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MEMORANDUM FOR: Frank Congel, Chief
Radiological Assessment Branch
Division of Systems Integration, NRR

FROM: Malcolm R. Knapp, Chief
Geotechnical Branch
Division of Waste Management, NMSS

SUBJECT: REVIEW OF PROPOSED CHANGES TO THE HYDROLOGICAL MODELS IN THE LADTAP II COMPUTER CODE

Richard Codell of my staff has reviewed the proposal from PNL to modify the LADTAP II code. He had several serious problems with the proposed revision, and questions the advisability of letting the PNL staff complete this task. His comments are attached. Please address any further questions directly to Dr. Codell at extension 7-4558.

Original Signed By

Malcolm Knapp
Geotechnical Branch
Division of Waste Management, NMSS

Enclosure:
As Stated

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| DATE | :85/05/07 | :85/05/9 | :85/05/9 | : | : | : | : |

# REVIEW OF PNL PROPOSAL TO MODIFY LADTAP II COMPUTER CODE (TASK PLAN REVISION #2, March 26, 1985)

by Richard Codell

1. Page 4, Paragraph 4

   Reference "Key and Whelan (1980)" does not appear in the reference list.

2. Page 4, Paragraph 4

   Reference "Key and Whelan (1981)" is incorrectly cited in both the text and reference list. The correct reference for NUREG 0868 is Codell, Key and Whelan (1981)

3. Page 5, Paragraph 1

Incorporating evaporation into this model seems inconsistent especially since they have not included other sources and sinks such as rainfall and tributary streams. (There are also many other simplifying assumptions in the model, such neglecting sorption with bottom sediments). It would be better to keep the models simple instead of adding second-order corrections which give a false impression of accuracy.

4. Page 5-8 "Partially-Mixed Model"

The discussion of the partially mixed model is highly misleading and self-serving. Firstly, the statement on page 6, "It assumes that $C_o$ and $\tau$ are constants and are not functions of $Q_b$ and $Q_p$." is completely wrong. Nowhere in Regulatory Guide 1.113 is such a statement made, and it is purely the erroneous conjecture of PNL. The dimensionless groups R and $\tau$ are defined in term of $Q_b$ and $Q_p$. The PNL proposer seems unable to grasp the dimensionless nature of Eq. 47 and Fig. 12 of Regulatory Guide 1.113. The PNL claim that Eq. 47 does not reduce to the asymptotic cases for plug flow and completely mixed flow as R approaches infinity and zero respectively is also in error. I have re-derived the equations and can assure you that RG 1.113 is correct. Furthermore, it is obvious from Figure 12, which is a numerical evaluation of Eq. 47, that the asymptotic behavior is qualitatively correct.

PNL proposed an alternative derivation for the partially mixed model (containing once again, the unnecessary evaporation term). The statement on page 8 "...the significance of $Q_p$ is <u>not</u> indicated by Eq. 47 as in Equation (e)" is incorrect. Eq. 47 does include both $Q_p$ and $Q_b$ . The PNL alternative model for the case of small $Q_b$ is in fact missleading as demonstrated below. PNL proposed that for negligable evaporation:

$$C_2/Q_c = \exp(-\theta)/ Q_p(1-\exp(-\theta)) \qquad (i)$$

where $\theta = -\lambda V_t/Q_p$

If Equation (1) purports to represent the concentration in the reservior, the mass of radionuclide in the reservoir is:

$$M(\text{curies}) = C_2 V_t = f(\theta) Q_c/\lambda \qquad (1)$$

where $f(\theta) = \theta \exp(-\theta)/(1-\exp(-\theta))$

A simple mass balance on a closed reservoir states that at steady state, the decay of the radionuclide in the reservoir is equal to its input rate:

$$Q_c = \lambda C V_t \qquad \text{or } M = Q_c/\lambda \qquad (2)$$

Notice that Equation 1 and 2 differ by the factor $f(\theta)$. This factor is shown in the table below and it is clear that the difference can be large:

| $\theta = \lambda V_t / Q_p$ | $f(\theta)$ |
|---|---|
| 0.01 | 0.995 |
| 0.1 | 0.95 |
| 1.0 | 0.582 |
| 10.0 | 0.0005 |

The difference between the two models is that the PNL model calculate $C_2$ at the end of the plug flow tube, while the NRC approach in RG 1.113 makes no statement about the location, and assumes that the concentration is representative of the total reservoirs. The NRC case would apply to the typical case of a power plant cooling lake where a large recirculation ($R = \infty$) occurs, and mixing would be nearly total, except for a very short lived nuclides. The PNL model would apply only at the far end of the reservoir, and depends on the assumption of plug flow. PNL's assertion that their model is better is not well justified. A better way to treat reservoirs in LADTAP II might be to calculate either the highest or average concentration. PNL's approach discusses neither.

In summary, the alternative model suggested by PNL for the partially-mixed case is not any better, and is in some cases worse than the original NRC models

presented in R.G.1.113. The partially mixed model of the R.G.1.113 remains a thoroughly useful concept, despite the claims of PNL. Their proposed change to the partially-mixed model should be rejected.

FROM

FJCONGEL

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RVW OF PROPOSED CHANGES TO HYDROLOGICAL MODELS IN THE LABTAP II COMPUTER CODES

ENCLOSURES

Closed by memorandum for Frank Congel from Mal Knapp.

85/05/09 K. Davis

| REFERRED TO | DATE | RECEIVED BY | DATE |
|---|---|---|---|
| M. Knapp | 4/26 | MK | 4/26 |
| R Codell | 4/26 | | |
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REMARKS

Suggested in 5520 4/26/85 MK

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