



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
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MEMORANDUM FOR: John G. Davis, Director  
Office of Nuclear Material Safety  
and Safeguards

Harold R. Denton, Director  
Office of Nuclear Reactor Regulation

Ray G. Smith, Acting Director  
Office of Standards Development

FROM: Robert B. Minogue, Director  
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH INFORMATION LETTER # 116 -  
MATHEMATICAL PHANTOMS REPRESENTING CHILDREN OF  
VARIOUS AGES FOR USE IN ESTIMATES OF INTERNAL DOSE

This memorandum describes briefly the mathematical phantoms developed to represent children of ages 0, 1, 5, 10, and 15 years for use in calculating organ doses from internal and external emitters. 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, Office of Nuclear Regulatory Research (RES). The complete description is given in NUREG/CR-1159, "Mathematical Phantoms Representing Children of Various Ages for Use in Estimates of Internal Dose."

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. One of the most pressing needs has been the lack of anatomical data for organ shapes and locations in children. To fulfill this need, a series of distinct phantoms representing children of ages 0 (newborn), 1, 5, 10, and 15 years has been developed. The report gives the explicit equations for locating organ boundaries and detailed drawings showing organ locations by age. In addition, the distributions of hematopoietically active bone marrow and inactive fatty marrow are defined.

Each phantom consists of three major sections: (1) an elliptical cylinder representing the trunk and arms; (2) two truncated circular cones representing the legs and feet; and (3) an elliptical cylinder capped by half an ellipsoid representing the neck and head. Attached to the legs section is a small region with a plane front surface to represent the testes. Attached to the

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trunk are portions of two ellipsoids representing the female breasts. Each phantom is composed of skeletal, lung, and other soft tissue. The skeletal system represents the total content of the intact skeleton and thus includes both bone and bone marrow, which is considered to be homogeneously distributed in the skeleton. The three tissue types are composed principally of hydrogen, carbon, nitrogen, and oxygen. In the skeleton, additional elements, primarily calcium and phosphorus, amount to about 18 percent of the total mass. The composition of the lungs is somewhat different from other soft tissues because the lungs contain almost no fat but a larger fraction of blood than other organs.

We recommend that your staff use the data presented in NUREG/CR-1159 in calculating doses to children from exposure to radionuclides as it provides much more realistic estimates than use of scaling factors from adult data. For further information on this method, please contact Dr. Judith D. Foulke (427-4358).



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