A4165 PDR-1
LPDR-WM-10 (2)
WM-11 (2)
WM-16 (2)

Stephens & Associates
10424 Windfall Court, Damascus, Maryland 20872 (301) 253-5576

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'87 SEP -1 A9:33

August 28, 1987

Mr. K.C. Chang
623-SS
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Chang:

VOUCHER FOR PROFESSIONAL SERVICES

Attached are the original and required two copies of the voucher for my professional services August 24-28, 1987.

I have now worked 16 days of the 130-day limit.

My activities covered by the voucher are described in the attached Progress Report.

Very truly yours,

Kenneth W. Stephens

Attachment
V2

WM-RES
WM Record File A4165
WM Project 10, 11, 16
Docket No.
PDR ✓
LPDR ✓ (B, J, S)

Distribution:
Chang
(Return to WM, 623-SS)

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WM Project: WM-10, 11, 16
PDR w/encl
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WM Record File: A4165
LPDR w/encl

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PROGRESS REPORT
Kenneth W. Stephens
August 24-28, 1987

Introduction

During this reporting period, my activities were associated with the continuing examination of possible synergistic effects of emplaced waste packages.

The Problem

Performance assessment (DOE and NRC) for waste packages is currently based on calculation of the lifetime and releases for individual packages. The effect for the repository of 50,000 or so packages is then determined through relatively straightforward extrapolation of the results for individual packages.

There is a possibility that the packages may influence each other so that the cumulative effect for the repository is greater than that based on extrapolation of individual package releases.

Any such synergistic effects should be identified to ensure that the repository analyses do not become non-conservative.

Current DOE Work on Synergistic Effects

A preliminary literature search and discussions with key DOE researchers revealed that DOE does not have a program to deal specifically with this issue. Although DOE did consider the possibility of synergistic effect in a limited fashion, the current feeling is that any such effects will be covered by conservatisms in the individual package analyses.

My Approach

My approach is to identify ways in which the individual packages can influence each other and then see whether it is possible to make a definitive conclusion in the near future concerning the importance of synergistic effects.

Although there is no consolidated body of knowledge on the subject, some work has been done in collateral areas and may prove useful. This potentially relevant work falls into two categories: coupled processes and field mapping.

Coupled Processes

Since the early days of the repository program, it has been recognized that performance assessment should include all the relevant processes, such as corrosion and radiation. This consideration of more than one process at a time carries the label, "coupled processes".

Unfortunately, the practicalities of research, development, and design have caused the work to be fraught with compromises. Even now, the DOE performance assessment efforts do not include pitting corrosion in the calculation of package lifetime. The modeling in use today may or may not include all the relevant processes.

Coupled processes were considered in a major symposium[1]. The processes covered in that meeting illustrate the means by which individual packages can influence each other:

thermal
hydrologic
radiation
mechanical
chemical

The work covered in the symposium deals with various combinations of these processes.

Field Mapping

Interspersed throughout waste management literature, there is a body of work on various field phenomena within the repository.

Thermal analyses constitute much of this material. Yung[2], et al, for example, use a three-dimensional model that simultaneously considers the packages, the near-field, and the far-field. The resulting isotherms have been used in choosing the design and performance assessment parameters for the packages. When information from this type of analysis is used in the DOE performance assessments, direct thermal synergistic

[1] LBL-21850, Proceedings of the International Symposium on Coupled Processes Affecting the Performance of a Nuclear Waste Repository, Berkeley, California, September 18-20, 1985.

[2] Yung, S.C., et al, "Thermal Analysis of Waste Package Preliminary Reliability Assessment", Proceedings of the Symposium on Waste Management, Tucson, Arizona, March 2-6, 1986 (Waste Management 86), Volume 2, p. 307 ff.

effects are in essence covered. Indirect thermal effects such as temperature-sensitive chemical changes may or may not have been considered, depending on the analyst's assumptions.

Very little has been reported concerning the radiation field within the repository. Clearly, if the packages are designed for the high field produced by the contents, the radiation contributed by other packages would probably be of little direct consequence. There is a possibility, however, that the field between the packages will produce radiolytic species that could migrate to other packages and thereby accelerate package degradation. This does not appear to have been considered by the DOE projects.

Groundwater flow is expected to be the mechanism for carrying released radionuclides outside the repository. The chemical species carried by incoming groundwater have been considered to some degree in the waste package lifetime analyses. However, there does not appear to have been much consideration to date of the effect of corrosion products on the failure rates of other packages.

Summary

My initial work on the subject of synergistic effects disclosed the following:

- DOE does not consider synergistic effects to be a significant issue and believes the waste package analyses will adequately cover possible synergisms.
- Flow of chemical species from degraded packages is one possible means of synergistic influence, but has not been fully explored. The same applies to radiolysis effects.

My Plans

Some more investigation is necessary to determine whether synergistic effects should be of concern to NRC. My near-term activities will include the following:

- Additional collection of information on DOE studies, including performance assessment work by the three repository projects.
- Specific work on: (1) the effect of chemical species from degraded packages, and (2) radiolysis effects from inter-package radiation fields.