

The Uncertainty Test for the MAAP Computer Code

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1. Introduction

After the Three Mile Island Unit 2 (TMI-2) and Chernobyl accidents, safety issues for a severe accident are treated in various aspects. Major issues in our research part include a level 2 PSA. The difficulty in expanding the level 2 PSA as a risk information activity is the uncertainty. In former days, it attached a weight to improve the quality in a internal accident PSA, but the effort is insufficient for decrease the phenomenon uncertainty in the level 2 PSA.

In our country, the uncertainty degree is high in the case of a level 2 PSA model, and it is necessary to secure a model to decrease the uncertainty. We have not yet experienced the uncertainty assessment technology, the assessment system itself depends on advanced nations. In advanced nations, the severe accident simulator is implemented in the hardware level. But in our case, basic function in a software level can be implemented.

In these circumstance at home and abroad, similar instances are surveyed such as UQM and MELCOR[1,2]. Referred to these instances, SAUNA (Severe Accident UNCertainty Analysis) system is being developed in our project to assess and decrease the uncertainty in a level 2 PSA. It selects the MAAP code to analyze the uncertainty in a severe accident.

2. Implementation

The configuration is SAUNA system is following.

- SAUNA : Control the program execution and data flow
- random : Produce random number
- creinput : create MAAP input with random number
- PWR4DOS : MAAP code execution (DOS version)

2.1 Uncertainty Sampling

In severe accident analysis there are uncertainties in the physical phenomena. Therefore, most of the severe accident analysis code might have many parameters to handle these uncertain phenomena. Severe accident phenomena models of MAAP code also have uncertainties. Users have control over the uncertainties via the input parameters. They are either used as an input to a given physical model or to select between different physical models. The input parameter may include the nominal values and the minimum and maximum values depending on the specific distributions. Some sample uncertain parameters of MAAP code are listed as a sample in Table 1. The sample input variables can be used to analyze the severe accident phenomena of the in-vessel hydrogen generation and the molten core-concrete interaction.

The MAAP code, selected for SAUNA to simulate severe accident, can use parameter option for uncertainty such as the above parameters. To assess the uncertainties, a great number of MAAP code execution are needed, and the analysis of the MAAP code results are needed also.

Random sampling methods are applied based on open source F90 (made by John Burkardt). In this draft version, 4 sampling methods are implemented such as beta, gamma, normal, uniform. Later additional sampling methods are implemented in turn. The sampling number created by this method, is applied with uncertainty parameters, and made results according to these parameters.

Table 1. MAAP code Parameter List for Uncertainty

System for Uncertainty	Parameter
Oxidation & In-vessel Hydrogen Generation	FACT, EPSCUT, FAOX
RCS Natural Circulation	FFRICR, FFRICX, FWHL
Cladding Failure	TCLRUP
Direct Containment Heating	ENT0, ENT0C
Lower Head and Vessel Failure	FOPTLH, FDAMLH, XROF0, XROF1
In-Vessel Cooling	XGAPLH, FQUEN, XGAPPB, FRCOEF
Induced SGTR	FAOUT, FERSGT
MCCI	FCHE, HTFB, HTCPCR, HTCPCS
HPME	FENTR, FENTRC, FKUTA

2.2 MAAP Code with Uncertainty Sampling

The SAUNA system makes all these procedures simple;

- The parameters range related uncertainties can be adjusted and modified.
- Random number sampling can be selected per each parameter.
- The number of code execution can be selected.
- Press of the button produces the sampling numbers per each parameter.
- MAAP code execution files can be selected by simple mouse handling.
- The directory and the files can be selected and

chosen simply.

- Finally action button makes the MAAP code execution according to above information, such as creating sub-directory, adjusting the sampling into MAAP code input, execute the MAAP code sequentially

All the above function is processed in one form which is consisted 2 tablet. All the log related sampling in each step is recorded in text file for later verification. According to the execution number selected in form-1, same execution image is repeated.

After the execution MAAP code, the results are saved in sub-directory. The formats are same in all these sub-directories, but the values related to uncertainty parameter are slightly different based on sampling.

Statistical part, which is used to analyze these results, will be developed hereafter, and will be attached above uncertainty templates. These can be used to assess uncertainty in level 2 PSA, and can be made progress in risk information.

3. Result and Verification

The calculation for a SBO BASE was modified to use the random sampling number. The range of random sampling is from 1.0 to 2.0, the number of sampling is 30. The input form is shown figure 1. Among the 30 results, 2 cases are shown in figure 2 and figure 3.

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SENSITIVITY ON
. . . . .
PARAMETER FILE U34M407.PAR 25
INCLUDE PLTMAP2.inc

C AC POWER RECOVERED
IF IEVNT(3) IS TRUE
    SET TIMER #1
END

IF TIMER #1 > 300
    IEVNT(248) IS TRUE
    IEVNT(323) IS TRUE
END
    
```

From these results, the sampling technique and the sequential processing of MAAP code is implemented well.

4. Conclusions

To develop the SAUNA, sampling methods were analyzed and implementation instances were surveyed. In this procedure, Open source which is F90, was adopted. The convenient handling of a MAAP code execution with a sampling is implemented through one form. The results of the MAAP code execution are saved in each sub-directory, which will be used at a later statistical usage. Through this SAUNA system using the MAAP code, risk information can be analyzed by various quantitative methods. This will accelerate the risk information research.

REFERENCES

- [1] Moonkyu HWANG, Young-Jin LEE, Bub-Dong CHUNG, "UNCERTAINTY QUANTIFICATION OF NEPTUNE ANALYSIS USING WILKS' FORMULA WITH AN EXTENDED NUMBER OF CALCULATIONS", Proceedings of ICONE14, Miami, Florida, USA, 2006.
- [2] MELCOR Uncertainty Analysis Methodology, R.O. Gauntt, Melcor Workshop Proceeding, Albuquerque, NM, USA, 2005.

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SENSITIVITY ON
. . . . .
PARAMETER FILE U34M407.PAR 25
INCLUDE PLTMAP2.inc

C AC POWER RECOVERED
IF IEVNT(3) IS TRUE
    SET TIMER #1
END

IF TIMER #1 > 300
    IEVNT(248) IS TRUE
    IEVNT(323) IS TRUE
END

PARAMETER CHANGE
FAOX = 1.21842
END
    
```

Figure 1. Input form : before and after the addition.

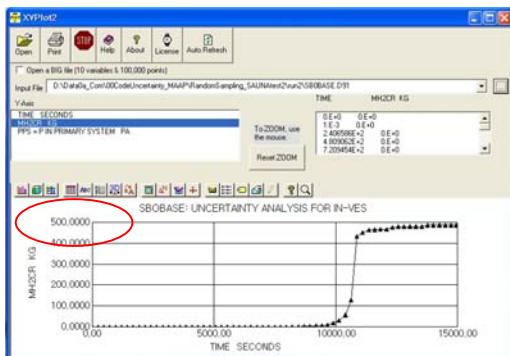


Figure 2. SBO-BASE : Case 1

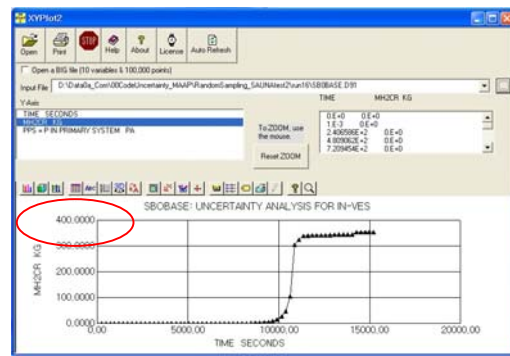


Figure 3. SBO-BASE : Case 2