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Department of Nuclear Energy

July 26, 1984

Mr. Everett A. Wick
High Level Waste Licensing Management Branch
Division of Waste Management
Mail Stop 965 SS
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Wick:

Review of Aerospace Corporation Reports

Attached is a BNL review by C. Sastre on two Aerospace Corporation documents:

1. Preparation of Engineering Analysis for High Level Waste Packages in Geological Repositories.

2 Methodologies for Assessing the Performance of High Level Waste Packages.

If you have questions on the review, please feel free to call Mr. Sastre (FTS 666-4077).

Sincerely,

Peter Soo, Associate Division Head
Nuclear Waste Management Division

PS:gfs
Enclosures
cc: M. S. Davis
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C. Sastre
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BROOKHAVEN NATIONAL LABORATORY

MEMORANDUM

DATE: July 24, 1984

TO: P. Soo

FROM: C. Sastre

SUBJECT: Review of Two Aerospace Documents

Attached are reviews of the drafts "Preparation of Engineering Analysis High Level Waste Packages in Geological Repositories" and "Methodologies for Assessing the Performance of High-Level Radioactive Waste Packages," as requested.

CS:ep
encs.

COMMENTS ON PROGRAM PLAN OF AEROSPACE

FOR

METHODOLOGIES FOR ASSESSING THE PERFORMANCE

OF HIGH-LEVEL RADIOACTIVE WASTE PACKAGES

2-1 Paragraph 3

If the probability of exceeding one part in 100,000 is small, the regulation is satisfied. However, implicit in the regulation is the assumption that the probability of larger releases falls rapidly with the size of the release. It is incumbent on the license application to make the argument that there is no significant failure mode leading to large releases. In other words if there is some significant probability that a release of one part in 1000 per year occurs, it will not be ignored.

2-2 Paragraph 2

Some of the physical processes will not be deterministic, corrosion for example. A process can have uncertainty of outcome if there are uncontrolled variables that cannot be practically measured. Consider a set of light bulbs from the same production run. Their life time will be a strong function of the line voltage, however, even if the voltage and the bulb temperature were to be kept at absolutely constant values, there will be a remnant variability due to uncontrollable small inperfections in the filaments. A model for life-time using only temperature of the bulb and voltage could be very successfully produced (and it has) but not all uncertainty of outcome could be allocated to input uncertainty.

2-9 Paragraph 2, last sentence

Makes no sense.

Pages 2-6 to 26

This is a tutorial on modeling and could increase its value as an elementary introduction by including some actual illustrations or examples. It is repetitive for the professional and too abstract for the uninitiated.

3-21 End of 3rd paragraph

In the evaluation of WAPPA, the authors have a way of commenting on uncertainties without giving an informed opinion about how important they are expected to be. For example, here it is stated that "the repository temperature depends on the processes that occur in the package to some extend". This is strictly true but totally misleading. In practical cases, unless the waste has leached away from the region, changes up to breaching of a barrier would affect the far field temperature at a negligible and transient level. If the reader is naive, he thinks that this is a problem. If the reader is more informed, he thinks that if this is the only problem worth mentioning, then everything is fine. But if the reader really knows something, he knows that the problem is the definition of the "Repository Temperature". But if he knows that much, then he does not need this review.

3-24 On structural model

There are obviously many failure modes not considered in WAPPA. The proper course of action is to suggest or recommnend that detailed stress analyses be made to evaluate what is important and what is not and then and only then recommend the inclusion.

There are teluric electric currents but that does not mean that WAPPA should also account for that in the galvanic corrosion model or that the variations in acceleration of gravity need to be included in the structural model.

4-4 Uncertainty factor multipliers

Not all the uncertainty in prediction comes from input data to a model. There is always in any model a series of minor effects which are normally neglected and that are assumed to be negligible for the purpose in hand. Consider the case of a projectile ejected at some initial velocity and at some angle to the vertical. The trajectory can be modeled assuming constant gravity and no air drag as in elementary physics. The computed point of impact would have an estimated error that any good engineer can estimate crudely given the actual conditions. Such model in practice will not predict

the point of impact with 10 decimal places. A better model would include air drag, a still better model average wind speed and direction, a better model would use the wind direction at every point, a better model would include curvature of the earth, a better model would include rotation of the earth, and at some point relativiatic effects would limit the accuracy. At each point in this example, there will be variables not accounted for which introduce uncertainties in the results.

These uncertainties are not uncertainties due to the input variables of the model but to neglecting minor variables.

Any good modeler should be able to provide an engineering judgement as to how good the model use may be.

There is no good methodology to estimate this uncertainty in a mechanical way. But it is better to bring the model adequacy by giving an estimate which other experts can evaluate than to pretend that all the uncertainty derives from the inputs.

4-5 Parameter uncertainty and variability

The DSTP on reliability used a very simplified model in the appendix to illustrate a few of the points made in the main body of the DSTP. The model was offered as an example and not as a proposed final model, which was not in the scope of work. Space and time variability was not included because it was judged that at the elementary level used it would not be meaningful. The temporal variability enters as part of the model, for instance if the thermal conductivity of the backfill is temperature dependent, there is no problem in including the effect in a determinisitc way. As far as space variability is concerned, if need be, it could be accomodated with a 3D formulation. The reader should be cautioned that the adjoint method introduces a linearization that would require firm justification particuarly when some parameters vary over several orders of magnitude and enter in non-linear expressions. The DSTP did not claim that the Monte Carlo method is the only or even the best.

4-9 Paragraph 3

The reference should be to BCL, not to BNL.

4-20 Combinatorial analysis

In some sense the proposed method is a natural extension of the event-tree methodology.

It would be advisable for Aerospace to try to do a PDF for at least one submodel to see how it does work in practice.

6-2

We notice that Aerospace has "determined that the standard fault-tree quantification method would generate non-representative reliability predictions...".

6-2 Paragraph 6

It would be useful for NRC to restrict the use of the word "conservative" to a few authorized applications, in which it means that something is proven to predict in all cases more severe consequences than is physically possible. If the canister life-time is chosen by the user, this is not necessarily conservative.

COMMENTS ON PROGRAM PLAN OF AEROSPACE

FOR

PREPARATION OF ENGINEERING ANALYSIS

FOR HIGH-LEVEL WASTE PACKAGES IN GEOLOGICAL REPOSITORIES

General Observations

This reviewer notes with interest that this program plan, one of the first deliverables in this contract, is in essence a Form 189, drafted in rather broad terms and included as a deliverable in 1985; a Form 189 for 1986.

The description of the proposed tasks is too vague to allow a comment on their adequacy.