

Considerations in Unit Cost Factor Development for Nuclear Power Plant Decommissioning Project

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1. Introduction

The accurate cost estimate is one of the basic elements for the successful execution of the projects. Following the permanent shutdown of Kori Nuclear Power Plant unit 1, touched in June 2017, the decommissioning work is emerging as one of the hottest social issues. In preparation for it, this paper surveys the concept of Unit Cost Factor (UCF) and its application example in foreign decommissioning cases. Finally this paper suggests the key points to be considered during the development of UCFs for the domestic decommissioning projects.

2. Main Discussion

2.1 Concept of UCF

The UCF method is widely used in cost estimating to simplify the estimation for a large number of plant inventory items (pipe, valves, pumps, tanks, etc). UCFs are developed in terms of hours of the mixed labor crew to perform an activity (such as removal) per unit of measure (such as each, ton, m², etc). Then, with the given hourly rates of the crew and equipment, the total cost for the unit of measure can be estimated [1].

2.2 Examples of UCFs in domestic general construction projects

In domestic construction projects, UCFs are referred to as “Ilwidaega” and the formalized tables with detailed input of the required material, laborers, their quantities and prices are referred to as “Ilwidaegapyo” as shown in Table 1.

Table 1. Example of UCF in domestic construction projects

Item	Spec.	Unit	Quantity	Unit Price	Amount	
1. Materials	Ziin Interior Film	FW Grade	m ²	1.1	15,000	16,500
	sub-total					16,500
2. Subsidiary Materials	Primer	PM02	kg	0.08	20,000	1,600
	Thinner	Samwha A-7	kg	0.16	7,000	1,120
	Putty	Poly Putty	kg	0.08	5,000	400
	sub-total					3,120
3. Laborer	Helper	Priming	MD	0.07	80,000	5,600
	Handyman	Cutting	MD	0.07	100,000	7,000
	Technician	Filming	MD	0.07	130,000	9,100
	sub-total					21,700
Total						41,320

2.3 Examples of UCFs in foreign decommissioning projects

In the decommissioning cost analyses for the nuclear power plants in United States, about 150 UCFs have been used. The report lists those UCFs as extracted in Table 2 and describes the detailed elements of a sample UCF as shown in Table 3.[2] The sample UCF of “Removal of Contaminated Heat Exchanger smaller than 3,000 lbs” presents 6 sub-activities, their duration, work difficulty factors, required laborers, equipment and consumables for the unit measure of the work.

Table 2. UCF List (part) used in US decommissioning cost analysis

Unit Cost Factor	Cost/Unit (\$)
Removal of Contaminated Pump Moter, 300-1000 pound	738.15
Removal of Contaminated Pump Moter, 1000-10,000 pound	2,374.95
Removal of Contaminated Pump Moter, > 10,000pound	5,364.75
Removal of Contaminated Heat Exchanger < 3000 pound	3,414.57
Removal of Contaminated Heat Exchanger > 3000 pound	9,912.93

Table 3. Detailed Elements of a UCF used in US decommissioning cost analysis [2]

Example: Unit Factor for Removal of Contaminated Heat Exchanger < 3,000 lbs.				
1. SCOPE				
Heat exchangers weighing < 3,000 lbs. will be removed in one piece using a crane or small hoist. They will be disconnected from the inlet and outlet piping. The heat exchanger will be sent to the packing area.				
2. CALCULATIONS				
Activity Description				Critical Duration (minutes)
Install contamination controls, remove insulation, and mount pipe cutters				60
Disconnect inlet and outlet lines, cap openings				60
Rig for removal				30
Unbolt from mounts				30
Remove contamination controls				15
Remove heat exchanger, wrap in plastic, and send to packing area				60
Critical Duration				255
Work Adjustments (Work Difficulty Factors)				
+ Respiratory Protection (25% of Critical Duration)				64
+ Radiation/ALARA (20% of Critical Duration)				51
Adjusted Work Duration				370
+ Protective Clothing (30% of Adjusted Work Duration)				111
Productive Work Duration				481
+ Work break adjustment (8.33 % of Productive Work Duration)				40
Total Work Duration				521
*** Total Work Duration = 521 minutes or 8.683 hours ***				
3. LABOR REQUIRED				
Crew	Number	Duration (hours)	Rate (\$/hr)	Cost
Laborers	3.00	8.683	\$47.52	\$1,237.85
Craftsmen	2.00	8.683	\$61.55	\$1,068.88
Foreman	1.00	8.683	\$65.29	\$566.91
General Foreman	0.25	8.683	\$68.99	\$149.76
Fire Watch	0.05	8.683	\$47.52	\$20.63
Health Physics Technician	1.00	8.683	\$36.57	\$317.54
Total labor cost				\$3,361.57
4. EQUIPMENT & CONSUMABLES COSTS				
Equipment Costs				none
Consumables/Materials Costs				
Universal Sorbent 50 @ \$0.43/sq ft (1)				\$21.50
Tarpaulins (oil resistant/fire retardant) 50 @ \$0.32/sq ft (2)				\$16.00
Gas torch consumables 1 @ \$8.19/hr x 1 hr (3)				\$ 8.19
Subtotal cost of equipment and materials				\$45.69
Overhead & sales tax on equipment and materials @ 16.00%				\$7.31
Total costs, equipment & material				\$53.00
TOTAL COST: Removal of contaminated heat exchanger <3000 pounds:				\$3,414.57
Total labor cost:				\$3,361.57
Total equipment/material costs:				\$53.00
Total craft labor man-hours required per unit:				63.386

2.4 Considerations in UCF Development for domestic decommissioning projects

A systematic and elaborate approach is needed for the UCF development as the domestic nuclear power plant decommissioning task and the cost estimate for it are the critical challenges. The key points to be considered during the UCF development are listed below.

- Review of the UCF Classification
 - Can the existing UCFs cover the whole scope of the decommissioning project?
 - Can the existing UCFs be applied to domestic decommissioning project?
 - Is there any need of adding or re-classifying of the existing UCFs?
 - What about and how to develop the bases and premises of the re-classification of UCFs?
- Review of sub-activities of each UCF
 - Are the existing sub-activities of each UCF are proper, feasible, applicable, and cost-effective in Korea?

- If not, what are the alternatives?
- What are the proper labor crews for each UCF?

- Review of duration of each sub-activity and UCF
 - Collection of and analysis on reference data in US decommissioning cost analyses as many as possible
 - Survey on the existence and productivity rate of domestic standard means of same or similar work type of each sub-activity
 - Study on site characteristics and work difficulty factors for domestic decommissioning site
 - Study of adjustment of existing duration considering the difference between US and domestic labor productivity rates.
 - Set up of our own productivity rate and duration of each sub-activity
- Pilot test program to set up the UCF
 - Pilot test on the specific supposed technics with relevant contractors to survey the feasibility and the productivity
 - Acquisition of test equipment, laboratory and contaminated test samples

3. Conclusion

Through the surveys on the existing UCF and its application example in foreign decommissioning cases, this paper suggests the key points to be considered during the development of UCFs for the domestic decommissioning projects

As the accurate cost estimate is critical in preparing the project, it is highly expected to develop the UCFs of our own through the thoughtful and systematic approach by relevant parties [3].

REFERENCES

- [1] RSCS, KEPCO E&C, Decommissioning Cost Analysis for the Korean pressurized Water Nuclear Power Plant, Final Report, 2009.
- [2] TLG Services, Inc., Decommissioning Cost Analysis for the Vermont Yankee Nuclear Power Station, 2012.
- [3] Wanil Jung, et. al., Development of Level 1 Schedule for Nuclear Power Plant Decommissioning Project in Korea, Korean Radioactive Waste Society 2017 Spring Conference, 2017.