Long-term Projection of Spent Fuel Arising in Korea

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1. Introduction

Projection of spent fuel arising from nuclear power plant is crucial to set up spent fuel management plan and to evaluate the economics depending on management strategies. However, the prediction process is not only closely related to technical variables, such as plant capacity, average burn-up, initial enrichment, thermal efficiency, but also economical factors including economic growth rate, electricity requirements, fraction of nuclear power capacity and so on. Therefore, clear and careful assumptions should be made to give a better understanding on the forecasting results. In this study, based on "The 3rd Basic Plan of Long Term Electricity Supply and Demand"[1] and the proper assumptions, the amount of the spent nuclear fuel generated from NPPs until 2050 is predicted.

2.Basic Assumptions

Projection of the spent fuel arising can be carried out based on the fraction of nuclear power capacity which has a close relation to economic growth rate, electricity requirements and power plant capacity margin and so on. All data used to evaluate the accumulated amount of spent fuel between 2006 and 2020 referred from "The 3rd Basic Plan of Long Term Electricity Supply and Demand." The basic assumptions to prospect the spent fuel arising from 2021 to 2050 are as follows

i) Operation period of existing NPPs is determined by the sum of design life and licence renewal period.
- Kori #1and Wolsung #1 : 50 years (Design life : 30 years, Licence renewal : 20 years)
- Other units : 60 years (Design life : 40 years, Licence renewal : 20 years)

ii) NPPs which will be decommissioned after 2020 is replaced by APR+ (1600 MWe).
iii) Construction and decommissioning are occurred at the same year.
iv) The spent fuel from newly constructed NPP is generated after one year of operation.

3. Projection of Spent Fuel Arising

3.2 Description of Projection Process

Although the exact amount of spent fuel after a given period of operation can be evaluated using a fuel depletion calculation code like Origen-S, it is time consuming process to prospect the long-term spent fuel arising for overall NPPs in Korea. Therefore, we used the simplified equation to calculate the annul amount of discharged spent fuel as follow[2]

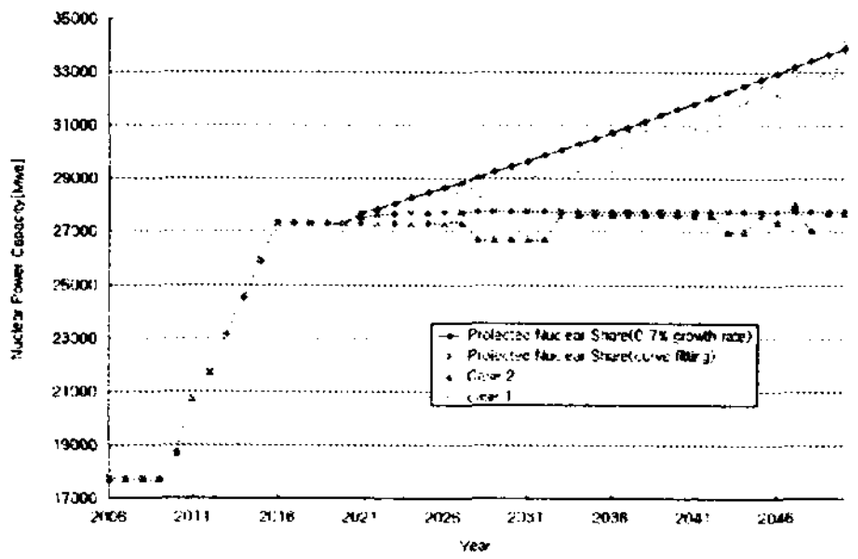
$$AFD[tHM/yr] = \frac{(Capacity/Efficiency) \times 365 \times Availability}{AverageBurnup}$$

where AFD = Annual amount of spent fuel discharged in a year[tHM]
Capacity= Nuclear power plant capacity in MWe,
Efficiency = Thermal efficiency of NPP(0.35 for PWR and 0.33 for PHWR)

Availability =0.9 for PWR and PHWR
Average Burnup= NPP's annual average burnup in MWD/MTU

The introduction plan of high burnup fuel for existing NPPs was considered for more realistic prediction. As for newly constructed NPPs after 2010, it is assumed that high burnup fuel will be loaded from the start-up. For the comparison of projection results, two cases of spent fuel arising scenarios were established as follows(see Figure 1).

Case 1: 0.7% annual growth of nuclear power capacity from 2020 to 2050
Case 2: Saturation after an uncertain period of years (Curve fitting of growth rates until 2020)



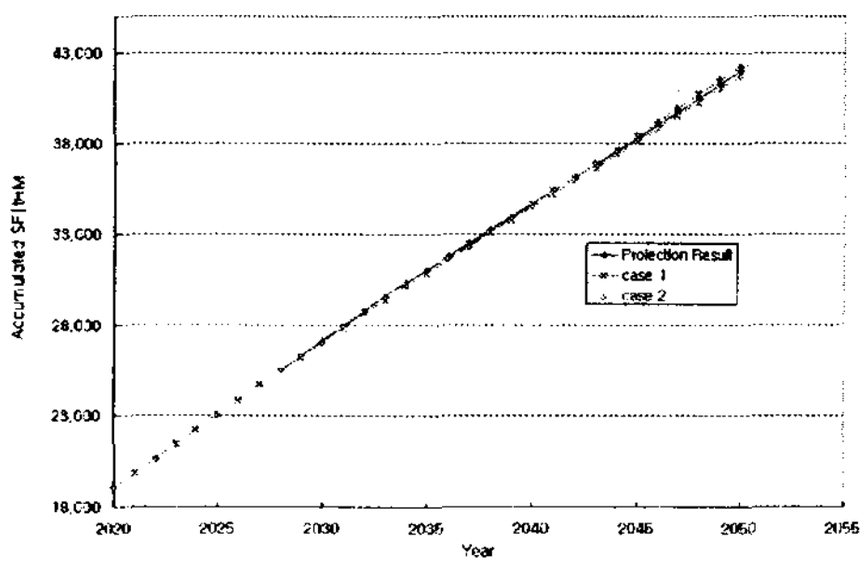


Figure 1. Nuclear power pool growth scenarios.

Figure 2. Projection of spent fuel arising.

3.2 Results

As shown in Figure 2, the amount of PWR spent fuel in 2050 was calculated as 22,037 tHM and 19,995 tHM for PHWR. In case of PHWR spent fuel, because there is no construction plan for the new type of PHWR, the spent fuel arising is same for the rest of cases. If the nuclear power capacity is saturated, the accumulated amount of PWR spent fuel is 22,296 tHM and it becomes 22,037 tHM for the continuous growth case.

4. Conclusions

By using "The 3rd Basic Plan of Long Term Electricity Supply and Demand," and assuming APR+(1600MWe) replaces the decommissioned NPPs, the spent fuel arising until 2050 was predicted. Two types of nuclear power pool growth scenarios, 0.7% continuous growth and saturation after several years, were compared with the above projection and it showed that there is no big difference between the calculation results(refer Fig. 2). Therefore, the prediction result showed the feasibility that it could be used as the raw data for the back-end fuel cycle related studies.

REFERENCES

[1] Ministry of Commerce, Industry and Energy, "The 3rd Basic Plan of Long Term Electricity Supply and Demand," Dec. 12, 2006

[2] IAEA, International Symposium on Nuclear Fuel Cycle and Reactor Strategy: Adjusting to New Reality, Key Issue Papers, Vienna, 1997.