Transactions of the Korean Nuclear Society Autumn Meeting
Pyeongchang Korea, October 30-31, 2014

A Probability Analysis of the Generating Cost for EU-APR1400 Single Unit

Gak-Hyeon Ha, Sung-Hwan Kim
kyeonh@khnp.co.kr

1. Introduction

The nuclear power plant market is expected to grow rapidly in order to address issues of global warming, reducing CO_2 emissions and securing stable electricity supplies. Under these circumstances, the main primary goal of the EU-APR1400 development is to ensure export competitiveness in the European countries. To this end, EU-APR1400 have been developed based on the APR1400 (Advanced Power Reactor, GEN III Type) The EU-APR1400 adds many advanced design features to its predecessor, as outlined below in Table 1.

Table 1. Summary of EU-APR1400 design features

	Item	EU-APR1400	APR1400
1	Containment Integrity	Aircraft impact Design	-
2	Seismic design	0.25g	0.3g
3	RX Building Type	Double Containment	Single Containment
4	Reactor Building entrance and exit during Normal Operation	Permission	Restriction
5	TBCCW HX Location	TBN BLDG Inside	TBN BLDG Outside
6	EDG	4 /unit	2/unit
7	AAC	2/unit (Gas TBN)	2/unit (Diesel)
8	Electrical Frequency(Hz)	50	60
9	Safety System	4 Train	Semi-4-Train
10	Water Tank -SFP -IRWST	Divided Two body	One body

2. A Probability Cost Analysis of EU-APR1400

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 were invited to select high level uncertainty elements minimum, maximum, and median values 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	11	Shipping
2	T/G(D)	12	Land
3	TG(F)	13	Contingency
4	BOP(D)	14	IDC
5	BOP(F)	15	O&M
6	MFI	16	Fuel
7	AFI	17	Decommissioning
8	AE(D)	18	Capacity Factor(%)
9	AE(F)	19	Discount Rate(%)
10	Owner	20	Exchange Rate(won/$)

D : Domestic, F : Foreign
MFI : Main Facilities Installation
AFI : Accessory Facilities Installation

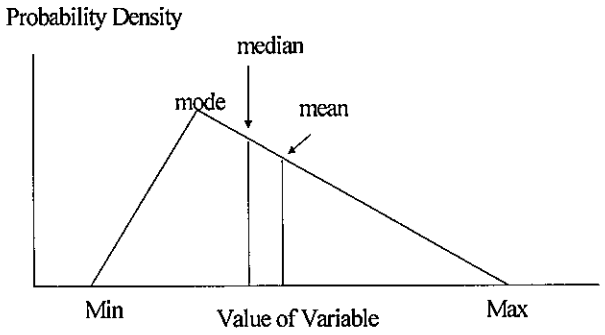
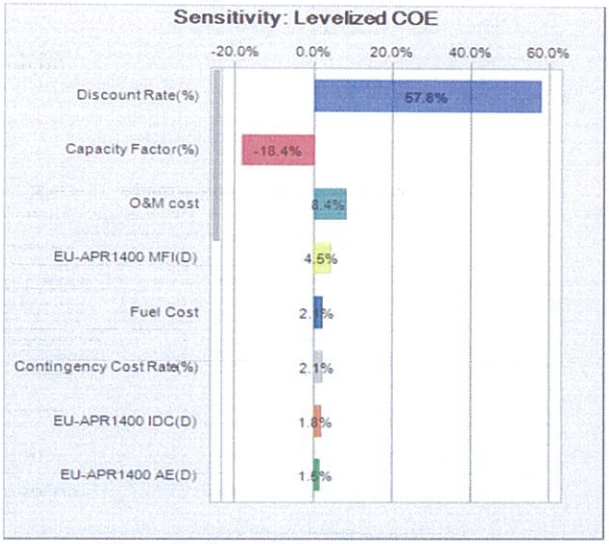


Figure 1. Triangular PDF

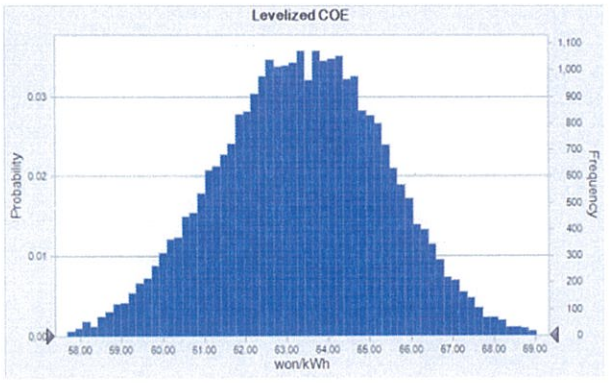
The peak of PDF is known as the "mode". The mode is the "best estimate". Although the probability density is highest at the mode, this does not mean that the mode represents the "most probable" value of the distribution. The peak merely means that the relative likelihood of obtaining a value near the mode is higher than the relative likelihood of obtaining values elsewhere on the distribution. The median of a distribution is a value such that there is a 50 percent probability that the actual value of the random variable may be either higher or lower. The median value indicated in figure 1 by a vertical line which separates the distribution into two regions of equal probability(equal areas). The mean is the centroid or first moment of the distribution, and in decision analysis terminology it is referred to as the expected value.

As a result of performing the probability cost analysis, using the Crystal Ball software, the most sensitive factor in generating cost was determined to be the discount rate. The next factors were capacity factor, O&M cost, installation cost, fuel cost, contingency, and so on, as shown in Figure 2.



. Figure 2. Sensitivity Chart

The median(50% cumulative probability value) Generating Cost was 63.38 won/kWh, the 0% non-exceedance value was 56.16 won/kWh, and the 100% non-exceedance value was 70.92 won/kWh for EU-APR1400 single unit generating cost.



Percentiles:	Forecast values
0%	56.16
10%	60.67
20%	61.61
30%	62.28
40%	62.84
50%	63.38
60%	63.92
70%	64.47
80%	65.09
90%	65.91
100%	70.92

Figure 3. Probabilistic cost analysis results for the EU-APR1400

3. Conclusions

In this simulation, the results of the generating cost of the EU-APR1400 single unit were determined using the probability cost analysis technique, the generating cost range was shown to be 56.16 ~ 70.92 won/kWh. The median value is 63.38 won/kWh..

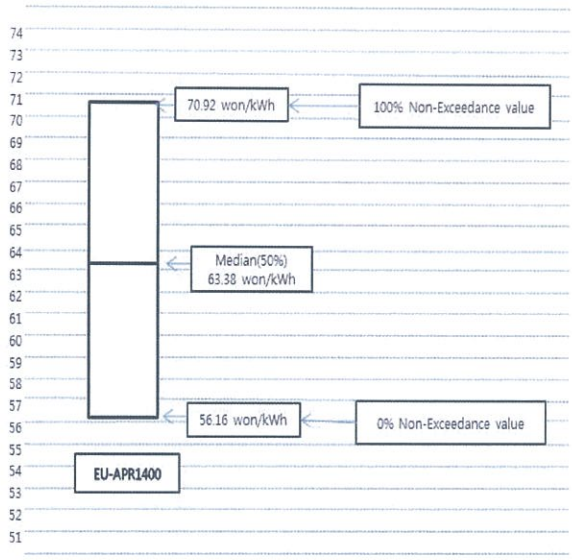


Figure 4. Generating cost distribution of a probabilistic analysis for the EU-APR1400 design

REFERENCES

[1] "EPRI URD Chapter 1 App.C, ALWR Costs Estimating Ground rules", June 1995,
[2] "Projected Costs of Generating Electricity", 2010, IEA/NEA
[3] "Advanced Design Nuclear Power Technologies (ORNL TM-10071, R3" , ORNL, 1993
[4] "CRYSTAL BALL Manual", Aug. 2005
[5] "EPRI TAG" Vols.1 & 3, 1986