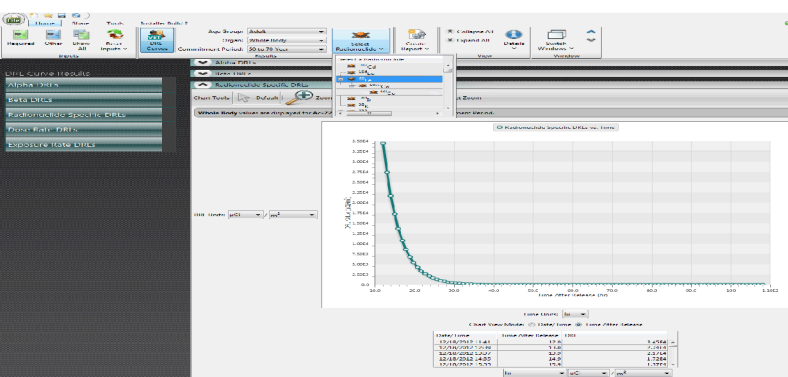


Exceptional service in the national interest

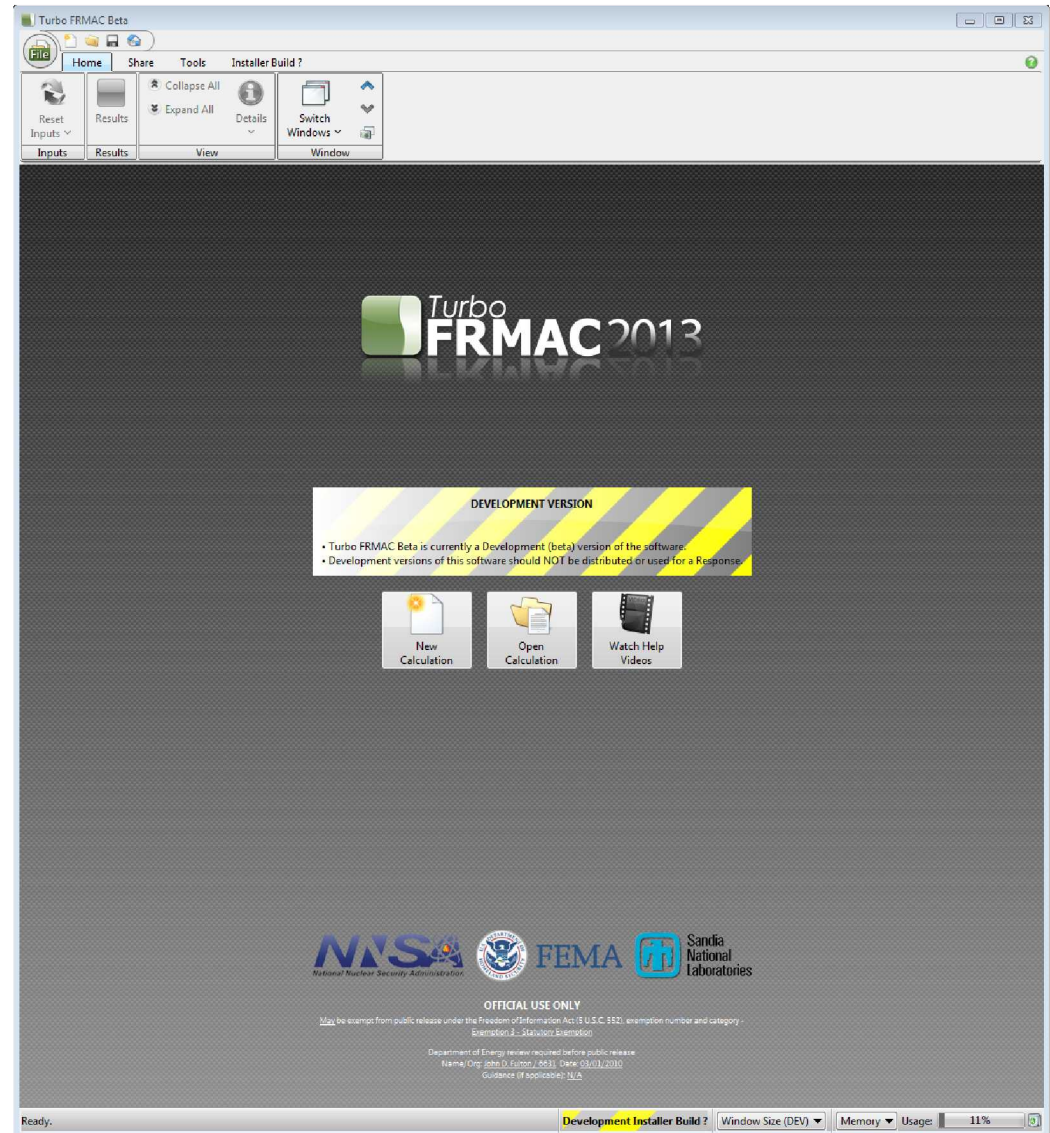


Turbo FRMAC 2013

John Fulton, PMP

Overview

- Why do I care?
- Available Calculations.
- General Features
- Collaboration.
- Other
- How to Access.

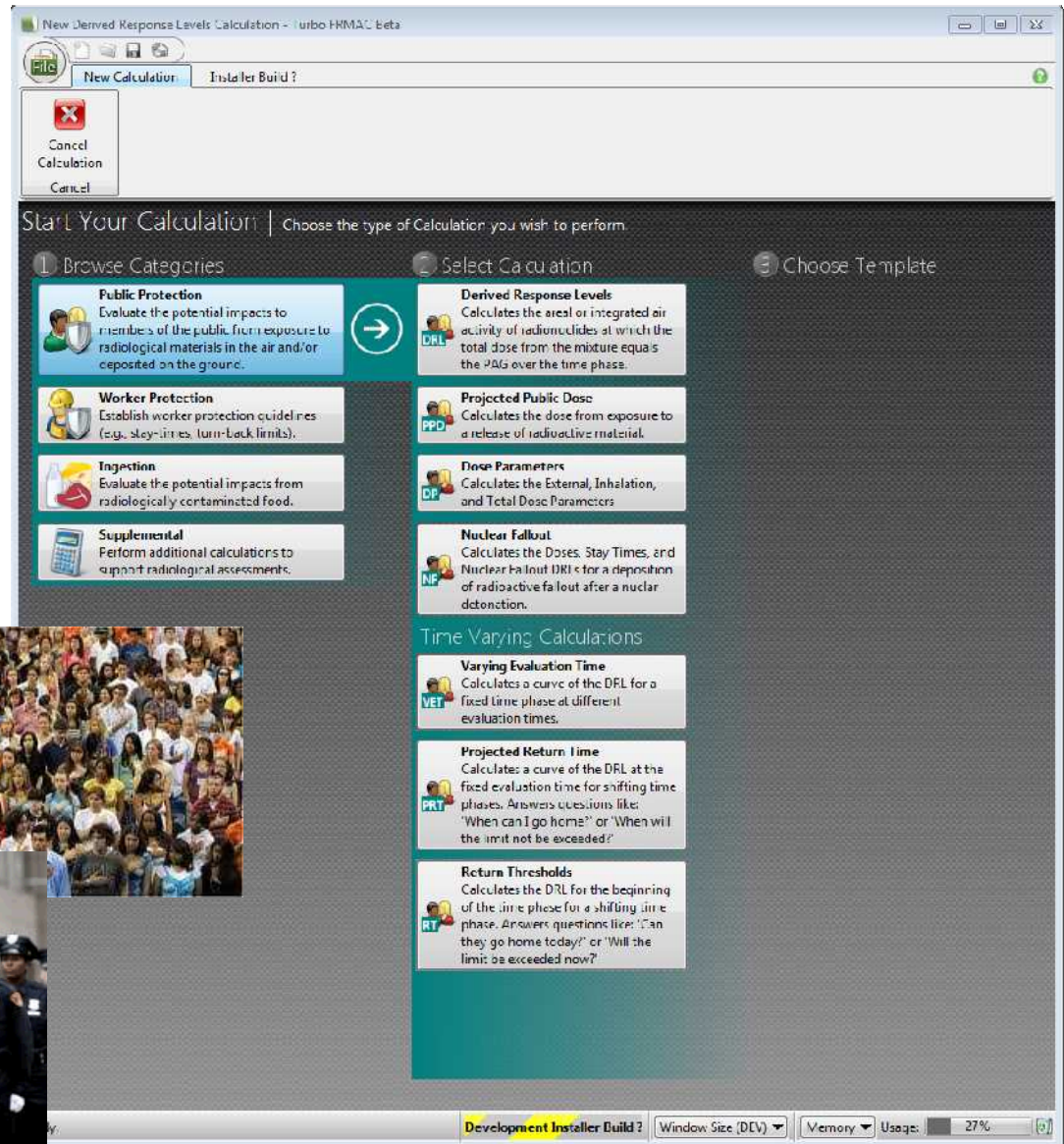


Why do I care?

- 2013 PAG Manual release for Public Comment
- The FRMAC Assessment Manuals (DOE 2010a, b)14 provide guidance in calculating DRLs and DCFs based on the ICRP dosimetry models (ICRP 60 series). In addition, the FRPCC encourages the use of computational tools such as DOE's **Turbo FRMAC** and NRC's Radiological Assessment System for Consequence Analysis (RASCAL) as well as other appropriate or more current tools to implement the PAGs.

Public Protection Calculations

- Derived Response Levels
- Public Projected Dose
- Dose Parameters
- Nuclear Fallout
- Varying Evaluation Times
- Projected Return Times
- Return Thresholds.



New Derived Response Levels Calculation - Turbo-HRMAC Beta

File Edit View Help

New Calculation Installer Build ?

Cancel Calculation Cancel

Start Your Calculation | Choose the type of Calculation you wish to perform.

1 Browse Categories 2 Select Calculation 3 Choose Template

Public Protection
Evaluate the potential impacts to members of the public from exposure to radiological materials in the air and/or deposited on the ground.

Worker Protection
Establish worker protection guidelines (e.g. stay-times, turn-back limits).

Ingestion
Evaluate the potential impacts from radiologically contaminated food.

Supplemental
Perform additional calculations to support radiological assessments.

Derived Response Levels
Calculates the areal or integrated air activity of radionuclides at which the total dose from the mixture equals the PADs over the time phase.

Projected Public Dose
Calculates the dose from exposure to a release of radioactive material.

Dose Parameters
Calculates the External, Inhalation, and Total Dose Parameters.

Nuclear Fallout
Calculates the Doses, Stay Times, and Nuclear Fallout DRLs for a deposition of radioactive fallout after a nuclear detonation.

Time Varying Calculations

Varying Evaluation Time
Calculates a curve of the DFL for a fixed time phase at different evaluation times.

Projected Return Time
Calculates a curve of the DFL at the fixed evaluation time for shifting time phases. Answers questions like: 'When can I go home?' or 'When will the limit not be exceeded?'

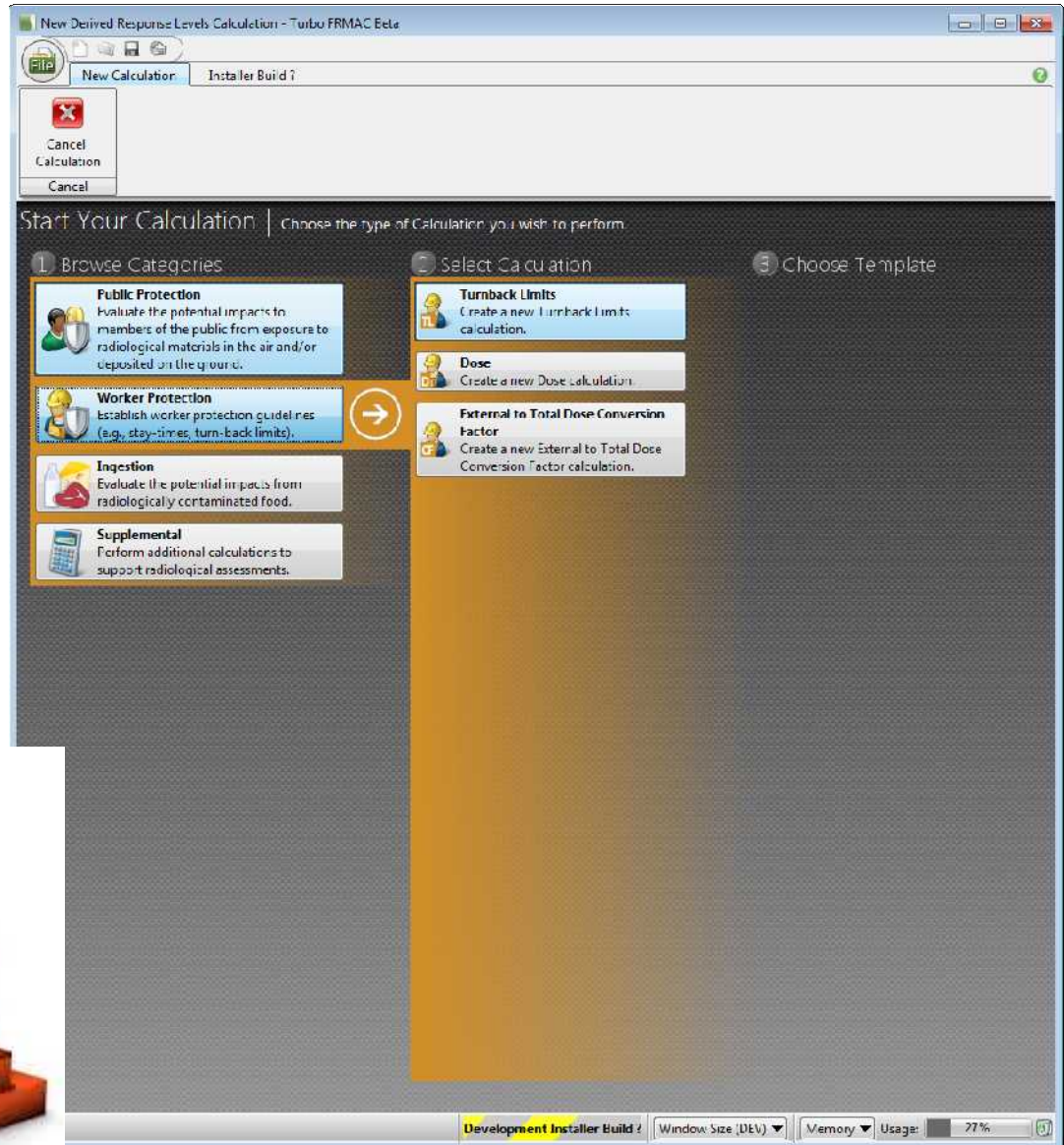
Return Thresholds
Calculates the DRL for the beginning of the time phase for a shifting time phase. Answers questions like: 'Can they go home today?' or 'Will the limit be exceeded now?'

Development Installer Build ? Window Size (DEV) Memory Usage: 27%



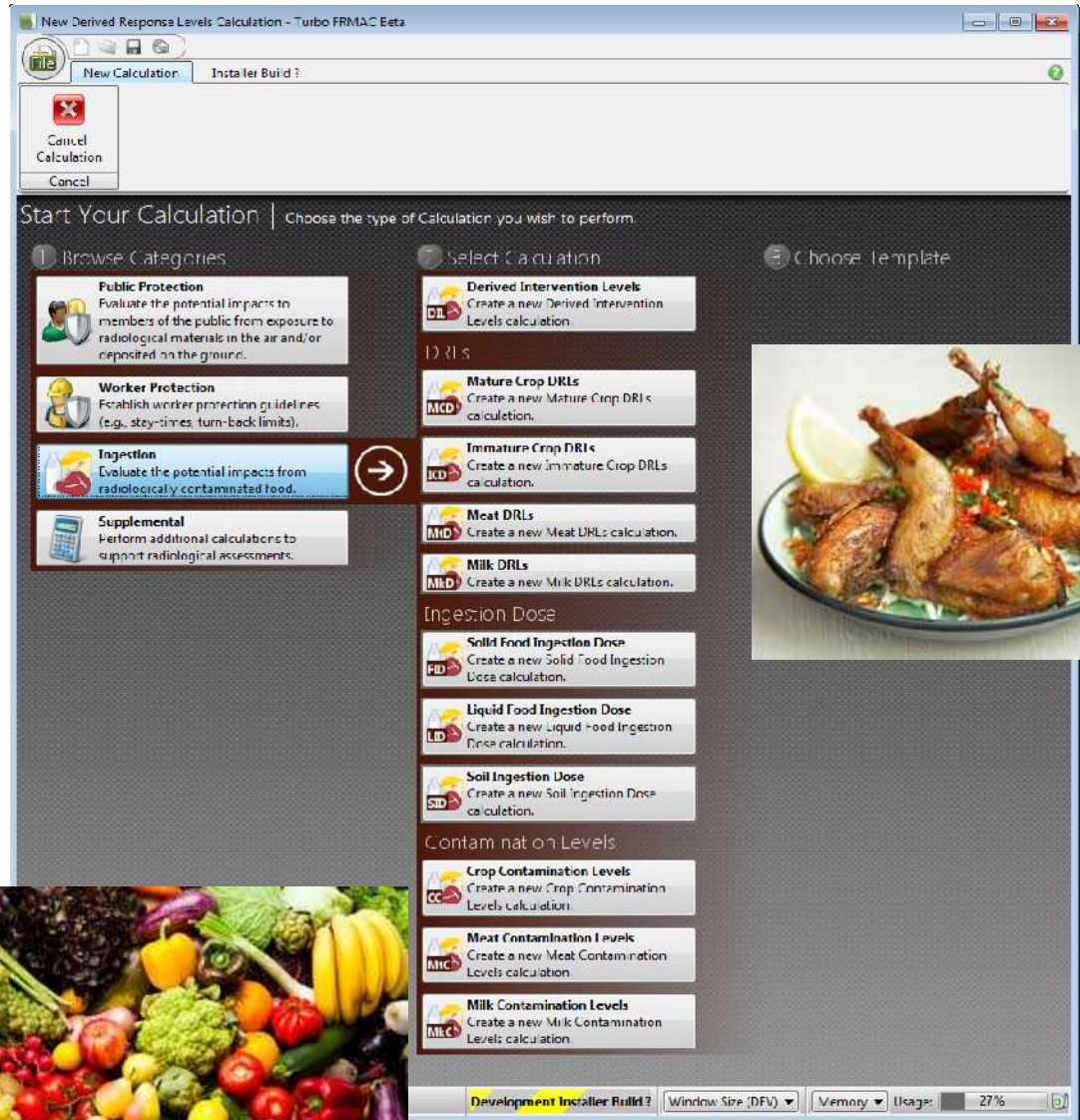
Worker Protection Calculations

- Turnback Limits
- Dose
- External To Total Dose Conversion Factor.



Ingestion

- Derived Intervention Levels
- Derived Response Levels
 - Mature Crop
 - Immature Crop
 - Meat
 - Milk
- Ingestion Dose
 - Inadvertent Soil
 - Liquid Food
 - Solid Food
- Contamination Levels
 - Crop
 - Meat
 - Milk



Supplemental

- Resuspension Factors
- Laboratory Detection Requirements
- Deposition Velocity



New Derived Response Levels Calculation - Turbo FRMAC Beta

File New Calculator: Installer Build ?

Cancel Calculation Cancel

Start Your Calculation | Choose the type of Calculation you wish to perform

1 Browse Categories

2 Select Calculation

3 Choose Template

Public Protection
Evaluate the potential impacts to members of the public from exposure to radiological materials in the air and/or deposited on the ground.

Worker Protection
Establish worker protection guidelines (e.g. stay-times, turn-back limits).

Ingestion
Evaluate the potential impacts from radiologically contaminated food.

Supplemental
Perform additional calculations to support radiological assessments.

Resuspension Factors
Calculate the Resuspension Factors of Radionuclides from Concentration and Deposition Velocity values.

Laboratory Detection Requirements
Determines the detection thresholds for a variety of analytical sample types.

Deposition Velocity
Create a new Deposition Velocity calculation.

Ready Development Installer Build ? Window Size (D&V) Memory Usage: 79%

General Features

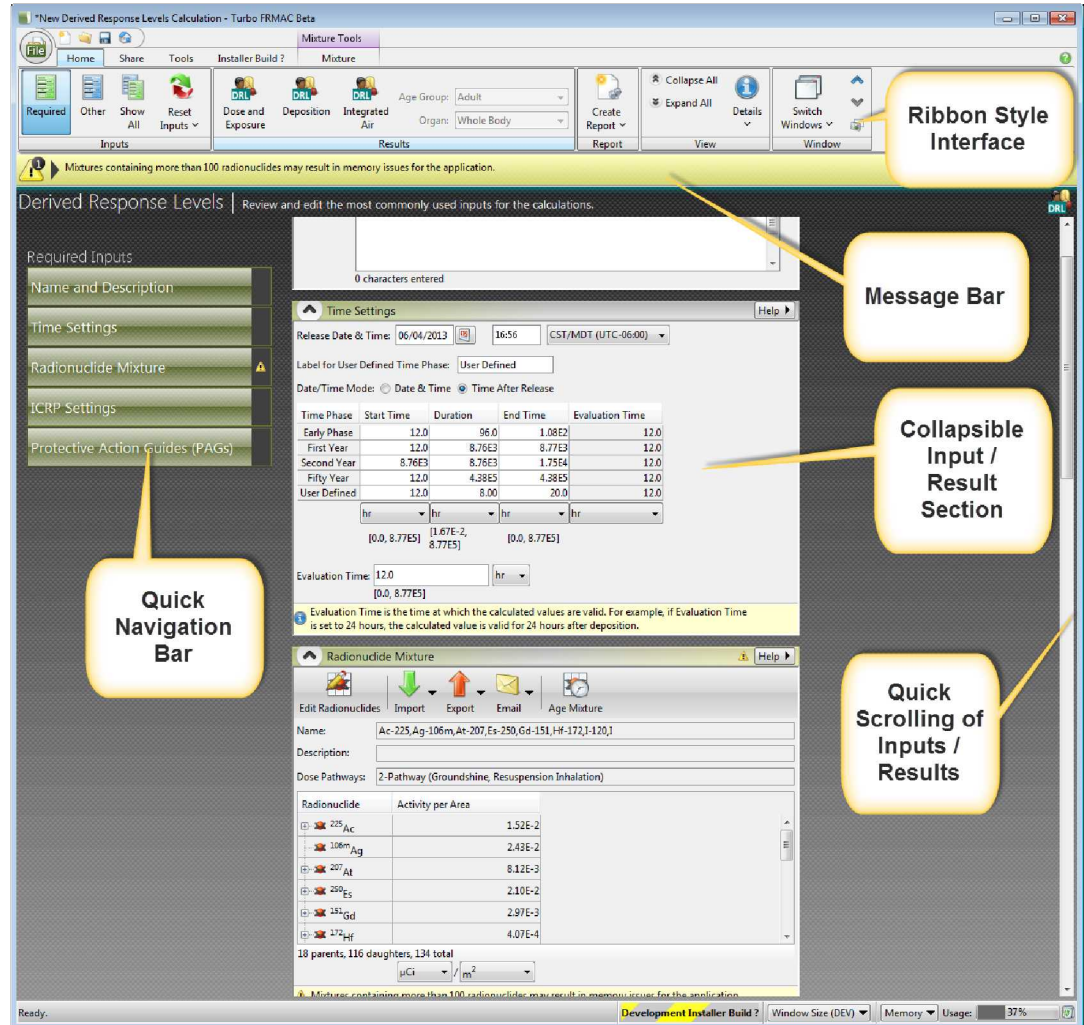
Microsoft™ Ribbon Style Interface

Quick Navigation Bar

Collapsible Input/Result Panes

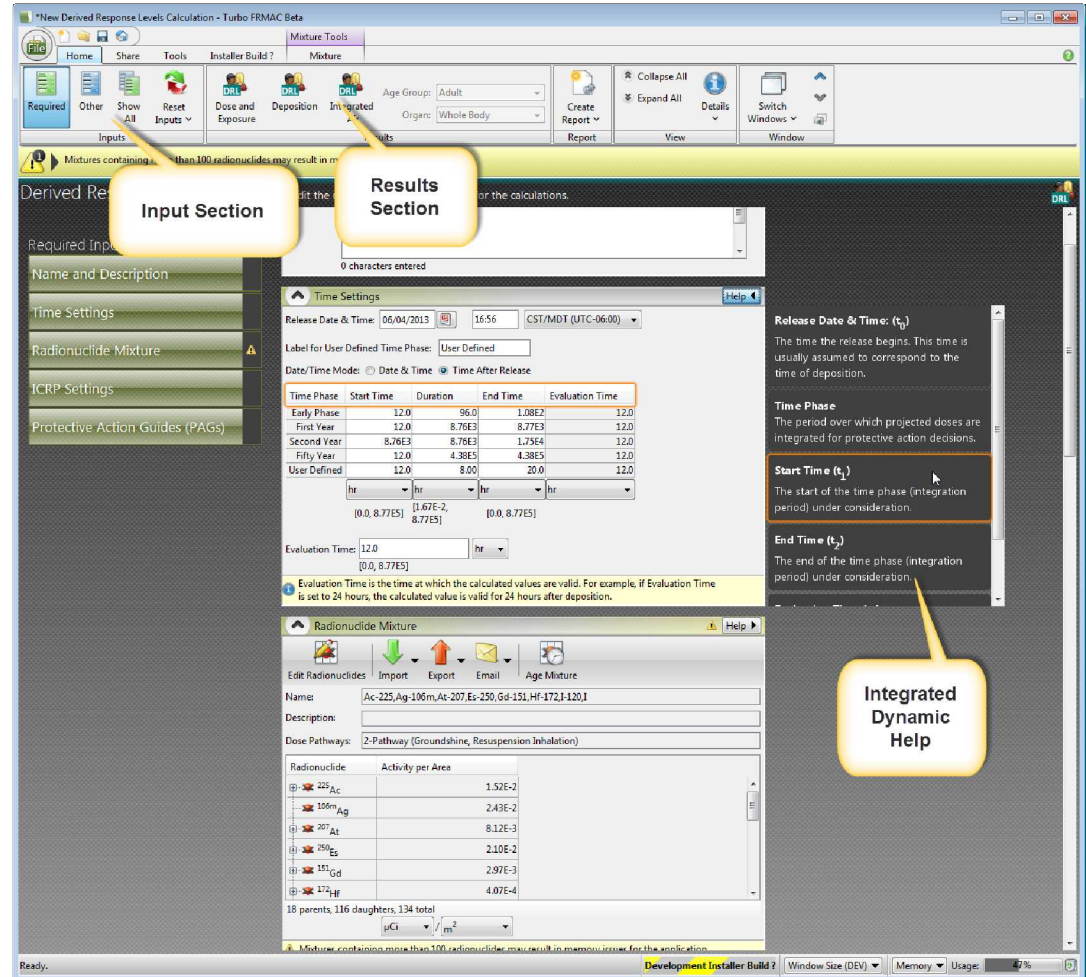
Quick Scrolling of Inputs

Message Bar



General Features Continued

- **Input Section**
 - Required
 - Other
 - Show All
- **Results Section**
- **Integrated Dynamic Help**
- **Integrated Help Videos**

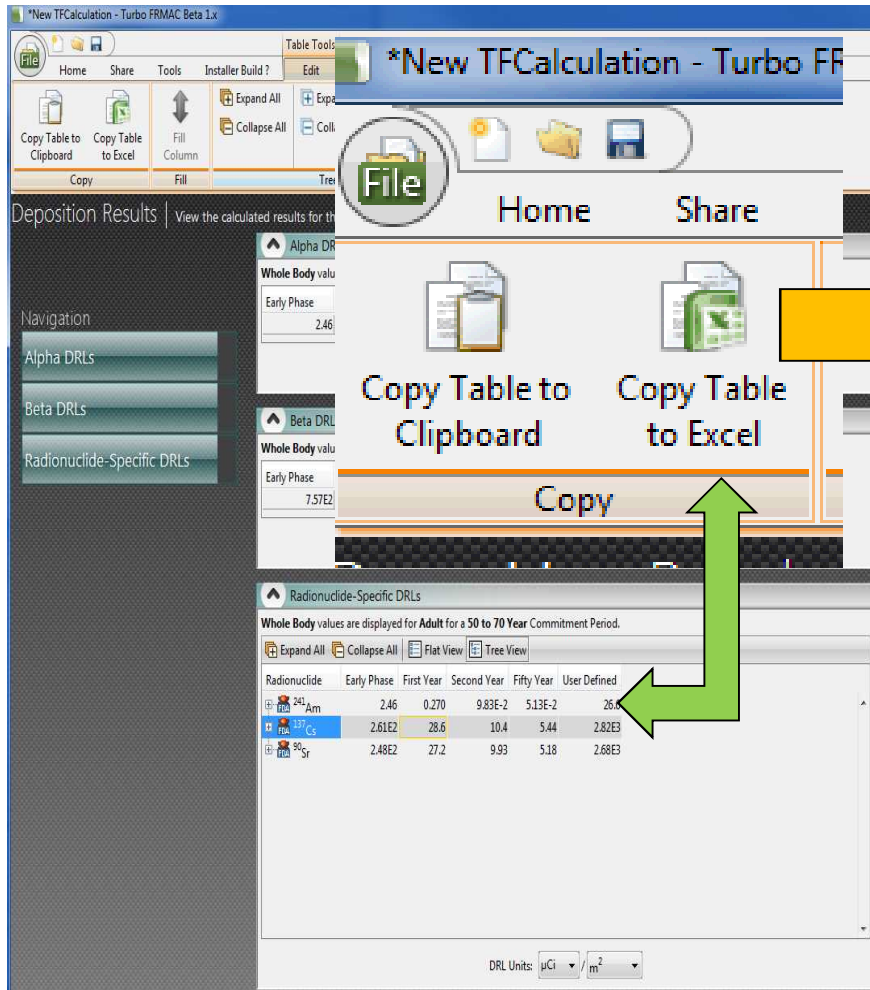


The screenshot displays the Turbo FRMAC Beta software interface. The main window is titled "New Derived Response Levels Calculation - Turbo FRMAC Beta". The interface includes a menu bar (File, Home, Share, Tools, Installer Build?, Mixture), a ribbon with various tool icons, and a central workspace. A yellow callout box labeled "Input Section" points to the "Inputs" tab in the ribbon. Another yellow callout box labeled "Results Section" points to the "Results" tab. A third yellow callout box labeled "Integrated Dynamic Help" points to a help window on the right side of the screen. The help window displays information about "Release Date & Time: (t₀)", "Time Phase", "Start Time (t₁)", and "End Time (t₂)". The main workspace shows a "Time Settings" dialog box with a table of time phases and a "Radionuclide Mixture" section with a list of radionuclides and their activity per area.

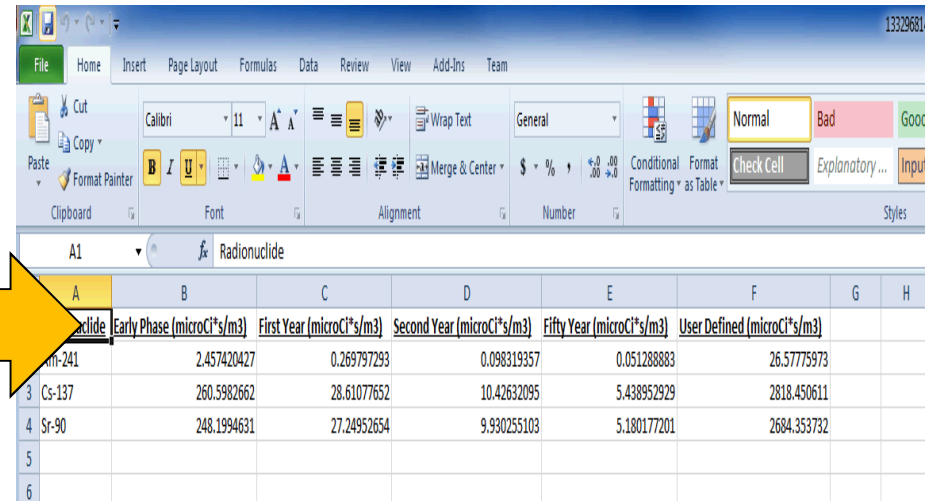
| Time Phase | Start Time | Duration | End Time | Evaluation Time |
|--------------|------------|----------|----------|-----------------|
| Early Phase | 12.0 | 96.0 | 1.08E2 | 12.0 |
| First Year | 12.0 | 8.76E3 | 8.77E3 | 12.0 |
| Second Year | 8.76E3 | 8.76E3 | 1.75E4 | 12.0 |
| Fifty Year | 12.0 | 4.38E5 | 4.38E5 | 12.0 |
| User Defined | 12.0 | 8.00 | 20.0 | 12.0 |

| Radionuclide | Activity per Area |
|--------------------|-------------------|
| ²²⁵ Ac | 1.52E-2 |
| ^{106m} Ag | 2.43E-2 |
| ²⁰⁷ At | 8.12E-3 |
| ²¹⁰ Pb | 2.10E-2 |
| ¹¹³ Cd | 2.97E-3 |
| ¹⁷² Hg | 4.07E-4 |

Collaboration



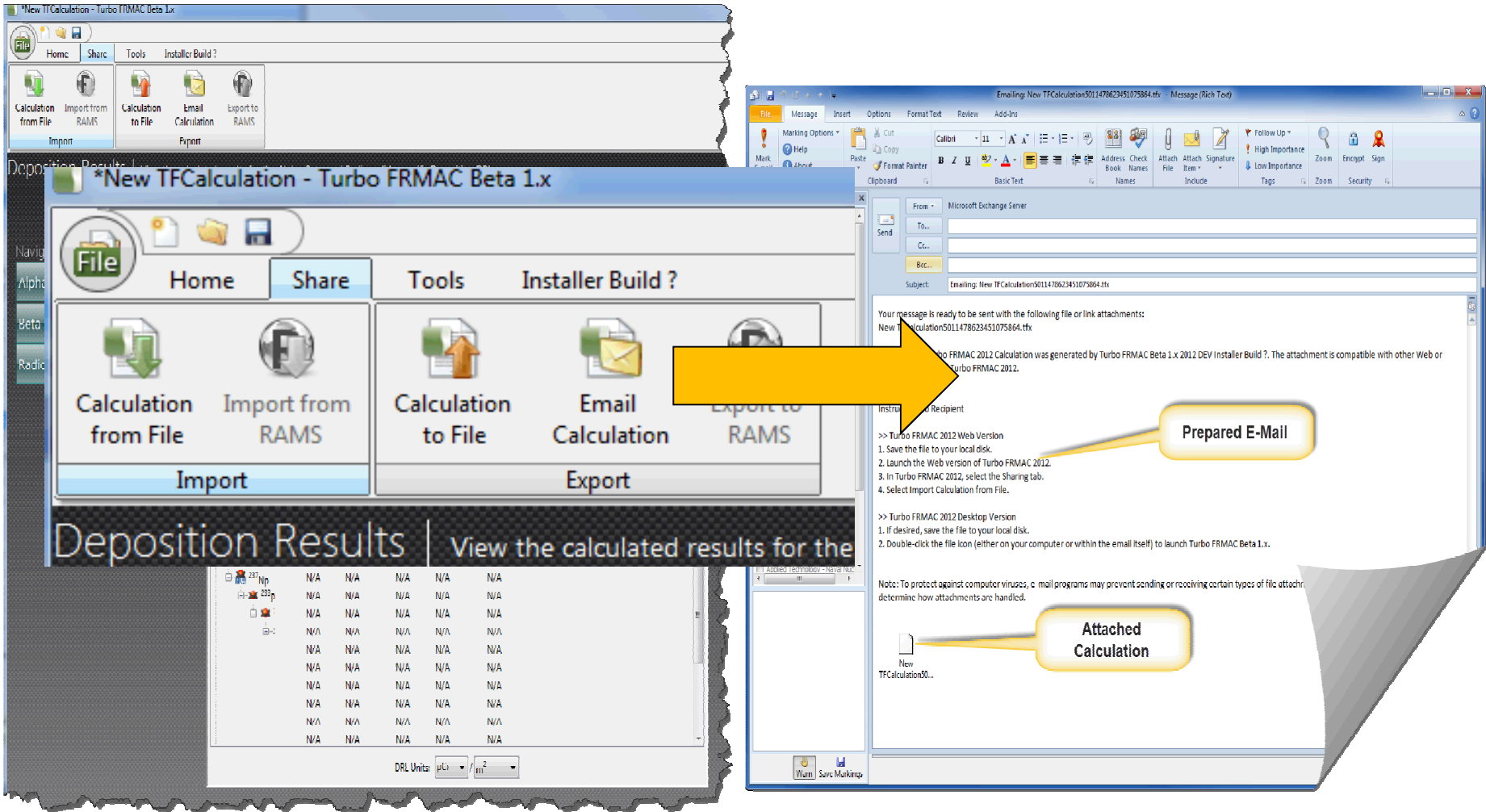
The screenshot shows the Turbo FRMAC software interface. The top menu bar includes Home, Share, Tools, and Installer Build?. Below the menu is a toolbar with icons for 'Copy Table to Clipboard', 'Copy Table to Excel', and 'Fill Column'. A yellow arrow points from the 'Copy Table to Excel' icon to the right. The main area displays 'Deposition Results' and 'Radionuclide-Specific DRLs'. A green arrow points from the 'Copy' button in the 'Radionuclide-Specific DRLs' section to the right.



The screenshot shows a Microsoft Excel spreadsheet with the following data:

| Radionuclide | Early Phase (microCi*/m ³) | First Year (microCi*/m ³) | Second Year (microCi*/m ³) | Fifty Year (microCi*/m ³) | User Defined (microCi*/m ³) |
|--------------|--|---------------------------------------|--|---------------------------------------|---|
| Am-241 | 2.46 | 0.270 | 9.83E-2 | 5.13E-2 | 26.5 |
| Cs-137 | 2.61E2 | 28.6 | 10.4 | 5.44 | 2.82E3 |
| Sr-90 | 2.48E2 | 27.2 | 9.93 | 5.18 | 2.68E3 |

Collaboration - Continued



The image shows two overlapping windows. The top window is the Turbo FRMAC Beta 1.x software interface, which has a ribbon menu with tabs: Home, Share, Tools, and Installer Build?. The 'Share' tab is active, showing options for 'Calculation from File' (Import) and 'Email Calculation' (Export). Below this is a 'Deposition Results' table with columns for various parameters and a 'View the calculated results for the' link. The bottom window is an email client showing an email titled 'Emailing: New TFCalculation5011478623451073864.tfx'. The email body contains instructions for using the Turbo FRMAC 2012 Web and Desktop versions. A yellow arrow points from the 'Email Calculation' button in the software to the email window. Two callout boxes are present: 'Prepared E-Mail' pointing to the email window and 'Attached Calculation' pointing to the attachment icon in the email client.

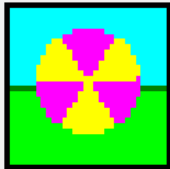
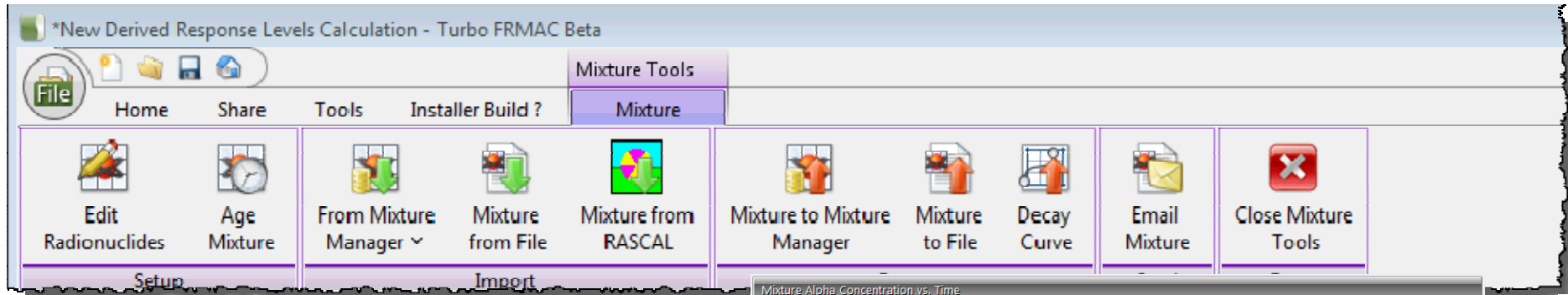
Prepared E-Mail

Attached Calculation

| File Name | Value 1 | Value 2 | Value 3 | Value 4 | Value 5 |
|-----------|---------|---------|---------|---------|---------|
| 100 | N/A | N/A | N/A | N/A | N/A |
| 101 | N/A | N/A | N/A | N/A | N/A |
| 102 | N/A | N/A | N/A | N/A | N/A |
| 103 | N/A | N/A | N/A | N/A | N/A |
| 104 | N/A | N/A | N/A | N/A | N/A |
| 105 | N/A | N/A | N/A | N/A | N/A |
| 106 | N/A | N/A | N/A | N/A | N/A |
| 107 | N/A | N/A | N/A | N/A | N/A |
| 108 | N/A | N/A | N/A | N/A | N/A |
| 109 | N/A | N/A | N/A | N/A | N/A |
| 110 | N/A | N/A | N/A | N/A | N/A |
| 111 | N/A | N/A | N/A | N/A | N/A |
| 112 | N/A | N/A | N/A | N/A | N/A |
| 113 | N/A | N/A | N/A | N/A | N/A |
| 114 | N/A | N/A | N/A | N/A | N/A |
| 115 | N/A | N/A | N/A | N/A | N/A |
| 116 | N/A | N/A | N/A | N/A | N/A |
| 117 | N/A | N/A | N/A | N/A | N/A |
| 118 | N/A | N/A | N/A | N/A | N/A |
| 119 | N/A | N/A | N/A | N/A | N/A |
| 120 | N/A | N/A | N/A | N/A | N/A |

DRL Units: μCi / m^2

Mixture Tools



Radiological Assessment System
for Consequence Analysis

RASCAL 4.2

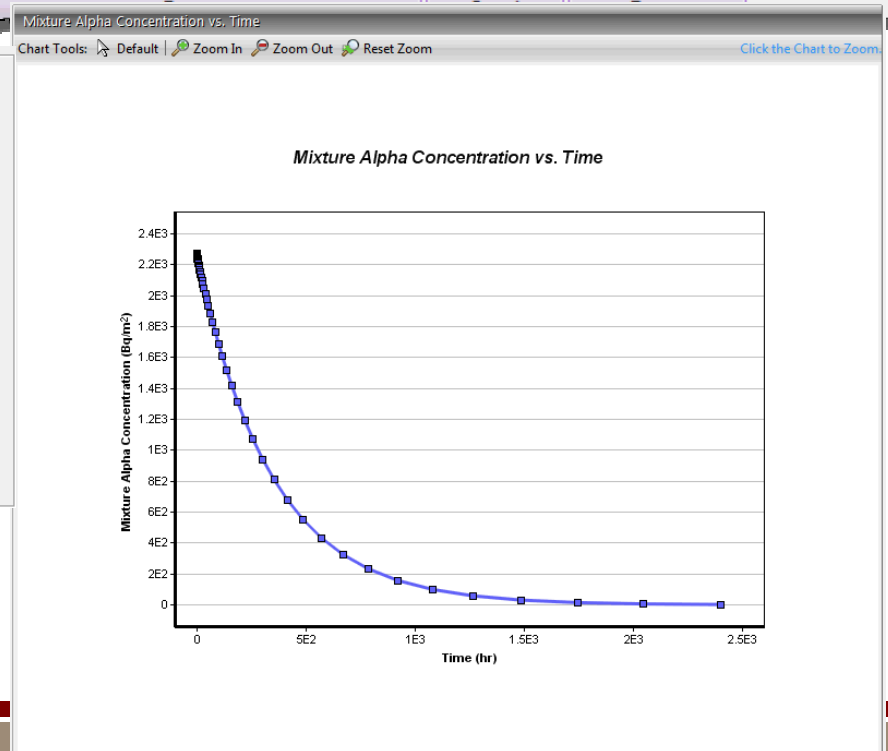
March, 2012

Developed for the U.S. Nuclear Regulatory Commission

For more information contact:

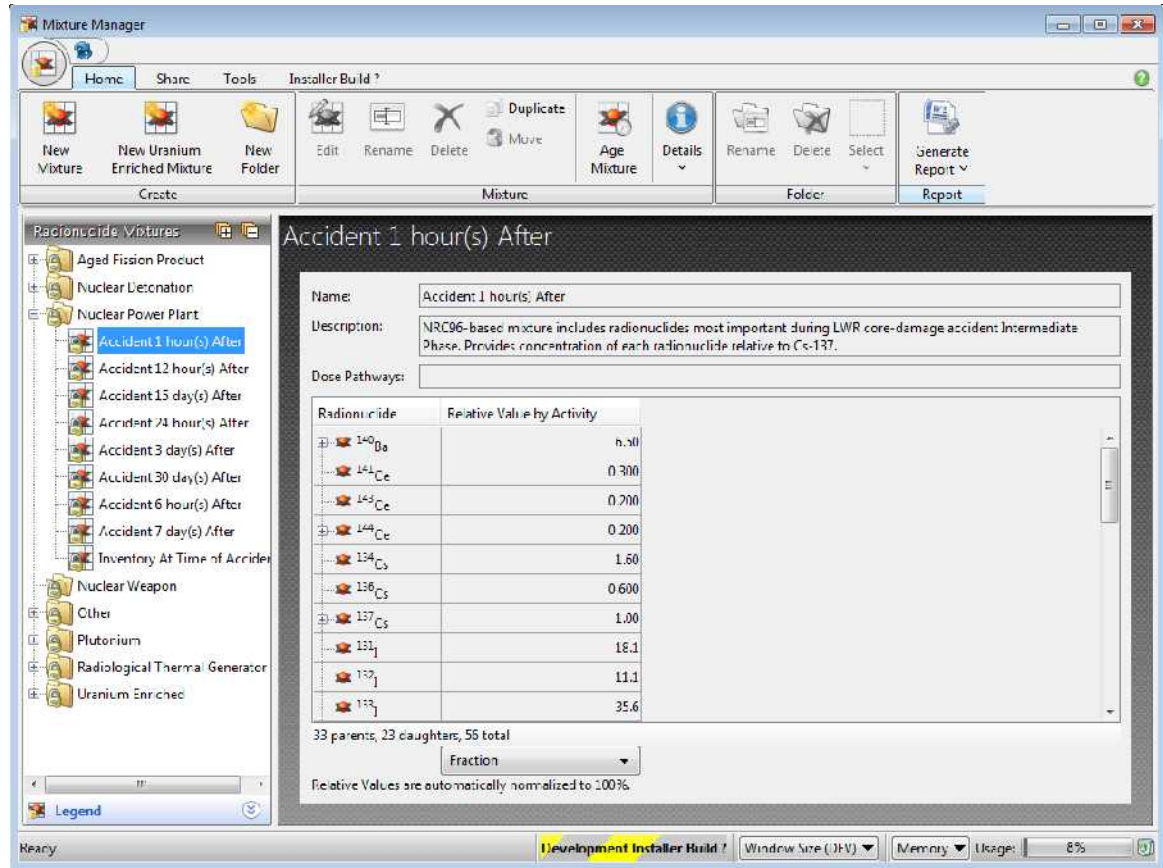
Lou Brandon - lou.brandon@nrc.gov or
George Athey - george.athey@atheyconsulting.com

OK



Mixture Manager

- Build Custom Mixture
 - Full Decay Chains
 - Truncated Chains
- Predefined Mixtures
 - Aged Fission Products
 - Nuclear Detonation
 - Nuclear Power Plant
 - Nuclear Weapon
 - Other
 - Plutonium
 - Radiological Thermal Generator
 - Uranium Enriched
- Tools



The screenshot shows the Mixture Manager application window. The left pane displays a tree view of 'Radionuclide Mixtures' with 'Accident 1 hour(s) After' selected. The main pane shows the details for this mixture, including its name, description, and a table of radionuclides with their relative values by activity.

Accident 1 hour(s) After

Name: Accident 1 hour(s) After

Description: NRC96-based mixture includes radionuclides most important during LWR core-damage accident: Intermediate Phase. Provides concentration of each radionuclide relative to Cs-137.

Dose Pathways:

| Radionuclide | Relative Value by Activity |
|-------------------|----------------------------|
| ^{140}Ba | 6.50 |
| ^{141}Ce | 0.300 |
| ^{143}Ce | 0.700 |
| ^{144}Ce | 0.200 |
| ^{134}Cs | 1.60 |
| ^{136}Cs | 0.600 |
| ^{137}Cs | 1.00 |
| ^{131}I | 18.1 |
| ^{132}I | 11.1 |
| ^{133}I | 35.6 |

33 parents, 23 daughters, 55 total

Relative Values are automatically normalized to 100%

Radionuclide Viewer

Radionuclide Viewer
View the decay chain, dose coefficients, and other properties of Radionuclides.

Development Installer Build ?

Radionuclides

View Options

ICRP Guidance:

Age:

Commitment Period:

Instrument Threshold:

Select Radionuclide

Filter:

Search:

- CF-244
- CF-248
- CF-248
- CF-240
- CF-250
- CF-251
- CF-252**
- CF-258
- CF-254

Decay Properties: CF-252

Columns Show Legends

| Radionuclide | Half-Life | Decay Mode | Decay Constant | Branch Factor | Specific Activity | Total Emitted Alpha Energy | Total Emitted Beta Energy | Total Emitted Photon Energy | Alpha/nl | Beta/nl |
|---------------|---------------|------------|----------------|---------------|-------------------|----------------------------|---------------------------|-----------------------------|----------|---------|
| CF-252 | 9.67E2 SF, A | | 7.19E-4 | N/A | 5.38E11 | 5.92 | 5.60E-3 | 1.20E-3 | 0.999 | 0.0 |
| 744 Cm | 1.24E8 SF, A | | 5.60E-9 | 0.969 | 4.25E6 | 4.63 | 6.00E-3 | 1.10E-3 | 0.916 | 0.0 |
| 244 Pu | 8.02E10 SF, A | | 2.30E-11 | 0.917 | 1.77E4 | 4.58 | 7.00E-3 | 1.20E-3 | 0.999 | 0.0 |
| 240 Pu | 0.588 B | | 1.18 | 0.099 | 9.25E14 | 0.0 | 0.137 | 7.50E-3 | 0.0 | 0.094 |
| 240m Pu | 5.14E-11 B | | 1.95E-7 | 1.00 | 1.0E+17 | 0.0 | 0.681 | 0.117 | 0.0 | 0.948 |
| 240 Pu | 2.39E6 SF, A | | 2.90E-7 | 1.00 | 2.28E8 | 5.16 | 1.05E-2 | 1.70E-3 | 1.00 | 0.0 |
| 244 Th | 8.50E9 A | | 8.10E-11 | 1.00 | 6.47E4 | 4.51 | 1.11E-2 | 1.50E-3 | 1.00 | 0.0 |
| 244 Th | 5.13E12 A | | 1.35E-13 | 1.00 | 1.10E2 | 4.00 | 1.24E-2 | 1.30E-3 | 1.00 | 0.0 |
| 228 Th | 2.10E3 B | | 3.30E-4 | 1.00 | 2.75E11 | 0.0 | 1.60E-2 | 0.0 | 0.0 | 0.0 |
| 228 Ra | 0.75E0 B | | 7.71 | 1.00 | 2.74E15 | 0.0 | 0.475 | 0.971 | 0.0 | 0.990 |
| 228 Ac | 6.99E2 A | | 9.92E-4 | 1.00 | 8.19E11 | 5.40 | 2.05E-2 | 3.20E-3 | 1.00 | 0.0 |
| 228 Th | 1.66 A | | 0.189 | 1.00 | 1.54E14 | 5.67 | 2.71E-1 | 9.50E-1 | 1.00 | 0.0 |

SF information not shown.

Decay Modes

- A: Alpha
- EC: Electron Capture
- B: Beta
- P: Positron
- IT: Isomeric Transition
- SF: Spontaneous Fission

More

Nuclear Transformation

Dose Coefficients

CF-252 Stochastic Inhalation Dose Coefficients

| Dose Coefficients | Inhalation | Dose Coefficient |
|-------------------|--------------------------|------------------|
| External | Organ | |
| Surface | Adrenal | 1.03E3 |
| 1 cm Soil Depth | Bone Surface | 3.26E6 |
| 5 cm Soil Depth | Bone | 1.54E7 |
| 15 cm Soil Depth | Breasts | 2.60E2 |
| Inhale Soil Depth | Kidneys | 6.00E-2 |
| Air Submersion | Liver | 5.07E5 |
| Water Immersion | Lower Large Intestine | 5.18E2 |
| | Lung | 4.00E5 |
| | Muscle | 3.66E2 |
| | Ovaries | 4.15E4 |
| | Pancreas | 6.88E2 |
| | Red Marrow | 4.27E5 |
| | Skin | 2.94E2 |
| | Small Intestine | 4.00E2 |
| | Spleen | 3.01E2 |
| | Stomach | 3.27E2 |
| | Committed Effective Dose | 1.37E5 |

ICRP Guidance: ICRP 60
Age: Adult
Commitment Period: Chronic

View Particle Sizes for:
 Compound Distribution
 Vapor or Gas

Compound Distribution

Distribution Summary:
1 Monoisotopic

Lung Clearance Class
Maximum
Fast (F)
Medium (M) - **Most Likely**
Slow (S)

Ready. Development Installer Build ? Window Size (DEV) Memory Usage 6%

DRL Curves

*New Return Thresholds Calculation - Turbo FRMAC Beta

Home Share Tools Installer Build ?

Required Other Show All Reset Inputs

Dose and Exposure Alpha and Beta Radionuclide Specific

Age Group: Adult Origin: Whole Body Commitment Period: Chronic

Results Cs 134

Collaps All Expand All Details Switch Windows

Turbo FRMAC Beta is currently a Development (beta) version of the software. Development versions of this software should NOT be distributed or used for a Response.

Return Thresholds | View the calculated results for the Radionuclide-Specific DRI Curves.

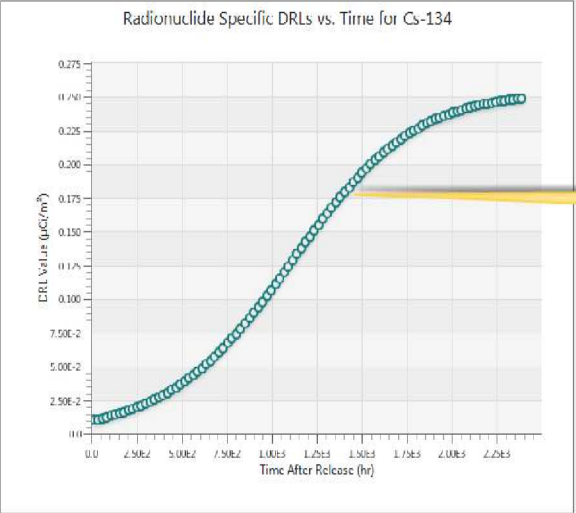
Radionuclide Specific Results

Radionuclide-Specific DRLs

Radionuclide Specific DRLs

Whole Body values are displayed for Cs-134 for Adult for a Chronic Commitment Period.

Radionuclide Specific DRLs vs. Time for Cs-134



DRL Units: μCi m^3

Time Units: hr

Date/Time Mode: Date & Time Time After Release

| Step # | Date/Time | Time After Release | DRI |
|--------|------------------|--------------------|---------|
| 1 | 03/26/2013 23:06 | 12.0 | 1.04E-2 |
| 2 | 03/27/2013 23:05 | 36.0 | 1.11E-2 |
| 3 | 03/28/2013 23:05 | 60.0 | 1.18E-2 |
| 4 | 03/29/2013 23:05 | 84.0 | 1.26E-2 |
| 5 | 03/30/2013 23:05 | 1.08E2 | 1.35E-2 |

hr μCi m^3

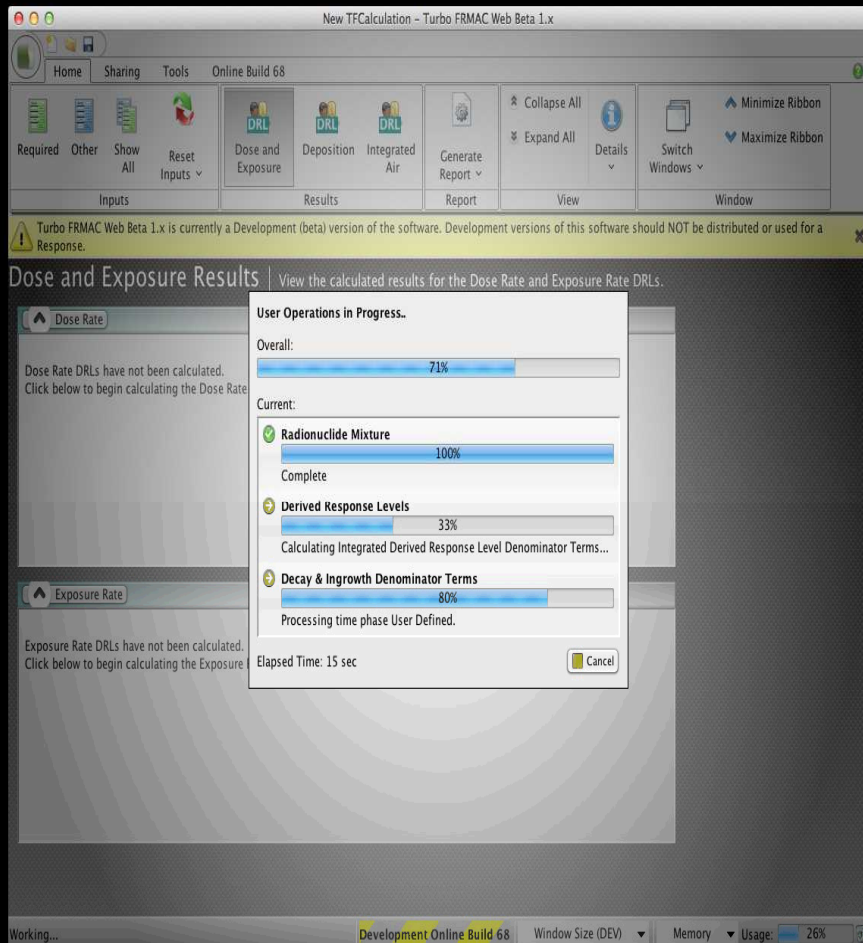
Ready.

Development Installer Build ? Window Size (DEV) Memory Usage: 78%

DRL Graph

DRL Graph Data

Macintosh Compatible.



New TFCalculation - Turbo FRMAC Web Beta 1.x

Home Sharing Tools Online Build 68

Required Other Show All Reset Inputs

Dose and Exposure Deposition Integrated Air

Generate Report

Collapse All Expand All Details Switch Windows

Minimize Ribbon Maximize Ribbon

Inputs Results Report View Window

Turbo FRMAC Web Beta 1.x is currently a Development (beta) version of the software. Development versions of this software should NOT be distributed or used for a Response.

Dose and Exposure Results

View the calculated results for the Dose Rate and Exposure Rate DRLs.

Dose Rate

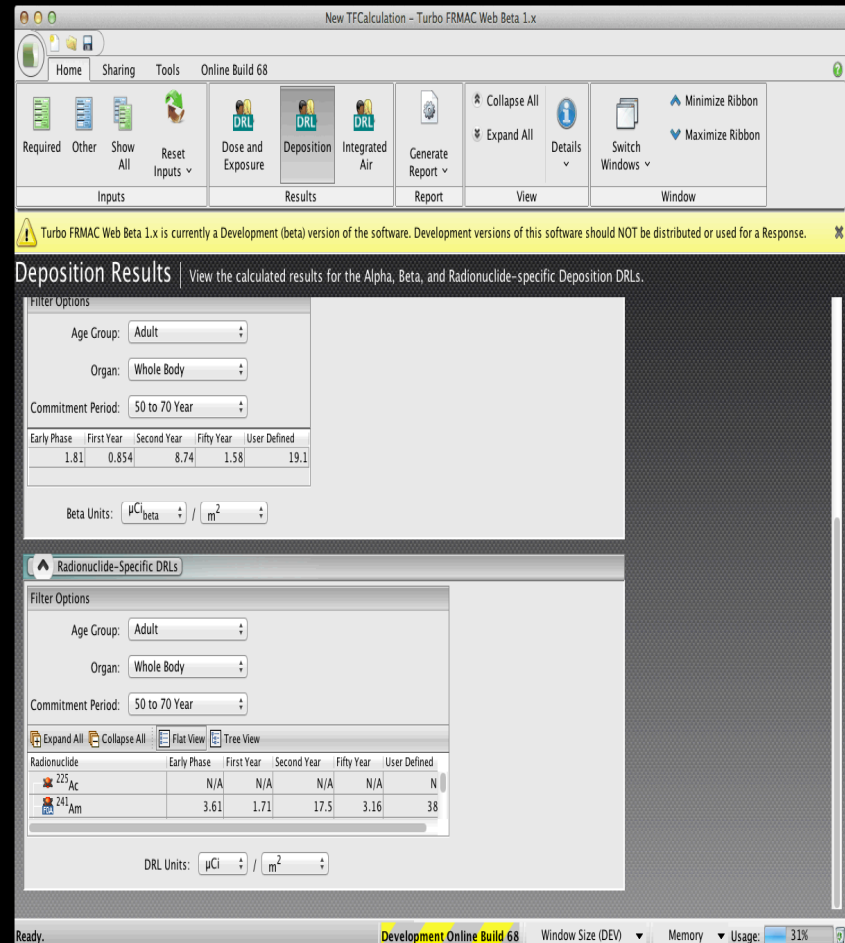
Dose Rate DRLs have not been calculated. Click below to begin calculating the Dose Rate

Exposure Rate

Exposure Rate DRLs have not been calculated. Click below to begin calculating the Exposure

User Operations in Progress.
Overall: 71%
Current:
Radionuclide Mixture 100% Complete
Derived Response Levels 33% Calculating Integrated Derived Response Level Denominator Terms...
Decay & Ingrowth Denominator Terms 80% Processing time phase User Defined.
Elapsed Time: 15 sec [Cancel]

Working... Development Online Build 68 Window Size (DEV) Memory Usage: 26%



New TFCalculation - Turbo FRMAC Web Beta 1.x

Home Sharing Tools Online Build 68

Required Other Show All Reset Inputs

Dose and Exposure Deposition Integrated Air

Generate Report

Collapse All Expand All Details Switch Windows

Minimize Ribbon Maximize Ribbon

Inputs Results Report View Window

Turbo FRMAC Web Beta 1.x is currently a Development (beta) version of the software. Development versions of this software should NOT be distributed or used for a Response.

Deposition Results

View the calculated results for the Alpha, Beta, and Radionuclide-specific Deposition DRLs.

Filter Options

Age Group: Adult

Organ: Whole Body

Commitment Period: 50 to 70 Year

| Early Phase | First Year | Second Year | Fifty Year | User Defined |
|-------------|------------|-------------|------------|--------------|
| 1.81 | 0.854 | 8.74 | 1.58 | 19.1 |

Beta Units: $\mu\text{Ci}_{\text{beta}}$ / m^2

Radionuclide-Specific DRLs

Filter Options

Age Group: Adult

Organ: Whole Body

Commitment Period: 50 to 70 Year

Expand All Collapse All Flat View Tree View

| Radionuclide | Early Phase | First Year | Second Year | Fifty Year | User Defined |
|-------------------|-------------|------------|-------------|------------|--------------|
| ^{225}Ac | N/A | N/A | N/A | N/A | N |
| ^{241}Am | 3.61 | 1.71 | 17.5 | 3.16 | 38 |

DRL Units: μCi / m^2

Ready. Development Online Build 68 Window Size (DEV) Memory Usage: 31%

How to Access

Turbo FRMAC is now web deployed.
Installation disks available only upon special request.

http://nirp.sandia.gov



The screenshot shows a web browser window displaying the Turbo FRMAC Web application. The browser's address bar shows the URL <https://nirp.sandia.gov/Software/TurboFRMACWeb/TurboFRMACWeb.aspx>. The page header includes the Sandia National Laboratories logo and the text "Sandia National Laboratories". The main content area features the "NUCLEAR INCIDENT RESPONSE PROGRAM" logo and a prominent "DEVELOPMENT VERSION" banner. Below this, the "Turbo FRMAC Web" logo is displayed, along with the text "powered by TurboFRMAC 2013". A navigation menu on the left side lists: Home, Software, Lab Analysis Portal, Training, Contact Us, and My Profile. The main content area includes a "Development Version" section with two bullet points: "Turbo FRMAC web is currently a development (beta) version of the software." and "Development versions of this software should NOT be distributed or used for a Response." Below this is an "Overview" section with a paragraph of text, and a "Features" section with one bullet point: "Implements a new user interface utilizing a Ribbon navigation system (similar to Microsoft Office products) to navigate the software. All inputs to a calculation are readily available on the same screen, as opposed to the Event's information being..."