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AGENDA, OVERHEADS, AND HANDOUTS FROM RECYCLING WORKSHOP, JUNE 11, 1996 AT 7:00PM, ALPHA BUILDING

06/11/96

DOE-FN PUBLIC
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AGENDA

RECYCLING WORKSHOP
AGENDA
June 11, 1996 @ 7:00pm
Alpha Building, Classroom B

Meeting Kickoff	Gary Stegner
Workshop Introduction	John Trygier
Recycling, Reuse, Waste Minimization, and Unrestricted Release Activities	
- Completed	Bob Lehrter
Case Studies	
- Underway and Ongoing	Bob Lehrter
Recycle/Waste Minimization (Handout)	
Reuse	
Unrestricted Release	
- Planned	Pete Yerace
Methodology for Evaluation	
Discussion	Group
Wrap-up	John Trygier

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FEMP Recycle, Reuse, Waste Minimization, and Unrestricted Release

INTRODUCTION

- Focussed meeting on recycling requested at Operable Unit 3 Proposed Plan Public Meeting
  - Please define "economic feasibility" and "unrestricted release" process
  - Does DOE have a Policy ?
  - Where can I have input ?
  - DOE commitment to alternatives to disposal ?

- Recycling as one of several alternatives to disposal in the OSDF

- DOE committed to championing alternatives to disposal
  - National Policy
  - Site Methodology
  - Investing in Recycling/Reuse Studies at the FEMP

- OU3 Performance-based ROD permits disposition decision-making on project-specific basis with Stakeholder Inputs
  - RD/RA Work Plan will detail recycling methodology
  - Complex-specific Implementation Plans

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Case Study - Scrap Metal Piles

DESCRIPTION

2,254 tons (~9,200 cubic feet) of scrap ferrous metal were metal melted at SEG, Inc. for restricted reuse recycling. The large ingots produced were made into radiation shielding blocks for use at other DOE sites.

EFFECTIVENESS

2,193 tons (97%) of the 2,254 tons of ferrous metal were successfully melted for restricted release, demonstrating that metal melt is a reliable method for restricted release of ferrous metal.

ISSUES

The results from this demonstration do not reflect lower costs which would be expected for larger scale contracting.

COST

The total cost of this demonstration was about $540 per cubic foot.

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Case Study - Plant 7 Lead Sheeting Decontamination and Recycling

DESCRIPTION

7.1 tons (~20 cubic feet) of sheet lead metal from Plant 7 was decontaminated at SEG utilizing a chemical decontamination process to remove the surface paint and contamination. The sheeting was then surveyed for unrestricted release and subsequent recycling.

EFFECTIVENESS

86% of the lead processed was successfully decontaminated and released for recycling, indicating the viability of lead sheeting decontamination for release and recycling.

ISSUES

Some of the lead (14%) could not be processed for unrestricted release due to the configuration of the metal.

Results from this demonstration do not reflect lower costs which would be expected for larger scale contracting.

COST

The total cost to decontaminate and recycle the lead was about $3,700 per cubic foot.

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Case Study - Plant 7 Structural Steel Decontamination and Recycling

DESCRIPTION

761 tons (~3,100 cubic feet) of structural steel from Plant 7 demolition was decontaminated at Alaron, Inc. utilizing shot blasting and a chemical decontamination process to remove the surface paint and contamination. Cleaned metal was surveyed and released for recycling.

EFFECTIVENESS

42% of the 3,100 cubic feet of steel was successfully decontaminated for unrestricted release and subsequent recycle, indicating the potential for this approach to clean recycling.

ISSUES

1,815 of the 3,100 cubic feet (~58%) of steel could not be processed for unrestricted release due to the configuration of the metal generated from D&D activities. Improved cutting technologies as part of D&D could improve this rate.

Results from this demonstration do not reflect lower costs which would be expected for larger scale contracting.

COST

The total cost to decontaminate and recycle structural steel was about $800 per cubic foot.

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Case Study - Reuse or Free Release Option for Plant 8 H-Beams

DESCRIPTION

Approximately 38 tons (~155 cubic feet) of unused H-beams left from a canceled construction project (Plant 8 Pad Upgrade) were evaluated for recycle/reuse. Reuse of the beams for a different project was preferred, but no suitable options were identified. Free-release of the beams for recycling was the next best option. The beams were size-reduced and moved to the material release facility (MRF) for decontamination (as necessary) and comprehensive radiological surveying. After the beams were shown to meet free-release criteria, they were sold to a local scrap dealer for recycling.

EFFECTIVENESS

All 38 tons (100%) of the H-beams were free-released and sold to the scrap dealer for recycling. The FEMP received approximately $1,520 for the beams.

ISSUES

Although the H-beams did not become LLW, reuse would have been preferable to recycling.

COST

The total cost to size-reduce and free-release the H-beams was approximately $100 per cubic foot.

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Summary of Recycle Case Studies

OU3 FS Material Category	Metal Type	Quantity Processed (CF)	Recycle Technology	Actual Cost ($/CF)	Estimated Quantity in FS Category (CF)
Accessible Metal (A)	Structural Steel	3,100	Shot Blasting & Chemical Decon for Unrestricted Release & Recycle	~800	63,000
Inaccessible Metal (B)	Ferrous Scrap	9,200	Metal Melt Recycle for Restricted Release	~550	304,000
Painted Light-Gauge (D)	Lead Sheet	20	Chemical Decon for Unrestricted Release & Recycle	~3,700	50

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Comparative Analysis of OU3 Disposition Costs

DISPOSITION OPTION	OU3 FS MATERIAL CATEGORY COST RANGE PER CUBIC FOOT ($/CF)[1]		
	Accessible Metal (A)	Inaccessible Metal (B)	Lead Sheet (D)
On-Site Disposal Facility	15 - 25	5 - 8	225 - 275[2]
Sanitary Landfill	10 - 12	N/A	N/A
Envirocare	60 - 75	15 - 25	275 - 300[2]
Nevada Test Site	400 - 600	50 - 100	No Data Available
Off-Site Decontamination for Unrestricted Release & Recycle	600 - 900	N/A	3,000 - 3,700
On-Site Decontamination for Unrestricted Release & Recycle	100 - 200[3]	N/A	No Data Available
Metal Melt for Restricted Reuse	150 - 200[3]	500 - 600	No Data Available

Notes:

1 Costs include containers, inspections, weighing, transportation, and burial, where applicable.
2 Costs include treatment prior to burial (macroencapsulation).
3 Costs reflect work on materials with only minor contamination levels.

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Property Management/Equipment Reuse

Recycle/Reuse Program	FY 96 (To Date) (*$K)	FY 95 ($K)	FY 94 ($K)
Property Transferred To Other DOE Activities	630	200	2,220
Property Transferred To Other Federal Agencies	490	70	370
Property Transferred To ERLE Program	0	20	160
Property Transferred To State Donees	120	2,600	74
Property Transferred to Local Donees	770	1	0
Property Sold Via Sales (Auction)	7,770	67	0
TOTALS	$9,780	$2,935	$2,824

*All dollar figures represent original acquisition value.

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Property Management Reuse Legend

Property Transferred to Other DOE Activities

- Transfers made to other DOE locations

Property Transferred to Other Federal Agencies

- Any executive agency or any establishment in the legislative or judicial branch of the government (except the senate, the house of representatives, and the architect of the capitol and any activities under his direction).

Property Transferred to ERLE Program

- ERLE represents the Energy Related Laboratory Equipment Program, which includes: Universities or other educational institutions throughout the United States engaged in research via federal grants, etc.

Property Transferred to State Donees

- Public agencies and eligible non-profit tax-exempt activities which are administered by the general services administration (GSA) are included in this category.

Property Transferred to Local Donees

- Schools and non-profit organizations including community based educational organizations are included.

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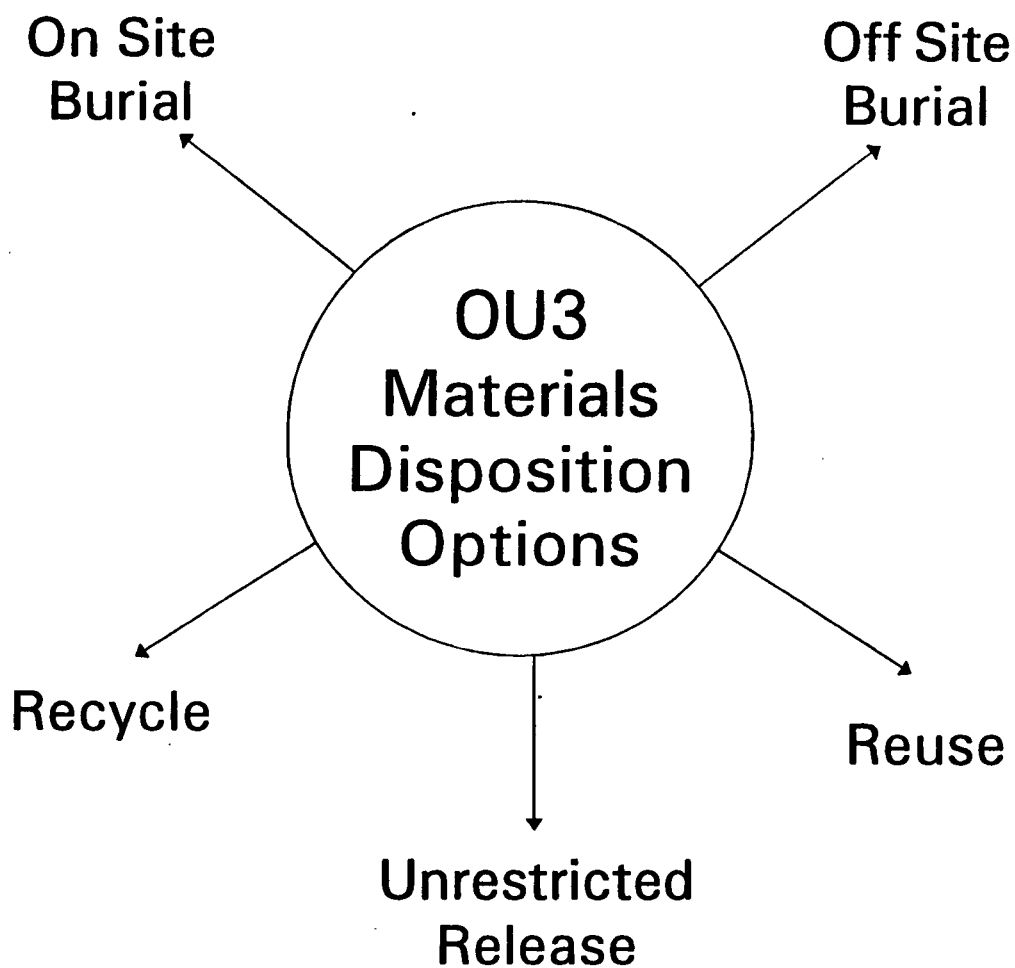
Operable Unit 3 Disposition Options



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Unrestricted Release of Materials at the FEMP

Unrestricted Release: Release of material from administrative control after confirming that residual radioactive material meets the guidelines of DOE 5400.5.

Also known as Free Release

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Rules and Procedures Governing Unrestricted Release

Regulatory Drivers/Industry Standards

- DOE Order 5820.2A, Radioactive Waste Management
- DOE Order 5400.5, Radiation Protection of the Public and the Environment
- DOE Radiological Control Manual
- NRC Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors

FERMCO Site Procedures/Requirements

- RM-0020, Radiological Control Requirements Manual
- RP-0009, Radiological Requirements for the Release of Materials at the Fernald Environmental Management Project
- RC-DPT-027, Radiological Survey of Vehicles Entering and Exiting the Controlled Areas of the FEMP
- 10 CFR 834 (Pending Regulation)

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Unrestricted Release for Surface Contaminated Materials

Survey Approach

All items exiting the Controlled Area must meet unrestricted release criteria prior to release from the site.

The release criteria is satisfied through radiological surveys and evaluations of the material including:

1. Direct surveys of the material to identify fixed contamination.
2. Smear surveys to identify the presence of removable contamination.

Surface Limits

- Uranium:

  5,000 dpm/100 cm^2 fixed + removable average
  15,000 dpm/100 cm^2 fixed + removable maximum
  1,000 dpm/100 cm^2 removable

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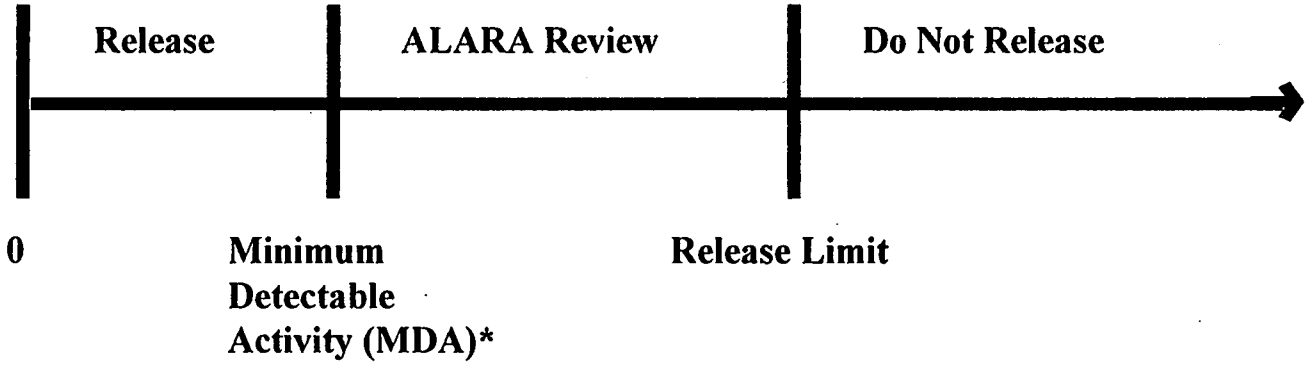
Unrestricted Release - FEMP Site Approach



* Not distinguishable from background

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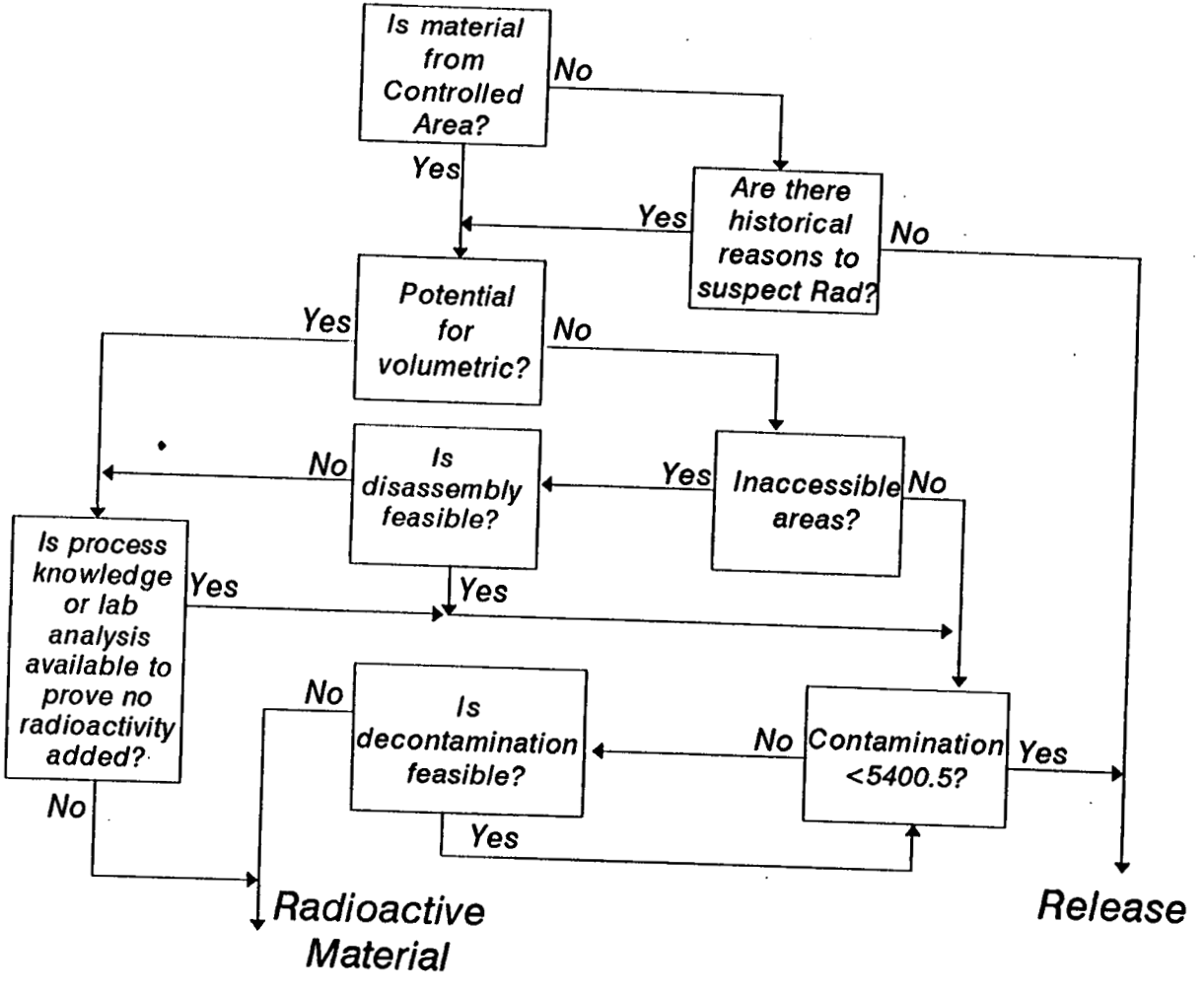
FEMP Unrestricted Release Diagram



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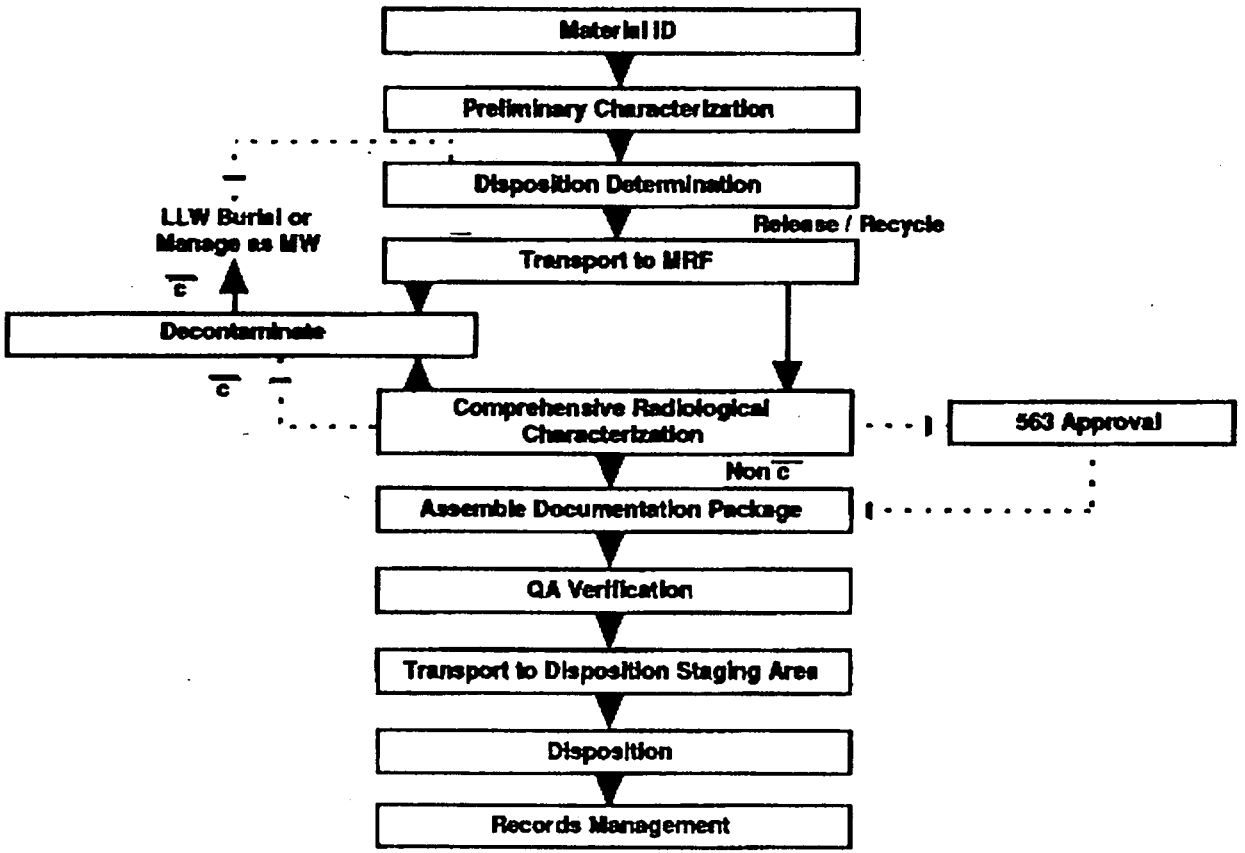
FEMP Unrestricted Release Diagram



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Case Study - MRF Pilot Project: Furnace Pots

DESCRIPTION

A pilot project was conducted in 1994 to demonstrate the viability of onsite decontamination and free-release of radioactive scrap metal (RSM) as an alternative to burial at NTS as LLW. A material release facility (MRF) was established at Building 78 and a batch of 612 unused furnace pots was chosen for the MRF pilot project. Although never used in production, the furnace pots had acquired surface radiological contamination during storage.

The furnace pots (~400 pounds each) were decontaminated using a steam/detergent spray. After decontamination, comprehensive radiological surveys were performed to document that the pots met free-release criteria. The pots were then sold to a local scrap dealer for recycling.

EFFECTIVENESS

120 of 122.4 tons (98%) was free-released. The FEMP received approximately $4,800 from sale of the furnace pots. The cost to process the furnace pots through the MRF was considerably cheaper than burial at NTS.

ISSUES

Radiological surveying was ~40% of the project costs. Automated surveying has the potential to significantly reduce the cost of MRF processing.

COST

The total cost to decontaminate and free-release the furnace pots was approximately $138 per cubic foot.

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Future Fernald Recycling Initiatives

- **Continued Use of Material Release Facility**

  - Water Wash
  - Detergent Spray
  - Grit Blast
  - New Technology (CO_2/Soda Blasting)

- **DOE-HQ Policy**

  - Recycle 2000 Policy (Draft)
  - M-100 Container Policy
  - Oak Ridge Re-Industrialization (MOU)

- **Evaluate New Technologies**

  - Plant 1 D&D Large-Scale Technology Demonstration
  - Copper Engineering Study (MSC)

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Case Study - Copper Recycling Proof-of-Concept Project

DESCRIPTION

The FEMP currently stores over 1,200 tons of scrap copper motor windings resulting from the upgrades at DOE's gaseous diffusion plants. This material is a relatively heavy gauge flat copper wire which is insulated with asbestos-bearing material and contains some uranium surface contamination. MSC of Oak Ridge, Tennessee was awarded a contract for the completion of a study to decontaminate and free-release 30 tons copper, expected to start in June.

EFFECTIVENESS

MSC estimates that approximately 92% of the copper will meet free-release criteria after decontamination.

ISSUES

Although the technology to be used is not new, it has never been applied to this specific task. Useful data will be generated from this study for evaluating the best option for dispositioning the remainder of the 1,200 tons.

COST

The total cost to decontaminate and release the scrap copper windings is estimated to be $1,500 per cubic foot.

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Decision Methodology for Fernald Scrap Metal Disposition Alternatives

- **Document Authors**

  - Katherine L. Yuracko - ORNL
  - Stanton W. Hadley - ORNL
  - Robert D. Perlack - ORNL
  - Peter J. Yerace - DOE-FN
  - Bob Lehrter - FERMCO

- **Drivers**

  - DOE-HQ & DOE-FN Waste Minimization/Recycle/EM/Waste Management
  - OEPA/USEPA
  - Operable Unit 3 RI/FS/ROD
  - Public Comment

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Decision Methodology for Fernald Scrap Metal Disposition Alternatives, Continued

- **Purpose**

  - Assist stakeholders and decision-makers in comparing and selecting among competing proposals throughout the life of project

  - Provide mechanism for public participation and input

  - Demonstrate DOE-FN/FERMCO commitment to continue to evaluate "economic feasibility" of disposition options (i.e. recycle vs. disposal)

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Decision Methodology for Fernald Scrap Metal Disposition Alternatives, Continued

- **Two-Phased Approach**

  A) Life Cycle Analysis Phase

  - Direct Cost and Benefits
  - Socioeconomic/Institutional Impacts
  - Environmental Health and Safety

  B) Decision Summary Phase

  - Utilize Multi-Attribute Analysis (tool to compare alternatives)
  - Both Qualitative and Quantitative Variables

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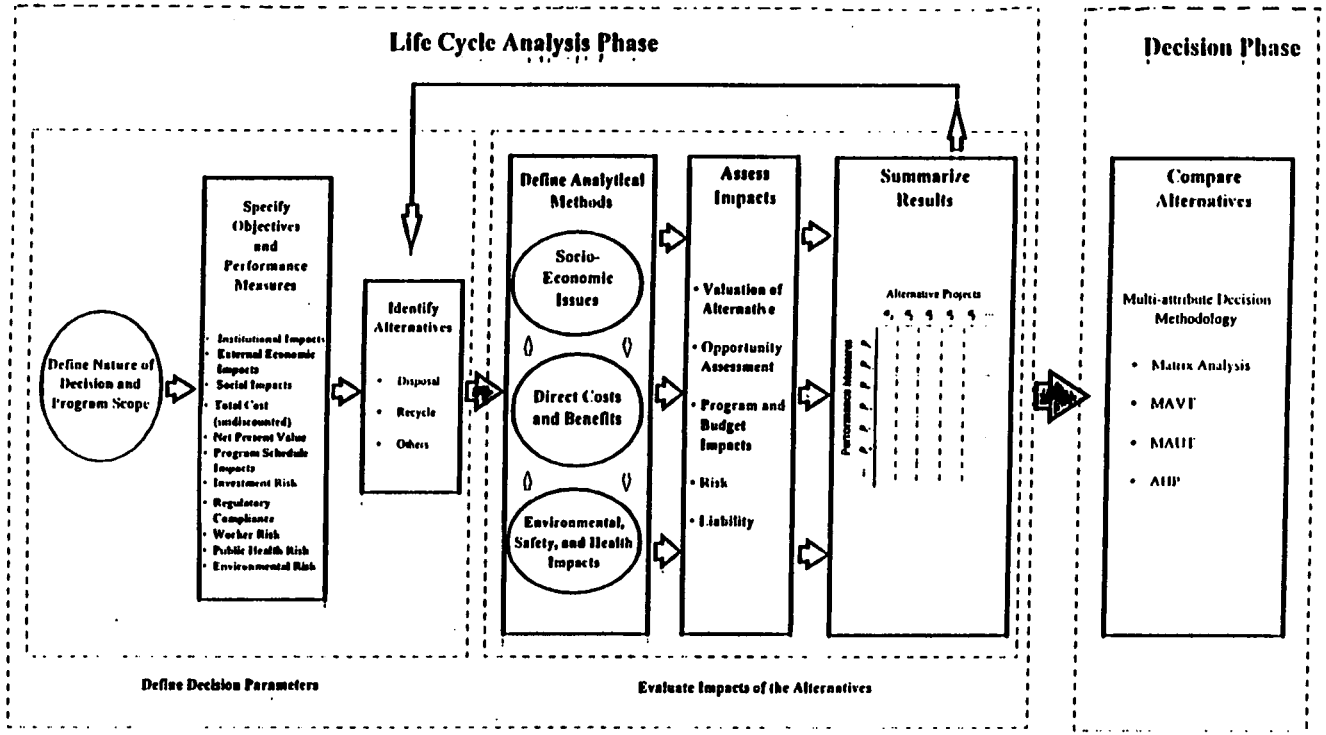
FEMP Decision Process for Scrap Metal Disposition



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Decision Methodology for Fernald Scrap Metal Disposition Alternatives, Continued

- **Life Cycle Analysis (Definition)**

  - Process for 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

  - Excellent process for long-term projects

  - Logical approach to a comprehensive assessment of alternatives which is mandated by the uncertain, hidden, and at times counter-intuitive costs and benefits of alternative proposals

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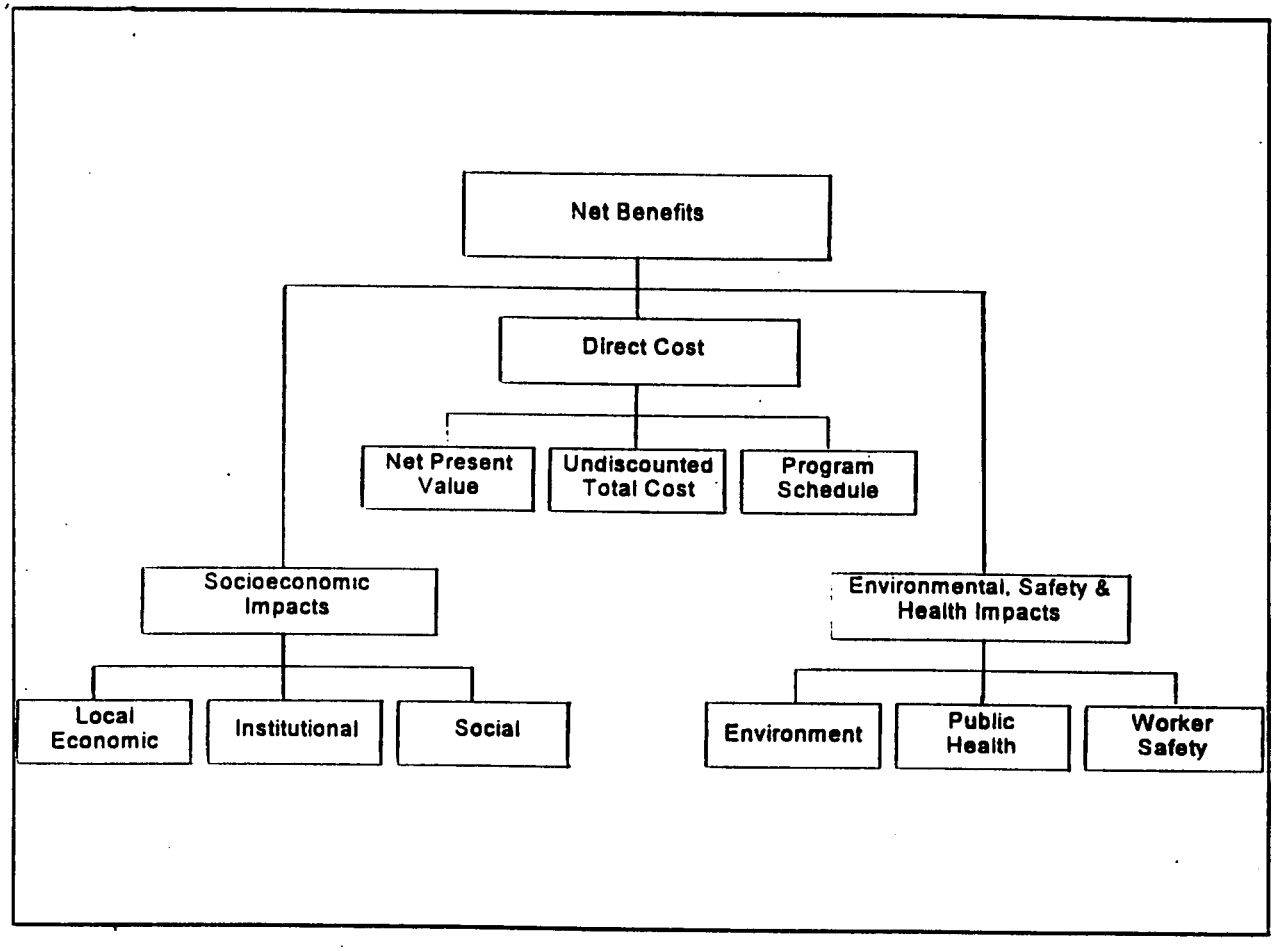
General Attributes Identified for Evaluating Alternatives



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Socioeconomic Analysis Example

Performance Measures	Rucycle 1	Recycle 2	Disposal 1	Disposal 2
Local Economic Impact	$15M	$14M	$12M	$14M
Employment	60 jobs	45 jobs	30 jobs	50 jobs
Property Values	Up 5%	Down 3%	No change	Up 3%
Market Demand for Product	Strong	Weak	–	–
DOE Policy Issues	Meets recycle, resource conservation policies	Meets recycle policies	Multi-state transport concerns	Local transport only
Privatization	Assists industry development	Lack of private participation	Private transportation used	Lack of private participation
Public Acceptance	Public prefer recycle	Public prefer recycle	Public prefer removal from site	Public prefer least cost
Legacy	Only less risky material left at site	Only less risky material left at site	Only less risky material left at site	Small amount of steel is little concern

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Environmental, Safety, and Health Analysis Example

Performance Measures	Recycle 1	Recycle 2	Disposal 1	Disposal 2
Public Health	10^{-5} risk of fatality	10^{-4} risk of fatality	10^{-4} risk of fatality	10^{-5} risk of fatality
Environmental	Low damage to ecological systems	Moderate damage to ecological systems	Moderate damage to ecological systems	Low damage to ecological systems
Worker Safety	10^{-4} risk of injury	10^{-3} risk of injury	10^{-3} risk of injury	10^{-4} risk of injury

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Decision Methodology for Fernald Scrap Metal Disposition Alternatives, Continued

- **Three Prominent Methods for Asset Disposition**
  - Multi-Attribute Value Theory (MAVT)
    - Define Alternatives and Criteria
    - Evaluate each Alternative on Criterion (scaling)
    - Assign Weights
    - Additive or Multiplicative Function
    - Conduct Sensitivity Analysis and Make Recommendation
  - Multi-Attribute Utility Theory (MAUT)
    - Same as MAVT; adding decision-maker risk attributes in utility functions
  - Analytical Hierarchy Process (AHP)
    - Differs from MAVT/MAUT
      (1) Construct Hierarchies
      (2) Establish Priorities
      (3) Ensure Logical Consistency

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Summarized Example Output

	Recycle 1	Recycle 2	Disposal 1	Disposal 2
Direct Cost Parameters				
Net Present Value	$5M	$7M	$6M	$5.5M
Total Cost Undiscounted	$9M	$13M	$11M	$10M
Program Schedule	9.2 years	11.1 years	10.5 years	10.1 years
Socio-Economic Parameters				
Local Economic	$15M	$14M	$12M	$14M
Institutional	Meets recycle, resource conservation, privatization policies	Meets recycle, privatization policies	Multi-state transport concerns	Local transport only, no privatization
Social	Public prefer recycle	Public prefer recycle	Public prefer removal of material	Public prefer least cost
Environment, Safety & Health Parameters				
Public Health	10^{-5} risk of fatality	10^{-4} risk of fatality	10^{-4} risk of fatality	10^{-5} risk of fatality
Environmental	Low damage to ecological systems	Moderate damage to ecological systems	Moderate damage to ecological systems	Low damage to ecological systems
Worker Safety	10^{-4} risk of injury	10^{-3} risk of injury	10^{-3} risk of injury	10^{-4} risk of injury

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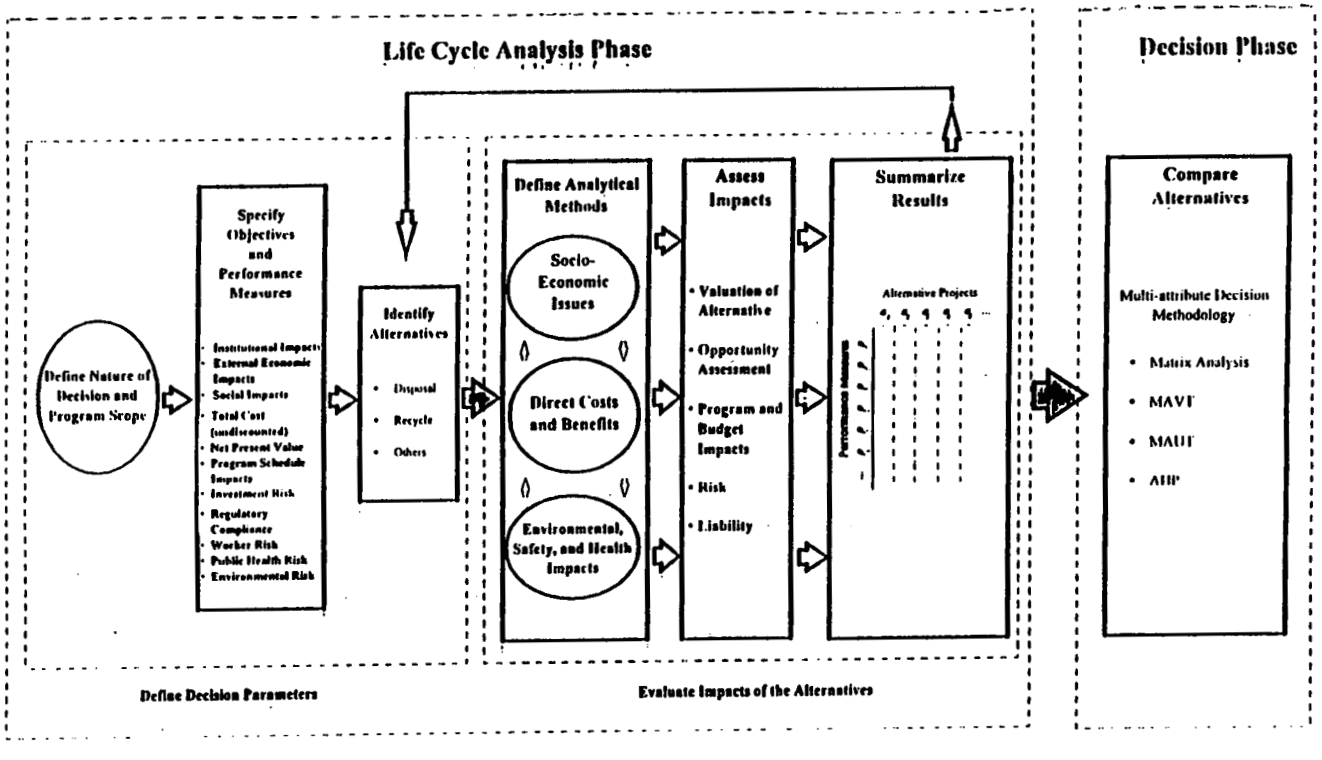
FEMP Decision Process for Scrap Metal Disposition



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Methodology Case Study

- **Next 6 Months**

  - Develop Methodology Implementation
  - Public Review
  - Plant 4 Evaluation for Structural Steel (Existing D&D Project)
  - Refine Models and Decision Summary Process
  - Incorporate Public/EPA Input

- **Next 12 Months**

  - OU3 RD/RA Work Plan Incorporates Methodology
  - D&D DEC Teams Utilize Methodology to Evaluate New D&D Projects
  - Decision Summaries Included in Future Implementation Plans
  - Public Inputs in Final Decisions

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Wrap-up

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Utilize Ongoing Programs to Inform Public of Recycling Initiatives

- Provide updates on recycling initiatives at regular Community Meetings
- Provide periodic updates on recycling initiatives through Fernald Envoy network and the Fernald Citizens Task Force Waste Management subcommittee
- Publish regular updates on recycling initiatives in monthly *Fernald Report*, which is distributed to more than 1,000 stakeholders

Provide Public Involvement Opportunities in Recycling Decision-Making Process

- OU3 Proposed Plan public comment period and Responsiveness Summary
- Public review of OU3 Remedial Design/Remedial Action Work Plan with public workshop, late 1996
- Public availability of D&D Complex Implementation Plans
- Focussed topical sessions (i.e., workshops, roundtables) as requested by public
- Public review of Recycling Methodology and involvement in specific evaluation processes (summer 1996)

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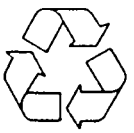
June 1996

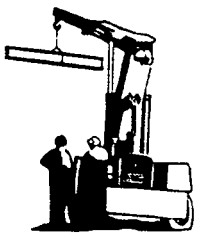
Fernald Recycling, Waste Minimization and Pollution Prevention Initiatives

Plant 7 Steel Recycling



Of 761 tons of structural steel, 460 tons were decontaminated and recycled by Alaron, near Pittsburgh, Pa. The remaining 300 tons were returned to Fernald for storage and are available for future recycling efforts.

Material Release Facility



A total of 275 tons of scrap steel, including 120 tons of furnace pots, 40 tons of battleship steel, 60 tons of miscellaneous I-beams, and other steel have been decontaminated and free released for sale. The steel was decontaminated using steam detergent spraying. The majority of steel has been sold and removed from the site. Additional decontamination activities are planned in this facility.

Grit Blast Project

Effort to size reduce and grit blast structural steel (mainly I-beams from the Plant 1 Ore Silo Project) for free release. Approximately 10 tons of steel have been processed to date.

Copper Recycling

An engineering study was awarded to MSC Inc., of Oak Ridge, Tenn., to size reduce (shred) and decontaminate 30 tons of the 1,200 tons of copper on site for free release and subsequent sale. The copper is wrapped with asbestos insulation and is potentially radiologically contaminated. Material processing will start in July 1996.

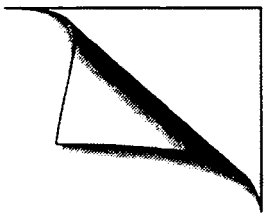
Green Is Clean Program

Fernald is currently achieving 55 percent recovery rate of trash, originally destined as low-level waste (LLW) disposal, by diverting it to a sanitary landfill. Cost savings to date are approximately $345,000, and 66,000 cubic feet of trash have been diverted.

Receiving Incoming Material Inspection Area (RIMIA) Packaging Material Segregation

Certain products received at RIMIA destined for the contaminated area are removed from shipping packages and placed into reusable crates. The clean packaging is then recycled. Cost savings to date are approximately $30,000, and 4,400 cubic feet of clean packaging have been diverted.

Paper Recycling



Revenue generated for the paper products are $40 a ton for high grade paper products such as office paper and computer printouts; $20 a ton for mixed paper products such as magazines and newspaper; and $5 a ton for cardboard. To date, Fernald has recycled 842,568 cubic feet of paper.

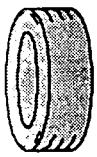
Lead Acid Batteries

All lead acid batteries are recycled to recover lead. A shipment of batteries is usually 30,000 to 40,000 pounds, which costs approximately $1,000. The recycling vendor in turn provides a credit for the lead recovery which amounts to approximately $800 per shipment.

Poly-Peanut Reuse (polystyrene)

Packaging "peanuts" are separated from the boxes at RIMIA prior to breaking them down and transported to a local company for reuse.

Used Tires



A contract was awarded in May 1996 to ensure tires are recycled and not buried or used in energy-to-fuel operations. The first tire collection included removal of 395 tires at a cost of $445, roughly $0.90 per tire. By recycling the tires instead of paying disposal costs at a sanitary disposal facility, Fernald saved approximately $500.

Aluminum Cans

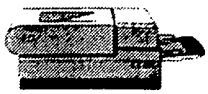
Fernald's aluminum cans are donated to Southwest and Ross Local Schools, Scouts, and other local organizations to recycle and use the money towards environmental projects and trips. To date, 36,692 pounds of cans have been recycled.

Fluorescent Lights

Fluorescent lights and ballasts are collected and recycled. Lights are recycled at an average of $0.42 each and ballasts $25 each.

Laserjet Toner Cartridge Recycling

A vendor takes Fernald's used cartridges at no charge and FERMCO/DOE receives reduced prices to purchase refurbished cartridges.



Annual cost savings are approximately $140,000. To date, 4,102 laserjet units have been recycled.

Reusable Laundry Bags

Fernald has replaced disposable plastic bags in a selected facility with reusable laundry bags to collect used personal protective clothing from contamination areas. Currently in the test phase with projected annual savings of $46,000 for site-wide implementation.

Reuse Bulletin Board

Fernald has established an electronic bulletin board to provide a mechanism for employees to advertise items for reuse. Cost savings to date are approximately $120,000.

Respirator Container Program

Fernald plans to replace cardboard boxes with plastic reusable containers to store and transport reconditioned respirators. This program is currently in the planning phase with a projected annual savings of $17,000.

Affirmative Procurement

Executive Order 12873 requires federal agencies to purchase EPA-designated items containing recycled contents.

Of the items Fernald has purchased from EPA's list during fiscal year 1995, 87 percent contain recycled contents, which exceeds DOE's fiscal year 1995 goal to purchase 50 percent. Fernald achieved the highest rating in the DOE complex.

For More Information . . .

Call DOE Public Information Officer Gary Stegner, 513-648-3153, or write to him at the following address:

Gary Stegner
Public Information Officer
DOE Fernald Area Office
P. O. Box 538705
Cincinnati, OH 45253-8705

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June 1996

GLOSSARY FOR RECYCLING

Accessible Metals: a material category comprised of structural steel and steel decking which has large accessible surface areas and thicknesses generally greater than 1/4-inch. The surface of accessible metals can be decontaminated, using physical surface decontamination techniques, and potentially surveyed for release since all surfaces are accessible.

Free Release: the release of materials for unrestricted use from DOE control to a non-DOE controlled environment. All free release materials must meet release criteria set forth in DOE Order 5400.5. (See Unrestricted Release)

Inaccessible Metals: a material category comprised of non-process piping; equipment in non-process areas; decontaminated process equipment; conduit; wire; electrical fixtures; miscellaneous electrical items; doors; and other miscellaneous metals. The surface of this metal is not accessible for surveying.

Material Category: one of 10 classifications of materials within Operable Unit 3. Each category will be further defined according to the type and level of contamination within the material. Examples of material categories include accessible metal, brick, concrete, and regulated asbestos containing materials.

Painted Light Gauge Metals: a material category consisting of painted metals less than or equal to 1/8-inch thick. Many painted metals have lead-based paint present. This category includes ductwork; louvers; metal interior and exterior wall panels; metal roof panels; and sheet lead.

Process Related Metals: a material category comprised of process equipment and process piping which are assumed to be highly contaminated and to contain holdup material.

Recoverable: any material with some inherent value which can either be reused as it is, whether contaminated or not, or can be recycled for restricted or unrestricted use.

Recycle: any process which reclaims items (which would otherwise become waste for their material value) to make new products or to substitute for new products.

Restricted Reuse: further use of a radioactively contaminated material for its original or modified purpose within a radiologically controlled environment only.

Restricted Recycling: recycling of contaminated materials resultings in a product which does not meet unrestricted release criteria. Example: volumetrically contaminated shipping containers from metal-melt recycling.

Reuse: further use of a material for its original or modified purpose.

Surface Decontamination: the reduction of existing surface contamination levels, thereby reducing direct exposure potential, as well as reducing available sources for air or waterborne contamination.

Unrestricted Release: the release of materials for unrestricted use to a nonradiologically controlled environment. (See **Free Release**.)

June 11, 1996

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DRAFT Decision Methodology for Fernald Scrap Metal Disposition Alternatives

May 1996

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May 1996

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EXECUTIVE SUMMARY

This document outlines a methodology that has been developed to help a decision maker or makers to compare and select among competing proposals for the disposition of radioactive scrap metal at the Fernald Environmental Management Project. 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.

A decision on metal disposition alternatives should be based on two categories of information: 1) the possible 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 metal 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 (or makers) in the comparison of alternatives and selection of the most desirable alternative.

1. INTRODUCTION

1.1 PURPOSE

The purpose of this document is to outline a methodology that will help a decision maker or makers to compare and select among competing proposals for the disposition of radioactive scrap metal at the Fernald Environmental Management Project (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.

A decision on scrap metal disposition alternatives should be based on two categories of information: 1) the possible 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 metal 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 (or makers) in the comparison of alternatives and selection of the most desirable alternative.

It is important to note that the methodology presented in this document does not provide a "cookbook" approach. A more specific and detailed analytical procedure for the FEMP decision problem will be developed after the initial applications of this methodology are made and an assessment can be made on the quantity and quality of available data and other information. The ultimate objective of this follow-on exercise will be to identify the analytical approaches that result in the most defensible analyses given available data and time and budget allowances.

1.2 OUTLINE OF REPORT

A general description of the methodology is presented in Section 2. Section 3 outlines the scope of the project, presents key assumptions, and discusses candidate metal disposition alternatives. Section 4 provides a description of the proposed performance measures and outlines analytical methods that may be used to describe the impacts of the alternatives in terms of the performance measures. Section 5 outlines decision methods that can be used to support decision makers in the comparison and selection of metal disposition alternatives. Attachment 1 is a definition of terms, and Attachment 2 provides an example application of the methodology.

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2. DESCRIPTION OF DECISION METHODOLOGY

The proposed methodology is illustrated in Figure 2.1. It consists of two distinct phases: in Phase 1 a life cycle analysis is performed for FEMP scrap metal disposition alternatives; Phase 2 is the decision phase that will aid the decision maker(s) in using the information generated in Phase 1 to formulate a decision.

The overall decision process for scrap metal disposition is divided into the following seven steps:

Life Cycle Analysis Phase:

1. Define Nature of Decision and Program Scope
2. Specify Objectives and Performance Measures
3. Identify Alternatives
4. Define Analytical Methods
5. Assess the Impacts of the Alternatives
6. Summarize Results

Decision Phase:

7. Compare Alternatives

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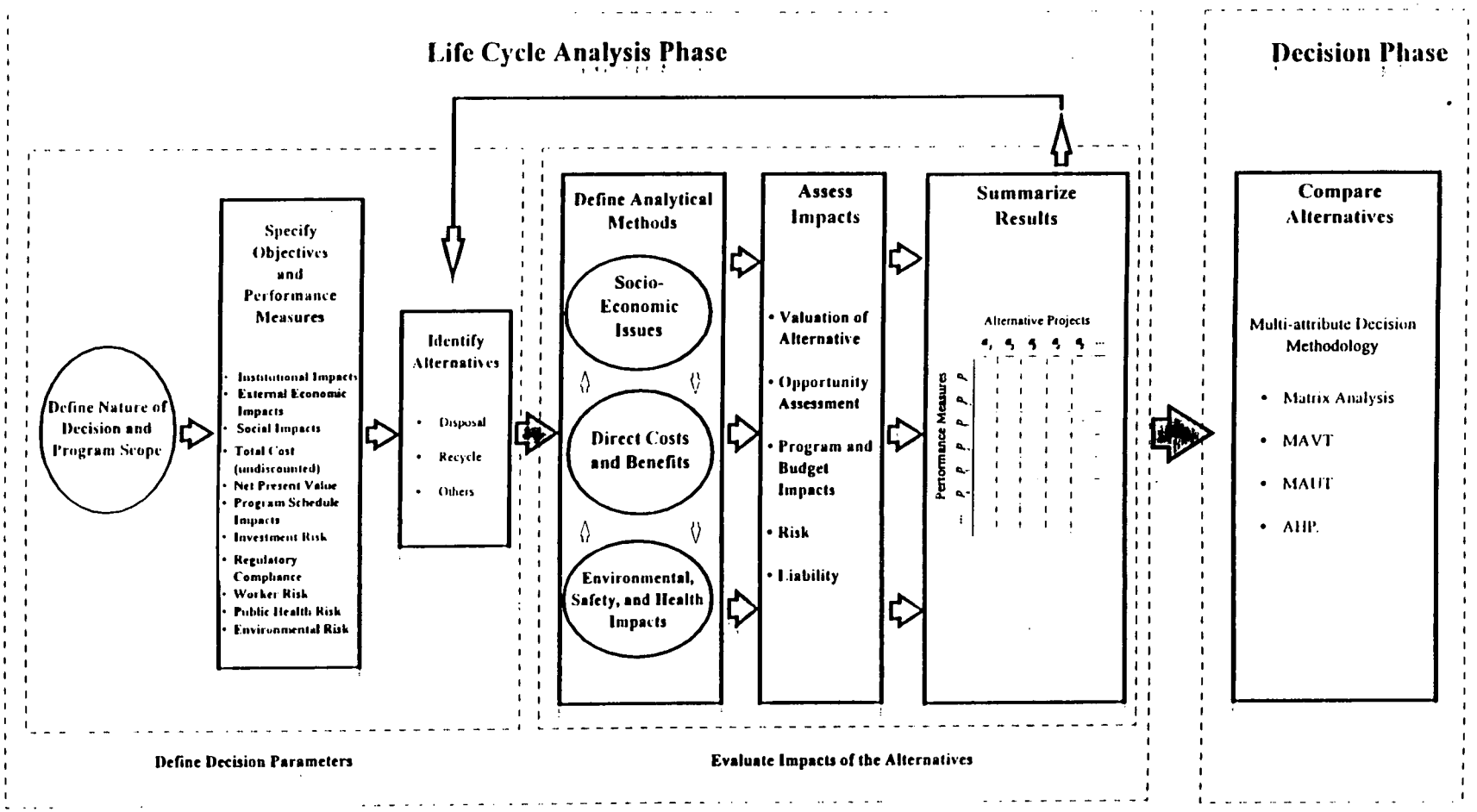
The first six steps comprise the life cycle analysis phase. The life cycle analysis phase is summarized in Section 2.1 and is described in more detail in Sections 3 and 4. The last step, which is the decision phase of the methodology, involves synthesizing the information obtained in the life cycle analysis phase to compare the alternatives. The decision phase is summarized in Section 2.2 and further described in Section 5. Attachment 2 presents an example application of the entire methodology.

2.1 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.

Figure 2.1 FEMP Decision Process for Scrap Metal Disposition



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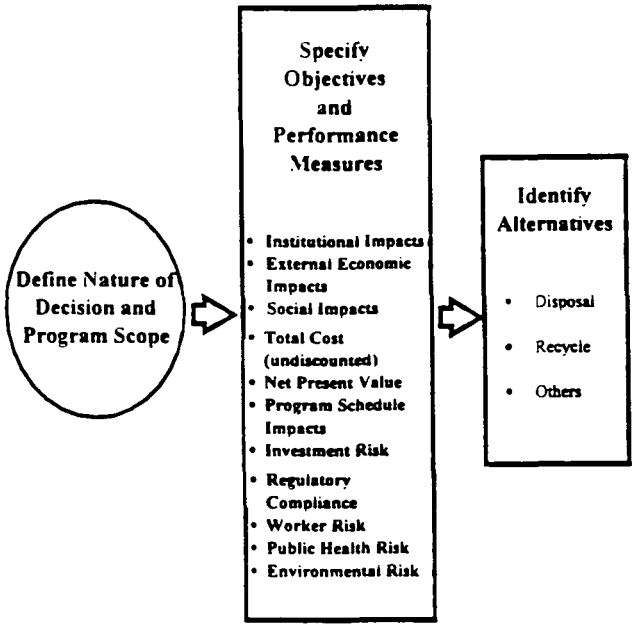
2.1.1 Definition of Decision Parameters

The life cycle analysis phase begins with the definition of decision parameters. This part consists of three steps:

- Define Nature of Decision and Program Scope;
- Specify Objectives and Performance Measures; and
- Identify Alternatives.

Figure 2.2 Define Decision Parameters



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 is 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 defined in

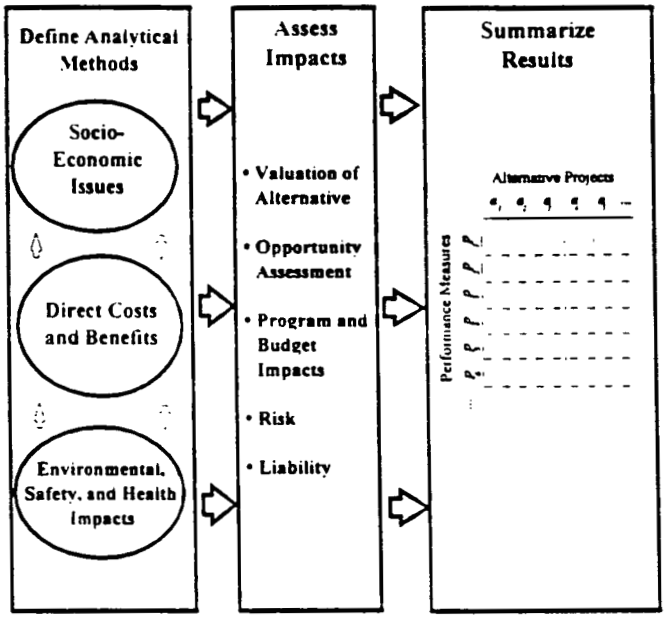
this step determine the specific analytical approaches that will be taken in subsequent steps of the methodology and constitutes the input to the decision phase. A preliminary set of FEMP performance measures is presented in Section 4.

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 specific 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.

2.1.2 Evaluation of 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 inter-linked and are described below.

Figure 2.3 Evaluate Impacts of the Alternatives



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 categories, however there are substantial interactions between the models in the different categories:

- Direct Costs and Benefits

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- Socio-economic Issues
- 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 indicate 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. Table 2.1 illustrates the product of the life cycle analysis phase.

2.2 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, as illustrated in Table 2.1. 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 or decision makers to decide upon which performance measures are most 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. Section 5 provides a description of the bases behind these methods. These methods can help inform the decision makers on their choices, but they must be recognized solely as tools to assist the decision makers, not replace them.

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Table 2.1 Illustrative Example of a Decision Matrix

PERFORMANCE MEASURES	ALTERNATIVES			
	Decontamination For Unrestricted Release	Metal Melt for Restricted Use	On-Property Disposal	Others
DIRECT COST PMs:				
Net Present Value				
Undiscounted Total Cost				
Program Schedule				
SOCIO-ECONOMIC PMs:				
Local Economic				
Institutional				
Social				
ENVIRONMENT, SAFETY, & HEALTH PMs:				
Public Health				
Environment				
Worker Safety				

3. SYSTEM DEFINITION AND DEFINITION OF ALTERNATIVES

3.1 DEFINE NATURE OF DECISION AND PROGRAM SCOPE

The first step in the decision process is to define the problem scope. The general rule for deciding whether or not a consideration should be included in evaluating metal disposition alternatives is whether or not that inclusion could have a significant impact on the evaluations of alternatives. As an example, if all alternatives being considered fully comply with all laws and regulations, then regulatory compliance could be eliminated from the comparative analysis of metal disposition alternatives. However, regulatory compliance would be relevant in deciding whether or not to include an alternative in the analysis. Similarly, if the aesthetic impacts were considered to be equivalent for all alternatives, this could be omitted in a comparative consideration. This general rule allows us to eliminate many considerations from the study.

Some of the key assumptions include:

- An on-site disposal facility will be built at the FEMP. The on-site disposal facility will not be operated during the winter months because of frost conditions.
- Recycle activities are not affected by frost conditions and so can be conducted throughout the entire year.
- All alternatives considered will be feasible given current technology.
- Only metal disposition alternatives that fully comply with all applicable laws, regulations, and DOE Orders will be considered.

3.2 SPECIFY PROGRAM OBJECTIVES

The development of a methodology to quantify the benefits of alternative activities begins with the determination of programmatic objectives to be considered when evaluating alternatives. In order to estimate how well alternatives perform against the identified objectives, measures are needed to quantify that performance. Thus, the next step in the methodology is to translate the identified objectives into attributes and corresponding measurement scales (performance measures) that relate descriptions of impact levels to quantitative scores. The general attributes identified for evaluating alternatives are presented in Figure 3.1. Section 4 presents the performance measures used to describe achievement of the objectives.

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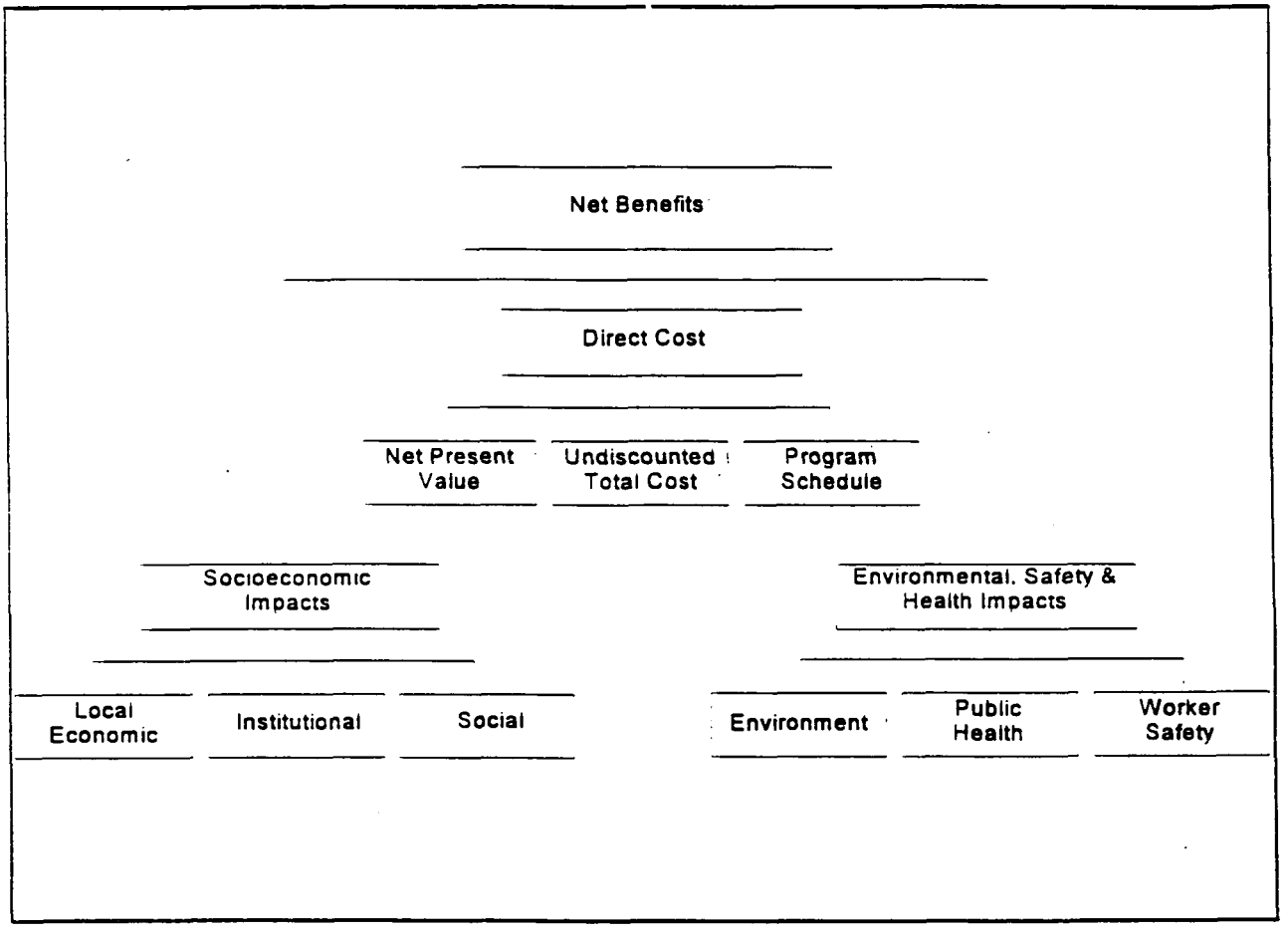
Figure 3.1 General Attributes Identified for Evaluating Alternatives



3.3 IDENTIFY ALTERNATIVES

Selection of alternatives is a crucial step for any decision-aiding approach, because the comparison of alternatives is obviously limited to the alternatives identified. The process of generating alternatives for evaluation should be done in an iterative manner, with DOE as the principal decision maker, and the alternatives should be refined as the understanding of the decision problem deepens.

A large number of potential alternatives currently exist for the disposition of the radioactive scrap metal at the FEMP. These alternatives include, at the extremes, total disposal and total recycle. The optimal alternative may prove to be some partial recycle alternative, in which some metal is recycled and the remaining metal is disposed. There are many different types of metals present in Operable Unit 3 (OU3), and it may prove desirable to treat the different types of metals in different ways.

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In practice, one must reduce the number of possible alternatives to a manageable group of candidate alternatives, which will then be compared with each other. Based on this initial analysis, new, improved alternatives should be defined and evaluated. This process requires the balancing of the time and effort required to evaluate additional alternatives against the likelihood that a more cursory evaluation will inadvertently eliminate some of the best alternatives.

To understand the large number of possible disposition alternatives for the FEMP, we consider the varieties of metals present at the site, and the possible options for disposition of each type of metal. The FEMP OU3 corresponds to the former production facilities, structures, equipment, and waste and product inventories remaining from site activities. OU3 metals consists of four categories of material, defined as follows:

- Accessible Metals: approximately 15,200 tons. An OU3 material category comprised of structural steel and steel decking which has large accessible surface areas and thickness greater than 1/4 inch. The surface of accessible metals can be decontaminated using surface decontamination techniques.

- Inaccessible Metals: approximately 25,700 tons. An OU3 material category comprised of non-process piping, equipment in non-process areas, decontaminated process equipment, conduit/wire, electrical fixtures, miscellaneous electrical items, doors, and other miscellaneous metals. These materials have surfaces which cannot be easily decontaminated or surveyed and are thus considered inaccessible.

- Process-related Metals: approximately 3,370 tons. An OU3 material category comprised of process equipment, electrical equipment not included in the Inaccessible Metals category, and process piping, which are assumed to be highly contaminated and to contain holdup material.

- Painted Light-gauge Metals: approximately 1,360 tons. An OU3 material category comprised of ductwork, louvers, metal wall and roof panels, sheet lead, and other painted metals less than 1/8 inch thick. Metals in this category are assumed to be painted with lead-based paint or, in the case of lead sheeting, to be made of lead themselves.

Some of the different options for disposition of OU3 metals are as follows. Note that not all of these options are necessarily applicable to each type of OU3 metal.

- On-site disposal facility. Burial in the FEMP permanent on-site disposal cell.

- Nevada Test Site. Packaging and transportation of materials to the DOE Nevada Test Site low level waste repository, and subsequent burial.

- On-property unrestricted release. Release of material from the FEMP radiologically controlled area, with no restrictions on end use, after documenting that residual radioactivity meets the guidelines of DOE Order 5400.5. Material handling, size reduction, decontamination, radiological monitoring, and other activities for this disposition alternative are performed by FERMCO personnel. The decontamination method includes removal of

the radionuclides and other contaminants from the surface of the metal using a combination of blasting and chemical decontamination technologies.

- Vendor facility unrestricted release. Containerization and shipment of materials from the FEMP to a commercial decontamination facility, where the material is decontaminated, surveyed, and documented to meet DOE Order 5400.5 residual radioactivity guidelines. The material is then released with no restrictions on end use. The decontamination method includes removal of the radionuclides and other contaminants from the surface of the metal using a combination of blasting and chemical decontamination technologies.

- Melt of metal and fabrication of restricted use products. The metal is transported to an off-site commercial facility, melted, and fabricated into end products such as B-25-type containers for DOE use.

- Commercial disposal facility. Packaging and transportation of material to an off-site commercial LLW disposal facility.

- Restricted release. Reutilization of a contaminated material or item for its originally intended purpose (e.g., reuse of a FEMP storage tank at another DOE facility), within a radiologically controlled environment.

The disposition of the secondary wastes generated as a result of the decontamination processes and the metal-melt process must also be considered.

The alternatives may include a combination of the options defined above reflecting the different metal types as well as variations in program schedules. Strategic alternatives will be formulated by considering appropriate disposition options for each category of OU3 metal. In addition to reflecting different metal types, the timing of metal disposition may be an important factor in the development of alternatives. For example, it might be desirable to recycle the steel from the first building (because the disposal cell is soil poor), but later in the process when there is ample soil, it might prove desirable to dispose of some metal. The optimal alternative may well prove to be a phased, hybrid approach, rather than a "total disposal" or "total recycle" option. The methodology presented here will facilitate the consideration of such phased, hybrid approaches.

4. DESCRIPTION OF PERFORMANCE MEASURES

Performance measures fall into three major areas. The first area is the direct financial costs and benefits. This includes the more common analyses performed for decision making but takes into account only those costs and benefits that are directly paid or received by the decision making party. The second area is socioeconomic impacts. This relates to the economic, cultural, political, and social issues involved in most major public decisions. The third area, environmental, safety, and health impacts, addresses impacts on the environment and human health. Some issues, such as regulations, will have impacts in more than one area.

The set of performance measures should be decided upon in consultation with all stakeholders. The most important criteria for the set of performance measures is that collectively, the set of performance measures should capture all of the things that the stakeholders care about. They should be mutually exclusive and collectively exhaustive.

In this section a working list of performance measures and the means for their analysis is presented. Several possible performance measures have been eliminated from the set of performance measures because they were considered not to differentiate among the alternatives under consideration in this analysis. However it is entirely appropriate for the set of performance measures to be refined as further information is developed and as the analysis proceeds. As stated in Section 2, life cycle analysis is an iterative process in which the analysis is continually refined and improved.

4.1 DIRECT FINANCIAL COST PERFORMANCE MEASURES

All major government decisions require a cost analysis. Depending on the scope of the analysis, the performance measures can be a summation of all costs, or the time value of money can be included through discounting. Guidance from the Office of Management and Budget requires the use of discounting. Many other factors intertwine with the financial cost: schedule changes can drive costs up or down, regulatory requirements may add costs to an alternative, market prices for product will influence the net cost of an alternative.

There are three performance measures for direct financial costs described below. Benefits and costs for four alternatives (two recycle and two disposal) are presented in Table 4.1. Actual values have not been calculated; these only serve to show the format of the way performance measure results would be displayed. If sensitivity cases are run, these can either be shown in separate tables or as uncertainty bounds around the expected values. Attachment 2 presents an example application of the methodology . The example includes a decision matrix which shows the direct cost performance measures in conjunction with the other performance measures used in the analysis.

Table 4.1 Direct Cost Analysis Example

Performance Measure	Recycle 1	Recycle 2	Disposal 1	Disposal 2
Net Present Value	$5M	$7M	$6M	$5.5M
Total Cost Undiscounted	$9M	$13M	$11M	$10M
Program Schedule	9.2 years	11.1 years	10.5 years	10.1 years

4.1.1 Net Present Value

The standard criterion for deciding whether a government program can be justified on economic principles is *net present value* -- the discounted monetized value of expected net benefits (i.e., benefits minus costs). Net present value is computed by assigning monetary values to benefits and costs, discounting future benefits and costs using an appropriate discount rate, and subtracting the sum total of discounted costs from the sum total of discounted benefits. Discounting benefits and costs transforms gains and losses occurring in different time periods to a common unit of measurement.

The cost analysis must fully include all of the financial costs and benefits of the recycle and disposal alternatives. These costs include both the direct budget allocations to the project and incremental costs to other activities such as permitting, monitoring, or other compliance costs. Costs must cover the full scope of the project, including packaging, storage, transportation, secondary waste treatment, et cetera. Likewise, financial benefits include both the direct proceeds to the project through such actions as sale of recycled products, and benefits to other activities through reduced costs or improved schedules. Uncertainties and potential liabilities should be addressed in any financial analysis through various means such as sensitivity studies, probabilistic risk assessment, or changing discount rates.

Analysis of the direct financial costs requires a number of steps. First, the necessary data must be found or generated if not already available. The cost will be computed based on all costs associated with management of the metals, including disassembly, handling, processing, and disposal. The calculation will also include any monies recovered from recycling. Hidden costs in overhead accounts must be extracted and assigned to the alternatives, as appropriate. In addition, future liabilities will be included in the estimate. For example, the disposal cell has some probability for failure and with metal present there may be some increase in the probability of failure. Also, the cost of repair may be different with metal present in the cell. Thus there may be some incremental expected cost for repair of the on-site disposal cell with metal present.

In addition, the cost impacts of the different work schedules under the alternatives will be included in the cost estimates for the alternatives. For example, the cost estimate will reflect the more efficient scheduling of labor under the recycle alternatives, made possible by the scheduling of recycle work during the winter months when the cell is not operated.

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To perform the financial cost analysis, a spreadsheet model must be developed to facilitate estimating costs for a wide variety of alternatives rapidly and efficiently. The spreadsheet model will include a user interface so that it can easily be used to analyze a variety of alternatives and sensitivities to different parameters. The spreadsheet will estimate costs by time period and will facilitate analysis of schedule impacts. Such factors as inflation and discount rates would be included in the financial spreadsheet based upon the Office of Management and Budget directives.

4.1.2 Total Undiscounted Costs

Undiscounted total costs can be studied through use of a zero discount rate in the analytical spreadsheet. This can be important for people concerned with the issues such as inter-generational equity or the potential for large costs after the project is completed. By not discounting these future costs, the later high costs are highlighted.

4.1.3 Schedule Impacts

The recycle and disposal alternatives may result in different program schedules. The impact on program schedule as a performance measure will capture schedule delays or accelerations under the alternatives. For example, recycle alternatives may accelerate the project schedule because of the more efficient use of labor during the winter months when the on-site disposal cell cannot be operated. The costs associated with schedule impacts are included in the two performance measures above, but schedule impacts in and of themselves are often important to decision makers.

4.2 SOCIOECONOMIC PERFORMANCE MEASURES

This section describes the major socioeconomic factors that should be considered, the performance measures that can be used to measure them, and some of the analytical tools used to calculate values for the performance measures.

In Table 4.2 we show a sample of the performance measures and the results for two recycle and two disposal options. Actual values have not been calculated; these only serve to show the format of the way performance measure results would be displayed. Note that while some attributes will have numeric results, others will have textual observations. Although the table only shows a few words, more explicit descriptions could be included as backup in the actual analysis. Attachment 2 includes a summarized form of these attributes in its matrix in conjunction with the results from the other areas of analysis.

Table 4.2 Socioeconomic Analysis Example

Performance Measures	Recycle 1	Recycle 2	Disposal 1	Disposal 2
Local Economic Impact	$15M	$14M	$12M	$14M
Employment	60 jobs	45 jobs	30 jobs	50 jobs
Property Values	Up 5%	Down 3%	No change	Up 3%
Market Demand for Product	Strong	Weak	–	–
DOE Policy Issues	Meets recycle, resource conservation policies	Meets recycle policies	Multi-state transport concerns	Local transport only
Privatization	Assists industry development	Lack of private participation	Private transportation used	Lack of private participation
Public Acceptance	Public prefer recycle	Public prefer recycle	Public prefer removal from site	Public prefer least cost
Legacy	Only less risky material left at site	Only less risky material left at site	Only less risky material left at site	Small amount of steel is little concern

4.2.1 Market and Economic Issues

While most economic factors are already captured in the direct cost analysis, some economic factors lie outside of the basic internal cost and benefit analysis. Some of those include local economic impacts on the surrounding community, employment effects, property values, and the impact of the recycled material in the larger market for scrap metal or contaminated scrap metal.

Local economic impact – As money flows into and out of the economy of a region, an economic stimulus may arise over and above the direct amount of spending on the alternative. There are multiple measures of economic impact, including household income, business sales, and net government revenues. The economic impact will vary over time as the spending schedule changes.

A simple method to analyze the impacts of economic inflows into a community is through an economic "multiplier". A more complex method used to study local economic impacts is an Input/Output model, such as the Oak Ridge Social Accounting Matrix (SAM). It characterizes and allows for the financial flows among major sectors of a regional economy. A SAM is an extension of the traditional Input/Output inter-industry model.

Employment – An increase or decrease in jobs will result with each alternative. The type of jobs created or lost will vary based on skills required, employer, and type of work involved. Direct

manpower requirements and timing may flow from the financial analysis while regional impacts can come from the SAM. Union involvement can be estimated based on the resultant job structure.

Property values – Based on the effect of the alternative in other parameters such as economic impact, public acceptance, and aesthetics, property values for the community may improve or decline. Property value analysis can be conducted through surveys of property values near similar facilities and control points of property in a similar economic region but without such facilities nearby.

Market demand for product – If an alternative includes the creation of a saleable product, then the market for that product must be examined to determine the resulting price and quantity that could be sold. The performance measure is the size of the market this material represents and the price that can be obtained. The results feed into the direct cost analysis through determination of revenues. Market demand issues are analyzed through research on the size and prices for the markets that the recycle material will enter.

4.2.2 Institutional Issues

Major decisions by DOE of necessity involve a number of institutions, not the least is DOE itself. DOE has numerous policies and directives with varying degrees of importance, some of which may conflict. These can include such directives as preferences for recycle, resource conservation mandates, privatization, or obligations to utilize final rather than interim solutions to clean-up. Alternatives can vary in how consistent they are with the different DOE policies. One performance measure is how well each alternative adheres to DOE policies. Another can be the feasibility of different alternatives within the DOE structure. Various DOE officials can provide this information, as can documentation such as DOE regulations. Other federal, state, and local institutions become involved through regulations, permitting requirements, or as stakeholders in the decision. The complexity of the interactions and their view of the alternatives can be recognized through a performance measure.

With privatization being considered for many DOE functions, it is critical to understand how private firms would play a part and how best to involve them. The performance measure will be the amounts and kinds of involvement, from traditional management and operations contracting to more entrepreneurial arrangements. These arrangements can in turn influence the direct cost analysis both by changing the total cost of an alternative and the timing of when the costs are incurred. This can be analyzed through several mechanisms, including publishing formal expressions of interest to informal discussions with either private firms or experts familiar with private company activities. Past experience with similar ventures would also provide information.

These alternatives occur in a larger context of the eventual clean-up of the entire DOE complex, as well as other contaminated facilities. New industries may develop for recycling of scrap material just as a large industry has already evolved for environmental remediation and restoration. The potential contributions of each alternative to industrial growth and competitiveness should be adjudged.

4.2.3 Social Issues

Most major decisions of the Department of Energy have a large impact on society, either that of the local area, the larger region, or nationwide. These social issues often become the key driver for the decision, more so than the economics or direct costs alone. Some of the key social issues are: public acceptance, impact on community services, and the legacy left for the community following clean-up. Lack of public acceptance has foreclosed many options or transformed them to be more in line with what people want. An alternative might change the nature of a community against the wishes of the current residents. A large influx of people may strain the capabilities of the local community to accommodate them, requiring additional expenditures and changing the atmosphere of the community. Alternatives can be judged on the social impact of what is left long-term for the community to deal with after the project is completed.

Societal concerns that are not fully addressed in the economics, regulations, or institutional issues may be studied through sociological and comparative value studies. Focus groups or local leaders can be used to identify issues, assess their significance, and recommend solutions.

4.3 ENVIRONMENT, SAFETY AND HEALTH PERFORMANCE MEASURES

The environment, safety and health performance measures address the operational risk and avoided risk associated with each alternative. The risks associated with each alternative to the local workers, outside public, and environment as a whole play an increasing role in DOE decision making and federal laws require its analysis.

Data must be gathered to understand the human health and environmental risks from the alternatives. Much of the information for local impacts is likely available as a result of the RI/FS and the corresponding Record of Decision. If there is not sufficient information, and the potential differences between cases suggest the need for further analysis, there are standard approaches available for calculating the impacts to human health and the environment. Below we summarize the information into three performance measures: environment, worker safety, and public health, but the actual analysis could involve studying specific impacts within each attribute, such as air emissions, water emissions, land-use, soil contamination, pathways of contaminants to people, and resulting damage to health.

A key element of life cycle analysis is the study, not only of the immediate risks from each alternative, but the risks avoided by not pursuing other alternatives. For example, the direct financial benefit of recycle is already captured in the price received for the recycled material; the environmental and health benefits come through the lessened releases of hazardous materials and occupational hazards created during initial manufacture. These environmental, safety, and health benefits as well as the adverse impacts of the alternatives are included in the environment, safety, and health performance measures. Care must be taken in this process to avoid double counting.

In Table 4.3 we show a sample of the performance measures and the results for two recycle and two disposal alternatives. Actual values have not been calculated; these only serve to show the

format of the way performance measure results would be displayed. Note that while some parameters have numeric results, others have textual observations. Although the table only shows a few words, more explicit descriptions could be included as backup in the actual analysis. Attachment 2 includes these parameters in its matrix in conjunction with the results from the other areas of analysis.

Table 4.3 Environment, Safety and Health Analysis Example

Performance Measures	Recycle 1	Recycle 2	Disposal 1	Disposal 2
Public Health	10^{-5} risk of fatality	10^{-4} risk of fatality	10^{-4} risk of fatality	10^{-5} risk of fatality
Environmental	Low damage to ecological systems	Moderate damage to ecological systems	Moderate damage to ecological systems	Low damage to ecological systems
Worker Safety	10^{-4} risk of injury	10^{-3} risk of injury	10^{-3} risk of injury	10^{-4} risk of injury

4.3.1 Public Health

The public health performance measure addresses the operational risk and avoided risk to off-site populations associated with the alternative. It addresses potential adverse impacts on the health and safety of the surrounding or affected off-site human population, for the DOE site, commercial disposal site, recycle facility, commercial decontamination facility, or the avoided steelmaking sites. This performance measure is used to assess potential health impacts to communities from accidents involving the release of radioactive or hazardous materials or the dangers of accidents during transportation on public roads.

4.3.2 Environment Protection

The environmental protection performance measure addresses potential adverse impacts on the environment, including physical degradation of surrounding or affected ecological systems and harmful effects on plants and animals. The environmental protection performance measure is used to assess potential widespread, localized, and long- and short-term impacts on entire ecological systems or constituents. The performance measure is also used to describe impacts resulting in loss of use of natural resources such as land or water.

4.3.3 Worker Safety

The worker safety performance measure addresses potential adverse impacts on the health and safety of personnel inside the site boundary or any worker associated with the avoided virgin metal production. The attribute includes the potential impact from release of hazardous and radioactive material. The release would require a transport pathway so that one or more persons on-

site could be exposed to contaminants at levels sufficient to cause injury. In addition. the performance measure covers the potential for physical danger including injury(ies) incurred by conventional industrial accidents (e.g., catastrophic fa lure of equipment or components. personnel caught in rotating or moving machinery, roof/structural failure. personnel falling from high locations. and personnel exposed to high-temperature or high-pressure fluid releases).

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5. DECISION PHASE

5.1 PRESENTATION OF LCA RESULTS FOR DECISION MAKING

As discussed earlier, the typical financial or benefit/cost framework is modified under a life-cycle analysis to include costs and benefits external to the direct out-of-pocket financial costs and revenues. These external effects generally include local, regional and global environmental impacts; health and safety impacts; socio-economic impacts; and institutional impacts and regulatory effects. The values of each performance measure are assessed over the complete life-cycle of the disposition alternative. For each direct financial and external effect performance measure values can be presented and summarized in a matrix with the disposition alternative along the top row of the matrix and the values of the performance measures along the side (Table 5.1).

Within each cell of the matrix will be the value of the performance measure for that particular disposition alternative. This "value" can be a monetized value, such as financial costs and revenues expressed in dollars, a numerical value expressed in some non-dollar metric, such as tons of pollutant or number of injuries, or this value can be a qualitative statement, such as the institutional and regulatory issues raised by the alternative. It can be expected that not all performance measures will favor one alternative. When there is no clearly superior alternative across all performance measures, it rests upon the decision makers to decide which parameters are most important and what is the relative value for the differences among the alternatives. Much work has been done to develop structured approaches for measuring and commensurating the values between dissimilar performance measures. The following section briefly discusses some approaches that can be used by decision makers to help rank and choose among alternatives.

5.2 STRUCTURED MULTIATTRIBUTE DECISION MAKING APPROACHES

For direct financial analysis the decision problem reduces to a single economic criterion. But with life cycle analyses the external effects must either be translated into economic terms or some method must be used to systematically compare among the different performance measures. Translating the external effects into dollars would effectively reduce the multiattribute decision problem back down into a single economic criterion. Damage function approaches have received the most attention by analysts in this area. However, applying damage functions can be difficult and costly especially if there are many different performance measures. Analysts usually recommend identifying only the priority external effects for quantification and monetization.

Table 5.1 Multi-attribute Decision Matrix

PERFORMANCE MEASURES	ALTERNATIVES			
	Decontamination For Unrestricted Release	Metal Melt for Restricted Use	On-Property Disposal	Others
DIRECT COST PMs:				
Net Present Value				
Undiscounted Total Cost				
Program Schedule				
SOCIO-ECONOMIC PMs:				
Local Economic				
Institutional				
Social				
ENVIRONMENT, SAFETY, & HEALTH PMs:				
Public Health				
Environment				
Worker Safety				

In the multiattribute problem. external effects are explicitly quantified. but no attempt is made at monetization. For example. a simple problem could include two criteria. say cost and environmental impact. Typically. these criteria are conflicting meaning that the attainment in one criterion. say lower cost. necessarily means the reduction of the other criterion. higher environmental impact. Because the criteria are conflicting, choosing among alternatives is impossible unless the decision maker(s) indicates some preference or willingness to trade-off the attainment of one criterion for another.

The manner in which decision maker preferences are elicited and incorporated into the solution process (e.g., derivation of weights) distinguishes the many multiattribute methods. Two general solution approaches -- prior and progressive articulation of preferences -- have been used by analysts to handle problems involving choice among a set of alternatives. The choice of technique also depends, in large part, on the characteristics of the particular problem and how well the problem is defined. For example, the choice of method might depend on whether the number of alternatives are few or numerous; whether the number of criteria are few or numerous; whether the values of the criteria are known or unknown; whether the alternatives are completely known in advance or not; and whether the criteria are explicitly or implicitly defined.

Methods based on prior articulation of preferences require the decision maker to specify a value (utility) function (judgement). This value (utility) function is used to rank order the alternatives. Basically, attribute weights are assessed before the model is solved and remain fixed. Prior articulation of preference methods are particularly relevant in contexts where full justification and rationale for decisions are required, such as in public decision problems. These also tend to be more applicable to well-defined problems (i.e., the alternatives and criteria are completely known).

With progressive methods, decision maker responses to specific questions are used by the analyst to guide the solution process toward an optimal or most preferred solution. In brief, preferences (i.e., criteria weights) are reassessed as the solution proceeds interactively. These methods allow the decision maker to explore solutions without having to specify prior preferences. As such, these methods require less of the decision maker in terms of preference structures. However, these methods are more open to manipulation and are less defensible when decisions or solutions have to be justified and defended. For multiattribute problems that are not well-defined (either the alternatives or the criteria are not known completely in advance), interactive search methods may be appropriate.

Given the manner in which decision maker preference information can be elicited and used as well as the characteristics of the problem, it is not surprising that the number of specific methods that have been developed is large. However, there are a number of fundamental or more prominent methods that are particularly relevant to the asset disposition problem. These methods include multiattribute value theory (MAVT), multiattribute utility theory (MAUT), and the analytical hierarchy process (AHP).

MAVT is the most widely used method for dealing with and solving multiattribute problems. A number of specific techniques have evolved, but they all share the following operational steps:

- Defining alternatives and criteria.
- Evaluating each alternative separately on each criterion (scaling).
- Assigning weights to the criteria.
- Aggregating the criterion weights and the single-criterion evaluations of the alternatives to obtain an overall measure of value or worth (e.g., additive or multiplicative value function).
- Conducting sensitivity analyses and making recommendations.

The principle differences among the specific techniques lie in the choice of procedures used to scale, weight, and aggregate. MAUT is distinguished from MAVT by the incorporation of

decision maker risk attitudes in single attribute utility functions and aggregation rule -- additive or multiplicative. Operationally, MAUT procedures are similar to that of MAVT with scaling, weighting, and aggregating. AHP differs fundamentally from MAVT and MAUT. AHP is built around three general principles: constructing hierarchies (decomposition), establishing priorities (comparative judgements), and ensuring logical consistency (synthesis of priorities). AHP is an extremely popular method. Simplicity, ease of use, ability to handle large numbers of criteria, and use of a linguistic scale to quantify difficult criteria are some of the features of the method. However, there are many analysts that have criticized AHP for being fundamentally flawed because it produces inconsistent results.

6. SUMMARY AND NEXT STEPS

This document outlines a methodology that has been developed to help a decision maker or makers to compare and select among competing proposals for the disposition of radioactive scrap metal at the FEMP. The goal of this effort was to develop a generic methodology for the analysis of disposition of radioactive scrap metal. Although the methodology may be applicable for a building-specific case at the FEMP, it is recommended that the methodology be applied for the entire FEMP site in order to take advantage of economies of scale. Indeed, the methodology is applicable, and ideally should be applied, for the entire DOE complex in order to take advantage of complex-wide economies of scale.

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 possibly rank, alternative proposals.

A decision on scrap metal disposition alternatives should be based on two categories of information: 1) the possible 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 metal 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 (or makers) in the comparison of alternatives and selection of the most desirable alternative.

The methodology presented in this document does not provide a "cookbook" approach. Detailed guidelines for conducting the FEMP evaluation will be developed after the initial applications of this methodology are made and an assessment can be made on the quantity and quality of available data and other information. The ultimate objective of this follow-on implementation exercise will be to identify the analytical approaches that result in the most defensible analyses given available data and time and budget allowances.

ATTACHMENT 1 -- DEFINITION OF TERMS

- AHP: Analytical hierarchy process. AHP is a multiattribute decision technique using an additive value function in which both the attribute values for the alternatives and the weights are chosen by a ratio questioning procedure and eigenvector analysis.

- CERCLA: Comprehensive Environmental Response. Compensation, and Liability Act of 1980. as amended (Public Law 96-510).

- Discount rate: The interest rate used to adjust future costs and benefits to reflect the change in the value of money over time. A fixed sum is worth less in the future than in the present because of the interest that can be accrued if it is invested. Note that interest is not the same as inflation. Discount rates can be "real", which means inflation has been removed or "nominal" which means they include inflation.

- DOE-FN: Fernald Area Office of the Department of Energy.

- FEMP: Fernald Environmental Management Project.

- FERMCO: Fernald Environmental Restoration Management Corporation.

- Free Release: the release of materials. for unrestricted use, from DOE control to a non-DOE controlled environment. Free released materials must meet the radiological release criteria set forth in NRC Regulatory Guide 1.86 and DOE Order 5400.5

- LCA: Life cycle analysis. 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.

- MAUT: Multiattribute utility theory. MAUT is a class of method for solving multiattribute decision problems. MAUT is distinguished from MAVT by incorporation of decision maker risk attitudes in its rescaled attributes and amalgamation procedure (either additive or multiplicative).

- MAVT: Multiattribute value theory. MAVT is used to describe a general category of technique for addressing multiattribute decision problems that involves the scaling of attributes using deterministic methods. choosing of criteria weights by non-lottery methods (e.g., rating), and use of an additive value function for amalgamation.

- NPV: Net present value. Net present value is the discounted monetized value of expected net benefits (i.e.. benefits minus costs). Discounting benefits and costs transforms gains and losses occurring in different time periods to a common unit of measurement.

- Opportunity cost: The cost of foregoing one investment option for another. If money is spent rather than saved. for instance. the interest that may have been earned is an opportunity cost associated with the expenditure.

- OSDF: On Site Disposal Facility.

- OU: Operable Unit: an area, facility, or group of facilities within the FEMP defined based on several criteria. including geographical location, the potential for similar technologies to be applied to remediation similar media types. and similar contamination types and levels.

- OU3: Operable Unit 3: the former production facilities, structures, equipment. and waste and product inventories remaining from site activities.

- ROD: Record of Decision. A document which specifies the remedy selected for environmental restoration of an Operable Unit. as approved by the Environmental Protection Agency.

ATTACHMENT 2 -- APPLICATION EXAMPLE

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LIFE CYCLE ANALYSIS FOR DISPOSITION OF FEMP MATERIAL

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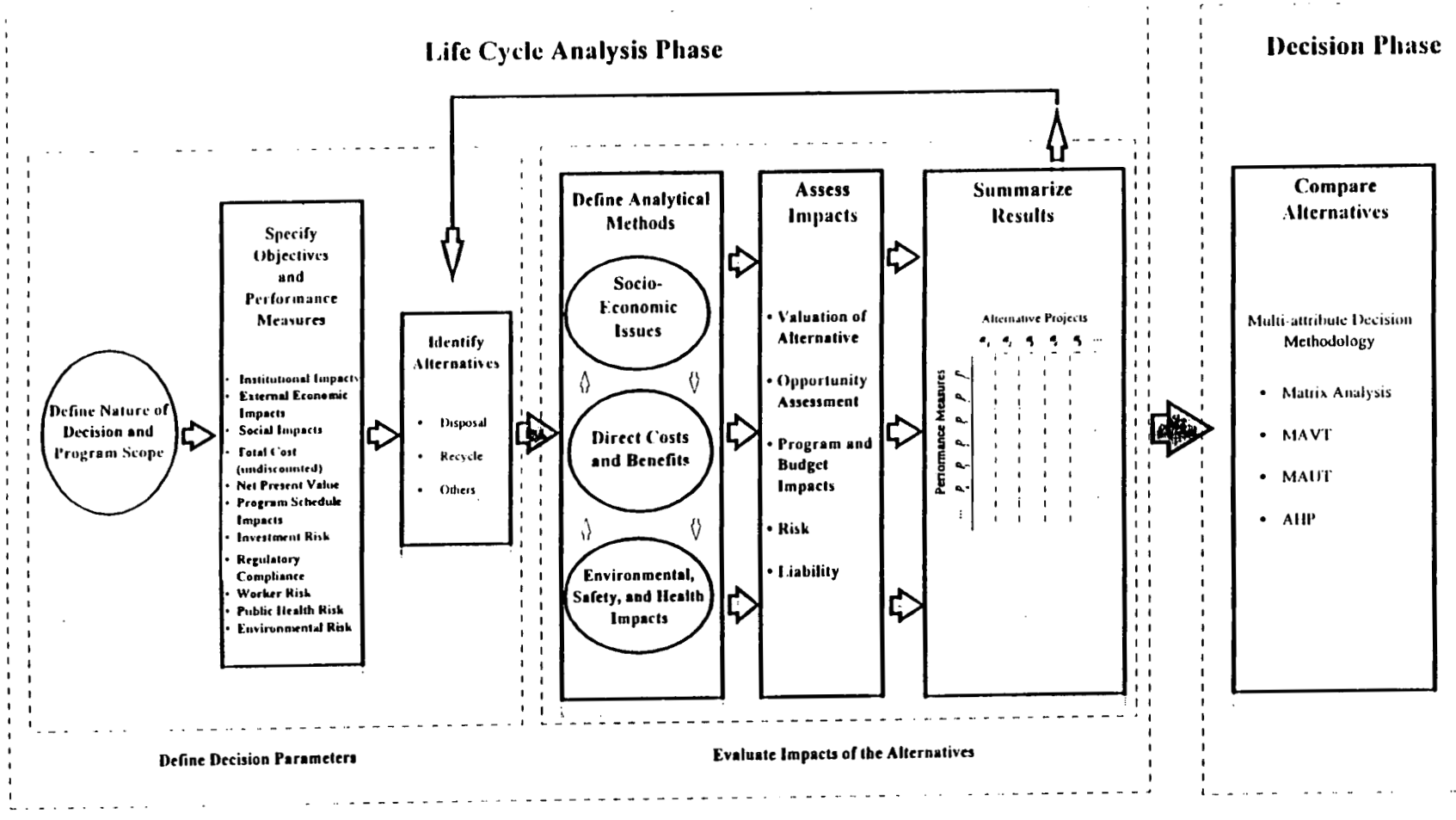
Life Cycle Analysis Phase
Decision Phase
Define Nature of Decision and Program Scope
Specify Objectives and Performance Measures
Institutional Impacts
External Economic Impacts
Social Impacts
Total Cost (undiscounted)
Net Present Value
Program Schedule Impacts
Investment Risk
Regulatory Compliance
Worker Risk
Public Health Risk
Environmental Risk
Identify Alternatives
Disposal
Recycle
Others
Define Analytical Methods
Socio-Economic Issues
Direct Costs and Benefits
Environmental, Safety, and Health Impacts
Assess Impacts
Valuation of Alternative
Opportunity Assessment
Program and Budget Impacts
Risk
Liability
Summarize Results
Alternative Projects
Performance Measures
Compare Alternatives
Multi-attribute Decision Methodology
Matrix Analysis
MAVT
MAUT
AHP
Define Decision Parameters
Evaluate Impacts of the Alternatives

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Define Decision Parameters

- Define Nature of Decision and Program Scope
  - Stakeholders
  - Existing Facility and Materials
  - Scope of Decision
- Specify Objectives and Performance Measures
  - Main Objective
  - Categorize Attributes of Objective into Major Areas
  - Establish Performance Measures within each Category
- Identify Alternatives
  - Create manageable list of alternatives
  - Ensure identified concerns will be addressed by alternatives considered

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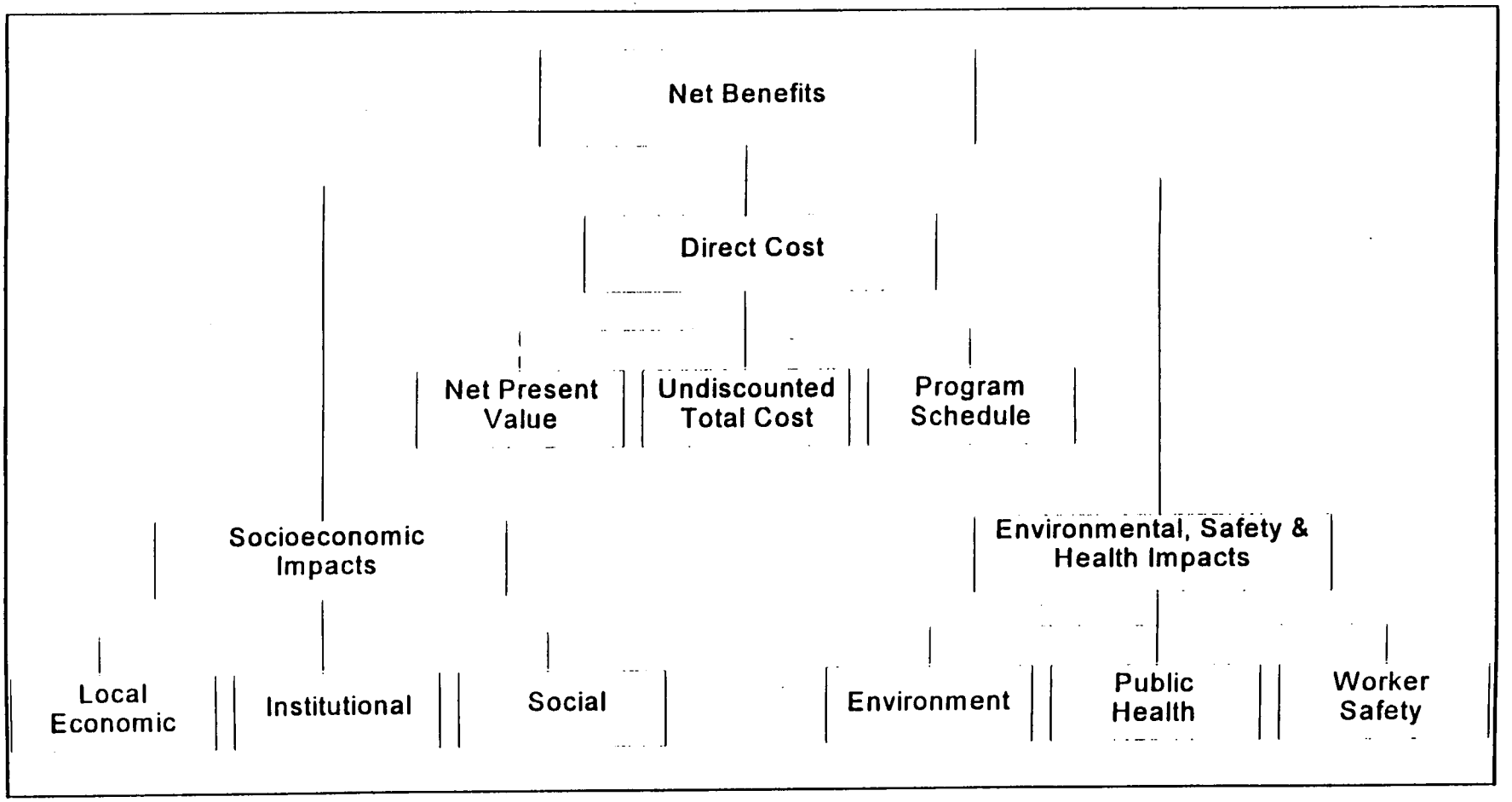
Attributes Used to Evaluate Alternatives



Identify Alternatives

- Four Classes of Metal:
  - Accessible
  - Process-Related
  - Inaccessible
  - Painted Light-gauge
- Seven Options for Disposition:
  - On-Site Disposal Facility
  - Nevada Test Site Disposal
  - On-Property Restricted
  - Vendor Facility Treatment
  - Melt of Metal
  - Commercial Disposal
  - Restricted Release
- Alternatives may include a combination of options reflecting metal types, and program schedules.

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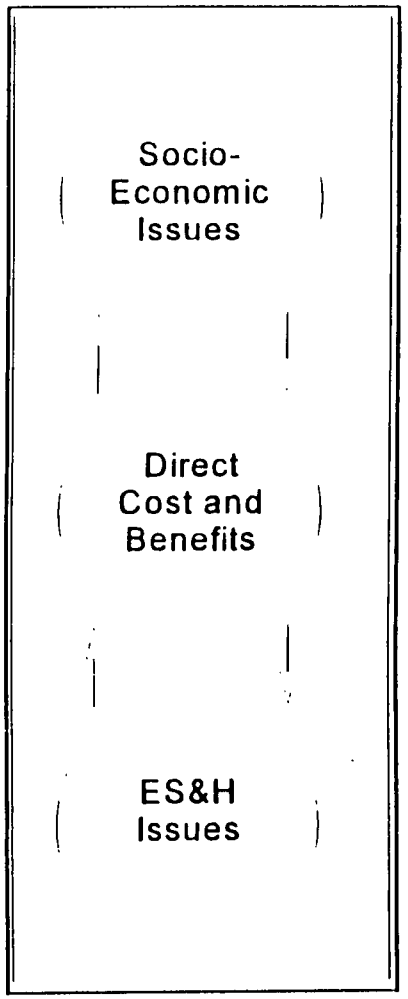
Assess Impacts



For Each Area of Analysis:

- **Decide Upon Tools**
- **Gather Data**
- **Evaluate Impacts**

Analyses are integrated through shared data and results.

Direct Financial Analysis

- Develop material flow and associated schedules
- Calculate cost for each component of alternative
- Include revenues from sale of product
- Conduct sensitivity studies on uncertainties:
  - Cost
  - Schedule
  - Potential incidents during and after project

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Socio-Economic Analysis

- Local economic issues are studied through analysis of inflows and outflows of funds in the local economy.
- Employment issues are studied through local economic impact and specific work schedules of each alternative.
- Institutional issues are studied through analysis of DOE orders and directives, and through state and local official responses.
- Social issues are studied through focus groups, interviews with area leaders, or newspaper content analysis.

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Environment, Safety & Health Analysis

- Public Health is studied through analysis of releases throughout the life cycle of the alternative and their potential for impact on health.
- Environmental effects are studied through impacts of releases or operations on the ecological system.
- Worker safety is studied through potential for disabling injuries or exposures to personnel involved in all steps of the alternative.
- Avoided releases, damages, injuries, or exposures because recycled material displaces virgin production should be credited to the recycle options.

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Summarized Example Output

	Recycle 1	Recycle 2	Disposal 1	Disposal 2
Direct Cost Parameters				
Net Present Value	$5M	$7M	$6M	$5.5M
Total Cost Undiscounted	$9M	$13M	$11M	$10M
Program Schedule	9.2 years	11.1 years	10.5 years	10.1 years
Socio-Economic Parameters				
Local Economic	$15M	$14M	$12M	$14M
Institutional	Meets recycle, resource conservation, privatization policies	Meets recycle, privatization policies	Multi-state transport concerns	Local transport only, no privatization
Social	Public prefer recycle	Public prefer recycle	Public prefer removal of material	Public prefer least cost
Environment, Safety & Health Parameters				
Public Health	10^{-5} risk of fatality	10^{-4} risk of fatality	10^{-4} risk of fatality	10^{-5} risk of fatality
Environmental	Low damage to ecological systems	Moderate damage to ecological systems	Moderate damage to ecological systems	Low damage to ecological systems
Worker Safety	10^{-4} risk of injury	10^{-3} risk of injury	10^{-3} risk of injury	10^{-4} risk of injury

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SIGN-IN SHEET

FERNALD RECYCLING PUBLIC WORKSHOP

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City/State/Zip:

Work Phone: 648-7630 Home Phone:

Please add my name to the Fernald Community Mailing List. Yes ____ No ____

Name: Vicky Dastillung

Affiliation: FRESH / CLN

Address: [redacted]

City/State/Zip: [redacted]

Work Phone: — Home Phone: [redacted]

Please add my name to the Fernald Community Mailing List. Yes ✓ I'm on it No ____

Name: Gary Storer

Affiliation: Crosby Trustee

Address:

City/State/Zip:

Work Phone: Home Phone:

Please add my name to the Fernald Community Mailing List. Yes ____ No ____

SIGN-IN SHEET

FERNALD RECYCLING PUBLIC WORKSHOP

June 11, 1996, 7 p.m., Alpha Building, Conference Room B

Name: Tom Schneider

Affiliation: OHIO EPA

Address:

City/State/Zip:

Work Phone: Home Phone:

Please add my name to the Fernald Community Mailing List. Yes ____ No ____

Name: ~~Jim Burns~~ Tom Ontko

Affiliation: OHIO EPA

Address:

City/State/Zip:

Work Phone: Home Phone:

Please add my name to the Fernald Community Mailing List. Yes ____ No ____

Name: Julie Laerch

Affiliation: FERNCO

Address:

City/State/Zip:

Work Phone: Home Phone:

Please add my name to the Fernald Community Mailing List. Yes ____ No ____

MEETING SUMMARY

Fernald Community Reuse Organization Public Workshop
May 28, 1996

General Summary

DOE held a public workshop to discuss initiation of a new community group, the Fernald Community Reuse Organization, on Tuesday, May 28 from 7 to 9 p.m. at The Plantation.
The Fernald CRO will advise DOE on community transition and economic development issues; make specific future land use recommendations within the parameters of the Fernald Citizens Task Force's recommendations; and advise on the disposition of excess government property.

Forty-four people, including Fernald workers, signed the attendance roster. Of the 44, 26 were stakeholders representing the following organizations:

Colerain Township Administration
Ross Local School district
Southwest Local School district
Morgan Township trustees
Crosby Township trustees
FRESH
Fernald Citizens Task Force
Hamilton County Communications
Hamilton County Park District
Hamilton County Environmental Services
Hamilton County Regional Planning Commission
Ross Area Merchants Association
Ohio Department of Health
Ohio EPA

DOE Public Information Director Gary Stegner opened the meeting with a presentation about CRO initiatives and future planned activities. Debbie Swichkow, Community Transition and Work Force Planning program manager, DOE Office of Worker and Community Transition, provided an overview of the national community transition program, including the process for applying for financial assistance.

The second half of the workshop was turned over to Maria Curro Kreppel, associate professor with University of Cincinnati's (UC) College of Applied Science. Kreppel was contracted in February to be the convener for the Fernald CRO. As convener, Kreppel will recommend the CRO's membership and chair to DOE and develop the group's operating procedures and charter. The convener process was used to select the membership and chair for the Fernald Citizens Task Force.
Kreppel outlined her activities as CRO convener and discussed future plans to recommend the CRO's membership and chair to DOE in June. To prompt open dialogue on community expectations, concerns and thoughts regarding the Fernald CRO, she asked attendees to complete a short questionnaire during the break. Several of the questions and public responses are summarized on page two. At the end of the workshop, Kreppel collected the completed forms. She plans to provide a summary report of community feedback to the new CRO chair.

Copies of the *Fernald Economic Impact Report 1991 - 1998* Executive Summary were available at the workshop. Developed by UC's Center for Economic Education and the Institute for Policy Research, the executive summary and the *Economic Impact Assessment 1991 - 1998* are also available to the public at the Public Environmental Information Center (PEIC). A copy of the workshop transcript will be placed in the PEIC by Friday, June 7.

FEEDBACK FROM 5/28/96 CRO PUBLIC WORKSHOP OPEN DISCUSSION

CRO convener's questions to stakeholders.

Q1: **I would like the Fernald communities to...**
R.: (Focus on) big picture.
(Have) insight for the large job the CRO will be.

Q2: **I am glad to be a part of these communities because....**
R: We like it (community) here.
It will help on the Western Hamilton County Collaborative Plan.
We like it (community) as it is now -- rural.
Long family history

Q3: **I'm afraid that.....**
R: The communities have different issues.
The attitude: "I'm the government and I'm here to help you."
Certain special issues and interests will dominate the CRO.

Q4: **The most important issue we face is.....**
R: A cleaned up site and funding to make sure it is clean
A healthy and safe community and environment
Keeping regional issues primary
Defining "region"
Fair future land use of site
Each community has different issues. (Example, one community is more rural; one community is more business oriented.)

Q5A: **What I've heard tonight.....surprises me because....**
R: No Ross Trustees here tonight -- this is part of their community, too.
Property sales

Q5B: **What I've heard tonight....concerns me because.....**
R: Money can cause problems -- used example of Mound controversy over money.
This organization (CRO) should not be involved in land use planning other than FEMP property.
(Under accelerated cleanup plan), bulk of "dirty" work will be done in five years. This CRO

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Q5C: **What I've heard tonight....encourages me because....**

R: The government hasn't walked away and abandoned people.
Wide diversity of people here (5/28 CRO public workshop) tonight.
Turnover of CRO (is good).