

**Civilian Radioactive Waste Management System
Management and Operating Contractor**

September 12, 1996

Mr. Rex Wescott
U.S. Nuclear Regulatory Commission
DWM/NMSS MS T-7-F-3
Washington, D.C., 20555-0001

SUBJECT: TRANSFER OF WASTE PACKAGE DEGRADATION (WAPDEG)
SIMULATION CODE, VERSION 1.0, TO SUPPORT THE NRC'S DETAILED
REVIEW OF THE WASTE PACKAGE CONTAINER DEGRADATION
SIMULATION RESULTS CONDUCTED FOR TSPA-1995

Dear Mr. Wescott:

Enclosed please find a floppy diskette containing the WAPDEG source code and miscellaneous supporting files, and a *preliminary draft* of the User's Guide for the code. The files contained in the diskette are

- 1) wapdeg.f: HP 9000/Fortran version source code which was used to simulate waste package container degradation in TSPA-1995;
- 2) wapdeg.inc: HP 9000/Fortran version include file which is called by wapdeg.f;
- 3) sort1.f: HP 9000/Fortran version post-processing file, which orders the first pit penetration times of waste packages;
- 4) trim.f: HP 9000/Fortran version post-processing file, which puts the simulation results in a format that is convenient for plotting pitting histories of individual waste packages;
- 5) wapdeglh.f: IBM PC-compatible Lahey Fortran version of wapdeg.f;
- 6) wapdeglh.inc: IBM PC-compatible Lahey Fortran version of wapdeg.inc;
- 7) sort1lh.f: IBM PC-compatible Lahey Fortran version of sort1.f;
- 8) trimlh.f: IBM PC-compatible Lahey Fortran version of trim.f;
- 9) input: Input file which is used in the example run problem discussed in the User's Guide (for both versions); and
- 10) readme: Contains information of the files in the diskette.

These materials are provided to the NRC to fulfill the NRC's request, as part of the NRC's detailed review of the waste package container degradation simulation results performed for the total system performance assessment-1995 (TSPA-1995). The source code of WAPDEG

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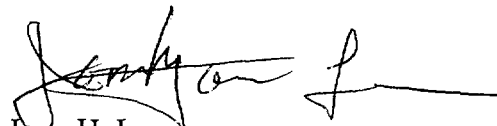
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Version 1.0 is dated September 9, 1996, although *the same code* was used for TSPA-1995. This version of the source code (to be transferred to the NRC) was dated following the inclusion of numerous detailed comments blocks to allow the NRC reviewer(s) to better understand the implementation of the corrosion models (discussed in the enclosed user's guide) and the logic flow of the stochastic waste package degradation simulation schemes. The enclosed User's Guide is **a preliminary draft** and therefore not a final version. The preliminary draft user's guide is provided to facilitate the NRC's review. *Distribution of the source code and the preliminary draft user's guide should be limited to the NRC review of the TSPA-1995 results.*

WAPDEG was coded to run on Hewlett-Packard 9000 Series 700 workstations with Fortran 77. Since the NRC plans to run the code on an IBM PC-compatible with a Lahey Fortran 77 Compiler, the source code was compiled and test run on an in-house IBM PC-compatible with a Lahey Fortran 77 Compiler. Several changes to the HP Fortran-version source code were found necessary in order to run the code with an IBM PC-compatible with a Lahey Compiler. A list of necessary changes are described in the Attachment to this letter. As discussed in the attachment, exact reproduction of the TSPA-1995 results may not be possible due to differences in sampling random variables between the HP Fortran Compiler and IBM PC-compatible Lahey Compiler. With the changes to the HP Fortran version code, the simulation results with an IBM PC-compatible with Lahey Fortran should be close enough to those with the HP Fortran for the NRC review purpose.

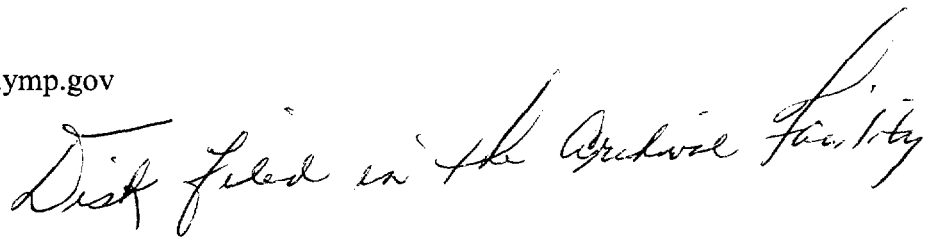
I hope that both the WAPDEG source code and its user's guide are helpful to the NRC's review of the TSPA-1995 results. If you have any questions regarding this letter, please contact me at (702) 295-4754 or Joel Atkins at (702) 295-4755.

Sincerely,



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Enclosures: As stated



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ATTACHMENT

The following is a list of the modifications to the HP Fortran-version WAPDEG source code (hereafter referred as WAPDEG source code), which were necessary to run the code on an IBM PC-compatible with a Lahey Fortran Compiler.

- 1) In the WAPDEG source code, there are three places where an array is set (or initialized) to 0. These are:

Bin = 0 in Subroutine SamplePackage
PitD = 0 in Main Program
GenD = 0 in Subroutine CathodicProtection

With Lahey Compiler, each element of the array needs to be set (or initialized) to 0 individually, i.e. for the array Bin,

```
DO I = 1, 800
  DO j = 1, 3
    Bin(i,j) = 0
  END DO
END DO
```

- 2) Many of the comment lines in the WAPDEG source code have a "c" in the first column. These initial characters for comment lines should be changed to "!".
- 3) In WAPDEG (running on the HP Fortran), RAN(iseed) is used as an intrinsic function to sample uniform random variable. In Lahey Fortran, RND() should be used instead of RAN(iseed).
- 4) In WAPDEG (running on the HP Fortran), gran() is used to sample standard normal variables. We are not aware of an intrinsic function to generate normal variables in Lahey Fortran. The WAPDEG code was tested on an IBM PC-compatible with a function from *Numerical Recipes in Fortran* (Press, et al. 1992).
- 5) It was necessary to split up some of the common blocks in the include file (wapdeg.inc). Common blocks which caused warnings when the program was compiled were separated.
- 6) Since the NRC will be using different functions to generate random numbers, it may not be possible to duplicate TSPA-95 results. However, an intrinsic function RANDS() in Lahey Fortran can be used to initialize a random number sequence, which would make results from the modified program reproducible.

Comparison of the simulation results of waste package failure (defined as first pit penetration) history, which were performed on two different platforms (HP workstations with Fortran 77 and

IBM PC-compatible with a Lahey Fortran) are shown in the figure on the following page. The simulations are for the case of 83 MTU/acre thermal loading, without backfill and high infiltration (0.3 mm/yr). A total of 400 waste packages and 250,000 pits per waste package were simulated. For the run on an IBM PC-compatible, the necessary changes listed above were made to the HP Fortran version code. It took about five hours to run the simulation on an IBM PC-compatible. It is shown that the results using the two platforms are very close.

Press, W.H., S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery, 1992. *Numerical Recipes in Fortran. An Art of Scientific Computing*, 2nd Ed., Cambridge University Press.

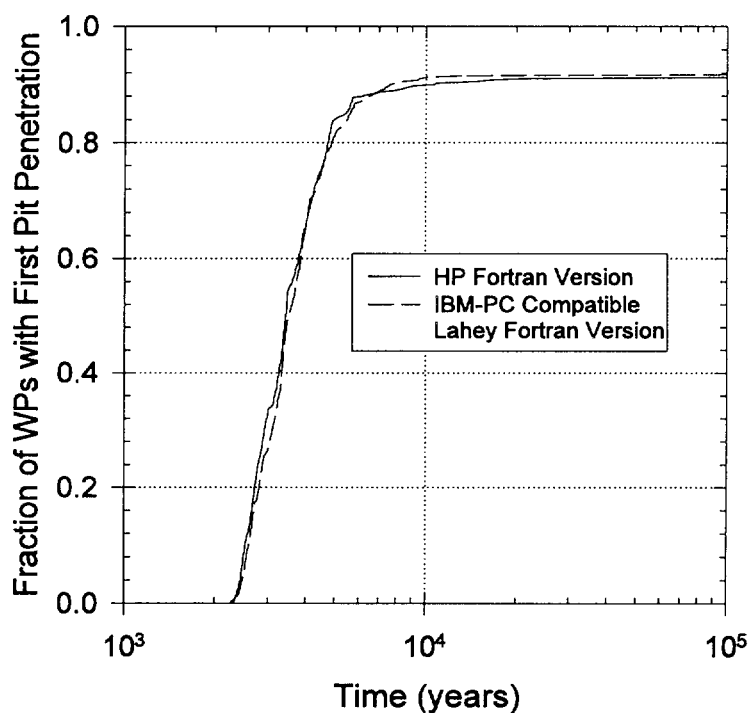


Figure: Comparison of simulation results of waste package failure (first pit penetration through the container wall thickness) history, which were performed on two different platforms: 1) HP 9000 Series workstations with Fortran 77; and 2) an IBM PC-compatible with Lahey Fortran. The simulations are for the case of 83 MTU/acre thermal loading, without backfill and high infiltration (0.3 mm/yr). For the run on an IBM PC-compatible, the changes listed in the attachment were made to the HP version source code.