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A Cost Scale Factor according to NPP's Power Capacity Up and Down

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1. Introduction

Nuclear power generation is the technologically and economically mature way to produce the electricity needed for future growth on a big scale without contributing to air pollution, water power pollution, and the green house effect. Additional contributions from hydro electric power generation are limited by the availability of suitable sites, the majority of which have already been utilized. The economic competition with coal and natural gas at high thermal efficiency will be a challenge for the development and construction of the next generation of nuclear power plants. In order to meet the requirements from utilities and safety authorities, a number of technical and economical factors have been taken into consideration. these include plant size; a balanced view on the safety, simplification, and operational friendliness; and cost reduction during construction through a short schedule and during operation through optimized plant arrangement. Recently the construction cost of PWR1400, CPP(Coal fired Power Plant) 800MWe had calculated using by Cost Scaling Factor(CSF) in Korea

The construction cost of new power plant is estimated by using the cost data of operation plant. And if the design concept of new power plant is same as operation power plant, and the power capacity of new plant is up and down compared to operation power plant, the construction cost of new power plant is calculated using by CSF. In the case, the equipment cost of new power plant is not possible quotation, then estimate cost of new power plant equipment is estimated using CSF. The concept of CSF is as follows;

2. Cost Scaling Factor(CSF)

$$C_2 = C_1 \times \left(\frac{Q_2}{Q_1}\right)^p = C_1 \times CSF$$

C_1 : Current plant construction cost($)
C_2 : New plant construction cost($)
Q : Technical quantity used to cost estimate, such as power level, motor horsepower, weight of component, etc
(Q_2/Q_1) : Technical Factor
P : Power Factor

$$\left(\frac{Q_2}{Q_1}\right)^P = Cost\ Scaling\ Factor\ (CSF)$$

2-1 Cost Scaling Factor suggested by DOE

DOE suggested CSF when same design concept plant power is up and down. This DOE's CSF is used The Long Term Power Plant Construction Plan of KEPCO. Technical Factor. Technical factor are suggested by the ratio of new and current electric power and power factors are suggested by construction big cost account

표 1. The Power Factor of DOE

Construction Account	Power Factor	
Direct Construction Cost	Nuclear	Coal
○ land	0.00	0.00
○ building and structure	0.50	0.45
○ reactor and boiler equipment	0.60	0.60
○ turbine equipment	0.80	0.70
○ electric equipment	0.40	0.30
○ other equipment	0.30	0.20
○ main condenser equipment	0.80	0.80
Indirection Construction Cost		
○ construction service	0.45	0.50
○ main office design	0.20	0.60
○ field design	0.40	0.50
○ owner	0.50	0.55
Weighting average value of Construction cost	0.50	0.55

2-2 Cost Scaling Factor suggested by EPRI

EPRI would rather the CSF of total construction cost than the CSF of individual equipment.

EPRI suggested CSF that the CSF Of NPP based on the 1980 actual construction cost and the CSF of CPP based on the 1990 actual construction cost

표 2. The Power Factor of EPRI

Plant Type	Power Factor	Application Scope
NPP	0.53	500MW ~ 1200MW
Particle CPP	0.85	500MW ~ 1000MW
	0.76	400MW ~ 500MW
	0.75	300MW ~ 400MW
Combined Power Plant	0.84	500MW ~ 750MW
	0.74	250MW ~ 500MW

* NPP : Nuclear Power Plant
* CPP : Coal-fired Power Plant

2-3 The Power Factor of ABB

In the case of U.S.A., added regulatory result in increase the construction cost of NPP, and increase the plant capacity of NPP decrease the construction cost of NPP.

표 3. Power Factor suggested by ABB

Regulatory Period	Power Factor
Pre-NEPA(pre ~ 1972)	0.64
Post-NEPA(1972 ~ 1976)	0.74
Post-SRP(1976 ~ 1980)	0.78
Post-NEPA(1980 ~ 1985)	0.80
Post-NEPA(post 1985)	0.92

* NEPA : National Environmental Policy Act
* SRP : Standard Review Plan

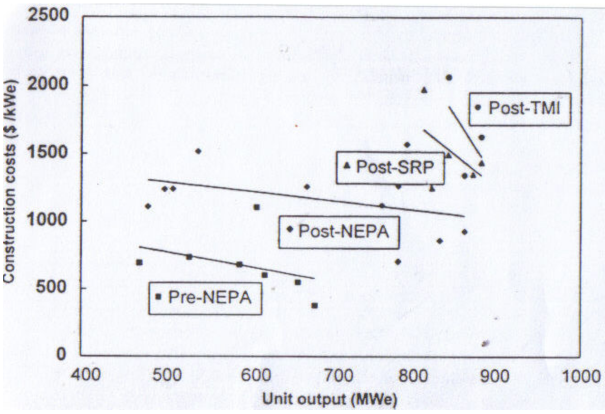

Fig.1 Construction Costs Pre-Severe Accident Policy

2-4 The Power Factor of SWEC

SWEC in US was suggested power factor according to components types

표 4. The Power Factor of SWEC

Items		Technical Quantity	Power Factor(p)
NSSS main component		Thermal Power(MWt)	0.5
Main Turbine		Electric Power(MWe)	0.62
Pump		Flow Rate(gpm)	0.63
Tank	NSSS	Capacity	0.8
	BOP	Capacity	0.65
Heat Exchange	NSSS	Heat Transfer Rate	0.5
	BOP	Heat Transfer Rate	0.51
Blower		Capacity(cfm)	0.77
AHU, ACU		Capacity(cfm)	0.75
Air Compressor		Capacity	0.78
Cubicle Cooler		Capacity	0.71
Filter		Flow Rate(gpm)	0.62
Demineralizer		Flow Rate(gpm)	0.6
FW Heater		Flow Rate(gpm)	0.55
Emergency D/G		Power(kW)	0.60
Chiller		Capacity(RT)	0.74
Crane		Capacity(TN)	0.6
AUX Boiler		Capacity(b/hr)	0.6
Transformer		MVA	0.6
Battery		AMP	0.6
Switchgear		BKR	0.6
Chager		AMP	0.6

3. Conclusion

By using the cost scaling factor methodology, The construction cost of PWR-1400 MWe were estimated from the real construction cost of PWR-1000 MWe. Among the construction cost of PWR-1400 MWe, ABB methodology is first high, and 2th SWEC, 3th EPRI, 4th DOE. The construction schedule of PWR 1000MWe was 58 Months and that of PWR 1400MWe was 64 Months

표 5. The Comparison of the Cost Estimate Value

company	PWR 1000MW (100million won/2uint	CSF	PWR 1400MW (100million won/2uint
DOE	33,770	1.183	39,546
EPRI	33,700	1.195	39,908
ABB	33,700	1.363	44,966
SWEC	33,700	1.226	41,300

When the capacity of PWR-1000 is upgrade PWR-1400, The Cost Scaling Factor is below 1.4, that's meaning, Economic scale factor is applied to NPP

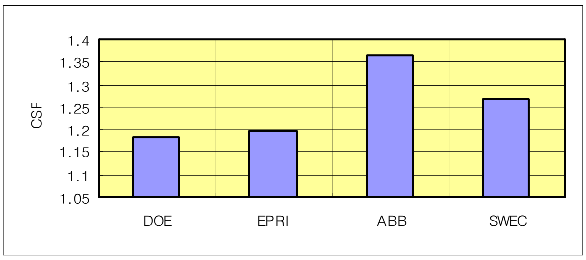

Fig. 2 Economic scale factor

REFERENCES

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[2] EPRI TAG(Technical Assessment Guide) Vol. 1, 1986, Rev.5

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[5] TOPNUX 96, Vol. 1, P131 ~ P142