

RASCAL 4.0

Radiological Assessment System for Consequence Analysis

National Radiological Emergency Preparedness Conference

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Contrast w/RASCAL 3.0.5

- Highlight new features – new ATD model
- Case Study - Fixed Parameters
Byron NPP, Core uncovered 1 hr
2% release per day, no spray, no filters
activity released – 9.5 E5 Curies 3.0.5
-- 8.9 E5 Curies 4.0
- Case Study – Varying Parameters
Stability Classes B and E
2 & 8 mph wind speeds, no precip

Byron Unit 2: Source Term

The screenshot displays the 'Source Term to Dose' software interface. The main window shows a 'Case Summary' for a 'Nuclear Power Plant' event at 'Byron - Unit 2'. The 'Source Term' button in the left sidebar is highlighted with an orange box. An inset window titled 'Source Term Options for Nuclear Power Plant' shows the 'Time Core Is Uncovered' option selected. A second inset window, 'Time Core Is Uncovered', provides detailed configuration for the event, including reactor shutdown and core recovery times, with the 'Yes' options highlighted in orange.

Source Term to Dose - [New Case.STD]

File Options Nuclide Data Viewer Site / Facility Data Viewer Help

Follow the steps below to define and run a problem. Use the Tabs below to review information.

Event Type
NPP Reactor

Event Location
Byron - Unit 2

Source Term

Case Summary

Event Type Nuclear Power Plant

Location

Name: Byron - Unit 2
City, county, state: Byron, Ogle, IL
Lat / Long / Elev: 42.0750° N, 89.2819° W
Time zone: Central
Population (2000): 587 / 9,752 / 24,985 (2 / 10 / 100)

Reactor Parameters

Reactor power: 358 MW
Average fuel burn-up: 3000 MWD/MTU
Containment type: PW
Containment volume: 2.90E6 m³
Design pressure: 61 MPa
Design leak rate: 0.10 m³/yr
Coolant mass: 2.51E6 kg
Assemblies in core: 193
Steam generator type: U-Tube

Source Term Options for Nuclear Power Plant

Source term based on reactor conditions

Time Core Is Uncovered

Specified Core Damage Endpoint

Containment Radiation Monitor

Coolant Sample

Time Core Is Uncovered

Reactor shutdown: 2010/02/20 00:00

Core uncovered? Yes 2010/02/20 01:00

No normal coolant activity released

Core recovered? Yes 2010/02/20 02:00

No

OK
Cancel
Help

Release Pathway

Source Term to Dose - [New Case]

File Options Nuclide Data View

Follow the steps below to define and run a problem

- Event Type**
NPP Reactor
- Event Location**
Byron - Unit 2
- Source Term**
Time Core Is Uncovered
- Release Path**
<undefined>
- Meteorology**
<undefined>

Calculate Doses

Detailed Results

Save Case

Available release pathways

Select the release pathway option to be used in the calculations

- Containment leakage/failure**
- Steam generator tube rupture
- Containment bypass

PWR Dry Containment – Leakage/Failure

The diagram illustrates a PWR Dry Containment system. It features a central Reactor Vessel connected to a Pressurizer and a Steam Generator. A Relief Tank is also connected to the system. The system is divided into three main areas: Auxiliary Building, Containment, and Turbine Building. A Low Pressure System is shown at the bottom. A Safety Relief Valve is located between the Containment and Turbine Building. A Condenser and Offgas Exhaust are also shown. Red arrows indicate release paths from the Reactor Vessel, Pressurizer, and Steam Generator, as well as from the Auxiliary Building and Containment area. A Filter and Sprays are also shown in the Auxiliary Building.

OK

Cancel

Help

Print

Release Pathway Options

PWR - Dry Containment Leakage or Failure

Pathway description: (optional; 60 character max)

Release height:

Release timings: Core uncovered: 2010/02/20 01:00

Leak rate to atmosphere described by:
 Percent volume / time
 Containment pressure / hole size

Date	Time	Event	Event setting
2010/02/20	01:00	Leak rate (% vol)	2.000 %/d
2010/02/20	01:00	Sprays	Off

Add Row
Remove Row
Sort Rows
Clear All

OK
Cancel
Help

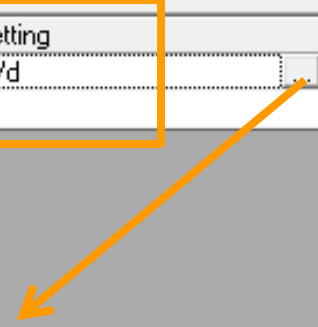
Leak Rate as Percent of Volume

Total Failure (100 %/h)

Percent Volume: % per

Design (0.10 %/d)

Minimum 10 m release height is optimum model default



Meteorology

Dataset Type

- Actual Observations and Forecasts
- Predefined Data (Non Site-specific)
- Predefined Data (Site Specific)

Available Datasets

BYRO 2010-02-07 2030 5 mph B	Description: 6 stations used; 1 records defined
BYRO 2010-02-07 2037 5 mph E	
BYRO 2010-02-20 1400 8 mph E sta	

Buttons: Create New, Edit Existing, Import, Delete

Meteorological Field Display

View Values

Winds View topography

Elevation (m)

- 250
- 300

Stability

- A
- B
- C
- D
- E
- F
- G

Precip Type

- no precipitation
- light rain
- moderate rain
- heavy rain
- light snow
- moderate snow
- heavy snow

Mixing Height

heights in kilometers

- < 0.2
- < 0.4
- < 0.6
- < 0.8
- < 1.0
- < 1.2
- < 1.4
- < 1.6
- < 1.8
- < 2.0
- >= 2.0

2010/02/20 00:00

Buttons: Return, Help

Meteorology

Calculate

The screenshot shows the 'Source Term to Dose' application window. On the left, a vertical sidebar contains several buttons: 'Event Type' (checked), 'Event Location' (checked), 'Source Term' (checked), 'Release Path' (checked), 'Meteorology' (checked), and 'Calculate Doses' (highlighted with an orange box). Below these are 'Detailed Results' and 'Save Case' buttons. The main area displays a 'Case Summary' with fields for 'Event Type' (NPP Reactor), 'Location' (Byron - Unit 2), and 'Reactor Parameters'. Overlaid on this is a 'Start the Calculations' dialog box. The dialog has a title bar and a close button. The main text reads: 'Specify options and description for this set of calculations, then OK to begin calculations.' Under 'Distance of calculation:', there are radio buttons for 'Close-in + out to 10 miles (16 km)', 'Close-in + out to 25 miles (40 km)', 'Close-in + out to 50 miles (80 km)', and 'Close-in only'. Below this, it says 'Using close-in distances in miles: 0.1, 0.2, 0.3, 0.5, 0.7, 1.0, 1.5, 2.0'. There are radio buttons for 'Defaults' (selected) and 'User defined', with a 'Set Close Distances' button. The 'Start of release to atmosphere:' is set to '2010/02/20 01:00 (from release pathway definition)'. Under 'End calculations at:', there are two options: 'Start of release to atmosphere plus:' (selected and highlighted with an orange box) and 'User specified time:'. The 'Start of release to atmosphere plus:' option has a spinner box containing the number '8' and the word 'hours'. The 'User specified time:' option has a date field '2010/02/20' and a time field '07:00'. At the bottom, there is a 'Case description:' field containing 'Byron 1 hr uncovered'. The dialog has 'OK', 'Cancel', and 'Help' buttons.

Default 8
hour dose
calculation

Source Term to Dose - [Byron 1 hr uncovered NREP.STD]

File Options Nuclide Data Viewer Site / Facility Data Viewer Help

Follow the steps below to define and run a problem

Use the Tabs below to review information.

Results

Event Type
NPP Reactor

Event Location
Byron - Unit 2

Source Term
Time Core Is Uncovered

Release Path
PWR Dry

Meteorology
Actual Observations

Calculate Doses

Detailed Results

Save Case

Maximum Dose Values (rem) - To 10 mi

Dist from release miles (kilometers)	3 (4.8)	4 (6.4)	5 (8.0)	7 (11.3)	10 (16.1)
Total EDE	6.9E-01	4.8E-01	3.8E-01	2.5E-01	1.6E-01
<u>Thyroid CDE</u>	<u>1.0E+01</u>	<u>7.1E+00</u>	<u>5.7E+00</u>	3.8E+00	2.4E+00
Inhalation CEDE	4.4E-01	3.1E-01	2.5E-01	1.6E-01	1.0E-01
Cloudshine	4.1E-02	3.0E-02	2.5E-02	1.7E-02	1.1E-02
1-day Groundshine	2.0E-01	1.4E-01	1.1E-01	7.1E-02	4.3E-02
Inter Phase 1st Yr	<u>3.0E+00</u>	<u>2.0E+00</u>	1.6E+00	1.0E+00	6.3E-01
Inter Phase 2nd Yr	1.9E+00	1.3E+00	1.0E+00	6.6E-01	4.1E-01

Notes:

- Doses exceeding PAGs are underlined.
- Early-Phase PAGs: TEDE - 1 rem, Thyroid (iodine) CDE - 5 rem
- Intermediate-Phase PAGs: 1st year - 2 rem, 2nd year - 0.5 rem
- *** indicates values less than 0.1 mrem
- To view all values - use Detailed Results | Numeric Table

Value displayed: Close-in dose Doses to 10 miles Criticality shine dose

Display units: English Metric

Definitions Print

Case Summary **Source Term** Maximum Dose Values

New

Check this

m to Dose Model

Viewer Site / Facility Data Viewer Help

Use the Tabs below to review information.

RASCAL 3.0.5

Total activity released to atmosphere: 9.5E+05 Ci

Activity Released 6% lower

Source Term to Dose - [Byron 1 hr uncovered NREP.STD]

File Options Nuclide Data Viewer Site / Facility Data Viewer Help

Follow the steps below to define and run a problem

RASCAL 4.0

Use the Tabs below to review information.

Total amount released to atmosphere: 8.9E+05 Ci

Nuclide	Ci	Nuclide	Ci	Nuclide	Ci
Ba-137m	1.1E+03	La-140	3.0E+00	Sr-92	
Ba-140	1.5E+03	Mo-99	1.7E+02	Tc-99m	
Ce-144	2.0E+01	Np-239	1.3E+01	Te-127	
Cs-134	2.2E+03	Pr-144	4.6E-01	Te-127m	
Cs-135	9.2E-06	Pr-144m	4.9E+00	Te-129	
Cs-136	5.1E+02	Pu-239	3.9E+02	Te-129m	
Cs-137	1.4E+03	Rb-87	5.7E-04	Te-131	
Cs-138	1.3E+03	Rb-88	1.1E+01	Te-131m	
I-129	3.1E-08	Rh-103m	2.1E+01	Te-132	
I-131	1.8E+04	Ru-103	2.4E+00	Xe-131m	
I-132	1.8E+04	Ru-106	2.7E+01	Xe-133	
I-133	3.3E+04	Sb-127	4.0E+04	Xe-133m	
I-134	5.6E+03	Sb-129	1.3E+02	Xe-135	
I-135	2.3E+04				

Notice Cs-137*

Case Summary

- Event Type
NPP Reactor
- Event Location
Byron - Unit 2
- Source Term
Time Core Is Uncovered
- Release Path
PWR Dry
- Meteorology
Actual Observations

the Tabs below to review information.

RASCAL 3.0.5

s (rem) - Close-In

TEDE (top) & CDE

0.2	0.3	0.5	0.7	1.	1.5	2.
(0.32)	(0.48)	(0.8)	(1.13)	(1.61)	(2.41)	(3.22)
<u>3.5E+01</u>	<u>2.1E+01</u>	<u>1.2E+01</u>	<u>9.2E+00</u>	<u>7.0E+00</u>	<u>5.0E+00</u>	<u>3.9E+00</u>
<u>6.6E+02</u>	<u>3.8E+02</u>	<u>2.2E+02</u>	<u>1.7E+02</u>	<u>1.3E+02</u>	<u>9.1E+01</u>	<u>7.1E+01</u>
<u>2.2E+01</u>	<u>1.3E+01</u>	<u>7.4E+00</u>	<u>5.5E+00</u>	<u>4.2E+00</u>	<u>3.0E+00</u>	<u>2.3E+00</u>
<u>2.9E+00</u>	<u>1.8E+00</u>	<u>1.1E+00</u>	<u>8.8E-01</u>	<u>7.0E-01</u>	<u>5.1E-01</u>	<u>4.0E-01</u>
<u>2.8E+01</u>	<u>1.6E+01</u>	<u>9.5E+00</u>	<u>7.1E+00</u>	<u>5.4E+00</u>	<u>3.9E+00</u>	<u>3.0E+00</u>
<u>8.7E-01</u>	<u>6.3E-01</u>	<u>4.5E-01</u>	<u>3.6E-01</u>	<u>3.1E-01</u>	<u>2.4E-01</u>	<u>1.9E-01</u>
<u>1.4E+00</u>	<u>8.0E-01</u>	<u>4.7E-01</u>	<u>3.5E-01</u>	<u>2.6E-01</u>	<u>1.8E-01</u>	<u>1.4E-01</u>
<u>6.6E+00</u>	<u>3.9E+00</u>	<u>2.2E+00</u>	<u>1.7E+00</u>	<u>1.3E+00</u>	<u>9.1E-01</u>	<u>7.0E-01</u>

Underlined.

rem Thyroid (iodine) CDE - 5 rem

Display units: English
 Metric

Definitions

Print

Source Term Summary

Maximum Dose Values

the Tabs below to review information.

4.0

n) - Close-In

0.3	0.5	0.7	1.	1.5
(0.48)	(0.8)	(1.13)	(1.61)	(2.41)
<u>1.4E+01</u>	<u>6.3E+00</u>	<u>4.1E+00</u>	<u>2.6E+00</u>	<u>1.7E+00</u>
<u>2.0E+02</u>	<u>9.1E+01</u>	<u>5.9E+01</u>	<u>3.7E+01</u>	<u>2.4E+01</u>
<u>8.6E+00</u>	<u>3.9E+00</u>	<u>2.6E+00</u>	<u>1.6E+00</u>	<u>1.0E+00</u>
<u>4.0E-01</u>	<u>2.5E-01</u>	<u>1.8E-01</u>	<u>1.2E-01</u>	<u>8.2E-02</u>
<u>4.6E+00</u>	<u>2.1E+00</u>	<u>1.3E+00</u>	<u>8.5E-01</u>	<u>5.4E-01</u>
<u>6.3E+01</u>	<u>2.9E+01</u>	<u>1.9E+01</u>	<u>1.2E+01</u>	<u>7.6E+00</u>
<u>4.0E+01</u>	<u>1.8E+01</u>	<u>1.2E+01</u>	<u>7.6E+00</u>	<u>4.9E+00</u>

Values about 1/3 lower

ed.

Thyroid (iodine) CDE - 5 rem

Year - 2 rem, 2nd year - 0.5 rem

Results | Numeric Table

Display units: English
 Metric

Definitions

Source Term

10 Maxim

Detailed Results of Dose Calculations

Result Type

- TEDE
 - Inhalation CEDE
 - Cloudshine Dose
 - 4-Day Groundshine Dose
- External Gamma Dose Rate (cloudshine + groundshine)
- Acute Bone Dose Total
- Acute Bone from Inhalation Only
- Acute Lung Dose
- Acute Colon Dose
- Thyroid CDE
- Groundshine Dose Over Defined Time Period
- Ground Concentration - Total
- Ground Concentration of: Am-241
- I-131 Air Concentration
- 1st year Intermediate Phase TEDE
- 2nd year Intermediate Phase TEDE
- 50 year Intermediate Phase TEDE

Time Period for Exposure

- Start of release to end of calculation
- Cumulative over interval

From: 2010/02/20 01:00

To: 2010/02/20 09:00
- Rate at single time

2010/02/20 09:00

Display Format

From 10-mile calculation

- Footprint
- Numeric table
- Special receptors

Define Receptors

From close-in calculation

- Footprint
- Numeric table

Display Units

- English
- SI

Display Result

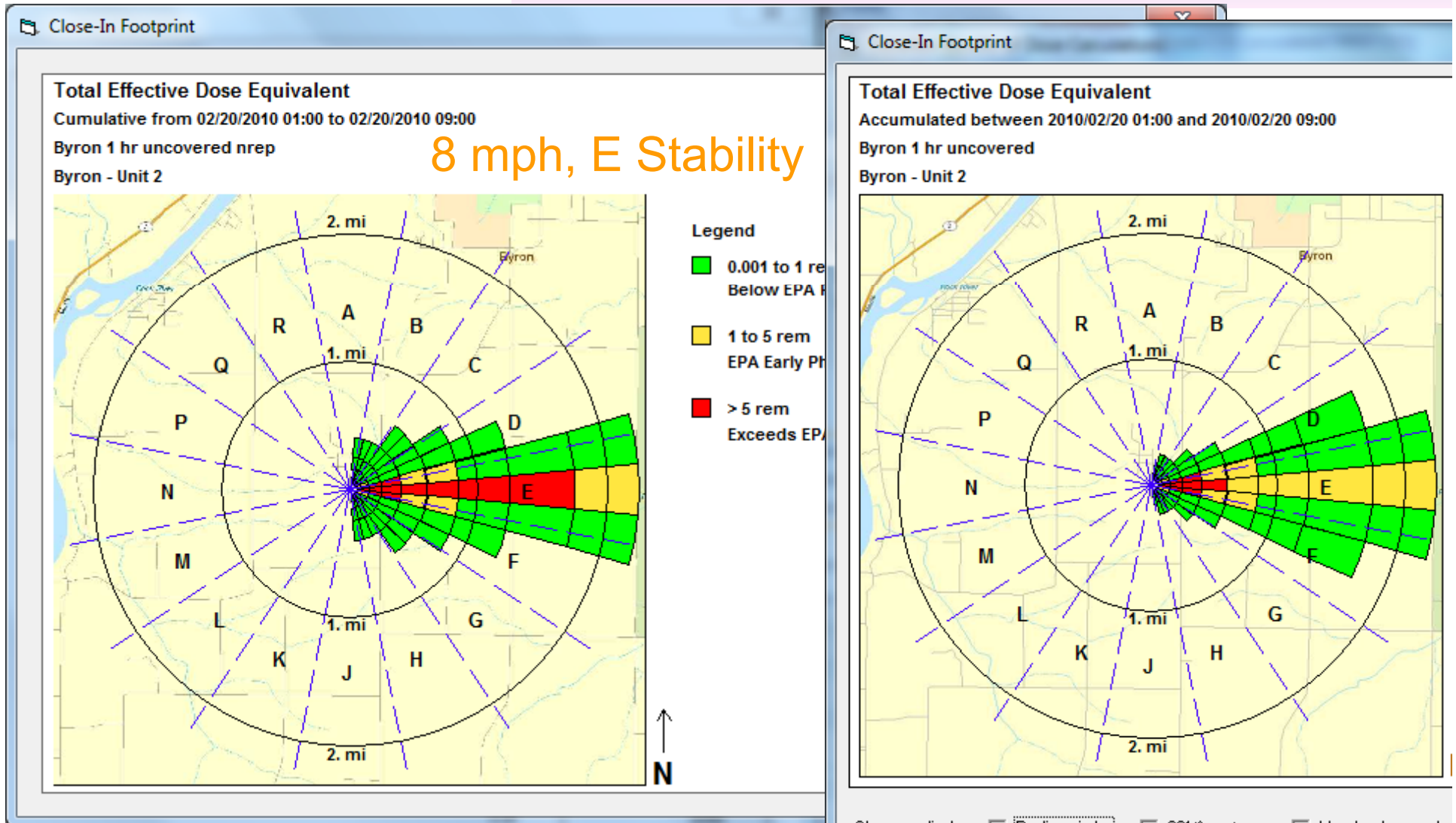
Check TEDE

Help

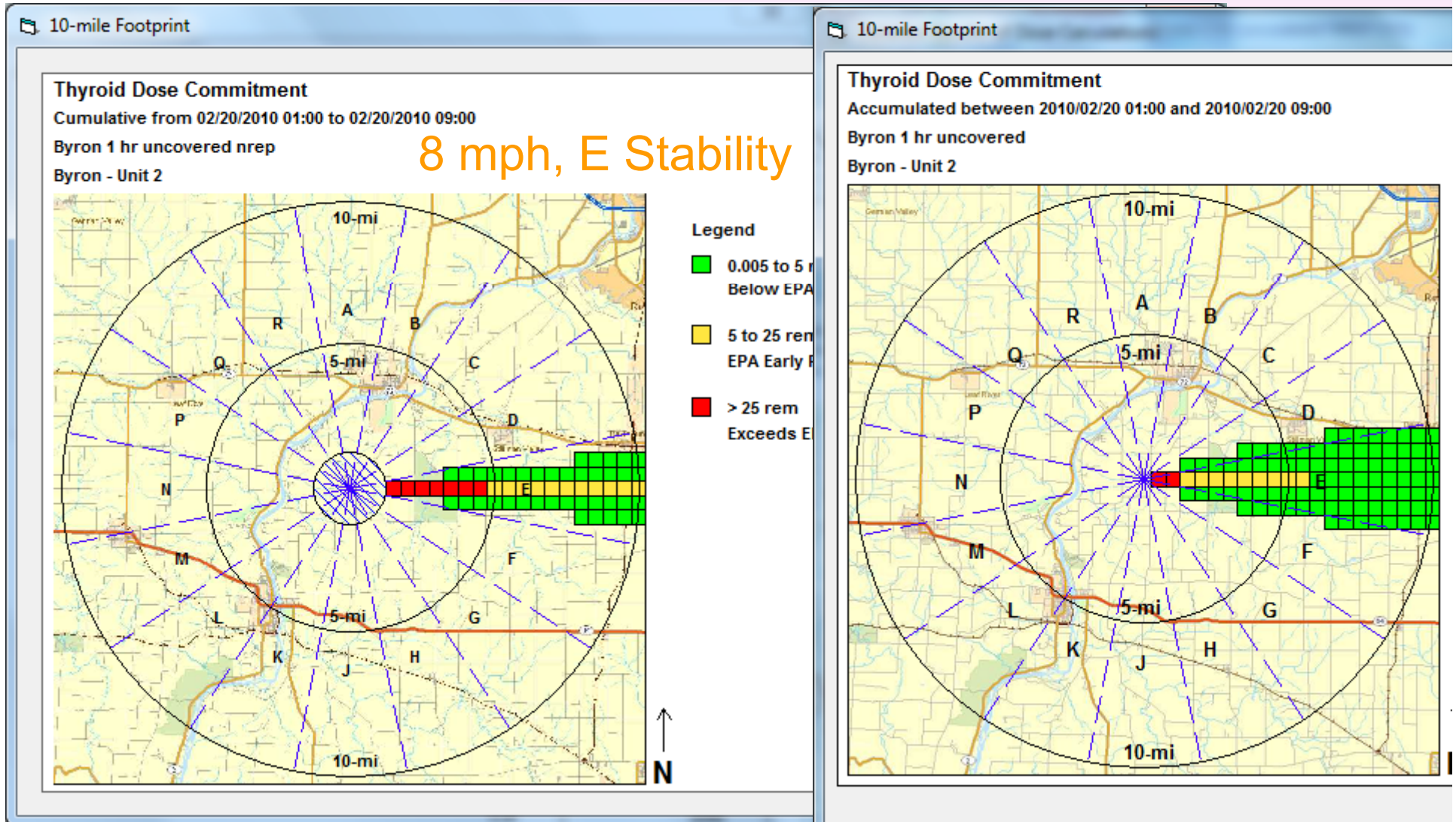
Exit

3.0.5 (left) vs 4.0 TEDE

3.9 rem vs 1.2 rem at 2 mi
1.3 rem vs 0.38 rem at 5 mi

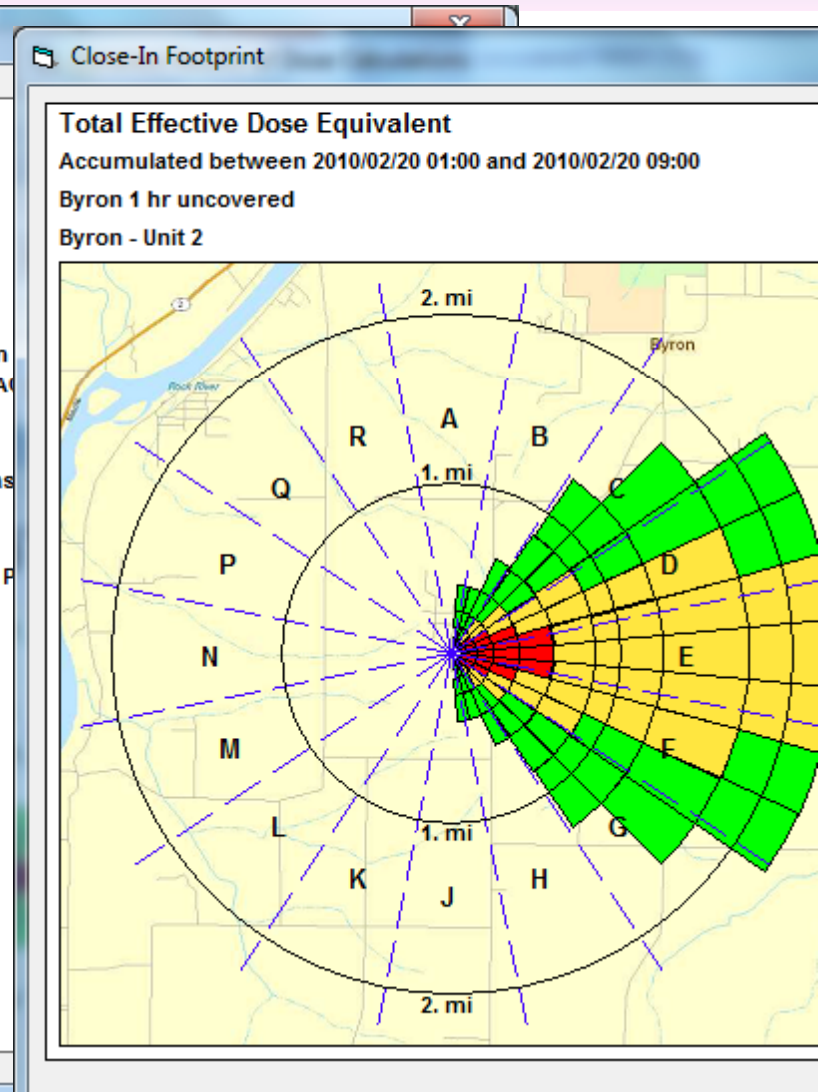
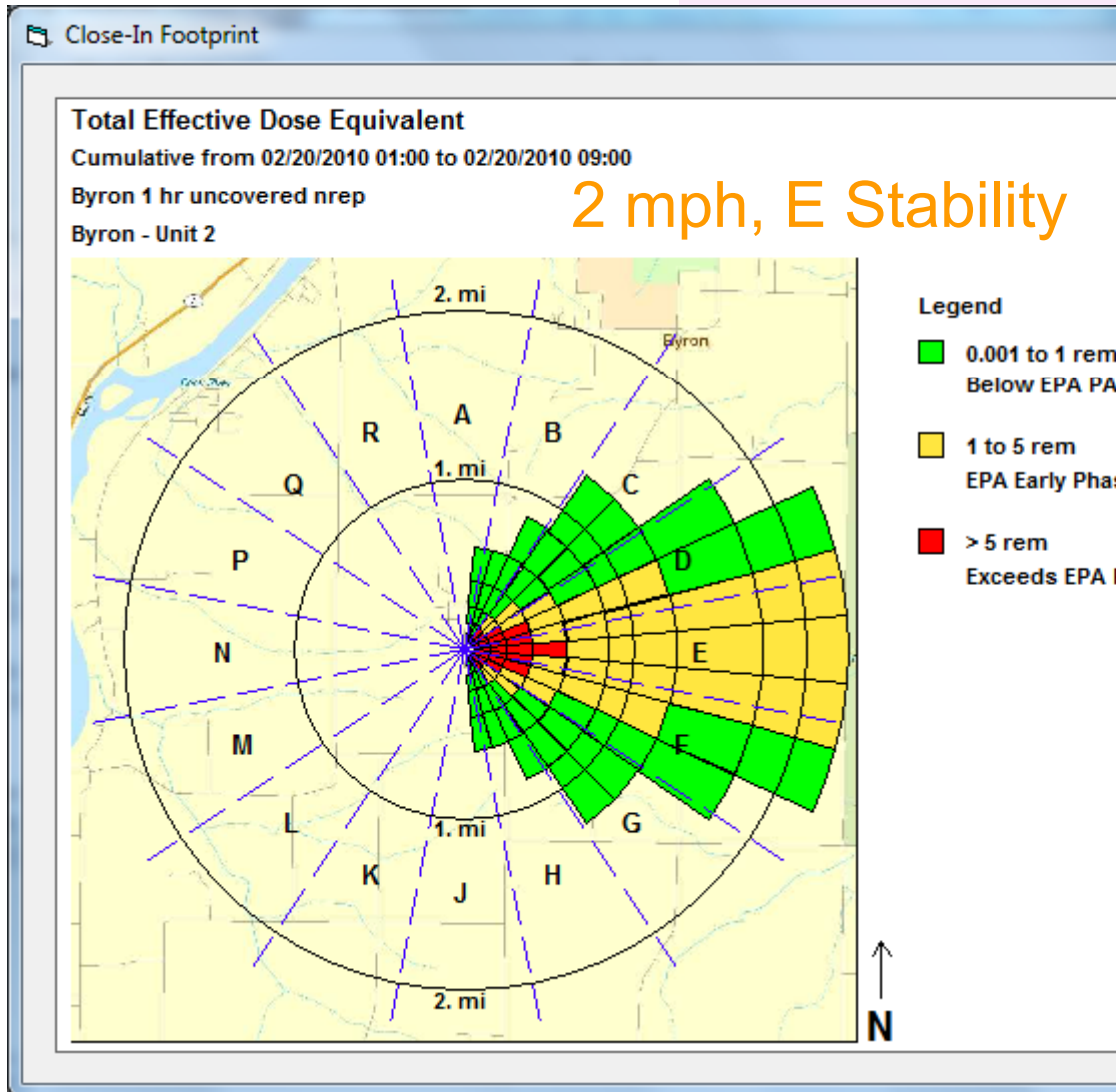


3.0.5 (left) vs 4.0 Thyroid
23 rem vs 5.7 rem at 5 mi
8.9 rem vs 2.4 rem at 10 mi



3.0.5 (left) vs 4.0 TEDE

3.3 rem vs 2.3 rem at 2 mi
1.9 rem vs 0.65 at 5 mi



3.0.5 (left) vs 4.0 Thyroid

36 rem vs 13 at 5 mi
15 rem vs 3.2 at 10 mi

10-mile Footprint

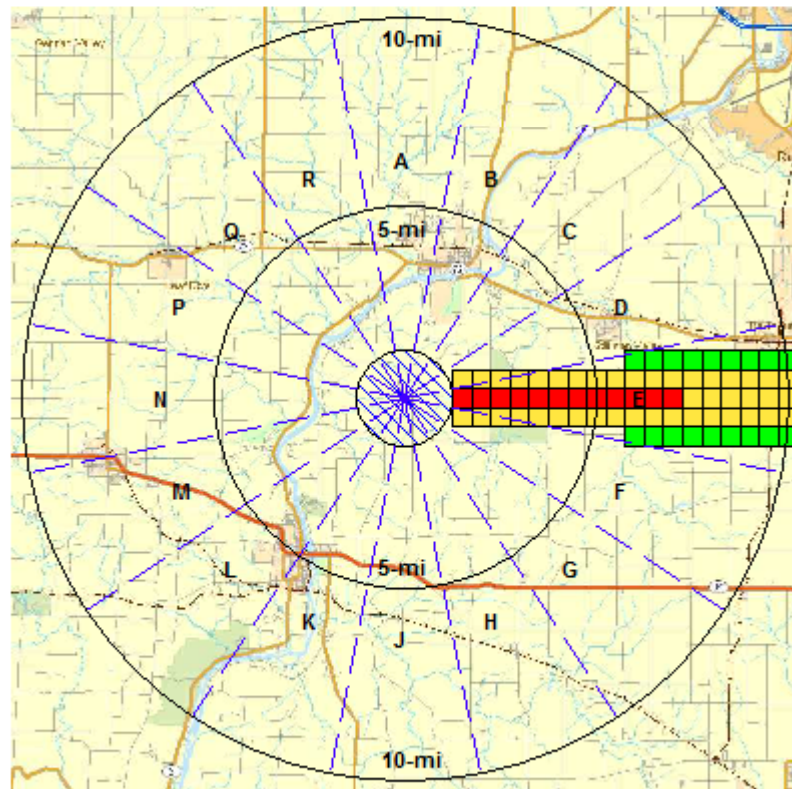
Thyroid Dose Commitment

Cumulative from 02/20/2010 01:00 to 02/20/2010 09:00

Byron 1 hr uncovered nrep

Byron - Unit 2

2 mph, E Stability



- Legend
- 0.005 to Below 5 rem
 - 5 to 25 rem EPA Early Warning
 - > 25 rem Exceeds



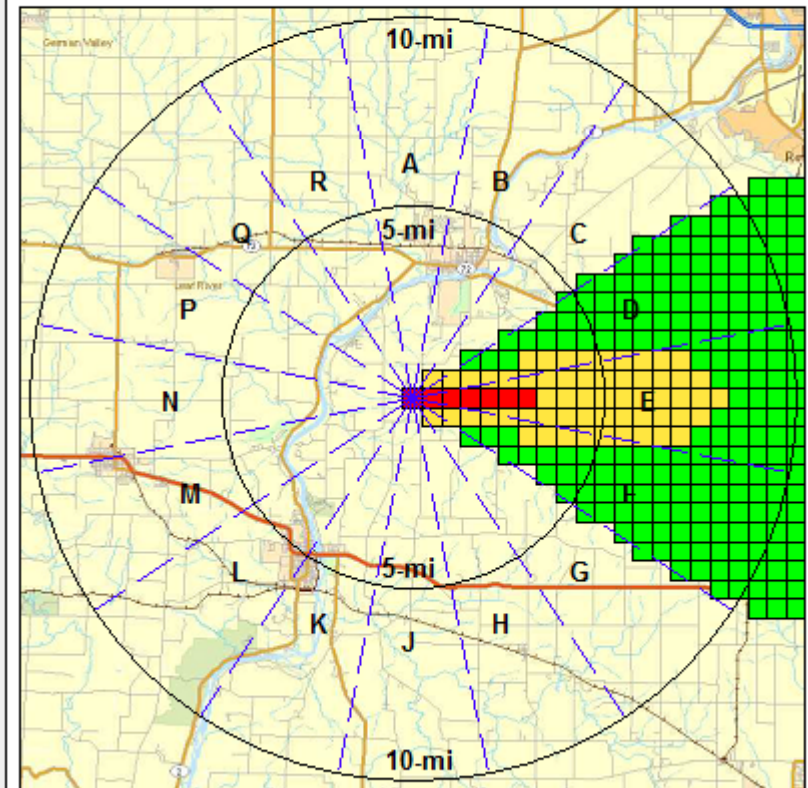
10-mile Footprint

Thyroid Dose Commitment

Accumulated between 2010/02/20 01:00 and 2010/02/20 09:00

Byron 1 hr uncovered

Byron - Unit 2

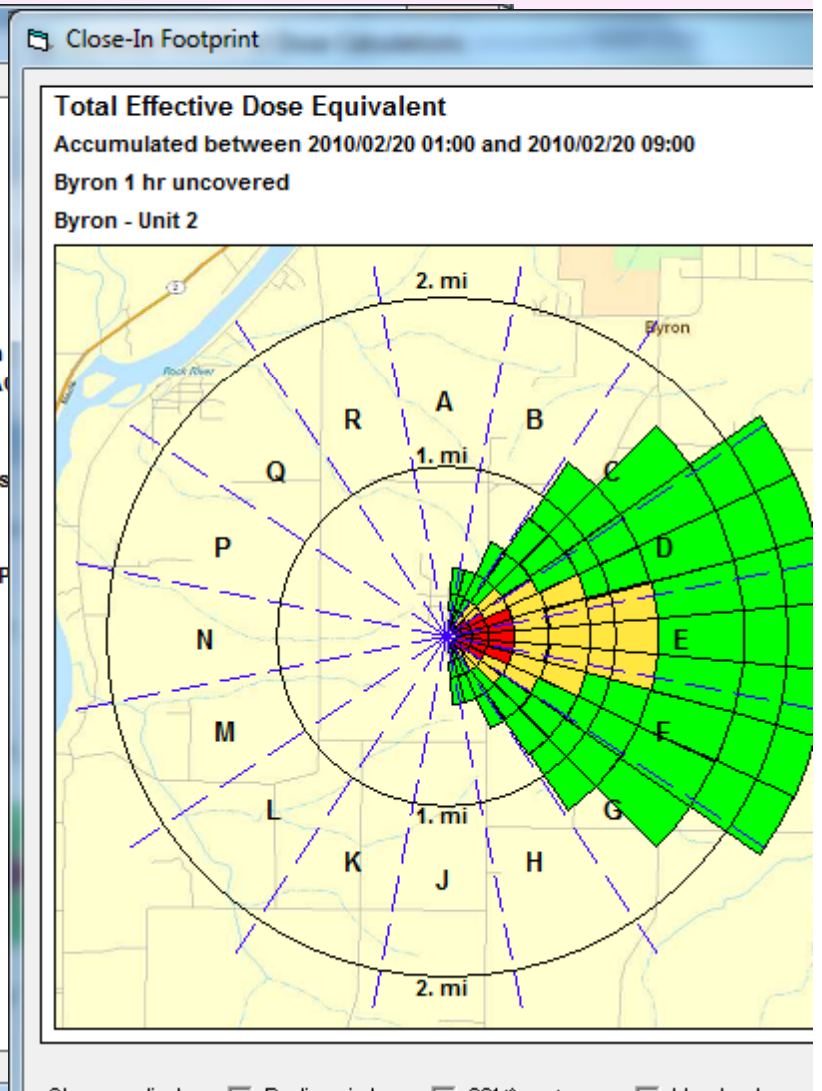
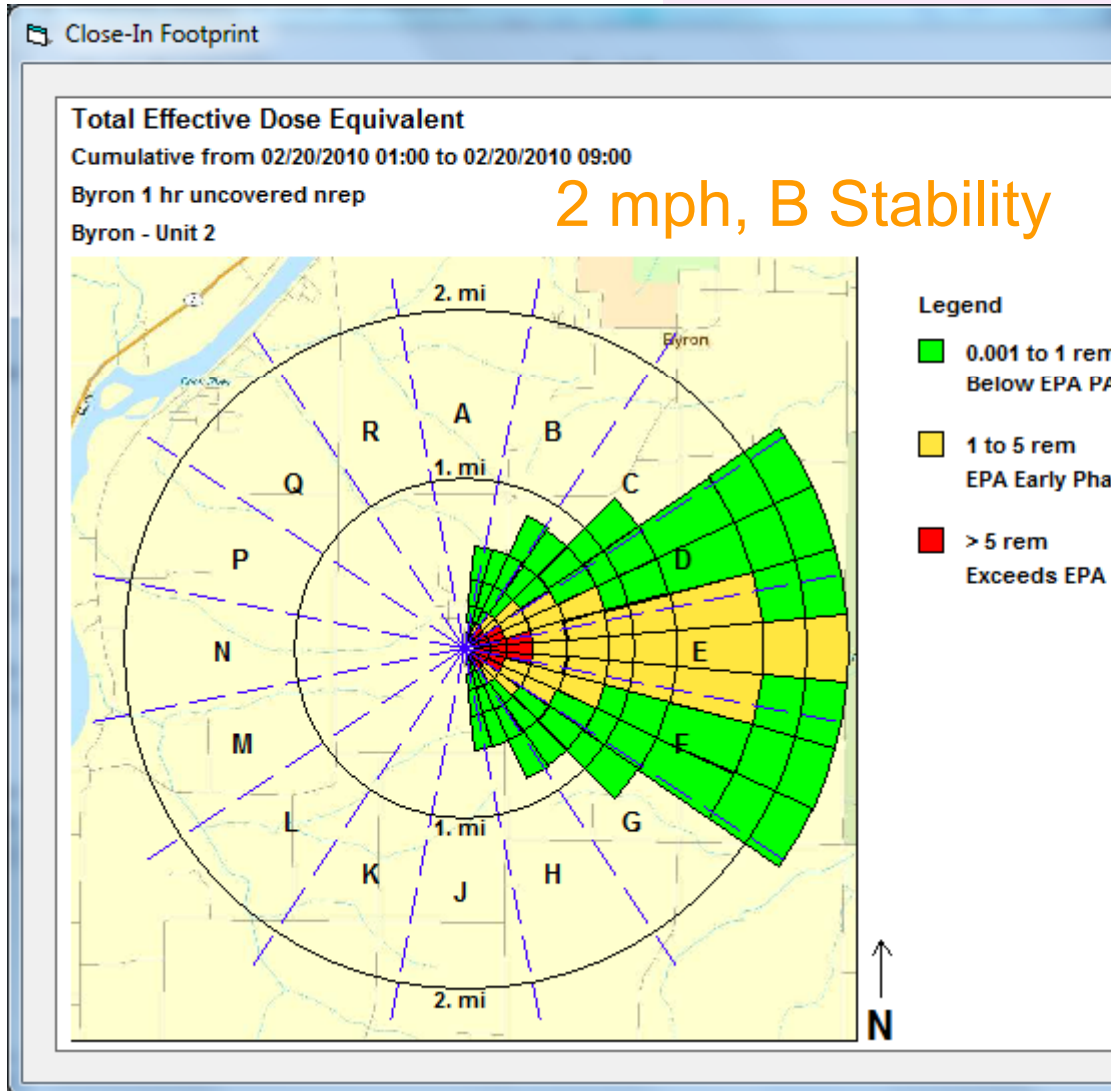


- Legend
- -
 -

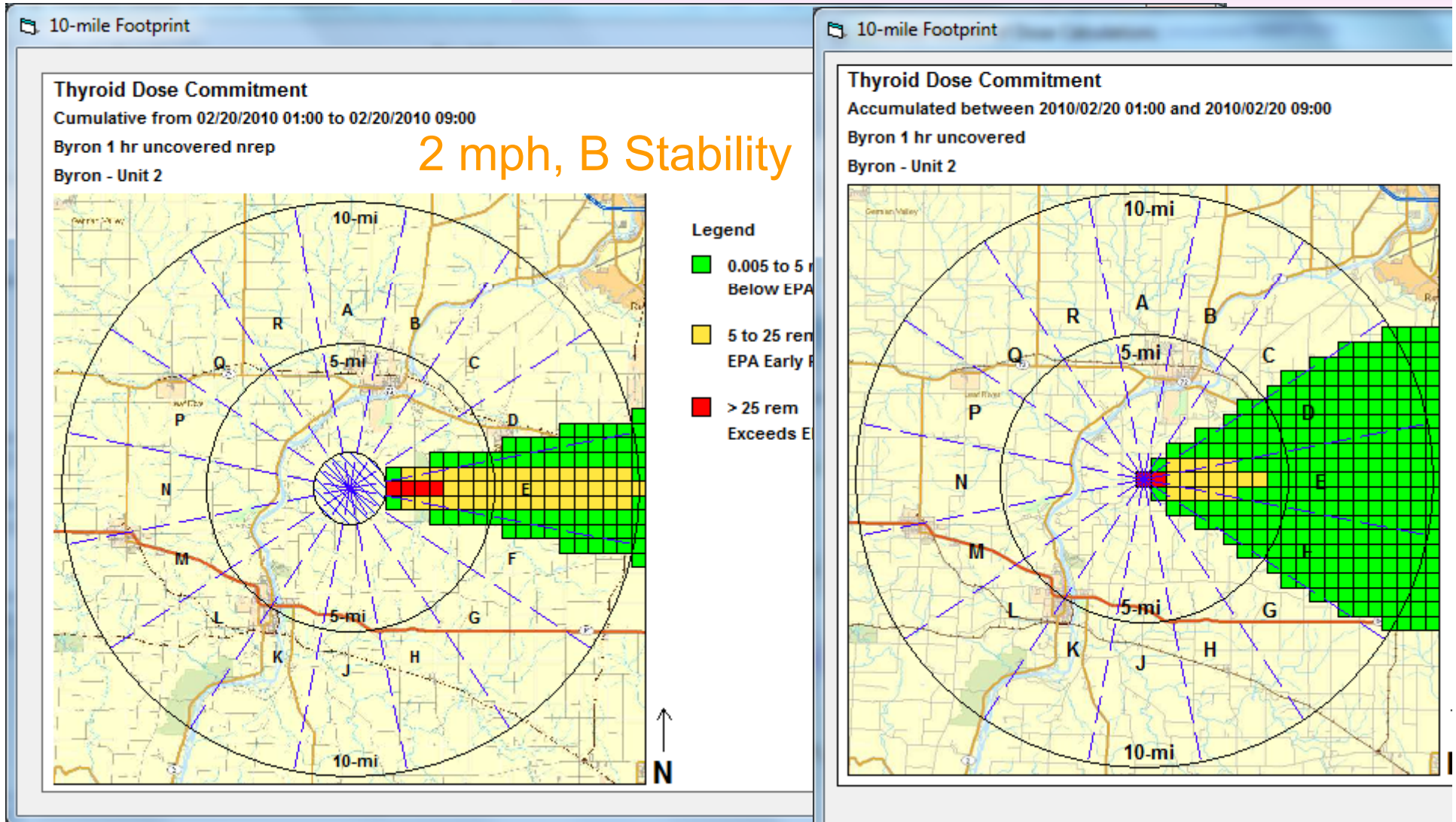


3.0.5 (left) vs 4.0 TEDE

2.1 rem vs 0.44 rem at 2 mi
0.88 rem vs 0.23 rem at 5 mi

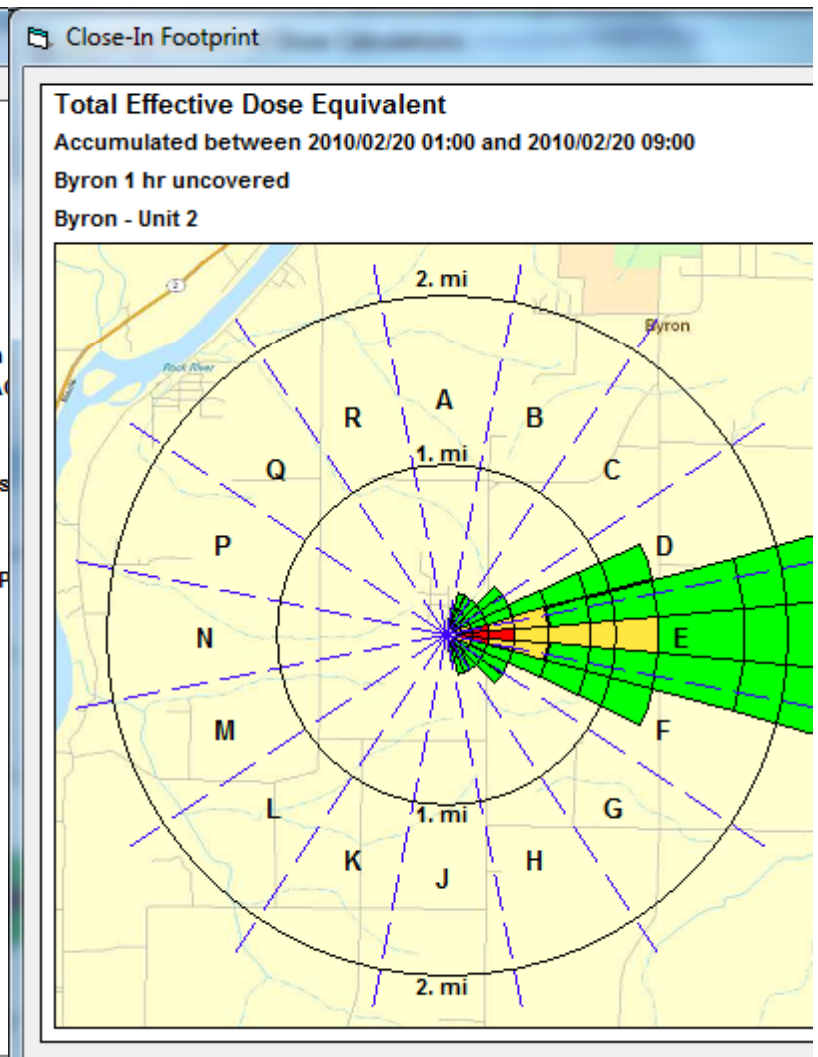
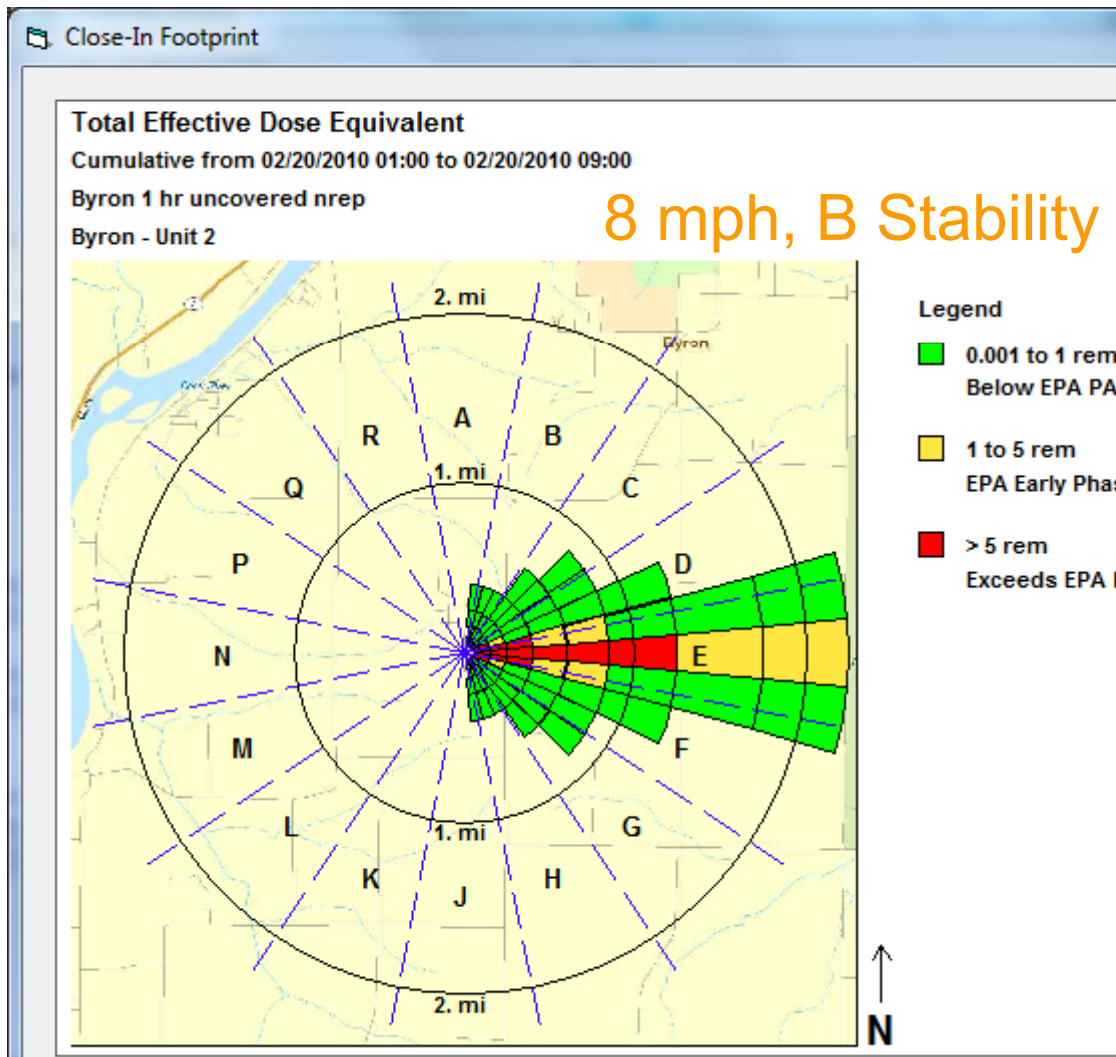


3.0.5 (left) vs 4.0 Thyroid
16 rem vs 3.9 at 5 mi
5.9 rem vs 1.2 at 10 mi

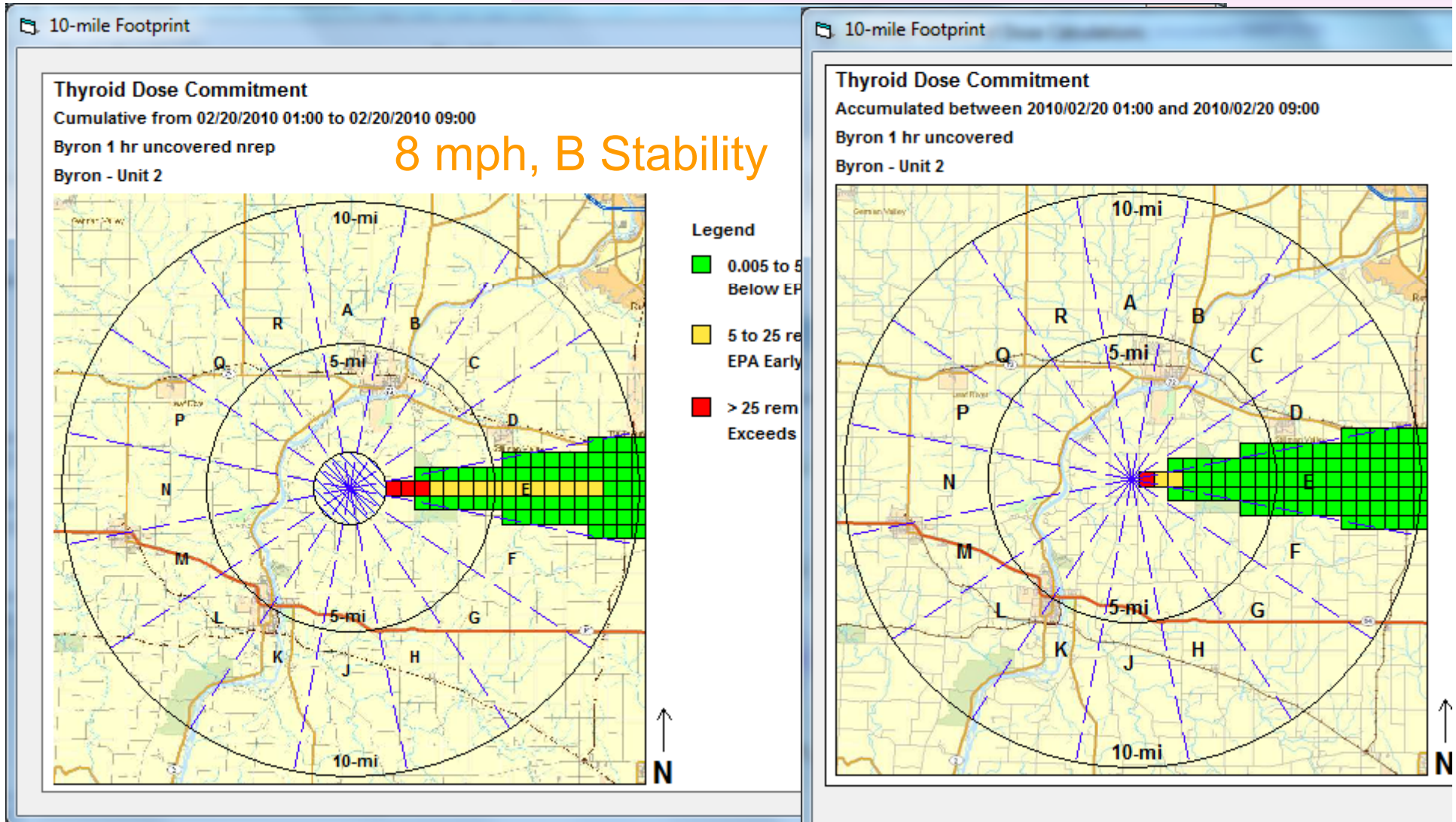


3.0.5 (left) vs 4.0 TEDE

2.4 rem vs 0.33 rem at 2 mi
0.64 rem vs 0.11 at 5 mi



3.0.5 (left) vs 4.0 Thyroid
11 rem vs 1.6 at 5 mi
4.0 rem vs 0.83 at 10 mi

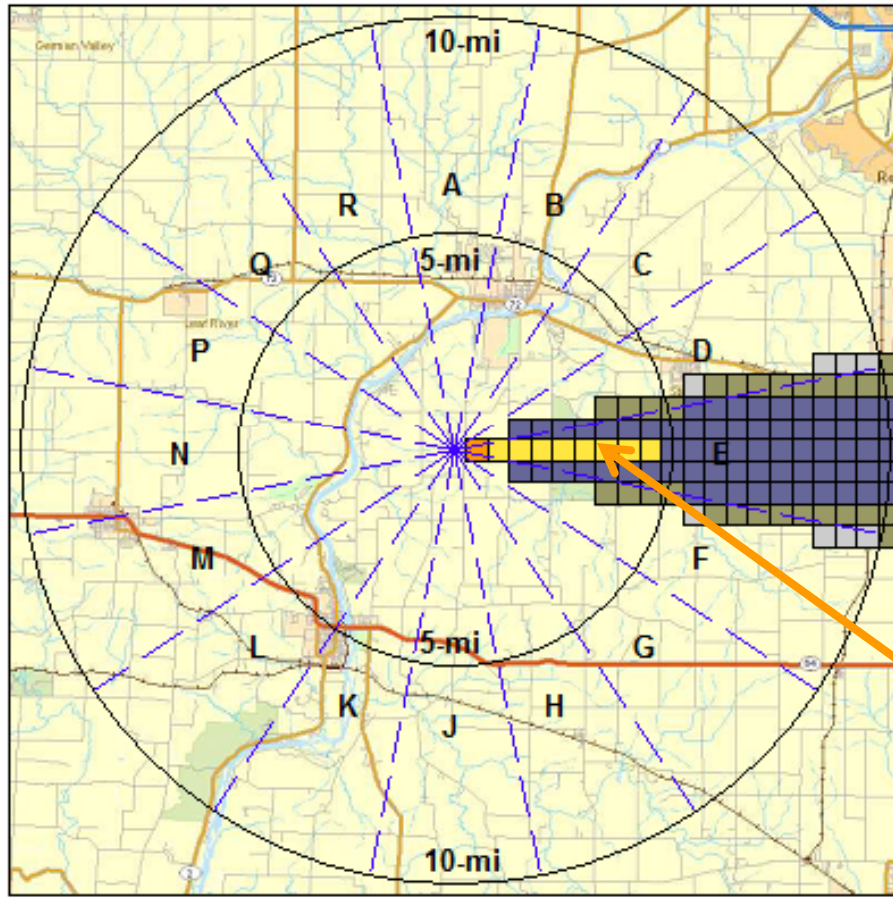


Surface Concentration

deposited between 2010/02/20 01:00 and 2010/02/20 09:00

Byron 1 hr uncovered

Byron - Unit 2



New Feature

Legend

- 0.1 to 1 $\mu\text{Ci}/\text{m}^2$
- 1 to 10 $\mu\text{Ci}/\text{m}^2$
- 10 to 100 $\mu\text{Ci}/\text{m}^2$
- 100 to 1000 $\mu\text{Ci}/\text{m}^2$
- 1 to 10 mCi/m^2
- > 10 mCi/m^2

Data at individual model receptors

Position cursor over cell to display

 at

 from release point

Click cell to display nuclide mix

- Impact Area
- Export
- Print
- OK
- Help

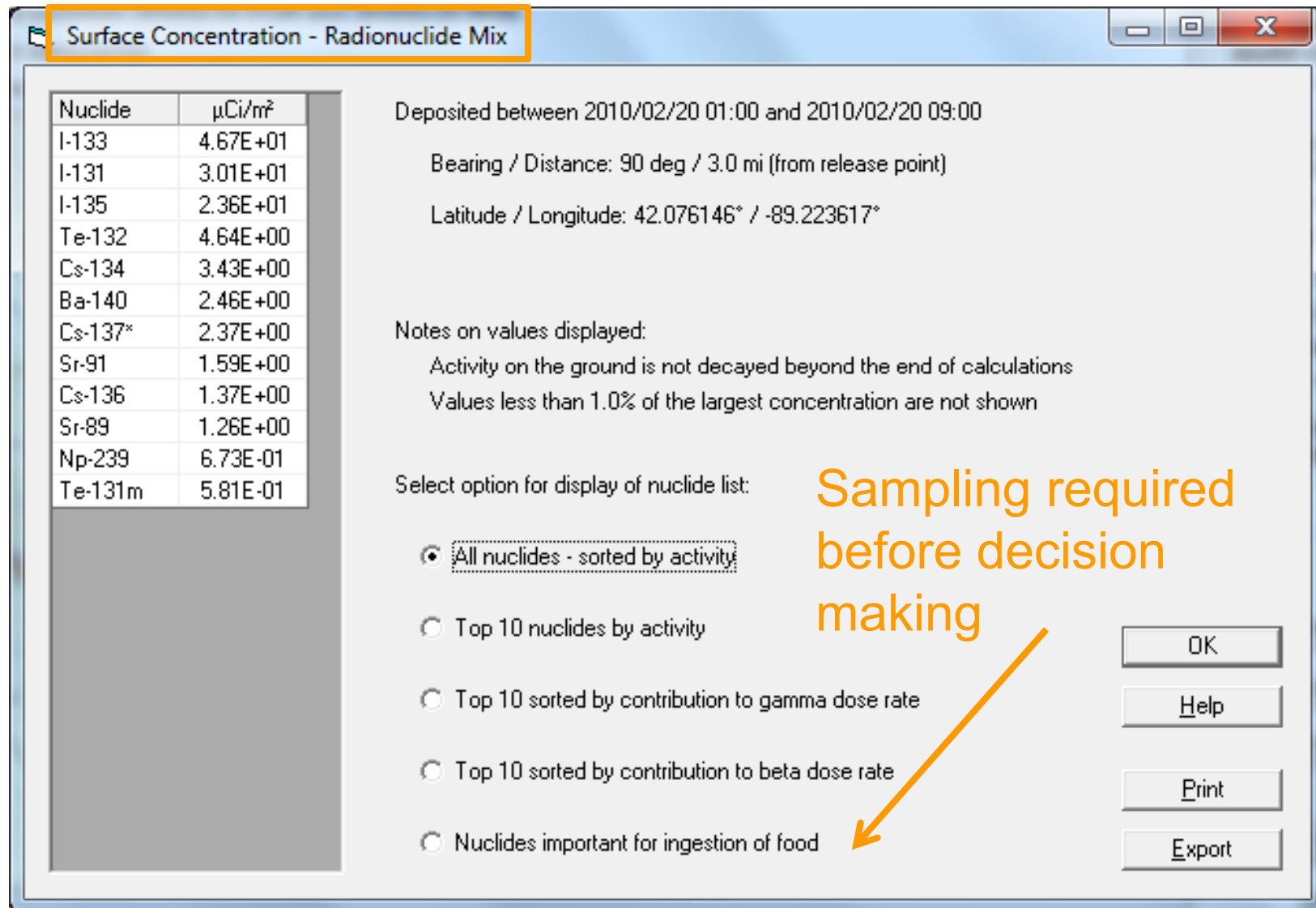
8 mph, B Stability

148 $\mu\text{Ci}/\text{m}^2$
at 3.0 miles

Show on display: Radius circles 22 1/2° sectors Map background

Click Cells for Detail

Radionuclide Deposition



Surface Concentration - Radionuclide Mix

Nuclide	$\mu\text{Ci}/\text{m}^2$
I-133	4.67E+01
I-131	3.01E+01
I-135	2.36E+01
Te-132	4.64E+00
Cs-134	3.43E+00
Ba-140	2.46E+00
Cs-137*	2.37E+00
Sr-91	1.59E+00
Cs-136	1.37E+00
Sr-89	1.26E+00
Np-239	6.73E-01
Te-131m	5.81E-01

Deposited between 2010/02/20 01:00 and 2010/02/20 09:00
Bearing / Distance: 90 deg / 3.0 mi (from release point)
Latitude / Longitude: 42.076146° / -89.223617°

Notes on values displayed:
Activity on the ground is not decayed beyond the end of calculations
Values less than 1.0% of the largest concentration are not shown

Select option for display of nuclide list:

- All nuclides - sorted by activity
- Top 10 nuclides by activity
- Top 10 sorted by contribution to gamma dose rate
- Top 10 sorted by contribution to beta dose rate
- Nuclides important for ingestion of food

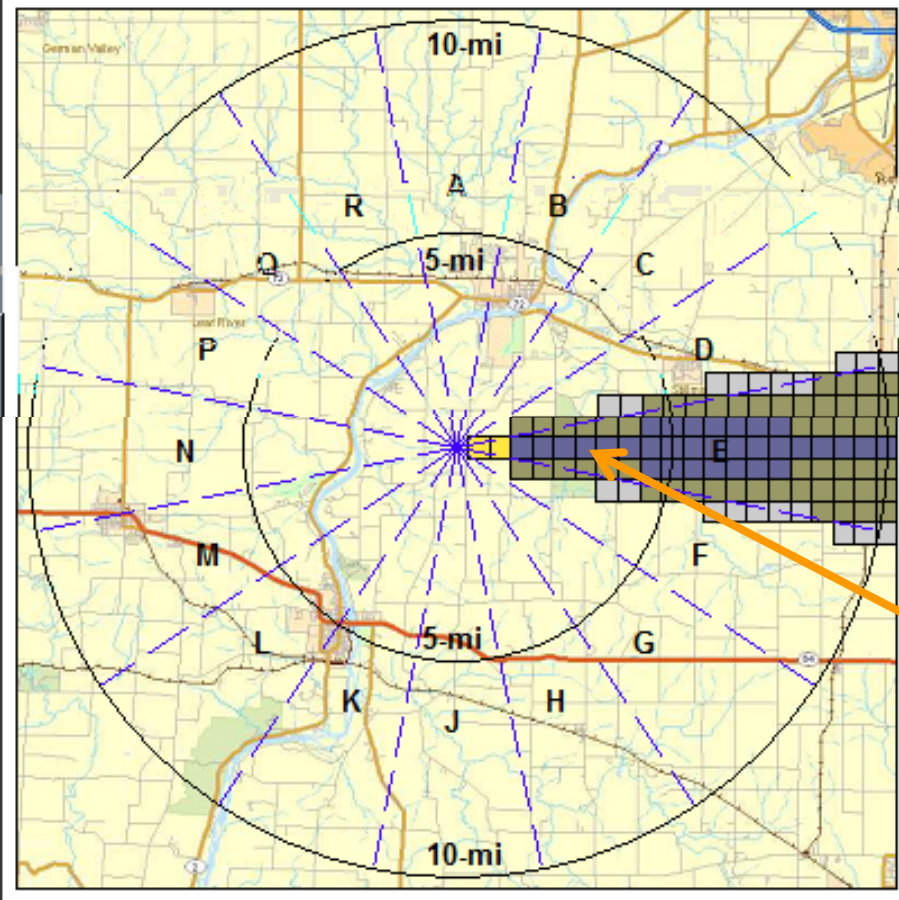
Sampling required before decision making

OK
Help
Print
Export

Surface Concentration of I-131

deposited between 2010/02/20 01:00 and 2010/02/20 09:00
Byron 1 hr uncovered
Byron - Unit 2

Specific Radionuclides



Legend

- 0.1 to 1 µCi/m²
- 1 to 10 µCi/m²
- 10 to 100 µCi/m²
- 100 to 1000 µCi/m²
- 1 to 10 mCi/m²
- > 10 mCi/m²

30 µCi/m²
I-131 at 3.0 miles

Data at individual model receptors

Position cursor over cell to display



Click cell to plot dose rate vs time

Impact Area

Export

Print

OK

Help

Show on display: Radius circles 22½° sectors Map background

Click Cells for Detail

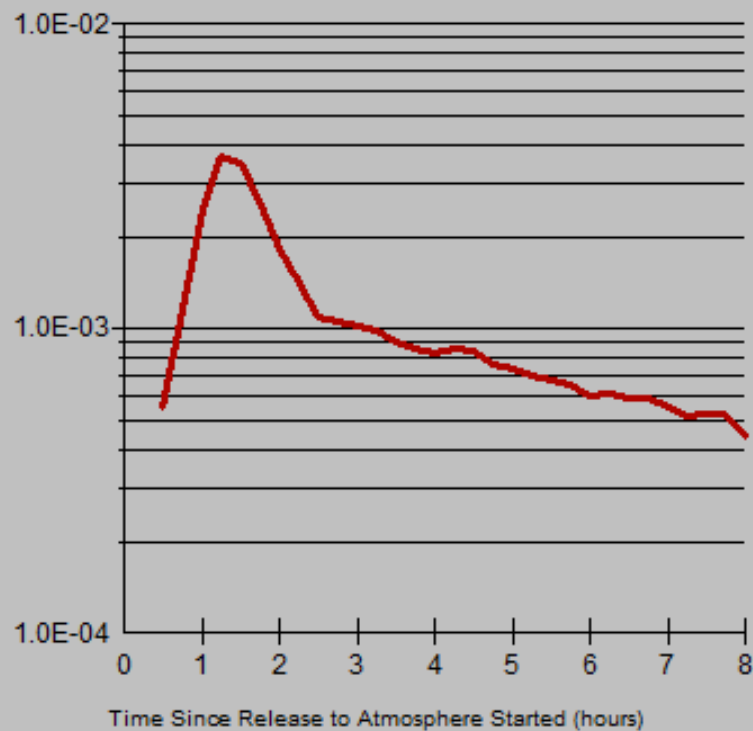
Case description: **Byron 1 hr uncovered**

Start of release: **2010/02/20 01:00**

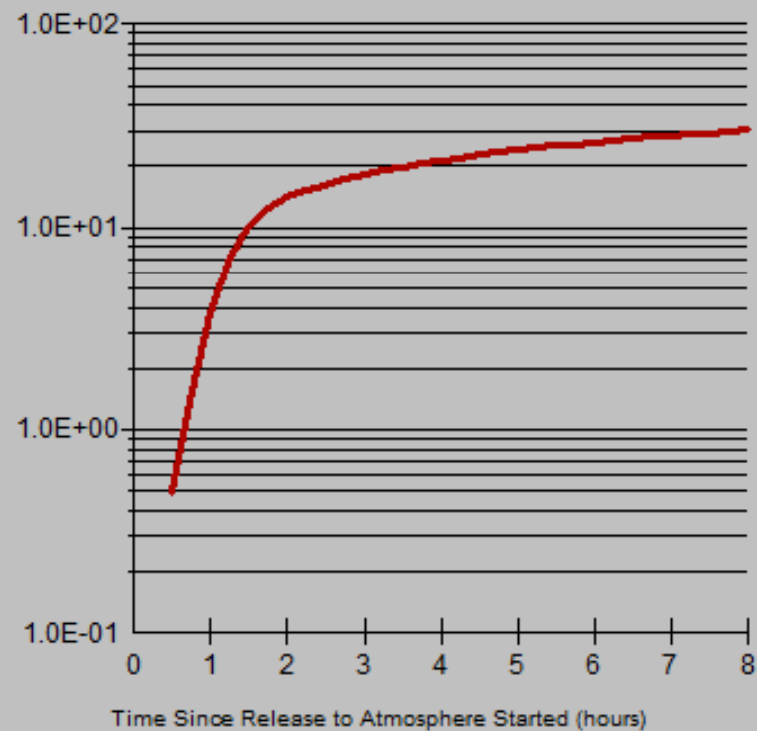
Receptor location: **90 deg, 3.0 mi (from release point)**

Release still in progress but calculation stopped at 8 hr.

Deposition Rate ($\mu\text{Ci}/\text{m}^2/\text{s}$) of I-131



Surface Concentration ($\mu\text{Ci}/\text{m}^2$) of I-131



Print

OK

Help

Monitored Mixtures

Source Term to Dose - [Byron 1 hr uncovered NREP.S

File Options Nuclide Data Viewer Site / Facility Dat

Follow the steps below to define and run a problem

Event Type
NPP Reactor

Event Location
Byron - Unit 2

Source Term
Effluent Releases - by Mixtures

Release Path
<undefined>

Meteorology
Actual Observations

Calculate Doses

Detailed Results

Save Case

Source Term Options

Source term base

Time Core Is Unc

Specified Core D

Containment Rad

Coolant Sample

Air Sample

Source term base

Effluent Release Rates - by Nuclide

Effluent Release Concentrations - by Nuclide

Effluent Releases - by Mixtures

Reactor shutdown: Yes 2010/02/20 00:00
 No

Sample taken: 2010/02/20 01:00

Release rate units: Ci/s

Release rates:

Noble gases 1.00E+03 (Ci/s)

Iodines

Total

I-131 equiv. 1.00E+00 (Ci/s)

Particulates 1.00E-01 (Ci/s)

OK

Cancel

Help

OK

Cancel

Help

Print

Case Summary Source Term Maximum Dose Values

Can now enter I-131 equivalent release rate

Release Pathway – Monitored, Filtered

The image shows a software interface with a dialog box titled "Direct to Atmosphere" and a main window titled "Reactor Parameters".

Direct to Atmosphere Dialog:

- Release height: 10.0 m
- Release timings: Effluent mixture sample taken: 2010/02/20 01:00
- Start of release to atmosphere: 2010/02/20 01:00
- End of release to atmosphere: 2010/02/20 02:00
- Release duration: 0 days 04:00 hh:mm
- Buttons: OK, Cancel

Reactor Parameters:

- Reactor power: 3586 MWt
- Average fuel burn-up: 30000 MWD / MTU
- Containment type: PWR Dry Ambient
- Containment volume: 2.90E+06 ft³
- Design pressure: 61 lb/in²
- Design leak rate: 0.10 %/d
- Coolant mass: 2.51E+05 kg
- Assemblies in core: 193
- Steam generator type: U-Tube

Navigation and Action Buttons:

- Release Path (highlighted)
- Meteorology
- Calculate Doses
- Detailed Results
- Save Case
- Print

Case Summary: Case Summary | Source Term | Maximum Dose Values

2 mph, E Stability, Results

Source Term to Dose - [Byron Mon Mix NREP R4.STD]

File Options Nuclide Data Viewer Site / Facility Data Viewer Help

Follow the steps below to define and run a problem. Use the Tabs below to review information.

Event Type
NPP Reactor

Event Location
Byron - Unit 2

Source Term
Effluent Releases - by Mixtures

Release Path
Direct to atmosphere

Meteorology
Actual Observations

Calculate Doses

Detailed Results

Save Case

Maximum Dose Values (rem) - To 10 mi

Dist from release miles (kilometers)	3 (4.8)	4 (6.4)	5 (8.0)	7 (11.3)	10 (16.1)
Total EDE	<u>1.7E+00</u>	<u>1.1E+00</u>	7.5E-01	<u>4.2E-01</u>	2.1E-01
Thyroid CDE	<u>1.8E+01</u>	<u>1.3E+01</u>	<u>9.3E+00</u>	<u>5.6E+00</u>	3.2E+00
Inhalation CEDE	6.5E-01	4.4E-01	3.1E-01	1.8E-01	1.0E-01
Cloudshine	9.8E-01	6.2E-01	4.2E-01	2.2E-01	1.0E-01
4-day Groundshine	7.0E-02	4.0E-02	2.5E-02	1.2E-02	5.8E-03
Inter Phase 1st Yr	1.1E-01	7.4E-02	5.3E-02	3.1E-02	1.7E-02
Inter Phase 2nd Yr	2.5E-03	1.6E-03	1.1E-03	***	***

Notes:

- Doses exceeding PAGs are underlined.
- Early-Phase PAGs: TEDE - 1 rem, Thyroid (iodine) CDE - 5 rem
- Intermediate-Phase PAGs: 1st year - 2 rem, 2nd year - 0.5 rem
- *** indicates values less than 0.1 mrem
- To view all values - use Detailed Results / Numeric Table

Value displayed: Close-in dose Doses to 10 miles Criticality shine dose

Display units: English Metric

Definitions Print

Case Summary **Source Term** Maximum Dose Values

Check this

- Event Type**
NPP Reactor
- Event Location**
Byron - Unit 2
- Source Term**
Monitored Release - Mixtures
- Release Path**
Direct to atmosphere
- Metering**
Actual Observations
- Calculations**
- Detailed**
- Save**

Source Term

RASCAL 3.0.5

Total activity released to atmosphere:

1.5E+07 Ci

Both
1000
Ci/s
nobles
1 Ci/s
I-131

Nuclide	Ci	Nuclide	Ci	Nuclide	Ci
Cs-137	7.2E+02	I-135	2.4E+04	Xe-131m	2.7E+04
I-131	1.4E+04	Kr-85	1.6E+04	Xe-133	4.7E+06
I-132	1.9E+04	Kr-85m	6.6E+05	Xe-133m	1.7E+05
I-133	2.8E+04	Kr-87	1.3E+06	Xe-135	9.1E+05
I-134	3.1E+04	Kr-88	1.9E+06	Xe-138	4.7E+06

Source Term to Dose - [Byron Mon Mix NREP.STD]

File Options Nuclide Data Viewer Site / Facility Data Viewer Help

Follow the steps below to define and run a problem

Cesiums corrected, only I-131 & I daughters
Use the Tabs below to review information.

Event Type

NPP Reactor

Event Location

Byron - Unit 2

Source Term

Effluent Releases - by Mixtures

Release Path

Direct to atmosphere

Source Term

RASCAL 4.0

Total amount released to atmosphere:

9.7E+06 Ci

Nuclide	Ci	Nuclide	Ci	Nuclide	Ci
Cs-134	2.8E+00	I-134	1.2E+02	Rb-88	8.5E+05
Cs-136	8.8E-01	I-135	2.7E+02	Xe-131m	3.2E+04
Cs-137*	1.9E+00	Kr-83m	1.4E+05	Xe-133	4.7E+06
Cs-138	3.0E+05	Kr-85	2.4E+04	Xe-133m	1.4E+05
I-131	1.4E+04	Kr-85m	4.1E+05	Xe-135	1.1E+06
I-132	1.5E+02	Kr-87	4.6E+05	Xe-135m	1.3E+05
I-133	3.2E+02	Kr-88	9.7E+05	Xe-138	4.5E+05

FM to Dose

RASCAL v4 - Beta Release

Radiological Assessment System for Consequence Analysis

Source Term to Dose

Field Measurement to Dose

Event Description

Event name:

Information below is optional. Check a box to include the item in the case file.

Release started:

OK
Cancel
Help

Sample Data

Sample ID:

Sample type: Ground concentrations in units of

Air concentrations in units of

Activity at time of deposition

Nuclide	Gnd Conc (µCi/m²)
I-133	4.67E+01
I-131	3.01E+01
I-135	2.36E+01
Te-132	4.64E+00
Cs-134	3.43E+00
Ba-140	2.46E+00
Cs-137*	2.37E+00
Sr-91	1.59E+00
Cs-136	1.37E+00
Sr-89	1.26E+00
Np-239	6.73E-01
Te-131m	5.81E-01

Information below is optional. Check a box to include the item in the case file.

Sample location

Latitude: degrees

Longitude: degrees

Sample location from release point

Bearing: degrees

Distance:

Sample description

OK

Enter sample data

Result

Field Measurements to Dose

File Nuclide Data Viewer Help

Event Description

Sample Data

Calculation Options

Compute Doses

Sample Data

Sample ID: Soil Sample 1

Sample Location: **Bearing / Distance 270.0° / 3.0 miles - from release**

Sample desc.: Activities from slide 21 - Byron D

Sample type: Ground concentrations

Nuclide	Ground Conc (µCi/m³)
I-133	4.67E+01
I-131	3.01E+01
I-135	2.36E+01
Te-132	4.64E+00
Cs-134	2.42E+00

Source Term to Dose - [Byron 1 hr uncovered NREP.STD]

File Options Nuclide Data Viewer Site / Facility Data Viewer Help

Follow the steps below to define and run a problem

Compare to: Use the 1

Event Type

NPP Reactor

Event Location

Byron - Unit 2

Source Term

Time Core Is Uncovered

Release Path

PWR Dry

Meteorology

Actual Observations

Calculate Doses

Detailed Results

Save Case

Maximum Dose Values (rem)

Dist from release			
miles	3	4	
(kilometers)	(4.8)	(6.4)	
Total EDE	1.7E-01	1.7E-01	1.7E-01
Thyroid CDE	2.4E+00	2.4E+00	2.4E+00
Inhalation CEDE	1.0E-01	1.0E-01	1.0E-01
Cloudshine	1.6E-02	1.6E-02	1.6E-02
4-day Groundshine	5.2E-02	5.2E-02	5.2E-02
Inter Phase 1st Yr	7.5E-01	7.5E-01	7.5E-01
Inter Phase 2nd Yr	4.8E-01	4.8E-01	4.8E-01

Notes:

- Doses exceeding PAGs are underlined
- Early-Phase PAGs: TEDE - 1 rem, Thyroid CDE - 5 rem
- Intermediate-Phase PAGs: 1st year - 2 rem, 2nd year - 0.5 rem, 50 years - 0.05 rem
- *** indicates values less than 0.1 mrem
- To view all values - use Detailed Results

Value displayed: Close-in dose Doses to 10 miles Criticality shine dose

Case Summary

Field Measurements to Dose

File Nuclide Data Viewer Help

Event Description

Sample Data

Calculation Options

Compute Doses

Intermediate Phase Doses (rem)

Exposure	1st Year	2nd Year	50 Years
Groundshine	7.43E-01	4.53E-01	5.96E+00
Inhalation	1.15E-04	2.67E-06	1.37E-04
Total	7.44E-01	4.53E-01	5.96E+00

Notes

- 1st year PAG = 2 rem, 2nd year objective = 0.5 rem, 50 year objective = 0.05 rem
- Total doses exceeding PAGs are underlined
- Doses less than 1E-6 rem (1E-8 Sv) set to zero.

Deposition time

Starts at 4 days

TF values about 80% RASCAL values

Turbo FRMAC

File Tools Help

Turbo FRMAC

Navigation

- New
- Open
- Byron 211 uncovered files
- Predictive Analyses
- Samples
 - Air Concentration
 - Deposition
 - Soil sample - 3 mi east of release
 - Exposure Rate
 - Food
 - Event-Level Items

Paperless FRMAC

Tools

- Analyst Manager
- Radionuclide Mixture Manager
- Radionuclide Viewer

Quick Event View

ICRP Guidance: [ICRP 30](#)

PAG Authority: [Federal Government](#)

Lung Clearance Class: [Maximum](#)

Weathering Correction: [Likhtarev's Method](#)

Resuspension Type: [Time Varying](#)
[NCRP 129 Method](#)

Respiratory Protection: [Not Administered](#)

Potassium Iodide (KI): [Not Administered](#)

Radionuclide	($\mu\text{Ci}/\text{m}^2$)
Ba-140	2.46
La-140	2.46
Cs-134	3.43
Cs-136	1.37
Cs-137	2.37
Ba-137m	2.24
I-131	30.1
I-133	46.7
I-135	23.6
Xe-135m	3.63
Np-239	0.673
Sr-89	1.26
Sr-91	1.59
Y-91m	0.919
Te-131m	0.581
Te-131	0.129
Te-132	4.64
I-132	4.64

release

Parent Level Reference Sample... Duplicate... Close Delete... Export

Radionuclide	Activity Concentration
¹⁴⁰ Ba	2.46
¹³⁴ Cs	3.43
¹³⁶ Cs	1.37

12 parent radionuclides exist in the mixture.

$\mu\text{Ci} / \text{m}^2$

Total Effective Dose Equivalent (TEDE)

Calculate Total Effective Dose Equivalent (TEDE)... More Mixture Properties...

Calculation Method: Calculate from Deposition Levels

Dose unit mrem

Filter Options

Age Group: Adult

Organ: Whole Body

Commitment Period: 50 Year

Note: Age Group and Commitment Period not apply to External Dose values

	Early Phase	First Year	Second Year	Fifty Year
Committed Effective Dose Equivalent	3.34E-2	0.118	2.71E-3	0.141
External Dose	32.4	6.22E2	3.45E2	3.11E3
Total Effective Dose Equivalent (TEDE)	32.5	6.23E2	3.45E2	3.11E3

30

Relocation DRLs (mR/h)

Field Measurements to Dose

File Nuclide Data Viewer Help

Event Description

Sample Data

Calculation Options

Compute Doses

Intermediate Phase Derived Response Levels (DRLs)

Reentry Time Days	Gamma dose rate (mR/h) at reentry equal to EPA PAG			Cs-137* surface concentration (μCi/m ²) equal to EPA PAG		
	1st Year	2nd Year	50 Year	1st Year	2nd Year	50 Year
0	3.84E+00	8.85E-02	1.14E+00	6.73E+00	2.16E+00	2.00E+00
1	1.70E+00	8.85E-02	4.99E-01	6.84E+00		
2	1.23E+00	8.85E-02	3.56E-01	6.92E+00		
4	9.20E-01	8.84E-02	2.64E-01	7.00E+00		
7	7.66E-01	8.84E-02	2.17E-01	7.08E+00		
10	6.80E-01	8.84E-02	1.91E-01	7.16E+00		
14	5.99E-01	8.83E-02	1.66E-01	7.24E+00		
30	4.41E-01	8.81E-02	1.19E-01	7.43E+00		
60	3.77E-01	8.78E-02	9.91E-02	7.59E+00		
90	3.68E-01	8.75E-02	9.45E-02	7.70E+00		

Notes

- Dose rates are measured at time of reentry
- NC = not calculated; value is a ratio where the denominator is going to zero.

DRL Table

Early Phase Doses

Intermediate Phase Doses

Deposition Exposure Rate DRLs

Marker Nuclide Concentration DRLs

Print

DRL map contours shrink with decay as days pass

On the Horizon...

- Automated weather entry
- Work with DOE – TurboFRMAC consistency
- Work with DTRA – HPAC consistency
- Detailed verification and validation
- State of the Art Reactor Consequence Analysis (SOARCA) source terms
- Create New Reactor models for RASCAL
- Continued progress on future model improvements

SOARCA Station Blackout

- Based on MELCOR run at Sandia
- PWR Scenario – earthquake – no AC power
1st cladding release - 16 h
Containment design leakage increase – 28 h
- BWR Scenario
1st fuel cladding release – 10 h
iodine release exceeds 1% inventory – 20 h
- Scenario ready to incorporate into RASCAL