Sandia National Laboratories

Albuquerque, New Mexico 87185

July 1, 1988

Mrs. Pauline Brooks
Operations Branch
Division of High-Level Waste Management
Office of Nuclear Materials Safety and
Safeguards
U. S. Nuclear Regulatory Commission
Mail Stop 4D16
Washington, D.C. 20055

Dear Mrs. Brooks:

Re: Observations on Seventh PSAC User's Group Meeting

I attended the seventh meeting of the Nuclear Energy Agency's Probabilistic Safety Assessment Codes (PSAC) User's Group as an NRC contractor under FIN A1165. The meeting was held June 20-22, 1988, in Braunschweig, Federal Republic of Germany. Also in attendance was Richard Codell from NRC. The purpose of this letter is to summarize my observations on the meeting and suggest some areas of possible future involvement for NRC within the context of the PSAC group.

Notwithstanding the fact that my briefcase was stolen at the airport in Frankfurt, I found the meeting to be quite interesting.

Monday, June 20

The first day was spent primarily in the presentation of short progress reports by the attendees on their activities since the last PSAC meeting (December, 1987). Because of the large number of reports presented, I will not discuss all of them here, but instead will mention activities (and the organizations carrying them out) that could be of interest to NRC.

Some of the participating organizations are devoting considerable resources to the development of repository and near-field models. While these models are not likely to be applicable to the US program, they may be worth examining from the point of view of the modeling strategies that are being implemented. Their developers claim that the models describe the system adequately and are computationally efficient. Specifically, the activities at (1) Intera-ECL (UK) for AERE Harwell (UK) and SKI (Sweden); (2) SKB (Sweden); and (3) Technical Research Centre of Finland are worth careful examination. Because of the lack of repository and near-field models available in the US, Sandia should investigate the aforementioned models as part of the activities under Task 1 of FIN A1165.

Also of potential interest to both NRC and Sandia should be the work being performed in attempts to improve the statistical sampling procedures used to generate multiple vectors of uncertain input parameters for Monte Carlo simulations. Most participating organizations have adopted the Latin hypercube sampling technique developed by Sandia for NRC under FINs A1192 and A1266. Some of these organizations are modifying LHS. It is important to keep up-to-date in these activities because they may be of interest to current activities under Task 2 of FIN A1165 and under FIN A1266.

Intera-ECL is currently examining the GENRISK code developed by Intera-USA. GENRISK is a framework for probabilistic risk assessment built around LHS that has been designed to have a user-friendly, menu-driven input and can be executed in a personal computer. Sandia has some familiarity with GENRISK because the code currently being used by Intera-USA in conjunction with GENRISK is NEFTRAN, developed under FIN A1266. In principle, any computer code can be coupled to GENRISK. The main advantage of GENRISK is that it is easy to use and relatively fast. Acquisition of GENRISK may provide the NRC with a tool that can be used to perform preliminary assessments in a timely and inexpensive manner.

Tuesday, June 21

I had to spend a large portion of this day trying to obtain my passport (which was in my stolen briefcase) at the US Consulate in Hamburg. I was present for the discussions on sensitivity analysis led by A. Liebetrau (PNL) and A. Saltelli (CEC, ISPRA) and for R. Codell's presentation on the synthetic data experiment.

The discussions on sensitivity analysis were part of a topical discussion on this subject. At the previous PSAC meeting (December, 1987), Saltelli presented a proposal for a sensitivity analysis exercise based on the Level E PSACoin problem. At that time, a lengthy discussion took place because the general feeling among the participants was that the problem was not well posed. Liebetrau and Saltelli agreed to perform a preliminary analysis on Level E results for presentation in Braunschweig. Liebetrau conducted a routine regression analysis on the results which yielded inclusive results because the regression models did not have "good" fits and could not represent the relationship between the independent variables and the dependent variable (mean dose) adequately. Saltelli used the ranks of both the independent variables and the dependent variable in an attempt to fit a model for the time-dependent dose. His general conclusion was that, if the actual physical relationship between specific independent variables and the dependent variable is monotonic, rank regression is useful. However, the rank-regression approach failed to describe a portion of the dose-time curve when the relationships were not monotonic. Both presentations clearly pointed out the inherent difficulties in performing sensitivity analyses and the extreme care that the analyst must exercise in interpreting results. Different participants voiced their opinions regarding the two presentations. Among the most significant were (1) that appropriate dimensionless groups must be used in sensitivity analyses because they tend

to force correlations dictated by the physics of the problem; and (2) that sensitivity analyses should not be conducted independently of corresponding uncertainty analyses.

Codell discussed a synthetic data experiment. In his presentation, he stressed the importance of spatial variability and some of the problems that using "lumped-parameter" models and codes can introduce when interpreting results from a regulatory point of view. He cited a recent study of his in which the impact of spatial variability on the estimate of ground-water travel time was investigated. He gave a brief description of the synthetic migration problem being proposed to INTRAVAL. He also explained how past history data can be used to create a synthetic "reality" against which predictions from performance assessment (pa) models and codes can be compared. He suggested that a PSACoin problem could be designed along these lines.

I believe that both the sensitivity analysis problem and the synthetic experiment problem should be of interest to NRC. First, it has been pointed out that it can be quite difficult to carry out a sensitivity analysis that yields meaningful results and, more importantly, that can be readily interpreted. The exchange of ideas that are likely to take place during discussions pertinent to sensitivity analysis, particularly at the next PSAC meeting, can provide NRC with insight regarding how to perform sensitivity analyses and how its results can be used in guiding future site characterization activities. The discussion on sensitivity analysis will continue at the next PSAC meeting (see comments for June 22 below).

I support the use of synthetic information, as proposed by Dick Codell, as a means of building confidence in simple performance assessment models. One approach that I suggested to Codell is to use synthetic information in an attempt to explore ways to compare relative complex research codes to the pa codes. He and I agreed to get together, if possible at Sandia, in early August to work on a proposal to present to PSAC at the next meeting.

Wednesday, June 22

The last day of the meeting was mainly devoted to (1) presentations of possible PSAC activities, (2) topical discussion on model uncertainty, and (3) preliminary discussion on sensitivity analysis for the next PSAC meeting.

Brian Thompson (UKDOE) presented three suggestions for PSACoin exercises. The first consisted of an extension to the current Level E problem to account for the temporal evaluation of the system. The proposed problem could be used to compare codes such as the UKDOE's VANDAL. His second suggestion was a comparison between time-dependent modeling of a deep disposal system (UKDOE's suggested approach) and the scenario approach (Sandia/NRC approach). The purpose of the problem should be to compare possible alternatives for performance assessment. His third suggestion was to develop a problem for fractured media. Thompson also discussed several

Staff from GSF, our host, gave two presentations. One, in preparation for the tour of the Asse Salt Mine, described in-situ experiments in support of the HLW program in Germany. The second presentation described the status of the German performance assessment program.

The meeting was closed with (1) a summary of actions taken (presented by C. Thergerstrom, NEA); (2) naming of a new PSAC chairman (A. Nies, GSF); and (3) date and venue for eighth PSAC meeting (Nov. 29 - Dec. 2, 1988 in Paris or Albuquerque).

Recommendations

First, I highly recommend continued NRC and Sandia participation in PSAC. The proposals for PSACoin exercises, particularly those regarding time-dependency vs. scenarios and research vs. pa codes, are important to current activities under FINs A1165 and A1266. Also, the topical discussions on sensitivity analysis, time-dependency, and uncertainty scheduled for future meetings address issues of interest to both NRC and Sandia. I also believe that much can be learned about the modeling strategies being used by other organizations, specially within the repository and in the near field.

Second, I think that it would be beneficial for NRC to participate in the sensitivity analysis study of the Level E results. The lessons that can be learned from a comparison of the approach used by Sandia on behalf of NRC to those used by other organizations should be very valuable in identifying potential limitations and their resolution. It is estimated that this sensitivity analysis can be carried out within the funds currently allocated for Subtask 2.6 and should require approximately three weeks to complete. This work should not impact the due dates for deliverables in the current statement of work because the person that would do the computer runs is not involved in A1165 at present.

Third, the proposal for a new PSACoin exercise based on synthetic information to compare research codes to pa codes should be pursued. This type of problem addresses one of the approaches that can be used to build confidence in pa models. Lessons learned from such an exercise can be quite valuable to NRC's activities on model uncertainty.

Summary

In summary, I found this PSAC meeting to be far more interesting than the previous one, primarily because of discussions on subjects relevant to the work Sandia carries out for NRC both under FIN A1165 and A1266. Judging from the topical discussions scheduled for the next two or three meetings and the nature of proposed PSACoin problems, all indications are that future PSAC activities will be of interest to NRC.

areas in which PSAC should be involved. These include: (1) preparing guidelines on documentation (structure, content, and quality assurance) of computer codes; (2) optimizing computer codes (e.g., complex vs. simple codes); (3) using dimensionless parameters; (4) conducting preliminary dry runs with uncertainty analysis; (5) investigating the impact of spatial variability; (6) investigating differences between classes of uncertainty (e.g., randomness vs. lack of knowledge); and (7) examining man-computer interactions. I tried to rank Thompson's suggestions starting with the most important. Below is my list:

(1) Time-Dependent Approach vs. Scenario Approach Comparison

(2) Preliminary Dry Runs

(3) Optimization of Computer Codes

(4) Classes of Uncertainties

(5) Impact of Spatial Variability

(6) Dimensionless Parameters

(7) Documentation of Computer Codes

I left out some of his suggestions from my list because either they are not likely to be of benefit to NRC or have been addressed in other intercomparison programs such as INTRACOIN and HYDROCOIN (e.g. fractured media problem). I found his proposal for the time dependence-scenario comparison to be most interesting.

A. Saltelli and A. Liebetrau continued the discussion of sensitivity analysis started the previous day. The discussion was in preparation for the topical discussion on sensitivity analysis to take place at the next PSAC meeting. It was agreed that J. Sinclair (AERE Harwell) would provide results of the Level E problem to participants. The latter would perform a sensitivity analysis as they see fit and present the results at the topical discussion. Eight to nine participants agreed to take part in the study. It was suggested that Sandia should be one of these because of our in-house expertise on sensitivity analysis. D. Codell suggested that PSAC should also investigate the use of differential analysis using techniques and codes such as GRESS and ADGEN. The group decided that it would be useful to invite one or two outside speakers to this topical discussion. The names suggested were Ron Iman (Sandia) and Brian Worley (Oak Ridge).

As part of the discussion on modeling uncertainty, I gave a presentation on the different aspects of model uncertainty that affect performance assessment. The emphasis of the presentation was on (1) the uncertainty in conceptual models; and (2) the need for preliminary assessments during site characterization to provide closure in terms of model uncertainty.

If you have any questions, please do not hesitate to contact me.

Sincerely,

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