Nuclide analysis at domestic Nuclear Power Plant with CZT Detector during the overhaul

KANG SEO KON[a], KANG HWA YOON[a], MOON JIN SOO[a], LEE BYOUNG-IL[a], KIM JEONG-IN[a*]
[a] KHNP, Radiation Health Research Institute(Korea)
[*]*Corresponding author neogen21@khnp.co.kr*

1. Introduction

For aggressive ALARA activities and evaluation of exposure of workers, monitoring source terms is necessary at a Nuclear Power Plant (NPP). For that reason, EDF (Electricite de France) has been conducting the "Source Term Reduction" Program since 2003[1]-[2], [4]-[7]. The program has EMECC (Ensemble de Mesure et d'Etude de la Contamination des Circuits)[3][6] and CZT (Cadmium Zinc Telluride)[6][7] campaign which are tools to analyze nuclides at a NPP. AEP (American Electric Power) also introduced another type CZT detector to perform source term monitoring and they had announced the results through the ISOE (Information System on Occupational Exposure)[8]. A CZT semiconductor detector is good to monitor source terms at a NPP in that it is possible to make a portable type because it does not need any cooling system at room temperature and it has good energy resolution. To follow up global atmosphere, KHNP (Korea Hydro and Nuclear Power) has been trying to use CZT monitoring system at a domestic NPP. This study shows a result of the kinds of nuclides between BEFORE H_2O_2 and AFTER Clean-Up process for primary reactor coolant system nearby a steam generator during the overhaul for the first time.

2. Methods and Results

2.1 Methods

In the Shutdown Chemistry, H_2O_2 process can detach CRUD (Chalk River Unidentified Deposit, they are activated deposits and become the main source terms in the primary coolant system) from a pipe and CVCS (The Chemical and Volume Control System) gets rid of them from the primary coolant during Clean-UP process. We measured gamma ray spectra before and after H_2O_2 process at a steam generator cold leg

	Cold Leg		Manway
	Before H_2O_2	After Clean-Up	After Clean-Up
Time(Sec)	28600	3600	1200
CPS	800-1200	880	20000
Dose Rate	450±50μSv/h	450±50μSv/h	8mSv/h

Table 1 Measurement conditions

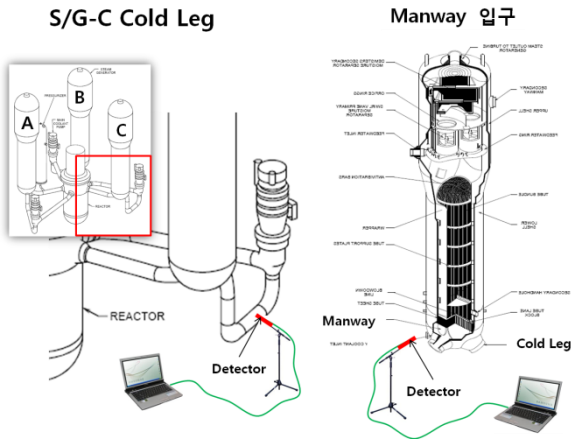

Figure 1 Measurement points, S/G Cold Leg(Left), Manyway(Right)

And then we also got a spectrum in front of Manway after Clean-up process to check how the source terms are changed by process and position (see the table 1 Measurement conditions and the figure 1 Measurement points). We used GBS SDP310 model as a detector which is made of CZT semiconductor.

2.2 Results

We could not help but analyze qualitative analysis, because the CZT monitoring system is being developed. All of the results don't have any quantities in this study for this reason.

You can see detected source terms at the figure 2 Results of nuclide analysis, steam generator cold leg, before H_2O_2 Process. The major nuclides are Co-58 and Co-60 and the minor nuclides are Mn-54, Zr-95 and Nb-95.

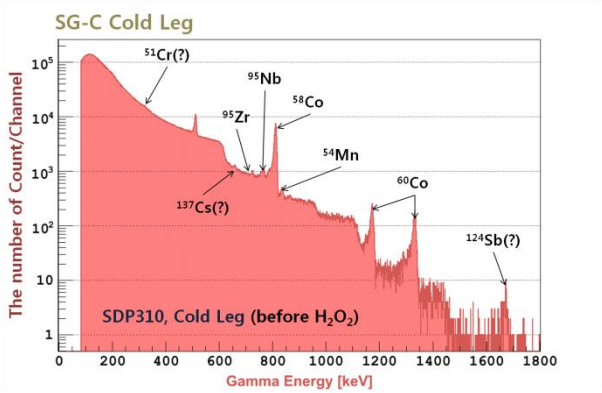

Figure 2 Result of nuclide analysis at steam generator cold leg before H_2O_2 process

We could not confirm Sb-124 at high energy region for lack of data and Cr-51, Cs-137 at low energy region for background signals. In case of Sb-124, EDF reported through ISOE and in case of Cs-137, AEP reported also through ISOE (2012) with regard to the same type reactor (PWRs). In case of Cr-51, The NPP where we measured Cr-51 has been conducting CRUD analysis using by the primary reactor coolant sample during the normal operation. It has been showed up very frequently at the test.

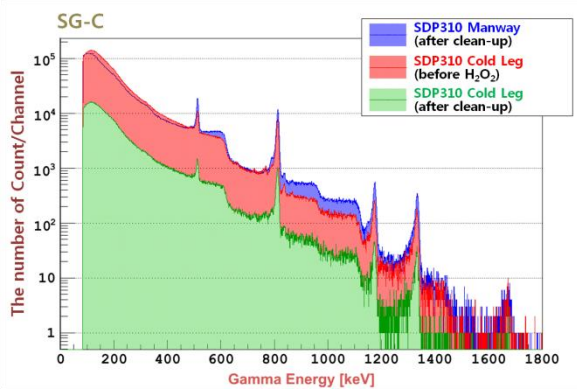

Figure 3 Measured gamma spectra at steam generator cold leg, before H_2O_2 process (Red) and after Clean-Up process (Green), at the Manway after Clean-Up (Blue)

The kinds of nuclides from the results of spectra are the same overall between BEFORE hydrogen peroxide (figure 3 red plot) and AFTER Clean-Up (figure 3 green plot) process at the steam generator cold leg but we cannot confirm the results for the minor source terms (except Co-58 and Co-60) due to the lack of data (at high energy range) and background signal (at middle energy region). Both BEFORE hydrogen peroxide at COLD LEG (figure 3 red plot) and AFTER Clean-Up at MANWAY (figure 3 blue plot) also show the same spectrum shape, however, the intensity of Co-58 and Co-60 is different.

3. Conclusions

The detected source terms were the same for all measurement conditions, but the measurement was not quantitative analysis. It needs Spectrum Analysis Program to acquire quantitative analysis and we are developing the system. If the system is set-up in the CZT monitoring system, we will be able to know detail information of nuclides more.

The result of spectra was the same regardless of measurement conditions and the intensity of the major nuclides is different obviously according to the measurement points. Even though the results only give us the information of the kinds of nuclides without any other information, the meaning is very significant to us, because the measurement is performed for the first time all over country.

Especially, the result of both Red Plot and Blue Plot at the figure 3 is very interesting in that the primary coolant is (Red plot) inside the pipe whereas it is not (Blue plot) inside the steam generator. Our study will be continued to find the reasons.

REFERENCES

[1] L. Guinard et al., 2008, Review of the evolution of international collective radiation exposure and associated good practices, with special focus on Source Term Reduction strategies for EDF PWRs, ISOE European ALARA Symposium, Turku (Finland)
[2] G. Ranchoux et al., 2009, Source Term Reduction Strategies for EDF PWRs, ISOE International ALARA Symposium, Vienna (Austria)
[3] R. Eimecke et al. 1988, Ensemble de Mesures et d'Etudes de la Contamination des Circuits, International Conference on Radiation Shielding, Bournemouth (UK)
[4] A. Rocher et al., 2009, New CZT measurement device – Comparison with EMECC measurements in EDF PWRs, ISOE European ALARA Symposium, Vienna (Austria).
[5] Yves GARCIER, 2008, Radiation protection challenges at EDF, ISOE(International Symposium on Occupational Exposure), Tsuruga (Japan)
[6] A. Rocher and al., 2009, New CZT measurement device – Comparison with EMECC measurements in EDF PWRs, ISOE(International Symposium on Occupational Exposure), Vienna (Austria)
[7] J. Bonnefon, et al., 2012, CZT technology applicaion at EDF, ISOE(International Symposium on Occupational Exposure), Prague(Czech Republic)
[8] David W. Miller and Zhong He, 2012, Field Application of CZT Detector for Evaluation of Radiation Source Term, 2012 Asian ISOE ALARA Symposium, Tokyo(Japan)