Transportation of Waste Containers Made From Radioactively Contaminated Scrap Metal

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Background

Millions of tons of potentially recoverable materials have accumulated over the years at U.S. Department of Energy (DOE) sites and facilities now undergoing environmental restoration. These materials include thousands of tons of scrap metals that can be recycled into new products, to conserve natural resources and avoid costly disposal. While some recoverable materials can be free-released and possess a significant market value, other materials are contaminated either on the surface or in mass, which limits their reuse or recycle in the open market.

The DOE environmental restoration program is considering a national policy for recycling radioactively contaminated scrap metals (RSM) within the DOE complex. The existing inventory of metals in scrap piles has been variously estimated to include from 150,000 to 400,000 tons of RSM. A large percentage of this is radioactively contaminated carbon steel (RCCS), the focus of the policy analysis. The "Recycle 2000" policy under consideration is investigating the fabrication of RCCS into ingots or waste containers to provide for better management of DOE wastes. Risks and costs of transportation would be associated with shipping the RCCS from the DOE metal-generating sites to the processing (including fabrication) or disposal sites and shipping the products (i.e., ingots or waste containers) from the processing site(s) to disposal or use sites. The DOE environmental restoration program has initiated an assessment of the risks and costs associated with transporting RCCS and its potential products throughout the DOE complex.

The Recycle 2000 Policy Proposal

To provide for responsible management of RCCS, the Department proposed the following policy: *By the year 2000, 50% of low-level waste disposal containers will be fabricated from DOE-generated RCCS.* These disposal containers, to be used one time only, will be used exclusively for disposal of low-level waste (LLW) generated

by the Environmental Management (EM) program. If insufficient newly generated RCCS is available to meet the 50% goal, the proposed policy would be to refrain from burying potentially recyclable RCCS (i.e., that material already stored in scrap piles at various sites) and to use all available containers made from RCCS.

An Innovative Policy Development Approach

Historically, DOE developed policies, then talked to stakeholders to explore how to implement the already-selected policy. As DOE's culture has changed, stakeholder involvement in decision making has increased dramatically. For the Recycle 2000 Policy concept, DOE invited stakeholders to identify their concerns prior to DOE's decision to pursue developing this policy. If the Recycle 2000 concept is pursued, it will be the first DOE policy decision incorporating stakeholder values and input prior to establishing the policy.

The Process

DOE identified a broad range of stakeholders to be involved in evaluating the proposed policy. These included DOE sites, regulators, industry, Public Interest Groups, local and State government (elected officials and business development representatives), and labor representatives.

A small group of these stakeholders reviewed the Recycle 2000 concept in July 1994. They were generally supportive of concept but wanted broader review. In response to this input, DOE invited a larger group of stakeholders to a December 1994 workshop to discuss the proposed policy. The workshop consisted of 42 participants from 26 organizations.

The result of this workshop was that stakeholders were supportive of the recycling concept subject to certain conditions, which included:

- protective of public and worker health and safety;
- developed through an open, credible process;
- economic compared to other viable waste disposal options;
- equitable (takes into account equity among sites and States);
- environmentally responsible, neither compromising cleanup nor adding to existing problems; and
- designed not to preclude further recycle initiatives.

Based on the above workshop conclusions, and a request from workshop participants for more and better information upon which to base policy development, DOE committed to conducting analyses of potential health and safety impacts associated with recycling radioactively contaminated scrap metal, the transportation of this material for purposes of recycling, and the cost of recycling. In addition, in response to a workshop recommendation, DOE also committed to developing a standardized

low-level waste disposal container suitable of being fabricated out of radioactively contaminated scrap metal.

The Recycle 2000 policy options considered in the various analyses mentioned above are as follows:

Option 1: Continuing RCCS disposal operations as currently practiced;
Option 2: Processing RCCS into ingots (volume reduced form) for disposal; and
Option 3: Processing RCCS into disposal containers for one-time use within the EM program.

Although initial discussions did not focus on a particular type of RSM, DOE narrowed the scope to focus exclusively on RCCS because it is abundant across the complex, its low market value limits incentive for decontamination and release, and it is suitable for waste management containers in demand with the EM program.

Standard Container Development

As stated above, DOE had committed to developing a standardized low-level waste container suitable of being fabricated out of RCCS. Yet DOE had additional incentives for developing a standard container. DOE is the largest generator of low-level radioactive waste (LLW) in the United States (generating nearly 70% of the total national volume). In 1993, DOE disposed of more than 50,000 cubic meters of LLW via shallow land burial at the Hanford Reservation in Washington State, the Idaho National Engineering Laboratory in Idaho, the Los Alamos National Laboratory in New Mexico, the Nevada Test Site in Nevada, the Oak Ridge Reservation in Tennessee, and the Savannah River Site in South Carolina. The DOE LLW generating sites package this waste using various sizes of containers. This results in transportation-related inefficiencies, the need for differing disposal site equipment, and potential for disposal site void space. Even the DOE "B-25-type" container is not standard, as it is modified at most sites in both external dimensions and engineered capacity.

In 1995, the Department initiated the effort to develop a standard container for disposal of DOE's LLW. The objectives for the initiative were:

- Design a family of standardized low level waste disposal boxes (M-100 series)
- Enhance economies of scale through larger DOE orders of uniformly designed containers
- Improve transportation efficiencies by minimizing variety of disposal containers used by DOE waste generators
- Minimize void space at disposal sites through use of standard size containers
- Reduce uncertainty for vendors of what is a "B-25-type" container

Among the various M-100 container requirements are the following:

- The M -100 series containers must be easily fabricated, using standard tooling and nonproprietary parts;
- The M -100 series container design must accommodate both RCCS and commercial fabrication paths;
- Each M-100 design must use a single gauge or metal thickness for all components (i.e., all 8-gauge or all 12-gauge components); and
- The M -100 series containers must meet Waste Acceptance Criteria for all DOE low-level waste disposal sites.

The M-100 series of containers are designed so a fully loaded container can be lifted by forklift or overhead hoist and the container is suitable as a six, 55-gallon drum overpack.

To ensure that a new container would be used by the different DOE sites, a consensus approach to container development was used. A container development task force was established that included representatives from the major generating sites and disposal site operators. This included representatives from Oak Ridge, Savannah River, Idaho, Hanford, and Nevada. Representatives of DOE's Transportation Management Program were also included, since another objective was that the container be a DOT-certified 7A Type A transportation package

The prototype 12-gauge, 7A-type (M-103/7A/12/90) container has been fabricated, and testing was completed in September 1995. M-100 information is being shared with commercial low-level waste generators and disposal site operators. Follow-on activities include:

- Integrating M-100 containers into DOE procurement
- Establishing DOE-wide commitment to use M-100 container designs for low level waste disposal
- Value-analyzing M-100 designs to minimize cost of manufacture (while retaining performance requirements)
- If "Recycle 2000" concept pursued, promote manufacture of M-100 containers from RCCS.

Due to the preliminary success of the standard container initiative, DOE expects to implement the fabrication and use of the standard container regardless of the outcome of the recycle policy decision.

Transportation Risk Analysis

A transportation risk analysis was conducted to provide an assessment of potential human health risks and developed unit risks and costs for transporting RCCS scrap between DOE sites. A summary of the report of the risk analysis (Chen et al., 1995) was presented at the September 1995 Recycle workshop. The report notes that the

RCCS may be generated from DOE activities (current or future) or from decommissioning of DOE facilities. The transportation system risk estimates reflect preliminary information regarding the quantities of RCCS at some sites and the spectrum of radioactive contamination in RCCS at various types of DOE facilities.

Transportation risks for the three options (shown above) were analyzed. For Options 2 and 3, conceptual system configuration alternatives for processing RCCS at two regional sites or one national site are also evaluated. Risks and costs of transportation would be associated with shipping the RCCS, its products (i.e., ingots or waste containers), and secondary wastes. Specifically, this assessment considers truck or rail transportation of (1) purchased containers to DOE RCCS-generating sites, (2) RCCS in boxes to disposal sites, (3) RCCS for processing into ingots or fabrication into containers, (4) ingots to disposal sites, (5) containers fabricated from RCCS to user sites, and (6) secondary waste to disposal sites. All transportation is assumed to occur by truck and rail services that are available commercially.

Given the current stage of DOE decommissioning operations, the information currently available did not permit a full-scale analysis of transportation risks. Complete RCCS inventory (physical quantity and activity) information for each major DOE site is not available; data on scrap inventories have only been compiled for a limited number of sites and there are no estimates for future scrap generation. Without extensive inventory estimates, it is not possible to determine the number of shipments required and the associated risk totals for DOE's alternatives. Therefore, the analysis was limited to providing unit risk and cost data elements.

The risk assessment methodology used was consistent with the DOE Environmental Management Programmatic Environmental Impact Statement (EM PEIS). The endpoints analyzed were:

- Cancer incidents and fatalities due to external radiological exposure from routine operations;
- Cancer incidents and fatalities due to external radiological exposure from accidental release;
- Cancer incidents and fatalities due to exposure to vehicle exhaust emissions from routine operations; and
- Injuries and fatalities from vehicle accident trauma.

The analysis indicated that total risk is dominated by traffic accident risks. Specifically, radiological transportation risks are a small part (10% or less) of total risk for transportation of RCCS and RCCS-fabricated boxes. Additionally, due to more people being in close proximity to roads than rails, truck transportation resulted in a higher external dose than rail transportation of RCCS and RCCS-fabricated boxes. Risks from shipping the empty fabricated containers are generally lower than for unprocessed RCCS because of the potential removal or immobilization of radioactivity by the metal melting process. Risk factors that include injuries are about a factor of 10 higher than those for fatalities alone. Risk factors including total cancer incidence

are about 50% higher than those for latent fatalities. Because trucks travel in close proximity to exposed populations, truck transportation results in slightly higher risks than rail transport.

Unit transportation risk factors for all options (estimated health effects/shipment mile) are on the order of 10^{-7} - 10^{-8}. These include fatalities, fatal and non fatal cancers, injuries, and severe genetic effects. For both truck and rail transportation, risks varied between the three options by less than a factor of 2, indicating that all three options were roughly equal in terms of risk.

Transportation Costs

The assessment provides fixed and variable unit costs (dollar/shipment-mile). Fixed and variable costs vary by transport mode (truck or rail), by distance traveled, and by the form of RCCS (scrap, ingots, fabricated containers, or secondary wastes). In practice, the costs may be affected by the number of shipments and the time period covered by the contract. Either truck or rail may have lower variable costs, depending on the dimensions and weight of the material being hauled and the shipping distance. Higher costs are assumed for secondary waste transportation because of greater handling and certification costs for this material. In general, variable costs decline as shipping distance increases, and variable costs are higher per ton for fabricated containers (empty) than for scrap haulage.

Transportation costs associated with implementing any of the three options ended up contributing between 2 and 12% of the total option cost. A centralized processing site yielded the highest transportation costs, contributing 10-12% of the total option cost, while a regionalized processing site yielded transportation cost contributions of 7-9%. Continuing present operations yielded the least transportation cost contribution of 2%. Transportation costs associated with processing to ingots for volume reduction ($\$1.72/ft^3$ for regionalized processing and $\$2.65/ft^3$ for centralized processing) were slightly less than transportation costs associated with fabricating disposal containers from RCCS ($\$2.12/ft^3$ for regionalized processing and $\$3.26/ft^3$ for centralized processing).

(For the centralized processing scenario, all RCCS origin sites shipping to a single processing site. A U.S. geographic centroid represents the fictitious centralized destination site. For the regionalized processing site, waste generating sites ship to either of two regional processing centers. The analysis showed that total risk is proportional to mileage, and Option 1 has the lowest estimated risk due to this option resulting in the lowest mileage. The analysis also showed that lower risk results from two regional processing facilities rather than a single, centralized processing facility, due to the RCCS and RCCS-fabricated boxes being transported over fewer miles. Additional processing sites did not provide substantial reductions as compared to two sites.)

Conclusion

Based on the transportation risks and costs, as well as other data presented at the workshop, participants encouraged DOE to establish a recycling policy with a 2-3 year demonstration, then reevaluate the success and cost of the policy. The participants felt that a decision based on the limited cost data available so far would result in the selection of either Option 2 or Option 1, and workshop participants clearly believe the "right thing for the environment" is to make disposal containers from RCCS. Participants also encouraged DOE to clearly state in the policy that a box made from RCCS is not waste, but is a product. This distinction will enable any site to use a box made from RCCS from either its own site or any other site without causing disposal site concerns. Participants also encouraged DOE to explore conducting a demonstration of RCCS recycling if it appeared too difficult to establish an EM-wide policy. Based on the strong support for recycling indicated by workshop participants, DOE staff will develop a policy package to be submitted for management approval. This package will recommend that the Office of Environmental Management establish a policy that recycling of contaminated metals should be pursued.

References

Chen, S.Y., et al., 1995, "Assessment of Risks and Costs Associated with Transportation of DOE Radioactively Contaminated Scrap Steel (Draft)," for the U.S. Department of Energy, Office of Environmental Management.