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Applying a Life Cycle Decision Methodology to Fernald Waste Management Alternatives

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Abstract: During the past five years, a number of U.S. Department of Energy (DOE) funded efforts have demonstrated the technical efficacy of converting various forms of radioactive scrap metal (RSM) into useable products. From the development of large accelerator shielding blocks, to the construction of low-level waste containers, technology has been applied to this fabrication process in a safe and stakeholder supported manner. The potential health and safety risks to both workers and the public have been addressed. The question remains: can products be fabricated from RSM in a cost efficient and market competitive manner? This paper presents a methodology for use within DOE to evaluate the costs and benefits of recycling and reusing some RSM, rather than disposing of this RSM in an approved burial site. This life cycle decision methodology, developed by both the Oak Ridge National Laboratory (ORNL) and DOE Fernald, is the focus of the following analysis.

1. Background

During January 1996, the "Decision Methodology for Fernald Scrap Metal Disposition Alternatives" was completed. This methodology is scheduled to be applied on a building-by-building basis, across the Fernald Environmental Management Project (FEMP) complex, beginning with Plant 4 during May-July, 1996.

2. Objectives

The decision methodology was developed to help a decision maker(s) compare and select among competing proposals the disposition of radioactive scrap metal (RSM) at the FEMP. The methodology developed takes into consideration both quantitative and qualitative factors in three categories: direct costs and benefits; socio-economic issues; and environmental, safety and health impacts. The methodology includes both the analytical requirements to develop defensible values for a comprehensive set of performance measures, and the structure for using the performance measures to compare and rank alternative proposals.

3. Procedure

The proposed methodology is illustrated in Figure 1. A decision on RSM disposition alternatives should be based on two categories of information: 1) the potential impacts of choosing each of the candidate alternatives; and 2) the values used in evaluating these impacts. Correspondingly, the methodology is divided into two phases: the life cycle analysis phase, in which the possible impacts of each of the candidate alternatives are assessed; and, the decision phase. In the first phase, the objectives and program scope are defined, the RSM disposition alternatives are identified, performance measures are specified, and the impacts of the alternatives are described in terms of the performance measures. In the second phase, the decision phase, the methodology will aid the decision maker(s) in the comparison of alternatives and the selection of the most desirable alternative.

4. Life Cycle Analysis Phase

Life cycle analysis is the process of identifying and assessing all categories of benefits and costs that result from a course of action over the entire period of time affected by the action, quantifying those benefits and costs where possible, and providing results that promote sound decision-making. A life cycle analysis provides a logical approach to the comprehensive assessment of alternatives which is mandated by the uncertain, hidden, and at times counterintuitive costs and benefits of alternative proposals. The elements of a life cycle analysis depend on the purpose of the analysis and the availability of specific data. In general, however, elements of a life cycle analysis consist of direct costs and benefits, which derive from the outlays that DOE would expend; socio-economic issues; and environmental, safety, and health impacts. The following outlines the steps that make up the life cycle analysis phase of this methodology.

4.1. Define Decision Parameters

The life cycle analysis phase begins with the definition of decision parameters. This part consists of three steps: 1) define nature of decision and program scope; 2) specify objectives and performance measures; and 3) identify alternatives.

Define Nature of Decision and Program Scope. A clear statement is needed of the current system and the nature of the decision that is required. This establishes the boundaries for which viable alternatives can be defined. It also defines the scope for which impact analysis is required. Finally, it helps in identification of possible decision-aiding approaches for use in the decision phase. This step also includes a preliminary assessment of the quality of the information available to perform the analysis; identification of the criteria for the quality and efficacy of the analysis; and, a preliminary identification and inventory of assets and resources.

Specify Objectives and Performance Measures. To conduct an effective analysis, it is required that a clear statement be made of the program objectives, so that the intents and reasoning behind the program are well understood by the analysts, the decision makers, and the stakeholders who will have a say in the final decision. This is the stage of the methodology where the decision maker identifies programmatic objectives and defines the specific performance measures that will be used to compare alternatives. This is an important step, because the performance measures determine the specific analytical approaches that will be taken in subsequent steps of the methodology and constitute the input to the decision phase.

Identify Alternatives. This is the step in the methodology where the specific alternatives to be considered are defined. This step forces the decision maker to think through the specific alternatives and identify the potential impacts of each proposed alternative. This step also includes a generic description of the system of activities (the general process) that are involved in carrying out a particular alternative. For example, in a metal melt option, the key steps of metal extraction, packaging, and shipment to a smelter would be outlined, as well as the key decisions and other issues that might be faced in carrying out that alternative.

4.2 Evaluate Impacts of the Alternatives

In this stage of the life cycle analysis, the analytical approach is defined for each of the performance measures and their value is calculated for each alternative. These components of the analysis are interlinked and are described below.

Define Analytical Methods. In this step, the analytical models and tools are defined that will be used to evaluate the alternatives on the performance measures. For simplicity, the tools are divided into three categorie; however, it is important to note that there are substantial interactions between the models in the different categories: 1) direct costs and benefits; 2) socio-economic issues; and, 3) environmental, safety, and health impacts.

Assess the Impacts of the Alternatives. In this step of the life cycle analysis, the analytical tools developed are used to evaluate the impacts of the alternatives on the performance measures. At this stage, the opportunity exists to re-assess the initial assumptions, objectives, and scope that were developed in the Define Decision Parameters stage. Although the entire methodology is an iterative process at every step, we indicate a feedback mechanism at the end of this step to emphasize that performance measures may be further refined, the system definition and process flow model revised, new strategic alternatives identified, and additional analyses performed.

Summarize Results. This step of the analysis summarizes the results of the analysis for use by the decision-maker(s). With the data and models developed through the life cycle analysis process, the results can be presented in any form desired by the decision-maker(s) for use in their own decision support system.

5. Decision Phase

The output of the life cycle analysis phase is a matrix listing the alternatives along the top and the performance measures along the side. Within each cell of the matrix will be the value of the performance measure for that alternative. In some cases, it will be a numerical value, such as total cost, and in others it may be a qualitative discussion, such as the institutional issues raised by the alternative. This matrix alone will provide the essential information needed for negotiations and decision making. It will help in making the discussions more concrete and allow the key issues to be brought into the open. Discussions can center on the relative importance of one factor versus another, rather than the alternatives as a whole. Oftentimes, based on the results reported in the matrix, one alternative will stand out as the best or some alternatives will be seen to be clearly inferior.

It can be expected that not all performance measures will favor one alternative. When there is no clearly superior alternative it rests upon the decision maker(s) to decide upon which performance measures are more important and what is the relative value to assign achievement on different performance measures. Much work has been done to develop structured approaches for analyzing tradeoffs between competing objectives. These methods can help inform decision makers on their choices, but they must be recognized solely as tools to assist decision makers, not replace them.

6. Acknowledgments

The "Decision Methodology for Fernald Scrap Metal Disposition Alternatives" was generated, in a cooperative manner, by both Oak Ridge National Laboratory (ORNL) and the U.S. Department of Energy's Fernald Environmental Management Project. The authors of this report recognize that this FEMP decision methodology was generated in full partnership with the following members of the ORNL Life Cycle Analysis Team: Katherine L. Yuracko (lead), T. Randall Curlee, Rafael G. Rivera, Stanton W. Hadley, and Robert D. Perlack. Mr. Bob Lehrter, of the Fernald Environmental Restoration Management Corporation was also a major contributor to this methodology.

7. References

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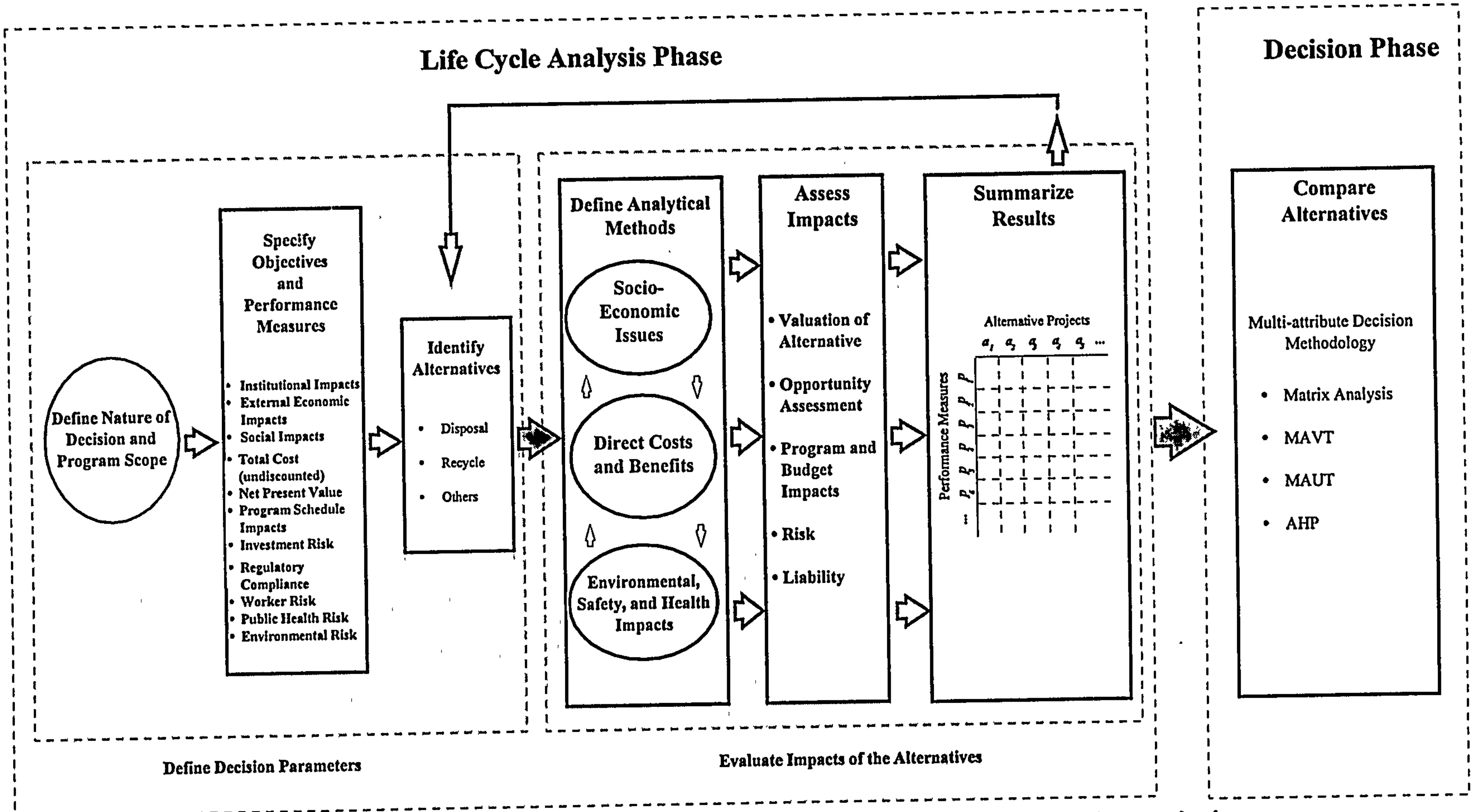

Figure 1: FEMP Decision Process for Scrap Metal Disposition