A DECISION ANALYSIS TECHNIQUE FOR EVALUATING AND COMPARING WORK DIRECTED TOWARDS MINIMIZING THE GENERATION OF NUCLEAR WASTE.

R. E. Thieme
S. M. Stoller Corp.
Albuquerque, N.M. 87107

P. G Hagan
Joint Integration Office
Rockwell International
Albuquerque, N.M. 87107

ABSTRACT

The United States Department of Energy has established policies and provides funding for research and development work for minimizing the generation of wastes produced at it's nuclear facilities. This work encompasses a wide range of activities oriented towards, avoiding the generation of waste, changing processes or operations to reduce waste, converting TRU waste into LLW by sorting or decontamination, reducing volumes through operations such as incineration or compaction. As a consequence of the variety of research and development work that can be undertaken to minimize waste, a need arose to develop a systematic method for evaluation and comparing tasks for possible funding. Therefore, a decision analysis technique was developed for task selection using an electronic worksheet software package written in LOTUS 123.

The decision analysis technique consists of dividing the task into four categories:

- Cost/Benefit
- Level of Development
- Resource Availability
- Concurrence of Management and DOE

Each of these categories is then further divided into individual attributes, thus developing an "attribute tree". The subsequent analysis using the electronic worksheet will be described in detail for ranking and comparing tasks. Theprinciple benefits of the system are that it allows for the simultaneous evaluation of objective and subjective criteria and it allows for repeatable and defendable results.This decision analysis technique has also been applied to the Comprehensive Environmental Assessment and Response Program (CEARP) at Los Alamos National Laboratory. In this application, the technique was used to help evaluate and prioritize buried waste sites for remedial action. Evaluation was done on the basis of four technical criteria:

- Source Mobilization
- Public Accessibility
- Occupational hazard
- Source Term Mobilization

The results were ranking lists of waste sites from highest to lowest priority for further investigations. The Los Alamos application is expandable to include subjective criteria as well.

BACKGROUND

The Department of Energy (DOE) has made policy for reducing the volume of transuranic (TRU) waste produced at its facilities. This policy is declared in DOE Order 5820.2, "Technical and administrative controls shall be directed towards reducing the gross volume of TRU waste generated and the amount of radioactivity in such waste." Funding for tasks directed towards compliance with the DOE directive is administered through the Defense Transuranic Waste Program (DTWP).

Prior to 1987 there was no systematic method being used to prioritize Reduced Waste Generation (RWG) tasks for funding. Task selection was done on an arbitrary and subjective basis with little or no actual research into the

benefits, if any, by the task. In FY87 it was decided to develop a systematic method of evaluating and comparing RWG tasks.

Since each cubic meter of waste costs a certain amount of money to process transport and dispose of, the reduction of waste being generated is translatable into dollars. From there, performing a simple cost/benefits analysis on each task and comparing the payback times of the different tasks would be a simple way of objectively prioritizing tasks.

However, other factors such as technical risk, manpower availability, and the level of project planning can enter into the decision process. Also, factors such as the costs/benefits ration are fairly objective in nature while the other criteria listed are subjective in nature. If a method for systematically prioritizing tasks were to be developed it would have to be able to evaluate a task by means of both the objective and subjective criteria. The best method for handling both types of criteria is the use of decision analysis with weighted scoring.

Decision analysis itself is nothing new. Decision analysis consists of comparing two or more items of interest by scoring each item in terms of various attributes. In this case the items of interest are RWG tasks. Usually the item is divided into two or more categories with each category being divided into one or more attributes. This division of the item into categories and attributes forms what is commonly known as an attribute tree with the attributes analagous to the twigs and the categories the branches.

Scoring an attribute can be done on a straight scaler basis such as the old classic "rate this from one to ten" for subjective criteria. For objective criteria which can be reduced to a numerical value the value itself can be the score.

Each attribute has associated with itself an attribute weight. The attribute weight denotes relative importance of that attribute compared to others within the same category. For example, of attribute A is perceived as twice as significant as attribute B then A would have a weight twice that of B. Usually the weights within a category are set so that the sum of the weights is always equal to one. The categories are also given weights to denote their importance relative to each other.

For the analysis of RWG tasks a decision analysis system known as the Reduced Waste Generation Electronic Worksheet (RWGEW) was developed using LOTUS 123 as a "language". The RWGEW enables up to 20 RWG tasks to be analyzed simultaneously with output in both graphical and tabular form. For RWG task evaluation four categories were chosen; Costs/Benefits, Level of Technical Development, Resources, and Management.

Costs/Benefits

The Costs/Benefits category consists of just one attribute -the cost/benefit ratio. The Costs aspect consists of the total annual funding for the task from start to finish. This includes Research and Development, Pilot Plant, Implementation, Facilities, and Other.

The savings incurred from reducing the volume of TRU waste produced is regarded as the Benefits aspect of the task. The costs of processing, packaging, certifying, and shipping the waste per cubic meter are listed on a site-specific basis. The total of these costs is multiplied by the number of cubic meters of TRU waste expected to be eliminated by the task. Combining that product with any other incidental annual costs results in the annual operational cost savings.

Dividing the total task cost by the operational cost savings gives a quotient with units of years. That quotient is the number of years it will for the annual savings to equal the task cost referred to as the payback time. (This calculation is done assuming 0% interest.)

To score the task a number is chosen by the user which is the maximum payback time allowable. (I.e. if a task takes longer than this amount of time to payback it's total cost the task is regarded as completely undesirable in that category.) If the payback time is less than or equal to one year the score is 100%. Between one year and the maximum payback time the score is figured between zero and 100% on a linear basis.

Level Of Technical Development

The Level of Technical Development category also consists of only one attribute. A task that is only at the theoretical stage of development has a relatively large amount of technical risk associated with it. A task that has already proved itself by means of a pilot plant operation or similar means and is ready for full-scale implementation has a relatively low amount of technical risk. Scoring is done by choosing one of four levels;

1) Theoretical

2) Bench

3) Pilot

4) Pre-Implementation

Choosing Theoretical gives a score of 25% and Pre-Implementation gives a score of 100%.

Resources

The Resources category has four attributes;

1) Manpower Required

2) Equipment Availability

3) Work Area/Glovebox Availability

4) Support Services Availability

Each of these categories is scored on the basis of 0-100% on the basis of their particular availability. If all of the manpower required is currently available than the score for that attribute would be 100%.

Management

The management category consists of two attributes:

1) Acceptance of Management/Operations and DOE

2) Logical Plan for Task Accomplishment

The acceptance attribute is scored on the basis of Yes or No giving 100% and 0% respectively. The logical plan attribute is rated as Inadequate, Adequate, or Excellent giving scores of 0%, 50% and 100% respectively.

The management category is the best example of a subjective criteria and how such a criteria is scored.

Weights

As described earlier, each attribute is given an associated weight to signify its importance relative to other attributes in the same category. In the case of the Costs/Benefits and Level of Technical Development categories, since there is only one attribute their weights are one. Each category also has a category weight in the same manner as the attribute weights.

No specific permanent weights are assigned to the attributes or the categories allowing the operator to designate what he or she feels is important.

Use Of The Electronic Worksheet

The RWGEW was used to evaluate RWG tasks for funding for Fiscal Year 1987. A total of seven tasks were evaluated. The results of the evaluation was used as input to the Reduced Waste Generation Technical Work Plan published in May 1987. The tasks that were evaluated are as follows:

1) RWG-National Working Group

2) RFP HEPA Filter Implementation

3) RFP Equipment/Materials Replacement

4) RHO TRUEX

5) INEL PREPP Volume Reduction

6) RFP Immobilization Improvement

7) LANL Assay/Sort at Source

Evaluation of the tasks was done by researching the necessary information to place in the RWGEW. Information on funding levels was obtained by reviewing FTPAs for then current FY87 funding requests as well as future funding estimates. Information was also obtained through telephone contact with the respective task managers at the various DOE sites. Information on previous funding levels was primarily obtained through telephone conversations. Along with funding levels, operational costs at each site also had to be determined to know what benefits might be received.

Technical information such as the level of technical development was obtained from the history, if any, of the task as well as descriptions given in the FTPAs. Information pertaining to resource availability and management questions were also obtained in similar manner.

Results of the FY87 task evaluation was supplied as input for the "Reduced Waste Generation Technical Work Plan" published in May 1987. The input scores for the tasks in summary as well as the results are given on the next few pages (See Table I). The stacked bar chart shown in Fig. 1 is the final ranking of the FY87 tasks produced by the RWGEW. Examination of the stacked bar chart shows how tasks weaknesses and strengths in different areas affected its position relative to other tasks.

Los Alamos National Laboratory

The same technique has been applied to the prioritization of waste sites at Los Alamos National Laboratory under their Comprehensive Environmental Assessment and Response program (CEARP). Los Alamos has within its boundaries a large number of buried hazardous waste sites, up to 350 individual sites. These sites have been organised into 28 individual site groupings for the purpose of prioritization. In this case prioritization concerns centered on which sites needed to be investigated for possible remedial action first.

The categories for the evaluation of the sites were technical in nature. The categories chosen were:

1) Source Mobilization

2) Public Accessability

3) Occupational Hazard

4) Source Term Mobilization

The decision analysis technique was modified from it's standard form for the Los Alamos task. Each group of sites had within it a group of subsites, each of which was scored on a 1-10 type scale. Each score level was given an associated weight, the subsite scores then being multiplied by their respective weights and added. From this the site-groups were ranked from 1 to 28 within each category, 28

being the number of site-groups. The rank that a site-group held for a category was then used as that site-groups category score. Multiplying by the category weights and summing gave their final prioritization of the site-groups.

TABLE I

FY87 Task Scoring

Table 1 FY87 Task Scoring

Name:	TASK 1 NWG	TASK 2 HPA	TASK 3 EMR
COSTS/BENEFITS			
Weight: 0.550			
Total Task Costs:	$0.00	$505,000.00	$455,000.00
Annual Benefits:	$0.00	$140,000.00	$553,000.00
Payback Time:	<1	3.607	0.823
Weighted Score:	0.550	0.192	0.550
TECH. DEVELOPMENT			
Weight: 0.150			
Input (1-4):	0.000	4.000	4.000
Weighted Score:	0.150	0.150	0.150
RESOURCES			
Weight: 0.150			
Manpower:	0.000	100.000	100.000
Work Area/ Gloveboxes:	0.000	100.000	100.000
Equipment:	0.000	100.000	100.000
Services:	0.000	100.000	100.000
Score:	0.150	0.150	0.150
MANAGEMENT			
Weight: 0.150			
DOE Support:	0.000	2.000	2.000
Logical Plan:	0.000	3.000	2.000
Score:	0.150	0.150	0.113

NWG -- National Working Group

HPA -- HEPA Filter Implementation RFP/AL

EMR -- Equipment/Materials Replacement RFP/AL

Name:	TASK 4 TRX	TASK 5 PRP
COSTS/BENEFITS		
Weight: 0.550		
Total Task Costs:	$10,130,000.00	$500,000.00
Annual Benefits:	$279,998,800.00	$355,000.00
Payback Time:	0.036	1.408
Weighted Score:	0.550	0.494
TECH. DEVELOPMENT		
Weight: 0.150		
Input (1-4):	2.000	2.000
Weighted Score:	0.075	0.075
RESOURCES		
Weight: 0.150		
Manpower:	0.000	50.000
Work Area/ Gloveboxes:	0.000	50.000
Equipment:	0.000	50.000
Services:	0.000	50.000
Score:	0.000	0.075
MANAGEMENT		
Weight: 0.150		
DOE Support:	1.500	2.000
Logical Plan:	2.000	3.000
Score:	0.075	0.150

TRX -- TRUEX Process RL/RHO (Now Westinghouse)

PRP -- PREPP ID/EG&G

TABLE I (CON'T)

Name:	TASK 6 IMI	TASK 7 A/S
COSTS/BENEFITS		
Weight: 0.550		
Total Task Costs:	$1,830,000.00	$865,000.00
Annual Benefits:	$700,000.00	$0.00
Payback Time:	2.614	<1
Weighted Score:	0.328	0.550
TECH. DEVELOPMENT		
Weight: 0.150		
Input (1-4):	2.000	1.000
Weighted Score:	0.075	0.038
RESOURCES		
Weight: 0.150		
Manpower:	50.000	100.000
Work Area/ Gloveboxes:	50.000	100.000
Equipment:	50.000	100.000
Services:	50.000	100.000
Score:	0.075	0.150
MANAGEMENT		
Weight: 0.150		
DOE Support:	1.500	2.000
Logical Plan:	1.000	2.000
Score:	0.038	0.113

IMI -- Immobilization Improvement RFP/AL

A/S -- Assay/Sort at Source LANL/AL

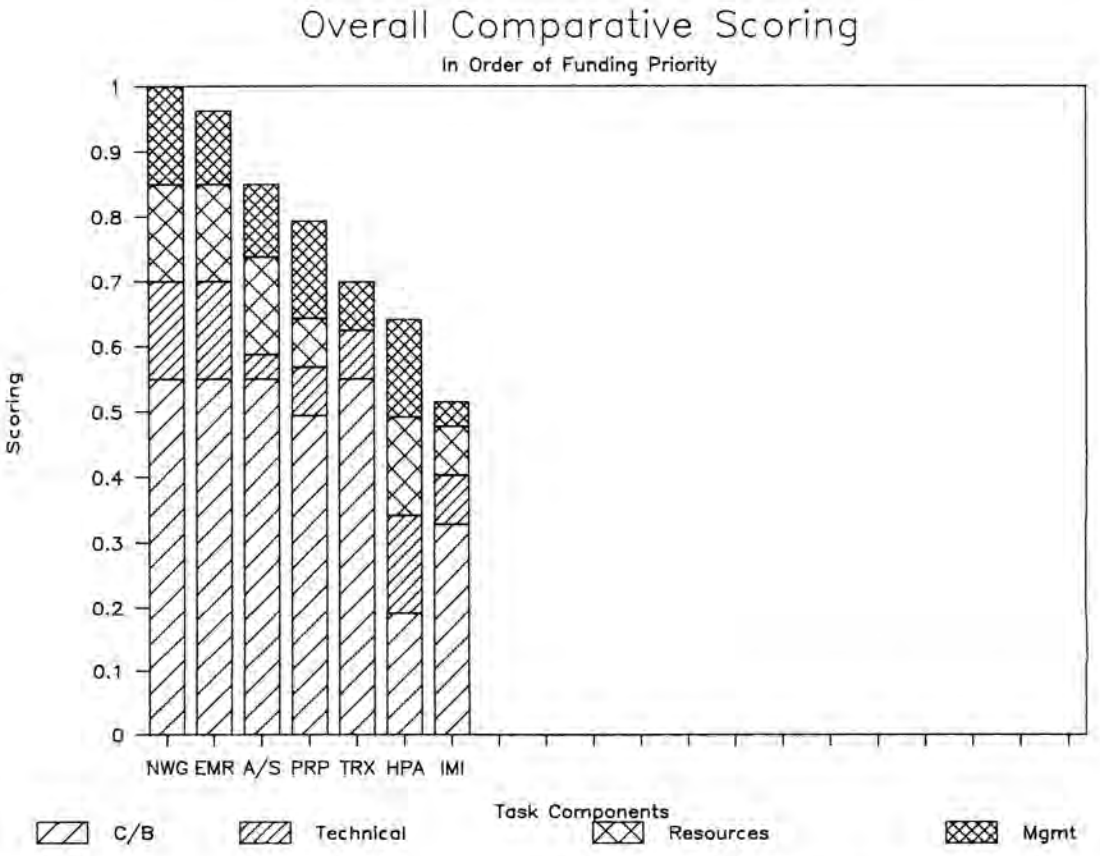

Fig. 1. Final Ranking of the FY87 Tasks Produced by the RWGEW.