

Real-Time Meteorological Data Integration in the Safe-KAERI Program for Public Dose Assessment and Protective Action Support

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1. Introduction

Nuclear or radiological emergency response systems are essential not only for regulatory authorities but also for nuclear operators responsible for early-phase accident response. Nuclear operators must perform situation assessment, dose evaluation, protective action decision-making, and notification of relevant authorities during the initial phase of an accident, which requires reliable, robust, and user-friendly computational support tools.

However, many existing tools rely heavily on manual data preparation, provide limited support for separating real emergency situations from training scenarios, and offer insufficient functionality for result reporting and post-analysis. These limitations reduce their practical usability for on-site emergency preparedness, training, and response.

Safe-KAERI was developed by the Korea Atomic Energy Research Institute (KAERI), as a nuclear operator, to support on-site radiological emergency response and early-phase decision-making. This paper summarizes the functional improvements implemented in 2025, focusing on usability, realism, training applicability, and result utilization.

2. Methods and Results

2.1 Overall System Architecture and Data Flow

Safe-KAERI consists of four modules: atmospheric dispersion, radionuclide concentration, dose assessment, and protective action decision. These modules are linked through standardized data structures, and the entire process from scenario input through meteorological and monitoring data linkage, calculation, and result output is automated. This design minimizes manual intervention and reduces the possibility of input inconsistencies.

2.2 Source Term Input and Scenario Configuration

Previously, radiation source terms were entered only via external text files (.txt), which frequently resulted in formatting errors, unit inconsistencies, and difficulties for non-expert users. To address this limitation, a GUI-based source-term input interface was introduced in

2025 as shown in Fig.1. This interface allows users to directly configure accident types, released radionuclides, release amounts, and release durations through step-by-step selection. It significantly reduced input errors, improved robustness of scenario configuration, and shortened the time required for scenario preparation, especially during training and drills.

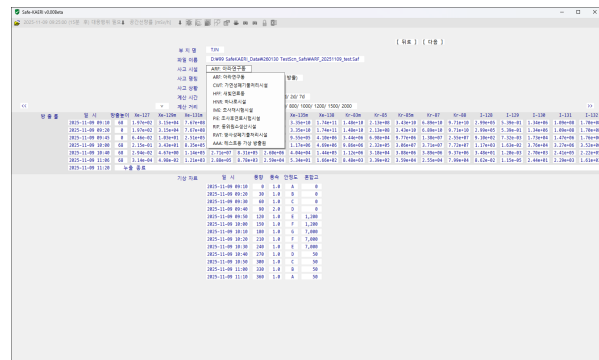


Fig. 1. GUI-based Source-Term Input Interface (Hypothetical source-term)

2.3 Meteorological Data Integration

In earlier versions, only user-input meteorological data were used for scenario evaluation. After improvement, meteorological data measured at the on-site meteorological tower corresponding to the accident evaluation time specified by the user are automatically retrieved and applied in real mode. This enhancement improved the realism of dispersion and dose calculations and reduced the risk of temporal mismatch between accident scenarios and meteorological conditions.

2.4 Scenario Evaluation Mode (Real vs. Training)

Scenario evaluation is divided into real and training modes. Real mode uses real-time meteorological data and measured on-site environmental radiation monitoring system (ERMS) data to reflect actual accident conditions. In contrast, training mode uses hypothetical meteorological data and calculated ERM results, allowing repeated drills and education without relying on real-time measurements.

This separation enables a single system to support both operational response and preparedness training while maintaining consistency in evaluation logic.

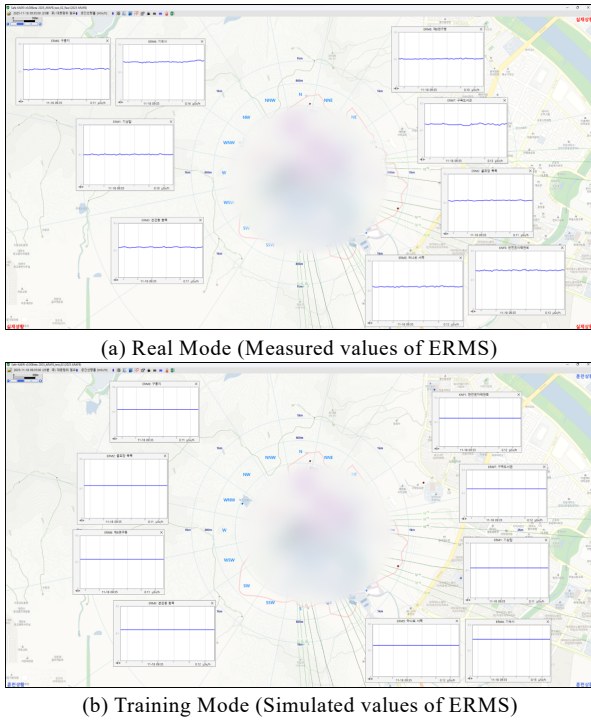


Fig. 2. Scenario Evaluation Interface

2.5 Public Protective Action Recommendation

The program compares calculated public dose results with national emergency protective action criteria to automatically identify areas requiring protective actions. Dose results are aggregated by administrative units or distance ranges, and areas exceeding the criteria are classified as protective action zones.

These zones are presented in tabular form and visualized on maps, allowing users to intuitively understand the spatial extent and location of areas requiring actions such as evacuation or sheltering, thereby supporting timely and informed decision-making.

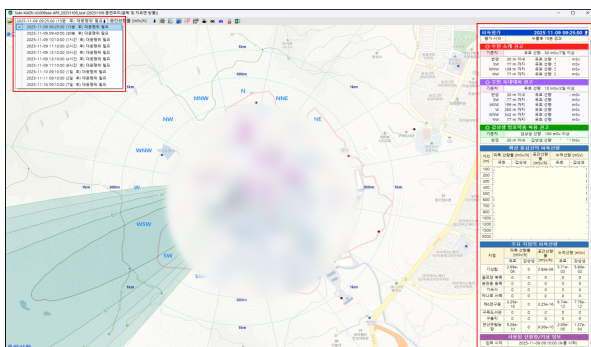


Fig. 3. Protective Action Recommendation Interface
 (Hypothetical source-term)

2.6 Result Output, Extraction, and Data Management

Scenario evaluation results are automatically stored as Txt, Sab, Cnc, Dos, Htm, and Xlsx files. Among these, Sab, Cnc, and Dos are internal binary files used for visualization and subsequent processing, while Htm, Txt, and Xlsx files are provided for user convenience during emergency response, reporting, and post-analysis. This multi-format output structure supports both real-time response and systematic documentation.

3. Conclusions

The 2025 improvements enhanced input reliability, realism, training applicability, and result usability of Safe-KAERI. These enhancements reduced operational burdens, improved scenario fidelity, and strengthened the practical effectiveness of nuclear operator-oriented emergency response tools. Future work includes the development of automated emergency notification report generation, implementation of an automatic program version update mechanism, development of administrator manuals, and official registration of the system as an institutional information system.

Acknowledgements

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REFERENCES

- [1] KAERI, "Radiation Emergency Plan" Revision 22, KAERI/EP-22, 2023.
- [2] Sohyeon Lee, et al., "Development of the ARA Fuel Building Emergency Response Program", Proceedings of the 2024 KARP Autumn meeting, pp.612-613, 2024.