| | | General Characteristics |
|---|---|---|
| 1 | **Abstract of Model Capabilities** | AXAIRQ is a dose assessment model used for acute atmospheric releases at the Savannah River Site. The program strictly follows the guidance in US NRC Regulatory Guide 1.145. The program is site-specific and runs on an IBM Mainframe. Dose from inhalation, plume shine and ground shine are considered and the period of the release is a minimum of 2 hours. Plume rise is not considered. Dose to the maximally exposed offsite is automatically calculated and doses can also be calculated at user-selected distances. Population doses are calculated for an 80 km (50 mile) region. The radionuclide library contains nearly 500 isotopes and site specific meteorological data is available for 7 different onsite locations. A site specific terrain file is also accessed. |
| 2 | **Sponsor and/or Developing Organization** | Ali A. Simpkins<br>Westinghouse Savannah River Company<br>773-A rm A1001<br>Aiken, SC 29808<br>(803)725-9643 (803)725-4233 **Fax**<br>ali.simpkins@srs.gov **sponsoring organization**<br>ali.simpkins@srs.gov **developing organization** |
| 3 | **Last Custodian/ Point of Contact** | Ali A. Simpkins<br>Westinghouse Savannah River Company<br>773-A rm A1001<br>Aiken, SC 29808<br>(803)725-9643 (803)725-4233 **Fax**<br>ali.simpkins@srs.gov **primary individual**<br>tim.jannik@srs.gov **secondary individual** |
| 4 | **Life-Cycle** | AXAIRQ originated as a code called NRC-145 in the early 80s. Several enhancements have occurred over the years and a controlled,verified version was developed in 1989 called AXAIR89Q. In 1995, enhancements included deposition and ground shine and the code was renamed AXAIRQ. Enhancements slated for 1997-1998 include the addition of a food ingestion model and the possibility of conversion to a PC version. |
| 5 | **Model Description Summary** | **AXAIRQ** is comprised of six main subprograms and each are discussed below.<br>**AXAIN95**. This module reads user input data and archived data files and writes temporary files for use by one or more of the remaining modules.<br>**AXATERL**. The AXATERL module reads terrain data from an Oak Ridge National Laboratory binary data base and generates an array (by compass sector) of maximum relative terrain heights at eleven distinct distances (out to 50 miles). The array is generated in concentric rings about the release point.<br>**AXAPOP89**. This module generates a temporary file of the projected offsite population (for a user-specified year) by sector and radial distance with respect to the release location. AXAPOP89 also calculates an array of the onsite population (all adult) in the same format.<br>**AXAMET95**. Relative concentrations in air are calculated in the AXAMET95 module for all user-specified sectors and distances. Within this module, depletion factors are calculated for each of the downwind distances for iodines and remaining particulates separately.<br>**PRIMUSL**. The PRIMUSL module prepares the radionuclide daughter ingrowth library from all nuclides specified in the source term. PRIMUSL is a modified version of PRIMUS.<br>**AXADOS95**. The last module, AXADOS95, computes individual and population doses by radionuclide and pathway. Pathways considered in AXADOS95 include inhalation, gammashine from plume immersion, and ground shine. Estimates can be obtained for maximum individual doses that are not exceeded 99.5% of the time, dependent on sector. Maximum individual doses for meteorological conditions that are not exceeded either 50% or 95% of the time are calculated independent of sector. Population doses are estimated for meteorological conditions that are not exceeded 99.5% of the time. |
| 6 | **Application Limitation** | AXAIRQ does not have the capability to analyze plume rise due to either buoyancy or momentum processes. Also in the present version an ingestion pathway model is not available. AXAIR is configured to run on the IBM mainframe at SRS and is not portable. |
| 7 | **Strengths/ Limitations** | **Strengths: 3-5 Model strengths:**<br>AXAIRQ strictly follows the guidance in USNRC Regulatory Guide 1.145 and is site specific for SRS. The program is very user friendly and the user-input template is easy to follow.<br>**Limitations:** An ingestion model is planned to be added to AXAIRQ in the next year and transfer to a PC is being considered to overcome those weaknesses. |

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| 8 | **Model References** | ! Simpkins, A.A. 1995a, Verification of AXAIRQ(U), WSRC-RP-95-708, Westinghouse Savannah River Company, Aiken, SC.<br>! Simpkins, A.A. 1995b, User's Manual for AXAIRQ(U), WSRC-RP-95-709, Westinghouse Savannah River Company, Aiken, SC.<br>! Simpkins, A.A. 1995c, Comparison Study of AXAIR89Q and AXAIRQ(U), WSRC-RP-95-888, Westinghouse Savannah River Company, Aiken, SC.<br>! USNRC 1982, Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants, US NRC Regulatory Guide 1.145, US Nuclear Regulatory Commission, Washington, DC, Rev. 1, November 1982. |
| 9 | **Input Data/Parameter Requirements** | The following items are needed for input: location of the release, release height, grade elevation, sector (if desired), meteorological data file, calendar year of release, gammashine dose methodology, daughter ingrowth option, include 95% or 50% dose, deposition option, diffusion coefficient type, mixing height, user distances, radionuclides, amount released, and time period (>2 hours). |
| 10 | **Output Summary** | AXAIRQ echoes the input and shows supporting files such as population, terrain, and meteorology. EDE and organ dose are given for each of the pathways and each radionuclide and totals are also shown. Population doses are reported in the same manner. A summary page is also available if the user selects it. |
| 11 | **Applications** | AXAIRQ (and previous versions of AXAIRQ) have been used for a majority of the Safety Analysis Reports at the Savannah River Site. |
| 12 | **User-Friendliness** | The input template for AXAIRQ is extremely easy to use as the user is just required to fill in the blanks with the appropriate response. A variety of checks have been added to the program to prevent the user from entering incorrect input. |
| 13 | **Hardware-Software Interface Constraints/ Requirements** | **Computer operating system:** AXAIRQ operates on the SRS IBM Mainframe<br>**Computer platform:** IBM Mainframe accessible from any SRS computer with an account number.<br>**Disk space requirements:** NA- mainframe.<br>**Run execution time** (for a typical problem)**:** 1-3 cpu minutes<br>**Programming language:** FORTRAN<br>**Other computer peripheral information:** None. |
| 14 | **Operational Parameters** | **Identify whether the code has any error diagnostic messages to assist the user in troubleshooting operational problems:**<br>If the error occurred in improper input, typically a message is displayed as part of the output. Otherwise, the IBM completion code manual can be referred to.<br>**Set up time for: Typical times are: *first-time user:* hour *experienced user:*** minutes |
| 15 | **Surety Considerations** | **All quality assurance documentation:** Verification Report listed above Simpkins, A.A. Software Quality Assurance Plan for Environmental Dosimetry, Westinghouse Savannah River Company Report, WSRC-RP-95-1159, Aiken, SC, November, 1994.<br>**Benchmark runs:** Runs are maintained by the Environmental Dosimetry Group at SRS and any time changes to code are made, test cases are performed.<br>**Validation calculations:** Reports cited above.<br>**Verification with field experiments that has been performed with respect to this code:** Simpkins, A.A. and D.M. Hamby, Comparisons of Observed versus Predicted Tritium Oxide Concentrations at the Savannah River Site, Health Physics Journal, 72(2), 1997. |
| 16 | **Runtime Characteristics** | Typically Runtime is 1-3 cpu minutes. Depending on the number of users on the IBM Mainframe, CPU time can equal real time or the run can take an hour or more. |

**Specific Characteristics**

**Part A: Source Term Submodel Type**

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| A1 | **Source Term Algorithm?** | _YES ✔ NO |

**Part B: Dispersion Submodel Type**

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|---|---|---|
| B1 | **Gaussian** | **✔ Straight-line plume __Segmented plume __ Statistical plume __ Statistical puff** |
| B2 | **Similarity** | **✔ Plume ✔ Puff**<br>Plume releases are modeled by the direct input of χ/Qs to the program by the user. Puff releases are modeled by requesting the program to calculate s or the user can directly input s. |

**Part C: Transport Submodel Type**

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|---|---|---|
| C1 | **Prognostic** | No prognostic capabilities |
| C4 | **Frame of Reference** | **_✔_ Eulerian __ Lagrangian __ Hybrid __ Eulerian-Lagrangian** |
| **Part D: Fire Submodel Type** (Not Applicable) | | |
| **Part E: Energetic Events Submodel Type** (Not Applicable) | | |
| **Part F: Health Consequence Submodel Type** | | |
| F2 | **For Radiological Consequence Assessment Models** | **Cloudshine: _✔_ finite cloud _✔_ semi-finite cloud __ other**<br>**Groundshine: _✔_ short-term __ long-term**<br>**Inhalation: _✔_ short-term __ long-term**<br>**_✔_ Total effective dose equivalent**<br>**_ Uptake of respirable fraction of particle spectra**<br>**Resuspension: __ short-term __ long-term __ Anspaugh**<br>**Food/Water Ingestion: __ dynamic ___ static**<br>**Skin dose: _✔_ absorption _ other**<br>**Dose assessment: __ ICRP-60 criteria _✔_ organs _✔_ pathways**<br>**Health effects: __ early __ latent** |
| **Part G: Effects and Countermeasures Submodel Type** | | |
| G1 | **For Chemical Consequence Assessment Models** | **Evacuation:** N/A<br>**Sheltering:** Population dose is adjusted by a factor 0.5 to account for attenuation through the building.<br>**Interdiction:**<br>**Spray/Foam:**<br>**Victim Treatment/Treatment Measures:** |
| **Part H: Physical Features of Model** | | |
| H1 | **Stability Classification Turbulence Typing** | **Pasquill-Gilfford-Turner:** User selects either Pasquill-Gifford Turner or Pasquill Briggs<br>**STAR:**<br>**Irwin:**<br>**Sigma theta:**<br>**Richardson number:**<br>**Monin-Obukhov length:**<br>**TKE-driven:**<br>**Split sigma:** |
| H2 | **Release Elevation** | **_✔_ ground ___ roof** |
| H6 | **Mixing Layer** | **__ trapping __ lofting _✔_ reflection __ penetration**<br>**_✔_ inversion breakup fumigation __ temporal variability** |
| H7 | **Cloud Buoyancy** | **__ neutral [passive] __ dense [negative] __ plume rise [positive]** |
| H10 | **Deposition** | **__ gravitational setting _✔_ dry deposition __ precipitation scavenging**<br>**__ resistance theory deposition _✔_ simple deposition velocity __ liquid deposition**<br>**__ plateout and re-evaporation** |
| H11 | **Resuspension** | None |
| H12 | **Radionuclide Ingrowth and Decay** | Yes |
| **Part I: Model Input Requirements** | | |
| I1 | **Radio(chemical) and Weapon Release Parameters** | **Release rate: _✔_ Continuous __ Time dependent __ Instantaneous**<br>**Release container characteristics: __ vapor temperature ___ tank diameter**<br>**__ tank height __ tank temperature __ tank pressure __ nozzle diameter**<br>**__ pipe length**<br>**Jet release: __ initial size __ shape**<br>**__ concentration profile at end of jet affected zone**<br>**Release dimensions: _✔_ point __ line __ area**<br>**Release elevation: __ ground __ roof __ stack** |

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|---|---|---|
| I2 | **Meteorological Parameters** | **Wind speed and wind direction: _✔_single point __ single tower/multiple point _✔_ multiple towers**<br>**Temperature: __ single point __ single tower/multiple point __ multiple towers**<br>**Dew point temperature: __ single point __ single tower/multiple point __ multiple towers**<br>**Precipitation: __ single point __ single tower/multiple point __ multiple towers**<br>**Turbulence typing parameters: __ temperature difference _✔_ sigma theta _✔_ sigma phi __ Monin-Obukhov length __ roughness length __ cloud cover __ incoming solar radiation __ user-specified**<br>**Four dimensional meteorological fields from prognostic model:**. |
| **Part J: Model Output Capabilities** | | |
| J4 | **Tabular at Fixed Downwind Locations** | Concentrations and doses are reported at user selected downwind distances. |
| **Part K: Model Usage Considerations** | | |
| K1 | **Ease of Model Use** | **Training required to run the model:** _2-3_ **background (years of education)**<br>_2-3 months_ **training time needed on the model to be able to exercise all model capabilities**<br>**Training required to continue development of the model:**<br>_4_ **background (years of education)**<br>._1 yr_ **training time needed on the model to be able to exercise all model capabilities**<br>Less than 5 minutes from problem definition to output display |
| K3 | **Ease of Use of Output, Evaluated as the Time Needed to Train a College Graduate in the Use of the Output** | One day would be sufficient for explanation of ouput. In depth understanding of results and why would take much longer. |