



# MARSSIM Update: Expanded Scope, Implementation Tools, & Examples

Continuing Education Lecture  
Health Physics Society Midyear Meeting  
February 19, 2002  
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# Overview

- ◆ Who's using MARSSIM?
- ◆ MARSSIM Planned Supplements
  - Release of materials
  - Subsurface soil
- ◆ Implementation Tools
  - COMPASS
  - MARSSIMPower 2000
- ◆ Bridging Gap Between DCGL and MARSSIM
- ◆ MARSSIM Example

# Congresswoman Nancy Pelosi (CA)

- ◆ **Letter to the Secretary of the Navy on Hunter's Point on May 21, 2001:**

**“In August of 2000, the Multiagency Radiation Survey and Site Investigation Manual(MARSSIM) was revised. In the Navy's survey and site investigation did the Navy follow these MARSSIM protocols?”**

# Are you on the right MARSSIM discussion board?

## ◆ MarsSim Discussion Board

MarsSim is actually a PC game...short for Mars Simulator

...don't be caught playing MarsSim at work!

# MARSSIM experience...just a few of the many examples

- ◆ Nuclear power plants – Trojan, CY, MY
- ◆ State oversight- CA, CO, ID, ME, NJ
- ◆ DOE at ANL, BNL, Rocky Flats
- ◆ ETTP Gaseous Diffusion Plants
- ◆ Army Corps FUSRAP sites; Air Force and Naval Base Cleanups
- ◆ Still waiting to see completed DQA for a major D&D Project

# MultiAgency Radiation Survey and Assessment of Materials & Equipment

- ◆ Focuses on the release of materials - first planned MARSSIM Supplement
- ◆ NRC provided the WG some materials from draft "Radiological Surveys for Controlling Release of Solid Materials"
- ◆ Tentative outline of both supplements expected to be posted soon at...

<http://www.epa.gov/radiation/marssim/>

# MultiAgency Radiation Survey and Assessment of Subsurface Soils

- ◆ Focuses on designing subsurface surveys – second MARSSIM supplement
- ◆ Spatial Analysis and Decision Assistance
  - SADA tools include modules for visualization, geospatial analysis, statistical analysis, risk assessment, sampling design, and decision analysis
  - <http://www.tiem.utk.edu/~sada/>

**COMPASS:**

**Computerization Of the MARSSIM for  
Planning and Assessing Site Surveys**

- ◆ Funded by the NRC, assists D&D professionals and regulators with MARSSIM implementation
- ◆ Help trains MARSSIM users with survey designs, power curves, DQA
- ◆ Consistency of information which facilitates the regulator's review
- ◆ <http://www.ornl.gov/essap/marssim.htm#Compass>



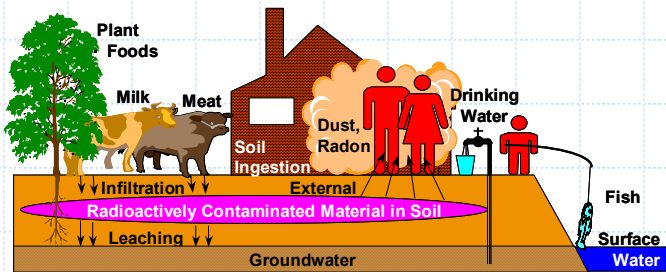
# Dr. Carl Gogolak's MARSSIMPower 2000

- ◆ Quick calculation of sample sizes for Type I and II errors, sigma and delta (DCGL – LBGR)
- ◆ Dynamic power curve and sample sizes generated for each design
- ◆ Look for MARSSIMPower 2002 (with retrospective power curves)
- ◆ <http://www.cvg.homestead.com/MARSSIMPower2000.html>

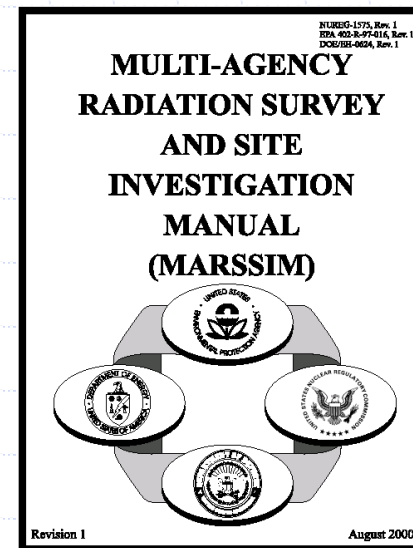
(alt-tab to MARSSIMPower 2000)

# Gaps Between DCGL Development and MARSSIM

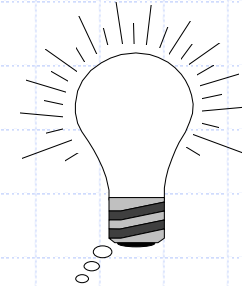
Pathway Analysis



DCGL MARSSIM Implementation



# RESRAD/COMPASS Application



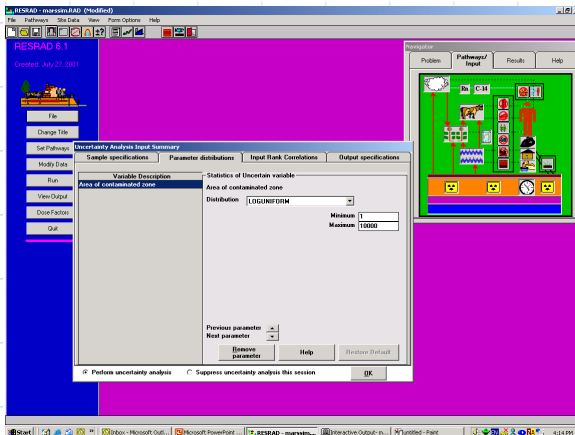
## ◆ Potential Approaches:

- Integrate RESRAD & COMPASS (OpenLink)
  - ◆ Add wizard similar to COMPASS site wizard to add DCGL's calculated in RESRAD into COMPASS database
  - ◆ Allow COMPASS to import area factor data from RESRAD

# RESRAD/COMPASS: Enhanced Computational Ability

- ◆ Incorporating RESRAD and COMPASS would allow users to quickly integrate dose based area factors into the MARSSIM DQO/DQA process

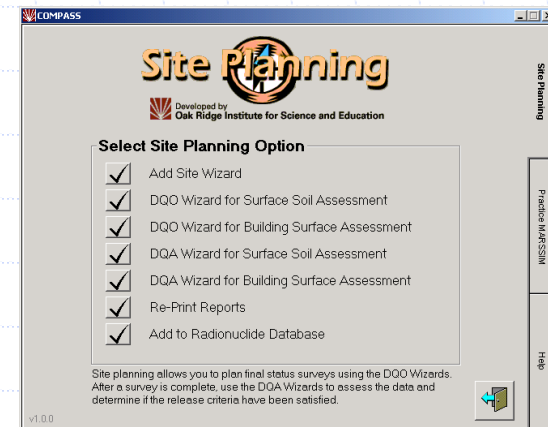
RESRAD



OpenLink



COMPASS



# Practice MARSSIM

## Select Practice Option



Statistical Tests and Prospective Power



Surrogate and DCGL Modification (Soils)

The purpose of the practice features of COMPASS is to allow the user to learn specific aspects of the MARSSIM without requiring the user to complete full site planning.



Front Page

Practice MARSSIM

Site Planning

# COMPASS: Practice MARSSIM - WRS Test for U-238 in Soil

$DCGL_W = 3 \text{ pCi/g (U-238)}$

$LBGR = 1.2 \text{ pCi/g}$

Standard Deviation =  $1.6 \text{ pCi/g}$

Type I error = 0.05

Type II error = 0.10

How many samples needed?

Prospective power curve satisfy DQOs?

**COMPASS - Practice**

## Statistical Tests and Prospective Power Practice

Enter the values required below. After these values are entered, you can view the prospective power curve on the right. Click the help button for detailed descriptions of each field.

**Enter Values**

Test:

DCGL:

LBGR:

Sigma:

Alpha:

Beta:

Units:




**Calculations**

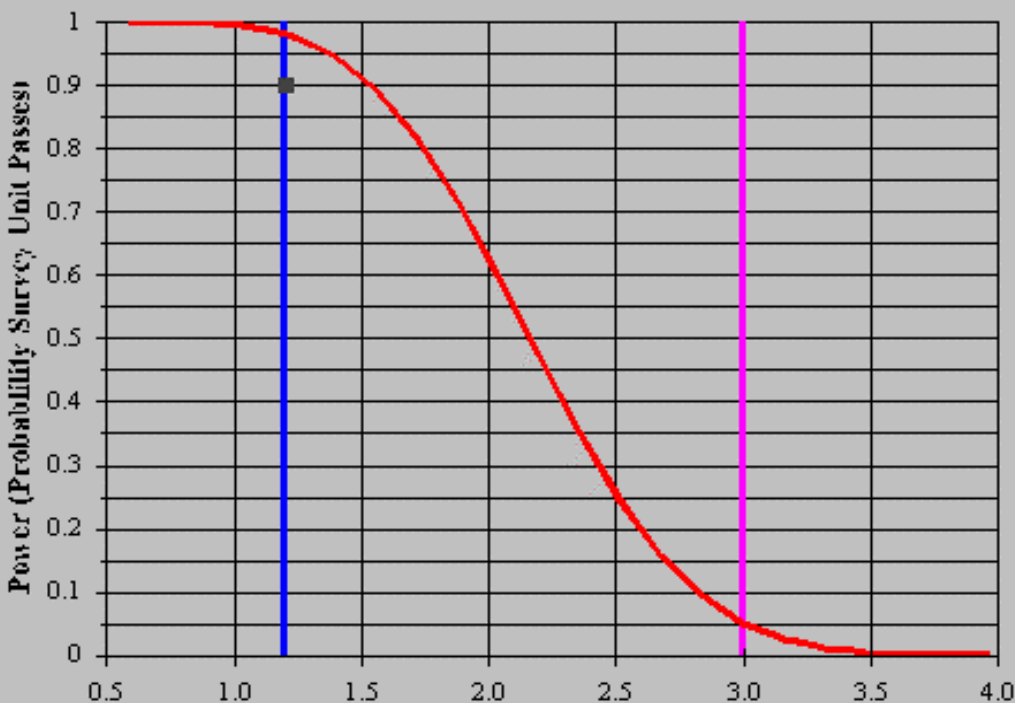
$\Delta/\sigma$ :

Pr:

N/2:

Calculate Sample Size/Update  
Prospective Power Curve

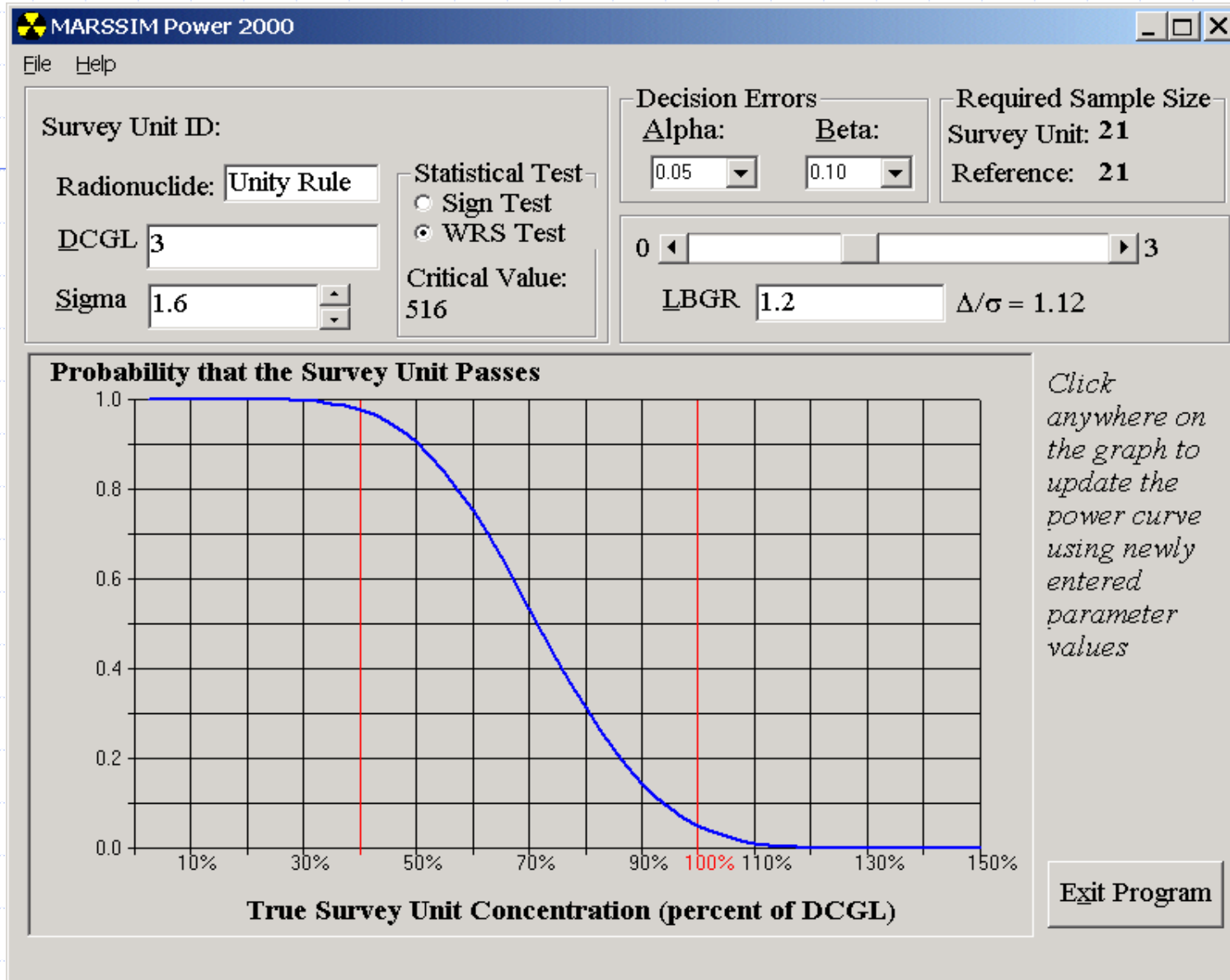


**Soil Concentration (pCi/g)**

— Prospective Power
— DCGL

— LBGR
■ 1-beta

**COMPASS v0.7.0**





# Class 2 Survey Unit with Surface Soil Contamination

<u>Contaminants:</u>	<u>DCGL<sub>w</sub>:</u>
◆ Cs-137	2.6 pCi/g
◆ Sr-90	4.2 pCi/g
◆ Am-241	1.6 pCi/g
◆ Survey unit size is 6000 m <sup>2</sup>	
◆ Type I and Type II error = 0.05	

# Site Planning

Developed by  
Oak Ridge Institute for Science and Education

## Select Site Planning Option

- Add Site Wizard
- DQO Wizard for Surface Soil Assessment
- DQO Wizard for Building Surface Assessment
- DQA Wizard for Surface Soil Assessment
- DQA Wizard for Building Surface Assessment
- Re-Print Reports
- Add to Radionuclide Database

Site planning allows you to plan final status surveys using the DQO Wizards. After a survey is complete, use the DQA Wizards to assess the data and determine if the release criteria have been satisfied.

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Site Planning

Practice MARRSIM

Help

### Enter Area Factors for Site Contaminants (Optional)

Enter the area factors for each site contaminant. If a contaminant has both a surface soil and building surface DCGL, then enter two area factor tables. It is important to enter area factor tables now. If they are needed in the DQO or DQA and are not provided here, the DQO and DQA will be unable to be completed.

#### Site Contaminant

Contaminant	Type
Am-241	Surface Soil
Cs-137	Surface Soil
SrY-90	Surface Soil

#### Area Factors

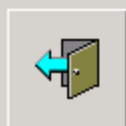
Area	Factor



Enter Data

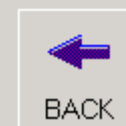
Area (m<sup>2</sup>):

Area Factor:



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### Site Selection

From the list below, select a site. The second list shows which contaminants have been entered for the selected site, the surface soil DCGLw, and if the NRC screening value was used.

#### Select a Site

CEL Orlando

#### Site Contaminants

Contaminant	DCGLw (pCi/g)	Screening Value?
Am-241	1.60	No
Cs-137	2.60	No
SrY-90	4.20	No



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### Survey Unit Details

Enter in a description of the survey unit. This text must be unique for the selected site and will be used when selecting a survey plan to re-print or to begin the data quality assessment (DQA) wizard. The list box below shows all the names previously entered. Then enter the survey unit area and classification.

Survey Unit Description:

Surface Soil

Survey Unit Area (m<sup>2</sup>): 6000

Class: 2



Add any additional comments below. These comments will appear on the survey plan report and entry is optional.

Comments: (Optional)



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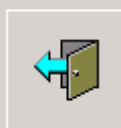
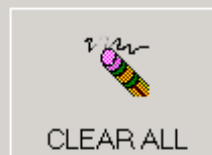




### Select Measured Contaminants

Because there are multiple contaminants, a surrogate approach can be used. Put a check mark next to each contaminant whose concentration will be measured (not inferred) by clicking the box to the left of the contaminant. Simply check the box again to un-check it. Each measured contaminant can only account for one inferred contaminant.

Contaminant	DCGLw (pCi/g)
<input checked="" type="checkbox"/> Am-241	1.60
<input checked="" type="checkbox"/> Cs-137	2.60
<input type="checkbox"/> SrY-90	4.20



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### Calculate Modified DCGL(s)

Select a measured contaminant from the DCGL Summary box that will be used as a surrogate for another non-measured (inferred) contaminant. Select a non-measured contaminant from the Inferred Contaminants box. Enter the required ratio then hit the Save Ratio button.

#### DCGL Summary

Measured	DCGLw (pCi/g)	Inferred	Ratio	Modified DCGLw (pCi/g)
Am-241	1.60			
Cs-137	2.60	SrY-90	3	0.91

Clear Surrogate Relationship

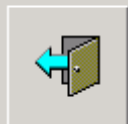
#### Inferred Contaminant(s)

Inferred	DCGLw (pCi/g)
SrY-90	4.20

Enter Ratio

Ratio :

Save Ratio



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### Enter Estimated Concentration Levels

Enter the estimated mean (pCi/g) and standard deviation (pCi/g) for each measured contaminant. If data is available for the reference area, be sure to include it as well. This will allow you to later make comparisons between the Sign and WRS tests if reference area data for at least one contaminant is included.

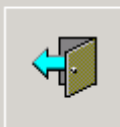
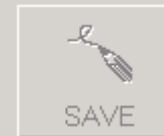
#### Measured Contaminant Estimated Mean Value(s)

Measured Contaminant	Survey Unit (pCi/g)	Reference Area (pCi/g)
Am-241	0.4 ± 0.3	
Cs-137	0.8 ± 0.3	0.5 ± 0.2

#### Enter Estimated Values

Survey Unit Mean (pCi/g):  ±  (1σ)

Reference Area Mean (pCi/g):  ±  (1σ)



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# Standard Deviation used for the Unity Rule

- ◆ For survey design, need standard deviation of weighted sum (MARSSIM Eqn I-17):

$$\sigma^2 = \left( \frac{\sigma_{Am-241}}{DCGL_{Am-241}} \right)^2 + \left( \frac{\sigma_{Cs-137}}{DCGL_{Cs-137}} \right)^2$$

# Calculation of Standard Deviation for Unity Rule

◆ Standard deviations:	DCGLs:
■ Am-241	0.3 pCi/g      1.6 pCi/g
■ Cs-137	0.3 pCi/g      0.9 pCi/g (mod)

$$\sigma^2 = \left(\frac{0.3}{1.6}\right)^2 + \left(\frac{0.3}{0.9}\right)^2 = 0.15; \quad \sigma = 0.38$$

$$\text{◆ LBGR} = 0.4/1.6 + (0.8 - 0.5)/0.9 = 0.58$$



### WRS TEST Sample Size and Prospective Power Curve Design

This step calculates the WRS Test sample size and prospective power curve. Enter values for the DQO parameters, then click the calculate button at the bottom. When you are satisfied with this design, click the NEXT button.

#### Enter Values

LBGR:

Alpha:  ▾

Beta:  ▾

#### Calculations

DCGL:

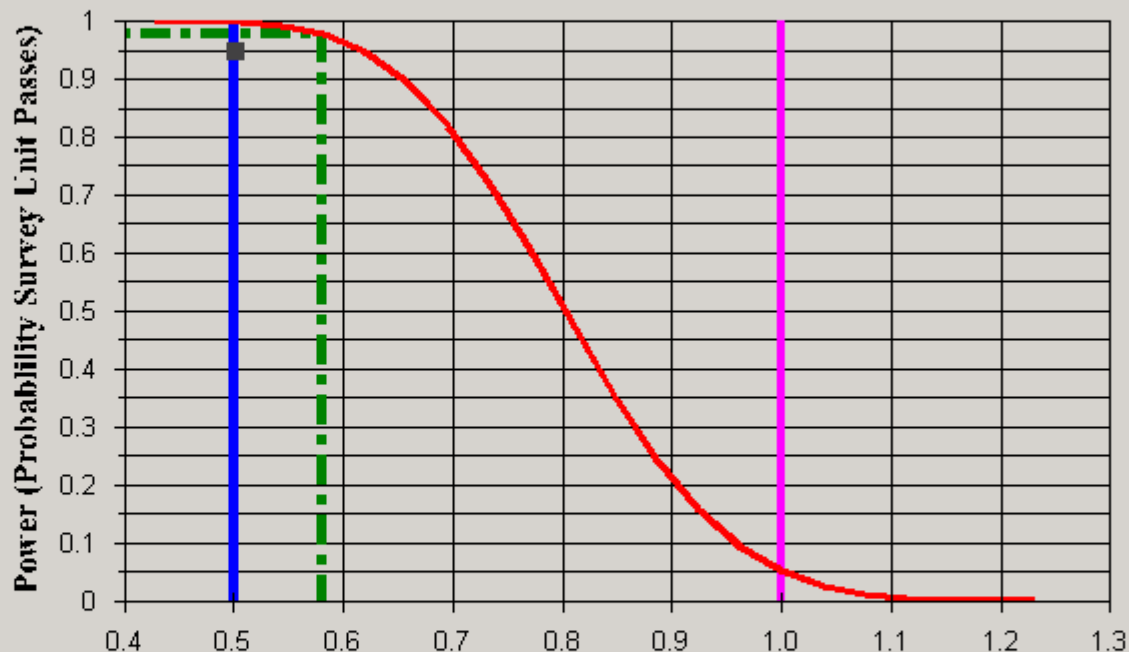
Sigma:

$\Delta / \sigma$ :

Pr:

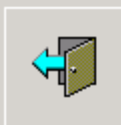
N/2:

Calculate Sample Size/Update Prospective Power Curve



Unity Rule Sum-of-Ratios, not including background

- Prospective Power
- DCGL
- - - Estimated Power
- LBGR
- 1-beta



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### WRS TEST Sample Size and Prospective Power Curve Design

This step calculates the WRS Test sample size and prospective power curve. Enter values for the DQO parameters, then click the calculate button at the bottom. When you are satisfied with this design, click the NEXT button.

Enter Values

LBGR:

Alpha:

Beta:

Calculations

DCGL:

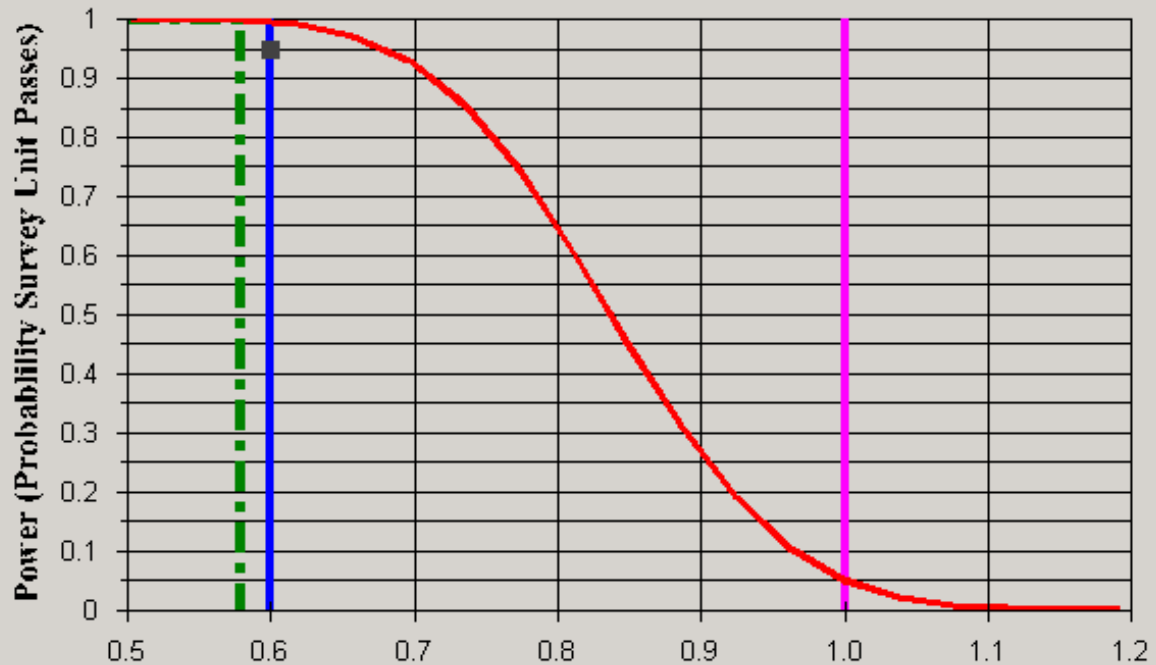
Sigma:

$\Delta / \sigma$ :

Pr:

N/2:

Calculate Sample Size/Update Prospective Power Curve



Unity Rule Sum-of-Ratios, not including background

- Prospective Power
- DCGL
- - - Estimated Power
- LBGR
- 1-beta



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# DQA for Am-241 and Cs-137 Class 2 Survey Unit

- ◆ Assume that WRS test with LBGR set at 0.5 was selected, and that 22 soil samples are collected from both the survey unit and the reference area

Select the Site

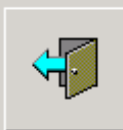
CEL Orlando

Select the Survey Unit

Surface Soil

Summary of Contaminants

Contaminant	DCGLw/MDCGLw	Measured	Inferred Radionuclide
Am-241	1.60	Yes	N/A
Cs-137	0.91	Yes	SrY-90
SrY-90	4.20	No	N/A



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**Enter the number of samples collected**

Systematic Samples:

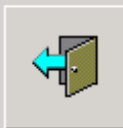
Reference Area Samples:

Are there any elevated areas in the survey unit?

Number of Elevated Areas:

**Select the method for importing sample data**

- Manual Entry
- Import from Excel file
- Import from comma delimited file



Enable Training Card Help

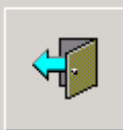
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### Imported Sample Data

Summarizes analytical results of each sample.

Sample #	Type	Am-241	Cs-137
14	S	0.8	0.8
15	S	0.5	0.2
16	S	0.4	0.7
17	S	0.2	0.4
18	S	0.2	1
19	S	0.6	0.6
20	S	0.4	0.9
21	S	0.5	0.7
22	S	0.4	0.7
23	R	0	0.4
24	R	0	0.6
25	R	0	0.5
26	R	0	0.2
27	R	0	0.3
28	R	0	0.7
29	R	0	1.1



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### Unity Rule Summary for Identified Contaminants

More than one contaminant was identified for the survey unit. Therefore, the list box below summarizes each sample results after application of the unity rule.

Sample #	Type	Sum of the Ratios
12	S	3
13	S	0.85
14	S	1.38
15	S	0.53
16	S	1.02
17	S	0.56
18	S	1.22
19	S	1.03
20	S	1.24
21	S	1.08
22	S	1.02
23	R	0.44
24	R	0.66
25	R	0.55
26	R	0.22
27	R	0.33



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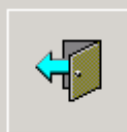


### Basic Statistical Quantities Summary

Summarizes the basic statistical quantities such as the mean, median, minimum value, maximum value, and standard deviation for the systematic sample, reference area samples if applicable and the estimated values provided from the DQO process.

Statistic	Survey Unit	Background	DQO Results
Sample Number	22	22	N/2=22
Mean (SOR)	1.27	0.66	0.58
Median (SOR)	1.15	0.66	N/A
Std Dev (SOR)	0.61	0.28	0.38
High Value (SOR)	3.00	1.21	N/A
Low Value (SOR)	0.53	0.22	N/A

**Because the difference between a survey unit measurement and a reference area measurement exceeds the DCGLw AND the difference of the survey unit average and reference area average is less than DCGLw, the WRS Test will be conducted after reviewing the retrospective power curve.**



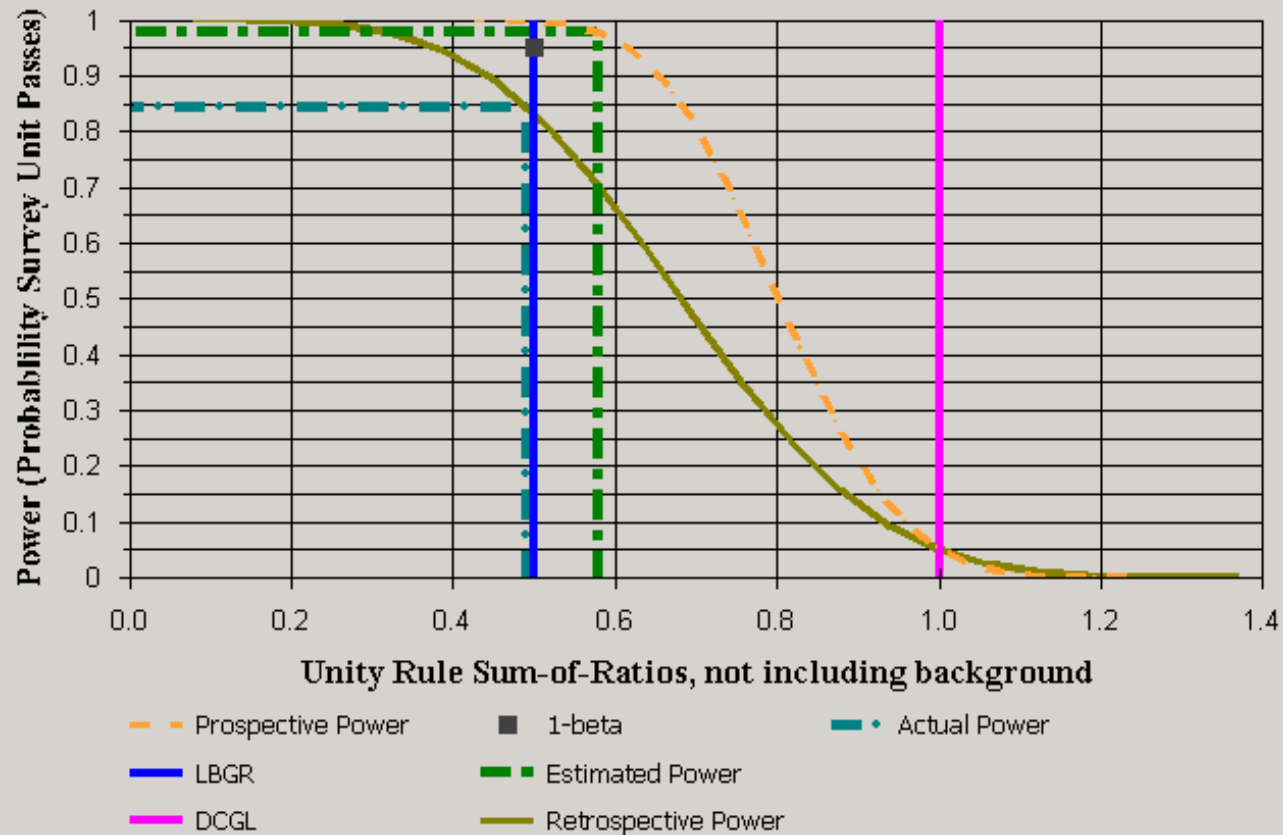
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### Retrospective Power Curve Design

This step compares the retrospective power curve with the prospective power curve for the selected survey unit. The legend below will assist in the interpretation .



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### Statistical Test Summary

Summarizes the results of the WRS Test.

The result of the statistical test is the decision to reject or not to reject the null hypothesis (indicated by Pass or Fail, respectively).

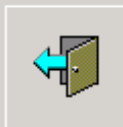
Data	Type	Adjusted Data	Rank	Ref Rank
0.22	R	1.22	12.5	12.5
0.22	R	1.22	12.5	12.5
0.33	R	1.33	17.5	17.5
0.33	R	1.33	17.5	17.5
0.44	R	1.44	21	21
0.44	R	1.44	21	21
0.44	R	1.44	21	21

Sum of Ranks: 990

Sum of Ref Ranks: 616

Critical Value: 565

Result: Pass



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# WRS Test Summary

- ◆ The critical value for  $n = 22$ ,  $m = 22$  and Type I error = 0.05 is 565
- ◆ Sum of the reference area ranks ( $W_r$ ) is 616
- ◆ Because  $W_r$  exceeds the critical value:  
 $H_0$  is rejected and survey unit passes