The study of necessity of verification-methods for Depleted Uranium

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1. Introduction

ROK has tried to establish management system for depleted uranium from 2004, and ROK achieved some results in this field including management software, management skill, and the list of company using the nuclear material. But, the studies for the depleted uranium are insufficient exclude the studies of KAERI. In terms of SSAC, We have to study more about whether the depleted uranium is really dangerous material or not and how is the depleted uranium diverted to the nuclear weapon. The depleted uranium was controlled by the item counting in the national system for the small quantity nuclear material. We don't have unique technical methods to clarify the depleted uranium on-the-spot inspection not laboratory scale. Therefore, I would like to suggest of the necessity of the verification methods for depleted uranium. Furthermore, I would like to show you the methods of the verification of the depleted uranium in national system up to now.

2. Shielding feature of the depleted uranium

When we use the radioisotope, we have to consider shield to protect human from radioactivity. At this point, we use the term HVL(half value layer) to explain concept about the cut-down distance. This concept depend on the material in shielding materials, the formula is as below,

$$\frac{i(x)}{i_0} = \frac{1}{2} = e^{-\mu x_{1/2}}$$

μ : the linear absorption coefficient

X : the distance to go halves to diminish the intensity of the gamma ray

HVL(cm) for the each material to shield based on the energy

Energy (Mev)	Pb	Fe	Al	H_2O	concrete
0.1	0.011	0.237	1.507	4.060	1.734
0.3	0.151	0.801	2.464	5.843	2.747
0.5	0.378	1.046	3.041	7.152	3.380
0.662	0.558	1.191	3.324	8.039	3.806
1.0	0.860	1.468	4.177	9.802	4.639
1.173	0.987	1.601	4.541	10.662	5.044
1.332	1.088	1.702	4.829	11.342	5.368

Energy (Mev)	Pb	Fe	Al	H_2O	concrete
1.5	1.169	1.802	5.130	12.052	5.698
2.0	1.326	2.064	5.938	14.028	6.612
3.0	1.442	2.431	7.249	17.456	8.141
5.0	1.429	2.798	9.059	22.871	10.361
10.0	1.228	2.940	11.070	31.216	13.227

Above table can explain the very reason that lead being used as a shielding material. Tungsten and depleted uranium also have unique trait for shielding material in many ways. But, tungsten is very expensive material to use in the smallest scale companies. The depleted uranium is the tail generated after reprocessing or has lower concentrate than natural uranium after burning in the reactor. Uranium is the high atomic number material, that means that uranium can be used in shielding material like lead and tungsten. Present, the companies use the depleted uranium as a shielding material mainly. The worker using depleted uranium is in safe because depleted uranium has lower concentrate than natural uranium. At the beginning, nobody worried about the dangerous of the depleted uranium. Since 1999, International Atomic Energy Agency has pointed out the depleted uranium's diversion possibility and has asked to report the status of the depleted uranium in Korea.

3. Status of the using the depleted uranium

The amount of depleted uranium in Korea is in excess of the 1SQ, which is the significant quantity , in accountancy and control of the nuclear material. On top of that, the shielding material is used to exchange among the Non destructive companies. Some cases are going in and out abroad for export and import. Those leads the government to hard to control the material.
Actually, there are many opinions in the control of the depleted uranium in spite of low radioactivity. Major pros is insisting the depleted uranium can be divert to Pu through the irradiation in the fast-reactor or accelerator. Naturally, Using the those equipments is not easy. can not use easily

- Difficulties in the verification of the depleted uranium

There are some reasons not to detect the deplete uranium exactly. The main reason of the difficulties is the low radioactivity in itself. Besides, radioisotope in activation disturbs detecting the nuclear material. Some cases are causing the Compton scattering in the detection procedure. But, In many cases, characteristic gamma energy range of the radioisotope is too low to disturb detecting depleted uranium. on 's

4. detection methods of the depleted uranium

1) detection method using the specific gravity

(25℃)

material	Specific gravity	material	Specific gravity
steel	7.8	Mercury	13.6
copper	8.9	Water	1
Gold	19.3	Iceed water	0.92
Lead	11.3	White gold	21.37
Silver	10.5	Uranium	19.05

According to above table, uranium is as high as gold in specific gravity. That means that someone to divert the uranium have to replace the uranium the heavier material like gold. So, weighing the depleted uranium and calculate the volume help to verifying the depleted uranium. Based on the data base regarding the small quantity of nuclear material, we can declare the weight of the radiological-camera device using depleted uranium..

	Type of radiological camera	weight(KG)	Error range
1	660	16.8	±10%
2	660B	16.8	±10%
3	680	130.0	±10%
4	680B	130.0	±10%

This method is very efficient to verify. But, this is indirect method to detect diversion of depleted uranium. So, we have to conduct this method with another NDA method at the same time.

2) NDA method using the HM5

The device ,HM5, is the digital gamma spectrometry in using as inspection equipment in IAEA. The device has the 1"(diameter) x 2" sized NaI detector. The device can analysis nuclide . HM5 sometimes mistake in Plutonium for the depleted uranium on the spot. This is because that the two nuclides have the similar energy range in characteristic gamma. In this case , we should re-measure the nuclear material with HM5.

5. Conclusion

There are some reasons not to detect the deplete uranium exactly. Therefore, we should develop some method to verify the depleted uranium exactly. Pratically, this is not important whether the method is really efficient to verify the material or not. The development of method or systematic procedure to decide the material will be needed to get the confidence of the people and IAEA.

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