Application of Spent Fuel Attribute Tester(SFAT) in National Safeguards Inspection

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1. Introduction

Since 1997, the SSAC of ROK has started the National Safeguards Inspection for Nuclear Facilities including NPP(Nuclear Power Plant) to verify whether the nuclear material was diverted. In terms of National Safeguards Inspection, it is important to improve the abilities of confirmation whether nuclear material is true or not. There are several ways to check the nuclear material. The most popular method is the NDA(Non-Destructive Analysis) measurement.

In these measurements, Gamma ray detection methods are dominantly used. Already, many scientists and technicians are using the special detectors to catch the gamma ray. The CdZnTe detector is one of the powerful detectors to catch the Gamma ray. The IAEA is using the CdZnTe detector to verify the nuclear material in NPP, especially verification of low burn-up spent fuel in storage pool.

The KINAC(Korea Institute of Nuclear nonproliferation and control) who is the official body for safeguards inspection in ROK is trying to develop and secure the new inspection equipment for National Inspection. The SSAC(State System of Accounting for and Control of Nuclear Material) in ROK and IAEA is using many inspection equipments under the cooperation from 1970's. In 2008, The KINAC want to use the SFAT, which is the inspection equipment for LWR. From August of 2008, The Integrated Safeguards system was entered into ROK. The SSAC should strengthen the National Inspection system. So, The SSAC decided to use IAEA equipment for verification of the Low burn-up spent fuel.

2. Methods and Results

When fission product radiation is too weak to be detected, the use of SFAT is needed in following situations.

- For low-burnup spent fuel (<10GWd/tU)
- When a very thick absorber blocks the active part of the item to be measured
- For assemblies stored near short-cooled spent fuel assemblies

The use of the SFAT meets the criteria for Category H verification(gloss Defect). Method H is defined in the Agency Safeguards Manual. The dominant peak in long cooled spent fuel is Cs-137 as you see in Fig.1. An average of cooling time is around 6 years.

2.1 Basic Theory

On below Fig. 1, we can see the Cs-137 in the center of graph, Green one. The energy range is about 66Kev. If you can see this value in the graph, it must be spent fuel. The KINAC has two SFATs for National Inspection. These equipments were prepared through the Project from MEST.

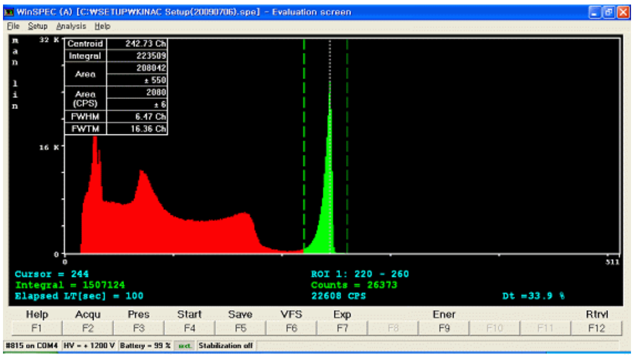

Fig. 1 Cs-137 peak on the monitor

The SFAT evolved for 10years in IAEA Technical Division. The beginning model, which is called heavy SFAT, is difficult to use in spot easily. So, IAEA developed light SFAT. The KINAC is trying to adopt the light SFAT for National Inspection.

2.2 General Description

The SFAT consists of a stainless steel body that provides buoyancy, shielding and collimation, a CdZnTe detector, and a preamplifier. Air collimator pipe segments attach to the detector cylinder. A multiwire cable connects the detector to the MMCA. The mutiwire can sustain sever al kgs in the sky. The IAEA also developed the multiwire for various purpose.

Fig. 2 SFAT, MMCA and HP 200LX

A lead or tungsten collimator/shield surrounds the CdZnTe detector in order to reduce the gamma radiation from other nearby irradiated items. The air pipes attached to the bottom of the housing exclude water from a narrow column inline with the collimator hole in the shield, further collimating the radiation from the spent fuel assembly to the detector. The air pipe is also used to attenuate the radiation from the spent fuel.

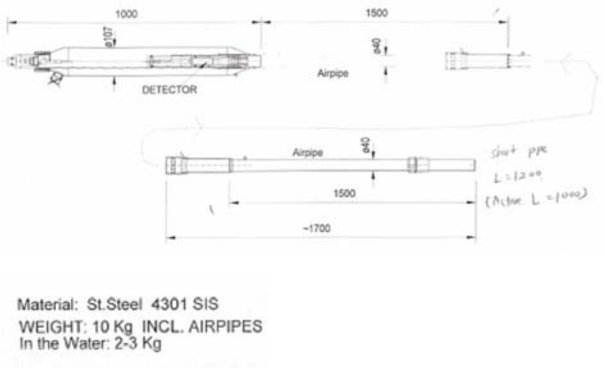

Fig. 3.SFAT LIGHT Collimator

2.3 Additional Information

The SFAT is suspended underwater with the end of the air collimator tube resting on top of the items to be verified. The MMCA and computer are not watertight and are operated above the water(usually on the bridge of the storage pond).

2.4 Shaping of peak from Spent fuel by ages

As time goes by, the spent fuel in the pond shows the Cs-137 peak dominantly. The below figure shows the fact. According to the graph, In this project, The SSAC tried to make two own SFAT for national safeguards inspection.

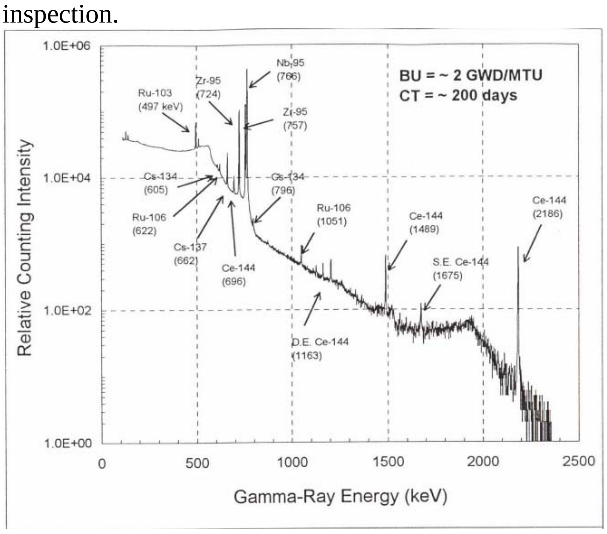

Fig. 4. Gamma Ray Energy Spent fuel in LWR/cooled about 200days

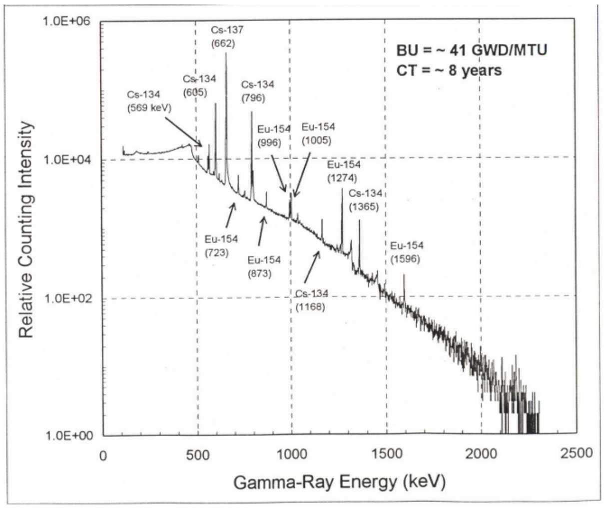

Fig. 5. Gamma Ray Energy Spent fuel in LWR/cooled about 8 years

3. Conclusions

In this project, the SSAC tried to make two own SFAT for national safeguards inspection. .Up to now, the national Inspector could not use the SFAT to verify long cooled spent fuel without IAEA Inspector. But, The SSAC can verify the long cooled spent fuel by ourselves with own SFAT in LWR. This is meaning the strengthen of National Safeguards capacities. We will reinforce the safeguards inspection equipments through the project.

REFERENCES

[1] IAEA Safeguards Manual, Part SMO, Section SMO 7.1
[2] Safeguards Criteria, Annex F, Procedures for Sampling Plans
[3] SG-CP-53. MMCA Keyboard Commands and Setup File. International Atomic Energy Agency. September 1998.
[4] SFAT – Attribute Measurement of Spent Fuel References