RADIOLOGICAL ASSESSMENT SYSTEM FOR CONSEQUENCE ANALYSIS (RASCAL) VERSION 3.0

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SUMMARY
The Radiological Assessment System for Consequence AnaLysis, Version 3.0 (RASCAL 3.0) is the U.S. Nuclear Regulatory Commission's (NRC) main computational tool for use during radiological emergencies. RASCAL estimates doses from radiological accidents for comparison with Protective Action Guides and acute health effects thresholds. It includes six computational tools: ST-Dose, FM-Dose, Decay, BackCalc, UF6Plume, and MetProc. ST-Dose computes time-dependent nuclide release rates, atmospheric transport, radiological decay, and doses. FM-Dose computes doses from environmental concentrations of nuclides. Decay computes radiological decay and daughter in-growth. BackCalc estimates a distribution of possible release rates from field measurements. UF6Plume computes uranium exposures and HF concentrations from a UF_6 release. MetProc prepares meteorological data for use by ST-Dose and UF6Plume.

Three databases are included in RASCAL 3.0. They contain U.S. radiological facilities data, nuclide dose and decay data, and field measurements made during an incident.

I. BACKGROUND

The current version of RASCAL, RASCAL 2.2[1], is a DOS-based set of tools that is primarily intended for power reactor emergencies. However, NRC has regulatory authority over radiological facilities other than power reactors (e.g., fuel cycle facilities). These facilities have accident scenarios that are different from those at power reactors. RASCAL 3.0 is an enhanced, Windows-based set of tools applicable to reactors, fuel cycle facilities, and transportation accidents.

II. ST-DOSE

ST-Dose (Source Term to Dose) estimates a radioactive source term, calculates atmospheric transport and radiation doses. Both the source and the reduction mechanisms (sprays, filters, etc) that are used during an emergency may be varied with time. Results are displayed as graphics or as summary or detailed tables. Cumulative dose, dose rate, and deposition may be displayed. Any result may be interpolated from the computational grid to user-defined receptor points.

ST-Dose can use either real-time or pre-calculated meteorological data files created by MetProc.

III. METPROC

MetProc is used to enter and view observed and forecast meteorological data. It creates the data files needed by ST-Dose and UF6Plume and displays the meteorological data fields used by these tools. It accesses the facilities database, which contains the locations of the meteorological stations nearest each of the NRC regulated sites. MetProc can estimate stability classes from other data and can supply reasonable default data when only partial information is available. MetProc can be accessed from within ST-Dose, or it can be run as a stand-alone program.

IV. UF6PLUME

UF6Plume computes uranium exposures and HF concentrations downwind of UF_6 releases. It includes a dense-gas dispersion model for the initial spread of UF_6 gas and a thermodynamic model to treat the exothermic chemical reaction between UF_6 and H_2O that produces HF and UO_2F_2. It also includes consideration of plume rise due to the temperature of the UF_6 and the heat of reaction.

V. FM-DOSE

FM-Dose (Field Measurements to Dose) computes emergency worker limits and early and intermediate-phase doses and exposure-rate derived response levels (DRLs) from concentrations of nuclides measured in the air and on the ground. Measurements may be decayed or expanded to an assumed reactor inventory mix. Doses and early-phase DRLs are tabulated. Intermediate-phase are plotted over a period of 180 days.

VI. DECAY

Decay computes radiological decay and daughter in-growth over a selected time period from one minute to 50 years.

VII. BACKCALC

BackCalc estimates potential release rates that might be associated with a set of field measurements given a description of the meteorological conditions and the likely release scenario. It is based on the straight-line Gaussian plume equation. Monte Carlo techniques make a large number of release rate estimates that are consistent with the measurements and uncertainties in the meteorological conditions, release scenario, and measurements. These estimates are used to determine the most likely, median, and geometric mean release rates, and a release rate that has less than 10% probability of being exceeded. BackCalc also displays the probability density function for the release rate estimates and their cumulative frequency distribution.

VIII. DATABASES

The databases included in RASCAL 3.0 contain much of the data used in the calculations. The U.S. radiological facilities database includes information required by ST-Dose and MetProc for all the radiological facilities regulated by the NRC. The nuclide dose and decay database includes all required dose factors and reactor inventory data. All RASCAL 3.0 modules allow the user to view these databases within their help systems, where appropriate. The nuclide decay chain may be displayed in a table or as a graphic.

The field-measurements database allows the user to maintain a record of all field measurements taken during an emergency. The database can be accessed from within FM-DOSE, to use the measurements as input to that model.

IX. CONCLUSIONS

RASCAL 3.0 is a major upgrade of RASCAL. It has been designed for quick assessments when very few data are available. It also permits increasingly detailed assessments as more information becomes available.

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REFERENCES

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