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U.S. Nuclear Regulatory Commission
ATTN: Ms. Deborah A. DeMarco
Office of Nuclear Materials Safety and Safeguards
Program Management, Policy Development and Analysis Staff
Office of the Director
Mail Stop T8-A23
Washington, DC 20555

Subject: Transmittal of Abstract for Probabilistic Safety Assessment and Management (PSAM) Conference

Dear Ms. DeMarco:

The purpose of this letter is to transmit for your programmatic review an abstract proposed for presentation at the Probabilistic Safety Assessment and Management (PSAM) Conference to be held in San Juan, Puerto Rico, from June 23–28, 2002. The abstract by S. Mohanty and Y.-T. (Justin) Wu is entitled "Mean-based Sensitivity Measures for Identifying Influential Parameters for Nuclear Waste Repositories".

This abstract is being submitted simultaneously to the PSAM 6 organizing committee for approval; however, if this abstract is found to be programmatically unacceptable, it will be withdrawn from the conference.

Please advise me of the results of your programmatic review. Your cooperation in this matter is appreciated. If you have any questions regarding the technical content of the report please contact S. Mohanty at (210) 522-5185.

Sincerely yours,

Budhi Sagar, Ph.D.
Technical Director

BS/cw

cc:

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Abstract for PSAM6

Mean-based Sensitivity Measures for Identifying Influential Parameters for Nuclear Waste Repositories

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Keywords:
Sensitivity analysis, Uncertainty Analysis, Risk Assessment, System Modeling, Waste Management, Nuclear Fuel Cycle and Waste Management

The U.S. Nuclear Regulatory Commission (NRC) and the Center for Nuclear Waste Regulatory Analyses (CNWRA) recently developed a general computer model for conducting total-system performance assessments of the proposed high-level waste repository at Yucca Mountain (YM) in Nevada, USA. This computer model is a tool for evaluating the performance assessments conducted by the U.S. Department of Energy (DOE) in support of their license application. The model uses a probabilistic framework implemented through Monte Carlo or Latin Hypercube Sampling (LHS) that permits the propagation of uncertainties associated with model parameters, conceptual models, and future system states. The problem involves hundreds of random parameters of which the ones that have significant influences on the response or the uncertainty of the response must be identified and ranked.

A variety of sensitivity measures have been used in the literature to identify influential parameters emphasizing different aspects of the input-output relationships. Extending importance measures used in reliability engineering, Eisenberg and Sagar [1] proposed two performance mean-based sensitivity measures, $\partial\mu_Y / \partial\mu_{X_i}$ and $\partial\mu_Y / \partial\sigma_{X_i}$, for application to probabilistic model. In these sensitivity measures, Y is the model output and X_i are input parameters and μ and σ are the mean and variance respectively. These measures may be important for regulatory decision-making because peak expected dose (μ_Y) is the performance measure in the proposed NRC regulation for the HLW repository. Hence, obtaining sensitivity with respect to the expected dose to input data appears logical. However, how these measures differ from other measures has not been tested to date.

This paper applies these two sensitivity measures and compares the parameters identified as most important with those identified previously using sensitivity measures proposed by Wu [2]. Expressions are derived for the use of these two sensitivity measures in conjunction with the cumulative distribution function (CDF)-based sensitivity analysis method [2,3]. The CDF sensitivity analysis method is chosen because (i) it is one of the methods that does not assume any specific relationship between the response and the input parameters, (ii) the sensitivity is dependent on the magnitude of the response, and (iii) sensitivity can be easily obtained at any CDF level. Based on a reliability sensitivity concept [2], the response CDF is defined as the integral of the joint probability-density-function of the parameters, with a domain of integration that corresponds to the domain of the identified samples. The response CDF sensitivities are then calculated from the derivatives of the probability integral. The derivatives are statistically estimated from the samples and used to identify and rank the importance of the random variables.

The example used to demonstrate these two sensitivity measures is the same as the one analyzed previously in Mohanty and Wu [3]. This example has 246 random variables, and 1000 LHS samples were generated for the study, including calculation of sensitivities. Based on the calculated, $\partial \mu_Y / \partial \mu_{X_i}$ eleven variables (corresponding to the data that are outside the acceptance limits) are identified as having significant sensitivities at 95 percent acceptance limit. It is interesting to note that the top 9 variables are the same as previously identified using mean sensitivity, $(\partial p / p) / \partial \sigma_i / \sigma_i$ where p is the CDF function, at CDF= 0.9. There appears to be a close relationship between $(\partial p / p) / \partial \sigma_i / \sigma_i$ and $\partial \mu_Y / \partial \mu_{X_i}$. Based on the calculated $\partial \mu_Y / \partial \sigma_{Z_i}$, 12 variables are identified as having significant sensitivities at 95% acceptance limit. The top four variables are in the same order as those identified by $\partial \mu_Y / \partial \mu_{X_i}$. It appears that fewer than 1000 samples may be sufficient to identify influential variables. The results will be summarized in the paper and compared with important parameters identified by using other sensitivity measures.

REFERENCES

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