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Development of CANDU Occupational Dose Database for Improvement of Radiation Works

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1. Introduction

In Wolsong, 4 units of CANDU are in operation. And the total operation-year is reached to 37 reactor-years. According to plant's aging, the occupational radiation exposure is expected to increase because of frequent repairing works and accumulation of radioactivity of primary system. Owing to the tendency to strengthen the regulation of radiation exposure, the importance of dose reduction is increasing. In compliance with 'ALARA(as low as reasonably achievable)' concept, cost-effective dose reduction is necessary. Therefore, the status of ORD(occupational radiation dose) in Wolsong 1~4 unit was analyzed in this study. On the basis of this assessment, high occupational radiation works are identified.

2. ORD database

From 2002 to 2004, the total 24767 data of radiation works were assessed. From the RWP(radiation work permit), the database was constructed. That includes permit number, work contents, work place, work-classification, the number of permitted workers, the number of real workers, work time, excepted dose, and real dose. These data are composed of 19 categories of main works(A~S) that are further subdivided into 119 categories of detail works.

Table I. Radiation works classification and respective number of works and total collective dose in Wolsong 1~4 unit from 2002~2004

	Contents	# of works	Total dose (mSv)
A	Refueling	4155	222.62
B	Reactor vessel or Internal	740	163.26
C	S/G – Primary Side	563	300.87
D	S/G – Secondary Side	13	0.34
E	RHR & SI SYS	632	17.77
F	CVCS & Coolant Pump Seal Water System	1	0
G	PZR	6	0.23
H	Reactor Water Clean	916	68.19
I	RCS Pump	353	27.95
J	Primary Circuit	117	19.45
K	Valve Work	473	43.42
L	Routine Inspections	2981	213.49
M	General Work	10405	758.64
N	Scaffolding	65	8.64
O	Insulation	0	0
P	Control Rod Drive	23	2.09
Q	Dose by System Not Listed Above	3233	258.56
R	Large Task	0	0
S	Decommissioning	0	0

3. Development of database managing program

The database program was developed for analysis of occupation dose data. This program provides 4 main functions.

- Searching and classification: Through this function, the data are searched and classified according to unit, work year, and work-classification
- Statistics calculation: After searching the data, the data's statistics (mean, deviation, total sum, minimum and maximum value) are calculated.
- Graphic comparison: Total numbers of workers, work time, dose trends are graphed according to year and searching-data.
- Prediction of dose reduction: Using existing data, this program provides evaluation result of dose reduction technology effects according to variable factors.

Using these functions, we analyzed the occupation dose database. And we will utilize prediction of dose reduction function of this program for optimization of radiation works with benefit-cost analysis.

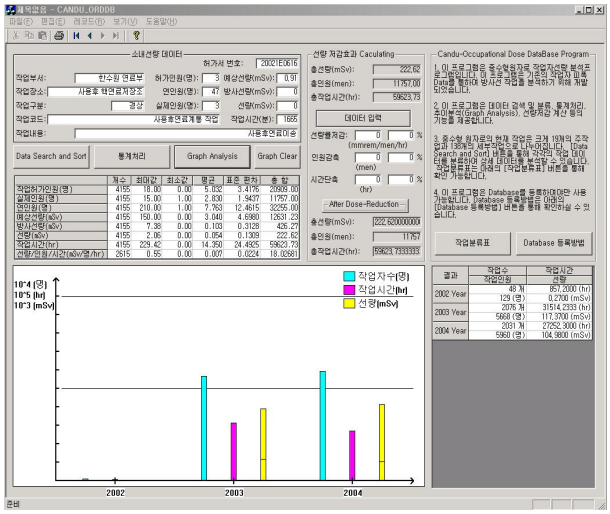

Fig. I. CANDU occupation dose database program

4. Analysis of the database

For identification of main radiation works that induce high occupational dose, the main works are classified by the number of work, the number of workers, work time, and total dose. Table II shows the results. As shown in table II, the order of ranks is almost same. That means many works cause many work time and worker and high dose. But this simple result is not meaningful. In order to identify radiation works' property, the factors are divided by number of works. Table III shows the rank of collective dose from first to tenth. From this results, it can be founded M, Q, A, L, H, and I radiation works are frequent and needs many time and worker while C, B, K, and J radiation works relatively high-exposure rate work.

Table II. The rank by number of work, number of workers(person), total work time(hr) and total collective dose(mSv) in Wolsong (2002~2004)

Rank	# of work	# of workers	Work time(hr)	Total dose(mSv)
1	M(10405)	M(34839)	M(401011)	M(759)
2	A(4155)	A(11757)	A(59624)	C(301)
3	Q(3233)	Q(9528)	Q(47382)	Q(259)
4	L(2981)	L(8465)	L(30156)	A(223)
5	H(916)	C(2751)	C(12721)	L(213)
6	B(740)	H(2449)	B(9748)	B(163)
7	E(632)	B(2134)	H(8831)	H(68)
8	C(563)	E(1441)	K(6518)	K(43)
9	K(473)	K(1395)	E(5809)	I(28)
10	I(353)	I(1057)	I(5257)	J(19)

Table III. The rank by number of workers(person), total work time(hr) and total collective dose(mSv) per number of work in Wolsong (2002-2004)

Rank	# of workers per work	Work time per work(hr/person)	Dose per work(mSv)
1	C(4.8863)	M(38.5402)	C(0.5344)
2	M(3.3483)	C(22.5943)	B(0.2206)
3	I(2.9943)	I(14.8933)	J(0.1662)
4	K(2.9493)	Q(14.6558)	N(0.1329)
5	Q(2.9471)	A(14.3499)	K(0.0918)
6	B(2.8838)	K(13.7793)	P(0.0909)
7	L(2.8397)	B(13.1736)	Q(0.0800)
8	A(2.8296)	J(10.9774)	I(0.0792)
9	D(2.6923)	L(10.1161)	H(0.0744)
10	H(2.6736)	H(9.6413)	M(0.0729)

In detail works, the most frequent and highest collective work is 'Management Radiation Safety Work(M21)'. And the highest collective dose work is 'DN Tube Work(11)'. Relatively, 'Worker Daily Test Work(M11)', 'Refueling Relation Works(A11)', and 'Fuel Management Others Work(A19)' were frequent. And 'End Fitting Lapping Work(B04)', 'Inspection During Operation(L01)', and 'PHT Filter Work(H13)' were appeared to high dose per number of work.

5. Conclusion

From the analysis, the 6 main works' accumulated ratio is of the total collective dose over 90% among 19 works. In detail works, the 5 detail works' accumulated collective dose occupied more than 50%. And the 17 detail works' accumulated ratio was over 75%. That means main several works dominate the major portion of total collective dose.

So, in this study, these high dose works were analyzed according to dose and the number of works, workers, and time. From these results, the main reason of high ORD was identified. We can find the optimized conditions to reduce the high ORD by using the DB program.

Table IV. The rank of mean workers, work time, collective dose per number of work and the analysis of reason of high collective dose in main works

	Ratio (Acc.)	Rank of mean value per number of work			Reason of high dose
		Workers (person)	Time (hr)	Dose (mSv)	
M	36	2	1	10	High frequency
C	14(50)	1	2	1	All factor
Q	12(63)	5	4	7	High frequency
A	11(73)	8	5	12	High frequency
L	10(83)	7	9	11	High frequency
B	8(91)	6	7	2	High exposure rate

Through this study, it was founded that several works account for main portion of high ORD. And the properties of these works are identified. With consideration of cost-benefit analysis, the characteristics of radiation works that were derived from these results will be used for the optimization of radiation works.

REFERENCES

[1] Dionne, B. J., Baum, J. W., Occupational Dose Reduction and ALARA at Nuclear Power Plants: Study on High-Dose Jobs, Radwaste Handling, and ALARA Incentives (NUREG/CR-4254). US Nuclear Regulatory Commission, 1985

[2] Nuclear Energy Agency(OECD), Occupational Exposures at Nuclear Power Plants Annual Report(1998-2003)