Development of Dose Assessment Program to Recommend Emergency Protective Actions for Public

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1. Introduction

In 2004, the Ministry of Science and Technology (MOST) issued "the Act on Protection and Prevention of Radiological Disaster in Nuclear Facilities" and the subordinate regulations. Until that time, the nuclear utility (KHNP) used source term and dose assessment programs such as MAAP, InterRAS[1], RASCAL[2], etc. on a site-by-site basis for emergency exercises.

It was required to develop the program which can recommend the appropriate emergency protective actions for public within a few ten minutes after recognizing emergency condition.

The purpose of this study was to develop the program having functions described above paragraph. The program was named K-REDAP (**K**HNP's **R**adiological **E**mergency **D**ose **A**ssessment **P**rogram)[3]

2. Configuration of K-REDAP Program

As shown in Figure 1, K-REDAP program consists of engineering calculation module, graphic user interface module, and data base. K-REDAP-ENG developed by Visual Fortran 6.0 compiler performs numerical calculations such as source term, atmospheric dispersion, and dose to public and workers in emergency condition.

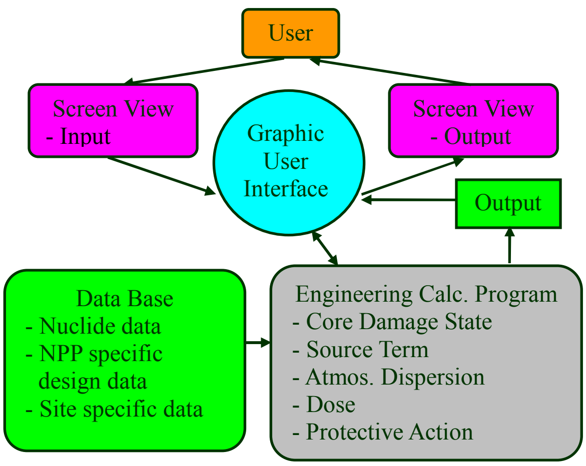


Figure 1. Configuration of K-REDAP Program

K-REDAP-GUI developed by Visual C++ 6.0 compiler supports communication between user and engineering calculation module to make input and to analyze output. K-REDAP-DB consists of nuclide data, NPP specific design data, and site specific meteorological and topographical data.

K-REDAP uses graphic user interface to maximize convenience for user to make input and to analyze output. It provides warning to user when the user tries to input inadequate data to the program.

Because most of design specific data and site specific data are constructed as data library and called automatically by the GUI, few data such as release starting/ending time, spray on/off, leak rate from building, model of atmospheric dispersion, real-time meteorological data measured at the site, etc. are required to be prepared by user.

K-REDAP provides images on the followings:

- Duration of core uncoverage depending on various variables
- Source terms released to environment for every 15 minutes and entire duration
- Atmospheric dispersion factor (χ/Q) and deposition factor within 80km from site. It shows movement of radioactive plume or puff in air and ground contamination with time after release
- Radiological doses for 2days, 7days, 1st month, 2nd month, and 70years
- Emergency protective actions required for public

3. Validation and Verification

KHNP has a plan to use this K-REDAP in emergency planning, exercise, and actual emergency for all NPP sites in Korea. Therefore, validation and verification of this program is very important to demonstrate the reliability of the program. K-REDAP was tested so many times to ensure stability in program execution and reliability in the results.

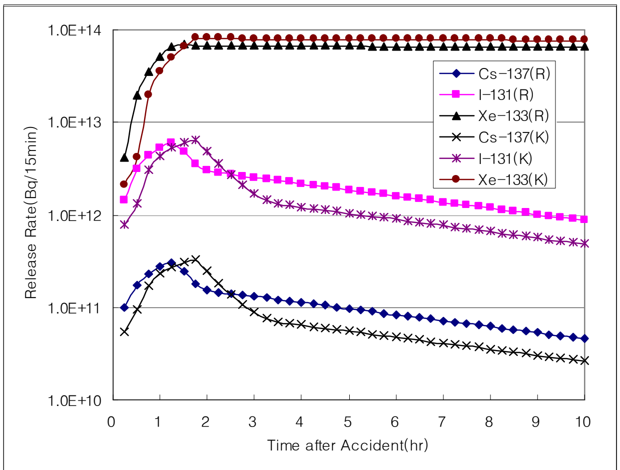
The results of K-REDAP calculation such as source term and dose were compared to the results of RASCAL and InterRAS calculations. The examples of verification calculations are given in Table I.

Table I. Example of Verification Calculations

Case	Example	Assumption (Input Data)
Case 1	Source Term Calculation	Power : 3,800MWt Core Melt : 80% Leak Rate : 0.1%/day No Spray
Case 2	Dose Calculation	Source Term(Bq/15min) - Xe-133 : $2.0x10^{17}$ - I-131 : $2.0x10^{15}$ - Cs-137 : $2.0x10^{14}$ Wind Speed : 1.78m/sec Stability Class : A Duration of Release : 6hr

Case 1 is performed to demonstrate the reliability of source term calculation module. The result of calculation is shown in Figure 2. As shown in Figure 2, K-REDAP calculation shows more delayed peak point of source term than that of RASCAL calculation. The difference comes from difference in the time at which source term removal by natural deposition starts in containment. RASCAL assumes that removal by natural deposition in containment is in effect during the time from release of first puff to 2hr after release. But in case of K-REDAP, the removal in containment is applied for individual puff independently. Because the removal of source term depends on the elapsed time of individual puff, the methodology of K-REDAP is more reasonable than that of RASCAL.

Case 2 is performed to verify the reliability of dose calculation. Figure 3 shows the result of dose assessment using K-REDAP, RASCAL, and InterRAS. As shown in Figure 3, the results of calculations are consistent with each other.



* (K) : K-REDAP calculation, (R) : RASCAL calculation
Figure 2. Comparison of Source Term

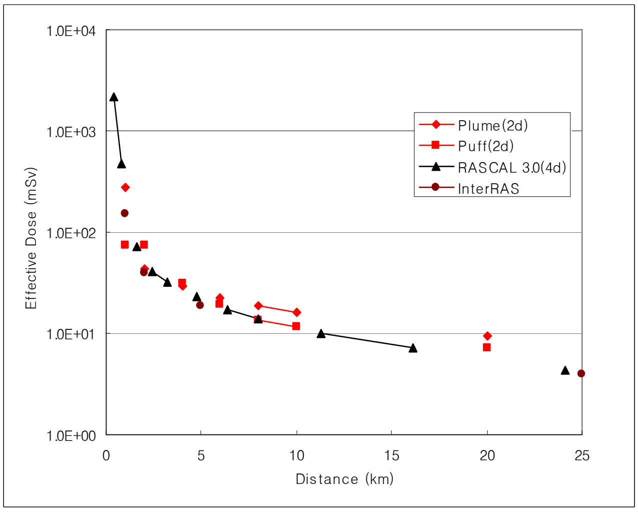


Figure 3. Comparison of Effective Dose Calculation

4. Conclusion

The purpose of this study was to develop the program having functions to support the utility's appropriate emergency protective actions before or after emergency condition in Korean NPPs. K-REDAP was verified and validated with various cases and showed stability in running and reliability in the results. This program will replace the program such as RASCAL and InterRAS currently used in the sites and will be utilized as a useful tool for emergency planning and exercise.

As a further study, the more detailed core damage estimation model for CANDU will be developed. In addition, the source term libraries for postulated severe accidents of PWR and CANDU will be constructed and combined into K-REDAP to make emergency planning as an effective measure to protect public from radiological disaster.

Acknowledgments

This study was implemented by financial support from Korea Hydro & Nuclear Power Co.,Ltd. (KHNP).

REFERENCES

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[2] NUREG-1741, "RASCAL 3.0: Description of Models and Methods," U.S. NRC, 2001.
[3] E05NT01, "Development of Dose Assessment Program to Recommend Emergency Protective Actions for Public," Korea Hydro & Nuclear Power Co.Ltd., 2006.