Preliminary Evaluation of the Human-Induced Hazard for Site Selection of the KIJANG Research Reactor

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1. Introduction

Korea Atomic Energy Research Institute (KAERI) has launched a project to construct a new research reactor called KIJANG research reactor at the Kijang-gun Chwadong-ri 47, Busan Korea (Fig. 1). The thermal power of reactor is being designed less than 20 MW and it has multiple functions like as Fission Moly radio-isotope, Neutron transmutation Doping and fast neutron flux irradiation [1].

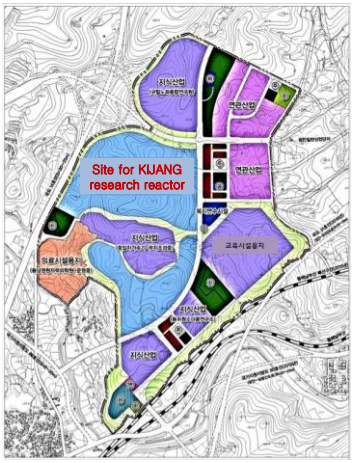

Fig. 1. Site plan for the KIJANG research reactor.

Article 8 (impact of man-made accident), ordinance of the Nuclear Safety and Security Commission(NSSC), requires that research reactor structures should be appropriately protected against dynamic effects coming from potential hazards from nearby industrial, transportation, and military facilities. The purpose of this study intends to provide preliminary evaluation on human-induced hazards, which may exclude potential site locations with construction of reactor facilities. The site evaluation shall be done through the architect engineering in near future.

2. Methods and Results

The preliminary evaluation report by Korea Development Institute (KDI) had assessed contents over geography, demography, and human-induced hazards at 2011 [3]. However, the reactor location and regional condition were locally changed since and it is required to re-evaluate the contents.

2.1 Geography and Demography

The site location was first evaluated based on its geography and demography. Exclusion Area Boundary (EAB) was most probably within 200 m radius of reactor center considering the nuclear source term and the ground release condition regarding the design basis accident. Low Population Zone (LPZ), which is to protect the resident in case of accidents, was determined to be 540 m by referring to the LPZ radius of 'Hanaro' research reactor located in Daejeon. When evaluating Population Center Distance (PCD) [2], the closest city with the resident more than 25,000 is Kijang-eup, which has more than 50,000 populations. Then, it is 8 km distant as shown in Fig. 2, satisfying the distance requirement, satisfying at least 4/3 times of the distance of LPZ boundary from the reactor.

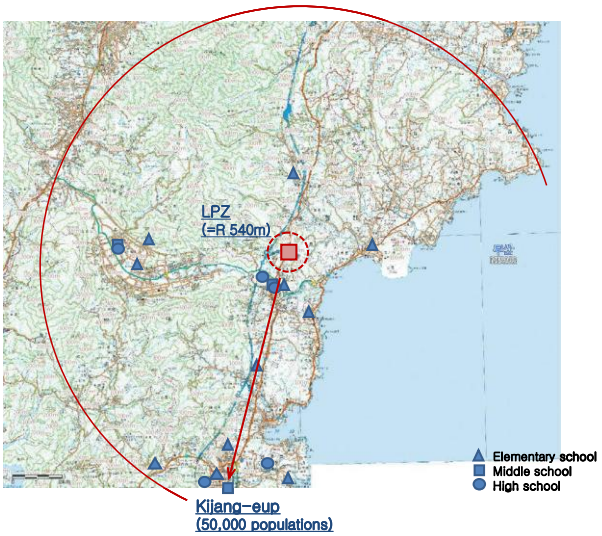

Fig. 2. Distance requirement of LPZ boundary from the reactor.

2.2 Evaluation on potential hazards of gas stations

The KDI investigated potential hazards of explosive storages at radius of 10 km from the site [3]. The results showed that there were no large fuel storages or facilities threatening safety of the research reactor except of small gas stations. Even if it is not necessary to consider those small gas stations, it was assessed on

conservative assumption in this study. Fig. 3 shows gas stations within 10 km radius from the site. The closed one is Sun-am gas station in 1.0 km distant south-west side (Fig. 4). Then, explosion at storage can be evaluated by the equation [4],

$$R \geq k\, W^{1/3}$$

where R is safety distance(m) and W in kilograms, k=18 (unit constant).

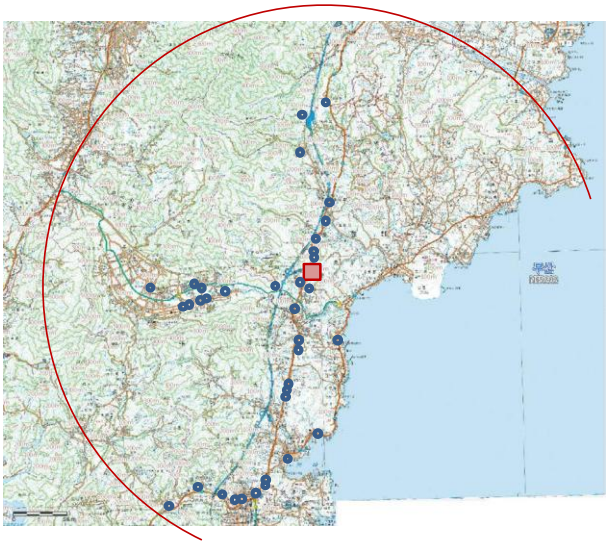

Fig. 3. Gas stations in 10 km radius from the site

For solid substances not intended for use as explosives but subject to accidental detonation, it is conservative to use a TNT equivalent of one [4] and Table 1 shows TNT equivalent weights to calculate safe distance from this gas station.

Table 1: TNT equivalent weights conversion

	Gas	Diesel	Kerosene
Capacity	40,000 ℓ	290,000 ℓ	30,000 ℓ
Specific gravity	0.75	0.80	0.8
TNT equivalent weight	30,000 kg	232,000 kg	24,000 kg

Therefore, total equivalent TNT weight is 286000 kg and R=1.2km (~1.0 km)

If necessary, engineered-safety-feature equipment and protecting of reactor structure be to be provided to lessen the likelihood and severity of the accidents.

2.3 Evaluation on potential explosion on transportation route

For early site selection, the risk of damage due to an explosion nearby transportation routes was also assessed in this study. The closed highway is Busan-Ulsan highway which is 1 km distant (Fig. 4). The Korean regulation specifies the maximum hazardous solid cargo for a single highway truck is 25 ton,

$$R = 18 \times (25{,}000)^{1/3} = 526 \text{ m}$$

Separation distance (= 1 km) is sufficiently great from even the maximum explosive incident. Also, Fig. 4 shows that the closed railway is 800m distant from the reactor site. The maximum loaded cargo in a single railroad box car is 50 ton,

$$R = 18 \times (50{,}000)^{1/3} = 663 \text{ m} < 800 \text{ m}$$

Fig. 4. Closest distance from the gas station and transportation routes

3. Conclusions

Human-induced hazards were evaluated to provide preliminary data in selection of site for the KIJANG research reactor. The results clearly show that 1) the current site location satisfies the distance requirement from PCD, 2) the site is appropriately separated from the closest gas station, and 3) the explosion from near transportation route will not affect the safety of reactor structures. In addition, it should be noted that the future populations need to be projected to the end of the reactor life in evaluation of safety distance from PCD. If explosive cargos are transported through connected vehicles, the possibility of explosion from more than one vehicle should be considered.

Finally, the detailed site evaluation shall be done through the architect engineering stage and it shall be approved by the regulatory body.

REFERENCES

[1] S.I. Wu, I.C. Lim, S.Y. Oh and J.J. Ha, Launching of a New Research Reactor Project in Korea, IGORR, 2012
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[3] KDI Report for Construction Project of a New Research Reactor, 2011.
[4] Regulatory Guide 1.91, Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants.