Validation of Decommissioning Engineering System Application against KRR-2

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1. Introduction

Various information systems have been developed and used at decommissioning sites for planning a project, record keeping for a post management and cost estimation [1]. KAERI is the only expert group which has decommissioning experiences and KAERI is trying to develop computer code to converge all the data which has been accumulated during KRR (Korea Research Reactor)-1 & 2 and UCP (Uranium Conversion Plant) decommission. This paper contains validation results of the KAERI DES by using KRR-2 decommissioning data.

2. KAERI DES code

KAERI has been developing DES application program, which includes five individual sub-systems, which are decommissioning facility characterization system, information system, work-unit productivity calculation system, cost estimation system and procedure building system. Figure 1 is KRR-2 decommissioning procedure building screen of KAERI DES. Detail information and data can be assigned at each procedure block by using this user interface.

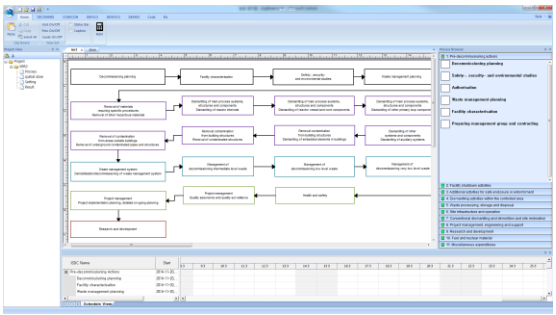

Fig. 1 KAERI DES code

3. Specification of Korea Research Reactor-2

In 1996, it was determined that research reactors, the KRR-1 and the KRR-2, would be shut down and dismantled. A project for the decommissioning of these reactors was launched in January 1997 with the goal of a completion by 2008. The total budget of the project was 19.4 million US dollars, including the cost for the waste disposal and for the technology development. General information of the target reactor presented in the table 1.

Type	TRIGA MARK-III
Operation Hours (hr)	55,000
Total Power(MWh)	69,700
Enrichment(%)	70
Coolant	H_2O

Table 1. KRR-2 Specification

4. Results

KAERI has raw decommissioning data for KRR-1, 2 and UCP, which data was reorganized with respect to International Structure for Decommissioning Costing (ISDC) [3]. Among 11 kinds of first level categories, items listed below were used this calculation.

- Pre-decommissioning actions
- Dismantling activities within the controlled are
- Waste processing, storage and disposal
- Project management, engineering and support
- Research and development

Each major category consists of sub-categories which are listed in the figure 2, for example, Pre-decommissioning actions have 'Decommissioning planning', 'Facility characterization' , 'Safety-, security- and environmental studies' ,'Waste management planning' and 'Authorization'. Summary of calculation results are shown figure 2 and 3.

	Workforce[man,h]	Costs[USD]	Labour costs[USD]
Total Value	178,716	12,381,796	5,112,813
Pre-decommissioning actions	18,900	877,500	562,500
Decommissioning planning	1,800	91,260	58,500
Facility characterisation	10,800	463,320	297,000
Safety-, security- and environmental studies	1,800	84,240	54,000
Waste management planning	1,800	91,260	58,500
Authorisation	2,700	147,420	94,500
Dismantling activities within the controlled area	86,604	3,596,851	2,245,075
Removal of materials requiring specific procedures	10,668	446,134	282,629
Dismantling of main process systems, structures and co...	42,699	1,772,107	1,095,289
Dismantling of other systems and components	14,606	616,020	383,565
Removal contamination from building structures	9,455	378,294	241,245
Removal of contamination from areas outside buildings	9,176	384,296	242,347
Waste processing, storage and disposal	12,912	4,860,765	352,238
Waste management system	3,886	175,398	108,525
Management of decommissioning low level waste	627	372,711	16,938
Management of decommissioning very low level waste	3,186	1,892,911	86,025
Management of decommissioning very short lived waste	3,194	1,897,641	86,240
Management of decommissioning waste generated outsid...	2,019	522,104	54,510
Project management, engineering and support	44,100	2,162,160	1,386,000
Project management	25,200	1,375,920	882,000
Health and safety	18,900	786,240	504,000
Research and development	16,200	884,520	567,000

Fig. 2 Workforce, Total Costs, Labor Costs

	Investment[USD]	Expences[USD]	Contingency[USD]
Total Value	188,470	5,371,834	1,708,681
Pre-decommissioning actions	0	168,750	146,250
Decommissioning planning	0	17,550	15,210
Facility characterisation	0	89,100	77,220
Safety-, security- and environmental studies	0	16,200	14,040
Waste management planning	0	17,550	15,210
Authorisation	0	28,350	24,570
Dismantling activities within the controlled area	48,252	704,051	599,475
Removal of materials requiring specific procedures	1,608	87,542	74,355
Dismantling of main process systems, structures and co...	34,096	347,372	295,351
Dismantling of other systems and components	7,808	121,977	102,670
Removal contamination from building structures	1,351	72,649	63,049
Removal of contamination from areas outside buildings	3,389	74,511	64,049
Waste processing, storage and disposal	140,218	3,913,133	455,176
Waste management system	4,236	33,404	29,233
Management of decommissioning low level waste	3,137	318,753	33,883
Management of decommissioning very low level waste	15,931	1,618,872	172,083
Management of decommissioning very short lived waste	15,970	1,622,918	172,513
Management of decommissioning waste generated outsid...	100,944	319,186	47,464
Project management, engineering and support	0	415,800	360,360
Project management	0	264,600	229,320
Health and safety	0	151,200	131,040
Research and development	0	170,100	147,420

Fig. 3 Investment, Expences and Contingency

4.1 Cost Analysis Results

Figure 4 is pie chart presentation of the total cost share. According to this diagram, it can be noticed that cost driver of KRR-2 type of reactor is waste processing,

storage and disposal (39.3%) and next is dismantling activities within the controlled area (29.0%).

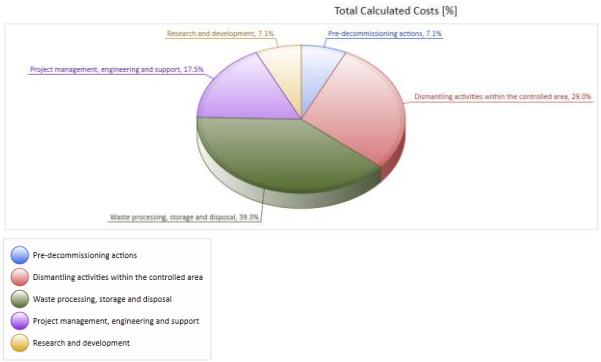

Fig. 4 Pie diagram for the total cost

Total cost of KRR-2 decommissioning in US dollar is shown in figure 5 and about 12 million was estimated.

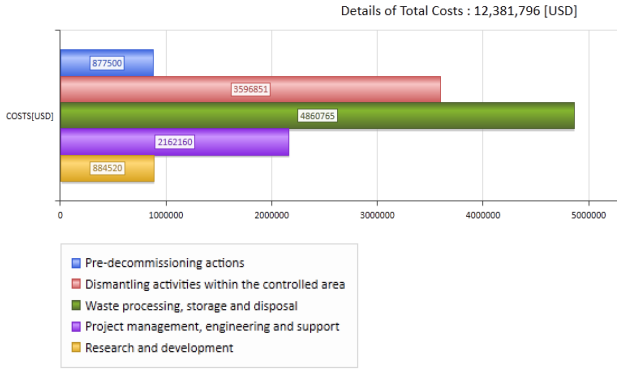

Fig. 5 bar chart for the total cost

In detail, each cost can be break down with labor, investment, expences and contingency cost. Labor cost is major cost driver in most cases, but expences is dominant regarding 'waste processing, storage and disposal.

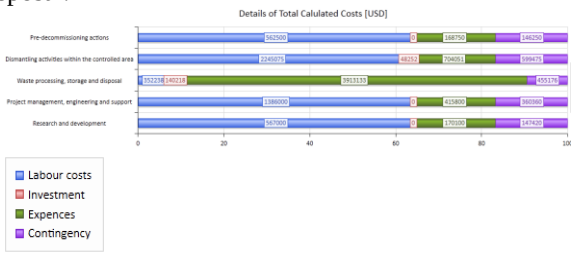

Fig. 6 Detail composition of the total cost

4.2 Workforce Analysis Results

In terms of workforce consumption distribution, Figure 7 shows that dismantling activities within controlled area spends almost half of total workforce (48.5%) and next is project management, engineering and support (24.7%)

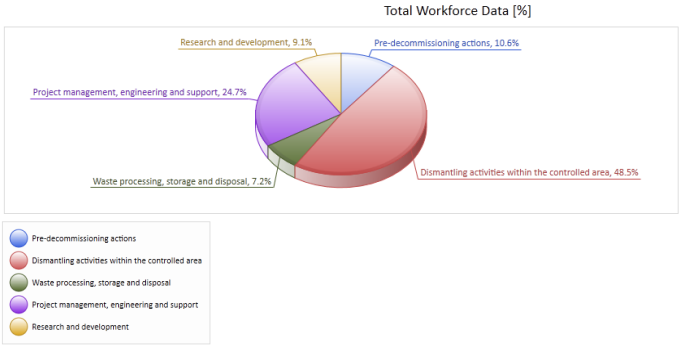

Fig. 7 Pie diagram for the total workforce

In total, 178k man hours are required for KRR-2 decommissioning process. Detail information and composition can be found in figure 8.

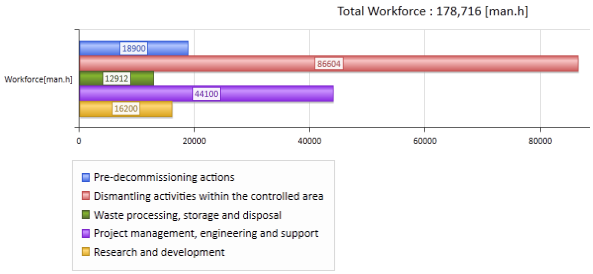

Fig. 8 bar chart for the total workforce

5. Conclusion

As a responsible leading group of Korean decommissioning research field, KAERI has been developing DES application program. One of decommissioning experience data, KRR-2 was used for KAERI DES validation and it successfully is reflected in KAERI DES.

References

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[2] Hyung Gon Jin, S. K. Park, et. al., "Status of the Decommissioning Engineering System Code Development of KAERI in 2014," the Korean Nuclear Society Autumn Meeting Vol.1 (2014).

[3] OECD NEA, "International Structure for Decommissioning Costing (ISDC) of nuclear installations", No.7088 (ISBN 978-92-64-99173-6)