ANL/EA/CP-97278

Development of DOE Complexwide Authorized Release Protocols for Radioactive Scrap Metals*

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Abstract

Within the next few decades, several hundred thousand tons of metal are expected to be removed from nuclear facilities across the U.S. Department of Energy (DOE) complex as a result of decontamination and decommissioning (D&D) activities. These materials, together with large quantities of tools, equipment, and other items that are commonly recovered from site cleanup or D&D activities, constitute non-real properties that warrant consideration for reuse or recycle, as permitted and practiced under the current DOE policy. The provisions for supporting this policy are contained in the *Draft Handbook for Controlling Release for Reuse or Recycle of Property Containing Residual Radioactive Material*[1] published by DOE in 1997 and distributed to DOE field offices for interim use and implementation. The authorized release of such property is intended to permit its beneficial use across the entire DOE complex. The objective of this study is to develop readily usable computer-based release protocols to facilitate implementation of the Handbook in evaluating the scrap metals for reuse and recycle. The protocols provide DOE with an effective oversight tool for managing release activities.

I. Introduction

Provisions for release of DOE property containing residual radioactivity have been specified in DOE Order 5400.5, "Radiation Protection of the Public and Environment" as amended, which was first issued on February 8, 1990. On March 25, 1993, DOE proposed to codify (proposed rule 10 CFR 834) standards and requirements that have been further interpreted in DOE guidance. Releases have generally been limited to materials with surface contamination, for which explicit release levels have been prescribed in Order 5400.5. Although these release levels were not specifically related to dose or risks, a screening analysis indicated that the implied doses to a hypothetical individual are largely at a level

*Work supported by the U.S. Department of Energy, Assistant Secretary for Environmental Management, under contract W-31-109-Eng-38.

DISCLAIMER

of a few mrem/per year.[2] No equivalent release levels for materials with volumetric contamination are currently sanctioned by DOE or any U.S. regulatory agency.

Because of the lack of explicit release standards, a process of "authorized" release, which is based on a case-by-case (but systematic) approach, is permitted under the existing Order 5400.5 or the proposed rule of 10 CFR 834. This approach provides for the development of authorized release limits through a series of prescribed steps before approval for release is granted. Specific requirements include the following: (1) pertinent radiological characteristics are identified and specified for the materials, (2) release limits are derived to meet the as-low-as-reasonably-achievable (ALARA) objectives, (3) requisite documentation is complete and approved by DOE authorities, and (4) concurrence by appropriate stakeholders is sought and obtained.

Although authorized release has been ongoing within DOE, the applications have primarily been limited to scrap metals with only surface contamination. Furthermore, the practice has lacked systematic and detailed guidance. In support of the authorized release, the DOE has published interim guidance that has been incorporated into the proposed ruling of 10 CFR 834. To further clarify the provisions and to implement the policy, the *Draft Handbook for Controlling Release for Reuse or Recycle of Property Containing Residual Radioactive Material*[1] (herein referred as the Handbook) was published by DOE. The document has been distributed throughout DOE field offices for interim use and implementation.

The release process prescribed by the Handbook applies only to non-real DOE property for which the preferred future use involves reuse or recycle. Release occurs when the property is transferred out of DOE control by sale, lease, gift, or other disposition, provided that the property does not remain under the radiological control of DOE, the U.S. Nuclear Regulatory Commission (NRC), or a responsible Agreement State. The release does not apply to real property, radioactive wastes, soils, liquid discharges, or gaseous or radon emissions. Examples of categories of property that are covered include:

- *Consumable Items* such as wood, containers, labwares, and paper;
- *Personal Items* such as clothing , brief cases, bags, respirators, and gloves;
- *Office Items* such as computers, telecommunication equipment, unused office supplies, and furniture;
- *Tools or Equipment* such as hand tools, construction machinery, vehicles, tool boxes, ladders, and scales; and
- *Scrap materials* such as wood, tanks, scrap metals, concrete, wiring, doors, and windows.

The authorized release approach described in the Handbook consists of 10 steps for non-real property that address the general areas of property characterization, evaluation and development of authorized limits, approval of release, verification and implementation of release. It is important to note that authorized or supplemental limits may be derived for individual releases of non-real property (e.g., one-time sale of reusable copper wire), or for categories of non-real property (e.g., scrap metal or office machines) that are routinely released over time. In the latter case, once authorized limits (or supplemental limits [the secondary limits applied only to special conditions]) have been approved for the category, individual releases of non-real property within the category are assumed to meet ALARA requirements if compliance with the limits has been demonstrated. Therefore, the entire 10-step process is not necessarily required for each proposed release. Determining the possible existence of previously established authorized or supplemental limits applicable to the proposed release is addressed early in the 10-step process. The 10 major steps of the release process for non-real property are as follows:[3]

- Characterize property and prepare a description.
- Determine whether applicable authorized or supplemental limits exist.
- Define authorized or supplemental limits needed.
- Develop authorized or supplemental limits.
- Compile and submit application for DOE Operations Office approval.
- Document approved limits in the public record.
- Implement approved limits.
- Conduct surveys/measurements.
- Verify that applicable authorized or supplemental limits have been met.
- Release property.

The Handbook recommends actions to guide field personnel in implementing each step and provides detailed instructions and examples for some steps. A detailed description of the process is provided in the Handbook.

The computer-based protocols described in this paper are designed to assist DOE field offices in implementing the Handbook. The protocols are developed in computer modules suitable for a personal computer with self-help and other user-friendly features. Modules are developed to guide the user through the 10-step process stipulated by the Handbook, using a default database or user-supplied values to reach a screening decision.

II. Approach

The authorized release protocols were developed in a two-stage fashion. The first incorporates a relational database developed using Microsoft Access. The database contains material descriptions, dose conversion factors, cost and pricing data, and other information required to develop authorized release limits for radioactive scrap metals. The second stage employs a Windows-based

graphical user interface (GUI) using Visual Basic. The GUI allows the user to modify data in the database in a sequential fashion such that authorized release limits for radioactive scrap metal can be derived following the process outlined in the Handbook.

Development of authorized release limits for radioactive scrap metals requires a dose assessment and an ALARA analysis to compare the costs and risks associated with multiple disposition alternatives for the scrap metal. The protocol user must specify the alternatives for consideration. The supporting information for the alternatives is assembled from six distinct modules; Surveying and Sectioning, Decontamination, Recycle, Reuse, Transportation, and Burial. Each alternative may contain one or more of the six modules. As an example, a user could compare the risks and costs of direct disposal with those of decontamination and recycle.

To compare multiple disposition alternatives and perform an ALARA analysis, each module in the database contains cost and radionuclide data when appropriate. Typical cost data include management, regulatory interface, survey, quality assurance, characterization, volume reduction, decontamination, packaging, transportation, burial, waste management components, and, on the income side, proceeds of material sale. The cost data were derived from both published cost-related studies and from contract price lists representing the 1995-97 time period. As a result, they generally represent charges for contract services.

Database Design

The database is designed with three distinct layers: (1) baseline data, (2) user input, and (3) results. The baseline data layer provides baseline cost information, radionuclide dose conversion factors, decontamination factors, secondary waste generation rates, and similar information for radioactive scrap metal and the processing steps associated with it. Default parameter values are stored in the baseline data layer, and the user cannot change or add to this data layer using the GUI. The user-input layer has the same structure as the baseline data layer, but in this layer the user is able to modify, add, and delete data. The information stored in the user-input layer is used to perform the radiological and cost assessments to support the ALARA analysis. The third layer of the database is the results layer, which stores the results from the dose and economic assessments for each alternative. Through the GUI, the user can sort, group, and filter the data and then print the results in a series of output reports for submission as part of the approval process.

The radionuclide data stored in the modules are used to estimate the radiological doses to members of the general public. These data include radionuclide dose conversion factors and radionuclide partitioning factors. Data for other

parameters, which are not linked to particular radionuclides yet are required for the dose assessment, are stored in separate tables and are connected to the specific modules.

The dose conversion factors for both the Recycle and Reuse modules were generated with the RESRAD-RECYCLE computer code.[4] These dose conversion factors were developed by estimating the dose a worker or member of the public would receive after processing 1 ton of scrap metal contaminated with 1 pCi/g of a radionuclide. The population dose is estimated by multiplying the dose conversion factor by the radionuclide concentration and the total amount of radioactive scrap metal selected for release. Other factors, such as the radionuclide partitioning factor and the effective decontamination factor, must be considered when these modules are selected for evaluation. The maximally exposed individual (MEI) dose is estimated in a similar fashion; however, the dose to an MEI reaches a maximum for a given radionuclide concentration when the amount of time required to process the material exceeds 2,000 hours per year.[4]

The dose conversion factors for the Burial module were developed with the RESRAD computer code,[5] which estimates radiological doses to members of the public from soil contaminated with residual radioactive material. The dose conversion factors for burial were based on executing RESRAD for 32,000 tons of material contaminated with 1 pCi/g for a given radionuclide and scaling the results to a per-ton basis.

User Interface Design

The GUI is both an interface to the database and a tool used to guide the user through the authorized release process as formulated in the Handbook. The GUI provides feedback to the user as to the step in the process and the data required to complete that portion of the process. Figure 1 shows an example of the GUI during the first step of the release process.

The first step, which is shown in Figures 1 and 2, involves describing and characterizing the radioactive scrap metal. The GUI allows the user to select the material category and subcategory. Depending on the subcategory, a surface-to-mass ratio is selected from the database and is used to estimate the amount of secondary waste generated from decontamination (in the Decontamination module). It is also used to convert surface activity levels to volume activity levels after melting and recycling the material into end-use products (in the Recycle module). Furthermore, the material subcategory determines which decontamination processes are valid. After selecting the appropriate material subcategory, the user will input the amount of metal being evaluated.

The key component in deriving authorized release limits for non-real property involves investigating the radiological history and estimating the amount of

contamination present. As shown in Figure 2, buttons are used to indicate whether the scrap metal is either volumetrically or surface contaminated. The user can input the contamination levels in either SI units (Bq/g, Bq/cm^2) or traditional units (pCi/g, DPM/100 cm^2). To provide a range of results as well as to compare decontamination methods, the user can input the maximum and average radionuclide concentrations for volumetrically contaminated materials. For surface-contaminated materials, the user can enter maximum, average, and removable concentration levels. After the radiological history is entered, the GUI checks the database to determine if release limits already exist that are applicable for the scrap metal.

If the check for applicable authorized reveals that such limits do not already exist and need to be derived, an ALARA optimization process is performed. This process takes dose, economic, social, environmental, technological, and public policy factors into consideration. The six modules (Survey & Sectioning, Decontamination, Recycle, Transportation, Reuse, and Burial) form the basis for the set of calculations used in the ALARA analysis. Figure 3 shows the module selection window, which determines the selection of the appropriate modules for each alternative. Currently, up to 10 alternatives can be analyzed in the ALARA analysis.

The Survey & Sectioning module estimates the costs associated with surveying and sectioning the scrap metal. Figure 4 shows an example of the Surveying & Sectioning module in which check boxes are used to indicate if the material will be surveyed before release and if management or quality assurance (QA) costs should be calculated. Buttons are used to indicate if the scrap metal is to be sectioned. When the sectioning button is clicked, the user is prompted to accept the default value or to enter a unit cost for sectioning ($ / ton) and a sectioning waste generation rate. The packing density and sectioning waste generation rate (lb/ton) will be used in the transportation module to determine the number of shipments of metal and secondary wastes. Radiation doses associated with surveying and segmenting the scrap metal are not calculated because the workers are assumed to be radiation workers and are part of a program to limit individual exposure.

The Decontamination module is used when the scrap metal is decontaminated prior to release. Figure 5 shows an example of the Decontamination module screen. Decontamination categories include abrasive blasting, water washing, and melt refining. Additional decontamination subcategories are available for many of the main decontamination categories. For example, a user may select abrasive blasting as the main decontamination category and plastic pellets as the subcategory. This feature enables the user to compare costs and performance of different decontamination subcategories. When a decontamination subcategory is selected, the GUI displays a series of parameters that describe that particular decontamination method. The parameters that describe the decontamination subcategory include the decontamination factor, secondary

waste generation rate, material input rate, unit cost for decontamination, and unit cost for disposal of the secondary waste. After the decontamination subcategory is selected for use, the user may edit the parameters to incorporate case- or site-specific data. It should be noted that multiple decontamination methods may be selected for use in a single alternative (e.g., water washing followed by abrasive blasting). Again, radiation doses associated with the decontamination process are not calculated because the workers are assumed to be radiation workers.

The Recycle module is used when the metal is recycled for use in products for public use. Figure 6 shows an example of the Recycle module screen. Radiological doses are estimated for each subprocess step and were incorporated from RESRAD-RECYCLE. The user may select which subprocesses are included in the dose assessment by checking the appropriate boxes. In a similar fashion, the user may select which end-use products are analyzed by either checking whether the products are distributed for unrestricted or restricted release and checking which products to include. Parameters such as radionuclide partitioning factors can be modified by the user when site-specific data are available.

The Reuse Module (Figure 7) currently has building reuse as the only reuse option. This alternative assumes that the building containing the contaminated reinforcing bars (rebars) or other metal products is reused. Special care should be taken in selecting decontamination methods in the Decontamination Module when using the Reuse module in its current form.

The Transportation module estimates the costs associated with packaging and transporting the radioactive scrap metal and secondary wastes from decontamination and packaging, and segmenting the wastes. The costs are estimated with the methodology from *Assessment of Risks and Cost Associated with Transportation of U.S. Department of Energy Radioactively Contaminated Carbon Steel.*[6] The number of shipments for each material type can be estimated on the basis of the total amount of material, packing density (set in the Surveying and Sectioning Module), and transportation mode. The user may opt to enter the number of shipments manually. Figure 8 shows an example of the Transportation module screen.

The Burial module is used to estimate the costs and risks associated with disposal of the radioactive scrap metal (Figure 9). The cost for disposal is estimated by multiplying the total amount of scrap metal by the unit burial cost. The user may edit the unit cost for burial ($ / ft^3) to incorporate site-specific cost data. The total volume is estimated on the basis of the package density and the total amount of radioactive scrap metal involved. Radiation doses associated with placement of the radioactive scrap in the landfill are not calculated because the workers are assumed to be radiation workers.

The results window provides a summary of the dose and cost assessments (Figures 10 and 11 show examples). The results may either be sorted by alternative, cost, or dose to allow for quick comparisons. A "view details" window allows the user to view the results of the dose assessment by subprocess or radionuclide. Similarly the "view details" button on the economic analysis window provides access to detailed results of the cost analysis.

III. Conclusions

The computer-based protocols described were developed to easily implement the 10-step process, as outlined in the Handbook, to establish authorized release limits for non-real property from DOE facilities. These protocols incorporate a relational database coupled with a GUI to guide the user through the appropriate steps so authorized release limits can be developed. With the information provided in the database, an ALARA optimization process can be easily setup and run for up to 10 distinct alternatives. The results of the ALARA optimization process can be printed in a series of reports and submitted as part of the application for the release of the non-real property.

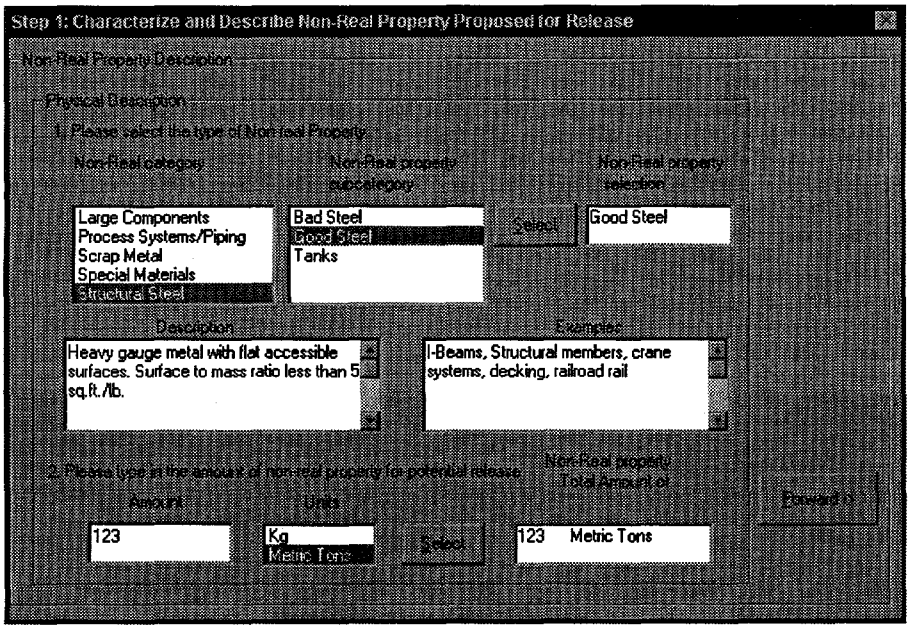

Figure 1. Step 1- Characterize Non-Real Property and Prepare a Description

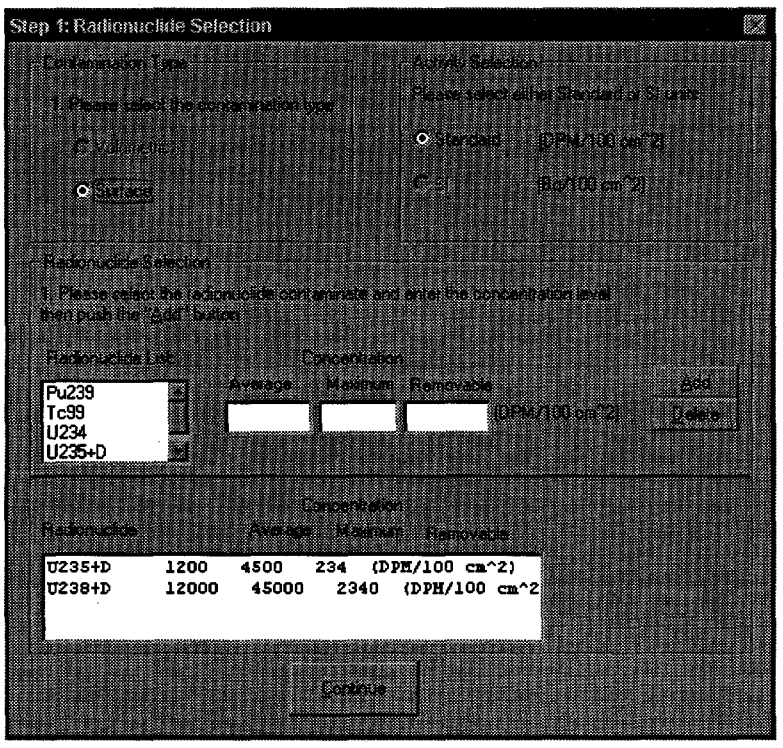

Figure 2. Step 1- Radiological History

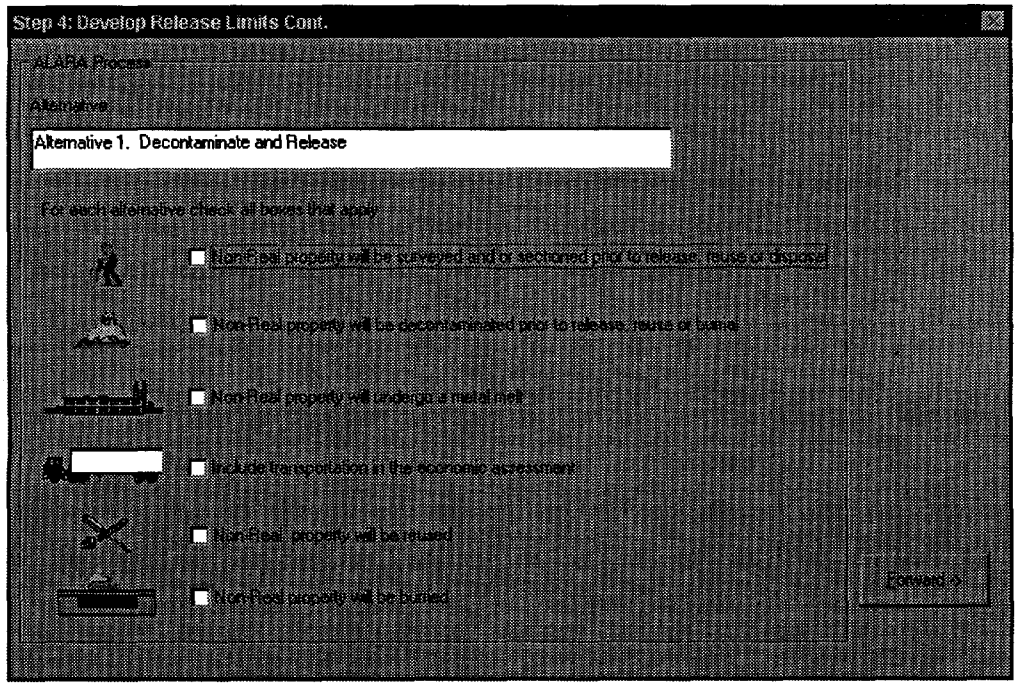

Figure 3. Module Selection Window

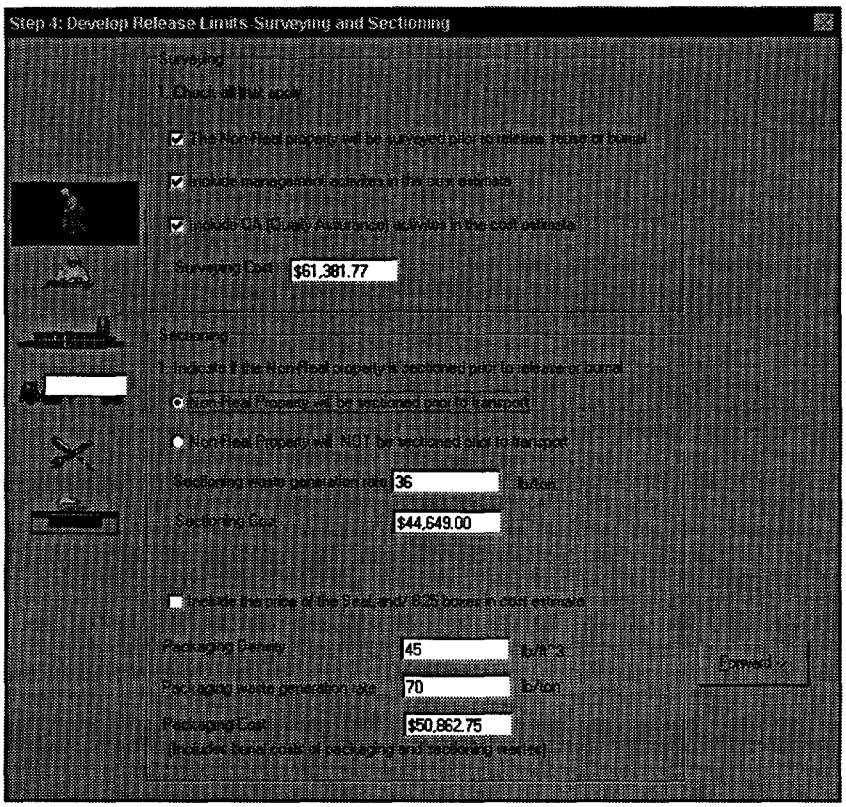

Figure 4. Survey & Sectioning Module

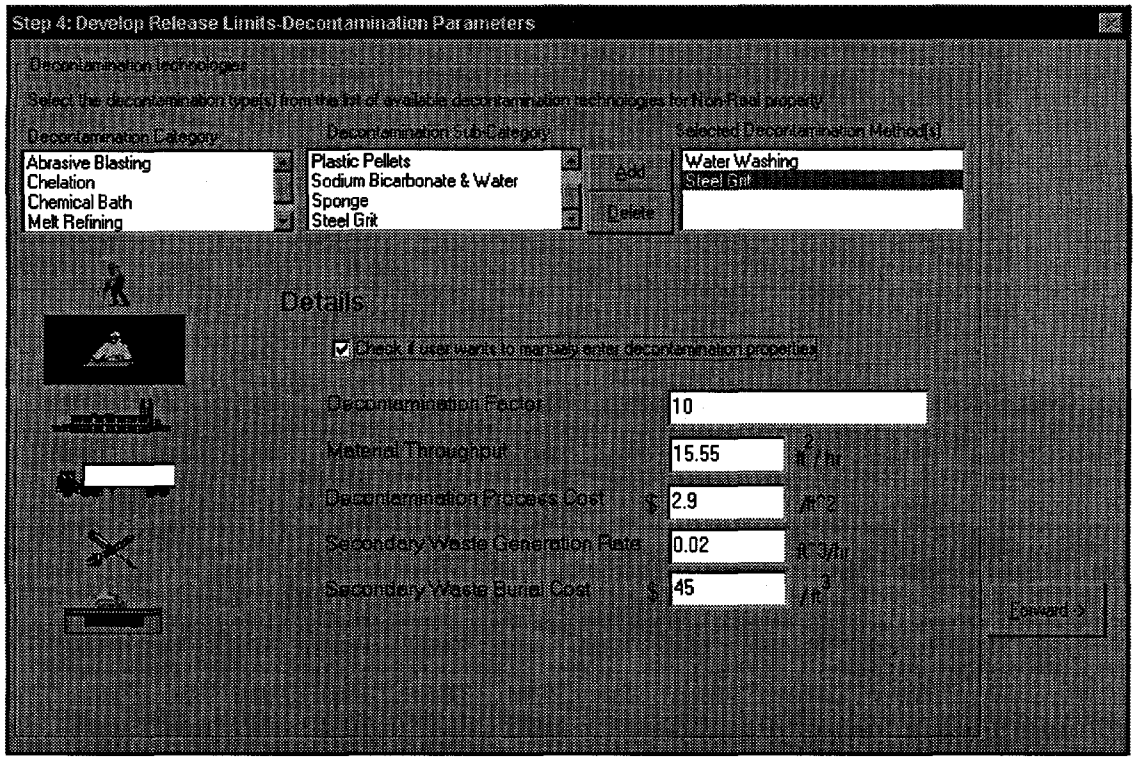

Figure 5 Decontamination Module

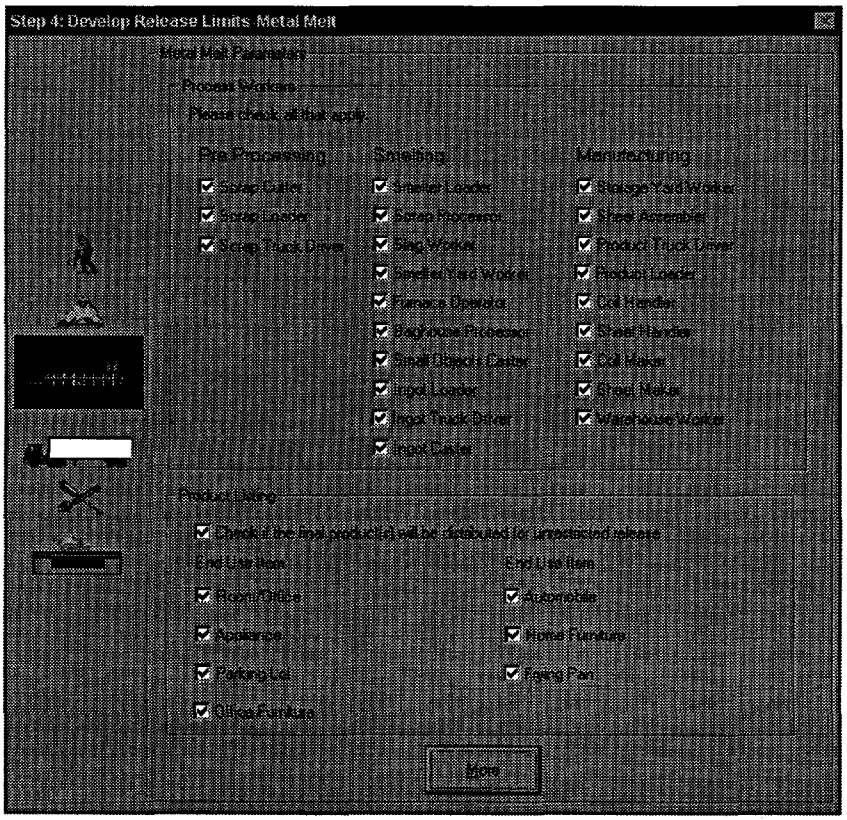

Figure 6 Recycle Module

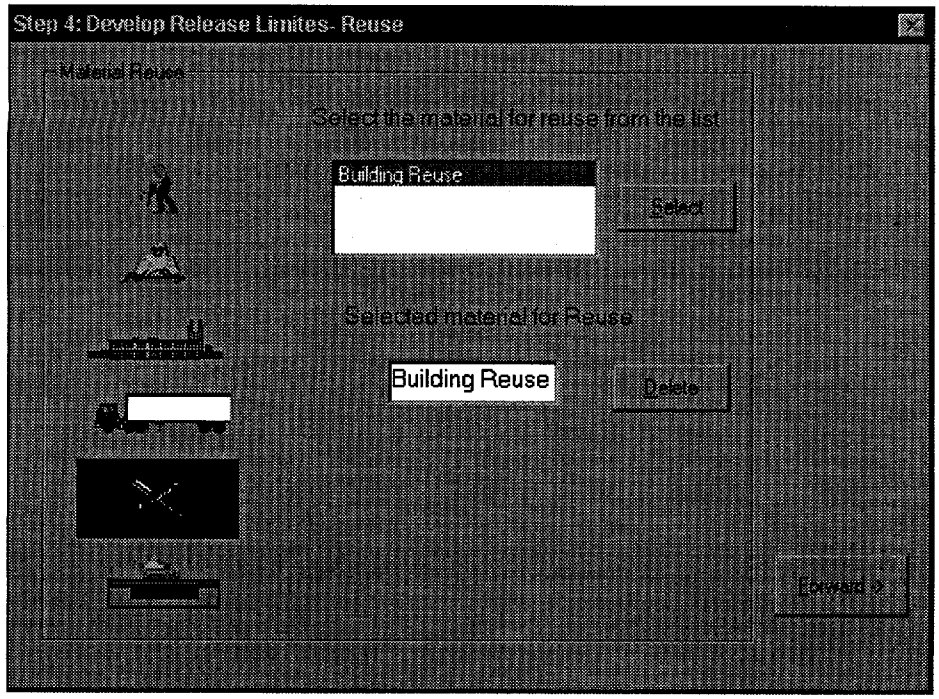

Figure 7 Reuse Module

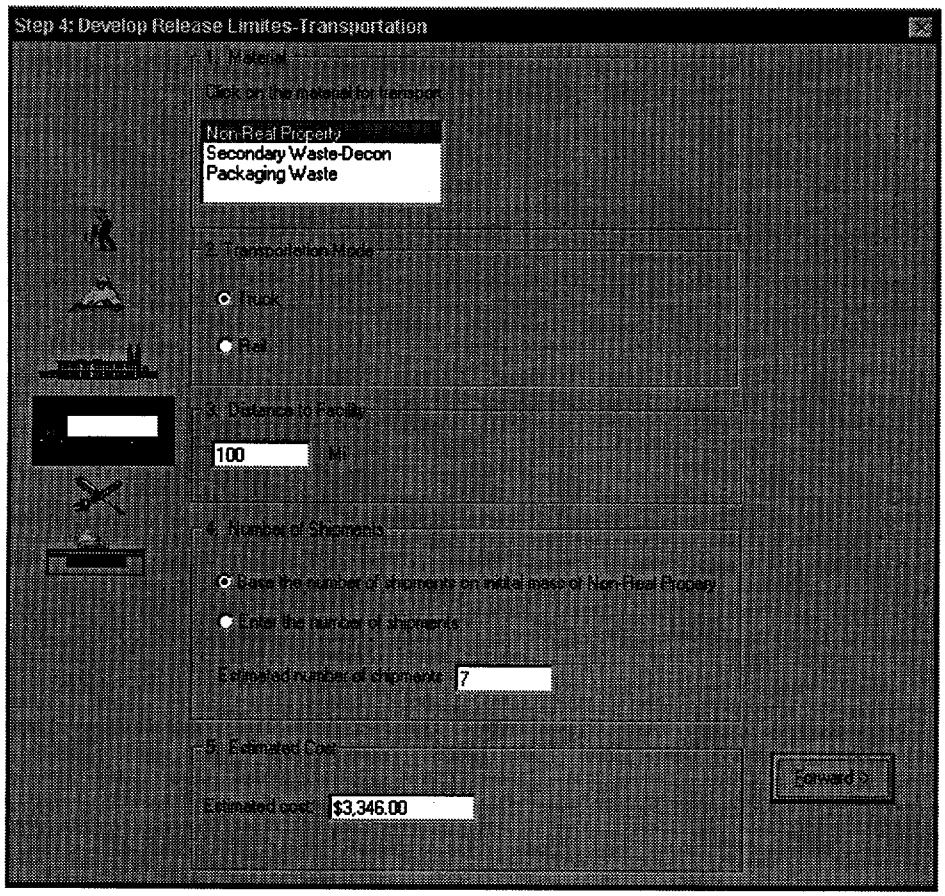

Figure 8 Transportation Module

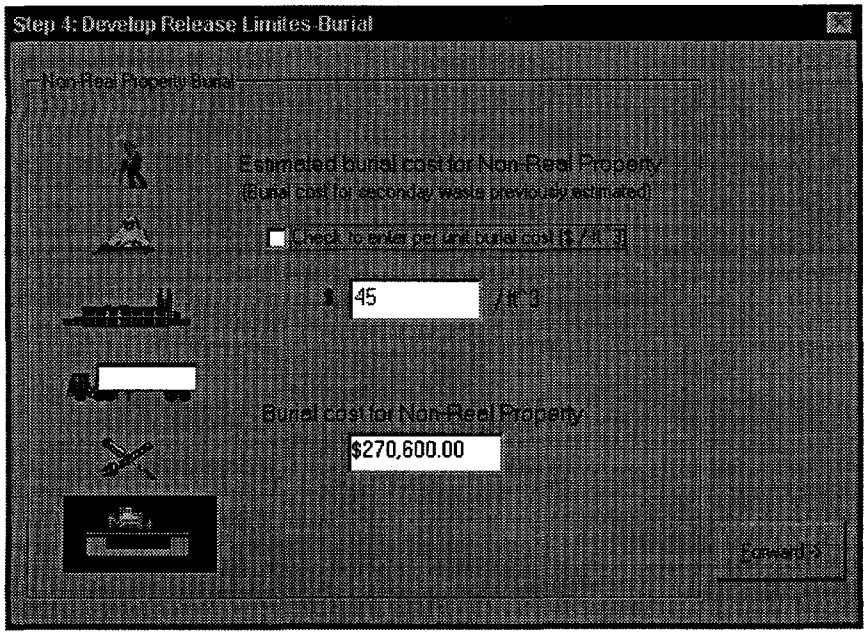

Figure 9 Burial Module

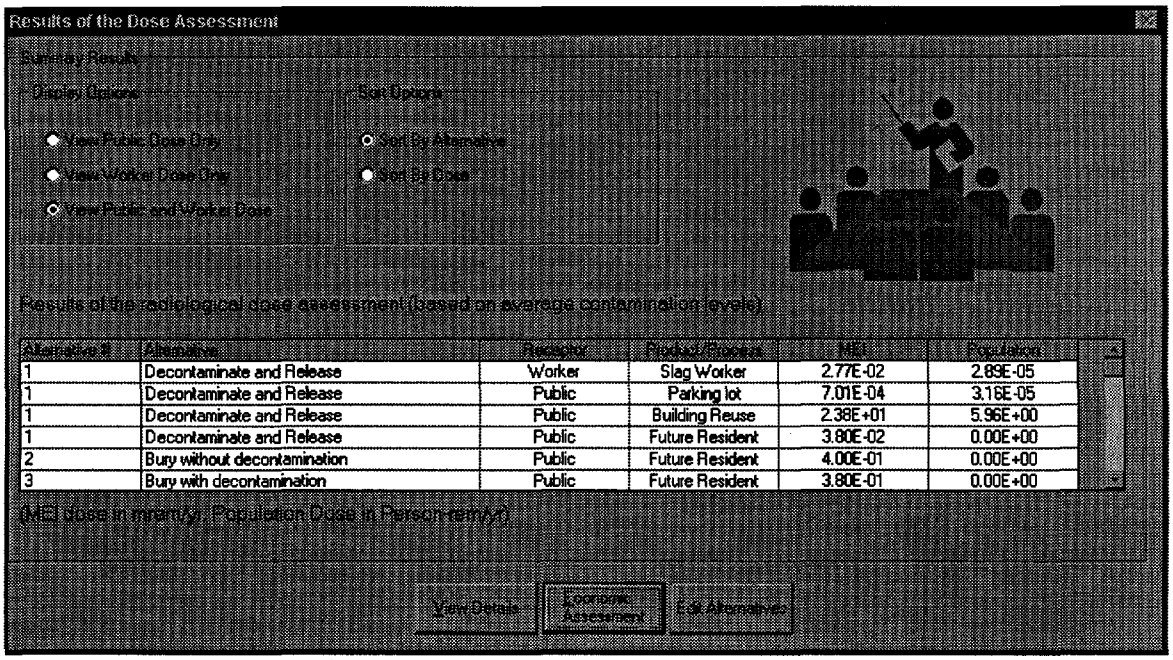

Figure 10 Dose Assessment Summary Window

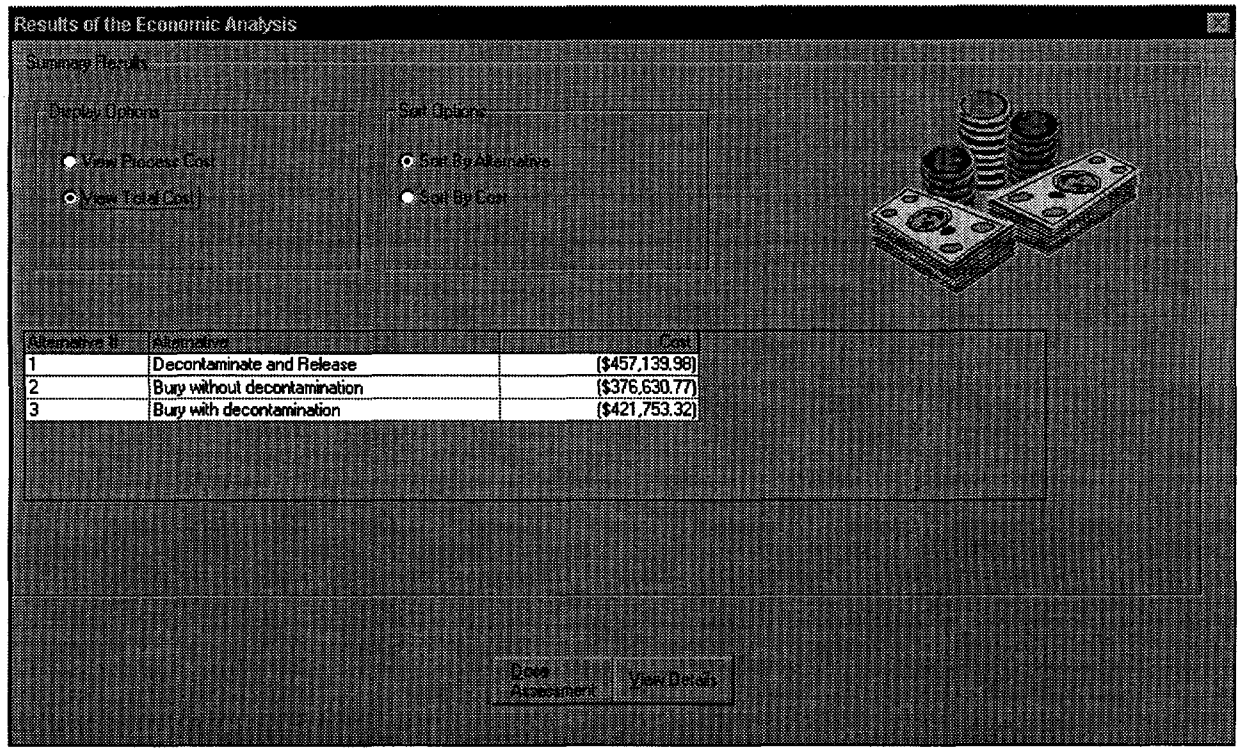

Figure 11 Cost Assessment Summary Window

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