163
5-26-78

UNCLASSIFIED

16.105

RFP 2728

NATIONAL WASTE TERMINAL STORAGE PROGRAM:
LOW LEVEL TRANSURANIC WASTE
TRANSPORTATION STUDIES

Rockwell International

Atomics International Division
Rocky Flats Plant

Issued April 3, 1978

MASTER

UNCLASSIFIED DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Printed
April 3, 1978

RFP-2728
UC-71 Transportation of
Property and
Nuclear Materials
TID-4500-R66

NATIONAL WASTE TERMINAL STORAGE PROGRAM:
LOW LEVEL TRANSURANIC WASTE TRANSPORTATION STUDIES

Richard J. Merlini
Robert J. Rushton
William R. Briggs

Component Development
Chemistry Research and Development

SUBJECT DESCRIPTORS

Waste Transportation
Radioactive Waste Management
Radioactive Wastes
Radioactive Waste Disposal
Transuranium Elements
Shipping Containers
Transport

ROCKWELL INTERNATIONAL
Atomics International Division
Rocky Flats Plant
P. O. Box 464
Golden, Colorado 80401

Prepared Under Contract EY-76-C-04-3533
for the
Albuquerque Operations Office
U.S. Department of Energy

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

INTERNAL DISTRIBUTION

Copies

1 F. E. Adcock
 1 A. Benjamin
 5 W. R. Briggs
 1 J. R. Gaines
 1 E. Jiannetti (Attn: R. W. Skulski)
 1 R. H. Karlsson
 1 B. L. Kelchner
 1 D. M. Krieg
 1 E. F. Lombardi
 1 G. Mah
 5 R. J. Merlini
 1 F. J. Miner
 1 G. Riordan, Editor
 5 R. J. Rushton
 1 D. K. Strangfeld
 1 E. Vejvoda
 1 C. W. Weidner
 1 D. A. Wiederecht
 1 R. E. Yoder
 20 TIO (Record)
 1 Library

EXTERNAL DISTRIBUTION

163 DTIE Distribution
 2 Standard Distribution
 50 OWI Records, Union Carbide Corp., P. O. Box Y, Oak Ridge, TN
 1 R. E. Best, Nuclear Assurance Corp., 24 Executive Park West,
 Atlanta, GA 30329
 1 J. D. DeSteele, BNWL, P. O. Box 999, Richland, WA 99352
 1 J. M. Freedman, Sandia Labs, P. O. Box 5800, Albuquerque, NM
 1 M. M. Heiskell, Union Carbide Corp., P. O. Box X, Oak Ridge, TN
 1 R. Jefferson, Sandia Labs, P. O. Box 5800, Albuquerque, NM
 1 D. S. Joy, Union Carbide Corp., P. O. Box X, Oak Ridge, TN
 1 J. R. Marshall, Union Carbide Corp., P. O. Box X, Oak Ridge, TN
 1 R. W. Peterson, Allied-General Nuclear Services, P. O. Box 847,
 Barnwell, SC 29812
 1 R. E. Rhoads, BNWL, P. O. Box 999, Richland, WA 99352
 1 J. L. Ridihalgh, Ridihalgh, Eggers & Associates, 2112 Iuka Ave.,
 Columbus, OH 43201
 1 L. Scully, Sandia Labs, P. O. Box 5800, Albuquerque, NM 87115
 5 L. B. Shappert, Union Carbide Corp., P. O. Box X, Oak Ridge, TN
 5 D. W. Turner, Union Carbide Corp., P. O. Box Y, Oak Ridge, TN
 1 L. D. Williams, BNWL, P. O. Box 999, Richland, WA 99352

TABLE OF CONTENTS

	<u>Page</u>
FOREWORD.	1
1.0 INTRODUCTION.	1
2.0 SUMMARY OF MAJOR FINDINGS	2
3.0 GENERAL INFORMATION ON RADIOACTIVE MATERIALS TRANSPORTATION.	3
3.1 Nuclear Regulatory Commission.	4
3.2 Department of Transportation	4
3.3 Interstate Commerce Commission, et al.	5
3.4 State and Local Regulations.	5
3.5 LLT Waste Sources.	7
3.6 Waste Processing	11
3.7 Packaging and Transport Containers	11
3.8 Maintenance of Transportation Hardware	12
3.9 Transportation Hardware Trends	12
4.0 SPECIFIC PROBLEMS AND RECOMMENDED ACTIONS	14
4.1 LLT Waste Disposal System Analysis	14
4.2 LLT Waste Volume Reduction Technology.	16
4.2.1 TRU Waste Definition.	16
4.2.2 Decontamination Procedures/ Equipment Development	17
4.2.3 Reducing Waste Generation	17

	<u>Page</u>
4.3 Transportation Hardware Designs.	18
4.3.1 Existing Railcar Systems Improvement	18
4.3.2 New Type B Hardware Design.	19
4.4 Transportation Hardware Safety	19
4.4.1 Carrier Emergency/Safety Procedure and Training.	19
4.4.2 Carrier Equipment Quality Assurance Review.	20
4.4.3 Waste/Package Compatibility	20
4.5 Current Nuclear Material Transportation Problems	21
4.5.1 Developing Federal Regulation Guidelines	21
4.5.2 In-Transit Low Level Leakage Detection Method.	21
5.0 REFERENCES.	22
6.0 BIBLIOGRAPHY.	23
APPENDIX A.	25
APPENDIX B.	27
APPENDIX C.	32

NATIONAL WASTE TERMINAL STORAGE PROGRAM:
LOW LEVEL TRANSURANIC WASTE TRANSPORTATION STUDIES

FOREWORD

This report was prepared under an agreement between the Department of Energy (DOE) Operations Offices of Albuquerque and Oak Ridge. This agreement involves two DOE prime contractors: Union Carbide Corporation, Nuclear Division; and Rockwell International, Atomics International Division. The working agreement was administered by the Office of Waste Isolation (OWI) and is part of the National Waste Terminal Storage (NWTs) Program. The principal objective of the NWTs Program is to provide facilities in various deep geological formations at several locations in the United States which will safely dispose of radioactive waste. Proposed Federal regulations would require that such wastes be delivered to a Federal repository for terminal storage. The OWI Transportation/Logistics Study addresses problems associated with shipping these wastes to NWTs facilities.

The objective of this Transportation/Logistics Study is to assess the availability of a viable system to transport the wastes to the Federal repositories. To accomplish this objective, a systems analysis of waste transportation is being performed by Oak Ridge National Laboratory (ORNL). A comprehensive report on this systems analysis will be prepared by ORNL. The work presented in this report is a part of this systems analysis and will be utilized in the ORNL report.

Several types of waste materials are expected to be transported to Federal repositories for storage or disposal. These are spent fuel, high-level waste (HLW), intermediate-level waste (ILW), and low-level transuranic-contaminated waste (LLT). This report principally addresses the problems of LLT waste transportation.

1.0 INTRODUCTION

This report presents the results of a study performed under agreement with the Union Carbide Corporation, Nuclear Division. The study was conducted by personnel at the Rocky Flats Plant (RFP) at Golden, Colorado. The RFP is operated under contract to the Department of Energy (DOE) by the Atomics International Division of Rockwell International.

The study was performed to identify transportation related problems and concerns for low-level transuranic (LLT) wastes. Recommended actions for these problems and concerns are also included. The bulk of the LLT wastes currently generated in this country are a result of defense related activities. These wastes are typically referred to as "defense LLT wastes." Some of these wastes are stored or buried at the generation site. Others are transported and stored. One such storage area is located on the grounds of the Idaho National Engineering Laboratory. The developing nuclear power industry may generate similar wastes if certain nuclear fuel technologies are adopted. These wastes are referred to as "commercial LLT wastes." This report identifies some problem areas associated with the transportation of these LLT wastes.

In addition to this introduction, other important sections presented in this report are as follows: a summary of major findings, general information on radioactive materials transportation and related matters, and recommendations on work to aid the development of a commercial LLT waste transportation system.

2.0 SUMMARY OF MAJOR FINDINGS

The problems, concerns, and recommendations presented in this report are the result of communications with personnel active in the field of nuclear materials processing, packaging, and transportation along with appropriate literature collation and a review of radioactive waste matters at Rocky Flats. Several general LLT waste transportation problem areas were identified as a result of this effort. Most of the problem areas defined in this report can be summarized under at least one of the general subjects listed below:

- No specific commercial LLT waste transportation system exists. This is because the low volumes of currently generated commercial LLT waste have not dictated extensive transportation requirements. Existing transportation methods are generic in design and provide features (shielding) not required for LLT wastes. The current system used for most defense LLT wastes does not appear to be licensable by the NRC.
- Federal, state, and local regulations controlling nuclear materials transportation are not always common. Many states and cities have adopted regulations more restrictive than existing Federal requirements.

- Transportation related regulations often require interpretation by the user that may not be consistent with the intent of the regulations. In addition, use of such regulations is difficult for the occasional user.
- The Federal regulatory definition for commercial LLT waste has not been established. This definition could significantly affect the volumes of commercial LLT waste requiring transportation. An existing definition⁽¹⁾ for defense wastes establishes transuranic wastes as wastes contaminated with greater than 10 nanocuries of certain isotopes per gram of waste.
- The technical packaging, shielding, and accident resistance requirements for the transportation of nuclear materials are well defined by regulatory agencies. However, certain important features such as the fabrication quality assurance requirements for transportation hardware are not specified.

This problem list was summarized from a larger group of problems listed in the "Specific Problems and Recommended Actions" section of this report.

3.0 GENERAL INFORMATION ON RADIOACTIVE MATERIALS TRANSPORTATION

U.S. Government regulations for the transportation of radioactive materials have been established to prevent the loss or dispersal of material during shipment and to insure the safety of the public. There is overlapping responsibility for controlling the safe transportation of radioactive materials. Primary responsibilities at the Federal level are with the Nuclear Regulatory Commission (NRC) and the U.S. Department of Transportation (DOT). The jurisdictions of NRC and DOT overlap with respect to safety for the transportation of hazardous by-products, sources, and special nuclear materials. To avoid duplication, the two agencies have entered into a memorandum of understanding signed in 1966 by which the NRC reviews and approves package designs while the DOT controls the labeling of packages and the conditions of carriage. Under this same agreement, the NRC requires reports on and investigates incidents that occur either prior to or after transportation of the nuclear shipment and the DOT requires reports on and investigates incidents that occur in transit. In effect, this means that the NRC is primarily concerned with approving packages for radioactive materials and the DOT is primarily concerned with the handling and safe transportation of hazardous materials.

Packaging for transportation of commercial radioactive materials is subject to issuance of the appropriate licenses. Applicants for a license to package or move radioactive materials must show by a combination of analysis and experiment that the proposed shipping system satisfies the requirements set forth in Titles 10 and 49 of the Code of Federal Regulations.

3.1 Nuclear Regulatory Commission

The NRC also develops standards for package designs and reviews package designs for Type B, fissile, and large quantity packages. The NRC objectives fall into two distinct but related areas:

(1) safeguards and (2) safety.

The safeguards objectives are to deter diversion of nuclear materials, sabotage, or theft.

The safety area involves two additional objectives: (1) to protect transportation workers and the general public from external radiation under normal conditions, and (2) to ensure, under both normal and accident conditions, that the integrity of the package prevents the loss of radioactive material or an increase in radiation levels from within the package to the surrounding environment.

Some offices in the NRC are:

Office of Nuclear Material Safety and Safeguards

Office of Standards Development

Office of Inspection and Enforcement

Office of Nuclear Regulatory Research

The following NRC regulations are applicable for radioactive material transportation safeguards and safety:

10CFR71 - NRC regulations governing the packaging and shipment of radioactive materials

10CFR73.30 - NRC regulations for the protection of special nuclear material in transit

3.2 Department of Transportation

Under the Hazardous Materials Transportation Act of 1974, the DOT is authorized to regulate the safe transportation in commerce of hazardous materials. These regulations include requirements on safety in packaging, shipping, storage, handling, classification, and marking of all radioactive materials.

The DOT also implements safety standards for the mechanical condition of carrier equipment and qualification of carrier personnel. Additionally, the DOT requires the NRC approval for all packages transported. Some offices in the DOT are as follows:

Federal Highway Administration
Materials Transportation Bureau
Federal Railroad Administration

Many of the DOT regulations applicable to transporting radioactive materials are listed in 49CFR170-199, i.e., the DOT regulations governing the transportation of hazardous materials.

3.3 Interstate Commerce Commission, et al.

The Interstate Commerce Commission (ICC) was created in 1887 by the act to regulate interstate commerce. The ICC regulates certain surface carrier operations such as establishing rate and routes, defining operating rights, controlling abandonment, and controlling mergers. Modes of transportation regulated include railroads, motor carriers, and water carriers.

Additional information on ICC activities is listed in Title 49 of the Code of Federal Regulations, Chapter X.

The Federal Aviation Administration also exercises some regulatory authority over the shipment of radioactive materials. The applicable regulations are listed in 14CFR103 which shows FAA regulations for shipment of radioactive materials by air. Water transportation is covered under 49CFR176, Subpart M which are the DOT requirements for governing the shipment of radioactive materials by water.

3.4 State and Local Regulations

Although Federal agencies dominate the regulatory process for the transportation of radioactive materials, state and local governments also exercise some control over these shipments. State highway departments regulate gross vehicle weights, vehicular dimensions, and other parameters concerning radioactive and other shipments. About one-half of the states have adopted Federal regulations to cover intra-state shipments. As shown in Figure 1, several states and cities have adopted or proposed additional regulations⁽²⁾ concerning radioactive materials. These local regulations include:

- Special routing of radioactive shipments
- Advance notification for shipments of large quantities of materials
- State inspections of some types of radioactive shipments
- Prohibition of certain types of shipments within the state
- Prior approval for radioactive shipments
- Requirement of exclusive vehicle use for radioactive shipments
- Use of pilot vehicles
- Speed restrictions for radioactive shipments
- Specific hours of movement
- Accompaniment of all shipments by radiation monitoring personnel

The variation of regulations between adjacent states typically requires special preparation for interstate shipments.

3.5 LLT Waste Sources

As aforementioned, very little commercial LLT wastes are currently generated. The commercial LLT wastes that are generated are mostly a result of reactor research activities, isotope research, and medical research and practice with isotopes. These wastes include resins and filter cartridges from liquid cleanup systems, HEPA filters, failed or obsolete equipment that is contaminated, contaminated trash such as plastic bags, gloves, protective clothing, paper, rubber materials, and medical specimens. Similar, but in larger quantity, wastes are currently generated as a result of defense activities. Most of the defense wastes are treated to reduce volume before packaging and transportation. Some of these treatments can significantly reduce packaging and transportation requirements.

The potential generators of large quantities of commercial LLT waste would probably be as follows:

- Power Reactors - Reactor wastes are primarily from the water treatment systems. The characteristics of the waste vary with reactor type, but are generally contaminated resins. Such wastes are not now typically categorized as LLT wastes. The principal containments are a result of radiation induced into trace minerals and metals in the cooling water. Such wastes would only be LLT if a leak existed in the fuel elements.

- Reprocessing Plants - LLT wastes will generally consist of failed equipment, removed HEPA filters, small amounts of wet and dry solids, and large amounts of combustible and noncombustible trash.
- Mixed Oxide Fuel - Fabrication Wastes - Fuel fabrication plant wastes include combustible/noncombustible trash, HEPA filters, and failed equipment.

As aforementioned, the volumes of commercial wastes that will be classified and treated as LLT waste will be significantly affected by a pending NRC definition. This definition will establish a curie level for LLT wastes. LLT wastes containing greater than the established curie level will require terminal storage. LLT wastes containing less than the established curie level will probably be disposed of using near-surface permanent burial. A similar curie level is currently observed by the DOE for LLT wastes generated as a result of defense activities. Defense wastes with greater than 10 nano-curies per gram (nCi/g) of waste are stored in a retrievable manner. Wastes with less than 10 nCi/g are buried in a non-retrievable fashion. The following, from the Federal Register, recounts the history of the DOE 10 nCi/g level and the present status of the NRC level-setting process.

December 1969 -- A Federal task force met to study and recommend ways and means to segregate LLT waste from all other radioactive waste.

March 1970 -- An Immediate Action Directive (AEC-IAD 0511-21) was prepared by AEC Headquarters and circulated to the AEC field offices for comment. This directive specifically required LLT waste to be segregated from non-LLT waste before burial. Comments from AEC personnel suggested an LLT waste burial limit be established.

June 1970 . A Committee was formed that drafted a proposal for the handling of LLT wastes. This proposal was entitled "Sorting of Solid Radioactive Wastes."

March 1971 -- After field comments were received about the Committee's proposal, AEC personnel recommendations were tentatively accepted and published in a draft copy of the AEC Manual Chapter 0511 which was again circulated for field comments.

September 1973 -- AEC Manual Chapter 0511 containing the burial limit of 10 nCi/g was published and inserted into the AEC Manual.

September 12, 1974 -- The following was published in the Federal Register. (3)

"The Atomic Energy Commission is considering the amendment of its regulations in 10CFR Part 20, 'Standards for Protection Against Radiation' to prohibit the disposal by burial in soil of transuranium elements. Transuranic waste would be required to be transferred to the AEC for storage as soon as practicable but within five years after its generation. The AEC would be responsible for subsequent storage, treatment, and disposal of such waste. The AEC would take title to the waste upon delivery, and would levy a fee on the generator of the waste to cover all cost for subsequent management.

"The quantities of transuranium elements (mostly plutonium) thus far buried in licensed commercial grounds are estimated to be about 80 kilograms dispersed through a large volume (about 7.5 million cubic feet) of material.

"In the evaluation of proposed licensed burial sites for radioactive wastes, two primary aspects are considered: (a) The geological, hydrological, and climatological characteristics of a site must be such that waste, once placed in the ground, will not migrate so as to have a significant impact on man or the environment; and (b) The burial grounds must be on land owned by the Federal or a State government to assure long-term control. Chemical and physical characteristics of plutonium are such that migration in soil or ground water is unlikely. Deep well water samples taken at the perimeter of the burial sites have not shown any detectable plutonium (the principal transuranium element), thus indicating that the buried plutonium has remained immobile. On the basis of the foregoing, the Commission has concluded that the plutonium already buried does not constitute a potential hazard to man or the biosphere and thus should not be required to be removed from burial. Continued surveillance of the burial sites will be maintained to assure that a potential hazard does not develop.

"Because of an anticipated increase in the quantities of wastes containing or contaminated with transuranium elements, the long half-life of transuranium elements, and their high specific radiotoxicity, the Commission believes that in the future, storage and disposal of such wastes at Government-owned facilities should replace

disposal in licensed commercial burial grounds. Such storage and disposal would provide a greater assurance against escape of the material to the biosphere than would near-surface burial in commercial burial grounds. The Commission is also considering whether radionuclides other than those covered by this proposed regulation, because of potential hazards, should also be earmarked for management by the AEC and it may propose further rule-making actions to this regard.

"Measurements made to determine the presence or absence of transuranium elements should be sufficiently sensitive to detect contamination levels as low as 10 nanocuries of transuranic elements per gram of waste. Waste that is suspect, but which has been measured and is not contaminated with more than 10 nanocuries per gram should be consigned to a licensed burial ground. A sensitivity of 10 nanocuries per gram for measurement has been chosen as a guide since it represents the upper range of concentration of radium in the earth's crust. In terms of long half-life and radiotoxicity, transuranium elements are comparable to radium. It appears reasonable, therefore, to permit the burial of waste which might contain transuranic elements in such concentrations, or below, in licensed burial sites."

March 10, 1977 -- The following was published in the Federal Register. (3)

"Only in recent time has consideration been given to the segregation of long-lived material, and no national standards have been implemented in this area. In 1970, the AEC implemented policies limiting the burial of long-lived transuranium radionuclides at AEC operated sites (transuranium elements are elements having atomic numbers greater than 92 including plutonium). Such waste containing greater than 10 nanocuries per gram were sent to retrievable storage facilities. The AEC issued a proposed rule on September 12, 1974, which would have limited burial of transuranium wastes at commercial sites also. Following creation of the NRC and ERDA, ERDA withdrew the draft environmental statement needed to fulfill requirements of the National Environmental Policy Act (NEPA). Although the rule has not been implemented, all the commercial burial sites except the Hanford site presently limit the burial of transuranium nuclides. Development of a rule and supporting environmental statement is still being pursued by NRC in concert with other reviews such as this one."

July 1977 -- Studies were in progress at the Los Alamos Scientific Laboratory (LASL) for the NRC to aid in defining a recommended burial limit for LLT waste. (4) A report was submitted to the NRC and DOE. Comments were expected back from these two agencies sometime in the fall of 1977.

Fiscal Year 1978 -- The results of the above recommendation will be published.

3.6 Waste Processing

Treatment processes in use or under development are generally designed to reduce waste volumes and/or place the waste in a less hazardous physical or chemical form. Several waste treatment processes are applicable to LLT wastes. Some of these processes have the potential for significantly reducing the volume of LLT wastes requiring transportation.

- Conventional incineration or acid digestion processes -- converts combustible wastes to ash and greatly reduce volume.
- Mechanical compaction and disassembly -- reduces waste volumes.
- Solidification or immobilization -- usually increases waste volumes but aids in producing an environmentally stable waste form.
- Ion exchange -- for removal of transuranic contamination from liquids.
- Fluidized bed incineration -- is a relatively low temperature process for combustible wastes that reduces furnace corrosion and maintenance problems.

3.7 Packaging and Transport Containers

Packaging requirements are outlined by DOT regulations for most forms of LLT waste. Because of the variation in physical form and radioactivity, packaging is required for LLT wastes in three different categories as follows:

- Low Specific Activity (49CFR173-392) -- shipment of this material requires only strong, tight industrial packaging.

- Type A Quantities (49CFR173-389) -- requires that the package be capable of surviving normal transportation conditions.
- Type B Quantities (49CFR173-389) -- requires shielded and unshielded packages that meet the test criteria of 10CFR71 or 49CFR173-389.

Specific package construction details vary significantly among both DOE users and commercial users. The durability of standardizing packaging is obvious for both transportation and permanent disposal operations. It is anticipated that future packaging configurations and materials of construction will, in part, be dictated by the requirements for permanent disposal. To date, these requirements have not been developed.

Several unshielded Type B transport containers or overpacks are currently in use. These include the "ATMX" railcars owned and used by the DOE, "Super-Tigers," "Half Super-Tiger Mode A," and "Poly Panthers" which are available for commercial use on a lease or buy basis.

Shielded Type B overpacks are typically smaller with less payload capacity than unshielded overpacks because of the added weight of the shielding. Some examples include the NECO B3, "Half Super-Tiger Mode B," and "ATCOR Models LL-50-100, LL-57-65, and BC-48-220. A more complete list of transport containers is included as Appendix A. Drawings showing the construction details of typical transport containers are included as Appendix B.

Many of the containers described in Appendix A are authorized for use under a DOT special permit. It is anticipated that these special permits will no longer be issued and permits presently in effect will be allowed to expire without renewal.⁽⁵⁾ The containers must then receive NRC approval before further use will be permitted. Economic considerations may prevent attempts to license some of these containers. As a result, some of the containers may not be available in the future.

3.8 Maintenance of Transportation Hardware

Special maintenance is not required by any governmental regulations for transportation equipment used for the shipment of LLT wastes. Typically, however, experience has shown that transport containers require minimal maintenance (worn bolt replacement, etc.) and have a projected life expectancy of about 10 years.⁽⁶⁾ Life expectancy is probably controlled more by design changes and regulatory changes than by wear. Highway tractors and trailers are maintained by continuous preventive care. Trailer beds will occasionally require replacing because of contamination.

The only railcars currently used for transporting LLT wastes are owned by the DOE. Maintenance of these railcars has been performed by the Santa Fe Railway Maintenance facilities in Cleburne, Texas. However, the Santa Fe Railway recently informed the DOE that they could no longer provide this service. DOE is currently selecting another contractor to resume this maintenance activity. The cost of an overhaul ranges up to \$3500 per car. In addition, visual inspection of these railcars is also performed between overhaul periods. Appendix C provides further data on the maintenance efforts. A list⁽⁷⁾ showing railroad vehicle maintenance facilities is also available.

3.9 Transportation Hardware Trends

Approximately half of the defense LLT wastes are currently transported by railway and half by highway. Most of the highway hauled wastes are classified as low specific activity (LSA) and Type A quantities and, therefore, do not require a transport container constructed to Type B package standards. Barring any significant change in waste definitions or substantial increases in highway transportation costs, this transportation scenario will likely continue. If significant commercial LLT wastes are generated, it is expected that highway transportation would also be used for the LSA and Type A quantities of waste.

Most Type B quantities of LLT defense waste are shipped by the DOE owned "ATMX" railcars. Continued use of these railcars is in jeopardy because of the potential demise of DOT special permits and the lack of NRC approval or license. It now appears (early 1978) as if the NRC will not license the "ATMX" railcar without additional demonstration that the railcar is indeed safe and both publically and environmentally acceptable. Without "ATMX" railcars, Type B quantities of defense waste would have to be shipped using NRC licensed transport containers. Because of the poor payload-to-container weight ratio typical of existing Type B transport containers, the costs of defense LLT waste shipments would increase substantially (probably by a factor of 3 to 5). Such events would undoubtedly stimulate DOE interest in the design of lightweight highway transport containers or a licensable waste railcar. Railcar use, however, is additionally complicated by the well publicized and unusual position adopted by Railroad Companies regarding the transportation of nuclear materials. Without clarification of the Railroad Companies' position and intentions, the interest in a new or altered "ATMX" railcar design would probably be less than enthusiastic.

Some Type B quantities of defense LLT waste and all commercial Type B quantities of LLT waste are now shipped by highway using the aforementioned Type B transport containers. The generation of significant commercial quantities of Type B LLT waste would also stimulate commercial interest in a light-weight Type B transport container for highway use. Use of the railroads for Type B quantities of commercial LLT waste would, of course, be subject to the same, and perhaps additional, clarification of the Railroad Companies' future actions.

4.0 SPECIFIC PROBLEMS AND RECOMMENDED ACTIONS

The general problem categories listed in the "Summary of Major Findings" section were condensed from a larger group of more specific problems and concerns about LLT waste transportation. This larger list starts with the section on "LLT Waste Disposal System Analysis." The recommendations accompanying these problems and concerns are structured to provide the following types of information:

1. The costs and operational needs associated with various system configurations of LLT waste transportation systems such as rail, truck, rail/truck, centralized/noncentralized waste processing, etc.
2. The effects of waste processing and treatment methods on the volume of LLT wastes to be transported.
3. The required hardware equipment designs and capabilities needed for viable LLT waste transportation systems and its associated costs.
4. Clarification of the certain transportation safety related matters.

It is recognized that some of the following suggestions may not be directly within the scope of the NWTs program. However, such information will eventually be beneficial for the establishment of an LLT waste transportation system.

4.1 LLT Waste Disposal System Analysis

- a. Concern: An overall systems study from generation through isolation of the LLT waste disposal problem has not been performed. No comprehensive collection of data exist from which the most desirable system characteristics can be defined. This information would be useful in developing

transportation hardware, waste processing criteria and hardware, and logistics design criteria.

- b. Basis of Concern: The establishment of an LLT waste disposal system has many interrelated features, most of which have been studied only on an individual basis. Some of these features are:

- Amounts, types, and form of LLT waste generated or currently in existence including contaminated soil on a site specific basis.
- Location and number of potential waste generation sites.
- Degree of on-site waste processing (recovery, reduction, etc.) and segregation of waste types.
- Individual waste package criteria.
- Location and desirability of potential centralized processing facilities.
- Location of emergency spill cleanup equipment.
- Modes of transportation used.
- Effect of strikes or system stoppages.
- Processing of retrievably stored wastes.

All the items of concern have the potential of affecting how a system might be configured and what the capital and operating costs of the system will be. An LLT waste processing, packaging, transportation, and isolation system can only be properly developed with a detailed, in-depth system plan.

- c. Recommendations: It is recommended that an LLT waste disposal systems study be initiated with the goal of identifying all of the elements of the system and their effect on transportation. Some tasks of the study would be as follows:

- Establish an ongoing data gathering program to document actual and potential waste volumes, waste types, and routes of LLT wastes being transported.
- Develop several practical system models that include all of the waste disposal elements from generation to isolation.

- Computer simulation to evaluate each model system primarily on the basis of capital costs, operating costs, waste volumes, waste generation location, and repository location.
- Review and analysis of the study results to aid in determining the optimum system configuration and requirements.
- Definition of system component design criteria.
- Develop background data for the establishment of computer programs for control of the LLT waste transportation logistics.

4.2 LLT Waste Volume Reduction Technology

The prediction of future LLT waste volumes is sensitive to three principal areas of technology development. These three features are: (1) high speed radiometric assay techniques for separating contaminated wastes from non-contaminated wastes, (2) processes that partition the contaminants from the waste, and (3) measures to minimize initial waste generation. These aspects would be studied under each of the following problem statements.

4.2.1 TRU Waste Definition

- a. Concern: The difficulty of detecting very low contaminate quantities will cause "suspect waste" to be transported to a terminal repository. This situation could have a substantial impact on LLT transportation requirements.

No radiometric assay equipment capable of accurately quantifying suspected transuranic contaminated waste presently exists for production waste volumes. This inability to assay suspect waste will result in waste being incorrectly classified as LLT waste when, in reality, this waste could be transported and disposed of using permanent near-surface burial. Existing techniques have been developed to measure contamination at this level. However, these techniques have limitations that forestall their application for large scale industrial use.^(8,9) These problems are the requirements that the waste be loosely packed and contain essentially no dense material.

Tests performed using the Multiple Energy Gamma Assay Survey (MEGAS)⁽⁹⁾ concept indicate that much of the LLT room-generated waste contains less than 10 nCi/g in transuranic contamination.

- b. Basis of Concern: Impending Federal regulations will soon specify the quantity of TRU contaminants that waste must contain to be defined as TRU. All waste with less than that quantity will probably be disposed of by nonretrievable near-surface burial. It is expected that this quantity will be somewhere between 10 to 100 nanocuries of TRU contaminate per gram of waste.
- c. Recommendation: Based on the soon-to-be-issued NRC definition for transuranic waste, an effort is needed to develop instrumentation that can assay high density, heterogeneous material with a heterogeneous radioactive waste matrix. A preliminary study could be initiated to define parameters such as design intent, potential assay or verification equipment concepts, operating conditions, packaging materials requirements, allowable fixation materials, and estimated costs.

4.2.2 Decontamination Procedures/ Equipment Development

- a. Problem: No large scale effective disassembly and decontamination techniques exist for worn and obsolete tools and equipment.
- b. Basis of the Problem: Many pieces of transuranic contaminated bulky equipment and tools are generated by current defense operations and would be generated from commercial fuel activities. Waste volumes from such equipment are large and often result in shipments of low density.
- c. Recommendation: Institute a development and subsequent conceptual design effort to develop better disassembly and decontamination methods. Such methods, if successful, would have two beneficial results. Materials could be recycled and waste density would increase. Materials not completely decontaminated might qualify for near-surface burial. A surface wipe method could be used to evaluate the effectiveness of the selected procedures in lieu of radiometric assay equipment.

4.2.3 Reducing Waste Generation

- a. Concern: No guidelines exist that present practical, operation-oriented methods of reducing or controlling waste generation.

- b. Basis for Concern: Much of the currently generated defense waste occurs because of failure to implement anti-waste generation practices. It is estimated that up to 50 percent of the LLT wastes could be eliminated if careful operational practices were utilized in nuclear materials processing areas.

For example, strict control of materials entering process areas or selection of materials which are more amenable to subsequent treatment can significantly reduce LLT waste volumes.

- c. Recommendation: Prepare an operating manual describing specific methods of avoiding waste generation and that identifies substitute materials that are compatible with waste treatment processes. Preparation of this manual may require development work to determine the suitability of some materials to volume reduction or other treatment processes.

4.3 Transportation Hardware Design

Designs of overall LLT waste system characteristics are affected by the hardware used to transport the waste. Optimized hardware for the transportation of LLT wastes does not exist, and existing non-optimized hardware for high volume transit (DOE "ATMX" railcar) may not meet NRC requirements. The following problem statements address this lack of existing transportation systems. The listed recommendations are structured to determine information needed to define transportation hardware.

Additionally, there is need to identify alternate DOE transportation means in anticipation of the "ATMX" railcar becoming unlicensable.

4.3.1 Existing Railcar Systems Improvement

- a. Problem: The DOE "ATMX" waste cars have not been proven to meet the requirements for an NRC license.
- b. Basis for Problem: The DOE has requested that NRC review "ATMX" waste car design to determine if the cars can be licensed with or without exemptions. Discussions with the NRC have revealed that "ATMX" cars are probably not licensable because they have not been tested to the hypothetical accident conditions per CFR Titles 10 and 49. After mid-1978, it is expected that the NRC will not issue exempted licenses. Because of this situation, the DOE may not have rail-based transportation available and therefore no such system would be available for adoption for commercial waste transportation.

- c. Recommendation: A study to define alternate transportation methods is needed in the event the "ATMX" railcars are declared unqualified for transporting radioactive waste. An existing railcar design analysis needs to be conducted to establish if some modification would be successful in qualifying the car to Type B testing requirements. Also, alternate (to the "ATMX") transportation methods need to be identified such as using existing transport containers in lieu of "ATMX" cars.

4.3.2 New Type B Hardware Design

- a. Problem: No high capacity/low weight Type B transport container, specifically designed for hauling LLT waste, exists.
- b. Basis of Problem: Presently approved transport containers meeting Type B conditions have a small payload capacity when compared to the total package weight (the Super-Tiger weighs 15,000 pounds empty and 45,000 pounds at maximum weight). This condition of poor payload-to-container ratio may be significantly improved by designing two- and three-component LLT waste transportation hardware where the impact, puncture, fire, and water immersion resistance are divided among the various components of waste package, transport container, and transport vehicle.
- c. Recommendation: Initiate a design/cost effort to describe the needed parameters and conceptual designs for multiple component LLT waste transport hardware.

4.4 Transportation Hardware Safety

Certain safety matters relating to the transportation of LLT waste have been identified as a result of this study. Each problem itemized below may affect the number of qualified nuclear materials transportation firms available and the required capital and operating costs for such firms.

4.4.1 Carrier Emergency/Safety Procedure and Training

- a. Problem: Rail and motor carriers are permitted to transport nuclear loads without establishment of nuclear emergency preparedness procedures for their operations.

- b. Basis of Problem: No Federal or State requirements exist that require carriers to establish safety plans for nuclear hauls, nuclear accident emergency plans, driver suitability (background checks), etc. Under current "heavy haul" authority granted by the ICC, any licensed carrier can transport NRC licensed nuclear casks or packages. This problem will expand if waste volumes increase significantly and more carriers become involved with nuclear waste transportation.
- c. Recommendation: Establish a program to identify basic emergency requirements and provide recommendations to upgrade emergency preparedness for shipment of LLT radioactive wastes.

4.4.2 Carrier Equipment Quality Assurance Review

- a. Problem: Highway transport companies are permitted to design and fabricate dedicated nuclear heavy hauling equipment without an independent overview of design features, material quality assurance, or fabrication quality control.
- b. Basis of Problem: Transport companies involved with nuclear materials are currently designing and fabricating transportation hardware. Although experience in the design and fabrication of such equipment is a great asset, formal quality assurance provisions for important design features and components would clearly reduce the possibility of in-service failure.
- c. Recommendation: Initiate a study to determine the scope of (1) upgrading design analysis, review, and fabrication quality assurance for transportation hardware scheduled for nuclear materials use; (2) determining what segment and agency of government should control such reviews, etc.; and (3) selection of areas of application such as weldments, fasteners, axles, etc.

4.4.3 Waste/Package Compatibility

- a. Concern: Compatibility information among waste materials, fixation agents, and package materials has not been developed or compiled.
- b. Basis of Concern: Compatibility data are limited and are not summarized. Noncombustible forms of waste, packaging, etc. are desired for storage, transportation, and disposal. Fire, gas buildup, or rapid package corrosion could compromise

safety during transportation or subsequent permanent disposal operations.

- c. Recommendation: Compatible and incompatible package and waste materials combinations need to be identified to provide options in the design or selection of waste fixation materials and package construction materials.

4.5 Current Nuclear Material Transportation Problems

Two pertinent problems currently affecting the shipment of nuclear materials have become apparent during this study. These problems are of a low priority relative to establishing an LLT waste disposal system, but solutions to these problems could be beneficial to current transporters and the public in general. These problems and the associated recommendations are presented as follows:

4.5.1 Developing Federal Regulation Guidelines

- a. Problem: Use and interpretation of Federal nuclear material packaging and transportation regulations by many users of these laws is difficult.
- b. Basis of Problem: Determination of the packaging and transportation requirements for a particular nuclear material, in a specific quantity and concentration, requires detailed knowledge of the Federal regulations. This results from the fact that the regulations must be all-inclusive and in legal language. Consequently, there is opportunity for misinterpretation by the occasional user which could result in illegal and unsafe practices.
- c. Recommendation: It is recommended that a program be established with the goal of devising user aids to assist in the definition of requirements to be met for the transportation of specific types of radioactive consignments. This approach would be similar to the user aids appended to the IAEA regulations. Flow charts, graphs, tables, and other aids should be developed.

4.5.2 In-Transit Low Level Leakage Detection Method

- a. Problem: Contamination leakage from radioactive waste packages received at commercial burial sites because of improper solidification or packaging is an occasional occurrence.

- b. **Basis of Problem:** Under current regulations, the shipper of radioactive wastes is required to provide certification to the carrier that the shipment, including packaging, is in compliance with applicable regulations. The carrier is not required to perform contamination leakage checks at loading, or at any time during carriage, except in air shipments. Consequently, if it does occur, leakage is not discovered until the package is monitored on arrival at the disposal site. Some commercial disposal site firms are currently passing on decontamination costs to the carriers. This is, however, an after-the-fact approach of detecting and preventing contaminant leakage. That is, a package containing radioactive material might leak and the leak will not be discovered during transportation.

- c. **Recommendation:** It is recommended that a program be initiated to develop inexpensive and simplified methods to detect above-limit radiation or contamination leakage that develops during transportation. A leaking package could then be placed in an approved overpack or isolated to guarantee prevention of further contamination spread. Perhaps a one-time "badge" device and/or simple air monitor could be attached to each container and/or vehicle. Whatever method is developed, it should be "readable" by vehicle operators and a large portion of the general public.

5.0 REFERENCES

1. DOE Manual Chapter 0511.
2. Tri-State Motor Transit, Joplin, Missouri (personal communication).
3. Federal Register, Thursday, September 12, 1974, Vol. 39, No. 178; Thursday, March 10, 1977, Vol. 10, No. 47.
4. Los Alamos Scientific Laboratory, Los Alamos, New Mexico (personal communication).
5. NRC (personal communication).
6. Protective Packaging, Louisville, Kentucky (personal communication).

7. The Repair Car Directory, Ad/Cal Publishing Company, 105 Boyd Circle, Michigan City, Indiana 46360.
8. Dunne, James Francis; An Evaluation of the Generation and Treatment of Transuranic Waste Resulting from the Commercial Nuclear Fuel Cycle; A Thesis presented in partial fulfillment of the requirements for the degree of Master of Science, Ohio State University, 1976, p. 124.
9. Transuranic Solid Waste Management Research Programs, Quarterly Report, October thru December 1973, LA-5614-PR, May 1974.

6.0 BIBLIOGRAPHY

- Adcock, Frank E., McCarthy, John D., "ATMX-600 Railcar Safety Analysis Report for Packaging," RFP-2244, Rev. 1, Rockwell International, Golden, Colorado, February 21, 1977.
- Bierlein, L. W., The Redbook of the Transportation of Hazardous Material, Cohmers Book International Inc., 1977.
- Code of Federal Regulations, 10CFR735-1, Office of the Federal Register, January 1, 1976.
- Code of Federal Regulations, 49CFR102.1, Office of the Federal Register, December 31, 1976.
- Colton, Richard S., Ward, Edmond S., "Practical Handbook of Industrial Traffic Management," The Traffic Service Corp., Library of Congress #72-95464, 1973.
- Dunne, James Francis, "An Evaluation of the Generation and Treatment of Transuranic Waste Resulting from the Commercial Nuclear Fuel Cycle," Ohio State University Thesis, 1976.
- Federal Register, Physical Protection of Plants and Materials, Vol. 42, No. 128, pp. 34310-34321, July 5, 1977.
- Federal Register, Packaging of Radioactive Material for Transport and Transportation of Radioactive Material Under Certain Conditions, Vol. 42, No. 150, pp. 39364-39368, August 4, 1977.
- Gorrick, Lee V., "Regulation of Nuclear Material Transportation: The Role of the NRC," AIF Conference on Transportation for the Nuclear Industry, May 26, 1976.

Grella, Alfred W., "State of Current and Proposed Regulations and Legislation for Transport of Radioactive Materials," Department of Transportation, May 7, 1976.

Jefferson, R. M., Bonzon, L. L., "Available Packaging and Transportation Systems," Abstract, Sandia Laboratories, Albuquerque, New Mexico, no date.

Rhoads, R. E., "An Overview of Transportation in the Nuclear Fuel Cycle," BNWL-2066, UC-71, Battelle Northwest Laboratory, May 1977.

APPENDIX A

EXISTING SHIELDED/NONSHIELDED TRANSPORT CONTAINERS

TYPICAL SHIELDED/NONSHIELDED TRANSPORT CONTAINERS

Container Name	Authorized Contents	Cavity Dimensions	Shielding	Heat Removal Capacity	Container Weight	Intended Transport Modes	DOT Permit Number
ATMX-60 Railcar	Large Quantity	9' x 3' x 50' (4050 cu ft)	None	500 watts	101,000 # net	Rail	5948SP
Super Tiger	Large Quantity	76" x 76" x 172" (573 cu ft)	None	235 watts	30,000 # net	Truck Rail	6400
1/2 Super Tiger Mode A	Type B	76" x 76" x 85"	None	157 watts (max.)	16,000 # net	Truck Rail	6679
1/2 Super Tiger Mode B	Type B	76" x 76" x 85"		157 watts (max.)	3,000 # net	Truck Rail	6679
Poly Tiger	Type B	61" x 65" (50 cu ft)	1 1/2-4" Lead	Solids-- 10 watts Liquids-- 5 watts	28,000 # net	Truck	6744
Poly Panther	Type B	50 3/8 x 48 3/8 x 72 3/4 (cu ft)	None	N/A	3,000 # net	Truck	6272
NECO B3	Large Quantity	26 1/4 dia x 36 3/4 (10.2 cu ft)	6" Lead		20,500 # empty	Truck	6058SP
ATCOR AL-50-100	Large Quantity	1.6m dia x 1.9m (3.71 m ³)	11.4 cm lead equiv.			Truck	6601SP
ATCOR AL-57-65	Large Quantity	0.91m dia x 2.9m (1.93 m ³)	17.8 cm lead equiv.			Truck Rail	5805SP
ATCOR BC-48-220	Large Quantity	1.85m dia x 2.23 (6.03 m ³)	17.8 cm conc. 6.4 cm steel			Truck Rail	5026SP
Brookhaven Waste Shipment Overpack	Large Quantity Fissile Class I	.58m x 1.6m x .35m (.32 m ³) and 1.1m x .6m x 1.8m (1.2 m ³)	.43 m conc. .3 m conc.	None	27,200 # empty	Truck Rail	
ORNL Model III	Large Quantity	29" x 23" x 78" (30 cu ft)	9" steel	440 watts	42,000 # empty	Rail	
SRP ⁶⁰ Co	Large Quantity	15" x 23" x 37" (7.8 cu ft)	8.5" lead	4200 watts	31,600 # empty	Truck	
BMI-1	Large Quantity	155"d x 54" (590 cu ft)	8" lead	1500 watts	23,600 # gross	Truck	
Paducah Demo Cask	Large Quantity	17"d x 51" (6.73 cu ft)	5.75 U ₉₂	10,500 watts	30,000 # gross	Truck	
NCL 6502	Large Quantity	12" x 12" x 130" (10.8 cu ft)	10" lead	7300 watts		Truck	
GEIF200B140	Large Quantity	15"d x 140" (14.3 cu ft)	8 3/8" lead	5800 watts	45,000 # empty	Truck	
GEIF100B137	Large Quantity	13"d x 137" (10.5 cu ft)	8 3/8" lead	5800 watts	44,000 # empty	Truck	
GEIF100B129	Large Quantity	13"d x 129" (9.9 cu ft)	8 3/8" lead	13,000 watts	56,000 # empty	Truck	

APPENDIX B

DRAWINGS SHOWING TYPICAL TYPE B TRANSPORT
CONTAINER CONSTRUCTION DETAIL. (REPRODUCED
WITH PERMISSION OF PROTECTIVE PACKAGING, INC.,
LOUISVILLE, KENTUCKY)

PAYLOAD LIMIT: 30,000 LBS.
EMPTY WEIGHT: 15,000 LBS.

MODE A: GROSS WT. = 24,000 LBS.
PAYLOAD WT. = 16,000 LBS.

MODE B: GROSS WT. = 45,000 LBS.
PAYLOAD WT. = 3,000 LBS.

OVERALL HEIGHT 61½ IN.
 OVERALL DIA. 49 IN.
 EMPTY WEIGHT 20,500#

APPENDIX C

"ATMX" RAILCAR MAINTENANCE FEATURES

"ATMX" RAILCAR MAINTENANCE FEATURES

The following checks and services are currently being performed on each DOE railcar every 2-3 years:

- Dismantle, check, and magnaflux trucks
- Dismantle and check wheels, axles, and couplers
- Clean air brakes
- Lubricate bearings
- Perform air checks and lubricate
- Inspect covers for alignment and cracks and repair as necessary
- Sand blast, paint, and remark

Visual inspection of critical components is also performed; typically after each trip. Maintenance of these cars after 1979 is scheduled to be conducted in a DOE facility located at the Pantex plant at Amarillo, Texas.