The Study on the Development of Unified Spent Fuel Attribute Tester

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1. Introduction

We have been studying the development of integrated γ-ray detector to improve national safeguards equipment.[1] Until now, we carried out conceptual design, prototype preparation[2] and field test for the development of USAT (Unified Spent fuel Attribute Tester) that is integrated SFAT (Spent Fuel Attribute Tester) and IRAT (Irradiated Fuel Attribute Tester). At the result, we could confirm effective factors and these factors are going to be applied to the next field test.

2. Methods and Results

USAT is verification equipment which has functions of SFAT and IRAT. SFAT can verify the spent fuel cooled over 15 years and IRAT has a function of non-fuel item's verification. Both are based on the detection of Cs-137(662Kev).

2.1 Conceptual Design [2]

The conceptual design of USAT is adding the IRAT's function into the SFAT's frame. And by MCNP (Monte Carlo N-Particle transport code) analysis, we could make decisions regarding the detector type, shielding methods, the air pipe length and etc.

2.2 Make a Prototype [2]

Based on conceptual design, we made USAT's prototype.

The SDP310/Z/60s CZT detector was used. The shield was made of ring blocks of the tungsten material and it can change the size of the radial and vertical directions. Also, the air pipe which is for SFAT's function was composed to two parts to change its length.

2.3 Field Test

To verify our prototype, we carried out field tests at spent fuel pond of Kori unit #3 and Uljin unit #3. And each test was carried out 28 times (SFAT's function 12 times and IRAT's function 16 times).

We selected target spent fuels before the test because we needed enough space to the side of fuel for IRAT's function testing.

At the tests, we confirmed SFAT's function of USAT and could find out the optimal length of the air pipe by changing its length. And we tested the optimal distance between the prototype and the target fuel which was already confirmed IRAT's function.

Since, the whole test was carried out again to reduce the weight of USAT, after the shield was reduced half to vertical direction.

2.4 Test Results

Table I and II are the summary of USAT's test results. Regarding Cs-137, we considered three factors among the available information of spent fuel and those are initial enrichment, cooling time and release burn-up of the spent fuel.

Table I and II show that the condition of Cs-137 detection is related to the cooling time of the spent fuel. Also, at the IRAT's function test, the reason of that Cs-137 is not detected from the spent fuel which has under 17 years cooling time is that the other fission products' radioactivity is more dominant than Cs-137.

Table I: USAT Test Results (SFAT's Function)*

Enrichment (%)	Cooling Time (year)	Burn-up (MWD/ MTU)	Cs-137 Peak
3.50	16.6	16,065	O
2.10	32.5	16,744	O
2.35	12.0	18,202	X
1.28	13.0	12,723	X
4.39	1.3	54,337	X

** The air pipe length: 90cm*

Table II: USAT Test Results (IRAT's Function)*

Enrichment (%)	Cooling Time (year)	Burn-up (MWD/ MTU)	Cs-137 Peak
3.20	23.1	32,776	O
3.20	30.0	29,637	O
3.50	17.7	40,007	O
3.70	14.7	40,942	X
3.22	11.0	38,482	X
3.97	8.0	41,817	X
4.39	2.6	46,242	X

** The distance between fuel & USAT: 55~80cm*
The shield was used half to vertical directions

3. Conclusions

This study was begun to make the national safeguards inspection efficient. We needed more simple, small and light equipment during the national inspection. Our prototype is partly satisfied with these options and has similar performance in comparison with SFAT and IRAT respectively.

Through 2 times of test, we could verify our conceptual design and prototype and confirm effective factors to develop USAT.

Hereafter, we are going to conduct systematic tests regarding the correlation between prototype and these factors including the spent fuel type to optimize USAT.

REFERENCES

[1] K. H. KIM, B. M. KOH, J. B. PARK, Necessity of Development of Integrated γ Detector to Improve National Safeguards System, Korea Nuclear Society, May 26-27, 2012.
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