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CONVERSATION RECORD

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(Return to WM, 623-SS)

Location of Visit/Conference: Richland, WA to Silver Spring, MD

NAME OF PERSON(S) CONTACTED OR IN CONTACT WITH YOU	ORGANIZATION (Office, dept., bureau, etc.)	TELEPHONE NO.
R. Baca, J. Larue	DOE	

ROUTING

NAME/SYMBOL	INT
MGordon	
MKnapp	
MLogsdon	
TVerma	
RWright	

SUBJECT

Responses to NRC Clarification Questions about SCR Description of PORFLO Modeling Program of BWIP

SUMMARY

Attached to this record is a listing of the questions submitted to DOE prior to receipt of this phone call. This summary provides the responses by R. Baca and J. Larue to these questions and associated questions initiated during the conversation.

Responses

1. DOE is presently preparing a User's Manual for the PORFLO code used in the SCR. Although it is not immediately releaseable, DOE will provide copies to the NRC within several months. Included in this User's Manual will be sample problems, which demonstrate the codes flexibility and implementation. DOE will provide all input and output to the PORFLO models used in Chapter 12 of the BWIP SCR along with this User's Manual.

(Continued on attached pages)

ACTION REQUIRED

Supply information to participants of Hydrogeology Review Meeting of March 7-8, 1983

NAME OF PERSON DOCUMENTING CONVERSATION	SIGNATURE	DATE
Michael F. Weber	Michael F. Weber	3/15/83

ACTION TAKEN

Distributed to WMHL, WMHT and GAI.

SIGNATURE	TITLE	DATE
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PDR WASTE
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Because DOE could not provide the documentation with I/O for PORFLO, they opted to answer the next seven questions. During the interim while the User's Manual undergoes Q/A review at DOE, DOE will forward head and temperature plots of the PORFLO transient simulations used in Chapter 12.

2. The thermal source data in the PORFLO model was calculated assuming 47,000 MTHM 10-year old spent fuel. The J/yr-m^3 values provided to the NRC, as a result of earlier clarification requests, were calculated by dividing the thermal decay curve (peak value of 53,000 KW) by the assumed value of the repository volume.* DOE stressed that the following numbers are approximate and "off the top of their heads:"

    Volume of long half of repository: 1300 m x 1700 m x 3 m
    Volume of short half of repository: 894 m x 1700 m x 3 m

    The thermal loading values provided earlier by DOE to NRC were used in the PORFLO model. The PORFLO model then calculates a thermal flux by multiplying the grid block volume for each repository block by the flux/volume terms previously provided to the NRC. The PORFLO model has 2 rows of repository blocks.**

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*Author's note: the repository blocks, therefore, incorporate the additional heat radiated in the z-direction into the flux/volume term.

**Authors note: this is the same approach as taken by the NRC in its 2-D SWIFT model of BWIP.

3. No, end effects are not taken into account because the power/volume values are calculated by dividing the total thermal output from 47,000 MTHM (10 year old spent fuel) by the repository volume. By calculating thermal flux in this manner, the repository blocks in the PORFLO model represent a vertical slab through an infinitely long repository perpendicular to the 2-D grid (minimum direction). The flux, however, is calculated for a repository of finite volume; DOE stresses that this repository design is only "pre-conceptual."

4. The precise gridding of the PORFLO models will be sent to the NRC. Two grids were used to simulate the two different locations of the repository. The model of the repository within the Umtanum dense zone measured 129 x 104 grid blocks (1 block in the y-direction is assumed by default) or a total of 13,416 blocks. The model of the repository within the "Cohasset" or the middle Middle Sentinel Bluffs Flows measured 129 x 96 grid blocks or a total of 12,384 blocks. DOE stressed that the PORFLO code requires x-y coordinates of block-centered nodes as input. The grid or mesh is self-generated (i.e., Δx and Δy spacings are not required as input).

5. The hydraulic conductivities input into PORFLO are assumed at the initial temperature of the water for any particular layer. Since these values of the different hydrostratigraphic units are mean values determined in various well tests at the ambient temperature as determined by the geothermal gradient and depth below surface, no attempts were made to correct for variations in hydraulic conductivity at temperatures above ambient for the intial runs. DOE asserted that ΔT's across all the tested hydrostratigraphic units were too small ($\pm$ 5.0 °C) to significantly alter the initial hydraulic conductivities. DOE also asserted that even ΔT's of 100 K only change the hydraulic conductivities by a factor of 3. After

the repository begins heating the groundwater to temperatures above ambient(z), decreases in density and viscosity are reflected in increased hydraulic conductivities. Intrinsic permeability is not entered as input into the model. The hydraulic conductivities (as measured in the field) are assumed to represent increasing K with increasing depth and T. The reference temperature of the repository horizon within the Umtanum is 57°.

6. The particle tracking program, PATHLINE, uses the same staggered grid or node spacing as PORFLO. Darcy velocities are calculated for the grid block face centers, while P, T, and C are calculated at grid block centers. To calculate the Darcy velocity through any grid block, the program bilinearly interpolates the Darcy velocity vertical components from the blocks below and above, and the horizontal velocity components from the blocks to the left and right. The two component vectors of Darcy velocity are then resolved to determine the Darcy velocity resultant in the grid block center. This velocity is then used through the grid block.

   Since the grid was chosen for the PORFLO model through an iterative procedure of altering the model mesh until the head distribution was regular in the model, step velocity changes are not expected in the PATHLINE program. Bilinear interpolation and resolution of velocity vectors also mitigate sharp contrasts in Darcy and linear velocities.

7. The temperature at the ground surface may be calculated by assuming the reference temperature of the repository horizon in the Umtanum and back-calculating the surface temperature by using the geothermal gradient of 40° C/Km. The reference temperature (°57 C) was recorded in a well test of the Umtanum horizon.

Pressures are not used in the PORFLO model because of the inherent numerical limitations in pressure-based flow models when simulating extremely low hydraulic head gradients (e.g., 1E-3 - 1E-5 m/m). Since the spatial variation in head is nominal throughout the grid (± 5 m) and the gravity term (i.e., $\rho g(z)$) is several orders of magnitude larger, round-off errors in the pressure terms may produce spurious results. DOE ran PORFLO on a Univac (36 bit word) and a Prime Computer (32 bit word) and had difficulty maintaining numerical accuracy. The products described in the SCR Chapter 12 were excecuted on a CRAY computer with 60 bit words. DOE recommended that pressure-based blow simulators should be executed in double-precision of any computer using less than a 32 bit or less word computer to maintain accuracy in the lower decimal places; otherwise the system may incur round-off errors and the simulation results will, therefore, be erroneous.

8. The initial hydraulic gradient (vertical) used in the PORFLO simulation in Chapter 12 SCR was zero (0). The NRC was misinformed earlier when staff members were informed that the vertical head gradient was 1E-3 m/m. The mistake arises from the simultaneous execution of several newer revised versions of the PORFLO model since the release of the SCR. The PORFLO models described in Chapter 12 of the SCR have zero hydraulic gradient in the vertical direction (i.e., hydrostatic condition) below the Umtanum flow unit. The base of the model, 500 m below the repository, is vertical no-flow boundary (constant head). The horizontal gradient is assumed to be 1E-3 m/m across the grid. More recent models of 2-D BWIP using PORFLO that are not described in the BWIP SCR use a vertical gradient of 1E-3 m/m.