

These few pages are excerpts from
the RRI Rad Calc User's Guide. For
more information, please contact us.



RRI Rad Calc

Rev 1a

The User's Guide

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Chapter 1: Introduction & Installation

A. Introduction

Thank you for selecting *RRI Rad Calc* as your radioactive materials shipping aide. *RRI Rad Calc* is copyright protected by Regulatory Resources, Inc., Kennewick, Washington. No portion or part of this program may be copied or reproduced without the express written permission of Regulatory Resources, Inc.

RRI Rad Calc is a spreadsheet program, using Microsoft™ Excel®, that performs the calculations necessary to determine the applicability of the U.S. Department of Transportation (DOT) Hazardous Materials Regulations (HMR) to the radioactive materials classification and categorization. This program looks at the following, based on user input:

- Definition of Class 7 radioactive materials for both exempt values and surface contamination;
- A_1 and A_2 activity determinations;
- Low Specific Activity (LSA) determinations;
- Surface Contaminated Objects (SCO) determinations, including the allowed SCO-II shortcut determination process authorized in NUREG-1608 (RAMREG-003);
- Fissile exception determination, including the specific paragraph for which exception applies;
- Fissile mass determination;
- Top 95% of nuclide contribution (for labels and shipping paper descriptions);
- Reportable quantity (RQ) determinations;
- Class 7 label categorization, including Transport Index (TI);
- Dose rate assessments for packages and vehicles;
- Contamination level assessments for packages and vehicles;
- ...and more.

Two worksheets comprise the user's portion of the program: Summary Worksheet and Entries Worksheet (see Appendix B). The Entries Worksheet is the main worksheet for entering the radioactive material specific data. Isotopic activity can be entered in units of TeraBecquerel (TBq), Curies, or grams. Once all necessary data is entered the user 'runs' the program by activating a program macro. The results are consolidated on the Summary Worksheet which can be saved to file and/or printed. Entry cells are also provided on the Summary Worksheet for the user to include information specific to the package for which the results are applicable.

All user entry cells are blue in color. Cells that are not entry cells are protected from inadvertent changes.

Macros have been written for the aid of the user and to initiate necessary actions. A custom toolbar will appear the first time the program is opened. The *RRI Rad Calc* toolbar initiates most of the frequently used functions and includes: a function box for access to macro operations and a "jump to" feature; an icon to initiate the calculation macro; an erase feature that clears all entry cells with a single click; a save to file option for the Summary Worksheet; a Summary Worksheet print option; and a save and exit program icon.

At times, error messages or informational messages may appear in either a Message Box or in a cell adjacent to a data entry cell. These messages may inform the user when an entry is made that is inconsistent with the cell question, or let the user know that additional information is requested.

Quality assurance (QA) has been performed on the program functions and calculations. The methodology used was two-fold:

- (1) Activity levels and mass entries were adjusted one at a time at 1 Bq, or 1 nanogram or 1 gram (as applicable) increments above and below an exact limit. For example: If a randomly selected A_2 value is 0.002 TBq, one Bq was added to verify the program recognized the change and made the appropriate activity determination; if a fissile excepted limit is 2 grams then 1 nanogram (1E-9 gram) was added to verify the program will capture the adjustment. This process was used to validate both lower and upper limit thresholds.
- (2) Macro and program operations were tested using known, existing packaging examples taken from previous and current RRI's Advanced Radioactive Materials Packaging and Transport Workshop materials. These examples have been proven numerous times by a multitude of class participants.

The outcome of the tests are recorded and filed. The results provide evidence of the program's accuracy and usability.

B. System Requirements

The program is built in Microsoft® Office Excel 2003. Any system with Microsoft® Office Excel installed can run this program.

NOTE: RRI does not guarantee this program will run on older or newer versions of Microsoft® Office Excel.

C. Installation

Installation of this program is quick and simple. The program consists of a single CD-Rom disk. To install, simply insert the disk in the appropriate CD-Rom drive and copy the folder to the file location of your choice. The "*RRI Rad Calc Program*" folder contains the *RRI Rad Calc* program, the User's Guide and the QA test documentation file.

NOTE: Unless specifically stated otherwise, all isotopic activity presented in the examples used throughout this User's Guide were entered in TBq units.

Total Act/Pkg (TBq): No Activity A2 for Mixture (TBq): No Activity LA Unit Sum: No Activity LA Unit - Solids: No Activity LA Unit - Liquids: No Activity HR/CQ Unit Sum: No Activity RQ Unit Sum: No Activity Bq/gram: No Weight Total Isotopic Wt (g): No Activity Meets Def of Class 7: No Activity		LSA-I Unit Sum: No Activity LSA-II Unit Sum: No Activity LSA-III Unit Sum: No Activity SCO-I B/G/LTA: No cm2 SCO-II Other Alpha: No Alpha SCO-II B/G/LTA: No cm2 SCO-II Other Alpha: No Alpha SCO-II Shortcut: No Activity		Grams U-235: 0.00000000E+00 Grams Pu-239: 0.00000000E+00 Grams Pu-241: 0.00000000E+00 Total Fissile (g): 0.00000000E+00 Fissile Excepted? N/A Inst or Article: None ICD Inst/Art Pkg: None ICD Inst/Art (Y or N): No Activity LSA Item Unit Sum: No Activity LSA Pkg Unit Sum: No Activity		g nonfiss : g fissile (173.453(b)) Tare Weight Entry Required g nonfiss : g fissile (173.453(e)) Tare Weight Entry Required g fiss : 360 kg nonfiss (173.453(c)) Tare Weight Entry Required		Actual Bq/g Non-Fix B/G/LTA Inaccess B/G/LTA Fixed Alpha 0.000000E+00 0.000000E+00 0.000000E+00 Fixed B/G/LTA Non-Fix Alpha Inaccess Alpha 0.000000E+00 0.000000E+00 0.000000E+00 Exmpt Mat'l US: No Activity Ex Consign US: No Activity Derived Ex Mat'l: No Activity Derived Consign: No Activity		CALC																													
All isotope entries are in TBq.																																							
Number of Like Radioactive Material Items in the Package: Default value = 1		CONVERSIONS TO TBq <table border="1"> <tr> <th>Have</th> <th>Have</th> <th colspan="2">Have</th> <th colspan="2">Have</th> </tr> <tr> <td>kBq</td> <td>MBq</td> <td>GBq</td> <td>uCi</td> <td>mCi</td> <td>Ci</td> </tr> <tr> <td colspan="2">Conversions to TBq</td> <td colspan="4">Conversions to TBq</td> </tr> <tr> <td colspan="2">0.000000E+00</td> <td colspan="2">0.000000E+00</td> <td colspan="2">0.000000E+00</td> </tr> </table>				Have	Have	Have		Have		kBq	MBq	GBq	uCi	mCi	Ci	Conversions to TBq		Conversions to TBq				0.000000E+00		0.000000E+00		0.000000E+00		Is this Special Form (A1) Radioactive Material?									
Have	Have	Have		Have																																			
kBq	MBq	GBq	uCi	mCi	Ci																																		
Conversions to TBq		Conversions to TBq																																					
0.000000E+00		0.000000E+00		0.000000E+00																																			
Isotope *Ac-224 *Ac-225 *Ac-226 *Ac-227 *Ac-228 *Ag-102 *Ag-103 *Ag-104m *Ag-104 *Ag-105 *Ag-106m *Ag-106 *Ag-108m *Ag-110m *Ag-111 *Ag-112 *Ag-115 *Al-26 *Am-237 *Am-238 *Am-239 *Am-240 *Am-241 *Am-242m *Am-242 *Am-243 *Am-244m *Am-244 *Am-245 *Am-246m *Am-246 *Ar-37 *Ar-39 *Ar-41 *Ar-42 *As-69 *As-70 *As-71 *As-72 *As-73 *As-74 *As-76 *As-77 *As-78 *At-207 *At-211 *Au-193 *Au-194 *Au-195 *Au-196 *Au-198m *Au-198 *Au-199 *Au-200m *Au-200 *Au-201 *Ba-126 *Ba-128 *Ba-131m *Ba-131 *Ba-133m *Ba-133 *Ba-135m *Ba-139 *Ba-140 *Ba-141 *Ba-142 *Be-7 *Be-10 *Bi-200 *Bi-201 *Bi-202 *Bi-203 *Bi-205 *Bi-206 *Bi-207 *Bi-210m *Bi-210 *Bi-212 *Bi-213 *Bi-214 *Bk-245 *Bk-246 *Bk-247 *Bk-249 *Bk-250 *Br-74m *Br-74 *Br-75 *Br-76 *Br-77 *Br-80m *Br-80 *Br-82 *Br-83		HAZARDOUS TBq (default)		MATERIAL NET MASS ENTRY <table border="1"> <tr> <th>In lbs:</th> <th>In kgs:</th> <th>In grams:</th> <th>Total Tare Wt (kg)</th> </tr> <tr> <td></td> <td></td> <td>0.000</td> <td></td> </tr> </table>				In lbs:	In kgs:	In grams:	Total Tare Wt (kg)			0.000		CONTAINER TARE MASS (kg)																							
In lbs:	In kgs:	In grams:	Total Tare Wt (kg)																																				
		0.000																																					
SCO ENTRY REQUIREMENTS <table border="1"> <tr> <th>Total cm2 (calculated)</th> <th>Total cm2 (given)</th> <th>Surface Area % Accessible</th> </tr> <tr> <td>0</td> <td></td> <td></td> </tr> </table> (see cell J46) % High Tox Alpha Activity in Pkg: 0.0000%		Total cm2 (calculated)	Total cm2 (given)	Surface Area % Accessible	0			CONVERSIONS TO CENTIMETERS <table border="1"> <tr> <th>Inches</th> <th>Feet</th> <th>Meters</th> </tr> <tr> <td></td> <td></td> <td></td> </tr> </table> Conversions to Centimeters 0.00 1.00 0.00		Inches	Feet	Meters				PHYSICAL STATE Solid Liquid Gas																							
Total cm2 (calculated)	Total cm2 (given)	Surface Area % Accessible																																					
0																																							
Inches	Feet	Meters																																					
Has the smear efficiencies of the smear already been factored into the contamination results? (y or n) Default = No Smear efficiency factor for SCO: Smear efficiency already factored into results.		Does type of surface area match contamination entries? BG Access Alpha Access No Accessible No Accessible BG Inaccess Alpha Inaccess No Inaccessible No Inaccessible		Is contamination evenly distributed on the material's surface or averaged over 300 cm2? (y=Yes n=No)																																			
Total activity of SCO (in TBq): 0.00000000E+00 Total SCO Activity Matches Total Package Activity		<table border="1"> <tr> <th>Beta/Gamma/LTA</th> <th>Bq</th> <th>dpm</th> <th>uCi</th> </tr> <tr> <td>Fixed Accessible</td> <td></td> <td></td> <td>No SCO Activity</td> </tr> <tr> <td>Non-Fixed Assess</td> <td></td> <td></td> <td>No SCO Activity</td> </tr> <tr> <td>Both Inaccessible</td> <td></td> <td></td> <td>No SCO Activity</td> </tr> <tr> <td>Total Activity:</td> <td>0.000000E+00</td> <td>0.000000E+00</td> <td>0.000000E+00</td> </tr> </table>		Beta/Gamma/LTA	Bq	dpm	uCi	Fixed Accessible			No SCO Activity	Non-Fixed Assess			No SCO Activity	Both Inaccessible			No SCO Activity	Total Activity:	0.000000E+00	0.000000E+00	0.000000E+00	<table border="1"> <tr> <th>TBq to Bq</th> <th>dps to dpm</th> </tr> <tr> <td>If TBq is:</td> <td>If dps is:</td> </tr> <tr> <td>Then Bq = 0.000000E+00</td> <td>Then dpm = 0.000000E+00</td> </tr> </table>		TBq to Bq	dps to dpm	If TBq is:	If dps is:	Then Bq = 0.000000E+00	Then dpm = 0.000000E+00	<table border="1"> <tr> <th>Bq to Bq</th> <th>Ci to uCi</th> </tr> <tr> <td>If Bq is:</td> <td>If Ci is:</td> </tr> <tr> <td>Then Bq = 0.000000E+00</td> <td>Then uCi = 0.000000E+00</td> </tr> </table>		Bq to Bq	Ci to uCi	If Bq is:	If Ci is:	Then Bq = 0.000000E+00	Then uCi = 0.000000E+00
Beta/Gamma/LTA	Bq	dpm	uCi																																				
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<table border="1"> <tr> <th>High Tox Alpha</th> <th>Bq</th> <th>dpm</th> <th>uCi</th> </tr> <tr> <td>Fixed Accessible</td> <td></td> <td></td> <td>No SCO Activity</td> </tr> <tr> <td>Non-Fixed Assess</td> <td></td> <td></td> <td>No SCO Activity</td> </tr> <tr> <td>Both Inaccessible</td> <td></td> <td></td> <td>No SCO Activity</td> </tr> <tr> <td>Total Activity:</td> <td>0.000000E+00</td> <td>0.000000E+00</td> <td>0.000000E+00</td> </tr> </table>		High Tox Alpha	Bq	dpm	uCi	Fixed Accessible			No SCO Activity	Non-Fixed Assess			No SCO Activity	Both Inaccessible			No SCO Activity	Total Activity:	0.000000E+00	0.000000E+00	0.000000E+00	<table border="1"> <tr> <th>MBq to Bq</th> <th>mCi to uCi</th> </tr> <tr> <td>If MBq is:</td> <td>If mCi is:</td> </tr> <tr> <td>Then Bq = 0.000000E+00</td> <td>Then uCi = 0.000000E+00</td> </tr> </table>		MBq to Bq	mCi to uCi	If MBq is:	If mCi is:	Then Bq = 0.000000E+00	Then uCi = 0.000000E+00	<table border="1"> <tr> <th>kBq to Bq</th> <th>pCi to uCi</th> </tr> <tr> <td>If kBq is:</td> <td>If pCi is:</td> </tr> <tr> <td>Then Bq = 0.000000E+00</td> <td>Then uCi = 0.000000E+00</td> </tr> </table>		kBq to Bq	pCi to uCi	If kBq is:	If pCi is:	Then Bq = 0.000000E+00	Then uCi = 0.000000E+00		
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If MBq is:	If mCi is:																																						
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kBq to Bq	pCi to uCi																																						
If kBq is:	If pCi is:																																						
Then Bq = 0.000000E+00	Then uCi = 0.000000E+00																																						
(Note: If total cm2 data is already obtained, input directly into cell G33.) Physical Data		<table border="1"> <tr> <th>Length (cm)</th> <th>Width (cm)</th> <th>No. of Pieces</th> <th>cm2/Item</th> </tr> <tr> <td>Item 1</td> <td></td> <td></td> <td>0</td> </tr> <tr> <td>Item 2</td> <td></td> <td></td> <td>0</td> </tr> <tr> <td>Item 3</td> <td></td> <td></td> <td>0</td> </tr> <tr> <td>Item 4</td> <td></td> <td></td> <td>0</td> </tr> <tr> <td colspan="3">Total cm2:</td> <td>0</td> </tr> </table>		Length (cm)	Width (cm)	No. of Pieces	cm2/Item	Item 1			0	Item 2			0	Item 3			0	Item 4			0	Total cm2:			0	<table border="1"> <tr> <th>dpm to Bq</th> <th>uCi to Bq</th> </tr> <tr> <td>If dpm is:</td> <td>If uCi is:</td> </tr> <tr> <td>Then Bq = 2.30E+04</td> <td>Then Bq = 0.000000E+00</td> </tr> <tr> <td>Then Bq = 3.7E+02</td> <td>Then Bq = 0.000000E+00</td> </tr> </table>		dpm to Bq	uCi to Bq	If dpm is:	If uCi is:	Then Bq = 2.30E+04	Then Bq = 0.000000E+00	Then Bq = 3.7E+02	Then Bq = 0.000000E+00		
Length (cm)	Width (cm)	No. of Pieces	cm2/Item																																				
Item 1			0																																				
Item 2			0																																				
Item 3			0																																				
Item 4			0																																				
Total cm2:			0																																				
dpm to Bq	uCi to Bq																																						
If dpm is:	If uCi is:																																						
Then Bq = 2.30E+04	Then Bq = 0.000000E+00																																						
Then Bq = 3.7E+02	Then Bq = 0.000000E+00																																						
EXCLUSIVE USE SHIPMENT INFORMATION Is the package being shipped in an exclusive use shipment? (y = yes, n = no)																																							
PACKAGE & VEHICLE CONTAMINATION ENTRY REQUIREMENTS Is the package and vehicle shipped as a DEDICATED VEHICLE per 173.443(d)? (y = yes, n = no)																																							
PACKAGE Contamination Limits Limits At Time Of Release (Except DY)				Conversion Fields																																			
Smear Size (cm2)		Alpha Bq	Within Limits Table 9	uCi to Bq		dps to Bq		dpm to Bq																															
Smear Efficiency %		Beta/Gamma Bq	Within Limits Table 9	If uCi is:		If dps is:		If dpm is:																															
If smear efficiency above is left blank, a default value of 100% is used which assumes smear efficiency has already been factored.			No Data	Then Bq = 0.000000E+00		Then Bq = 0.00E+00		Then Bq = 0.000000E+00																															
VEHICLE Contamination Limits Limits At Time Of Release (Except DY)				Conversion Fields																																			
Smear Size (cm2)		Alpha Bq	Within Limits Table 9	uCi to Bq		dps to Bq		dpm to Bq																															
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If smear efficiency above is left blank, a default value of 100% is used which assumes smear efficiency has already been factored.			No Data	Then Bq = 0.000000E+00		Then Bq = 0.000000E+00		Then Bq = 0.000000E+00																															

Figure B-2. Entries Worksheet Cell Range A1:Q113

* Br-84									
C-11									
C-14									
* Ca-41									
Ca-45									
Ca-47									
* Cd-104									
Cd-107									
Cd-109									
* Cd-113m									
* Cd-113									
* Cd-115m									
Cd-115									
* Cd-117m									
* Cd-117									
* Ce-134									
* Ce-135									
* Ce-137m									
* Ce-137									
Ce-139									
Ce-141									
* Ce-143									
Ce-144									
* Cf-244									
* Cf-246									
* Cf-248									
* Cf-249									
* Cf-250									
* Cf-251									
* Cf-252									
Cf-253									
* Cf-254									
Cf-255									
* Cl-36									
* Cl-38									
* Cl-39									
* Cm-239									
* Cm-240									
* Cm-241									
* Cm-242									
* Cm-243									
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Cm-245									
* Cm-246									
Cm-247									
* Cm-248									
* Cm-249									
* Co-56									
Co-58									
* Co-58m									
Co-59									
* Co-60m									
Co-60									
Co-61									
* Co-62m									
* Cr-48									
* Cr-49									
Cr-51									
* Cs-125									
* Cs-127									
Cs-129									
Cs-130									
Cs-131									
Cs-132									
* Cs-134m									
Cs-134									
* Cs-135m									
Cs-135									
Cs-136									
Cs-137									
* Cs-138									
* Cs-139									
* Cs-140									

PACKAGE Limits - DEDICATED VEHICLE				Conversion Fields	
Closed & Dedicated Vehicle (173.443(d))					
Smear Size (cm2)	Alpha Bq	Within Limits Table 9		uCi to Bq	
		No Data		If uCi is:	0.000000E+00
				Then Bq =	
Smear Efficiency					
If smear efficiency above is left blank, a default value of 100% is used which assumes smear efficiency has already been factored.					
Smear Size (cm2)	Beta/Gamma Bq	Within Limits Table 9		dpm to Bq	
		No Data		If dpm is:	0.000000E+00
				Then Bq =	
				dps to Bq	
				If dps is:	0.000000E+00
				Then Bq =	

DEDICATED VEHICLE Contamination Limits				Conversion Fields	
Closed & Dedicated Vehicle (173.443(d))					
Smear Size (cm2)	Alpha Bq	Within Limits Table 9		uCi to Bq	
		No Data		If uCi is:	0.000000E+00
				Then Bq =	
Smear Efficiency					
If smear efficiency above is left blank, a default value of 100% is used which assumes smear efficiency has already been factored.					
Smear Size (cm2)	Beta/Gamma Bq	Within Limits Table 9		dpm to Bq	
		No Data		If dpm is:	0.000000E+00
				Then Bq =	
				dps to Bq	
				If dps is:	0.000000E+00
				Then Bq =	

EMPTY PKG Internal Contamination Limits				Conversion Fields	
Excepted Package (173.428)					
Smear Size (cm2)	Alpha Bq	Within Limits Table 9		uCi to Bq	
		No Data		If uCi is:	0.000000E+00
				Then Bq =	
Smear Efficiency					
If smear efficiency above is left blank, a default value of 100% is used which assumes smear efficiency has already been factored.					
Smear Size (cm2)	Beta/Gamma Bq	Within Limits Table 9		dpm to Bq	
		No Data		If dpm is:	0.000000E+00
				Then Bq =	
				dps to Bq	
				If dps is:	0.000000E+00
				Then Bq =	

PACKAGE & VEHICLE DOSE RATE ENTRIES					
Package Dose Rate Limits					
NON-EXCLUSIVE USE					
	Have (mrem/hr)	Within Limits		Conversion Fields	
Package Surface		No Data			
Package @ 1m		No Data			
Package & Vehicle Dose Rate Limits					
EXCLUSIVE USE					
	Have (mrem/hr)	Within Limits		Conversion Fields	
Package Surface		No Data		If mSv/hr is:	0.016
Pkg Surface in CTV		No Data		Then mrem/hr =	16
Package @ 1m		No Data			
Vehicle Surface		No Data		If uSv/hr is:	4
Vehicle @ 2 m		No Data		Then mrem/hr =	0.4
Vehicle Occupant		No Data		If urem/hr is:	1
		No Data		Then mrem/hr =	0.001
EXCEPTED PACKAGE					
Package/Vehicle	Have (mrem/hr)	Within Limits		VEHICLE RELEASE	
Package Surface		N/A			
Vehicle Surface		No Data			

Figure B-3. Entries Worksheet, Cell Range A114:Q185

* U-237					
U-238					
* U-238 (seq =)					
* U-239					
* U-240					
U (natural)					
U (<20%)					
U (depleted)					
* U (irradiated)					
* V-47					
V-48					
V-49					
* V-176					
* V-177					
V-178					
* V-179					
V-181					
V-185					

U-235 Enrichment	
Weight Percent	
Mass U-235 (g):	0.000000E+00
Enter % enrichment in cell above.	

Figure B-4. Entries Worksheet, Cell Range A770:Q787