The development of National Nuclear Forensics Library system

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1. Introduction

Generally, when an accident or crime happens, a database(DB) of hazardous materials is a useful method to trace the origin and owner of materials. It is similar to the event using radioactive or nuclear (RN) materials in the perspective of providing evidences. For tracking down the origin of undeclared materials, the RN materials DB should be established as preliminary action. It could evidence the objects of cases and bring a prosecution against criminals. Korea Institute of Nuclear Nonproliferation and Control (KINAC) has established the "National Nuclear Forensic Library (NNFL)" system with characteristics of fresh nuclear fuels (FF) and spent nuclear fuels (SF). This article shows the composition of the NNFL, its function, and future works.

2. Library system

The Republic of Korea (ROK) fabricates the nuclear fuel with the imported uranium and operates the nuclear power plants. Firstly, KINAC considered FF and SF data for the proto type NNFL system.

The NNFL consists of three categories as shown in Fig.1. The signatures had been researched based on license holders provided Quality Control (QC) data [1~3]. After signatures chosen, each of the parameters was accumulated in the DB. The comparison algorithm to interpret unidentified materials had been developed by Kyunghee University. These three categories were unified as one system on ECMiner . The NNFL system has flexible system for extension and user-friendly interface forusers with the commercial software, ECMiner.

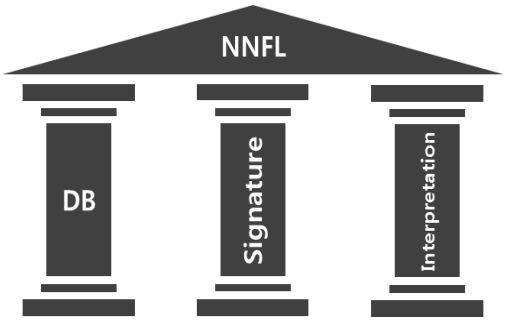

Fig.1. Structure of the NNFL [4]

2.1 Fresh nuclear fuel comparison

FF signatures were chosen from the QC data. The data schema is shown in Fig.2.

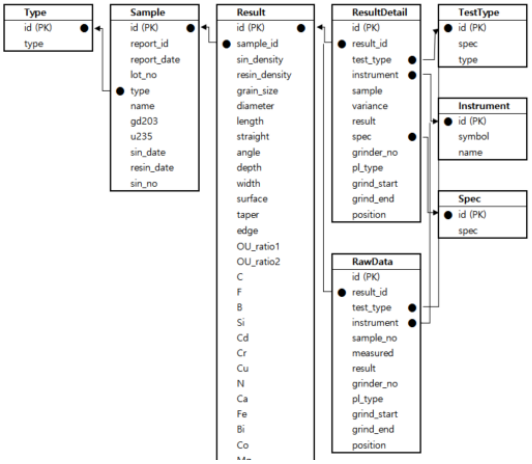

Fig. 2. Data schema of fresh fuel [5]

These data are loaded into the NNFL and it could be added further. Moreover, analysis results of unidentified materials will be entered in the same format for comparing to interpret. Therefore, input screen should be designed instinctively for users and could manage the massive data. There are two ways for data entry; uploading with EXCEL file and Graphical User Interface. Fig.3 shows screenshot which is checking the input data [5].

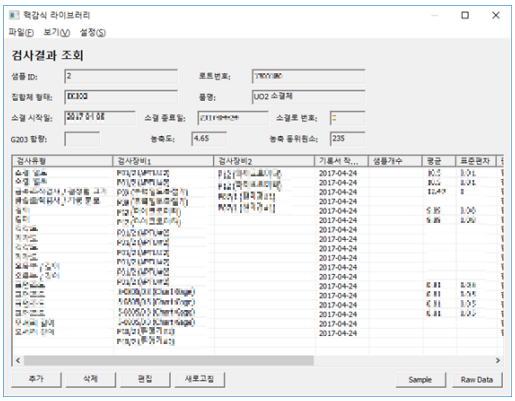

Fig. 3. The results of checking DB [5]

The comparison result between DB and the unidentified materials are showing up when researchers enter the analysis results. The comparison screen shows similarity index between DB and the analysis results based on each signature to prepare such a situation that the unidentified materials had already lost its own characteristics. Table I. shows example comparison screen [6]. Subject Matter Experts (SME) would take a role to confirm these results.

Table. I: The comparison results example [6]

Signatures		Unknown	Comparison	Note
Physical	Pellet diameter	10 mm	Low	Shape damaged
	Pellet Length	12 mm	High	
	Surface Roughness	Null	Unverifiable	
Chemical	Enrichment	3.61%	High	
	O/U Ratio	2	High	
	Element (Impurities)	C:200ppm F:200ppm	High	

2.2 Spent nuclear fuel regression analysis

If the unidentified materials assumed as SF, it is more complicated. Because destructive analysis is unable to conduct for every SF pellet. The SF DB is managed and accumulated operational history of nuclear power plants. The kernel regression algorithm is for prediction of operational history such as burn up, cooling time and etc. from the analysis results of unidentified materials [4]. Fig. 4 shows the schema of SF analysis system.

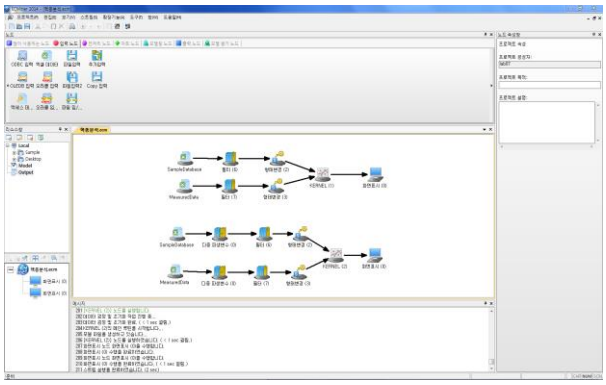

Fig. 4. The NNFL principle for spent nuclear fuel

2.3 System extension

KINAC had researched signatures on FF and SF. Moreover, there might be more signatures had not been discovered yet, such as microstructures. Interpretation of microstructure image could be a challenge to handle with the algorithm, KINAC already established. KINAC has a plan to verify whether the variation of microstructures is able to be quantified depending on the fabrication condition, such as dopant, sintering pressure or temperatures.

The proto type system has FF and SF, restrictively. However, information related to whole fuel cycle in each country should be accumulated in NNFL. The information of nuclear or radioactive materials is managed by each stake holders or regulatory bodies with each institutes' objectives. For example, the Korea Institute of Nuclear Safety (KINS) manages the radioactive material with Radiation Safety Information Systems (RASIS) and KINAC has Nuclear Material Accounting (NMA) system. Those systems would be synchronized with the NNFL and updated as a unified system in the future. The legislation and related institute assistance are required to establish for achieving above.

3. Conclusions

KINAC has been established about structure of the NNFL and developed the prototype NNFL system as a result. NNFL is not only a system, also includes each steps of fuel cycle's SME pool. KINAC has the candidates for SME, however, didn't established the SME pool yet. KINAC will update the NNFL system with the SME.

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