

SUBTASK 3.2

Dr. Nestor R. Ortiz, Acting Supervisor
Waste Management Systems
Division 6416
Sandia National Laboratories
Albuquerque, NM 87185

MAY 10 1988

Dear Dr. Ortiz:

SUBJECT: COMMENTS ON "PRELIMINARY ASSESSMENT OF TECHNIQUES APPROPRIATE FOR DETERMINING PROBABILITIES OF OCCURRENCE OF EVENTS AND PROCESSES" (DECEMBER 1987 AND JANUARY 1988 PROGRESS REPORTS FOR FIN A-1165)

The December 1987 and January 1988 monthly reports for FIN A-1165 contained enclosures that provided some preliminary assessments of techniques for estimating probabilities of occurrence of events and processes, work that was conducted by SNL under subtask 3.2. I am now enclosing NRC staff comments on this preliminary work. I expect these comments to be considered in developing the draft formal report called for under subtask 3.2. Although no formal response to these comments is being requested with this letter, I would like to know what your plans are for completing this subtask, and how you propose to follow-up on the preliminary work submitted.

The action taken by this letter is considered to be within the scope of the current contract (FIN A-1165). No changes to cost or delivery of contracted products are authorized. Please notify me immediately if you believe this letter would result in a change to the cost or delivery of contracted products.

Sincerely,

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Daniel A. Galson, Project Manager
Operations Branch
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure:
As stated

cc w/encl.:
P. Davis, Division 6416, SNL
E. Bonano, Division 6416, SNL
R. Cranwell, Division 6416, SNL

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~~Attach all Hist. except for [unclear]~~
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NRC STAFF COMMENTS ON
"PRELIMINARY ASSESSMENT OF TECHNIQUES APPROPRIATE FOR
DETERMINING PROBABILITIES OF OCCURRENCE OF EVENTS AND PROCESSES"
(DECEMBER 1987 AND JANUARY 1988 PROGRESS REPORTS FOR FIN A1165)

General Comments

- (1) As indicated in Volume 1 of Hunter and Mann, 1987, (page 3, 1st full paragraph), the choice of a method for determining probabilities that is most suitable in a particular application depends upon the complexity of the system producing the events, upon how well the system is understood, and upon the availability of data about the system. From the information presented, it is not clear how SNL is factoring the site-specific systems of the Yucca Mountain site into their selection of events for analysis or in recommending approaches for determining probabilities. Before a meaningful evaluation of applicable probabilistic methods can be undertaken, the site-specific system must be considered. We recommend that the important processes, events and scenarios of concern be determined prior to committing to a large effort in assessing probability techniques. The work would benefit from a more systematic treatment within the categories as to which probabilities are needed, and where the problem areas are.
- (2) From the information presented in these reports, it is not clear how the proposed efforts fit into a systematic examination of techniques for assigning probabilities for events and processes of concern in predicting the post-closure performance of geologic repositories. In particular, it is unclear as to what consideration has been given to the discussions, analyses, evaluations, and recommendations presented in Hunter and Mann (1987). We recommend SNL provide a connection between the results of Hunter and Mann (1987) and what they propose to address in this study.
- (3) The information presented in these reports is insufficient to allow an understanding of which direct and indirect mechanisms that could potentially cause adverse performance were considered in the brief analyses presented for failure events. We recommend SNL present information regarding their evaluation of such items as specific system modeling, failure mode definition, and dependent failure, including propagating and common-cause multiple failure, in arriving at the recommendations presented.
- (4) From the information presented in these reports, the main emphasis of this exercise seems to be to try to find some model or formula that will provide an answer which will be acceptable to all. We are dealing with a

problem which requires projections over 10,000 years; where the data base is currently poor to nonexistent; where the process is generally poorly understood, or as in the case of rock mechanics, probably better understood than most processes if there is an adequate data base. Under these conditions experts will use modeling, frequentist and axiomatic approaches to help them come up with a subjective answer. This is really in line with the licensing process which will have the licensing board making the decisions, and they will have to rely very heavily on the opinion of experts to arrive at a subjective answer as to the licensability of the site. For the above reasons any approach that is in any way useful in reducing subjectivity is acceptable.

The following comments concern the respective topics addressed in the reports.

Resource Exploration

Resources and potential indicators, such as faults or geophysical anomalies, are not located in a random manner; therefore, the exploration for these resources is not random in space. Resource exploration is highly dependent on the present economic situation and therefore the exploration is not random in time. Even when there is an attempt to do either random or grid drilling, drilling locations are moved in the field to accommodate such things as topographic constraints, and therefore the pattern again becomes nonrandom. There is not sufficient data for frequentistic projections to be reasonable; modeling can be done, but the data base is insufficient; the events are not random and, therefore, theoretically correct probabilities cannot be expected from an axiomatic approach. Subjective judgement will have to be used to help obtain the final answer.

Also, how do you "modify" an axiomatic approach?

Climate

Hunter and Mann (1987) established a good reference foundation from which SNL should be able to progress in recommending which probabilistic methodologies are applicable to climatologic events and processes. In addition, for SNL's consideration, there has been a considerable study of the probability of occurrence of extreme rainfall (a substantial listing of references should be readily assembled), and apropos to this issue, SNL is referred to the recently completed report of the National Research Council "Estimating Probabilities of Extreme Floods - Methods and Recommended Research" (a copy was enclosed with D. Galson's letter to R. Cranwell of March 2, 1988).

We do not disagree with the treatment of probabilities for climate in your progress report. There is one passage, however, that suggests that external factors such as the Earth's rotational and orbital variations may be responsible for changes in continental glaciation. There is a point of view

held by some modelers that the Earth does not have a stable climate, and no outside forces are necessary for dramatic shifts. In the recent book "Chaos, Making a New Science", author Jame Gleick cites meteorologist Edward Lorenz (p.170): to push the earth's climate into the glaciated state would require a huge kick from some external source. But Lorenz described yet another plausible kind of behavior called 'almost intransitively.' An almost-intransitive system displays one sort of average behavior for a very long time, fluctuating within certain bounds. Then, for no reason whatsoever, it shifts into a different sort of behavior, still fluctuating but producing a different average." We believe that reference to this alternative would be timely.

Finally, the logic of the statement "If models are found to be applicable, the occurrence of certain climatic conditions could be expressed in terms of probability." is not immediately apparent. One logical possibility may be developing the probability of occurrence of an extreme event for a given stationary condition (or period) and then combining a series of stationary periods (a scenario) for an evaluation of the combined probability of occurrence.

Thermomechanical Effects/Tunneling and Mining Engineering

Using the modeling approach to determine the probability of occurrence of chimneys will only work well if the data base on such things as jointing and rock properties is reasonably well known. The Yucca Mt. site will be an area with a relatively low extraction ratio, which by virtue of the relatively small volume excavated, will provide a relatively small amount of information. The experts will probably rely on the modeling approach to a larger degree in this discipline, and the models themselves will be greatly influenced by expert opinion. Thus, the resulting assigned probabilities will also be essentially estimated based upon expert opinion.

It is not clear why the two subjects of "Thermomechanical Effects" and "Tunneling and Mining Engineering" have been combined in this preliminary report. While it is true that a number of failure modes for openings are affected by thermal considerations, it is also true that other events and processes impact on the process of heat transfer. It is suggested that each topic be first treated separately followed by consideration of combinations of all anticipated and unanticipated processes and events that affect performance.

Faulting

The term "active fault" should be defined. Also, what are "randomly selected faults" and how would one select them?

The Yucca Mt. site has many faults with Quaternary movement, and it is hard to get "exact" data on the relative or absolute movement of any fault in this area. In many ways the stress data and the earthquake fault plane solutions provide conflicting information. Potential models are poorly constrained,

especially with the consideration of the hypothesis of detachment faulting. In addition, good deep geophysical data will be relatively hard to obtain. Subjective expert opinion will have to be used to determine the probabilities of tectonic events and processes.

Seismicity

The comments above apply.

Uplift/subsidence

See above.

In addition, uplift/subsidence could result in a redistribution of stress and, at least for the saturated zone, would modify fluid flow. As the data are, and most likely will still be, sparse, expert opinion will be needed.

What is meant by the term "unlikely probability distribution"? Does it mean that estimating probabilities of certain rates or ranges of rates of uplift or subsidence will be difficult?

Volcanism

The present dating techniques yield a wide range in values, and even if the data are taken at face value, the present information can be used to support an argument for either increased or decreased activity in the future. When this is combined with the uncertainties associated with hydrovolcanic activity, co-volcanic activity, and structural control, the need for expert opinion becomes even more important.

Summary

In determining the probabilities of processes and events it will be necessary to use both objective and subjective techniques. It must be recognized, however, that because of the sparse data base even the best objective technique for projection over the 10,000 year time frame of concern will be strongly driven by subjective judgement in such things as selecting the correct boundary conditions, the correct probability distribution and the like. If that is the case (and we believe that it is), we need to put a lot more thought into identifying and structuring statistical techniques which can be used to help the expert make his decision, and how to structure expert opinion to fit into the various models and statistical tools. The thought process must consider what we now know about the process and events. It must consider realistic projections of what more we can expect to learn considering the limitations of available time and money to obtain additional knowledge. It must also consider what is required for decisions in the licensing process. The bottom line in reality is: What have we got now that will help guide the program, and can it be built upon, starting with the Site Characterization Program, to help in the

licensing decision? A case in point involves the subject of climatology. Hunter and Mann (1987) provided a recommendation for a comprehensive research program involving the efforts of five or more investigators over a five-year period to see if new methods of climate predictions can be developed. At this time we need to question if we really need a detailed climatic model, or do we need to make a subjective judgement as to the climatic extreme and be able to model the effects of these extremes on waste isolation? While work should continue on attempting to refine our ability to determine probabilities of these processes and events, more effort should be spent on evaluating bounding conditions extremes and modeling the effects of relevant processes and events. If we concentrate on the models of the processes and events which can aid in the decision making, we need to determine what specific data, in what form, are needed to make such second-order models work. A better approach may be to start at the spot where we assume we have nothing but expert opinion and then ask ourself, how does this need to be structured so that the decisions can be made based on best possible use of our knowledge base? This subjective approach can then be modified (and possibly made more objective) as our knowledge increases.

References

Sandia, 1987. Techniques for Determining Probabilities of Events and Processes Affecting the Performance of Geologic Repositories: Volume 1--Literature Review, edited by R.L. Hunter and C.J. Mann, NUREG/CR-3964, SAND86-0196, Sandia National Laboratories, Albuquerque, New Mexico

James Gleick, 1987. "Chaos - Making a New Science", Viking Penguin, Inc., New York.