Introduction of Instructors and Overview of Codes

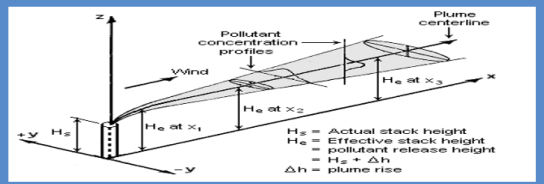
Dose Assessment Codes in RAMP

Environmental

MILDOS 4

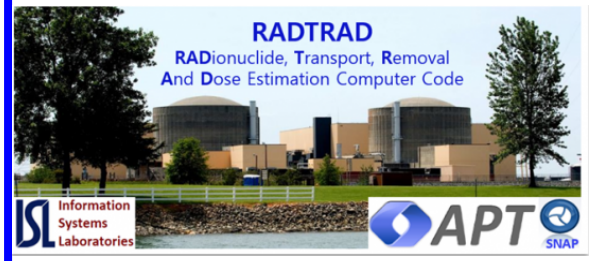
Radiological Dose from Uranium Milling

Atmospheric Codes



PAVAN ARCON96 XOQ/DOQ

NPP Licensing



Gaseous And Liquid Effluent

Habit 2.0

Emergency Response Code

Other Dose Assessment Codes

RAMP Codes - Introductions

Code	Purpose	Source	Pathway
RASCAL	Response	Normal/Accident	Air
HABIT	Licensing	Design Basis Accident	Air
VARSKIN	Licensing	Normal/Accident	Body
GALE	Licensing	Normal	Air
Atmospheric Codes	Licensing	Normal/Accident	Air
MILDOS	Licensing	Fuel Cycle	Air
RADTRAD	Licensing	Design Basis Accident	Air
D&D	Decommissioning	Non-Rx	Ground/Water
GENII	Research	Normal/Accident	Air/Ground/Water
Rad Toolbox	Research Database	-	-
PIMAL	Research GUI	-	-

RAMP Code Team:
RASCAL

- John Tomon, CHP
  - U.S. NRC, COR
- Jeff Kowalczik
  - U.S. NRC, Technical Monitor
- George Athey
  - Athey Consulting, Inc.
- Jeremy Rishel
  - Pacific Northwest National Laboratory
- John Fulton
  - Sandia National Laboratory

RASCAL

Instructors:

George Athey
Athey Consulting

Jeff Kowalczik, CHP
U.S. NRC

John Tomon, CHP
U.S. NRC

Use Forums and
RASCAL_Help@nrc.gov

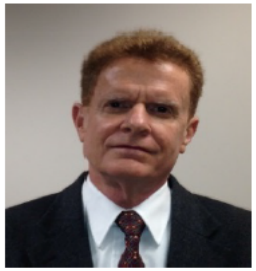
RAMP Code Team:

SNAP/RADTRAD

- John Tomon, CHP
  - U.S. NRC, COR
- Mark Blumberg
  - U.S. NRC, Technical Monitor
- Bill Arcieri
  - Information Systems Laboratory, Inc.
- Diane Mlynarczyk
  - Information Systems Laboratory, Inc.

SNAP/RADTRAD

Instructors:



William Arcieri
Information Systems
Laboratories, Inc.

John Tomon, CHP
U.S. NRC

Use Forums and RADTRAD_Help@nrc.gov

RAMP Code Team:
VARSKIN

- Vered Schaffer
  - U.S. NRC
- David Hamby, Ph.D.
  - Oregon State University
- Colby Mangini, Ph.D.
  - St. Jude Hospital

VARSKIN

Instructor:

Colby Mangini Ph.D.
St. Jude's Children's Hospital (Memphis, TN)

Vered Shaffer, Ph.D.
RAMP Team Member

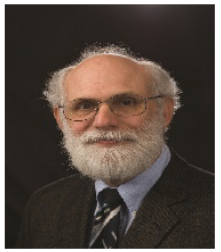
VARSKIN_Help@nrc.gov, Forums coming soon!!!

RAMP Code Team:
GENII

- Stephanie Bush-Goddard
  - U.S. NRC
- Bruce Napier
  - Pacific Northwest National Laboratory
- Jeremy Rishel
  - Pacific Northwest National Laboratory

GENII

Instructor:



Bruce Napier
Pacific Northwest
National Laboratory

For technical questions specific to the GENII Code, please call Bruce Napier at (509) 375-3896

Coming Soon Forums and GENII email help

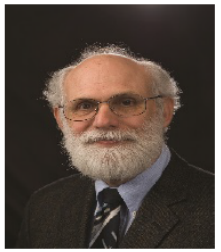
RAMP Code Team:

Atmospheric Codes

- Stephanie Bush-Goddard
  - U.S. NRC
- Kevin Quinlan
  - U.S. NRC
- Jeremy Rishel
  - Pacific Northwest National Laboratory
- Bruce Napier
  - Pacific Northwest National Laborator

GENII

Instructor:



Bruce Napier
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National Laboratory

Use Forums and ATM_Help@nrc.gov

RAMP Codes

RASCAL	Response	Normal/Accident	Air

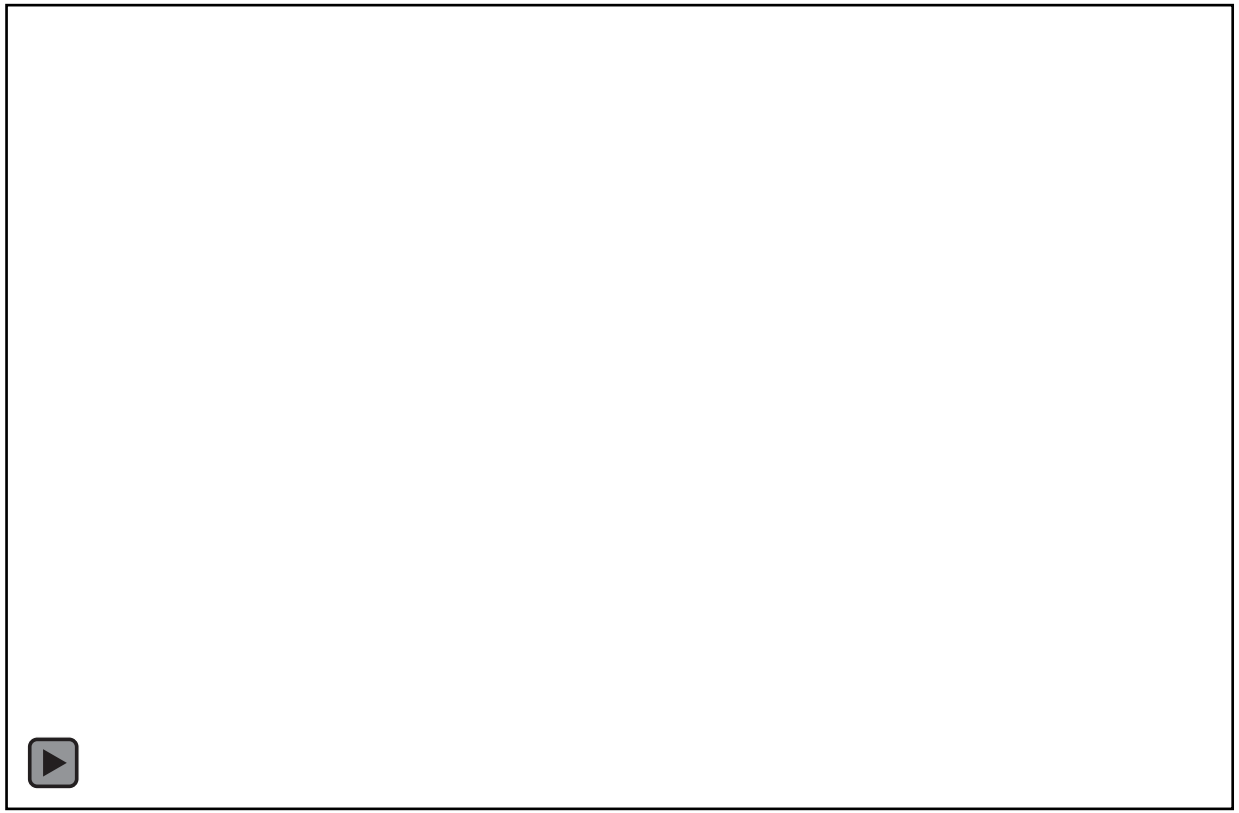
Radiological Assessment System for Consequence AnaLysis

Fast running software used in radiological incidents to assess off-site dose consequences

RASCAL Use

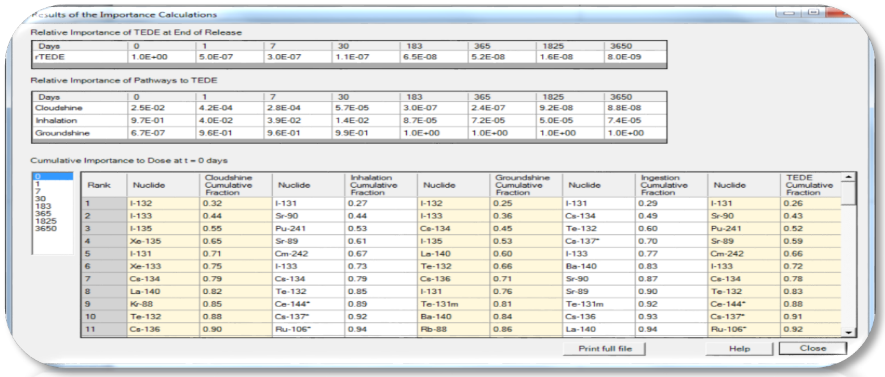
- Who
  - Response organizations
- When
  - Pre-release or plume phase of radiological release to atmosphere
- Why
  - To help inform or evaluate protective actions

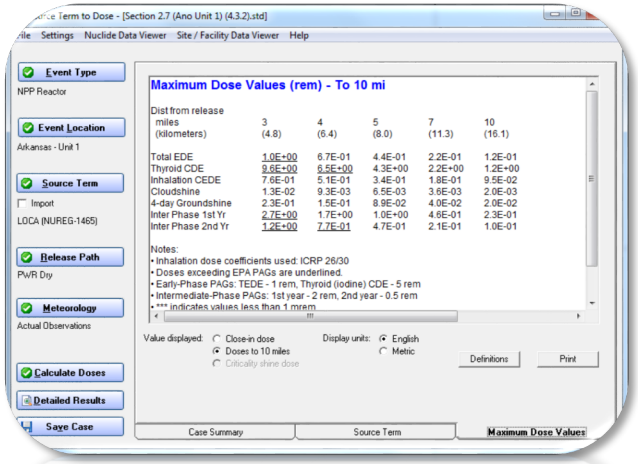
RASCAL Methods

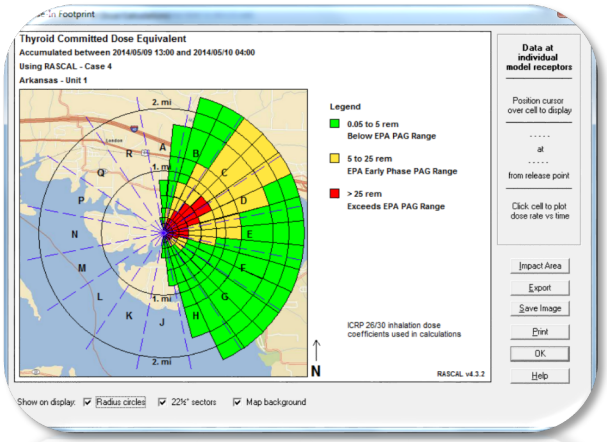


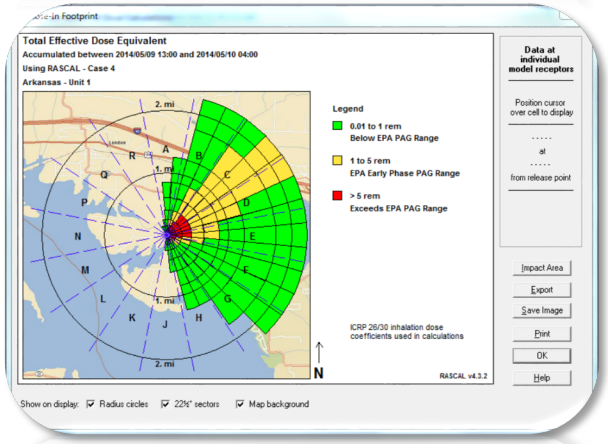
RASCAL Methods

- Tabular and graphical outputs



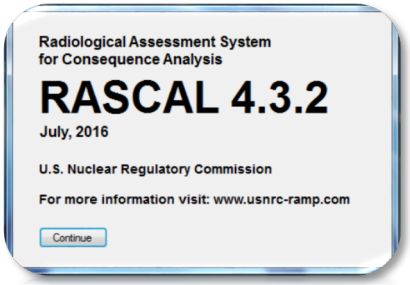






RASCAL Information

- Version 4.3.2



- Web-Based Training

RASCAL Web-Based Training
This content is provided as introductory courses to RASCAL and is a pre-requisite to instructor-led training.

Module(Link to File)	Module description	Applicable RASCAL User
Module 1 - Introduction to RASCAL	Brief overview providing general information RASCAL capabilities, limitations, and use.	New RASCAL users, managers, and decision-makers.
Module 2 – RASCAL Fundamentals	In-depth course covering how to use RASCAL and the models and methods within.	New RASCAL users.

- RASCAL Version 5.0

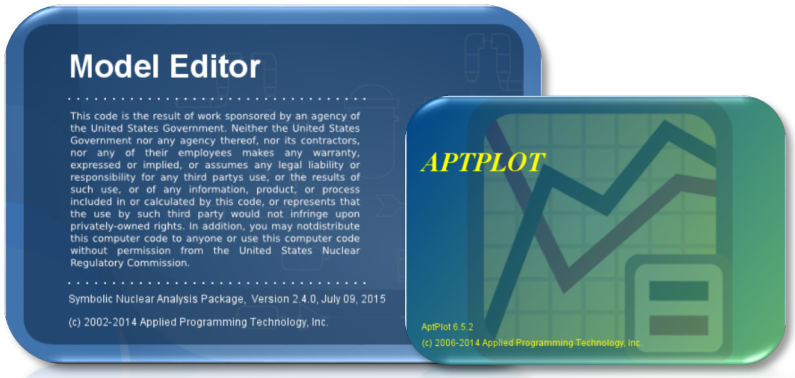
SNAP/RADTRAD

SNAP/RADTRAD

Symbolic Nuclear Analysis Package

RADionuclide Transport, Removal And Dose Estimation

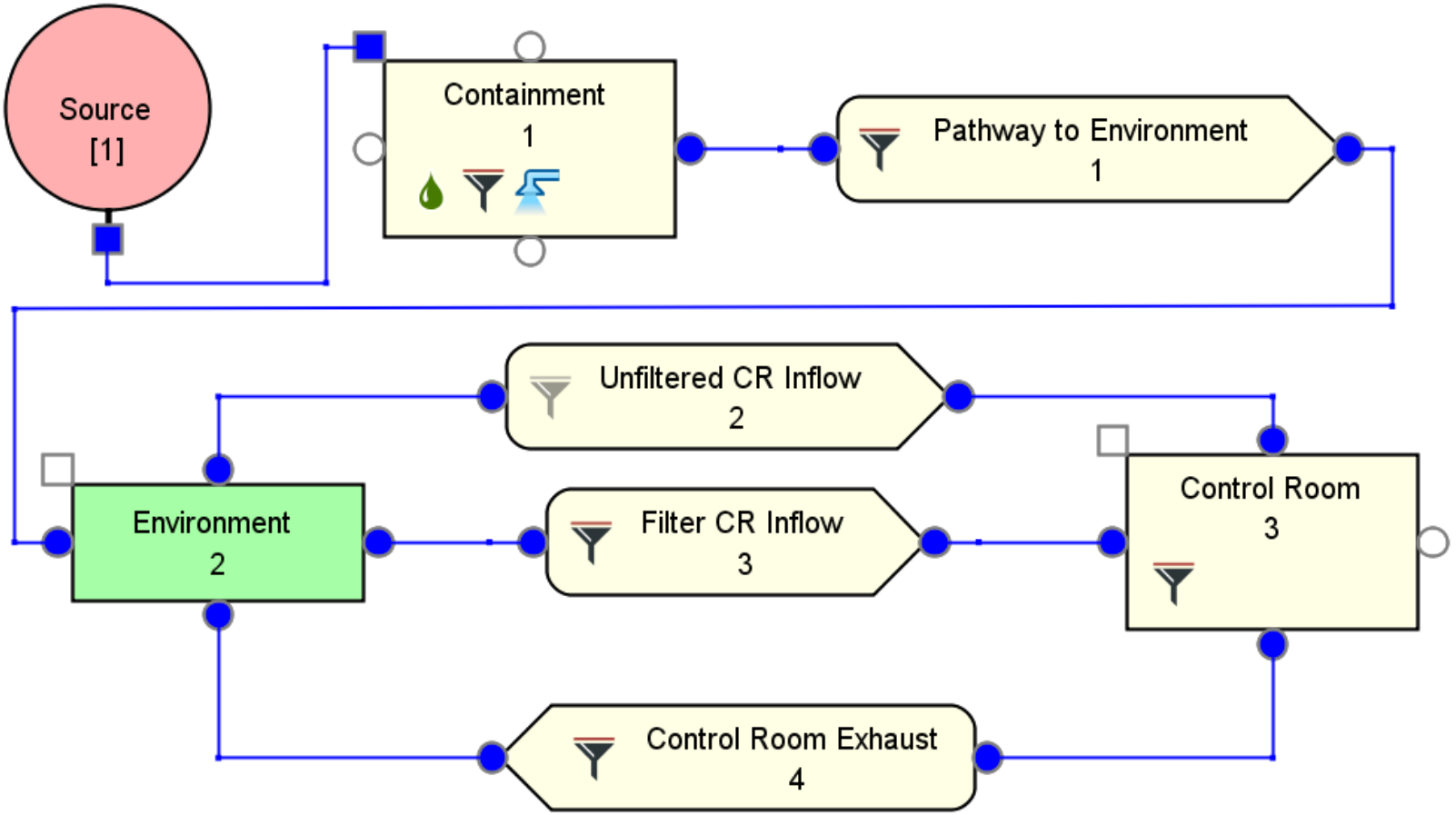
Information Systems Laboratories



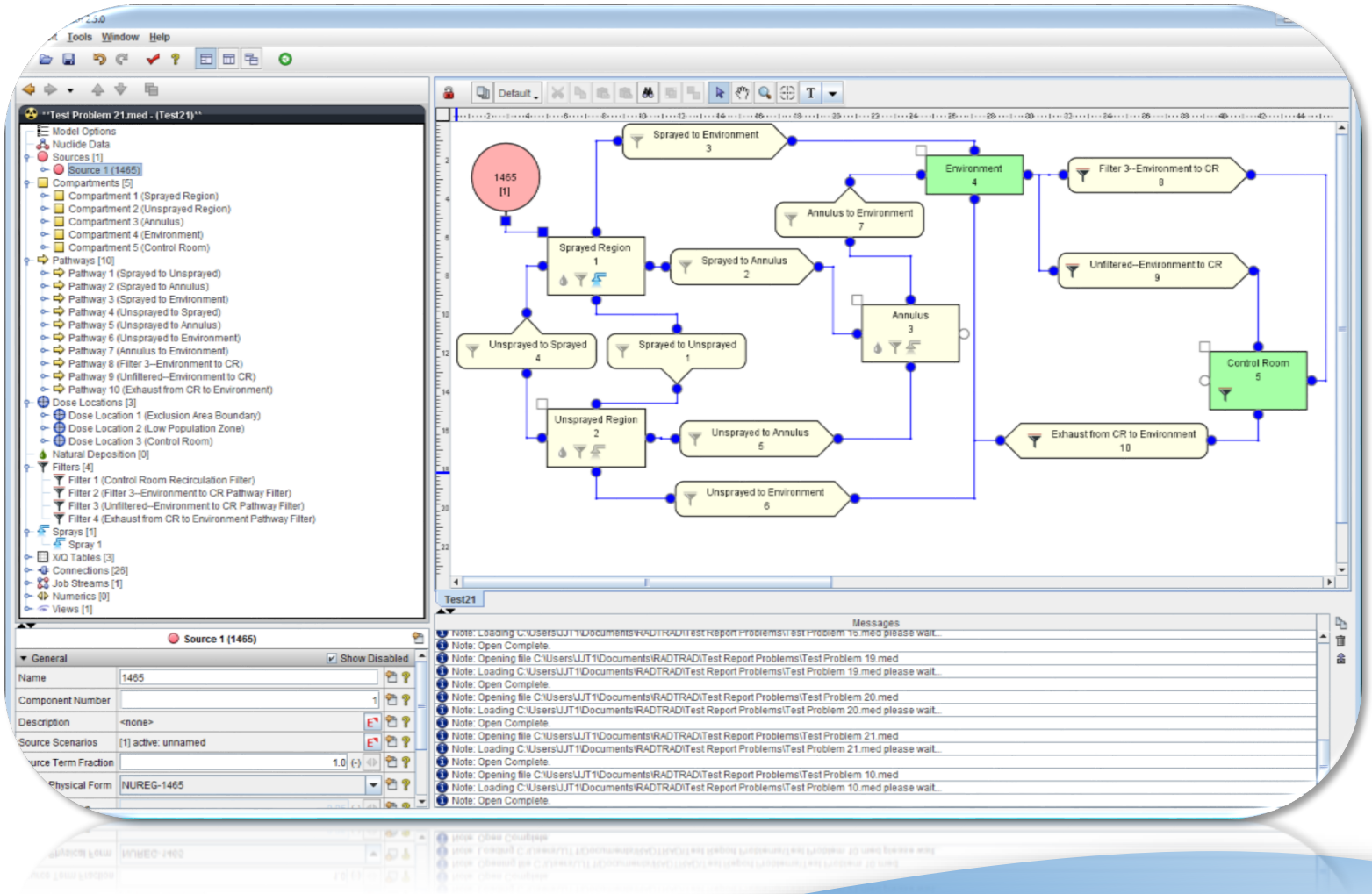
SNAP/RADTRAD Use

- The NRC uses SNAP/RADTRAD as licensing analysis **confirmatory** code to verify that the plant's design and the licensee's offsite and control room dose calculations following a DBA meet the following criteria:
  - 10 CFR Part 100, "Reactor Site Criteria"
  - 10 CFR 50.67, "Accident Source Term"
  - 10 CFR 50.34, "Contents of applications; technical information"
  - 10 CFR 50, Appendix A, GDC 19, "Control Room"

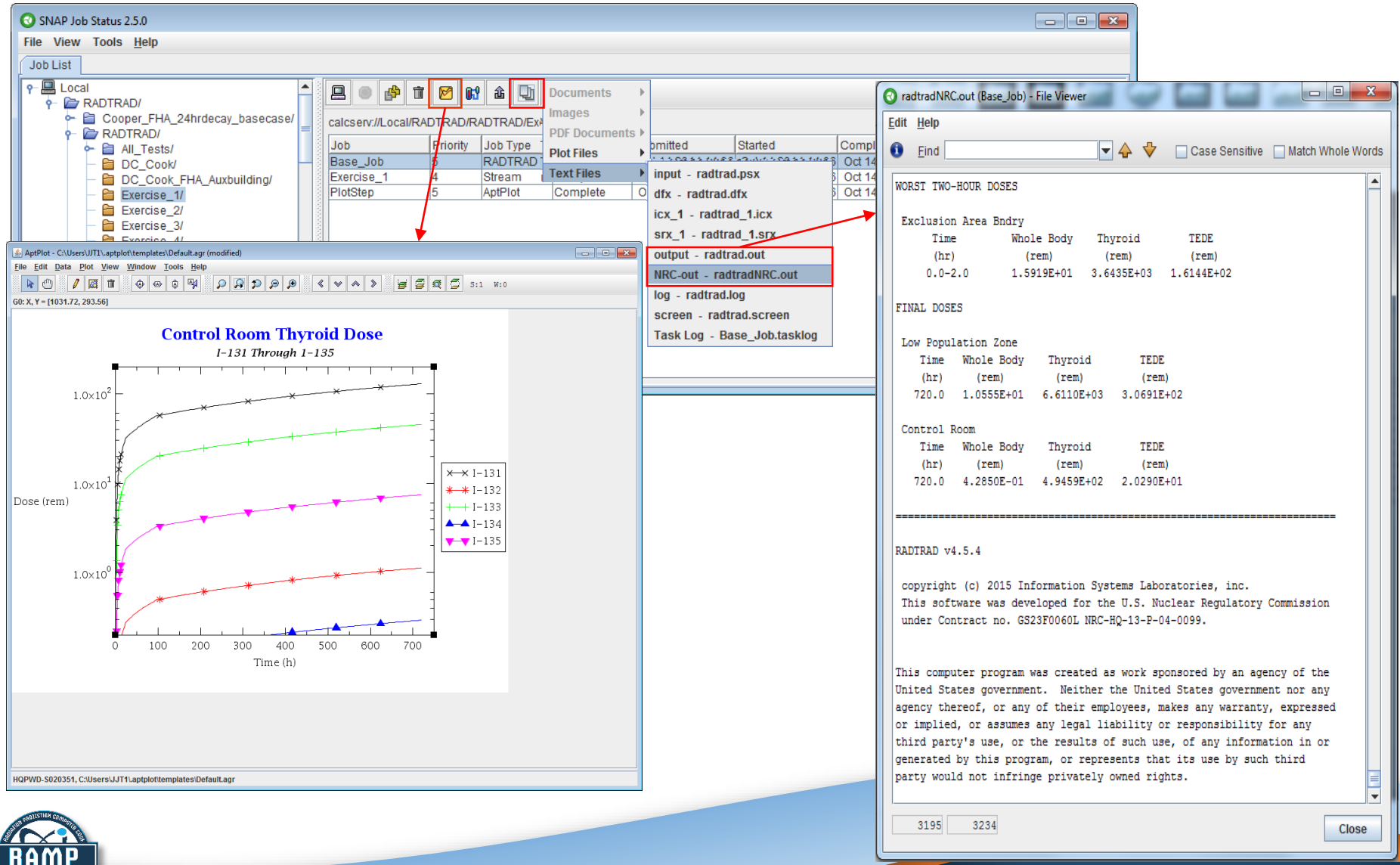
SNAP/RADTRAD Methods



SNAP/RADTRAD Methods



SNAP/RADTRAD Outputs



SNAP/RADTRAD Information

- SNAP/RADTRAD
  - SNAP Model Editor (v2.5.3)
  - RADTRAD Plugin (v4.11.5)
  - RADTRAD-AC (v4.5.5)
  - AptPlot (v6.7.2)
- NUREG/CR-7220
  - SNAP/RADTRAD 4.0: Description of Models and Methods
- Support (FAQs and Forums)
  - Error Reports
  - General Usage Questions
  - Model Questions

RAMP Codes

The GENII Environmental Radiation Dosimetry Software package provides users the capability to estimate environmental dispersion, accumulation, and human and biotic exposure and impacts.

GENII Use

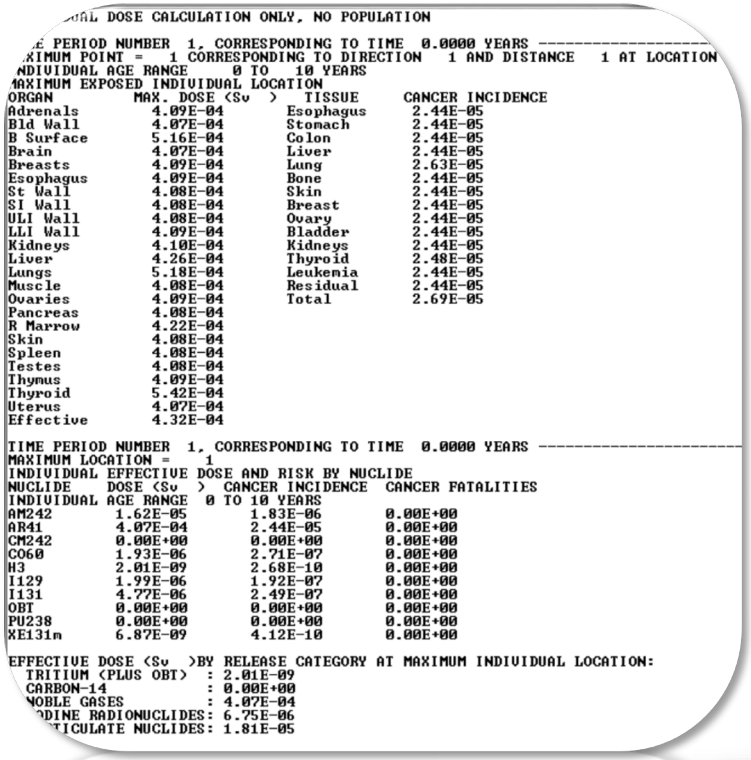
- GENII is designed for use by environmental assessors in industry, government, and academia.
- Uses include annual demonstration of compliance with regulations, accident analyses, and planning for emergency response.
- GENII is an NQA-1 qualified code with extensive documentation.

GENII Methods

- GENII requires input of a radionuclide “source term” describing quantity released to the air or water, or initial concentrations in soil, plants, or animal products.
- GENII includes Gaussian plume and puff dispersion models (which need weather data), surface water transport models, plant and animal bioaccumulation models, and descriptors of human exposure.

GENII Outputs

- Output is in terms of human-readable tabular data on radiation dose and dose rate.

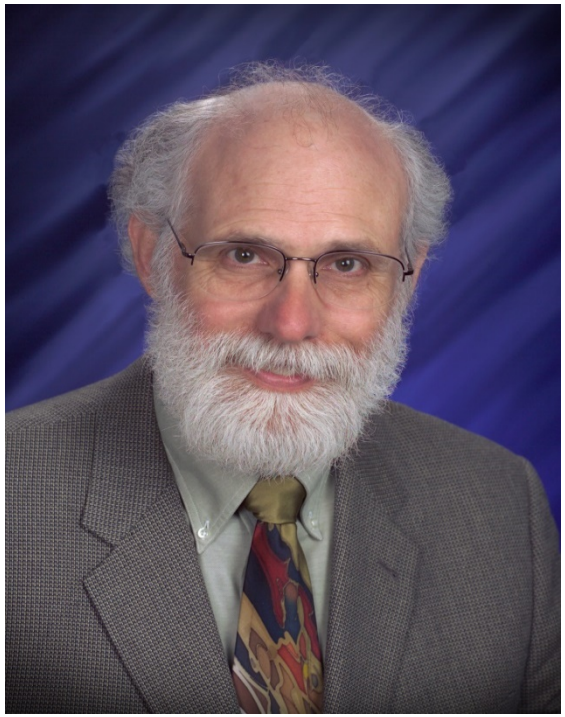


```
UAL DOSE CALCULATION ONLY, NO POPULATION

E PERIOD NUMBER  1, CORRESPONDING TO TIME  0.0000 YEARS ----------
XIMUM POINT =  1 CORRESPONDING TO DIRECTION   1 AND DISTANCE   1 AT LOCATION
NDIVIDUAL AGE RANGE     0 TO    10 YEARS
AXIMUM EXPOSED INDIVIDUAL LOCATION
ORGAN          MAX. DOSE (Sv  )    TISSUE       CANCER INCIDENCE
Adrenals          4.09E-04         Esophagus       2.44E-05
Bld Wall          4.07E-04         Stomach         2.44E-05
B Surface         5.16E-04         Colon           2.44E-05
Brain             4.07E-04         Liver           2.44E-05
Breasts           4.09E-04         Lung            2.63E-05
Esophagus         4.09E-04         Bone            2.44E-05
St Wall           4.08E-04         Skin            2.44E-05
SI Wall           4.08E-04         Breast          2.44E-05
ULI Wall          4.08E-04         Ovary           2.44E-05
LLI Wall          4.09E-04         Bladder         2.44E-05
Kidneys           4.10E-04         Kidneys         2.44E-05
Liver             4.26E-04         Thyroid         2.48E-05
Lungs             5.18E-04         Leukemia        2.44E-05
Muscle            4.08E-04         Residual        2.44E-05
Ovaries           4.09E-04         Total           2.69E-05
Pancreas          4.08E-04
R Marrow          4.22E-04
Skin              4.08E-04
Spleen            4.08E-04
Testes            4.08E-04
Thymus            4.09E-04
Thyroid           5.42E-04
Uterus            4.07E-04
Effective         4.32E-04

TIME PERIOD NUMBER  1, CORRESPONDING TO TIME  0.0000 YEARS ----------
MAXIMUM LOCATION =     1
INDIVIDUAL EFFECTIVE DOSE AND RISK BY NUCLIDE
NUCLIDE    DOSE (Sv  )  CANCER INCIDENCE  CANCER FATALITIES
INDIVIDUAL AGE RANGE  0 TO 10 YEARS
AM242        1.62E-05        1.83E-06        0.00E+00
AR41         4.07E-04        2.44E-05        0.00E+00
CM242        0.00E+00        0.00E+00        0.00E+00
CO60         1.93E-06        2.71E-07        0.00E+00
H3           2.01E-09        2.68E-10        0.00E+00
I129         1.99E-06        1.92E-07        0.00E+00
I131         4.77E-06        2.49E-07        0.00E+00
OBT          0.00E+00        0.00E+00        0.00E+00
PU238        0.00E+00        0.00E+00        0.00E+00
XE131m       6.87E-09        4.12E-10        0.00E+00

EFFECTIVE DOSE (Sv  )BY RELEASE CATEGORY AT MAXIMUM INDIVIDUAL LOCATION:
 TRITIUM (PLUS OBT)  : 2.01E-09
 CARBON-14           : 0.00E+00
 NOBLE GASES         : 4.07E-04
 DINE RADIONUCLIDES: 6.75E-06
 TICULATE NUCLIDES: 1.81E-05
```

GENII Information

Bruce A. Napier, CHP

- Mr. Napier works with the development and operation of models concerned with the environmental transport of radiological and chemical contaminants. His professional experience includes mathematical modeling and calculation of effects to individuals and populations from releases of various contaminants to the environment, as well as management of specific projects.



Bruce.Napier@pnnl.gov

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RAMP Codes

ATMOSPHERIC CODES

ATMOSPHERIC CODES

- ARCON96
- PAVAN
- XOQDOQ

ARCON96

- ARCON96 is a Gaussian dispersion model for calculating short-term relative concentrations (χ/Q's) at nuclear power plant control room air intakes that would be exceeded no more than 5% of the time.
- Dispersion is near-field, in the vicinity of buildings.
- ARCON96 includes enhanced diffusion coefficients for low wind speed conditions and building wake.

ARCON96 Use

- Used by the NRC for New Reactor Safety Reviews for design-basis accidents
- 10 CFR Part 50, Appendix A, General Design Criterion 19 (GDC 19), Control Room
  - Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem (0.05 Sv) whole body, or its equivalent to any part of the body, for the duration of the accident

PAVAN

- PAVAN is a Gaussian dispersion model for calculating short-term relative concentrations (χ/Q's) at offsite locations, including the:
  - Exclusion Area Boundary (EAB)
  - Low Population Zone (LPZ)
- PAVAN uses Pasquill-Gifford (PG) diffusion coefficients with simple modifications to account for low wind speed conditions and building wake for ground-level releases.

PAVAN Use

- Used by the NRC for New Reactor Environmental Impact Statements and Safety Reviews for design-basis accidents
- 10 CFR 52.79(a)(1)(vi), Contents of applications; technical information in final safety analysis report
  - Perform an assessment assuming a fission product release from the core into the containment
    - An individual located at any point on the boundary of the EAB for any 2-hour period would not receive a dose in excess of 25 rem (0.25 Sv) TEDE
    - An individual located at any point on the outer boundary of the LPZ would not receive a dose in excess of 25 rem (0.25 Sv) TEDE during the entire period of the passage of the radioactive cloud

XOQDOQ

- XOQDOQ is a Gaussian dispersion model for calculating long-term relative concentrations (χ/Q's) and deposition (D/Q's) at user-specified locations and standard radial distances/segments out to 50 miles
- XOQDOQ plume horizontal distribution is assumed to be evenly distributed within the 22.5 degree downwind sector (sector-averaging)
  - For ground-level releases, plume vertical diffusion coefficient modified to account for building wake

XOQDOQ Use

- Used by the NRC for New Reactor Environmental Impact Statements and Safety Reviews to access impacts from routine releases
- 10 CFR Part 20, Subpart D, Radiation Dose Limits for Individual Members of the Public
  - The annual average concentrations of radioactive material released in gaseous effluents at the boundary of the unrestricted area do not exceed the values specified in Table 2 of Appendix B to Part 20
    - Intended to result in doses below 0.05 rem (0.5 mSv)
- Appendix I of 10 CFR Part 50, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet ALARA Criterion for Radioactive Material in Reactor Effluents
  - Section II.B: Unrestricted annual air dose < 10 mrad (0.1 mGy) gamma or 20 mrad (0.2 mGy) beta
  - Section II.C: Unrestricted annual individual organ dose from all pathways of exposure < 15 mrem (0.15 mSv)
  - Section II.D: radwaste system cost-benefit analysis based on population dose out to 50 miles

Atmospheric Codes Information

- Jeremy Rishel
  - Mr. Rishel supports the RAMP Atmospheric Codes, including ARCON96, PAVAN, and XOQDOQ. In addition, Mr. Rishel supports the development of the NRC's RASCAL emergency response code.

jeremy.rishel@pnnl.gov

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RAMP Codes

- An algorithm to compute ionizing dose to the skin following radiological contamination
- Photon dosimetry
  - attenuation, buildup, electron scatter
- Electron dosimetry
  - Bragg energy loss, backscatter
- The code agrees well with the EGSnrc probabilistic transport code

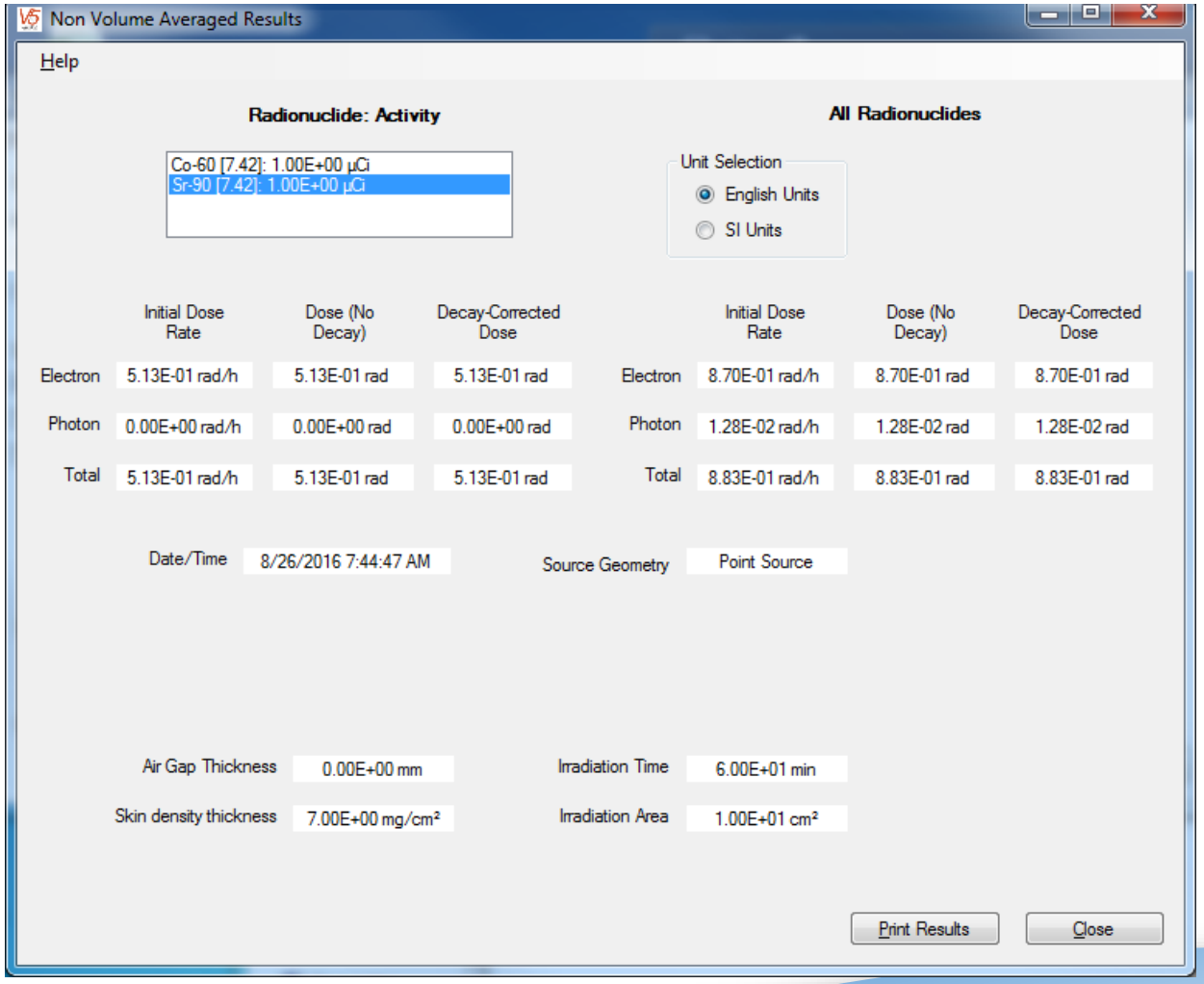
VARSKIN Use

- Used by NRC Staff and Licensees
- To show compliance with 10 CFR 20.1201(c) (or ICRP recommendations)
- As stated therein, the shallow dose equivalent to skin is calculated at the location receiving the highest dose within a 10 cm^2 (or 1 cm^2) area at a tissue depth of 70 microns
- Various tissue depths and dose-averaging areas are possible

VARSKIN Methods

- Data entry is condensed to a single screen
  - includes specification of source geometry, nuclide(s), source strength, tissue depth, and protective clothing characteristics
- A point-kernel deterministic model is used for both photon and electron dosimetry
- Electron source term considers beta or positron emissions, with internal conversion and Auger electrons

VARSKIN Outputs



VARSKIN Information

- Current version is VARSKIN 5.3
- V6.0 will be released end of 2017
- User's Group has ~350 members
  - http://www.usnrc-ramp.com/content/varskin-overview
- Our wish list includes:
  - User's Group technical conference
  - Web-based use
  - Injected-source scenario
  - Sensitivity/uncertainty methods
  - Decay daughters
  - ICRP 107 data

RAMP Codes

VARSKIN	Licensing	Normal/Accident	Body

Our Role

- We are glad you are here!
- Participate actively
  - Ask as many questions as you want
- Share your insights
  - Share your experience of how you use the code
  - Share your experience of how you want to use the code
  - ..and how you do not know do know how to use the code.
- Work together to enhance radiation protection and nuclear safety
- Build networks
  - After the meeting, email us, use the forums on the website
- Strengthen collaboration
- Relax and enjoy

Questions?