Software Requirements Specification

for

THE HANFORD ENVIRONMENTAL DOSE RECONSTRUCTION PROJECT
AIR PATHWAY ENVIRONMENTAL ACCUMULATION AND DOSE CODES

December 28, 1992

This specification covers software and quality assurance requirements for the software that will compute environmental accumulation and doses associated with the air release pathway. This requirements specification supersedes all previously documented software requirements.
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1.0 GENERAL REQUIREMENTS

1.1. The software shall calculate environmental accumulations and doses from atmospheric releases and transport of radionuclides from Hanford site operations as modeled by the Source Term Release Model (STRM) and by the Regional Atmospheric Transport Code for Hanford Emission Tracking (RATCHET).

1.2. The software shall be capable of reporting environmental accumulation estimates and dose estimates separately.

1.3. The software shall be capable of operating on data for the time period from 1944 through 1972 inclusive.

2.0 QUALITY ASSURANCE REQUIREMENTS

2.1. The software development and design shall be subject to the quality assurance (QA) requirements in the HEDR QA plan (QAP #OHE-003, dated 7/21/92) and the PNL Software Control Procedures (SCP's) in PNL-MA-70.

2.2. The software shall log information such as names and versions of files used, data identification labels, and version of the software to provide complete traceability of the output.

2.3. The software shall produce the same output for separate runs using identical inputs.

2.4. The software shall be documented with the following items as HEDR project records:
   a. software development plan (SDP)
   b. software design document (SDD)
   c. interface requirements specification (IRS)
   d. data dictionary (DD)
   e. configuration management plan (CMP)
   f. users guide (UG)
   g. module development folders (MDF)
   h. software requirements specification (SRS)
   i. software test plan (STP)

   Requirements for the contents of each document shall be identified in the SDP.

2.5. The software shall be subjected to the following HEDR internal reviews:
   a. software design review
   b. code walkthrough
   c. final internal development review
   d. independent testing review
   e. operational readiness review

   Requirements for each review shall be identified in the SDP.

3.0 HOST SYSTEM REQUIREMENTS

3.1. The software shall operate on the HEDR Sun 690 platform.
3.2. The following three operating environments shall be supported:
   a. development and/or maintenance
   b. test and/or verification
   c. production

   The operating environments do not have to function simultaneously. Production runs do not need to support more than a single nuclide at a time.

4.0 GENERAL USER INTERFACE REQUIREMENTS

4.1. The software shall provide a procedure to allow operation by a trained nondeveloper through the use of script or text control files.

5.0 DATA SIZE REQUIREMENTS

5.1. The software shall support calculations for one radionuclide, $^{131}$I, with the capability to expand to a total of five radionuclides. Future expansion may require code modifications.

5.2. The software shall be designed to support future expansion with up to 15 plant media and up to 12 animal media. Implementation of future expansion may require code modifications.

5.3. The software shall support using up to 100 realizations of air concentration and deposition data through the environmental accumulation and dose estimates. A single realization of the code consists of all values input or calculated for each active mode for each operational time step.

5.4. The software shall be capable of operating on a spatial grid containing up to 1064 nodes.

6.0 MATHEMATICAL MODELS

6.1. The software calculations shall implement the functionality of equations DES-1 through DES-18 and CID-1 through CID-5 as documented in


6.2. The software shall support only simple exponential decay of radionuclides.

6.3. The software shall provide the capability to generate random numbers from the following statistical distributions:
   a. uniform
   b. piecewise uniform
   b. loguniform
   c. normal
   d. lognormal
   e. triangular
f. discrete uniform

Generation of values from the normal and lognormal distributions will be truncated at the tail probabilities of 0.01 and 0.99.

6.4. The software shall provide the capability to generate all random numbers using a stratified sampling technique.

6.5. The software shall be capable of selecting identical stochastic parameters for separate runs which differ only by the radionuclide being processed.

6.6. The environmental accumulation software shall use the Euler method for solution of all differential equations.

6.7. The software shall support the stochastic parameter definitions and sampling frequencies defined in Section 6.0 and Table A-1 of PNWD-2023 HEDR (dated September 1992).

7.0 ENVIRONMENTAL ACCUMULATION DATA INTERFACE REQUIREMENTS

7.1. The environmental accumulation software shall receive air transport information from the RATCHET code as documented in


7.2. The software shall implement milk information as presented in:


and

"Milk Production and Distribution in Low-Dose Counties for Hanford Thyroid Disease Study”, PNL-8153, June 1992.

7.3. The software shall implement a fresh leafy vegetable distribution network as presented in


7.4. Physical locations shall be specified by node.

7.5. The software shall use a creamery identifier to distinguish creamery milk information.
8.0 ENVIRONMENTAL ACCUMULATION CONTROL REQUIREMENTS

8.1. The environmental accumulation software shall allow user selection of the set of nodes where environmental accumulation calculations shall be performed.

8.2. The environmental accumulation software shall allow the user to process one or more plant and/or animal media independently.

8.3. The software shall be able to utilize default values when no input values exist.

9.0 ENVIRONMENTAL ACCUMULATION GENERAL REQUIREMENTS

9.1. The environmental accumulation software shall be able to accept information from RATCHET in daily time steps.

9.2. The environmental accumulation software shall provide an environmental accumulation database to the dose code at user selectable intervals: daily, weekly, or monthly.

9.3. A de minimus dose threshold shall be implemented with respect to environmental media to restrict data passed to the dose software to significant levels. The algorithm for this calculation is to be determined.

10.0 ENVIRONMENTAL ACCUMULATION REPORTING REQUIREMENTS

10.1. The environmental accumulation software shall be able to report, in human-readable form or electronic media, the radionuclide concentrations in the following media for selected nodes and time steps:

Plant Media
a. inner leafy vegetables
b. outer leafy vegetables
c. other vegetables
d. inner fruit
e. outer fruit
f. grain
g. alfalfa hay
h. pasture
i. grass hay
j. silage
k. sagebrush

Animal Media
a. backyard goat milk
b. grocery cow milk (rural)
c. grocery cow milk (urban)
d. creamery cow milk
e. cow feeding regime 1 milk
f. cow feeding regime 2 milk
g. cow feeding regime 3 milk
h. cow feeding regime 4 milk
i. eggs
j. beef
k. poultry

Other Media
a. air
b. upper soil layer
c. soil root zone

11.0 DOSE MODEL REQUIREMENTS

11.1. The software shall be able to calculate doses for both reference and real individuals.

11.2. The dose software shall operate internally on a daily time step, even when the environmental data is passed on a weekly or monthly time step.

11.3. The dose software shall be able to calculate prenatal doses for infants. Prenatal doses are based on the diet and lifestyle of the mother. The transfer function of the mother's intake to the infant's dose is represented by dose factors in units of rad to infant per curie of maternal intake.

11.4. The dose software shall be able to calculate doses for nursing infants. Doses for nursing infants are based on the diet, location and lifestyle of both the mother and the child. The infant's dose is a function of infant's intake plus a transfer parameter multiplied by the mother's intake. The infant and mother are required to live at the same node.

11.5. The dose software shall allow only one type of fresh milk and one type of stored milk to be included in a diet at any single time step.

11.6. The dose software shall utilize environmental concentration values from the node where an individual lives. An individual can only live at one node for a given time step.

11.7. The dose software calculations shall account for holdup times (decay) from the previous year's harvest in both fresh and stored food media.

12.0 DOSE CONTROL REQUIREMENTS

12.1. The dose software shall allow the user to select a start date and end date.

12.2. The dose software shall support "map" data generation for reference individuals and a user specified set of nodes.

12.3. A user specified diet shall be implemented as an override of a reference diet by food category.

12.4. The dose software shall allow the user to supply a diet that may change with time.

12.5. The dose software shall allow the living location of an individual to change with time.

12.6. The dose software shall allow real individuals to exit and reenter the study area.
12.7 Changes to an individuals' diet, living location, and lifestyle may be allowed to occur at a frequency no more rapid than the internal time step at which the dose software is running.

12.8 The dose software shall be capable of operating in a multiple run mode. The multiple run mode will allow the sequential calculation of doses to multiple individuals at different locations with different diets and lifestyles.

13.0 DOSE REPORTING REQUIREMENTS

13.1 The dose software shall be able to report doses on an annual basis.

13.2 The dose software shall be able to report cumulative doses over the entire time period selected.

13.3 The dose software shall be able to report doses to the thyroid, red bone marrow, lower large intestine and effective dose for the following pathways based on operator selection:
   a. external
   b. inhalation
   c. beef ingestion
   d. leafy vegetable ingestion
   e. other vegetable ingestion
   f. fruit ingestion
   g. grain ingestion
   h. poultry ingestion
   i. eggs ingestion
   j. milk ingestion
   k. total over all pathways.

   The doses shall be output for the entire set of realizations.

14.0 COMPUTATION TIME REQUIREMENTS

14.1 The environmental software shall be capable of producing a full environmental accumulation database for use by the dose code (1 radionuclide, all media, 1064 nodes, years 1944 through 1972) in 10 days wall clock time.

14.2 The dose software shall be able to calculate and output data for a "map" run of 1064 nodes on a dedicated machine for a single year and a single radionuclide with an elapsed wall-clock time of no more than 532 minutes (30 seconds average per node). The output of this production run includes the doses to a representative individual at each node for 3 organs, 10 pathways and subpathways, and 100 realizations.