INTERIM REPORT

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Union Carbide Corporation
for the
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QUARTERLY PROGRESS REPORT

INTERIM REPORT

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FOR JANUARY-MARCH, 1979

DOSIMETRY AND BIOTRANSPORT MODELS TO IMPLEMENT ALARA
(189 No. B0188)

Health and Safety Research Division
Oak Ridge National Laboratory

PRINCIPAL SCIENTISTS: G. G. Killough and D. C. Kocher

OBJECTIVE:

To implement current dosimetric and environmental transport models and associated data bases to calculate realistic estimates of radiation doses to the general public, with the view of meeting particular needs of the NRC as the Commission develops capabilities to implement dose limits which satisfy the requirement "as low as reasonably achievable" (ALARA).

PROGRESS IN JANUARY-MARCH, 1979:

Publications. "Dose-Rate Conversion Factors for External Exposure to Photon and Electron Radiation from Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities," by D. C. Kocher, has been submitted to Health Physics. An expanded version of this paper, same title and author, is in press as NUREG/CR-0494, ORNL/NUREG/TM-283.

Implementation of Terrestrial Food-Chain Model. We have selected the existing Terrestrial Model (TERMOD), as defined in A Methodology for Calculating Radiation Doses from Radioactivity Released to the Environment, ORNL-4992, by G. G. Killough and L. R. McKay, as a structural starting point for further development. The purpose is to test the structural adequacy of terrestrial food-chain models that are presently used to estimate radiation dose to maximally exposed members of the public and to populations from radionuclides released from nuclear facilities (e.g., the model defined in USNRC Regulatory Guide 1.109). This approach complements error-analysis studies which assume structural adequacy and examine the statistical distributions of response variables when hypothesized distributions are substituted for the model parameters. In our development, two specific areas for immediate modification of the Terrestrial Model have been identified: (1) representation of the dynamics of growth and decay of radioactive progeny and their differential movement among model compartments; and (2) inclusion of an explicit compartment to represent edible plant parts, with simulated uptake of radionuclides through the roots.

A preliminary computer code with these modifications has been written and is currently being tested. The implementation makes use of the GEAR integration package, a modern discrete-variable program for ordinary differential equations designed for systems that may become "stiff" in certain time ranges of their independent variables. This problem is known to affect the equations governing the decay dynamics of some radionuclide chains.

The Global Iodine Model. A draft report titled A Dynamic Model of the Global Iodine Cycle for the Estimation of Dose to the World Population from Releases of Iodine-129 to the Environment, by D. C. Kocher, has been prepared and is undergoing technical review. The primary emphasis of this report is an analysis of the global iodine cycle in order to determine mean residence times for globally circulating iodine in various parts of the environment (atmosphere, hydrosphere, and lithosphere), and to determine fractional transfer rates between environmental compartments in a linear compartment model for the global cycle. This analysis suggests that a release of ^{129}I to the environment -- e.g., from a point source at ground level on land -- will enter into global circulation sufficiently slowly that a proper assessment of dose to the general population will require a progression from local to regional to global scale models. The model for the global iodine cycle should help determine the time periods following release over which the local and regional models would be appropriate. The relatively slow mixing of released ^{129}I into the global environment also means that a pathway analysis is required to estimate properly the intake of ^{129}I by an exposed individual for considerable periods of time following a release -- i.e., a specific activity model is not appropriate until the released ^{129}I is well mixed in the global environment. The report provides worldwide population dose estimates for a 1-Ci release, which is assumed to be instantaneously well mixed in a global-scale environmental compartment. Further work is required before these dose estimates can be applied to releases from a point source.

STATUS OF CURRENT SUBTASKS:

Task 1: INREM II and SFACTOR codes

a. Preparation of supplementary report on SFACTOR computer code.

The intent of this task is to provide documentation of the version of the SFACTOR code that has been used in connection with the preparation of the report Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel-Cycle Facilities, Vol. 2, NUREG/CR-0150v2, ORNL/NUREG/TM-190v2, by D. E. Dunning, Jr., et al. We experienced considerable difficulty and several months' delay in obtaining technical reviews for the latter document and held back the preparation of the supplementary SFACTOR report to permit inclusion of any further changes that might be indicated by the review. The last technical review of NUREG/CR-0152v2 has just been received, and the preparation of the supplementary report on SFACTOR can now proceed. No impact on other subtasks is anticipated.

Task 2: Terrestrial Food-Chain Model

b. Review and comparison of suitable structures for model.

On schedule, as indicated in PROGRESS section.

c. Preliminary computer program for the model.

Ahead of schedule, as indicated in PROGRESS section.

Task 3: ^{14}C Analyses

This task was postponed until FY80 at the request of NRC.

Task 4: Global-Scale Models for Selected Long-Lived Radionuclides

a. Survey of global geophysical and geochemical literature for the selected long-lived isotopes.

b. Preparation of report on literature survey and current feasibility of dynamic global models for the selected isotopes.

c. Development of preliminary global models for selected long-lived radionuclides as indicated by feasibility in item b.

Items a, b, and c have been consolidated and completed for ^{129}I.

BUDGET AND TECHNICAL MANPOWER EXPENDITURES (FY 1979):

Reporting Period	Project Costs, $	Technical Support, Man-months
Jan.-March, 1979	47,814	3.5
Total to Date	97,301	
Estimated Cost to Completion	96,699	

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