Suggestion of Contingency Application Criteria for Nuclear Power Plant Decommissioning Cost Estimation

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1. Introduction

Many nuclear power plants (NPPs) around the world are about to be decommissioned. Accordingly, at domestic and overseas, NPP decommissioning cost estimation is being carried out, and related research is being conducted continuously. The NPP decommissioning cost estimation is different from the actual cost due to the lack of basic data and the difficulty of realizing the variables that occur during the decommissioning process.[1] Contingency is applied to solve the uncertainty in the decommissioning cost estimation and to ensure adequate funds for decommissioning. However, contingencies depend on the estimation of the estimator and are the least well understood cost internationally. Therefore, a clear explanation is required in relation to each application and limitations.[2] In this study, the contingency standard is suggested based on the comparison of the AIF/NESP-036 report criteria and the actual NPP decommissioning cost estimations.

2. Definition of Contingency

The definition of contingency is as follows in Advancement of Cost Engineering International (AACEI). An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs.[3] The definition of contingency as used in the ISDC is “specific provisions for unforeseeable elements of cost within the defined project scope”.[4] Typically estimated using statistical analysis or judgement based on past asset or project experience.[3] Contingency is applied either as a single value to the total cost or as a multi-valued percentage for each line item of the estimate and then added together with the total cost.[5]

There are four types of contingency: Contingency related to the man-hour calculation, experience based cost estimations, organization, and other costs. For each, it is estimated as a percentage value, and the cost is recalculated by taking into account the cost contribution for each ratio. [6]

3. Standard and Examples for Application of Contingency

The AIF/NESP-036 report suggested the standard for the contingency, and the US NRC designated 25% of the total cost as the contingency. Also, in the OECD/NEA report, 30% of the total cost was calculated as a contingency in the ordinance on the decommissioning of nuclear facilities and the waste management. The AIF/NESP-036 report suggests the application of contingency as shown in Table 1.[7]

Table 1: Contingency in the AIF/NESP-036 report

Decommissioning process	Contingency (%)
Engineering	15
Utility (Energy) and DOC Costs	15
Decontamination	50
Remove Contaminated Instruments	25
Contaminated Concrete Removal	25
Steam generator, pressurizer, and circulation pump removal	25
Reactor Removal (Dismantling)	75
Reactor (waste) packaging	25
Reactor (waste) transport	25
Reactor (waste) disposal	50
Radioactive waste packaging	10
Transport of radioactive waste	15
Radioactive waste disposal	25
Non-contaminated device removal	15
Supply/Consumables	25

Sweden's Svensk Kärnbränslehantering AB (SKB) company prepared a process-specific contingency for the decommissioning of the Oskarshamn NPP, a BWR type, in accordance with the OECD/NEA format.[6] TLG presents the cost estimation for two scenarios, DECON and SAFSTOR. Table 2 shows the average values and ranges of the contingencies applied by TLG when estimating the cost of decommissioning NPP. For the BWR type Columbia Generation Station and Oyster creek, Monticello, and the PWR type Crystal River Unit 3, the contingencies according to the decommissioning process for each scenario are summarized. The numbers in square brackets are the contingencies applied to the PWR NPP.

Through this, it was possible to confirm the application rate for each decommissioning process through the contingency standards and case review. For BWR and PWR NPPs, there is a difference between the large component removal process and the license termination process. The contingencies were derived as shown in Table 3 according to the ISDC format. For the PWR NPP, average value of contingency from the AIF/NESP-036 report and TLG were used. Also, for the BWR NPP, average value of contingency from SKB

and TLG were used. Each average value was matched with the each operation for a total of 11 processes of ISDC. Then, by deriving the average value of each contingency ratio, the average value for the contingency ratio applicable to each process was presented. For the PWR, an average was not derived because of the different decommissioning scenarios.

Table 2: Contingency by process for each TLG decommissioning scenario

(Unit:%)

Scenario	DECON		Scenario	SAFSTOR	
NPP	Columbia, Oyster creek, Monticello (BWR)		NPP	Columbia, Oyster creek (BWR), [Crystal River Unit 3 (PWR)]	
Decommissioning process	Average	Range	Decommissioning process	Average	Range
Pre-Shutdown Early Planning	13	13	Pre-Shutdown Early Planning	13	13
Shutdown through Transition	13	13	Shutdown through Transition	13	13
Decommissioning Preparations	15	14~16	SAFSTOR Limited DECON Activities	18	17~19
Large Component Removal	19.67	19~21	Preparations for SAFSTOR Dormancy	14	14
Site Decontamination	16	15~18	SAFSTOR Dormancy with Wet Spent Fuel Storage	13 [8]	13 [8]
Spent fuel delay prior to SFP decon	13	13	SAFSTOR Dormancy with Dry Spent Fuel Storage	13 [13]	13 [13]
Decontamination	15.67	15~16	SAFSTOR Dormancy without Spent Fuel Storage	7.5 [12]	3~12 [12]
License Termination	16.67	16~18	Reactivate Site Following SAFSTOR Dormancy	14 [13]	13~15 [13]
Site Restoration	13	13	Decommissioning Preparations	14 [15]	13~15 [15]
Fuel Storage Operations/Shipping	12.33	12~13	Large Component Removal	14.5 [20]	13~16 [20]
GTCC shipping	13.33	12~14	Site Decontamination	17 [15]	17 [15]
ISFSI Decontamination	18	14~20	License Termination	17.5 [2]	17~18 [2]
ISFSI Site Restoration	13	13	Site Restoration	13 [13]	13 [13]

Table 3: Average value of contingency by decommissioning process

Decommissioning Process	PWR		BWR		
	AIF /NESP (%)	TLG (%)	SKB (%)	TLG (%)	Total average value(%)
01 Pre-decommissioning activities	15.00	8.50	10.00	14.89	12.45
02 Facility shutdown activities	-	11.50	15.00	13.00	14.00
03 Additional activities for safe enclosure	50.00	15.00	-	15.84	15.84
04 Dismantling activities within the controlled area	37.50	20.00	13.00	19.67	16.34
05 Waste processing, storage and disposal	25.00		13.00	-	13.00
06 Site infrastructure and operation	-		15.00	-	15.00
07 Conventional dismantling, demolition and site restoration	15.00	13.00	15.00	13.00	14.00
08 Project management, Engineering and support	-		17.00	-	17.00
09 Research and development	-		-	-	-
10 Fuel and nuclear material	-		-	13.93	13.93
11 Miscellaneous expenditures	-		29.00	-	29.00

In the actual cost estimation, the contingency can evaluate 9 items for the application of the contingency.[2]

4. Conclusion

Currently, many NPPs at domestic and overseas are about to be decommissioned. At this time, the results of the NPP decommissioning cost estimation have uncertainty, and contingencies are reflected in order to compensate for this. However, it is difficult to determine an appropriate contingency due to the lack of actual decommissioning experience data and cost estimation. In addition, the contingency may vary depending on the method and standard of the person who calculates it. Therefore, it is necessary to present a standard for this, and a clear explanation of how to apply the contingency is required. In this study, the average value of the contingency for each process was derived from the contingency standards suggested by various organizations and the cost estimation data of TLG, which actually evaluated the cost of decommissioning NPPs. It is judged that this will become the standard for applying the contingency for each process in countries with no experience of decommissioning. In addition, it is judged that it will be helpful for clear cost estimation by reviewing the suggested contingency application checklist after cost estimation. However, due to the lack of cost estimation data, it was not possible to present the criteria for applying the contingency for PWR. If data from the cost estimation results for PWR NPPs are incorporated in the future, it is judged that it will be possible to present a clear contingency standard for PWR NPPs.

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ACKNOWLEDGEMENT

This study was supported by the Korea Institute of Energy Technology Evaluation and Planning (KETEP No. 20204010600130 and No. 20191510301180) and the Ministry of Trade, Industry & Energy (MOTIE) of the Republic of Korea.