A Probability Analysis of the Generating Cost of APR+ Dual Unit

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1. Introduction

As a part of a national long-term R&D program, the Advanced Power Reactor plus (APR+) project was launched in 2007. The APR+ project consists of three phases. In the first phase, the basic design was developed. The second phase involves the development of the standard detailed design and the submittal of the request for Standard Design Approval (SDA) to the Korean nuclear regulatory body. The third phase is the completion of the APR+ design optimizing core part. This paper describes the probabilistic analysis of generating cost results in the final of the process of the APR+ standard detailed design.
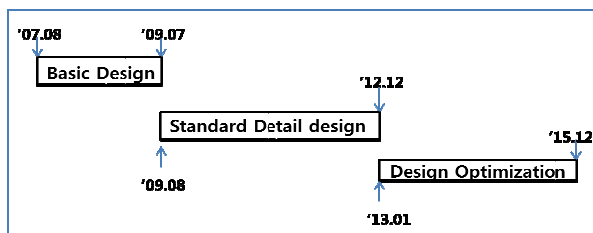

Figure 1. **APR+ Development Phase**

The APR+ adds many advanced design features to its predecessor, as outlined below in Table 1.

Table 1. Summary of APR+ advanced design features

	Item	APR1400	APR+
1	Electric Capacity	1,455MWe	1560MWe
2	Core Thermal Capacity	3,983MWt	4,361MWt
3	Fuel Assembly Number	241	257
4	Reactor Vessel inner Dia	4.7m	5.0m
5	RCP	Foreign	Domestic
6	Hot leg/Cold leg Temp	615 F/555F	619F/557F
7	Safety-Related system	Semi-4 Train	4-train
8	Load follow operation	Daily Load	Frequency control
9	Aux. Feed Water System	Active	Passive
10	Diesel Generator	2 EA/unit	4 EA/unit
11	AAC	Diesel 1 EA	Gas Turbine 2 EA
12	Air Craft Impact	Not consider	Consider
13	Severe Accident	IVR+RCFS	IVR + RCFS
14	MS Line LBB	Not Apply	Apply
15	MSIV	4/unit	8/unit
16	Construction schedule(FC-FL) N-th	41 months	36 Months

*IVR: In-Vessel Corium Retention,
 RCFS: Reactor Cavity Flooding System

2. A Probabilistic Analysis of the Generating Cost of APR+

The probability density functions(PDFs) of twenty generating cost elements were developed through expert group meetings. Many cost field experts were invited to undertake the PDFs for the elements of nuclear power plants. The cost experts invited to select high level uncertainty elements minimum, maximum, and median values were determined through discussions, their experiences, and engineering judgments. The cost evaluator developed PDFs for each cost element. Next, the screening analysis was undertaken. If an uncertainty problem existed, the problem was returned to the cost experts. The cost experts then discussed the problem again and provided a more efficient PDF. The final PDFs were decided and the simulation was performed.

Table 2. Generating Cost Elements

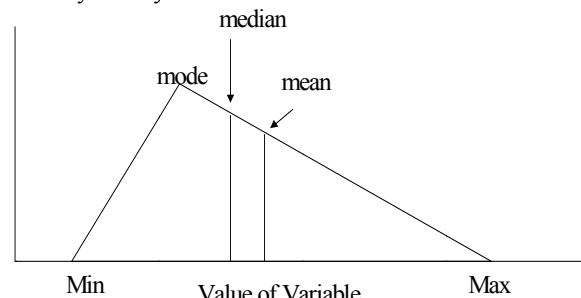| No	Cost Element	No	Cost Element
1	NSSS (D)	11	AE(D)
2	NSSS (F)	12	AE(F)
3	T/G (D)	13	Owner
4	T/G (F)	14	Shipping
5	BOP (D)	15	Land
6	BOP (F)	16	Contingency
7	Main Facilities Installation	17	IDC(Interest During Cost)
8	Accessory Facilities Installation	18	Exchange Rate
9	Discount Rate	19	O & M cost
10	Capacity Factor	20	Fuel Cost

Figure 2. Triangular PDF

As a result of performing the probability cost analysis, using the Crystal Ball software from Oracle, the most sensitive cost element is discount rate. The next cost is capacity factor, exchange rate, O&M cost, IDC, Fuel

cost, BOP(D), main facility installation cost and so on, as shown in Figure 3.
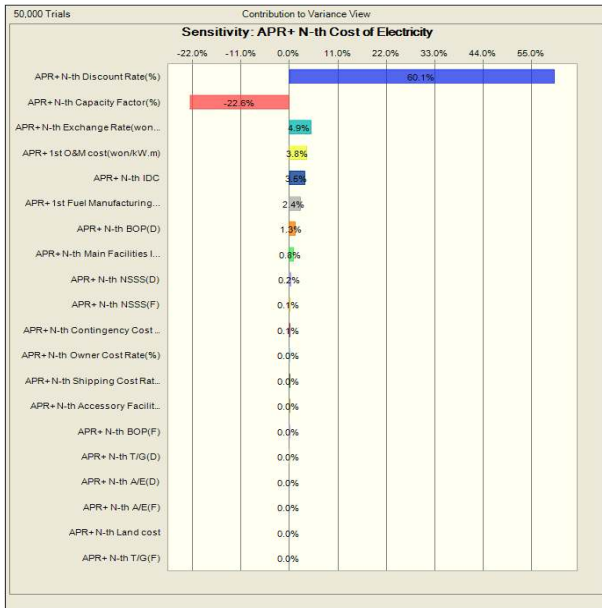

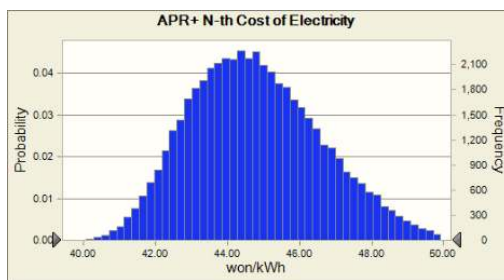
. Figure 3. Sensitivity Chart

The median(50% cumulative probability value) cost of electricity(COE) of APR+ N-th plant 44.66 won//kWh, the 0% non-exceedance value was 39.60 won/kWh, and the 100% non-exceedance value was 52.82 won/kWh for APR+ dual unit.

Figure 4. Probabilistic cost analysis results for the APR+

3. Conclusions

In this simulation, the results of the generating cost (COE, Cost of Electricity) of APR+ dual unit were determined using the probability cost analysis technique, the COE range was shown to be 39.60 won/kWh ~ 52.82 won /kWh.

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