Hazardous and Mixed Waste Transportation Program*

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INTRODUCTION

Sandia National Laboratories (SNL) has developed a program to address the packaging needs associated with the transport of hazardous and mixed waste during the United States' Department of Energy (DOE) remediation efforts. The program addresses the technology needs associated with the transport of materials which have components that are radioactive and chemically hazardous.

The mixed waste transportation activities focus on on-site specific applications of technology to the transport of hazardous and mixed wastes. These activities were identified at a series of DOE-sponsored workshops. These activities will be composed of the following: (1) packaging concepts, (2) chemical compatibility studies, and (3) systems studies. This paper will address activities in each of these areas.

BACKGROUND

The basic motivation for hazardous and mixed waste transportation derives from the DOE-sponsored Transportation Assessment and Integration (TRAIN) final report. This document outlines the approach to the DOE transportation needs for the 1990s. In this document, it is clear that transportation will play an integrating role in the environmental restoration activities being undertaken by the DOE. Further, as is shown in Figure 1, the research and development activities for transportation play an integrating role for transportation. This figure shows the interface between the research and development function and seven major elements of transportation. These elements are: (1) institutional and outreach programs, (2) regulatory development and impacts, (3) emergency preparedness, (4) training, (5) operations, (6) the definition of transportation and packaging needs, and (7) the role of the DOE's Transportation Management Program.

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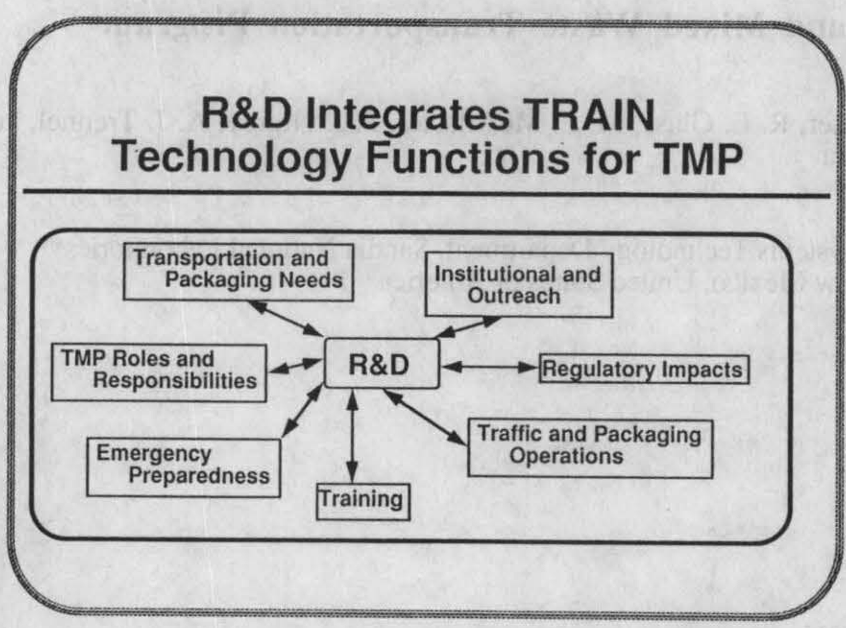

Figure 1. The Integrating Role of Research and Development in Transportation Functions

The research and development activities are divided into the seven tasks shown in Figure 2. These include: (1) packaging development, (2) engineering analysis, (3) testing, (4) advanced technology development, (5) certification support, (6) regulatory development support, and (7) systems and safety assessments. The focus of the hazardous and mixed waste transportation program is the development of packagings for sample transport. The success of the hazardous and mixed waste activity requires each of the seven elements of research and development to be applied. For example, the development of a packaging is undertaken due to a need identified during a systems analysis. The development of that packaging requires engineering analysis of preliminary designs, testing development models and prototypes to demonstrate compliance with the regulatory requirements in the development of the Safety Analysis Report for Packagings.

PACKAGING CONCEPTS

The purpose of this activity is to provide conceptual designs that meet the needs of the DOE and its contractors for packagings to transport hazardous and radioactive materials. This activity is done in parallel with the chemical compatibility activities and systems studies to ensure that (1) the conceptual designs meet a projected need and (2) the systems engineering studies are based on manufacturable packaging designs.

The short term goal of this project is to produce a family of conceptual designs that meets the requirements of the Westinghouse Hanford Company Sample Packaging criteria. A conceptual design will be completed in 1993 for a chilled sample packaging. The preliminary design for the chilled sample container is shown in Figure 3. The intent of this package is to transport chemically hazardous, radioactive, or mixed waste samples. This goal is achieved with a modular package. The interior of the package contains a teflon insert that can be machined to hold sample sizes of up to 1 liter. It is anticipated that the samples will be transported in glass vials. Hence the teflon insert will be lined with a low durometer elastomeric material to provide shock attenuation. Containing the samples and the insert is the internal containment vessel which is being designed to meet the requirements of the United States Department of

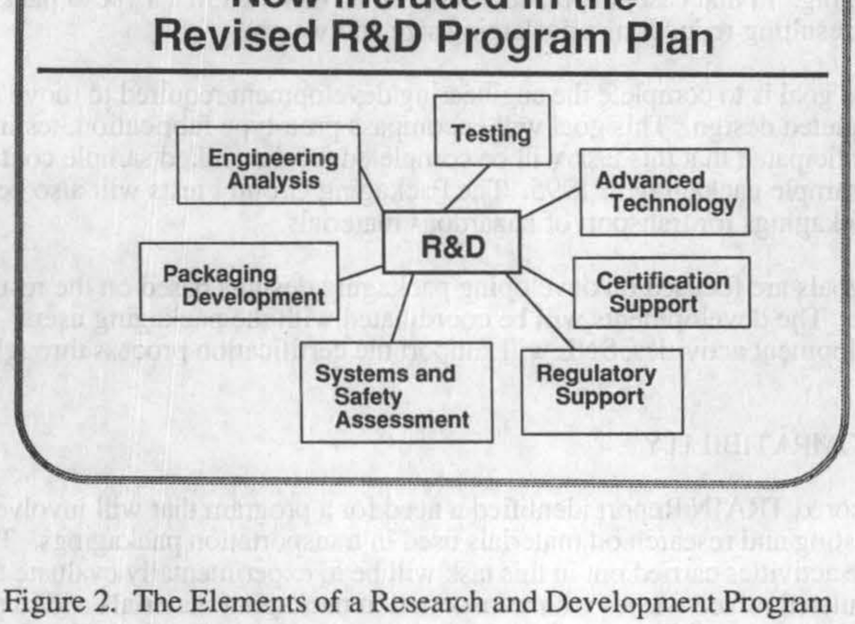

Figure 2. The Elements of a Research and Development Program

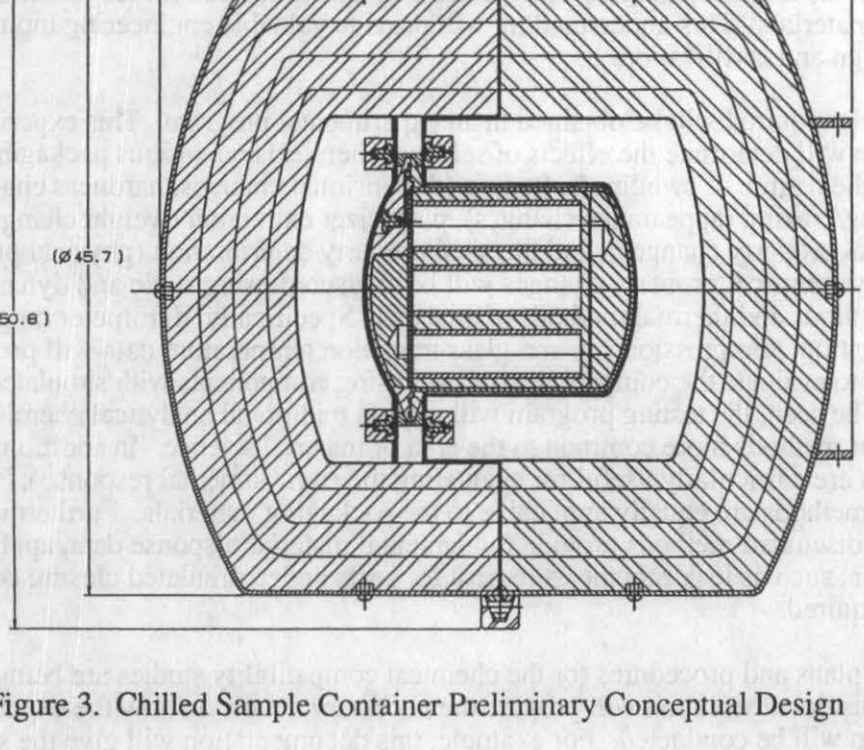

Figure 3. Chilled Sample Container Preliminary Conceptual Design

Transportation Packaging Group I criteria. This internal package is then surrounded with a bladder which contains a high heat of fusion material with the requisite melting point (usually ice). This module is the basic chilled sample container. For the package to also be capable of transporting type B quantities of radioactive materials, a sacrificial outer shell is included that provides the impact, puncture, and thermal protection required of a Type B packaging. It is anticipated that the requirement for chilling will not occur concurrently with the requirement for a Type B packaging. In that case, the bladder will not be included in a Type B packaging design with the resulting reduction in packaging size and weight.

The intermediate goal is to complete the engineering development required to move from concept to completed design. This goal will encompass prototype fabrication, testing, and analysis. It is anticipated that this task will be completed for the chilled sample container and for the Type B sample packaging in 1995. The Packaging Group I tests will also be completed to certify the packagings for transport of hazardous materials.

The long-term goals are focused on developing packaging designs based on the results of the systems studies. The developments will be coordinated with the packaging users. In all packaging development activities, SNL will support the certification process through completion.

CHEMICAL COMPATIBILITY

The DOE-sponsored TRAIN Report identified a need for a program that will involve chemical compatibility testing and research on materials used in transportation packagings. The short-term goal for the activities carried out in this task will be to experimentally evaluate the behavior of simulated mixed wastes with transportation packaging materials and to provide significant chemical compatibility data for package design and certification. The chemical compatibility testing will initially focus on seals, liners, and sample ports. The preliminary testing will be done with simulated mixed waste chemicals. The long-term goals are to select specific mixed wastes and perform similar compatibility testing. Both of these goals are intended to provide an understanding of the effects of hazardous and mixed-waste substances on packaging materials. This understanding will provide valuable engineering input to packaging design and certification.

The specific data required will be obtained in an experimental program. This experimental testing program will determine the effects of selected chemicals on various packaging materials by measuring the degree of swelling/softening (dimensional changes, hardness changes), surface cracking/crazing (appearance changes), plasticizer extraction (weight changes), effects (physical property changes), and physical property deterioration (physical property changes). These physical property changes will be measured using static and dynamic mechanical methods and thermal methods of analysis. Specifically, durometer range, tensile strength, elongation, compression set, and glass transition temperature data will provide additional data to evaluate the compatibility of packaging components with simulated mixed waste. As can be seen, the testing program will rely on traditional analytical chemistry methods and on methods more common to the area of material science. In addition, while the above methods are particularly useful for evaluating the environmental response of plastics, some of these methods are equally applicable to the packaging materials. Furthermore, while the previously discussed methods provide fundamental material response data, applied component data, such as leak rate measurement for seals under simulated closure conditions, will also be acquired.

Currently, test plans and procedures for the chemical compatibility studies are being developed. This documentation will provide the necessary details on how the experimental testing program will be conducted. For example, this documentation will give the sample dimensions, the exposure protocol (i.e., the length of time that the sample will be exposed to the waste), and the sequence of physical measurements to be performed. It will also include the criteria that will be used to establish whether the material has been affected by exposure to the waste. Most importantly, this documentation will address any quality assurance and environmental, safety, and health issues that must be addressed to perform this work. Upon completion (and DOE acceptance) of the test plans and procedures, compatibility testing will begin in October 1993. Before work can begin, several simulated mixed wastes will be selected. The simulated waste chosen will most closely resemble actual waste streams. The experimental evaluation will begin in the March 1994 and be completed by the end of September 1995. With the completion of the simulated waste testing, a performance report will be issued by September 1996. Since the transportation packagings to be designed will contain mixed wastes, test plans and procedures for chemical compatibility studies with actual mixed wastes will be initiated in 1997 and compatibility testing on these wastes can begin in 1998.

SYSTEMS STUDIES

The systems studies effort at SNL focuses on four areas. These are: (1) sample packagings, (2) Greater-Than-Class C materials (GTCC), (3) other packagings, and (4) engineering systems analysis of technology needs. The systems engineering analysis of sample packages will ensure that efficient and cost-effective packagings are available to support the DOE's Environmental Restoration and Waste Management laboratory sample analysis program. The systems engineering analysis will analyze and integrate the transportation elements in the GTCC program to ensure that safe, timely, and cost-effective packagings are available to meet the storage and disposal needs for GTCC wastes as mandated by United States Federal law. A systems engineering analysis for other material and waste packages will ensure that efficient and cost-effective packagings are available to support DOE's transportation needs on a timely basis. The purpose of the systems engineering analysis of technology needs is to identify what technologies will be required for future USDOE packaging development activities. Assessments will be made together with others in the Transportation Management Division to address how well current technology development is addressing DOE's needs as well as to identify technology gaps.

Laboratory sampling requirements to support materials characterization for the Office of Environmental Restoration and Waste Management (EM) wastes are expected to increase dramatically. Examples of waste requiring characterization includes drums of buried and stored high-level and low-level wastes; transuranic wastes; uncontained low-level wastes; materials from hazardous, radioactive, and mixed-waste sites; mill tailings sites; and materials at facilities scheduled for decommissioning and decontamination. These wastes must be characterized before clean-up operations become effective. The Analytical Services Program (ASP) will make maximum use of U.S. laboratory capability in order to meet waste characterization schedules. The analysis of DOE waste samples will be performed using a mix of commercial laboratories, DOE laboratories, and site field tests including those that can be best accomplished by a mobile laboratory. This effort will result in the need for a significant and responsive transportation network to feed the analytical laboratories. Thus transportation will be a critical component in assuring maximum efficiency in processing on- and off-site laboratory samples.

United States Public Law 99-240 (the Low-Level Radioactive Waste Policy Amendments Act of 1985) requires the Federal government (DOE) to provide technical and other assistance to the States in their efforts to meet responsibility under the law and for the Federal government to dispose of GTCC low-level waste. In response to the legislative requirement for the DOE to dispose of these wastes, the DOE has developed a three-phase strategy to provide safe and effective management of commercially generated GTCC waste. The first phase is to provide for interim storage of limited amounts of GTCC waste that pose a potential threat to public health and safety. Selection of a specific DOE facility for interim storage is in process. The second phase of the strategy provides for a centralized dedicated storage facility for all commercial GTCC wastes until a U.S. Nuclear Regulatory Commission- (NRC-) licensed disposal facility becomes available. The third phase provides for the disposal of GTCC waste, either by storage in conjunction with a high-level waste repository or at a separate GTCC disposal facility.

SNL will perform systems engineering analysis of technology needs to identify what technologies will be required for future EM packaging development activities. Assessments will be made together with others in the Transportation Management Division to address how well current technology development is addressing EM's needs as well as to identify technology gaps. The full range of analysis and testing disciplines will be addressed: structural, thermal, criticality, shielding, containment, optimization, testing methodologies and facility requirements, new package concepts, advanced technology development, standards development and regulatory support, normal environments and severe accident studies, and risk and systems engineering analysis techniques. The packaging needs will be addressed and the results will provide input into the technology assessments.

Roadmapping

A specific example of a systems study methodology embraced by SNL is the Roadmap. Roadmapping is a process used by the DOE EM to show issue-based planning activities necessary for achieving final waste disposal, completing site remediation, and bringing waste operations into compliance. Roadmaps are developed at both the headquarters and installation levels by following a systematic planning process that largely focuses on issue identification, root-cause analysis, and issue resolution. The Roadmap methodology sets the course of events necessary to complete a mission.

The Roadmap methodology includes nine steps that are grouped into three phases: assessment, analysis, and issue resolution. The Assessment phase defines the current status and background of the organization. Planning assumptions are identified and documented. Regulatory drivers are cataloged, and schedules of commitments are determined. It is during this phase that logic diagrams are constructed to show the sequence of events necessary to achieve a particular goal and to indicate interface requirements.

A logic diagram has been developed (Figure 4) that, in general, shows the steps necessary to begin development of a Roadmap for Transportation of Hazardous and Mixed Waste. Certain activities and decisions delineated in the diagram may be accomplished in parallel to shorten the time required to complete a program. The diagram becomes the backbone to which the remaining Roadmap steps may be added as deemed necessary. For instance, assumptions, issues, and milestones (these steps may be accomplished prior to logic diagram development) leading to activities and issue resolution steps can be developed with the logic diagram acting as a core project reference tool. Upon completion of the Roadmap steps deemed necessary, activities can be planned to accomplish the transportation mission with a high degree of confidence that all requirements have been met.

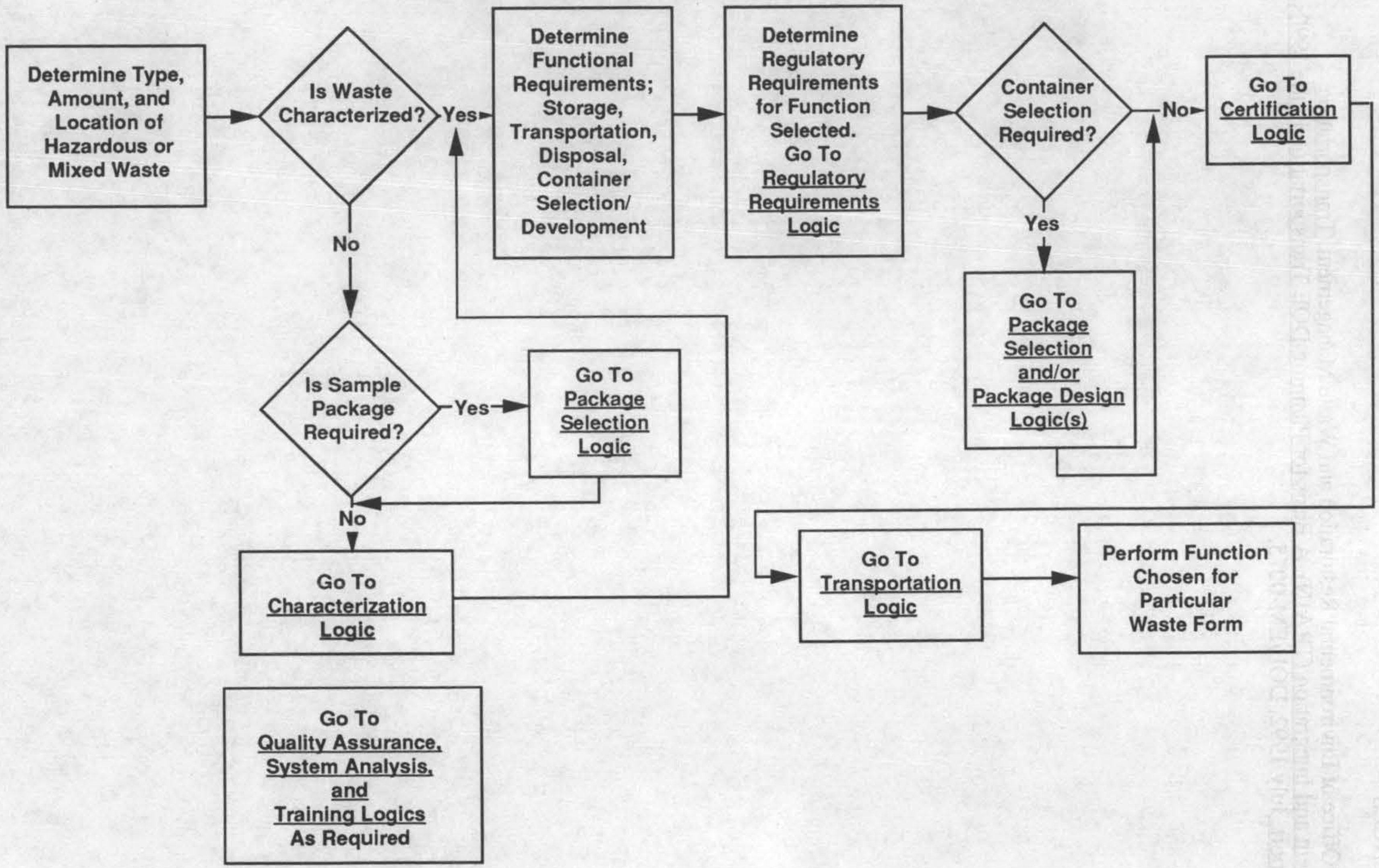

Figure 4. Hazardous and Mixed Waste Transportation Logic Diagram

REFERENCES

USDOE Office of Environmental Restoration and Waste Management, Transportation Assessment and Integration (TRAIN), A Basis for Planning DOE Transportation in the 1990s, Final Report, July 1992, DOE/EM-0075.

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