WELCOME TO THE

2016 RAMP USERS MEETING

RADIATION PROTECTION COMPUTER CODE ANALYSIS AND MAINTENANCE PROGRAM

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

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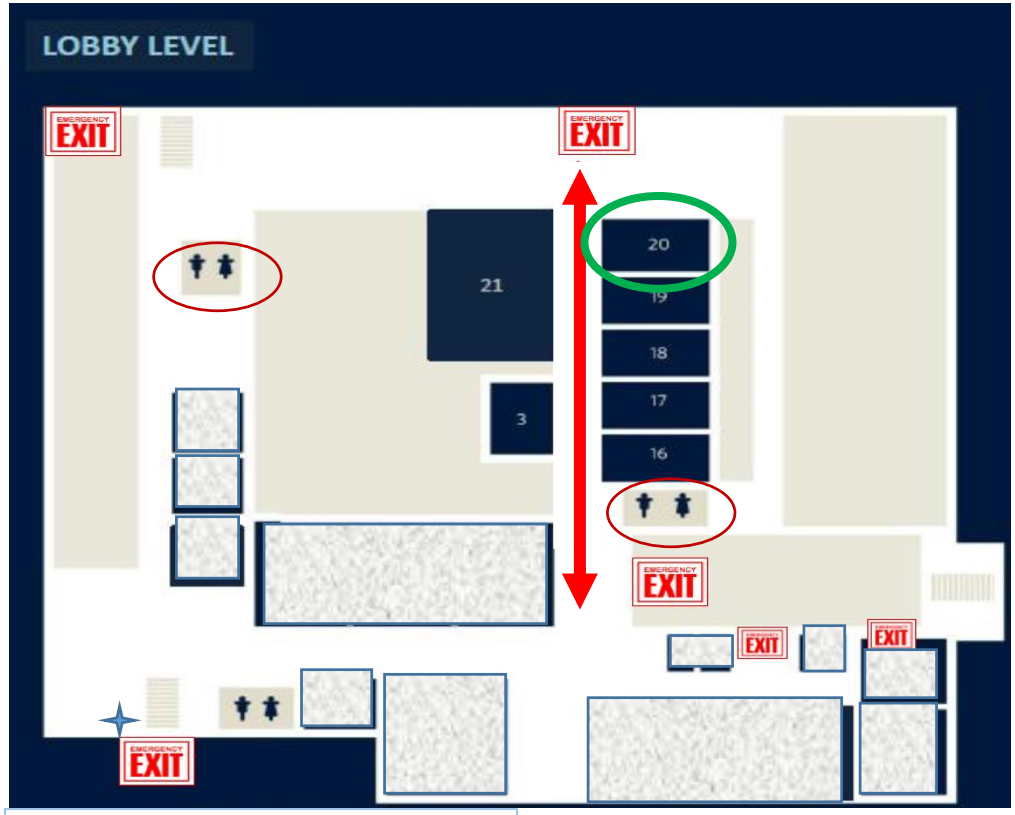
2016 Fall RAMP Meeting

Stephanie Bush-Goddard, Ph. D.

RAMP Program Manager
Radiation Protection Branch
Division of Systems Analysis
Office of Nuclear Regulatory Research

October 17th, 2016

Housekeeping / Emergency Exits



Exit To Twinbrook Metro

Restrooms

Meeting Rooms:

- 21 – Eisenhower
- 20 – Jackson
- 19 – Lincoln
- 18 – Monroe
- 17 – Truman
- 16 – Wilson
- 03 – Washington

Help Desk

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Welcome Session Speakers

- Welcome
  - Michael Weber, Director, Office of Nuclear Regulatory Research
- The RAMP Program Overview
  - Rebecca Tadesse, Chief Radiation Protection Branch
- User Meeting Information
  - Stephanie Bush-Goddard, RAMP Program Manager
- Networking Session and Break
- Overview of RAMP Codes
  - Code Principle Investigators and Trainers
- Questions and Answers
- Check in for Ops Tour and International Meeting

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Welcome to the RAMP Users Meeting

Enhancing Radiation Protection Worldwide through Collaborative Code Development and Maintenance

Mr. Michael Weber

Director of Nuclear Regulatory Research

Fall 2016 RAMP Meeting
Rockville, MD
October 17th-21th, 2016

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United States Nuclear Regulatory Commission
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Welcome!

- Welcome to the 2016 Fall RAMP Users Meeting
- Over 400 registered RAMP Users
- Over ~50 participants at this RAMP Meeting
  - Representatives from Countries
    - South Africa, Canada , South Korea, UAE, China and Taiwan
  - US Government Agencies – NRC, EPA, DOC/NIST, DHS, DOD
  - US State agencies - Ohio
  - US National Laboratories – PNNL, ORNL, ANL, SNL
  - Universities – University of Texas, University of Central Florida
  - Industry

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Nuclear Regulatory Research

- Mandated by Congress
- Three technical divisions and a support organization:
  - Division of Engineering
  - Division of Risk Analysis
  - Division of Systems Analysis
  - Program Management, Policy Development & Analysis Staff
- About 200 engineers, scientists, analysts, and support staff.
  - ~ 30% M.S. and 30% Ph.D.
- About $90M funding

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Research Mission

- Develop technical bases to support regulatory decisions
- Conduct confirmatory and anticipatory research
- Provide specialized technical expertise and tools
- Partner with national labs, commercial contractors, universities, other government agencies, industry organizations, and international organizations
- Issue Commission and congressionally mandated reports
- Manage the Generic Issues Program

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Key Research Areas

- **Radiation and Environmental Protection**
- Thermal-Hydraulics
- Fuel and Core
- Severe Accident and Accident Consequences
- Risk Assessment
- Human Reliability and Human Factors
- Fire Safety
- Natural Events
- Materials Performance
- Structural Performance
- Digital Instrumentation & Control and Electrical Engineering

www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1925/

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Research Roles

- Licensees and applicants have the primary responsibility for nuclear safety and security
- NRC determines if a safety or security issue exists
- NRC conducts confirmatory and anticipatory research to confirm safety and security
- NRC develops tools, codes, and information to confirm safety and security
- NRC does not conduct developmental research

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International Research Collaboration

- Strong international cooperation
- 100+ bilateral or multilateral agreements with over 20 countries
  - Cooperative Research Programs
- Shared insights and resources
- Wide range of technical activities, including
  - Fukushima Activities
  - Halden Reactor Project
  - Zirconium Fire during Loss-of-coolant Accident Study
  - Fire Research

Halden Lab

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Cooperative Research Programs

- **RAMP**: Radiation Protection Code Analysis and Maintenance Program to exchange information on radiation protection and dose assessment codes.
- **CSARP**: Cooperative Severe Accident Research Program to exchange information on severe accident safety issues related to reactor, spent fuel pool, and plant systems.
- **CAMP**: Code Applications and Maintenance Program to exchange information on thermal-hydraulic safety issues related to reactor and plant systems.
- **SGTIP**: Steam Generator Tube Integrity Program provides data and analysis for predicting the ability of degraded steam generator tubes to withstand normal operating and accident conditions.

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Importance of RAMP

- Collaborate on radiation protection, dose assessment, and emergency response computer codes
- Share knowledge about radiation safety through training, code discussions, and "in-kind" contributions
- Refine codes and models based on strengths and deficiencies from the user community
- Enhance nuclear and radiological safety
- Protect people and the environment

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Your Role

- Thank you for coming!
- Participate actively
- Share your insights
- Work together for safety
- Build networks
- Strengthen collaboration
- Enjoy Washington

Welcome to the 2016 RAMP Users Meeting

Rebecca Tadesse, Chief

Radiation Protection Branch

Office of Nuclear Regulatory Research

U.S.NRC

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Agenda

- What is RAMP?
- Benefits of RAMP membership
- RAMP Website
- RAMP Partners
- What is New in RAMP?
- Future Activities in RAMP
- Schedule at a Glance

What Is RAMP?

- RAMP is a Computer Code Management Program that will support development and maintenance of radiation/dose assessment codes
  - Streamline updates
  - Incorporating the latest accepted state of the art models
  - Prioritize technical updates
  - Achieve consistency in documentation
  - Implement a software QA program
  - Fiscally responsible by leveraging group dynamics
  - Implement centralized and consistent management and control structure
  - Responsive to the RAMP-user needs
  - Leverage the US NRC expertise in member country activities

RAMP Program

- RAMP Program:
  - Internal to NRC
    - Meeting Program Office Request
    - Meeting Software Quality Assurance Requirement
    - Aligning with changes in OIS (i.e. Windows 7)
    - Documenting Resources required to develop computer codes
    - Looking for ways to combine codes for greater efficiencies
  - Domestically and Internationally
    - Sharing expertise
    - Providing funds (~$20K) to help maintain codes used by Program Offices, Federal and State Agencies, International Regulatory Authorities

Benefits of RAMP

- Why Join RAMP?
- Larger RP community exercises codes more thoroughly
- User forums/groups benefit from multiple users
- More efficient use of resources (larger resource pool)

- Encouraging Organizations to join:
  - Regulators, licensees, vendor groups, etc.

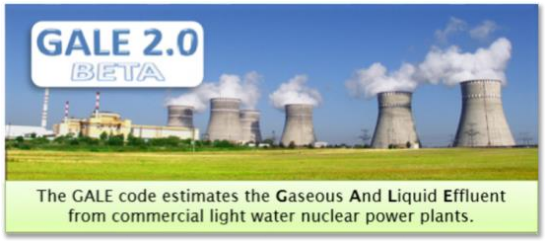
Benefits to Members

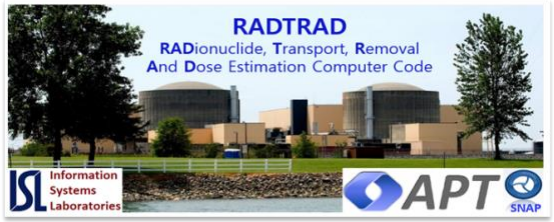
- Computer Codes will have:
  - Up-to-date ICRP Reports
  - Country Specific Reactor Types
  - International Units: Sv, Gy
  - Addressing other country specific needs

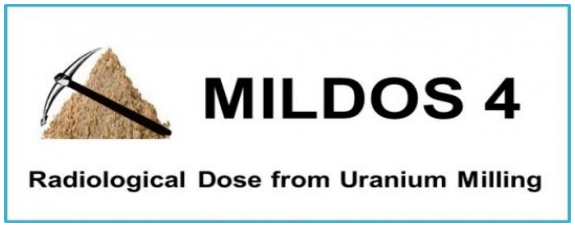
RAMP Website

www.usnrc-ramp.com

Computer Codes on RAMP Website



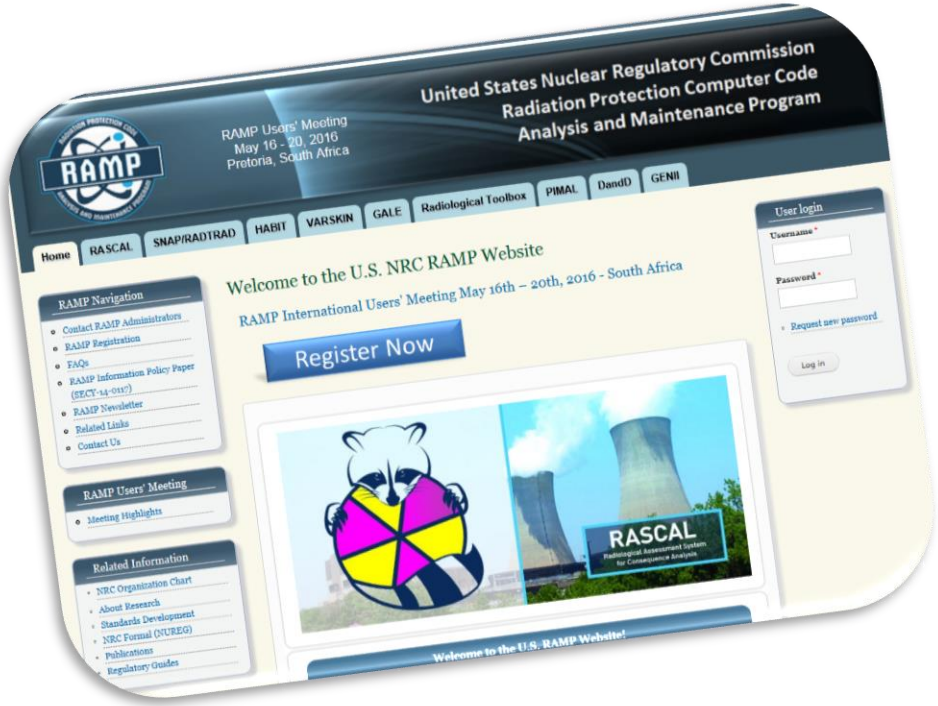




Atmospheric Codes

RAMP Membership

- RAMP: ~400
- RASCAL: ~150
- VARSKIN: ~350
- Users Forum
- Code Documentation
- Training Modules
- Support



Current RAMP International Agreements













What is New in RAMP?

- Code Updates
  - RASCAL –
    - Online Training Modules
    - Forum – use the forum!!!!
  - RADTRAD –
    - Test Reports, User Manuels
  - HABIT – GUI
    - Added new Dense Gas model
- New to RAMP
  - GENII
  - MILDOS
  - Atmospheric Codes

Future Activities in RAMP

- Include Additional Codes:
  - In talks with DOE for RESRAD, TurboFRMAC
- Updated Software Quality Assurance Program
- Combine Codes for Greater Efficiencies
- Maintain Code Development
  - Ensure Compatible platform
  - Consistent Documentation
- Develop online training and information modules
  - More RASCAL Modules, VARSKIN, RADTRAD
  - Health Physics and Radiation Safety Training
- Meeting regulatory requirements
  - Security and Safeguards

Schedule at a Glance

October 17 - 21, 2016 8am - 5pm		RAMP Users Group 2016 - Description of Training & Events				
Mon., Oct 17 2016	Morning Session	Welcome to RAMP - Opening Ceremony				
	Afternoon Session	RASCAL	VARSKIN	MILDOS	HABIT	Atmospheric Codes
	"Social Night Out" Evening Event - RAMP Users Group Networking Session					
Tues., Oct 18 2016	Morning Session	RASCAL	VARSKIN	MILDOS	*RAMP Discussions & Meetings	
	Afternoon Session					
Wed., Oct 19 2016	Morning Session	RASCAL	VARSKIN	MILDOS		
	Afternoon Session	GENII	RADTRAD	GALE	PiMAL	Country Meetings
	4:00 PM - NRC Emergency Response Operations Tour					
Thurs., Oct 20 2016	Morning Session	GENII	RADTRAD	GALE	PiMAL	*RAMP Discussions & Meetings
	Afternoon Session					
	4:00 PM - NRC Emergency Response Operations Tour					
Fri., Oct 21 2016 * 8am - 12pm	Morning Session	GENII	RADTRAD	GALE	*RAMP Discussions & Meetings	
	Afternoon Session	RAMP Closing Ceremony				

Welcome to the 2016 RAMP Users Meeting

Stephanie Bush-Goddard, Ph. D.

RAMP Program Manager
Radiation Protection Branch
Division of Systems Analysis
Office of Nuclear Regulatory Research

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Detailed Schedule Monday-Tuesday

Monday	Eisenhower (#21)	Washington Theater (#03)	Jackson (#20)	Lincoln (#19)	Monroe (#18)	Truman (#17)	Wilson (#16)
9am	Welcome - Opening Ceremony (9AM)		Help Desk				
noon	Lunch/Closed						
1pm	RASCAL	RAD Toolbox discussion	Help Desk	HABIT	Atmospheric Codes	VARSKIN	MILDOS
		DCFPAK discussion	Open Networking Area				
5pm	End Sessions/Closed						
6pm	"Social Night Out" Evening Event - RAMP Users Group Networking Session - Miller's Ale House						

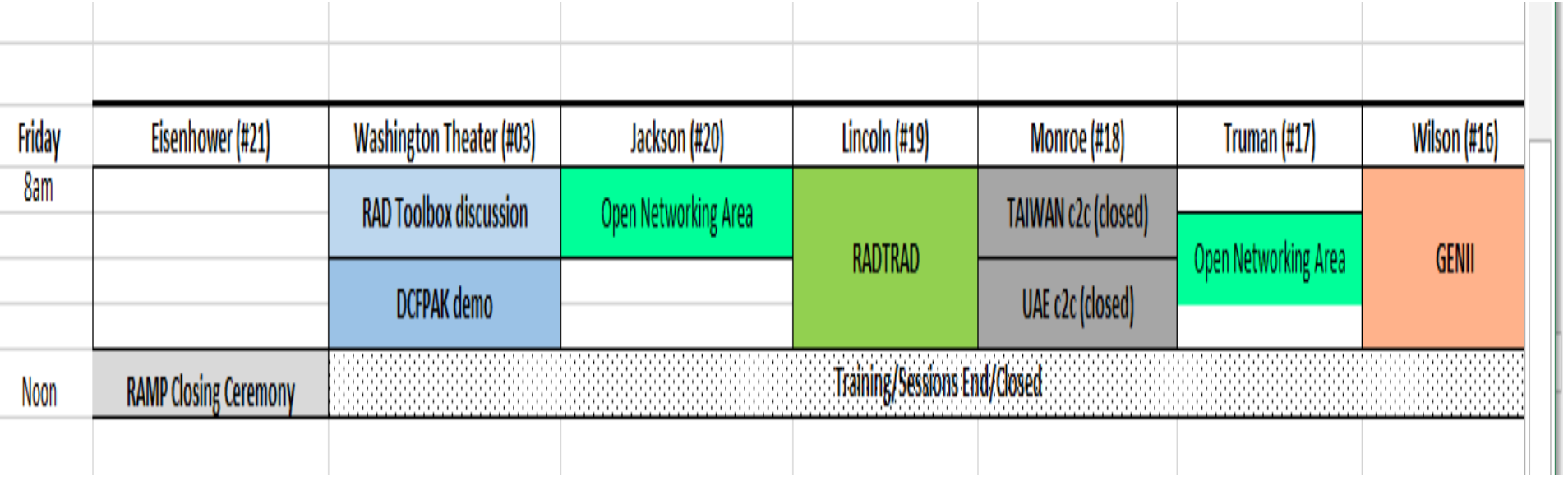
Tuesday	Eisenhower (#21)	Washington Theater (#03)	Jackson (#20)	Lincoln (#19)	Monroe (#18)	Truman (#17)	Wilson (#16)
8am	RASCAL	Open Networking Area	Help Desk	Open Networking Area	Open Networking Area	VARSKIN	MILDOS
Noon	Lunch/Closed						
1pm	RASCAL	RADTRAD discussion	Open Networking Area	Open Networking Area	CHINA C2C (closed)	VARSKIN	MILDOS
5pm	End Sessions/Closed						

Detailed Schedule Wed-Thurs

Wednesday	Eisenhower (#21)	Washington Theater (#03)	Jackson (#20)	Lincoln (#19)	Monroe (#18)	Truman (#17)	Wilson (#16)
8am	RASCAL	GENII discussion	Help Desk		GALE	VARSKIN (discussions only)	MILDOS
	Country to Country Luncheon		Open Networking Area				
Noon		Lunch/Closed					
1pm		Open Networking Area		RADTRAD	GALE	PiMAL (disuccsions)	GENII
4pm	NRC Emergency Response Operations Tour (4PM departure to US NRC HQ)						
5pm	Washington DC Night Time Tour (6:30 PM departure from Hilton)						

Thursday	Eisenhower (#21)	Washington Theater (#03)	Jackson (#20)	Lincoln (#19)	Monroe (#18)	Truman (#17)	Wilson (#16)
8am		RASCAL discussion	Open Networking Area	RADTRAD	SOUTH KOREA c2c (closed)	PiMAL	GENII
Noon	Lunch/Closed						
1pm	Open Networking Area		Open Networking Area	RADTRAD	Canada/MILDOS Canada NRC discussion (closed)	PiMAL	GENII
	Leave for Ops Tour						
5pm	NRC Emergency Response Operations Tour (4PM departure to US NRC HQ)						

Detailed Schedule Friday



Friday	Eisenhower (#21)	Washington Theater (#03)	Jackson (#20)	Lincoln (#19)	Monroe (#18)	Truman (#17)	Wilson (#16)
8am		RAD Toolbox discussion	Open Networking Area	RADTRAD	TAIWAN c2c (closed)		GENII
		DCFPAK demo			UAE c2c (closed)	Open Networking Area	
Noon	RAMP Closing Ceremony	Training/Sessions End/Closed					

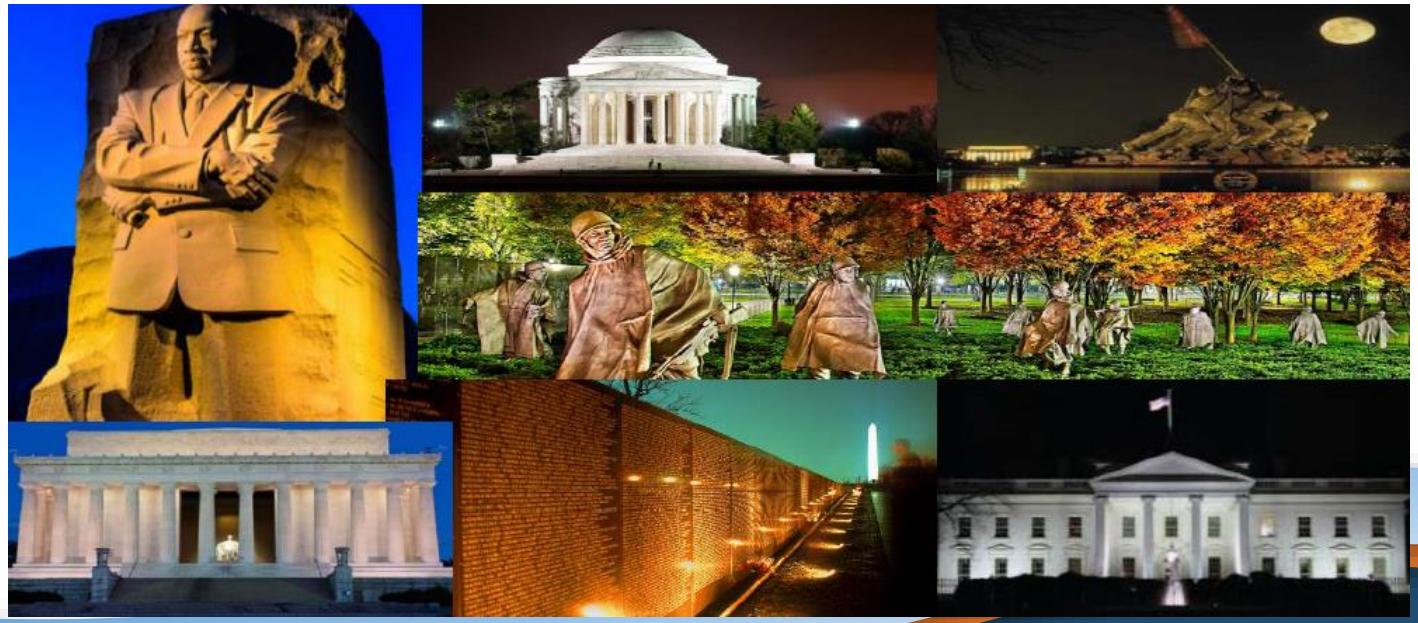
- Closing Ceremony at 12 noon
- RAMP Attendance Certificates will be distributed
  - Certificates can be mailed
- Please stay for group pictures

NRC Operations Center Tour

- Wednesday and Thursday at 4pm
- Take the Metro – meet at the registration desk

Enjoy Washington! - Washington DC Tour

- **Itinerary:**
  - 5:20pm Pick Up: Tour bus arrives at RAMP User Group Meeting Location
  - 6:20pm Meet tour guide at the White House Gifts - 3 hour private tour
  - 9:00pm Depart Washington DC for Rockville, MD
  - 10:00pm Drop Off: Returns to the RAMP User Group Meeting Location
- **Price: $55.50 per person** pay online.
  - Computers in Hilton Atrium



Enjoy Washington - Happy Hour

- Social Night Out
- **Date:** Monday, October 17, 2016
- **Time:** 4:30pm – 7:00pm
- **Location:** Millers Ale House, 1471 Rockville Pike, Rockville, MD 20852
- Program Booklet
  - Welcome Letters
  - Descriptions of Major Training
  - Nearby Dining
  - Local Activities

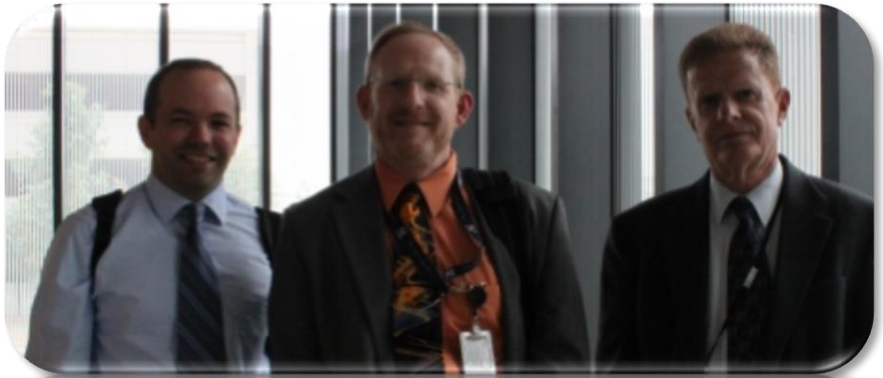
~~Your~~ Our Role

- We are glad you are here!
- Participate actively
- Share your insights
- Work together to enhance radiation protection and nuclear safety
- Build networks
- Strengthen collaboration
- Enjoy Washington

1st RAMP Users' Meeting Highlights

Mike Weber welcoming everyone

Getting to know each other



RAMP Team and International Participants

Establishing Sustainable Relationships

Building networks
through RAMP!

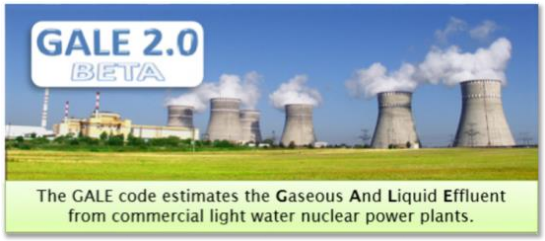
South Africa -
RAMP Users' Meeting Highlights

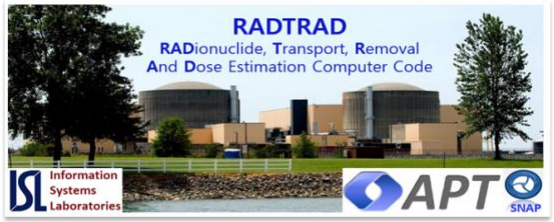
Ask Us! The RAMP Team

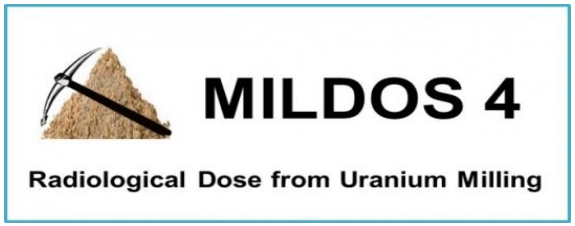
Networking Session

Networking Session

Computer Codes on RAMP Website







Atmospheric 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

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.

RAMP Code Team:

VARSKIN

- Stephanie Bush-Goddard
  - U.S. NRC
- David Hamby, Ph.D.
  - Oregon State University

RAMP Code Team:

GENII

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

RAMP Code Team:

Atmospheric Codes

- Stephanie Bush-Goddard
  - U.S. NRC
- Kevin Quinlan, Technical Monitors
  - U.S. NRC
- Brad Harvey, Technical Monitors
  - U.S. NRC
- Jeremy Rishel
  - Pacific Northwest National Laboratory

RAMP Code Team:

PIMAL

- Tanya Oxenberg, Ph.D.
  - U.S. NRC
- Vered Schaffer, Ph.D.
  - U.S. NRC
- Sami Sherbini, Ph. D.
  - U.S. NRC; Sr. Technical Advisor
- Shaheen Dewji, Ph. D.
  - Oak Ridge National Laboratory
- Michael Bellamy, Ph. D.
  - Oak Ridge National Laboratory
- Nolan Hertel, Ph. D.
  - Oak Ridge National Laboratory
- Mauritius Hiller, Ph. D.
  - Oak Ridge National Laboratory

RAMP Code Team:

GALE

- John Tomon, Ph.D.
  - U.S. NRC, COR
- Ken Geelhood
  - Pacific Northwest National Laboratory
- Walter Luscher, Ph.D.
  - Pacific Northwest National Laboratory
- April Augustine, PMP
  - Pacific Northwest National Laboratory

RAMP Code Team:

HABIT

- Casper Sun, Ph.D.
  - U.S. NRC, COR
- Tom Spicer, Ph. D.
  - University of Arkansas
- Wendy Chinchilla
  - Leidos

RAMP Code Team:

Radiological Toolbox

- Casper Sun, Ph.D.
  - U.S. NRC
- Tanya Oxenberg, Ph.D.
  - U.S. NRC
- Sami Sherbini, Ph. D.
  - U.S. NRC; Sr. Technical Advisor
- Shaheen Dewji, Ph. D.
  - Oak Ridge National Laboratory
- Michael Bellamy, Ph. D.
  - Oak Ridge National Laboratory
- Nolan Hertel, Ph. D.
  - Oak Ridge National Laboratory
- Mauritius Hiller, Ph. D.
  - Oak Ridge National Laboratory

RAMP Code Team:

DandD

- Stephanie Bush-Goddard, Ph. D.
  - U.S. NRC, PM
- Adam Schwartzman
  - U.S. NRC
- Cynthia Barr
  - U.S. NRC

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

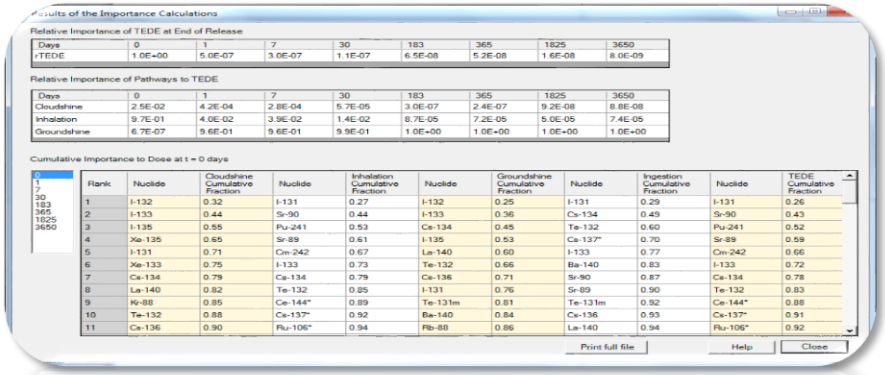
RASCAL Use

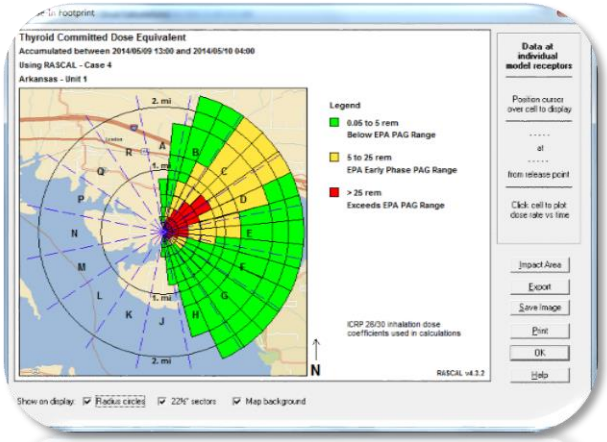
- Who
  - Response organizations
- When
  - Pre-release or plume phase of radiological release to atmosphere
- Why
  - To help inform or evaluate protective actions

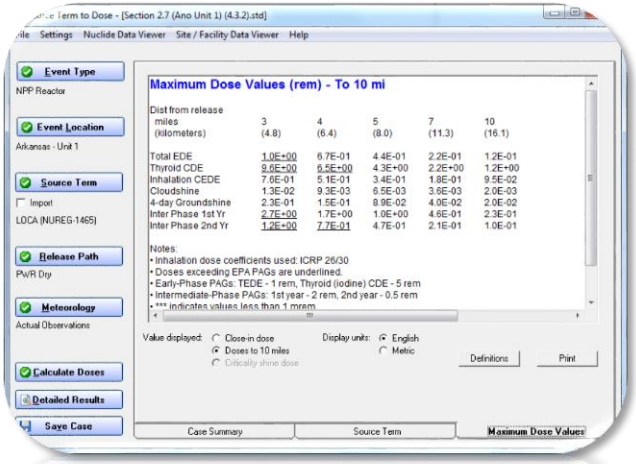
RASCAL Methods

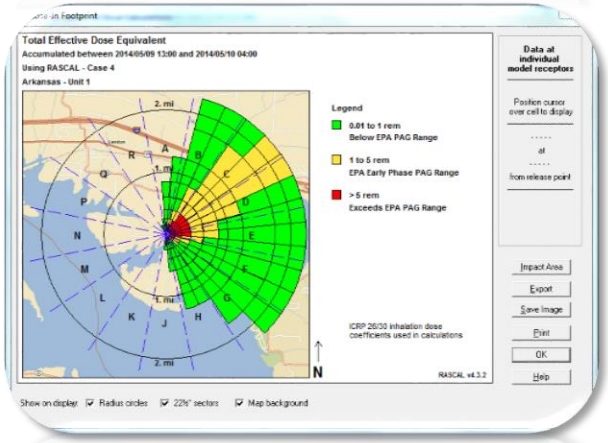
RASCAL Methods

- Tabular and graphical outputs



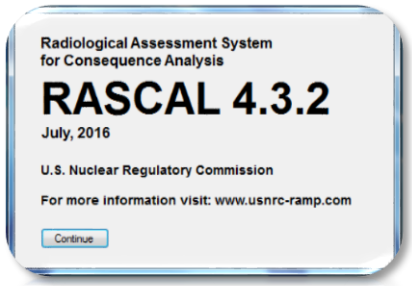






RASCAL Information

- 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

RAMP Codes

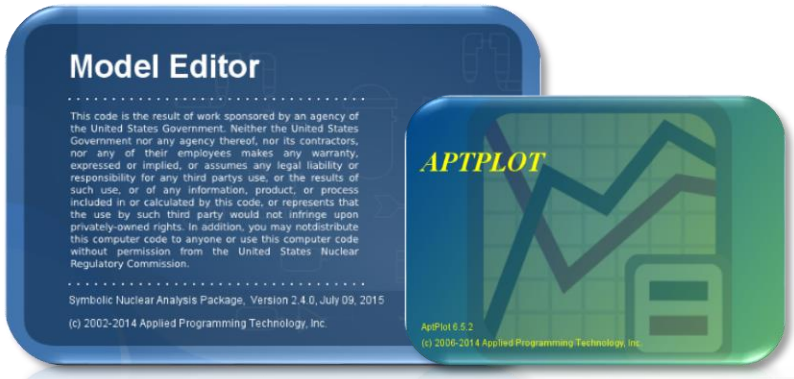
SNAP/RADTRAD

SNAP/RADTRAD

Symbolic Nuclear Analysis Package

RADionuclide Transport, Removal And Dose Estimation

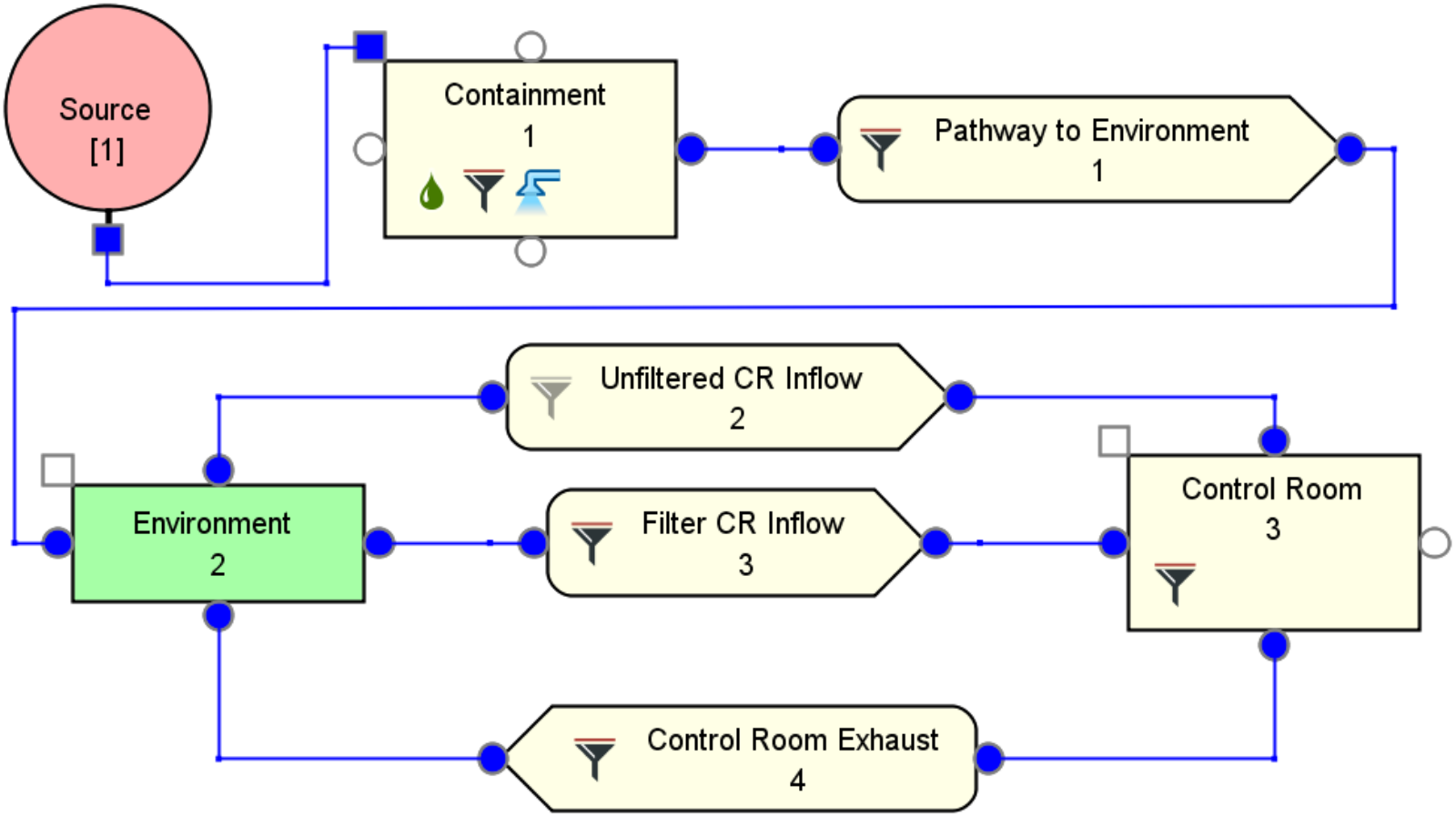
Information Systems Laboratories



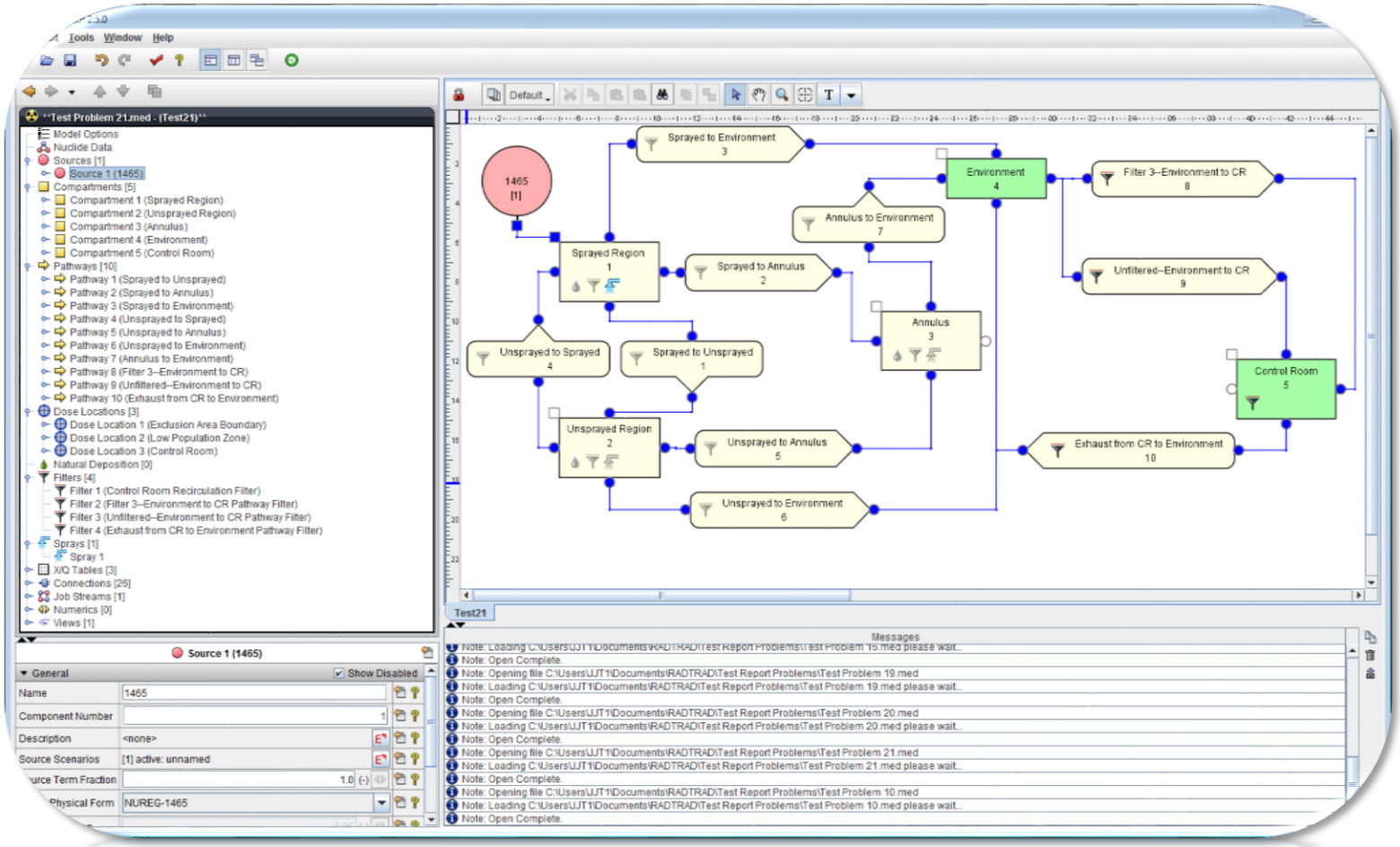
SNAP/RADTRAD Use

- 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"

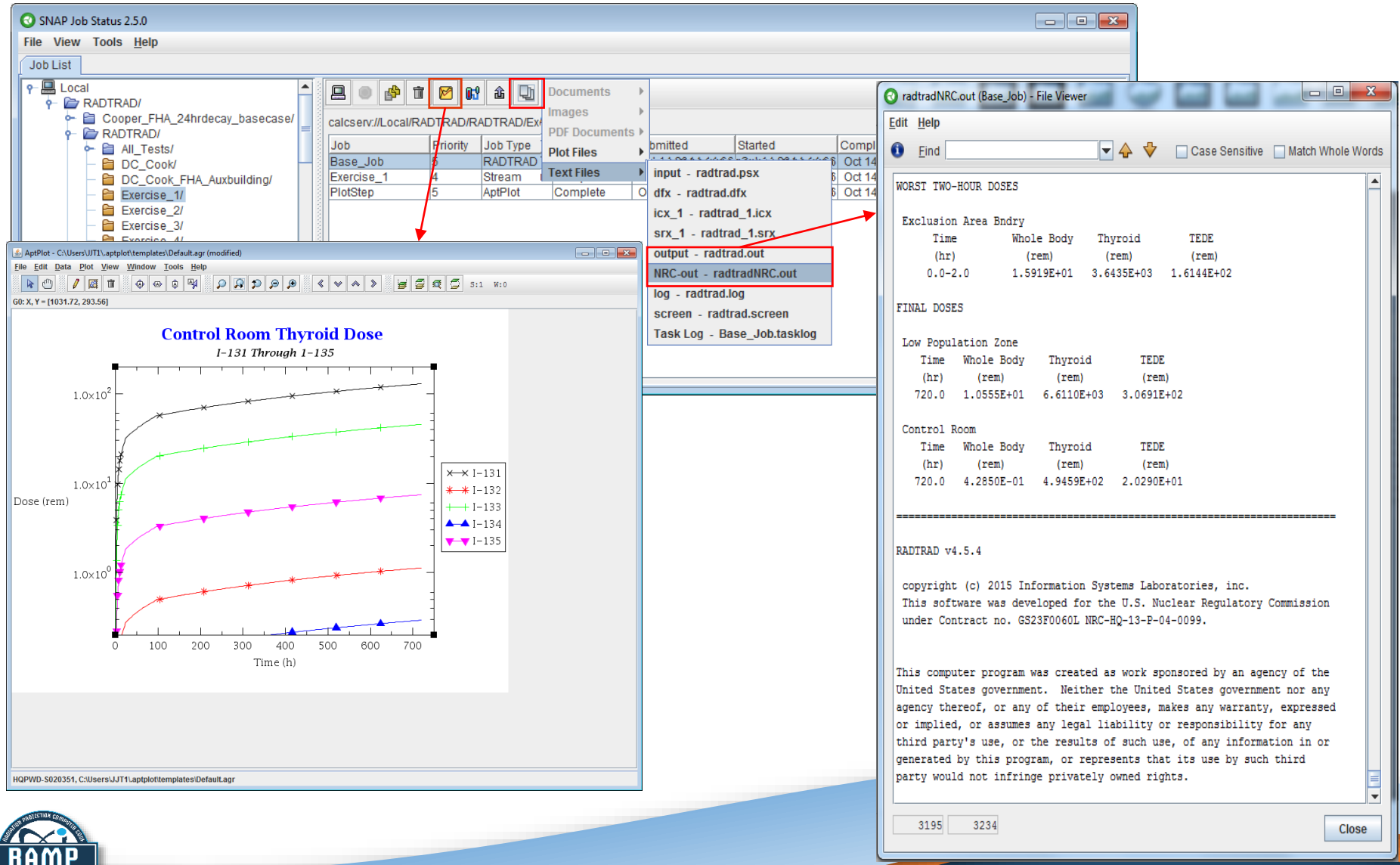
SNAP/RADTRAD Methods



SNAP/RADTRAD Methods



SNAP/RADTRAD Outputs



SNAP/RADTRAD Information

- SNAP/RADTRAD
  - SNAP Model Editor (v2.5.0)
  - RADTRAD Plugin (v4.11.2)
  - RADTRAD-AC (v4.5.4)
  - AptPlot (v6.70)
- 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

GALE 2.0

GALE 2.0

Gaseous And Liquid Effluent Computer code

Computerized mathematical model for calculating the releases of radioactive material in gaseous and liquid effluents from BWRs and PWRs.

GALE Use

- The NRC uses the GALE code as licensing analysis code to verify (confirm) that the plant's design meets the requirements of Appendix I to Title 10 of the Code of Federal Regulations (CFR) Part 50.

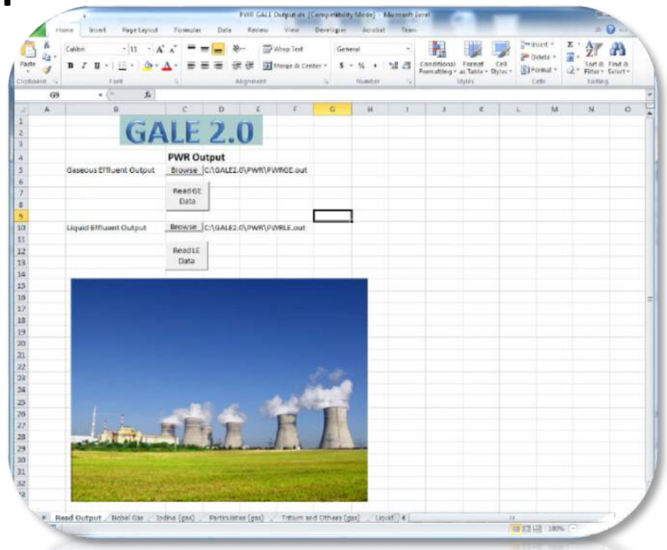
GALE Methods

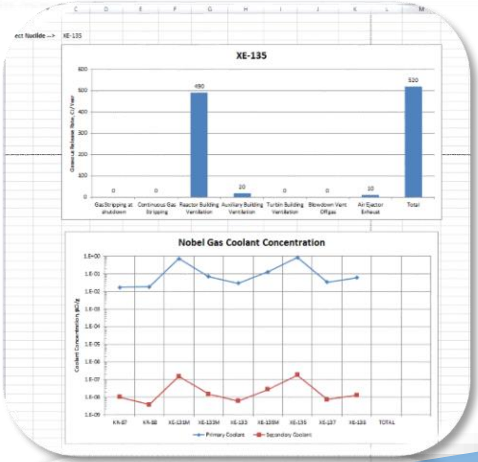
- GALE 2.0
- Code runs on Microsoft Windows PCs
- GUI was added to facilitate user interactions
- Ability to read legacy input files from GALE
- Code benchmarking was performed to validate GALE 2.0 to GALE 09
- Hard-coded parameters were updated to reflect recent plant operations data

GALE Outputs

- Text file output and Excel spreadsheets

```
                         Sample PWR                                      PWR
            THERMAL POWER LEVEL (MEGAWATTS)                         3400.00000
            PLANT CAPACITY FACTOR                                      0.90
            MASS OF PRIMARY COOLANT (THOUSAND LBS)                   550.00000
            PRIMARY SYSTEM LETDOWN RATE (GPM)                         75.00000
            LETDOWN CATION DEMINERALIZER FLOW (GPM)                    7.50000
            NUMBER OF STEAM GENERATORS                                 4.00000
            TOTAL STEAM FLOW (MILLION LBS/HR)                         15.00000
            MASS OF LIQUID IN EACH STEAM GENERATOR (THOUSAND LBS)    112.50000
            BLOWDOWN RATE (THOUSAND LBS/HR)                           75.00000
            CONDENSATE DEMINERALIZER REGENERATION TIME (DAYS)          8.40000
            CONDENSATE DEMINERALIZER FLOW FRACTION                     0.65000

LIQUID WASTE INPUTS
                                 FRACTION  FRACTION  COLLECTION  DECAY
     STREAM       FLOW RATE   OF PCA DISCHARGED    TIME       TIME      DECONTAMINATION  FACTORS
                  (GAL/DAY)                       (DAYS)     (DAYS)       I          CS         OTHERS
 SHIM BLEED RATE   1.44E+03    1.0000    0.1000   22.6000    0.9300   5.00E+03  2.00E+03  1.00E+05
 EQUIPMENT DRAINS  3.30E+02    0.9700    0.1000   22.6000    0.9300   5.00E+03  2.00E+03  1.00E+05
 CLEAN WASTE INPUT 9.80E+02    0.0930    0.1000    5.7000    0.1300   5.00E+02  1.00E+03  1.00E+04
 DIRTY WASTES      2.10E+03    0.0100    1.0000    3.8000    0.1900   5.00E+02  1.00E+03  1.00E+04
BLOWDOWN           2.16E+05              0.000     0.000     0.000    1.00E+03  1.00E+02  1.00E+03
UNTREATED BLOWDOWN 0.00E+00              1.000     0.0000.000    1.00E+00  1.00E+00  1.00E+00
REGENERANT SOLS    3.40E+03              0.100     4.700     0.370    5.00E+02  1.00E+03  1.00E+04

GASEOUS WASTE INPUTS
            THERE IS CONTINUOUS STRIPPING OF FULL LETDOWN FLOW
            FLOW RATE THROUGH GAS STRIPPER (GPM)                      75.22916
            HOLDUP TIME FOR XENON (DAYS)                              60.00000
            HOLDUP TIME FOR KRYPTON (DAYS)                             3.54000
            FILL TIME OF DECAY TANKS FOR THE GAS STRIPPER (DAYS)       0.00000
            PRIMARY COOLANT LEAK TO AUXILIARY BLDG (LB/DAY)          160.00000
            GAS WASTE SYSTEM     PARTICULATE RELEASE FRACTION          0.01000
            FUEL HANDLG BLDG     IODINE RELEASE FRACTION               0.10000
                                 PARTICULATE RELEASE FRACTION          1.00000
            AUXILIARY BLDG       IODINE RELEASE FRACTION               0.10000
                                 PARTICULATE RELEASE FRACTION          1.00000
            CONTAINMENT VOLUME (MILLION FT3)                           2.71800
            FREQUENCY OF PRIMARY COOLANT DEGASSING (TIMES/YR)          2.00000
            PRIMARY TO SECONDARY LEAK RATE (LB/DAY)                   75.00000
            THERE IS NOT A KIDNEY FILTER
```

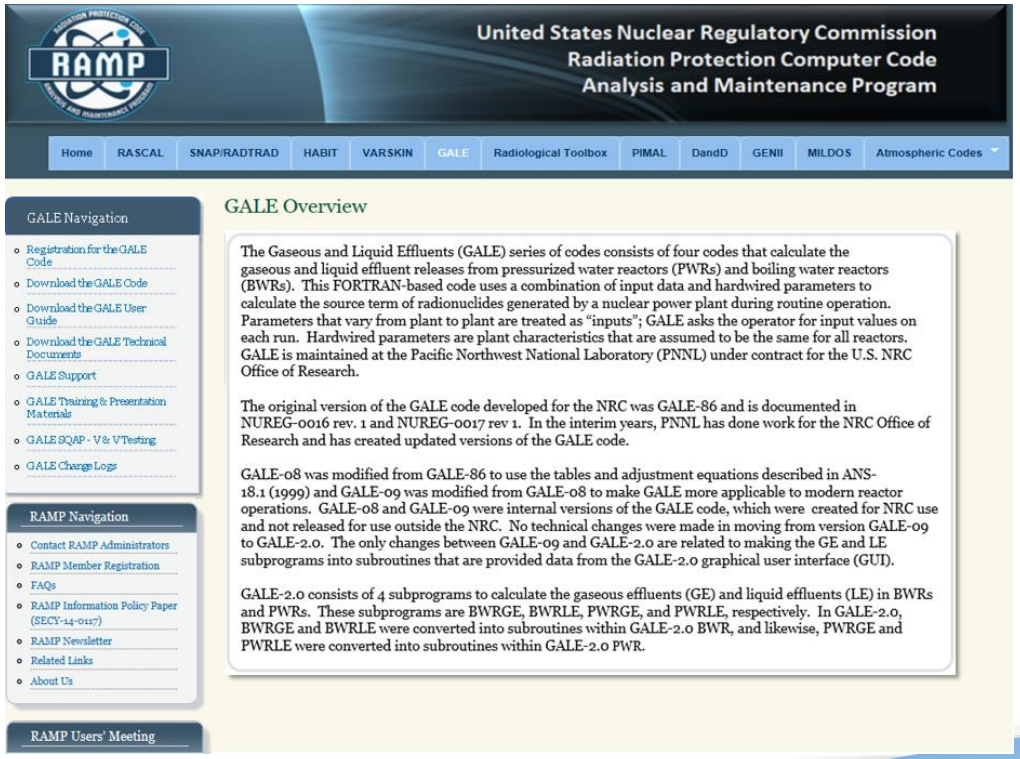




C	D	E	F	G	H	I	J	K	L	M
			Gas Stripping at shutdown	Continuous Gas Stripping	Reactor Building Ventilation	Auxiliary Building Ventilation	Turbin Building Ventilation	Blowdown Vent Offgas	Air Ejector Exhaust	Total
KR-87	1.70E-02	1.00E-08	0.00E+00	0.00E+00	2.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E+00
KR-88	1.80E-02	3.80E-09	0.00E+00	0.00E+00	4.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.00E+00
XE-131M	7.30E-01	1.50E-07	1.10E+01	4.70E+01	1.60E+03	1.70E+01	0.00E+00	0.00E+00	8.00E+00	1.70E+03
XE-133M	7.00E-02	1.50E-08	0.00E+00	0.00E+00	1.10E+02	2.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+02
XE-133	2.90E-02	6.00E-09	0.00E+00	0.00E+00	5.80E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.80E+01
XE-135M	1.30E-01	2.70E-08	0.00E+00	0.00E+00	3.00E+00	3.00E+00	0.00E+00	0.00E+00	1.00E+00	7.00E+00
XE-135	8.50E-01	1.80E-07	0.00E+00	0.00E+00	4.90E+02	2.00E+01	0.00E+00	0.00E+00	1.00E+01	5.20E+02
XE-137	3.40E-02	7.10E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
XE-138	6.10E-02	1.30E-08	0.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E+00
TOTAL	NOBLE	GASES	4.80E+03							

GALE Information

- Version 3.0
- Website Updates



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

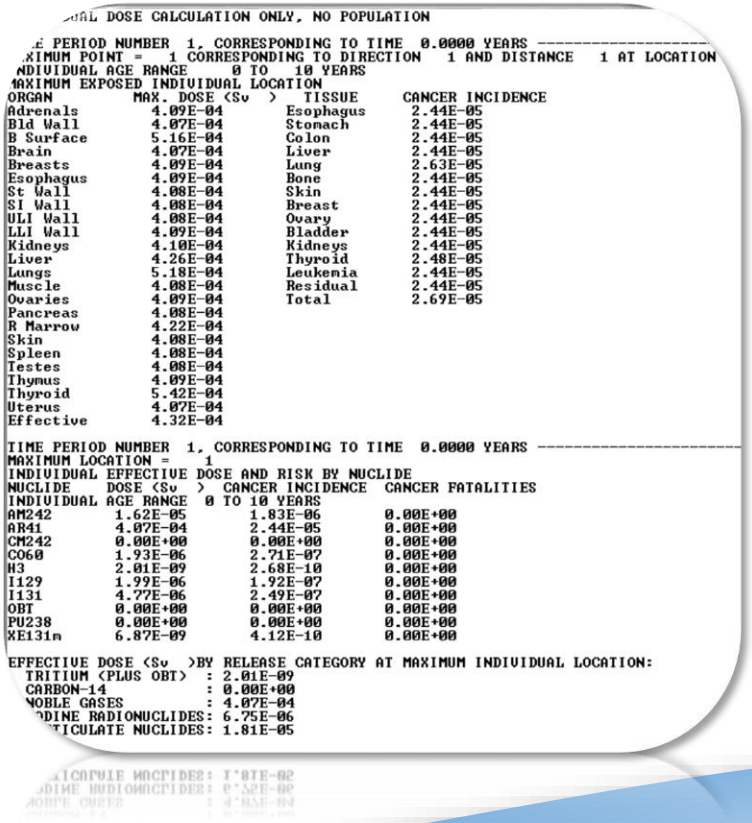
- GENII is designed for use by environmental assessors in industry, government, and academia.
- Uses include annual demonstration of compliance with regulations, accident analyses, and planning for emergency response.
- GENII is an NQA-1 qualified code with extensive documentation.

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

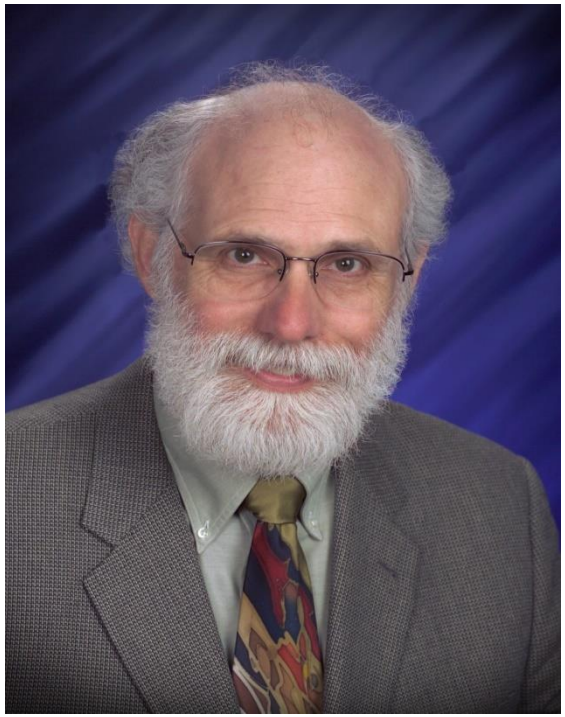
- Output is in terms of human-readable tabular data on radiation dose and dose rate.



```
     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.



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 support 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

509-375-6974

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

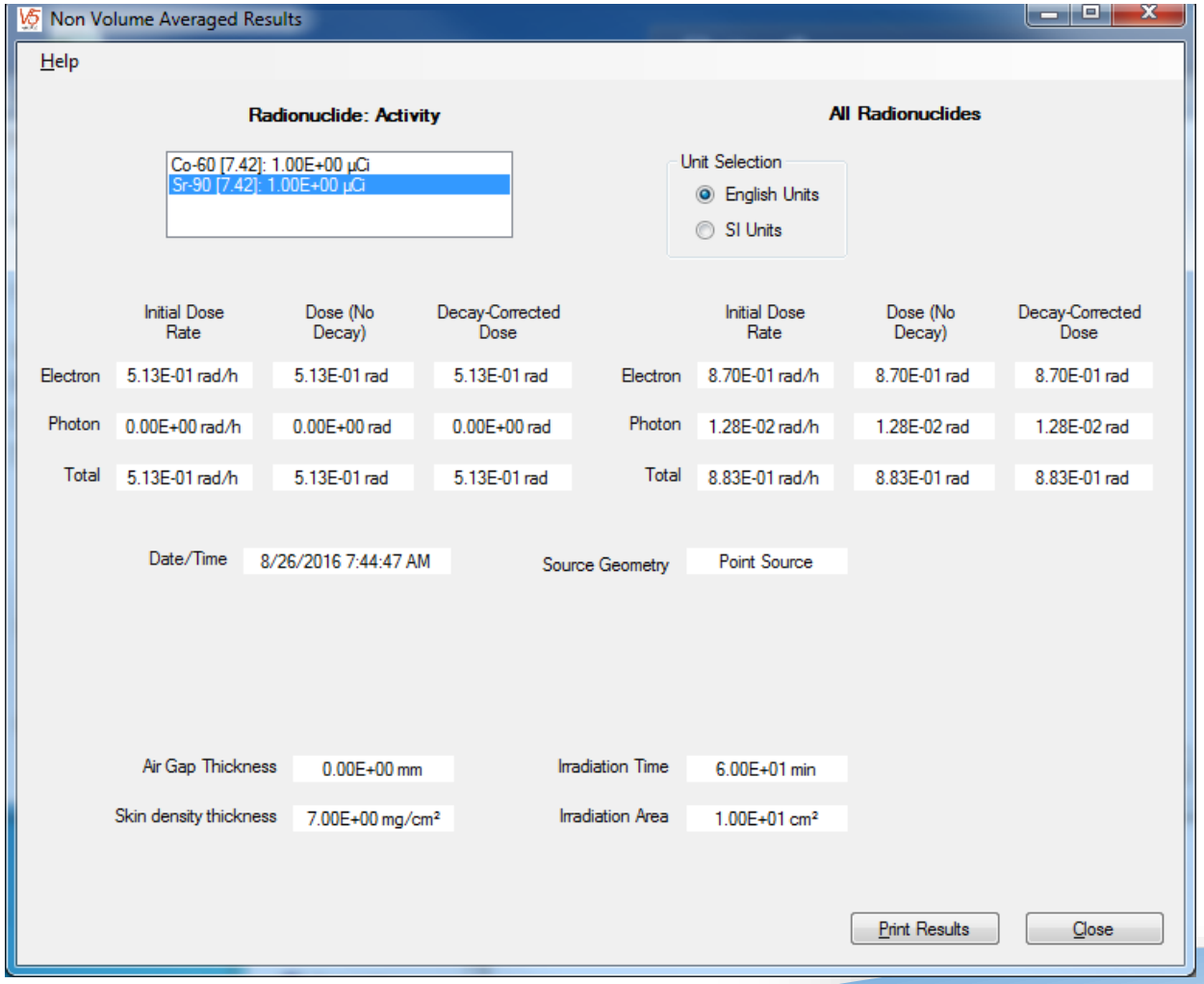
VARSKIN Use

- Used by NRC Staff and Licensees
- To show compliance with 10 CFR 20.1201(c)
- As stated therein, the shallow dose equivalent to skin is calculated at the location receiving the highest dose within a 10 cm2 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 5.2
- V5.3 will be released shortly
- User's Group has ~350 members
  - https://web.engr.oregonstate.edu/varskin
- Our wish list includes:
  - User's Group technical conference
  - Web-based use
  - Injected-source scenario
  - Sensitivity/uncertainty methods

RAMP Codes

MILDOS 4

Radiological Dose from Uranium Milling

MILDOS 4

Radiological Dose from Uranium Milling

Estimates the radiological impacts of airborne emissions from uranium milling facilities, both conventional uranium ore operations and operations associated with in situ recovery facilities

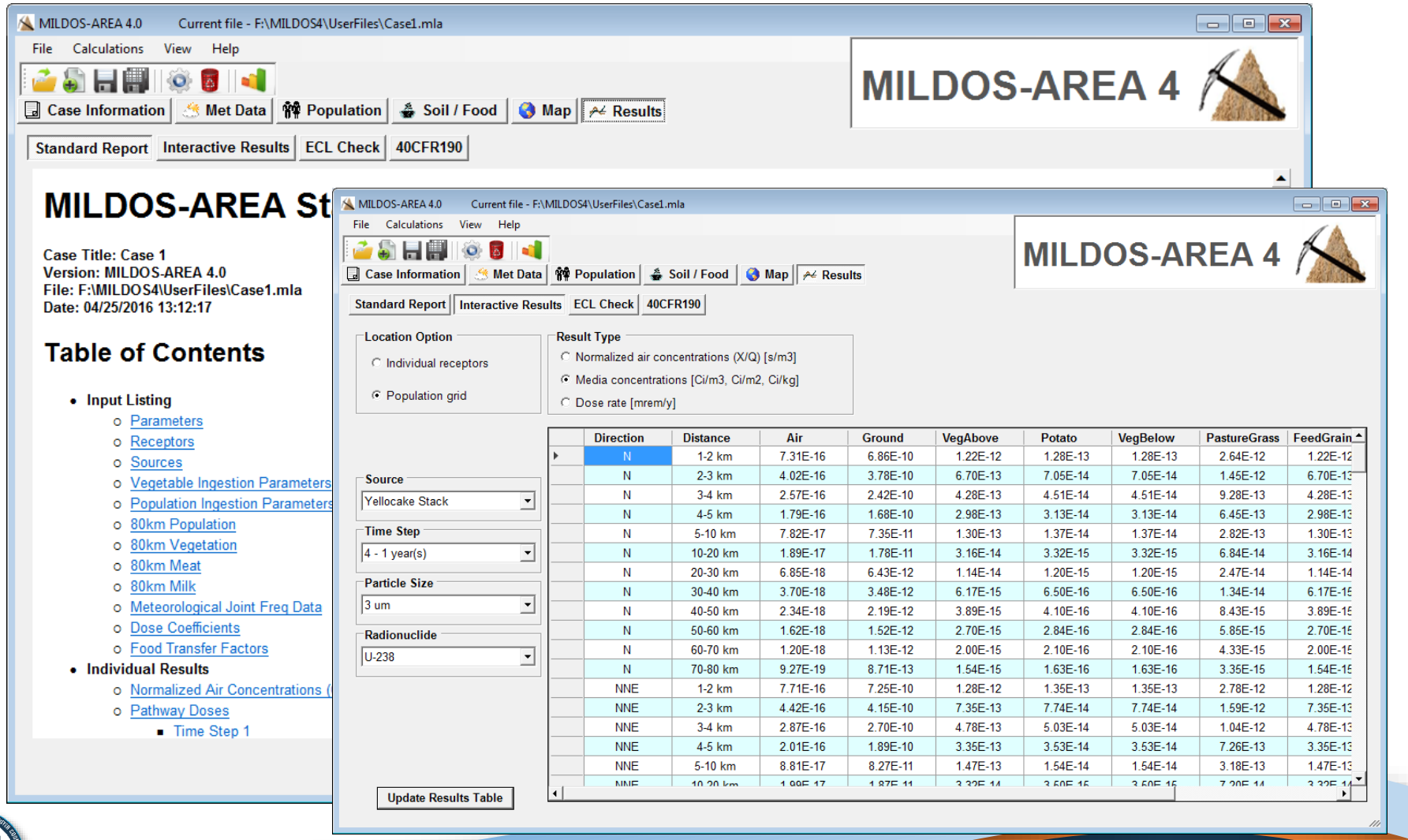
MILDOS Use

- Who – Uranium recovery facility applicants / licensees and NRC staff
- When – Prior to facility construction or modification
- Why – Give reasonable assurance that public health standards will not be exceeded (dose from Rn daughters included) (10 CFR 20, 40 CFR 90)

MILDOS Methods

- Inputs
  - U- and Th-series isotope concentrations
  - Recovery facility /environmental parameters
- Models/Calculations
  - Particulate emission model for ore/tailings
  - Gaussian plume air dispersion with plume rise, dry+wet deposition, gravitational settling
  - Individual and population dose estimates for inhalation, external, and ingestion exposure

MILDOS Outputs



MILDOS Information

- Version 4 released in May 2016
  - New
    - Th-232 series radionuclides (Th ores)
    - Sensitivity analysis
    - Meteorological data pre-processor
    - More user accessible parameters
  - Revised
    - Area source model
    - Graphical user interface (complete re-write of GUI + code)
- Currently updating default parameter values

RAMP Codes

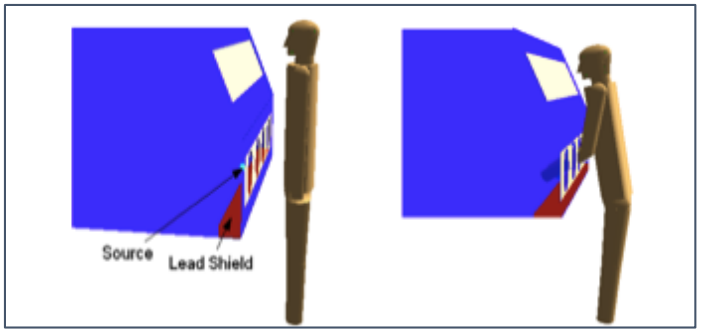
PIMAL

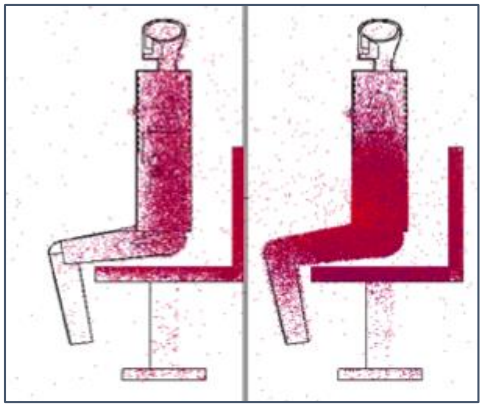
- PIMAL 4.1.0 software employs a graphical interface to adjust the posture of a phantom.
- Generates a corresponding input file for the Monte Carlo N-Particle (MNCP) radiation transport code;
- Performs the radiation transport simulations for dose calculations in MCNP.

PIMAL Use

- The simple GUI interface permits definition of phantom geometry, internal and external source simulation and visualization, and native execution to MCNP yielding absorbed organ dose values.

PIMAL as a glovebox worker in a traditional vertical upright posture (left) and in a realistic posture better representing the worker's position (right). [1]

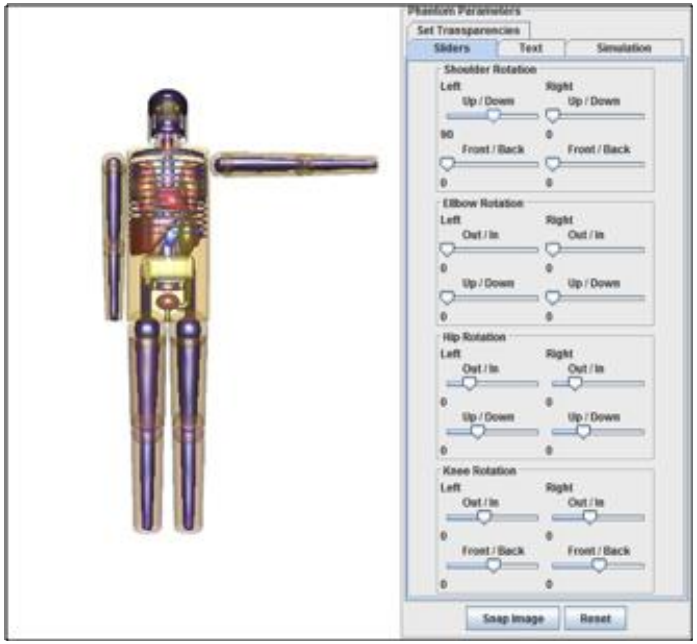




PIMAL phantoms modeled as I-131 patient seated on a bus behind a member of the public. [2]

PIMAL Methods

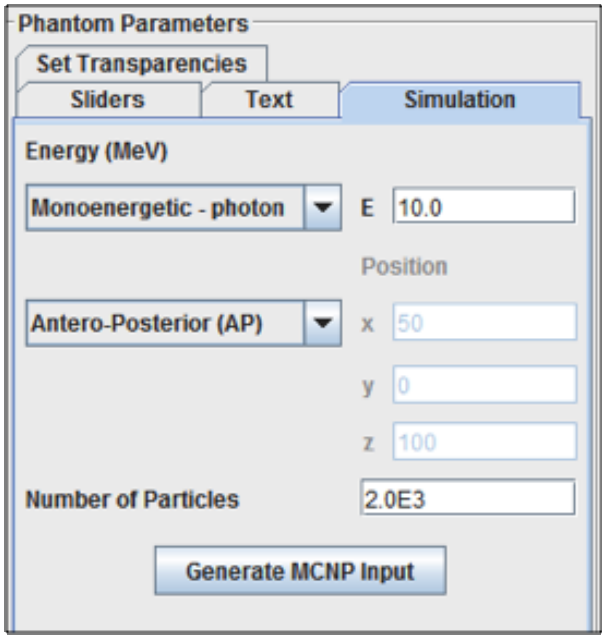
- Geometry Customization
  - Phantom geometry can be articulated using slider bars or textbox input of joint angle.
  - Customizable joints: shoulders, elbows, hips, knees



Screenshot of PIMAL 4.1.0 GUI Interface with sliders to define joint articulation of limbs.

PIMAL Methods

- Source Configuration
  - Source Energies and Spectra
    - Radionuclide sources (60Co, 131I, 134Cs)
    - X-ray sources (80-120 kVp)
    - Neutron spectra (AmBe or PuBe)
  - External Source Configuration
    - Point source (user specified X, Y, Z coordinates)
    - Standard irradiation geometries (AP, PA, RLAT, LLAT, ISO)
  - Organ Volume Sources
    - Brain, Thyroid, Heart Wall/Content, Stomach Wall/Content, Liver, Left/Right/Both Lungs, Left/Right Kidney, Pancreas



PIMAL source configuration simulation tab.

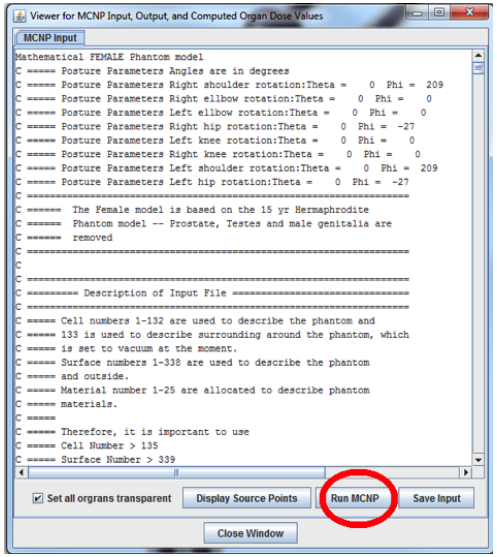
PIMAL Methods

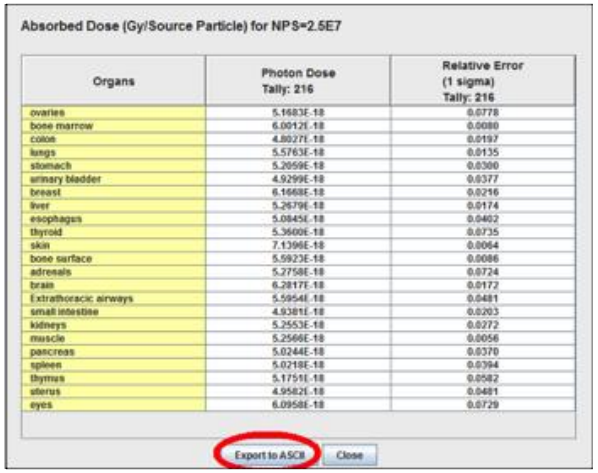
- Source Visualization
  - PIMAL has the ability to natively visualize the pre-defined sources, both internal and external.

PIMAL Source Visualization – LLAT external plane (left); internal brain source (right).

PIMAL Outputs

- MCNP input (.i) file is generated and executed. The option to modify the input file and execute via the MCNP command prompt is also possible for more advanced MCNP users.





- Summary table of organ absorbed doses and relative errors appear upon completion of the MCNP simulation.
- Output table can be easily exported to an ASCII file.
- MCNP output (.o) file is also saved in the working directory should users want to analyze the output in detail.

PIMAL Information

- References
  - [1] Akkurt, Hatice, Kursat Bekar, and K. Eckerman. "Assessment of Organ Doses for a Glovebox Worker Using Realistic Postures with PIMAL and VOXMAT." Trans. of Am. Nuc. Soc 101 (2009): 671-673.
  - [2] Dewji, S., et al. "Estimated dose rates to members of the public from external exposure to patients with 131I thyroid treatment." Medical physics 42.4 (2015): 1851-1857.
- Contact

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Oak Ridge National Laboratory

Center for Radiation Protection Knowledge

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Tel: (865) 576-9348

PIMAL e-mail: pimal@ornl.gov

CRPK e-mail: crpk@ornl.gov

RAMP Codes

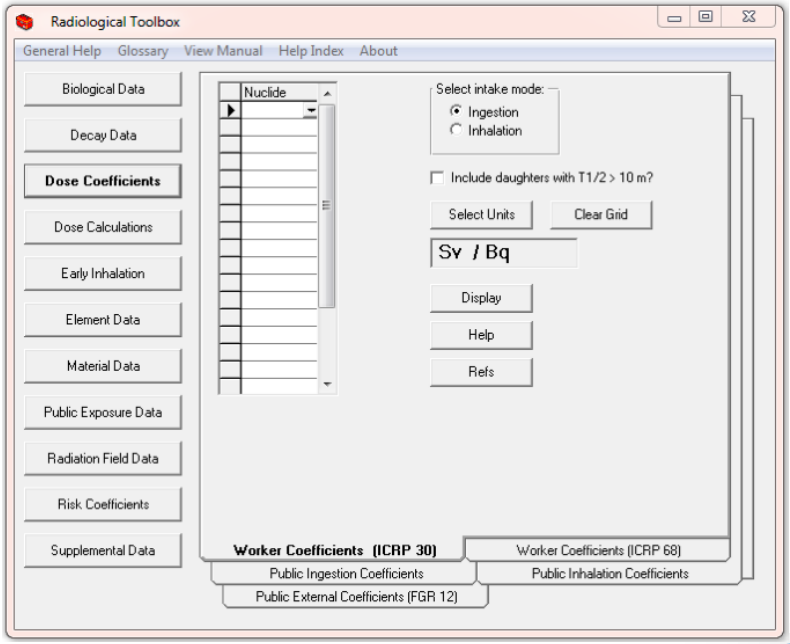
RADIOLOGICAL TOOLBOX

Rad Toolbox

Radiological Toolbox 3.0.0 software is designed to provide electronic access to a vast and varied array of data needed in the field of radiation protection and shielding.

RadToolbox Use

- Initially designed to serve the needs of the radiation protection specialist in the field, provides invaluable information to radiation protection and shielding specialists in electronic format.



RadToolbox Methods

- Biological Data

The Biological Data section consists of the following:

- Biokinetic Models from ICRP 68 and 72
- Bioassay Data consisting of urinary and fecal excretion data and retention data
- Composition of Tissues from Coursey et al.
- Organ Masses from ICRP Publications 23, 72, and 89
- ICRP 89 Reference Values providing an extensive set of anatomical and physiological reference values
- Radiation Health Effects, both deterministic and stochastic, of ionizing radiation summarized from various sources

RadToolbox Methods

- Decay Data
  - Energies and intensities of the radiations emitted during nuclear transformations (decays) from ICRP Publication 107.
- Dose Coefficients
  - Access to 5 sets of nuclide-specific dose coefficients.
  - For each coefficient dataset, it is possible to display up to 20 nuclides at a time for a chosen route of exposure or intake.
- Dose Calculations
  - The Dose Calculations collection was developed to enable rather simple numerical calculations of dose for a mixture of radionuclides.
  - Mixture can consist of up to 20 radionuclides.

RadToolbox Methods

- Early Inhalation
  - Early Inhalation collection provides a means to derive inhalation dose coefficients for deterministic health effects.
- Dose Coefficients
  - Access to five sets of nuclide-specific dose coefficients. For each coefficient dataset, it is possible to display up to 20 nuclides at a time for a chosen route of exposure or intake.
- Dose Calculations
  - Developed to enable rather simple numerical calculations of dose for a mixture of radionuclides. The mixture can consist of up to 20 radionuclides.

RadToolbox Methods

- Risk Coefficients
  - Provides access to the risk coefficients of Federal Guidance Report 13. The data is presented for each of 14 cancer sites.
  - Mortality Risk Coefficient -- an estimate of the risk to an average member of the US population of dying from cancer as a result of the intake of the radionuclide or external exposure to its emitted radiations.
  - Morbidity Risk Coefficient -- a comparable estimate of the average total risk of experiencing a radiogenic cancer, whether or not the cancer is fatal.

RadToolbox Methods

- Element Data
  - Provides access to interaction coefficients for alpha, electron, photon, and neutron radiations in elemental absorbers.
  - User may select the type of data (coefficient) for display and its units as well as plot it as a function of energy.
- Material Data
  - Provides access to various radiological properties of materials. Interaction and kerma coefficients for the materials are derived using elemental compositions.

RadToolbox Methods

- Public Exposure Data
  - The Public Exposure Data collection contains data such as:
  - Natural Background Radiation
  - Background Radiation in the Body
  - Radionuclides in Materials
  - Radionuclides in Devices
  - Primordial Radionuclides
  - Typical Exposures during Medical Procedures

RadToolbox Methods

- Radiation Field Data
  - Radiation Field Data collection provides access to conversion coefficients for the operational dose quantities and organ dose coefficients for mono-energetic neutron and photon radiation fields.
  - Organ dose coefficients are available for antero-posterior, posterio-anterior, left-lateral, right-lateral, rotational, and isotropic exposure geometries.

RadToolbox Methods

- Supplemental Data
  - Provides access to other radiation and radiation protection data which includes:
  - SI Units
  - Physical Constants
  - Conversion Factors
  - International Nuclear and Radiological Event Scale (INES)
  - Formulas
  - Web Pages
  - DOE Dose Ranges
  - Transport Package Regulations (A1/A2 Table)

RadToolbox Information

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Slide acknowledgements: Issac D'Agostino (CRPK-Georgia Tech Intern)

RAMP Codes

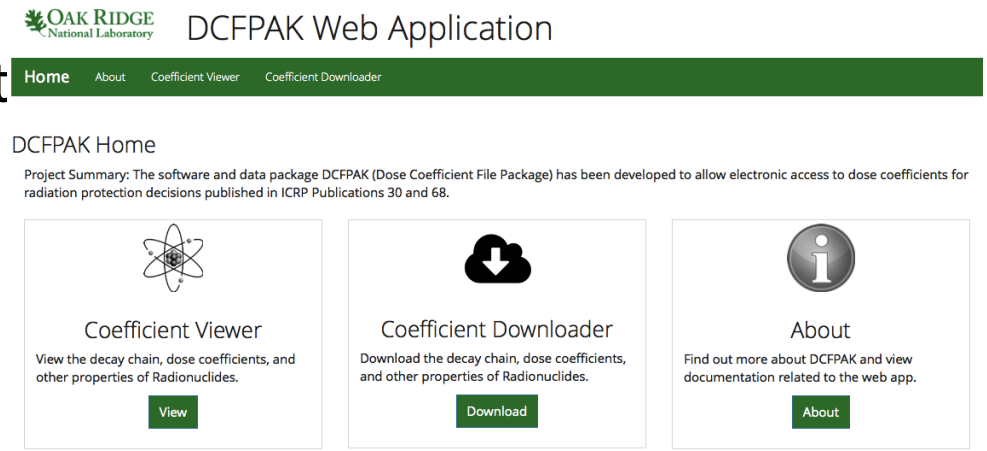
DCFPAK

DCFPAK

- The software and data package DCFPAK (Dose Coefficient File Package) provides electronic access to
- Nuclear decay data
- Dose and risk coefficients for exposure to radionuclides
- Eight versions of DCFPAK from 1996 through 2008
- Current version DCFPAK 3.0 has an expanded set of radionuclides addressed in the inhalation and ingestion scenarios
- DCFPAK 4.0 is due for release shortly

DCFPAK Project

- A joint project between Oak Ridge, Argonne, and Sandia National Laboratories to resolve key issues with DCFPAK
- Transform DCFPAK data into a common format
- Provide a common DCFPAK version across the user community
- Provide a common point



- Solution was to develop
- a DCFPAK Website.
- https://www.dcfpak.org,

DCFPAK Output

- Exportable as XML

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DCFPAK Information

- With release of DCFPAK 4.0 pending
- Dose coefficients are living values
- Real-time update capabilities through web interface
- Looking for support by users
- Software sustainability and maintenance
- Knowledge management

DCFPAK Information

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RAMP Codes

HABIT	Licensing	ent	Air

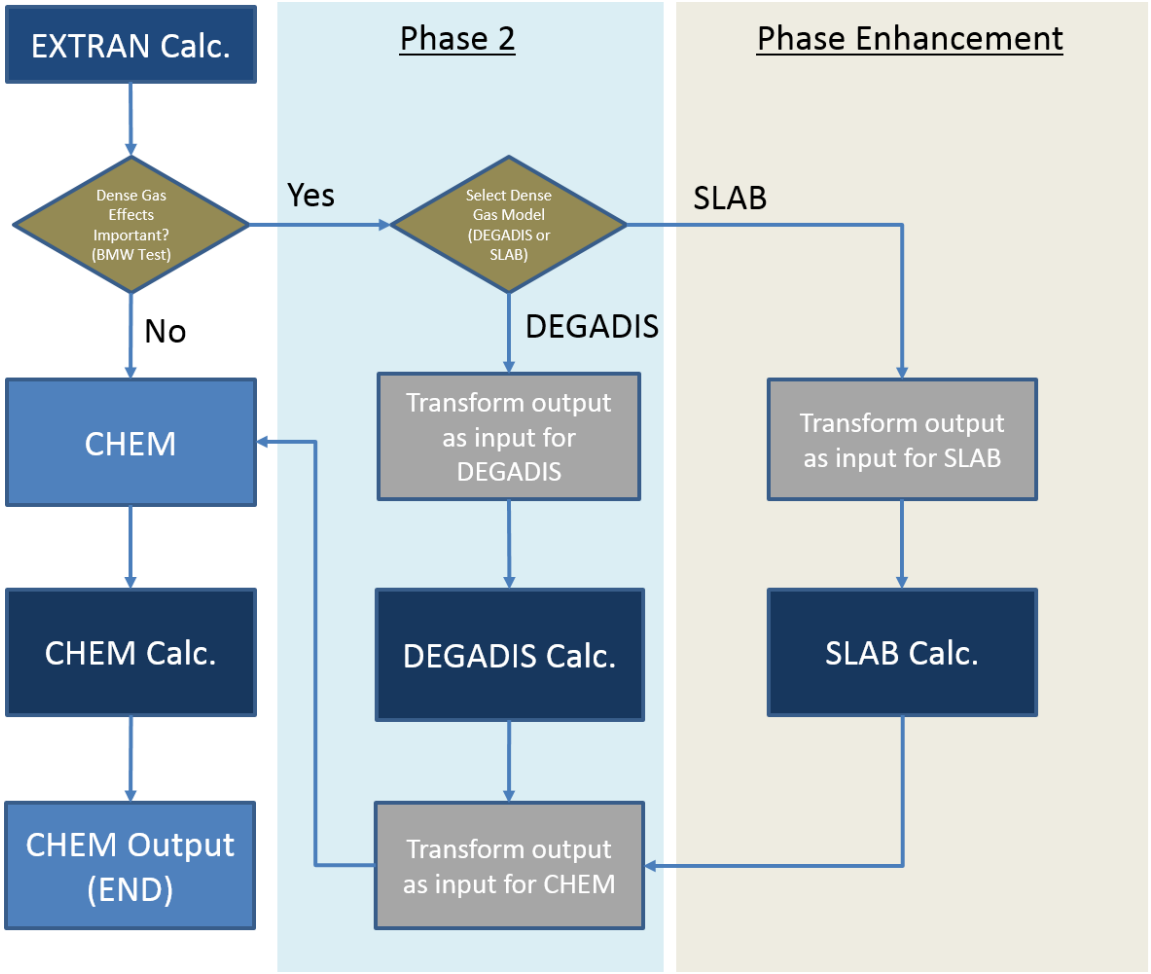
Computer Codes for Evaluation of Control Room Habitability (HABIT)

HABIT Use

- Used by NRC as licensing analysis confirmatory code to verify that the plants design and licensee's Control Room Habitability for postulated Release of Toxic Chemical meet the criteria.
- Regulatory Guide (RG) 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," endorses HABIT computational code.
- Designed for examining control-room (CR) habitability following a postulated release of toxic chemical in air.

HABIT Flowchart

Habit 2.0



HABIT Methods

- HABIT uses Gaussian puff dispersion with modified building-wake diffusion algorithm by Ramsdell (1995).
- Added well-established models DEGADIS v2.1 (1989) and SLAB (1985) for diffusion simulation of denser-than-air chemicals.
- Added Britter and McQuaid (1988) methods to auto-detect when dense-gas effects will be important for any accident scenarios.

HABIT Information

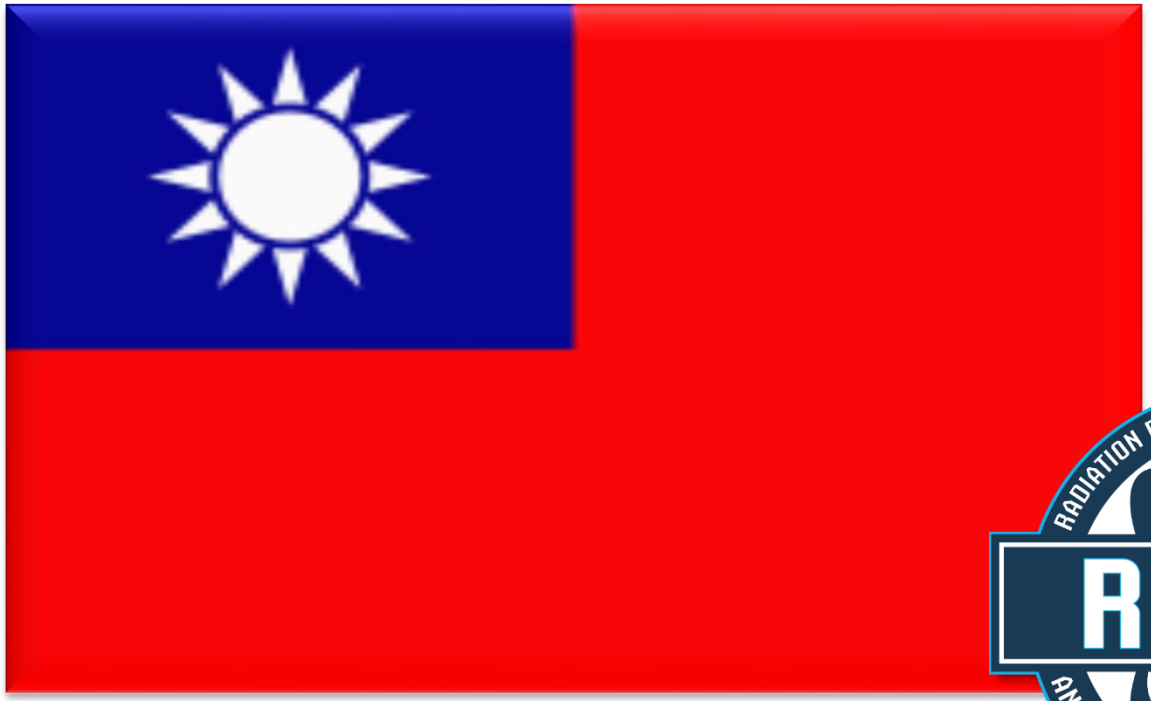
- User Manual for HABIT V 2.01
- HABIT Quality Assurance Program manual
- NUREG/CR-6210, “Computer Codes for Evaluation of Control Room Habitability (HABIT)
- RG 1.78

RAMP Codes

HABIT	Licensing	Design Basis Accident	Air

RAMP 2017 International Meeting

See you in Taiwan – April 2017



Questions?