Development of the radioactive waste risk volume verification method

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1. Introduction

Since 2008, 20 commercial nuclear power plants have been operating and massive High Level radioactive Waste (HLW) including nuclear spent fuels are generating. Therefore, construction of a long-term dry storage facility is necessary. Decay heat emitting from HLW, as well as radiation emitting, is a important parameter on step of designing of a long-term dry storage facility. Because it could affect the structural and environmental safety of compartments in a storage facility, such a nuclear spent fuel storage canister and a circumstance. So development of a reasonable thermal safety analysis method is required.

2. Methods and Results

For this research, we analyzed the forms and characteristics of various types of dry storage facilities in different countries. In principle we must perform a thermal analysis for each form of storage facilities. However, we don't have any established standards for forms of long-term dry storage facilities for intermediate storage of spent nuclear fuel. Accordingly, we created three models of ground type, underground type, and cave-type long-term dry storage facilities that use natural convection cooling and air as filling gas based on the location of the cooling system of various commercialized long-term dry storage facilities, and analyzed the important parameters that can give thermal effect for each model.

2.1 Ground type long-term dry storage facilities

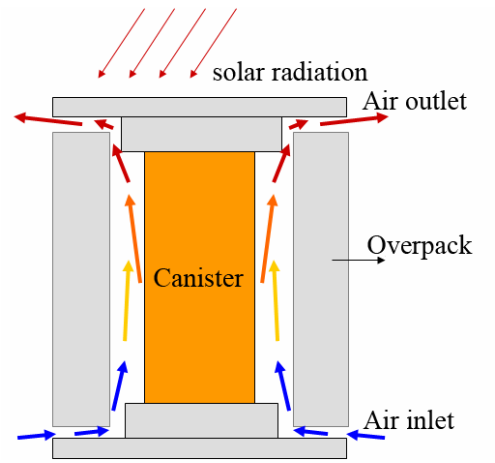

Fig. 1. Ground-type Long-term Dry Storage Facility Model

The ground type long-term dry storage facilities are ground facilities for high-level radioactive wastes that use natural convection cooling system. The outer walls of canisters that pack wastes are cooled by the air buoyancy caused by the temperature difference with external air, and an overpack for radioactive shielding is installed. Because they are installed above ground, they are affected by solar radiation and air temperature. See Figure 1.

2.2 Underground type long-term dry storage facilities

The underground type long-term dry storage facilities are underground facilities for long-term dry storage of high-level radioactive wastes which have applied the dry well method and uses natural convection cooling system. The outer walls of canisters that pack wastes are cooled by the air buoyancy caused by the temperature difference with external air. External air is sucked in through air inlets on ground and discharged after cooling canister. Because they are installed underground, they are less affected by solar radiation and have thermal gain due to the low ground temperature. See Figure 2.

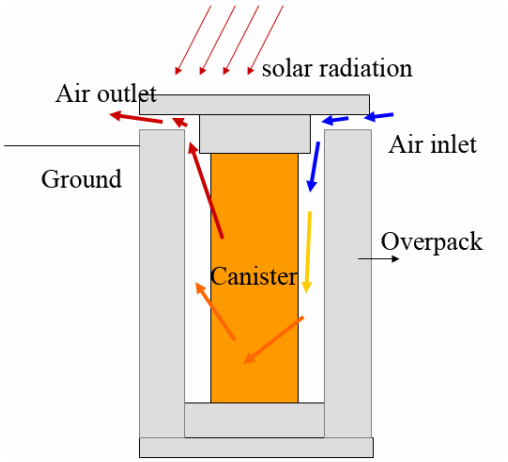

Fig. 2. Underground-type Long-term Dry Storage Facility Model

2.3 Cave-type long-term dry storage facilities

The cave-type long-term dry storage facilities are being used in countries that have many mountain areas such as Switzerland and store high-level radioactive wastes in vault-type modules or canisters in a cave. They use natural convection cooling system. The buoyancy generated from the decay heat from canisters

of high-level radioactive wastes in a cave causes a pressure difference between the inside and outside of the cave, which sucks in external air while the heated air is discharged to ground through the air outlet of the cave. Because they are installed in a underground cave, they are not affected by solar radiation, and can improve storage density of high-level radioactive wastes compared to other facilities due to the low temperature effect of rocks. See Figure 3.

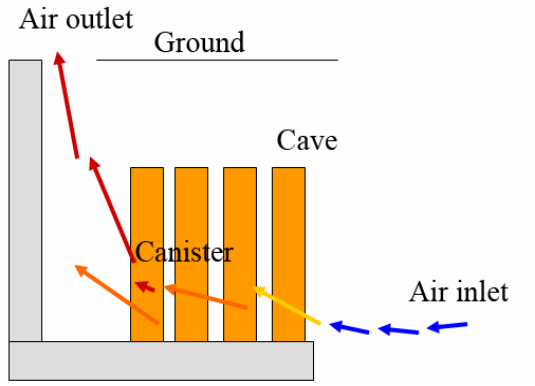

Fig. 3. Cave-type Long-term Dry Storage Facility Model

3. Conclusions

Thermal safety analysis method for the HLW long term dry storage development in this research can be applied to designing of the spent nuclear fuel dry storage facility. Moreover, it will be useful for the interim storage site selection and policy making not only from the enhancement of the reliability by settling the public uneasiness and deficiency of understanding which is occurring from site selection of the interim storage but also from contributing for possessing the prominent technology in view of safety.

REFERENCES

[1] "Operation and Maintenance of Spent fuel Storage and Transportation Casks/Container", IAEA-TECDOC-1532, IAEA(2007).
[2] Seung-Woo Lee, Dong-Keun Cho, Jong-Woo Choi, Heui-Joo Choi, "Burnup and Source Term Analyses for a CANDU Spent Fuel", Transactions of the Korean Nuclear Society Autumn Meeting(2007).
[3] 최희주 외, "고준위폐기물 처분기술/처분시스템 개발", KAERI/PR-2765/2006, 한국원자력연구원(2006).
[4] "Optimization Strategies for Cask Design and Container Loading in Long Term Spent fuel Storage", IAEA-TECDOC-1523, IAEA(2006).
[5] 조동건, "심지층처분시스템 설계를 위한 기준 사용후핵연료 선정 및 선원항 평가", KAERI/TR-3084/2005, 한국원자력연구원(2005).
[6] 서중석, 박주완, "사용후핵연료 저장시설의 열해석 기법", KAERI-NEMAC/AR-21/94, 한국원자력 부설 원자력환경관리센터(1994).