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The Stainless Steel Beneficial Reuse Integrated Demonstration (U)

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THE STAINLESS STEEL BENEFICIAL REUSE INTEGRATED DEMONSTRATION

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ABSTRACT

In 1992 there was a desire to determine the ultimate disposition of 68 Process Water Heat Exchangers at the Savannah River Site (SRS). Each Heat Exchanger weighs about 100 tons. Since the Heat Exchangers are radioactively contaminated they could be classified as radioactive waste and disposed through shallow land burial on site. The cost for such a disposal would exceed $10 million. The Heat Exchanger material being over 95% 304 stainless steel would represent a commodity value of several million dollars on the commercial scrap market. Unfortunately, the metal is volumetrically contaminated, a situation for which there is no "de minimis free release" level, thereby preventing recycle of the metal into the commercial market place. However, the metal could be recycled back to the DOE in a "controlled release" manner. The radioactive scrap metal (RSM) could be reprocessed into new reusable products which are returned to the DOE for use within the DOE Complex. The new products would not be used within the public arena.

In 1994 the DOE Office of Technology Development initiated a demonstration to recycle contaminated stainless steel by melting 60 tons of RSM and refabricating it into containers (55 gallon drums and 100 cubic feet boxes) that could be used for long term, temporary storage. The Demonstration covers the entire recycle chain from the accumulation of the feed stock (through the disassembly of excess components) to the receipt and utilization of the final products. The disposition of waste generated during the recycling process is also a part of the Demonstration. The actual melting of the radioactive scrap metal and the fabrication of the final products is accomplished through subcontracts with private industry. The Demonstration is a precursor to the establishment of regional stainless steel recycle facilities at or near major DOE sites. Radioactivity levels of the RSM to be shipped have been provided to the melt/fabrication subcontractors for their utilization in obtaining regulatory permit modifications.

Delivery of final products is schedule for 1995 and 1996. The activity level of the RSM to be supplied to industry has been determined to be less than one curie in total. The average specific activity level of the Cobalt-60 which will be volumetrically imbedded in the final products has been estimated to be of the order of 117 pico curies per gram (4.31 becquerels per gram). This level is expected to cause no difficulty in the utilization of the drums and boxes as containers of other waste forms.

THE INTEGRATED DEMONSTRATION

The Savannah River Site (SRS) has a large amount of radioactive scrap metal (RSM) which includes approximately 6800 tons contained in the form of excess heat exchangers. These heat exchangers have reached the end of their productive life and are normally declared Low Level Radioactive Waste. As such the heat exchangers would normally be disposed by burial at SRS at a cost of over $10 million. If however, the metal could be melted and refabricated into items such as waste containers, the material would be beneficially reused, eliminating the need to add an equivalent amount of clean metal to the contamination stream. In effect a potential liability would be changed into an asset. Figure 1 displays the concept.

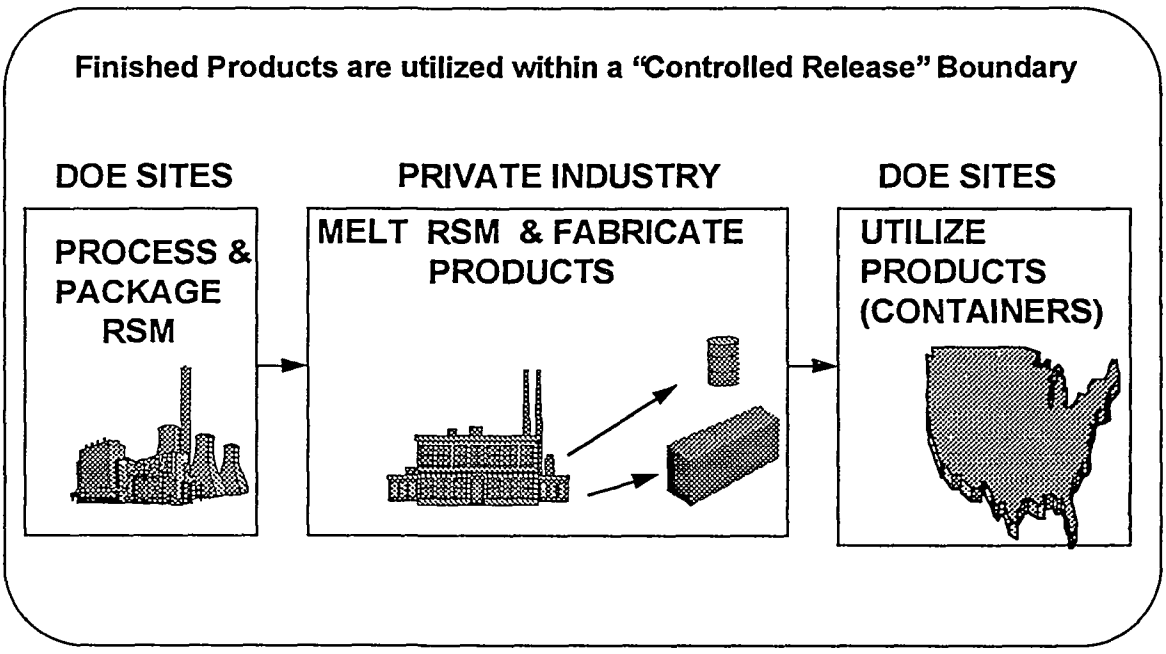

FIGURE 1. Recycle Concept

To demonstrate the feasibility of this concept, the DOE (Office of Technology Development) is funding an Integrated Demonstration at SRS, in which a small amount of stainless steel RSM (60 tons) is to be melted, and refabricated into drums (55 gallons each) and boxes (100 cubic feet each). The melting and refabricating will be accomplished by private industry. The products will be sent to SRS for use. The secondary waste stream, consisting primarily of a small volume of clippings and possibly slag, will be returned to SRS for disposal as LLW. A total of approximately 485 drums and 85 boxes are expected to be produced. Delivery is scheduled for the 1995 - 1996 time frame.

The two private industrial companies participating in this Integrated Demonstration are:

(1) Carolina Metals Inc. of Barnwell SC (a subsidiary of Nuclear Metals Inc.) , and

(2) Manufacturing Sciences Corp. of Oak Ridge TN.

The finished products to be produced by the private industrial participants are identified in Table I.

TABLE I. Finished Products

	Carolina Metals Inc.	Manufacturing Sciences Corp.	Totals
RSM to be Processed (tons)	20	40	60
Number of 100 cu. ft. boxes to be fabricated	44	40	84
Number of 55 gallon drums to be fabricated	-	485	485

The numbers of boxes and drums to be fabricated are approximate since the actual values will depend on the efficiency of the (yet to be implemented) manufacturing processes.

EXPOSURE TO THE FINISHED PRODUCT

An important part of the Integrated Demonstration is to establish that the fabricated products will be sufficiently low in activity so as to allow worker proximity.

The total activity contained in the 60 tons of RSM to be sent to the melters is less than one curie. Most of the activity, being tritium, will off-gas. Of specific interest is the amount of cobalt-60 which will be volumetrically distributed in the remelted steel. This isotope will dominate the exposure from the fabricated boxes and drums. Samples taken from the 60 tons of RSM indicate the total cobalt-60 activity is of the order of 0.00636 Ci. If homogeneously distributed in the refabricated products, the concentration will be of the order of 117 pico curies per gram (4.33 Becquerels per gram).

A spectrum of RSM taken from different components will be used as feed metal. Table II groups the specific RSM selected and the cobalt-60 activity associated with each Group.

TABLE II. Feed RSM Grouping

Group	Amount (pounds)	Co-60 Activity (pCi/g)
Ramshorn Piping	6,300	275
Heat Exchanger Inlet Piping	5,400	463
Expansion Joints	11,700	13
Small Diameter Piping	600	782
Heat Exchanger Heads	56,000	118
Slug Buckets	40,000	63
TOTAL	120,000	117 (avg)

The melters, of course, will not homogeneously mix all of the recycled RSM to make each Heat at an activity of 117 pCi/g. Each Heat will be different. Figure 2 was generated assuming two ton Heats, starting with the highest activity feed RSM and proceeding to the lowest activity feed RSM. The 60 tons results in a total of 30 Heats.

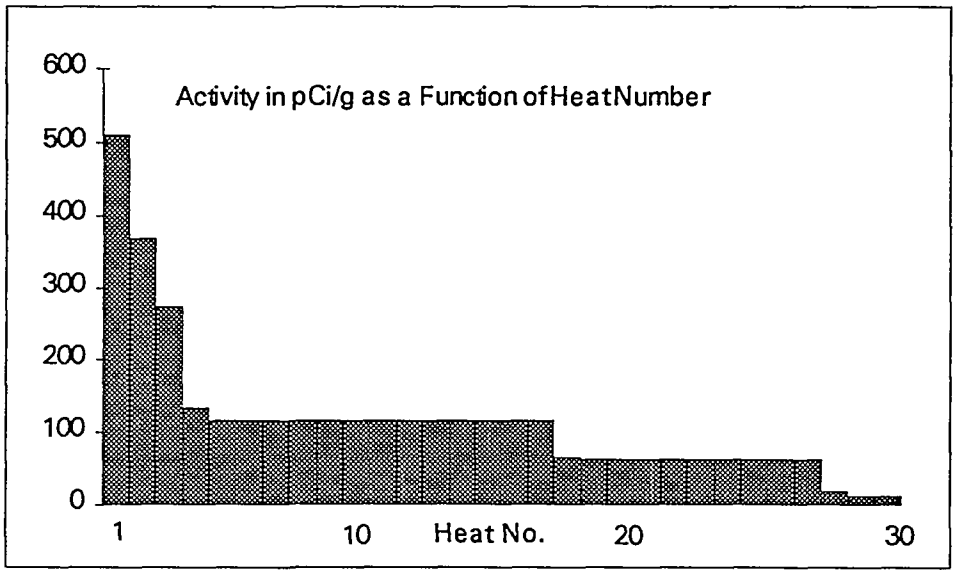

FIGURE 2. Activity as a function of Heat

It is important to know the exposure one might receive from the fabricated boxes and drums. One Heat of 2 tons will result in approximately four boxes or forty drums. Figure 3 depicts the geometry of the calculation of the maximum exposure dose rate to

an individual at 100 centimeters from two boxes or eight drums fabricated out of the highest activity Heat (511 pCi/g).

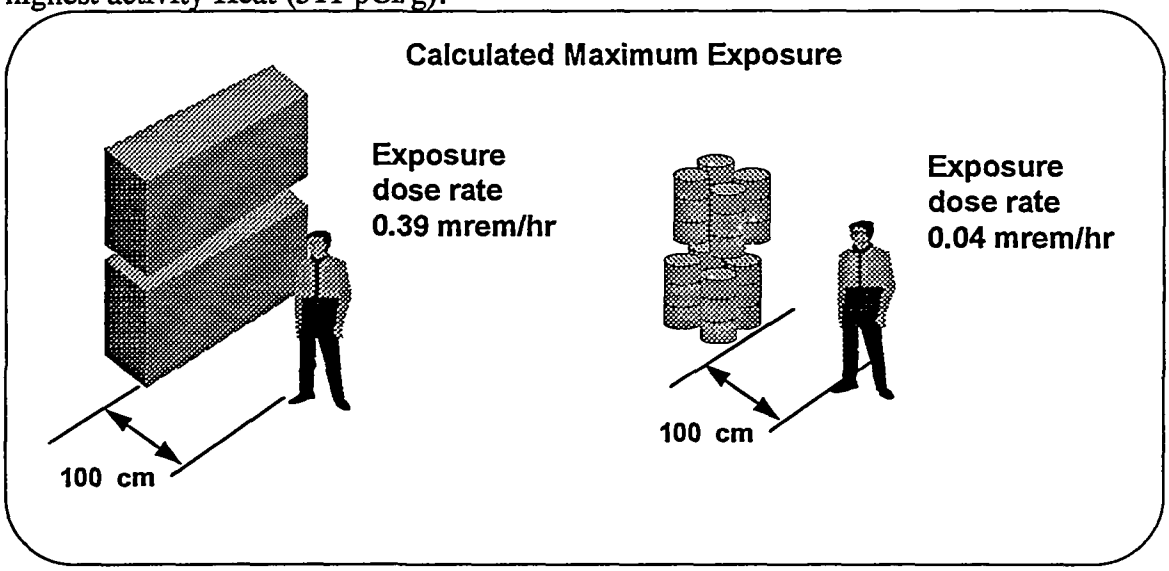

FIGURE 3. Exposure to Worker

Under this calculated maximum exposure a worker continuously standing in the vicinity of the products would receive a maximum of 0.39 mrem per hour (or 3420 mrem per year). A worker spending 40 hours a week for 50 weeks a year at the position depicted would receive a yearly dose of 780 mrem per year (which represents about 15% of the 5000 mrem per year dose set by the Nuclear Regulatory Commission for occupational workers). It is important to realize that these are calculated values which represent a conservative approximation of reality. The melt activity will most likely result in a mix of the various groupings in a manner which best suits the requirement to melt the actual geometry of the RSM at hand. This will cause the maximum exposure to be less than calculated. In reality it should be difficult to detect any radiation beyond background in the vicinity of the products. Table III identifies the calculated exposures at 100 centimeters for the various Heats shown in Figure 2.

TABLE III. Calculated Worker Exposure

Heat	Boxes (mrem/hr)	Drums (mrem/hr)
#1	0.39	0.04
#2	0.22	0.02
#3	0.16	0.02
#4	0.08	<0.01
#5 through #17	0.07	<0.01
#18	0.04	<0.01
#19 through #27	0.04	<0.01
#28	0.01	<0.01
#29 & #30	0.01	<0.01

ESTABLISHMENT OF A VIABLE STAINLESS STEEL RSM INDUSTRY

To assure the commercialization of this Beneficial Reuse Industry will require a commitment to procure sufficient quantities of product over a multi-year period. The DOE has a need for large numbers of waste containers. A commitment by the DOE to buy product would allow industry to obtain financing for production equipment. Because it will also benefit the commercial nuclear industry, this activity is expected to survive on its own once it is up and running. Figure 4 depicts the steps required to establish a viable industry.

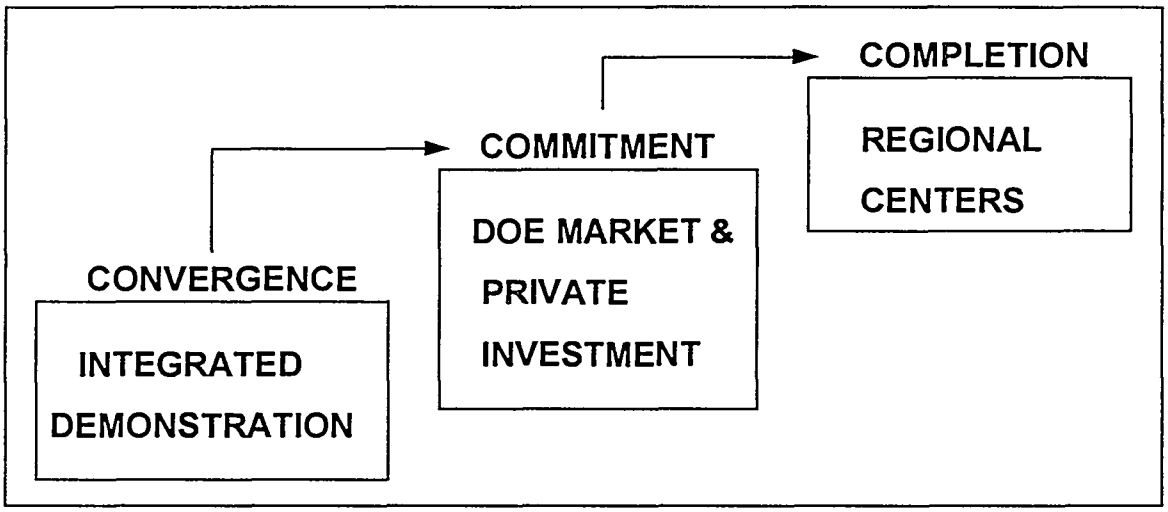

FIGURE 4. Steps to a viable RSM Recycle Industry

The stainless steel RSM recycle industrialization program (see Figure 4) has essentially three phases. (1) The first phase is this Integrated Demonstration or Convergence Phase in which Government, industry, and other stakeholders converge on the best relationship for manufacturing products. (2) The second or Commitment Phase will require private industry to invest to produce products, most economically, for a government supported market. A partnership of government and industry during this Phase may be necessary. (3) The third or Completion Phase will be a self sustaining RSM recycle industry operating without the need for explicit government support. Regional RSM recycle centers on or close to a number of the DOE Sites may eventually exist.

PROGRAM BENEFITS

The recycle of any quantity of RSM eliminates the need to obtain an equivalent amount of new metal which would itself become contaminated. Also the cost of and need for burial space for the recycled RSM is avoided. If the program is successful, potential environmental liabilities can be turned into assets. Resources will be conserved and waste minimized.