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SOFTWARE QUALITY ASSURANCE PLAN FOR ENVIRONMENTAL DOSIMETRY

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PREPARED FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT NO. AC09-96SR18600

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ABSTRACT

A software quality assurance plan has been developed for application with codes owned by Environmental Dosimetry. The plan contains the specific requirements for the operation and maintenance of the codes as specified in Washington Savannah River Company (WSRC) Manual 1Q Procedure 20.1 concerning Software Quality. All portions of this procedure which are not addressed will be complied with directly.

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TERMS AND DEFINITIONS

The following list of acronyms and terms are listed to ensure understanding.

Code - one or more computer programs or parts of a computer program.

Computer Program - a combination of computer instructions and data definitions that enable computer hardware to perform computational or control functions.

Cognizant Quality Function (CQF) - person/organization responsible for reviewing and approving software quality assurance plans and procedures and verifying software classification has been established, and concurring with software classification of Level “E”.

Cognizant Technical Function (CTF) - primary point of contact for the organization responsible for ensuring applicable software management and quality assurance controls are implemented. Designated by management and responsible for software technical adequacy during acquisition, development and/or maintenance activities.

Customer - the primary point of contact for the user community.

Design Description for Software (DDS)– the controlling document that specifies the design of a software product.

Functional Classification – a graded classification system used to determine minimum requirements for structures, systems, or components (SSCs) (i.e., design, operation, procurement, and maintenance requirements).

Independent Review Type 1 (IR-1) – review of document performed by an individual knowledgeable in the area of review to ensure that the assumptions, methodology, and resulting product reflect sound engineering judgment. An individual other than the initiator performs the Independent Review.

Independent Review Type 2 (IR-2) – an independent review conducted by an individual subject to different technical directions.

Job Control Language (JCL) – programming language specific to the IBM mainframe used to set up the necessary instructions to execute codes

Non Conformance Report (NCR) – report issued when code is not operating as expected.

Requirements Traceability Matrix (RTM) – a document that traces requirements from the Requirements Specification for Software (RSS) to design elements in the DDS and to the completed testing documentation.

Software - computer programs, procedures, rules and associated documentation and data pertaining to the operation of a computer system.

Software Evaluation Package (SEP) – set of documents that is utilized to demonstrate adequate confidence that the existing or acquired software is acceptable for its intended end use.

Software Inventory Database (SID) – electronic and/or paper records that contain configuration management and action tracking information.

Software Quality Assurance Plan (SQAP) - defines requirements and responsibilities for the management of computer software and control of software quality.

Software Test Case – a specific set of test data and associated inputs, execution conditions and expected results that determine whether the software being tested meets functional requirements.

Software Test Plan (STP) – a document or collection of documents for executing, controlling, and documenting the software testing process.

Software validation - the test and evaluation of the completed software to ensure compliance with software requirements.

Software verification - the process of determining whether or not the product of a given phase of the software development cycle fulfills the requirements imposed by the previous phase.

Testing - the process of exercising or evaluating a system or system component by manual or automated means, to verify that it satisfies specified requirements or to identify differences between expected and actual results.

SOFTWARE QUALITY ASSURANCE PLAN FOR ENVIRONMENTAL DOSIMETRY

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1. SCOPE

This plan lists the requirements for completing the quality assurance activities to be performed over the lifecycle of software managed by the Environmental Dosimetry (ED)* personnel of the Environmental Science and Biotechnology Section of Savannah River National Laboratory (SRNL). This plan follows procedures specified in Washington Savannah River Company (WSRC) Manual 1Q, Procedure 20-1 concerning Software Quality Assurance. All software currently used by ED is shown in Table 1 along with their associated software functional classifications. The Software Classification Documents for each code are provided in Appendix A. This Software Quality Assurance Plan (SQAP) is developed in accordance with software functional classification B.

All software used by Environmental Dosimetry is unclassified (for security purposes) as specified in Simpkins (2001b). This SQAP (revision 1) applies to all software currently owned by ED. A revision to this SQAP, or a separate plan, will be issued if new software is acquired or developed.

2. EXISTING AND ACQUIRED SOFTWARE

With the exception of LADTAP-PA and LADTAP-PA-FTF, all of the software listed in Table 1 was in existence prior to the current revision (revision 8, dated 10/16/03) of Manual 1Q, Procedure 20-1 and is therefore treated as existing software. LADTAP-PA and LADTAP-PA-FTF were developed in accordance with Procedure 20-1, but are included in this SQAP revision for convenience and completeness.

ED obtained the following free software: CAP88 PC, RESRAD-Biota (also known as RAD-BCG Calculator), RESRAD, and RESRAD-Build. All other codes were developed or modified by ED. If in the future software were to be acquired or developed by ED, this SQAP would be revised, or a new SQAP would be developed specific to that software.

All requirements for existing and acquired software specified in section F of Manual 1Q, Procedure 20-1 are addressed in this SQAP.

* Environmental Dosimetry is not a group at SRNL, but refers to an entity that works with the topic.

Table 1. Software Identification Number and Software Functional Classifications For all (non-Level E) Environmental Dosimetry Software

Name	Software Identification #	Software Classification
AXAIRQ	Q-SWCD-A-00006	B
AXAOTHER	Q-SWCD-A-00007	B
AXAOTHER XL	Q-SWCD-A-00008	B
CAP88	Q-SWCD-A-00009	B
CAP88 PC	Q-SWCD-A-00010	B
LADTAP	Q-SWCD-A-00011	B
LADTAP XL©	Q-SWCD-A-00012	B
LADTAP-PA	Q-SWCD-A-00028	B
LADTAP-PA-FTF	Q-SWCD-A-00029	B
MAXDOSE-SR	Q-SWCD-A-00013	B
MAXIGASP	Q-SWCD-A-00014	B
MAXINE	Q-SWCD-A-00015	B
POPDOSE-SR	Q-SWCD-A-00016	B
POPGASP	Q-SWCD-A-00017	B
RESRAD	Q-SWCD-A-00019	B
RESRAD-Biota	Q-SWCD-A-00018	B
RESRAD-Build	Q-SWCD-A-00022	B
VENTSAR	Q-SWCD-A-00020	B
VENTSAR XL©	Q-SWCD-A-00021	B

3. SOFTWARE LIFE CYCLE

3.1. Introduction

The intent of this SQAP is to ensure that all software owned by ED is controlled in a traceable, planned, and orderly manner. The specific Software Life Cycle requirements identified in Manual 1Q, Procedure 20-1 are addressed in this section.

3.2. Requirements Phase

In accordance with Manual 1Q, Procedure 20-1, software requirements need to be defined for functionality, performance, design constraints, installation and operating system attributes, and external interfaces necessary to design the software. Even though all ED software already exists (except for the recently developed LADTAP-PA and

LADTAP-PA-FTF), for each of the codes developed, modified, or obtained by ED all of the above requirements are addressed in following sections. Supporting references for each of the codes is listed in Appendix A. For a general overview of several of the codes, refer to the Environmental Dose Assessment Manual (Lee 2001).

3.2.1. AXAIRQ

3.2.1.1. Function

AXAIRQ is a site-specific code used to predict doses following radioactive atmospheric releases of short duration. AXAIRQ strictly follows the guidance in U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.145 (USNRC 1982). Dose modeling provided by AXAIRQ is primarily used for Safety Analysis Reports. Given minimal input to characterize a release, the AXAIRQ code estimates the doses via inhalation, plume shine, and ground shine pathways to the onsite population, the offsite population within 50 miles, onsite individuals at user-selected locations and the offsite maximally exposed individual. The doses evaluated are those that would be exceeded only 0.5% of the time based on worst-case, worst-sector meteorological probability analysis. The resulting doses are reported by radionuclide, body organ, and pathway.

AXAIRQ provides automatic selection or generation of the following: dose conversion factors, inhalation and gamma exposure parameters, onsite and offsite population distributions, meteorological parameters, relative terrain elevations, and minimum boundary distance in each compass sector. Ingrowth of daughter radionuclides from released parent decay during plume transport may be considered at the user's discretion. Different methodologies can be used in the determination of external dose via gamma radiation using one of the following assumptions:

- nonuniform plume upper-bound approximation,
- rigorous nonuniform plume approximation, or
- semi-infinite uniform plume.

Results can be presented as a summary or as full output with doses reported by pathway and nuclide. The user may choose the summary, full output, or both. Several of the input datasets are echoed as part of the output. These include: terrain data file, meteorological joint frequency distribution, and onsite and offsite population databases.

3.2.1.2. Performance

AXAIRQ will perform approximately 50,000 calculations of downwind air concentration and dose. CPU time should be on the order of a few minutes on the IBM unclassified mainframe depending on the number of nuclides entered. CPU time will be longer if a large number of isotopes are selected.

3.2.1.3. Design Constraints

Coding is accomplished using FORTRAN 77, executable through IBM Job Control Language (JCL).

3.2.1.4. Attributes

The computer code AXAIRQ has been compiled and link-edited, and is ready for execution on the IBM unclassified mainframe with the JCL and user input template specified in a controlled dataset. FORTRAN and load modules are maintained in a write-protected file, accessible only by the Cognizant Technical Function (CTF).

3.2.1.5. External Interfaces

Use is limited to members of ED or those authorized by ED. Users are expected to have a base knowledge of atmospheric dispersion and dosimetry prior to executing the code. AXAIRQ requires minimal input with defaults for a majority of the parameters. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) or by contacting the CTF.

3.2.2. AXAOTHER

3.2.2.1. Function

AXAOTHER is used to predict doses during a postulated tornado or periods of high-velocity straight winds. With known dispersion factors, the AXAOTHER code can be used to calculate radiological consequences including maximum dose to an offsite individual and doses to onsite and offsite populations. The exposure pathways considered in the AXAOTHER code include inhalation of radionuclides and immersion in the plume.

AXAOTHER allows for automatic selection or generation of dose conversion factors, and inhalation and gamma exposure parameters. Inhalation and gamma-shine doses to the maximum individual at a user-specified location and the populations within 50 miles are determined. External dose via gamma radiation using a semi-infinite uniform plume model is also determined.

3.2.2.2. Performance

AXAOTHER operates on the IBM unclassified mainframe and CPU time is on the order of a few seconds.

3.2.2.3. Design Constraints

Coding of software is accomplished using FORTRAN 77, executable through IBM JCL.

3.2.2.4. Attributes

AXAOTHER has been compiled and link-edited, and is ready for execution on the IBM unclassified mainframe. FORTRAN and load modules are maintained in a write-protected file, accessible only by the CTF.

3.2.2.5. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have general knowledge of atmospheric dispersion prior to executing the code. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) or by contacting the CTF.

3.2.3. AXAOTHER XL

3.2.3.1. Function

AXAOTHER XL is used to predict doses during a postulated tornado or periods of high-velocity straight winds. With known dispersion factors, the AXAOTHER XL code can be used to calculate radiological consequences including maximum dose to an offsite individual and doses to onsite and offsite populations. The exposure pathways considered in the AXAOTHER code include inhalation of radionuclides and immersion in the plume.

AXAOTHER XL allows for automatic selection or generation of dose conversion factors, and inhalation and gamma exposure parameters. Inhalation and gamma-shine doses to the maximum individual at a user specified location and the populations within 50 miles are determined. External dose via gamma radiation using a semi-infinite uniform plume model is also determined.

3.2.3.2. Performance

AXAOTHER XL operates on any PC supporting Microsoft Excel©.

3.2.3.3. Design Constraints

Coding of accomplished through Microsoft Excel© programming language MACROS.

3.2.3.4. Attributes

AXAOTHER XL is ready for execution using a write-protected Microsoft Excel© file. MACROS and data files are maintained in write-protected files, accessible only by the CTF.

3.2.3.5. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have general knowledge of atmospheric dispersion prior to executing the code. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) or by contacting the CTF.

3.2.4. CAP88

3.2.4.1. Function

CAP88 estimates health impacts from routine atmospheric release of radioactivity. Inhalation, ingestion, air immersion and ground surface irradiation pathways are considered, and doses are estimated for maximally exposed individuals and regional populations. CAP88 uses a modified Gaussian plume equation to estimate the average dispersion of radionuclides released from up to six sources at the same release location with different release heights. Assessments are done for a circular grid within a radius of 50 miles. The use of CAP88 is required when assessing health impacts for National Emission Standard for Hazardous Air Pollutants (NESHAP) applications.

CAP88 has automatic selection or generation of one or more of the following: dose conversion factors, inhalation, ingestion, and gamma exposure parameters, onsite and offsite population distributions, agricultural parameters, and meteorological joint frequency data. CAP88 uses these parameters for the determination of inhalation, ingestion, and gamma-shine doses to the maximally exposed individual at a user-specified location and to the population within 50 miles.

3.2.4.2. Performance

CAP88 software can handle a maximum of 36 nuclides released from up to six stack heights. The EPA program has been installed on the IBM unclassified mainframe and can estimate either individual or population doses with CPU time on the order of seconds.

3.2.4.3. Design Constraints

Coding of software is accomplished using FORTRAN 77, executable through IBM JCL.

3.2.4.4. Attributes

CAP88 has been compiled and link-edited, and is ready for execution on the IBM unclassified mainframe. FORTRAN and load modules are maintained in a write-protected file, accessible only by the CTF.

3.2.4.5. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have general knowledge of atmospheric dispersion and the assessment of health effects for NESHAP applications. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) or by contacting the CTF.

3.2.5. CAP88 PC

3.2.5.1. Function

CAP88 PC estimates health impacts from routine atmospheric release of radioactivity. Inhalation, ingestion, air immersion and ground surface irradiation pathways are considered, and doses are estimated for maximally exposed individuals and regional populations. CAP88 PC uses a modified Gaussian plume equation to estimate the average dispersion of radionuclides released from up to six sources at the same release location with different release heights. Assessments are done for a circular grid within a radius of 50 miles. The use of CAP88 is required when assessing health impacts for National Emission Standard for Hazardous Air Pollutants (NESHAP) applications.

CAP88 PC has automatic selection or generation of one or more of the following: dose conversion factors, inhalation, ingestion, and gamma exposure parameters, onsite and offsite population distributions, agricultural parameters, and meteorological joint frequency data. Determination of inhalation, ingestion, and gamma-shine dose to the maximum individual at a user-specified location and the population within 50 miles.

3.2.5.2. Performance

CAP88 PC software can handle a maximum of 36 nuclides released from up to six stack heights. The Environmental Protection Agency (EPA) program has been installed on and IBM PC and can estimate either individual or population doses with CPU time on the order of seconds.

3.2.5.3. Design Constraints

Coding of software is accomplished using FORTRAN and the executable is provided to users.

3.2.5.4. Attributes

CAP88 PC Version 3.0 has been loaded and is ready for execution on an IBM PC.
Please Note: At the time of this SQAP revision, all site specific input data (e.g. meteorology and population distributions) have not been loaded into CAP88 PC Version 3.0, therefore, the test cases have not yet been run for this software.

3.2.5.5. External Interfaces

The software is freeware downloadable from the EPA website (www.epa.gov). The user is expected to have general knowledge of atmospheric dispersion and the assessment of health effects for NESHAP applications.

3.2.6. LADTAP

3.2.6.1. Function

The LADTAP code is designed to evaluate radiological dose due to the release of radioactive material from the Savannah River Site (SRS) during normal operation via liquid effluent pathways. The code implements the models described in the USNRC Regulatory Guide 1.109 (USNRC 1977a) for liquid radioactive releases. Up to 200 nuclides may be included in the release source term. Available options include the complete mixing, partial mixing, or the plug-flow model. These models are described in the USNRC Regulatory Guide 1.113 (USNRC 1977c). LADTAP calculates the radiation dose to a person from ingestion of water and aquatic foods, and also the dose to biota. Doses are calculated for both individuals and offsite populations, and are summarized for each pathway by age group and organ.

Doses are determined for the following receptors and locations:

- The SRS maximally exposed individual
- Beaufort-Jasper Water Treatment Plant
  - maximally exposed individual
  - average individual
  - population
- Port Wentworth Water Treatment Plant
  - maximally exposed individual
  - average individual
  - population
- Biota
- Downstream consumers of fresh and salt water fish and invertebrates.

3.2.6.2. Performance

LADTAP performs calculations of downstream doses in less than 5 CPU seconds on the IBM unclassified mainframe.

3.2.6.3. Design Constraints

Coding of software is accomplished using FORTRAN 77, executable through IBM JCL.

3.2.6.4. Attributes

LADTAP has been compiled and link-edited, and is ready for execution on the IBM unclassified mainframe. FORTRAN and load modules are maintained in a write-protected file, accessible only by the CTF.

3.2.6.5. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have a general knowledge of the models discussed in USNRC Regulatory Guides 1.109 and 1.113 (USNRC 1977a and 1977c) prior to executing the code. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) or by contacting the CTF.

LADTAP XL©

3.2.6.6. Function

LADTAP XL© is a Microsoft Excel© Spreadsheet version of LADTAP. The LADTAP XL© code is designed to evaluate doses due to the release of radioactive material from the Savannah River Site (SRS) during normal operation via liquid effluent pathways. The code implements the models described in the USNRC Regulatory Guide 1.109 and 1.113 (USNRC 1977a and 1977c) for liquid radioactivity releases. LADTAP XL© calculates the radiation exposure to person from ingestion of potable water and aquatic foods, and swimming and boating. Doses are calculated for both individuals and offsite populations, and are summarized for each pathway by age group and organ.

Usage and population parameters specific to the SRS vicinity are automatically selected. Doses are determined for the following receptors and locations:

- The SRS maximally exposed individual
- Beaufort-Jasper Water Treatment Plant
  - maximally exposed individual
  - average individual
  - population
- Port Wentworth Water Treatment Plant
  - maximum individual
  - average individual
  - population

3.2.6.7. Performance

LADTAP XL© performs calculations of downstream doses instantaneously through changes in the input portion of the spreadsheet.

3.2.6.8. Design Constraints

LADTAP XL© has been programmed using a Microsoft Excel© spreadsheet.

3.2.6.9. Attributes

LADTAP XL© has been locked to prevent the user from making model or coding changes. Only the input may be changed.

3.2.6.10. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have a general knowledge of the models discussed in USNRC Regulatory Guide 1.109 and 1.113 (USNRC 1977a and 1977c) prior to executing the code. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) or by contacting the CTF.

3.2.7. LADTAP-PA

3.2.7.1. Function

LADTAP-PA is an EXCEL© spreadsheet used to estimate potential radiological dose to humans resulting from groundwater contamination beneath E-Area at the Savannah River Site (SRS). LADTAP-PA is a modified version of the existing LADTAP XL© software described above.

LADTAP-PA contains two worksheets: LADTAP and IRRIDOSE. The LADTAP worksheet estimates dose for environmental pathways including ingestion of water and fish and external exposure resulting from recreational activities. IRRIDOSE estimates potential dose to individuals from irrigation of food crops with contaminated groundwater.

3.2.7.2. Performance

LADTAP-PA performs calculations of doses from exposure to E-Area groundwater instantaneously through changes in the input portion of the spreadsheet.

3.2.7.3. Design Constraints

LADTAP-PA has been programmed using a Microsoft Excel© spreadsheet.

3.2.7.4. Attributes

LADTAP-PA has been locked to prevent the user from making model or coding changes. Only the input may be changed.

3.2.7.5. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have a general knowledge of the models discussed in USNRC Regulatory Guide 1.109 and

1.113 (USNRC 1977a and 1977c) prior to executing the code. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) (refer to the LADTAP XL© section), or by contacting the CTF.

3.2.8. LADTAP-PA-FTF

3.2.8.1. Function

LADTAP-PA-FTF is an EXCEL© spreadsheet used to estimate potential radiological dose to humans resulting from groundwater contamination beneath E-Area at the Savannah River Site (SRS). LADTAP-PA-FTF is a modified version of the existing LADTAP XL© and LADTAP-PA software described above.

LADTAP-PA-FTF contains two worksheets: LADTAP and IRRIDOSE. The LADTAP worksheet estimates dose for environmental pathways including ingestion of water and fish and external exposure resulting from recreational activities. IRRIDOSE estimates potential dose to individuals from irrigation of food crops with contaminated groundwater.

3.2.8.2. Performance

LADTAP-PA-FTF performs calculations of doses from exposure to E-Area groundwater instantaneously through changes in the input portion of the spreadsheet.

3.2.8.3. Design Constraints

LADTAP-PA-FTF has been programmed using a Microsoft Excel© spreadsheet.

3.2.8.4. Attributes

LADTAP-PA-FTF has been locked to prevent the user from making model or coding changes. Only the input may be changed.

3.2.8.5. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have a general knowledge of the models discussed in USNRC Regulatory Guide 1.109 and 1.113 (USNRC 1977a and 1977c) prior to executing the code. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) (refer to the LADTAP XL© section), or by contacting the CTF.

MAXDOSE-SR

3.2.8.6. Function

MAXDOSE-SR is used to estimate dose to the maximally exposed offsite individual resulting from a chronic atmospheric release and follows the methodologies discussed in USNRC Regulatory Guides 1.109 and 1.111 (USNRC 1977a and 1977b). The MAXDOSE-SR code calculates annual average air and ground deposition concentrations per unit release at the site boundary in 16 compass sectors. No credit is taken for plume rise induced by momentum or thermal effects. The average air and ground concentrations and the user-specified source term are then used to estimate radiation doses from atmospheric exposure pathways. The main outputs from the MAXDOSE-SR code are the doses to the maximally exposed individual. The maximally exposed individual is assumed to reside continuously at the location of highest potential exposure. MAXDOSE-SR allows for automatic selection of dose factors, meteorological data, terrain data, etc.

3.2.8.7. Performance

MAXDOSE-SR operates on an IBM PC utilizing a compiled FORTRAN 95 program. CPU time is negligible.

3.2.8.8. Design Constraints

Coding of software is accomplished using FORTRAN 95, executable through an IBM PC.

3.2.8.9. Attributes

MAXDOSE-SR has been compiled, linked, and is ready for execution. Only the executable is provided to the users and the CTF maintains the FORTRAN.

3.2.8.10. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have general knowledge of the models discussed in USNRC Regulatory Guides 1.109 and 1.111 (USNRC 1977a and 1977b) prior to executing the code. Use is limited to ED personnel. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) or by contacting the CTF.

3.2.9. MAXIGASP

3.2.9.1. Function

MAXIGASP is used to estimate dose to the maximally exposed offsite individual resulting from a chronic atmospheric release and follows the methodologies discussed in USNRC Regulatory Guides 1.109 and 1.111 (USNRC 1977a and 1977b). The MAXIGASP code calculates annual average air and ground deposition concentrations per unit release at the site boundary in 16 compass sectors. No credit is taken for plume rise induced by momentum or thermal effects. The average air and ground concentrations and the user-specified source term are then used to estimate radiation doses from atmospheric exposure pathways. The main outputs from the MAXIGASP code are the doses to the maximally exposed individual. The maximally exposed individual is assumed to reside continuously at the location of highest potential exposure. MAXIGASP allows for automatic selection of dose factors, meteorological data, terrain data, etc.

3.2.9.2. Performance

MAXIGASP operates on the IBM unclassified mainframe in a compiled and linked version of FORTRAN. CPU time is typically less than one minute.

3.2.9.3. Design Constraints

Coding of software is accomplished using FORTRAN 77, executable through IBM JCL.

3.2.9.4. Attributes

MAXIGASP has been compiled and link-edited, and is ready for execution on the IBM unclassified mainframe. FORTRAN and load modules are maintained in a write-protected file, accessible only by the CTF.

3.2.9.5. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have general knowledge of the models discussed in USNRC Regulatory Guides 1.109 and 1.111 (USNRC 1977a and 1977b) prior to executing the code. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) or by contacting the CTF.

3.2.10. MAXINE

3.2.10.1. Function

MAXINE is used to estimate dose to the maximally exposed offsite individual resulting from a chronic atmospheric release and follows the methodologies discussed in USNRC Regulatory Guides 1.109 and 1.111 (USNRC 1977a and 1977b). The MAXINE code determines the dose to the maximally exposed individual given relative air concentrations and deposition concentrations as input.

3.2.10.2. Performance

MAXINE performs calculations of doses instantaneously through changes in the input portion of the spreadsheet.

3.2.10.3. Design Constraints

MAXINE has been programmed using a Microsoft Excel© spreadsheet.

3.2.10.4. Attributes

MAXINE has been locked to avoid inadvertent changes by the user. Only the input may be changed.

3.2.10.5. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have general knowledge of the models discussed in USNRC Regulatory Guides 1.109 and 1.111 (USNRC 1977a and 1977b) prior to executing the code. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) (refer to the MAXDOSE-SR section), or by contacting the CTF.

3.2.11. POPDOSE-SR

3.2.11.1. Function

POPDOSE-SR is used to estimate 50-mile offsite population dose resulting from a chronic atmospheric release and follows the methodologies discussed in USNRC Regulatory Guides 1.109 and 1.111 (USNRC 1977a and 1977b). The POPDOSE-SR code calculates annual average air and ground deposition concentrations per unit release for each of 16 compass sectors within an 50-mile radius of the release location. No credit is taken for plume rise induced by momentum or thermal effects. The main output from the POPDOSE-SR code is the dose to the population residing within 50 miles of the release location.

POPDOSE-SR allows for automatic selection of dose factors, meteorological frequency distributions, agricultural data, terrain data, population distribution, etc. POPDOSE-SR predicts the dose to the 50 mile population from inhalation, ingestion, and external pathways.

3.2.11.2. Performance

POPDOSE-SR operates on an IBM PC utilizing a compiled FORTRAN 95 program. CPU time is negligible.

3.2.11.3. Design Constraints

Coding of software is accomplished using FORTRAN 95, executable through an IBM PC.

3.2.11.4. Attributes

POPDOSE-SR has been compiled, linked, and is ready for execution. Only the executable is provided to the users and the CTF maintains the FORTRAN.

3.2.11.5. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have general knowledge of the models discussed in USNRC Regulatory Guides 1.109 and 1.111 (USNRC 1977a and 1977b) prior to executing the code. Use is limited to ED personnel. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) or by contacting the CTF.

3.2.12. POPGASP

3.2.12.1. Function

POPGASP is used to estimate 50-mile offsite population dose resulting from a chronic atmospheric release and follows the methodologies discussed in USNRC Regulatory Guides 1.109 and 1.111 (USNRC 1977a and 1977b). The POPGASP code calculates annual average air and ground deposition concentrations per unit release for each of 16 compass sectors within a 50 mile radius of the release location. No credit is taken for plume rise induced by momentum or thermal effects. The main output from the POPGASP code is the dose to the population residing within 50 miles of the release location.

POPGASP allows for automatic selection of dose factors, meteorological frequency distributions, agricultural data, terrain data, population distribution, etc. POPGASP predicts the dose to the 50-mile population from inhalation, ingestion, and external pathways.

3.2.12.2. Performance

POPGASP operates on the IBM unclassified mainframe in a compiled and linked version of FORTRAN. CPU time is typically less than one minute.

3.2.12.3. Design Constraints

Coding of software is accomplished using FORTRAN 77, executable through IBM JCL.

3.2.12.4. Attributes

POPGASP has been compiled and link-edited, and is ready for execution on the IBM unclassified mainframe. FORTRAN and load modules are maintained in a write-protected file, accessible only by the CTF.

3.2.12.5. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have general knowledge of the models discussed in USNRC Regulatory Guides 1.109 and 1.111 (USNRC 1977a and 1977b). Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) or by contacting the CTF.

3.2.13. RESRAD-Biota (RAD-BCG Calculator)

3.2.13.1. Function

RESRAD-Biota (also called the RAD-BCG Calculator) estimates doses for aquatic (fish, shellfish, algae), riparian (raccoon and duck), and terrestrial (deer) biota. The doses are determined using measured radioactivity in soil, sediment, and SRS streamwater.

3.2.13.2. Performance

Execution time for RESRAD-Biota (RAD-BCG Calculator) is negligible since programming is accomplished using a spreadsheet.

3.2.13.3. Design Constraints

Coding of the software is performed and controlled by the Argonne National Laboratory and the executable file is provided free to users through the RESRAD website: (web.ead.anl.gov/resrad/home2/).

3.2.13.4. Attributes

RESRAD-Biota (RAD-BCG Calculator) has been loaded and is ready for execution on an IBM PC.

3.2.13.5. External Interfaces

The software is freeware downloadable from the Argonne National Laboratory website (web.ead.anl.gov/resrad/home2/). The user is expected to have general knowledge of dose estimates and in particular biota dose estimates.

3.2.14. RESRAD

3.2.14.1. Function

RESRAD is used to estimate the dose due to residual radioactive contamination at SRS. RESRAD is an IBM PC based computer code designed to calculate radiation doses to the maximally exposed individual. The model considers direct exposure, inhalation of dust and radon, and ingestion of plant foods, meat, milk, aquatic foods, soil, and water pathways.

Default exposure scenarios include the resident farmer, suburban resident, and industrial worker. However, other exposure scenarios can be accomplished by adjusting the applicable input parameters.

3.2.14.2. Performance

The program has been installed on and IBM PC and can estimate doses with CPU time on the order of seconds.

3.2.14.3. Design Constraints

Coding of the software is performed and controlled by the Argonne National Laboratory and the executable file is provided free to users through the RESRAD website: (web.ead.anl.gov/resrad/home2/)

3.2.14.4. Attributes

RESRAD has been loaded and is ready for execution on an IBM PC.

3.2.14.5. External Interfaces

The software is freeware downloadable from the Argonne National Laboratory website (web.ead.anl.gov/resrad/home2/). The user is expected to have general knowledge of pathway analysis and subsequent dose calculations.

3.2.15. RESRAD-Build

3.2.15.1. Function

RESRAD-Build is used to estimate the dose due to residual radioactive contamination remaining in decommissioned buildings at SRS. RESRAD-Build is an IBM PC based computer code designed to calculate radiation doses to the maximally exposed individual. The model considers direct exposure, inhalation of dust and radon, and incidental ingestion of dust.

3.2.15.2. Performance

The program has been installed on an IBM PC and can estimate doses with CPU time on the order of seconds.

3.2.15.3. Design Constraints

Coding of the software is performed and controlled by the Argonne National Laboratory and the executable file is provided free to users through the RESRAD website: (web.ead.anl.gov/resrad/home2/)

3.2.15.4. Attributes

RESRAD-Build has been loaded and is ready for execution on an IBM PC.

3.2.15.5. External Interfaces

The software is freeware downloadable from the Argonne National Laboratory website (web.ead.anl.gov/resrad/home2/). The user is expected to have general knowledge of pathway analysis and subsequent dose calculations.

3.2.16. VENTSAR

3.2.16.1. Function

The VENTSAR code was developed for estimating pollutant concentrations on or near buildings. The building may be modeled as a simple rectangular structure or a structure that contains a penthouse on the roof. The release point may be either upwind or on top of the structure. The user also has the option of allowing for plume rise from thermal buoyancy, momentum or both. Concentrations are predicted at downwind distances at user-specified increments.

3.2.16.2. Performance

VENTSAR operates on the IBM unclassified mainframe in a compiled and linked version of FORTRAN. CPU time is typically less than one minute.

3.2.16.3. Design Constraints

Coding of software is accomplished using FORTRAN 77, executable through IBM JCL.

3.2.16.4. Attributes

VENTSAR has been compiled and link-edited, and is ready for execution on the IBM unclassified mainframe. FORTRAN and load modules are maintained in a write-protected file, accessible only by the CTF.

3.2.16.5. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have general knowledge of atmospheric dispersion and building wake effects prior to executing the code. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) or by contacting the CTF.

3.2.17. VENTSAR XL©

3.2.17.1. Function

The VENTSAR XL© code was developed for estimating pollutant concentrations on or near buildings. The building may be modeled as a simple rectangular structure or a structure that contains a penthouse on the roof. The release point may be either upwind or on top of the structure. The user also has the option of allowing for plume rise from either thermal buoyancy or momentum or both. Concentrations are predicted at downwind distances at user-specified increments.

3.2.17.2. Performance

VENTSAR XL© is an Excel© Spreadsheet version of VENTSAR. An input template is accessed to obtain user information. VENTSAR XL© runs instantaneously. Results are presented in a tabular form.

3.2.17.3. Design Constraints

Coding of software is accomplished using MACROS for Microsoft Excel©.

3.2.17.4. Attributes

VENTSAR XL© has been locked to avoid changes by the user. Only the input may be changed.

3.2.17.5. External Interfaces

Use is limited to members of ED or those authorized by ED. The user is expected to have general knowledge of atmospheric dispersion and building wake effects prior to executing the code. Assistance for execution of the code can be found in the Environmental Dose Assessment Manual (Lee 2001) or by contacting the CTF.

3.3. Design Phase

All new software designed by ED will be developed, documented, reviewed, and controlled in accordance with Manual 1Q, Procedure 20-1. For all new software developed by ED, a Technical Report will be issued documenting compliance with all applicable software QA design phases outlined in Procedure 20-1. Supporting references for each of the codes previously developed by ED are listed in Appendix A.

3.4. Implementation Phase

Software test cases were developed in accordance with Manual 1Q, Procedure 20-1. Software test case inputs are shown in Appendix B for all existing software owned by ED. All computer programs developed by ED were placed under configuration control (See section 4) prior to testing. For all new software developed by ED, a Technical Report will be issued documenting the instructions for computer program use. Supporting references for each of the codes previously developed by ED are listed in Appendix A.

3.5. Test Phase

A Software Test Plan (STP) was previously developed (Simpkins 2002) in accordance with Procedure Manual E7, Procedure 5.40. This STP is applicable to the Test Phase requirements of Manual 1Q, Procedure 20-1 and is in effect for all software owned by ED (see Table 1). Appendix B contains the inputs for each of the test cases for all software owned by ED. The number of test cases varies according to the complexity of the code. The results of the test cases are maintained by the CTF either in paper or electronic form.

Testing is performed following initial design, upon change of platform, or upon any changes to the code. It is advised that test cases be executed prior to initial use. If software ever fails during the test cases, a non-conformance report will be issued and the software will not be used until the issue is resolved.

3.6. Installation and Acceptance Phase

Since all software owned by ED is existing, the installation and acceptance lifecycle activities are covered under the test activities defined above. For all new software developed by ED, a Technical Report will be issued documenting the 1) installation process, 2) the validation process, and 3) the final acceptability.

Review and analysis of all computer software owned by ED has been either performed by ED or the supplier. Appendix A shows a list of all supporting documentation for each of the codes. Lee (2001) also contains an overview on each code as well as direction to specific references.

3.7. Operations and Maintenance Phase

Any time software is installed on a different computer or when significant hardware or operating system configuration changes are made test cases will be executed to ensure the software is still operating as expected.

If any changes to the computer programs are needed, approval is required as established in the configuration management/baseline control section of this SQAP.

3.8. Retirement Phase

If any software utilized by ED is retired, support will be terminated and routine use of the software product will be prevented.

4. SOFTWARE CONFIGURATION CONTROL

Each code has an assigned version number. Version numbers will be kept up-to-date in the Software Information Database (SID). Current hard copies of the records contained within the SID will be maintained by the Software Administrator and can be referred to for current version numbers. All software used by ED is controlled such that either all users are known or access of a specific version can be prevented if desired.

The following codes are located on the IBM Mainframe: AXAIRQ, AXAOTHER, CAP88, LADTAP, MAXIGASP, POPGASP, and VENTSAR and as such only the current versions are available to the user. The coding for CAP88 PC, RESRAD, RESRAD-Biota, and RESRAD-Build are controlled by the developers and the latest versions are available free to any user. All codes developed by ED have a specified list of users who are notified when changes are made and a new version is available.

If a change is to be made to any code owned by ED, Procedure 5.62 entitled ‘Computer Program Modification Tracker’ of Procedure Manual E7 shall be followed. The appropriate forms and approvals shall be obtained per Procedure 5.62.

5. SOFTWARE PROCUREMENT

Procurement of software and software services by ED shall be done in accordance with Procedure Manual 3E, Procurement Specification Procedure Manual and placed under configuration control prior to use.

6. PROBLEM REPORTING AND CORRECTIVE ACTION

If a problem is discovered with the codes developed by SRNL the CTF is to be notified and a Nonconformance Report (NCR) – (OSR Form 28-12) initiated by the CTF as per Procedure Manual 1Q, Procedure 15-1. As soon as the NCR is initiated either the code will be pulled from use and/or all known users will be notified of a potential problem with the code. Once the problem is resolved, users will then be notified of the outcome and whether a new version of the code is available.

For codes that have been obtained, problems are to be reported to the supplier and use of the code shall be suspended until resolution of the problem occurs.

If a problem is detected with the code all past applications of the code will be evaluated and impact reported to affected organizations.

7. ACCESS CONTROL

The CTF shall ensure that access control to computer systems complies with applicable requirements specified in Procedure Manual 10Q.

8. RECORDS

The following records are retained as Quality Assurance records as per Procedure Manual 1Q, Procedure 17-1:

Software Quality Assurance Plan for Environmental Dosimetry

Software Classification Documents

Technical Reports documenting compliance with all applicable phases of the SQAP, including evidence of required reviews.

Software Test Plan, Test Cases, and Software Test Form including results

9. CONCLUSIONS

This SQAP covers all software currently owned by Environmental Dosimetry and discusses methods to ensure use of quality software. If in the future software were to be acquired or developed by ED, this SQAP would be revised, or a new SQAP would be developed specific to that software.

10. REFERENCES

Lee, P.L., *Environmental Dose Assessment Manual*, WSRC-IM-91-1, Rev 3., Savannah River Site, Aiken, SC, July 2001.

Simpkins, A.A., *A Software Identification Numbering and Classification for Environmental Dosimetry Software*, SRT-EST-2001-00244, Savannah River Site, Aiken, SC 2001a.

Simpkins, A.A. *Security Classification for Environmental Dosimetry Software*, SRT-EST-2001-00318, Savannah River Site, Aiken, SC 2001b.

Simpkins, A.A. *Software Test Plan for Environmental Dosimetry Software*, SRT-EST-2002-00051, Savannah River Site, Aiken, SC 2002.

U.S. Nuclear Regulatory Commission, *Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 20, Appendix I*, Regulatory Guide 1.109 (Rev 1.), Washington, D.C., 1977a.

U.S. Nuclear Regulatory Commission, *Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors*, Regulatory Guide 1.111, Washington, D.C., 1977b.

U.S. Nuclear Regulatory Commission, *Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I*, Regulatory Guide 1.113 (Rev. 1), Washington, D.C., 1977c.

U.S. Nuclear Regulatory Commission, *Atmospheric Dispersion Models for Potential Accidental Consequence Assessments at Nuclear Power Plants*, Regulatory Guide 1.145 (Rev. 1), Washington, D.C., November 1982.

Appendix A. Software Documentation

The following contains a list of documentation for each code used by ED. For some codes, the user's manual and verification report are separate documents and for others they are contained within one document.

<u>AXAIRQ</u>

Simpkins, A.A., *Verification of AXAIRQ*, WSRC-RP-95-708, Savannah River Site, Aiken, SC, 1995.

Simpkins, A.A., *AXAIRQ User's Manual*, WSRC-RP-95-709, Savannah River Site, Aiken, SC, 1995.

<u>AXAOTHER</u>

Huang, J.C. and Pillinger, W.L., *Dose Calculation for Incidents caused by High-Velocity Straight Winds and Tornadoes*, DPST-85-505, Savannah River Site, Aiken, SC, 1985.

<u>AXAOTHER XL</u>

Simpkins, A.A., *AXAOTHER XL – A Spreadsheet Determining Doses For Incidents Caused by Tornadoes or High-Velocity Straight Winds*, WSRC-RP-96-504, Savannah River Site, Aiken, SC, 1996.

<u>CAP88</u>

Beres, D.A., The *Clean Air Act Assessment Package – 1988 (CAP-88) A Dose and Risk Assessment Methodology for Radionuclide Emission to Air*, U.S. EPA Contract No. 68-D9-0170, U.S. Environmental Protection Agency, October 1990.

<u>CAP88 PC</u>

Beres, D.A., The *Clean Air Act Assessment Package – 1988 (CAP-88) A Dose and Risk Assessment Methodology for Radionuclide Emission to Air*, U.S. EPA Contract No. 68-D9-0170, U.S. Environmental Protection Agency, Washington, D.C., October 1990.

Shroff, B. *CAP88-Version 3.0 User Guide*, U.S. Environmental Protection Agency, Washington, D.C., March 2006.

<u>LADTAP</u>

Strenge, D.L., Peloquin, R.A. and Whelan, G. *LADTAP II – Technical Reference and User Guide*, NUREG/CR-4013, U.S. Nuclear Regulatory Commission, Washington, D.C., April 1986.

<u>LADTAP XL©</u>

Simpkins, A.A., *LADTAP XL© A Spreadsheet for Estimating Dose Resulting from Aqueous Releases,* WSRC-TR-2004-00059, Savannah River Site, Aiken, SC, 2004.

Hamby, D.M., *LADTAP XL: An Improved Electronic Spreadsheet Version of LADTAP II*, WSRC-RP-91-975, Savannah River Site, Aiken, SC, 1991.

<u>LADTAP-PA</u>

Jannik, G.T. and Dixon, K.D., *LADTAP-PA A Spreadsheet for Estimating Dose Resulting from E-Area Groundwater Contamination at SRS,* WSRC-STI-2006-00123, Savannah River Site, Aiken, SC, 2006.

<u>LADTAP-PA-FTF</u>

Jannik, G.T. and Dixon, K.D., *LADTAP-PA A Spreadsheet for Estimating Dose Resulting from F-Area Tank Farm Groundwater Contamination at SRS,* WSRC-STI-2007-00291, Savannah River Site, Aiken, SC, 2007.

<u>MAXDOSE-SR</u>

Simpkins, A.A., *MAXDOSE-SR: A Routine-Release Atmospheric Dose Model Used at SRS*, WSRC-RP-94-1159, Savannah River Site, Aiken, SC, 1999.

<u>MAXIGASP</u>

Bauer, L.R., *Modeling Chronic Atmospheric Releases at SRS: Evaluation and Verification of XOQDOQ*, WSRC-RP-91-320, Savannah River Site, Aiken, SC, 1991.

Hamby, D.M., *Verification of the GASPAR Dose Assessment Module used in MAXIGASP and POPGASP*, WSRC-RP-92-418, Savannah River Site, Aiken SC, 1992.

<u>MAXINE</u>

Hamby, D.M., MAXINE*: An Improved Methodology for Estimating Maximum Individual Dose from Chronic Atmospheric Radioactive Releases,* WSRC-TR-94-053, Savannah River Site, Aiken, SC 1994.

Simpkins, A.A., *MAXINE: A Spreadsheet for Estimating Dose from Chronic Atmospheric Radioactive Releases*, WSRC-TR-2002-00360, Savannah River Site, Aiken, SC, 2002.

<u>POPDOSE-SR</u>

Simpkins, A.A., *POPDOSE-SR: A Routine-Release Atmospheric Population Dose Model Used at SRS*, WSRC-RP-94-1159, Savannah River Site, Aiken, SC, 2000.

POPGASP

Bauer, L.R., *Modeling Chronic Atmospheric Releases at SRS: Evaluation and Verification of XOQDOQ*, WSRC-RP-91-320, SRS, Aiken, SC, 1991.

Hamby, D.M., *Verification of the GASPAR Dose Assessment Module used in MAXIGASP and POPGASP*, WSRC-RP-92-418, Savannah River Site, Aiken SC, 1992.

RESRAD-Biota (RAD-BCG Calculator)

U.S. DOE 2000, *A Graded Approach to Evaluating Radiation Doses to Aquatic and Terrestrial Biota,* DOE Technical Standard ENVR-0011, U.S. Department of Energy, Washington, D.C., 2000.

U.S. DOE 2004, *RESRAD-BIOTA: A Tool for Implementing a Graded Approach to Biota Dose Evaluations,* Interagency Steering Committee on Radiation Standards Report 2004-02, DOE/EH-0676, U.S. Dept. of Energy, Washington, D.C., 2004.

RESRAD

Yu, C. et al. *User's Manual for RESRAD Version 6*, ANL/EAD-4, Argonne National Laboratory, Argonne, IL, July, 2001.

Yu, C. et al. *RESRAD Benchmarking Against Six Radiation Exposure Pathway Models,* ANL/EAD/TM-24, Argonne National Laboratory, Argonne, IL, October, 1994.

RESRAD-BUILD

Yu, C. et al. *Users Manual for RESRAD-BUILD Version 3*, ANL/EAD/03-1, Argonne National Laboratory, Argonne, IL, 2003.

Kamboj, S., et al. *RESRAD-BUILD Verification*, ANL/EAD/TM-115, Argonne National Laboratory, Argonne, IL, October, 2001.

Yu, C. et al. *Verification of RESRAD-BUILD Computer Code Version 3.1*, Contract No. 1F-00741, Argonne National Laboratory, Argonne, IL, March, 2003.

VENTSAR

Smith, F.G. and Weber, A.H., A *Computer Code for the Estimation of Pollutant Concentrations on or Near Buildings*, National Technical Information Service, DP-1668, Springfield, VA, 1983.

VENTSAR XL

Simpkins, A.A., *VENTSAR XL – A Spreadsheet for Analyzing Building Effects and Plume Rise*, WSRC-RP-97-37, Savannah River Site, Aiken, SC, 1997.

Appendix B. Software Test Cases

AXAIRQ Test Cases
Located in ‘TENVT.DATA.TMECA(AXTE95#)

Parameter	1	2	3	4	5	6	7	8
Release Location	F	CENTER	A	P	L	D	C	K
Release Type	STACK	VENT	STACK	VENT	STACK	VENT	STACK	VENT
Vertical X-Section	-	0	-	0	-	2000	-	0
Stack Height (m)	0	-	30	-	61	-	10	-
Grade Elevation	BLANK	500	BLANK	BLANK	BLANK	300	BLANK	BLANK
Sector Analysis	WNW	ALL	ALL	WSW	NE	ALL	ALL	W
Met Database	NEW	OLD	NEW	NEW	NEW	NEW	NEW	NEW
Calendar Year	1980	2020	1995	1995	1990	2000	2000	2050
Gamma Shine Model	1	0	1	2	0	2	0	0
Daughter Ingrowth	YES	YES	NO	YES	YES	YES	YES	NO
50% or 95% met	50%	NO	95%	50%	50%	95%	NO	NO
Deposition	NO	NO	YES	YES	NO	NO	YES	YES
PB(1) or PG(2)	PG	PG	PB	PG	PG	PB	PB	PG
Mixing Height (m)	200	200	200	500	200	1000	1000	1000
ICRP Dose Factors	2	30	30	30	30	30	30	30
Number of Distances	0	1	0	0	1	0	0	1
Printout Type	NORM	SUMM	SUMM	NORM	BOTH	NORM	SUMM	BOTH
Release Time (hr)	30	8760	2	2	2	8760	2	30
Distance (miles)	-	10	-	-	0.06	-	-	0.4
Nuclide, Activity(Ci)	H-3,1 U-238,1	H-3,1 U-238,1	I-129,2 Pu-238,4	H-3,1 Ar-41,3	H-3,1 Ar-41,3	I-135,2 Cs-137,4	H-3,25000 Co-60,2	H-3, 1000 Xe-135, 2

AXAOTHER and AXAOTHER XL Test Cases

Parameter	1	2	3	4
Average Wind Speed (m/s)	30	50	20	40
Individual Dose (Y//N)	Y	Y	Y	Y
Distance (m)	15,000	10,000	13,000	5,000
/q (s/m^3)	5E-06	1E-8	5E-7	7E-8
Population Dose	Y	Y	Y	Y
Onsite or offsite	Offsite	Onsite	Offsite	Onsite
% Adults	50	100	75	100
% Teens	40	0	15	0
% Children	10	0	10	0
/Q, People				
0.5 miles	1E-6,10	1E-5,100	1E-6,10	1E-5,100
1.5 miles	5E-7,20	8E-6,50	9E-7,20	8E-6,50
2.5 miles	2.5E-7,30	6E-6,25	8E-7,30	6E-6,25
3.5 miles	1.3E-7,40	4E-6,10	7E-7,40	4E-6,10
4.5 miles	6.5E-8,50	2E-6,10	6E-7,50	2E-6,10
7.5 miles	3.2E-8,60	1E-6,2	5E-7,60	1E-6,2
15.0 miles	1.6E-8,70		4E-7,70	
25.0 miles	1.1E-8,80		3E-7,80	
35.0 miles	9.0E-9,90		2E-7,90	
45 miles	8.0E-9,100		1E-7,100	
Nuclide, Activity (Ci)	H-3, 5E+4 Ar-41, 5E+2 C-14, 5E+1 I-129, 5E-1	H-3, 5E+4 Ar-41, 5E+2 C-14, 5E+1 I-129, 5E-1	H-3, 5E+4 Ar-41, 5E+2 C-14, 5E+1 I-129, 5E-1	H-3, 5E+4 Ar-41, 5E+2 C-14, 5E+1 I-129, 5E-1

CAP88 Test Cases
Located in 'TENVT.DATA.CAP88(CAPTEST#)

Parameter	1	2	3	4	5	6	7
Receptor	Individual	Individual	Population	Population	Population	Individual	Individual
Sector Analyzed	WSW(6)	N(1)	-	-	-	NE(15)	ENE(14)
Receptor Distance(m)	10000	100	-	-	-		
No. of Stacks **	2	1	2	2	1	1	1
Stack Heights (m)	0,50	5	5,50	50,100	100	0	50
Met Data	P	F	H	C	D	K	A
Nuclide, Activity (Ci)	H-3,0.5 Cs-137,0.5*	H-3,1.0 Cs-137, 1.0*	H-3,0.5 Cs-137,0.5*	H-3,0.5 Cs-137,0.5*	H-3,1.0 Cs-137, 1.0*	H-3,1.0 Cs-137, 1.0*	H-3,1.0 Cs-137, 1.0*

* Includes progeny (Ba-137m)
** Same activity released for both stacks

CAP88 PC Test Cases

Parameter	1	2	3	4	5	6	7
Receptor	Individual	Individual	Population	Population	Population	Individual	Individual
Sector Analyzed	WSW(6)	N(1)	-	-	-	NE(15)	ENE(14)
Receptor Distance(m)	10000	100	-	-	-		
No. of Stacks **	2	1	2	2	1	1	1
Stack Heights (m)	0,50	5	5,50	50,100	100	0	50
Met Data	P	F	H	C	D	K	A
Nuclide, Activity (Ci)	H-3,0.5 Cs-137,0.5*	H-3,1.0 Cs-137, 1.0*	H-3,0.5 Cs-137,0.5*	H-3,0.5 Cs-137,0.5*	H-3,1.0 Cs-137, 1.0*	H-3,1.0 Cs-137, 1.0*	H-3,1.0 Cs-137, 1.0*

* Includes progeny (Ba-137m)
** Same activity released for both stacks

LADTAP Test Cases

Case #	1	2	3	4	5
Receptor	Max. Ind. Avg Flow	Max. Ind. At B-J	Population at PW	Biota Dose - FMC	Max. Ind. Low Flow
CFS	10,000	4,000	25,000	3	4,000
Treatment Plant Population	N/A	97,000	11,000	N/A	N/A
Source Term	Curies	Curies	Curies	Curies	Curies
H-3	10,000	1	10,000	5,000	10,000
Sr-90	1	0.1	1	0.1	1
I-129	1	0.1	1	0.1	0
Co-60	1	0	0	0	0
Cs-134	0	0.1	1	0	0
Cs-137	1	0.1	1	0.1	1
U-234	1	0.1	1	0.1	0
U-235	1	0.1	1	0.1	1
U-238	1	0.1	1	0.1	0
Pu-238	1	0.1	1	0.1	0
Pu-239	1	0.1	1	0.1	1
Am-241	1	0.1	1	0	0
Cm-244	1	0.1	1	0	0
Adult Consumption and Usage Parameters					
ST Multiplier	1				
50-mile Population	620100				
Fish Consumption Max Ind (kg/yr)	19				
Fish Consumption Population (kg/yr)	9				
Fish Bioaccumulation for Cs-137	3000				
Invertebrate Consumption Max (kg/yr)	N/A				
Invertebrate Consumption Pop (kg/yr)	2				

LADTAP Test Cases Continued

Aquatic Plant Consumption (kg/yr)	0				
Drink Water Consumption Max (kg/yr)	760				
Drink Water Consumption Pop (kg/yr)	370				
Shoreline Usage Max Ind (hr/yr)	23				
Shoreline Usage Population (hr/yr)	960,000				
Swimming Max Ind (hr/yr)	8.9				
Swimming Population (person-hr/yr)	160,000				
Boating (hr/yr)	21				
Boating Population (person-hr/yr)	1,100,000				
Dilution Factor for Estuary	3				
Shore Width Factor	0.2				
Transit Time for Max Ind (hr)	24				
Transit Time for Treatment Plants (hr)	72				
Irrigation parameters					
Veg. Irrigation Rate (L/m^2/month)	102				
Harvest Amount (kg)	1.73E+07				
Veg. Adult max Consumption (kg/yr)	276				
Veg. Adult Ave Consumption (kg/yr)	163				
Food Process Time - Max. Ind (hr)	336				
Food Process Time - Pop (hr)	1440				
Dilution rate for irrigation	1				
Harvest (kg/yr)	1.70E+07				
Transit Time (hr)	24				

LADTAP XL© Test Cases – LADTAP Worksheet Input

Parameter	Case 1	Case 2	Case 3	Case 4	Case 5
Measured River Flow Rate (Hwy 301):	10000	4000	20000	12000	4000
Flow Rate at Beaufort-Jasper:	10000	5600	25000	14000	4000
Flow Rate at Port Wentworth:	10000	5040	28000	16000	4000
Flow Rate at the Estuary:	10000	7000	30000	16000	4000
Annual Max. Ind. Shoreline Usage:	23	23	23	23	23
Annual Max. Ind. Swimming Usage:	8.9	8.9	8.9	8.9	8.9
Annual Max. Ind. Boating Usage:	21	21	21	21	21
Ind. Fish Usage (Avg, Max,value):	max	avg	none	max	max
Ind. Water Usage (Avg, Max, value):	avg	avg	max	max	max
Recreation Transport Time (MEI):	1	1	1	1	1
Water Transport Time (MEI):	1.5	1.5	1.5	1.5	1.5
Fish/Invertebrate Transport Time (MEI):	2	2	2	2	2
Beaufort-Jasper Population:	75000	75000	75000	75000	75000
Port Wentworth Population:	10000	10000	10000	10000	10000
50-Mile Population:	620000	620000	620000	620000	620000
BJ/PW Travel Time:	4	4	4	4	4
Pop. Water Usage (Avg, Max, value):	avg	max	avg	max	avg
Pop. Fish Usage (Avg, Max, value):	avg	max	0	avg	avg
Pop. Invert Usage (Avg, Max, value):	avg	max	0	avg	avg
Total 50-Mile Fish Consumption:	0	0	0	0	0
Total 50-Mile Invertebrate Consumption:	0	0	0	0	0
Annual Sport Fish Harvest (edible):	35000	35000	35000	35000	35000
Annual Commercial Fish Harvest (edible):	2700	2700	2700	2700	2700
Annual Invertebrate Harvest (edible):	390000	390000	390000	390000	390000
Sport Fish Transport Time:	10	10	10	10	10
Commercial/Invertebrate Transport Time:	13	13	13	13	13
Estuary Dilution Factor:	3	3	3	3	3
Population Shoreline Usage:	960000	960000	960000	960000	960000
Population Swimming Usage:	160000	160000	160000	160000	160000
Population Boating Usage:	1100000	1100000	1100000	1100000	1100000
Source Term:	1 Ci for each rad	1 Ci for each rad	1 Ci for each rad	Alternating 1 Ci, 0 Ci	Alternating 0 Ci, 1 Ci

LADTAP XL© Test Cases – IRRIDOSE Worksheet Input

Parameter	Case 1	Case 2	Case 3	Case 4	Case 5
Exposed population:	1000	1000	1000	1000	1000
Irrigated land area:	1000	1000	1000	1000	1000
Pop dose determined by:	area	area	area	pop	pop
Savannah River flow rate:	10000	4000	20000	12000	4000
River transit time:	1	1	1	1	1
Irrigation rate:	3.4	4.4	5.4	6	7
Weathering removal constant:	0.0495	0.0495	0.0495	0.0495	0.0495
Crop exposure time:	30	30	30	30	30
Grass exposure time:	30	30	30	30	30
Buildup time in soil:	5475	5475	5475	5475	5475
Vegetable crop yield:	2	2	2	2	2
Pasture grass yield:	2	2	2	2	2
Surface density of soil:	240	240	240	240	240
Pasture grass hold-up time:	0	0	0	0	0
Veg transport time (individual):	14	1	14	1	14
Veg transport time (population):	14	1	14	1	14
Milk transport time:	3	1	3	1	3
Meat transport time:	6	1	6	1	6
Fraction of fodder from irrigated field:	1.00	1.00	1.00	1.00	1.00
Cattle consumption rate of fodder:	50	50	50	50	50
	50	50	50	50	50
Fraction of water from Savannah River:	1.00	1.00	1.00	1.00	1.00
Cattle consumption rate of water:	50	50	50	50	50
	60	60	60	60	60
Individual consumption rates:	276	200	276	10	276
	43	20	43	10	43
	81	50	81	10	81
	230	200	230	10	230
Population consumption rates:	163	10	163	10	163
	21	10	21	10	21

	43	10	43	10	43

LADTAP XL© Test Cases – IRRIDOSE Worksheet Input Cont.

Parameter	Case 1	Case 2	Case 3	Case 4	Case 5
	120	10	120	10	120
Total Production:	1.73E+07	2.00E+07	1.73E+07	1.73E+07	1.00E+03
	1.11E+06	2.00E+06	1.11E+06	1.11E+06	1.00E+03
	4.34E+06	5.00E+06	4.34E+06	4.34E+06	1.00E+03
	3.13E+07	4.00E+08	3.13E+07	3.13E+07	1.00E+03
Fractional retention on leaves:	0.25	0.25	0.25	0.25	0.25

LADTAP-PA Test Cases – LADTAP Worksheet Input

Parameter	Case 1	Case 2	Case 3	Case 4	Case 5
Annual Max. Ind. Shoreline Usage (h/y):	23	23	23	23	23
Annual Max. Ind. Swimming Usage (h/y):	8.9	8.9	8.9	8.9	8.9
Annual Max. Ind. Boating Usage (h/y):	21	21	21	21	21
Ind. Fish Usage (Avg, Max) (kg/y):	max	avg	none	max	max
Ind. Water Usage (Avg, Max) (kg/y):	avg	avg	max	max	max
Recreation Transport Time (MEI) (d):	1	1	1	0	0
Water Transport Time (MEI) (d):	1.5	1.5	1.5	0	0
Fish Transport Time (MEI) (d):	2	2	2	0	0
Source Term:	1.12E-10 uCi/mL each rad	2.80E-10 uCi/mL each rad	5.60E-11 uCi/mL each rad	Alternating 9.33E-11, 0 uCi/mL	Alternating 0, 2.80E-10 uCi/mL

LADTAP-PA Test Cases – IRRIDOSE Worksheet Input

Parameter	Case 1	Case 2	Case 3	Case 4	Case 5
Water transit time (d):	1	1	1	0	0
Irrigation rate ($L/m^2/d$):	3.4	4.4	5.4	6	7
Weathering removal constant (1/d):	0.0495	0.0495	0.0495	0.0495	0.0495
Crop exposure time (d):	30	30	30	30	30
Grass exposure time (d):	30	30	30	30	30
Buildup time in soil (d):	5475	5475	5475	5475	5475
Vegetable crop yield (kg/m^2):	2	2	2	2	2
Pasture grass yield (kg/m^2)::	2	2	2	2	2
Surface density of soil (kg/m^2)::	240	240	240	240	240
Pasture grass hold-up time (d):	0	0	0	0	0
Veg transport time (individual) (d):	14	1	14	1	14
Milk transport time (d):	3	1	3	1	3
Meat transport time (d):	6	1	6	1	6
Fraction of fodder from irrigation:	1.00	1.00	1.00	1.00	1.00
Cattle fodder consumption rate:					
Meat (kg/d):	50	50	50	50	50
Milk (kg/d)	50	50	50	50	50
Fraction of water from groundwater:	1.00	1.00	1.00	1.00	1.00
Cattle consumption rate of water:					
Meat (L/d):	50	50	50	50	50
Milk (L/d)	60	60	60	60	60
Individual consumption rates:					
Grain (kg/y):	276	200	276	10	276
Leafy vegetables (kg/y):	43	20	43	10	43
Meat (kg/y):	81	50	81	10	81
Milk (L/y)	230	200	230	10	230
Fractional retention on leaves:	0.25	0.25	0.25	0.25	0.25
Source Term:	Same as LADTAP	Same as LADTAP	Same as LADTAP	Same as LADTAP	Same as LADTAP

LADTAP-PA-FTF Test Cases – LADTAP Worksheet Input

Parameter	Case 1	Case 2	Case 3	Case 4	Case 5
Annual Max. Ind. Shoreline Usage (h/y):	23	23	23	23	23
Annual Max. Ind. Swimming Usage (h/y):	8.9	8.9	8.9	8.9	8.9
Annual Max. Ind. Boating Usage (h/y):	21	21	21	21	21
Ind. Fish Usage (Avg=9, Max=19) (kg/y):	max	avg	none	max	max
Ind. Water Usage (Avg=337, Max=730) (kg/y):	avg	avg	ave	max	max
Recreation Transport Time (MEI) (d):	1	1	1	0	0
Water Transport Time (MEI) (d):	1.5	1.5	1.5	0	0
Fish Transport Time (MEI) (d):	2	2	2	0	0
Source Term:	1.12E-10 uCi/mL each rad	2.80E-10 uCi/mL each rad	5.60E-11 uCi/mL each rad	Alternating 9.33E-11, 0 uCi/mL	Alternating 0, 2.80E-10 uCi/mL

LADTAP-PA-FTF Test Cases – IRRIDOSE Worksheet input

Parameter	Case 1	Case 2	Case 3	Case 4	Case 5
Water transit time (d):	1	1	1	0	0
Irrigation rate (L/m2/d):	3.4	4.4	5.4	6	7
Weathering removal constant (1/d):	0.0495	0.0495	0.0495	0.0495	0.0495
Crop exposure time (d):	30	30	30	30	30
Grass exposure time (d):	30	30	30	30	30
Buildup time in soil (d):	5475	5475	5475	5475	5475
Vegetable crop yield (kg/m2):	2	2	2	2	2
Pasture grass yield (kg/m2):	2	2	2	2	2
Surface density of soil (kg/m2):	240	240	240	240	240
Pasture grass hold-up time (d):	0	0	0	0	0
Veg transport time (individual) (d):	14	1	14	1	14
Milk transport time (d):	3	1	3	1	3
Meat transport time (d):	6	1	6	1	6
Fraction of fodder from irrigation:	1	1	1	1	1
Fraction of fodder for meat from irrigated field:	0.56	0.56	0.56	0.56	0.56
Fraction of fodder for milk from irrigated field:	0.75	0.75	0.75	0.75	0.75
Cattle fodder consumption rate:					
Meat (kg/d):	50	50	50	50	50
Milk (kg/d)	50	50	50	50	50
Fraction of water from groundwater:	1	1	1	1	1
Cattle consumption rate of water:					
Meat (L/d):	50	50	50	50	50
Milk (L/d)	60	60	60	60	60
Individual consumption rates:					
Grain (kg/y):	276	200	276	10	276
Leafy vegetables (kg/y):	43	20	43	10	43
Meat (kg/y):	81	50	81	10	81
Milk (L/y)	230	200	230	10	230

LADTAP-PA-FTF Test Cases – IRRIDOSE Worksheet input Cont.

Parameter	Case 1	Case 2	Case 3	Case 4	Case 5
Fraction vegetable from garde	0.173	0.173	0.173	0.173	0.173
Leaf	0.173	0.173	0.173	0.173	0.173
Meat	0.306	0.306	0.306	0.306	0.306
Milk	0.207	0.207	0.207	0.207	0.207
Fractional retention on leaves:	0.25	0.25	0.25	0.25	0.25
Source Term:	Same as LADTAP	Same as LADTAP	Same as LADTAP	Same as LADTAP	Same as LADTAP

MAXIGASP and MAXDOSE-SR Test Cases

Parameter	1	2	3	4	5	6	7	8	9	10**
No. Release Pts.	1	1	1	1	2*	2*	2*	2*	1	1
Operating Period (yrs)	200	200	50	1	1	100	100	50	201	201
Consumption Rates	MAX	AVG	AVG	MAX	AVG	MAX	AVG	MAX	MAX	MAX
Mild Type	COW	COW	GOAT	GOAT	GOAT	COW	COW	GOAT	COW	COW
Grade Elevation(ft)	300	1000	300	300	0	1000	0	0	0	0
Met Database	D	C	K	H	A	P	H	F	H	H
Release Coordinate(E)	20330	46200	41000	58000	51860	64800	63380	53970	58000	58000
Release Coordinate(N)	65080	67600	53500	62000	106670	43800	71900	78020	62000	62000
Ground Level or Elevated	Ground	Elevated	Ground	Ground	Elevated	Elevated	Elevated	Ground	Ground	Ground
Vent Air Velocity (m/s)	0	20	0	0	0	0	5	0	0	0
Vent Inside Diameter (m)	0	10	0	0	0	0	10	0	0	0
Release Height (m)	0	-5	0	0	-5	-50	-100	0	0	0
Building Height (m)	100	0	0	100	0	25	50	0	0	0
Vertical X-Section (sq. m)	0	500	0	500	500	250	0	500	0	0
Selected Wind Ht. (m)	10	5	10	10	5	50	10	10	10	10
Heat Emission Rate (cal/s)	100	100	0	0	0	100	100	0	0	0
Elemental Iodine	0	1	0.5	1	0.5	0	0.5	1	1	1
Source Nuclide - Ci Activity (Ci)	H-3, 1 Ar-41, 1 I-133, 1 Cs-137, 1 U-238, 1	H-3, 1 Ar-41, 1 I-133, 1 Cs-137, 1 U-238, 1	H-3, 1 Ar-41, 1 I-133, 1 Cs-137, 1 U-238, 1	H-3, 1 Ar-41, 1 I-133, 1 Cs-137, 1 U-238, 1	H-3, 1 Ar-41, 1 I-133, 1 Cs-137, 1 U-238, 1	H-3, 1 Ar-41, 1 I-133, 1 Cs-137, 1 U-238, 1	H-3, 1 Ar-41, 1 I-133, 1 Cs-137, 1 U-238, 1	H-3, 1 Ar-41, 1 I-133, 1 Cs-137, 1 U-238, 1	H-3, 1 Ar-41, 2 I-133, 3 Cs-137, 4 U-238, 5	H-3, 1 Ar-41, 2 Pd-107,3 I-133, 4 Cs-137, 5 U-238, 6

*Second release point is located at center of site with same vent characteristics as listed for each case
** Case is designed to fail to check code changes

MAXINE Test Cases

Input Parameter	1	2	3	4	5	6	7	8
Relative Concentration (X/Q):	2.7E-08	3.35E-08	2.7E-08	3.35E-08	2.7E-08	3.35E-08	2.7E-08	3.35E-08
Decayed X/Q:	2.7E-08	3.19E-08	2.7E-08	3.19E-08	2.7E-08	3.19E-08	2.7E-08	3.19E-08
Depleted X/Q:	2.5E-08	2.19E-08	2.5E-08	2.19E-08	2.5E-08	2.19E-08	2.5E-08	2.19E-08
Relative Deposition (D/Q):	2.0E-10	6.78E-11	2.0E-10	6.78E-11	2.0E-10	6.78E-11	2.0E-10	6.78E-11
Distance to Receptor:	7752	7000	8000	9000	8000	7000	6000	2000
Vegetable Consumption (AVG, MAX, value):	Max	Avg	Max	Avg	Max	Avg	Max	Avg
Leafy Veg Consumption (AVG, MAX, value):	Max	Avg	Avg	Max	Max	Avg	Max	Avg
Milk Consumption (AVG, MAX, value):	Max	Avg	Max	Avg	Max	Avg	Avg	Max
Meat Consumption (AVG, MAX, value):	Max	Avg	Avg	Max	Max	Avg	Max	Avg
Origin of Milk (Cow or Goat):	Goat	Cow	Goat	Cow	Goat	Cow	Goat	Cow
Deposition Buildup Time:	38	5	10	15	20	25	30	40
Breathing Rate:	8,000	10000	9000	8000	8000	8000	8000	8000
Elemental Iodine Fraction:	1.00	0	1	1	0	0.5	0.5	0.5
Absolute Humidity:	0.01125	0.01125	0.01125	0.00800	0.00800	0.00800	0.01125	0.01125
Tritium Plant-to-Air Ratio:	0.54	0.54	1.00	0.54	0.54	0.50	0.54	0.54
Shielding Factor:	0.70	1	0.70	0.70	0.70	1.00	0.70	0.70
Fraction of Year C-14 Released:	1.00	0.5	1	0.5	0.5	1	1	1
Retained Fraction (iodines):	1.00	1	1	0.5	0.5	0.5	1	0.8
Retained Fraction (particulates):	0.20	0.4	0.6	0.8	1	0.2	0.2	0.2
Weathering Rate Constant:	18.1	17	18.1	18.1	18.1	18.1	18.1	18.1
Crop Exposure Time:	0.192	0.1	0.192	0.192	0.1	0.192	0.192	0.1
Pasture Grass Exposure Time:	0.0822	0.04	0.0822	0.0822	0.0822	0.0822	0.0822	0.04
Pasture Grass Productivity:	1.8	1.8	1.8	1.8	1.8	2	2	2
Produce Productivity:	0.7	1	0.3	1	0.3	1	0.3	0.3
Surface Soil Density (15 cm):	240	250	240	250	240	240	240	240
Pasture Grass Holdup Time:	0.00000	0.001	0.002	0	0	0	0	0.00247
Stored Feed Holdup Time:	0.24700	0.1	0.24700	0.1	0.24700	0.1	0	0.1
Leafy Vegetable Holdup Time:	0.00274	0.00274	0.00274	0.001	0.00000	0.00274	0.00274	0.001

MAXINE Test Cases continued.

Input Parameter	1	2	3	4	5	6	7	8
Produce Holdup Time:	0.16400	0.1	0.164	0	0.1	0.1	0.08	0.164
Goat Feed Consumption (6):	6	1	2	3	4	5	6	7
Beef Cattle Feed Consumption:	36	36	36	36	36	40	5	2
Feed-Milk-Man Transport Time:	0.00822	0.004	0.00822	0.00822	0.004	0.004	0.00822	0.004
Fraction of Year on Pasture (beef):	1.00	1	1	0.5	1	0.2	1	1
Fraction of Year on Pasture (milk):	0.79	1	1	1	1	0.79	0.3	0.2
Fraction Intake from Pasture (beef):	0.75	0.2	0.2	0.75	0.75	0.75	0.75	0.75
Fraction Intake from Pasture (milk):	0.85	1	1	1	1	0.7	0.7	0.2
Slaughter to Consumption Time:	0.0164	0.0164	0.0164	0.0164	0.0164	0.0164	0.008	0.008
Fraction of Produce from Garden:	0.76	1	1	1	1	1	0.5	0.3
Fraction of Leafy Vegs from Garden:	1.00	0.25	0.1	0.5	1	1	0.25	1
Source Term	1Ci Each H-3 Cs-137 Pu-239	1Ci Each H-3 Cs-137 Pu-239	1Ci Each H-3 Cs-137 Pu-239	1Ci Each H-3 Cs-137 Pu-239	1Ci Each H-3 Cs-137 Pu-239	1Ci Each H-3 Cs-137 Pu-239	1Ci Each H-3 Cs-137 Pu-239	1Ci Each All Rads

POPGASP and POPDOSE-SR Test Cases

	1	2	3	4	5	6	7	8
Operating Period (yr)	1	50	100	201	50	201	1	100
Grade Elevation (ft)	300	0	0	1000	300	0	1000	0
Meteorological Databases	F	C	H	P	H	K	A	D
Release Coordinate (E)	53970	46200	63380	64800	58000	41000	51860	20330
Release Coordinate (N)	78020	67600	71900	43800	62000	53500	106670	65080
Ground-level or Elevated	Elevated	Ground	Ground	Ground	Elevated	Elevated	Elevated	Ground
Vent Air Velocity (m/s)	20	0	0	0	0	5	0	0
Vent Inside Diameter (m)	10	0	0	0	0	10	0	0
Release Height (m)	-5	0	0	0	-5	-100	-50	0
Building Height (m)	0	100	100	0	0	50	25	0
Vertical X-Section (m^2)	500	0	500	0	500	0	250	500
Selected Wind Height (m)	5	10	10	10	5	10	50	10
Heat Emission Rate (cal/s)	100	100	0	0	0	100	100	0
Elemental Iodines	0.5	1	0	1	0.5	0	0.5	1
Source Nuclides Activity (Ci, each)	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci Cs-137, 1 Ci U-238, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci Cs-137, 1 Ci U-238, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci Cs-137, 1 Ci U-238, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci Cs-137, 1 Ci U-238, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci Cs-137, 1 Ci U-238, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci Cs-137, 1 Ci U-238, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci Cs-137, 1 Ci U-238, 1 Ci	H-3, 1 Ci Ar-41, 1 Ci I-133, 1 Ci Cs-137, 1 Ci U-238, 1 Ci

RESRAD Test Cases

Parameter	Case 1	Case 2	Case 3
Exposure Scenario:	Resident Farmer	Suburban Resident	Industrial Worker
	Default	Default	Default
Source Term:	100 pCi/g for: tritium cesium-137 strontium-90 uranium-235	100 pCi/g for: tritium cesium-137 strontium-90 uranium-235	100 pCi/g for: tritium cesium-137 strontium-90 uranium-235

RESRAD-Biota Test Cases

Parameter	Case 1	Case 2
Exposure Scenario:	Terrestrial Animal Default	Aquatic Animal Default
Source Term:	1.0 pCi/g in soil and water for: tritium cesium-137 strontium-90 uranium-235	1.0 pCi/g in soil and water for: tritium cesium-137 strontium-90 uranium-235

RESRAD-BUILD Test Cases

Parameter	Case 1	Case 2	Case 3
Exposure Scenario:	Default Test Case with no Shielding	Default Test Case with 10 cm of Shielding	Default Test Case with no Shielding
Source Term:	1 pCi/g (volume) of cobalt-60	1 pCi/g (volume) of cobalt-60	1 pCi/g (volume) of tritium

VENTSAR and VENTSAR XL Test Cases Cont.

Parameter*	1	2	3	4	5	6	7	8
Consider Plume Rise	YES	YES	NO	YES	NO	NO	YES	NO
Area of Release	P	D	H	C	A	K	F	OTHER#
Building Height (m)	10	0	5	20	15	8	10	12
Building Width (m)	20	0	30	100	200	200	10	30
Building Length (m)	30	0	100	30	200	10	10	15
Penthouse Height (m)	1	0	3	6	7	3	5	6
Penthouse Width (m)	2	0	5	10	200	150	5	20
Penthouse Length (m)	3	0	5	10	100	8	5	10
Bldg. to Penthouse (m)	5	0	20	0	100	2	0	1
Min. Vent to Receptor (m)	10	10	10	10	10	10	10	10
Max. Vent to Receptor (m)	1000	1000	1000	1000	1000	1000	1000	1000
Compass Sector	NNW	S	N	NE	WNW	SSE	ENE	E
Vent to Roof Edge (m)	-500	0	-100	10	-10	500	100	-30
Vent Height (m)	50	25	5	0	100	50	5	0
Radioactive Release?	NO	NO	YES	NO	YES	YES	NO	YES
Release Rate (Ci/min)	-	-	1	-	1	1	-	1
Pollutant Mole Fraction	0.000001	0.000001	-	0.000001	-	-	0.000001	-
Vent-Gas Flow Rate (m^3/s)	500	750	1000	100	500	750	1000	100
Met. Averaging?	YES	YES	NO	NO	NO	YES	YES	NO
Probability Level	0.005	0.005	-	-	-	0.005	0.005	-
Wind Speed (m/s)	-	-	2	1	4	-	-	3
Stability Class	-	-	D	F	B	-	-	A
Vent Diameter (m)	3	2	3	1	3	2	2	1
Vent-Gas Molecular Weight	210	200	200	190	200	180	230	220
Vent-Gas Temp(C)	20	17	17	18	17	17	19	14
Ambient Air Temp(C)	15	17	17	12	17	17	16	13
Calculate Dose	N	N	Y	N	N	Y	N	N
Breathing Rate (m^3/yr)			12000			12000		

VENTSAR and VENTSAR XL Test Cases Cont.

Parameter*	1	2	3	4	5	6	7	8
Radionuclide, Source Term	H-3, 3 Ci Cs-137, 2Ci Ba-137m,2Ci	H-3, 3 Ci Cs-137, 2Ci Ba-137m,2Ci	H-3, 3 Ci Cs-137, 2Ci Ba-137m,2Ci	H-3, 3 Ci Cs-137, 2Ci Ba-137m,2Ci	H-3, 3 Ci Zr-95, 5 Ci Nb-95m, 5 Ci	H-3, 3 Ci Zr-95, 5 Ci Nb-95m, 5 Ci	H-3, 3 Ci Zr-95, 5 Ci Nb-95m, 5 Ci	H-3, 3 Ci Zr-95, 5 Ci Nb-95m, 5 Ci

* unit are in meters unless otherwise stated
# Release Coordinates at center of site: E58000; N 62000

SOFTWARE QUALITY ASSURANCE PLAN FOR ENVIRONMENTAL DOSIMETRY

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ED Files (2)