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A preliminary uncertainty analysis of phenomenological inputs in TEXAS-V code

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1. Introduction

Uncertainty analysis is important step in safety analysis of nuclear power plants. The better estimate for the computer codes is on the increase instead of conservative codes. These efforts aim to get more precise evaluation of safety margins, and aim at determining the rate of change in the prediction of codes with one or more input parameters varies within its range of interest. From this point of view, a severe accident uncertainty analysis system, SAUNA, has been improved for TEXAS-V FCI uncertainty analysis. The main objective of this paper is to present the TEXAS FCI uncertainty analysis results implemented through the SAUNA code.

2. Methods and Implementation

The uncertainty analysis are treated importantly in the PSA and severe accident analysis field which includes uncertainty[1]. NUREG-1855 identifies three types of epistemic uncertainties: completeness uncertainty, parameter uncertainty, model uncertainty[2]. Using computer codes, uncertainty analysis can analyze the influences of various input variables or the influences of the reliability for the output variables from the analyzed results. Even though the severe accident analysis code is to be quantified by applying more advanced model or numerical approaches, the uncertainty always exists due to the inherent diversity complexity. Using time-consuming computer code execution for uncertainty analysis, the most effective method is to apply the computer based platform which can execute enormous simulation automatically. The effective approach of uncertainty analysis through a time-consuming integral computer code has shown to employ a computer-based platform which automatically implements lots of simulations as a part of an integral code[3].

2.1 SAUNA system adjustment for TEXAS-V code

SAUNA 1.0 system[4] is developed for to MAAP code in KAERI, which used to analyze uncertainty. To analyze with TEXAS-V code using SAUNA, interface parts have been adjusted for TEXAS-V code. The TEXAS-V code is 1-D code, which used to analyze steam explosion load. The TEXAS-V code composed of 2 parts in its execution using same execution code. One is the mixing calculation part, and another is the explosion calculation part. In these 2 parts, similar inputs are used. So the input template files, the sampling and the execution for uncertainty analysis are treated in 2 parts according to the TEXAS-V code properties. The analysis program for TEXAS-V calculation results, which is code output file, has been also adjusted.

An overall process for uncertainty analysis using the SAUNA system is shown in Fig.1. It is composed of three parts: sampling, execution control, and the result analysis. It is shown in Fig.1.

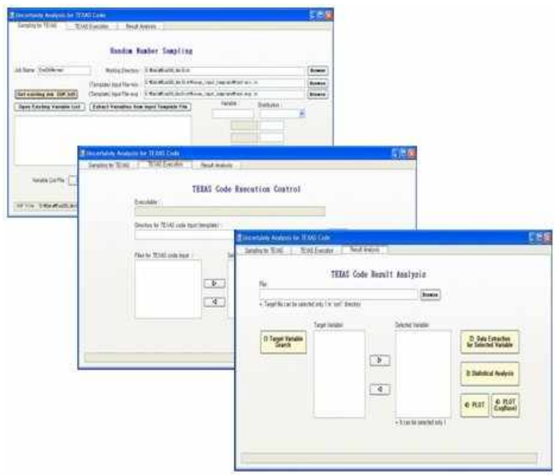

Fig. 1. Three parts of implementation SAUNA system with TEXAS-V code.

2.2 Uncertainty analysis

The steam explosion phenomenon is greatly influenced by initial conditions. For uncertainty analysis, the 4 factors, which are assumed to mostly affect the FCI phenomena, are selected as important parameters among the various major factors: cavity water temperature, particle diameter, initial melt temperature, and release jet velocity. And two major outputs, peak pressure and impulse at the bottom, are used for uncertainty analysis. For the importance/influence analysis, the PICORR code is used, which was developed in KAERI. The values used are shown in Tab.1. In this preliminary analysis 2 types of distribution are assumed such as normal PDF and uniform PDF. As an example, the normal distribution for melt velocity (UPIN) is shown in fig.2.

	Variable	PDF		Description
		Type	Min Max Ave	
1	TLO	Normal Uniform	294.0 344.0 319.0	The water temperature in the cavity
2	RPARN	Normal Uniform	0.05 0.15 0.1	The semi-diameter of particles in initial melting material
3	TPIN	Normal Uniform	2750 3150 2950.0	The temperature of initial melting material
4	UPIN	Normal Uniform	-12 -1 -6.5	The velocity of release in initial melting material

Tab.1. TEXAS-V input variables and its distribution

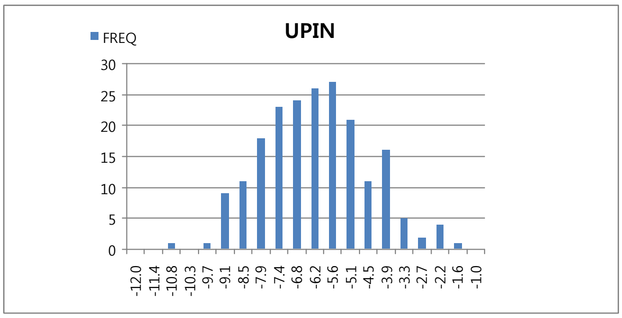

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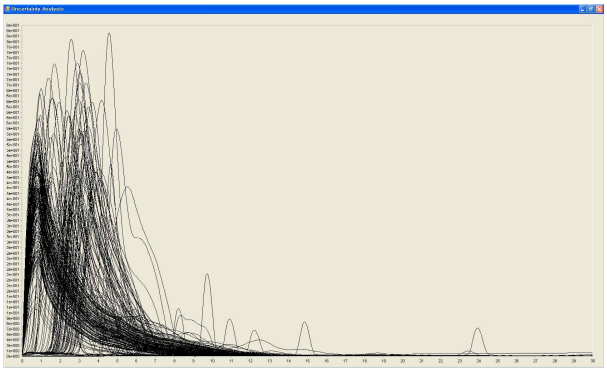
Fig.2. Input analysis of UPIN variable for normal distribution

When the execution time of TEXAS-V code is enormously long, the graphical display is not important. Thus the graphical display function of TEXAS-V code is adjusted to off.

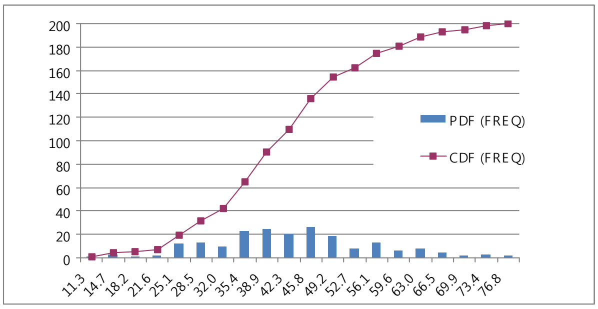
On a certain extreme cases, code execution is not finished normally. It may be caused from inappropriate adjustment of input values. These abnormal execution cases cause disturbance of accurate statistical analysis due to the mismatch between the sampling values and the code output. To adjust these mismatch cases small program has been implemented and used.

3. Results and Conclusions

The size of sampling is 200 each. In the case for uniform distribution, there are 5 cases for abnormal execution. So the 200 cases for normal distribution and the 195 cases for uniform distribution are used for result analysis. The measurement for importance/influence by IPCORR code is PCC, SRC, PRCC, SRRC, etc. Through the FCI analysis based on TEXAS-V code it is revealed that the most important variables are melt particle diameter and jet release velocity ('RPARN', 'UPIN') which strongly influenced to 'Peak value of pressure and impulse at the bottom'. Fig.3 shows the result analysis for the pressure at the bottom.



(a) Graphical analysis



(b) Peak value for normal distribution input

Fig.3. Result analysis for the pressure at the bottom

For an uncertainty analysis in the severe accident code TEXAS-V, the SAUNA system is being adjusted based on the early version of SAUNA 1.0 system. The TEXAS-V code is used to simulate FCI phenomenon for PWR. This SAUNA system with TEXAS-V code has shown that this system could perform enormous code simulations to obtain a statistical confidence on the code outputs in a fast and efficient way.

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