

A Nuclide Inventory Verification System for the Development of a Waste Certification Program

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1. Introduction

For the safe disposal of decommissioning wastes, they must be processed, managed, and transferred in accordance with waste acceptance criteria [1]. The waste certification programs (WCP) have been developed in many countries to resolving problems related to the management of radioactive wastes. To support the development of WCP, properties of radioactive wastes such as the inventory of each radionuclide in a drum must be evaluated and verified. Therefore, we developed a nuclide inventory verification system to support the development of a WCP for decommissioning wastes.

2. Methods and Results

In this section, the overall scheme of the nuclide inventory verification system and the example verification is described. The verification is made based on the specific activity of each radionuclide in the radionuclide inventory database.

2.1 Database for Radionuclide Inventories

We developed a radionuclide inventory database of radioactive wastes through the survey of reports and the calculation of them using ORIGEN [2] and PISFACT [3] program. The important fields of the database for the nuclide inventory verification are a reactor type, an isotope, a waste stream, and a specific activity as shown in in Fig. 1.

ID	Source	Country	Arising Date	Reactor Type	NPP Site	Waste Type	Waste Stream	Isotopes	Specific Activity
1	SN000001	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	H-3 1.69E+05
2	SN000002	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	C-14 1.66E+01
3	SN000003	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Fe-55 2.71E+02
4	SN000004	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Co-58 1.07E+00
5	SN000005	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Co-60 2.96E+01
6	SN000006	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Ni-59 3.76E+02
7	SN000007	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Ni-63 6.10E+00
8	SN000008	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Sr-90 3.46E+02
9	SN000009	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Nb-94 6.54E+01
10	SN000010	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Tc-99 2.83E+01
11	SN000011	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	I-129 1.36E+03
12	SN000012	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Cu-117 4.66E+01
13	SN000013	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Ce-144 8.81E+01
14	SN000014	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Alpha 2.32E+01
15	SN000015	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	H-3 5.88E+03
16	SN000016	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	C-14 5.75E+01
17	SN000017	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Fe-55 9.41E+00
18	SN000018	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Co-58 3.70E+02
19	SN000019	Reference	Korea	01.12.2014	CANDU	월성	단순저장	함고체	Co-60 1.03E+00

Fig. 1. Example of database for nuclide inventory.

2.2 Nuclide Inventory Verification System

The nuclide inventory verification system consists of following menus: a database for nuclide inventory, an analysis, a verification and assessment, and a change account as shown in Fig. 2. In the database menu, there are submenus such as search, add, delete, and modify to control the radionuclide inventory database. The analysis menu is a menu for identifying statistical trends by obtaining mean (μ) and standard deviation (σ) of a specific activity of each nuclide. The example analysis result for H-3 in dry active wastes of all kinds of reactor types are shown in Fig.3. Based on the statistical analysis results, the user can obtain the mean and the standard deviation of a selected radionuclide and the log-normal probabilistic distribution function as shown in Fig.3. The verification and assessment menu is a menu for verifying radionuclide inventories in a waste drum by checking whether they are within an acceptable range or not. The change account menu is a menu for changing account from a general user to administrator.

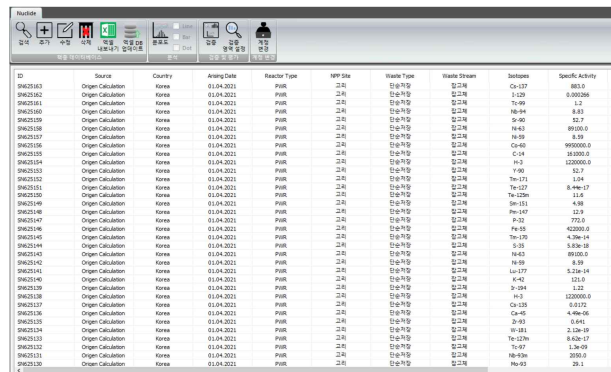


Fig. 2. Main screen and menus of the nuclide inventory verification system.

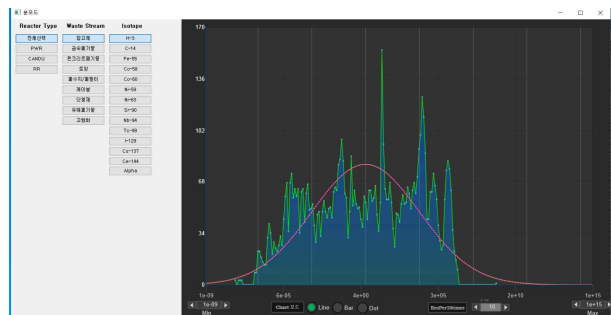


Fig. 3. A display screen for the distribution of specific activity of a radionuclide (H-3).

2.3 Example Verification of Nuclide Inventories

The example verification of nuclide inventories in a waste drum is made through the verification and assessment menu using the characteristics data of each waste drum and statistical values of each radionuclide in the radionuclide inventory database. It is made based on the information of the waste drum given by the waste generator. The screen for the selection of verification data is shown in Fig. 3. First of all, if a user clicks the get waste drum information button in the upper part of Fig. 3, a user can import the information of waste drums to be verified and then they are displayed in the box in the upper part of Fig. 3. And then a user can choose a waste drum to be verified, and the drum number and related information are displayed in the boxes of left-hand side of Fig. 3. The distribution of each radionuclide with mean and standard deviation are plotted in the right-hand side of Fig. 3. The minimum and maximum value of specific activity are also displayed in red color.

For the verification, a user can modify the number of n in $m \pm n\sigma$, which is the acceptable range of the specific activity of each radionuclide. The default value of n is 3. The minimum and maximum value of a specific activity of each radionuclide are also displayed based on the statistical analysis results of data in the nuclide inventory database.

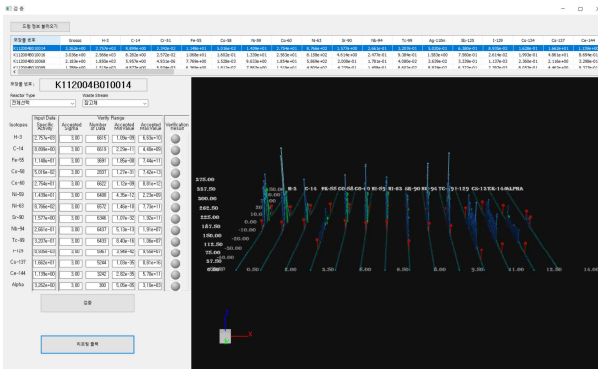


Fig. 3. Screen for the selection of verification data

With this information, the verification result of a waste drum is displayed if a user clicks the verification button. The example verification results are shown in Fig. 4. As shown in Fig. 4, the color of verification result is green if the verification result is acceptable. If the value of specific activity of a radionuclide is beyond the acceptable range, the color of verification result of each radionuclide changes to red. After the verification for each waste drum is finished, the verification result can be output as a report in the PDF format by clicking the report generation button. The example verification report in the PDF format is shown in Fig. 5. As shown in this figure, the identification number of a waste drum and the verification result for each radionuclide in a waste drum are displayed.

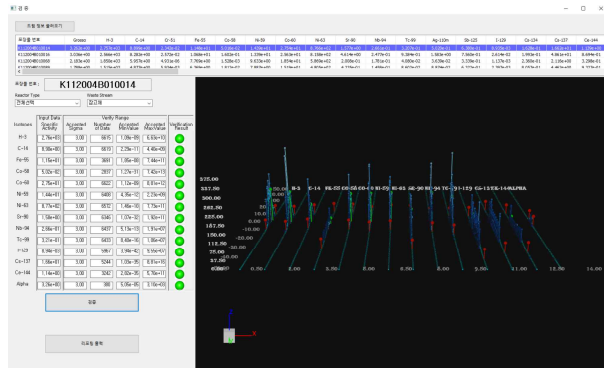


Fig. 4. Screen for the example verification result

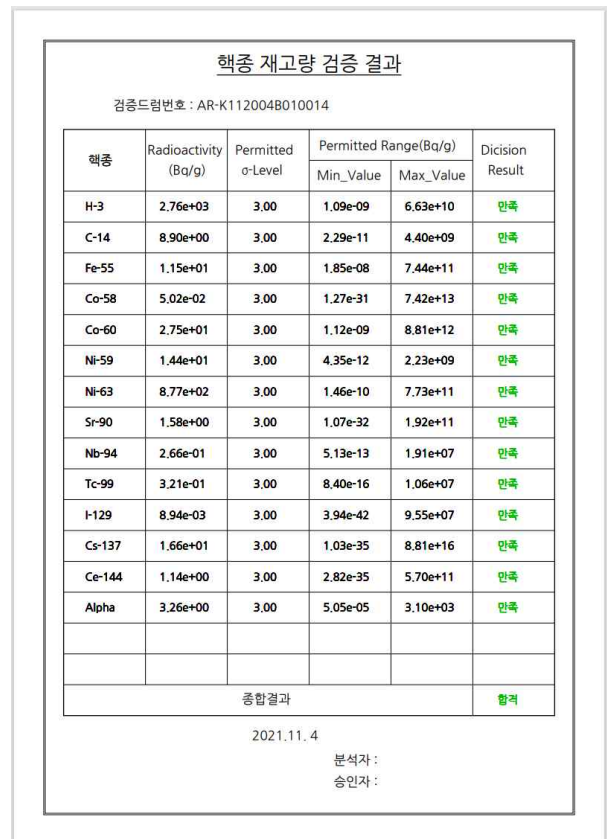


Fig. 5. Screen for the example verification result

3. Conclusions

The verification of nuclide inventories in waste drums is a fundamental task for securing the safe disposal of radioactive wastes. Therefore, we developed a nuclide inventory verification system to support the development of a waste acceptance program. The verification is made based on the statistical analyses of specific activity of radionuclides in the database of radionuclide inventory. We checked the applicability of nuclide inventory verification system by applying it to the radionuclide inventory data of the operational wastes. This radionuclide inventory verification system can be a useful tool to support the development of WCP.

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