Considerations of determinants for optimized staffing of SMR operators

HanSuk KO [a*]
[a] *Nuclear Education and Training Center, Korea Atomic Energy Research Institute*
hsko@kaeri.re.kr

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1. Introduction

At this time, SMR in Korea seems to be the booming stage. This spotlight seems to be considered the results of ongoing Small Modular Reactor (SMR) development efforts, including those by existing nuclear entities including the KAERI. After the KAERI/KEPCO developed the SMART(System integrated Modular Advanced ReacTor), and integral PWR type of SMR, the NSSC approved standard design of SMART July 2012, with the technical review from the KINS. KAERI has developed the new SMART and KHNP, with the KAERI, KEPCO E&C and KEPCO-NF and others, is in the process of developing the innovative SMR(iSMR) with the licensing goal of 2028. The Bandi SMR from KEPCO E & C are also introduced.

To sustain this prosperous period, it is required that not only rapid technological development but also the optimization of labor costs, which constitute a significant portion of the operational expenses of power plants, is to be addressed. Furthermore, this labor cost should be covered from the construction of SMRs to dismantle of SMRs.

While the number of staff in the organization are determined by the results of enormous job analysis in management area with long time, the finalizing of the job analysis is needed to the more specific technical specifications of SMRs. Instead of time-consuming job analysis, this study will using the benchmark results of staffing of operators in other NPPs.

For implementing the benchmark, this study scrutinizes the comparative analysis of staffs among different type of NPPs. This work draw on the cases study involving the IAEA and its Member States in 2001.

2. Job analysis and its application of NPPs operators

2.1 Job analysis

In the management side, the methods of job analysis can be categorized into 'new analysis method', 'verification method', and 'DACUM (Developing A Curriculum)'.

The 'new analysis method' widely used in personnel and labor management involves directly visiting the company for analysis when there is a lack of reference materials or knowledge and experience.

The 'verification method' involves comparing the currently analyzed data with reference to the existing job status to confirm, especially when the target job has a broad scope that is difficult to grasp in a short period. This 'verification method' is used when there is sufficient literature and information available for the target job, which is widely publicized.

The 'DACUM method' is employed when a field expert, such as vocational professional, teacher, skilled worker, or manager of industrial company at the level of supervisor or higher, who possesses rich experience and knowledge about the job, is available. In 'the DACUM method', a group of around 10 individuals from organizations like associations and unions engage in a 2-3 day workshop to extract analysis data.

In this study, it is difficult one of those methods because of its lack of technical specification of SMR. Therefore this study adopts the benchmark method with more open staffing data of current NPPs operators.

2.2 Job analysis of NPPs operators

The most of previous studies on job analysis of NPP are focused on the NPP operators tasks.

Y.H Lee, et. al (1994) noted that tasks of NPP operator are more complicative aspects compared with the task of other job and it could be varied from the type of NPP(PWR or BWR), normal/abnormal/emergency operation, increasing/decreasing of power generation.

In this study, it is not deals with more job analysis of SMRs because it accompanies with more huge resources and time consumed to do it.

3. Staffing for different NPP

According to the previous studies, this study also focused on the NPP operators.

3.1 CANDU

D. McQUADE(2001) reflected his experience gained on CANDU reactors; Nuclear Power Development Plant ,(Rolphton, 25Mwe), demonstration Plant Douglas Point, 200MW, Pickering 'a'(4*540MW), Point Lepreau (668MW) These Ontario Hydro and New Brunswick Utilities operated independent of resources and trained staffs. He showed the staffing number of CANDU 6 as the Table. 1.

Table 1. CANDU 6 single unit staffing

Staff designation	Staff level	Function
Management (includes VP nuclear)	6	Various corporate support
Station manager	1	Oversee entire plant operation.
Planning	8	Plan, schedule, monitor & coordinate all work.
Store (supply)	20	Material management, spare part storage.
Production manager	1	Manage operation, maintenance, fueling & chemistry.
Operations	89	Operate all plant equipment
Maintenance	151	Maintain all plant equipment
Fueling	28	Operate & maintain fuel handling systems
Chemistry	18	Sample, monitor, initiate action to maintain chemistry specs.
Technical manager	1	Manage technical unit to support production & ensure reactor safety.
Technical EC&I	33	Technical engineering specialist for electrical & instrumentation & control
Technical mechanical	31	Technical engineering specialist for mechanical & process systems
Technical specialists — Safety systems	14	Technical engineering specialist for 4 special safety systems
Technical engineering services	5	Technical engineering specialist for project management & contractor services
Nuclear safety manager	1	Maintain nuclear safety analysis & licensing
Nuclear safety analysis	11	Carry out safety evaluations & special analysis
Regulatory affairs (licensing)	3	Deal with all licensing & related issues
Nuclear safety reliability	4	Practical reliability model, monitor & evaluate plant performance.
Administration manager	1	Manages administration, material procurement, accounts, security etc.
Public affairs	1	Interface with plant and public, media, local community
Budget and cost control	1	Monitor budget and cost
Security	22	Provide plant security
Administrative support (clerical)	38	Services for typing, document management, procurement role.
Training	20	Coordinate & provide training for all staff.
Quality assurance	8	Support the station manager with QA activities.
Health physics	21	Define policy and develop procedures for radiation plant.
Health physics (laboratory)	3	Perform all lab work for dose monitoring programs.
Total staff	534	

Table 2 assumes a single unit in Canada on a coastal location, some distance from the mail industrial centers. His major assumptions used to determine the staff numbers are design features, regulatory pressure, material management system, best practices and so on.

Table 2. updated OM&A staffing for a new CANDU 6 station

Staff Designation	Pt. Lepreau 1-Unit (1997)	CANDU 6 1st Unit	CANDU 6 2nd Unit	CANDU 6 2-Units
Management (head office)	6	6	1	7
Station manager	1	1	0	1
Planning	6	6	3	9
Stores	18	16	6	22
Production manager	1	1	0	1
Operations	79	81	75	152
Maintenance	141	141	109	250
Maintenance support	0	7	4	11
Fuelling	21	21	19	40
Chemistry	16	16	10	26
Technical manager	1	1	0	1
Technical EC&I	23	21	16	37
Technical mechanical	25	22	18	40
Technical specialists — safety systems	12	12	9	21
Technical engineering services	3	3	2	5
Nuclear safety manager	1	1	0	1
Nuclear safety analysis	11	4	0	15
Nuclear safety licensing	3	2	0	4
Nuclear safety reliability	4	3	1	6
Administration manager	1	1	0	1
Public affairs	1	1	0	1
Budget and cost control	1	1	0	1
Security	21	21	0	21
Administrative support (clerical)	34	32	11	43
Training	18	18	9	27
Quality assurance	8	8	2	10
Health physics	19	17	10	27
Health physics laboratory	3	3	1	4
TOTAL	478	467	306	773

3.2 Russian type reactors

G.M. Antonovsky. et. al.(2001) showed the staffing requirements for SMR with Russian experiences. At that time Russia operated several type of NPP as Table 3.

Table 3. main performances of NPP developed by Russia OKBM

Parameter	VPBER-600	ATETs	KLT	ABV	AST-500	VGM	GT-MHR
Thermal power, MWt	1800	690	150	54	500	200	600
Electric power, MWe	640	230	35	12		77	285
Quantity of heat produced, GKal	1050	170	25	24	430		

Table 4 shows that the number range of the operation personnel for NPP from its capacity from 600 MW(e) to 12 MW(e) deviates not more that by 3 times.

Table 4. operation personnel number and operation personnel of Russian NPP

	NP-1100	AES-91	AES-92	NP-500	VPBER-600	GT-MHR	ABV-6
Power, MW(e)	1150	1074	1068	645	640	285	12
Personnel, men	325	349	320	303	273	230	103
Specific number, man/MW(e)	0.283	0.325	0.3	0.47	0.428	0.8	8.5

Table 5 shows that the operation staff number between WH and Russian AP600 is not big difference, from 190 to 168 respectively.

Table 5. comparison between number of personnel for WH NPP and AP-600

Department	An existing Westinghouse 2-loop	AP-600
Administration	34	35
Operations / engineering	**70**	**77**
Maintenance	**82**	**56**
Planning	4	13
HP / chemistry	**38**	**35**
Training	25	35
Contractors (including security)	85	85
Total	338	336
Operation personnel amounts to 190 and 168 respectively. Specific number is 0.317 and 0.28 man/MW		

4. **determinants of staffing of NPP**

The operators number of NPPs is usually defined based on its design documentation requirements of NPP and the national requirements from its nuclear safety regulations should be considered.

In previous study, more than 50% of cost and long duration in lifecycle of NPP is needed to decide the optimized the staff number of NPP.

It is considered two options to affect the staff number. First one is more optimizing of its national regulations. As its operation experience of NPP has been accumulated, it raised the need to revise and optimize the national regulations concerning the staff number of NPP. Second one is to develop the more innovative equipment and facility being designed to reduce the necessity staff of its equipment and facility without any possible affection in its reliability and safety.

5. Conclusion

This study tried to contribute to determine the optimized staffing operators number of SMR with previous study analysis. While the staffing operators number of SMR is not quite different compare to its current NPP with large capacity, the major determinant of staffing operator is to be the legal requirements such as the Nuclear Safety Act and codes from national safety regulatory body. Furthermore it is also considered the Framework Act on fire services from Ministry of Public Administration, Security and Occupational safety and Health Act from Ministry of Health and Welfare and Labor Standards Act from Ministry of Labor.

This study has its limitations because it contains relatively old data because the nuclear society has long experience of NPPs. If the certain technical specifications of the SMR opened, then this study will have chance to be revised with that data. Accordingly, future study will be needed the investigation and analysis of its real cased of research reactors and NPP in Korea.

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