Development of a computer program for the cost analysis of spent fuel management

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1. Introduction

So far, a substantial amount of spent fuels have been generated from the PWR and CANDU reactors. They are being temporarily stored at the nuclear power plant sites. It is expected that the temporary storage facility will be full of spent fuels by around 2016. The government plans to solve the problem by constructing an interim storage facility soon.

The radioactive management act was enacted in 2008 to manage the spent fuels safety in Korea. According to the act, the radioactive waste management fund which will be used for the transportation, interim storage, and the final disposal of spent fuels has been established. The cost for the management of spent fuels is surprisingly high and could include a lot of uncertainty.

KAERI and Kyunghee University have developed cost estimation tools to evaluate the cost for a spent fuel management based on an engineering design and calculation. It is not easy to develop a tool for a cost estimation under the situation that the national policy on a spent fuel management has not yet been fixed at all. Thus, the current version of the computer program is based on the current conceptual design of each management system.

The main purpose of this paper is to introduce the computer program developed for the cost analysis of a spent fuel management. In order to show the application of the program, a spent fuel management scenario is prepared, and the cost for the scenario is estimated.

2. Assumptions and Structure

Since the characteristics of spent fuels are different from each other, the number of nuclear power reactors should be fixed. According to the government policy on an electricity supply, it was planned to introduce a total of 28 reactors. We assumed 20 PWRs, 4 CANDU reactors, and 4 APRs.

National time schedule for the spent fuel management is not yet fixed. Thus, temporarily it is assumed that the interim storage will start from around 2016 and the final disposal of CANDU spent fuel will start in 2041. The location of the interim storage site and the Final Repository (FR) site are assumed to be close and on the coastline of the Korean peninsula.

2.1. CASE program

The cost estimation is based on the overnight cost. The structure of the spent fuel management cost is as shown in Fig. 1. The computer program, CASE, is composed of three sub-programs, CASK, CA_IS, and CAFÉ. The main function of each program is described briefly in Fig. 1. This program only covers the engineering cost related to a spent fuel management. MS Visual Basic and MS SQL are used to develop the CASE program.

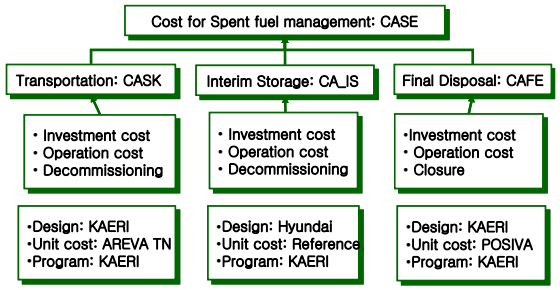

Fig. 1. Structure of the CASE program.

2.2. CASK program

This program can analyze the logistics of spent fuels and provide a cost estimation for a spent fuel transportation [1]. The logistics analysis between the sites is carried out by solving the following mass balance equation (1):

$$\frac{\partial F_i}{\partial t} = S_i + \sum_j k_j F_j - \sum_i k_i F_i \qquad (1)$$

A sea transportation between the nuclear power plant sites and the Centralized Interim Storage Facility (CISF) and a road transportation between CISF and FR are assumed. Fig. 2 shows an input window of the CASK program.

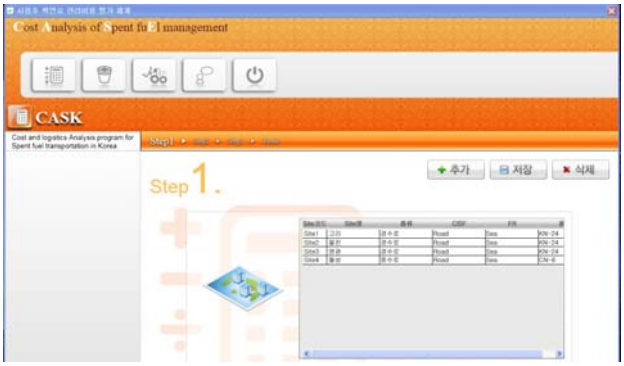

Fig. 2. An input window of the CASK program.

2.3. CA_IS program

This program calculates the cost for the Interim Storage of CANDU and PWR spent fuels, respectively. In this program only a dry storage of spent fuels is considered. The Interim Storage Facility can be located at reactor sites or at a Centralized site.

Fig. 3. An example of CA_IS program window.

2.4. CAFÉ program

This program is developed to calculate the final disposal cost of the spent fuels based on the Korean Reference disposal System for spent fuels (KRS) [2]. The KRS is a geological disposal system with the Swedish KBS-3 concept (Fig. 4).

Fig. 4. Korean Reference disposal System.

3. Scenario and Analysis

A scenario for the spent fuel management was illustrated to demonstrate the application of the developed computer program, CASE. In this scenario, we assume the CANDU spent fuel disposal will start from 2041 for 25 years and the PWR spent fuel disposal from 2066 for 52 years. Fig. 5 shows the scenario.

Spent fuel arising from the 28 reactors is estimated by using the CASK program in CASE, and the annual transportation rates are determined through a logistics analysis (table 1). The capacity of the CISF is recommended. The costs for a transportation, interim storage, and final disposal are obtained by using a computer program, CASE.

Table 1. Transportation rates from the CASK program

원전 부지	분석 결과	1단계	2단계	3단계
영광	시작연도	2016	2066	
	종료연도	2040	2086	
	운반물량	100 톤/년	116.3 톤/년	
고리	시작연도	2016	2066	
	종료연도	2065	2085	
	운반물량	112 톤/년	109.9 톤/년	
월성	시작연도	2066		
	종료연도	2080		
	운반물량	108.6 톤/년		
울진	시작연도	2016	2041	2066
	종료연도	2040	2065	2085
	운반물량	120 톤/년	120 톤/년	108.3 톤/년
월성 CANDU	시작연도	2016	2041	
	종료연도	2040	2065	
	운반물량	280 톤/년	349.3 톤/년	

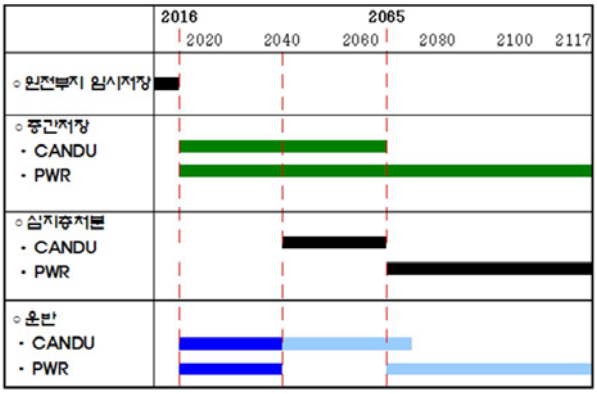

Fig. 5. Spent fuel management scenario for illustrating the CASE program.

4. Conclusion

A computer program, CASE, consisting of three sub-programs, CASK, CA_IS, and CAFÉ, has been developed for a cost estimation of spent fuel management. The program is developed by using MS Visual and MS SQL language for improving the GUI. The three subprograms are based on the preliminary conceptual design of the facilities. A scenario was analyzed for the illustration of the program.

Acknowledgement

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REFERENCES

[1] Heui-Joo Choi, , Jeong-Hun Cha, and Jongwon Choi, Development of a Computer Program for the Analysis of Logistics of PWR Spent Fuels, J. of the Korean Radioactive Waste Society, Vol.6(2), pp. 147-154 (200).

[2] Jong Youl Lee, Dongkeun Cho, Heui-Joo Choi, and Jongwon Choi, Concept of a Korean Reference Disposal System for Spent Fuels, J. of Nuclear Science and Technology, Vol. 44(12), pp.1565-1573 (2007).