Stainless Steel RSM Benefical Reuse Technical Feasibility to Business Reality (Draft)

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by

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DISCLAIMER

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ABSTRACT

Stainless Steel RSM Beneficial Reuse Technical Feasibility to Business Reality

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The Stainless Steel Beneficial Reuse Program began in 1994 as a demonstration funded by the DOE Office of Science and Technology. The purpose was to assess the practicality of stainless steel radioactive scrap metal (RSM) recycle. Technical feasibility has been demonstrated through the production of a number of products made from recycled RSM. A solid business foundation is yet to be achieved. However, a business environment is beginning to develop as multiple markets and applications for RSM are surfacing around the Complex. The criteria for a successful business reality includes:

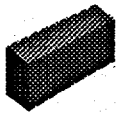
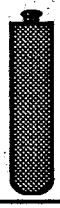
- affordable programs,
- a continuing production base from which to expand,
- real product needs,
- adequate RSM supply, and
- a multi-year program.

The program currently sponsored by SRS and DOE-ORO to fabricate Defense Waste Processing Facility (DWPF) canisters from RSM provides an activity that satisfies these criteria. The program status is discussed.

A comparison of the cost of DWPF canisters fabricated from recycled RSM and virgin metal is presented. The comparison is a function of several factors: disposal costs, the fabrication cost of virgin metal canisters, the fabrication cost of recycled RSM canisters, free release decontamination costs, and the cost to accumulate the RSM. These variables are analyzed and the relationship established to show the break-even point for various values of each parameter.

Background

The DOE's Office of Science and Technology Development has funded the demonstration of the beneficial reuse of recycling stainless steel radioactive scrap metal (RSM). A number of demonstration products have been fabricated and used at several sites throughout the Complex. The chart below identifies the products fabricated as part of the demonstration.

Item	Status	Funding Source
RD-100 	Fabrication complete	Programmatic
RD-55 (UN1A2 Certified) 	Fabrication complete	Programmatic
RD-85 (UN1A2 Certified) 	Fabrication underway	Programmatic
RD-TVS 	Initial Shipment made	Multiple
RD-D_2O 	Production commenced	Multiple
Ingots 	Production commenced	Programmatic
RD-DWPF 	Qualification initiated	Multiple

The status of each demonstration product is summarized below.

RD-100 (100 cubic foot box)
All RD-100 boxes have been fabricated and distributed to SRS.

RD-55 (55 gallon drum)
All RD-55 drums have been fabricated and distributed to SRS, LANL, Hanford, and ORNL.

RD-85 (gallon drum)
Approximately 250 RD-85 drums have been fabricated to date. 195 have been distributed to SRS and INEEL. 100 remain to be fabricated.

RD-TVS (containers for glass from the Transportable vitrification system)
All RD-TVS boxes have been fabricated, half of which have been shipped. In addition to programmatic funding, support for the RD-TVS fabrication came from the Mixed Waste Focus Area, LANL, and from SRS Set-Aside sources.

RD-D_2O (Heavy Water Storage Drums)
Fabrication of the RD-D_2O (heavy water) drums is under way. Completion is expected prior to the end of the fiscal year. In addition to programmatic funding, financial support for the RD-D_2O fabrication originates from the SRS Spent Fuel Division (EM-30 funding) and SRS Set-Aside sources.

Ingots
As part of the demonstration a ten ton Reactor Pump from SRS is to be melted, combined with all remaining process inventory in the vendor shop, and cast into ingots. Some of the metal will be cast into RAM-LOC™ shielding blocks for use at SRS. Support for this additional scope is expected to come from SRS Set-Aside funding.

RD-DWPF (qualification canisters for the Defense Waste Processing Facility)
SRS is cooperating with DOE-ORO to fabricate a number of DWPF qualification canisters. Five to ten canisters will be fabricated.

Criteria for Business Reality

Though technical feasibility has been demonstrated, the business reality of dispositioning large amounts of the Department's stainless steel RSM has yet to be realized. To achieve business reality the following criteria must be satisfied.

1. An affordable program for dispositioning the RSM and producing products must be undertaken. Such a program must be competitive with alternatives.
2. A continuing production base is needed to assure the proper economies of scale and to allow industry to establish itself.
3. Real products, i. e. products for which there is a real need, must be fabricated.
4. An adequate supply of feed stock (RSM) must be made available to industry.
5. A multi-year program must be funded in order to allow industry growth to ensue.

The large amount of RSM possessed by the DOE combined with the several decade long need by the DOE for DWPF canisters adequately addresses criteria 2 through 5. The rest of this paper deals with the "Affordable Program" criterion.

Affordable Program

To properly assess the competitiveness of RSM recycle, the costs for the entire recycle process must be compared with the standard (commonly referred to as "virgin metal")

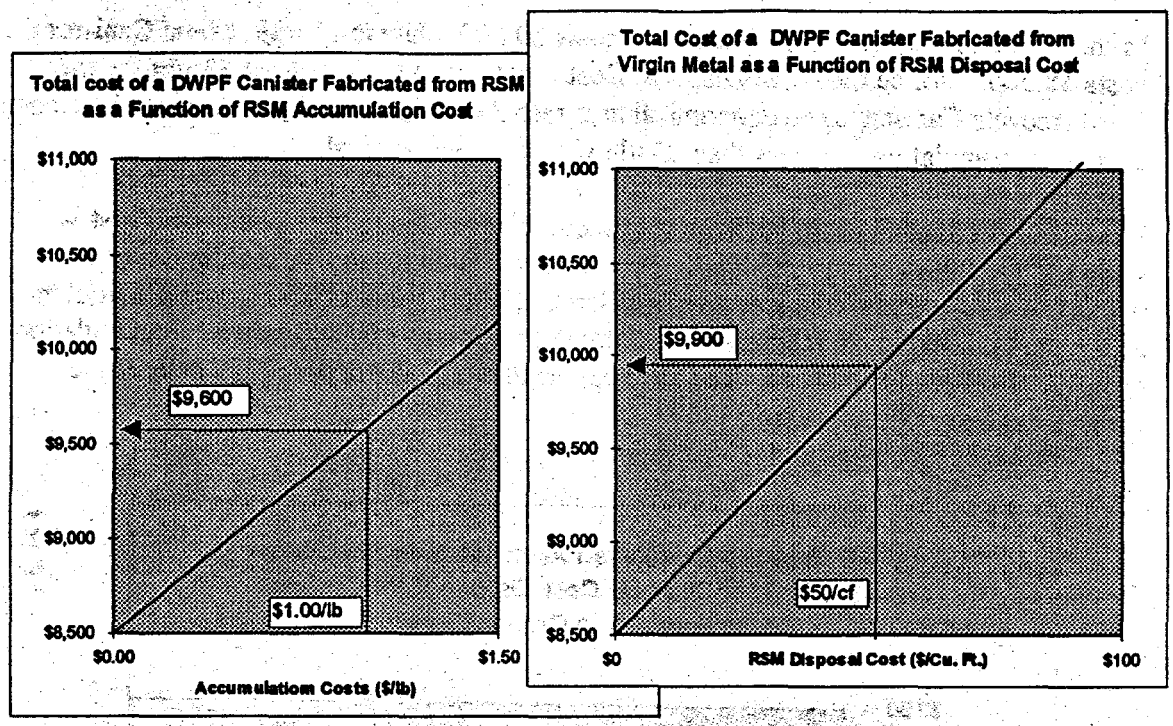
process. The comparison is called an Avoided Cost analysis because it incorporates the recognition that when RSM is recycled the cost to dispose of the RSM is "avoided".

The following table provides an example avoided cost calculation for producing DWPF Canisters. The metal used for the RSM Recycle process is assumed to come from SRS process water heat exchangers. There are two fabrication methods shown: the RSM recycle fabrication process and the virgin metal fabrication process. With the virgin metal process, the cost of disposing of an equivalent amount of RSM not used is included. Notice that the Accumulation Cost (the cost to process the heat exchanger metal to ready it for the meltor) is more than offset by the avoided disposal cost. In this case there is a calculated $300 per canister savings for the RSM recycle alternative.

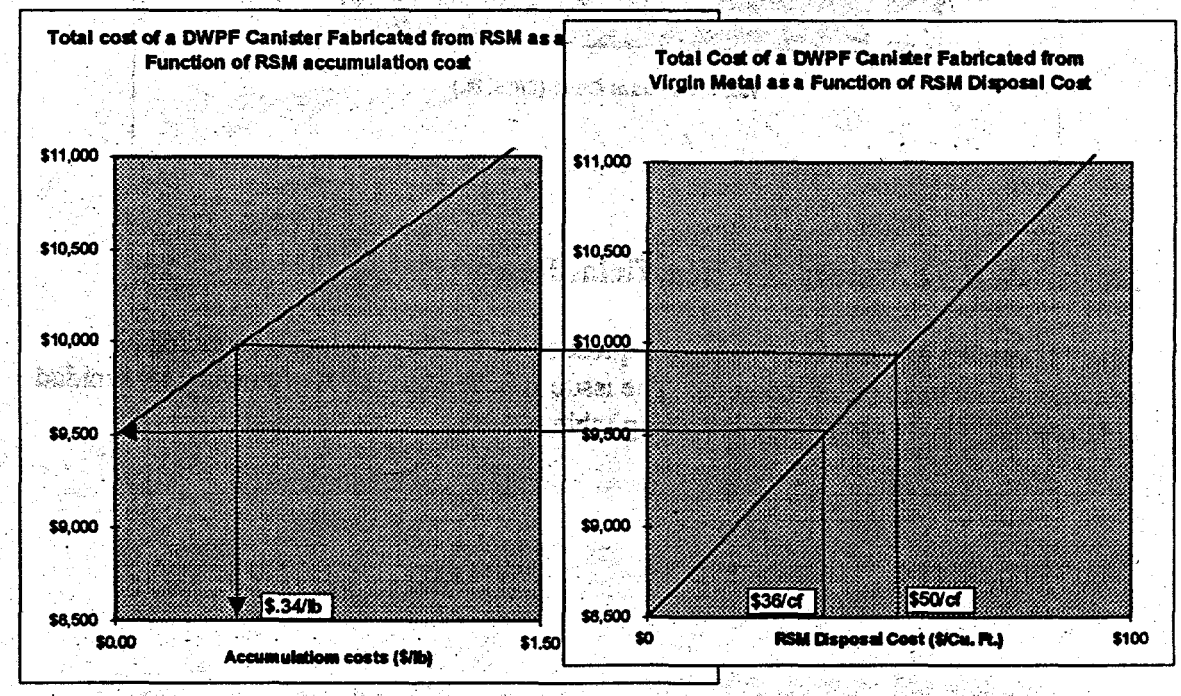
Avoided Cost Comparison

Item	RSM Recycle Fabrication	Virgin Metal Fabrication
DWPF Canister (Vendor) Cost	$ 8,500 per Canister	$ 8,500 per Canister
Disposal of equivalent amount of scrap at $50/cf		$ 1,400 per Canister
Accumulation Cost (Decon., size reduction, ...) at 1.00/lb	$ 1,100 per Canister	
Subtotal	$ 9,600 per Canister	$ 9,900 per Canister
Recycle Savings	**$300 per Canister**	

The values for the Disposal Cost (set at $50/cf) and Accumulation Cost (set at $1/lb) are uncertain, and will become known with greater accuracy as more information from future activities becomes available. The following graph displays the effect of changes in these variables on the total cost.

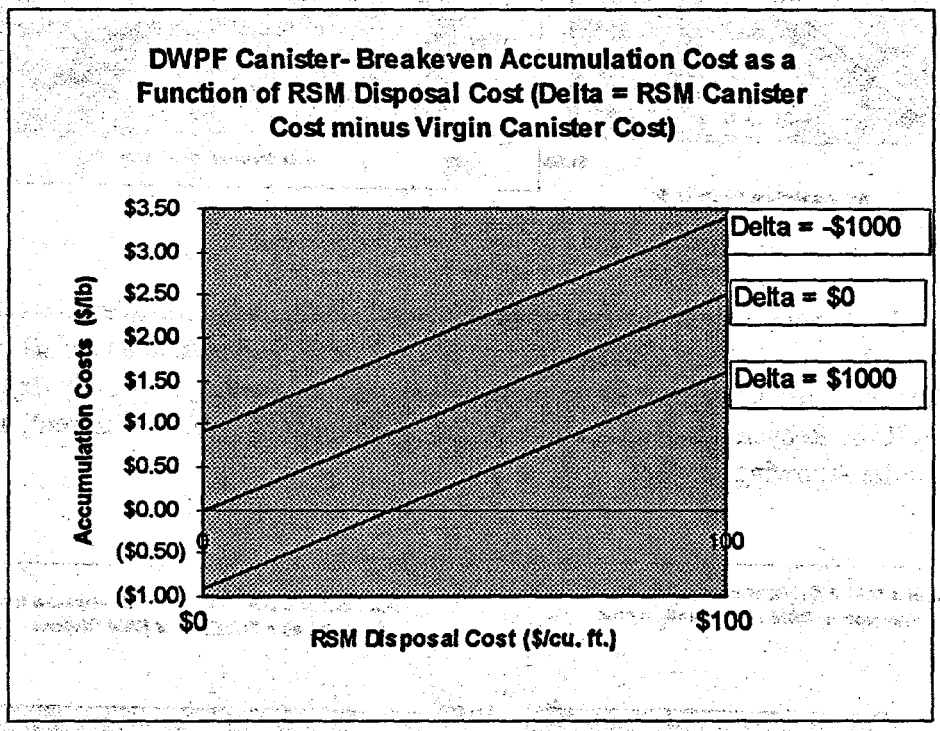


The values for Accumulation Cost and RSM Disposal Cost used in the previous table are displayed on the graphs. The vendor costs to fabricate the RSM Recycle Canister and the Virgin Metal canister is assumed to be equal in this case. However, it is likely that the cost of the RSM Recycle Canister and the Virgin Metal canister will be different, as depicted in the following graphs.



In this example the RSM recycle canister costs $9,500 while the Virgin Metal Canister costs $8,500. Notice the RSM Disposal Cost would have to be at least $36/cf for the RSM Recycle Canister to be economical at a zero Accumulation Cost. At $50/cf disposal cost, an accumulation cost less than $34/lb would be economical.

The break even relationship between the Accumulation Cost and the Disposal Cost is shown in the following graph. Three separate conditions for the "RSM Canister cost minus the Virgin Metal Canister cost" (called Delta) are shown. This graph is useful in assessing the break-even relationship among the three important variables: Accumulation cost, Disposal cost, and Delta. The line representing a Delta of zero also defines the break-even free release scenario.



Decision- Free Release or Beneficial Reuse

Once a decision to recycle is made, the question as to which is more economical, free release or beneficial reuse, remains. The issue is best addressed by viewing an avoided cost comparison as seen in the following table.

Avoided Cost Comparison

Item	RSM Recycle Fabrication	RSM Free Release & Virgin Metal Fabrication	RSM Disposal & Virgin Metal Fabrication
DWPF Canister (Vendor) Cost	$ 8,500 per canister	$ 8,500 per canister	$ 8,500 per canister
Disposal of equivalent amount of scrap at $50/cf			$ 1,400 per canister
Free Release Cost (Chemical Decontamination, etc.) at $1.00/lb		$ 1,100 per canister	
Accumulation Cost (Decon., size reduction, etc.) at $1.00/lb	$ 1,100 per canister		
Subtotal	$ 9,600 per canister	$ 9,600 per canister	$ 9,900 per canister
Savings	$ 300 per canister	$ 300 per canister	

In this table, three possibilities are shown: RSM recycle (beneficial reuse), RSM free release & virgin metal fabrication, and RSM disposal & virgin metal fabrication. The first two possibilities are shown to have an equal advantage over disposal. Which one is more advantageous will be determined as the future programs proceed. Such programs will provide information on the cost of decontamination and free release compared to the cost of size reduction and metal melt & fabrication. It is not expected that canisters made by recycling RSM would cost the same as canisters made from virgin metal. The following table shows the break-even analysis for the situation where the canisters made from RSM are $1000 more costly than the canisters made from virgin metal.

Cost Comparison

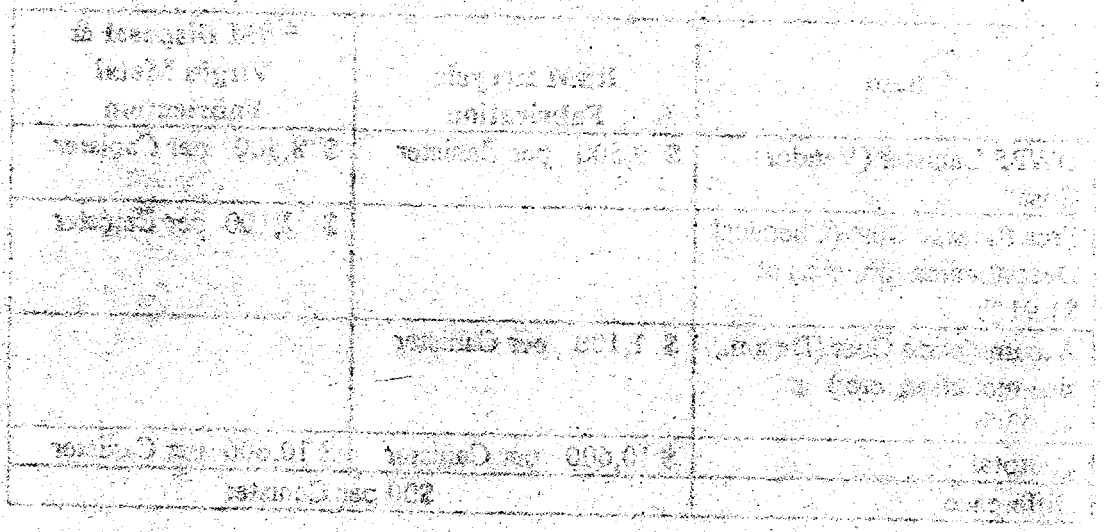
Item	RSM Recycle Fabrication	RSM Disposal & Virgin Metal Fabrication
DWPF Canister (Vendor) Cost	$ 9,500 per Canister	$ 8,500 per Canister
Free Release Cost (Chemical Decontamination, etc.) at $1.91/lb		$ 2,100 per Canister
Accumulation Cost (Decon., size reduction, etc.) at $1.00/lb	$ 1,100 per Canister	
Subtotal	$ 10,600 per Canister	$ 10,600 per Canister
Difference	$00 per Canister	

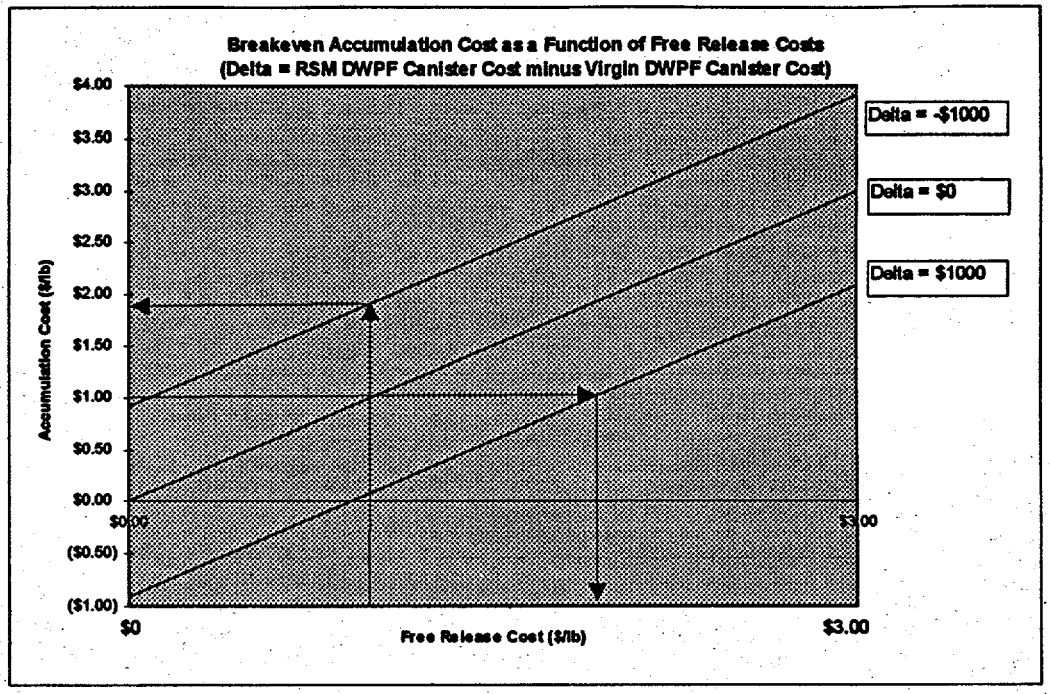
In this case at an accumulation cost of $1.00 per pound to make stainless steel ready for the meltor would break-even with a $1.93 per pound chemical processing cost to free release the metal. The reciprocal is true as depicted in the following table, where the canisters made from RSM are $1000 less costly than the canisters made from virgin metal.

Cost Comparison

Item	RSM Recycle Fabrication	RSM Disposal & Virgin Metal Fabrication
DWPF Canister (Vendor) Cost	$ 7,500 per Canister	$ 8,500 per Canister
Free Release Cost (Chemical Decontamination, etc.) at $1.00/lb		$ 1,100 per Canister
Accumulation Cost (Decon., size reduction, etc.) at $1.91/lb	$ 2,100 per Canister	
Subtotal	$ 9,600 per Canister	$ 9,600 per Canister
Difference	$00 per Canister	

The following graph shows the relationship between the accumulation and free release break-even costs for various "delta's", where delta equals the RSM DWPF canister cost minus the Virgin metal DWPF canister cost. The examples depicted in the two preceding tables are shown by the horizontal and vertical arrows on the graph.





It is expected that the most economical scenario will be a situation where a portion of a heat exchanger is decontaminated to free release levels and the remainder is recycled for beneficial reuse. Future activities will provide insight into this issue.

Beneficial Reuse '97
Knoxville, TN
August 5-7, 1997

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Pollution Prevention Conference XIII
Atlanta, GA
August 26 - 28, 1997

Contaminated Stainless Steel Beneficial Reuse Technical Feasibility to Business reality

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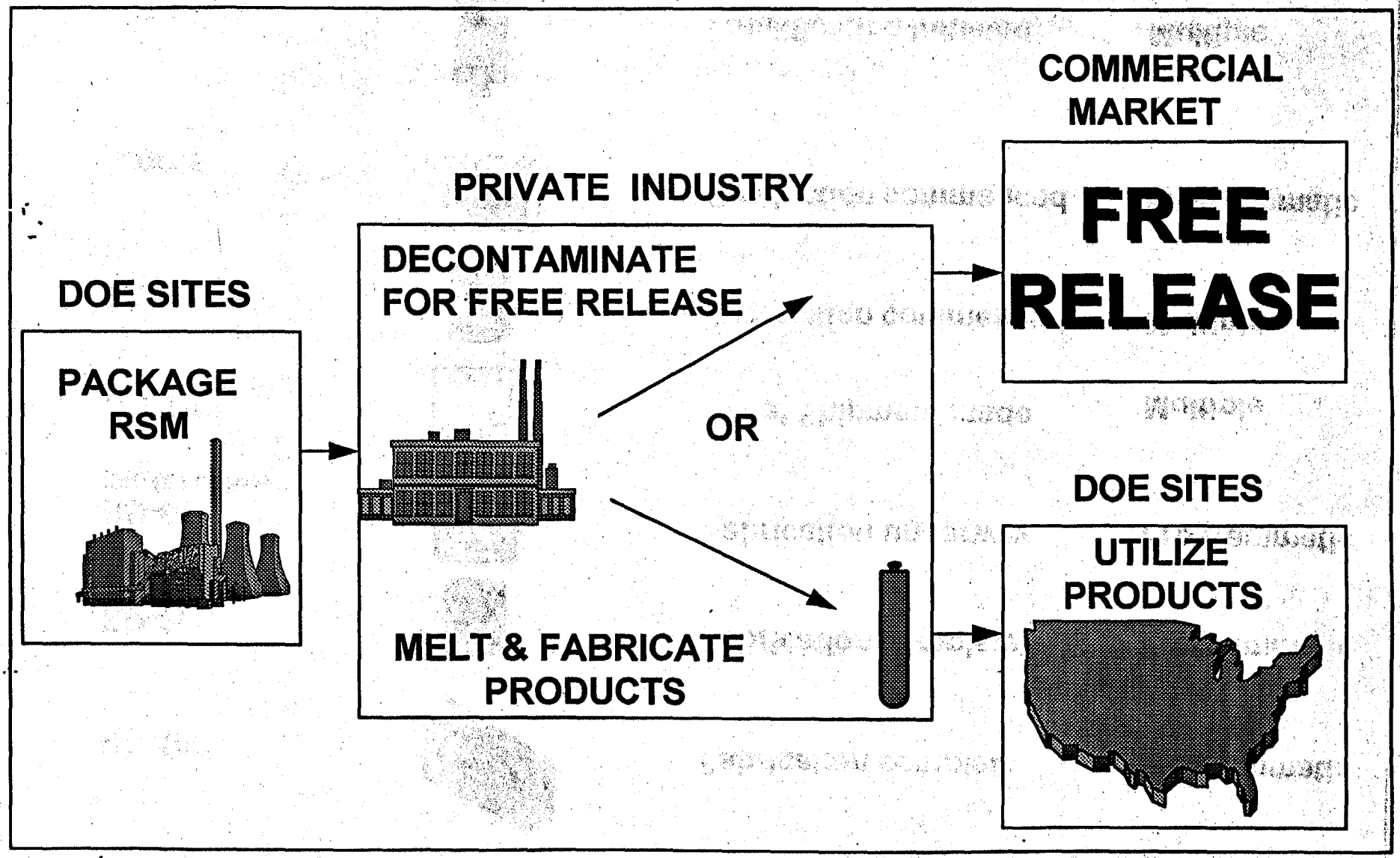
CONTAMINATED STAINLESS STEEL
FREE RELEASE & BENEFICIAL REUSE TDI



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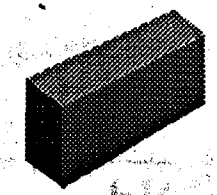
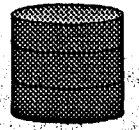
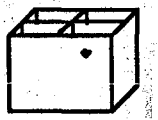
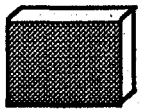
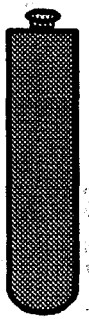
Item		Status	Funding Source
RD-100		Fabrication complete	Programmatic
RD-55 (UN1A2 Certified)		Fabrication complete	Programmatic
RD-85 (UN1A2 Certified)		Fabrication underway	Programmatic
RD-TVS		Initial Shipment made	Multiple
RD-D_2O		Production commenced	Multiple
Ingots		Production commenced	Programmatic
RD-DWPF		Qualification initiated	Multiple

BR97PPT

Criteria for a Successful Free Release & Beneficial Reuse Program

- Affordability
- A continuing production base from which to expand
- Adequate supply of feed RSM
  (HX Sizing Deployment)
- Real product need for metal that must be Beneficially Reused - Market pull
  (DWPF Canisters)
- Multi-year decision basis

Free Release & Beneficial Reuse Program

- Utilizes developed technology
- Complemented by EPRI funding
- Supports Metal Recycle Policy
- Can disposition significant amount of HX & Complex SS within 10 years
- Substantial amount of metal can be free released
- Only the metal that cannot be free released will be beneficially reused
- Beneficial reuse of metal can fulfill all future needs for DWPF Canisters
- Private industry participation and assumption of business risk maximized
- Participation by other Sites - already initiated
- Vendor responsible for waste generated

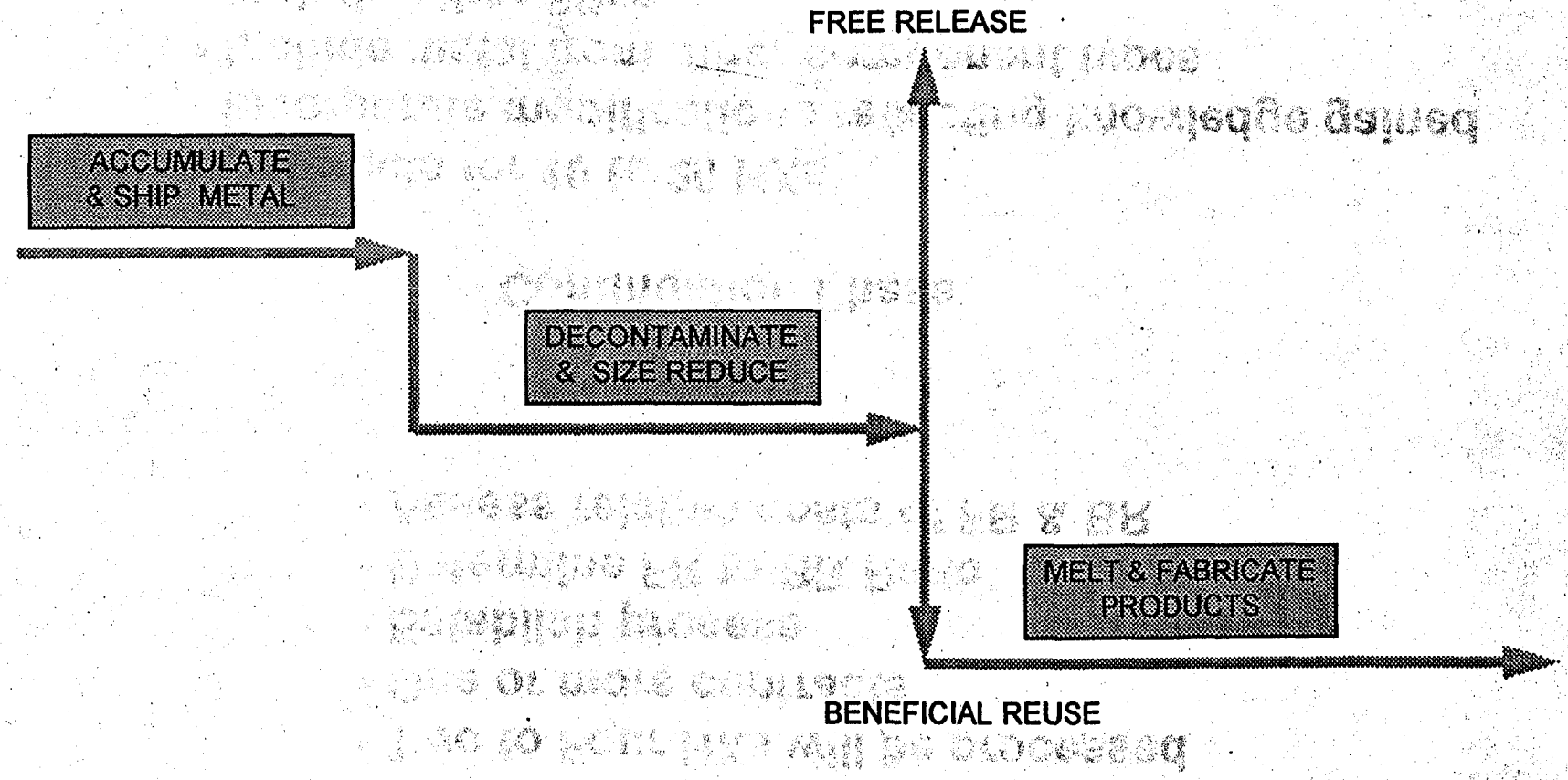
Initial Phase

- Two to Four HXs will be processed
- One or more contracts
- Establish process
- Determine FR to BR Ratio
- Assess relative costs of FR & BR

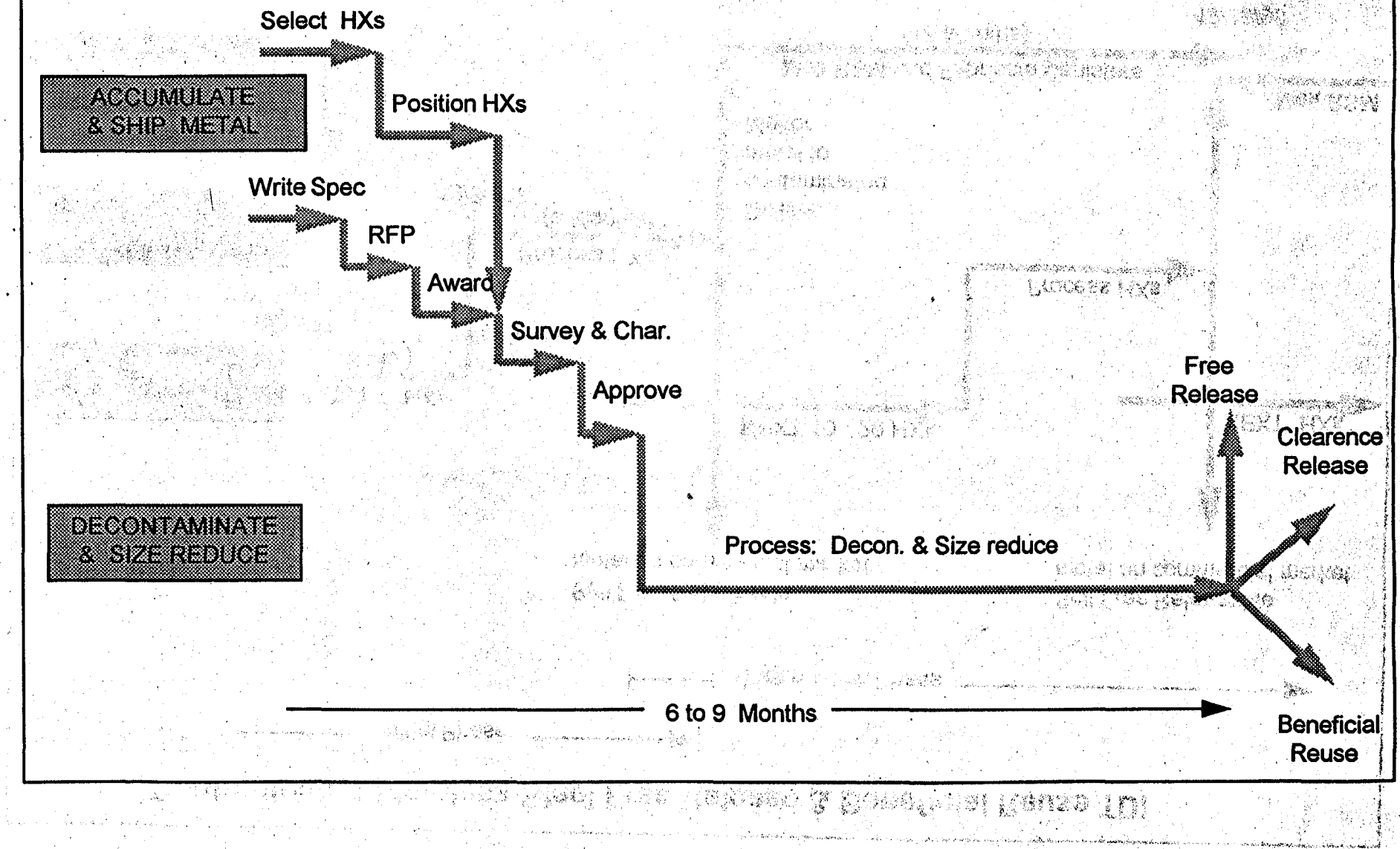
Continuation Phase

- Contracts for 10 to 20 HXs
- Incorporate modifications reflecting knowledge gained
- Include metal from other component types
- Include other Sites
- Identify other markets

Contaminated Stainless Steel Free Release & Beneficial Reuse TDI



Contaminated Stainless Steel Free Release & Beneficial Reuse TDI
FY 1998 Initial Phase



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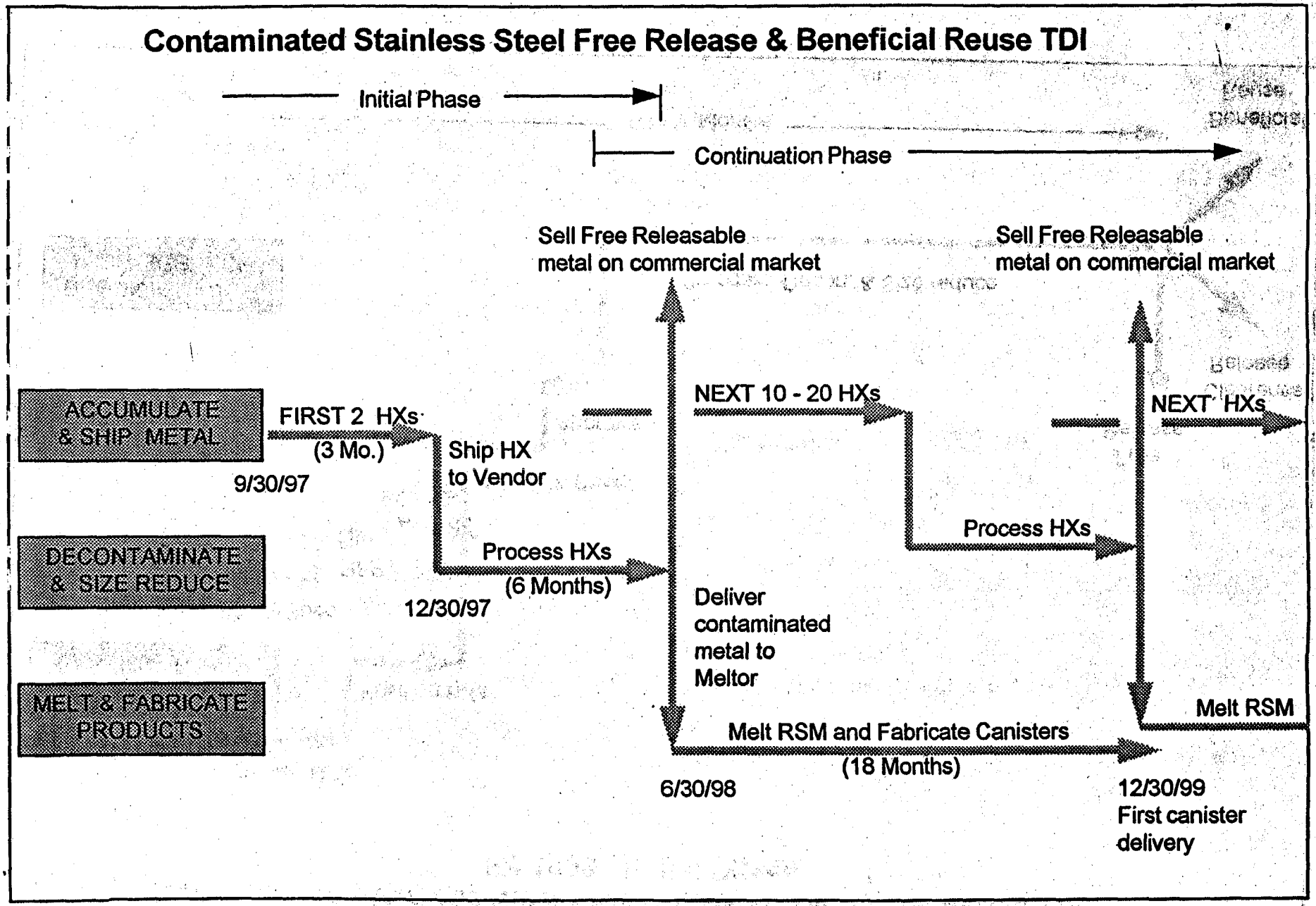
Contaminated Stainless Steel Free Release & Beneficial Reuse TDI
Initial Phase
Continuation Phase
Sell Free Releasable metal on commercial market
Sell Free Releasable metal on commercial market
ACCUMULATE & SHIP METAL
FIRST 2 HXs
(3 Mo.)
9/30/97
Ship HX to Vendor
NEXT 10 - 20 HXs
NEXT HXs
DECONTAMINATE & SIZE REDUCE
Process HXs
(6 Months)
12/30/97
Process HXs
Deliver contaminated metal to Meltor
MELT & FABRICATE PRODUCTS
Melt RSM
Melt RSM and Fabricate Canisters
(18 Months)
6/30/98
12/30/99
First canister delivery

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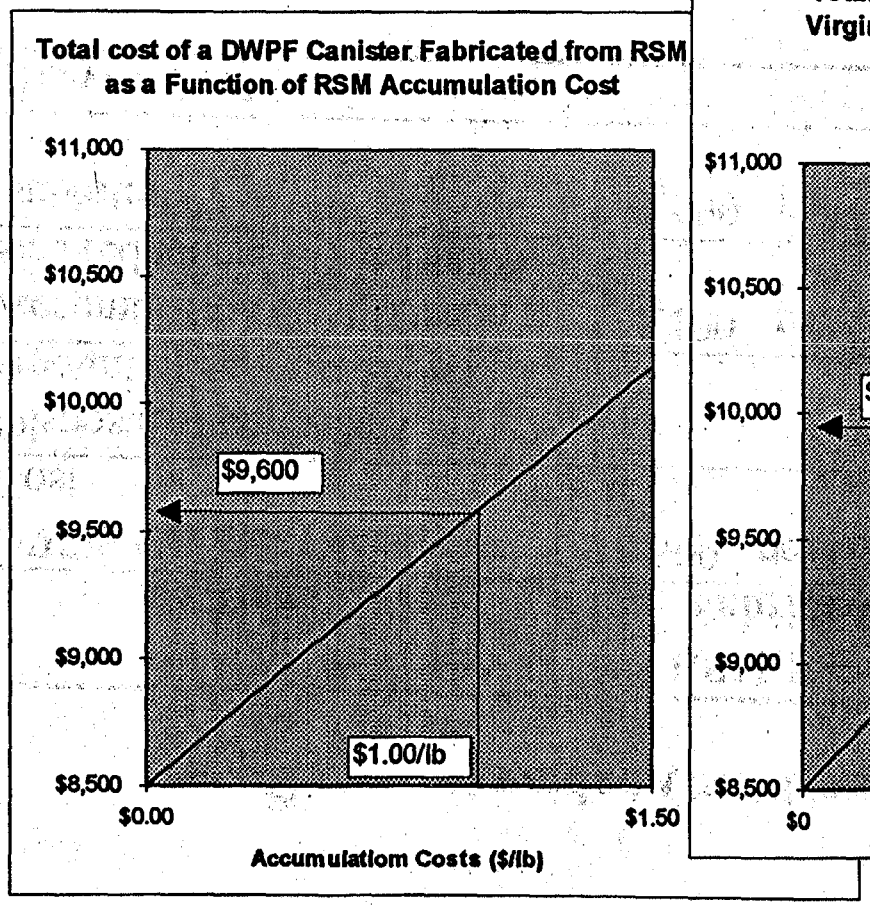
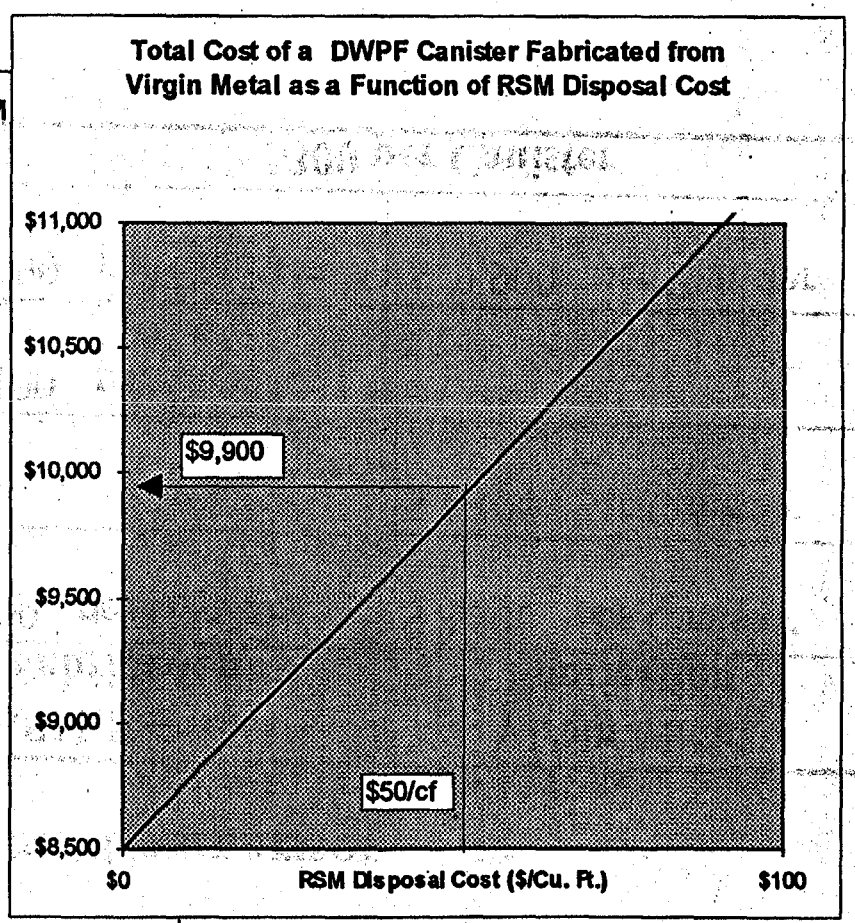
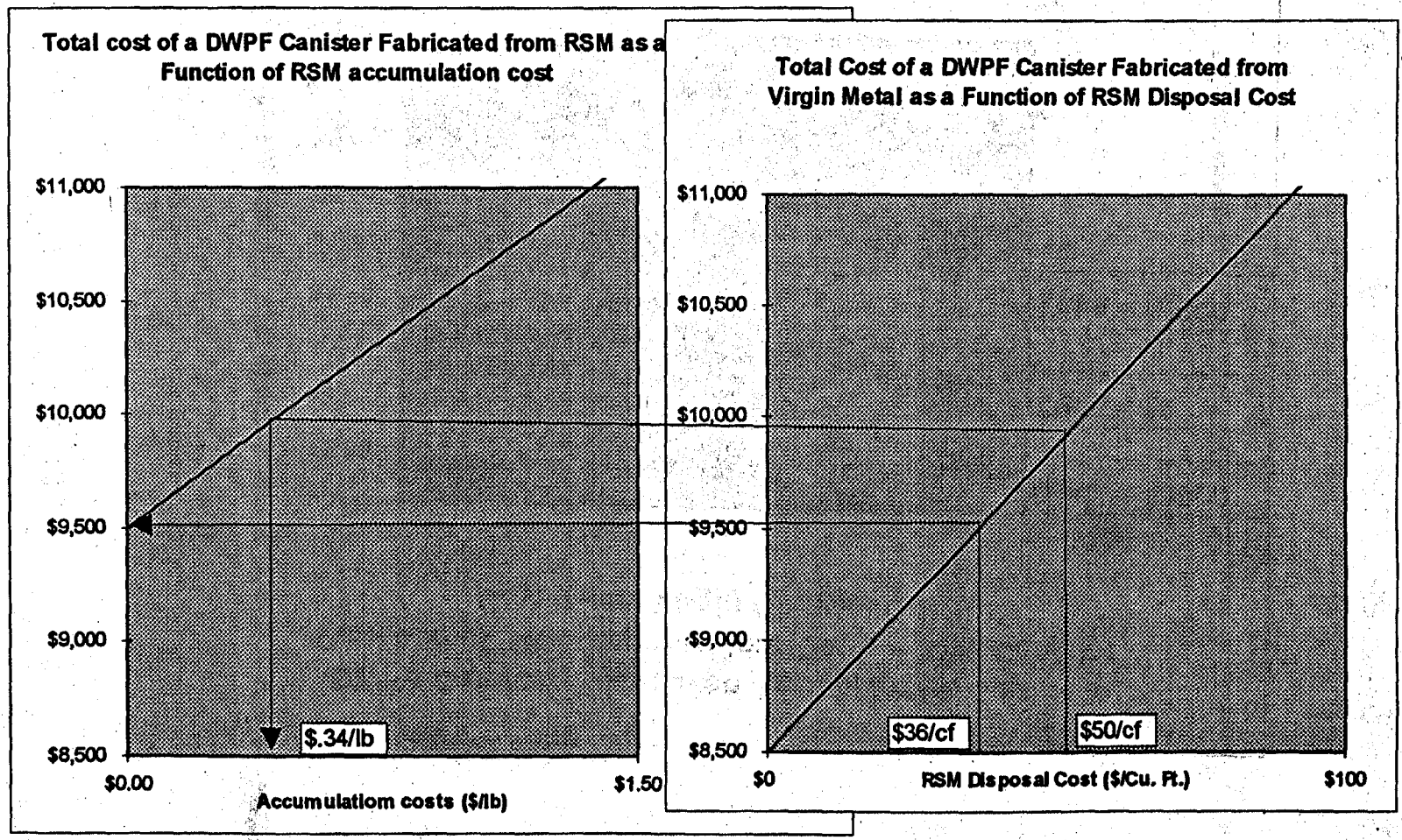
Avoided Cost Comparison

Item	RSM Recycle Fabrication	Virgin Metal Fabrication
DWPF Canister (Vendor) Cost	$ 8,500 per Canister	$ 8,500 per Canister
Disposal of equivalent amount of scrap at $50/cf		$ 1,400 per Canister
Accumulation Cost (Decon., size reduction, ...) at 1.00/lb	$ 1,100 per Canister	
Subtotal	$ 9,600 per Canister	$ 9,900 per Canister
Recycle Savings	**$300 per Canister**	


Total cost of a DWPF Canister Fabricated from RSM as a Function of RSM Accumulation Cost
$11,000
$10,500
$10,000
$9,500
$9,000
$8,500
$9,600
$1.00/lb
$0.00
$1.50
Accumulation Costs ($/lb)


Total Cost of a DWPF Canister Fabricated from Virgin Metal as a Function of RSM Disposal Cost
$11,000
$10,500
$10,000
$9,500
$9,000
$8,500
$9,900
$50/cf
$0
RSM Disposal Cost ($/Cu. Ft.)
$100

21


Total cost of a DWPF Canister Fabricated from RSM as a Function of RSM accumulation cost
$11,000
$10,500
$10,000
$9,500
$9,000
$8,500
$.34/lb
$0.00
$1.50
Accumulatiom costs ($/lb)
Total Cost of a DWPF Canister Fabricated from Virgin Metal as a Function of RSM Disposal Cost
$11,000
$10,500
$10,000
$9,500
$9,000
$8,500
$36/cf
$50/cf
$0
RSM Disposal Cost ($/Cu. Ft.)
$100

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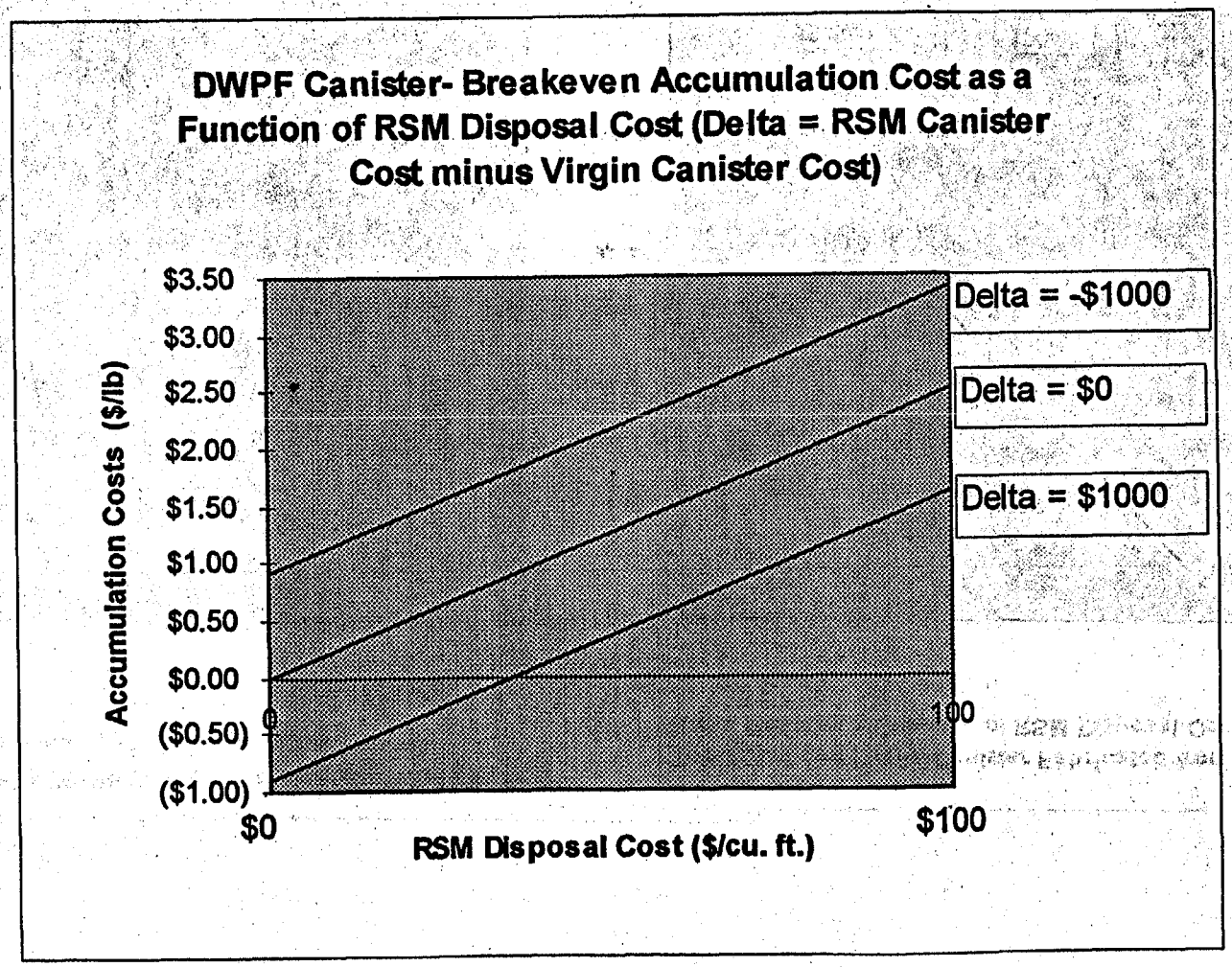

DWPF Canister- Breakeven Accumulation Cost as a Function of RSM Disposal Cost (Delta = RSM Canister Cost minus Virgin Canister Cost)
$3.50
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$0.00
($0.50)
($1.00)
Accumulation Costs ($/lb)
Delta = -$1000
Delta = $0
Delta = $1000
0
100
$0
$100
RSM Disposal Cost ($/cu. ft.)

Avoided Cost Comparison

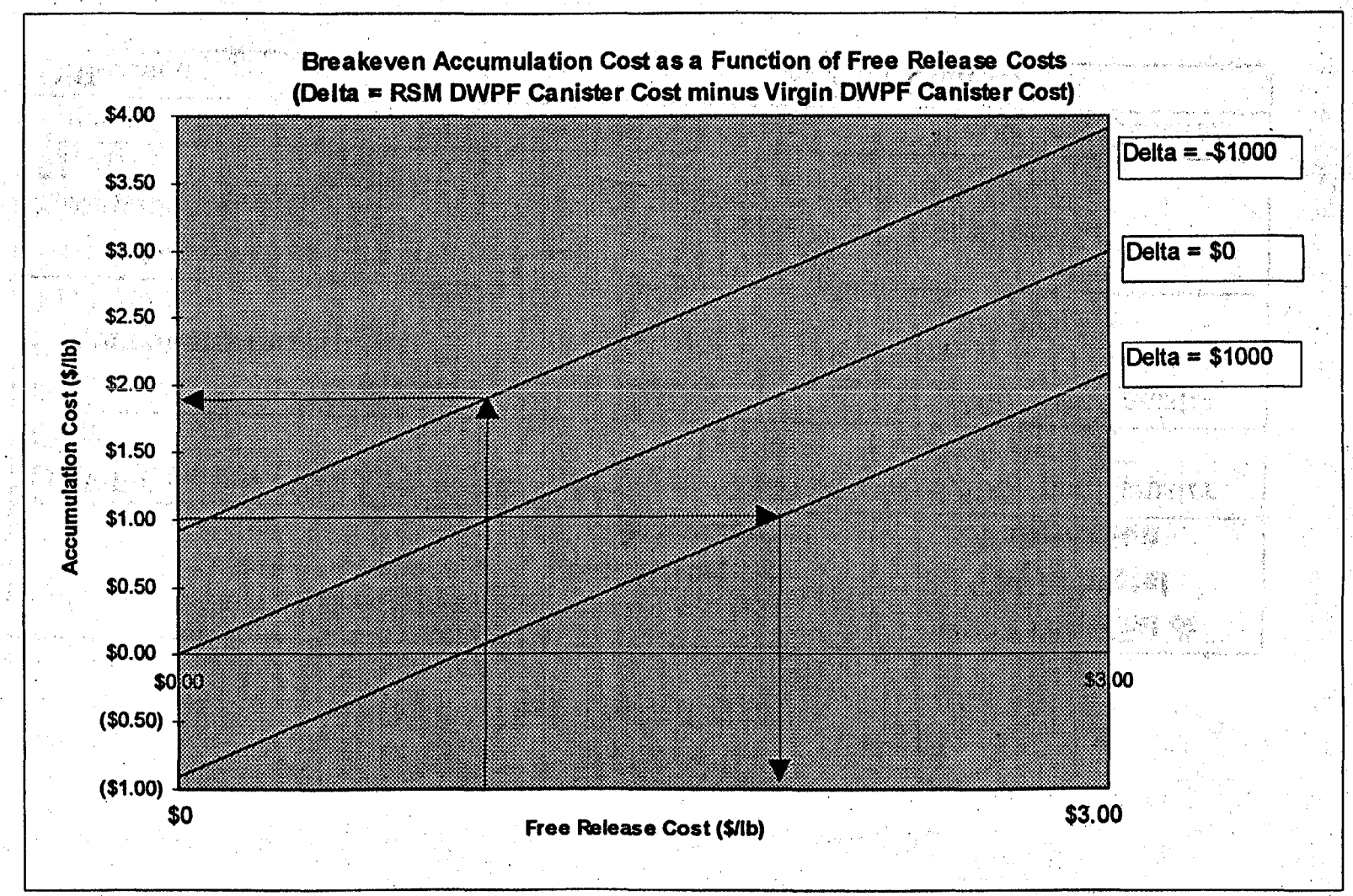
Item	RSM Recycle Fabrication	RSM Free Release & Virgin Metal Fabrication	RSM Disposal & Virgin Metal Fabrication
DWPF Canister (Vendor) Cost	$ 8,500 per canister	$ 8,500 per canister	$ 8,500 per canister
Disposal of equivalent amount of scrap at $50/cf			$ 1,400 per canister
Free Release Cost (Chemical Decontamination, etc.) at $1.00/lb		$ 1,100 per canister	
Accumulation Cost (Decon., size reduction, etc.) at $1.00/lb	$ 1,100 per canister		
Subtotal	$ 9,600 per canister	$ 9,600 per canister	$ 9,900 per canister
Savings	$ 300 per canister	$ 300 per canister	

Cost Comparison

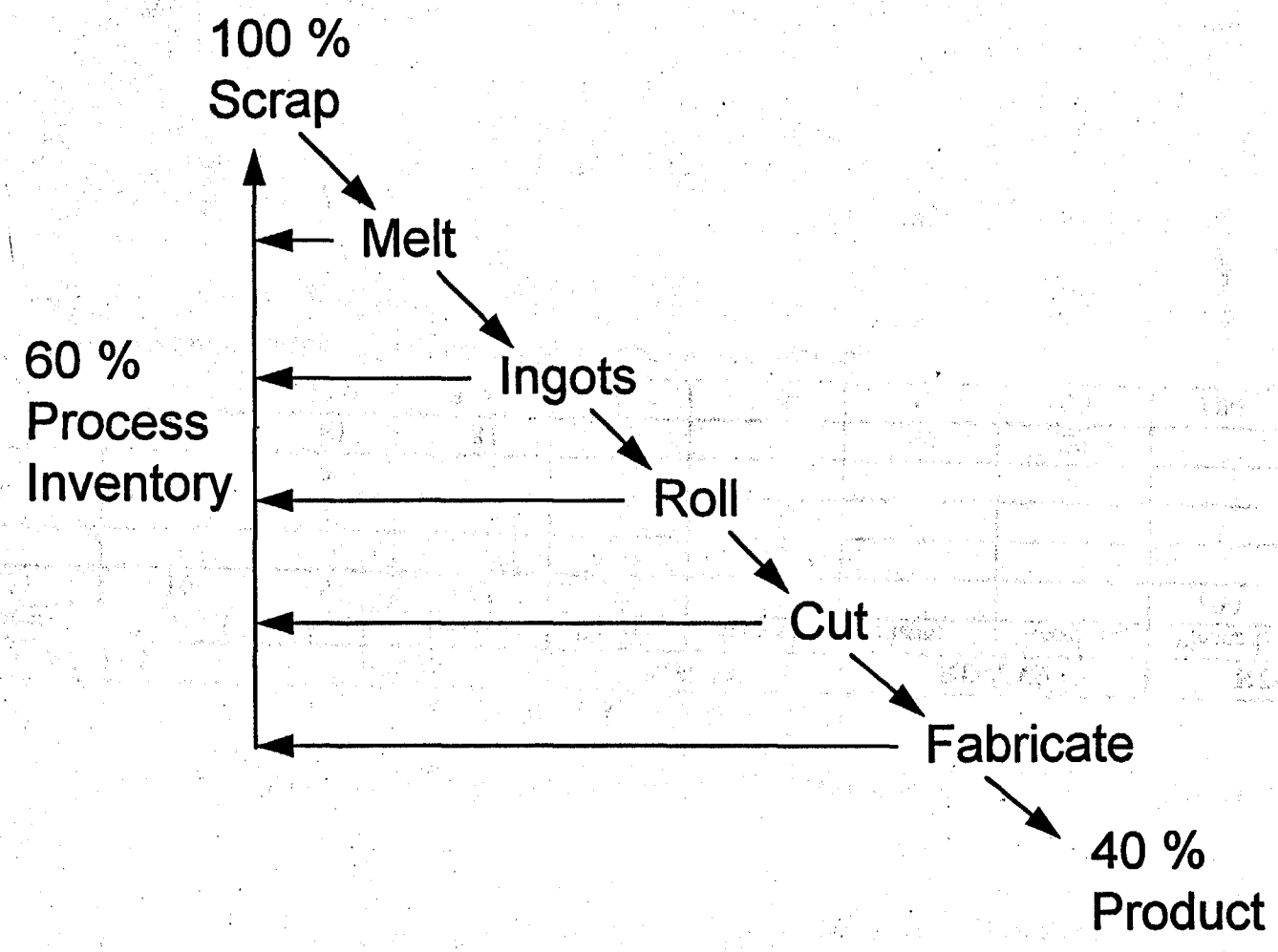
Item	RSM Recycle Fabrication	RSM Disposal & Virgin Metal Fabrication
DWPF Canister (Vendor) Cost	$ 9,500 per Canister	$ 8,500 per Canister
Free Release Cost (Chemical Decontamination, etc.) at $1.91/lb		$ 2,100 per Canister
Accumulation Cost (Decon., size reduction, etc.) at $1.00/lb	$ 1,100 per Canister	
Subtotal	$ 10,600 per Canister	$ 10,600 per Canister
Difference	$00 per Canister	

Cost Comparison

Item	RSM Recycle Fabrication	RSM Disposal & Virgin Metal Fabrication
DWPF Canister (Vendor) Cost	$ 7,500 per Canister	$ 8,500 per Canister
Free Release Cost (Chemical Decontamination, etc.) at $1.00/lb		$ 1,100 per Canister
Accumulation Cost (Decon., size reduction, etc.) at $1.91/lb	$ 2,100 per Canister	
Subtotal	$ 9,600 per Canister	$ 9,600 per Canister
Difference	$00 per Canister	


Breakeven Accumulation Cost as a Function of Free Release Costs
(Delta = RSM DWPF Canister Cost minus Virgin DWPF Canister Cost)
$4.00
$3.50
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$0.00
($0.50)
($1.00)
Accumulation Cost ($/lb)
$0.00
$3.00
$0
$3.00
Free Release Cost ($/lb)
Delta = -$1000
Delta = $0
Delta = $1000

One pass efficiency is about 40%



Product Distribution

Site	RD-100		RD-55		RD-85		RD-TVS		RD-D2O	
	Planned	Received	Planned	Received	Planned	Received	Planned	Received	Planned	Received
SRS	11	16	157	145	107	85			100	
INEL					108	118**				
LANL			81	81	45	1				
Hanford			81	81	45	1				
ORNL	5		81	81	45		40	20		
Total	**16**	**16**	**400***	**388**	**350***	**205**	**40**	**20**	**100**	

as of 5/29/97 *12 each destroyed in testing **10 retained by vendor for development