FEB 14 1985

Distribution:
WM File 109.1
WMEG
NMSS
REBrowning
MJBell
LHBarrett
TCJohnson
EAWick
CHPeterson
HJMiller
JOBunting
LBHigginbotham
PDR

109.1/CHP/2/13/85

MEMORANDUM FOR: E. A. Wick
Materials Engineering Section
Engineering Branch

FROM: C. H. Peterson
Materials Engineering Section
Engineering Branch

SUBJECT: PROPOSED PAPER: "SOURCE TERM FOR RADIONUCLIDE MIGRATION FROM HLW OR SPENT FUEL UNDER REALISTIC REPOSITORY CONDITIONS

The subject paper appears to be a needed pioneering effort to establish numerical criteria for waste package performance deriving the initial 300-1000 year containment period for a HLW repository. The example included in the paper shows that many package failures can be tolerated in the early years but also that more failures are permissible as the radionuclide inventory decays. It appears that further insight can be obtained through an algebraic treatment as shown in Attachment 1.

C. H. Peterson
Materials Engineering Section
Engineering Branch

WM Record File 109.1

WM Project 1
Docket No.
PDR ✓
LPDR

Distribution:

(Return to WM, 623-SS)

8505070010 850214
PDR WASTE
WM-1 PDR

OFC :WMEG						
NAME :CPeterson:gh						
DATE :02/14/85						

Permissible Package Failure Rate In a High Level Waste Repository

Let I_{1000} = radionuclide inventory at time t = 1000 years in one package, Ci

Let N_p = number of packages in the repository

Let R_I = permissible release rate during the isolation period, Ci/y

Then by 10 CFR Part 60, Section 60.113(a)(1)(ii)B,

1. $R_I = (1 \times 10^{-5})\ I_{1000}\ N_p$

This assumes each package contains the same number of the same type of fuel rods having identical radionuclide inventories.

Next, let F_p = fraction of packages failed at time t

F_t = allowable fractional release rate per package at time t

and R_t = allowable release rate at time t

Then 2. $R_t = (F_p N_p) I_t F_t$, Ci/y

If release rate R_t is tolerable during the isolation period, it is reasonable to conclude it would be tolerable during the containment period. Further study might show, however, that different radionuclides might be released at different times and hence this averaging approach would not be completely satisfactory.

3. $F_p N_p I_t F_t = (1x10^{-5})(I_{1000} N_p)$

4. $F_p = \frac{(1x10^{-5})}{F_t} \frac{(I_{1000})}{I_t}$

If F_t is set at $1x10^{-5}$, the fractional package failure rate during the containment period is seen to depend only on the ratio of the package inventories. If this ratio is the same as the ratio of rod inventories,

5. $F_p = 4.6/960$, or 0.00479

and given 70,000 packages, the permissible number of package failures is 335 for 10 year old fuel. In other words, if 70,000 packages were emplaced at essentially the same time, namely ten years after discharge, then 335 of them could release their total radionuclide content immediately and the repository performance would still be within the prescribed limit. Certain other conclusions may be drawn.

(1) If the package loading is reduced, quality control on individual packages might be less restrictive.

(2) If the fractional release rate per package (F_t) is actually greater than $1x10^{-5}$, then fewer packages can be permitted to fail. This tends to offset the conclusion in (1), above, but focuses attention on the trade off between waste form release rate and waste form loading.