System Requirements Analysis and Design for Supporting the Radioactive Waste Certification Program

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1. Introduction

The low and intermediate-level radioactive waste generated within the Korea Atomic Energy Research Institute undergoes various procedures before being transported to disposal sites. In accordance with the Nuclear Safety and Security Commission's "Regulations on the Transfer of Low and Intermediate-Level Radioactive Waste," the disposal operator (KORAD) has recently revised the "Criteria for the Transfer of Low and Intermediate-Level Radioactive Waste," specifying detailed standards for radioactive waste management and quality assurance. Consequently, the waste generator (disposer) is required to provide information verifying objectivity, fairness, stability, and more, to facilitate the transfer. To meet government requirements and ensure public acceptance, there is a need to develop a system that supports the radioactive waste certification program.

2. Methods and Results

In this section, we will discuss the requirements and design methods for establishing the support system for the Waste Certification Program (WCP) and elaborate on the design of the radioactive waste characterization task system and supporting modules.
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2.1 Radioactive Waste Certification Program Requirements Analysis and Design

Detailed requirements were analyzed, considering user and system requirements for the radioactive waste certification program support system. Input was gathered from stakeholders and experts. The results were documented in the Waste Certification Program Support System Requirements Specification, providing detailed analysis content for each unique requirement number. Additional requirements were incorporated into the specification based on feedback from the industry and expert opinions.

Table I: List of Requirements Specification for WCP Support System

No.	Detail Description	Unique No.
02	System Analysis Design (ISO Standard)	FFR-01
03	WCP Task Analysis and Expert Opinion Collection	FFR-02
04	WCP Requirement Analysis	FFR-03
06	Full Lifecycle process design	FFR-05
07	Characterization DB/Process design	FFR-06/07
12	Radiological Requrements	FFR-09/10
14	Physical/Chemical Requirementys	FFR-11/12
16	Small Packaging Trace	FFR-13
19	Radwaste delivery/Accept	FFR-16
20	Radwaste Requirements Output	FFR-17
22	Radwaste Tracing Dashboard	FFR-19
27	Radwaste Packaging	Expert
32	Nuclide Analysis material	Expert
33	Surface dose rate	Expert
39	Characterization Results	Expert
41	Liquid test results	Expert

2.2 Radioactive Waste Characterization Support System Design Model

To incorporate radioactive waste characterization into the certification program's support system, we designed a system supporting the entire life cycle of radioactive waste, a database system for waste characterization, and a process design for waste characterization needed for waste transfer (Fig. 1).
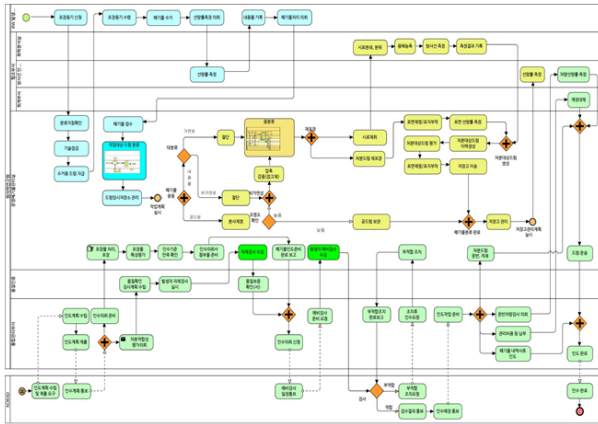

Fig. 1. Full life-cycle process of radioactive waste

2.3 Radioactive Waste Certification Program Characterization Support Module Design

The waste characterization criteria were categorized into six major classifications (general requirements, solidification and fixation requirements, radiation requirements, physical requirements, chemical requirements, and biological requirements), further divided into 18 subcategories. The design of the characterization support module was based on the specific characterization procedures, depicted using an activity diagram.

2.4 Design of Query/Trace/Output/Dashboard for Radioactive Waste Certification Program Support System

Design considerations include recording QR codes for small packaged waste following guidelines, real-time tracking of waste generated based on the waste origin, and the ability to query data such as drum count, facility-wise drum count, quarterly and yearly waste generation (Fig. 2 and Fig. 3).
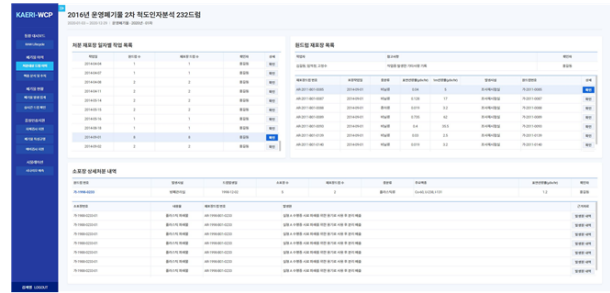

Fig. 2. Screen view of tracking and identification for small packaged wastes

Fig. 3. Screen view of inquiring a drum disposal status

For outputting the radioactive waste characterization requirements, we referred to templates and forms from the permanent disposal procedure and characterization procedure, as well as those requested by the operational waste management office, creating a template database to preserve the composition and history of these output documents (Fig. 4).
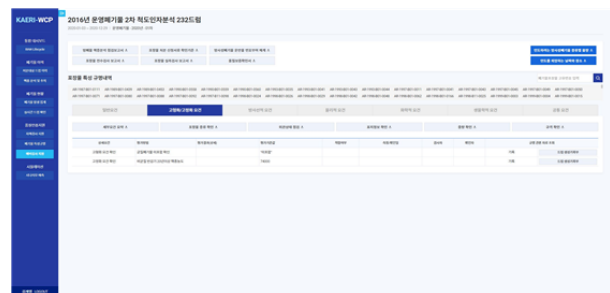

Fig. 4. Screen view of a solidification/immobilization requirements during preliminary inspection

The radioactive waste characterization tracking dashboard displays an overview of waste types, contents, and characterization results for each disposal order (Fig. 5).
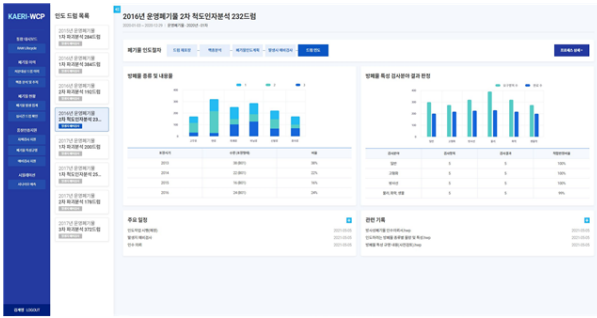
Fig. 5. Dashboard screen view of a tracking of characterization for radioactive wastes

3. Conclusions

This system enhances trust between waste generators and disposal operators by confirming that the radioactive waste is being handled in accordance with the transfer criteria set by the disposal operator (KORAD). Additionally, the support system for the radioactive waste certification program serves as a useful tool for streamlining tasks and communication between regulatory bodies, disposal operators, and waste generators, offering a potential avenue to secure public acceptance.