Sangju Yeongcheon Expressway, Iksang-Pohang Expressway and Donghae Expressway. This study divided the distance of about 260km into a total of 10 transportation sections in consideration of the population density, traffic volume and accident rate of the administrative districts on the transportation route as shown in [Table 3]. The maximum value of each section was used as the population density of the transportation route in consideration of the population subject to exposure in case of an accident. Recent data, specified as information standard, was used as the statistics used for each transportation section.

2.3 Transportation scenario

This study applied the normal transportation scenario and the transportation accident scenario to the new transportation route to assess each scenario, and the number of accidents per unit distance (collision accident rate) for the number of floating vehicles was applied to access the transportation accident scenario.

3. Result of transportation safety assessment

The collective radiation dose of ordinary citizens and radiation workers (loading and unloading) during normal transportation and transportation accidents was assessed. Also, the expected population around the route and stopover sites and the assessed collective radiation dose were used to calculate the personal radiation doses, and they were compared with the legal standards.

The radiation dose of each subject of exposure during normal transportation and loading/unloading of RI wastes is shown [Table 2]. If the personal radiation dose of each subject is compared with the legal standard, the annual personal radiation dose of vehicle drivers during normal transportation was 1.59% of the legal standard, that of ordinary citizens 0.29%, and radiation workers doing the loading and unloading work 3.70%. It was confirmed that the annual personal doses of all subjects are within the dose limit.

Moreover, the estimated radiation dose was predicted according to the behavior of the radioactive

material leaked from the drum during a collision transportation accident in consideration of accident rates, and the radiation dose of each section was shown in [Table 4].

Table 2. Radiation dose by exposure subject during normal transportation

Subject	Collective dose	Personal radiation dose	Legal standard
Drivers	1.91E-01 mSv	9.55E-02 mSv	6 mSv
Ordinary citizens	9.95E+00 mSv	2.91E-03 mSv	1 mSv
Radiation workers	1.55E+01 mSv	1.85E+00 mSv	50 mSv

The personal radiation dose of each section in consideration of the radiation dose during a collision accident is 5.43E-19 ~ 8.37E-17, and it is clear that it is a very low value compared to the annual dose limit of ordinary citizens, i.e. 1 mSv.

4. Conclusion

In this study, the Radiological Impact Assessment of the new RI waste land transportation route using expressways and national highways was done for the two transportation scenarios, i.e. the normal transportation scenario and the transportation accident scenario. The radiation doses were lower than the legal standards in both scenarios.

If the RI wastes and radioactive wastes are transported using the new lad transportation route, proposed in this study, it is believed that assessment that reflects radiation shielding and the nuclide inventory of actual radioactive wastes must be conducted.

REFERENCES

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Table 3. Population and traffic data by section

Section number	Starting and End Points of the Sections	Distance Of section (km)	Adapted Population Density [people/km^2]	Daily vehicle accident occurrence [Acc/day]	Daily traffic [Car/day]	Vehicle accident rate [Occurrence/km Car]
1	Bukdaejeon IC ~ Hoedeok JC	15.64	2,866 (Daedeok-gu)	2.47E-02	74,643	6.12E-09
2	Hoedeok JC ~ Cheongju JC	9.04		5.48E-01	119,200	1.11E-08
3	Cheongju JC ~ Boeun IC	29.3	885 (Cheongju-si)	2.74E-03	38,718	2.54E-10
4	Boeun IC ~ Nakdong JC	50.73	82 (Sangju-si)	2.74E-03	38,718	2.54E-10
5	Nakdong JC ~ Gunwi JC	39.82	682 (Gumi-si)	8.22E-03	23,591	3.71E-09
6	Gunwi JC ~ Hwaseon JC	33.77	110 (Yeongcheon-si)	8.22E-03	23,591	3.71E-09
7	Hwaseon JC ~ Pohang IC	40.5	460 (Pohang-si)	1.64E-02	32,954	3.83E-09
8	Pohang IC ~ Nampo Port IC	14.7		1.10-E02	9,157	8.14E-08
9	Nampo Port IC ~ Donggyeongju TG	20.9		1.37E-02	17,769	4.38E-09
10	Donggyeongju TG ~ Disposal Facility	7.8	196 (Gyeongju-si)	2.74E-03	6,778	5.18E-08

Table 4. Personal radiation dose in a collision accident (considering accident rates)

Section number	Inhalation [mSv]	Resuspension [mSv]	Cloud shine [mSv]	Ground shine [mSv]	Total [mSv]
1	1.81E-17	1.51E-19	1.54E-19	1.84E-18	2.03E-17
2	1.90E-17	1.58E-19	1.61E-19	1.93E-18	2.13E-17
3	4.86E-19	4.04E-21	4.12E-21	4.93E-20	5.43E-19
4	8.41E-19	6.99E-21	7.14E-21	8.54E-20	9.41E-19
5	9.64E-18	8.01E-20	8.01E-20	9.79E-19	1.08E-17
6	8.18E-18	6.82E-20	6.95E-20	8.31E-19	9.16E-18
7	1.01E-17	8.42E-20	8.59E-20	1.03E-18	1.13E-17
8	7.81E-17	6.49E-19	6.63E-19	7.93E-18	8.37E-17
9	5.98E-18	4.97E-20	5.08E-20	6.07E-19	6.68E-18
10	2.63E-17	2.19E-19	2.24E-19	2.68E-18	2.95E-17