Preliminary Study on Optimization of Disposal Facilities Against Human Intrusion

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1. Introduction

It is the preferred option to contain the radwaste and isolate it from the human environment for a long-term management of the radwaste. The concentration and containment of the waste in one location, however, could make future generation be in hazard condition if someone were to disturb the disposed waste.

In this study, protective measures to increase robustness of disposal facilities against human intrusion were proposed on the basis of methodology developed HIDRA project, with the assumption that the intrusion occurs after loss of knowledge of the hazardous nature of the disposal facility.

At first, the assumption regarding disposal facilities and assessment methodology of human intrusion were briefly explained, followed by assessment of potential measure to propose protective measure against inadvertent human intrusion scenarios.

2. Conditions and Assumptions

2.1 Safety framework

It was assumed the safety framework regarding human intrusion were the same as the ones described in references 1 and 2. The important things are as follows. The main purpose of assessing human intrusion is to optimize the disposal facility with higher robustness rather than to check whether the disposal facility satisfies dose constraint. And, protective measures against human intrusion should not jeopardize safety function of the disposal facility.

2.2 Hypothetical Disposal facilities

It was assumed that silo-type geological disposal facility is under operation stage for intermediate-level wastes. The silo which conceptually has diameter of 25 m and height of 50 m, respectively, is located at 100-150 m from the sea level. The radwaste to be composed of contains 10% of long-lives nuclide in terms of radioactivity.

2.3 Premises of human intrusion

It was assumed that human intrusion occurs after loss of knowledge of the hazardous nature of the disposal facility. It is definite that future generation will have advanced technologies than current generation, but it was assumed that future generation would have the level of current technologies to exclude uncertainty induced from speculation. Representative human intrusion scenario were also driven on the basis that future generation would have the same human activities and residential habits as those current generation has.

2.4 Assessment method for optimization

In this paper the methodology to assess human intrusion developed through HIDRA project by IAEA, in which the main purpose to derive protective measure against human intrusion is to make disposal facility robust as an optimization process, was adopted. In this methodology, to derive protective measure, safety framework is defined at first, and then the potential measure on the basis of general measures and specific disposal system is derived. Finally, the potential measure is accepted as protective measure after assessing the conflict with safety function of the facility, implementation of the potential measure, and effectiveness of the reduction of potential for and/or consequence of human intrusion. Here, general measures means all kinds of measures which can be considered as a potential measure. And, the potential measure means appropriate candidate to derive eventual protective measure. Please refer to references 1 and 2 for more detailed information.

3. Scenario and Potential Measures

3.1 Human intrusion scenario

Drilling scenario was considered as a representative human activity. Drilling a borehole through disposal facilities results in radwaste or contaminated material to be brought to the surface. This activity can causes acute exposure to the borehole driller and field scientists. If the radwaste or contaminated material is spread to a farmland, it can also cause chronic exposure to residents who could ingest crops and vegetable cultivated on contaminated soil.

3.2 Potential measures

Two plausible potential measures were considered: one is transmute long-lived nuclides in waste and the other is implement 2.5 m-thick reinforced concrete slab beneath ground surface. The former one is transmute long-lived radionuclides contained in radwate by using accelerator or nuclear reactor to

reduce radioactivity and hazard of radwaste itself. The latter one is install implement 2.5 m-thick reinforced concrete slab beneath ground surface just over silo-type disposal facility. A reinforcing rod frame installed to prevent drill bit from intruding the concrete silo is contained within concrete. The total thickness of the reinforced concrete is 30 cm and it is installed at a depth of 2 m from the ground surface. The diameter and pitch of each mesh to compose of the reinforcing rod frame are 1 cm and 5 cm, respectively. The rod frame is composed of 8 mesh plates that are staggered by 5 cm each. Fig. 1 shows conceptual drawing representing geological disposal facility with reinforced concrete slab.

Table 1. Potential Measures

ID	Candidate Potential Measures
PM-1	Transmutation of long-lived nuclides in radwaste
PM-2	Insertion of a 2.5 m-thick reinforced concrete slab over near surface

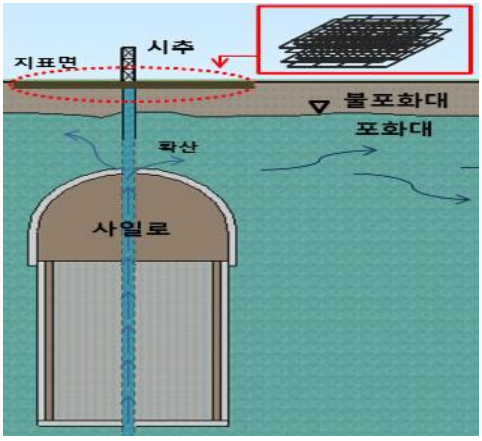

Fig. 1. Conceptual Drawing of Facilities.

4. Derivation of Protective Measures

According to references 1 and 2, protective measure is derived through four steps. In this paper, however, the last 4th step was only considered.

First, it was assessed whether PM-1 could be accepted as a protective measure. According to the data announced in Scottland, the probability of installing a borehole at a depth of 150 m and 250 m are 1.5×10^{-10}/m^2-yr and 7×10^{-11}/m^2-yr, respectively. Therefore, increasing the depth of the silo by 100 m can be a highly effective protective measure in terms of reducing the likelihood of human intrusion. However, since the construction of silos is already completed, this potential measure can't be a adopted as measures in terms of implementation.

According to the assessment methodology of human intrusion developed by HIDRA project, protective measure is identified until an appropriate protective measure is derived. Therefore PM-2 was assessed as an iteration process. The method of installing reinforced concrete is to install reinforced concrete with a thickness of 2.5 m at a depth of 2.5 ~ 5.0 m below ground surface. Because of reinforcing rod frame, it is very hard for drill bit with a diameter of 5 cm or more to pass through the silo. Generally, the strength of reinforcing rod is significantly higher than that of ordinary rock. This method can delay and deter the human intrusion into the disposal facilities due to the operation time and the breakage of the drill bit. The next important thing is feasibility of the implementation of PM-2 to geological facility. The reinforced concrete containing reinforcing bars with a depth of 2.5 m below ground surface does not require much cost compared to the cost of construction of the disposal facility. Although the reinforced concrete is installed above the silo containing radwaste, the load from the installed reinforced concrete is negligible. Therefore PM-2 does not jeopardize safety function of geological disposal facility. Therefore, it is reasonable to adopt reinforced concrete over the footprint of the silo as a protective measure to reduce the risk of human intrusion.

5. Summary and Conclusion

In this paper, protective measure against human intrusion was derived on the basis of assessment methodology developed by HIDRA project, for an optimization of geological disposal facility. Only drilling human intrusion scenario and the 4th step for the derivation of protective measure were considered. Feasibility of implementation, economic cost, and conflict with safety function were considered when the potential measure was assessed qualitatively. As a result, installation of reinforced concrete over concrete silo was adopted as protective measure. In this paper, the protective measure was derived through simple qualitative consideration, but the implementer should submit comprehensive safety case for the derivation of protective measure against human intrusion to support their justice.

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