

Typical cost analysis of I&C System Upgrade for NPPs in Korea

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1. Introduction

About 450 nuclear power plants are operating in the world and almost half of these nuclear power plants are at least 20 years old. Most existing I&C(Instrumentation and Control) systems in nuclear power plants throughout the world were built with analog equipment and relays that were designed 30 to 50 years ago[1]. And among these nuclear power plants many utilities are needed to modernize their I&C systems due to obsolescence and aging etc. Due to the upgrade characteristics of High cost and long term, in-depth feasibility study with systematic investment planning is needed for successful I&C modernization. Besides, in order to perform an efficient modernization project, cost effective analysis which is an essential factor for the Cost-benefit investment must be considered first.

In this paper, a typical calculation has been made for evaluating the cost of each I&C upgrade for the target of Westinghouse plants in Korea and compared with the operating maintenance cost. This study is made in a part of economic analysis for research task, named 'Development of Reliability Evaluation system for Upgrading Nuclear Power Plant I&C systems', which performed during 2004 – 2007

2. I&C Upgrade plan

2.1 I&C Upgrade methods

Typically I&C upgrade plans have three type methods.

- Method I. Like Equipment Replacement
- Method II. Replacement in Kind
- Method III. Integrated, Digital Based System

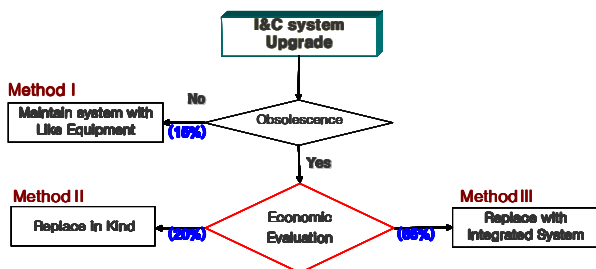


Fig. 1. I&C system upgrade strategy.

Figure 1 shows the general I&C Upgrade strategy process. In the strategy, Method I(Like Equipment Replacement) is largely operated as a regular and usual maintenance in nuclear power plants. But it would not be a permanent solution for aging and obsolescence.

Therefore actually economic analysis is necessary action when we select the Method II and III (Figure 1 reference). This paper analyzed and compared Method II (Replacement in Kind) with method III (Integrated, Digital Based System) focusing on the expense and Method I provided summaries of the maintenance cost as a reference data.

3. Cost estimation and analysis

3.1 Like Equipment Replacement

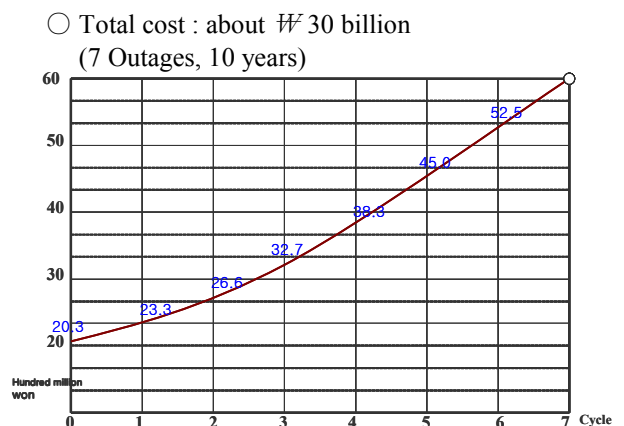


Figure 2. O&M cost expectation(7 outages)

Summary of related basis data

Throughout Calculating current O&M cost(table 1 reference) and quoting below graph(Figure 3, 4 reference), produced expected O&M cost(Figure 2 reference)

System	SSPS	7300	RCS&DPRI	SSILS
ICT	100card*230 =23,000	200card *230 =46,000	109card *230 =25,070	400card *230 =92,000
Part repairs	45,000	70,000	43,000	50,000
Man Day for procedure	4 type : 124M*200= 24,800	36 type : 1,485M*200 =297,000	6 type : 100M*200 =20,000	4 type : 50M*200 =10,000
Man Day for O/H	50M*200 =10,000	1,354M*200 =270,800	37M*200 =7,400	1,473M*200 =294,600
Spare part replacements	10card*13,000\$*1=130,000	30card *13,000\$*1=390,000	21card *12,000\$*1=252,000	20card *10,000\$*1=200,000
Total	232,800	803,000	347,470	646,600

table 1. I&C system O&M cost

- √ O&M Cost per 1 Cycle(1 unit) : ₩ 2.03 billion
- . SSPS : ₩ 230 million
- . 7300 : ₩ 800 million
- . RCS & DRPI : ₩ 350 million
- . SSILS : ₩650 million

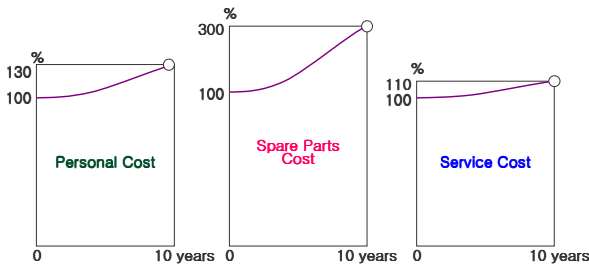


Fig. 3. Cost Increase over 10 years with Analog Equipment[2]

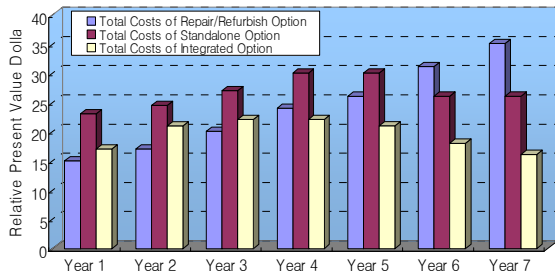


Fig. 4. Total Capital, O&M, and Replacement Fuel Costs [3]

3.2 1:1 Replacement in Kind

- Total cost : about ₩ 77 billion (10 years)
- Summary of related basis data
 - √ Current I&C main card status(YGN 1&2)
 - . SSPS card : 120
 - . 7300 card : 1,600
 - . RCS & DRPI card : 200
 - . SSILS card : 4,000
 - √ Calculation the cost of full replacement
 - . SSPS : $120 \times \$13,000 = \$1,560,000$
 - . 7300 : $1,600 \times \$12,000 = \$19,200,000$
 - . RCS & DRPI : \$361,184(reference KHNP purchase plan ('06.3.29))[4]
 - . SSILS : $4,000 \times \$15,000 = \$60,000,000$

☞ Conversion into won currency :

$$\$3,000,000 + \$12,000,000 + \$361,184 + \$60,000,000 = \$81,121,184 \times \text{₩}950 = \text{₩}77,065,124,800$$

3.2 1:1 Integrated, Digital Based System

- Total cost : about ₩ 20 - 30 billion(10 years)
- Summary of related basis data
 - √ EMERSON OVATION DCS : ₩ 20 billion
 - . H/W : ₩ 8 billion(Controller 80ea, MMI 10ea, 40,000 Point)
 - . S/W : ₩12 billion(Include Engineering cost)
 - √ The cost of DCS for new Nuclear Power Plant in Korea : about ₩20 billion
 - . Ulchin unit 5&6, Shin Kori unit 1&2 (HFC6000)

- √ Comanche Peak Nuclear Power plant I&C Upgrade cost : about ₩35 billion
- . Siemens proposal price at feasibility study

4. Conclusions

So far we calculated typically the cost of each I&C upgrade method and compared with each other in the point of economic aspect

Results From the study show that the Method III (Integrated Digital based System) is equal or more cost beneficial modernization than other methods even if considering additional expense.

Of course, it is not so easy to conclude the result from just simple comparison of limited expense analysis in Nuclear Power Plants because there are some other various factors to be considered such as reliability, regulatory requirements and so on. Specially, in case of integrated digital based system upgrade, it is true that we hesitate to make prompt decision because of the requirements of regulatory aspect and insufficient experiences of foreign nuclear power plants. Because safety is most important factor in nuclear power plants, the Like Equipment Replacement upgrade which has lower risk might be remain more convenient and suitable. But in the future when equipment is not supported from vendors, we might pay much more expenses than now with much more risks.

Fortunately, In case of WEC plants in Korea, supplier can supply the main parts continuously so it is possible to keep the current operating status.

The primary objectives of this study are to give the outline of I&C upgrade cost and to provide guidance for decision of I&C modernization.

Actually, the economic analysis should be performed more detailed manner with additional economic factors such as investment concentration and single vendor approach etc. soon after the upgrade decision is made considering some evaluating factors like obsolescence, aging etc. .

REFERENCES

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- [4] I&C Upgrade Card list and price, KHNP official notice, Mar 29 2006