Development a computer codes to couple PWR-GALE output and PC-CREAM input

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Abstract. Radionuclide dispersion analysis is part of an important reactor safety analysis. From the analysis it can be obtained the amount of doses received by radiation workers and communities around nuclear reactor. The radionuclide dispersion analysis under normal operating conditions is carried out using the PC-CREAM code, and it requires input data such as source term and population distribution. Input data is derived from the output of another program that is PWR-GALE and written Population Distribution data in certain format. Compiling inputs for PC-CREAM programs manually requires high accuracy, as it involves large amounts of data in certain formats and often errors in compiling inputs manually. To minimize errors in input generation, than it is make coupling program for PWR-GALE and PC-CREAM programs and a program for writing population distribution according to the PC-CREAM input format. This work was conducted to create the coupling programming between PWR-GALE output and PC-CREAM input and programming to written population data in the required formats. Programming is done by using Python programming language which has advantages of multiplatform, object-oriented and interactive. The result of this work is software for coupling data of source term and written population distribution data. So that input to PC-CREAM program can be done easily and avoid formatting errors. Programming source term coupling program PWR-GALE and PC-CREAM is completed, so that the creation of PC-CREAM inputs in souceterm and distribution data can be done easily and according to the desired format.

1. Introduction
Radionuclide analysis under normal operating conditions was performed using PC-CREAM program. Required inputs include source term derived from output of PWR-GALE program, population distribution, production and consumption of agricultural products as well as atmospheric stability. The calculation of source term for PWR reactors under normal conditions has been done using the PWR-GALE program [1]. The output of the program will be used as input to the radionuclide distribution program using the PC-CREAM program. PC-CREAM input data is arranged in a certain format and entered manually, so it is very susceptible to errors due to incompatibility with the desired format. To overcome these errors, easy to written and to facilitate the required input data, a coupling program was written using Python language.

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Python programming has been used by several researchers for various problems, among others related to the calculation of physical parameters and reactors, performed by Martensen at al, Ragan-Kelley B at al, Huff K and Shim HJ [2,3,4,5]. Python programming is also used for research on site analysis conducted by researchers Stahlsmidt Z R et al, Matott S L et al and Pogacas T et al [6,7,8]. It is also used for data control system and uncertainty analysis by White J T et al, Binder J M et al and Enkovaara J et al [9,10,11].

In this work, Python programming language is utilized for coupling of radionuclide dispersion calculation which is source term as the output of program PWR-GALE is used as input data for PC-CREAM. Python is used due to its advantages such as multiplatform (can be used and work in MS Windows, Macintosh, Linux and others). In addition, Python also shaped object-oriented programming, interactive and functional. Commands in Python allow the users to have a direct interaction on the monitor screen, such as a table form that can be filled in directly and executed into a file after the completion of the table.

The objective of this work is to develop computer programs to couple PWR-GALE output data and PC-CREAM input. The first step of this work is to examine the data requirements used as input for the radionuclide dispersion in PC-CREAM code. Next step is to design the program to meet those needs and then write a routine using Python language. The programming results are checked whether the results obtained are in accordance with the needs.

2. Methodology

PWR-GALE and PC-CREAM coupling program is a routine to rectify input-output of two data of source term and population distribution. The input of PC-CREAM in the form of source term is shown in Table 1.

| Radionuclide | Activity (Bq) |
|--------------|--------------|
| Ar-41        | 4.00E-09     |
| Kr-89        | 3.31E-09     |
| I-131        | 2.25E-06     |
| Cs-137       | 3.71E-04     |

Furthermore, a work was conducted for the PWR-GALE program output, and the output from PWR GALE can be seen in Figure 1.
Further work was conducted to programming for population distribution input data is shown in Figure 2.

Based on Figure 1, a routine is written to obtain input according to Table 1. The steps taken are: to create a flow chart to read the PWR-GALE program output; and to write the output out of the program whose form and results are similar to the PWR-GALE program output. After that the program is written and executed, if the result is correct, it can be sure that the program reading is correct. Two output files (output PWR-GALE and output Coupling Programming) are written which...
are the same content and furthermore making programming output file containing only the name of nuclide and the activity of nuclide in accordance with Table 1.

For programming to written the population distribution, the initial step was to create a flow chart to create a display on the screen, which shows how to create a population distribution table. Furthermore programming is written so that it obtain a Table that can be filled as needed. When the table is executed will get a file containing the population distribution function of distance and tangential direction according to PC-CREAM format.

3. Results and Discussions
The results obtained are flow diagrams for writing coupling program from PWR-GALE program output with PC-CREAM program.

![Flowchart 3](image1)

![Flowchart 4](image2)

The flowcharts above show that the coupling programming is done gradually, beginning with opening the output file PWR-GALE program, and then reading the output data line by line. Then a routine is written in accordance with the output program PWR-GALE. After programming is done the program is executed, and the result is compared. When the result of the created program is the same as the file being read, then the programming is done. If the result is not the same, improvement is made
to the program, and done the same process with the previous one. Furthermore, a routine was written to couple the source term from PWR-GALE and PC-CREAM. The results obtained are as shown in Figure 5.

![Programming output file result of source term from PWR-GALE](image)

**Figure 5.** Programming output file result of source term from PWR-GALE

This programming to read the output of PWR-GALE has been in accordance with the planning. Furthermore, a routine was added on top of the coupling program to write the output of the data file nuclide and total activity, seen in the last 7 lines of the program output. The output file is used as input for the PC-CREAM program, and the results obtained are as shown in Figure 6.

![Radionuclide activity for the PC-CREAM input](image)

**Figure 6.** Radionuclide activity for the PC-CREAM input
From Figure 6, it shows that to make PC-Cream input easy. It can only run a coupling program that has been created with input from the PWR-GALE program, and generate input in accordance with the PC-CREAM format.

Further programming is conducted to make programming to written the population distribution as a function of distance and radial direction. The first step is to create an interactive table on the monitor screen and the results are shown in Figure 7 and Figure 8.

Figure 7 shows an interactive table to create a table as shown in Figure 8. By filling the tangential distance and direction in Figure 7, it will appear on the screen as shown in Figure 8. Figure 8 is an interactive table on the monitor screen, where by filling in the columns in Figure 8, and then by executing the program, it will get the population distribution file with the format as in Figure 2. By running the program of population distribution data, the input will be obtained for the PC-CREAM program according to the desired format, and avoid the error if done manually. Based on the results obtained, the programming for the coupling source term and written input population distribution is completed as planned.

4. Conclusion
A coupling programming was completed for source term coupling and written of data population distribution inputs. The routine was made to facilitate the inputs for PC-CREAM program, so it will avoid errors in the input format and simplify the data entry work compare to manual entry data. The use of Python language in programming provides advantages because it facilitates interaction with the monitor, so that the results made can be seen directly so as to minimize errors in programming.
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