GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. _____

Project No. G-34-803 (T5094-2A1) GTRC/~~GIT~~ XXXX DATE 4 / 24 / 85

Project Director: A. D. Van Nostrand Misc School/~~Lab~~ XXXX English

Sponsor: Alfred P. Sloan Foundation

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Sponsor Amount: This Change Total to Date

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ADMINISTRATIVE DATA

OCA Contact Ralph Grede x4820

1) Sponsor Technical Contact:

Dr. James D. Koerner
Alfred P. Sloan Foundation
630 Fifth Avenue
New York, NY 10111
212/582-0450

2) Sponsor Admin/Contractual Matters:

Mr. Stewart Campbell
Alfred P. Sloan Foundation
630 Fifth Avenue
New York, NY 10111

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RESTRICTIONS

See Attached _____ Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with GIT - However no equipment is proposed.

COMMENTS:

Continuation of G-34-802. Overhead rate fixed @ 15%.

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GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 10/16/86

Project No. G-34-803 School/Lab English

Includes Subproject No.(s) N/A

Project Director(s) A. D. Van Nostrand GTRC /GIT

Sponsor Alfred P. Sloan Foundation

Title RETLA Extension

Effective Completion Date: 7/31/86 (Performance) 8/31/86 (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [x] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
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- [ ] Other

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Readings for Decision Analysis in Ethics

#1 Ethical Decision Making: Three Theories
by Stan Carpenter

#2 The Decision Tree Technique
by Robert T. Francoeur

#3 Decision Analysis
by Ray Treadway

Reading #1:

Ethical Decision Making: Three Theories

by

Stan Carpenter

Professor of Philosophy
Georgia Institute of Technology
Atlanta, Georgia

Overview

Utilitarianism

Contractarianism

Libertarianism

Readings for Decision Analysis in Ethics

This module is designed to show you that decisions affecting groups of people can be arrived at by using systematic decision procedures. The purpose of this portion of the module is to demonstrate that hidden assumptions may be present when people try to decide on the best course of action. The assumptions that we are particularly interested in examining are those that reflect concerns about actions that we consider to be right or good.

When assumptions about right and good are included in the decision-making process, a new dimension is added to the discussion, a dimension that is ethical in character. The philosophical topic that focuses upon this dimension is thus called "ethics." Ethical presuppositions reflect concerns about what we believe one ought to do on grounds other than convenience. In fact, ethical beliefs may lead us to take actions which we find neither convenient nor personally pleasurable. Ethical concerns are likely to introduce into the discussion concerns about fairness or about "greatest good for the greatest number of people." We may also hear calls to do one's duty or to respect certain rights of others in making our decisions.

There are three ethical approaches to decision-making that we wish to discuss in the present context. Each approach has significant numbers of supporters and is likely to be found influencing events that you may encounter any time you listen to the news or read the paper. In practice, however, these approaches are usually not specifically identified, either because the decision-maker is not completely clear about the factors she/he considers crucial to the decision or because it seems less controversial to leave these ethical starting points unstated. Philosophers take it to be their business to identify the unstated, to ferret out the assumptions for examination and criticism. It is their belief that you as a decision-maker are better equipped to make a "rational" decision if the factors of the decision are known, stated and examined.

The three positions we wish to examine are utilitarianism, contractarianism, and libertarianism. Each emphasizes certain factors which it considers most important. The goal of this portion of the module is to provide you with enough familiarity with each of these positions to enable you to adopt it as you play the role of decision-maker in the simulation game contained in this module. What follows are thumbnail sketches of the three ethical theories you will employ in your role playing.

Utilitarianism

Utilitarianism bases decisions affecting groups of people on the amount of utility that would result from an anticipated course of action. The term "utility" was used by the founder of Utilitarianism, Jeremy Bentham (1748-1832) to refer to pleasure. Bentham held that an action was right that led to a surplus of pleasure over pain and wrong when pain outweighed pleasure. Bentham believed that it was possible to quantify pleasures and pains. He even provided a system for doing this which he called a "felicific calculus." (Lest we think this sounds hopelessly naive, it may be noted that something like this is attempted each time decision-makers use the modern tool called "cost/benefit analysis.") While Bentham believed that pleasure and pain was to be calculated on an individual basis, he did argue that a pleasure that extended to several individuals was preferable to that experienced by one individual only. All other things being equal, therefore, that action was best that provided the greatest pleasure for the greatest number of persons.

Bentham's most famous pupil was John Stuart Mill (1806-1873). Mill broadened the meaning of "utility" beyond considerations of mere quantity of pleasure. Qualitative differences of pleasure must be included in one's calculations. Mill thought that there would be times when it was right that humans ought themselves to forego pleasure if the good of the group would be increased by the act. Acts of heroism or self-sacrifice would fit into this category. It is better, he believed, to be a Socrates dissatisfied than a pig satisfied.

Mill applied his "altruistic" utilitarianism to the study of economics. Utilitarianism continues to play a crucial role in the thinking of contemporary economists. What has happened with the passage of time, however, has been a gradual redefinition of "utility" from an emphasis upon pleasure to considerations of human preferences in general. Humans are considered to be preference maximizers or satisficers (rather than simple pleasure seekers or pain avoiders). A decision is considered to be rational that leads to the greatest realization of preferences for the greatest number of persons that will be affected by the decision.

The ideal decision or policy recommendation would be that one that produced more satisfaction than any other decision for all of the persons involved. Since such a possibility is rare in a world where resources are limited--there are usually both winners and losers when a public decision is reached--modern utility theory dictates that an action is justified if it can be shown to increase the total or aggregate utility, or preference satisfaction, over other contemplated actions or over taking no action at all.

We will now introduce a formula that shows how a utilitarian would be led to take action based on utility theory.

Suppose for simplicity that an action is contemplated that will affect two groups of people. Call the first group "a" and the second group "b." With no action taken, group "a" has a set of utilities expressed as Ua and group "b" has a set of utilities expressed as Ub. If the proposed action were taken, group "a" would have a new utility of Ua' and group "b" would have a new utility of Ub'. The question is: Should the action be taken? The answer dictated by utilitarian theory is:

(1) If (Ua' + Ub') > (Ua + Ub),
then the action should be taken.

Another way to express this formula is: If the sum of the utilities with the action taken, that is, (Ua' + Ub'), is greater than the sum of the utilities with no action taken, that is, (Ua + Ub), then the action should be taken. According to utilitarian theory, it would be the rational course of action to take.

It should be pointed out that following the utilitarian theory, we would take a course of action that might make someone worse off while the overall level of satisfaction was actually increased. That is, it is possible that (1) is true while, say, Ua' is actually less than Ua. This is considered by anti-utilitarians to be a major problem with the entire utilitarian approach. Can you give examples that support this worry by anti-utilitarians? We will postpone further discussion of utilitarian theory for later and turn to the second theory of decision-making: contractarianism.

Contractarianism

Contractarianism takes its name from a body of political thought called "social contract theory." This theory tries to provide a legitimate basis for government itself by outlining what actions a government should take, including such actions as the making of laws, the levying of taxes, or the implementation of policy decisions. It holds that the citizens of a nation should be viewed as participants in a contract. Each citizen upholds her/his end of the contract by fulfilling the duties of citizenship, obeying the laws, respecting the rights of other citizens, etc. The nation, usually referred to as the State, fulfills its end of the contract by protecting the citizen from loss of life, liberty or personal property. The citizen is said to possess a "right" to these things.

Social contract theory does not usually claim that citizens of a country actually sign a piece of paper called a contract. The social contract is considered to be "hypothetical." Given this "what if" character to the contract itself, contractarians ask the following questions: What if the citizens of a country did set down to devise a contract that was to govern their actions and to dictate the policies of the government they would establish? What would this contract be like?

The philosopher John Rawls provides an answer to this question in his famous work entitled A Theory of Justice (1971). Rawls asks us to engage in the following thought experiment:

Imagine a bargaining game in which you are a participant with a number of other people (in fact, the very people that are trying to set up a nation according to a social contract). Now, suppose further that neither you nor any of the other participants of the game is aware of her/his own personal characteristics, social position, or position in history. That is, you don't know if you are rich or poor, intelligent or dull, handsome or homely, aristocrat or plebeian, medieval or modern. You are thus to consider that your bargaining is to take place behind what Rawls calls a "veil of ignorance." Given these conditions, how would you reason in the bargaining game? What would be the central elements of the social contract that you would set up?

Rawls argues that each person would see it as in her/his own best interest to devise as fair a system as possible, that is, a system that provides for the weak and limits the power of the strong. "After all," you would say to yourself, "it might turn out, when the veil of ignorance is lifted, that I am one of the weak members of the society. Thus it is in my best interests to devise a system that would provide for me in such an eventuality." Rawls believes that it is apparent that all participants would reason conservatively against just such an eventuality. In doing so they would be led to devise a contract for society that was just and fair.

What, then, would be the general outlines of that contract? These Rawls provides in his "general conception of justice." First of all the contract would be egalitarian. That is, we would opt for a system that had as much equality of liberty, income, and opportunity as was possible. Secondly, we would conclude that inequalities that did exist would only be tolerated if it could be shown to be to everyone's advantage to do so.

Rawls is next led, by a discussion we will not trace here, to his "special conception of justice." The result of our bargaining game will produce two principles of justice with the first taking precedence over the second.

Principle One. As extensive a system of equal liberty as is possible.

Principle Two. A guarantee of equality of opportunity with any inequality tolerated only if the least advantaged benefits the most.

Please note that application of principle two clearly distinguishes contractarianism from utilitarianism. Utilitarianism would allow a redistribution of benefits if the resulting total utility is increased in the process, even if the redistribution hurts the weakest member of the society. Contractarian theory, on the other hand, would regard such a redistribution as intolerable.

We can now create a formula for contractarianism as we did for utilitarianism above. Whereas in the case of utilitarianism we were concerned only with the end result of a greater total utility, we are limited by contractarian considerations to special patterns of utility. (This is what is meant by a "patterned distribution function.")

Consider again a universe of two groups "a" and "b". If Ua is the current distribution of benefits to group "a", and Ub is that for group "b", we can take action to change these distributions only if the following conditions prevail.

(1) $(Ua' + Ub') > (Ua + Ub)$

and

(2) $\max \min (Ua' + Ub')$, such that, if $Ua < Ub$ increase until

$Ua' = Ub$, or conversely if $Ub < Ua$.

Another way to express this formula is: Take no action that does not increase the total utility of the system, but take those actions that increase total utility only if they benefit most the least well off of the population. It can be seen that following Rawls' system would contribute to a narrowing of inequalities among the population. No system that produced a greater total amount of utility at the expense of the least well off would be tolerated.

Libertarianism

An alternative body of political thought to contractarianism is known as "libertarianism." Like both contractarianism and utilitarianism, this position claims to provide an ethical basis for making decisions that will affect groups of people. Unlike both contractarianism and utilitarianism which call for significant action by the government to implement public policy decisions, libertarianism minimizes the role of government. It argues that the members of a society should be "at liberty" to engage in the business of producing goods and services with an absolute minimum of interference by the government. In fact, the role of the State is likened by libertarians to that of a "nightwatchman." The State, or government, somewhat like the nightwatchman, should protect every citizen from theft, force, and fraud.

The most famous advocate of libertarianism is the philosopher Robert Nozick. He argues that it is not the business of the government to redistribute wealth that has been created by the enterprise of some individual or class of individuals. The role of the government is not to take positive action which provides citizens with benefits that they have not earned, and therefore, according to libertarianism, do not deserve. To the contrary the government must see that the rightful rewards of achievement are not taken away. The emphasis upon protection from the removal of rights, rather than positive promotion of rights, explains why Nozick's position is called a "negative rights" argument.

According to libertarianism, an action or policy is a good one if it makes someone or some group better off without making any other individual or group worse off in the process. It should be pointed out that what is considered as "worse off" for this position is much more narrowly interpreted than would be the case with either utilitarianism or contractarianism. For libertarianism, an action which redistributed wealth in favor of the wealthy would not, in general, be considered an example of making someone worse off even though it most probably would be considered so by both contractarianism and utilitarianism. At times it seems libertarianism is disposed to limit the phrase "worse off" to actions which cause serious bodily harm or death.

Keeping in mind the narrowness of the concept of "worse off," the libertarian formula for utility of an action is as follows:

(1) If $Ua' >= Ua$ and $Ub' >= Ub$, then the action should be taken.

Another way to express this formula is: If the policy being considered either improves the status and condition of "a" or does not worsen it, and at the same time either improves the status and condition of "b" or does not worsen it, then it is rational to take this action." Recall that "a" and "b" stand for individuals <u>or</u> groups, and further that while we have described the formula in terms of only two persons or groups of persons, we are not limited to this. The formulas can be applied to large groups with the principles remaining the same.

Reading #2:

The Decision Tree Technique

by

Robert T. Francoeur

Overview

A Sample Decision Tree

Completion of the Decision Tree

Analyzing the Decision Tree and Coming to a Decision

Using the Decision Tree with your Case Study

From: Biomedical Ethics: A Guide to Decision Making
by Robert T. Francoeur. Chapter 10: "The Decision Tree Technique," pp. 119-125.

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(Letter to Helen R. Trobian, December 16, 1985)

CHAPTER 10
THE DECISION TREE TECHNIQUE

In making decisions, most people try in some informal way to weigh the alternatives open to them based on their expected immediate or short-term results. The decision tree format, commonly used in business management, has an advantage because it structures and makes explicit some elements in the decision process that are implicit but not often examined carefully in less structured techniques. In a decision tree you draw a picture to visualize three important factors. As a first step you identify the alternatives. Then you assign probability estimates to the events associated with each alternative. Finally, you calculate the pay-off, or consequences, for each combination of a decision or action and its immediate results. When you finish you have what looks very much like a tree lying on its side, with branches spreading out to the right from a single trunk or starting point on the left.

Each branching point in the tree represents one of two kinds of points, or nodes, indicated by a square or circle. The starting point where you make a decision or act is represented by a small square with branches to the right listing all the relevant decisions or actions you might take. Only two alternatives are given for the example used here, to medicate or not to medicate. But, as we discovered in Chapter 7, a case may have many alternatives. In this situation, your list of alternatives or possible decisions depends a lot on your creativity, insight, and past experiences. The more creative you are, the more complete your decision tree will be. Also remember that taking no action, as we do in the case here, is a perfectly acceptable alternative.

The second kind of branching point or node, shown as a small circle, indicates the chance events that might follow a particular decision or action. The probability of these individual events is calculated and shown in parentheses. At the far right of the tree, the pay-off or the outcome for each branch will be calculated, taking into account the combination of an action or decision and its immediate consequences (Hill, et al., 1978; Hodgetts, 1979).

A Sample Decision Tree

As an illustration of how one might use a decision tree we can use the decision faced by an 87-year-old invalid widow. Symptoms indicate that she may have an inoperable dormant tumor but it cannot be diagnosed for certain. Ignore the possible tests that you know might be done and accept this hypothetical situation in which there is a 50/50 chance that the original problem, an inoperable dormant tumor, actually exists. The decision is whether or not to prescribe medication to prevent a reactivation of the suspected malignant growth. The medication being considered is effective but has some side effects, which may be minor or serious.

To arrange these possibilities in a decision tree, we start with our initial decision and draw our branches to the right, taking each event in turn. The final arrangement is shown in Figure 10.1.

The decision tree in Figure 10.1 is not complete. There are several possibilities not included, but the two basic alternatives illustrate the method. To complete the decision tree we must add two elements, an assigned value for each outcome and a probability estimate for each event. Then we will be ready to analyze the tree and come to a decision.

Completion of the Decision Tree

Assigning a value to each potential outcome is done on the far right side of the tree. The outcome of a course of action with its series of chance events that result in no further problems can be assigned a value of zero. Any outcome that does not result in this ideal outcome would merit a larger or smaller negative value, depending on how closely the outcome approximates the ideal of no further problem. In this case, if the outcome of a decision is a minor complication from the medication, the value might be set at -1. If the complications are more serious, a value of -2 might be appropriate. If the original serious problem recurs, the outcome could have a value of -3. If the original problem recurs and is complicated by side effects of the medication, we might assign a -4 if side effects are minor and a -5 if they are more serious. The assigned values for each outcome are placed in a circle after the appropriate outcome (Fig. 10.2).

Next we need to estimate the probability of as many events as we can in this tree. To simplify our illustration we can assume that medical research has already been done and we have good statistics to use in filling in the probabilities for each chance event. Table 10.1 lists these probabilities. All of these probabilities have been entered in parentheses in Figure 10.2. If solid probability figures are not available one can estimate the probabilities.

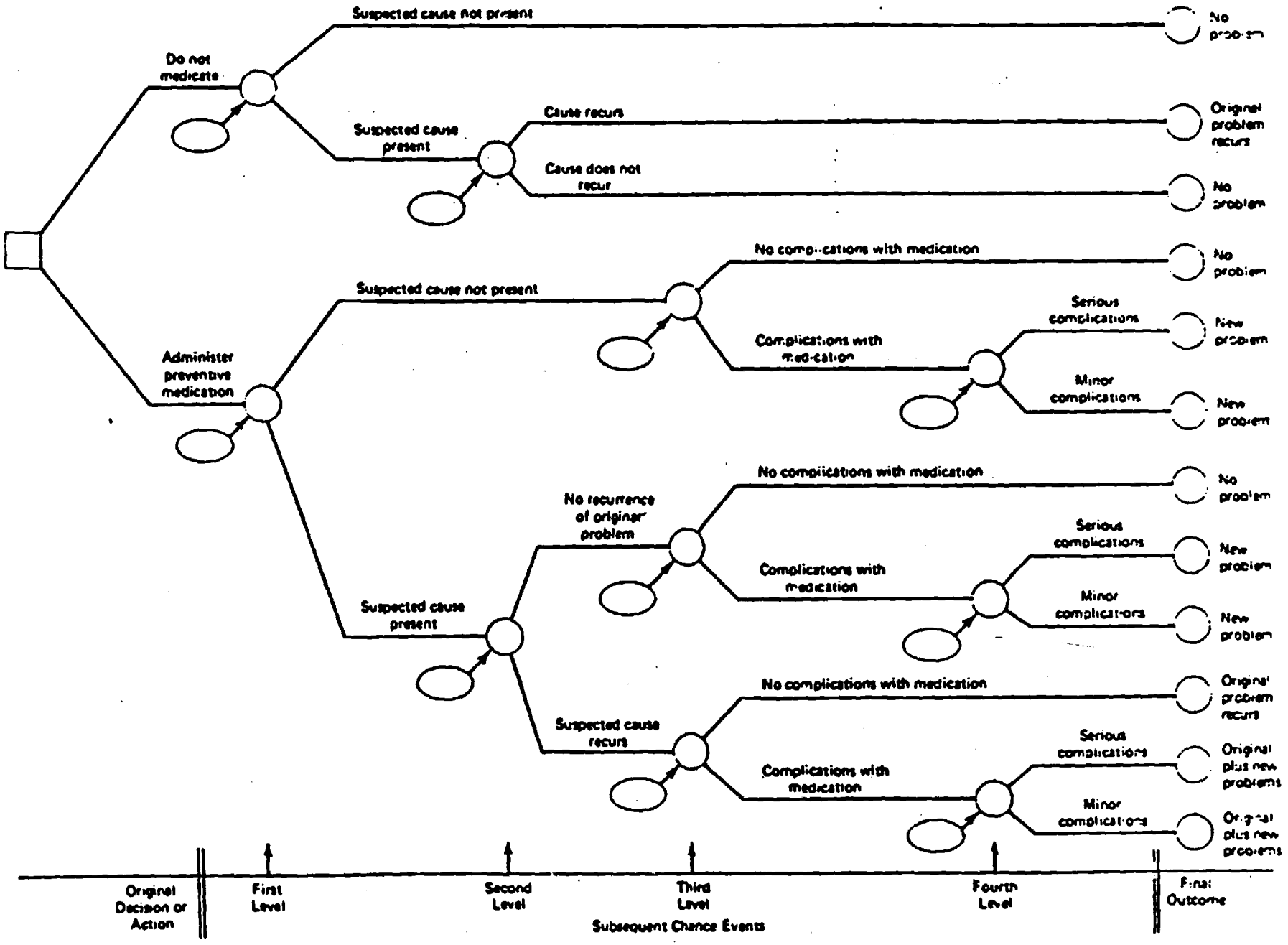


FIGURE 10.1 Decision tree showing the original two decisions or actions considered, their possible or likely consequences (chance events), and final outcomes.

TABLE 10.1 Chance Events and Their Probabilities

Event	Probability (%)	Event	Probability (%)
Tumor is present	50	Tumor is absent	50
Tumor reactivates	35	Tumor remains dormant	65
Medication causes side effects	90	Medication causes no side effects	10
Side effects are major	20	Side effects are minor	80

This step completes construction of our decision tree. Learning to use this diagram is our next task.

Analyzing the Decision Tree and Coming to a Decision

Now we can analyze our statistics to arrive at the optimal decision. We do this by "rolling back" our tree from right to left. Start at the far right bottom in Figure 10.2 with the assigned value for the last outcome, −4. Multiply this figure by the probability of that outcome, 80%: $-4 \times 0.8 = -3.2$. Move to the next line up and multiply the −5 outcome by the 20% probability: $-5 \times 0.2 = -1.0$. Add these two subtotals and you have the *calculated value* for the node leading to these two outcomes: $-3.2 + -1.0 = -4.2$. This calculated value is entered in a circle with an arrow pointing to the node (Fig. 10.3).

The next outcome, moving up the branches on the far right, can be ignored for the moment because it comes from a node on the third level rather than from the fourth level. We will work with it when we roll back to the third level. The next pair of outcomes from a fourth level node gives us the following calculations: $(-1.0 \times 0.80) + (-2 \times 0.20) = -1.2$.

The next outcome stems from the third level and is also ignored for the moment. The next set of calculations is a repeat of the second calculations, yielding a value of −1.2. This completes all the calculated values for the fourth level.

Rolling back to the third level and the bottom node, the figures are $(-4.2 \times 0.9) + (-3 \times 0.1) = -4.08$.

The calculated value for the next node up on the third level is $(-1.2 \times 0.10) + (0 \times 0.1) = -1.08$.

The last calculated value for the third level is a repeat of the one just done: −1.08.

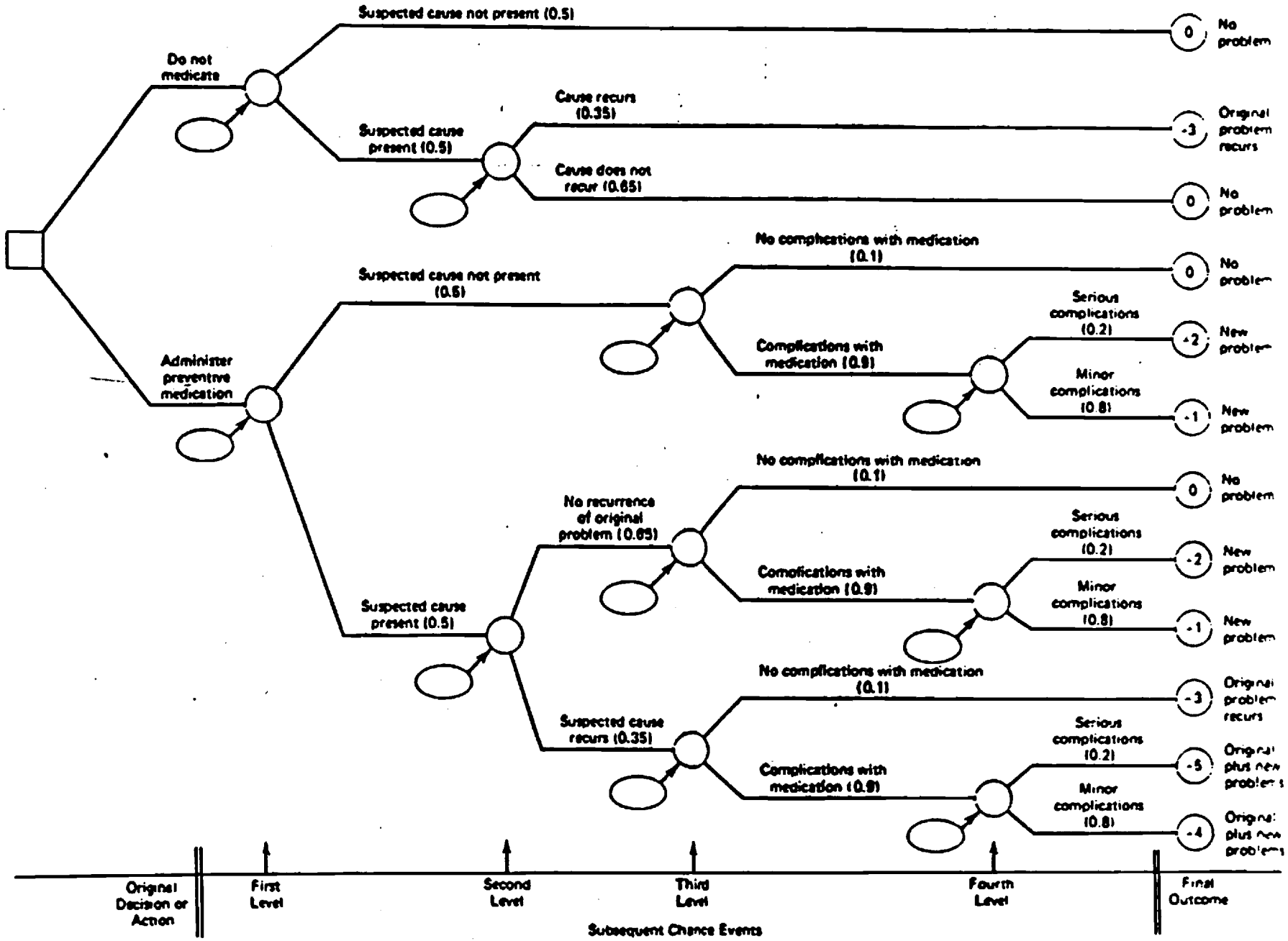


FIGURE 10.2 Same decision tree shown in Figure 10.1, with assigned values listed for each final outcome on the far right and with probability estimates given in parentheses for each chance event.

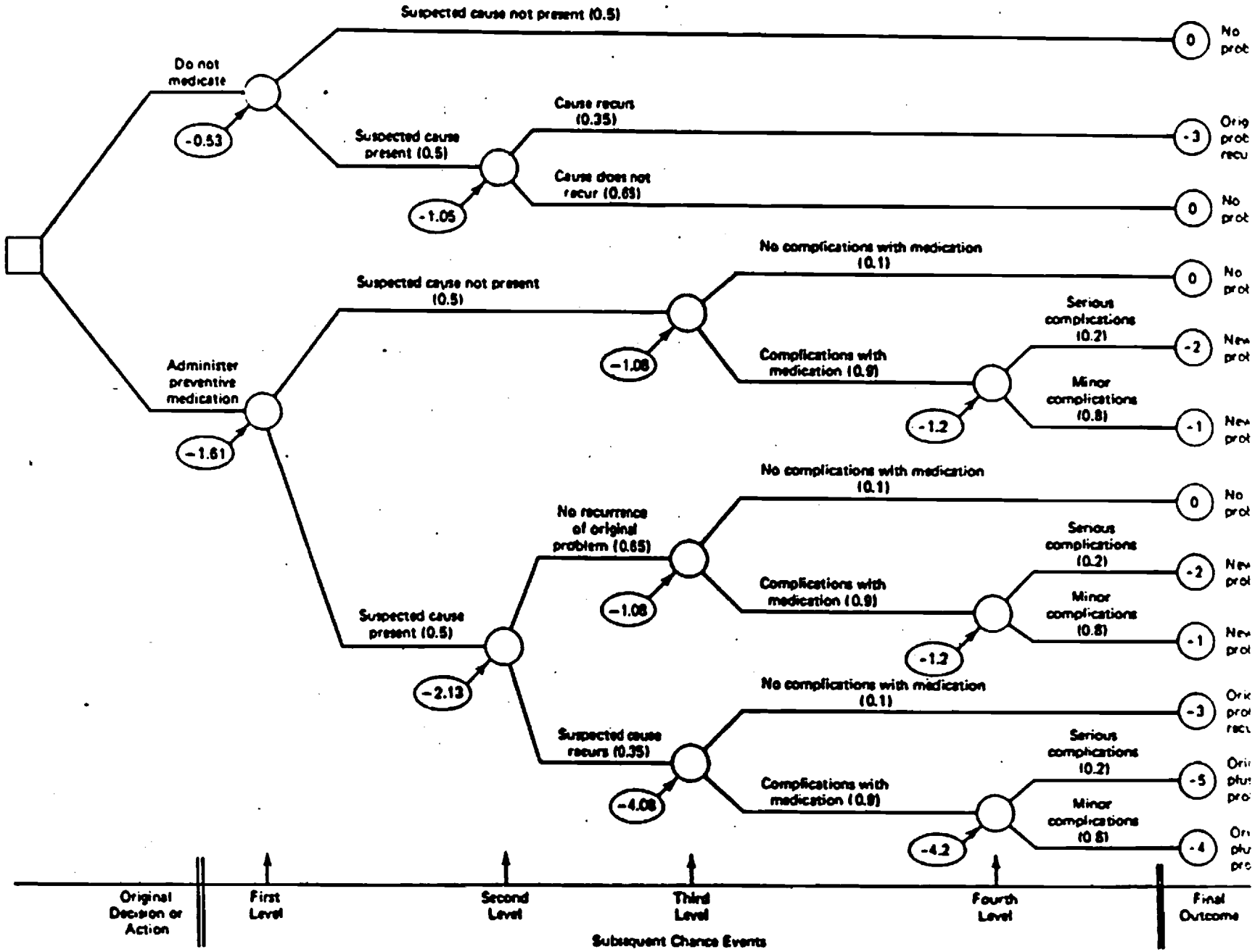


FIGURE 10.3 Completed version of Figure 10.1 decision tree. Calculated values have been worked out for each event node and enter in the oblong boxes with arrow pointing to the event node.

Calculated values for the two nodes on the second level are as follows:

$(-4.08 \times 0.35) + (-1.08 \times 0.65) = -2.13$

$(-3 \times 0.35) + (0 \times 0.65) = -1.05$

Calculated values for the final nodes, on the first level, are as follows:

$(-2.13 \times 0.5) + (-1.08 \times 0.5) = -1.61$

$(-1.05 \times 0.5) + (0 \times 0.5) = -0.53$

The optimal decision revealed by this decision tree is the alternative action with the lowest first level calculated value, in this case a value of -0.53 compared with a calculated value of -1.61. The decision is not to give the preventive medication.

Using the Decision Tree With Your Case Study

Having calculated the optimal ethical decision using the decision tree, you can work through a case of your own or a case assigned to you in class by using the exercise in Part Two.

REFERENCES AND FURTHER READINGS

Hill, P., et al. *Making Decisions: A Multidisciplinary Introduction*. Reading, MA: Addison-Wesley, 1978, pp. 152–176.

Hodgetts, R. *Management Theory, Process, and Practice*. Philadelphia: W.B. Saunders, 1979, pp. 198–202. Introductory texts on business management always contain good illustrations of decision trees and their applications.

Reading #3:

Decision Analysis

by

Ray Treadway

General Overview to Decision Trees

Part I: A Decision Tree

Part II: Probabilities

Part III: Quantitative Values

Part IV: Expected Value

General Overview to Decision Analysis

Decision analysis, or preference theory, is one of the many strategies that can be used as a basis for making decisions, particularly those decisions that involve uncertain events, taking "chances," and value judgments. This strategy requires the use of simple concepts from the theory of probability and a formal quantitative argument. It involves the use of a diagram, called a decision tree, to help you visualize the uncertain events that may occur, the choices to be made, and the relative merits of the possible consequences.

Decision analysis is often used when it is necessary to weigh alternatives in order to make an informed decision so that the "expectation" of desirable outcomes is maximized or the "expected value" of unwanted outcomes is minimized. Because the future cannot be predicted exactly, the probabilities of outcomes, or their likelihood of occurring, must be used. Decision analysis is used often in business decisions, where the numerical values assigned to the outcomes are usually given in terms of profit or loss. Difficult decisions about medical treatments can also be analyzed using the same concepts. Of more difficulty are those decisions which involve moral or ethical questions, since the assessment of preferences of outcomes often rests on individual moral values or philosophical foundations. Nevertheless, undertaking a formal decision analysis can be one of several strategies used to come to a difficult decision.

Decision analysis is useful for several reasons. The precise consequences of the alternatives may not be known, so that uncertainty may influence the outcome of the decision. For example, medical treatment may not always be successful, it may involve unwanted side effects, or it may involve treatment which compromises one's moral values. Also, there may be a clash between conflicting consequences. Cost of an item may have to be balanced with quality or safety. Finally, many situations involve a sequence of possible outcomes, in which the preceding event influences the succeeding one. There may be several choices to make. In short, the decision making process can become quite complicated.

The decision tree technique involves four major ingredients:

1. **A Decision Tree**--a schematic diagram which shows the various possibilities and the relationships between the decisions and possible consequences. This diagram is sometimes called a "decision-flow" diagram.

2. **The Probabilities of Outcomes**--numbers between 0 and 1 inclusive which are assigned when the results of a branch of the tree is determined by chance rather than by choice.

3. **Quantitative Values Assigned to Each Possible Eventual Outcome**--numbers associated with final outcomes based on an objective analysis (that is, profit or loss in business-oriented situations) or subjective analysis (that is, value judgments of the relative merit of the outcomes).

4. **Expected Values for Each Fork**--a numerical value which summarizes the potential "good" or "bad" which can come from each "event" comprising the total situation. These values are in some sense an average "payoff" for each combination of related possible outcomes.

Part I: A Decision Tree

A decision tree is determined by drawing branches (from left to right) to represent alternatives. Each fork represents either choice or chance. Choice forks are determined when the outcomes represented by the branches are the result of a decision, such as choosing to buy a specific product. Chance forks are determined when the outcomes represented by the branches are uncertain, such as the results of a sales campaign or the benefits of a medical treatment. A choice fork is indicated by a square □ , while each chance fork is represented by a circle O . The far right-hand end of each branch of the tree indicates one of the possible "final results" and is represented by the underline __. For ease of analysis, each node, that is, each fork or each final result, is labeled with a number. The numbers increase from left to right on the tree. Figure 1 represents a typical decision tree.

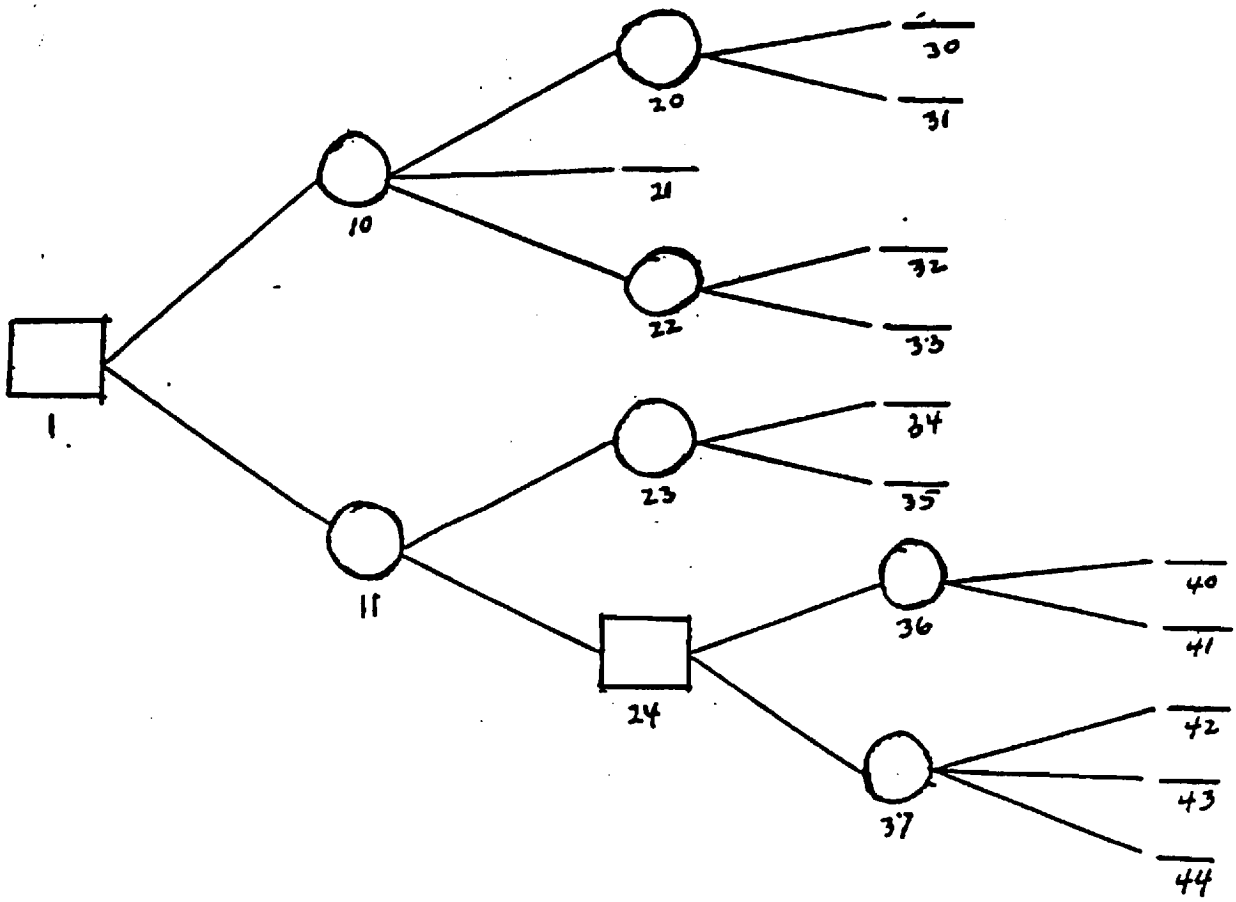


Figure 1: Decision Tree

Part 2: Probabilities

At each chance fork the tree represents the possibility of one or more "outcomes" that can theoretically happen. The totality of the possible outcomes of a given situation is called an experiment. In the theory of probability the collection of possible outcomes is called a sample space. The probability of each outcome is a number between 0 and 1 inclusive such that the sum of all probabilities of outcomes in the experiment is equal to 1. In mathematical symbols, this is summarized by the following:

Let $\{o_1, o_2, o_3, \ldots, o_n\}$ represent the possible outcomes, that is, the sample space, where n is a positive integer. Let o be any outcome. The symbol P(o) represents the probability assigned to o. P satisfies:

<u>Property 1</u> $0 \leqslant P(o) \leqslant 1$ and

<u>Property 2</u> $P(o_1) + P(o_2) + \ldots + P(o_n) = 1.$

It follows that the probabilities assigned to the branches emanating from a single fork of the decision tree must be non-negative, not more than 1, and sum to exactly 1.

Probabilities can be assigned according to one of three schemes, depending on the situation and information available:

(1) **Empirical** (or statistical): This scheme uses the frequency concept of probability, according to which the probability of an event is interpreted as the "proportion of the time that such kind of event will occur in the long run." (Freund, 1970, p. 73). This value is determined by a statistical analysis of similar situations and is subject to estimation based on previous experience.

(2) **Subjective:** Probabilities are assigned to the various outcomes according to how a person may "feel" that the possibilities will take place. Frequently one is asked to consider what sort of chances he/she is willing to take. The strength of one's beliefs regarding uncertainties is evaluated in terms of probabilities. The subjective dimension of this second scheme has been assessed by Freund.

> This method of dealing with uncertainties works nicely (and is certainly justifiable) in situations where there is very little direct evidence, and there may be no choice but to consider collateral (indirect) information, "educated" guesses, and perhaps intuition and other subjective factors. (Freund, p. 75)

(3) **Theoretical:** If every outcome has an equal chance of happening, that is, the outcomes are "equally likely," then the probability of any of the outcomes is defined by:

<u>Property 3</u> $P(o) = 1/\text{number of outcomes}$

For example, the probability of choosing the ace of clubs from a deck of 52 cards is 1/52.

An event is defined to be a subset of the sample space, so an event can contain one or more outcomes, or possibly no outcomes (the empty set), or possibly all the outcomes (the sample space). If E represents an event, then from Property 2, we can derive:

<u>Property 4</u> $$P(E) = \frac{\text{number of outcomes in the event}}{\text{number of outcomes in sample space}}$$

For example, the probability of choosing a heart from a deck of 52 cards is P(Heart) = 13/52 = 1/4.

Two other formulas follow from the properties of probabilities above:

<u>Property 5</u>

If events E and F have no elements in common (that is, they are mutually disjoint), then P(E or F) = P(E) + P(F).

The probability of choosing an ace or a king is
P(Ace or King) = P(Ace) + P(King) = 4/52 + 4/52 = 2/13.

<u>Property 6</u>

If the probability of an event E is known, and E' represents all the outcomes not in E, that is, the complement of E, then
$P(E') = 1 - P(E)$.

This formula comes from observing that if
$E = \{o_1, o_2, o_3, \ldots o_k\}$ where k is a positive integer, and

$E' = \{s_1, s_2, s_3, \ldots s_m\}$ where m is a positive integer,

then every element in the sample space must be either in E or in E', so

$$S = \{o_1, o_2, o_3, \ldots o_k, s_1, s_2, s_3, \ldots s_m\}.$$

S contains k+m outcomes. No element can be in the event E and in E' simultaneously. By Property 2, P(S) = 1, so
$1 = P(E) + P(E')$.
$P(E') = 1 - P(E)$

Figure 2 represents a decision tree with probabilities that are assigned.

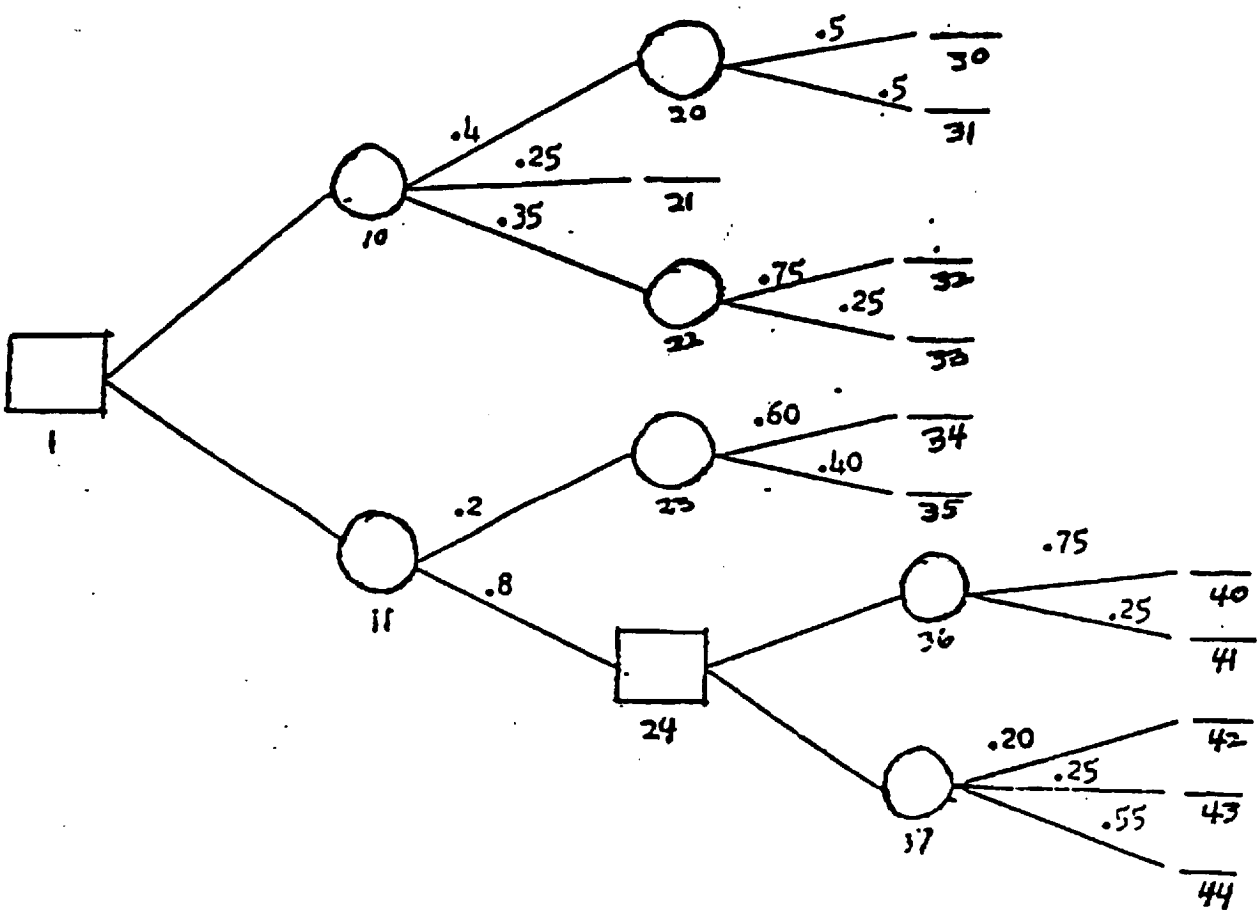


Figure 2: Decision Tree

Part 3: Quantitative Values

For many experiments, numerical values can be assigned to each of the outcomes in the sample space. These values can be assigned on a purely subjective basis or by a more objective analysis. In a business situation, the values or "utility" may be computed or estimated in terms of profits and losses specified in dollars and cents. The values can be amounts won or lost in a game of chance or scores on a test. In other situations an individual can assign values to the outcomes according to a personal sense of preferences, based on comfort, displeasure, inconvenience, complications, or cost. In any case the assignment of numerical values to the outcomes of a sample space is an example of what mathematicians call a "function" and statisticians call a "random variable." The values can be any real number, including fractions and negative numbers.

Example 1

Recent state lotteries have made the headlines by awarding a few lucky persons large amounts of money, while most persons fail to win any amount. Various systems use a combination of digits to determine winners. For simplicity, consider the figures from one of the earliest New York State Lotteries and compute the expected value for a single $0.50 (50 cents) ticket. Suppose 1,000,000 tickets are sold. The prizes given are as follows:

1	$50,000 prize
9	$5,000 prizes
90	$500 prizes
900	$50 prizes

The outcomes and the corresponding values can be given as follows:

Prize	Amount Won
First	$49999.50
Second	4999.50
Third	499.50
Fourth	49.50
No Prize	-0.50

Example 2

Suppose Tonya hears a weather report indicating that there is a chance that it will rain during the day, and she needs to decide whether or not to carry an umbrella.

Situation 1: Tonya has many books to carry, and carrying an umbrella will cause considerable difficulty. However, she obviously doesn't want to get wet. She assigns "inconvenience values" according to a -5 to 5 scale:

Outcomes	Utility Assignments
Umbrella & Rain	+3
Umbrella & No Rain	-5
No Umbrella & Rain	-2
No Umbrella & No Rain	+3

Situation 2: Tonya has to give a class presentation but does not need to carry any books. It is quite important that she not get wet, but carrying an umbrella will be only a slight inconvenience. She assigns utility values differently.

Outcomes	Utility Assignments
Umbrella & Rain	+5
Umbrella & No Rain	-1
No Umbrella & Rain	-5
No Umbrella & No Rain	+1

Decision Trees

With decision trees a numerical value is assigned to each possible final result on the far right side of the tree. Figure 3 represents the sample decision tree with arbitrary values indicated in the numbered spaces on the far right-hand end of each representing a final result.

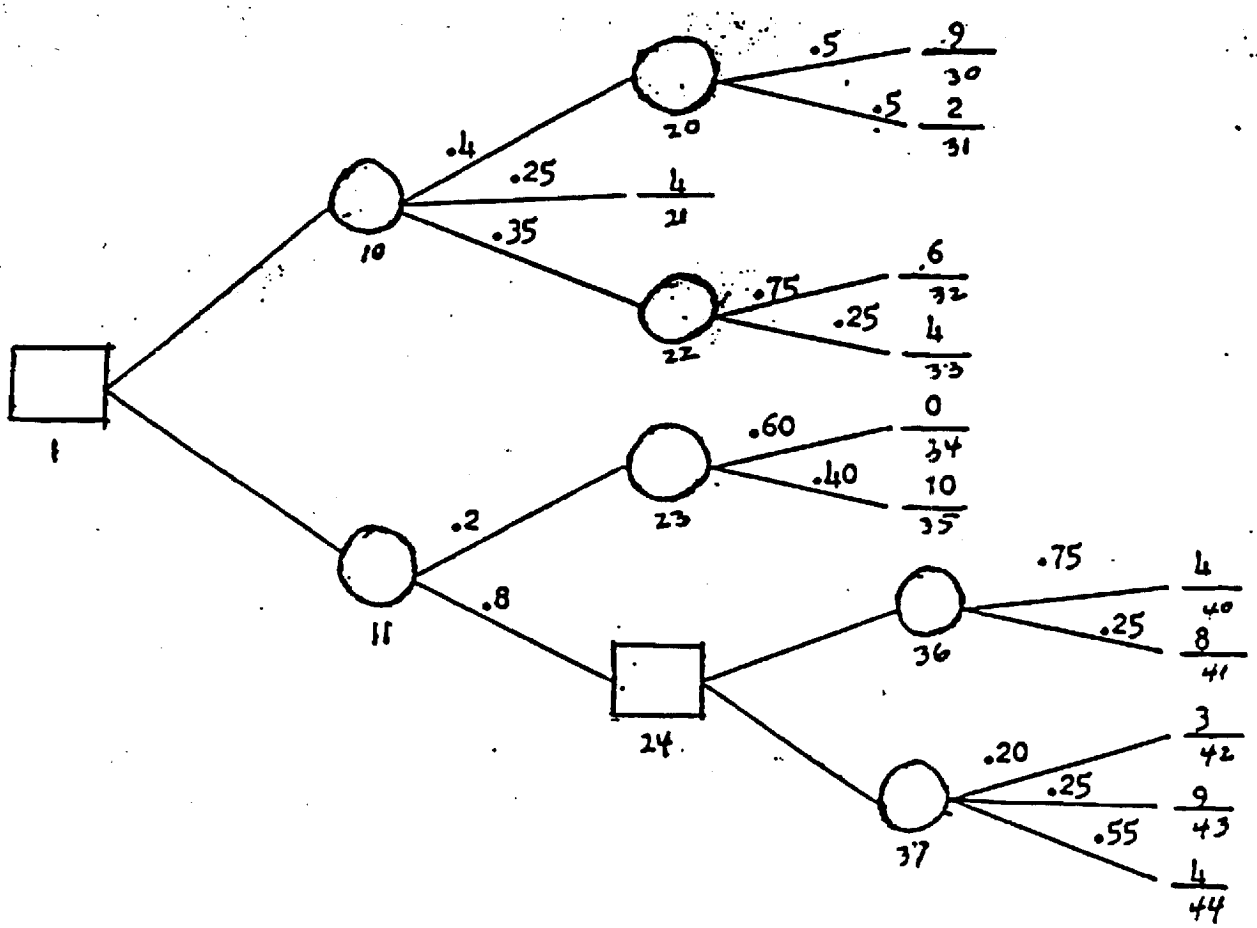


Figure 3: Decision Tree

Part 4: Expected Values

We may now assume that for each of the outcomes in a sample space, a probability and a value have been assigned. The expected value, sometimes called "mathematical expectation," of an experiment represents an "average" value of the entire experiment, based on the relationship between the probabilities and the assigned values in which the outcomes with higher probabilities count more. The expected value is the average outcome in a second sense. If the experiment is "repeated many times independently, the mean value of the outcomes approaches the expected value" (Moore, p. 256). Another way of expressing this is that the expected value is the "certainty equivalent"--a number that can be substituted as a typical representative of the random variable. It turns out that the formula for computing the ordinary average or mean from grouped data is similar to the formula for expected value. The computation for the mean serves to suggest how the expected value can be found in the general case.

Consider the following example of scores on a quiz for eleven students: 8,9,9,8,5,9,8,6,7,7,8. The mean is found by adding the scores and dividing by the number of outcomes (students):

$$\frac{8+9+9+8+5+9+8+6+7+7+8}{11} = \frac{84}{11} = 7\frac{7}{11}$$

An alternative approach would be to group the scores and use multiplication as repeated addition, e.g. 8+8+8+8 = 4 x 8 = 32.

Score (Values)	Frequency	Frequency x Score
5	1	5
6	1	6
7	2	14
8	4	32
9	3	27
Sum	11	84

The mean is given by $\frac{1x5 + 1x6 + 2x7 + 4x8 + 3x9}{11} = \frac{84}{11} = 7\frac{7}{11}$

We can rewrite this expression as

$$\text{mean} = \frac{1}{11} \times 5 + \frac{1}{11} \times 6 + \frac{2}{11} \times 7 + \frac{4}{11} \times 7 + \frac{4}{11} \times 8 + \frac{3}{11} \times 9$$

Note that $\frac{1}{11}$, $\frac{1}{11}$, $\frac{2}{11}$, $\frac{4}{11}$, and $\frac{3}{11}$ are the probabilities of getting the scores 5, 6, 7, 8, and 9 respectively, since each student has an equal chance of being selected as an outcome. Hence, this can be written as:

$$\text{mean} = P(5) \times 5 + P(6) \times 6 + (7) \times 7 + (8) \times 8 + P(9) \times 9$$

In tabular form this becomes

Score (Value)	Probabilities	Prob x Value
5	1/11	5/11
6	1/11	6/11
7	2/11	14/11
8	4/11	32/11
9	3/11	27/11
Sum	11/11	84/11

This example can be written in symbols:

Sample Space = $o_1, o_2, o_3, \ldots o_n$

Respective Probabilities = $p_1, p_2, p_3, \ldots p_n$

Respective Values = $v_1, v_2, v_3, \ldots v_n$

Expected Value = $p_1v_1 + p_2v_2 + p_3v_3 + \ldots + p_nv_n$

This formula makes sense even if the probabilities are not equally likely, as long as the sum of the p_i's is 1. Hence, it is taken as the definition. Usually it is convenient to present the information in tabular form:

Outcome	Probability	Value	Prob x Value
o_1	p_1	v_1	p_1v_1
o_2	p_2	v_2	p_2v_2
o_3	p_3	v_3	p_3v_3
⋮	⋮	⋮	⋮
o_n	p_n	v_n	p_nv_n
Sum	1		Expected Value

Example 1

Consider the New York State Lottery problem in the previous section. The following table indicates how you can find the expected value of the amount won, taking into consideration the cost of the lottery ticket. The cost of the ticket is 50 cents; 1,000,000 tickets are sold.

Prize	Amount Won	Probability	Amount x Probability
First	49999.50	$\frac{1}{1,000,000}$	.0499995
Second	4999.50	$\frac{9}{1,000,000}$	.0449955
Third	499.50	$\frac{90}{1,000,000}$	.044955
Fourth	49.50	$\frac{900}{1,000,000}$	.04455
No Prize	-0.50	$\frac{999000}{1,000,000}$	-0.4995
Sum		1	-0.315

Rounded to the nearest hundredth, the expected value for the lottery is -0.32, that is, a loss of 32 cents for every 50 cents spent.

Example 2

Consider the decisions that Tonya must make about carrying an umbrella (p. 9 of this reading). Suppose that the official probability that it will rain is 70%. We have the following analysis:

Situation 1

Carry an Umbrella

Outcomes	Probabilities	Values	Product
Rain	.70	4	2.80
No Rain	.30	-5	-1.50
Sum	1.00		1.30

Do Not Carry an Umbrella

Outcomes	Probabilities	Values	Product
Rain	.70	-2	-1.40
No Rain	.30	3	.90
Sum	1.00		-0.50

The expected value for "carrying an umbrella" is 1.30, while the expected value for "not carrying an umbrella" is -0.50. Therefore, Tonya should decide to carry an umbrella, given the situation, her values, and the probability of rain.

If the official probability of rain changes, then it is possible that the optimal decision will change. For example, suppose that the official probability that it will rain is only 20%. We have the following analysis:

Situation 2

Carry an Umbrella

Outcomes	Probabilities	Values	Product
Rain	.20	4	0.80
No Rain	.80	-5	-4.00
Sum	1.00		-3.20

Do Not Carry an Umbrella

Outcomes	Probabilities	Values	Product
Rain	.20	-2	-0.40
No Rain	.80	3	2.40
Sum	1.00		2.00

Hence, the expected value for "carrying an umbrella" is -3.20 while the expected value for "not carrying an umbrella" is 2.00. Based on the low probability of rain and the inconvenience of having to take an umbrella, Tonya should decide to maximize the "utility value" by choosing not to take an umbrella.

There are three important properties of expected value which can be used to calculate expected values.

Let the sample space be: $s = o_1, o_2, \ldots o_n$

Let the corresponding probabilities be: $p_1, p_2, \ldots p_n$

<u>Property 1</u>. The expected value of a constant random variable is the constant value.

Let the value assigned to each outcome be the constant c. That is, if X stands for the random variable, then $X(0_i) = c$ for each $i = 1, 2, \ldots, n$.

Then the expected value $= cp_1 + cp_2 + \ldots + cp_n$

$= c\,(p_1 + p_2 + \ldots p_n)$ by the distributive law

$= c\,(1)$ since the sum of the probabilities is 1

$= c$

<u>Property 2</u>. The expected value of the sum of two random variables is the sum of the expected values of each of the random variables.

Let X be a function which assigns values to the outcomes as $x_1, x_2, \ldots x_n$.

Let Y be another function which assigns values to the outcomes as $y_1, y_2, \ldots y_n$.

Let Z be the function which adds the two values together. That is, $z_i = x_i + y_i$ for each $i = 1, 2, \ldots n$.

Then we have the expected value of z:

$$= (x_1 + y_1)p_1 + (x_2 + y_2)p_2 + \ldots + (x_n + y_n)p_n$$

$$= (x_1p_1 + y_1p_1) + (x_2p_2 + y_2p_2) + \ldots + (x_np_n + y_np_n)$$

$$= (x_1p_1 + x_2p_2 + \ldots x_np_n) + (y_1p_1 + y_2p_2 + \ldots + y_np_n)$$

= expected value of X + expected value of Y

Property 3. The expected value of a constant times a random variable is the same as the product of the constant times the expected value of the random variable.

Let X be the function which assigns values to the outcomes as x_1, x_2, ...x_n. Let c be a constant value. Let Y be the function which assigns values to the outcomes as cx_1, cx_2, ...cx_n.

Then we have the expected value of Y:

$= cx_1p_1 + cx_2p_2 + \ldots + cx_np_n$

$= c\ (x_1p_1 + x_2p_2 + \ldots + x_np_n)$ by the distributive law

= c (expected value of X)

Example:

In the problem concerning the New York State Lottery, separate the analysis into two parts: the amount paid (call this function X) and the amount received (call this function Y). Then the sum Z = X + Y is the amount actually won.

Outcome	Probability	Amount Won (Y)	Prob x Y
First	.000001	50000.00	.05
Second	.000009	5000.00	.045
Third	.00009	500.00	.045
Fourth	.0009	50.00	.045
No Prize	.999	0.00	0.0
Sum	1.000000		0.185

The random variable X is a constant function since for each outcome, the amount paid is -0.50. By property 1, the expected value of X is -0.50. By property 2, the expected value of Z (the amount won) is the sum of the expected value of X (the amount paid) and the expected value of Y (the amount received), which is -0.50 + 0.185. The result is -0.315, which is the same answer as was computed directly.

Property 4 will be given without proof: the expected value of the expected value is the expected value.

Completion of the Decision Tree Analysis

The final step in the analysis in order to arrive at an optimal decision is to use the decision tree to compute expected values of each of the choice nodes, starting from the "end" or right-hand side of the tree. The branches from each of the nodes represent the outcomes of a sample space, since the probabilities add to 1 and the values are assigned to each branch (outcome). Figure 4 will help you to visualize this step.

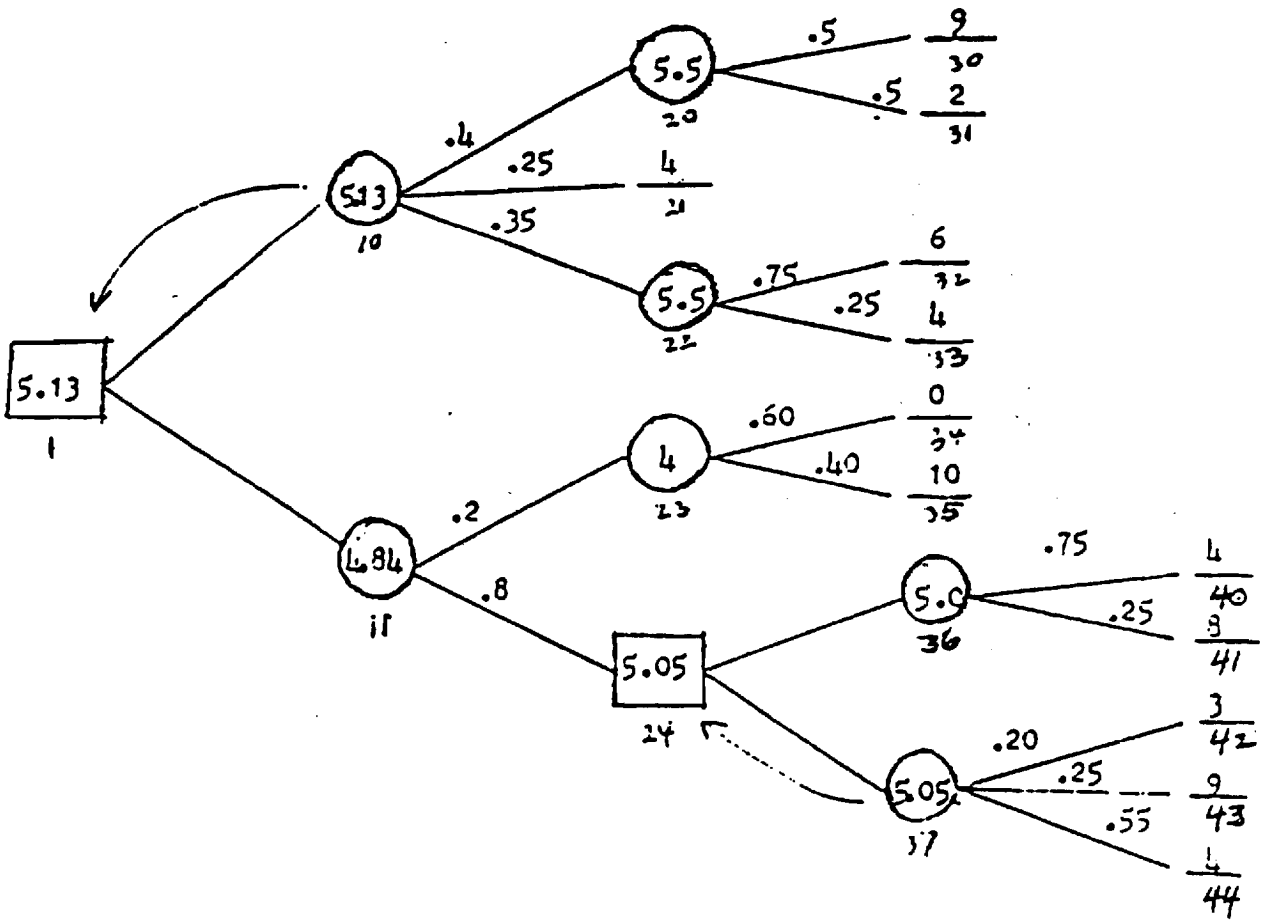


Figure 4: Decision Tree

At the far right in the example, the choice node at circle #36 has an expected value of $p_1 x v_1 + p_2 x v_2 = .75x4 + .25x8 = 5$. The calculated expected value for the choice node at circle #36 is entered inside the circle. The expected value for the choice at #37 is the sum of the probabilities on the branches leading away from the node times the values on the final outcomes represented by the ends of the branches. Hence EV (#37) = .20x3 + .25x9 + .55x4 = 5.5. Continuing in this way, we obtain the expected values for circles #22 and #23 to be 5.5 and 4.0 respectively.

Box #24 represents a <u>choice</u>. If the expected values are to be maximized, the largest of the two <u>connected</u> expected values (5.0 in #36 and 5.05 in #37) is tranferred to box #24. This is shown in Figure 4. On the other hand, if the expected values are to be minimized, the smallest of the connected expected values would be transferred. This analysis indicates which decision should be made at box #24; to maximize the expected value, the branch leading to #37 should be chosen.

All the expected values on the third level have been determined. The expected values on the second level, moving toward the left, are:

EV (#10) = .4x5.5 + .25x4 + .35x5.5 = 5.125

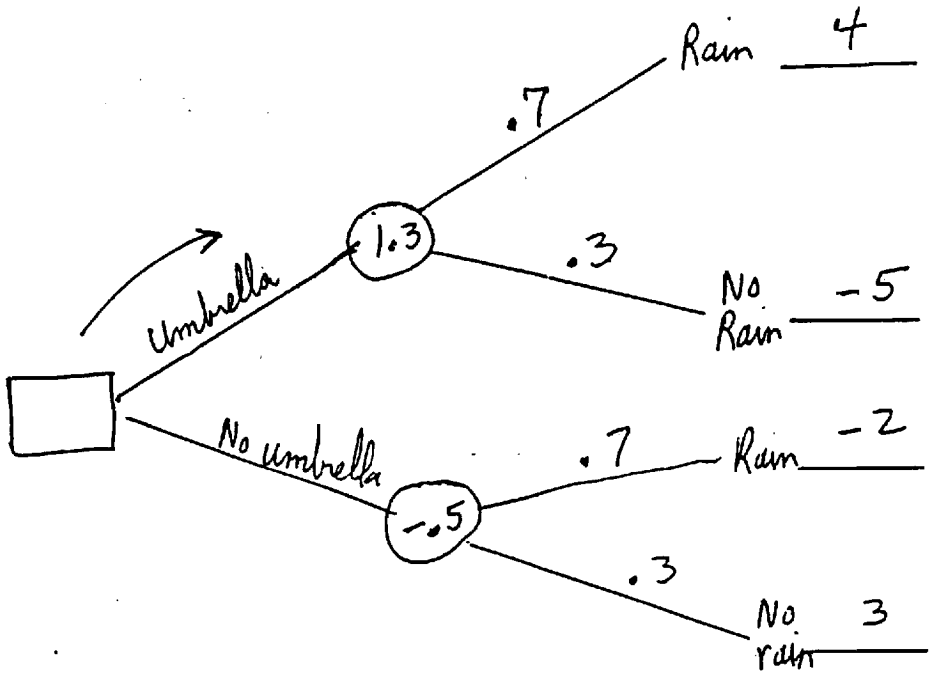
EV (#11) = .2x4 + .8x5.05 = 4.84

Box #1 represents a choice. To maximize the expected value, again we should choose the outcome leading to box #10 with the largest expected value. Hence, the value 5.125 in #10 is transferred to box #1.

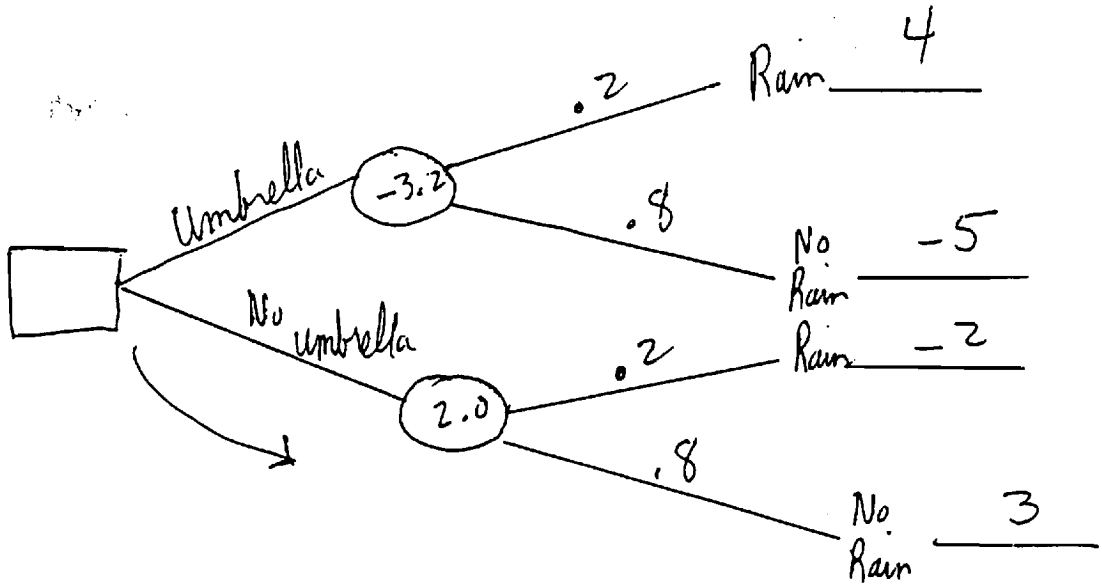
The original decision should be to choose the outcome represented by the branch leading to box #10. Chance will then determine the remaining paths. The decision will maximize the expected value, but chance determines the final result, whether it be the 9 points in node #30, the 2 points in node #31, or some value between 2 and 9. As indicated in the sample tree, some paths may require more than one decision, but the analysis will indicate the choices needed to maximize the expected value at each choice node.

Decision Trees for Umbrella Problem: Example 2
(pp. 14-15)

Situation 1



Situation 2



Hazardous Chemicals, Computer Technology, and Public Policy

by

Kathryn S. Aultman

and

Gilbert L. Rochon

Dillard University
New Orleans, Louisiana

Student Handbook
for an Instructional Module
in Chemistry and Public Policy

Resourceful Exchange: Technology and the Liberal Arts (RETLA)

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Introduction

Hazardous chemicals are widespread in our society. Used in the past as solutions to mankind's problems, both "man-made" substances, such as DDT, eldrin, and dieldrin, and "natural" substances, such as aresenicals, cinnabar, and calomel, have come back to haunt us.

Many of the substances in use today can also harm humans and/or their environment. Nuclear fuels and wastes, crude oil, chlorine used in water treatment facilities, fertilizers, pesticides, and antibiotics have all been shown to cause damage when "spilled" or "leaked" into the environment or used in inappropriate ways.

Science, particularly chemistry, is the body of knowledge on which the use of these chemicals is based. Chemistry not only contributes to the design and implementation of chemical technologies but is also responsible, at least partially, for predicting the impacts of these technologies on society.

Various governmental agencies are responsible for regulating the use of chemicals, their storage by manufacturers, and their disposal as well as for responding to accidental spills. The regulations established by these agencies are based on predictions of the good and bad impacts of the chemicals and on risk-benefit analyses.

One of the tools used by regulatory agencies as well as scientists is the computer. Data bases are used to manage an enormous wealth of information about chemicals, such as the reactions they undergo in the environment, the species which are harmed, and the time required for these chemicals to leave the environment by decomposition.

These data bases can also be used to keep track of pollution incidents which do occur and to look for trends. Mapping, for example, can be done to catalog these incidents and to show, more clearly, the resources available for spill response.

Hazardous Chemicals, Computer Technology, and Public Policy

The module is designed to help you to take a critical look at:

--the nature of hazardous chemicals,

--the circumstances under which chemicals are harmful,

--the regulation of manufacture, transport, use, storage, and disposal of hazardous chemicals,

--the role of chemists in the regulatory process,

--the role of computers in the management of hazardous chemicals and their spills, and

--the limitations of science in predicting the risks of chemical use.

Learning Objectives

After completing this module, you should be able to complete any of the following tasks.

--Define the following terms: chemical, hazard, damage technology, environment, regulation, public policy, and risk-benefit analysis.

--Describe the specific problem of chemical spills in the Mississippi River at the Port of New Orleans in terms of how and why these spills occur, what types of harm can be done, what types of responses can be made, such as mopping up, dispersion, and neutralization, and how these responses can be coordinated.

--Describe the use of the computer in management of these chemicals and the responses to chemical spills. Your response should focus on data bases (both relational and hierarchical), mapping, and the use of the computer to "model" the Port or any other environment and to simulate chemical spills.

--Discuss the relationship among science, technology, hazards, and governmental regulatory agencies.

--Describe the processes by which public policy is formed and used to create specific regulations regarding the management of hazardous chemicals. Your response should answer two questions: who contributes to these processes and who enforces and implements the regulations?

--Describe the types of information on which public policy is based. Your response should answer three questions: who provides this information, what is its accuracy, and what is its reliability?

Dimensions of the Module

This module will occur at intervals throughout the year in the basic course in chemistry. It consists of six sessions, each requiring one hour of class time. Three of these sessions occur during the fall semester; three occur during the spring semester.

Instructional Formats

Lecture/discussion--4 hours
Demonstration--1 hour
Discussion--1 hour

Preparation for Session 1

Prior to Session 1, read the following two texts:

Carson, Rachel. Silent Spring. Boston, Ma.: Houghton Mifflin, 1962.

Graham, Frank. Since Silent Spring. Boston, Ma.: Houghton Mifflin, 1970.

Session 1

Brief Summary of Activities

Session 1 includes a brief introduction to chemicals, as they are popularly defined, hazards, hazardous chemicals, and chemical spills. It also includes a description of the environmental context in which these things exist.

Classroom Presentation

Your instructor begins the presentation by describing the environment in which we live in terms of its physical, chemical, and biological characteristics. Emphasis is placed on the relationships among these characteristics, including carbon, nitrogen and energy cycles, the food chain, and the concept of an ecological niche.

The second half of the presentation focuses on the hazardous chemicals described by Rachel Carson and the circumstances surrounding the damage they caused.

Classroom Discussion

You participate in a discussion of the changes which have taken place since Silent Spring was written and its role in initiating these changes. This discussion will specifically include the following questions:

--Is DDT used today? Are halogenated hydrocarbons used today? Is their use carried out in the same way, or are there new restrictions?

Classroom Discussion (continued)

--Has any alternative method of pest control described in Carson's book been tried? Was it successful? Can you describe the attempts?

--Is the general public's current awareness of the hazards posed by chemicals different from the general public's awareness in the early 1960s?

Assignments

Reading

Read the following article:

"The Computer and the River: A Spillage Response System for the Port of New Orleans," by Gilbert L. Rochon, Musa Eubanks, Carroll Wiltz and Lionel C. McIntyre, 1984, in Urban Resources, 2:N01-N04.

Preparing for a Quiz

Throughout this module, prepare for an unannounced quiz by taking careful notes on reading, lectures, discussions and demonstrations. This quiz, which may occur during any of the lecture sessions, will represent a portion of the module grade.

Assignment Deadlines

Complete the reading assignment before Session 2.

Continue to review the materials in the module for the unannounced quiz.

Session 2

Brief Summary of Activities

The presentation covers the issues of hazardous chemical management, focusing specifically on who is hurt by these substances, why these substances are used, and what must be done to regulate them.

Classroom Presentation and Discussion

Your instructor presents an overview of marine pollution in the United States. This overview includes discussion of the dimensions of the problem for the United States and the Port of New Orleans.

Your instructor also introduces the array of technological tools utilized by emergency response personnel in coping with hazardous chemical spills, focusing on the informational needs of on-scene coordinators and the potential sources of data available to them.

Assignment

Maintaining a Journal

Listen to the radio and television and read newspapers and magazines to find information about chemical spills and pollution. You will need this information to write a term paper about a hazardous chemical.

Assignment Deadline

Continue to search for information until you are ready to write a term paper, which is assigned in Session 3 and is due in Session 4, during spring semester.

Session 3

Brief Summary of Activities

This session includes four demonstrations of the SRIS (Spill Response Information System). Attendance at one of four demonstrations is mandatory, but you should feel free to attend more than one demonstration.

Descriptions of Computer Demonstrations of SRIS

1. Relational Databases

This software integrates user-defined data files with statistical analysis and graphics and communications capability. Databases, developed by a Dillard research team, include historical spill, vessel casualty, regional response personnel, chemical and oil industries, and spill clean-up equipment location.

The specific software package, selected to demonstrate this class of data base management systems, is PC/FOCUS, developed by Information Builders, Inc. Like its mainframe counterpart, FOCUS, the PC version of the software has similar integration possibilities.

2. Hierarchical Databases

The demonstrated system includes files on shoreline use, endangered species habitats, aids to navigation, underwater obstructions, current flows, and port facilities.

This system was developed for the Port of New Orleans Information System by Weyl, Gulbransen and others of the Marine Science Research Center at SUNY, the State University of New York at Stoney Brook.

3. Computer-Assisted Cartography

AUTOCAD includes features such as coded layered maps in three dimensional color on which data pertinent to chemical spill incidents have been entered.

AUTOCAD is a relatively inexpensive CAD package.

4. Laser Video Mapping System

This system is an interactive laser video mapping system that is currently being field tested by Dillard. It permits ikons to be entered on a series of alternative map bases, depicting all of the appropriate locational data in the SRIS.

The system was developed by Perceptronics, Inc. for the U. S. Army Corps of Engineers, FEMA, NOAA, USGS, and the USCG. It uses a SONY laser video player and monitor and an IBM PC/AT with proprietary graphics boards and software.

Classroom Discussion

Having viewed one or more of these demonstrations, you should be aware of the complex nature of spill response and of the information needed to manage the response. You should be prepared to describe one of these systems in detail, including the role of each component of the system in spill response.

Assignments

Maintaining a Journal

Continue gathering information about chemical hazards from the radio, television, newspapers, and magazines for your journal.

Writing a Term Paper

Write a term paper about a hazardous chemical. The paper should consist of five double-spaced, typed pages. The term paper should contain five parts, each conforming to one of the following specifications:

--a description of the nature and properties of the hazardous chemical,

--a description of the damage it does, including the type of damage, the parts of nature which are damaged, either directly or indirectly, and the circumstances under which damage is done,

--a description of the benefits derived from the chemical,

--a summary of the regulations about use of the chemical,

--a personal value judgment about the value of the chemical which answers these two questions: Do the benefits outweigh the risks? Is containment of the hazard cost-effective?

The first four sections of the paper must be based on outside references, but the fifth section reflects your opinion about the value of the chemical. This opinion should be supported or defended within the body of the paper.

Assignment Deadlines

Turn in your term paper in Session 4, during spring semester.

Session 4

Brief Summary of Activities

This session focuses on the generation of public policy and the use of this generated information to compile, implement, and enforce regulations of hazardous chemicals.

Classroom Presentation and Discussion

Your instructor presents specific topics that address management regulations. These regulations are based on specific public policy statements and are created by advisory committees of public governmental agencies.

Your instructor also addresses the legislative authorization for regulatory activity involving hazardous chemicals. Following this presentation, you participate in a discussion on the public policy implications of chemical pollution in the environment. This discussion also takes into consideration the roles of computer-assisted data bases and geographical information systems as tools for public policy formulation and regulatory monitoring.

Assignment

Read the following four articles:

"Science and Its Limits" by Alvin M. Weinberg, 1985, in Issues in Science and Technology, 2:59-73.

"Science and Technology Policy" by George A. Keyworth II, 1985, in Technology Review, 88:44-54.

"Science and the Public Process" by Daniel Yankelovich, 1984, in Issues in Science and Technology, 1:6-15.

"Risk, Science, and Democracy" by William Ruckelshaus, 1985, in Issues in Science and Technology, 1:19-39.

Assignment Deadline

Complete these readings before Session 5.

Session 5

Brief Summary of Activities

This session focuses on the limitations of science as a means of predicting the impacts of technologies and of eliminating risk from society.

Classroom Presentation

Your instructor returns to a discussion of the types of information that are used in the creation, development, production, transportation, use, storage, and disposal of chemicals. Emphasis is placed on the following issues: how that information is obtained, how it is evaluated, and how it is used.

This presentation includes an exploration of the limits of certainty in scientific measurements and the inability of scientists to predict the hazards that a chemical may pose. It also covers the role of values and biases in evaluating risks.

Classroom Discussion

Be prepared to participate in a discussion of a representative technology that has been prominent in the news, such as SDI or MIC production. This technology is considered from the point of view of the research and development chemist, the chemical engineer in charge of production, a chemist on an advisory committee of a regulatory agency (EPA or OSHA, for example), and a chemist consulting with the Coast Guard on cleaning up a spill.

Assignment

Review Carson's Silent Spring.

Assignment Deadline

Complete this review before Session 6, in which you will participate in a discussion of this book.

Session 6

Brief Summary of Activities

In small groups, you and your classmates discuss Silent Spring and the public view of chemical pollution.

Classroom Discussion

Your instructor establishes guidelines for the discussion of chemical pollutants. Be prepared to discuss the problem of chemical pollutants as it existed in 1962, when Carson wrote Silent Spring, the problem as it now exists, and changes which have come about since 1962.

Be prepared also to discuss the conditions we find ourselves in today and the role of individuals in the management of chemicals.

The discussion should help you formulate your own conclusions about the following questions:

--How serious a problem were chemical pollutants in the early 1960s? How serious are they today?

--How have pesticide regulations changed in the 24 years since Carson's book?

--How have these regulations been created? Are they adequate today?

--What level and types of social and individual benefit are needed to justify the following increases in the cancer rate: 1 in 1,000,000, 1 in 10,000, 1 in 100?

--How well can science and government protect society from risks and danger?

--What role, if any, can an individual citizen play in the management of chemical hazards?

Assignment

Review the material in this module before your next hourly exam in this course.

Evaluation

You demonstrate your achievement in this module by:

--taking a quiz on the readings, lectures, discussions, and demonstrations,

--maintaining a journal that contains current reports of hazardous chemicals,

--writing a term paper about a hazardous chemical, and

--answering six test questions (multiple choice, short answer, or essay) based on the learning objectives on page three of this student handbook. These test questions will be administered during the first hourly exam in the course after the completion of this module.

Weighting of the Grade

Activities	Percentage of the Grade
Journal and Quiz	10%
Term Paper	75%
Test Questions	15%

Hazardous Chemicals, Computer Technology, and Public Policy

by

Kathryn S. Aultman

and

Gilbert L. Rochon

Dillard University
New Orleans, Louisiana

Faculty Handbook
for an Instructional Module
in Chemistry and Public Policy

Resourceful Exchange: Technology and the Liberal Arts (RETLA)

1986

Brief Description of the Module

This module encourages students to develop informed opinions about the nature of some particular chemical hazard and to develop an argument for or against its use based on risk/benefit analysis. It helps students understand the process of technology assessment and to synthesize information about hazardous chemicals, their management and regulation, and the roles of various indidividuals in the process.

The module contains three components:

--a student handbook,

--a faculty handbook, and

--a video tape.

To help you make decisions about whether or not this module, or some modification of it, can be implemented in a course you are teaching, this faculty handbook:

--presents a brief overview of the student handbook and

--provides supplementary materials for the instructor.

Overview of the Student Handbook

The student handbook contains the following information:

--an introduction,

--learning objectives,

--dimensions of the module,

--instructional formats,

--descriptions of six sessions, each of which includes the following information:

--brief summary of activities,

--classroom presentation and discussion,

--assignments, and

--assignment deadlines.

See pp. 5-6 of the student handbook for an example of these session descriptions.

In addition, the student handbook describes the evaluation procedure for the module, focusing on what is evaluated and how the items are weighted.

The Faculty Handbook

The faculty handbook presents information about the following subjects:

--the video tape,

--the contents of the session presentations,

--resource faculty and appropriate courses,

--distribution of the sessions,

--space and materials,

--modifications to the module.

Video Tape

The authors of this module have developed a video tape, entitled **Hazardous Chemicals: the Big River.** This tape runs for approximately eight minutes and is available in either VHS or Beta formats. The 3/4 inch master tape is broadcast quality.

In brief, this tape describes a system that entails the use of the computer to organize disparate information. This system has been constructed to assist the U. S. Coast Guard in dealing with hazardous spills. It is composed of four computer programs: a PC FOCUS relational database, a hierarchical database developed at the State University of New York (SUNY) at Stoney Brook, computer assisted cartography, and a laser video mapping system. (For more information about these packages, see pp. 8-9 of the Student Handbook of this module.) Students at Dillard are engaged in the development and maintenance of this system, performing such tasks as identifying sources, creating programs, and inputing.

Instructors can use this tape in one of two ways: as an overview to the module or as a preview of the presentations delivered in Session 3 of the module. As an overview, the tape provides an orientation to the technologies that can help scientists make informed decisions. As a preview to the presentations, it can help students decide which presentation(s) best address(es) their needs. (See the student handbook, pp. 8-9 for a description of this session.)

Contents of the Session Presentations

This module was designed for a course in general chemistry. It focuses on research on waterway pollution control, disaster planning, and emergency management. The examples are derived from Dillard's Urban Port Research Project, under contract with the Office of the Secretary, U. S. Department of Transportation. The U. S. Maritime Administration and the U. S. Coast Guard served as technical representatives to the project.

The following lecture outline should help you to perceive how we integrated information derived from our respective disciplines: chemistry and political science. Presentations I and IV were delivered by the chemistry instructor; presentations II and III were delivered by the political science instructor.

Outline of Presentations

I. Introduction to Hazardous Chemicals

A. Definitions

1. chemical
2. hazard
3. environment
4. policy
5. management
6. pollution

B. Types of Hazards

1. health hazard
2. carcinogen
3. teratogen
4. biohazard
5. species
6. ecological hazard
7. general hazard

C. Types of Chemical Damage

1. damage based on reactions

a. availability (solubility, volatility, etc.)
b. reactivity
c. concentration

Outline of Presentations (continued):

2. damage based on partitioning

    a. oil spills
    b. precipitations

3. ecological balance

D. Uses of Chemicals

1. agriculture (fertilizers, pesticides, herbicides)
2. medicine
3. miscellaneous (plastic, alloys, etc.)

II. Public Policy 1

A. Nature and Extent of the Problem

B. Potential Threat to the Public and Environment

C. Justification for a Strong Public Response

D. Modes of Existing Responses

1. legislation
2. regulation
3. mass organization
4. technological tools

III. Public Policy 2

A. Review of Hazardous Chemical Pollution and Its Implications: Corporate Responsibility and Government Regulation

B. Consideration of Alternative Strategies for Public Policy Related to the Management of Hazardous Chemicals

C. Discussion of Public Policy as It Relates to Technology and Its Use in Ecological Intervention

D. Need for Clarification of Public Values and Political Consciousness Raising with Respect to Environmental Protection

IV. Scientists, Technology Assessment, and the Public

A. Limitations of Science

1. scientific information: error plus confidence
2. deduction vs. induction
3. ability to predict all consequences/impacts

Outline of Presentations (continued):

B. Accessibility and Utility of Scientific Information

1. statistics (The number of scientific articles in **Biochem**, for example, doubles every six months.)
2. huge data bases for information retrieval (Their usefulness depends on indexing.)

C. Role of the Public

1. the people primarily affected
2. input opportunities, such as hearings
3. public pressure groups

Following are brief annotations of this lecure outline.

I: Introduction to Hazardous Chemicals

Nature of the Hazard

This first presentation addresses the nature of the danger that hazardous chemicals pose. It focuses first on chemical definitions, both discipline-related and popular, and a list of the potential physical and chemical properties of chemicals, such as volatility, flammability, and corrosiveness. These definitions and lists are followed by a description of specific hazards, the damage they may cause, and the elements of nature which are susceptible to damage, either directly or indirectly. Finally, a description of the value of these chemicals is presented.

Understanding the material covered in the first presentation, the nature of hazardous chemicals, does not require any specific knowledge of chemistry on the part of the students. While general definitions must be presented, this aspect of the module does not include an exhaustive survey of hazardous chemicals. Instead, it illustrates the complexities and subtle balance of nature and the ways that chemicals can disturb that balance and therefore disrupt it. In addition, this presentation indicates that although hazardous chemicals have the potential to cause harm, society has the potential to minimize that harm by modifying the ways that chemicals are used.

Useful sources of information pertaining to this presentation are two texts:

Carson, Rachel. Silent Spring. Boston, Ma.: Houghton Mifflin, 1962.

Graham, Frank. Since Silent Spring. Boston, Ma.: Houghton Mifflin, 1970.

Specific examples from these texts enliven the discussions of the properties of chemicals, the ways in which they damage the environment (both directly and indirectly), and the uses of chemicals which benefit society. The accounts that students gather for their journals are also useful resources. (For a detailed description of these journals, see the student handbook of this module.)

II: Public Policy 1

Nature and Extent of the Problem

A good source for statistical information on hazardous chemicals and oil spills affecting shorelines and coastal waterways, by type of substance and by state and year, is Polluting Incidents in and Around U. S. Waters, published annually by the U. S. Coast Guard. For inland areas, the Environmental Protection Agency's STORET system is a useful source.

Potential Threat to the Public and Environment

This part of the presentation focuses on the probable environmental and public health threat posed by discharges of those substances most commonly spilled in Louisiana waters. Emphasis is placed on acutely toxic chemicals.

These substances are listed in a quarterly report of hazardous incidents responded to by the New Orleans Fire Department and the PC Focus database on historical spills (1980-1986) developed by Dillard researchers from the files of the 9th Coast Guard District, the USCG Captain of the Port (COTP) and the Marine Safety Officer (MSO) in New Orleans.

Data on the effect of such chemicals is available from several on-line sources, including NDAA, developed by the National Oceanic and Atmospheric Administration, HAZMAT, and such proprietary services as TOXLINE, ENVIROLINE, CHEMTREC, CHRISS, developed by the USCG, OHMTADS and the Chemical Emergency Preparedness Program, published by EPA in November 1985 and available from the EPA in Washington, D. C. 20460. The New Orleans Fire Department also publishes a periodic list of spills to which it responds as do most metropolitan fire departments.

The discussion of the Port of New Orleans could include the following subjects:

--the initial reporting of the spill,

--monitoring of its movement through the river,

--analysis of the environmental segments at risk, such as populations or levees,

--on-site containment,

--evacuation (if necessary),

--public notification about the danger,

--clean up, and

--analysis of the factors which contributed to the accident in the first place.

Justification for a Strong Public Response

This part of the presentation focuses on the role of the public in influencing public policy related to the environment and, more specifically, related to the pollution of waterways by hazardous chemicals and oil spills. Primary emphasis is placed on the rationale for public response to environmental degradation.

Students can identify a variety of sources from their own experiences. The list ranges from moral mandates, both from humanitarian and religious frameworks, political imperatives, based upon ideological positions, and ecological necessity arguments, which emphasize the linkages between plants, animals, and humans and the quality of water and air. Also included are civic responsiblity positions, which center on legislative requirements, corporate responsiblity, and our duty as citizens.

Modes of Existing Responses

This part of the presentation includes discussions of the modes of existing responses and the alternative forms of expression adopted by environmental interest groups. These forms of response to chemical hazards, whether pertaining to land, air, or water, are credible to students in the aftermath of such incidents as Love Canal, Three Mile Island, and, more recently, Chernobyl.

Topics for discusssion include:

--the degree of intensity and the radical nature of the reponses as reflections of the political persuasions of the leadership and the class affiliations and/or vested interests of the groups being organized and

--response styles, ranging from writing letters to congressmen, lobbying for more stringent legislations, and encouraging mass mobilizations, such as the "Clam Shell Alliance."

Excerpts from Saul Alinsky's "Rules for Radicals" also provide useful material for discussion.

Finally, discussion focuses on the role of technological tools in influencing public opinion, as used by the chemical industry, by governmental regulatory agencies, such as NOAA, FEMA, USCG, and the Minerals Managements Service of the U. S. Department of the Interior. References are also made to the use that environmental proponents are beginning to exercise in data base management and geographical informations systems, such as those used by the Sierra Clubs, Audubon Societies, Historical Preservation Trusts, and "Save the Wetlands" groups.

III: Public Policy 2

Review of Hazardous Chemical Pollution and Its Implications: Corporate Responsibility and Government Regulation

The principle group selected for case study during this part of the presentation is the Federal Regional Response Team (RRT) for Region 6. This body is composed of representatives from each of the federal and state agencies that have jurisdiction over hazardous chemical and oil spill response activities. Also included in the membership are representatives of the Chemical Industry Trade Associations. The minutes of a recent meeting of the RRT and reports published by the industry in attempts to self-regulate are described.

Also considered are various pieces of existing legislation that directly affect waterway pollution, such as the Superfund Bill, and acts that have indirect impact on regulation, such as the Magnasen Act, which is overtly concerned with espionage and waterway security, yet sufficiently flexible to permit a Coast Guard Captain of the Port to order a suspect vessel boarded.

Consideration of Alternative Strategies for Public Policy Related to the Management of Hazardous Chemicals

This part of the presentation provides a brief review of the permitting system, now carried out in tandem by a host of local, state, and federal agencies, sometimes conflicting with each other. This review is followed by a discussion of proposals to unify the regulatory responsibility for crucial waterways that are frequently subject to chemical contamination.

Another strategy considered is the isolation of hazardous industries to specified industrial corridors, suitably equipped with adequate storage, processing, disposal, and reclamation facilities, in order to minimize transport distances.

Stiffer penalities for industry offenders and rewards for firms with clean records are also discussed. Major emphasis is placed on involving industry in the planning process with government and appropriate citizen groups.

Public Policy as It Relates to Technology and Its Use in Ecological Intervention

No such policy exists, so the discussion becomes speculative at best; however, the need for understanding state-of-the-art technological applications to human service needs and environmental issues is instructive. This part of the presentation is best delivered in combination with the demonstrations of the various computer databases and mapping systems so that the implications of social computing become more evident. The pitfalls of over reliance upon mechanized monitoring in the absence of clear and well-enforced policy is also emphasized.

Need for Clarification of Values and Political Consciousness Raising with Respect to Environmental Protection

In our judgment, this part of the presentation is crucial because it engenders a forum for introspection on the part of students and encourages them to begin to formulate an enlightened position with respect to the issues raised. The issues are raised in as provocative a manner as possible, with follow-up discussions in the last session of the module.

A useful source of information for Presentations III and IV is:

Sherry, Susan. High Tech and Toxics: A Guide for Local Communities. Washington, D. C.: Conference on Alternative State and Local Policies, 1986.

IV: Scientists, Technology Assessment, and the Public

This presentation focuses on regulations on which management is based, concentrating mainly on how regulations are generated. First addressed are three underlying assumptions: benefits should be maximized, risks should be minimized, and production and use of chemicals should be cost effective. Presentations next address the types of information on which the regulations are based, the policies on which they are based, and an examination of the roles of scientists, industrialists, public regulators and the general public in the process. The presentation concludes the module with an exploration of the limitations of science and scientists in providing the information on which regulations are based. Ideally, this aspect will convey to the students that they have the ability to understand what is happening around them and to influence those happenings.

Resource Faculty and Appropriate Courses

This module is designed for team teaching by a chemist and a political scientist. Courses for which this module would be appropriate are general chemistry, public policy, or any chemistry or social sciences seminar. The seminar format is appropriate because the demonstrations and discussions are conducted in groups no larger than twelve to fifteen students.

Distribution of the Sessions

As currently designed, the module is presented in six sessions which are distributed over two semesters of a year-long course. Three sessions, including two lectures and a demonstration, are followed later in the course by three more sessions, which include two lectures and a discussion. This distribution enables students to use the intervening time between the sessions to compile a journal about hazardous chemicals from accounts in newspapers, in magazines, on radio or on television.

Space and Materials

The demonstrations of hazard management procedures and techniques may take place either inside or outside the classroom. Inside, classroom presentations can be enhanced by the use of filmstrips, videotapes, or computer software. Outside, field trips can provide excellent resources. These trips might include visits to a chemical plant, to a library with access to Hazmat (or some other nationwide chemical database), or to one of the agencies that respond to chemical spills, such as the Coast Guard, EPA, FDA, USDA, or the state health department.

Modifications to the Module

Modifications to adapt this module to other courses include the following:

--the current focus on chemical hazards could be replaced by a focus on another type of hazard, such as physical or biological,

--the scientific discipline could be changed by including a scientist from the appropriate discipline on the team,

--the module could be presented as part of a course in computer applications,

--the four, fifty-minute lectures could be condensed to three, seventy-five minute sessions,

--the sessions could take place within a single semester if the journal assignment were either presented at the beginning of the semester or dropped, or

--the classroom demonstrations could be converted to field trips.

Interfacing Mathematics and Technology with Design and Architecture

by

Lee Ransaw

and

Abiola Lawal

Morris Brown College
Atlanta, Georgia

Student Handbook
for an Instructional Module
in Art and Technology

Resourceful Exchange: Technology and the Liberal Arts

1986

Rationale

This module presents problem-solving tasks that focus on the arch. Completing these tasks requires the integration of knowledge derived from art, mathematics, and technology. When you successfully complete this module, you should be able to proceed with confidence to a similar or more complex task.

This module will:

--provide factual information about the history of art,

--stress the importance of mathematics in art history, and

--define the role of technology in art and mathematics.

Learning Objectives

This module should help you to:

--demonstrate knowledge of the role of architecture in art history,

--demonstrate knowledge of technical problems in mathematics that architects faced during the Gothic and Renaissance periods,

--understand the technological process as it relates to art and mathematics,

--develop a structural vocabulary in art history and mathematics,

--develop basic skills in drawing, measuring, and mathematics,

--construct a simple arch and identify its components, and

--develop your ability to solve problems by applying abstract knowledge derived from art, mathematics, and technology to a project requiring the construction of a three-dimensional arch.

Dimensions of the Module

This module continues for three weeks. It consists of ten sessions, nine requiring fifty minutes of class time and one, a field trip, requiring four hours.

Instructional Formats

Lecture--a portion of six sessions
Drawing Activities--a portion of two sessions
Workshop-two sessions
Field Trip--one session
Seminar in Evaluation--one session

Session 1

Brief Summary of Activities

Your instructor will provide an historical overview of art history during the Roman, Gothic, and Renaissance periods.

Classroom Presentation

Your instructor will focus on the architecture and the architects of each period, reinforcing the lecture with appropriate slides. The presentation will also include a definition of technology and a description of its role in the arts.

Classroom Activities

While listening to the lecture, your aim should be to develop a broad framework of understanding of the art history and technology presented in the lecture. Such understanding will make it easier for you to perform the tasks that will be assigned later in the module.

Instructional Materials

slides of architects and architecture during the Roman, Gothic, and Renaissance periods

Assignments

Reading

Read "The Gothic Style" in Fleming, Art and Ideas, pp. 150-160.

Questions to Guide Reading

What were the major features of Gothic architecture?

Can you explain how Gothic architecture was often based on mathematical proportions?

Oral Reporting

Review principles of design, such as space, line, and form. Be prepared to discuss how height, open walls, and complex linear design are all integrated into a vast system of spiritual forms in Gothic architecture.

Writing

Take notes on the lecture addressing the art history of the Roman, Gothic, and Renaissance periods.

Briefly explain how Brunelleschi (1377-1446) and Bartolommeo (1390-1472) use mathematics in their designs.

Assignment Deadlines

Complete these assignments by Session 2.

Session 2

Brief Summary of Activities

You will take part in a discussion of the lecture delivered during the previous session. Following that discussion, your instructor will lecture on Roman and modern arches. You will then find examples of arches and make a simple sketch of one.

Classroom Presentation

Your instructor will lecture on:

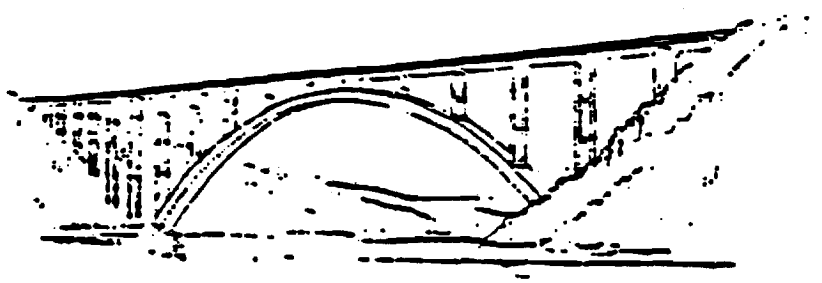
--Roman arches and their construction in masonry and brick, and

--modern arches and their construction in concrete and steel.

Classroom Activities

You will go through magazines in the classroom, find examples of modern arches in bridges, churches, and other structures, and cut out these examples.

You will then make a simple sketch of an arch. Here is an example of such a sketch:



Instructional Materials

magazines
slides and reproductions of Renaissance architecture
drawing paper (8 1/2" x 11")

Assignments

Reading

Read "The Roman Style" in Fleming, Art and Ideas, pp. 85-86 and "The Pantheon" in Salvadori, Why Buildings Stand Up, pp. 230-233.

Questions to Guide Reading

Can you differentiate between the semi-circle and the arch?

What are the distinguishing characteristics of different kinds of arches?

--Why are some bridges made of reinforced concrete and others made of steel?

--Why do some bridges have an arched shape while others are straight?

--Why does one steel bridge have an arch over the roadway while another has an arch below it?

Oral Reporting

Be prepared to discuss the major features of Gothic architecture.

Writing

Take notes on the lecture on Renaissance art and Roman and modern arches.

Assignment Deadlines

Complete these assignments by Session 3.

Session 3

Brief Summary of Activities

Your instructor will lecture on the mechanical analysis of design.

You will take a quiz on Roman, Gothic, and Renaissance architecture. You will also continue your sketch of the arch that you began in Session 2.

Classroom Presentation

Your instructor will help you to build a structural vocabulary by reviewing mathematical terminology, circumference, and geometric terms as well as introducing modular technology.

Classroom Activities

You will perform exercises with the compass, scan magazines, continue your sketch of the arch, and participate in group discussions of the strengths and weaknesses of the drawing designs.

You will also work on the isolation of the arch into geometric forms and the development of lines tangent with circles.

Instructional Materials

diagrams and pictures, compasses, rulers, 6B pencils, tracing paper

Assignments

<u>Reading</u>

Read "Developing a Structural Vocabulary" in Keedy and Bittinger, <u>Essential Mathematics</u>, pp. 190-227.

Questions to Guide Reading

Gothic art as a whole was designed to bridge the gap between matter and spirit, mass and void, natural and supernatural, inspiration and aspiration, finite and the infinite.

Can you explain how harmony, space, form, line and beauty are expressed in the prototype Gothic Cathedrals, such as Chartres, Notre Dame, or Rheims?

Can you define the following terms: volume, sphere, angle, perspective, and force?

Oral Reporting

The Pantheon is the best preserved building from the ancient world and the oldest and most impressive of domed buildings. In many respects this durability is due to the architect's successful mathematical approach to such factors as force, weight, and volume.

You will participate in a discussion of how the Pantheon's geometry is based on the union of the sphere and hemisphere over a circular ground plan.

Writing

Take notes on the lecture.

Assignment Deadlines

Complete these assignments by Session 4.

Session 4

Brief Summary of Activities

Your instructor will deliver a presentation on mathematical calculation. You will take a pre-test on the use of the calculator.

Classroom Presentation

The lecture on how to calculate will address the following:

--measurement: length and perimeter, angle measure, space figure and their measures,

--volume: sphere, cube, and others

--area: circle, square, triangle

--the exponential function: $\exp(x)=y$ if and only if $x=\ln y$

--geometric formulae: $A=lw$, $d=2l+2w=2(l+w)$, $A=(1/2)h(a+b)$,

$$A=(1/2)bh = \frac{bh}{2}$$

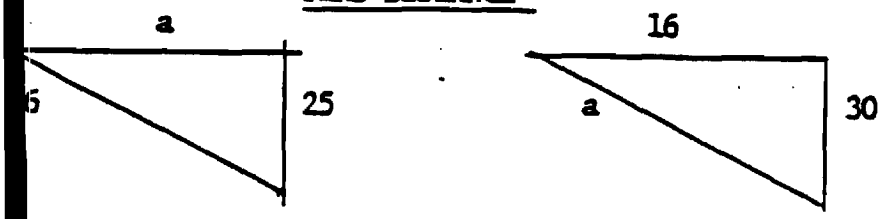
Classroom Activities

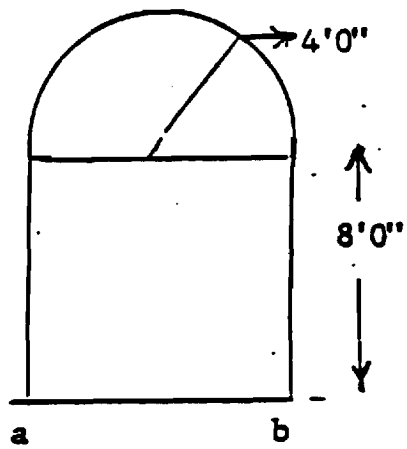
You will draw circles, rectangles, trapezoids, cuboids, and prisms.

You will calculate distance formulae. Your task will be to solve two problems of measurement: the length and the perimeter of a triangle. Here is the formula you will use and the problems you will solve:

istance formula $d(x,y)=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$

FIND DISTANCE





Instructional Materials

calculators

Assignments

Reading

Read "Math Calculations" in Keedy and Bittinger, Essential Mathematics, pp. 148-177.

Questions to Guide Reading

What is the importance of basic geometry in the construction of Roman and modern arches?

Can you define volume, sphere, perspective, strudo, truss, and stiffness?

Oral Reporting

You will be asked to explain why it was necessary for the Roman architects to approach the problem of force and weight in the construction of the dome of the Pantheon by increasing the thickness of the concrete at the base of the dome? (For reference, see Salvadori, p. 223.)

Writing

Take notes on the lecture about how to calculate.

Assignment Deadline

Your assignments should be completed by Session 5.

Session 5

Brief Summary of Activities

Your instructor will lecture on bridges and other forms of arches and present more information on mathematical calculation.

Classroom Presentation

In a lecture on mathematical calculation, your instructor will first explain stress, strain, yield point, force and weight and then discuss this formula:

Young's modulus=E=stress/strain

stress = f/A strain = $\frac{\Delta L}{L}$

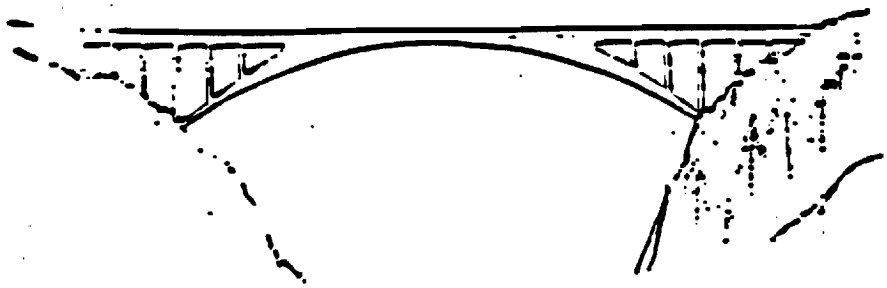
The lecture will also convey information about how to use scale and how to use grafts.

Classroom Activities

After an explanation of one-dimensional and two-dimensional graphs, you will correct grafts and redefine the specification of a masonry arch.

Referring to a study model, you will calculate the dimensions of an arch.

Here is an example of such a model:



At the end of this session, you will take a quiz on the use of the calculator.

Instructional Material

calculators

Assignments

Reading

Read "Mathematics Review" in Keedy and Bittinger, Essential Mathematics, pp. 214-219.

Question to Guide Reading

Possibly the most interesting man-made structural material is reinforced concrete. It can be poured into forms and given any shape suitable to the channeling of loads because it combines the compressive strength of concrete and the tensile strength of steel.

What is the important loading system of the arch in relation to materials, such as steel and concrete?

Oral Reporting

You will be expected to participate in a discussion of how to use the calculator and how to calculate the span of a simple arch.

This discussion will also focus on distance formulae as they relate to two problems in measurement and the breakdown of graphs into key points with detailed dimensions.

Assignment Deadlines

Complete all assignments by Session 6.

Session 6

Brief Summary of Activities

You will become engaged in a two-dimensional, problem-solving task. This task will help you learn how to draw an arch to scale.

Your instructor will briefly present information about the field trip that is scheduled as Session 7 of this module.

Classroom Presentation

You instructor will demonstrate how to create a two-dimensional drawing of an arch, using appropriate materials.

Your instructor will also present information that will guide your field trip, scheduled for the next session. A brief summary of that information appears in Handout #1, included in this handbook on p. 25.

Classroom Activities

You will be expected to take part in a discussion of the lecture presented in Session 5 about how to calculate such items as stress, strain and force, how to use scales, and how to use grafts.

You will then review drawing assignments, gather materials for drawing, practice the use of the calculator for drawing, and examine materials that will be used to build an arch.

Instructional Materials

albiene or clear print tracing paper (11" x 12"), rulers, triangles, compasses, mechanical drawing pencils, erasers

Assignments

Reading

Read "Materials, Tension and Compression," in Salvadori, Why Buildings Stand Up, pp. 59-71 and "Arches and Bridges" in the same text, pp. 144-150.

Questions to Guide Reading

The arch is a curved structure used to span a space between two vertical elements, such as posts (piers) or walls.

Can you define the following terms as they apply to the arch?

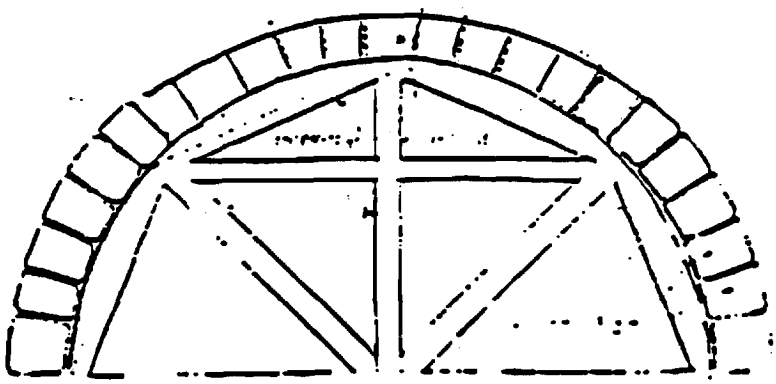
voussoir	key stone	order
barrel vault	bay window	capital
cross vault	segmental arch	colonnade
groin vault	syrian arch	

Oral Reporting

You will be asked to explain how to read scales and how to make graphs.

Art Activity

Given exact dimensions of the keystone of an arch, you are to work as one member of a pair to develop a two-dimensional drawing to scale. Here is a model of such a drawing:



This drawing will later be used to help you construct a three-dimensional form.

Assignment Deadlines

Your two-dimensional drawing is a two-hour task that requires work outside of class. All of your assignments should be complete by Session 8.

Session 7

Brief Summary of Activities

You will gather at 8:00 a.m. to receive whatever additional information you need to guide your field trip. Then you will go on a field trip to specific historic sites in your community that provide examples of arches for study.

Field Trip Activities

You and two other students will travel as a team to develop a report on five different arches on the college campus and in town. Since you will be assigned to a specific area of the city, your team will not duplicate the efforts of another team.

For some information about specific sites that will guide your efforts to develop a report, see Handout #2, Descriptions of Specific Sites, on pp. 26-28 of this handbook.

Instructional Materials

sketch pads, note pads, pencils, erasers, cameras, and film

Assignments

Reading

Your instructor will select readings from The Atlanta Architecture: the Victorian Heritage and from Sawyer and Mathews, The Old in New Atlanta.

Questions to Guide Reading

Since many of the historic buildings have vanished from the Atlanta landscape and others seem to have become lost in the shadows of the great modern buildings of the 1960s and 1970s, it has become extremely important for us to focus our attention on these architectural expressions that have been preserved.

Can you explain why the older buildings that you will view on your field trip are still considered architectural works of art in the 1980s?

What role does the arch play in the overall design of whatever building you choose to study?

Oral Reporting

After you have identified and located five different arches, you are to report on their approximate sizes, stress points, simple functions, composition (materials used), and the qualities of their aesthetic forms.

Assignment Deadline

You will deliver your report in Session 8.

Sessions 8-9

Brief Summary of Activities

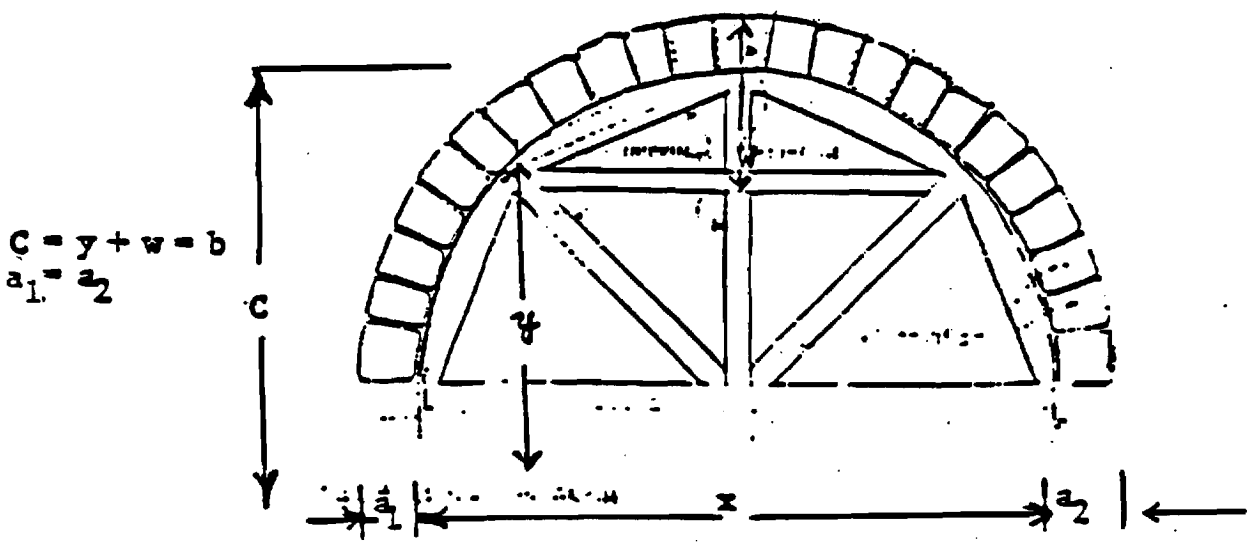
You and your classmates will display slides and drawings of field trip landmarks with arches.

You will also work in pairs to solve an engineering problem: the transfer of a two-dimensional drawing to a three-dimensional arch.

Classroom Presentation

Your instructor will provide specifications for your problem-solving task. Here is a model of those specifications:

Masonry Arch



Classroom Activities

You and your classmates will work in pairs to select materials and to transfer your two-dimensional drawing to a three-dimensional arch.

Instructional Materials

styrofoam sheets (1/2"-1"), mat knives, dowel rods (1/16" to 1/8"), Elmer's glue, cardboard, putty, rulers, compasses, triangles, calculators, pencils, clay

Assignments

Reading

Review all reference materials.

Oral Reporting

Session 8

You will be expected to participate in a discussion of the vocabulary from your glossary on the arch and in a review of all the lectures and readings.

You should be prepared to respond to the following questions:

Why do some bridges have arches above?

Why are some bridges straight?

Why are some bridges made of concrete?

Session 9

You will participate in a discussion of the historic sites you viewed on the field trip.

You should be prepared to respond to the following questions:

Why were the buildings you viewed on the trip preserved?

What were some of the aesthetic qualities of the buildings?

What role did the arch play in the overall design of the building?

Assignment Deadlines

Your assignments should be completed by Session 10.

Session 10

Brief Summary of Activities

You and your classmates will present a visual representation of your arch and an oral report, describing its development.

Evaluation

You will demonstrate your achievement in this module by:

Taking a Pre-Test

This pre-test will assess your use of the calculator.

Taking Two Quizzes

Quiz #1, administered at the beginning of Session 3, will test your understanding of Roman, Gothic, and Renaissance architecture.

Quiz #2, administered at the end of Session 5, will test your understanding of measurement in mathematics, simple geometric formulas, and mathematical calculation.

Constructing a Two-Dimensional Drawing

This assignment includes both a freehand sketch and a technical drawing.

Presenting an Oral Report

This report will demonstrate your knowledge and comprehension of the total problem-solving task.

Constructing a Final Project

The final project entails the completion of activities that lead to the construction of a three-dimensional arch. This process will help you to use the art skills as well as analytical skills that you will have learned during the lectures and discussions.

The process includes the formulation of a concept, the development of an idea, the creation of a simple drawing, as well as more complex tasks, such as calculating volume, spheres, and cuboids.

An evaluation procedure will help you to determine your success at transfering your two-dimensional drawing into a three-dimensional arch.

Weighting of Your Grade

Activities	Percentage of Your Grade
Pre-Test	0%
Two quizzes (20 points each)	40%
Oral Presentation	10%
Two-Dimensional Drawing	10%
Construction of Project	40%
	100%

Bibliography

Fleming, William. Art and Ideas. 6th ed. New York, N.Y.: Holt Rinehart and Winston, 1985. (pp.55-86, 230-233)

Keedy, Mervin L. and Marvin L. Bittinger. Essential Mathematics. 4th ed. Boston, Mass.: Addison-Wesley Publishing Company, 1984. (pp.190-227)

Lial, Margaret L. and Charles D. Miller. Algebra and Trigonometry. 3rd ed. Glenview, Illinois: Scott Foresman and Company, 1984. (pp.62-66, 120-125)

Mainstrone, Roland J. Development in Structural Form. Boston, Mass.: M.I.T. Press, 1982. (Reference)

Richard, Paul S. and Ernest F. Haenasler. Algebra and Trigonometry for College Students. Reston, Va.: Reston Publishing Co. Inc., 1985. (pp. 214-237)

Salvadori, Mario. Why Buildings Stand Up. New York, N. Y.: Mc Graw-Hill, 1980. (pp.59-71, 144-150)

Sawyer, Elizabeth M. and Jane Foster Mathews. The Old in New Atlanta. Atlanta, Ga.: Jems Publications, 1976. (Reference)

Stevenson, Paul. Architectural Illustration: The Value Delineation. New York, N.Y.: Hacker Art Books. (Reference)

Stuger, Russell. Architectural Source Book. New York, N. Y.: Van Nostrand Reinhold Co., Inc., 1984. (Reference)

The Atlanta Architecture--The Victorian Heritage. Atlanta, Ga.: The Atlanta Historical Society, 1976.

Audio Visual Aids

Carousel slide projector and slides of Gothic, Roman, and Renaissance arches

Software

Calculators

Handout #1: Field Trip Information

Excused Absences

Provided that no exams are given in your morning classes, your instructor will issue permits to excuse you from these classes on the day of the field trip.

Transportation

You and your classmates will assemble at 8:00 a.m. in front of Fountain Hall on the morning of the field trip.

Three mini-vans will be available to transport students to sites during the four-hour trip. The driver of each of these vans will have directions and a simplified city map to transport students to four sites during the trip.

Materials Required

Students should bring sketch pads, note pads, pencils, erasers, cameras, and film.

Handouts

Your instructor will call your attention to Handout #2, Descriptions of Specific Sites, on pp. 26-28 of this handbook. This handout should serve as a guide to your field trip.

Handout #2: Descriptions of Specific Sites

1. St. John Lutheran Church--1911
   1410 Ponce de Leon Avenue NE

Three stalwart gables characterize the facade of "Stonehenge," the Gothic, castle-like structure which was built for Samuel H. Venable shortly after he purchased the land in 1912. Constructed with granite from Stone Mountain, the former home also features rusticated chimneys. Several additions to the original house feature various kinds of arches.

2. Big Bethel AME Church--1891
   220 Auburn Avenue NE

Said by old timers to have been rolled to the church site from Stone Mountain, huge blocks of granite characterize this well-known structure on Auburn Avenue. Organized in 1865, the church was remodeled in 1921, after it was gutted by fire. With the exception of the west wall, the walls in the building date from the 1890s. The sign on the church's tower, "Jesus Saves," can be seen from points all over the city. Big Bethel is also known for its pageant, "Heaven Bound," which features Negro spirituals annually in the sanctuary.

3. North Avenue Presbyterian Church--1901
   607 Peachtree Street NE

The Roman architecture of this gray granite church, founded in 1898, features a square tower linked to a smaller circular one by a triple arched vestibule. The vault is dome-shaped, and the memorial windows were designed by Tiffany Studio.

4. 178 15th Street NE--1907

Built in eclectic Victorian style, this structure features three arches across the front and down one side. It is constructed of brick in a warm terra cotta color with decorative stone trim. The multi-leveled roof contains gables and squared-off sections. Built by W. O. Jones as a single family residence, it was turned into four apartments some years ago. The present owners are restoring it to its original function as a single-family dwelling.

5. The Rhodes Mansion--1903-1905
   1516 Peachtree Street NW

Turrets and towers, battlements and cupolas, inspired by Rhineland castles, abound in this castle-like structure of Stone Mountain granite, built for Amos Giles Rhodes, a well-known furniture dealer. The veranda features rounded arches and large stone columns. Hand carved wood work and imported mantels are found in the first floor rooms, each with a different motif. The famous stained glass windows, a memorial to the Confederacy, which once graced this building, have been removed to the Georgia Department of Archives and History on Capitol Avenue.

6. Rockefeller Hall--1884
   Spelman College

Named in honor of the college's benefactor, John D. Rockefeller, this red brick structure with arched doors on the front and side is topped with a cupola, which is set off with a widow's walk, and a quill weathervane. Leaded glass windows at the entrance and fanlights with intricate wood trim are features of this four-story administration building.

7. Graves Hall--1889
   Morehouse College

Its entrance marked with a stone arch supported by marble columns, this four-story brick building is one of the main dormitories. It is named for Samuel T. Graves, President from 1885-1900.

8. Baptist Student Center at Georgia State University--1900
   125 Edgewood Avenue NE

Originally the Coca-Cola Bottling Company, this brick and shingle structure with square turret, crow-stepped gables and arched windows is typical of Victorian asymmetric design. Acquired by the Atlanta Baptist Association in 1964, it has been used by Baptist students at Georgia State University since 1970.

9. Candler Building--1904-1906
   127 Peachtree Street NE

A landmark since its completion, this handsome marble and terra cotta building--the inspiration of Asa G. Candler, founder of the Coca-Cola Company--is now the home of the First Georgia Bank and also provides prestigious office space for lawyers, architects and other professional persons. The white Georgia marble extends to the third floor, where carved panels of noted figures from the arts and sciences--Shakespeare, Wagner, Michelangelo, and Raphael, among them--adorn the facade on Pryor, Houston and Peachtree Streets.

10. Administration Building--1888
    Georgia Institute of Technology
    225 North Avenue NW

Designed by Bruce and Morgan, this building is topped by the famous red brick "Tech Tower," the hallmark of the school built on land donated by Richard Peters, one of the city's early civic leaders. Prior to extensive renovation in 1964, its massive winding staircase was famous.

11. Carnegie Building--1907
    Georgia Institute of Technology
    225 North Avenue NW

A grant from Andrew Carnegie made possible the college's first library. The dignified-looking structure, its impressive arched entrance framed by columns, was modernized in 1954 and converted to offices for the president and vice president.

12. Union Mission--1908
    54 Ellis Street NE

Although in a run-down condition, this one-time Elks Lodge is a reminder of grander days. The arched door is richly ornamented in elaborately executed terra cotta.

Interfacing Mathematics and Technology with Design and Architecture

by

Lee Ransaw

and

Abiola Lawal

Morris Brown College
Atlanta, Georgia

Faculty Handbook
for an Instructional Module
in Art and Technology

Resourceful Exchange: Technology and the Liberal Arts

1986

Introduction

This faculty handbook should help you understand the kinds of decisions that have to be made when an instructor decides to integrate technology into a course that has typically not addressed that subject. It is the product of interdisciplinary collaboration between an art instructor and a mathematics instructor who wished to provide a new learning experience for their students, an experience that would help them to learn content from an interdisciplinary perspective.

This faculty handbook was designed as one of two resources for an instructional module in art and technology, **Interfacing Mathematics and Technology with Design and Architecture.** The other resource, a student handbook, helps prepare students for their adventure in learning. This faculty handbook should help you to decide whether or not you wish to take part in a similar adventure.

This handbook should help you to make the informed decisions that restructuring any course requires. Some of these decisions may be global, such as whether to adopt the module as it now stands or to adapt the module to fit a new context. Other decisions may be less global, but they are, nevertheless, significant. For example, such subjects as how to organize the classroom or how to evaluate achievement need to be addressed early in the decision-making process.

Teaching technology across the curriculum is, assuredly, an exploration. Much is yet to be learned. This handbook represents our suggestions, not our prescriptions. We hope that the information we provide facilitates your exploration, but we also realize that the most rewarding part of your exploration will be the discoveries that you make.

Classroom Presentations

Responsibility for Presentations

This module is designed to be taught by an art instructor and a mathematics instructor. Here is a workable division of responsibility for classroom presentations:

--Sessions 1 and 2 (Art History)--Art Instructor
--Sessions 3, 4, 5, and 6 (Mathematics Units)--Mathematics Instructor
--Session 7 (Field Trip)--Art Instructor
--Sessions 8-9 (Workshop)--Both Instructors
--Session 10 (Evaluation)--Either Instructor

Most mathematics instructors, with only a limited knowledge of art history, however, could secure the necessary slides of the Gothic, Roman, and Renaissance architecture and make the art history presentation.

Most mathematics instructors should be able to teach the basic skills required in this module without difficulty.

Format

We have found the various instructional formats described in the student handbook to be quite satisfactory for the teaching of this module. However, we believe that other formats may also be effective. Instructors with progamming experience, for example, may wish to teach this module with the aid of micro-computers. Once the students learn basic programming, they could feed the proper mathematical formulas into the computer, receiving assistance with both the two-dimensional design and the three-dimensional arch.

Classroom Participation

Students are more apt to participate if they understand what is required of them. We found it useful to:

--give an overview at the beginning of each session of what was expected from each student during the session,

--display reference materials so that they were readily available when needed, and

--display drafting materials so that students could readily select appropriate materials.

Assignments

To increase student participation in assigned tasks, we offer the following suggestions:

--The art instructor or an art major could design and display a scale model arch.

--The mathematics instructor or a mathematics major could design a scale model arch.

--An architect could speak to the class and display examples of his work.

--The class might review a film on collapsing bridges or buildings, which would be followed by a discussion of why buildings collapse.

--The instructors could review career opportunities for those students interested in industrial design and architecture.

Mathematical Concepts and Terms

The mathematics instructor will need to present the following information about mathematical concepts and terms in the following sessions.

<u>Session 3</u>

An explanation of the use of a compass, ruler, tracing paper, and other mathematical instruments.

The development of a sketch of an arch, using various mathematical instruments.

A demonstration of the concepts of isometric drawings, using simple graphics.

A review of the following mathematical concepts and terms:

Definition of the volume of different objects, definition of spheres, and examples of how volume and sphere can be determined:

$$V_s = \frac{4}{3} (\pi r^3)$$

where V = Volume of a sphere

r^{ex} = Radius of a sphere

Definition of angles and how different angles can be drawn by using compass and rulers or by using protractors.

Definition of different terms, such as elasticity, force, weight, and the use of units.

Definition of the circle and its circumference:

$$C_c = 2\pi r = \pi d$$

where C_c = circumference of the circle

r = radius of the circle

d = diameter of the circle

An analysis of structures in terms of strudo, stress, and stiffness.

<u>Session 4</u>

Measurement

A demonstration of how to use rulers to measure the length, width, and height of a given object(s) and how to measure different angles, using protractors.

An explanation of space figures and their measures.

An explanation of how to calculate the volume of a given sphere, of a cube, and of a cylindrical object:

Sphere:

$$V_s = (4/3)\pi r^3$$

Cuboid $\equiv$ rectangular parallelepiped

$$V_c = (l \times w \times h) \text{ unit}^3$$

where V_c = volume of a given cuboid

l = length of the cuboid
w = width of the cuboid
h = height of the cuboid

Cylindrical Object:

$$V_g = \pi r^2 l$$

where l = length of cylinder
r = radius
V_g = volume of cylinder

An explanation of how to calculate the area of a circle, a cuboid, triangle, and trapezoid.

Circle:

$$A_c = \pi r^2$$

where A_c = area of a circle

r = radius of a circle

Cuboid:

$$A_f = l \times w \qquad A = 2(l \times w) + 2(l \times h) + 2(w \times h)$$

$A_f \equiv$ area of one face

(means of calculating different faces of a given cuboid for a rectangular angle)

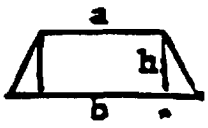
Triangle:

$$A_t = (1/2)bh = \frac{bh}{2}$$

where b = base of the triangle
h = height of the triangle

Trapezoid:

$$A_{tr} = h\,\frac{(a+b)}{2}$$



Other Geometric Formulas

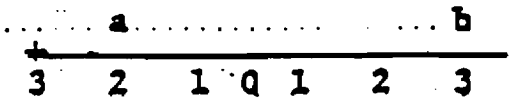
The perimeter of a rectangle:

$$p = 2\,(l + w)$$

An explanation of the Pythagorean theorem:

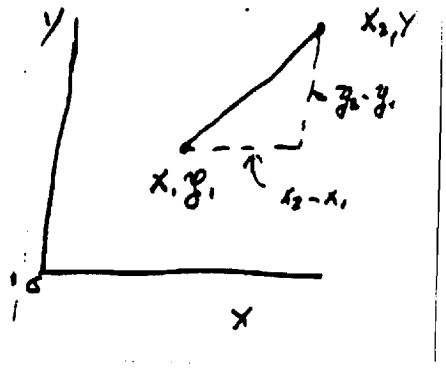
$Z^2 = X^2 + Y^2$ for a right angle triangle

Distance formulas, using number lines (the use of absolute value):



$d(a,b) = a-b = b-a$
$= 1-2-3 = 3 - (-2) = 5$

$d(x,y) = \sqrt{(x_2-x_1)^2+(y_2-y_1)}$



An explanation of the use of graphs in determining distance.

<u>Session 5</u>

Calculations and Definitions

Stress:

Stress = f/A

where f = applied load or force
A = cross-sectional area of object

Strain:

Strain = $\Delta L/L$

where L = original length of the object
ΔL = change in length

Definitions of:

--yield point,
--ductility,
--and brittleness.

Force:

Force = mg

where m = mass
g = acceleration due to gravity

Weight:

Young's Modulus $E = \frac{\text{Stress}}{\text{Strain}}$

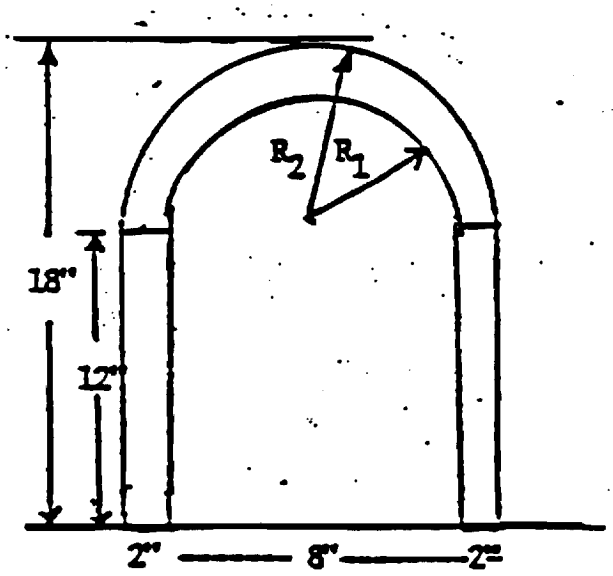
Demonstration of the Use of Scale

Graphs:

An explanation of two-dimensional planes

--x-axis (first axis)
--y-axis (second axis)
--the quadrants
--origina and how to draw different graphs

Here is an example:



$R_2 = 6''$
$R_1 = 4''$
$R = R_2 - R_1$

Linear Equations (optional)

Explanation of Linear Graphs

--slopes (gradients)
--intercepts

Sessions 8-9

An explanation of the effects of climate:

--temperature (cold weather and hot weather)

--wind

--other factors.

Review

Most of the information presented in this module needs periodic review. We suspect that many of the students who take art courses are not particularly strong in mathematics and that those who may be strong in mathematics courses are not, for the most part, artistically inclined.

We found it useful to review previously covered material to insure clarity of understanding before we introduced new material.

The module provides opportunities for such review:

--Students take two quizzes, one in Session 3 on the role of architecture in art history and one in Session 5 on mathematics. Discussions following these quizzes insure that the students have the correct information.

--The problem-solving task entails the completion of a series of activities. At any stage of this process instructor and student have the opportunity to review what has either been presented or achieved.

The review procedure may be formal or informal. We found it useful to review at the beginning of each class period for about five to ten minutes, but we also found it useful to engage in discussion with individual students as problems arose.

Evaluation

This module places rather strenuous demands on students. To adequately recognize student effort, we assigned 25% of the total grade for the semester course to this module, a decision that, we believe, increased student productivity.

Formative and Summative Evaluation

Although grades are assigned throughout the module, evaluation is often formative, rather than summative. That is, before a grade is assigned, the instructor or other students in the class make suggestions about how the students can improve their products.

The short quizzes help the students assess their own learning in two ways. Taking these quizzes makes students focus on the information they need to solve the two-dimensional or three-dimensional problem. Follow-up discussions of these quizzes afford students another opportunity to evaluate their own progress.

Students help each other throughout the module with the various group activities and team tasks. For example, students interact with each other while scanning magazines, completing field trip tasks, learning how to use art tools and mathematical instruments, and working together on problem-solving tasks.

The construction of the three-dimensional project, the arch, is an engineering activity that is composed of a total problem-solving task, rather than segments of it. Students are prepared for this summative task, the construction of an arch, by manageable sub-tasks, such as those required for successful completion of the two-dimensional drawing. These tasks entail the use of mathematics and quantitative reasoning and include both a freehand sketch and a technical drawing.

Credit is given to the student's oral presentation because it demonstrates knowledge and comprehension of the total problem-solving task. This presentation reveals the student's ability to assess the strengths and weaknesses of the technical drawing or final construction.

Criteria for Evaluation of Final Project

The problem-solving task is judged complete if the following has occurred:

--the student has demonstrated understanding of measurement, area and volume in the two-dimensional drawing,

--the student has demonstrated an ability to calculate the dimensions of an arch from the dimensions of the key stone as part of the two-dimensional drawing task,

--the student can successfully transfer a two-dimensional scale drawing to a three-dimensional arch with available materials, and

--the student can give a report identifying the strengths and weaknesses of the final project.

Resource Faculty and Space

This module may be taught in either the mathematics or art department, provided space is available for drawing and construction. In our opinion, the beauty of this module is that faculty can be obtained from various disciplines within the field of art, such as basic design, drawing, sculpture, illustration, art history, or engineering graphics.

Allocated Time

The two sessions on art history provide adequate coverage of the material. But the mathematics sessions could be extended to six fifty-minute sessions. This extension would give students more time to comprehend the mathematics concepts and terms. It would also provide more time for hands-on experiences with mathematics instruments, such as calculators, compasses, and rulers.

Time for developing the two-dimensional drawing could be extended to four sessions. This extension would permit students to make mistakes and still develop a master drawing.

The three-dimensional, problem-solving task could also be extended. If five sessions were allocated to this task, the students would produce more successful projects. They would have the opportunity to experiment with the available materials as well as with materials of their own choice.

Here is an adjusted time schedule that extends the time allocated to the module to six weeks:

Session	Assignment
#1 and #2	Lectures on art history and architectural forms
#3-#8	The development of mathematics concepts and terms. The use of mathematics instruments. Taking of quizzes.
#9-#12	The development of two-dimensional drawing. The understanding of materials and tools.
#13	Field trip.
#14-#17	The development of the problem-solving task.
#18	Student evaluation.

Equipment and Materials

Following is a list of the equipment and materials you will need to teach this module.

Equipment

Calculators--These may be obtained from the business or mathematics department.

Carousel Slide Projector

Kiln--A kiln will help you to pre-bake or bisque fire clay to save time during the building of the arches.

This equipment will be useful in the following sessions:

Calculators--Sessions #4-#6, #8-#9

Kiln--Session #4

Slide Projector--Sessions #1-#2

Materials

Two kinds of materials are needed for this module:

Mathematics Instruments

compasses
mechanical drawing pencils--6B
protractors
rulers
tracing paper
triangles

Art Tools

albiene or clear print tracing paper
cardboard
clay
dowel rods 1/8" or 1/16"
exacto knives
magazines
mat knives
match sticks
pencils--2B
putty
scissors
sketch pads
styrofoam sheets 1/2" to 1"

The student handbook that accompanies this faculty handbook lists in each session what materials the students will need to complete their activites.

Module and Course Modifications

At Morris Brown this module could be used in the following disciplines: art history, fine arts, and mathematics.

At other institutions, little, if any, modification would be needed to teach this module in any of the following courses: basic design, basic drawing, ceramics, illustration, public school art, and sculpture.

Literature as a Form of Technology Assessment

by

Violet H. Bryan

and

Kathryn Aultman

Dillard University
New Orleans, Louisiana

Student Handbook
for an Instructional Module
in Technology Assessment

Resourceful Exchange: Technology and the Liberal Arts (RETLA)
1985

Introduction

Technology assessment and literature have a great deal in common. Technology is the application of scientific principles or hypotheses to the solution of a problem of everyday life. Technology Assessment is an attempt to evaluate that application in terms of its predicted impacts or side effects. Such assessment involves a deliberate attempt to consider different, often opposing, points of view.

Literature is also an evaluation of everyday life. Novels obtain their dramatic impact from conflict within or among people and ideas. In these two respects literature and technology assessment are similar.

Technology assessment and literature also differ in several ways. Technology assessment is always looking toward the future. Literature may be set in the past, present, or future. Literature may focus on a single aspect or many aspects of a situation, and it may emphasize any or all of them to different degrees. Technology assessment is constrained to be as complete as possible within the boundaries set forth in its initiation. For example, an assessment of nuclear power plants might be restricted to fission plants or to water-cooled reactors, but this assessment would have to consider all of the impacts of these plants on the environment, both direct and indirect. Finally, technology assessment is often dry and appears only in scientific and trade journals; it has a limited audience. Literature, on the other hand, can be a far-reaching medium for the airing of all sides of an issue

This module is designed to accomplish four things:

--It will introduce novels of social criticism which were written around the turn of the twentieth century in the United States.

--It will introduce the concept and process of technology assessment and provide an opportunity for you to simulate such assessment,

--It will compare the evaluative processes and products of the novel, the Octopus, and TEKASSES, a computer program that will enable you to perform a simulation of technology assessment.

__It will reinforce the process of literary analysis undertaken in any literature class by the process of analysis used to perform the simulation.

Rationale

This module will reveal connections between man's aesthetic and technological efforts. It will demonstrate that fiction and reality, whether that reality is social, political, or economic, can have important impacts on each other. It will introduce novels of social criticism, indicating that a central characteristic of both novels and technology is a focus on the role of confict in various dimensions, such as those pertaining to people, to the environment, or to values.

Learning Objectives

This module will help you:

--to become familiar with the history of technological development in the United States during and following the Civil War, when literature of social reform, such as Frank Norris's The Octopus and Upton Sinclair's The Jungle, were written,

--to analyze The Octopus and other novels of social reform in terms of the development of character, theme, and imagery,

--to evaluate how these aspects of the novel help to account for its overall impact on the society's perceptions of the railroad technology and management,

--to understand the concept of technology assessment, its goals, procedures, and limitations,

--to simulate technology assessment,

--to perceive The Octopus as a form of assessment of railroad technology and to compare this novel with an assessment of technology performed with modern methods.

Dimensions of the Module

This module consists of five sessions, each requiring one hour of class time. In addition, you will be required to take a test in the session immediately following the module.

Instructional Formats

Discussion/Seminar--four hours
Workshop/Lab--one hour

Literature as a Form of Technology Assessment

Prior to Session 1, you should complete the following readings:

Horton and Edwards, Backgrounds of American Literary Thought, Chapter 7, "The Triumph of Industry."

Norris, The Octopus, Chapters ( ).

Spiller, A Literary History of the United States, Chapters 57-62, "The Continental Nation."

Tarbell, The Nationalizing of Business: 1878-1898, Chapter 1, "The Economic Outlook in 1878."

Session 1

Brief Summary of Activities

Session 1 will include a brief history of technological development during and following the Civil War, a brief definition of technology assessment, and an explanation of the ways in which the literature of the 1880s and 1890s can be viewed as a form of technology assessment.

Classroom Presentation

Your instructor will provide a brief history of the accelerated technological development of the United States during and following the Civil War. This history will include a discussion of technologies pertaining to the following industries: oil, steel, railroad, and meat-packing. Emphasis, however, will be placed on the development of railroad technology and its influence on American society.

Following a brief definition of technology assessment, your instructor will explain in what ways the literature of the 1880s and 1890s can be viewed as a form of technology assessment. Such works as Upton Sinclair's The Jungle and Edward Bellamy's Looking Backward forecast the influences that the new technologies would later have on the society, and these novels also cite variables that would account for changes in the quality of life. The major focus for discussion, however, will be Frank Norris's The Octopus, a fictional work that can be viewed as a form of technology assessment.

Classroom Activities

Given this reading background and the instructor's lecture, you will isolate variables that are important to assessing the impacts of the new technologies on the society.

Assignments

Reading

Continue to read Norris, The Octopus.

Writing

Take notes on the lecture/discussion to prepare for a test at the end of the module, which will require that you:

--describe the historical context of The Octopus,

--define technology assessment, and

--explain how literature can be viewed as a form of technology assessment.

Assignment Deadlines

You should continue to read The Octopus to prepare for discussion in Session 2; you should begin to prepare for the test, which you will take in Session 6.

Session 2

Brief Summary of Activities

This session focuses on comparisons between Norris's assessment of railroad technology and a systematic assessment based on the principles of technology assessment. Following a discussion of the impacts that Norris emphasized, you will attempt to discover the biases inherent in Norris's position.

Classroom Presentations

The object of this lecture/discussion will be to help you discern how Norris's intuitive and imaginative assessment of railroad technology compares with a systematic assessment of technology.

Classroom Activities

Focusing on the advancement of railroad technology in the San Joaquin Valley of California, Norris implied that specific impacts of the railroad technology would affect the quality of life, either positively or negatively. You will be encouraged to name some of these impacts and provide illustrations from The Octopus. Here are some possible responses:

--damage to the environment,

--increased production of wheat,

--increased food distribution,

--increased racial conflict,

--increased land speculation,

--increased control of the land and transportation system by the monoply,

--increased alienation of railroad workers and small farmers from the products of their labor

Every technology assessment has its inherent biases. By means of discussion, you will be invited to evaluate Norris's position, pointing out any biases you perceive. As a naturalist, for example, he believed that nature is amoral and invincible and that there are forces beyond man's control which influence his behavior, such as the accelerating power of the monopolies.

Assignments

Reading

Marx, The Machine in the Garden.

Norris, The Octopus. Continue to read this text.

Tarbell, The Nationalizing of Business, 1878-1896. Chapter 5, "The Rise of the Industrial Trust," and Chapter 6, "The Nationalizing of the Railroads."

Writing

Take notes to prepare for the brainstorming in Session 4, during which you will engage in the creation of a list of the potential impacts of railroads. This list will be used in Session 5, when you will run a computer program, TEKASSES, which simulates technology assessment.

A five-page essay (1,000-1,250 words) will be assigned on the subject, The Octopus Viewed as a Form of Technology Assessment.

Reporting

Group oral reports, requiring you to analyze The Octopus, will also be assigned. These reports should focus on the structure of the novel and the novel's effect on the contemporary society.

These reports will be responses to one of the following questions:

--Trace "the rape of the land" or "the machine in the garden" motif in The Octopus.

--Analyze the major characters of The Octopus in terms of their relationship to the railroad and the environment.

--Explain the sources of conflict between the wheat ranchers and the Pacific and Southwestern Railroad in the fiction and historically. Do they have similar motivations?

--Evaluate the influence that such fiction as The Octopus had on anti-trust legislation and labor organization of the 1890s and 1900s.

Assignment Deadlines

The essay will be due two weeks after this session.

Oral reports will be presented in Session 3.

Session 3

Brief Summary of Activities

This session will concentrate on:

--an evaluation of the effect of literary technology assessment on technological development and

--an analysis of the means by which literature affects people's perceptions.

Classroom Presentations

Group reports on the assigned questions will be delivered.

Classroom Activities

This session will be composed of group discussions. During these discussions, you will be expected to respond to the following questions:

--What was the effect of social reform novels, such as The Octopus, on the popular and governmental attitudes toward technology development? How did these novels influence legislation and organized labor efforts?

--How did the literature operate to cause changes in people's perceptions of technology? Was the influence due in large part to the author's development of a myth of technology, for example, "the rape of the land" by the hands of the ruthless robber barons and the powerful machinery?

Assignment

Reading

Porter et al., Chapters 1-4, A Guidebook for Technology Assessment and Impact Analysis.

Assignment Deadline

The reading assignment should be completed before Session 4.

Session 4

Brief Summary of Activities

Your instructor will deliver a lecture on technology and technology assessment.

Classroom Presentations

The lecture will include general definitions and background material about technology, technology assessment, the processes of assessment, and analysis in general. It will also include specific descriptions of the process of isolation of variables and instructions for the use of the computer simulation.

The lecture will present information that will help you to answer the following questions about technology assessment.

__What is technology? What is technology assessment? What are some impacts of technology assessment?

__What are the components of technology assessment?

__What are the techniques used in technology assessment?

__What are the uses of technology assessment? Why is it done?

__Who generally performs a technology assessment?

--What was the social context of railroad development?

--What were the impacts of the railroads?

--Who used the railroad?

--What alternative form of transportation was displaced?

--How were the railroads run?

--What technologies were involved in railroad development?

Instructional Materials

You will receive a handout. This handout is a guide to performing the computer simulation.

Classroom Activities

The class as a whole will discuss the subject: the political impact of railroads on life in Southern California in the 1830s. Our discussion will focus on the relationship between technology and literature. Specifically, we will analyze Norris's criticism of the railroad and abstract a list of the impacts that he perceives the railroads to have had on the quality of life of the period.

The class will also discuss the use of the computer and of the computer program, TEKASSES, as a means of assessing techology that differs from the means that Norris used.

Assignments

Reading

Read again the assignments made in Session 3. Study the handout.

Assignment Deadlines

Your review of the readings should help you to prepare for the running of the computer simulation in Session 5.

Session 5

Brief Summary of Activities

You will perform a computer simulation, fill out the data sheet provided in the handout, and answer a list of questions about your computer task.

Classroom Activities

This session will take place in the computer lab, where you will participate in computer simulation. This simulation will require running the FGS-based program: Quality of Life, written by K. S. Aultman. While running this program, you may find it useful to refer to the handout, which explains the necessary procedures.

Assignments

Writing

Fill out the data sheet and answer the following questions about this computer simulation.

--What is quality of life?

--What variables are used to calculate it?

--What influence does each variable have on the overall calculation? Does it enhance or detract? Does its effect stand alone or depend on some other variable?

--How many different values for quality of life can you calculate?

--What is the relationship between this computer simulation and an actual technological assessment?

--Which variable has the greatest influence? the least? Are these results what you would have expected?

--What is the role of personal values in technology assessment? (Hint: How did the author's values influence the format of the simulation? If you had written it, would it have been different?)

Write a lab report that summarizes your findings.

Assignment Deadlines

Your data sheet, the reponses to questions, and the lab report should be turned in at the beginning of Session 6.

Session 6

Brief Summary of Activities

This session will help you to synthesize the insights you have derived from your analysis of Norris's vision in The Octopus and your analysis based on the results of the computer simulation. Achieving synthesis will help you to complete your five-page essay, The Octopus Viewed as a Form of Technology Assessment.

Evaluation

You will demonstrate your achievement in the module by:

A Unit Test

This test will measure your ability to explain the concepts of technology assessment and how literature can be viewed as a form of technology assessment. It will also require that you describe the historical background of The Octopus and evaluate the effect of the reform literature of the 1890s on government and popular attitudes toward the new technologies and their management.

A Written Essay

The five-page (1,000-1,250) essay will require that you explain logically how the Octopus, through its structure, its author's purposes, and its effects on the public, can be viewed as a form of technology assessment. The essay will require a detailed explanation of topics discussed in class along with additional elements.

An Oral Presentation

The group presentations will measure the ability to analyze The Octopus in terms of the development of character and imagery and to relate these elements of structure to its overall impact on the society's perception of the new technology.

Lab Report

You will use the computer simulation program to collect data and write a lab report summarizing the influence of the various impacts of the railroad technology on the quality of life.

Weighting of Your Grade

Activities	Percentage of Grade
Unit Test	20%
Written Essay	30%
Operation of Computer Program and Lab Report	25
Oral Presentation	25%
	100%

Bibliography

Reading Materials

Course Text

Norris. The Octopus.

On Reserve

Horton and Edwards. Backgrounds of American Literary Thought.

Marx. The Machine in the Garden.

Parrington. The Beginnings of Critical Reaslism in America, 1860-1920.

Spiller. A Literary History of the United States.

Tarbell. The Nationalizing of Business: 1878-1898.

Porter et al. A Guidebook for Technology Assessment and Impact Analysis. New York, N. Y.: Elsevier Press, 1980.

Collateral Readings

Adams. "The Dynamo and the Virgin," in The Education of Henry Adams.

Crane. Maggie: A Girl of the Streets.

Dreiser. The Financier.

James. The Jolly Corner.

Norris. "A Plea for Romantic Fiction," in The Octopus.

Sinclair. The Jungle.

Audio-Visual Aids

Slides from the New Orleans Museum of Art and Public Library

Science Kit

Computer Software

FGS-based program: Quality of Life, designed by K. S. Aultman

The preliminary version of this program is named TEKASSES and includes handouts explaining procedures.

Quantitative and Analytical Concepts for the Social Studies

by

Veula J. Rhodes

and

Don Williams

Albany State College
Albany, Georgia

Student Handbook
for an Instructional Module
in Math and Social Science

Resourceful Exchange: Technology and the Liberal Arts

1986

Rationale

This module incorporates into the study of social sciences logical and quantitative methods for use in identifying, classifying, and discovering solutions to problem situations. You will use the computer as a means of understanding these methods.

Learning Objectives

This module should help you to:

--identify problem situations,

--classify problem situations,

--use methods of data collection,

--analyze data,

--use appropriate procedural steps in both inductive and deductive reasoning,

--make predictions,

--test solutions, and

--draw logical conclusions based on knowledge gained from solving the problem.

Dimensions of the Module

This module continues for two weeks. It consists of ten sessions, each requiring an hour of class time.

Instructional Formats

During these two weeks, you will attend lectures and participate in discussions and workshops. Overview sheets and a handout will also help you to understand the content of the module.

Session 1

Classroom Discussion

No formal lecture is presented. Instead, you participate in a general discussion of statistical terms, such as measurement, data, sample, and trend. Questions to guide discussion will include, but not be limited to:

--What is statistics?

--Why study statistics?

--What is the meaning and use of these concepts: measurement, data, sample, and trend?

The purpose of this discussion is (1) to help you assess your knowledge of statistics and (2) to help you define important terms. These definitions will evolve during the discussion.

By the end of this session, you should understand what kinds of problems the field of statistics addresses and why studying statistics is useful.

At the conclusion of the discussion, refer to **Handout #1: Basic Terminology for Statistics** on pp. 19-21 of this Student Handbook. This handout includes definitions of measurement, data, statistics, mean, median, mode, range, variance, standard deviation, and frequency distribution. Understanding these definitions will help you complete the assignments in this module.

Assignments

<u>Reading</u>

Read local newspapers and news magazines to identify and collect statistical examples that appear in articles, graphs, charts, and other visual representations.

<u>Reporting</u>

Report in Session 2 on the statistical examples that you have identified and collected. Your report should include an explanation of why you chose a particular article to serve as an example.

Writing

Using the statistical examples you have gathered:

--translate an article into a graph,

--translate a graph into a chart, and

--translate a chart into language.

Assignment Deadlines

Complete these assignments by Session 2.

Session 2

Classroom Presentation and Discussion

Your instructor delivers a brief presentation that focuses on:

--the methodology used to distinguish among language, charts, and graphs and

--the procedures used in determining the relationships among language, charts, and graphs.

The class presents and discusses the statistical examples contained in the collected articles, charts, and graphs.

Classroom Activities

You respond in writing to a short diagnostic evaluation in which you apply the statistical concepts and terms introduced in Session 1.

At the end of this session, taking a quiz helps you to review basic statistical terminology.

Assignments

Reading

Read and assess the articles selected from the local newspapers and news magazines.

Writing

Using the selected articles, charts, and graphs, respond to the following questions:

--What hypothesis is being made?

--Is the hypothesis valid? Why or why not?

--Do you agree with the hypothesis?

--Is a prediction made?

Assignment Deadlines

Complete these assignments by Session 3.

Session 3

Classroom Presentation and Discussion

Your instructor delivers a short lecture on the value of data collection, methods of data collection, and the utilization of data.

Using the writing samples generated in Session 2, the class responds to specific questions. These questions include:

--Why collect data?

--After collecting data, how may you use them?

--What is a generalization?

--What is a prediction?

Assignments

Writing

Define the above terms and cite examples of them. In addition, record and bring to Session 4 the height of four friends, who are identified as #1, #2, #3, and #4. These heights will be used to illustrate frequency distribution, and they will be plotted on charts and graphs.

Assignment Deadlines

Complete these assignments by Session 4.

Session 4

Classroom Presentation and Discussion

Your instructor delivers a brief lecture on definitions, uses, and math formulas, referring to **Overview #1: Definitions, Uses, and Math Formulas.** See p. 22 of this Student Handbook for a copy of this overview.

The class then participates in a discussion of such concepts and terms as data, ordering data, frequency distribution, charts (histograms), and graphs (frequency curves). This discussion also includes the uses of statistical concepts and mathematical formulas.

Classroom Activities

Following the discussion, you apply these concepts and terms to the information you recorded about the heights of four friends.

Assignments

Reading

Your instructor will presents a number of graphs. Analyze these graphs to determine what kind of information they provide.

Reporting

Use Overview #1 to determine:

--the type of graph,

--the number and types of variables, and

--the information provided.

Writing

In narrative form, interpret a chart, graph, or other article.

Assignment Deadlines

Complete these assignments by Session 5.

Session 5

Classroom Presentation and Discussion

The discussion begun in Session 4 continues in this session, which helps develop your awareness of how frequency distribution, graphs, and charts are used as means of interpreting statistical data.

Referring to Overview #1, the class discusses the different types of information provided. This overview presents information on frequency distribution, charts, and graphs. This discussion helps you generate definitions of data, ordering data, frequency distribution, histograms, and frequency curves.

Following this discussion, your instructor introduces the computer and demonstrates how the computer can be used to perform statistical calculations. This presentation also describes the difference between using hand calculators and computer programs.

Two programs will help you perform computer tasks:

--Introductory Statistics, a computer program that enables statistical analysis, and

--a program, designed by the mathematics instructor, that provides randomly selected numbers for you to use in your lab assignments.

Assignments

Lab

Work on a lab assignment, distributed by your instructor, which provides practice with frequency distribution and histograms. To perform this task, use options #1 and #2 of the computer program, Introductory Statistics. These options pertain to frequency distribution and histograms.

Assignment Deadline

Complete this assignment by Session 7.

Session 6

Classroom Activities

Your instructor will provide an article, entitled "Declining Crime Rate." Read and analyze the information provided. Then respond in writing to the following questions:

--What hypothesis is being made?

--Is it valid?

--Do you agree with the hypothesis?

--Is a prediction made?

In addition, make a graphic representation of the information provided.

This exercise assesses your understanding of the content of the course; it also assesses your ability to apply what you have learned.

Session 7

Classroom Discussion

This session develops your awareness of how mean, variance, and standard deviation are used as means of interpreting statistical data.

You engage in a discussion of three statistical concepts: mean, variance, and standard deviation. For reference, see **Overview #2: Mean, Variance, and Standard Deviation**, which contains definitions of these concepts and computational formulas that will help you to understand and apply these concepts. A copy of this overview is included on p. 23 of this Student Handbook.

Assignments

Reading

Read chapter 6 in Frankenburger and Blakemore, Introductory Statistics.

Lab

Work on a lab assignment, distributed by your instructor, which provides practice in mean and standard deviation. To perform this task, use Option #3 of the program, Introductory Statistics.

Assignment Deadlines

Complete these assignments by Session 8.

Session 8

Classroom Discussion

This session helps you to develop an awareness of how correlations can be used as a means of interpreting statistical data.

You engage in a discussion of the concepts of correlation and coefficient of correlation. For reference, see **Overview #3, Correlation and Coefficient of Correlation**, which contains definitions of these concepts and a mathematical formula that enables the computation of correlation coefficients. A copy of this overview is included on p. 24 of this handbook.

Assignments

Reading

Read chapter 7 in Frankenburger and Blakemore, Introductory Statistics.

Lab

Work on a lab assignment, distributed by your instructor, which serves as practice in calculating correlation coefficients. To perform this task, use Option #4 of the program, Introductory Statistics.

Assignment Deadlines

Complete these assignments by Session 9.

Session 9

Classroom Discussion

The class discusses correlation and the coefficient of correlation. In addition, the class reviews the major concepts and terms covered in Sessions 7 and 8, referring to Overviews #2 and #3. These discussions help you to prepare for the final exam, which will occur in Session 10.

Assignments

Prepare for the final test by reviewing classroom notes, readings, Handout #1, and Overviews #1, #2, and #3.

Session 10

Classroom Activities

The final exam assesses your understanding of the content of the module and your ability to apply the concepts to statistical data.

Part 1 of the exam requires an explanation of major concepts with examples to illustrate an understanding of these concepts. This portion of the exam includes the concepts and terms covered from Session 1 to Session 9.

Part 2 of the exam requires you to plug in data, work through formulas, and develop simple graphs and histograms, based on an assignment developed by your instructor.

Evaluation

You will demonstrate your achievement of the learning objectives for this module by:

--taking two quizzes and a final exam (Sessions 2, 6, and 10),

--delivering oral presentations (Sessions 2 and 4)

--completing lab assignments (Session 5, 7, and 8),

--writing short answer responses and an essay (Sessions 2 and 4), and

--paticipating in classroom discussion.

Weighting of The Grade

Activities	Percentage of Grade
Quizzes and Final Exam	50%
Oral Presentations	20%
Short Answer Responses/Written Essay	10%
Lab Assignments	10%
Classroom Participation	10%
	100%

Bibliography

Texts

Doby, John Thomas. An Introduction to Social Research. New York: Appleton Century Crofts.

Drew, Clifford J. An Introduction to Designing Research Evaluation. St. Louis: C. V. Mosby.

Gee, Wilson. Social Sciences Research Method. New York: Appleton Century Crofts.

Goode, William J. Methods in Social Research. New York: McGraw Hill.

Madge, John H. The Tools of Social Sciences. New York: Longmans, Green.

McCall, Robert. Fundamental Statistics for Psychology. New York: Harcourt, Brace, Jovanovich.

Tufte, Edward R. The Visual Display of Quantitative Information. Connecticut: Graphics Press.

Software

Frankenburger and Blakeman, Introductory Statistics. Addison-Wesley.

Other Sources of Information

Newspapers, magazines, and journal articles
Charts and graphs
Handout #1
Overview sheets #1, #2, and #3
Software handout

Handout #1: Basic Terminology for Statistics

1. MEASUREMENT: the systematic assignment of numbers to objects and events, and it forms the very basis of science. If an event or attribute cannot be measured, it does not find its way into the domain of science.

2. DATA: factual information (as measurements or statistics) used as a basis for reasoning, discussion, or calculation.

3. STATISTICS: the study of methods of handling quantitative information, including techniques for organizing and summarizing as well as for making generalizations and inferences from data.

   a. Descriptive Statistics - refers to procedures for organizing, summarizing, and describing quantitative information or data.

   b. Inferential Statistics - concerns the methods by which inferences are made to a larger group on the basis of observations made on a smaller subgroup.

4. MEAN (AVERAGE): a middle point between extremes. The most common measure of the central tendency of a group of scores is the average or mean.

   The mean, symbolized by $\overline{X}$ (read "X bar"), is given by the formula

$$\overline{X} = \frac{\sum X_i}{N}$$

5. MEDIAN: is the point that divides the distribution into two parts such that an equal number of scores fall above and below that point.

   Formula: $$M_d = L + \left(\frac{N/2 - nb}{nw}\right) i$$

   in which

   M_d = the median

   L = the lower real limit of the score interval containing the median

   N = the number of scores in the total distribution

n_b = the number of scores falling below the lower real limit of the score interval containing the median

n_w = the number of cases within the score interval containing the median

i = the size of the score interval ($i = 1$ if the data are in whole numbers)

6. MODE: M_0, is the most frequently occurring score. Sometimes a distribution will have two modes. This distribution is called bimodal.

7. RANGE: is estimated by taking the largest minus the smallest score.

8. VARIANCE: an index which reflects the degree of variability in a group of scores but which does not have the limitations of the range.

The variance is the sum of the squared deviations of the scores from their mean, $\sum(X_i - \bar{X})^2$, divided by the number of scores minus one $(N - 1)$.

$$S^2 = \frac{\sum(X_i - \bar{X})^2}{N - 1} \qquad \text{(definitional)}$$

$$S^2 = \frac{N\sum X_i - (\sum X_i)^2}{N(N - 1)} \qquad \text{(computational)}$$

9. STANDARD DEVIATION: S, is the positive square root of the variance.

$$S = \sqrt{S^2} = \qquad S = \sqrt{\frac{\sum X - \bar{X})^2}{N - 1}} \qquad \text{(definitional)}$$

$$S = \sqrt{\frac{N\sum X_i^2 - (\sum X_i)^2}{N(N - 1)}} \qquad \text{(computational)}$$

10. FREQUENCY DISTRIBUTION: is a tallying of the number of times each score value (or interval of score values) occurs in a group of scores.

Overview #1: Definitions, Uses, and Math Formula

Definitions of the following concepts and terms will be generated by classroom discussion:

--data
--ordering data
--frequency distribution
--charts (histograms)
--graphs (frequency of use).

These statistical concepts and terms can be used to help you to:

--arrange class data in one data set,
--order data in descending order,
--use frequency distribution to rearrange data more completely,
--group data in a predetermined number of intervals, and
--plot data items against frequency.

Math formula:

--determine range of data items: range is N
N = largest number - smallest number + 1

--determine the length of intervals:
length = N divided by the number of intervals

Software Exercise:

--Use the Introductory Statistics program.

--Choose Option #1: Enter data into program.
Observe and study the computer results.

--Choose Option #2: Enter Data into program.
Observe and study both the histogram and frequency curves.

Overview #2: Mean, Variance, and Standard Deviation

1. MEAN (AVERAGE): a middle point between extremes. The most common measure of the central tendency of a group of scores is the average or mean.

   The mean, symbolized by $\bar{X}$ (read "X bar"), is given by the formula

$$\bar{X} = \frac{\sum X_i}{N}$$

2. VARIANCE: an index which reflects the degree of variability in a group of scores but which does not have the limitations of the range.

   The variance is the sum of the squared deviations of the scores from their mean, $\sum(X_i - \bar{X})^2$, divided by the number of scores minus one, $(N - 1)$.

$$S^2 = \frac{\sum(X_i - \bar{X})^2}{N - 1} \qquad \text{(definitional)}$$

$$S^2 = \frac{N\sum X_i - (\sum X_i)^2}{N(N - 1)} \qquad \text{(computational)}$$

3. STANDARD DEVIATION: S, is the positive square root of the variance.

$$S = \sqrt{S^2} = \qquad S = \sqrt{\frac{\sum X - \bar{X})^2}{N - 1}} \qquad \text{(definitional)}$$

$$S = \sqrt{\frac{N\sum X_i^2 - (\sum X_i)^2}{N(N - 1)}} \qquad \text{(computational)}$$

Software Exercise:

--Use the <u>Introductory Statistics</u> program.

--Choose Option #3: Enter data into program.
Observe and study the computer results.

Overview #3: Correlation and Coefficient of Correlation

Definitions

Correlation is a statistical technique that allows us to measure the relationship between:

--two sets of data obtained from the same sample or

--two samples in which individuals in the sample have been matched.

The coefficient of correlation is the numerical index whose magnitude indicates the degree to which two frequency distributions of data are related. The range of the index proceeds from -1 (a perfect negative correlation) to +1 (a perfect positive correlation).

Mathematics

The formula for calculating the correlation coefficient (r) is:

$$r = \frac{\Sigma XY - \frac{(\Sigma X)(\Sigma Y)}{N}}{\sqrt{\left[\Sigma X^2 - \frac{(\Sigma X)^2}{N}\right]\left[\Sigma Y^2 - \frac{(\Sigma Y)^2}{N}\right]}} \quad \text{or} \quad r = \frac{N \cdot \Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{\left[N \cdot \Sigma X^2 - (\Sigma X)^2\right]\left[N \cdot \Sigma Y^2 - (\Sigma Y)^2\right]}}$$

In this formula, N is the number of pairs of data, x and y.

Software Exercise:

--Use Introductory Statistics program.

--Choose Option #4: Enter pairs of data into the program. Observe and study the computer results.

Social and Legislative Responses to Nuclear Waste Disposal

by

W. F. Lawless

and

Ephraim Williams

Paine College
Augusta, Georgia

An Instructional Module
on Nuclear Waste Management Issues

Resourceful Exchange: Technology and the Liberal Arts (RETLA)

1986

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Pond Slider Turtle Contaminated by Strontium 90

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Introduction to the Casebook of Readings

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2.6: DOE Environmental Policy Statement

2.7: Letter from House Subcommittee on Energy Conservation and Power to Secretary Herrington Requesting Information in Preparation for a Hearing on Proposed DOE Policies and Prehearing Questions for DOE

2.8: Memo of the House Subcommittee on Energy Conservation and Power Providing Background for the Hearing

2.9: Proposed DOE Byproduct Rule

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2.10: Responses to Congressional Prehearing Questions 15 and 20 (Requested in 2.7 Prehearing Questions)

2.11: House Bill H. R. 2006 to Clarify the Regulation of Solid Waste at DOE Facilities and House Bill H. R. 2593 to require EPA to Establish and Regulate Radioactive Emission Standards at DOE Facilities

2.12: The Spokesman-Review and Spokane Chronicle Editorial on Monitoring DOE Facilities

2.13: Testimony of Mary Walker, Assistant Secretary DOE, Before the House Subcommittee on Energy Conservation and Power

2.14: Statement of Virginia Aveni, Deputy Director of the Ohio Protection Agency, before the House Subcommittee on Energy Conservation and Power

2.15: Overview of Oak Ridge Lawsuit Against DOE

2.16: Summary Report of Nancy Smith, Staff Member, Subcommittee on Energy Conservation and Power, about Citizen Response to Environmental Issues

2.17: Memorandum from Mary Walker, Assistant DOE Secretary, Environment, Safety and Health, entitled "Byproduct Rulemaking"

2.18: Section 2: Questions for Discussion

Section 3: High-Level Radioactive Waste Tank Corrosion Pitting at the Savannah River Plant

3.1: Excerpts from Final Enviromental Impact Statement on New Waste Tanks at SRP

3.2: Du Pont Report on Corrosion Pitting

3.3: Arthur D. Little, Inc. Report on Corrosion Pitting

3.4: DOE Inspector General's Memorandum to Secretary of DOE

3.5: Atlanta Constitution Article on DOE Inspector General's Memorandum on Suppressed Information

3.6: Section 3: Questions for Discussion

Appendix A: Acronyms

Appendix B: Glossary

The Library Research Guide

Introduction to the Module

Introduction to the Module

What is **Social and Legislative Responses to Nuclear Waste Disposal**?

It is an instructional module composed of three components:

--a **Video Tape**,

--a **Casebook of Readings about Nuclear Waste Disposal**, and

--a **Library Research Guide.**

Nuclear waste disposal has been receiving an ever-increasing amount of media attention. This module provides an ideal opportunity for introducing students to this technical subject, which they already feel has great relevance to their personal lives. The focus on a tangible site, the Savannah River Plant (SRP) in South Carolina, enables them to become engaged in an exciting interchange between those who argue for or against specific decisions about nuclear waste disposal.

In what courses might the module be used?

A topic like nuclear waste disposal has broad implications: social, political, ethical, and environmental. Therefore, the module may be incorporated into courses in a variety of subject areas in order to teach a number of important skills. Relevant subject areas include sociology, political science, philosophy, and health and the environment.

This module has also been especially designed to provide the focus for units or courses which help students learn how to research and write research papers. A freshman English course might therefore make excellent use of the module.

Why is the **Video Tape** included in the module?

The classroom video presentation is a documentary, entitled <u>The Quiet and Lethal Legacy: The Fire Unleashed</u>, which was originally presented by ABC News Closeup on June 6, 1985. It was produced by John Fielding, directed by Vincent Stafford, and is narrrated by Marshall Frady. It runs for thirty-one minutes.

This documentary focuses on nuclear energy, nuclear weapons, and the legacy of each, nuclear wastes. Addressing nuclear waste management, it provides a useful overview to this module.

Introduction to the Module

The following topics addressed in the documentary can provide a focus for discussion:

--the differences among spent fuel, high-level waste, and low-level waste,

--the past management of each of these three kinds of nuclear waste,

--the effects of nuclear waste management on the environment, both within the United States and outside its boundaries,

--the role of the Nuclear Regulatory Committee and of the Department of Energy in nuclear waste management, and

--the need for effective technology assessment of nuclear energy.

What does the **Casebook of Readings about Nuclear Waste Disposal** contain?

The Casebook is a set of readings on the urgent social, ethical, and legislative issues raised by nuclear waste disposal, an important technological problem. The overall objectives of the module, wherever it is used, are to help students become more capable in handling technological subjects and more comfortable in responding to the issues they raise. The readings have been selected and organized to help instructors and students achieve these goals.

There are three sections of readings in the student casebook.

--Section 1 introduces the broad subject of nuclear waste disposal and covers the general handling of nuclear waste at the Savannah River Plant (SRP) by the Department of Energy (DOE).

--Section 2 presents documents relevant to the legislative response to problems at SRP.

--Section 3 focuses on a specific technological problem: the pitting of nuclear waste storage tanks at SRP.

Introduction to the Module

Students are probably not familiar with the relevant issues and the concepts and terms necessary to understand discussions of nuclear waste management. Since the subject is both technical and specialized, the casebook has been organized to help students understand the material. There is an introduction to each section. Wherever possible, more general and more accessible readings come first, preparing students for the more specialized and more difficult materials to follow. The material is also arranged--again, wherever possible--in chronological order, providing a sense of the on-going nature of the discussions. Readings are often paired as pro/con responses to the issues to engage students in formulating their own responses to these issues.

Wherever possible, the texts in the casebook are reproduced in their original forms. Articles from journals and magazines, government documents, and internal corporate reports--as well as committee reports and transcripts of testimony--are photocopied. This authenticity preserves their immediacy and allows students to become familiar with the appearance of original documents.

Included also in the casebook are **Questions to Guide Discussion** for each of the three sections and two appendices: Appendix A contains a list of **Acronyms;** Appendix B contains a **Glossary.**

In what ways can the casebook be used?

The casebook can serve as:

--a <u>self-contained source of information and issues about nuclear waste disposal</u> or

--a <u>means of teaching research paper skills</u>.

The Casebook as a Self-Contained Source of Information and Issues about Nuclear Waste Disposal.

Example #1

In an American government course, the casebook might provide the focus for a unit on the legislative process. Students would read the material to become familiar with an urgent contemporary problem that is technical in nature. The unit might focus on how citizens can help solve such problems by influencing the legislative process. Instruction can be made concrete through reference to readings in the module that reveal lobbying efforts by corporations and government departments as well as reports of the work of legislative committees, including transcripts of testimony given before them and discussions of legislative bills.

Example #2

The materials also raise issues in public ethics. Charges are made and responded to concerning "coverups" by private contractors and government agencies. One agency is accused of avoiding oversight by redefining hazardous waste from one category into another. Charges are leveled and debated that supplier companies cut corners to increase their profits. In all cases, the documents show the conflicting forces which encourage the compromises that some find necessary and proper and others detrimental to the public safety. Students can examine the evidence for themselves, arrive at their own conclusions and, perhaps, formulate suggestions for fostering high ethical standards in governmental nuclear waste management.

The Casebook as a Means of Teaching Research Paper Skills

The casebook may be used as:

--a self-contained text or

--a collection of specific readings on a narrow range of topics that students are to supplement by individual research.

The Casebook as a Self-Contained Text

The casebook can be an excellent tool for instructors who want to provide a controlled exercise in research paper writing. The readings in the casebook could be used to teach all the usual research paper skills with the exception of library or other research outside the classroom. The materials also provide the opportunity to teach reading skills (reading for the main idea and recognizing thesis and support); reasoning skills (logical arguments, induction, and deduction); composition skills (forming a thesis, writing various kinds of paragraphs, outlining, and summarizing); and research writing skills (note-taking, incorporating quoted material, and documentation format).

The instructor who uses the module readings as a self-contained text may want to spend some class time guiding students through the more specialized technical material. The instructor might also help students locate general topics that they might first narrow into thesis questions and then develop, using the readings. Here are a few topics that indicate the wide range of possibilities:

1. the problems associated with monitoring safety standards in nuclear waste management and solutions to these problems,

2. the advantages and disadvantages of types of nuclear waste disposal,

3. possible motives for distortion and/or dishonesty in nuclear waste management,

4. the strengths/weaknesses of the legislative response to problems in nuclear waste management,

5. the relationship between the Department of Energy (DOE) and its corporate contractors,

6. opportunities for citizen input in the legislative oversight of nuclear waste management,

7. the strengths/weaknesses of DOE responses to criticism,

8. the adequacy of the legislative bills responding to problems in nuclear waste management,

Topics (continued):

9. the media's handling of nuclear waste management issues, or

10. ethical issues in nuclear waste management.

The Casebook as a Collection of Specific Readings on a Narrow Range of Topics that Students are to Supplement by Individual Research

This casebook is an ideal vehicle for a research paper unit or course that emphasizes library research. One of the module's primary goals is to help students become more informed and active citizens of a technological society, and one characteristic of such citizens is the ability to inform themselves about crucial issues. The ability to use the library is an important tool of self-education, but students need guidance in their research. They do not do well when they are just sent to the library on their own. To provide such guidance, a research guide has been prepared for this module which you may find useful.

How might the instructor use the **Library Research Guide?**

The Library Research Guide presents a process that helps students to engage effectively in library research. The overall strategy for researching an unfamiliar topic in the library is to work from the general to the specific. This strategy is especially pertinent when working with technical subjects. The student will primarily need to learn how to find more general material, which should be read before the more specialized materials. Sources of generalized materials are articles in newspapers and magazines addressed to a wide public.

Specialized sources are usually those written by experts for other experts, for example, nuclear engineers writing to the managers of nuclear power plants. The casebook already contains some specialized sources, and students can prepare themselves through guided research to understand these more specialized discussions.

Such students essentially need tools to use in thinking about the topic. These tools include historical backgound information, relevant terms and their definitions, sub-topics and related topics, the debatable issues in relation to nuclear waste disposal, the names of authorities in the field, and the best sources of information.

Instructors might consider using the video tape and assigning the more general portions of the casebook as students search the encyclopedias and other general sources. These general portions include the introductions and the first reading or two in each section. The more specialized readings probably should not be assigned before students have nearly completed the research guide.

If there is sufficient time, instructors might consider having students write the background study outlined in the Library Research Guide before writing their research papers. An acceptable background study demonstrates that the student has enough understanding of the general topic and a given issue to complete a research paper successfully. If there is not enough time, the background study can be omitted.

The Casebook of Readings

Introduction to the Casebook of Readings

Introduction to the Casebook of Readings

This **Casebook** contains three sections. Section 1, Department of Energy Nuclear Waste Management, presents an overview of nuclear waste management in the United States, focusing mainly on the Department of Energy's practices in the disposal of military nuclear waste. This section enables a reader to view the issue of military nuclear waste management from the perspective of the Department of Energy as well as from the perspectives of those outside the DOE. Also included are the environmental consequences of the disposal and release of nuclear waste.

Section 2 presents the legislative response to the problems created by military nuclear wastes. This section first addresses the reaction of DOE to its loss of a federal lawsuit and the legislative response to this reaction from the U. S. Congress. Next, a Congressional hearing is presented that requests DOE to review future legislation designed to restrict its present right to self-regulate nuclear wastes. Finally, the DOE and the State of Ohio comment on groundwater contamination problems at the DOE Fernald facility in Ohio.

Section 2 enables the reader to compare two responses to a technological issue and then to assess social and legislative responses to that issue. In the past, the responsibility for technological assessment has generally been the responsibility of scientists and engineers.

Section 3, High-Level Radioactive Waste Tank Corrosion Pitting at the DOE Savannah River Plant, provides a specific example of problems with military nuclear waste. Attention is directed to corrosion pitting, discovered in 1980 in the high-level waste tank farm at the Savannah River Plant.

The Savannah River Plant manufactures plutonium and tritium for the nation's nuclear weapons. These processes result in high-level radioactive wastes, transuranic wastes, low-level wastes and airborne wastes. In the late 1970s, new high-level waste tanks were required and constructed. However, as the result of a lawsuit by the Natural Resources Defense Council in Washington, DC, DOE was directed to review its tank construction program in an Environmental Impact Statement (EIS). After the EIS, corrosion pitting was discovered, but it was not brought to the attention of the federal courts or of the DOE Inspector General until 1983.

In Section 3, the reader explores an issue in nuclear waste management by reading selected material from DOE technical reports. Included are excerpts from a copy of the Department of Energy Inspector General's (IG) report of the IG investigation of the high-level waste tank corrosion pitting incident at the Savannah River Plant.

Section 1

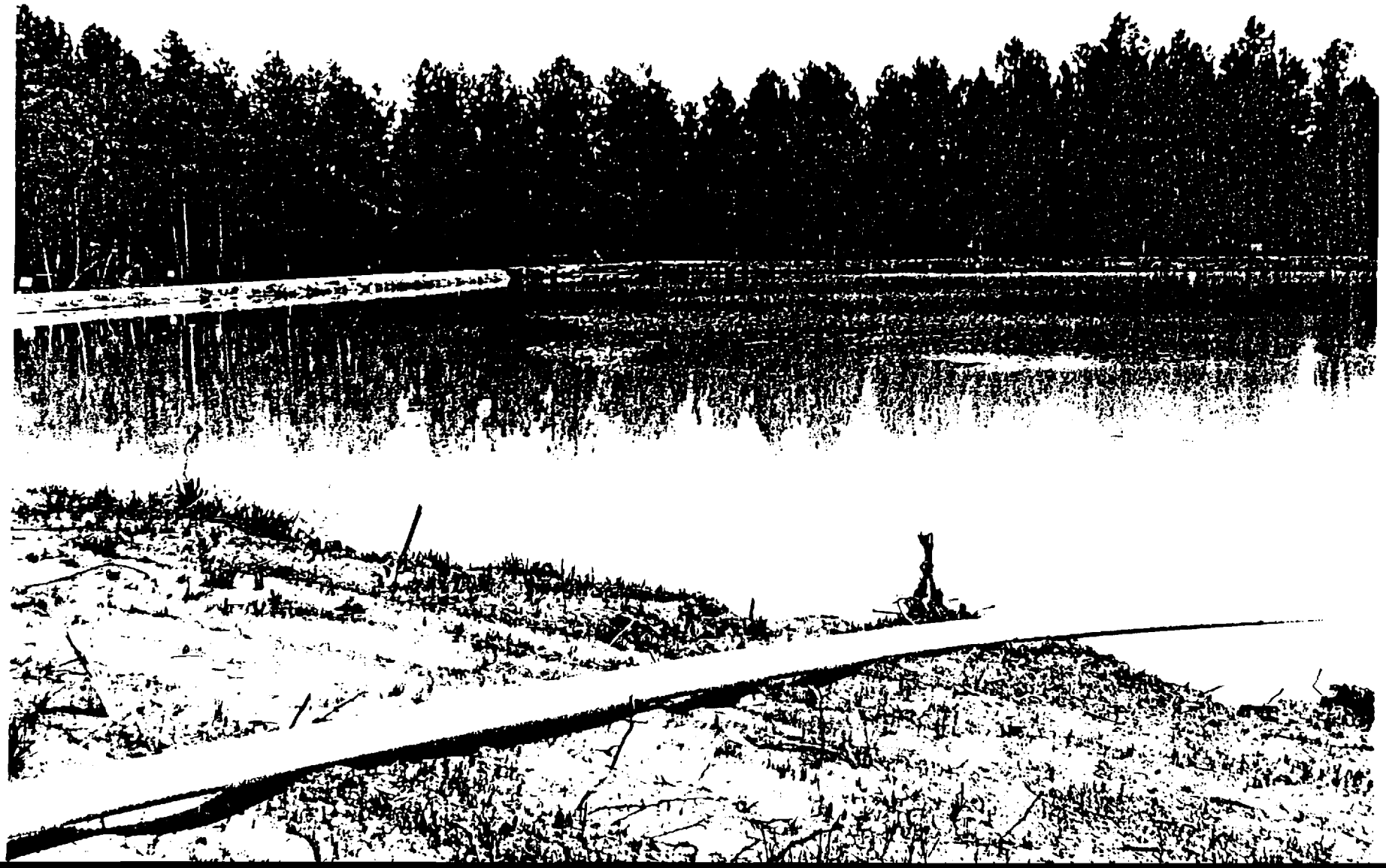
DOE Nuclear Waste Management

The Department of Energy (DOE) manages military nuclear waste throughout the United States but primarily at five disposal sites--the Savannah River Plant in South Carolina, the Oak Ridge facility in Tennessee, the Idaho National Engineering Laboratory in Idaho, the Los Alamos National Laboratory in New Mexico, and the Hanford Reservation in Washington. Problems with military nuclear wastes have occurred at all DOE facilities, but Section 1 concentrates on Oak Ridge, the Savannah River Plant, and Hanford.

At Oak Ridge, a 2.4 million pound spill of mercury led to a lawsuit lost by the DOE. The federal court stripped DOE of its right to self-regulate hazardous waste at its facilities. At the Savannah River Plant, where the nation's nuclear weapons material plutonium-239 and tritium are manufactured, drinking water was contaminated by seepage basins. Problems at Hanford that may have contributed to the DOE's revision of its criteria for the management of nuclear wastes were later mitigated by the new DOE standard for radioactive waste management.

The Manufacturing Area Seepage Basin at the Savannah River Plant

This photograph was included in the report from the General Accounting Office to Senator E. A. Hollings. (See 1.4 of this casebook.)



1.1

Memorandum from DOE Secretary to the President Announcing the Defense Waste Management Plan

and

Executive Summary of the DOE Defense Waste Management Plan

This plan describes the DOE plans for the permanent disposal of high-level and transuranic wastes resulting from military nuclear waste activities in each of the states where military waste is located. The DOE plan notes the strong commitment made to safely dispose of nuclear wastes. The plan provides an overview of DOE nuclear waste management including the costs and milestones expected to carry the plan through the year 2015.

DOE/DP-0015

The Defense Waste Management Plan

June 1983

U.S. Department of Energy
Assistant Secretary for Defense Programs
Washington, DC 20585

THE SECRETARY OF ENERGY
WASHINGTON, D.C. 20585

May 25, 1983

MEMORANDUM FOR The President
The White House

Enclosed for your transmittal to Congress is the Defense Waste Management Plan developed by the Department to comply with Public Law 97-90, the Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1982. The report describes reference plans for the permanent disposal of high-level and transuranic wastes resulting from atomic energy defense activities in each of the six States where such waste is located.

It should be noted that with the strong support of this Administration, we have initiated an extensive effort to reverse the open-ended "interim" storage approach which has been in effect for decades. In FY 1983, construction funding was approved for the Waste Isolation Pilot Plant in New Mexico. This facility will demonstrate the safe disposal of defense waste. In the FY 1984 budget, construction of the Defense Waste Processing Facility at Savannah River was approved. This facility will immobilize into a glass form suitable for disposal, the sludge waste currently stored in large tanks. In addition, facilities were approved for processing the large volume of stored transuranic waste in Idaho so that such waste will be suitable for permanent disposal.

The report being forwarded to you contains plans for additional new facilities for the treatment of nuclear wastes at other defense sites. Because such wastes have been and can continue to be stored in a safe and environmentally sound manner, the Department is addressing the final disposition of these wastes in a set of sequential steps on a site-by-site basis. Not only does this avoid large funding fluctuations, but also it allows the Department to acquire operating experience before proceeding to the next site. The reference plan provides the necessary context for implementing site-specific activities. As new information is developed or new technical options become available, the Plan will need to be adjusted accordingly.

In that regard, cost estimates and schedules in the report will be reviewed annually by the Department during the course of the normal budget cycle. We will shortly begin preparing our FY 1985 budget submission. New activities described for FY 1985 in the report will be evaluated in terms of their scope, timing, need, and relative ranking compared to other Departmental priorities.

The Plan has already been informally coordinated with the Environmental Protection Agency, Department of the Interior, and Nuclear Regulatory Commission. The Governors of the States of Georgia, Idaho, Nevada, New Mexico, South Carolina, Tennessee, and Washington were briefed and provided with a draft plan for review and comment. The congressional delegations of the seven States and the congressional committees which have cognizance over atomic energy defense activities were also briefed. Comments received as a result of these reviews have been addressed in the Plan or reconciled with the originating organization by separate correspondence.

Additionally, the Plan is mindful of Section 8 of the Nuclear Waste Policy Act of 1982 regarding the placement of defense high-level waste in a commercial or defense repository. An evaluation of this issue is underway.

The Administration can be proud of the strong commitment it has made to the safe disposition of nuclear waste from both defense and commercial nuclear activities. I intend to assure that this commitment is carried out in a manner both that is cost-effective and that recognizes the very real concerns of the Congress and affected States.

Respectfully,

Donald Paul Hodel

DONALD PAUL HODEL

Enclosure

EXECUTIVE SUMMARY

Public Law 97-90, the Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1982, states that:

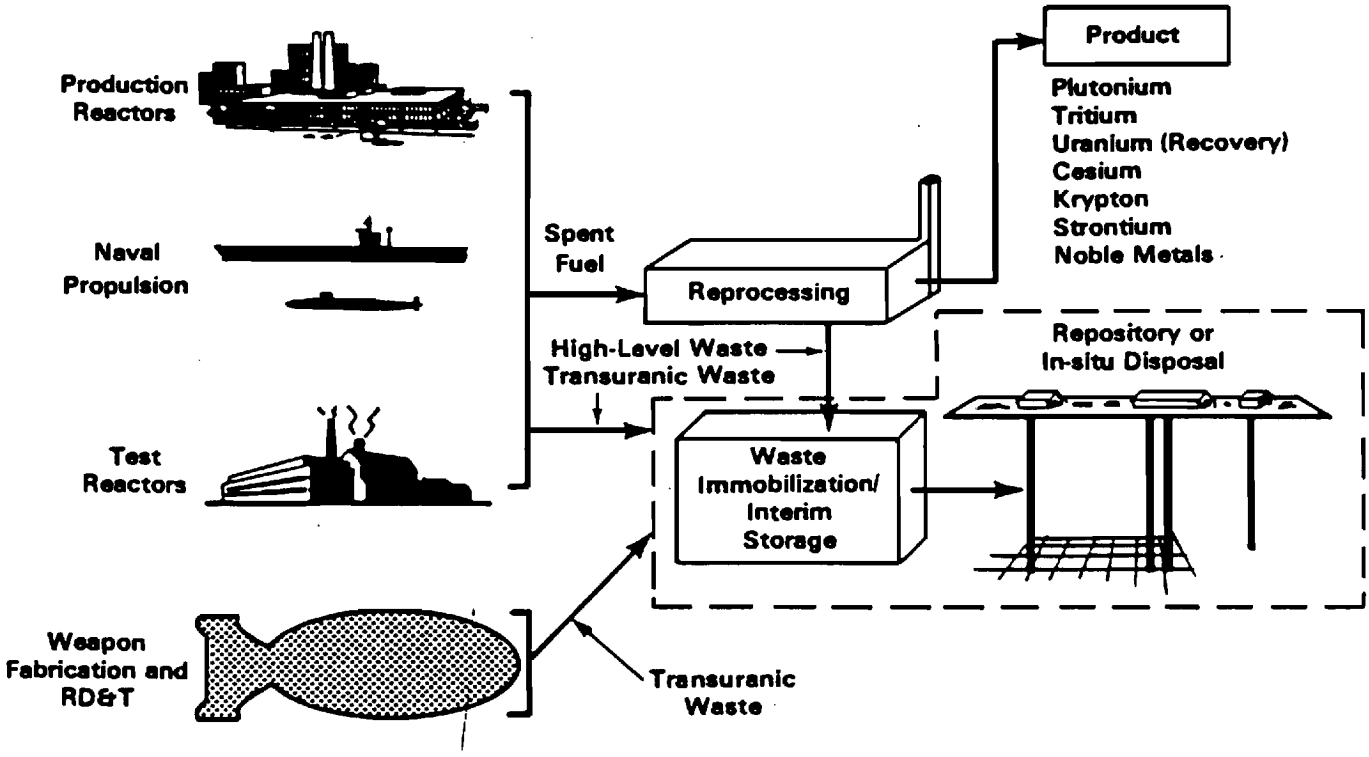
> "The President shall submit to the Committees on Armed Services of the Senate and of the House of Representatives not later than June 30, 1983, a report which sets forth his plans for the permanent disposal of high-level and transuranic wastes resulting from atomic energy defense activities".

According to the Atomic Energy Act of 1954, as amended, and the Department of Energy Organization Act, responsibility for radioactive waste and byproducts generated by DOE's nuclear activities belongs to the Secretary of the Department of Energy. The flow of materials and the resulting waste from the atomic energy defense activities addressed in P.L. 97-90 are illustrated in Figure E-1.

Defense high-level waste (HLW) and defense transuranic (TRU) waste are in interim storage at three sites, namely: at the Savannah River Plant, in South Carolina; at the Hanford Reservation, in Washington; and at the Idaho National Engineering Laboratory, in Idaho. Defense TRU waste is also in interim storage at the Oak Ridge National Laboratory, in Tennessee; at the Los Alamos National Laboratory, in New Mexico; and at the Nevada Test Site, in Nevada. (Figure E-2).

This document describes a workable approach for the permanent disposal of high-level and transuranic waste from atomic energy defense activities. The plan does not address the disposal of "suspect" waste which has been conservatively considered to be high-level or transuranic waste but which can be shown to be low-level waste. This material will be processed and disposed of in accordance with low-level waste practices.

The primary goal of this program is to utilize or dispose of high-level and transuranic waste routinely, safely, and effectively. This goal will include the disposal



Note: The plan covers the outlined portion of the diagram.

FIGURE E-1

ATOMIC ENERGY DEFENSE ACTIVITIES. IRRADIATED FUELS FROM PRODUCTION, TEST AND NAVAL REACTORS ARE REPROCESSED TO SEPARATE PRODUCTS. THE WASTE FROM THESE ACTIVITIES AS WELL AS FROM WEAPON FABRICATION AND RESEARCH/DEVELOPMENT AND TESTING IS PROCESSED AND DISPOSED OF OR STORED PENDING DISPOSAL.

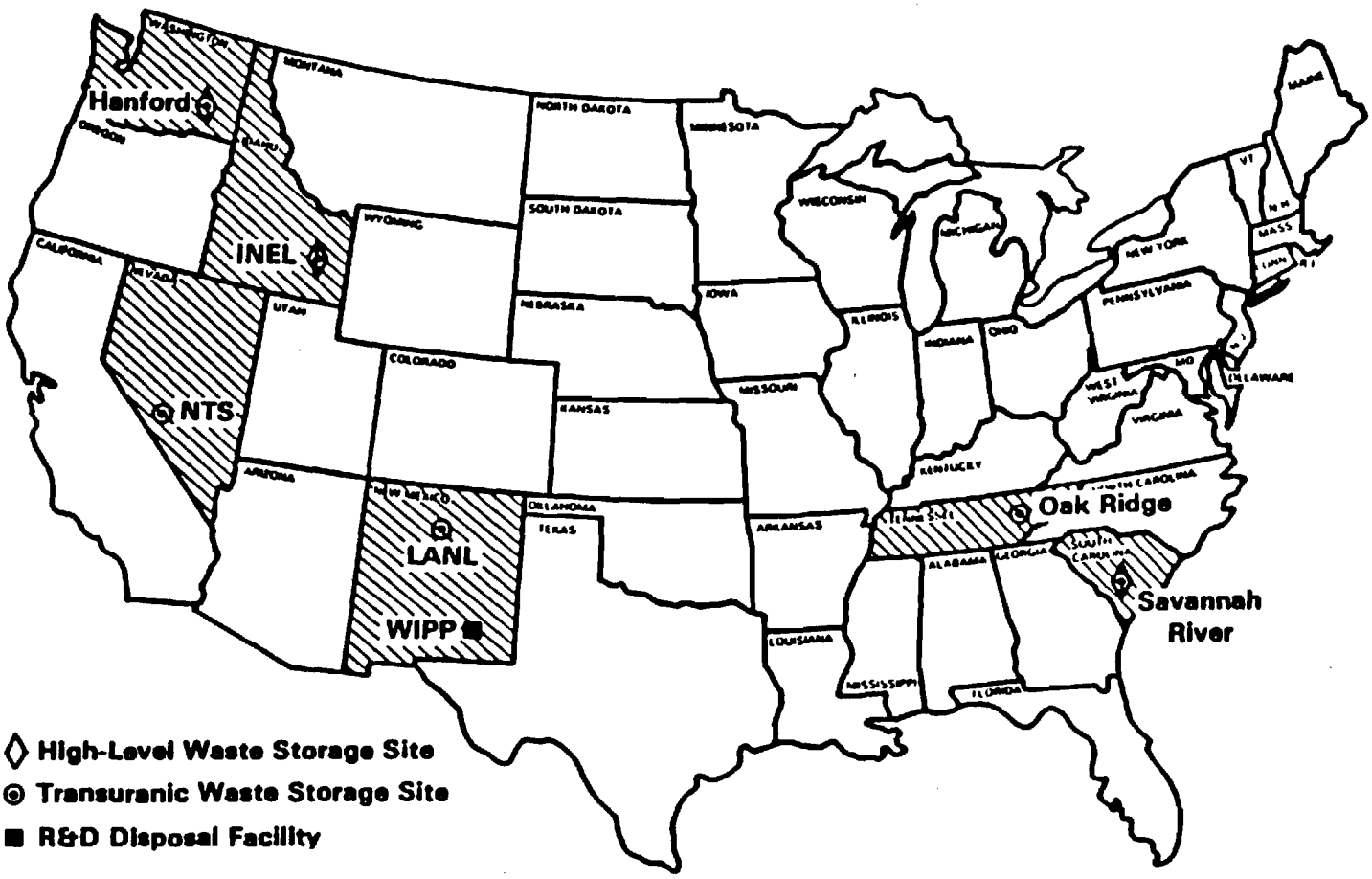


FIGURE E-2
HIGH-LEVEL WASTE AND TRANSURANIC WASTE STORAGE SITES

of the backlog of stored defense waste. A "Reference Plan" for each of the sites describes the sequence of steps leading to permanent disposal.

No technological breakthroughs are required to implement the reference plan. Not all final decisions concerning the activities described in this document have been made. These decisions will depend on: completion of the National Environmental Policy Act process, authorization and appropriation of funds, agreements with states as appropriate, and in some cases, the results of pilot plant experiments and operational experience.

The major elements of the reference plan for permanent disposal of defense high-level and transuranic waste are summarized below:

High-Level Waste (HLW)

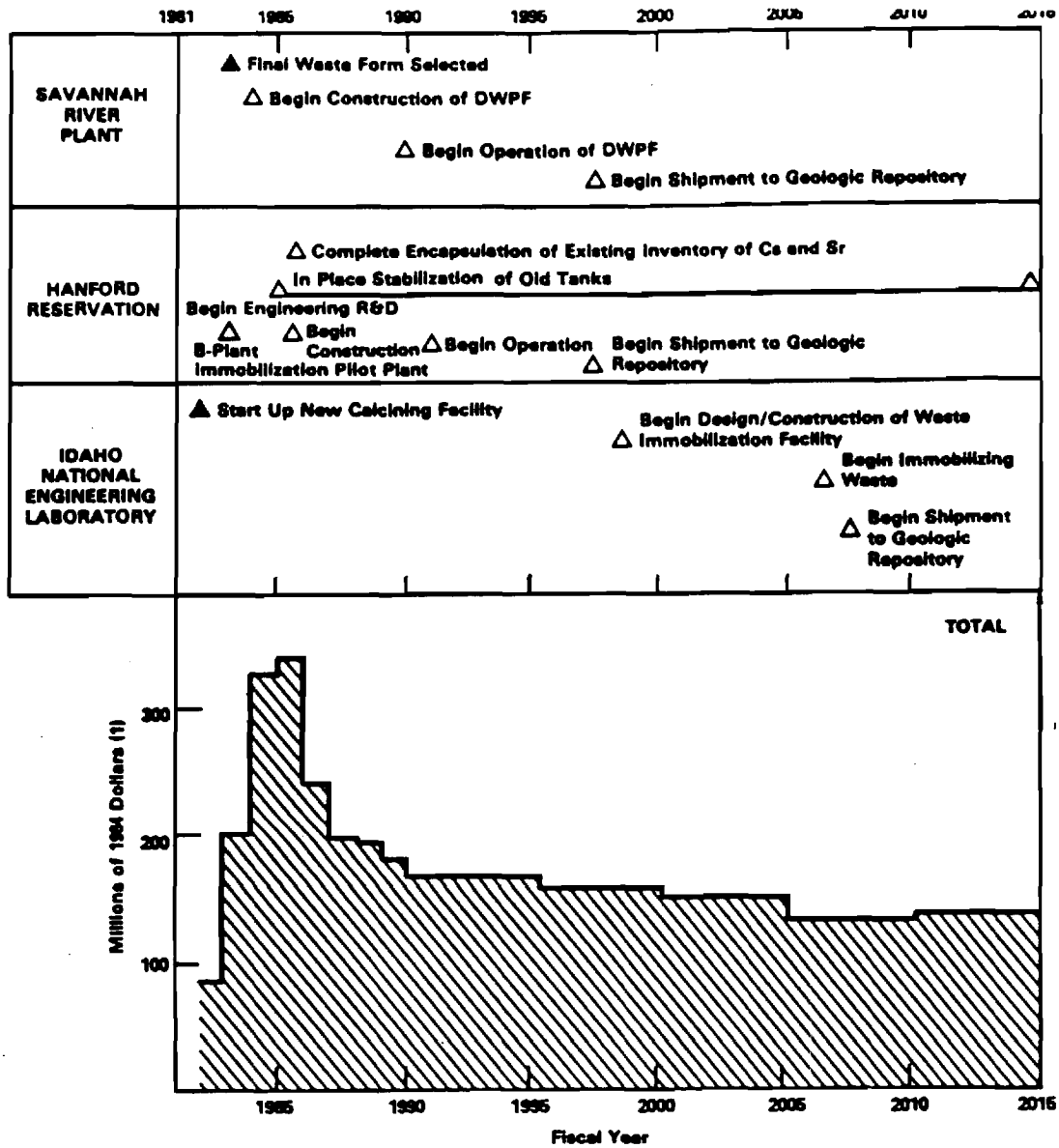
The objective is to end interim storage and to achieve permanent disposal by immobilizing and preparing high-level waste for shipment to a geologic repository. The orderly transition to permanent disposal at the three DOE sites will proceed sequentially (Figure E-3). This approach permits the experience gained at the first site to be applied to the other sites thereby achieving the more efficient use of resources including funding.

Valuable byproduct materials will be separated from the waste for beneficial use in military and civilian applications where separation is economical and safe.

New and readily retrievable old high-level waste will be processed for disposal in a geologic repository. Other waste will be stabilized in place if, after the requisite environmental documentation, it is determined that the short-term risks and costs of retrieval and transportation outweigh the environmental benefits of disposal in a geologic mined repository.

Geologic disposal is the reference method for permanent disposal of immobilized defense high-level waste. The geologic repository is being developed under the commercial radioactive waste management program. It is assumed that the repository can receive high-level waste beginning in 1998. Defense high-level waste will be placed in a commercial repository unless there would be unacceptable adverse impacts to defense programs. The Nuclear Waste Policy Act of 1982 (P.L. 99-425) requires an evaluation of this issue by January 1985.

The plans for the individual DOE sites are described below:



(1) Includes Cost for Transport to and Disposal in Geologic Repository.

△ Milestone

▲ Completed Milestones

FIGURE E-3

MAJOR MILESTONES AND COSTS FOR PERMANENT DISPOSAL OF DEFENSE HIGH-LEVEL WASTE

Savannah River Plant (SRP). High-level waste* from this site is readily retrievable and will be sent off-site for disposal in a geologic repository. Processing for disposal will begin at this site before the other two because it contains 75 percent of DOE's tanked waste radioactivity and because environmental factors are less favorable than at the other two sites. Savannah River Plant waste will be immobilized in the Defense Waste Processing Facility (DWPF) (Figure E-4) beginning in 1989.**

Hanford Reservation. Hanford's high-level waste tanks are isolated from the water table and contain much less radioactivity than tanks at the Savannah River Plant. Immobilization of new and readily retrievable high-level waste will begin about 1990 after sufficient experience is available from Savannah River's vitrification process.

*Volumes of stored waste and quantities of radioactive constituents are shown in Appendix B.

**All years shown in this plan are fiscal years.

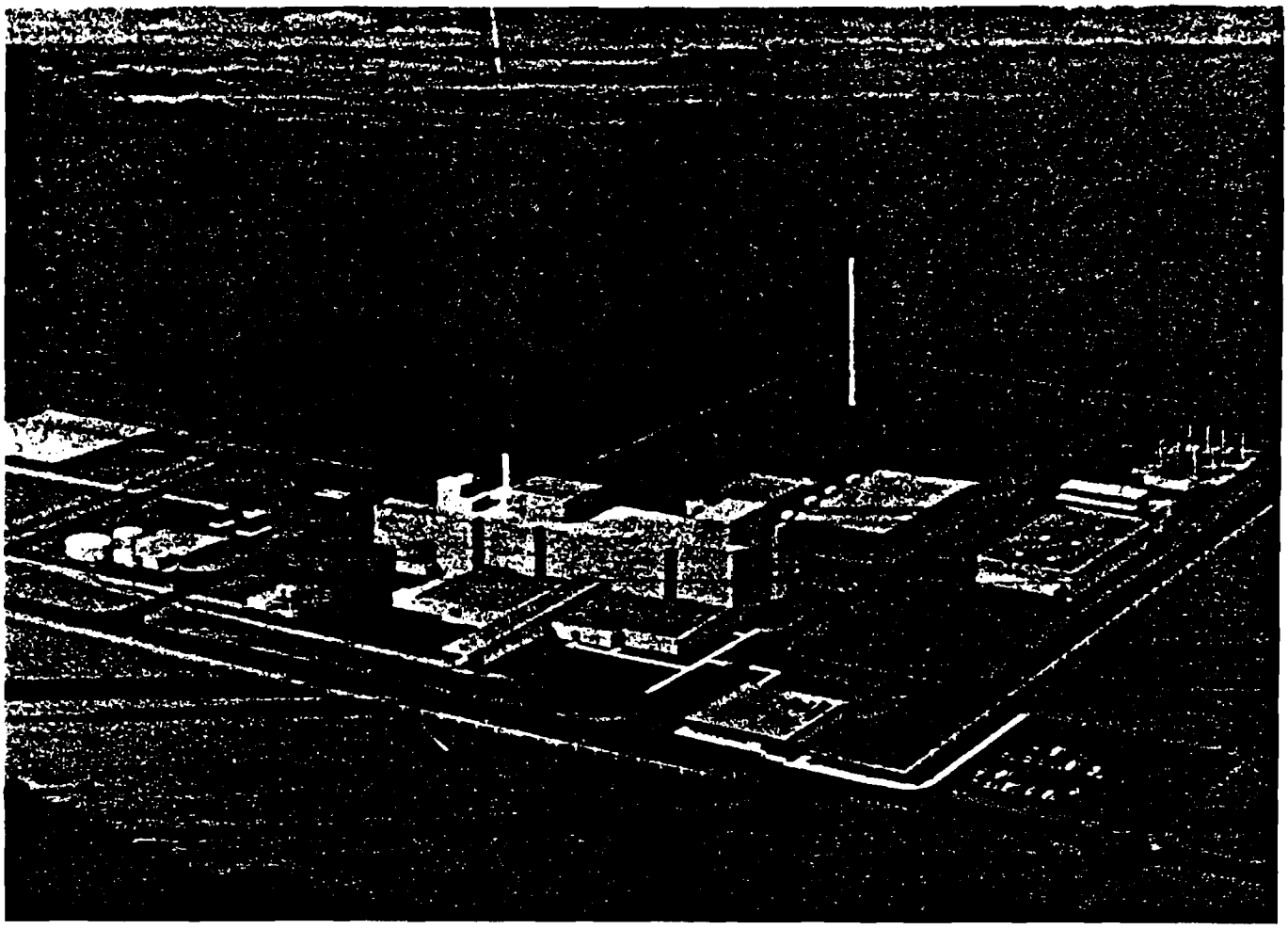


FIGURE E-4

DEFENSE WASTE PROCESSING FACILITY AT SAVANNAH RIVER PLANT

Other waste will be stabilized in place in the 1985-2015 time frame if, after the requisite environmental documentation, it is determined that the short-term risks and costs of retrieval and transportation outweigh the environmental benefits of disposal in a geologic mined repository.

Idaho National Engineering Laboratory (INEL). High-level waste at INEL is readily retrievable and will be processed third because it is being calcined and is exceptionally stable in this solid form. A facility to immobilize new high-level waste from the Idaho reprocessing plant is planned for operation by 2008. It will also be able to process the solid stored calcine.

Milestones and costs for the permanent disposal of defense high-level waste are shown in Figure E-3.

Transuranic (TRU) Waste

The objective is to end interim storage and to achieve permanent disposal. Newly generated and stored defense transuranic waste will be certified for compliance with waste acceptance criteria, after processing if necessary, and then sent to the Waste Isolation Pilot Plant (WIPP). Certification of newly generated waste was initiated in 1983. Stored waste will be retrieved, examined, processed if necessary, and certified. As with the high-level waste, the transition to permanent disposal at the different sites will proceed sequentially. After the WIPP is operational, waste generating sites will send certified waste directly to WIPP. After 5 years of operational experience, a decision will be made to "leave or retrieve" the transuranic waste.

Before 1970, transuranic contaminated solid material was disposed of by burial as low-level waste. The National Academy of Science and others have found that retrieval of this waste can be more hazardous than leaving it in place. The reference plan for such buried waste is to monitor it, to take such remedial actions as may be necessary, and to re-evaluate its safety periodically. Major evaluations will be scheduled as necessary or in about 10-year periods.

The plans for the individual DOE sites are described below:

Idaho National Engineering Laboratory (INEL). The Stored Waste Examination Pilot Plant (SWEPP) will begin certification of retrievably stored transuranic waste in 1985. Experiments will begin in the Process Experimen-

tal Pilot Plant (PREPP) in 1986 to demonstrate production scale treatment and certification and to provide design and operational data for other transuranic waste processing facilities. Processing will begin at INEL before the other sites because it has the largest inventory of stored transuranic waste. Certified transuranic waste will be sent to the WIPP beginning in 1989.

Hanford Reservation. Beginning in 1992, stored waste could be retrieved, examined, and certified in the Waste Receiving and Processing Facility (WRAP). Certified transuranic waste will be sent to the WIPP beginning in 1992.

Savannah River Plant (SRP). Waste processing will begin in 1989 by incineration or by disassembly and decontamination. Stored waste will be retrieved, processed (if necessary), and certified. Certified transuranic waste will be sent to the WIPP beginning in 1992.

Oak Ridge National Laboratory (ORNL). Examination and certification of stored transuranic waste was initiated in 1983. Certified transuranic waste will be sent to the WIPP beginning in 1990.

Los Alamos National Laboratory (LANL). Transuranic waste will be processed in a controlled air incinerator beginning in 1985. Certified transuranic waste will be sent to the WIPP beginning in 1990.

Nevada Test Site (NTS). A decision on where and how to process non-certified waste will be made in 1990. Certified transuranic waste will be sent to the WIPP beginning in 1990.

Waste Isolation Pilot Plant (WIPP). This research and development facility near Carlsbad, New Mexico (Figure E-5) is intended to demonstrate the safe disposal of radioactive waste from national defense programs. The WIPP will be used to retrievably emplace and dispose of defense transuranic waste and to conduct experiments with high-level waste. The limited quantity of high-level waste emplaced for experimental purposes will be removed from the WIPP before decommissioning. The WIPP can be completed in December 1987 and the first radioactive waste received for emplacement 10 months later. The "leave or retrieve" decision will be made after five years of emplacement operations.

The milestones and costs for the permanent disposal of defense transuranic waste are shown in Figure E-6.

The annual cost for the disposal of defense high-level and transuranic waste is shown in Figure E-7. Estimated cost savings from the transition from interim waste management to permanent disposal are also shown.

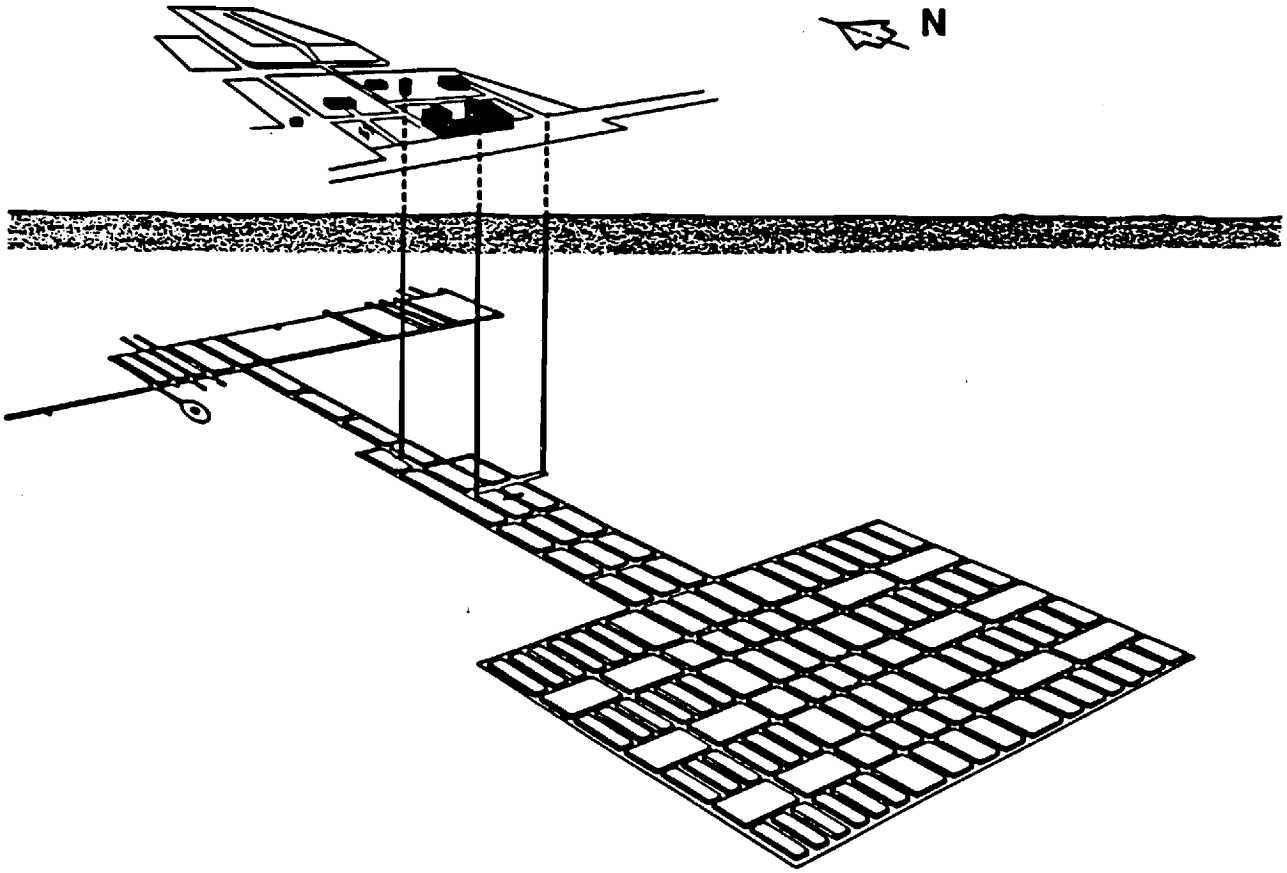
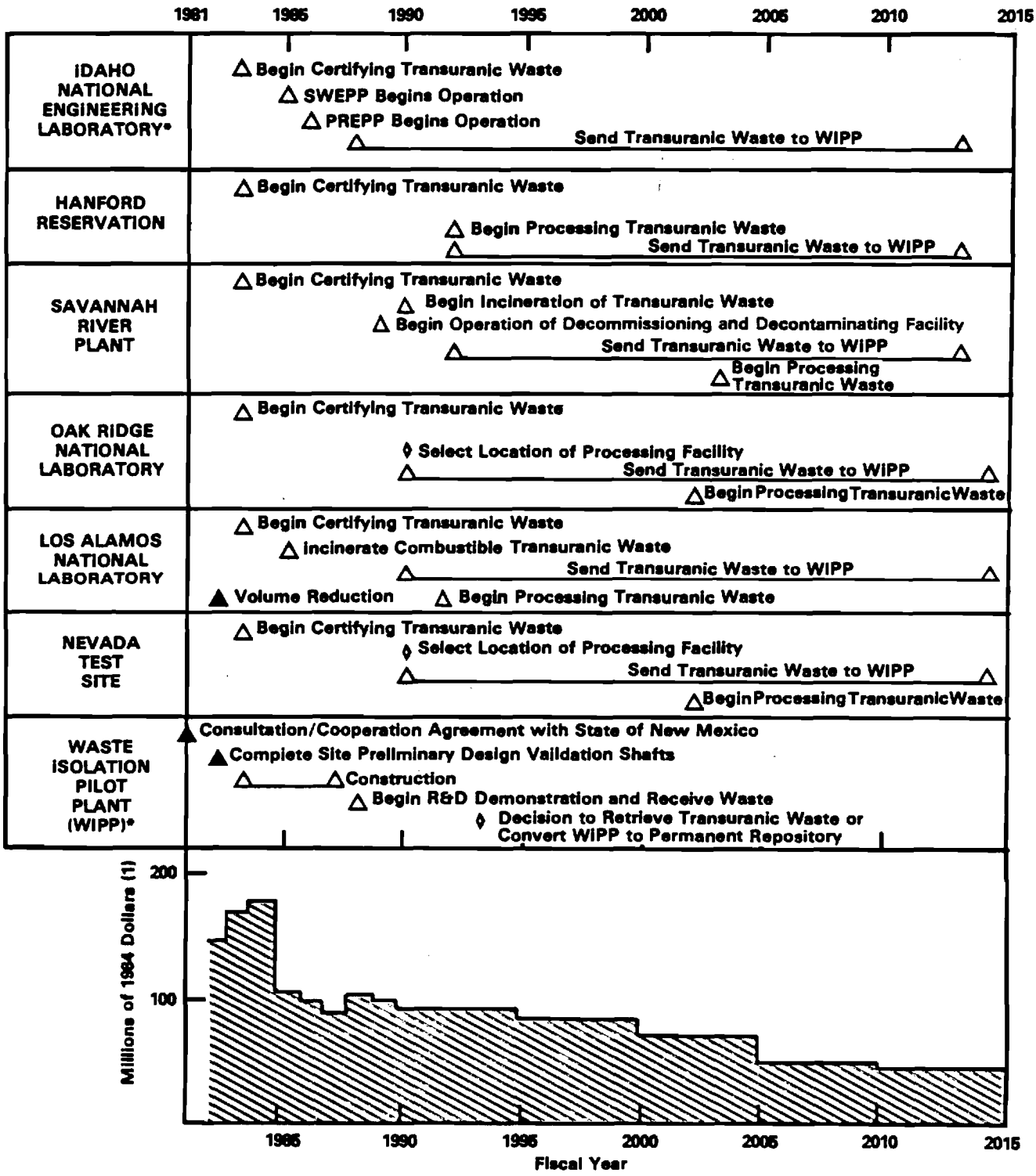


FIGURE E-5
ARTIST PERSPECTIVE OF THE WASTE ISOLATION PILOT PLANT



(1) Includes Cost for Transport and Disposal in WIPP.

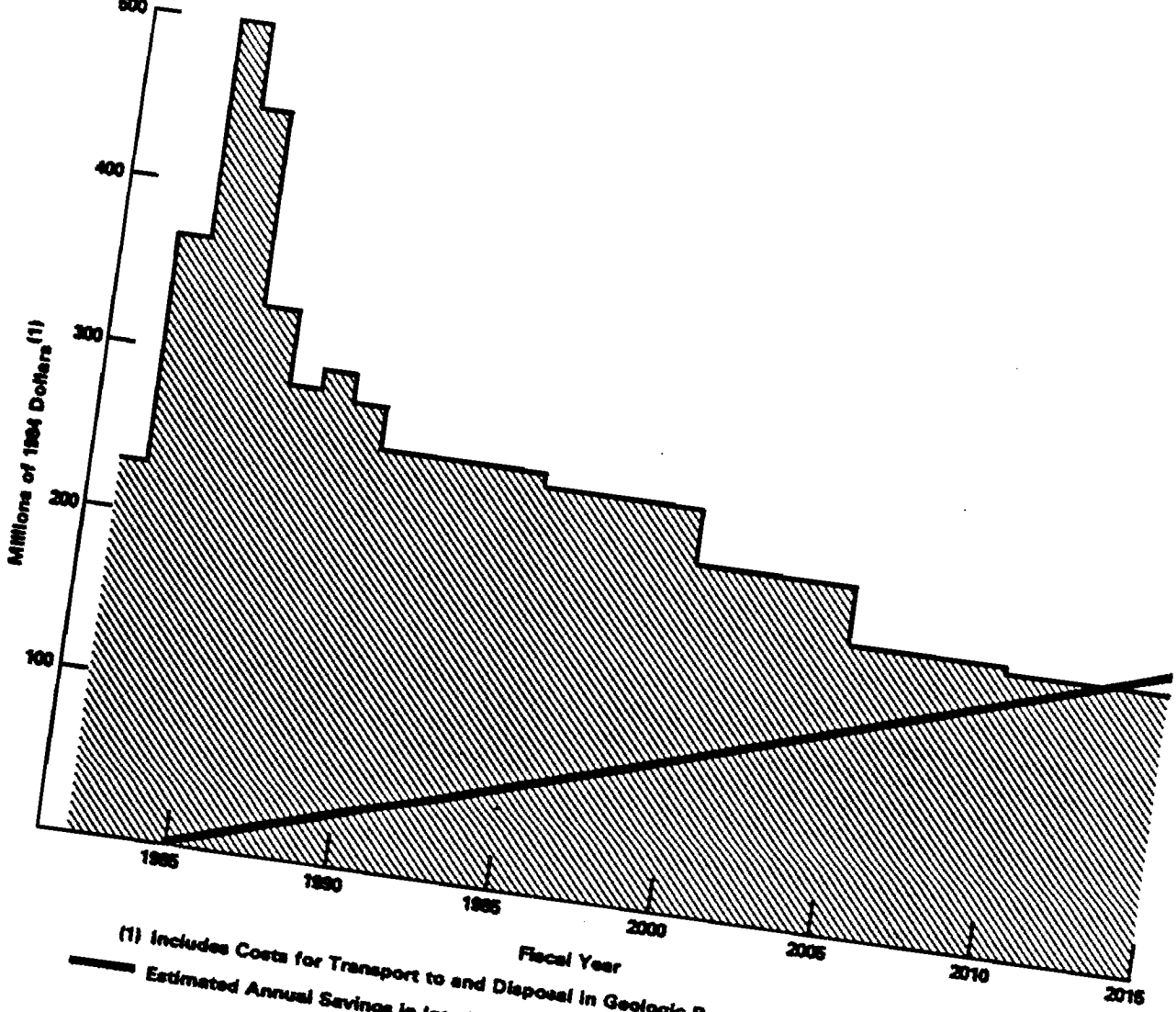
△ Milestone

▲ Completed Milestones

◊ Decision

* The NEPA Process for Shipment of Stored INEL Transuranic Waste to the WIPP has been Completed.

FIGURE E-6
MAJOR MILESTONES AND COSTS FOR PERMANENT DISPOSAL OF DEFENSE TRANSURANIC WASTE



(1) Includes Costs for Transport to and Disposal in Geologic Repository and WIPP.

Estimated Annual Savings in Interim Operation Program Costs Due to Activities Shown in this Plan.

FIGURE E-7

TOTAL COST OF DEFENSE LONG-TERM HIGH-LEVEL AND TRANSURANIC WASTE MANAGEMENT

1.2

"The 'Lost' Mercury at Oak Ridge"

The Science News and Comment article, "The 'Lost' Mercury at Oak Ridge," introduces the large spill of mercury that occurred at the DOE research facility in Tennessee. More than a spill of mercury was involved. Bureaucrats tried to contain information about the release, and a lawsuit filed by environmental groups was enjoined against and then lost by DOE (See the article by B. A. Finamore, Section 2.17 of this casebook.)

Marshall, E. "The 'Lost' Mercury at Oak Ridge" in Science. Vol. 221, 8 July 1983, pp. 130-132.

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The "Lost" Mercury at Oak Ridge

A year after a scientist is disciplined for checking privately on mercury pollution, vast spills from a bomb plant are confirmed

The worst moment in his career, biologist Stephen Gough recalls, was on 12 April 1982 when he learned that his division chief wanted him and his brother to surrender "all the samples, all the field notes, all the analysis sheets" on the vegetation they had collected one Saturday as they walked around the edges of the government facility where Stephen was working. The Goughs complied, for they had aroused higher ups in the bureaucracy and stumbled onto a toxic residue problem of enormous proportions for Stephen's employer, the Oak Ridge National Laboratory (ORNL) of Oak Ridge, Tennessee.

ORNL, a research institution, is one of three federal operations at the site managed for the Department of Energy (DOE) by Union Carbide. The others are the Y-12 hydrogen bomb plant and the K-25 gaseous diffusion uranium fuel plant. Each has its own environmental monitoring staff, linked fraternally with ORNL.

On 5 December 1981, the Saturday when the Goughs went sample collecting, they picked up bits of moss, liverwort, and sycamore roots near a stream that runs under the Y-12 plant. As it turned out, they had begun to document the highest levels of mercury contamination ever recorded in the United States. Tennessee Representatives Albert Gore, Jr. (D), and Marilyn Lloyd (D) plan to hold a day-long inquiry into the affair on 11 July in Oak Ridge, particularly to investigate a report that the Y-12 plant has lost 2.4 million pounds of mercury.

The Goughs did their sample collecting on free time while Stephen's brother Larry was making a family visit on his way home from a business convention in Atlanta. (Larry works for a division of the U.S. Geological Survey (USGS) that analyzes trace metals in the environment.) They hoped to gather enough data to justify a joint ORNL-Geological Survey research project. It is hard to get new projects funded, Stephen explains, and the Oak Ridge environs seemed a fertile source of data. He had learned there were high levels of mercury in the stream from working on an environmental study at ORNL in 1978.

In addition to mercury, the Goughs hoped to look for traces of other toxic heavy metals reported in the area—arsenic, cadmium, and lead. But their plans were cut short. Stephen Gough says that the director of environmental sciences at ORNL, Stanley Auerbach, confiscated all the research materials. "My brother called me that day [12 April]" Gough says, "and told me that his division chief had been contacted by Auerbach and instructed to return all the samples [then at the Geological Survey] to Oak Ridge." Auerbach insisted that no cover letter accompany the package,

Eliot Marshall

Stephen Gough

Reprimanded after finding mercury in moss

probably because DOE wanted "no official record that the sampling and analysis took place," according to Gough.

Gough was angry, but says "I didn't have the guts to call Auerbach." Instead, he talked with an intermediate supervisor, W. Van Winkle, who confirmed that Auerbach had intervened. Today Gough tends to stress the irony of the situation rather than his outrage. The research which Gough was prevented from doing is being done nevertheless, but with more flap and fanfare than if Gough had been allowed to carry on as he had planned.

Gough was reprimanded for insubordination. He left Oak Ridge under a cloud in June 1982, his research unfinished. Auerbach's staff at ORNL picked up the work and carried out a quick study in May 1982. Gough suggests, however, that it was done only to protect the management should word of the problem leak out.

Auerbach said in a telephone interview that he disciplined Gough because the junior scientist took on a study for which he was not qualified, and because Gough involved another federal agency without clearance. Auerbach adds that ORNL staff experts are "acclaimed nationally and internationally for their work on environmental aspects of mercury pollution," but none was consulted by Gough. This led Auerbach to fear that Gough's inexpert work might injure the laboratory's scientific reputation. As it happens, the senior experts have never carried out a thorough mercury study at Oak Ridge, and, in fact, the only known request for such a study, made in 1977, was turned down by DOE. The quick study of May 1982, intended as a follow-up to Gough's work, did not find that he had exaggerated the problem. On the contrary, it reported even higher levels of contamination.

Auerbach confirms that Gough was warned in January 1982 that he might be forced to leave ORNL, but insists that the warning was prompted by budget distress and that it came 3 months before the lab learned of Gough's mercury project. However, as soon as Auerbach did learn of the unauthorized sampling, he stopped the project.

When a USGS supervisor sought permission to record the samples in the spring of 1982, Auerbach refused. He says he asked to have the material returned immediately because it had been collected without consent. He also asked that the findings be kept out of the official records. "No cover letter was requested since USGS was not involved in the sampling, nor did they wish to be," Auerbach says. Asked if he specifically requested no cover letter, he replied: "It is pretty hard to recall a telephone conversation." But he does recall that the USGS official "was happy to get rid of the samples as soon as he could." They were returned as requested—that is, with no traces entered in the file.

After Gough's departure, the local press coaxed out data confirming his early findings and revealing that the Y-12 plant may have lost as many as 2.4 million pounds of mercury since 1953. That was the conclusion of a classified Union Carbide report written in 1977, released only in May 1983 because the *Appalachian Observer* heard about it and filed a Freedom of Information request.

The process that used mercury at Y-12 was shut down in 1963. Yet mercury continues to leak into the little stream known as the East Fork of Poplar Creek, fed by springs under the Y-12 plant. The current rate of leakage, according to James Alexander, a spokesman for DOE, is about 2 ounces a day. He says that staff geologists speculate that hundreds of thousands of pounds of mercury may be lodged in sumps, sewers, and in shale cavities beneath the plant. Whenever it rains heavily, some of the old mercury is stirred and moved into the stream. Yet laboratory officials think that no serious damage has been done to the environment and they say that no human health problems have been reported. There are high levels of mercury in creek sediments and nearby vegetation, and some of the fish close to the Y-12 plant have been found to contain a little over twice the level of mercury accepted by the Food and Drug Administration (FDA) [1 part per million (ppm) is deemed safe]. Oak Ridge officials argue that there is no reason for alarm; this situation has existed for nearly 30 years with no apparent ill effects.

The revelations about the 2.4 million pounds of lost mercury, however, have created a mood of restrained frenzy among health and environmental officials in the area. After insisting for years that it could manage its own environmental problems, DOE conceded recently that perhaps there was a role for state and federal health agencies as well. Under intense pressure, DOE agreed on 26 May to a memorandum of understanding with the state of Tennessee and the regional office of the Environmental Protection Agency, promising to take some remedial action on mercury. The first meeting of a joint study group created by the memo took place on 23 June in Knoxville. One of the two coordinators, state water quality enforcement official Barry Sulkin, says that as far as he is concerned, the DOE's decades-long record of pollution monitoring is less than adequate. He wants to rebuild from the ground up. A comprehensive review is now beginning. Although no sponsor has stepped forward, all eyes have turned to DOE. Sulkin says, "The study will be done, and it will be funded."

Some townspeople are understandably edgy, for mercury in the methylated form is known to affect the central nervous system. In the notorious Minamata scandal in Japan during the 1960's, people died and were paralyzed after consuming methyl mercury dumped into drinking water supplies.

DOE officials have assured Oak Ridgers that their predicament is entirely different because the Y-12 leaks involved only elemental mercury, a form relatively insoluble in water. It is converted slowly by natural processes to methylated mercury, but DOE maintains that the quantities must be small. It seems that none of the mercury has reached the town's drinking water, for these supplies are taken from an area upstream of the Y-12 plant. Downstream, according to DOE, the mercury will sink 300 to 1000 feet into the earth and then be trapped by shale before reaching deep ground water.

Alexander, DOE's spokesman, says that there are some immediate problems requiring more study. DOE would like to know the extent of mercury contamination in vegetable gardens filled with silt taken from the stream bed. DOE hopes to learn whether there is any significant level of mercury in the flesh and milk of cows grazing near the creek. And a few wells near the edge of town are being monitored. Fish in another creek and in the Clinch River (farther downstream) have been found to contain slightly higher than normal amounts of mercury, but not more than the FDA "guideline" level of 1 ppm for commercial fishing.

One of DOE's biggest challenges now is to reestablish its credibility. State water quality official Sulkin says that he has learned from working on this case for 10 months that DOE tends to be too optimistic. For example, Sulkin was surprised by DOE's response when he first learned of the mercury problem in the fall of 1982. He had just been assigned to the region and asked Oak Ridge officials to come to a meeting to discuss pollution. While the DOE representatives confirmed that some fish in the creek were showing unacceptably high levels of mercury, they minimized the finding by saying that Oak Ridge is a town of scientists and engineers who are too busy and too well-off to go fishing for dinner. They calculated that a person would have to eat 159 large bluegills a year to be at risk. Finally, they argued, anyone who did go fishing would not take fish from one of the least promising of local streams and lakes—the East Fork of Poplar Creek. Its fish are too scrawny.

Courtesy of DOE

Mercury poured into Y-12's process pipes (1950's)

In the rush to make H-bomb fuel, DOE says, incoming supplies were not carefully logged.

Sulkin brushed aside these arguments and got approval from the state health commissioner to post the creek as unfit for fishing in December 1982. Since then it has been learned that people occasionally eat turtles taken from these waters. Sulkin is confident that he took the right step, particularly because he does not regard the FDA guideline as sacrosanct. "Up until 1977 the standard was 0.5 ppm," he says. "Then they changed it to 1 ppm for the tuna fish lobby."

Sulkin learned to be skeptical of DOE's data on mercury leaks as well. "We began asking where all the mercury

was coming from," he recalls. "In October they told us there had been a leak of 100,000 pounds in 1966, and half of it was recovered. That was all." Then Sulkin began hearing rumors that an inventory of all mercury leaks was being declassified. He requested a copy during the winter. Just before DOE released the report in response to a newspaper request on 17 May, an official called Sulkin to warn him to brace himself, for "the number would be large." Indeed it was: not only were 2.4 million pounds of mercury unaccounted for, but 475,000 were thought to have gone down Poplar Creek. Sulkin now says, "There are a lot of other chemicals in that creek—PCBs, acids, organic solvents, plutonium." He wants to look into all of them.

One question the congressional inquiry may wish to examine is why it took so long for this pollution to come to light. The official in charge of environmental monitoring at the Y-12 plant, James White, says that he was most concerned with radionuclides and mercury vapors in the workplace and less with the effects on biota outside. The workers' safety was his first priority. White says that the water in the creek meets federal drinking water standards for mercury, and "there isn't any standard for mercury in soil." As for fish, "We did only a small amount of sampling" in the part of the creek near the Y-12 plant, for "as far as we knew it wasn't fished at all." Most samples were taken further downstream near the Clinch River. More fishing goes on there, and mercury levels are also lower.

The research staff at ORNL does not look into local problems such as this unless invited to do so by peers at the Y-12 or K-25 plants, Auerbach explains. However, the managers of Y-12 did ask for some broad advice on pollution in the mid-1970's. Jerry Elwood, an environmental scientist at ORNL, took a preliminary look at the creeks and recommended in 1977 that an in-depth study be funded to learn the extent of mercury pollution. DOE's chief of environmental protection at Oak Ridge, Jerry Wing, wrote back thanking Elwood for his recommendation and informing him that his paper was being classified "business confidential." The issue lay dormant until December 1981, when Gough began collecting samples on his own.

The early information suggests that the town of Oak Ridge is stuck with a major waste cleanup problem but not one that clearly threatens public health. Sulkin says, however, "We're only one-third through." He has not yet tackled pollution from K-25 and ORNL.

—ELIOT MARSHALL

1.3

DOE Responses to EPA comments to the L-Reactor Final Impact Statement

In 1983, the Environmental Protection Agency (EPA) publicly agreed that the environmental assessment performed by DOE for its modernized L-reactor was sufficient and that no formal environmental impact statement was necessary. However, news accounts of disclosures that EPA scientists who were working more directly with the problem disagreed with the EPA's public position undermined the earlier EPA publicity. The L-reactor environment assessment became a formal environmental impact statement and was reviewed in detail by EPA scientists. An excerpt from their review comments, followed by DOE responses, is next.

DOE/EIS-0108
Volume 3 of 3

FINAL
ENVIRONMENTAL IMPACT STATEMENT

L-Reactor Operation Savannah River Plant

Aiken, S.C.

Volume 3

May 1984

U.S. Department of Energy

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IV
345 COURTLAND STREET
ATLANTA, GEORGIA 30365
November 4, 1983

4PM-EA/GM

Mr. M. J. Sires, III
Assistant Manager for Health,
Safety and Environment
U.S. Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, S.C. 29801

Dear Mr. Sires:

In accordance with Section 309 of the Clean Air Act and the National Environmental Policy Act, the Environmental Protection Agency has reviewed the Draft Environmental Impact Statement, and appendices, on the proposed resumption of L-Reactor operation at the Savannah River Plant (Barnwell County) South Carolina. Our evaluation reveals that there are a number of significant environmental issues resulting from this action which remain unresolved or are still under study in an effort to effect mitigation. The major issues are groundwater contamination associated with certain of the reactor's support facilities, discharge of heated effluent into Steel Creek which will result in the destruction of extensive wetlands within the creek and its delta with the Savannah River, and uncertainty involving the treatment and disposal of various potential and actual hazardous wastes generated from reactor operations.

The enclosed comments address all the issues which we have determined or suggest require additional assessment in the Final EIS. Nevertheless, the information in the document, coupled with our extensive dialogue with your staff members and this agency's long-term association with the Savannah River Plant,

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	allow us to make a reasoned decision on the proposal's overall environmental acceptability. On the basis of the outstanding water quality issues, a rating of EU-2 was assigned. That is, we have determined important ground and surface water impacts resulting from the facility's operation will be environmentally unsatisfactory in its currently proposed design in that the document does not provide sufficient information regarding the corrective measures that will be employed to avoid adverse environmental impacts. We know that the DOE is presently working on developing these measures, in cooperation with the regulatory agencies. We believe that much of the additional information that we have requested is already available to you and should be included in the Final EIS. If we can be of any assistance to you on this matter or you wish to discuss any of our observations/suggestions, Howard D. Zeller (FTS 257-3476) will serve as our point of contact. Sincerely yours, Charles R. Jeter Regional Administrator Enclosure	

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	L-REACTOR SAVANNAH RIVER PLANT GENERAL OBSERVATIONS AND SPECIFIC COMMENTS	
DA-1	o The Draft EIS describes the major environmental effects of the project. However, the final EIS could be improved by the inclusion of a more complete description of the deficiencies in the present reactor and attendant support system, and indicating what will be done to correct these conditions. A survey of the projected improvements and new items required for the overall facility to meet air and water quality standards reveals the shortcomings of the present system. It also reveals certain of the cleanup items that are necessary to meet requirements of the Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response Compensation and Liability Act (CERCLA), or DOE equivalent standards. o Most of the improvements necessary to meet the desired standards are adequately described in Chapter 5, "Incremental, and Cumulative Impacts from L-Reactor Operation." However, we suggest that they be summarized in the first chapter, "Summary." Individual detailed coverage could then be given under "Environmental Consequences" in each of the chapters covering items which need mitigation or improvement. The major items in this regard involve addressing surface water discharges of certain contaminants, mitigation of thermal discharges, and better techniques for handling of hazardous materials. A clean-up/monitoring plan, to assess the present zone of contamination, is of special interest. Particular care must also be taken in regard to potential/actual groundwater supplies in those areas already determined to be contaminated or anticipated to become so. o The Draft EIS contains a summary of projects which are being planned or are underway to correct the major deficiencies noted above. These facilities/cleanup measures are vital to any restart effort since they are necessary for the safe operation of the plant and subsequent attainment of air and water quality standards. This should be made clear in the Final EIS.	All applicable Federal and state requirements for air and water quality will be met by L-Reactor, including NPDES permit conditions. In this final EIS, an expanded discussion of cooling-water mitigation alternatives and the SRP groundwater protection and remdial action programs have been included. Pursuant to the suggestions contained in these comments, the summary to Volume I of this EIS identifies the mitigative actions to be taken by DOE, as well as the commitments with respect to other environmental protection programs.

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
DA-2	o The Draft EIS fails to address the impact on the groundwater system from the increase in effluent and waste volumes which will be generated at supporting facilities when the L-Reactor restarts. The report does state (Table 2-2) that there will be a 33% increase in effluent volume at the Fuel Fabrication Facility and at the Chemical Processing Facility, together with a 33% increase in waste volume to the Waste Management Facility. Yet, the Draft EIS omits any further discussion of the implications of the increased volume on the planned remedial actions. It also fails to develop alternative strategies to deal with the additional material. Development of alternatives to deal with this issue was one of the essential suggestions EPA made in its previous coordination efforts on this facility. These options need to be included in the Final FIS.	The EIS contains discussions of potential impacts to the ground waters beneath the SRP from the operation of L-Reactor and its support facilities (Sections 4.1.1.3, 4.1.2.2, 4.3.3, 5.1.1.2, and 5.1.1.4). These sections have been expanded to provide a more thorough discussion of groundwater impacts. As noted in the EIS, the incremental impacts to the shallow aquifers beneath the central shops, burial ground, and M-, F-, H-, and K-Area basins, and impacts beneath L-Area are expected to be minor. Alternatives to the use of the L-Reactor seepage basin are discussed in Section 4.4.3. Use of seepage basins elsewhere on SRP and the use of the SRP burial ground are all being evaluated on a sitewide basis. These facilities were used when L- and R-Reactors were operating. The incremental effects of L-Reactor operation are not likely to appreciably affect planned remedial actions. Alternative strategies to deal with the incremental releases of liquid wastewater and low-level radioactive wastes are discussed in the "SRP Ground-Water Protection Implementation Plan." This plan has been reviewed by the State of South Carolina and EPA and is currently being revised based on their comments. This plan will be the subject of a separate NEPA review (Section F.6). The DOE's commitment to the protection of ground-water quality are discussed below. As noted in the opening remarks to the public hearings on the L-Reactor DEIS, the DOE is committed to (1) an expanded program of sitewide ground-water monitoring and study; (2) the involvement of the State of South Carolina in onsite and offsite ground-water monitoring activities; and (3) mitigative actions at SRP to reduce pollutants released to the ground water as needed. Additional details are provided in Sections 6.1.6 and F.6 of this EIS. Current plans call for discontinuing the use of the M-Area seepage basin before April 1985 and operating a process wastewater-treatment facility at that time. Based on Congressional authorization and approval of a FY 1986 funding request, DOE plans to operate an effluent treatment facility by October 1988 to process wastewater and discontinue the use of the F- and H-Area seepage basins (Section 5.1.1.2).

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
DA-3	o According to DOE's "Groundwater Protection Implementation Plan," the proposed restart comes at a critical stage in the management of SRP's groundwater problem. Three facilities, Fuel Fabrications, Chemical Processing and Waste Management, are scheduled for decommissioning in the near future since they have been responsible for significant groundwater contamination.	As mentioned in response to comment DA-2, the "SRP Ground-Water Protection Implementation Plan" was recently developed to examine strategies and schedules to implement mitigative actions required to protect the quality of the groundwaters beneath SRP. Implementation of mitigative actions would be accomplished under DOE's Resource Conservation and Recovery Act requirements, and would be compatible with the State of South Carolina's hazardous waste management requirements. The small incremental discharges due to L-Reactor restart will be accounted for in the design of effluent treatment facilities that will replace existing seepage basins. The sitewide ground-water protection plan will be the subject of a separate NEPA review (Section F.6). This NEPA review on the ground-water protection plan will cover such topics as seepage basin decommissioning, cleanup levels, costs and schedules, and need for institutional controls.
DA-4	To comply with the Congressional mandate, the Fuel Fabrication Facility basin will be closed out by June 1985. At that time, wastewater will be routed to a wastewater treatment unit. At present, the seepage basin which receives effluent from the Fuel Fabrication Area is impermeable to downward percolation. This results in effluent overflows in a southwesterly direction to a lake down gradient. Severe contamination in the upper aquifer poses an imminent threat to a deeper aquifer that supplies drinking water to plant employees and off-site communities. Even though this could only be a short-term situation, the potential health and safety implications should be addressed in the Final EIS.	Pollutants, principally chlorinated hydrocarbons used as degreasers, that were released to the M-Area basin, leaked from the process sewer, and spilled from the M-Area solvent tank in the early 1960's, have migrated into the Tertiary sediments. This contamination is discussed in Sections 5.1.1.2. The sewer line to Tims Branch no longer receives process wastewater and the line to the M-Area basin has been repaired; discharges to the M-Area basin will be discontinued by April 1985. Although seepage basins have been in service at SRP since the mid-1950s, drinking water from the Tuscaloosa wells in the central portion of the SRP does not appear to be contaminated by radionuclides or chlorinated hydrocarbons. However, in 1983, two wells producing from the Tuscaloosa in A-Area were found to have low concentrations of chlorinated hydrocarbons; concentrations in water samples from these wells ranged from less than 3 to less than 27 micrograms per liter. Based on recent investigations by Geraghty & Miller (1983) the following findings have been made with respect to the entry of chlorinated hydrocarbons into the Tuscaloosa Aquifer: "The presence of trichloroethylene in well 53-A indicates that contaminants most likely are migrating from the shallower Tertiary zone downward along the outside of the well

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
		casing into the gravel pack outside of the well screen section. The contaminants appear to enter the well in the upper part of the screened section between approximately 400 and 500 feet bls. An alternate interpretation considered is that the contamination is entering the well from the upper Tuscaloosa itself. However, this zone is free of contamination only 250 feet away, as shown by the analyses of water samples from monitor wells MSB-34 TA and TB." Public health and safety will be protected by the extensive monitoring program and plume management and remedial action strategy that is planned for M-Area. When monitoring first confirmed the presence of chlorinated hydrocarbons in water from A-Area Tuscaloosa wells, the contaminated wells were shut down to protect onsite personnel. The monitoring in A- and M-Areas and neighboring municipal water wells has shown that the contaminants have not migrated offsite and that no offsite health risk will exist in the foreseeable future. The M-Area ground-water remedial action project, scheduled for implementation in August 1984, is being designed to prevent chlorinated hydrocarbons from reaching the Tuscaloosa Aquifer and any offsite well producing from the Tertiary ground-water system (Steele, 1983). The remedial program will arrest further migration of the present contaminant plume in the Tertiary ground-water system. State and Federal agencies are reviewing plans for impeding the growth of the contaminant plume and the removal of the chlorinated hydrocarbons using a combination of recovery wells, and a large air-stripper with a capacity of at least 9 times the incremental discharges to the M-Area seepage basin. Pilot and prototype air-strippers are currently operating in M-Area with capacities of 0.075 and 0.18 cubic meter per minute, respectively. In addition, the health of onsite personnel will be protected by changes in the water distribution system, which will obtain potable water only from the A-Area Tuscaloosa wells, which are unlikely to receive contamination from Tertiary aquifers. DOE has recently conducted a workshop to discuss and review the M-Area remedial action program. Participants included the EPA, SCDHEC, SC Water Resources Commission, USGS, DuPont, and Geraghty & Miller. All agreed that the planned program is sound technically.

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
		The L-Reactor incremental releases to the M-Area seepage basin are currently projected to be 0.16 cubic meter per minute; they are expected to be substantially smaller by the end of 1984. The incremental releases will not contaminate the groundwater within the Tuscaloosa Formation, nor will drawdown of the Tuscaloosa Formation by pumping in A-Area increase the movement from the seepage basin and Lost Lake areas to the watertable. The A- and M-Area ground-water remedial action project is scheduled to be operating by August 1984. The recovery wells will intercept seepage from the M-Area seepage basin and Lost Lake areas when it reaches the water table in about 10 to 17 years. Use of the M-Area seepage basin is scheduled to be discontinued by April 1985, when a wastewater treatment facility will be in service. Additional details are provided in Section 5.1.1.2, which has been expanded.
DA-5	Decommissioning of the Chemical Processing Facility basins is planned for late 1988. The effluent will then be routed to a wastewater treatment unit, with subsequent discharge to surface water. The present effluent, which is discharged to seepage basins, meets the definition of a hazardous waste based on pH and chromium. Groundwater in the area has been contaminated by both of these constituents, as well as radionuclides. As a result of seepage, surface streams and adjacent wetlands are receiving contaminated discharge from the groundwater system. Any additional discharge volume (i.e., the 33% additional volume from L-Reactor operation) can only contribute to the existing problem. Again, the health and safety implications of this issue need to be addressed in the Final EIS.	The amount of mercury and chromium released to the Separations Areas seepage basins has decreased since the early and mid-1970's. Before 1972, approximately 7.9 and 9.4 kilograms of mercury were released per reactor to the F- and H-Area basins, respectively. More recently, the average contribution per reactor has been about 0.7 and 2.1 kilograms, respectively. Releases of mercury to these basins is currently 0.5 and 8.0 kilograms per reactor. The addition of a second evaporator to process radioactive waste in the H-Area waste tanks has caused a small increase in the amount of mercury added to the H-Area seepage basin since mid-1982. In 1975 approximately 120 and 2310 kilograms of chromium were discharged to the F- and H-Area seepage basins respectively. The discharge of chromium to the H-Area seepage basin since 1982 was principally due to the processing of radioactive waste produced prior to 1982. After processing by the waste evaporator, the concentrated fractions are sent to the high-level radioactive waste storage tanks. Newly generated chromium that comes from the RBOF facility, which processes offsite fuels and removes oxide from onsite target assemblies, is processed through a waste evaporator. This process step greatly reduces the amount of chromium released to the H-Area seepage basins. Incremental releases of chromium to the H-Area seepage basin from SRP reactor support operations are currently about 0.2 kilogram per year per reactor and are not expected to be hazardous.

Table H-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
		On an annual average basis the releases of mercury and chromium to the F- and H-Area seepage basins are expected to remain at levels below those considered hazardous. Weekly composite analyses showed that the influent streams to these seepage basins were not hazardous with respect to mercury and chromium in 1982 (J.D. Spencer letter to G.A. Smithwick of 13 May 1983); these waste streams could be frequently classified as hazardous on the basis of low pH. In 1983, however, the waste streams to the H-Area basins exceed the hazardous limits of mercury and chromium about 10 percent of the time. Most of the chromium entering the basin is related to the processing of non-SRP fuel elements. In 1983 mercury exceeded the 200 microgram per liter hazardous limit in 6 weekly composite samples, reaching a maximum of 640 micrograms per liter. The source of mercury to the basins is waste tank evaporator overheads. Although more mercury will go to tanks as a result of L-Reactor restart, discharges of mercury should not increase significantly. Also, fewer exceedances of the mercury limit are expected because the amount of mercury being released has been reduced. The continued use of the F- and H-Area seepage basins is being evaluated on a sitewide basis (Section 6.1.6. and F.6 of the FEIS) Waste treatment facilities for the F- and H-Areas are being studied and bench scale demonstrations are being performed. The draft SRP Groundwater Protection Implementation Plan discusses the schedule for completion of the waste treatment facilities in the Separations Areas (October 1988) provided Congressional authorization and appropriation is obtained. The L-Reactor incremental releases to the Separations Areas seepage basins are projected to be 0.04 cubic meters per minute and 0.09 cubic meters per minute to the F-Area and H-Area seepage basins, respectively. The incremental releases are expected to increase the concentrations of constituents in the contaminant plume by about 7 percent. The water quality ofFour Mile Creek will be impacted as the ground water flows into the creek through seepline springs in lowlying wetland areas. Concentrations of constituents in the creek water will be increased by about 7 percent. However, drinking water standards are not expected to be exceeded, and the quality of the creek water is expected to be similar to that of the Savannah River below the outfall of C-Reactor. Radioactive constituents will meet DOE criteria for releases to uncontrolled areas when Four Mile Creek flows into the Savannah River. The direction of

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
		ground-water flow and the ground-water islands make it highly unlikely that any contaminated shallow ground water will reach offsite ground-water users (Du Pont, 1983; DPST-83-829). Beneath the central portion of SRP, the predominant flow directions in the Congaree and Tuscaloosa are toward the Savannah River; these formations discharge to the Savannah River. Also see the responses to comments DA-2 and DA-4.
DA-6	The draft "Groundwater Protection Implementation Plan" proposes to decommission the Low Level Waste Burial Ground in the late 1990's; however, EPA has requested that the decommissioning and alternate disposal plan be expedited. The present practice of disposing of low level radioactive waste, in combination with chemical waste, into trenches in the ground does not represent state-of-the-art technology and may violate RCRA requirements. To increase the volume of waste which must be handled by this facility before the decommissioning plan has been developed, is out of logical phasing. Practically speaking, SRP needs to develop a proper disposal facility to handle the present volumes of waste materials before any additional waste is generated. Impacts on the groundwater system from the discharge of contaminated water from the disassembly basin to a seepage basin located near the L-Reactor, have been discussed in the Draft EIS. Wastewater discharged to this basin is primarily contaminated with radionuclides which contaminate the upper aquifer and eventually discharge to Steel Creek. Alternatives to seepage basin disposal were discussed and evaluated in the EIS, with the subsequent conclusion that seepage basin disposal is the preferred alternative. As stated before, seepage basins do not represent state-of-the-art disposal technology and may violate RCRA requirements. Every attempt should be made to develop an appropriate alternative to replace the seepage basin, or to improve	SRP operating procedures do not allow hazardous wastes to be disposed of at the SRP burial ground. An implementation plan is being developed at SRP to assure compliance with DOE requirements (DOE Order 5480.2) for the management of hazardous and radioactive mixed waste. A groundwater protection plan and a RCRA program management plan have been formulated by DOE for SRP. Research programs at SRP are investigating new methods for immobilizing and improving methods of low-level radioactive waste disposal at SRP. These programs include (1) wastewater treatment processes; (2) beta-gamma waste incineration; (3) immobilization and stabilization of waste in cement grouts (saltcrete and ashcrete); and (4) greater confinement disposal technologies. Effluents discharged to F-, H-, and M-Area seepage basins frequently meet the definition of hazardous waste because of low pH. Typically, these waste streams can contain 1,1,1-trichloroethane (M-Area), chromium (H-Area), and mercury (F- and H-Areas). In 1982 the concentrations of these substances were below levels considered to be hazardous (J. D. Spencer letter to G. A. Smithwick dated May 13, 1983). However, in 1983 the waste streams to the H-Area seepage basin exceeded the hazardous limits for mercury and chromium about 10 percent of the time. As noted in response to comment DA-4, almost all of the chromium entering the H-Area seepage basin is related to the processing of non-SRP reactor fuel elements. In 1983, mercury exceeded the 200 microgram per liter hazardous limit in 6 weekly composite samples, reaching a maximum of 640

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	water quality before discharge to the groundwater, to minimize impact on the groundwater system and associated discharge areas. In the meanwhile, the range of potential consequences of this situation should be discussed in Final EIS.	micrograms per liter. The total discharge (including the L-Reactor incremental releases) of chromium and mercury are expected to be below their respective hazardous limits on an annual average basis. The contaminant plumes from the F-, and H-Area basins will be confined to the Tertiary groundwater systems. DOE Order 5480.2, "Hazardous and Radioactive Mixed Waste Management," was issued on December 13, 1982, to regulate the generation, transportation, treatment, and/or disposal of hazardous wastes at DOE defense-related facilities. As noted in Chapter 7 of this Final EIS, DOE is implementing--under the 22 February 1984 Memorandum of Understanding with EPA--a Hazardous Waste and Radioactive Mixed Waste Management Program which is comparable to the design and performance criteria, other technical requirements, and record keeping and reporting requirements of the regulations adopted by EPA to implement RCRA. The SRP hazardous-waste management program will meet the technical requirements of the EPA hazardous-waste regulations (40 CFR 260-266 and 270) and is compatible with SCDHEC requirements. DOE is also working closely with SCDHEC on all activities related to hazardous-waste management. The remedial actions proposed in the draft "SRP Ground-Water Protection Implementation Plan" are consistent with the DOE RCRA compliance program; initiatives will be compatible with SCDHEC hazardous-waste management regulations. DOE is formulating closure plans for seepage basins and the burial ground on a sitewide basis. The NEPA review of the ground-water protection plan will, when applicable, address the decommissioning of certain facilities to the extent practicable. The consequences that might result from the use of the L-Reactor seepage basin or one of the alternatives to its use have been discussed in Sections 4.1.2.2 and 4.4.3. Sufficient details are provided to assist the decisionmaker in formulating a reasoned decision relating to the disposal of deionized and filtered disassembly purge water.

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
DA-7	o Control and disposal of hazardous wastes generated by the operation of the L-Reactor are not adequately addressed. The types and quantities of hazardous wastes produced and how those wastes are handled in terms of storage, treatment and ultimate disposal need to be detailed. The Final EIS should address the type of technical standards which DOE will use for the storage, treatment, and disposal of hazardous wastes, as well as how DOE will comply with state and federal environmental permitting requirements for hazardous waste facilities under RCRA. In a letter to EPA in November 1980, DOE stated that it considered its hazardous waste activities at the Savannah River Plant to be exempt from regulation under RCRA. However, a June 22, 1983, opinion from A. James Barnes, EPA General Counsel, states that RCRA applies to DOE facilities except in instances where application of those regulations would be inconsistent with the requirements of the Atomic Energy Act. From the limited information on page 5-2, it appears that the facility does generate some wastes which will be regulated under RCRA. Therefore, the Final EIS should provide a list of those waste chemicals which are considered hazardous under RCRA, and a description of how these wastes will be handled in compliance with RCRA. During the permitting process, EPA will evaluate all groundwater quality data, the design and operating procedures for those basins/ponds, and any other hazardous waste activities. Section 5.1.1.2 describes the increase in contamination of the groundwater as a result of the L-reactor operation but does not discuss any remedial action for cleaning up the groundwater. This contamination is coming mainly from seepage basins in the F and H areas, Since the "SRP Groundwater Implementation Protection Plan" is mentioned in the response to DA-2, and since the corrective action for the seepage basins in areas F and H would be accomplished under that plan, a tentative schedule for its implementation should be developed. This schedule would take into consideration the the uncertainties of the review process. If Order DOE 5480.2 incorporates the provisions of RCRA by reference, as stated, then it contains requirements for corrective action for groundwater contaimination.	Sections 4.1.1.5, 4.1.1.7, 4.1.2.1, 4.1.2.2, 5.1.1.2, 5.1.2.1, 5.1.2.2, and 5.1.2.8, which have been expanded, discuss discharges from L-Reactor and the incremental discharges in the F- and H-Areas and M-Area. The handling of these wastes will be in accordance with DOE Order 5480.2 and the 22 February 1984 Memorandum of Understanding with EPA. DOE will cooperate with and coordinate these activities with SCDHEC. Effluent treatment facilities that would take the place of the F- and H-Area seepage basins are scheduled to be completed by October 1988, and the seepage basins are scheduled to be decommissioned by the end of 1990, pending Congressional authorization and appropriation. Current plans call for discontinuing the use of the M-Area seepage basin before April 1985 and operating a process wastewater-treatment facility at that time. The M-Area ground-water remedial action project is scheduled for implementation in August 1984. Also see the response to comment DA-6.

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
DA-8	o The effect on groundwater of material leaving the seepage basins poses some further environmental concerns involving RCRA. F&H area studies have shown that chemicals, e.g., mercury, 1,1,1,-trichloroethane and chromium from the seepage basins have entered the shallow groundwater system and are migrating through the saturated soil to outcrop zones and springs near Four Mile Creek. Although water quality in the Savannah River is expected to meet the criteria for a Class B waterway below Four Mile Creek, there is no mention of how these groundwater discharges affect Four Mile Creek. This appears to demonstrate a method of discharging pollutants to a stream without a permit by using the groundwater as the medium of transport. Furthermore, RCRA requires that all hazardous wastes be contained or, if a treated by the land treatment method, that the contaminant not go beyond the treatment zone. Since there is a definite relationship between reactor operations and waste products generated and stored in all areas of SRP, this matter needs to be resolved in the Final EIS. o Likewise, contaminants discharged to the seepage basin in M area have entered the groundwater. Methods to remove these contaminants are presently being investigated. Nonetheless, the basin will be deactivated in 1985. The resultant mitigation plan developed from these studies should be expeditiously formulated and made available for interagency review in a supplemental document. We recommend that closure plans for M area be developed immediately and that these closure plans contain enforced schedules. Post closure plans describing groundwater monitoring and corrective action for groundwater contamination, should also be developed. The closure and post closure plans should be submitted to EPA and the South Carolina Department of Health and Environmental Control for review. o In a related matter, there is concern that the resumption of L-Reactor operation will result in increased groundwater withdrawal. This could cause additional drawdown of the groundwater level beneath adjacent seepage basins, thereby increasing the tendency of contaminants to enter the groundwater and migrate. This possibility should be factored into any mitigation study with the range of potential impacts discussed in the Final EIS.	RCRA considerations are discussed in the responses to comments DA-6 and DA-7. Gas chromatograph scans for hydrocarbons in the effluent released to F- and H-Area seepage basins show concentrations of less than 66 micrograms per liter. These concentrations are similar to those measured in upgradient and downgradient ground water (Section F.5.3; Du Pont 1983, DPST-83-829). As noted in Sections 5.1.1 and 5.1.2 discharges of chemicals and radioactivity have migrated from the ground water beneath the F- and H-Area seepage basins to outcrop zones near Four Mile Creek. As a result, concentrations of chloride, nitrate, sulfate, sodium, and calcium are substantially higher in Four Mile Creek upstream of C-Reactor cooling-water effluent than in Upper Three Runs Creek; the concentrations of these chemicals in Four Mile Creek are similar to those in the Savannah River (Table 4.17 in DOE, 1982, DOE/EIS-0082). Tritium and nonvolatile beta activities are also elevated in this stretch of Four Mile Creek, (Ashley et al., 1982, DPSPU 80-302), but do not exceed DOE concentration guides for uncontrolled areas. Incremental impacts to the water quality due to L-Reactor operation are expected to be small. At most, the concentrations will increase by 7 percent. The water quality of Four Mile Creek above the C-Reactor outfall will remain similar to that of the Savannah River. Tritium and other radionuclides in Four Mile Creek will not exceed DOE concentration guidelines for releases to uncontrolled areas. The DOE commitment to ground-water quality protection and remedial actions in relation to M-Area are discussed in response to comment DA-2. The migration of contaminants from seepage basins into the shallow groundwater systems and the protection of public health and safety are discussed in the revised Sections 4.1 and 5.1 of this EIS as well as in response to comments DA-4 and DA-5. Several hydrogeologic systems exist beneath the SRP seepage basins. A thick clay unit of the basal Congaree and upper Ellenton formations overlies the Tuscaloosa sands and separates this unit from overlying units. Other clays hold intermediate positions between the Tuscaloosa and the surface. Thus,

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
		drawdowns in the Tuscaloosa will not tend to increase the movement of pollutants from seepage basins to the groundwater. In A-Area the cone of depression in the Tuscaloosa Formation is not reflected in the water level of the overlying Tertiary groundwater system even though the green clay is discontinuous in this area. The green clay in the Separations Area is about 2 meters thick and has a very low permeability; it supports a head difference of as much as 24 meters. Measurements at the H-Area seepage basins indicate that the underlying Congaree Formation has not been contaminated by tritium migrating from these basins. The green clay also supports a large head difference at the Par Pond pumphouse well. Tritium concentrations in this well are below background levels even though Par Pond water exhibits tritium concentrations of 27,000 pCi/l. At the pumphouse and in L-Area the green clay is about 7 meters thick and very impermeable. Groundwater withdrawal from the Tuscaloosa Aquifer for L-Reactor and incremental use is expected to be only a few percent greater than in 1982. The green clay and other clay units above the Tuscaloosa Formation will continue to offer protection to Tuscaloosa groundwater in areas where the upward head differential between the Tuscaloosa and Congaree Formations becomes zero or downward.
DA-9	o The large, uncontrolled, thermal discharges pose major regulatory problems. Since 1980, when President Carter decided to increase production of nuclear materials, there has been an apparent presumption that the L-Reactor could be restarted without any control of the thermal discharge. This presumption was apparently based on the prior operation of the plant and did not account for pollution laws enacted subsequent to the reactor being placed on "stand-by" in 1968. The Draft EIS recommends discharge of untreated cooling water to Steel Creek. Steel Creek is presently classified as a Class 'B' stream in South Carolina. Such a classification means that the stream is suitable for fishing, survival and propagation of fish and other fauna and flora. The proposed action would allow eleven cubic meters/sec of effluent, at 80°C, to be discharged to the stream. Such action will effectively eliminate the present life forms from the stream. As such, we determine that the proposed action is not compatible with the established water use classification assigned to Steel Creek. We noted that Steel Creek was	Section 4.4.2 of the EIS, which discusses cooling-water mitigation alternatives, has been revised based on public comments received on the draft EIS. Specifically, Section 4.4.2 has been revised to provide a detailed discussion of additional combinations of various cooling-water systems. In Section 4.4.2, each of the cooling-water mitigation systems is evaluated for attaining the thermal discharge limits of the State of South Carolina. Section 4.4.2 and a revised Appendix I, Floodplain/Wetland Assessment, discuss the wetland impacts of each of the systems considered. The Department of Energy has been reviewing and evaluating alternative cooling-water systems for L-Reactor. Based on these reviews and evaluations, and consultations with representatives of the State of South Carolina regarding a mutually agreed upon compliance approach, a preferred cooling-water mitigation alternative is identified in this EIS. This preferred cooling-water alternative is to construct a 1000-acre lake before L-Reactor resumes operation, to redesign the reactor outfall, and to operate L-Reactor in a way that assures a balanced biological community in the lake. The Record of

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	previously subjected to a thermal effluent and suffered adverse impacts similar to these noted above. However, since the discharge was terminated habitat/species succession has occurred such that the area has recovered, to a great extent. The proposed discharge would reverse the recovery and, in our evaluation, would be a violation of the State water quality standards. In a related matter, we believe the discussion of the NPDES permit action avoids a major issue. Namely, what alternatives will the Department of Energy consider if the permit is not granted under the conditions anticipated in the Draft EIS?	Decision prepared by the Department on this EIS will state the cooling-water mitigation measures that will be taken which will allow L-Reactor operation to be in compliance with the conditions of an NPDES permit to be issued by the State of South Carolina.
	o EPA has been performing various modeling analyses to estimate the radiological impact of current and future releases at the SRP. The results of these analyses compare closely with the calculated values which were generated by DOE and presented in the Draft EIS. In addition, field surveys were conducted by EPA to determine radioactivity in air emissions from the plant site by direct measurement. Although the report of this data is still in preparation, EPA's monitoring data appear to be within a few percent of DOE's results. These surveys and analyses were conducted not only for comparative purposes to verify EPA's analysis against DOE's models, but to establish an additional data base for EPA's standard setting effort under Section 112 of the Clean Air Act (CAA). Considering the dose and risk numbers which EPA generated for DOE facilities as a part of proposing standards for CAA, we find that the proposed L-Reactor operations will comply with the standard which EPA is proposing.	
	o The total occupational doses which DOE expected from the operation of L-Reactor were also reviewed. "The total expected occupational dose from operation of L-Reactor and its support facilities is 360 person-rem (i.e., 69 person-rem for L-Reactor and 291 person-rem from support facilities). The average work force in each reactor area is about 375 people; thus, the average annual individual dose to workers in the L-Area will be about 185 millirem per year." Comparing these numbers to EPA's proposed Radiation Protection Guides (Federal Register Vol. 46, No. 15, Friday, January 23, 1981), which proposed 5 rem whole body, we found that L-Reactor will be below EPA's proposed Radiation Protection Guides for occupational workers.	

Table M-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	An assessment of the health impact from resumed operation of the L-Reactor indicates an estimated individual lifetime fatal cancer risk of 1.0E-4. The estimated collective cancer risk per year of operation is 5E-3, with 85 percent of the risk due to tritium. Ingestion is also the major contributing liquid pathway to health risk (72 percent). We can conclude from the above that the risks to the general public, off-site, should be considerably less than the estimated on-site risks. The EPA National Interim Primary Drinking Water Regulations, promulgated under the provisions of the Safe Drinking Water Act, became effective in June 1977, and apply to the community water supply systems such as those at Beaufort-Jasper, South Carolina, and Port Wentworth, Georgia, downstream of the Savannah River Plant. These regulations include limits for radionuclides, such as tritium, radiocesium, cobalt, and strontium, that will limit radiation doses to water users to less than 4 millirem per year. Both of these water supplies have been monitored by the states. Radiation exposures in recent years have been about 0.28 mrem/year. Based on the expected releases from the restart of the L-Reactor, its contribution has been estimated at up to .04 millirem per year from tritium, radiocesium and cobalt from the L-Reactor, or a contribution of about one-seventh of the total. The total dose of about 0.32 mrem/year is about one-twelfth (1/12) of the EPA Drinking Water Standard.	
DA-10	Further radiological and monitoring data should be presented at scheduled intervals, perhaps as supplements to the Final EIS, or as monitoring and data reports. This supplemental information should include any observed displacement of radioisotopes, which are now contained in Steel Creek sediments, together with and monitoring data from the seepage basins and surrounding wells, until such time that these seepage basins are discontinued.	Radiological monitoring of Savannah River water, water supplies at Beaufort-Jasper and Port Wentworth, and aquatic food supplies from the river and the estuary are reported annually in a series of reports entitled Environmental Monitoring in the Vicinity of the Savannah River Plant; the most recent issue, for calendar year 1982, is DPSPU-83-30-1. Expanded monitoring, to assess the displacement of radioactive isotopes in Steel Creek and in the Savannah River swamp, will be included in future issues of this report. Onsite monitoring of wells and seepage basins is reported annually in a series of reports entitled Environmental Monitoring at the Savannah River Plant. This report is an internal report for DOE and its contractors for use in reviewing the effects of ongoing SRP operations. DOE is considering placing this report in the DOE Public Reading Room in Aiken, South Carolina.

1.4

Letter of Transmittal to Senator Hollings from GAO Director

and

Digest from GAO Report on Hazardous Wastes

at the Savannah River Plant

Congressman Dingell, Chairman of the Congressional Oversight and Investigations Subcommittee, requested that DOE respond to many of the questions publicly raised about radioactive waste management at the Savannah River Plant. At about the same time, Senator E. F. Hollings, D-SC, requested that the General Accounting Office look into the groundwater contamination by hazardous wastes at the SRP. The summary from the General Accounting Office (GAO) report in November 1984 reviews the extent of the SRP contamination and the planned cleanup of the groundwater.

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

RESOURCES, COMMUNITY, AND ECONOMIC DEVELOPMENT DIVISION

B-216332

The Honorable Ernest F. Hollings
United States Senate

Dear Senator Hollings:

In response to your request, this report provides our evaluation of the Department of Energy's efforts to control and cleanup groundwater contamination from hazardous wastes at the Department of Energy's Savannah River Plant.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 7 days from the date of this report. At that time, we will send copies to the Chairmen of the House Committee on Government Operations, Senate Committee on Governmental Affairs, and Senate Committee on Energy and Natural Resources; the Administrator of the Environmental Protection Agency; and other interested parties.

Sincerely yours,

J. Dexter Peach
Director

BY THE U.S. GENERAL ACCOUNTING OFFICE

Report To The Honorable Ernest F. Hollings, United States Senate

Department Of Energy Acting To Control Hazardous Wastes At Its Savannah River Nuclear Facilities

Since the Department of Energy's (DOE's) discovery in 1981 that the groundwater beneath the fuel fabrication facility at its Savannah River Plant was contaminated with nonradioactive hazardous wastes, DOE has taken several steps to clean up the problem and to prevent future environmental damage. There is no evidence that contaminants from small amounts of wastes reaching the deep Tuscaloosa Aquifer--a source of drinking water for much of the Southeast--have migrated offsite. DOE has implemented a 20-year plan to remove the wastes from the upper level groundwater. It has also begun to identify and monitor other waste disposal sites within the plant's boundaries and has developed an environmental action plan that prioritizes work necessary to prevent future problems. In addition, DOE has entered into formal agreements with the Environmental Protection Agency and the state of South Carolina to increase coordination on nonradioactive waste disposal matters at the Savannah River Plant.

GAO/RCED-85-23
NOVEMBER 21, 1984

U.S. GENERAL ACCOUNTING OFFICE
REPORT TO THE
HONORABLE ERNEST F. HOLLINGS
UNITED STATES SENATE

DEPARTMENT OF ENERGY ACTING TO CONTROL HAZARDOUS WASTES AT ITS SAVANNAH RIVER NUCLEAR FACILITIES

D I G E S T

The Department of Energy's (DOE's) Savannah River Plant produces nuclear materials for the nation's defense program. The plant's five nuclear reactors and several large processing facilities are located on a 300-square-mile tract in South Carolina bordering the Savannah River near Augusta, Georgia.

Since the plant opened in 1952, E.I. du Pont de Nemours and Company (Du Pont), the on-site DOE contractor, has disposed of large amounts of radioactive and nonradioactive wastes within the plant's boundaries. For many years nonradioactive wastes, including hazardous chemicals, were often deposited in seepage basins[1] or buried in sealed containers. DOE, Du Pont, and environmentalists for many years considered these methods to be efficient and acceptable means of disposal. In some instances, however, they proved inadequate to protect the underlying groundwater and the surrounding environment. In June 1981 Du Pont discovered that the groundwater underlying the seepage basin that receives liquid chemical wastes from the fuel fabrication facilities was contaminated with suspected carcinogens. (See p. 1.)

GAO performed this review in response to Senator Ernest F. Hollings' July 21, 1983, request, which asked GAO to determine (1) what steps DOE has taken or plans to take to clean up existing groundwater contamination at the Savannah River Plant, (2) what information is available on the past disposal of hazardous wastes at the Savannah River Plant, (3) what actions DOE has taken or plans for monitoring and preventing future problems, and (4) how well DOE is coordinating with the Environmental Protection Agency (EPA) and other federal and state agencies on Savannah River Plant hazardous waste matters. (See p. 5.)

GAO found that while wastes discarded in that part of the plant known as the M-Area (the fuel

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[1]Ponds or impoundments, either natural or manmade, intended for disposing waste liquids into the ground by percolation through the basins' bottoms and sides.

fabrication plant) have contaminated groundwater in the immediate vicinity, to date they have had no impact outside of the Savannah River Plant boundaries. DOE and Du Pont have taken actions to clean up the M-Area. In addition, since 1981 DOE and Du Pont have acted to identify and monitor other sites at the Savannah River Plant where wastes were disposed of, and have prepared an environmental action plan that prioritizes work needed to prevent further environmental damage. DOE has also established formal agreements to improve coordination with EPA and South Carolina officials in dealing with hazardous waste disposal.

IDENTIFYING AND CLEANING UP GROUNDWATER CONTAMINATION IN THE M-AREA

DOE and Du Pont officials stated that the contamination of the M-Area groundwater is the most serious environmental threat caused by nonradioactive hazardous wastes at the Savannah River Plant. Wastes from the fuel fabrication facilities, including 3.5 million pounds of organic solvents used to strip grease from metal fuel assemblies, have been discharged into the M-Area seepage basin since 1958. EPA has since determined that these solvents are hazardous and suspected carcinogens. DOE officials said that while most of these substances probably evaporated upon disposal, unknown quantities did seep into the ground from the M-Area seepage basin. Once underground, solvents readily permeate groundwater systems. (See p. 8.)

After the initial discovery of solvents in the M-Area groundwater, Du Pont, the South Carolina Department of Health and Environmental Control, and a groundwater consultant conducted a series of tests throughout 1982 and 1983 to determine the extent of the contamination. Tests showed that concentrations exceeding existing drinking water (but not groundwater quality) standards adopted by DOE have contaminated groundwater beneath the M-Area in the geological strata above the large, deep Tuscaloosa Aquifer. This aquifer provides drinking water to a large part of the Southeast. (See p. 3.) EPA is preparing federal standards for many hazardous wastes, including the solvents, but could not state when they will be finalized. South Carolina is also working on hazardous waste standards. (See p. 11.)

Subsequent investigations by Du Pont and the consultant also revealed that much smaller amounts of solvents have seeped down into the Tuscaloosa Aquifer through the defective linings of two of the four wells providing drinking and process water to the M-Area. According to the groundwater consultant, very small amounts of the solvents entered the Tuscaloosa and the contamination has been limited to the water in and immediately around the two water wells. (See p. 12.)

Since discovery of the contamination, DOE and Du Pont have undertaken several initiatives to clean up and prevent future contamination of the M-Area. Steps have been taken to reduce the discharge of pollutants to the seepage basin, and DOE and Du Pont have initiated a 20-year plan to remove the solvents already in the underlying groundwater by pumping the contaminated water to the surface and exposing it to the air so that the volatile solvents will evaporate. Total cost of the M-Area cleanup is estimated to be $49 million to $54 million, plus annual operating costs. (See pp. 14 and 15.)

DOE ACTING TO IDENTIFY, MONITOR, AND PREVENT OTHER HAZARDOUS WASTE PROBLEMS AT THE SAVANNAH RIVER PLANT

Spurred by the discovery of contaminants in M-Area groundwater and the increased attention of South Carolina environmental officials, Du Pont initiated efforts in 1982 to identify all waste disposal sites at the Savannah River Plant. These efforts identified 153 sites, including 68 seepage basins, where radioactive and nonradioactive wastes have been disposed of or stored since the plant began operating in 1952. Of this total, 118 sites contain nonradioactive wastes, 15 contain both radioactive and nonradioactive, and 20 just radioactive. Although some information on the kinds of wastes disposed of at each site is available, accurate records on the specific types and quantities of nonradioactive chemicals and other hazardous wastes disposed at most sites were not maintained or required. At the time of disposal, little was known about the potential future impact of these wastes. (See p. 18.)

Existing studies made by South Carolina and a private institution have concluded that, to date,

hazardous waste disposal at the Savannah River Plant has had little impact outside its boundaries. The M-Area problem has demonstrated, however, the impact of hazardous waste disposal on-site and the potential for widespread problems. It has also led to the realization that very little information is available on the extent to which contamination exists near many of the disposal sites, or on the potential of the pollutants to migrate off-site where they could affect drinking water. (See p. 22.)

Du Pont is collecting additional information through an expanded monitoring program and has identified projects designed to protect the Savannah River Plant environment in a comprehensive draft environmental action plan issued in October 1983. The plan identifies each emission or discharge to the environment at the Savannah River Plant along with a priority for proposed action based on existing information. DOE states that the plan will be continually revised as new data indicate the need for different priorities. (See p. 23.)

Although work on identifying the priority project list for all environmental concerns is not complete, an implementation plan has been developed for groundwater-related projects. This plan, issued on April 4, 1984, contains a priority listing of groundwater concerns, proposed remedial action projects, and an expanded groundwater monitoring program that requires installing monitoring wells at disposal sites where none currently exist or where the existing ones are insufficient. (See pps. 23, 24).

DOE and Du Pont are also planning, over the next several years, to: (1) decommission 36 of the 68 seepage basins located on-site, (2) build at least four process wastewater treatment facilities, (3) excavate buried hazardous materials for incineration or redrumming, and (4) construct hazardous waste storage and incinerating facilities. Capital and operating funds needed for these projects are estimated at over $117 million. (See p. 25.)

In fiscal year 1984 DOE expects to obligate about $97 million for Savannah River Plant environmental projects and has requested $73.6 million for the Savannah River Plant environmental program in

fiscal year 1985. These amounts are over 10 times greater than the budget for fiscal year 1983, which totaled $7.1 million. (See p. 18.)

COORDINATION BETWEEN DOE, EPA, AND SOUTH CAROLINA IMPROVING

Until hazardous waste regulations were developed and authority for their enforcement passed from EPA to the state, little coordination on hazardous waste matters between the Savannah River Plant, South Carolina, and EPA regional officials was required. Following that delegation, which began in 1980, DOE's concerns about security, and its view that DOE was exempt from regulation by EPA under the Resource Conservation and Recovery Act of 1976--the nation's most important hazardous waste act--hindered coordination. DOE stated that EPA regulation under the act would be duplicative and inconsistent with DOE's authority and activities under the Atomic Energy Act of 1954. (See p. 28.)

DOE's desire to restart one of the Savannah River Plant's production reactors--shut down since 1968 because of reduced production demands--led to a formal agreement between the Secretary of Energy and South Carolina in April 1983 calling for an increased DOE commitment to hazardous waste management at the Savannah River Plant. Following that agreement, coordination improved. For example, during a December 1983 workshop on the M-Area groundwater contamination problem, Du Pont and DOE officials agreed that the state has the regulatory lead for this program. In addition, state officials are now provided timely access for on-site monitoring and inspection. (See pp. 31 and 32.)

At the national level, EPA and DOE signed a memorandum of understanding in February 1984 that addressed the longstanding question of the degree of oversight EPA has over DOE's program for the management of hazardous and mixed wastes. Under the terms of the memorandum, DOE agreed to comply with the technical provisions of the Resource Conservation and Recovery Act. Following that agreement a federal district court ruled in April 1984 that the act applies to DOE's nonradioactive hazardous wastes at atomic energy facilities at Oak Ridge, Tennessee. DOE officials have now concluded that this is a precedent-setting case for all atomic energy facilities and as of July 1984 were

meeting with EPA officials to formalize EPA and DOE responsibilities under the act. (See pps. 29, 30.)

AGENCY COMMENTS

DOE and EPA stated that GAO's report was an accurate summary of the progress being made in managing hazardous wastes at the Savannah River Plant. DOE noted however, that its Savannah River Operations Office took strong initiative in interacting with the South Carolina Department of Health and Environmental Control while formulating its hazardous waste management program. DOE stated that this aggressive program of cooperation was not evident in the report. (See pp. 34 and 36.) The South Carolina Department of Health and Environmental Control stated that GAO's report did not adequately describe the leadership its office provided in initiating much-needed changes within the Savannah River Plant's hazardous waste program. (See p. 37.)

It is very difficult to attribute the source of the impetus behind many of the steps taken to control hazardous wastes at the plant. In many cases, it was not possible to clearly identify which institution took the lead at any one point in time. GAO's report recognizes the contributions of DOE, Du Pont, and South Carolina to the extent they are identifiable and measurable.

The South Carolina Department of Health and Environmental Control comments also emphasized the scope of the hazardous waste problem at the Savannah River Plant from its perspective. In particular, it highlighted the amount of resources needed to carry out the state's delegated environmental responsibilities at the Savannah River Plant. (See p. 37).

DOE, EPA, and the state also had several technical comments that have been incorporated into the report. Appendixes I, II, and III contain the complete text of the DOE, EPA, and South Carolina comments.

1.5

"Problems with Military Nuclear Waste"

In 1985, an article on DOE nuclear waste was published by the Bulletin of the Atomic Scientists. The article, "Problems with Military Nuclear Waste," analyzes the problems of radioactive waste management within the DOE, but focuses on liquid waste discharges into the soil at DOE facilities. Radioactive and hazardous waste disposal practices and the Oak Ridge mercury spill are reviewed. The article concludes that an environmental impact statement (EIS) should be written by DOE for the new DOE radioactive waste management guidelines.

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U.S.—Soviet Summit

Weapons Design Impedes Test Ban

Spent Nuclear Fuel and Waste

Problems with military nuclear waste

The Department of Energy has used careless and technically obsolete methods for handling radioactive and toxic chemical wastes. The Department's standards should be subject to an environmental impact study.

by William F. Lawless

THE MANAGEMENT of radioactive wastes is complicated by significant differences in the nature, handling, and regulation of military and commercial waste. Since 1982, the differences have been sharpened, as controls on civilian wastes have been tightened, but the management of wastes associated with the production of plutonium and tritium for nuclear weapons has come under increasing criticism and led to an investigation by the General Accounting Office in 1984 which found alarming problems with waste disposal at one Department of Energy facility, the Savannah River plant in South Carolina—problems which may be repeated across the nuclear weapons complex.

Not only is military radioactive waste regulated and managed by the same agency which produces it—the Department of Energy—but, as explained below, the Department's waste-handling technology is severely outdated. By contrast, commercial nuclear reactor or radioactive waste disposal is licensed and regulated primarily by the Nuclear Regulatory Commission (NRC), with assistance from other federal agencies, and with part of the NRC authority shared with cooperating states. The Environmental Protection Agency sets health and environmental standards, the U.S. Geological Survey conducts basic geological research, and the Department of Transportation regulates interstate shipments. The Department of Energy shares radioactive waste technology with these agencies and with commercial industry.

The commercial nuclear and the nuclear weapons industries produce both similar and different wastes. Natural uranium (99.3 percent U-238, 0.7 percent fissionable U-235) is enriched and fabricated into reactor fuel rods generally used to transmute fertile or depleted uranium (U-238) target rods into plutonium for nuclear weapons. (Highly enriched weapons grade uranium is at least 20 percent and usually between 90 and 100 percent fissionable U-235; typical U.S. reactor fuel is low-enriched uranium, up to a few percent U-235.) Commercial reactors do not transmute target rods as in the defense program, but convert fission energy into heat to turn water into steam to drive turbines that generate electricity.

Fissioning of reactor fuel creates highly radioactive materials mostly retained in the fuel elements as the fuel is "spent" and removed from the reactor. If not reprocessed, the spent fuel is considered radioactive waste. The U.S. commercial spent-fuel inventory is about 1.6 billion curies of radionuclides with half-lives greater than 20 years, growing annually at about 300 million curies within the 2,000 metric tons of spent fuel annually removed from presently licensed U.S. reactors. Reprocessed spent fuel from nuclear weapons has produced about 700 million curies of radionuclides with half-lives greater than 20 years.[1]

Spent fuel elements contain the largest amount of radioactivity, but commercial spent fuel is not presently being reprocessed in the United States, so the wastes are left contained within spent fuel assemblies and are not immediately accessible to the environment. By reprocessing military spent fuel to separate plutonium and unspent uranium from the highly radioactive and high-heat fission product waste, known as high-level waste (99.5 percent fission products and about 0.5 percent plutonium and uranium), nuclear weapons manufacture produces more dangerous radioactive wastes than do current commercial processes. In addition to high level waste, Department of Energy facilities also generate transuranic (mostly long-lived radioactive plutonium) waste and low-level solid or liquid waste. Low-level waste is something of a misnomer because it is potentially hazardous and can require shielding.

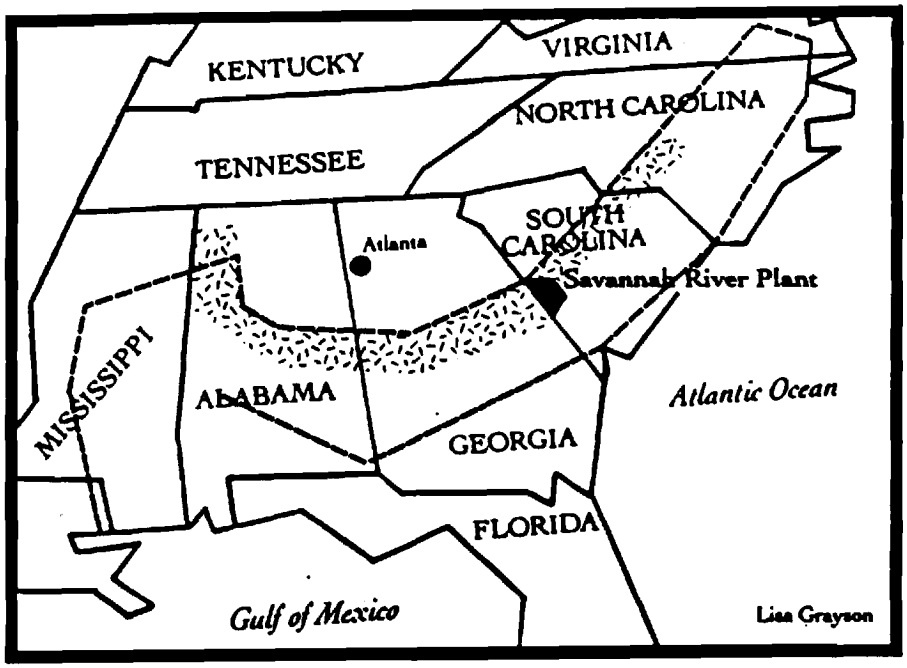
Virtually all transuranic wastes, nearly all high-level wastes, and half the low-level wastes come from weapons manufacturing. High-level waste, generated by reprocessing spent reactor fuel or depleted uranium target elements, is stored until it can be incorporated into a stable solid medium for disposal in a geologic repository. At the Savannah River plant, for example, the high level wastes will be sealed in borosilicate glass.

The Department treats transuranic waste in concentrations under 100 nanocuries per gram as low-level waste, acceptable for unrestricted shallow land burial, although significant burial depth restrictions apply to commercial transuranic waste at those concentrations. Such waste in higher concentrations is planned to be sent to the Department's Waste Isolation Pilot Plant in New Mexico, although the Hanford, Washington plant is apparently leaving three million cubic meters of high-concentration transuranic waste in shallow land burial.[2]

DIFFERENCES BETWEEN commercial and military radioactive waste management practices become most apparent, however, in the disposal of low-level wastes. In 1982, the NRC responded to problems at its commercial low-level

William F. Lawless, an assistant professor of mathematics at Paine College in Augusta, Georgia, was until 1983 a senior project engineer in radioactive waste management in research and operations for the Department of Energy.

Tuscaloosa Group Formation



Shaded area indicates location of Tuscaloosa Group Formation. (East of central Georgia, the formation is known as Middendorf.)

Dashes enclose area where there are outcrops from the Tuscaloosa aquifer. (The aquifer does not outcrop on the Savannah River Plant.)

Source: Department of Energy.

waste disposal sites by issuing a new, publicly reviewed regulation establishing strong performance objectives with specific technical, administrative, and procedural requirements.[3] The NRC licenses and regulates commercial disposal facilities and assures that each facility meets technical and financial requirements. On the other hand, the Department of Energy regulates its own facilities through the issuance of technical guidelines which it claims are "comparable" to the NRC regulations.[4] The Department issued new criteria for military radioactive waste management in 1984 after deleting performance objectives, significantly loosening its guidelines, and doing so without public review.[5]

The operational difficulties of Department facilities eclipse those of NRC-licensed commercial sites. Drinking water has been contaminated at Hanford, Savannah River, and the Idaho National Engineering Laboratory.[6] Cardboard boxes, used to dispose of most DOE radioactive waste until 1985,[7] were one of the main causes of subsidence and failed burial grounds, yet Energy petitioned the NRC not to ban cardboard boxes in its 1982 regulation. At the Oak Ridge, Tennessee plant, 2.4 million pounds of mercury leaked into the environment over 20 years—the highest levels of mercury contamination ever recorded in the United States.[8] This contamination, in addition to the 4.7 million gallons of chemical wastes annually leaking from disposal ponds into the groundwater at the Oak Ridge plant, prompted the Eastern District of Tennessee federal court to rule that Energy must comply with the EPA Resource Conservation and Recovery Act regulations for hazardous wastes, but affirmed the Department's right to self-regulate radioactive wastes.

The new Department guidelines allow even more questionable practices than did previous Atomic Energy Commission (AEC) guidelines. Under these standards, the Hanford plant has been able to reclassify nine of 12 million cubic meters of soil contaminated by spilled or disposed liquid plutonium waste as low-level waste,[9] and to reduce the remaining three million cubic meters without explanation to 32,000 cubic meters.[10] The new standards may also allow the Hanford plant to leave high-level wastes in storage tanks—contrary to public law—in cases where the tanks have failed and the wastes cannot be removed.[11]

But one of the most serious loopholes in the new guidelines is the sanctioning of the practice of releasing large volumes of very low concentrations of radioactive and/or chemical liquid wastes into the environment. Both the plutonium soil contamination at Hanford and the Oak Ridge mercury contamination resulted from this practice—one so standard with the Department that it is cited as the reason that no inventories of such wastes are kept.[12]

The Department has known for many years that dumping into streams, seepage basins, cribs (back-filled ditches where raw liquid wastes are pumped into the bottom and allowed to seep into the soil), or other soil release points—collectively known as natural soil columns—could overload the capacity of the soil to release contaminated liquids slowly and safely into the environment. The 1973 AEC guidelines, recognizing this danger, required that such practices be discontinued as soon as technologically practical. The AEC contractors understood the intent of the 1973 guidelines:

> The practice of exploiting the favorable ion-exchange properties of some soils to remove radioactivity from liquid wastes and confine them in soil columns is a well-established, safe procedure. However, there is an explicit assumption that the environmental conditions will exist until the radioactivity in the soil decays to innocuous levels. Because of the long-term burden of control and surveillance inherent in the use of techniques that results

in large local accumulations of radioactivity in soil, AEC sites are eliminating the routine use of surface and near-surface techniques that depend on soil to remove radioactivity from liquid wastes.[13]

However, with the tacit approval of AEC management, then successively the Energy Resource and Development Administration and the Department of Energy, the contractors ignored the guidelines. One contractor, DuPont, still the prime contractor of the Savannah River plant, concluded that the release of radioactivity to natural soil columns or seepage basins was not a hazard:

Continued discharges [into seepage basins of radioactive strontium-90 and cesium-137] at rates comparable to current rates will not add significantly to future exposure potential. . . . Most nonradioactive materials discharged to seepage basins do not constitute an undue potential future hazard because the amounts are small or because they are diluted and flushed by groundwater to surface streams at non-toxic concentrations.[14]

THE SEEPAGE basins referred to in this quotation are simply very large ponds, unlined holes in the ground. The consequences of their use are well exemplified by the M-Area seepage basin at the Savannah River plant, the subject of the recent General Accounting Office (GAO) investigation.

The Savannah River plant is a major installation of the Department of Energy for producing military nuclear materials, primarily weapons-grade plutonium and tritium. "M-Area" refers to the manufacturing area of the plant, where fuel and target elements are fabricated. When production started at the plant in 1952, waste water from the fabrication processes containing uranium, industrial degreasers, acids, caustics, metals, and other waste was released into the Tims Branch stream on the premises.

In 1958, a seepage basin was dug near the manufacturing facilities and stream in order to settle out and contain uranium from fuel and target extrusion, one of three fabrication processes in M-Area. Liquid wastes from the other two processes (depleted uranium target fabrication and lithium-aluminum tritium production tubes) continued to be released into Tims Branch until 1982; since then, the stream has received only nonprocess and drainage water.

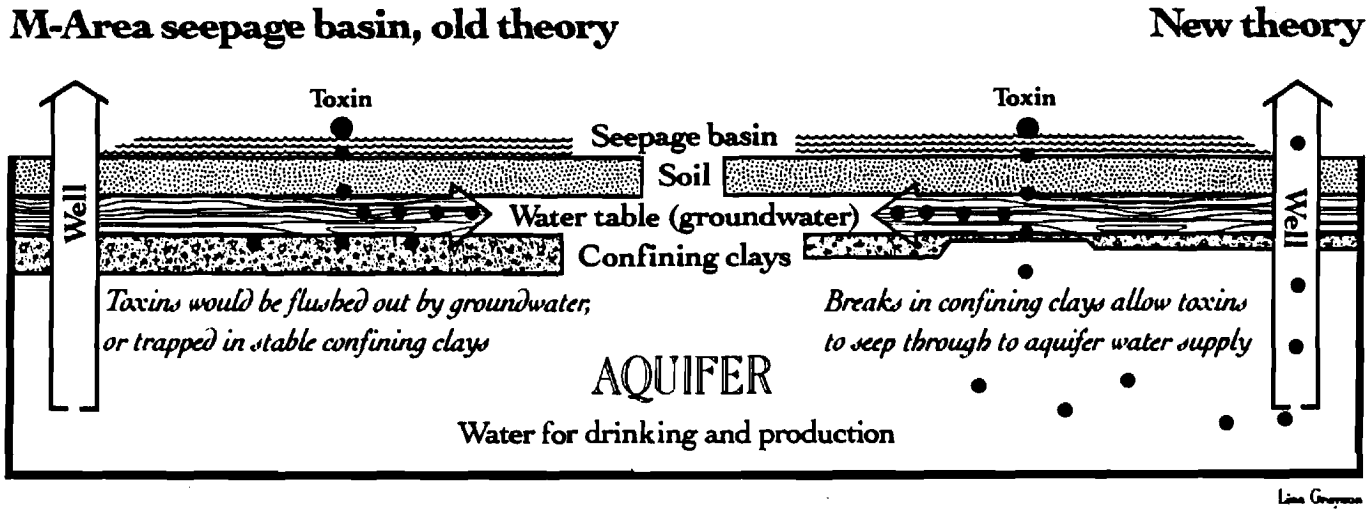
The M-Area seepage basin began to receive all raw process waste effluents in 1982 and continued to do so until it was removed from service this year. Between 1982 and 1985, these effluents averaged a much reduced 7.5 million gallons per month into the basin from a pre-1982 high of 20 million gallons per month, including the nonprocess cooling and surface runoff waters. The 1.4 million-gallon basin was not able to contain or absorb these large volumes of effluents, and the downward seepage rate has been negligible for an unknown length of time. Consequently, most of the contaminated wastes overflowed the basin and seeped into the ground downstream at Lost Lake and points between. Considerable seepage occurred upstream as well, because the sewer pipes to the basin leaked for an indeterminate number of years. Releases to Tims Branch dwarfed those to the M-Area seepage basin, apparently peaking at 40 million gallons of effluent per month in 1979.[15]

Compared to other seepages at the plant, however, it is not clear at first why this particular basin became the centerpiece of the GAO investigation. It is one of 153 known waste sites at the plant, 68 of which are unlined seepage basins. Thirty-one basins are solely chemical liquid seepages, and 37 are radioactive liquid seepages, but 17 of the latter also seep raw chemical waste. The M-Area basin, one of these 17, is about average in size—with a small capacity and a surface area of 17,556 square feet—and is neither the most radioactive nor the most severely contaminated with toxic chemicals.

The M-Area basin was constructed over several geological formations and aquifers, including the Tuscaloosa aquifer, a vast, important water-bearing formation supplying drinking and process water to the plant and drinking water to nearby parts of Georgia and South Carolina, and extending north to North Carolina and westward to Mississippi. Since the different formations, including the Tuscaloosa aquifer, are supposedly separated by confining clays, it was believed for many years that liquid wastes could be adequately handled by seepage basins. Theoretically, contaminated liquids diluted by surface and rain waters would slowly percolate into the earth until they encountered underlying groundwater, which would dilute and flush them safely away. The first or near-surface levels of groundwater in the area were thought to be isolated from the lower Tuscaloosa aquifer, so the contaminants could not enter the deeper sources of drinking water and would have time to decay safely before the increasingly diluted contamination in the near-surface groundwater resurfaced into lakes, swamps, or streams. The ion exchange properties of the soil and the higher artesian pressure of the Tuscaloosa aquifer would further ensure that contamination would safely decay and not endanger the aquifer.

These conclusions remained untested, however; rigorous research in support of them was not pursued. Instead, the Department continues to assert that it is doing all it can to protect the environment, while evidence mounts that its early assessments of seepage basins were faulty:

- Strontium-90 migrating from the F-Area reprocessing seepage basins has reached concentrations in the near-surface groundwater and in a creek 42,500 times greater than the EPA drinking water standard, and between eight and 1,100 times Department of Energy guidelines. (This water is generally not accessible to the public. The EPA drinking water standard is a measure of performance since the plant site cannot be turned back to the public until contamination in the water is below the drinking water standard.) When questioned about plant strontium-90 levels in excess of its own guidelines,[16] and about whether action had been taken against the contractor (DuPont), the Department said no action was required because the contractor only exceeded guidelines, not regulations; yet the Depart-



ment claimed in 1984 to GAO investigators that it was "developing an aggressive waste management program."[17] Last June the South Carolina Department of Health and Environmental Control cited the Department with a Notice of Violation for unstated groundwater monitoring deficiencies.

• Pond-slider turtles, contamined with radioactive strontium-90 up to 1,000 times background levels, were discovered in 1982 at distances of up to four kilometers from a plant seepage basin and in a commercial hog farm pond about one kilometer from the plant.[18]

• In July 1981 and 1982, and again in March 1983, chlorinated hydrocarbons were found in drinking water pumped from a Tuscaloosa aquifer well on the plant premises.[19] These organics are degreasers and industrial solvents and are suspected carcinogens. It was not until April 5, 1983, however, that the South Carolina Department of Health and Environmental Control analyzed the drinking water drawn from the Tuscaloosa, and two contaminated wells were withdrawn from service. Since then two other wells have been found to be similarly contaminated and removed from drinking water service—the latest in August 1984.

• The groundwater below the M-Area seepage basin and above the Tuscaloosa aquifer has been found to be extensively contaminated. It is estimated that at least 10 percent of the 1.6 million kilograms of chlorinated hydrocarbons that have been released to the basin and the Tims Branch stream are still in the ground or groundwater under the manufacturing area. There is evidence that the zone of contamination is moving south and west from under the basin, reaching half the distance to the plant boundary in the direction of the adjacent town of Jackson, South Carolina. The maximum concentration of organic contaminants is 12 million parts per billion at a depth of about 130 feet below the surface, and about 500 parts per billion at 300 feet—within the top of the Tuscaloosa formation. Nor has the bottom of the contaminated area been determined.[20]

• It was discovered in 1984 that the confining clays thought to protect the Tuscaloosa aquifer were instead absent or discontinuous under the plant's manufacturing area.[21] Moreover, information indicates that the M-Area basin is located within a zone from which the aquifer may be recharged with surface and groundwater. Plant officials have conceded that the spreading contamination, after reaching the Tuscaloosa aquifer, could be intercepted by other drinking water wells, on or off the plant site.

According to the GAO report, DuPont reduced the discharge of solvents to the basin and took steps to remove solvents from the surrounding near-surface groundwater. While the GAO predicts the process will cost $49–54 million, in addition to $500,000 in annual equipment operating costs for 20 years,[22] the Savannah River plant estimates the cleanup will take as long as 40 years. The cleanup involves pumping contaminated groundwater up from nine 200-foot-deep wells to airstrippers, which will eject the chlorinated hydrocarbons into the air at the initial rate of about 30 tons per year. Although the airstrippers will be located in one of the most populated work areas on the plant site, the administration and manufacturing areas, DuPont and the Energy Department feel that this method will be safe, and airborne releases of the degreasers have begun.[23] Alternatives to the airstrippers have not been publicly reviewed in an environmental impact statement.

ALTHOUGH THE AEC knew of many of the dangers associated with seepage basins in 1973, by 1977 AEC contractors had concluded that the 1973 regulations were unnecessarily restrictive, the Department of Energy, credited itself with exemplary performance in environmental affairs, "particularly with regards to AEA [Atomic Energy Act] activities involving occupational health and safety."[24]

In January 1984—a month before issuing its new guidelines for radioactive waste management—the Department was cleared by its inspector general of charges of rewriting its guidelines to cover up waste mismanagement. By April

of that year, however, because of the mercury spill at the Oak Ridge facility, the federal court set a precedent and stripped the Department of its claimed right to regulate its own disposition of toxic chemical waste—a ruling which brought EPA and state inspectors onto Department of Energy sites for the first time.

But the ruling left an enormous loophole by restricting EPA regulation to waste streams containing hazardous levels of toxic chemicals; for radioactive or nonhazardous waste releases, it is business as usual. Energy and EPA's interpretation of the ruling is that as long as the waste streams themselves are nonhazardous—regardless of whether the effluents build up and contaminate the soil and groundwater below—they need not be regulated by the EPA. In its last Savannah River plant environmental impact statement the Department did not report the organic effluents into the M-Area seepage basin as hazardous waste, even though those chlorinated hydrocarbons had contaminated the Tuscaloosa aquifer.[25]

A month after the April 1984 court case, the Department published details of the M-Area seepage contamination and cleanup, and the report on the contaminated turtles was published in June. But in September 1984 the Department published the latest inventory of radioactive wastes, as usual, without statistics on liquid low-level waste discharges, and it has no plans to keep such statistics.[26]

Unlike the NRC, which issued an environmental impact statement for its 1982 commercial radioactive waste regulations, the Department of Energy has not made any public accounting of its new order, although it represents a major federal action. The new order does not restrict seepage basin use, and the 1985 restart of a nuclear materials production reactor at the plant includes plans for yet another radioactive waste seepage basin.

Mandated by Congress in 1983, the Savannah River plant stopped using the M-Area seepage basin on July 16, 1985 and is planning to issue an environmental impact statement to describe how it will rectify groundwater damage. After 30 years of operation, $65 million is being spent to clean up this typical basin (only one of 68), not because the Department considered the releases toxic,[27] but apparently because organics were discovered in the plant and administration drinking water.

Nor will the Savannah River environmental impact statement account for the groundwater contamination throughout the Department of Energy national complex. Just as Savannah plant workers did not know for almost two years that their drinking water was contaminated, the nation does not yet know how contaminated other Department facilities are. If the Department's environmental programs are indeed aggressive and exemplary, it should have nothing to fear from an environmental impact statement on the new radioactive waste guidelines, nor should it try to keep that information fragmentary or concealed. Such a statement would publicly account for past radioactive waste problems, review why the Department feels the many changes contained in the order are necessary, and provide the public a sense of participation. The Department can ill afford to do otherwise. □

1. U.S. Environmental Protection Agency, July 7, 1985 working draft of 40CFR 191, *Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Wastes*, pp. 4–5, reference 6560-28.

2. W.L. Kennedy, B.A. Napier, J.K. Soldat, "Advanced Disposal Systems for Transuranic Waste: Preliminary Disposal Criteria for Plutonium-239 at Hanford," *Nuclear and Chemical Waste Management*, 4 (1983), pp. 103–11.

3. *Final Environmental Impact Statement on 10 CFR Part 61*, "Licensing Requirements for Land Disposal of Radioactive Waste," U.S. Nuclear Regulatory Commission Report NUREG-0945 (1982).

4. B.A. Finamore, "Atomic Bombs, Chemical Wastes," *Environment*, 26 (1984), pp. 2–4.

5. Department of Energy Order 5820.2, *Radioactive Waste Management* (1984).

6. W.F. Lawless, *The DuPont Management of Savannah River Plant Radioactive Wastes*, a report to Chairman J. Dingell, U.S. House of Representatives, Committee on Energy and Commerce, Subcommittee on Oversight and Investigations (1984).

7. Department of Energy Savannah River Operations Office response to the Aug. 13, 1984 letter from Congressman John Dingell to Secretary Donald P. Hodel, attachment 4B, pp. 52–84.

8. Eliot Marshall, "The Lost Mercury at Oak Ridge," *Science*, 221 (1983), pp. 130–32.

9. Kennedy, op. cit.

10. *Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics*, U.S. Department of Energy annual report DOE-RW-0006 (1984).

11. W.F. Lawless, *Major Issues and Questions on DOE Defense Radioactive Waste Management*, an unpublished resource report in response to questions by ABC news on DOE nuclear waste management (1985).

12. J.A. Klein and D. Eyman, Oak Ridge National Laboratory, personal telephone communications, April 30, 1985.

13. W.L. Marter, *New Criteria for Seepage Basin Use*, a Savannah River Plant report DPST-77-444 (1977), p. 4.

14. Ibid., p. 27.

15. *Technical Summary of Groundwater Quality Protection Program at Savannah River Plant*, vol. 1. *Site Geohydrology, and Solid and Hazardous Wastes*, a Savannah River Plant report DPST-83-829 (1983); *Final Environmental Impact Statement, L-Reactor Operation, Savannah River Plant, Aiken, SC*, U.S. Department of Energy three-volume report DOE/EIS-0108 (1984).

16. *Public Comment and Meeting Report, A Centers for Disease Control Review Panel's Recommendations on Health Effects and Epidemiological Studies of Operations at the Savannah River Plant, Aiken, South Carolina*, DOE/ER-0225 (1985), p. B-10.

17. *Department of Energy Acting to Control Hazardous Waste at its Savannah River Nuclear Facilities*, U.S. General Accounting Office Report to Senator Ernest F. Hollings, report GAO/RCED-85-23 (1984), p. 34.

18. *Environmental Monitoring at the Savannah River Plant, Annual Report for 1982*, Savannah River Plant report 200, DPSU 83-302 (1984), pp. 27–28.

19. *Assessment of the Presence of Volatile Organic Compounds in Water Supply Well 53-A, A-M Area, Savannah River Plant*, prepared for E.I. DuPont de Nemours Co., Inc., Atomic Energy Division, Aiken, S.C., by Geraghty and Miller, Inc., Water Resources Consultants (1983), pp. 1–4.

20. *Technical Summary of Groundwater Quality Protection Program at Savannah River Plant*, chap. 6.

21. *Final Environmental Impact Statement, Savannah River Plant*, chap. 3, p. 29.

22. *Department of Energy Acting to Control Hazardous Waste.*

23. *Final Environmental Impact Statement, Savannah River Plant.*

24. S.H. Greenleigh, Department of Energy assistant general counsel for environment, "Compliance with EPA Hazardous Waste Regulations," memorandum to J.A. Rogers, associate general counsel, U.S. Environmental Protection Agency, Nov. 17, 1980, p. 6.

25. *Final Environmental Impact Statement, Savannah River Plant*, chap. 5, p. 10.

26. Klein and Eyman, telephone communications, April 30, 1985.

27. *Final Environmental Impact Statement, Savannah River Plant*, p. M267.

More detailed references are available upon request from the author.

Section 1: Questions for Discussion

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1. Describe how commercial nuclear power facilities operate. From your own study of the literature, compare nuclear power generation with coal-fired power generation. Compare nuclear power generation with nuclear weapon materials (for example, plutonium and tritium) production.

2. What is transuranic waste? What are the half-lives of the constituents of transuranic wastes? What type of radioactivity is emitted by transuranic wastes? What are other types of radioactivity? Describe the health and safety concerns for all types of radioactivity. Describe how workers can be protected from the harmful radiation by type of radiation. Describe how the public should be protected from radioactive wastes.

3. What is a curie? Is a curie of tritium as harmful as a curie of strontium-90, or as a curie of plutonium-239? Explain.

4. Should each government or federal agency be allowed to establish separate or different nuclear or hazardous waste regulations? Is it satisfactory for the DOE to create its own guidelines and also to determine solely that its own guidelines are "comparable" to the regulations established by the NRC or EPA? Who should best be able to decide whether radioactive waste guidelines used by the DOE are comparable to regulations of the NRC and EPA? What role should the affected states and the public take in this decision process?

5. Since the Department of Energy does most of the nuclear waste management research in the U. S., and since the DOE transfers nuclear waste technology to other agencies, especially agencies that establish regulations, can this DOE technology transfer lead to abuses? Explain why the technology transfer can be advantageous or not. How could checks and balances be added to prevent abuses?

6. Should an agency such as the DOE or NASA be allowed to self-regulate its own operations? The 1954 Atomic Energy Act was established to create an elite technological organization that could collect the best technology for building nuclear weapons and protecting the environment. Did the subsequent isolation of the Department of Energy lead to problems with military nuclear waste? Considering DOE, NASA, and DOD, are abuses within technical and highly specialized federal departments the inevitable result of self-regulation? Do the environmental problems that have resulted from DOE management of radioactive waste also reflect on the nuclear weapons that have been produced by DOE? How is it best to regulate a government agency that manages advanced technology? What role should the states play? What should be the role of individual citizens?

7. Should changing DOE radioactive waste management guidelines be considered a major federal action that must be reviewed in an environmental impact statement (EIS)? Explain. The federal Council on Environmental Quality requires that an EIS be written for all major federal actions, but who determines what a major federal action is? Describe a check and balance for this CEQ requirement.

8. Explain how seepage basins or natural soil columns work in theory and in practice. Contact a DOE facility using seepage basins and write an analysis of the seepage basin.

9. Should the EPA cite DOE for effluent releases that exceed EPA regulations? Contact a DOE facility and compare the EPA and state actions against the facility. How can the public be assured that federal or state regulations governing technology are enforced? Should DOE at the Savannah River Plant cite its prime contractor Du Pont for exceeding DOE release guidelines? What is the difference between guidelines and regulations? What role should the affected states play in enforcing regulations? What role should the public take?

10. Why do anti-technology or anti-progress groups organize against pro-technology and pro-progress groups? What are the motivators of both sides? Interview the members of both a pro and an anti group and discuss how they interact. Suggest a method of how two opposing groups could resolve technical issues? Explain. Is it in society's interest to have opposing groups on technical issues? What role should science play?

11. Would local peer review groups, composed of scientific and non-scientific individuals, be a way to moderate the abuses that result from a self-regulated federal agency? Should such independent local peer review groups be funded by the federal department that is peer reviewed, while organized and staffed by their respective states? The National Academy of Sciences provides a national peer review of DOE radioactive waste management. How could locally independent peer review groups work effectively with the National Academy of Sciences or the Centers for Disease Control?

12. Should any federal agency be allowed to publish non-classified but technical documents that are not peer reviewed? Should environmental impact statements and other technical documents written by any federal department be peer reviewed before they are reviewed by the public?

13. How effective has been the National Academy of Sciences' review process of DOE radioactive waste management?

14. Why is the free exchange of scientific information important? What are the advantages and disadvantages of manipulating the free exchange of technical information? Should technical information be restricted from the public? Who should be allowed access to restricted information? Should scientists and engineers be responsible for technical decisions, even though such decisions impact all citizens?

15. How can society best respond to the technological issues? To the best benefit of society, should the information on technological issues be restricted from free access? In your answer consider the effect of economics.

16. Can the collection of data by scientists be influenced by their own expectations? Discuss.

17. Can the collection of data by scientists and engineers be influenced by the expectations of the organizations that employ those scientists and engineers? Give examples. How do scientists and engineers have their work verified or validated?

18. What is scientific inference? How can one be assured that data are representative? Do statistical tests provide a measure of how much uncertainty exists in collected data? Should scientific inference be used in the future validation of DOE release models?

19. What precautions should one federal agency take when reviewing the work of another federal agency? Give examples.

20. Provide a history and analysis of environmental impact statements (EIS), and explain why they were necessary. Offer a pro and con critique of EIS statements.

Section 2

The Legislative Response

After a lawsuit in 1985, DOE lost its right to self-regulate hazardous wastes as a direct result of a 2.4 million pound mercury spill at the DOE Oak Ridge facility. By 1985, DOE reacted to that loss, stating that its proposed byproduct rule was intended to clarify the responsibility for hazardous waste between DOE and EPA. Reduced to essentials, the rule indicates that what was once radioactive waste will be renamed byproduct. But it also suggests that when hazardous or chemical waste contains radioactive byproduct material, then EPA and the states may not regulate that waste stream. The rule was challenged by Congress.

This section covers three separate but interrelated paths. First, DOE's defense of the byproduct rule and of its operational record. Second, Congress's questioning of DOE on the contamination at the DOE Fernald, Ohio facility, including DOE's response and also testimony from an environmental official of the State of Ohio, Virginia Aveni. Third, congressional legislation reviewed by DOE is followed by the proposed legislation.

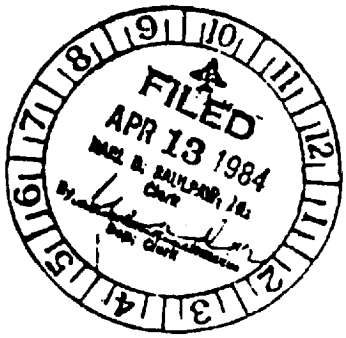
The relationship of all three sets of episodes is reviewed by a staff member of Congressman Markey's subcommittee, Nancy Smith. Reading through these episodes should enable the reader to define the issues through the responses and the legislation.

2.1

Summary Judgment of Oak Ridge Court Case

The court case at Oak Ridge is presented in the court summary judgement. The effect of the judgement on DOE waste management has been profound but still incomplete as both sides fight for position and an understanding of what the court decision means.

IN THE UNITED STATES DISTRICT COURT FOR THE
EASTERN DISTRICT OF TENNESSEE
NORTHERN DIVISION



LEGAL ENVIRONMENTAL ASSISTANCE FOUNDATION, INC., and NATURAL RESOURCES DEFENSE COUNCIL, INC.	:	
Plaintiffs	:	
STATE OF TENNESSEE Plaintiff-Intervenor	:	
V.	:	CIV. 3-83-562
DONALD HODEL, SECRETARY, UNITED STATES DEPARTMENT OF ENERGY, ET AL	:	

M E M O R A N D U M

Plaintiffs allege that defendants are in violation of the Resource Conservation and Recovery Act [RCRA], 42 U.S.C. §§ 6901-6987, and the Clean Water Act

[CWA][1], 33 U.S.C. §§ 1251-1376. Plaintiffs seek declaratory and injunctive relief plus the imposition of civil penalties., This case is now before the Court on cross motions for summary judgment.

Defendants are the United States Department of Energy [DOE] and the Secterary of DOE. Defendants operate the Y-12 Plant in Oak Ridge, Tennessee, pursuant to the Atomic Energy Act [AEA].[2] 42 U.S.C. §§ 2011-2284. Plaintiffs, Legal Environmental Assistance Foundation and Natural Resources Defense Council, Inc., are non-profit corporations concerned with environmental protection. Several members of these organizations reside in the Oak Ridge, Tennessee, area and the organizations have standing to bring this suit. The State of Tennessee intervened as plaintiff to protect its interest in hazardous waste and water quality regulation.

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[1]Also known as the Federal Water Pollution Control Act. See Gaba, Federal Supervision of State Water Quality Standards Under the Clean Water Act, 36 Vand. L. Rev. 1167, 1168 n.3 (1983).

[2]DOE is successor to many functions formerly vested with the Atomic Energy Commission. 42 U.S.C. §§ 5814, 7151.

The Y-12 Plant consists of approximately 260 buildings located on 600 acres. Y-12 is primarily engaged in the fabrication and assembly of nuclear weapons components. It is an esential and unique facility in this country's system of nuclear defense. Y-12 produces a large amount of hazardous wastes containing chromium, mercury, PCBs, cadmium and other pollutants. Some of these wastes are leaked or discharged into ground water and the tributaries of the Clinch River.

The questions before the Court are: 1) Whether the Y-12 Plant is subject to the provisions of the RCRA, and 2) Whether defendants have violated the CWA by allowing unpermitted discharges of pollution at Y-12.

RESOURCE CONSERVATION AND RECOVERY ACT

One purpose of the RCRA is "to promote the protection of health and the environment . . . by . . . regulating the treatment, storage, transportation, and disposal of hazardous wastes which have adverse effects on health and the environment." 42 U.S.C. § 6902. The RCRA and its accompanying regulations establish a comprehensive program for the handling of hazardous wastes. This comprehensive program is applicable to federal facilities. 42 U.S.C. § 6961. Nothing in the RCRA, however, "shall be construed to apply to (or to authorize any State, interstate, or local authority to regulate) any activity or substance which is subject to the . . . Atomic Energy Act of 1954 except to the extent that such

application (or regulation) is not inconsistent with the requirements of such [Act]." 42 U.S.C. § 6905(a).

Defendants oppose application of the RCRA to Y-12. They argue that application of the RCRA to Y-12 is inconsistent with the AEA for three reasons. First, the AEA precludes state regulation of activities of DOE, 42 U.S.C. § 2018, but the RCRA subject federal facilities to state regulation. 42 U.S.C. § 6961. Second, the RCRA gives the United States Environmental Protection Agency [EPA], state and local authorities the authority to set standards for waste disposal, 42 U.S.C. § 6902, yet the AEA places that authority with DOE. 42 U.S.C. § 2201(i)(3). Third, the AEA restricts dissemination of restricted data pertaining to nuclear weapons and materials, 42 U.S.C. §§ 2014(y), 2274, 2277, but the RCRA would subject this information to public disclosure. 42 U.S.C. § 6927.

Section 271 of the AEA, 42 U.S.C. § 2018, provides that:

> Nothing in this chapter shall be construed to affect the authority or regulations of any Federal, State, or local agency with respect to the generation, sale, or transmission of electric power produced through the use of nuclear facilities licensed by the [Atomic Energy] Commission: Provided, That this section shall not be deemed to confer upon any Federal, State, or local agency any authority to regulate, control, or restrict any activities of the Commission.

The parties are in disagreement as to whether this section prohibits any state or local regulation of Y-12 or whether it merely prohibits state and local regulations of electricity. In any event, plaintiffs assert, and defendants do not deny, that Y-12 is currently subject to federal, state and local regulations under several other environmental statutes. See, e.g., National Environmental Policy Act, 42 U.S.C. §§ 4321-4347; Safe Drinking Water Act, 42 U.S.C. §§ 300f to 300j-10; Clean Air Act, 42 U.S.C. §§ 7401-7642; Clean Water Act, 33 U.S.C. §§ 1251-1376; and Toxic Substances Control Act, 15 U.S.C. §§ 2601-2629. Admittedly, none of these other environmental laws contain a provision limiting its application to consistency with the AEA. But see 33 U.S.C. § 1371(a) (Clean Water Act does not limit inconsistent regulations of other agencies). The fact that Y-12 is subject to other state and local environmental regulations, however, precludes the argument that state and local environmental regulation of Y-12 is inconsistent with the AEA.

"Federal installations are subject to state regulations only when and to the extent that congressional authorization is clear and unambiguous." Environmental Protection Agency v. California ex rel State Water Resources Control, 426 U.S. 200, 211 (1976). On the other hand, a court must give full effect to a statute unless it is in "irreconcilable conflict" with another statute. Radzanouver v. Touche Rose & Co., 426 U.S. 148, 155 (1976). [W]hen two statutes are capable

of co-existence, it is the duty of the courts . . . to regard each as effective." Id., quoting Morton v. Mancari, 417 U.S. 535, 551 (1974). The RCRA and the AEA are certainly not in irreconcilable conflict. Congress must have intended that the RCRA be at least partially applicable to facilities operated pursuant to the AEA. Otherwise 42 U.S.C. § 6905(a) would have simply excluded application of the RCRA to AEA federal facilities. Although defendants have taken the position that Y-12 is totally excluded from RCRA regulations, § 6905(a) precludes RCRA application only to the extent it is inconsistent with the AEA. Defendants' position would render § 6905(a) a nullity.

The RCRA provides a comprehensive program for the handling of most hazardous wastes, but expressly excludes regulation of nuclear wastes. 42 U.S.C. § 6903 (27). The AEA regulates nuclear material, regardless of whether it is considered waste. 42 U.S.C. § 2014(e), (z), (aa). The Court concludes that the most reasonable reconciliation of the RCRA and the AEA is that AEA facilities are subject to the RCRA except as to those wastes which are exclusively regulated by the AEA: nuclear and radioactive materials. Although it could be said this interpretation renders § 6905(a) redundant with § 6903(27), the Court believes that these two sections support one another and firmly evince Congressional intent as to the application of the RCRA.

Section 161 of the AEA, 42 U.S.C. § 2201, provides that:

> In the performance of its functions the [Atomic Energy] Commission is authorized to--
>
> . . . .
>
> (i) prescribe such regulations or orders as it may deem necessary
>
> . . . .
>
> (3) to govern any activity authorized pursuant to this chapter, including standards and restrictions governing the design, location, and operation of facilities used in the conduct of such activity, in order to protect health and to minimize danger to life or property.

It does not appear that 42 U.S.C. § 2201(i)(3) vests DOE with exclusive authority to regulate health and safety standards in the operation of Y-12. Accordingly, the RCRA is not inconsistent with the AEA in this respect. Cf. Blaber v. United States, 212 F. Supp. 95 (E.D.N.Y. 1962), aff'd., 332 F.2d 629 (2nd Cir. 1964) (DOE's authority to prescribe health and safety regulations is discretionary, not mandatory).

If application of the RCRA to Y-12 would require disclosure of restricted nuclear material data protected by 42 U.S.C. §§ 2014(y), 2274, 2277, this would be inconsistent with the AEA. The burden is upon defendants, however, to show that such an inconsistency would result. Nothing the Court says today should be construed to require disclosure of restricted nuclear material data, however, defendants have not shown that application of the RCRA to Y-12 would result in such disclosures. Defendants' conclusory statement that such disclosures would be required is unsupported. The Court

can no more assume that the RCRA would require defendants to disclose restricted nuclear material data than it could assume that the RCRA would require private business to disclose trade secrets. If security of nuclear material data would conflict with the RCRA, defendants should apply for a Presidential exemption from the RCRA for Y-12. 42 U.S.C. § 6961. Apparently, defendants have not sought a Presidential exemption. Where DOE has not applied for a Presidential exemption, national security considerations should not be considered by the Court. See United States v. Puerto Rico, 721 F.2d 832, 835 n.4 (1st Cir. 1983)(interpreting the Clean Water Act, which has a similar Presidential exemption. 33 U.S.C. § 1333(a)).

The Court concludes that application of the RCRA to Y-12 will not be inconsistent with the AEA. The restriction upon the RCRA found in 42 U.S.C. § 6961 merely clarifies the Congressional intent to exclude nuclear wastes from coverage by the RCRA. The AEA still provides exclusive regulation of nuclear wastes. Defendants acknowledge that they have neither an EPA permit, 42 U.S.C. § 6925, nor a state permit, 42 U.S.C. § 6926, for the treatment, storage or disposal of hazardous waste. Accordingly, summary judgment for plaintiffs is appropriate for their claim under the RCRA.

CLEAN WATER ACT

The goal of the CWA is to eliminate the discharge of pollutants into navigable waters. 33 U.S.C.

§ 1251. Except as permitted under certain exceptions, "the discharge of any pollutant by any person shall be unlawful." 33 U.S.C. § 1311(a). One exception is granted for discharges allowed by a National Pollutant Discharge Elimination System [NPDES] permit issued pursuant to 33 U.S.C. § 1342. The "discharge of a pollutant" is defined as "any addition of any pollutant to navigable waters from any point source." 33 U.S.C. § 1362(12). "The term 'point source' means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged." 33 U.S.C. § 1362(14). Every identifiable point that emits pollution is a point source which must be authorized by a NPDES permit. United States v. Earth Sciences, Inc., 599 F.2d 368 (10th Cir. 1979); 40 C.F.R. § 122.1(b)(1).

The EPA issued a NPDES permit for Y-12 in 1974 which was to expire on February 15, 1980. Since DOE made application for a renewal of this permit more than 180 days before it was to expire, the 1974 permit is still in effect. 40 C.F.R. § 122.10(b)(2) (1979) (recodified at 40 C.F.R. § 122.21(d)(2) (1983)). This permit authorizes discharges at four points: Kerr Hollow Quarry, Rogers Quarry, New Hope Pond and Bear Creek. The parties acknowledge that at one time it was EPA policy to designate the facility boundry as the

point of discharge, but that this is no longer consistent with the requirements of the CWA. Apparently the 1974 permit conforms with EPA's prior policy.

Plaintiffs claim that defendants are violating the CWA because they do not have a NPDES permit covering Y-12 discharges at four other locations: the Oil Landfarm, the S-3 ponds, the Burial Ground Oil Pond and over 200 discharge pipes into Upper East Fork Poplar Creek. It seems clear to the Court, and defendants have offered no evidence to the contrary, that these four locations are point sources that are discharging pollutants into navigable waters. Since this lawsuit was filed, DOE has submitted NPDES permit applications for many of these point sources.

DOE argues that because it has a NPDES permit for Y-12, any discharge of pollution from Y-12 is not in violation of the CWA. DOE says that judicial review of the permit may only be by the appropriate Court of Appeals within ninety days after the permit was issued. 33 U.S.C. § 1369(b)(1). Plaintiffs, on the other hand, claim that they are not challenging the issuance of the 1974 permit. They construe this case as a complaint against the unlawful discharge of pollutants without a permit, which may be challenged in a citizen's suit such as this. 33 U.S.C. § 1365. The Court is inclined to agree with plaintiff's characterization of this suit. The 1974 permit does not purport to allow pollutant discharges at the Oil Landfarm, S-3 ponds, Burial Ground

Oil Pond or Upper East Fork Poplar Creek. The permit allows pollutant discharges only in accordance with the limitations and conditions of the permit. Defendants have taken the position that a NPDES permit for one point source of pollution, allows many other point sources of pollution unless someone appeals the issuance of the permit. This position is inconsistent with the remedial purpose of the CWA and the requirement that any point source of pollutant discharge be authorized by permit. 40 C.F.R. § 122.1(b)(1).

Defendants argue in the alternative that, if the Court determines that Y-12's NPDES permit does not authorize other pollution discharges, this Court should defer to the primary jurisdiction of the EPA and dismiss this action.

> Primary jurisdiction is a common-law doctrine that enables a court to determine the appropriate timing of its own exercise of jurisdiction so that an agency sharing concurrent jurisdiction with the court over the subject matter has time to make its own findings with respect to the claims and disputes. United States v. Western Pacific R.R., 352 U.S. 59, 64, 77 S. Ct. 161, 165, 1 L. Ed.2d 126 (1956). Its objective is to encourage "proper relationships between courts and administrative agencies charged with particular regulatory duties." Id. at 63, 77 S. Ct. at 164. Primary jurisdiction is appropriately invoked "when a claim is cognizable in a court but

> adjudication of the claim: requires the special competence of administrative bodies created by Congress to regulate the subject matter. Hansen v. Norfolk & Western Ry., 689 F.2d 707, 710 (7th Cir. 1982).

Illinois Hospital Association v. Illinois Department of Public Aid, 576 F. Supp. 360 (N.D. Ill. 1983). Whether several locations at Y-12 are point sources for pollution is a question within the competence of courts. See e.g., United States v. Earth Sciences, Inc., 599 F.2d 368 (10th Cir. 1979). Accordingly, deferal to the EPA would not be appropriate in this case.

REMEDY

The Court concludes that defendants are in violation of the RCRA and the CWA. At this time, however, the Court will impose neither an injunction nor civil penalties upon defendants for the following reasons:

1. The [illegible] is a unique and essential element of this nation's system of nuclear defense. See Weinberger v. Romero-Barcelo, 456 U.S. 305, 310 (1983).

2. Defendants have already taken and have agreed to take steps that will reduce environmental harm caused by violations of the RCRA and the CWA.

It is therefore ORDERED that plaintiffs' motion for summary judgment be and the same hereby is granted. It is further ORDERED that defendants' motion for summary judgment be, and the same hereby is, denied. It is further ORDERED that defendants, with all deliberate speed, file for and seek a permit for the treatment, storage and disposal of hazardous waste at X-12. 42 U.S.C. §§ 6925,6926 . It is further ORDERED that defendants, with all deliberate speed, file for and seek a NPDES permit for any discharge of pollutants into Upper East Fork Poplar Creek, and into Bear Creek from the Burial Ground Oil Pond, the Oil Landfarm and the S-3 ponds. See Barcelo v. Brown, 478 F. Supp. 646, 798 (D.P.R. 1979), aff'd. sub nom, 456 U.S. 395.

Order Accordingly.

Robert L. Taylor

United States District Judge

2.2

"Nuke Weapons Cleanup Marching"

"Costly Cleanup Building for Nuclear Bomb Wastes" is a headline used by the Engineering News Record to introduce its lead story, "Nuke Weapons Cleanup Marching." The article provides a summary to DOE of the impact of the Oak Ridge federal court case and decision.

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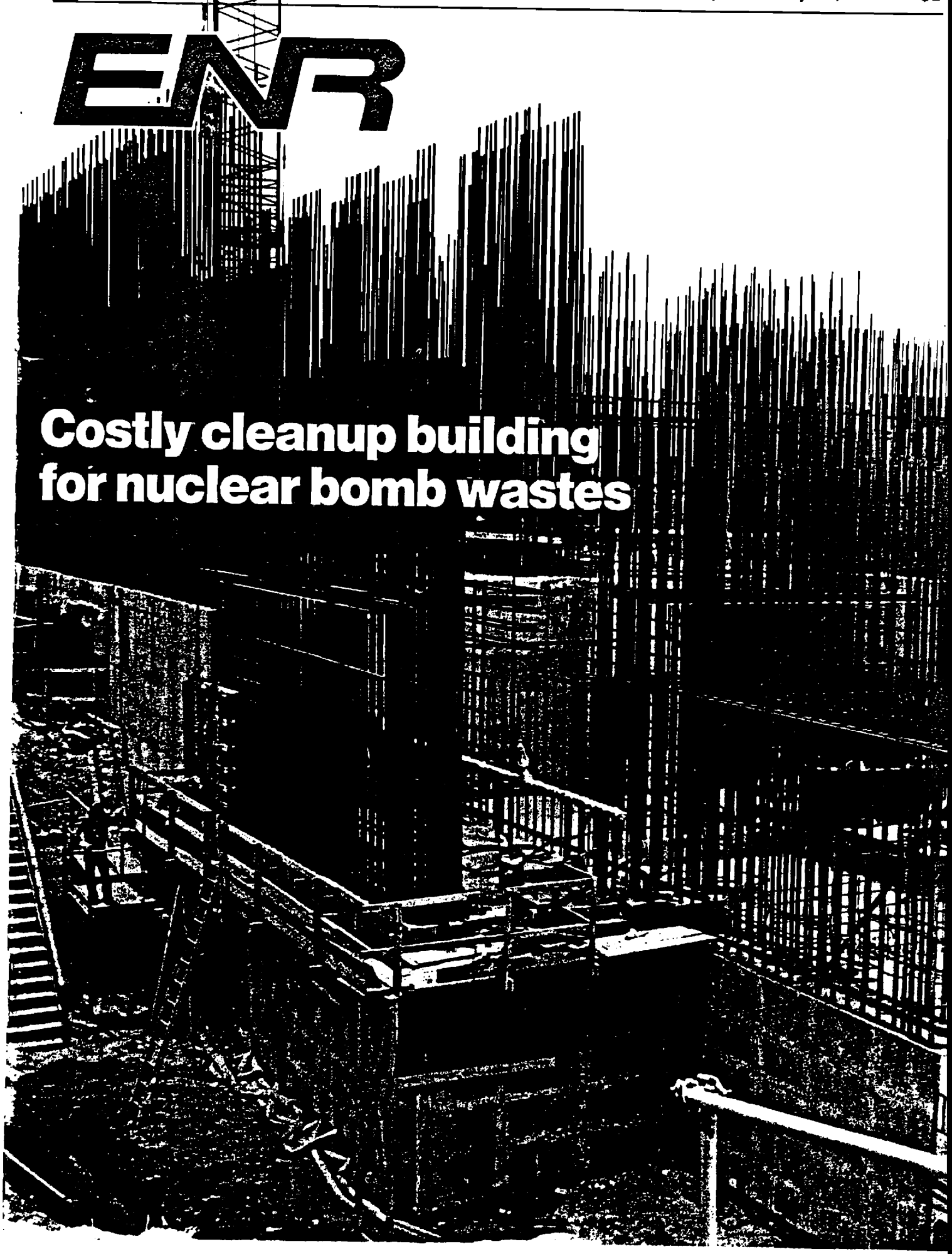


Costly cleanup building for nuclear bomb wastes

Nuke weapons cleanup marching

Toxic waste law is lifting the veil of secrecy at bomb plants

The Department of Energy's $25-billion nuclear-bomb-making empire is under attack by an angry mob worried about the millions of gallons of industrial chemicals and radioactive wastes that have been dumped or leaked into the soil around defense plants over the past 40 years. Armed with a new and potent sword, the Resource Conservation and Recovery Act, citizens' groups and state officials are piercing the wall of secrecy around the remote bomb plants. The result is likely to be a costly cleanup campaign at DOE's weapons factories, laboratories and test areas. The speed at which the environmental projects will move depends on the federal budget balancing process now under way and a number of lawsuits seeking to define DOE's responsibilities under RCRA. But combatants on both sides say the groundwork is set for a major redirection of the nuclear weapons program in the U.S.

"It is my pledge that the Department of Energy will be dedicated to correcting the environmental problems we now have and establishing a framework for addressing environmental problems in the future," said Energy Secretary John S. Herrington last September. "What was acceptable in 1945 is not acceptable in 1985."

For Joe LaGrone, who was brought in from San Francisco to manage DOE's Oak Ridge operations two years ago, Herrington's pledge is close to a miracle. "That's a remarkable commitment," he says. "We're going to do something about it rather than ignore it. The environment is a growth industry at DOE."

DOE's LaGrone plans to clean up Oak Ridge.

Lawyer Davis' suit opened a can of worms.

Fighting for years. For the people who have been fighting for years to get DOE and its operations contractors to clean up the nuclear weapons mess, Herrington's pledge isn't enough. "They have to meet the letter of the law because people like us will sue them every step of the way," says Frances Close Hart, chairwoman of the Energy Research Foundation, a public interest group in Columbia, S.C.

DOE's defense establishment, housed in a sprawling office outside of Washington, D.C., is hardly an easy mark—for Herrington or Hart. The nuclear weapons program has been an impregnable fortress for 40 years.

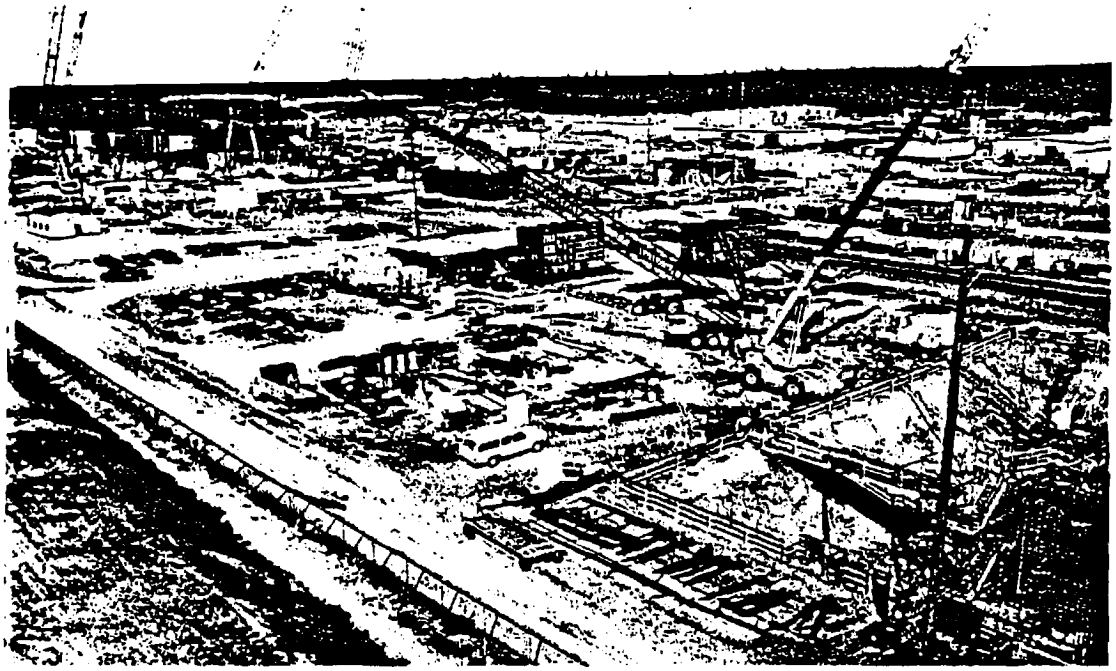
It was born in secrecy during the Manhattan Project and nurtured on the mistrust of the Cold War years. The Atomic Energy Act codifies the veil of secrecy. The Price-Anderson Act protects DOE's private operators from lawsuits. A military chieftain, currently a former admiral, runs the civilian agency's weapons office. The Armed Services committees of the House and Senate rule the nuclear weapons roost on Capitol Hill. The secretaries of Energy and Defense both sit on the President's Cabinet.

Their primary mission is to produce 21,000 new nuclear warheads, bombs and artillery shells by 1995. To achieve that goal, appropriations have been building steadily from $3 billion in 1980 to $7.6 billion this year. The total over those seven years is $39 billion.

Some $658 million of this year's spending is for the management of waste, mainly radioactive materials. Much of the rest goes to pay the 52,500 scientists, managers and workers who run the 30 facilities that make up DOE's weapons complex (see map p. 31). Compared with other programs, the spending on wastes has been increasing steadily as more and more demands are put on the outdated equipment at DOE's weapons plants.

The mostly idle bomb-making complex at the Hanford Engineering Works near Richland, Wash., was built more than 40 years ago. Its successor, the 300-sq-mile plutonium and tritium production complex at the Savannah River Plant near Aiken, S.C., is nearly 25 years old. "The plants are 1953 Fords. It's obsolete technology," says Robert Alvarez, director of the nuclear power and weapons project at the Environmental Policy Institute, Washington, D.C.

Other forces are also acting on DOE and Congress. Hart's $100,000-a-year Energy Research Foundation was joined by the State of South Carolina in a major lawsuit seeking to force compliance with RCRA's hazardous-waste disposal rules at Savannah River. The Natural Resources Defense Council in Washington is challenging DOE's narrow interpretation of



Waste processing plant at Savannah River will solidify highly radioactive wastes.

which of its wastes fall under RCRA. At least two House committees plan to hold hearings this spring to address that issue and other waste-management problems at defense plants. And "eco-commandos" from the militant environmental group Greenpeace are being recruited for a major demonstration at Savannah River this summer.

At the weapons plants themselves, the increasing militance of atomic trade unions, the rising concern about radiation hazards and the high claims being awarded for radiation exposure are likely to lead to more spending on waste management, Alvarez says.

Halo effect. In a paper on the politics of expanding weapons production at Savannah River and Hanford, A.T. Peaslee Jr. of DOE's Los Alamos National Laboratory notes what he calls the "halo effect" of new construction: "The prospect of additional economic well-being . . . can be expected to more than offset any qualms about radiation exposure risk or other fears."

Yet no new plutonium production reactors have been built in the U.S. for more than two decades. Instead, capital spending in recent years has been targeted at keeping existing production equipment running well.

It is also concentrated geographically. The defense program's capital budget of about $1 billion a year is heavily focused on Savannah River, where nearly 800 projects worth close to $3 billion are under construction, mainly by outside contractors. Charles H. Fox Jr., assistant manager for project management, says he expects the work to peak at a $700-million level in fiscal 1987 before winding down. "We see the light at the end of the tunnel," he says.

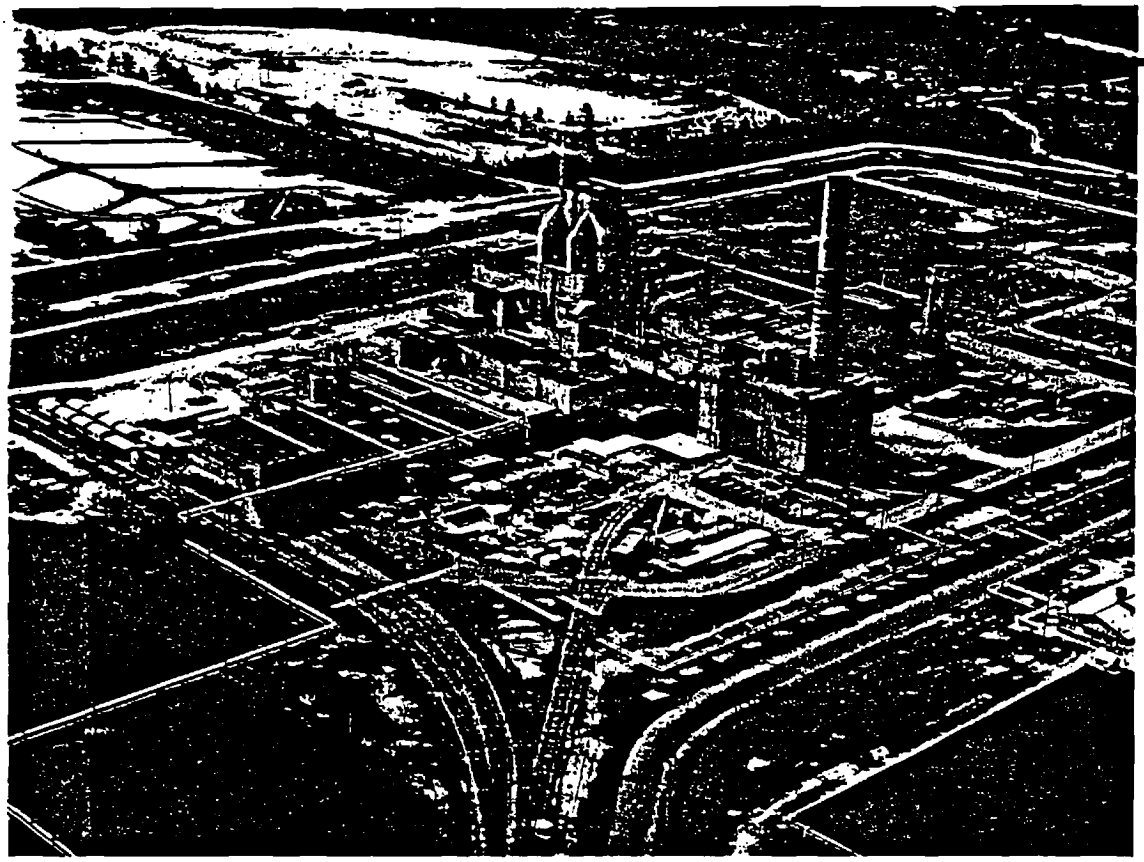
Elsewhere—and especially around Oak Ridge, Tenn.—DOE has not been able to produce much of a halo effect. "There haven't been many DOE projects completed in the past 10 to 15 years," says an aide to Rep. Marilyn Lloyd, who represents the district that includes Oak Ridge. Lloyd sits on the House Armed Services subcommittee on procurement and military nuclear systems. "A lot of people are getting skeptical," the aide adds.

Alvarez says Congress will be willing to fund DOE's environmental programs, if not new reactors. "You're not dealing with DuPont. The decisions on waste cleanup will be made on the floor of the House and Senate," he says. "Its a win-win situation for politicians. They can bring money into their districts for projects that everybody likes."

Solid answers. Nearly all of DOE's environmental spending is being driven by the clamoring of state officials and local groups. Their goal is to get all of DOE's radioactive and chemical wastes moved out of storage tanks, lagoons and unlined landfills and converted into more stable forms that won't contaminate the environment around weapons sites.

At Savannah River, part of that solution is an $870-million plant to immobilize highly radioactive sludge now stored in steel tanks. Begun in 1983, the so-called Defense Waste Processing Facility will seal thickened and pretreated sludges within a matrix of borosilicate glass. That leach-proof mixture will be placed in stainless steel canisters and sealed. Starting

Weapons wastes were disposed of in shallow burial cribs.



Plutonium-production reactor at Savannah River, near Aiken, S.C., was built 25 years ago.

harmful effects of radioactivity alone.

The department's long-time strategy of disposing of most of its wastes in surface cribs—the equivalent of septic tanks and leach fields—was based on the assumption that the radioactive material would bond with the soil and remain in place for thousands of years while the radioactivity decayed to harmless levels. There is some question in the scientific community about whether that assumption holds water. But there is no question that when chemicals are included in the waste mix, the process of attenuation and decay does not stand the test of time. "For a number of reasons, DOE's waste disposal philosophy has not worked," says Tony Baney, federal facilities enforcement coordinator for the Environmental Protection Agency.

As the scientific and regulatory distinctions between low-level radioactive wastes, hazardous wastes and mixed wastes disappear, the nature of the bomb-makers' legacy becomes clear. "We've got a fantastically broad palette of problems," says Werner F. Furth, director of environment, safety and health for Martin Marietta Energy Systems Inc., operator of the Oak Ridge lab.

in 1989, some 450 canisters will be produced each year and stored onsite for eventual disposal in DOE's proposed geological repository for high-level nuclear wastes. Bechtel National Inc., San Francisco, did most of the design and Morrison-Knudsen Co. Inc., Boise, is building the first-of-a-kind plant.

At Hanford, a draft environmental impact statement expected in March will cover a number of options for dealing with old bomb-making wastes stored in 169 tanks there. The estimated cost for duplicating the Savannah River program—removing all the radioactive sludge, immobilizing it in glass and disposing of it in DOE's deep geological repository—is $9 billion. Many of the steel tanks are in such poor condition that nearly $7 billion of that would go to remove the encrusted wastes from the tanks with remote-controlled equipment.

It took 10 years and a lot of arm-twisting by South Carolina politicians to get the money appropriated for the Savannah River waste processing plant. Because of the high cost of the proposed solutions and because DOE is not under any statutory deadline to do anything with its high-level radioactive wastes, the tanks at Hanford are likely to leak a while longer. The key to solving Hanford's problems is convincing Congress to appropriate money. Says Alvarez, "Mark Hatfield, the chairman of the Senate Appropriations Committee, has fallen into a coma on environmental protection at Hanford."

Chemical concerns. Chemical waste management under RCRA is just beginning to have an effect on the nuclear weapons budget. Much of the waste produced at bomb plants and DOE laboratories is a mixture of industrial chemicals and radioactive material. But DOE's scientific and management focus for 40 years has been on containing the

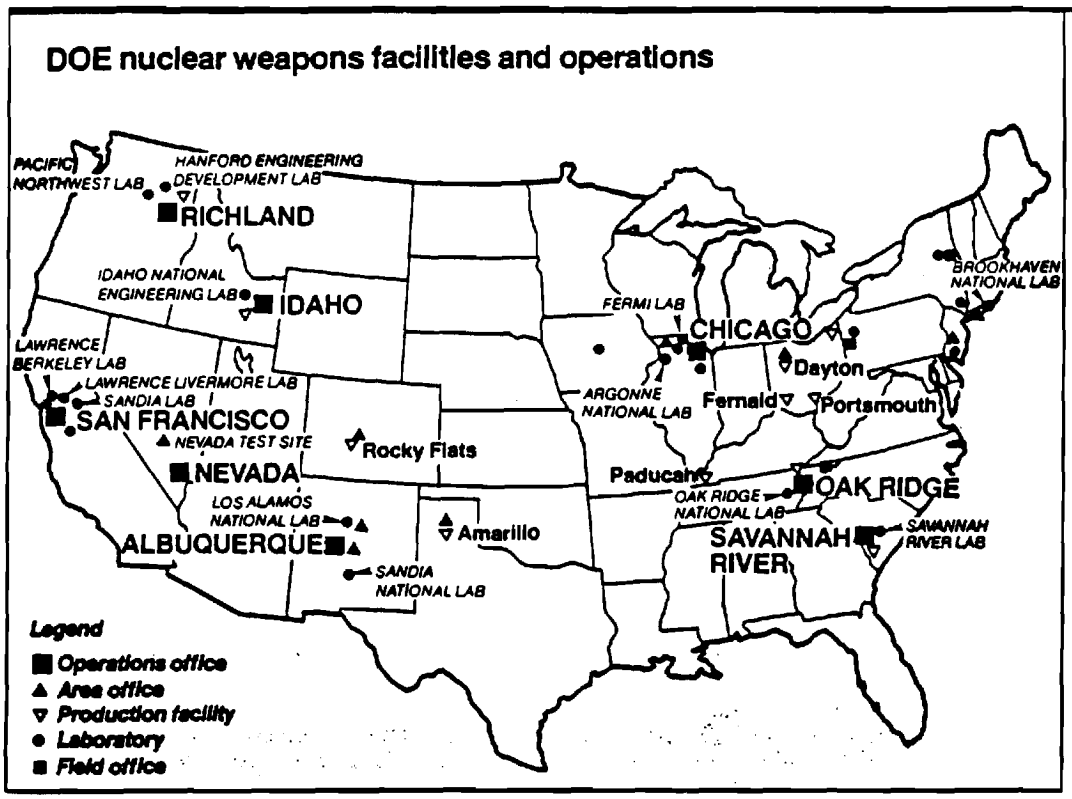
Project chief Fox has a $3-billion program.

Industrial requirements stronger. William Lawless, a mechanical engineer who worked for DuPont at Savannah River for six years, adds, "There isn't a DOE facility in this country that could operate for one day under the same requirements that exist for private industrial plants."

The shift in thinking on the science of waste disposal at DOE was given the force of law last year when the agency was ordered to comply with RCRA. Last April an 84-year-old federal judge appointed by President Truman ruled that EPA hazardous-waste disposal rules applied to the agency's Y-12 weapons plant at Oak Ridge, Tenn. The suit was based on the revelation in 1983 that DOE had spilled, dumped or otherwise lost at least 2.4 million pounds of mercury from the Y-12 plant between 1950 and 1963. DOE also admitted that some 4.7 million gal a year of metal plating wastes, acids and organic solvents were leaching into groundwater from seepage basins.

Although the judge's summary judgment opened the door to visits by EPA and state inspectors at every defense plant in the country, it was not challenged by DOE. "They knew they were going to lose and didn't want the publicity," says Gary A. Davis, the Knoxville lawyer and chemical engineer who led the fight against DOE.

Union Carbide Corp. had operated Oak Ridge for many years before Martin Marietta took over in April 1984. With



the lawsuit and the arrival of Joe LaGrone and Martin Marietta, Davis, the son of an Institute, W.Va., Union Carbide executive, says things have changed for the better. "They have a very focused environmental program now," Davis says.

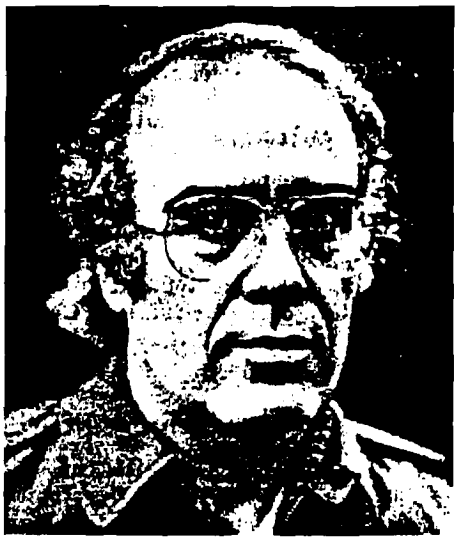
Oak Ridge model. LaGrone says he intends to make Oak Ridge the national model for DOE's environmental programs. It is a logical place to start. In addition to being the first DOE installation to be sued over RCRA, Oak Ridge considers itself America's premier atomic city. H. Wayne Hibbitts, environmental coordinator at Oak Ridge, also points out, "Our fixation is not just on national defense. Savannah River and Richland are much more focused on that mission."

LaGrone has a $700-million wish list of environmental projects, including $500 million worth that he wants to complete between 1985 and 1989. Most of the spending would go toward fixing old problems. The Y-12 plant, the target of the RCRA suit, is slated for $190 million worth of capital projects.

Nearly $450 million of the total is aimed at the facilities and grounds of the Oak Ridge National Laboratory (ORNL), which is not involved in weapons production.

According to DOE's internal newspaper, the mission at ORNL is "the development of efficient, economical, safe and environmentally acceptable technologies for the production of energy from various sources," mainly fission and fusion power. In carrying out that mission, DOE researchers have made a huge mess, says Frank L. Parker, a professor of environmental science and water resources at Vanderbilt University in Nashville.

Parker was head of radioactive-waste research at ORNL from 1956 to 1967. Along with Davis, he sits on a peer review committee for environmental programs at Oak Ridge. Parker claims that the laboratories are DOE's toughest waste management problem. The big production facilities repeat routine tasks, he says, so the process streams are comparatively easy to monitor and control. At the labs, "when you have 1,000 individual scientists each doing his own thing with an enormous number of experiments and chemicals, it is very difficult to control."


Engineer Lawless tracks DOE cleanup failings.

Finding the money to clean up the problems at DOE's labs will be equally difficult, he says. "The cleanup cost is peanuts for the big production operations. In research, the money all comes in small grants so it's an institutional problem of trying to find the cleanup money in all the little packages." Besides, he says, "The labs already think they're starving."

Door opener. Combined with all the rights of discovery in the legal system, RCRA opens a large breach in the federal monopoly over the nation's nuclear weapons complex by delegating enforcement authority to states.

The 1976 law and its 1984 amendments specifically require that federal facilities meet the EPA's cradle-to-grave hazardous-waste disposal regulations, and the legislation gives deadlines for each step toward that goal.

RCRA requires the EPA administrator—and authorizes the states—to make annual compliance inspections of federal facilities that produce hazardous wastes. It requires DOE to undertake "a continuing program" to compile and submit to EPA and states an inventory of all hazardous-waste sites the agency has ever owned or operated. It directs the EPA administrator to provide that inventory if DOE doesn't. It requires each federal facility to bring all of its units into compliance under a permit administered by states. And it gives citizens the right to sue DOE in federal court.

DOE's defense headquarters is clearly not the place for complaints about leaking radioactive waste tanks or chemical spills. Says EPA's Baney, "We've been butting our heads against DOE for so long that a lot of people have decided it's an insolvable problem and have gone on to other things."

After operating with one mission for 40 years, change is also difficult for the individual managers in the field who run the weapons plants and laboratories. "The people there are very good. They're not cynics or liars. They work in a system that's out of control," says Lawless.

More likely, change will be forced on the weapons makers by state officials wielding their RCRA sword. Says Donald Duncan, head of groundwater protection for South Carolina: "Its our state. Its our resource. They're not going to wear us out. We're very patient and tenacious." ■

By William G. Reinhardt

2.3

ENR Editorial: "DOE's Environmental Time Bomb"

An editorial that appeared in the same issue of Engineering News Record as the previous article frames hazardous waste management issues for the DOE.

DOE's environmental time bomb

Cleaning up the industrial chemicals and radioactive wastes discarded in the backyards of nuclear bomb plants over the past 40 years will challenge the construction industry on every front. Dozens of companies, from groundwater modelers to megabuilders, are already on the job helping the Department of Energy come to grips with its toxic-waste problems. The skills of many more will be required over many years to defuse the environmental time bomb that is ticking in the soil around the federal government's weapons plants (see p. 28).

Among the sad legacies of Hiroshima and the Cold War are the millions of gallons of toxic wastes dumped into the soil around these remote weapons plants. To the mostly rural citizens living near them, the legacy is a scary lot of industrial junk in the ground and water. To taxpayers, the legacy is another unpaid cost of the arms race, the many billions of dollars it will take to clean up around and behind the weapons makers.

Accomplishing that task will be difficult and risky. The daunting liability problems already facing engineers and contractors working on hazardous-waste projects will be greatly magnified by the scale and complexity of the weapons cleanups where chemical and radioactive wastes are often mixed and the disposal records are secret. Removing that contractual hurdle early will go a long way toward speeding the remedial work.

The leadership at the Energy Department has committed itself to fixing old environmental problems and retooling to prevent new ones from occurring at its weapons plants. The construction industry is massed and ready to attack. The next move is up to the budget makers in Congress and at the White House.

2.4

Policy Announcements from John S. Herrington, DOE Secretary

John S. Herrington, Secretary of the DOE, issued his position on the DOE record for protecting the environment. His statement asserts that his department's record has been good and that, while not responsible for the environmental legacies of the past, the DOE will thoroughly review its environmental and safety programs and make whatever changes are necessary. These policies have been distributed both within and beyond DOE.

Department of Energy
Washington, DC 20585

STATEMENT OF SECRETARY OF ENERGY JOHN S. HERRINGTON

ENVIRONMENT, SAFETY AND HEALTH
September 18, 1985

A CLEAN AND SAFE ENVIRONMENT IS A CONCERN THAT IS SHARED AND CHERISHED BY EVERY AMERICAN. IT IS AN ISSUE OF SPECIAL CONCERN AND IMPORTANCE TO ME BECAUSE THE DEPARTMENT OF ENERGY HAS MANY RESPONSIBILITIES AND OBLIGATIONS IN THE AREAS OF THE ENVIRONMENT, PUBLIC SAFETY AND HEALTH.

IT IS ESSENTIAL THAT THESE RESPONSIBILITIES ARE MET AND THAT THE OPERATIONS OF THE DEPARTMENT ARE CARRIED OUT IN A SAFE AND ENVIRONMENTALLY SOUND MANNER. AND IT IS IMPERATIVE THAT THESE OPERATIONS HAVE THE PUBLIC'S TRUST AND CONFIDENCE.

WHILE THE RECORD OF THE DEPARTMENT IN THIS AREA HAS GENERALLY BEEN A GOOD ONE, I WANT TO BE CERTAIN THAT THIS DEPARTMENT LOOKS AHEAD TO THE MANY CHALLENGES OF THE FUTURE WITH A STRONG AND AGGRESSIVE PROGRAM IN PLACE TO MEET OUR COMMITMENTS TO A CLEAN ENVIRONMENT, PUBLIC HEALTH AND SAFETY.

SOME OF OUR FACILITIES HAVE BEEN IN USE FOR NEARLY 40 YEARS. THE ENVIRONMENTAL PROBLEMS WE ARE FINDING NOW AT DOE FACILITIES ARE FOR THE MOST PART LEGACIES FROM THE PAST, FROM ACTIVITIES CONDUCTED IN A DIFFERENT ATMOSPHERE AND UNDER DIFFERENT STANDARDS THAN TODAY'S. WHAT WAS ACCEPTABLE IN 1945 IS NOT ACCEPTABLE IN 1985.

WE HAVE LEARNED A GREAT DEAL ABOUT HANDLING HAZARDOUS ACTIVITIES IN THE LAST FORTY YEARS.

I DO NOT INTEND TO LET TODAY'S ACTIVITIES CREATE PROBLEMS FOR TOMORROW. WE MUST APPLY THE SOPHISTICATED KNOWLEDGE AND TECHNIQUES THAT WE HAVE ACQUIRED TO OUR DAILY OPERATIONS.

FOR THESE REASONS, SHORTLY AFTER BECOMING SECRETARY OF ENERGY, I ORDERED A THOROUGH REVIEW OF THIS DEPARTMENT'S ENVIRONMENT AND SAFETY FUNCTIONS. THE REVIEW IDENTIFIED AREAS IN MANAGEMENT, PROGRAMS AND EMPHASIS WHICH COULD BE STRENGTHENED. IN RESPONSE, I HAVE DEVELOPED A PLAN WHICH WILL ENABLE THE DEPARTMENT TO ADDRESS ENVIRONMENTAL AND SAFETY ISSUES IN THE IMMEDIATE FUTURE AND IN THE LONG TERM.

2.5

DOE Fact Sheet

U.S. DEPARTMENT OF ENERGY
OFFICE OF THE PRESS SECRETARY
WASHINGTON, DC 20585

DOE FACTS

September 18, 1985

New DOE Initiatives in Environment, Safety and Health

FACT SHEET

Secretary of Energy John S. Herrington today announced a series of initiatives to strengthen the environment, safety and health function within the Department of Energy. There are three key elements of the long-range plan which will provide the framework for a strong emphasis on environmental and safety matters at the Department of Energy.

- Reorganization of ES&H

  - A new position of Assistant Secretary for Environment, Safety and Health has been established.

  - This ES&H function will include the consolidation of the Department's ES&H current functions, and the upgrading of ES&H responsibilities, and the oversight of new initiatives.

  - ES&H will be integrally involved in the operations of the Department at all levels.

  - ES&H will provide line management with more detailed information about the nature of the safety and environmental problems to be dealt with, and will oversee more directly the corrective action to be taken and the safety and environmental aspects of ongoing operations.

- The Environmental Survey

  - ES&H will conduct a baseline survey of all DOE facilities to identify and prioritize areas of existing environmental risk.

  - The survey will be a management tool to enable long-range planning, to correct any problems, to ensure compliance and to reduce identified areas of risk.

  - Details of the survey will include:

    - All DOE facilities, and all programs.
    - All media (air, water, soil).
    - All areas of environmental regulation.
    - Sufficient preliminary sampling and analysis to determine the nature of the problems.
    - Audits performed by ES&H using 5 teams led by DOE staff and supported by contractor experts.

  - It is estimated it will take approximately two years to complete the entire survey.

2.6

DOE Environmental Policy Statement

U.S. Department of Energy

Washington, D.C.

DOE N 5400.1

1-8-86

EXPIRES: 1-8-87

SUBJECT: ENVIRONMENTAL POLICY STATEMENT

It is the policy of the Department of Energy (DOE) to conduct its operations in an environmentally safe and sound manner. Protection of the environment and the public are responsibilities of paramount concern and importance to this Department. All activities of DOE should recognize and reflect this concern and public trust. To that end, DOE is firmly committed to assuring incorporation of national environmental protection goals in the formulation and implementation of DOE programs. It has an equal commitment to advance the goals of restoring and enhancing environmental quality, and assuring public health. Accordingly, it is the policy of DOE to conduct the Department's operations in compliance with the letter and spirit of applicable environmental statutes, regulations, and standards. In addition, DOE is committed to good environmental management in all of its programs and at all of its facilities in order to correct existing environmental problems, to minimize risks to the environment or public health, and to anticipate and address potential environmental problems before they pose a threat to the quality of the environment or the public welfare. Finally, it is DOE's policy that efforts to meet environmental obligations be carried out consistently across all operations and among all field organizations and programs.

While responsibility for good environmental management is a Departmental one, environmental protection practices will, of necessity, be carried out at the levels and locations where many of DOE activities are performed by its management and operating contractors. Thus, although the Department will continue to indemnify its management and operating contractors for fines, penalties, and other liabilities that are incurred pursuant to their contracts and not the result of willful misconduct or lack of good faith, it is DOE policy that contractors will share the Department's commitment to good environmental management. DOE expects its management and operating contractors to conduct their operations in an environmentally sound manner that limits the risks to the environment and protects the public health. DOE will actively oversee contractors' activities to assure compliance with this policy.

To further assure that these goals and objectives are met, the Department's environmental compliance activities will be coordinated at the Headquarters level. Effective immediately, the responsibility for this coordination is assigned to the Office of the Assistant Secretary for Environment, Safety, and Health.

JOHN S. HERRINGTON
Secretary

DISTRIBUTION:
All Departmental Elements

INITIATED BY:
Assistant Secretary for
Environment, Safety, and Health

2.7

Letter from House Subcommittee on Energy Conservation and Power to Secretary Herrington Requesting Information in Preparation for a Hearing on Proposed DOE Policies

and

Prehearing Questions for DOE

NINETY-NINTH CONGRESS

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(EX OFFICIO)

LAWRENCE R. SIDMAN
CHIEF COUNSEL AND STAFF DIRECTOR

ROOM H2-316
HOUSE OFFICE BUILDING ANNEX NO. 2
PHONE (202) 226-3474

U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER
OF THE
COMMITTEE ON ENERGY AND COMMERCE
WASHINGTON, DC 20515

March 25, 1986

The Honorable John S. Herrington
Secretary
Department of Energy
Forrestal Building
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Dear Mr. Secretary:

On April 10, 1986, the Subcommittee on Energy Conservation and Power and the Subcommittee on Commerce, Transportation, and Tourism will hold a joint hearing on the regulatory scheme governing Department of Energy facilities and new initiatives undertaken to strengthen the environment, safety and health function within the Department. In particular, the hearing will focus on the regulatory treatment of mixed waste at such facilities.

We request that Mary L. Walker, Assistant Secretary for Environment, Safety and Health and Admiral Sylvester R. Foley, Assistant Secretary for Defense Programs appear and testify at this hearing, which is scheduled to begin at 9:45 a.m. in a room to be announced.

In addition to the appearance of the Assistant Secretaries, we request that you answer the attached pre-hearing questions no later than Tuesday, April 1, 1986.

While the detailed written statements for insertion in the hearing record may be of any length the Assistant Secretaries deem appropriate, the statements should be double-spaced. A one page summary of the written statement should also be provided.

In accordance with Committee rules, witnesses scheduled to testify should deliver a minimum of 25 copies of their written and summary statements to the Subcommittee on Energy Conservation and Power no later than 10:00 a.m. on April 7, 1986. Also, an additional 80 copies of each statement should be brought to the hearing room by 9:15 a.m. on the day of the hearing for distribution to Members of the Subcommittees, the public and the press. In addition, on arrival at the hearing, testimony should be given to the Subcommittee clerk.

If you, Ms. Walker or Admiral Foley have any inquiries concering the hearing, please contact Nancy Smith at the Subcommittee on Energy Conservation and Power (226-2424) or Bill Roberts at the Subcommittee on Commerce, Transportation and Tourism (226-3160).

Sincerely,

James J. Florio
Chairman
Subcommittee on Commerce,
Transportation and Tourism

Edward J. Markey
Chairman
Subcommittee on Energy,
Conservation and Power

PRE-HEARING QUESTIONS FOR THE DEPARTMENT OF ENERGY

1) How do you currently define "mixed waste"?

2) With respect to mixtures of radioactive materials and hazardous wastes (as defined under 40 CFR part 261) at each DOE facility and contractor operations:

   a) What are the quantities of mixed wastes which have been disposed of since start-up of operations?

   b) What are the quantities of mixed wastes which are disposed of on a yearly basis?

   c) What are the waste streams which contain mixed wastes?

   d) What are the listed RCRA constituents contained in such waste streams?

   e) What are the RCRA characteristic wastes contained in such waste streams?

3) With respect to the Proposed Byproduct Material Rulemaking (50 Fed. Reg. 45736, November 1, 1985):

   a) Provide copies of all documents, memoranda, correspondence, reports, legal opinions, communications, comments, drafts, and other materials relating to the proposed Byproduct Material rulemaking.

   b) What is the current status of the proposed rule?

   c) What is the legal basis for interpreting the definition of "byproduct material" under section 11(e)(1) of the Atomic Energy Act to include the non-radioactive chemical as well as the radioactive consitutents of mixed wastes?

   d) What is the legal basis for DOE to change the definition of byproduct material?

   e) What is the legal basis for calling "direct" process wastes "byproduct material" and "indirect" process wastes not "byproduct material"? Please cite in your answer any legislative history to support such an approach.

   f) What agency and who in that agency will be responsible for making the final determination of whether a waste stream is "direct" or "indirect"? Explain in detail how such a determination would be made. Address specifically in your answer whether such a decision will be made generically for the entire DOE system, by facility or waste stream.

g) In the proposed rulemaking DOE states:

"If the rule proposed here today is adopted by DOE, its application will have the effect of leaving under the exclusive AEA regulatory scheme all DOE radioactive wastes currently stored or in the future to be stored in High Level Waste Tanks at DOE facilities. These wastes are regulated under a system of DOE Orders which require the proper storage and treatment of these wastes."

Please cite and specify the environmental standards contained in such orders which would govern the regulation of hazardous materials which are contained in such tanks.

h) Under what orders or authority will the non-radioactive chemical hazards of "direct" process wastes be regulated? Cite and describe such orders or regulatory provisions.

i) List those regulations and guidelines promulgated under RCRA governing the disposal of mixed wastes for which compliance would constitute a violation of orders issued by the DOE under the Atomic Energy Act.

j) Are there mixed waste streams containing identical or substantially similar RCRA listed or characteristic wastes which are nevertheless classified differently based on the direct-indirect process distinction? If the answer is yes, please identify such waste streams and list by facility and location.

k) Would RCRA regulation of mixed waste streams containing low-level radioactivity increase radiation hazards in any way? If so, how? Which waste streams in particular?

l) Would RCRA regulation of mixed waste streams containing high-level radioactivity increase radiation hazards in any way? If so how? Is there any provision of RCRA which would allow for resolution of such hazards?

m) In the proposed rule notice it is noted that the "DOE has prepared for each of its facilities a report indicating which existing individual waste streams would be considered Byproduct Material under this proposed rule, and which individual waste streams would be considered mixed waste. (The reports identify some wastes as 'candidate' mixed wastes because it is not yet known whether there are in fact constituents in these waste streams.)"

i) Supply all such reports.

ii) What definition of hazardous waste was used in these reports? Was a common definition of

hazardous and mixed waste used by all DOE facilities in evaluating waste streams? If a RCRA definition of hazardous waste was not used, why was it not used?

iii) What was the total cost of the studies?

iv) What percentage of mixed waste would be excluded from RCRA regulation as a result of the proposed rule?

v) How much of the DOE budget is allocated for identifying and characterizing potential mixed waste streams at DOE facilities. Please provide breakdown by facility.

vi) Why haven't the "candidate " mixed wastes been characterized? Will they be characterized under the standards set out in RCRA? If not, why not? When will they be characterized?

4) Please name each solid waste management unit (SWMU) at Hanford, the Savannah River Plant, and Oak Ridge which contains a mixture of radioactive materials and hazardous wastes (as defined under RCRA) but which are not included in the facility's Part B application. For each SWMU explain why the unit was not included in the Part B application.

5) What specific standards does DOE have concerning protection of groundwater with respect to non-radiological constituents?

6) Please supply the Subcommittee with all documents, memoranda, correspondence, reports, legal opinions, communications, comments, drafts and other materials relating to RCRA regulation of DOE facilities and the implications of RCRA regulation for DOE facilities.

7) On September 18, 1985, DOE announced a series of initiatives to strengthen the environment, safety and health function within the Department. As a result, oversight responsibility for the environment, safety and health function was consolidated and upgraded under a new Assistant Secretary for Environment, Safety and Health.

a) Has the line management structure at DOE changed as a result of upgrading the Office of Environment, Safety and Health? If yes, contrast the new line management stucture with the former system. If no, describe in detail the current line management system. Specifically address whether operations' office managers report directly to the Assistant Secretary of Environment, Safety and Health. Supply management

chart if available.

b) In the event of serious environmental problems at DOE contractor facilities, would the Assistant Secretary for Environment, Safety and Health have the direct authority to order managers of operations offices to take proscribed actions? Please explain in detail how the new Assistant Secretary would be able to ensure that Headquarter's directives are effectively implemented by the operations offices and their contractors.

8) Describe in detail DOE's programs for ensuring that DOE facilities are achieving the objectives of the Department in the areas of protecting the environment, safety and health. Cite the specific responsibilities of Headquarters, field offices and contractors. In particular, describe the role of the Undersecretary of Energy.

9) List all bonuses, awards, and other forms of recognition which have been given to DOE employees since 1980 for performance in the area of environment, health and safety safety. Identify by name, and date, and summarize reasons for granting such recognition.

10) Have any DOE or contractor personnel ever been disciplined by DOE because of actions concerning environment, health and safety? Please list and describe all such occurences, identifying individuals, contractors, and programs involved, as well as, specific actions taken by DOE.

11) DOE currently indemnifies its management and operating contractors for fines, penalties, and other liabilities that are incurred pursuant to their contracts which are not the result of willful misconduct or lack of good faith.

a) List by amount all fines, penalties and other liabilities which have been incurred by DOE management or operating contractors since 1980. Identify contractors and offices, summarizing the events leading to such fines, penalties or liabilities.

b) List and describe any instances where DOE contractors were fined, penalized or incurred liabilities due to willful misconduct or lack of good faith since 1980. Describe DOE actions taken as a result of such instances.

12) Is the Assistant Secretary for Environment, Safety and Health responsible for the oversight of environment, safety and health concerns at DOE nuclear weapons

facilities? If not, please explain how this oversight is performed.

13) In the event that there is a serious conflict between meeting DOE programmatic requirements and ensuring that objectives of the Office of Environment, Safety and Health are achieved, would the Assistant Secretary for Environment, Safety and Health have the authority to order a reduction or curtailment of the programmatic requirements in order to meet such objectives? If not, please explain in detail how such decisions would be made. Identify the individuals within the Department responsible for resolving such conflicts.

14) Describe the oversight function within the Office of the Assistant Secretary for Defense Programs for environment, safety and health concerns. How does this function specifically ensure that Defense Programs field offices and contractors are performing adequately in protecting the environment, safety and health? Describe how the Assistant Secretary for Defense Programs coordinates with the Assistant Secretary for Environment, Safety and Health in terms of oversight in this area.

15) You indicated that it is the policy of DOE to conduct its operations in an environmentally safe and sound manner. How then, can you explain the recent problems at the Fernald plant where radioactive materials were released to the environment? How do you explain the recent mercury problem at DOE's Y-12 plant? Who was held accountable for these failures? Please explain fully.

16) In reviewing the performance of DOE regarding environment, safety and health, what are the ten most serious instances when environment, safety and health were impaired? Describe such instances and the remedial actions undertaken by DOE. In addition, identify the DOE personnel responsible for such lapses and the actions DOE undertook to discipline such individuals.

17) In DOE Notice 5400.1 concerning the subject of environmental policy, DOE states that the Department "will actively oversee contractors' activities to assure compliance with this policy." Assuming that funds for completing the Environmental Survey are not supplanting ongoing oversight activities please answer the following questions and state when activities described are part of the Technical Safety Appraisal Program:

    a) What is the current funding level for ongoing oversight?

    b) How many individuals have been assigned to ongoing

oversight on a full-time basis?

c) Identify these individuals and organizational affiliation.

d) What specific form of oversight will be undertaken? For instance, will oversight entail on-site inspections, monitoring of data, and/or interviews?

e) How often will these individuals visit each DOE facility and for what length of time?

e) Will these individuals inspect weapons facilities?

18) With respect to conducting the Environmental Survey and Technical Safety Appraisals:

a) How many teams have been assembled?

b) Identify the individuals serving on each team and their organizational affiliations.

c) Describe how the members of the teams were selected and identify the individuals who selected them?

d) How was the order of facilities for review chosen?

19) Supply the Subcommittees with all DOE orders and guidelines regulating all DOE facilities. With respect to such orders and guidelines:

a) Are there instances where DOE orders and guidelines concerning the environment, safety and health differ from similar requirements contained in regulations and requirements issued by the Nuclear Regulatory Commission and EPA applicable to commercial facilities? Please include in your analysis the ability of DOE and commercial facilities to obtain waivers or exemptions.

b) If yes, cite and describe such differences.

c) Is there a mechanism for exempting DOE facilities from such orders and guidelines? If yes, describe the process for granting exemptions or waivers and identify the individual or individuals who have the authority to grant such exemptions or waivers.

d) Provide the Subcommittee with copies of all documents, reports, memoranda, and correspondence concerning the process for granting such exemptions or waivers.

e) How many waivers or exemptions have been granted since

1980? Supply all copies of such waivers or exemptions along with any documents describing ultimate DOE action.

20) Please provide comments on the following bills:

a) H.R. 2009, a bill introduced by Mr. Luken, which would amend the Solid Waste Disposal Act to clarify the jurisdiction of the Environment Protection Agency over the regulation of solid waste mixed with radioactive materials at Department of Energy Atomic Energy Act facilities;

b) H.R. 2593, a bill introduced by Mr. Wyden, to require the Administrator of the Environmental Protection Agency to establish certain standards for radioactive emmissions from atomic energy defense facilities of the Department of Energy and to monitor radioactive and nonradioactive emissions from such facilities.

2.8

Memo of the House Subcommittee on Energy Conservation and Power

Providing Background for the Hearing

This memo provides notice of a Congressional hearing on the DOE byproduct rule and on mixed wastes. The 1984 Oak Ridge court case declared that EPA and the respective states would regulate hazardous wastes disposed at DOE facilities. But what if the wastes were mixed radioactive and hazardous wastes? How would the DOE byproduct rule change the regulatory landscape? The hearing questions were written by Congressman Markey's staff, presented to DOE, and responded to by DOE.

EDWARD J. MARKEY, MASSACHUSETTS, CHAIRMAN

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JAMES T. BROYHILL, NORTH CAROLINA
(EX OFFICIO)

LAWRENCE R. SIDMAN
CHIEF COUNSEL AND STAFF DIRECTOR

HOUSE OFFICE BUILDING ANNEX NO. 2
PHONE (202) 226-2424

U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER
OF THE
COMMITTEE ON ENERGY AND COMMERCE
WASHINGTON, DC 20515

April 7, 1986

MEMORANDUM

TO: Subcommittee Members

FROM: Subcommittee Staff

SUBJECT: April 10, 1986 Hearing on the Safety of Department of Energy Facilities, the Treatment of Mixed Wastes at DOE Facilities, and H.R. 2009 and H.R. 2593

Summary

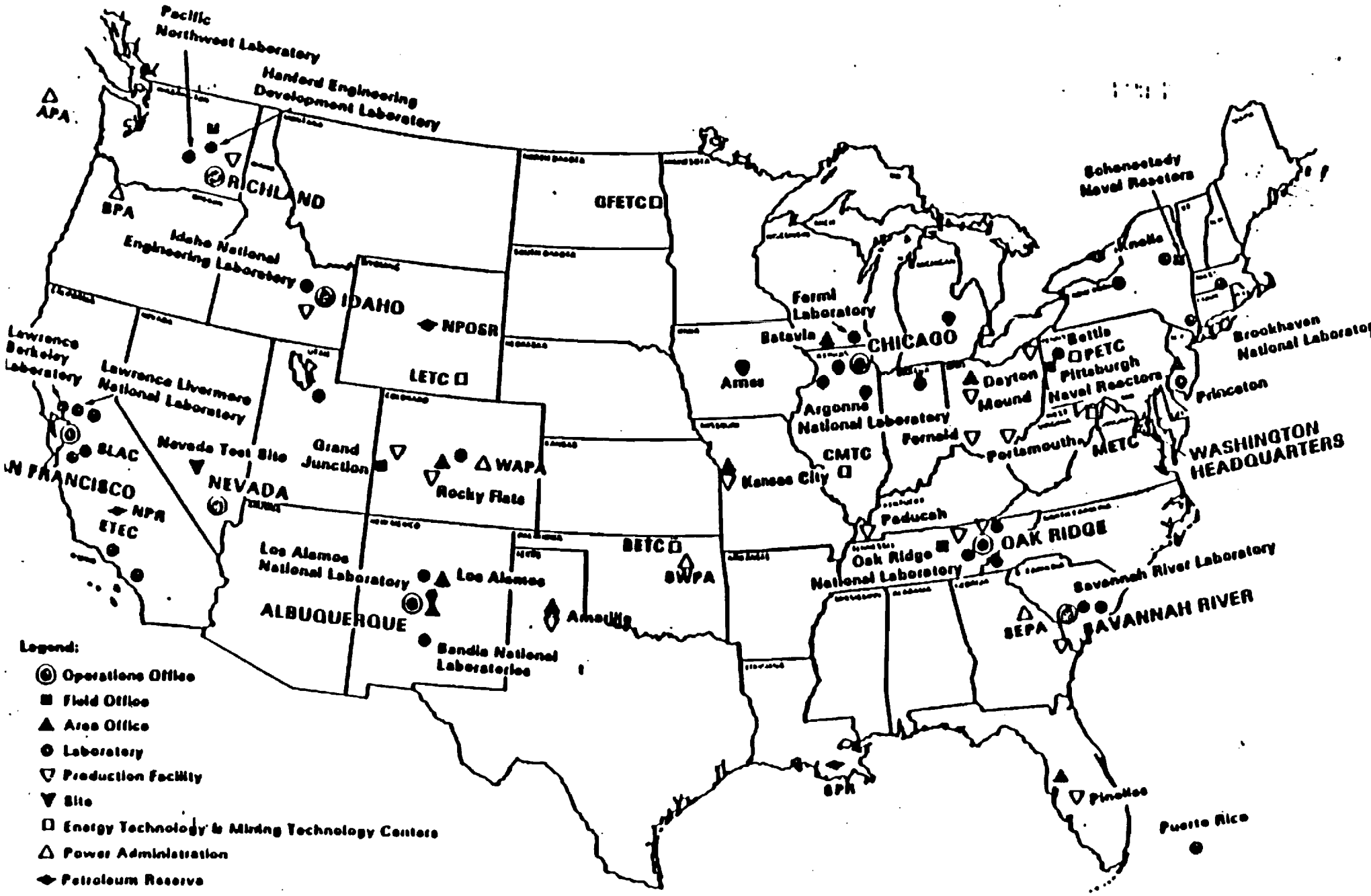
On Thursday, April 10, 1986, at 10:00 a.m. in Rayburn HOB, Room 2322, the Subcommittee on Energy Conservation and Power and the Subcommittee on Commerce, Transportation and Tourism will hold a joint hearing on Department of Energy (DOE) facilities, the treatment of mixed wastes at such facilities and two bills, H.R. 2009 and H.R. 2593.

DOE operates approximately thirty different nuclear weapons facilities across the United States (see enclosed map). The mission of these facilities include: producing and testing nuclear weapons; enriching uranium; producing plutonium; conducting research and development; and processing, storing, and disposing of radioactive and nonradioactive waste. This hearing will focus primarily on DOE's safety and environmental record to date on the disposal of radioactive and nonradioactive waste, and measures that can be taken to improve DOE's past performance. An issue of key concern is the relationship between DOE self-regulation and the applicability of the Resource Conservation and Recovery Act (RCRA) to DOE facilities.

RCRA and DOE Facilities

In 1976, Congress passed RCRA and established a comprehensive federal hazardous waste regulatory scheme which required federal facilities to comply with all federal, state and local requirements respecting hazardous waste disposal. Under RCRA, the Environmental Protection Agency (EPA) has authorized states to implement and enforce RCRA regulations.

MAP OF DOE FIELD FACILITIES AND OPERATIONS



DOE initially claimed that RCRA did not apply to federal facilities operated under the Atomic Energy Act. This claim was challenged in LEAF, NRDC v. Hodel and rejected by the court. The court found that RCRA did apply to purely hazardous wastes at DOE facilities.

Next, DOE claimed that RCRA did not apply to "mixed waste". Mixed waste is a combination of both radioactive and hazardous materials. DOE reasoned that since "byproduct material" is exempted from RCRA regulation, and mixed wastes are a mixture of byproduct material (radioactive) and hazardous materials, that RCRA would not govern mixed wastes. EPA objected to this analysis and claimed that RCRA did apply to mixed wastes. As a result of this impasse, the two agencies sat down to work out their differences. In an attempt to bridge their differences, the two agencies adopted King Solomon's solution: the two agencies split the mixed wastes at DOE facilites into two parts, mixed waste which would be solely regulated by DOE and mixed waste which would be regulated by both DOE and EPA. In order to make the split stick, DOE decided to change the definition of "byproduct material".

On November 1, 1985, DOE published a proposed rule (enclosed) which changed the definition of "byproduct material". The Atomic Energy Act of 1954 defined byproduct material as:

> "[A]ny radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material."

DOE proposed a new definition:

> "Byproduct Material means a waste substance containing radioactivity that is either directly yielded in the process of producing or utilizing Special Nuclear Material as that term is defined in the Atomic Energy Act of 1954, as amended, or its being made radioactive is a direct and necessary consequence of that process."

In addition to the proposed new definition, DOE prepared for each of its facilities a report indicating which wastes would be considered byproduct material under the proposed definition and which would not.

DOE explained the impact of the new definition:

> "If the rule proposed here today is adopted by DOE, its application will have the effect of leaving under the exclusive AEA regulatory scheme all DOE radioactive wastes currently stored or in the future to be stored in High Level Waste Tanks at DOE facilities....Other DOE radioactive hazardous wastes would either continue to be regulated under the exclusive AEA authority, if they are direct process wastes, or be regulated under both the AEA and RCRA authorities, if they are not."

Several federal agencies and interested parties commented on the proposed rule and the impact of the new definition. The Nuclear Regulatory Commission issued staff comments:

> "...NRC staff believe that if DOE's proposed definition is promulgated as a final rule, it would inevitably have a significant effect on the nature and scope of the NRC's and Agreement States' longstanding regulatory regime for the possession and use of byproduct and special nuclear material....If this concept were applied to the commercial sector, it would contradict forty years of accepted regulatory understanding and would leave unregulated radioactive materials which are currently regulated by NRC or agreement states as byproduct material....In our opinion, the Department's proposed redefinition of byproduct material is enough at variance with the plain meaning and historical understanding of the statutory definition to call the legality of the proposal into question."

The EPA responded:

> "...[W]e find the draft definition and preamble discussion somewhat ambiguous, and are not convinced that the definition will always translate into the classifications made in the draft booklets....We also do not consider it appropriate for DOE to defend its definition on the basis of the potential impact of a contrary interpretation on the RCRA exemption. Again, we view the regulation as an interpretation of the Atomic Energy Act, not RCRA."

The Natural Resources Defense Council (NRDC) commented:

> "We consider the proposed rule to be a blatantly illegal attempt by DOE to gain exclusive AEA control over wastes which both as a matter of law and logic should be regulated under RCRA as well as the AEA. The proposed rule is contrary to the AEA's language, legislative history and case law. Furthermore, it conflicts directly with the clear intent of RCRA. Finally, the rule is so illogical, ambiguous and unworkable as to be 'arbitrary and capricious.' We are concerned that the proposed rule, if adopted, would open up a major gap in RCRA's comprehensive control of chemical hazards and thereby pose unnecessary risks to human health and the environment."

The NRDC went on to note that millions of gallons of mixed wastes have been disposed of at DOE facilities in unlined pits, ponds, trenches and lagoons resulting in contamination of ground and surface waters. These wastes often contain corrosive acids and carcinogenic solvents as well as radioactive materials. The NRDC concluded that "the health risks from the hazardous chemical constituents of mixed waste often outweigh the dangers from the associated radioactivity."

Environment, Health and Safety at DOE Facilities

In 1979, the accident at Three Mile Island not only focused attention on safety and health issues at commercial nuclear facilities, but also prompted an assessment of DOE nuclear facilities. On August 4, 1981, the Government Accounting Office (GAO) issued a report (Better Oversight Needed for Safety and Health Activities at DOE's Nuclear Facilities, EMD-81-108) which found deficiencies in DOE's programs for worker protection, emergency preparedness, facility safety, and environmental monitoring at all types of DOE nuclear facilities. A follow-up report by GAO issued on November 30, 1983 (DOE's Safety and Health Oversight Program At Nuclear Facilities Could Be Strengthened) found that "DOE has made improvements in its safety and health program. However, the improvements have been made, for the most part, on a piecemeal basis. Consequently the major cause of the problems has not been addressed."

In the Spring of 1985, DOE released a study of its Environment, Safety and Health program entitled the Kane Report. The Kane Report found:

"The Department has proclaimed its dedication to the principle of safety and environmental oversight, while at the same time it has allowed the organization responsible for this oversight, the Office of Environment, Safety and Health (ES&H) to atrophy....

The current state of ES&H is a disgrace. It is widely perceived as having "no clout", and of being ignored by senior management unless a crisis develops. Morale is low, and as successive reports recommending action are followed by no action, it sinks further. It is not an office that would be attractive to aggressive young people on the way up. In spite of dedicated efforts by many of its staff, it has become a toothless watchdog guarding the safety and environmental integrity of one of the potentially most hazardous undertakings in the world....

The Department must get its act together. It needs a comprehensive, well-planned approach to handling the cleanup of sites to meet environmental requirements. Without it, the Department will continue to lose credibility and could face significant interruption in its programs."

On September 18, 1985, Secretary Herrington announced a series of initiatives to strengthen the environment, safety and health function within DOE. As a result of those initiatives, the Environment, Safety and Health Program (ES&H) will undertake a baseline Environmental Survey of all DOE facilities to identify Department-wide existing environmental problems, areas of potential risk and to prioritize corrective actions. In addition, ES&H will conduct Technical Safety Appraisals of DOE's nuclear facilities to determine compliance with safety requirements.

This hearing will explore the changes that have occured within ES&H and their impact on resolving past DOE problems. An issue of significant concern is the extent to which DOE facilites are in compliance with current federal laws, RCRA in particular, and whether DOE facilities are required to attain the same standards required of commercial facilities.

Legislation

H.R. 2009

H.R. 2009, introduced by Representatives Luken and Wyden, is a bill to amend the Solid Waste Disposal Act and to clarify the intent of Congress that the generation, transportation, treatment, and storage of solid waste mixed with radioactive material is subject to the Solid Waste Disposal Act, and that the disposal of solid waste mixed with radioactive material at Department of Energy Atomic Energy Act facilities, and at other facilities not licensed for the disposal of radioactive materials, is also subject to such Act. (A copy of H.R. 2009 is attached.)

H.R. 2593

H.R. 2593, introduced by Representative Wyden, is a bill to require the Administrator of the EPA to establish certain standards for radioactive emissions from atomic energy defense facilities of DOE and to monitor radioactive and nonradioactive emissions from such facilities. (A copy of H.R. 2593 is attached.)

A section-by-section analysis of H.R. 2593 follows:

Section 1. SHORT TITLE: The Military Radioactive Emissions Control Act of 1985."

Section 2. RADIATION STANDARDS AND EFFLUENT LIMITATIONS FOR ATOMIC ENERGY DEFENSE FACILITIES.

(a) STANDARDS FOR RADIOACTIVE RELEASES FROM LOW-LEVEL RADIOACTIVE WASTE -- The EPA Administrator is required to issue standards for radioactive releases from the management and disposal of low-level radioactive waste at atomic energy defense facilities. These standards should not be less stringent than those issued for radioactive releases from the disposal of low-level radioactive waste at facilities licensed by the Nuclear Regulatory Commission.

(b) WATER POLLUTION STANDARDS -- Requires nuclear material discharged from atomic energy defense facilities to be regulated under the Clean Water Act.

(c) RADIONUCLIDE EMISSION STANDARDS -- Requires the EPA Administrator to revise the national emission standards for radionuclide emission from DOE facilities. These standards shall be equivalent to radionuclide emissions set by the EPA for commercial nuclear facilities. DOE facilities can exceed these standards if the President determines such operation is in the national security interest.

Section 3. MONITORING BY ENVIRONMENTAL PROTECTION AGENCY

(a) IN GENERAL -- The Environmental Protection Agency shall monitor, on a continuous or periodic basis, compliance of atomic energy defense facilities with standards established under this act and under any other provision of law.

(b) ONSITE MONITORING AND INSPECTION -- The EPA shall conduct this monitoring onsite at Department of Energy faciltites as well as in areas surrounding such facilities.

(c) SPECIFIC MONITORING ACTIVITIES -- Specific monitoring activities shall include monitoring of stack and liquid discharges, monitoring of surface waters offsite and the sediments in these surface waters.

Section 4. ANNUAL REPORT

The EPA Administrator is required to submit to the Congress an annual report setting forth the findings and assessments, an analysis of the extent of compliance of atomic energy facilities with the standards set forth in this act and any recommendations for legislative or other action to ensure compliance of atomic energy defense facilities with these standards.

Section 5. DEFINITIONS

Section 6. REIMBURSEMENT BY THE DEPARTMENT OF ENERGY

The Department of Energy is required to reimburse the Environmental Protection Agency for expenses incurred in carrying out the provisions of this act.

2.9

Proposed DOE Byproduct Rule

DOE proposes to redefine radioactive waste products so that it can monitor their use. An interesting comparison can be made between the proposed rule and comments by Nancy M. Smith. (See 2.16 in this casebook.)

DEPARTMENT OF ENERGY

10 CFR Part 962

Byproduct Material

AGENCY: Department of Energy (DOE).

ACTION: Notice of proposed rulemaking.

SUMMARY: The Department of Energy proposes to issue regulations under section 161.p. of the Atomic Energy Act of 1954 (42 U.S.C. 2011 *et seq.;* hereinafter the "AEA") for the purpose of clarifying the Department of Energy's obligations under the Resource Conservation and Recovery Act (42 U.S.C. 6901 *et seq.;* hereinafter "RCRA"). This regulation will clarify the application of the term Byproduct Material, as defined in section 11e(1) of the AEA (42 U.S.C 2014(e)(1)), to Department of Energy owned or produced radioactive waste substances for the purpose of determining which of these waste substances are Byproduct Material under the AEA and are therefore not "solid waste" as that term is defined in RCRA. This proposed rule does not affect materials that are Byproduct Material under section 11e(2) of the AEA.

The proposed regulations are necessary to clarify which of these radioactive wastes shall continue to be regulated by DOE exclusively under the AEA and which wastes shall be subject to regulation both under RCRA and the AEA.

DATE: Comments must be received on or before December 2, 1985.

ADDRESSES: Comments should be addressed to: Henry K. Garson, Esq., Assistant General Counsel for Environment, Department of Energy, 1000 Independence Ave., SW., GC-11, Washington, DC 20585.

FOR FURTHER INFORMATION CONTACT:

Henry K. Garson, Esq., Assistant General Counsel for Environment, Department of Energy, 1000 Independence Ave., SW., Room 6A-113, Washington, DC 20585, Telephone: (202) 252-6947

Robert J. Stern, Director, Office of Environmental Guidance (EH-23), Department of Energy, 1000 Independence Ave., SW., Washington, DC 20585, Telephone: (202) 252-4600.

SUPPLEMENTARY INFORMATION:

Background

The Resource Conservation and Recovery Act (RCRA), enacted in 1976, establishes a comprehensive regulatory scheme to govern the generation, transportation, treatment, storage and disposal of hazardous waste. Federal agencies are required by section 6001 of RCRA (42 U.S.C. 6961) to comply with that regulatory scheme in the same manner, and to the same extent, as any private person or entity. DOE had interpreted section 1006 of RCRA (42 U.S.C. 6905) as exempting from regulation under RCRA DOE's activities and substances subject to the AEA relating to our Nation's national security programs. In 1984, the United States District Court disagreed with this interpretation and held RCRA to be applicable to the activities of DOE under the Atomic Energy Act. *LEAF* v. *Hodel*, 586 F.Supp. 1163 (E.D. Tenn. 1984).

By its definitional provisions, however, RCRA excludes from its regulatory scheme "source, special nuclear and byproduct materials," as those terms are defined by the AEA (section 1004(27) of RCRA, 42 U.S.C. 6903(27)). Thus, any DOE waste substance which is Source, Special Nuclear or Byproduct Material, even those that otherwise could qualify as hazardous waste under RCRA, will continue to be regulated under DOE's exclusive AEA regulatory authority.

The AEA provides detailed definitions for Source Material and Special Nuclear Material, but only defines Byproduct Material, in pertinent part, as "any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material," section 11e(1). While in practice, little need has previously arisen to address this definition's applicability to radioactive wastes, the use in RCRA of Byproduct Material as a waste term now requires a clarification of what DOE radioactive waste substances meet the statutory definition of Byproduct Material.

II. Discussion

Unlike the AEA's definitions of the related terms Source Material (section 11z. of the AEA, 42 U.S.C. 2014(z)) and Special Nuclear Material, (section 11aa. of the AEA, 42 U.S.C. 2014(aa)) which mention particular substances by name, the definition of Byproduct Material, for purposes here pertinent, speaks only in terms of a technical process. The legislative history of this definition provides little guidance as to its intended application, and the definition has not been clearly elucidated by judicial interpretation.[1] Because the plain words of the definition are keyed to the process for producing and utilizing Special Nuclear Material, that process itself would appear to be determinative of whether particular radioactive materials are properly within the definition. Thus, while the definition is clear on its face that Byproduct Material must be radioactive, it would appear that radioactivity alone does not suffice to characterize a waste substance as Byproduct Material. The radioactive waste must be either directly yielded in the process of producing or utilizing special nuclear material, or have been made radioactive as a direct and necessary consequence of that process.

Radioactive wastes that are accelerator produced or that are yielded in the process of producing or utilizing Source Material or Byproduct Material are not Byproduct Material, because those wastes do not result from the process of producing and utilizing Special Nuclear Material. If those wastes display any hazardous characteristics, they would, under the regulation proposed today, be subject to regulation under RCRA, despite their radioactivity.

In contrast, high-level radioactive waste emanating from the chemical processing of spent fuel for the production of plutonium, and radioactive waste cutting oil used for the machining of plutonium to a usable configuration, are Byproduct Material as defined in the AEA, and therefore are excluded from regulation under RCRA, because the contained radioactivity in these wastes is a direct, necessary and inherent consequence of the process of producing and utilizing Special Nuclear Material. These wastes, which today's proposed rule would define as Byproduct Material, are perhaps best thought of as production or utilization "direct process wastes."

Intermediate to the examples set forth in the two preceding paragraphs is the case of wastes whose contained radioactivity is an indirect result, rather than direct process waste, from the process of producing and utilizing Special Nuclear Material. For example, some DOE facilities prepare Byproduct radionuclides for use in commerce. While it is clear that the products as radionuclides are themselves Byproduct Material, it would appear less clear that the radioactive residues resulting from

[1] Two early decisions interpreting the Atomic Energy Commission's licensing authority over low level radioactive waste clearly conclude that these wastes are Byproduct Material. The specific issue of whether the wastes, in their entirety, were Byproduct Material was not, however, specifically at issue because the wastes clearly contained Byproduct Material subjecting them to regulation by the AEC. Harris County v. United States, 292 F.2d 370 (5th Cir. 1961); City of New Britain v. Atomic Energy Comm'n, 308 F.2d 648 (D.C. Cir. 1962).

the preparation or use of the products are properly so characterized, because their contained radioactivity is at best an indirect consequence of the process for producing and utilizing Special Nuclear Material, by no means a direct process waste. Such wastes and wastes made radioactive in a similar manner, may be termed "indirect process wastes." While containing Byproduct Material, these wastes would not, under today's proposed rule, be considered Byproduct Material in their entirety. Rather, if otherwise found to contain hazardous waste, they would be considered "mixed waste", containing both Byproduct Material and or other radioactive material and hazardous waste.

While it would appear possible to construe the AEA to include indirect process wastes and other mixed wastes as Byproduct Material because, in the context of DOE's AEA activities, their contained radioactivity is, in the most literal sense, "incident to" the process for producing and utilizing Special Nuclear Material and these wastes clearly contain Byproduct Material, it would seem more accurate to say that these wastes are primarily incident to a different process, the process employed by DOE to produce commercial radionuclide products. Under this line of reasoning, while indirect process wastes would be said to *contain* Byproduct Material (trapped radionuclides, to use the example given in the preceding paragraph), they would not themselves *be* Byproduct Material, because their contamination with radioactivity is neither a direct nor, strictly speaking, a necessary consequence of the process for producing and utilizing Special Nuclear Material. Because of this distinction, DOE is proposing that these indirect process wastes exhibiting hazardous characteristics be treated as "mixed" waste, handled in accordance with the requirements of both RCRA and the AEA.

Thus, DOE's proposed interpretation of "Byproduct Material" for purposes of clarifying RCRA's applicability to radioactive waste substances at DOE's AEA facilities, would apply only to production or utilization "direct process wastes."

This proposed rule is supported by the fact that virtually all radioactive waste substances yielded in the process for producing or utilizing special nuclear material are contained, dissolved or suspended in a nonradioactive medium, from which their separation is impracticable. High-level radioactive waste and most transuranic waste, for example, exist only in this form; the maximum practicable separation of their radioactive and nonradioactive components has already occurred before the substances are actually disposed of or classified as waste. It seems apparent, then, that unless the term "radioactive material" as used in section 11e(1) of the AEA is taken to include the entirety of a direct contact process waste substance in which radioactive elements are dispersed, the exclusion of Byproduct Material from RCRA's coverage would be reduced to a virtual nullity.

III. Effect of Proposed Rule

DOE has prepared for each of its facilities a report indicating which existing individual waste streams would be considered Byproduct Material under this proposed rule, and which individual waste streams would be considered mixed wastes. (The reports identify some wastes as "candidate" mixed wastes because it is not yet known whether there are in fact hazardous constituents in these waste streams.) These reports are available for inspection at the following locations during normal business hours:

U.S. Department of Energy, Room 1E-190, 1000 Independence Avenue, SW., Washington, DC 20585
Albuquerque Operations Office, National Atomic Museum, Wyoming Blvd., Building 20358, Albuquerque, NM 87115
Chicago Operations Office, 9800 South Cass Avenue, Argonne, IL 60439
Idaho Operations Office, 550 Second Street, Idaho Falls, ID 83401
Nevada Operations Office, Public Reading Room, 2753 South Highland Street, Las Vegas, NV 89109
Oak Ridge Operations Office, Federal Building, 200 Administration Road, Oak Ridge, TN 37830
Richland Operations Office, Hanford Science Center, 825 Jadwin Street, Richland, WA 99352
San Francisco Operations Office, 1333 Broadway, 2nd Floor Oakland, CA 94612
Savannah River Operations Office, FOI Publication/Document Room, University of South Carolina—Aiken, Aiken SC 29801

Should processes change, or should new waste streams not in reports be produced, these wastes would be classified using the definition proposed today, applied in a consistent manner to achieve consistent results. DOE believes that this porposed rule provides a reasonable basis to classify the wastes produced at its AEA facilities consistent with both DOE's AEA authorities and its responsibilities under RCRA.

If the rule proposed here today is adopted by DOE, its application will have the effect of leaving under the exclusive AEA regulatory scheme all DOE radioactive wastes currently stored or in the future to be stored in High Level Waste Tanks at DOE facilities. These wastes are regulated under a system of DOE Orders which require the proper storage and treatment of these wastes. Ultimately, all of these wastes are to be disposed of pursuant to other statutory schemes including the Energy Reorganization Act of 1974, the Department of Energy Organization Act, and the Nuclear Waste Policy Act. Other DOE radioactive hazardous wastes would either continue to be regulated under the exclusive AEA authority, if they are direct process wastes, or be regulated under both the AEA and RCRA authorities, if they are not.

IV. Invitation to Comment and Notice of Public Hearing

Interested persons are invited to submit written comments and recommendations to the address set forth at the beginning of this document. All comments or recommendations received on or before December 2, 1985 will be considered before the issuance of final regulations.

All comments submitted in response to these proposed regulations will be available for public inspection, during and after the comment period in Room 1E-190, 1000 Independence Ave., SW., Washington, DC, 20585 between the hours of 9:00 a.m. and 4:00 p.m., Monday through Friday of each week except Federal holidays.

Pursuant to section 501 of the Department of Energy Organization Act the Department will provide an opportunity for oral presentation of views, data and arguments. Interested persons may request a public hearing by the date set forth above. If any requests for a public hearing are timely received, the Department will conduct a public hearing on November 13, 1985, at 9:00 a.m. in Room 1E-245, 1000 Independence Ave., SW., Washington, DC. If no requests for a hearing are received, the hearing will be cancelled. Procedural rules for the hearing will be announced at the commencement of the hearing.

V. Related Rulemaking

This proposed rule clarifies the jurisdictional basis for the application of RCRA to certain DOE wastes. The Environmental Protection Agency has proposed, or will shortly propose, rules under its RCRA authorities to govern other issues involved in RCRA's application to DOE facilities including issues of national security, state

program consistency, protection of data and access to DOE facilities. Interested persons should also review that rulemaking in order to have an awareness of all of the issues involving RCRA application to DOE facilities.

VI. Procedural Matters

A. Executive Order 12291

These proposed regulations have been reviewed in accordance with Executive Order 12291.

They are not classified major because they do not meet the criteria for major regulations established in that Order.

B. Regulatory Flexibility Act Certification

The regulations will not have a significant impact on a substantial number of small entities.

C. Paperwork Reduction Act of 1980

There are no information collection requirements in the proposed rules.

List of Subjects in 10 CFR Part 962

Nuclear materials, Byproduct material.

Issued in Washington, DC, October 24, 1985.

J. Michael Farrell,

General Counsel.

In consideration of the foregoing, Part 962 of 10 CFR Chapter III is proposed to be added as set forth below.

Part 962 is added to 10 CFR Chapter II to read as follows:

PART 962—BYPRODUCT MATERIAL

Sec.

962.1 Scope.

962.2 Purpose.

962.3 Byproduct material.

Authority: The Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 *et seq.*); Energy Reorganization Act of 1974 (42 U.S.C. 5801 *et seq.*); Department of Energy Organization Act of 1977 (42 U.S.C. 7101 *et seq.*); Nuclear Waste Policy Act of 1982 (Pub. L. 97–425, 96 Stat. 2201).

§ 962.1 Scope.

This part applies to radioactive waste substances which are owned or produced by the Department of Energy at facilities owned or operated by the Department of Energy under the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 *et seq.*).

§ 962.2 Purpose.

The purpose of this Part is to clarify the term Byproduct Material under section 11e(1) of the Atomic Energy Act (42 U.S.C. 2014(e)(1)) for use in determining the Department of Energy's obligations under the Resource Conservation and Recovery Act with regard to radioactive waste substances owned or produced by the Department of Energy pursuant to the exercise of its authority under the Atomic Energy Act of 1954, as amended. It does not affect the definition of Byproduct Material contained in section 11e(2) of the Act.

§ 962.3 Byproduct material.

For purposes of this part, the term Byproduct Material means a waste substance containing radioactivity that is either directly yielded in the process of producing or utilizing Special Nuclear Material as that term is defined in the Atomic Energy Act of 1954, as amended, or its being made radioactive is a direct and necessary consequence of that process.

[FR Doc. 85–26312 Filed 10–31–85; 10:53 am]

BILLING CODE 6450–01–M

2.10

Responses to Congressional Prehearing Questions 15 and 20

(Requested in 2.7 Prehearing Questions)

DOE responded to the Congressional inquiry on contamination at Fernald and at the Y-12 Plant at Oak Ridge (Question 15) and to the question about two proposed bills (Question 20).

Comments by Virginia Aveni, Ohio state official, serve as a counterpoint to the DOE responses. (See 2.14 of this casebook.)

15. You indicated that it is the policy of DOE to conduct its operations in an environmentally safe and sound manner. How then, can you explain the recent problems at the Fernald plant where radioactive materials were released to the environment? How do you explain the recent mercury problems at DOE's Y-12 Plant? Who was held accountable for these failures? Please explain fully.

The Feed Materials Production Center (FMPC) located at Fernald, Ohio began operation in the early 1950's as a large scale integrated production facility for processing uranium and its compounds from natural uranium ore concentrates. Today, recycled uranium materials is utilized as a feedstock for the facility. Until January 1, 1986, NLO, Inc., (NLO) operated the site as a prime contractor to DOE.

The principal product from the FMPC operations is high purity uranium metal in various physical forms having several standard isotopic assays. The primary mission is the production of depleted uranium target element cores for the DOE Savannah River Plant near Aiken, South Carolina, production reactors; low enriched machined ingots and billets for fabrication into fuel cores for the DOE N Reactor at Richland, Washington; and depleted uranium metal for DOE's Y-12 Plant in Oak Ridge, Tennessee, and the Rocky Flats Plant in Colorado.

Following the initial $117 million construction project, an approximate $60 million expansion occurred in the mid-1950's. Metal deliveries peaked in 1960 at approximately 10,000 metric tons of uranium and then in 1964, began to decline to a low in 1975 of about 1,230 metric tons of uranium. During the 1970's, consideration was given to closing the FMPC so capital improvements and staffing were minimized. The staffing level, which peaked at 2,891 in 1956, slowly declined over the same period to 538 in 1979. Then, in FY 1981, direction was given to plan the Center's restoration to accommodate projected product requirements that were to grow to near the originally installed capacity of the FMPC.

This transition included significantly increased production levels, rapid staff buildups in many areas, and implementation of a major facilities restoration program. As of this date, accomplishments include: production output of 288 percent of the 1979 level; a staff increase from 538 to over 1,000; and the initiation of over $70 million of capital facility improvements.

During the past approximately 30 years of FMPC operation, uranium, through process losses, was released to the environment via both the air and water pathways. While a small percentage of total uranium throughput, the cumulative discharges are large when viewed independently. The major discharges occurred during the 1950's and 1960's, during the early years of plant operations. The total discharge to the air was 95,954 kilograms of uranium (Kg/U) and 74,308 Kg/U to the water. An additional 5,121,717 Kg/U was disposed of in onsite pits. Large volumes of contaminated scrap have also been sent to the FMPC for storage. There are also three concrete silos of dry waste at the FMPC. One silo contains low-radium metal oxides and the other two contain high-radium content uranium ore residues left over from material processed earlier at the FMPC or shipped from the Mallinkrodt Plant in St. Louis or the Niagara Falls site.

On December 7, 1984, DOE Oak Ridge Operations (ORO) was informed of a uranium release from the FMPC. Upon learning that the loss was reported to have occurred as a result of malfunction of the Plant 9 baghouse air filtration system from approximately mid September to December 6, 1984, ORO immediately ordered an investigation because the release was considered excessive for the operating period in question. The loss has been determined to have been 123.9 kilograms of slightly enriched uranium emitted from sometime after September 11, 1984, through the early morning of December 7, 1984. The Investigation Board was charged with assessing the situation at the FMPC and determining the causal factors which contributed significantly to the release.

Oak Ridge Operations reported the release to the National Response Center and the Ohio EPA on December 7, 1984, pursuant to the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act.

A press release was also issued that day to inform the public of the release. In response to public reaction and concern, several members of ORO staff went immediately to the FMPC and conducted a public meeting near the Plant on the evening of December 13, 1984, to benefit from face-to-face communication.

NLO, following the shutdown of the Plant 9 baghouse on December 7, 1984, undertook a number of corrective actions.

Operations were restarted on December 12, and continued normally until the morning of December 14, when instrument readings indicated that the Plant 9 baghouse might again be malfunctioning. NLO responded immediately and shut the unit down. Analysis indicated that the uranium discharge had been very small. However, it was the judgment of ORO that this baghouse should not be restarted until an outside group of experts on air filtration systems could conduct a thorough review and provide a demonstration that the facility was adequate to operate. Again, the appropriate agencies were notified, and an onsite press conference was held to explain the latest problem on the day of its occurrence. The press were also taken on a tour of Plant 9.

As a result of an intensive inspection of all major process ventilation systems at the FMPC, NLO made a decision to temporarily shut down a portion of a second processing facility (Building 5) because of marginal performance of two of the facilities bag filtration systems.

On December 18 and 19, 1984, the outside group of independent experts carried out an inspection of the FMPC major process ventilation systems.

On February 6, 1985, DOE issued its report on the "Investigation of September-December 1984, Plant 9 Excessive Uranium Emissions." Following release of the report, ORO held a press conference in Cincinnati, and a public meeting in the community near the FMPC.

On April 22, 1985, the Committee on Governmental Affairs of the U. S. Senate held hearings in Cincinnati on the issue of DOE's management of the health and safety programs at the FMPC.

With regard to the contractor's actions concerning the release at FMPC, the Manager of Oak Ridge Operations, on December 11, 1984, wrote the Executive Vice President of NL Industries, Inc., the parent company of NLO, to express his deep concern that this event was not reported promptly to the public, regulatory bodies, or DOE.

Also in December 1984, NL Industries, Inc., was advised of the ORO decision to recommend to DOE, Headquarters, that the contract for operation of the FMPC be competed. Although the NLO contract for the management and operation of the FMPC had been renewed every five years since its inception and would have normally been routinely renewed again in October 1985, it was the ORO Manager's judgment that DOE could not routinely renew the contract and instead should initiate a recompetition to include a wide participation of qualified organizations.

NL Industries, Inc., indicated that they would not be interested in competing for the new contract and agreed to DOE's desire for a 6-month extension of the contract through March 31, 1986, to afford an effective, orderly transition to a new contractor operation by April 1, 1986. Even though this was a major procurement action, DOE placed high priority on this activity and were able to select a new operating contractor in advance of the April 1, 1986, target. The new contractor, Westinghouse Materials Company of Ohio assumed responsibility for FMPC operations on January 1, 1986. One of the key elements in selecting a new operating contractor was a strong commitment to environment and health in all aspects of the plants operations.

While safety and environment had been assessed in the past under the NLO Award Fee Plan, the composite of evaluations, with greater weights for production activities, resulted in less than adequate visibility for this key operational area.

More specifically, in FY 1984, there were five functional areas assessed: (1) production operations; (2) safety and environmental control; (3) maintenance management; (4) budget; and (5) engineering.

The Award Fee Plan for the first half of FY 1985 retained the same five areas identified above and added three others: (1) safeguards and security; (2) small and disadvantaged business procurement; and (3) industrial relations.

In light of the excessive uranium emissions that occurred in the September - December 1984 timeframe, Oak Ridge Operations determined that environmental matters should be given greater emphasis in the award fee structure than had been in the past; i.e., set it out as a separate item for evaluation rather than including it with safety. On December 18, 1984, NLO management was informed of the change which would be in effect for the second half of FY 1985.

The DOE contract with NLO provided for an award fee pool of $2,360,000 for FY 1985. NLO, Inc., performance during the first and second half of FY 1985 was determined by DOE to be unsatisfactory and the $2,360,000 award fee available was not paid.

With respect to mercury releases, in 1977, the Oak Ridge Operations requested Union Carbide Corporation Nuclear Division, the Y-12 operating contractor to reconstruct the mercury inventory situation as it existed earlier at Y-12. The report was classified Secret Restricted Data under the Atomic Energy Act of 1954, because some of that information

pertained to the production of special nuclear materials for weapons. In response to a Freedom of Information Act request in November 1982, for all reports on mercury spillages and emissions at Oak Ridge, a 1966 spill report was made available in December 1982 and the 1977 Report underwent declassification review under the DOE's Freedom of Information Act regulations.

On May 17, 1983, DOE released statistical information on quantities of elemental mercury that are unaccounted for or have been lost, primarily during the 1950's from a former processing activity at the Y-12 Plant. That report, dated June 1977, estimates that 2.4 million pounds of mercury was lost in releases to the ground, water, and air or is unaccounted for.

Lithium enriched in the lithium-6 isotope is used in the production of lithium deuteride fuel for thermonuclear weapons. In the early 1950's, weapons tests confirmed the success of thermonuclear weapons utilizing lithium deuteride and the United States launched a crash program to produce large quantities of enriched lithium. The DOE Y-12 Plant was chosen as the production site and two large scale production facilities were completed and placed in operation during the period of December 1953 through September 1955.

The lithium separation processes used at Y-12 involved large quantities of mercury. The mercury was obtained from the General Services Administration (GSA) and was shipped to Y-12 from the GSA stockpile and other sources in flasks nominally containing 76 pounds of mercury. Due to the high priority of getting the facilities in operation, the incoming mercury was added into process equipment upon receipt without measurement of the contents of the flasks.

Development and pilot plant facilities were operated in four buildings at Y-12 from 1950 through 1955. Stripping and decontamination of the development and pilot plant facilities was completed by mid-1958.

Large scale production facilities were operated for lithium separation at Y-12 during the period of 1953 through 1963. The mercury was removed from the BETA-4 production plant in 1956 and stripping and decontamination were completed in 1957. The ALPHA-5 production plant was drained, stripped and decontaminated in 1965 and 1966. The mercury was drained from the ALPHA-4 production plant and the equipment flushed by 1977. However, the process equipment is still in place.

During the operation of the lithium production plants, four major mercury spills occurred between 1955 and 1956. The quantity of mercury involved in the spills was not measured. The estimated losses are between 100,000 and 400,000 pounds.

The last major spill at Y-12 occurred in March 1966. In this instance, 100,000 pounds was spilled and approximately 50,000 pounds was recovered.

In addition to spills, mercury was released in process water from the large separation facilities. The major discharges occurred in the 1955 through 1959 period when nitric acid was used to clean the mercury. Since some of the mercury was converted to mercuric nitrate, it was carried out in the process stream discharge. In mid-1958, a water wash for mercury was introduced to reduce the mercury loss and the resulting discharge was substantially reduced.

In 1963, New Hope Pond was constructed at Y-12 to reduce discharges to the environment and the quality of water discharged from New Hope Pond has progressively improved.

About 240,000 pounds of mercury is believed to have moved by process drainage systems and surface movements to East Fork Poplar Creek during the 1950's. After flowing for approximately 20 miles, the Creek empties into the Clinch River in the western portion of Oak Ridge. Much of the mercury discharge to East Fork Poplar Creek deposited into sediment along the full length of the creek bed and into the Clinch River.

The majority of the mercury falls into the category of unaccounted for. Approximately 1,900,000 pounds is in this category. Since the original quantity of mercury received cannot be verified, it is not reasonable to expect that an accurate figure will be forthcoming.

Unaccounted for material would include possible shortages of mercury in the original inventory received from GSA, mercury carried out on equipment during clean-up, and mercury retained in the process materials during lithium separation. Since this is not measured, it can only be estimated. Spills of mercury due to piping failure, valve leaks, etc., while not uncommon can only be estimated. Since such losses can not be verified by audit, they can only be considered as material unaccounted for.

Following release of the Y-12 mercury accountability report on May 17, 1983, Oak Ridge Operations briefed the Oak Ridge City Council on May 23, 1983. At that meeting, DOE offered to assume responsibility for conducting soil or water sampling and analysis requested by the City. A geological drilling program was initiated at the Y-12 Plant area to provide information on mercury lost into the soil under the lithium separation process buildings following receipt of comments on the plan from the City of Oak Ridge, State of Tennessee Department of Health and Environment, and Region IV U. S. EPA.

On June 23, 1983, an Interagency Mercury Task Force comprised of U. S. EPA, State of Tennessee, City of Oak Ridge, Tennessee Valley Authority, U. S. Geologic Survey, Corps of Engineers, and DOE held its first meeting in Knoxville, Tennessee. This Task Force is charged with developing near term and long term recommendations on remedial actions.

On July 6, 1983, a joint Congressional Hearing was held in Oak Ridge by two subcommittees of the House Science and Technology Committee chaired by U. S. Representatives Lloyd and Gore of Tennessee. The Hearing focused specifically on the Y-12 mercury releases, the health and environmental consequences of the mercury and DOE's plans for addressing the problem.

Extensive on-site and off-site efforts since 1983 have characterized those locations where residual mercury can be found. An FY 1985 project "Air and Water Pollution Control" authorizes $15M to reduce mercury discharges from the Y-12 Plant site through a variety of techniques, with emphasis on prevention of contact between residual mercury and storm, process, and ground water. Current discharge concentrations average about 2 ppb, the EPA Drinking Water Standard. These further reductions are aimed toward the more stringent fish and aquatic life standards. Some removal of on-site mercury contaminated soil has been accomplished; however, very little mercury has been found in soils, the underlying geologic strata, or in ground water.

Off-site, the interagency task force, chaired by the State, has sponsored extensive residual contamination characterization studies which have been funded by DOE. Current efforts are primarily focused on a risk assessment of the characterization data. A feasibility study of alternative remedial actions is in the planning stages.

Since 1983 the Y-12 Plant and other Oak Ridge facilities have made major progress in identifying environmental problems and in achieving compliance with regulatory requirements. Union Carbide Corporation - Nuclear Division[1] has been replaced by a new operating contractor, Martin Marietta Energy Systems, Inc. This new operating contractor for the DOE Oak Ridge facilities has elevated environmental compliance to a top priority goal.

1 In May 1982 Union Carbide - Nuclear Division notified DOE of their decision to withdraw from the operating contract.

The large releases of uranium which occurred at FMPC in the 1950's and early 1960's and the mercury releases during the same time frame occurred during a period in which concern for the environment was secondary to production goals. Nor were the releases unacceptable in light of the standards which existed at that time.

DOE is today attempting to catch up with the extensive environmental requirements that have been promulgated in the intervening years. These and other environmental legacies of past operations are difficult to rectify and do require considerable resources.

Question 20: Please provide comments on the following bills:

a. H.R. 2009 - Mr. Luken
b. H.R. 2593 - Mr. Wyden

Answer: (a.) H.R. 2009, the "Mixed Hazardous Waste Amendment Act of 1985", introduced by Mr. Luken (for himself and Mr. Wyden) is identical to S. 892, introduced by Senator Glenn. Comments for the Department of Energy on the bill S.892 were presented by John R. Barker, Director of the Office of Environmental Audit and Compliance before the Subcommittee on Environmental Pollution and the Subcommitee on Nuclear Regulation, Committee on Environment and Public Works, U.S. Senate on March 25, 1986. A copy of Mr. Barker's statement is included. The statement indicated that the Administration does not have a current position on the bill and that we are in the process of formulating a position through joint meetings with EPA and NRC.

(b.) H.R. 2593, the "Military Radioactive Emission Control Act of 1985," was originally introduced by Mr. Wyden on May 23, 1985. This bill would require the Administrator of the Environmental Protection Agency to establish standards for radioactive emissions from atomic energy defense facilities of the Department of Energy and to monitor radioactive and nonradioactive emissions from such

facilities. Specifically, the EPA standards would apply to the management and disposal of low level radioactive waste at DOE facilities. Such standards would be required to be no less stringent than those applicable to low level waste disposal facilities licensed by the Nuclear Regulatory Commission. The bill would also require EPA to establish standards for atmospheric radionuclide emissions from DOE facilities under the Clean Air Act that would be equivalent to standards for commercial nuclear power operations. The bill would require the EPA to conduct onsite as well as offsite monitoring and inspection to assess DOE atomic energy defense facility compliance with radioactive and nonradioactive contaminant standards, effluent limitations and maximum contaminant levels established under this bill or any other provision of Federal law. The bill would add discharges of source, special nuclear, and byproduct material from DOE atomic energy defense facilities to the definition of "pollutant" contained in the Clean Water Act. Finally, this bill would require the Department of Energy to reimburse the EPA for any expense incurred by that agency in carrying out the provisions of this bill, as enacted.

The Department of Energy has the following comments on this bill: Controls at the Federal level are either already embodied in regulations or are under development in the areas addressed by the standard setting provisions of the bill. EPA has issued radionuclide air emission standards under the Clean Air Act which are comparable to those established for commercial nuclear operations, and is actively working on low-level radioactive waste standards. It is not clear, then, what additional benefit would be obtained from adoption of this bill. In addition, the proposal for inclusion of source, byproduct, and special nuclear material under the provisions of the Clean Water Act would not assure that such materials would be regulated by the agency with the appropriate expertise. DOE believes that continued separation of radiological and non-radiological protection is more appropriate.

With respect to the monitoring requirements of the bill, the DOE is actively moving toward mandatory radiological surveillance requirements for air, and ground and surface water. DOE already has substantial initiatives in these areas.

As a matter of course, all DOE facilities conduct various onsite and offsite monitoring activities on a daily,

monthly, quarterly and annual basis, as appropriate. This program, necessary for proper, safe, efficient operation, monitors radioactive and nonradioactive materials and emissions resulting from the facility's operations. The results are used by onsite operations personnel to manage and control program activities on a real time basis. These results are also compiled in reports. For instance, an annual summary report of offsite environmental monitoring data is prepared by each facility and provided to the public, as mandated by DOE Order 5484.1.

In addition, DOE operations and facilities cooperate with EPA, state and local environmental health and safety regulatory offices. These offices work with DOE operations personnel and conduct independent assessments of DOE facility operations and emissions as they deem appropriate. Their results are then compared with the DOE facility data to ascertain the Department's compliance with national and State emission controls. DOE is also in the process of establishing a comprehensive DOE/EPA/State system for the verification of contractor reported data.

DOE spends considerable funds on environmental monitoring at its facilities. Section 6 of the proposed amendment would have DOE reimburse the EPA for peforming

monitoring work as well, most of which would be redundant to current DOE effort. This dual expenditure of funds does not seem efficient from a budgetary standpoint.

In summary, the Department believes that legislation is not necessary to establish the standards sought, and that the proposed monitoring effort would largely duplicate ongoing efforts.