33 Worksheets for Cost/Benefit Analysis[1]

An analysis of costs and benefits is an important aid in decision making. The analysis may assist in illustrating whether measures to reduce or control contaminaiton provide a net benefit. Moreover, if several options are available, the approach should indicate the most cost-effective option.

There are various approaches to cary out a cost-benefit analysis. One simple but effective approach is described in detail in ref. 1. A summary of that approach is given in this section.

The approach is based on the following concept: There are several approaches available to, for example, remove contamination. One of these options is to do nothing and let the situation remain as it is. This last option we call the datum case.

The technique is to compare each of the available options with the datum case. The comparison with the datum case shows whether an option would produce a net benefit. After all the options have been compared with the datum case, one can compare the benefits from each option to decide on a course of action.

The approach described in detail in ref. 1 is illustrated here by four worksheets and final summary sheet which gives the main findings of the analysis.

The use of the worksheets is illustrated by an example. In this example, the reactor cavity was to be decontaminated. Two options were available: (a) hand scrubbing or (b) the WEPA process. In the worksheets, the hand scrubbing option is compared to the datum case of "doing nothing to clean up the reactor cavity."

In an analogous manner, the second option, the WEPA process, may be considered and the final results of the two (or more options, as the case may be) could be summarized in the summary sheet shown in section 33.3.

For full details on how to most effectively utilize these worksheets, the reader is referred to the reference shown in the footnote.

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[1] "Optimization of the Control of Contamination at Nuclear Power Plants", NUREG/CR-5038, BNL-NUREG-52073, February 1988, Superintendent of Documents, U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20013-7982.

Worksheet 1: Annual Benefits

Worksheet 1 is concerned with the annual benefits from a particular action as compared to datum case.

Worksheet 2: Aggregate Benefits

Worksheet 2 is used to convert the annual benefits calculated in Worksheet 1 to an aggregate present worth value. In addition, the salvage value of equipment, which should be a one-time benefit, is added to the aggregate value. Lastly, the aggregate dose savings in terms of man-rem is estimated.

Worksheet 3: Costs

Worksheet 3 is used to compute the total cost associated with the action being considered. First, the one-time costs are computed. These are the capital, installation, and waste-processing costs. The installation costs includes the component associated with the monetary value of the dose used during installation.

Worksheet 4: Results

The results are computed in Worksheet 4. The worksheet is almost self-explanatory. The aggregate benefits of Worksheet 2 and the aggregate costs of Worksheet 3 are used to calculate the cost/benefit ratio and the net benefit. Lastly, the net dose savings are computed.

WORKSHEET 1 - ANNUAL BENEFITS

PROJECT NAME: Reactor Cavity Pool Decontamination

OPTION: Hand Scrubbing

W1.1 Dollar Equivalent Dose Savings, ($/year):

		rem/year	×	$/rem	=	$/year
W1.2	Critical Skill Labor:					
W1.3	Whole Body	22		1125		24,750
W1.4	Extremity	250		75		18,750
W1.5	Skin	100		225		22,500
W1.6	Non-Critical Skill Labor:					
W1.7	Whole Body	0		113		0
W1.8	Extremity	0		8		0
W1.9	Skin	0		23		0

W1.10 Dollar Value of Annual Dose Savings, ($/year):

(sum W1.2 through W1.9) = 66,000

W1.11 Annual Dose Savings, (rem/year):

W1.12 Whole Body (W1.3 + W1.7) = 22

W1.13 Extremity (W1.4 + W1.8) = 250

W1.14 Skin (W1.5 + W1.9) = 100

WORKSHEET 1 - ANNUAL BENEFITS

PROJECT NAME: Reactor Cavity Pool Decontamination

OPTION: Hand Scrubbing

W1.15 Equipment Savings, ($/year):

W1.16	Surveying	=	400
W1.17	Monitoring, Frisking	=	0
W1.18	Laboratory	=	270
W1.19	Protective Apparel	=	230

W1.20 Value of Annual Equipment Savings, ($/year):

(sum W1.16 through W1.19) = 900

W1.21 Operation Savings, ($/year):

		h/year	×	$/h	=	$/year
W1.22	Training (insert H2.40 of Helpsheet 2)	139.7		20		2794
W1.23	Time on the Job (efficiency, access control suiting up, paper work)	64.0		20		1279
W1.24	Radiation Protection Services (HP supervision, paper work, etc.	15.0		20		300

WORKSHEET 1 - ANNUAL BENEFITS

PROJECT NAME: Reactor Cavity Pool Decontamination

OPTION: Hand Scrubbing

W1.25 Dollar Value of Annual Operation Savings, ($/year):

(sum W1.22 through W1.23) = 4,373

W1.26 Maintenance Savings, ($/year):

	h/year	×	$/h	=	$/year
W1.27 Equipment Maintenance	0.0		0		0

W1.28 Dollar Value of Annual Maintenance Savings, ($/year):
(insert W1.27)

0

W1.29 Replacement Power Savings, ($/year):

	h/year	×	$/h	=	$/year
W1.30 Critical-path Time (If work time saved is on critical-path,	64.0		20,000		1,279,227

W1.31 Dollar Value of Annual Replacement Power Savings, ($/year):

(insert W1.30) 1,279,227

WORKSHEET 1 - ANNUAL BENEFITS

PROJECT NAME: Reactor Cavity Pool Decontamination

OPTION: Hand Scrubbing

W1.32 Hidden Benefits, ($/year):

W1.33	Hidden Benefits (enhanced safety, reduced risk of contamination, worker morale, etc.)	10,000	
W1.34	Dollar Value of Annual Hidden Benefits Savings, ($/year):		
	(insert W1.33)		10,000

W1.35 Total Annual Benefits, ($/year):

W1.36 Dollar Value of Total Annual Benefits, ($/year):

(W1.10 + W1.20 + W1.25 + W1.28 + W1.31 + W1.34) = 1,360,499

END OF WORKSHEET 1

WORKSHEET 2 - AGGREGATE BENEFITS

PROJECT NAME: Reactor Cavity Pool Decontamination

OPTION: Hand Scrubbing

W2.1 Total Annual Benefits, ($/year)

(insert W1.36 from Worksheet 1A)	=	1,360,499

IF THE BENEFITS ARE NOT PERIODIC BUT OCCUR JUST ONCE IN THE PROJECT LIFETIME, STEPS 2, 3, AND 4 MAY BE SKIPPED.

W2.2 Discount Rate, r;

(Obtain discount rate [>0, e.g. 0.04]. BNL spreadsheet displays it as a % figure.)	r =	4.0%

W2.3 Project Lifetime, n; (years)

(period during which annual savings will be summed and equipment amortized)	n =	20.0

W2.4 Present Worth Coefficient, H;

(Converts annual savings or costs to an aggregate sum. Obtain from table in Appendix or calculate from the formula.)

$H = \{[(1 + r)^n] \cdot 1\} / \{r[(1 + r)^n]\}$	H =	13.59

W2.5 Savings from Salvage; ($)

(Salvage value of equipment)	=	$0

W2.6 Total Aggregate Benefits, B; ($)

(B = W2.1 × H + W2.5 or B = W2.1 + W2.5 if benefits only occur once)	B =	$18,489,631

WORKSHEET 2 - AGGREGATE BENEFITS

PROJECT NAME: Reactor Cavity Pool Decontamination

OPTION: Hand Scrubbing

W2.7 Total Aggregate Dose Savings; (rem)

(Use W.12, W1.13, W1.14 from Worksheet 1)

W2.8	Whole Body (n × W1.12)	=	440
W2.9	Extremity (n × W1.13)	=	5,000
W2.10	Skin (n × W1.14)	=	2,000

END OF WORKSHEET 2

WORKSHEET 3 - COSTS

PROJECT NAME: Reactor Cavity Pool Decontamination

OPTION: Hand Scrubbing

W3.1 Capital Cost, ($):

W3.2	Equipment (including decontamination, robotics, surveying, apparel)	=	15,000
W3.3	Materials	=	5,000
W3.4	Engineering	=	0
W3.5	Fabrication and Assembly	=	3,000
W3.6	Miscellaneous (equipment rental, other)	=	1,000
W3.7	Dollar Value of Capital Cost, ($): (sum W3.2 through W3.6)	=	$24,000

W3.8 Installation Cost, ($):

		(hours)	×	($/hour)	$
W3.9	Labor (May use W1.27)	0.0		20.00	0
W3.10	Training (May use W1.22)	0.0		20.00	0
W3.11	Replacement Power (May use W1.30 from Worksheet 1)	0.0		20,000	0
W3.12	Total CASH Cost of Installation, ($) (sum W3.9 through W3.11)			=	0

WORKSHEET 3 - COSTS

PROJECT NAME: Reactor Cavity Pool Decontamination

OPTION: Hand Scrubbing

W3.13 Installation Dose, (rem):

W3.14	Whole Body	0
W3.15	Extremity	0
W3.16	Skin	0

W3.17 Cost of Installation Dose, ($)
(insert H1.8, H1.11, H1.14
from Helpsheet 1)

		(rem)	×	($/rem)	$
W3.18	Whole Body	0		1,125	0
W3.19	Extremity	0		75	0
W3.20	Skin	0		225	0

W3.21 Total DOSE Cost of Installation, ($):
(sum W3.18 through W3.20) = 0

W3.22 Dollar Value of Total Installation Cost, ($):

(W3.12 + W3.21) = $0

W3.23 Cost of Processing any Waste Associated with the Cleanup:

		(Volume)	×	($/unit Volume)	$
W3.24	Liquid (gallons)	0		2.3	0
W3.25	Solid (cu. ft.)	0		3	0

WORKSHEET 3 - COSTS

PROJECT NAME: Reactor Cavity Pool Decontamination

OPTION: Hand Scrubbing

W3.26 Dollar Value of Waste Processing Cost, ($)

(W3.24 + W3.25) = $0

W3.27 Total PRESENT Cost, ($):

(W3.7 + W3.22 + W3.26) = $24,000

W3.28 Annual Maintenance Cost Associated with Cleanup, ($/year):

		(h/year)	× ($/h)	($/year)
W3.29	Labor	100	20.00	2,000
W3.30	Training	20	20.00	400
W3.31	Replacement Power	48	20,000	960,000

W3.32 Annual Dollar Value of Labor, Training and Replacement Power, ($/year) (sum W.29 through W.31) = 962,400

W3.33 Annual Waste Processing Cost:

		(Volume/yr)	x$/unit Volume)	= ($/year)
W3.34	Liquid (gallons)	6,700	2.3	15,410
W3.35	Solid (cu. ft.)	50	3.0	150

W3.36 Annual Dollar Value of Waste Processing Cost, ($/year):

(W3.34 + W3.35) = 15,560

WORKSHEET 3 - COSTS

PROJECT NAME: Reactor Cavity Pool Decontamination

OPTION: Hand Scrubbing

W3.37	Other Annual Maintenance Costs, ($/year): (e.g. materials, etc.)	=	3,000
W3.38	Total Annual Cash Cost, ($/year): (W3.32 + W3.36 + W3.37)	=	980,960
W3.39	Annual Maintenance Dose, (rem/year):		
W3.40	Whole Body	=	5
W3.41	Extremity	=	300
W3.42	Skin	=	170

W3.43 Annual Cost of Maintenance Dose

		(rem/year)	×	($/rem)	$/year
W3.44	Whole Body	5		1,125	5,625
W3.45	Extremity	300		75	22,500
W3.46	Skin	170		225	38,250

W3.47	Total Annual Cost of Maintenance Dose, ($/year): (sum W3.44 through W3.46)	=	66,375

WORKSHEET 3 - COSTS

PROJECT NAME: Reactor Cavity Pool Decontamination

OPTION: Hand Scrubbing

W3.48 Total Value of Annual Maintenance Cost, ($/year):

(W3.38 + W3.47) = 1,047,335

W3.49 Aggregate Maintenance Cost, ($):

(H × W3.48) = $14,233,624
(H is from W2.4 of Worksheet 2)

W3.50 Total Aggregate Cost, ($):

(W3.49 + W3.27) = $14,257,624

W3.51 Aggregate Installation and Maintenance Dose, (rem):

W3.52 Whole Body (W3.14 + n × W3.40) = 100

W3.53 Extremity (W3.15 + n × W3.41) = 6,000

W3.54 Skin (W3.16 + n × W3.42) = 3,400

(where n is from W2.3 of Worksheet 2)

END OF WORKSHEET 3

WORKSHEET 4 - RESULTS

PROJECT NAME: Reactor Cavity Pool Decontamination

OPTION: Hand Scrubbing

BENEFIT-COST RATIO:

W4.1	Total Aggregate Benefits, B ($): (insert from W2.6 of Worksheet 2A)	=	$18,489,631
W4.2	Total Aggregate Costs, C ($): (insert from W3.50 of Worksheet 3A)	=	$14,257,624
W4.3	Benefit-Cost Ratio, R: (B / C)	=	1.3

IF R > 1, THE BENEFIT MAY EXCEED THE COST BY A FACTOR OF R

NET BENEFIT:

W4.4	Net Benefits, Q ($):		
	(B - C)	=	$4,232,006

IF Q > 0, (or Q not in parentheses) THE BENEFIT EXCEEDS THE COST BY $ Q.

IF Q < 0, (or Q in parentheses) THE COST EXCEEDS THE BENEFIT BY $ Q.

WORKSHEET 4 - RESULTS

PROJECT NAME: Reactor Cavity Pool Decontamination

OPTION: Hand Scrubbing

NET DOSE SAVINGS:

W4.5 Net Dose Saved, (rem):

(Use W2.8, W2.9, W2.10 of Worksheet 2
and W3.52, W3.53, W3.54 of Worksheet 3)

W4.6	Whole-body dose saved, X (rem): (W2.8 - W3.52)	=	340
W4.7	Extremity dose saved, Y (rem): (W2.9 - W3.53)	=	-1000
W4.8	Skin dose saved, Z (rem): (W2.10 - W3.54)	=	-1400

END OF WORKSHEET 4