UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 19 1979

MEMORANDUM FOR: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

FROM: Saul Levine, Director
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH INFORMATION LETTER # 47 INREM II: A COMPUTER IMPLEMENTATION OF RECENT MODELS FOR ESTIMATING THE DOSE EQUIVALENT TO ORGANS OF MAN FROM AN INHALED OR INGESTED RADIONUCLIDE

This memorandum transmits the INREM II code[1] which calculates the internal radiation dose equivalent to human organs resulting from the intake of a radionuclide by inhalation or ingestion and Volume 1 of a tabulation of internal radiation dose conversion factors[2] obtained using the INREM II code. This work was performed by the Health and Safety Research Division of the Oak Ridge National Laboratory under the direction of the Environmental Effects Research Branch of RES.

Research Request NRR 78-5, "Confirmatory Research Programs in Radiation Dose Estimation," stated that NRR staff estimations of radiation exposure to man required a broadly applicable, documented, state-of-the-art dose estimation methodology. As part of its comprehensive development of computer codes for calculation of internal doses resulting from incorporation of radionuclides, ORNL has developed the INREM II code. This code computes the dose equivalent to various organs of a reference adult human being from user-supplied dosimetric and metabolic information about the radionuclides inhaled or ingested.

The INREM II code implements contemporary dynamic models for internal dose estimation. The ICRP Task Group Lung Model is used to estimate the deposition and retention of inhaled particulates and their absorption into the blood and clearance into the gastrointestinal tract. A four-segment model of the gastrointestinal tract with first-order mass transport and absorption activity permits calculation of residence times of radionuclides in the tract

[1] INREM II: A computer Implementation of Recent Models for Estimating the Dose Equivalent to Organs of Man from an Inhaled or Ingested Radionuclide, NUREG/CR-0114.

[2] Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel-Cycle Facilities, Vol. 1, NUREG/CR-0150.

and the dynamics of their assimilation from that site. Transfer functions from blood and residence times of activity in other organs are calculated from parameters specified as input to INREM II, thus providing for use of various metabolic models. The INREM II code calculates the "activity residence" times (in microcurie-days) in specified source organs using the metabolic parameters supplied by the user. INREM II utilizes S-factors (in rem per microcurie-days) obtained from the SFACTOR code[3]/ (RIL #35, September 15, 1978) to calculate the total dose equivalent to organs of interest. In principle, the INREM II approach is similar to the one used in WASH-1400[4]/.

The formation and decay of radioactive daughters is treated explicitly. The residence times of the radioactive daughters are calculated with consideration of their differential transfer among the body's compartments. This approach permits each nuclide in the chain to be cleared from the lungs, absorbed from the gastrointestinal tract, and taken up and retained by other organs in accordance with its own properties.

The dose equivalent to an organ is computed as the sum of contributions from each source organ in which radioactivity is assumed to be situated. When penetrating radiations are present, cross-irradiation effects can be assessed.

The dose conversion factors in NUREG/CR-0150 and the upcoming Vol. 2 are to be considered as illustrative of results obtained from use of INREM II. They are not endorsed for adoption since some of the metabolic models used

[3]/ SFACTOR: A Computer Code for Calculating Dose Equivalent to a Target Organ per Microcurie-Day Residence of a Radionuclide in a Source Organ, ORNL/NUREG/TM-85.

[4]/ Reactor Safety Study: An Assessment of Accident Risks in U. S. Commercial Nuclear Power Plants, WASH-1400.

are subject to criticism: For example, the same value was used for all isotopes of iodine for the fractional transfer from blood to thyroid, whereas this value is a function of radioactive half-life. We plan to direct ORNL to continue efforts to define acceptable metabolic models and future revisions will be transmitted to you.

The INREM II code, as presented in NUREG/CR-0114, can be useful in calculating internal doses to human beings. With the further development of acceptable metabolic models, this code will provide a state-of-the-art methodology for internal dose calculations. If you have any questions with regard to this report, please contact Dr. Judith D. Foulke (427-4358).

Saul Levine

Saul Levine, Director
Office of Nuclear Regulatory Research

Enclosures:

1. NUREG/CR-0114
2. NUREG/CR-0150