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ESR/Alanine dosimetry on Wolsung Unit 1

Choi Hoon, Ha Joo Hee, Lim Young Ki,
Radiation Health Research Institute
93105117@khnp.co.kr

1. Introduction

Alanine/EPR Dosimetry system is classified as a reference-standard dosimeter which used to calibrate radiation environments and to calibrate routine dosimeters in absorbed dose range of 1 to 10^5 Gy.[1][2] Characteristics of Alanine/EPR dosimetry system are better suitable than routinely used personnel dosimeters for the long term radiation measurement in harsh condition of Nuclear power plant : This system is not significantly affected by temperature and humidity and also has low fading rate.[3]

About 1 year ago, Alanine and Lithium compound dosimeters were installed at Wolsung unit 1 for the environment monitoring as a part of equipment qualification program. 35 positions which are most severe and representative cable positions were chosen for radiation and temperature monitoring. The recovered alanine dosimeter in the period of maintenance was measured by E-scan alanine analyzer system, Meanwhile measurement result shows extremely high radiation level in few points of specific rooms, in most of the points, radiation level are comparatively low for measurement by system. For the accurate measurement of these low level radiation points, additional method was used for the points.

2. Methods and Results

Expected radiation difference between maximum and minimum radiation level in NPP is too big to be compared in same plot. So measurement range was divided into three radiation dose ranges ; * High dose range : 500Gy to 10kGy, * Medium dose range : 20Gy to 500Gy and * Low dose range : 1Gy to 20Gy.

Alanine dosimeters were commercially sold BioMax dosimeters which contains α-amino acid alanine, NH_2-$C_\alpha H(CH_3)$-COOH and teflon as binding material to form the cylindrical pallet form(material ratio>9/1). The form of pallet has dimension of 5 mm in diameter and 3mm in height. The mass distribution of pallet is 65.0 ±0.5 mg, and this mass difference maybe caused by the sensitivity difference of each dosimeter to radiation. The three alanine dosimeters which was sealed in plastic case for preventing the effect of environmental moisture were recovered after being irradiated for 13 month(October 2005 to November 2006) in Wolsung Unit 1. The plastic cases containe alanine dosimeter were tied on the power cables or signal transferring cables beside the concerned instruments with the temperature monitoring device.

The measurement was done by two steps, first step was rough measurement of all alanine dosimeters by use of high dose range parameters and devices. After these measurement, dosimeter pallet which estimated as had being installed at high radiation level position was selected and measured several times for assurance.
The measurement result is as follow tables. The positions above 20 Gy were 9 points of 35 points.

No.	Target instrument	Dose (Gy)	etc.
50	63312-TE5	2,451	Feeder Cabinet
16	63230-PV2	49	R-107
27	7311-LACM10	296	R-107
30	7311-PV	1,039	R-107
35	67311-TE13	996	R-108
26	3211-PM1	820	R-111
48	60800-JB3164	387	R-111
47	QC83	904	R-111
44	68212-IC	1,797	R-111

Table 1. *Comparably high radiation level points and gamma radiation dose quantity for 13 month

Typically, used for this experiment E-scan EPR Alanine analyzer is not optimized for the comparably low radiation level(under 20 Gy) measurement. But as you see above table1, most of the alanine dosimeters were estimated under the 20 Gy radiation level. At this case, typical measurement method(device and factors) is not available for low dose measurement. So, after the dosimeter recovered from NPP, additional dose (about 25Gy, Cs-137, blood irradiator) was given to all alaine pallet for replenishing lower signal of dosimeters with proper radiation dose quantity. Generally these method is not so wise one for estimating dose quantity. But the characteristics of alanine dosimeters were considered which is 1) a good linearity in dose range of 0.1 to 50kGy 2) not so dependent on the dose rate up to 10^2 Gy/sec and irradiation energy 3) low fading rate (1%/year).[2][3][4] Two method was chosen to get more accurate value considering dosimeter mass difference, first, as follow table 2 show, 10 dosimeters of the same batch were selected randomly and measured at least 10 times to get proper mean dose-response value for reference with the recovered alanine dosimeters. Certainly repetition test and reproducible test were also done for deviation estimation of measurement and dosimeter itself. Then each alanine dosimeter was irradiated again for getting information of each dosimeters dose-response characteristics with other dosimeters for reference value. By this method, the sensitivity value(dose-response) of each alanine dosimeter, maybe caused by different dosimeter density

and mass distribution, was estimated for each alanine dosimeter. By this additional radiation exposure, ratio between proper mean value of reference dosimeter and measured value of each dosimeters was used in calculation. Below table shows final result by considering above all matters

No	Target instrument	Measurement(Gy)		Final Dose(Gy)
		1st	2nd	
45	3341-MV17	37.69	62.40	0.00
11	QC50	34.68	62.74	1.89
37	AD11	32.60	71.96	12.55
23	CF13	31.86	62.55	2.32
15	63341-TY12	32.44	63.35	1.48
42	CCA	31.08	65.71	2.65
49	BE24	31.77	62.88	1.51
8	63432-SV178	34.16	63.55	0.86
22	63432-PRV178	33.83	66.15	3.27
29	3432-MV79	36.31	62.90	2.08
41	60420-PL1124	34.49	63.22	1.32
2	67314-ZS24Q1	32.27	61.87	1.35
19	63333-LT14	31.57	62.83	1.47
18	63432-PT3L	32.25	64.49	3.31
1	63331-FY8#2	31.11	62.47	1.31
4	3331-MV13	41.87	66.99	5.86
9	63230-PS1A	32.16	63.15	0.88
10	3173-SA1	32.20	62.02	1.15
21	63332-PY3	32.12	62.16	1.89
46	AA65	31.69	62.35	3.06
34	XB16	31.97	62.57	2.02
7	63431-PV3Q1	32.39	65.77	3.29
6	QE50	32.37	62.32	0.00
31	63432-FC11	32.00	68.02	7.78
39	63432-FT18	32.24	62.31	1.12
33	AX12	31.56	62.11	1.52

Table 2. *1st and 2nd dose value measured after giving additional exposure to recovered dosimeters from NPP, final dose value is considered value of mass distribution of each dosimeter. The reference value of 1st and 2nd additional exposure is 32.08

3. Conclusion

To get proper dose value in radiation monitoring, EPR/Alanine dosimetry method has been researched by many experts. In general, EPR/Alanine radiation assessment was focused on the comparably high and medium radiation level dosimetry[2]. In Wolsung NPP, alanine dosimeter and lithium formate compound was installed simultaneously for low dose estimation. Absolute deviation value in comparably high dose radiation level is not so significant one as in low dose level. But, for measuring dose quantity in low radiation level, various dosimetry method should be considered for good accuracy. In this study, proper quantity of radiation dose was given to the dosimeter, after recovering, for detection of signal using typical E-scan analyzer. finding relationship between dosimeter mass distribution and signal value could be one of the method to get good accuracy at low dose level. Other good method like using already installed lithium compound for measurement could be tried for accuracy after two fuel cycle of NPP. And all the minor effect like temperature and fading could be considered in the future.

REFERENCES

[1] ISO/ASTM 51261 : 2002(E) Standard guide for selction and calibration of dosimetry systems for radiation processing , First edition (2002-3-15)
[2] ISO/ASTM E 1607-94 Standard Practice for Use of the Alanine-EPR Dosimetry system
[3] IAEA-TECDOC-1188 Volume I, 2 Assessment and management of aging of major nuclear power plant componenets important to safety :
In-containment instrumentation and control cables
[4] Assessment of an alaine EPR dosimetry technique with enhanced precision and accuracy, Robert B. Hayes, Nuclear Instruments and Methods in Physics Research A 44(2000) 453-461