Development of Source Term Uncertainty Analysis Supporting Program, MERTAG

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1. Introduction

- Since severe accidents generally have extreme conditions, such as high-temperature, high-pressure, and high-radiation, there are difficulties in experimenting and verifying the phenomena of the accidents.
- The regulatory authorities in Korea and the United States, MELCOR code is used to analyze severe accidents and their source terms characteristics.
- Although the uncertainty analysis system using MELCOR has been sufficiently established through previous studies, the following problems remain in handling the uncertainty analysis results.
- For performing uncertainty analysis, at least hundreds of samples as well as hundreds of PTF files (MELCOR Plot Files) are required.
- In addition, reading a variety of PTF files, extracting data in files, and statistical data processing will be needed for handling the uncertainty analysis result.
- However, the number of PTF files and the size of PTF files are too considerable to carry out analysis.
- The process, which consists of three steps, is significantly demanding and time-consuming task.
- In this regard, we developed the MELCOR Result to Table and Graph (MERTAG) program.

2. MERTAG Program

- Loading PTF files is the first step of executing MERTAG.
- Owing to the type of PTF file, which is a binary file, a special translator or interpreter is required to read PTF files.

Table I. A typical structure of a MELCOR Plot file.

	Block	Section	Subsection
MELCOR PLOT FILE	Block 1	Header	Title
			Key
		Specials	Special Data
			Special Data
		Time Records	Time Record
			Time Record
	Block 2	Header	Title
			Key
		Time Records	Time Record
			Time Record
	⋮	⋮	⋮
	Block n	Header	Title
			Key
		Time Records	Time Record
			Time Record

- The PTF file consists of a contiguous set of blocks and each block is composed of three Sections: Header, Specials, and Time Records.
- Among these sections, reading the Time Records Section, which contains considerable binary time-series data, is necessary for analyzing and plotting results.
- Despite of identical time step, each PTF file's calculation time sets have slightly differences.
- To solve this problem, MERTAG generates identical time step and interpolates time-series data.
- With interpolated data, two parameters, which are the arithmetic mean and standard deviation, can be calculated.
- The logarithmic mean (mu) and logarithmic standard deviation (sigma) are calculated form the arithmetic mean and the standard deviation.
- Using these parameters, MERTAG estimates 5th percentile, median, 95th percentile values.

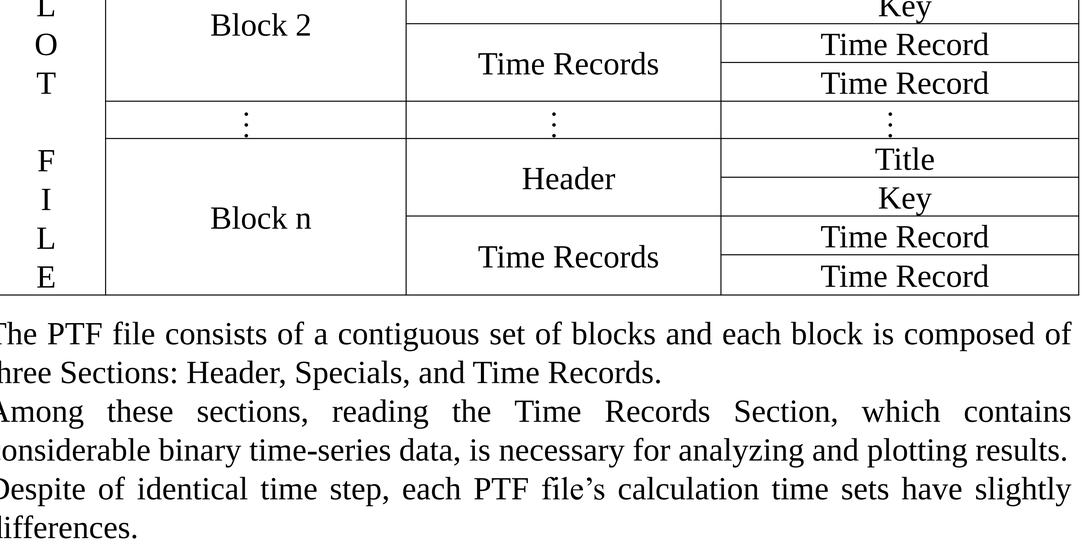

Fig. 1. A simplified flowchart of MERTAG.

- Printing a table and plotting a graph are the end of MERTAG.
- By using a file save function, the result formats are saved as CSV (Comma-separated Values) file and PNG (Portable Graphics Format) file, respectively.

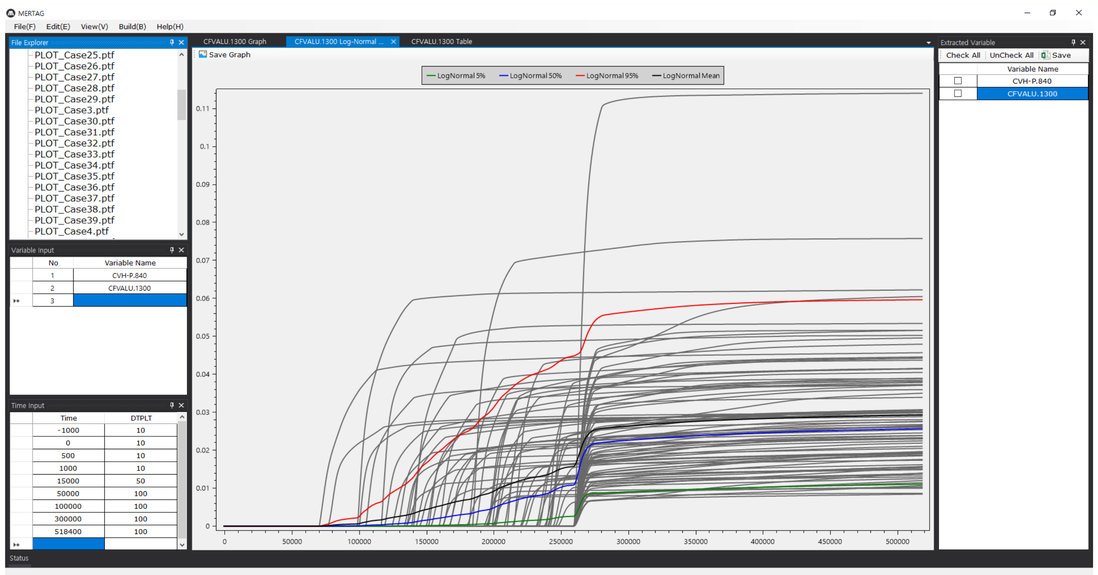

Fig. 2. A sample screenshot of MERTAG.

3. Example of Source Term Uncertainty Analysis

- For the verification, WH600 (Westinghouse two-loop plant) is selected as a reference plant.
- As a test-case scenario, a Station Blackout (SBO) is selected as an initiating event.
- In the scenario, the turbine-driven auxiliary feedwater pumps are only available and can operate 2 hours.
- Referring to the previous studies' results, 24 input were selected as the target inputs for MELCOR uncertainty analysis.
- The number of samples was determined to be 100.
- The input samples were generated by MELCOR Uncertainty Software, which uses Latin Hypercube Sampling (LHS) techniques.
- The samples were simulated using MELCOR version 2.2.

Table II : The result of uncertainty analysis in mass of Cs class released to the environment.

Time (seconds)	5th percentile	Median	Mean	95th percentile
518400	4.47	6.52	6.69	9.51

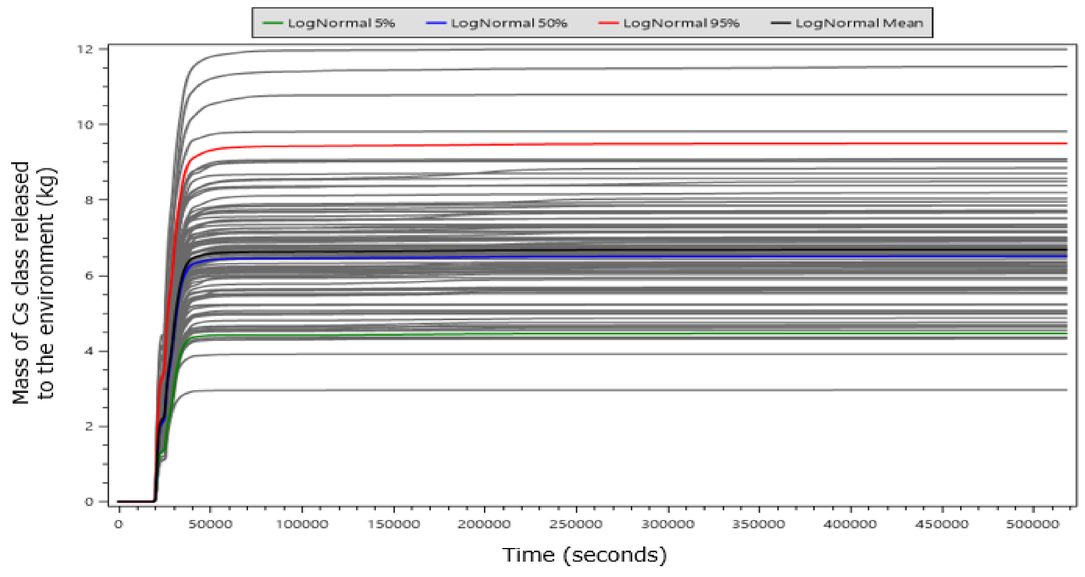

Fig. 3. An example of source terms uncertainty analysis results.

4. Conclusions

- Since severe accidents have large uncertainties, various studies on severe accident uncertainty analysis have been performed using MELCOR.
- The uncertainty analysis system using MELCOR has been sufficiently organized.
- Nevertheless, the problems on handling the uncertainty analysis results have remained.
- Numerous PTF files, which have MELCOR results, can be created because of many samples for conducting uncertainty analysis.
- Reading numerous PTF files, extracting data, and statistical data processing take an enormous amount of man-power and a lot of time.
- MERTAG, which was developed program, fully systematizes this process, and runs it automatically.
- MERTAG can not only save many required resources efficiently but also estimate release characteristics more easily.
- As a future work, we will conduct that uncertainty analysis is possible for other factors such as hydrogen generation, containment pressure.

5. Acknowledgement

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