



OVERVIEW

SAND2013-4649C

RESRAD – Code for Estimating Cleanup

Hotspot – Health Physics code for the PC

CAP88 – Code for Compliance Screening of Air Emissions

(These slides were clipped from various Internet sites for discussion with Jordan Atomic Energy Commission (JAEC) colleagues. They are available for unlimited distribution.)

JAEC Radiation Protection Study Tour

Sandia National Laboratories
10 – 14 June 2013



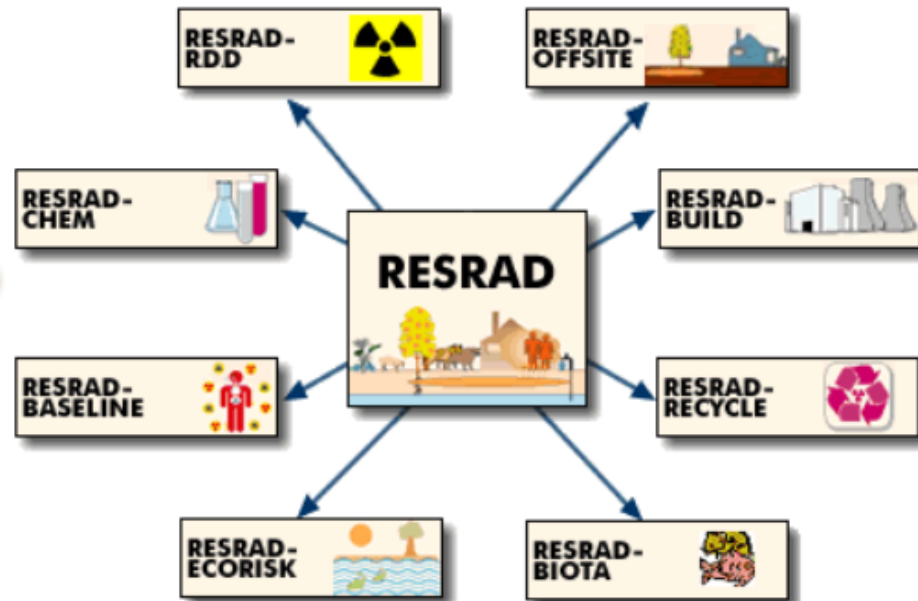
RESRAD

<http://web.ead.anl.gov/resrad/home2/>

RESRAD
FAMILY OF CODES

- Download Codes
- Documents
- Training
- User Center
- RESRAD FAQ
- E-Mail List
- Contact Us

RESRAD Home Page



RESRAD Input Screen

RESRAD - W:\TTR Test Calcs\Site1.RAD

File Pathways Site Data View Form Options Help

RESRAD 6.5
Created: October 30, 2009

File
Change Title
Set Pathways
Modify Data
Run
View Output
Dose Factors
Quit

Navigator

Problem Pathways/ Input Results Help

Rn C-14

The diagram in the Navigator panel illustrates the site model and pathways. It features a green background with various icons representing different components: a cloud (atmosphere), a cow (livestock), a person (human), a house (residence), and a clock (time). Red arrows indicate the flow of radon (Rn) and carbon-14 (C-14) from the atmosphere through the ground and into the cow and person. The bottom of the diagram shows a blue bar with three radiation warning symbols and a clock icon.

RESRAD “Change Title” Input Screen

Title

Title:

Library:

External dose factors: FGR 12

Internal dose factors: FGR 11

Risk factors: FGR 13 Morbidity

Cut-off Half Life:

Total Available Nuclides:

Total No DCFs Nuclides:

Graphics Parameters

Number of Points:

Log Spacing

Linear Spacing

Time integration Parameters

Maximum number of Points for:

Dose

Risk

User Preferences :-

Use Line Draw Character Find peak pathway doses

Save All files after each run Time integrated probabilistic risk

RESRAD “Set Pathways” Input Screen



The screenshot shows the 'Set Pathways' input screen for RESRAD 6.5. The interface is divided into two main vertical panels on a blue background.

Left Panel:

- Header: **RESRAD 6.5**
- Text: Created: October 30, 2009
- Icon: A small illustration of a farm with a barn, trees, and a cow.
- Buttons (from top to bottom): File, Change Title, Set Pathways, Modify Data, Run, View Output, Dose Factors, Quit.


Right Panel:

- Header: **Set Pathways**
- Buttons (from top to bottom): External Gamma, Inhalation, Plant Ingestion, Meat Ingestion, Milk Ingestion, Aquatic Foods, Drinking Water, Soil Ingestion, Radon, Close.

RESRAD “Modify Data” Input Screen



RESRAD 6.5
Created: October 30, 2009



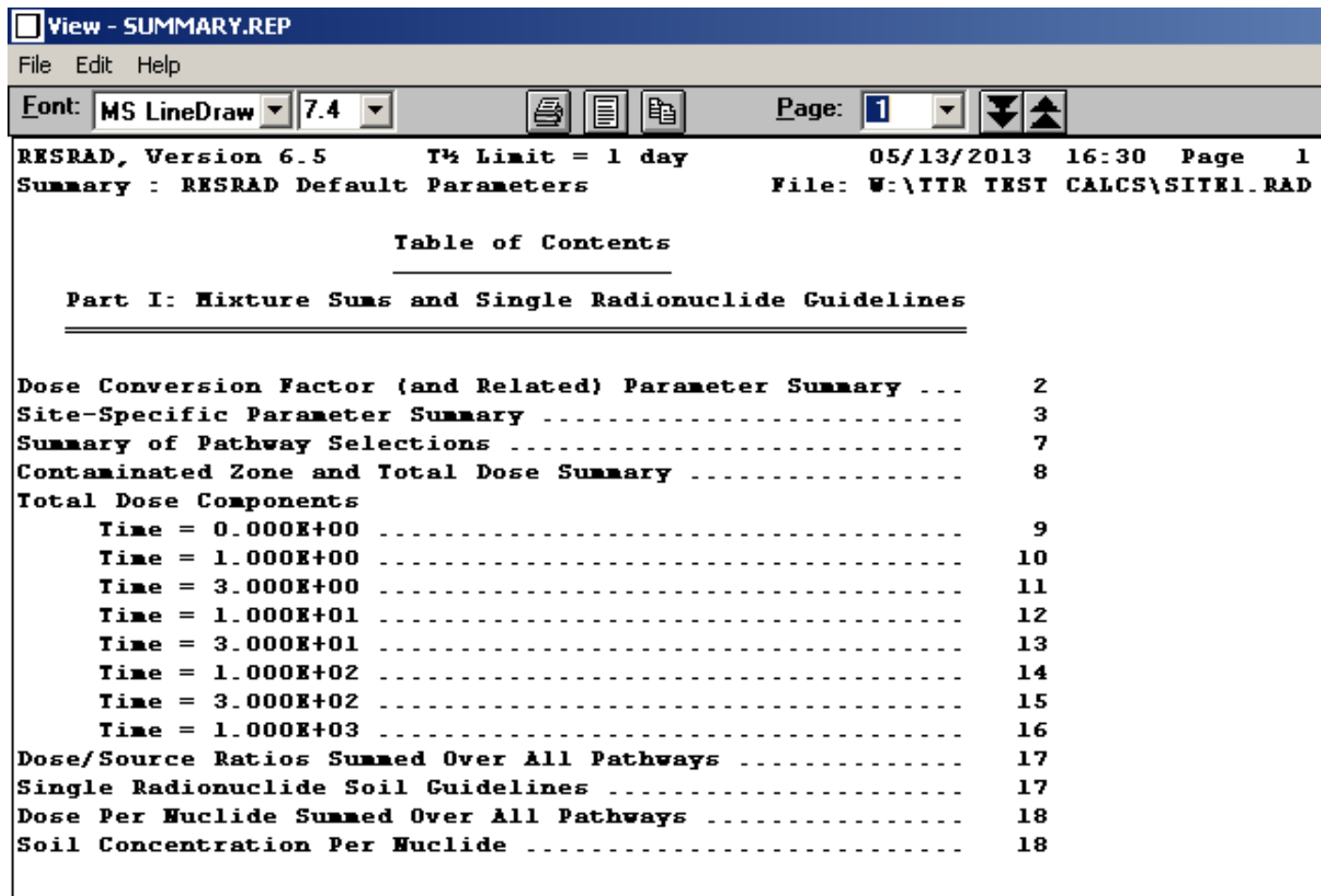
File
Change Title
Set Pathways
Modify Data
Run
View Output
Dose Factors
Quit

Modify Data

Soil Concentrations
Calculation Times
Contaminated Zone
Cover/Hydrol.
Saturated Zone
Unsaturated
Occupancy
Ingestion:Dietary
Ing:Non-Dietary
Radon
Storage Times
C-14

Close

RESRAD "Run Data" Output Screen (1 of many)



View - SUMMARY.REP

File Edit Help

Font: MS LineDraw 7.4 Page: 1

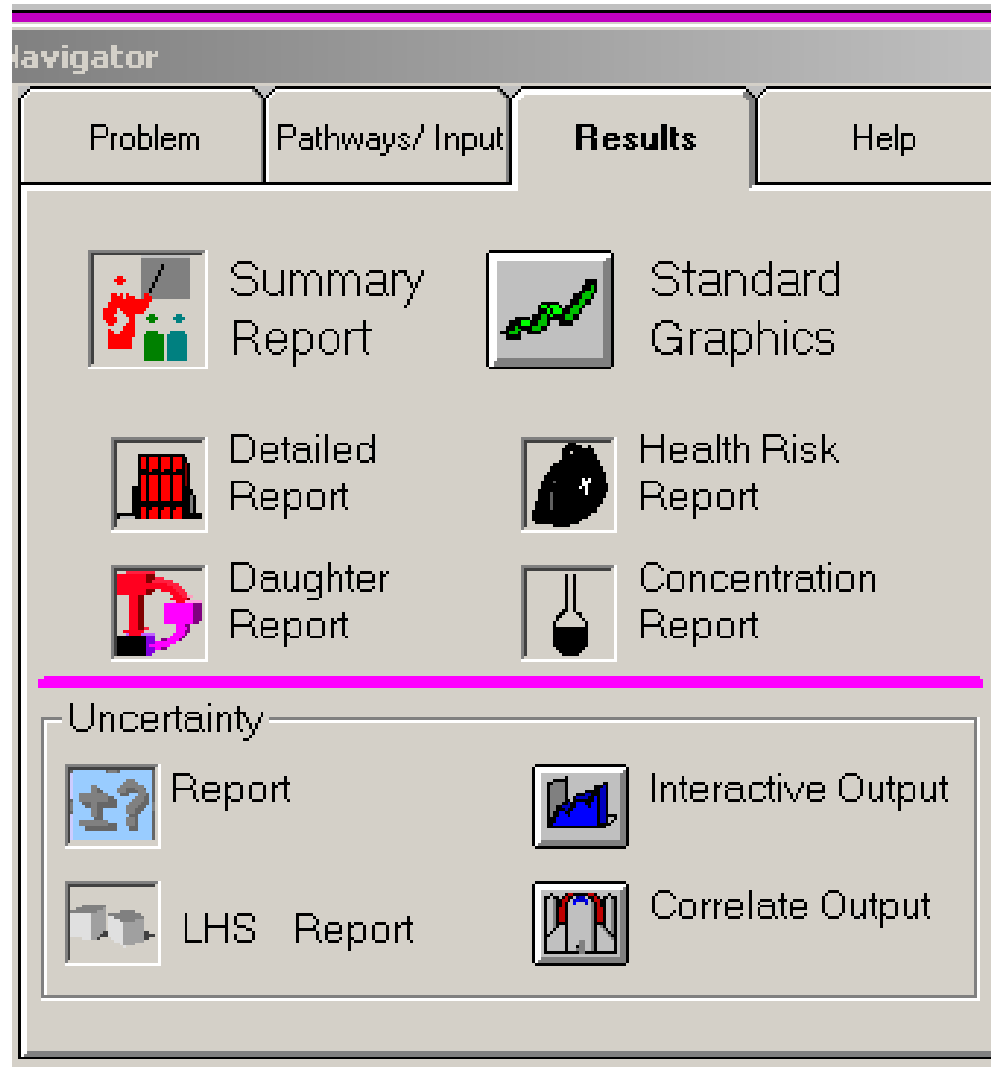
RESRAD, Version 6.5 T½ Limit = 1 day 05/13/2013 16:30 Page 1
Summary : RESRAD Default Parameters File: W:\TTR TRST CALCS\SITEL.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ...	2
Site-Specific Parameter Summary	3
Summary of Pathway Selections	7
Contaminated Zone and Total Dose Summary	8
Total Dose Components	
Time = 0.000E+00	9
Time = 1.000E+00	10
Time = 3.000E+00	11
Time = 1.000E+01	12
Time = 3.000E+01	13
Time = 1.000E+02	14
Time = 3.000E+02	15
Time = 1.000E+03	16
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RESRAD “View Output” Options Screen



HOTSPOT

Availability

- Free download from the web:

<https://narmac.llnl.gov/HotSpot/HotSpot.html>

- Or visit www.llnl.gov and search for 'hotspot'
- Current version: **Version 2.07**
- Developed by Steve Homann of LLNL

Main Purpose

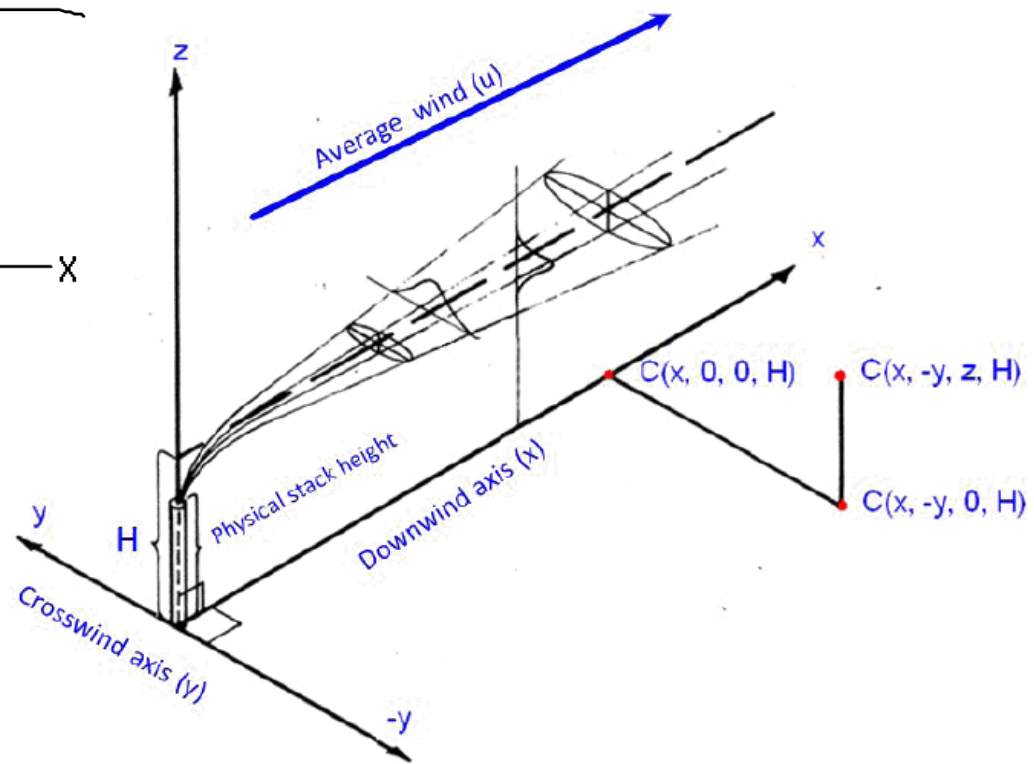
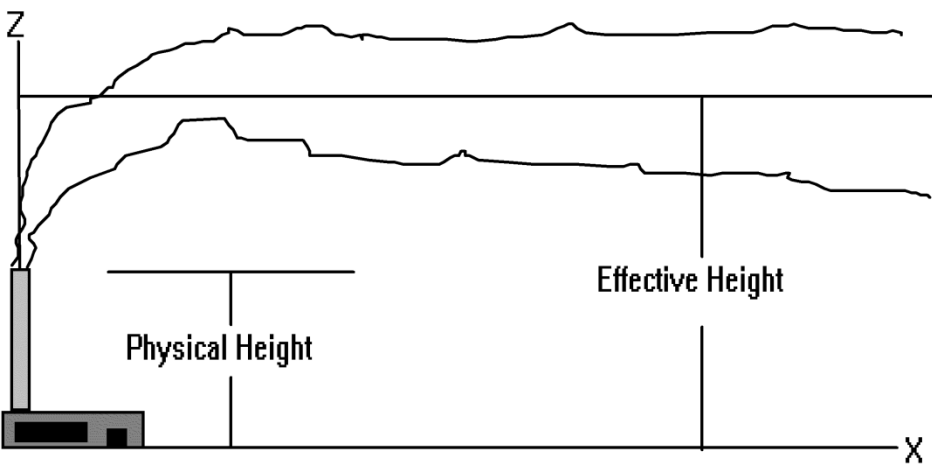
- The HotSpot Health Physics codes were created to provide emergency response personnel and emergency planners with a fast, field-portable set of software tools for evaluating incidents involving radioactive material.
- The software is also used for safety-analysis of facilities handling nuclear material.
- Can also be used for planning, training, and exercise.
- Results can be output to GoogleEarth (with practice)

Overview

- Computer code to model radioactive material dispersion after a release, including:
 - Deposition levels
 - Exposure from cloud passage and ground contamination
 - Include inhaled dose
- To be used by health physics personnel to assist with:
 - Operational Planning
 - Monitoring locations
 - Consequence Management
 - Training
- Runs “stand alone” on PC computer.

Radioactive Material Transport

- User enters weather and source data (wind speed and direction, release height..)
- Hotspot does NOT:
 - Use complex wind assumptions
 - Calculate fate and transport of radioactive material in the environment (except for weathering and resuspension)

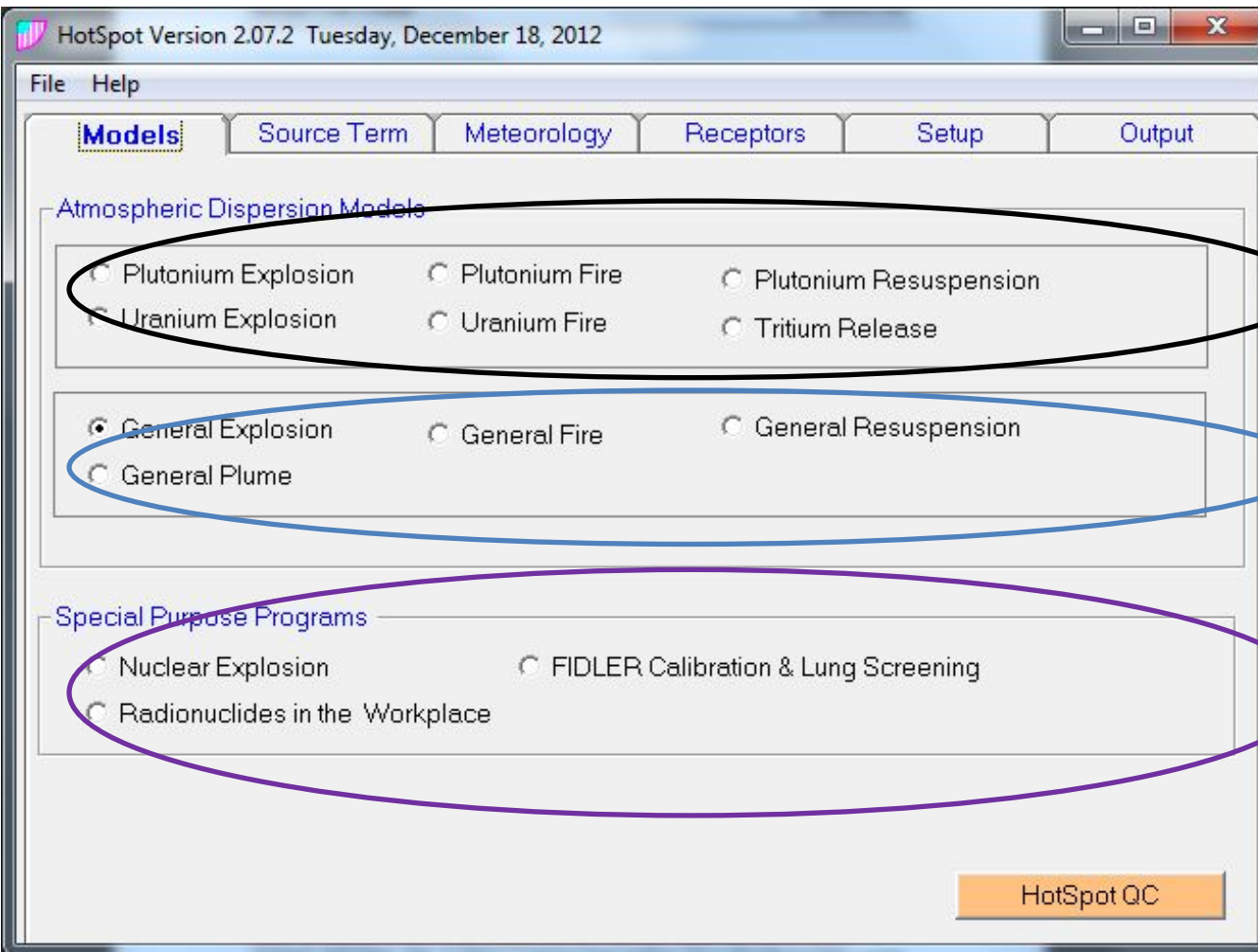


HotSpot Coordinate System

Applicability

- Optimize locations for sampling and monitoring
- Safety-analysis of facilities handling nuclear material
- Evaluate outcomes of accidents to assist with training and planning
- Calculate doses to surrounding locations from facility operations

Hotspot Main Screen



USDOE Emergency Response Dispersion Tools

General workplace and emergency response dispersion tools

Special purpose programs

Four basic modes

- General Use
 - Plume
 - Explosion
 - Fire
 - Re-suspension

General Explosion

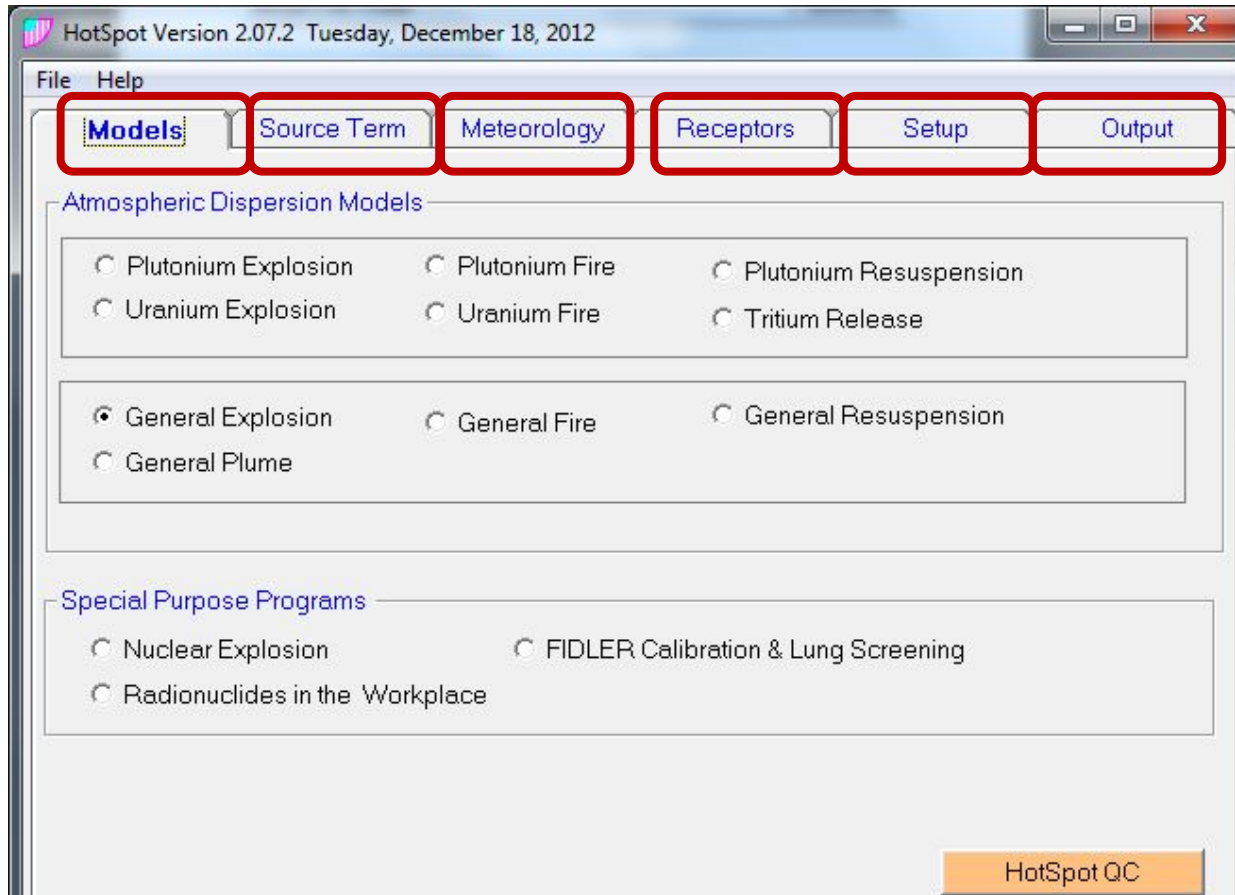
General Fire

General Resuspension

General Plume

Program Each Tab in Sequence

Follows natural progression of defining problem



Example #1

- Reactor Release:
 - Release of Iodine as a result of failed fuel
 - Use General Plume
 - Need to enter:
 - source term = I-131
 - Wind speed, direction, atmospheric stability
 - Stack height

Selecting source term

Hotspot Library

Radionuclide

I-131 F 8.04 d

OK

Cancel

FGR 13/12 DCF values. ICRP series 60 and 70.

- First select Nuclide from a list (mixtures are possible)
- Dose conversion factors are displayed

Hotspot Library

Radionuclide

Iodine

I-131 F 8.04d

View Inhalation DCFs

View Submersion DCFs

View Ground Shine DCFs

Return

Print

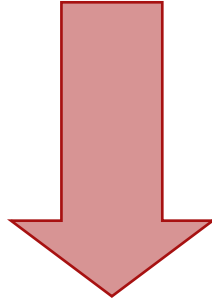
FGR 13/12 DCF values. ICRP series 60 and 70.

Inhalation Dose Conversion Factors (rem / curie)

R Marrow	1.37E+02	ULI Wall	7.59E+01	Adrenals	6.25E+01
Lung	2.21E+02	LLI Wall	1.17E+02	Skin	9.25E+01
SI Wall	5.81E+01	Kidneys	5.59E+01	Spleen	6.22E+01
Brain	2.00E+02	Liver	6.18E+01	Testes	5.03E+01
Breast	7.81E+01	UB Wall	9.51E+02	Thymus	2.12E+02
ET-region	7.96E+03	Muscle	1.74E+02	Thyroid	5.44E+05
St Wall	1.47E+02	Ovaries	6.14E+01	Uterus	7.25E+01
B Surface	1.80E+02	Pancreas	6.73E+01		

SI Classic **One micron AMAD** **50-yr CEDE** 2.73E+04

Source inputs



- 1E6 Ci
- 10 meter stack height
- Damage Ratio 25%

HotSpot Version 2.07.2 Tuesday, December 18, 2012

File Help

Models **Source Term** Meteorology Receptors Setup Output

Model **General Plume**

Radionuclide: I-131 D 8.04d

Change Radionuclide Source Term

Material-at-Risk (MAR): 1.0000E+06 Ci

Damage Ratio (DR): 0.250

Leakpath Factor (LPF): 1.000

Effective Release Height: 10 m

Deposition Velocity: 0.30 cm/sec

Calculate Plume Rise

Airborne Fraction (ARF): 1.00E+00

Respirable Fraction (RF): 1.00E+00

The screenshot shows the 'Source Term' tab of the HotSpot software. A red arrow points from the title 'Source inputs' to the software window. Several elements are circled in red: the 'Source Term' tab, the 'Setup' tab, the 'Radionuclide' input field containing 'I-131 D 8.04d', and the 'Change Radionuclide Source Term' button. The input fields for MAR (1.0000E+06 Ci), DR (0.250), Effective Release Height (10 m), and Deposition Velocity (0.30 cm/sec) correspond to the values listed in the bullet points on the left.

Meteorology Inputs

Hotspot Version 2.06 Thursday, December 17, 2006

File Help

Models Source Term **Meteorology** Receptors Setup Output

10-meter Wind Speed
10 m/s

Selected Stability Class
C

Display Wind Chart

Wind Direction
210

Wind from the SSW

Atmospheric Stability

Enter Solar Information - or- Enter the Actual Stability

Sun High in the sky
 Sun Low in the sky or cloudy
 Night

A - Very unstable
 B - Moderately unstable
 C - Slightly unstable
 D - Neutral
 E - Slightly stable
 F - Moderately stable
 G - Special nighttime (low wind)

- Wind speed: 10 m/s
- Wind direction 210
- Sun High in the sky

Other setup parameters

Hotspot Version 2.06 Thursday, December 07, 2006

File Help

Models Source Term Meteorology Receptors **Setup** Output

Return to Original Defaults

Terrain

- Standard : Conservative Option
- City : Large Metropolitan Area

Wind Input Height 10 meters

Mixing Layer

- Enable Inversion

Radiological Units

- Classic (rem, rad, Ci)
- SI (Sievert, Gray, Bq)

Distance Units

- Metric
- English

Sample Time 10

Source Geometry

- Simple
- Complex

Contour Values

TEDE (rem)	Deposition (uCi/m ²)
Inner: 1	Inner: 100.00
Middle: 0.5	Middle: 10.00
Outer: 0.1	Outer: 1.00

uCi/m²
 dpm/(100 cm²)

DCF Library

- FGR 11
- FGR 13
- Acute (1-day)

- Include 4-days of Ground Shine

Wet Deposition

- Enable Rainout

Holdup Time 0 min

Breathing Rate 3.33E-04 m³/s

Non-respirable Deposition Velocity 0 cm/sec

Default Source Location Set Default

35.00707N106.44528W

Coordinate Format Change

Degrees

Ellipsoid OK

WGS 84

Configuration for International Use



HotSpot Version 2.07.2 Monday, December 10, 2012

File Help

Models Source Term Meteorology Receptors **Setup** Output

Terrain
 Standard : Conservative Option
 City : Large Metropolitan Area

Radiological Units
 Classic (rem, rad, Ci)
 SI (Sievert, Gray, Bq)

Distance Units
 Metric
 English

Wind Ref Height 10 meters **Sample Time** 10
Mixing Layer
 Enable Inversion

Source Geometry
 Simple
 Complex

Explosion Model AF Distribution
Default HotSpot Vertical AF
 Change/View AF Distribution

DCF Library
 FGR 11 FGR 13 Acute (30-days)

Ground Shine & Resuspension
 Include Ground Shine (Weathering Correction Factor : None)
 Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
 Change Exposure Parameters
Exposure Time: (Start: 0.00 days; Duration: 4.00 days)

Contour Values
TED (Sv)
Inner 0.001
Middle 0.00025
Outer 0.00015
Deposition (kBq/m²)
Inner 3700.00
Middle 370.00
Outer 37.00

Metric
SI Units
FGR 13

Changing Dose Conversion Database from FGR-11 to FGR-13

Continuing this option will change the HotSpot Dose Conversion Coefficients from the current Federal Guidance Report 11 (FGR-11), to the Dose Conversion Coefficients used in Federal Guidance Report 13 (FGR-13)

FGR-11 uses the ICRP 30 lung model and methodologies.
FGR-13 uses the new ICRP-66 lung model and ICRP series 60/70 methodologies.
FGR-12 is used for external submersion and ground-shine DCF values.

Do you want to continue with this change ?

Yes No

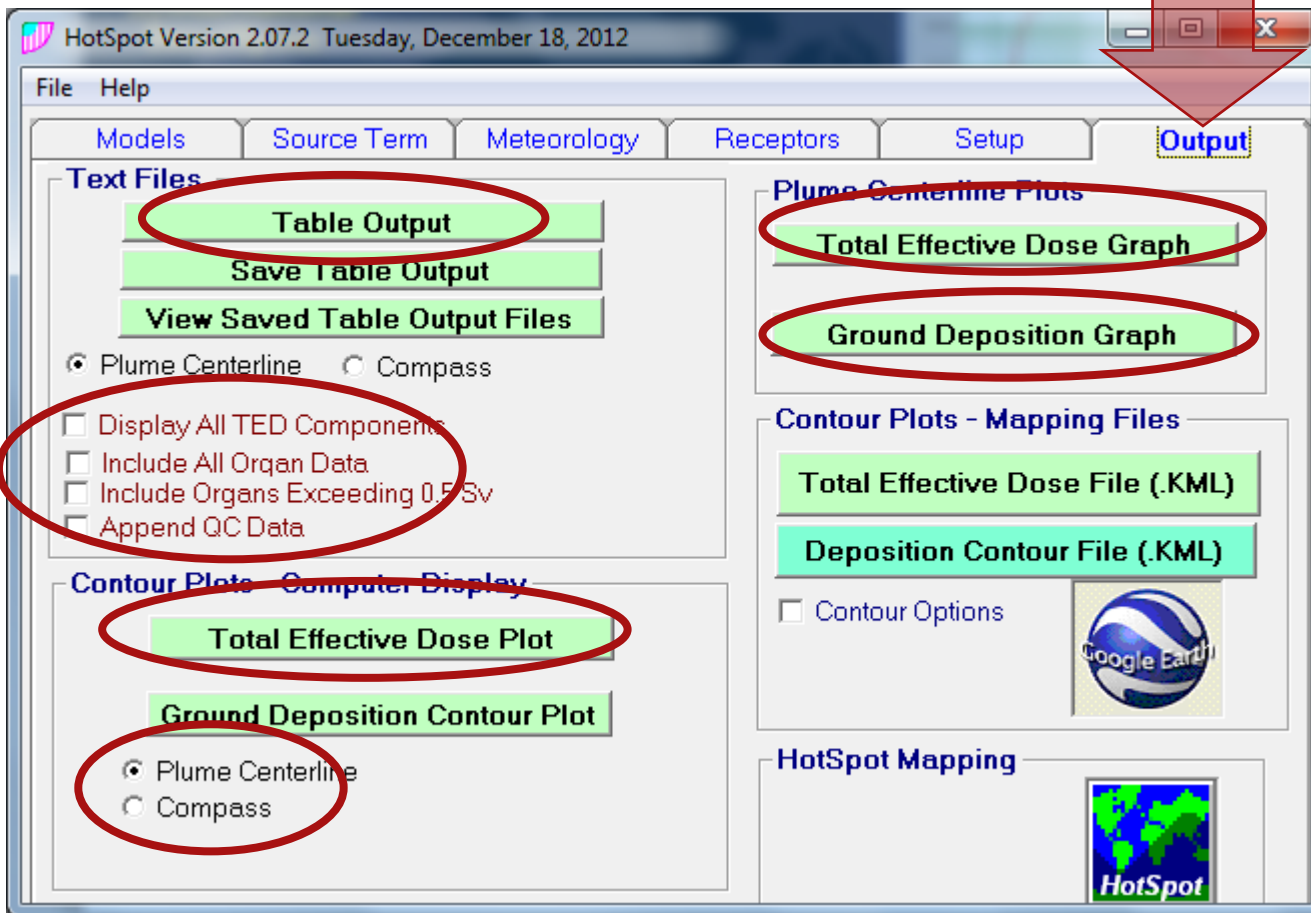
Terminology

Old ICRP 26/30 (HotSpot FGR-11 Option)	New ICRP 60/66 (HotSpot FGR-13 Option)
Committed effective dose equivalent	Committed effective dose
Committed dose equivalent	Committed equivalent dose
Cumulative total effective dose equivalent	Cumulative total effective dose
Dose equivalent	Equivalent dose
Effective dose equivalent	Effective dose
Quality factor	Radiation weighting factor
Weighting factor	Tissue weighting factor
Total effective dose equivalent	Total effective dose

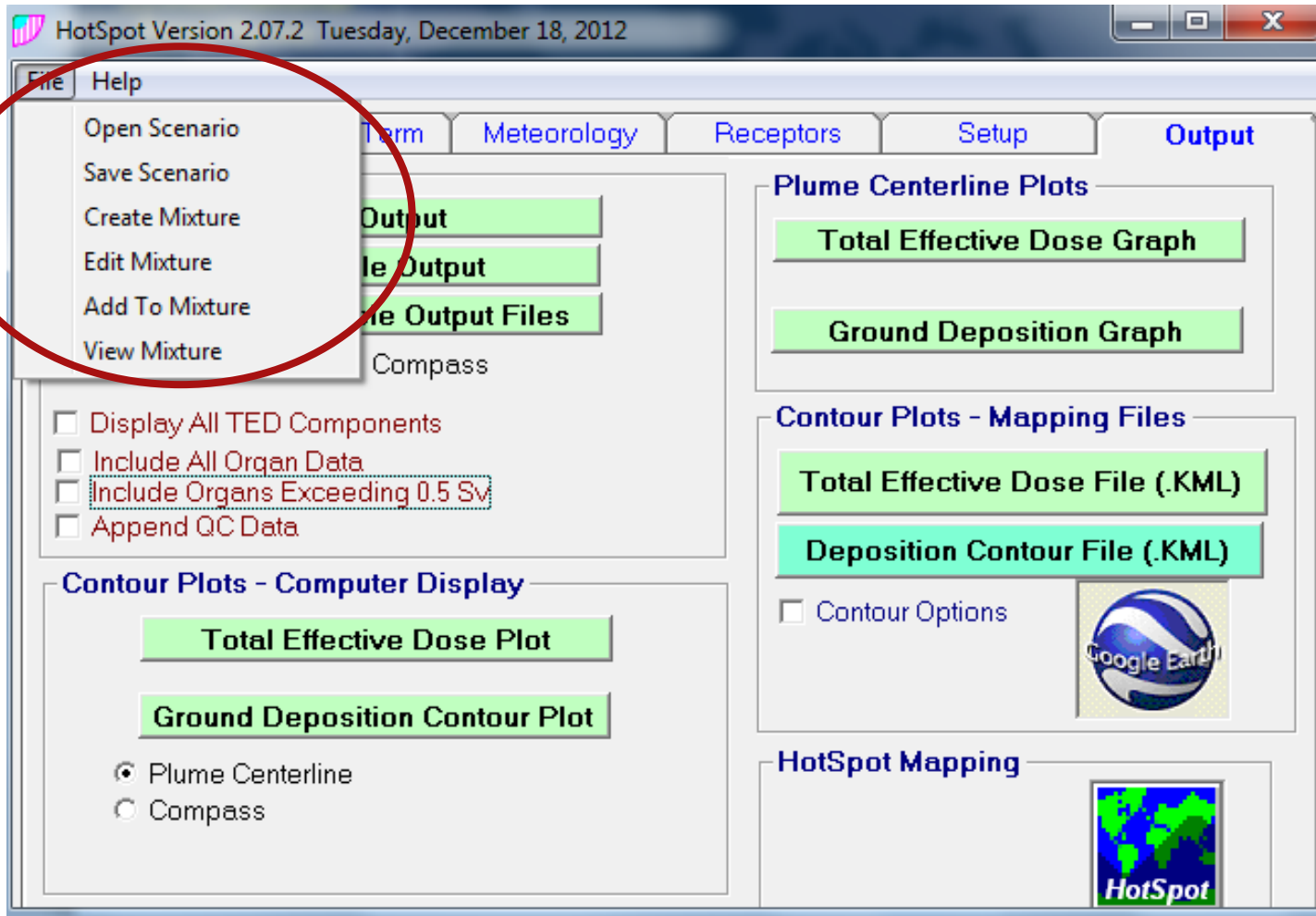
Output



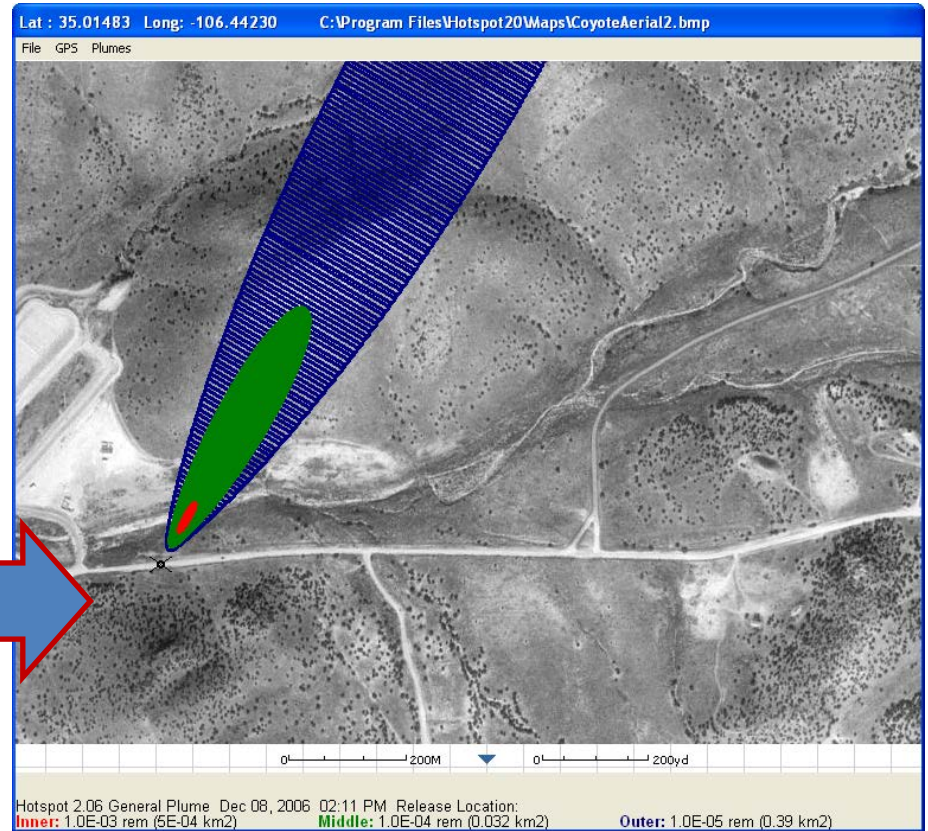
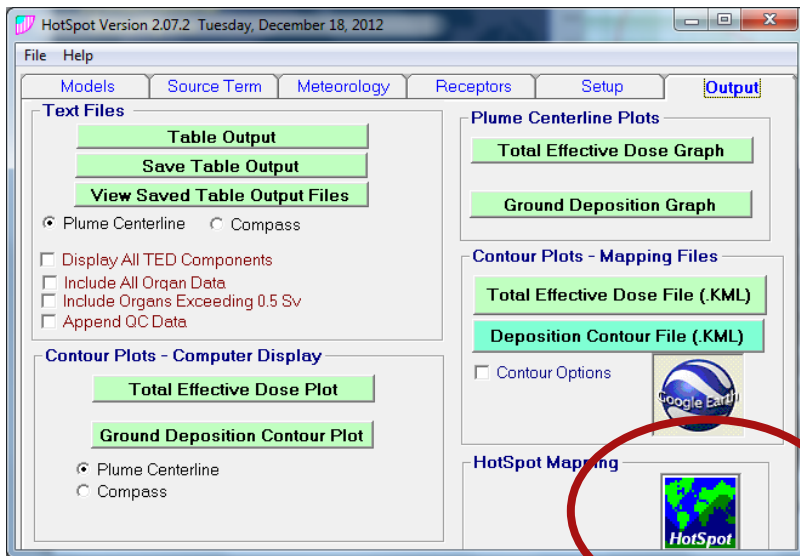
Many Options for Data Output



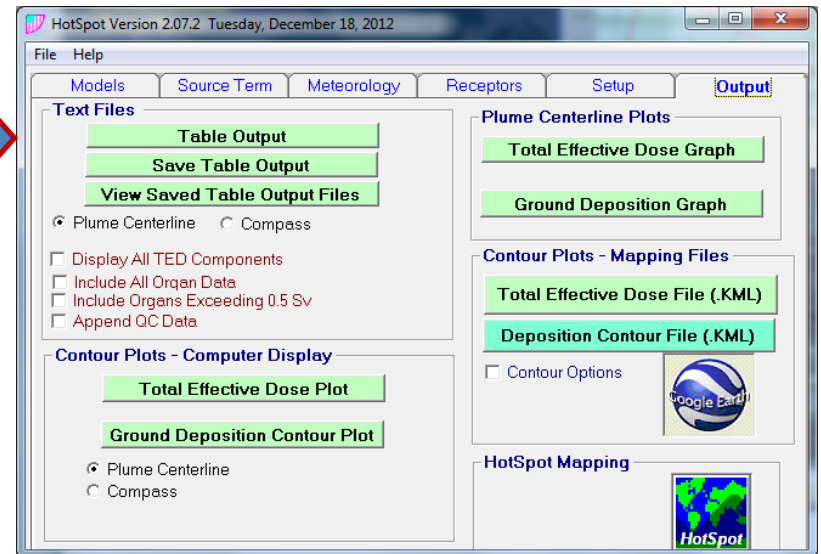
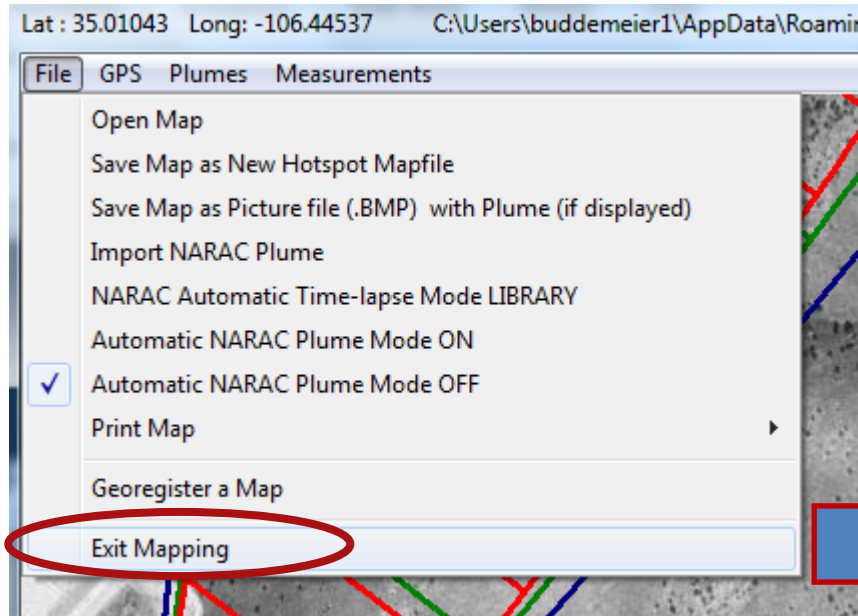
Save Scenarios for later reuse



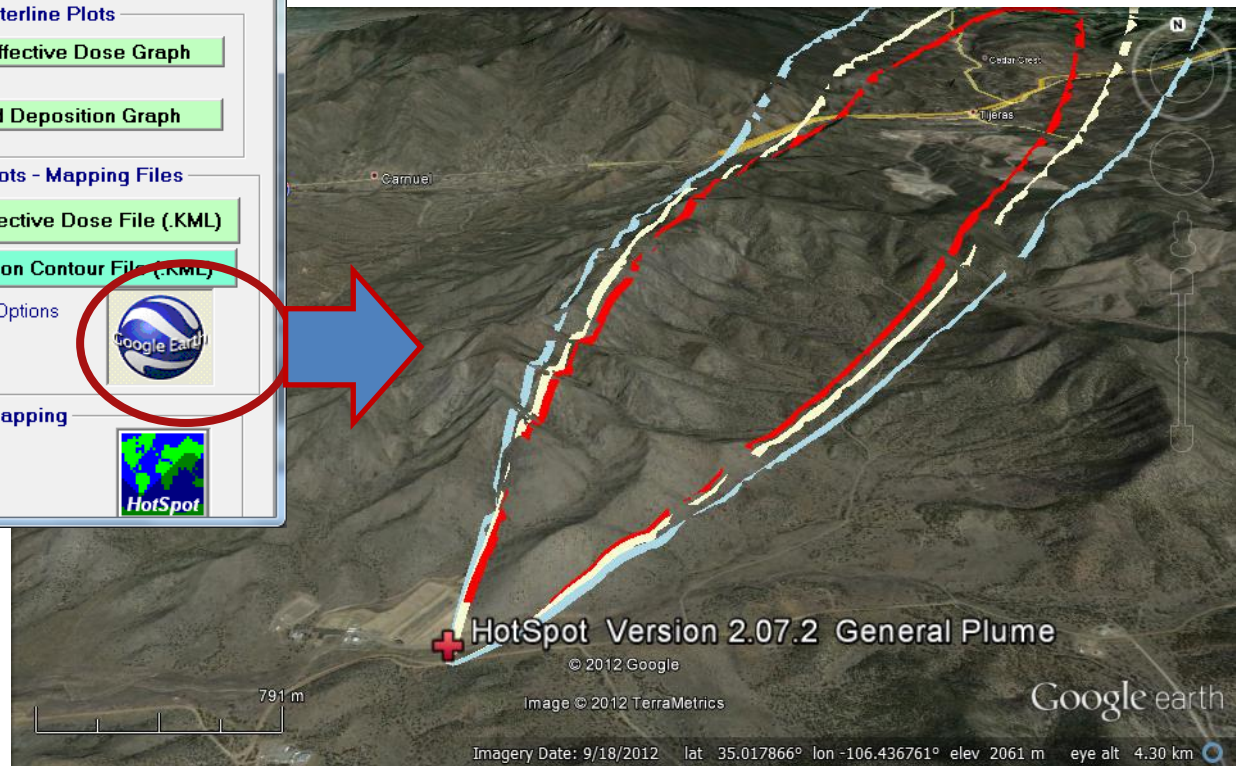
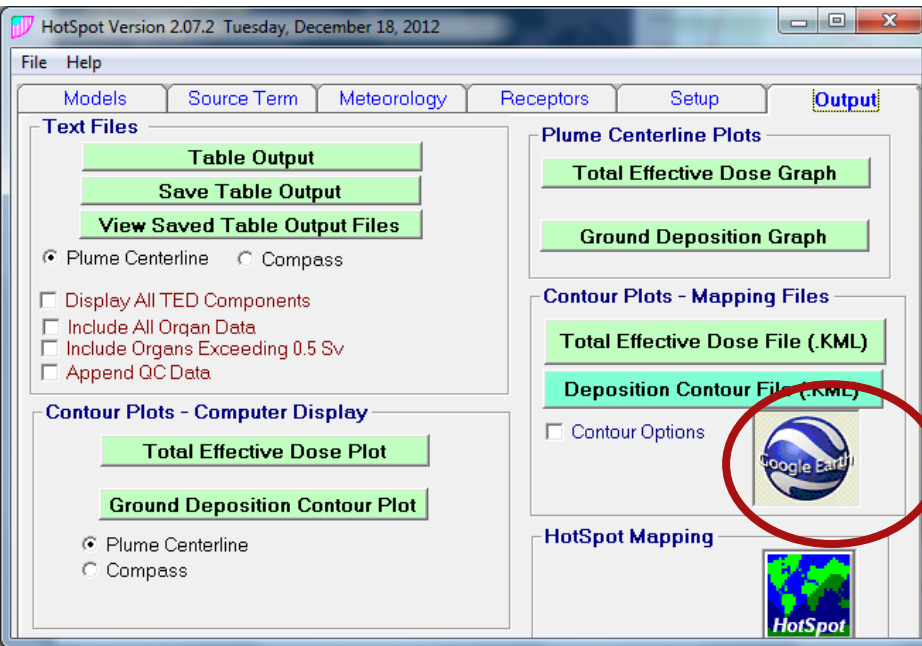
Output Modes



Going Back to Output Screen



Google Earth Export



Great For Asking “What If”

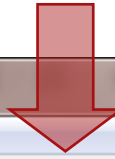
Table 3. Recommended avertable doses for undertaking countermeasures

Countermeasure	Avertable dose (for which the countermeasure is generically optimised)
Sheltering	~10 mSv in 2 days (of effective dose)
Temporary evacuation	~50 mSv in 1 week (of effective dose)
Iodine prophylaxis (if radioiodine is present)	~100 mSv (of equivalent dose to the thyroid)
Relocation	~1000 mSv or ~100 mSv first year (of effective dose)



What Actions Would you take?

Play With Parameters and Assumptions



- Exposures

HotSpot Version 2.07.2 Monday, December 10, 2012

File Help

Models Source Term Meteorology Receptors **Setup** Output

Terrain

- Standard : Conservative Option
- City : Large Metropolitan Area

Wind Ref Height: 10 meters Sample Time: 10

Mixing Layer

- Enable Inversion

Ground Shine & Resuspension

- Include Ground Shine (Weathering Co
- Include Resuspension (Resuspension
- Change Exposure Parameters

Exposure Time: (Start: 0.00 days; Du

Contour Values

TED (Sv)		Deposition	
Inner	0.001	Inner	370
Middle	0.00025	Middle	370
Outer	0.00015	Outer	37.0

HotSpot Health Physics Codes

Ground Contamination Options

Return

Exposure Time Settings

Start of Exposure: 0.00 days Exposure Duration: 4.00 days

Ground Roughness Correction Factor (GRCF)

GRCF: 1.000 Other

Weathering Correction Factor (WCF)

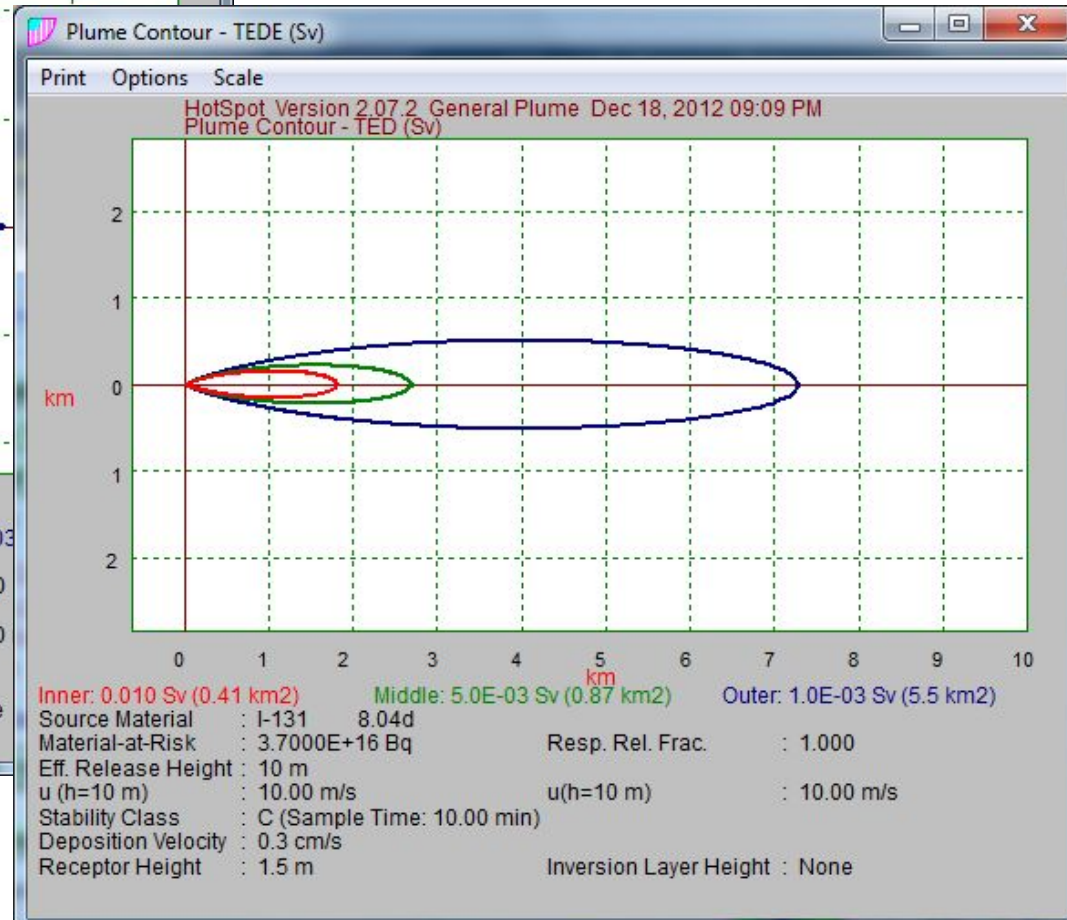
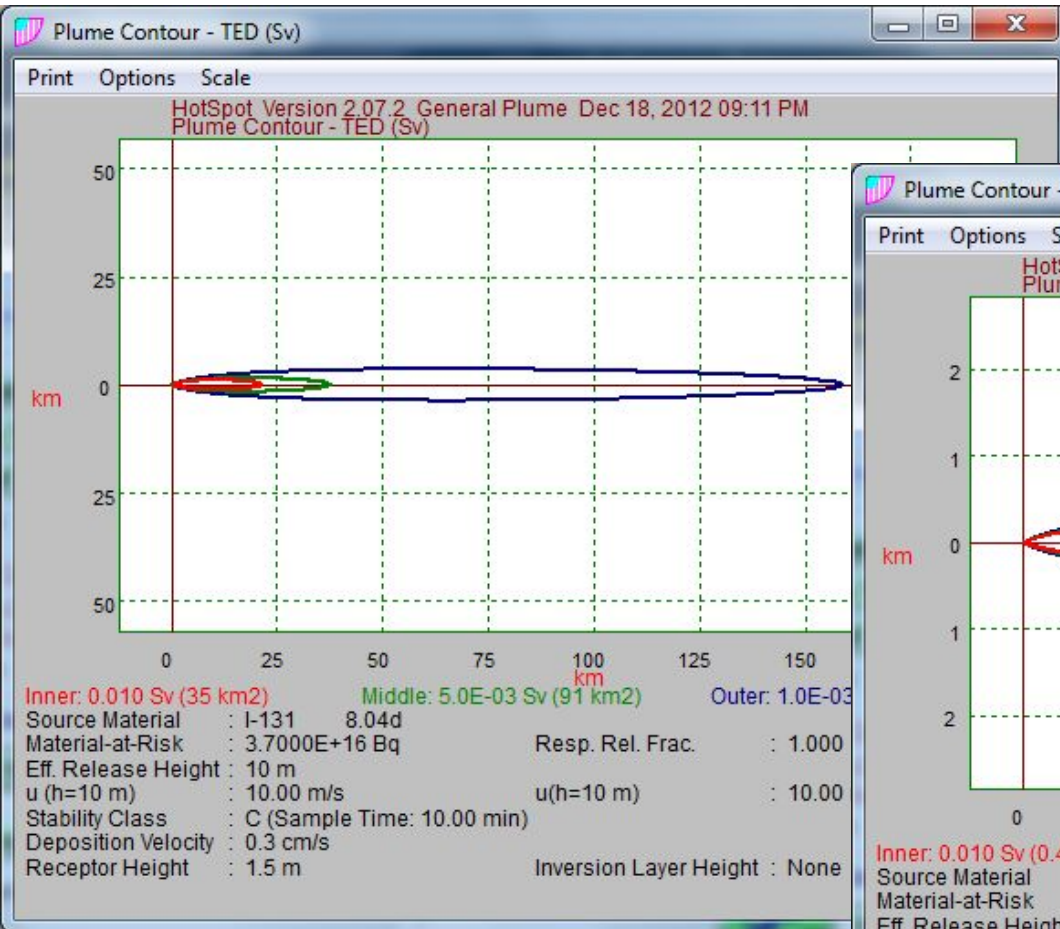
- No Weathering
- WASH 1400 (NUREG-75/014): $WCF = GRCF [0.63 \exp(-1.13 t) + 0.37 \exp(-0.00748 t)]$; t in years
- Likhtarev - Health Physics, March 2002, Vol.82, No. 3: $WCF = GRCF [0.40 \exp(-0.46 t) + 0.60 \exp(-0.014 t)]$; t in years

Resuspension Factor (RF [1/meter])

- Maxwell and Anspaugh- 2010 $RF = 1E-05 \exp(-0.07 t) + 7E-09 \exp(-0.002 t) + 1E-09$; t in days
- NCRP Report No. 129 $RF (0-1) \text{ day} = 1E-06$; $RF (1 \text{ to } 1,000 \text{ days}) = 1E-06 / t$; $RF (t > 1000 \text{ days}) = 1E-09$; t in days
- WASH 1400 (NUREG-75/014) $RF = 1E-05 \exp(-0.677 t) + 1E-09$; t in years
- Constant $RF = 1.00E-09 (1 / \text{meter})$

Play With Parameters and Assumptions

TED from Time =0.5 to 2 days



TED from Time =0 to 2 days

CAP88 – EPA's Air Emissions Compliance Screening Tool

Download code and user manuals

<http://www.epa.gov/radiation/assessment/CAP88/index.html#version3>

Caveats about CAP88

What CAP88 DOES do:

- Annual **SCREENING** projections of dose from **ANNUAL** averages
- **ROUTINE**, not accident air emission pathway dose estimates
- **AIRBORNE** pathway **ONLY**
- Used for regulatory compliance demonstration

What CAP88 DOESN'T do:

- Emergency dose projections (use **HOTSPOT** for that)

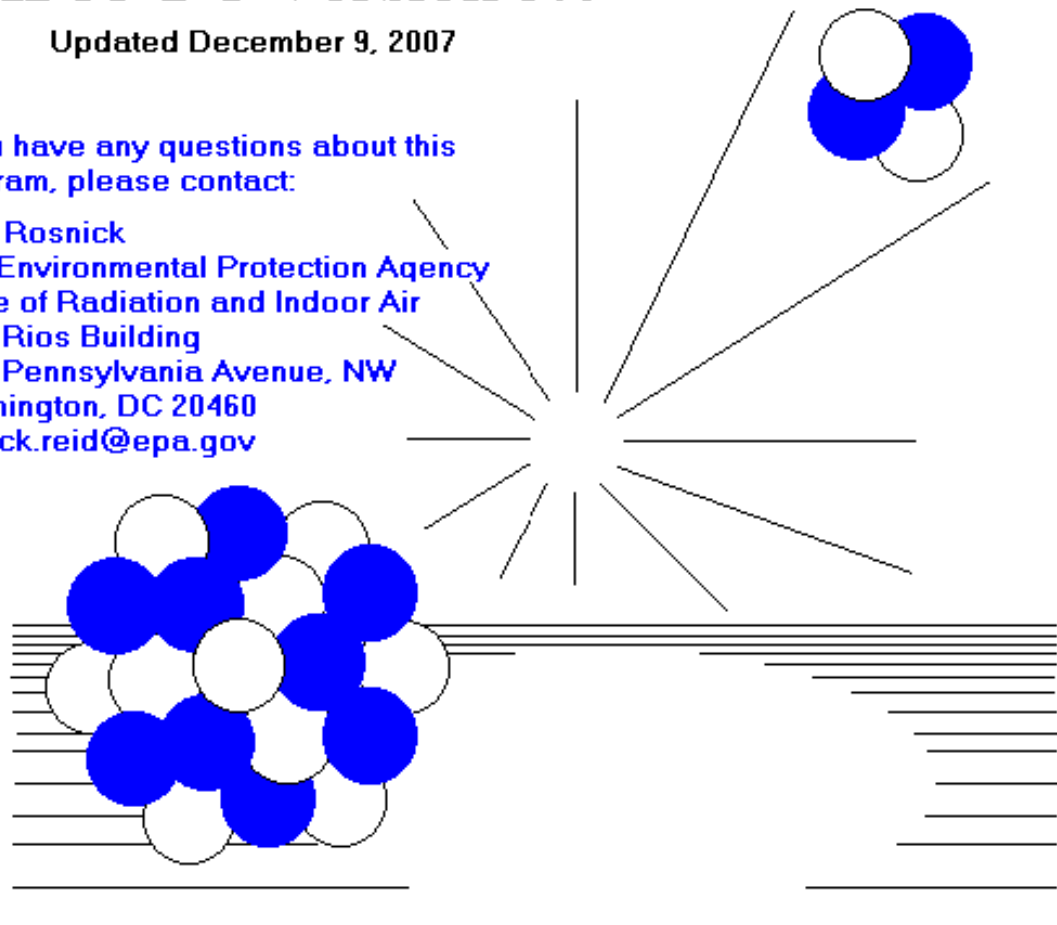


CAP88-PC Version 3.0

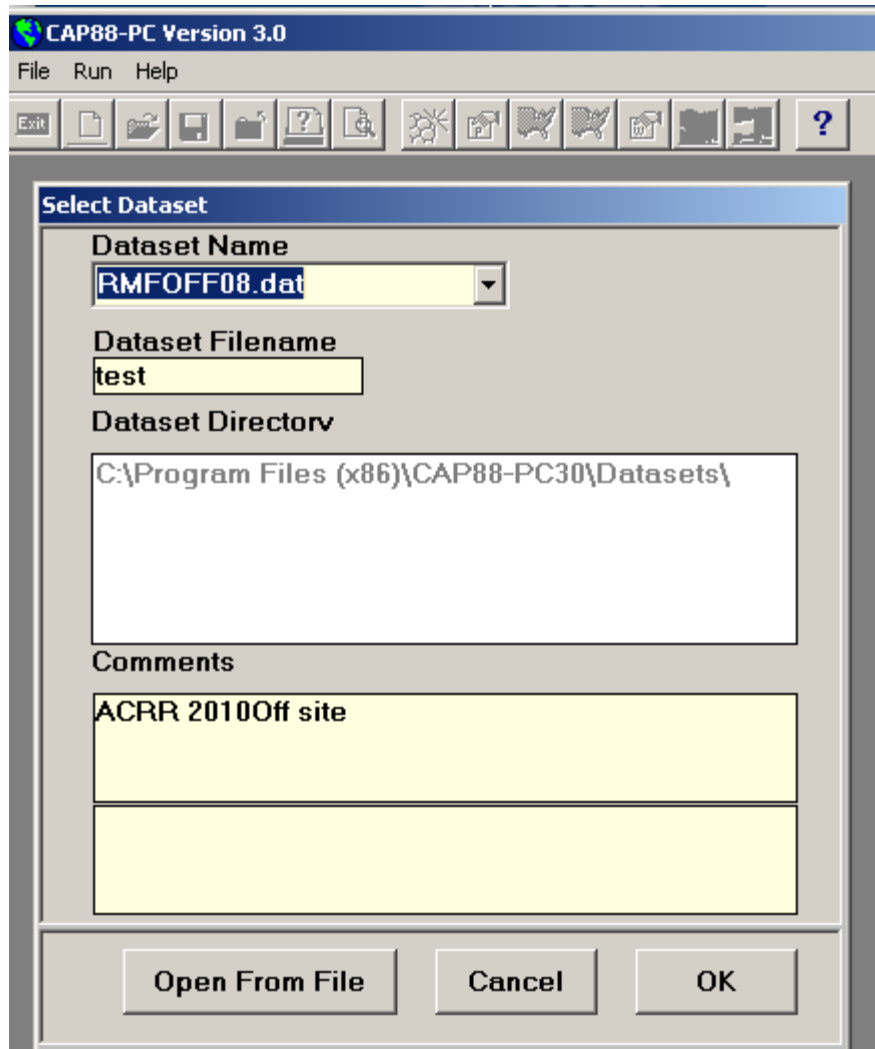
Updated December 9, 2007

If you have any questions about this program, please contact:

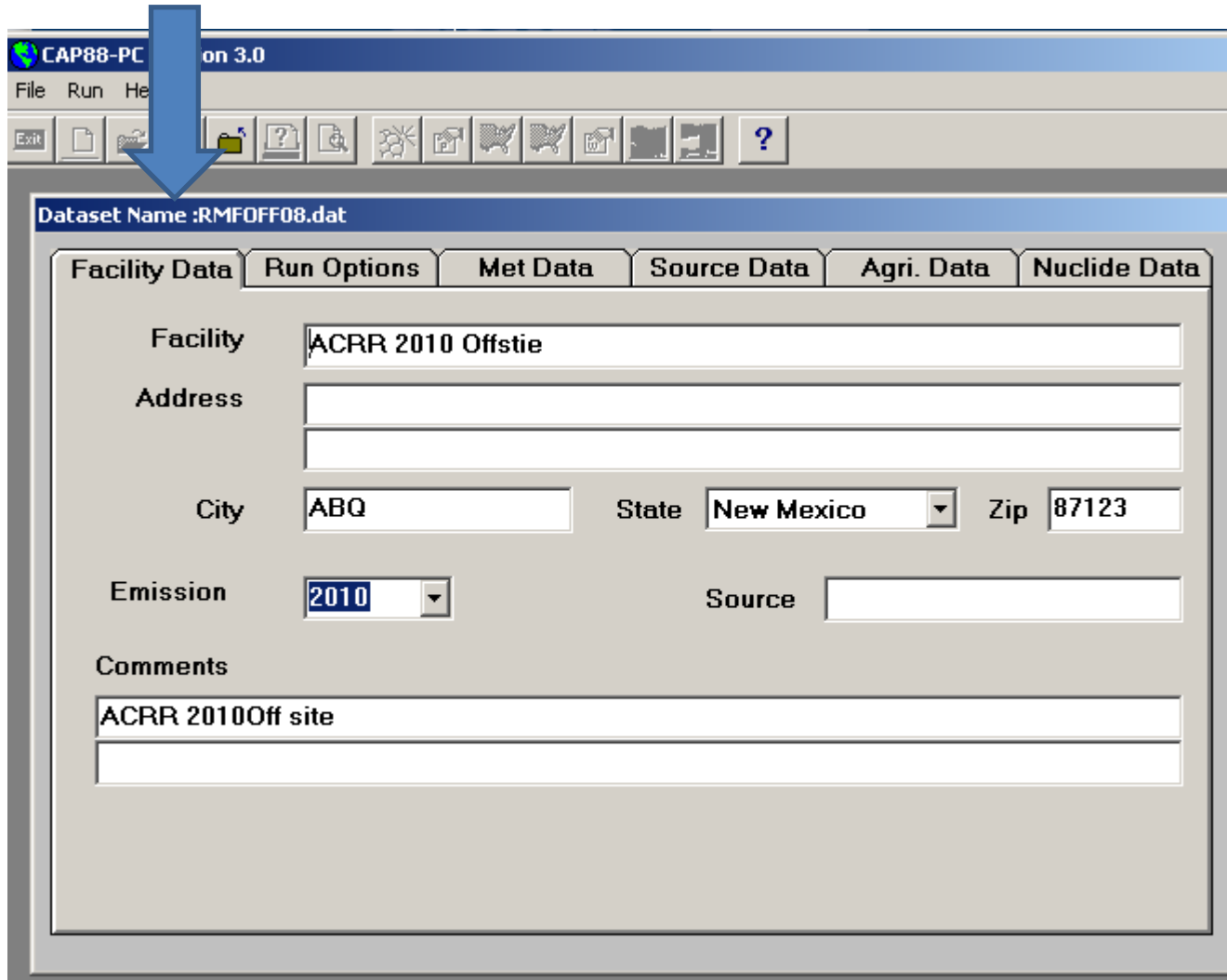
Reid Rosnick
U.S. Environmental Protection Agency
Office of Radiation and Indoor Air
Ariel Rios Building
1200 Pennsylvania Avenue, NW
Washington, DC 20460
rosnick.reid@epa.gov



CAP88 Dataset Open Option



CAP88 Facility Data Tab



The screenshot shows the CAP88-PC software interface. The window title is "CAP88-PC on 3.0". The menu bar includes "File", "Run", and "Help". The toolbar contains icons for "Exit", "New", "Open", "Save", "Print", "Help", "Facility Data", "Run Options", "Met Data", "Source Data", "Agri. Data", "Nuclide Data", and a question mark. The "Facility Data" tab is selected, and a blue arrow points to it. The dataset name is "RMFOFF08.dat". The form fields are as follows:

Facility Data	Run Options	Met Data	Source Data	Agri. Data	Nuclide Data
Facility	<input type="text" value="ACRR 2010 Offstie"/>				
Address	<input type="text"/>				
City	<input type="text" value="ABQ"/>	State	<input type="text" value="New Mexico"/>	Zip	<input type="text" value="87123"/>
Emission	<input type="text" value="2010"/>	Source	<input type="text"/>		
Comments	<input type="text" value="ACRR 2010Off site"/>				
	<input type="text"/>				

CAP88 Run Options Tab

CAP88-PC Version 3.0

File Run Help

Exit [File] [Print] [Save] [Open] [Help] [?]

Dataset Name :RMFOFF08.dat

Facility Data **Run Options** Met Data Source Data Agri. Data Nuclide Data

Run Individual Population

Population File Directory Custom Population File

Locate C:\Program Files (x86)\CAP88-PC30\Poplib\SNL_2010.pop

Print Organ Dose Summaries? Yes No

Create Dose and Risk Factors? Yes No

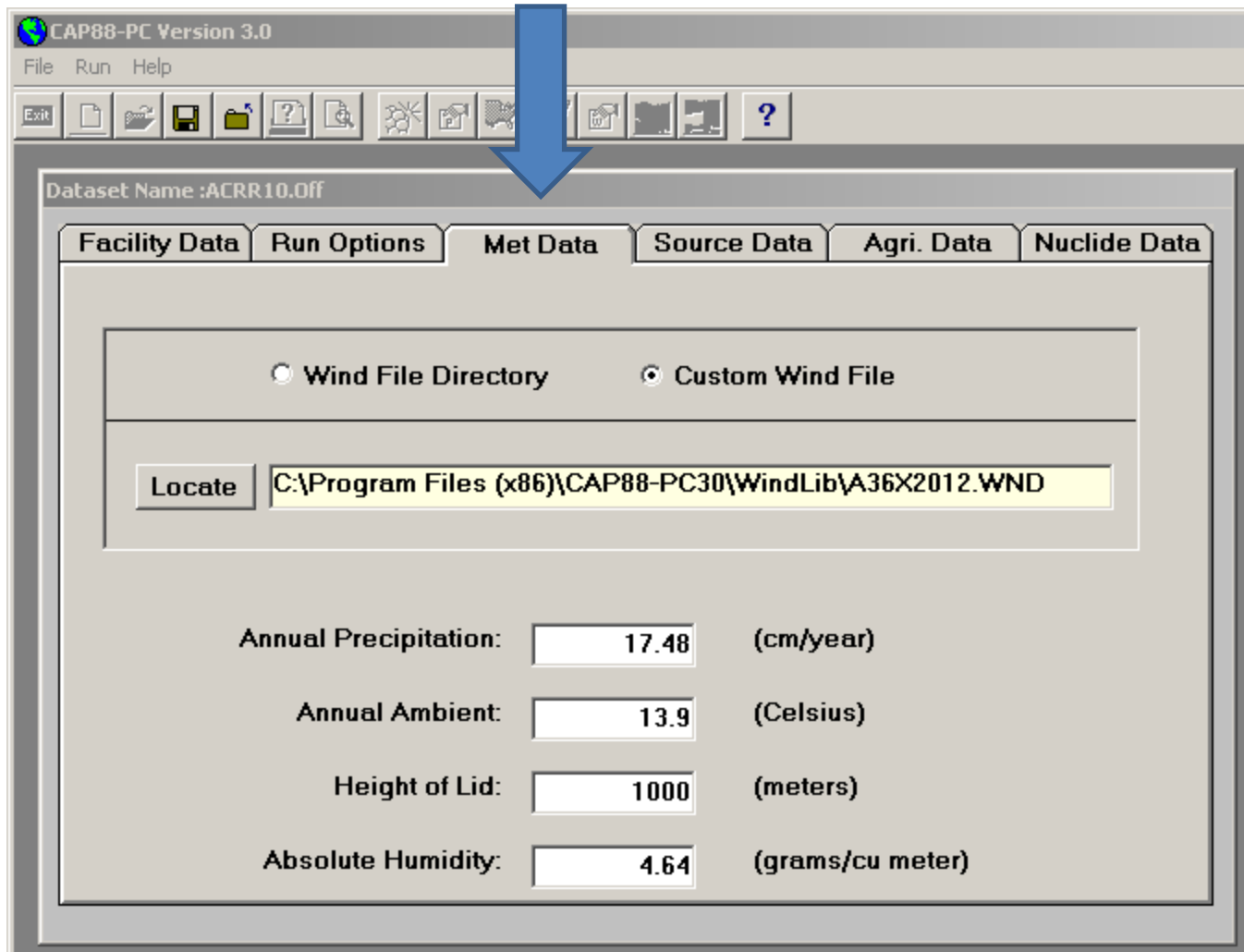
Create Concentration Table? Yes No

Create Chi/Q Table File? Yes No

Build up Time in Years

100.

CAP88 Meteorological Data Tab



CAP88-PC Version 3.0

File Run Help

Exit [File icons] [Help icon]

Dataset Name :ACRR10.Off

Facility Data Run Options **Met Data** Source Data Agri. Data Nuclide Data

Wind File Directory Custom Wind File

Locate C:\Program Files (x86)\CAP88-PC30\WindLib\A36X2012.WND

Annual Precipitation:	17.48	(cm/year)
Annual Ambient:	13.9	(Celsius)
Height of Lid:	1000	(meters)
Absolute Humidity:	4.64	(grams/cu meter)

CAP88 Source Data Tab

CAP88-PC Version 3.0

File Run Help

Exit [Icons] ?

Dataset Name :ACRR10.Off

Facility Data Run Options Met Data **Source Data** Agri. Data Nuclide Data

Run Individual Population Set Max Exposed Individual

Midpoint Distances	5477	5986	6174	6556	6631
	6739	6970	7041	7466	7491
	7541	8695	13328	16998	17762

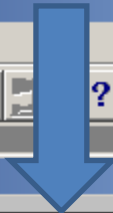
Print Organ Dose Summaries? Yes No

Create Dose and Risk Factors? Yes No

Create Concentration Table? Yes No

Create Chi/Q Table File? Yes No

Build up Time in Years



CAP88 Agricultural Data Tab

CAP88-PC Version 3.0
File Run Help

Exit [Icons] ?

Dataset Name :ACRR10.Off


Facility Data Run Options Met Data Source Data **Agri. Data** Nuclide Data

Run Individual Population

Midpoint Distances	5477	5986	6174	6556	6631
	6739	6970	7041	7466	7491
	7541	8695	13328	16998	17762

Print Organ Dose Summaries? Yes No
Create Dose and Risk Factors? Yes No
Create Concentration Table? Yes No
Create Chi/Q Table File? Yes No

Build up Time in Years



CAP88 Nuclide Data Tab

CAP88-PC Version 3.0
File Run Help

Exit [Icons] ?

Dataset Name :ACRR10.Off

Facility Data Run Options Met Data Source Data Agri. Data **Nuclide Data**

Number of Radionuclides: 1

Time Step Days

Limit Chain

Set Length

- 1 -

NUCLIDE	Rel. Rate (Ci/yr)	SIZE	Type	Chem. FORM
Ar-41	1.090E-03	0	G	unspecified

Modify Nuclides

Add Nuclide

Edit Nuclide

Delete Nuclide

Save and Close

