WASTE TRANSPORTATION AND PACKAGING

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A REVIEW OF THE STATUS OF TRANSPORTATION ACTIVITIES IN VARIOUS WASTE MANAGEMENT SYSTEMS*

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INTROUDCTION

Transportation of nuclear materials is an indispensable component of both the nuclear industry and nuclear-related governmental activities in the United States. It is a particularly important component of that part of the industry dealing with the processing, storage, and ultimate disposal of radioactive wastes. The U. S. Department of Energy (DOE) is involved in transportation as both a generator of nuclear waste and a promoter of nuclear activities. Issues arise relative to the transportation of radioactive materials supporting the various DOE activities, specifically focused on spent fuels and nuclear wastes. These issues result in part because of the variety of forms of material involved, and in part because of the multiplicity of facilities and organizations which have produced, are producing or plan to produce the materials to be transported. In addition, for older wastes which have been stored and which will be transported to disposal sites in the future, the current state of the waste may be in question. Thus various transportation systems are needed, and these systems should be as flexible as possible to minimize the number required.

Since the early 1970's, DOE and its predecessor agencies have recognized the importance of the safe transportation of radioactive materials (as this activity is involved with a substantial part of their programs). Initially, this interest took the form of a series of isolated programs, each directed at providing a solution to a specific transportation problem. By the mid 1970's this approach became inadequate to address the growing complexities of the problem, and in late FY 78 the Transportation Technology Center (TTC) was established together with a coherent program in the transportation of radioactive materials with the Albuquerque Operations Office as the lead DOE field office and Sandia National Laboratories (SNL) as the lead contractor. The balance of this paper is a review of the current status of transportation activities being conducted by the TTC in support of DOE waste management programs. These activities are focused on the following radioactive wastes and spent fuels.

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Defense Wastes

- Contact-Handled Transuranic Wastes
- Special-Handled Transuranic Wastes
- Processed Transuranic Wastes
- High Level Wastes

Commercial Wastes

- Terminal Isolation Wastes
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- Low-Level Wastes
- Remedial Action Wastes

Spent Fuels

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- Breeder Reactor Spent Fuel
- Research Reactor Spent Fuel

Miscellaneous DOE Materials

- Beneficial-Use Materials
- Radioactive Sodium Waste

DEFENSE WASTES

Defense radioactive wastes are generated as a result of U. S. Government nuclear weapon and military propulsion system activities. The Federal Government is the owner of these materials and has direct responsibility for storage, transport, and ultimate disposal. Historically, many of the systems used for transporting defense wastes have been owned and operated by the Federal Government. At present, the volume of defense waste is far greater than that of commercial waste, however the quantity of radioactivity (total curies) in residues from the commercial fuel cycle has recently surpassed that of the defense fuel cycle (Ref. PNL-3564). A review of transportation activities involved with defense radioactive materials is given by waste category.

Contact-Handled Transuranic Waste.

Large quantities of Contact-Handled transuranic (CH-TRU) wastes have been generated as a result of U. S. defense activities, and the generation of these materials is expected to continue. The management of these wastes is being handled by the Transuranic Waste Systems Office (TWSO) at Rocky Flats, CO. In the past these wastes have either been stored or buried at the site where they were generated, or they have been transported to interim storage sites such as the Idaho National Engineering Laboratory (INEL). Eventually, the stored, and possibly some of the buried CH-TRU will be transported to a terminal repository such as the Waste Isolation Pilot Plant (WIPP). In addition, shipments of CH-TRU from waste producers to waste storage sites and/or waste processing sites will continue into the forseeable future.

A transportation system capable of handling the many CH-TRU waste containers in a safe and efficient manner is required. Shipments in the past have been made with either the ATMX railcar or a commercial packaging known as the Super Tiger®. The ATMX car operates for TRU waste shipments under a DOT exemption, although it is desirable to ship such wastes in certificated packagings. The existing number of Super Tiger® packagings is inadequate for the quantity of shipments expected in the near future, and it has also experienced some structural/containment problems which has limited its use on a certificated basis to a limited number of waste forms.

A CH-TRU transportation system must be capable of accommodating many different styles of waste containers, including 210 liter (55 gallon) drums, fiberglass reinforced plywood boxes, metal boxes, concrete liners and corrugated cylinders of many different dimensions. Therefore, the system must be designed to be as flexible as possible while accommodating the high throughput needs of a waste repository. Many of the waste containers are, or were when the waste was placed in the containers, Type A packagings. However, many of these Type A packagings contain greater than Type A quantities of materials. Therefore, the transportation system for CH-TRU waste must qualify as a Type B packaging. The transuranic waste program has been funding the development of the TRUPACT system for the transportation of CH-TRU. Truck versions of this packaging system are expected to be in operation in 1984. The truck TRUPACT will be no more than 2.43 m (8 ft) in width, and will have a loaded weight no greater than 22,700 Kg (50,000 lb); thereby allowing for standard sized, legal weight transport in most states. In addition, the system will be capable at being carried on flat-bed railcars. The development of a 3.05m (10 ft) wide wide TRUPACT, with a loaded weight of 31,780 Kg (70,000 lb) for rail carriage, will be completed by FY 87.

Special-Handled Transuranic Waste.

Many of the TRU waste containers that are stored or buried at the various DOE sites, and some of the TRU waste which will be generated in the future may not be capable of being transported in the TRUPACT system. They may fall into a "Special-Handled" transuranic (SH-TRU) waste category for a number of reasons. They may be too large or too heavy for carriage in CH-TRU systems under development. Their contents may be unknown, and can not be verified without special handling such as processing or assaying. They may contain multiple hazards. For whatever reason, these wastes will require special handling and/or special transportation hardware.

In addition, some remote handled transuranic (RH-TRU) wastes have been and will be generated, and these also will require different transportation systems. For convenience, the TWSO is classifying all such wastes as SH-TRU and the DOE must address these wastes on almost a case by case basis. While no activity is currently underway to develop systems for transporting SH-TRU, it is expected that assessment and development of necessary transportation systems will begin in FY 84. This will include a determination of the applicability of existing systems for moving these waste forms.

Processed Transuranic Waste.

One method for handling waste containers where their contents are not quantified accurately is to process them into a homogeneous and stable waste form such as through the use of a slagging pyrolysis incinerator. One such facility has been studied at INEL. If this facility were constructed, the resulting waste form would be a solid basalt-like glass. This waste form, would have a higher density than the usual CH-TRU wastes, and a separate transportation assessment would be needed. In addition, the waste form may qualify as a Low Level Solid, which would allow it to be transported in less expensive packagings. Pre-conceptual designs of processed TRU waste transportation systems were developed by Pacific Northwest Laboratories (PNL), but this activity has been terminated as a result of the termination of funding for the Transuranic Waste Treatment Facility.

High Level Wastes.

Solidified Defense High Level Waste (DHLW) will be produced by different DOE facilities for eventual terminal disposal. This waste form will require shipping casks which, in addition to providing containment, must provide shielding and heat dissipation. The sites in South Carolina, Idaho, and Washington which will produce this waste have each proposed different canister dimensions. In addition, each waste form will have different neutronic characteristics. However, the DHLW from the different waste sites could be shipped in a common cask if the canister dimensions and the plant/canister/cask interfaces are standardized. The Defense Waste Processing Facility (DWPF) has been taking the lead in high-level waste transportation activities by funding a cask development program at General Atomic Co. (GA) through the TTC. The initial focus of this cask development program was on rail casks for transporting up to eight defense high-level waste canisters (0.61 M in diameter x 3.0 m long). During the past year, the design effort has focused on a legal weight truck cask for transporting a single waste form.

COMMERCIAL WASTES

Commercial radioactive wastes are generated as a result of the beneficial uses of nuclear technology which range from electrical power generation to medical therapy. The radioactive wastes themselves are similar to their defense waste counterparts. Thus, there are numerous synergistic benefits from coordinating defense and commercial transportation technolgoy development. Typically, defense waste systems have served as precursors for development of commerical systems for similar waste forms. Commercial radioactive materials are usually owned or possessed by private licensees of the Nuclear Regulatory Commission or Agreement States during their period of use. Because it is assumed that government organizations will be able to maintain the greatest long-term institutional control, wastes from commercial nuclear activities are disposed of at government owned or supervised sites. It is generally accepted that facilities for long-term storage or disposal in geologic formations will be owned and operated by the Federal Government (note: some states have accepted responsibility for low-level waste disposal sites where shallow or intermediate depth burial is sufficient). This role as final receiver of nuclear wastes is in addition to the Government's responsibility of overseeing and regulating commercial nuclear activities to assure public health and safety.

Commercial nuclear waste activities are thus a mixture of government and private responsibilities. Private companies are shippers and original owners of the waste materials. The Government is a regulator, receiver and final owner of the wastes. This mixed responsibility has lead to difficulties in clearly defining the roles of the respective parties. Since transportation is the link in the middle, it has frequently been the focus of misunderstandings.

The TTC philosophy with regard to commercial waste transportation systems is that private industry will design, license fabricate, own, maintain and operate the needed hardware. This philosophy is not without its problems, since incentives for private industry are uncertain. However, in its responsibilities to protect public interest and to be the central receiver of the waste materials for storge and disposal, the Federal Government will impact commercial waste transportation systems in an effort to improve safety and enhance efficiency. For some activities, such as the West Valley program, the Federal Government has proposed to take ownership and responsibility for wastes at a stage prior to transport. Thus in some limited cases, the Government role regarding commercial waste will parallel its responsibilities for defense waste. A review of transportation activities involved with commercial waste management programs is given by waste program category.

<u>Terminal Isolation Wastes.</u>

The National Waste Terminal Storage (NWTS) Program is the DOE activity focusing on nuclear wastes that will be disposed of in deep geologic formations. Materials ranging from high-level wastes (HLW) (vitrified waste from reprocessing or from canistered spent fuel) to contact-handled transuranic wastes (CH-TRU) are considered for disposal in NWTS repositories. Transportation activities are tied to spent fuel, high-level waste and transuranic waste programs. The NWTS program is coordinated for the DOE by the Office of NWTS Integration (ONI) located at Battelle Memorial Institute in Columbus, Ohio. Major NWTS activities are focused on the evaluation of different geologies (salt, basalt, tuff, and granite) for possible repositories.

It is expected that transportation systems for commercial wastes will be handled by the private sector. However, DOE is involved in developing packaging systems for sample or limited quantity shipments needed for test activities where no economic market exists. Consequently, evaluations are currently underway to determine transportation hardware needed to support these test activities (primarily, the Test and Evaluation Facility). Since a major geologic disposal test facility is planned for the late 1980's with full scale repositories becoming operational about a decade later, a major portion of transportation support includes systems evaluations (assessments of logistics and routing alternatives) needed as input to making NWTS programmatic decisions. Provided that packaging hardware for full scale repositories is supplied by private industry, the main transportation problems faced by the NWTS program relate to obtaining information for system decisions and evaluations and developing efficient package/facility interface criteria and hardware. Activities are currently underway to rank potential improvements in interface hardware and to develop handling technology where needed.

West Valley Wastes.

The Western New York Nuclear Service Center (WNYNSC) facilities include the only commercial nuclear fuel reprocessing plant that ever operated in the U. S. This facility was a fuel receiving and storage facility, a burial site for solid radioactive wastes, and is the location of tanks containing liquid high-level radioactive waste which resulted from the reprocessing operations. Nuclear Fuel Services, Inc. (NFS), commerical operator of the Center, reprocessed fuel there from 1966 to 1972. The plant is now being maintained in a shutdown condition. The facility is located on land that was leased by NFS from New York State. The State of New York requested, in November 1976, that the Federal Government take over the site. DOE has been taking a lead role for the Federal Government activities at the site.

The DOE West Valley (WV) Project, coordinated by DOE Idaho Operations, is presently evaluating options and developing capabilities for the management of the West Valley wastes. Westinghouse Electric Corporation has been selected as the lead site contractor for the WV project. Transportation support activities to date include shipment characterization, cost estimating, risk and environmental impact analyses, logistics assessments, and transportation system/facility interface evaluations. Hardware development activities include the modification of an existing cask to carry liquid high-level waste samples. Since the WV-HLW form is nearly identical to defense high-level waste, the West Valley project has supported the high-level waste cask being developed by GA.

Three Mile Island Waste.

The accident at Three Mile Island (TMI) Unit II resulted in the development of a number of specialized radioactive waste management problems. While the quantity of radioacative waste to be shipped is not particularly significant when compared with the total generated or transported in the U. S., special cases such as high specific-activity resins or deformed, failed fuel require new criteria for packaging systems. DOE involvement with TMI Unit II recovery activity is coordinated through the TMI Technical Integration Office (TIO) and DOE/HQ. Several DOE waste management programs are interested in receiving wastes from TMI for test and experimental purposes. Consequently, DOE has supported research and development necessary to transport these waste forms. Some of the new packaging methods and criteria (e.g. design specifications for a high integrity container) developed will be applicable to other defense and commercial wastes. The quantity of radioactive materials loaded onto zeolites was significantly increased as a result of the DOE-SDS task force. As a result, the number of Submerged Demineralizer System Liners which will be produced from clean-up of the containment building water will be reduced significantly. The TTC has been supporting the assessment of methods for transporting these liners, which contain as much as 60,000 curies of cesium, with a total radioactive material inventory in excess of 100,000 curies.

Low-Level Waste.

Low-Level radioactive waste is defined as radioactive waste not classified as high-level waste, transuranic waste, spent fuel, or byproduct material. This category includes miscellaneous wastes such as filter sludges, resins, contaminated paper and tools, or contaminated chemicals and used medical research materials, generated by the following sectors: 1. Commercial nuclear power plants, 2. Industry (other than commerical nuclear power plants), 3. Medical and educational institutions, and 4. Government and military. Most commercial LLW is packaged and shipped in Type A or Low Specific Activity (LSA) packages to shallow land burial sites. Consequently, LLW transport is very dependent on DOT specification packaging standards. A small amount is carried in Type B packages. Problems regarding LLW transport relate to ensuring the existence of a sufficient quantity of certified packages; providing adequate enforcement of existing regulations and preventing institutional barriers from unnecessarily hindering shipments. As LLW management shifts to regional disposal sites, some concerns with the existing transportation system will change. The DOE has taken the lead in developing a national plan for low-level waste (LLW) disposal. These activities are coordinated by the Idaho Operations Office and its lead contractor, EG&G.

While LLW is produced in government energy research and military programs throughout the country, most of this waste is disposed of at Federal Government owned and operated disposal sites. A small percentage of Department of Defense LLW - from the Navy and from veterans hospitals - is disposed of at commercial facilities. Many of the major government LLW waste generators have waste disposal sites co-located with their installations and thus transportation on public highways is limited or nonexistent. However, as a major generator of LLW, the DOE has traditionally taken a significant role in the development and certification of packagings for LLW, DOE test documentation is frequently cited as the basis for different specification packages being able to meet Type A criteria. However, at the present time no major DOE activities are directed at the transportation of LLW.

Remedial Action Wastes.

Contaminated soils, subsoils, and buildings located at sites used for uranium milling, sampling, assay, separation and purification in support of the U.S. nuclear program in World War II and the decade that followed have been classified as remedial action wastes. The U.S. DOE through the Formerly Utilized Site Remedial Action Program (FUSRAP) or the Uranium Mill Tailing Remedial Action Program (UMTRAP) has identified the sites eligible for remedial action. These actions include site decontamination, stabilization and restoration. Waste materials are generally Low Specific Activity which, if moved in bulk, will require minimum modifications to common bulk-haul technology. Small-quantity remedial action wastes are commonly placed in 55 gallon drums for transport to disposal sites. As a result of the low-specific activity of these materials, no development of transport systems is needed or planned.

SPENT FUELS

Reactor fuel is one material component of the nuclear fuel cycle. After use in a nuclear reactor up to its useful limits, fuel assemblies are called spent fuel and contain residual uranium, plutonium and highly radioactive fission products. The radioactive decay processes of some of these materials also generate decay heat. The properties of spent fuel, including large gamma and neutron radiation doses and heat generation combine with the constraints of transportation regulations to place stringent requirements on spent fuel transport packaging.

Materials, such as uranium ore, uranium hexafluoride and fresh fuel, which precede spent fuel in the fuel cycle, have been transported in large quantities and there is an established commercial capability. However, spent fuel transport is not a large-scale, established industry in the U.S. Many technical and institutional concerns that organizations have about radioactive material transport are focused on spent fuel. Spent fuel is considered a waste by some and a resource by others. As both a user of nuclear fuels and a participant in nuclear power development, the DOE is involved in spent fuel transport. Activities which affect spent fuel transport are reviewed below by reactor type.

LWR Spent Fuel.

Commercial LWR spent fuel is discharged periodically from the nuclear reactors employed in electric power generation. Reactor plant operating history and reactor design characteristics, such as fuel enrichment, design burnup, etc., are among the factors that determine the frequency with which spent fuel is discharged from reactor cores. After discharge from the reactor, spent fuel must be stored, reprocessed, or disposed of permanently. Currently most spent fuel is stored at the reactor plants in on-site pools, the capacity of which is limited. DOE programs to deal with this problem include or have included evaluation of methods to enhance at-reactor storage capacity, development of away-from-reactor interim storage concepts (AFR), support of the development of a reprocessing industry, and development of the capability to directly dispose of spent fuel in geologic respositories.

Although it is anticipated that private industry will bear the responsibility for the development and provision of sufficient spent fuel transportation equipment and services for commercial operations, DOE has provided transportation technology support for LWR spent fuel management programs. Recent emphasis of this support has been placed on developing the capability to transport high-burnup spent fuels and evaluating methods to transport fuel following extended at-reactor storage either using rod consolidation or on-site storage casks.

Breeder Reactor Spent Fuel.

Spent fuel shipping casks are needed for transporting spent fuel from the DOE liquid metal fast breeder reactors (LMFBR). The Fast Flux Test Facility (FFTF) is currently operating and is producing spent fuel which will eventually be shipped to a processing or disposal site. The FFTF has incorporated a supplementary fuel storage facility which will allow the facility to continue operating into the late 1980's without offsite shipments but casks will be needed at that time to move the fuel to another location. Nuclear Packaging, Inc. has developed a cask which is being used for pin shipments and can be used for single assembly transport.

The Clinch River Breeder Plant (CRBRP) will eventually need a spent fuel cask for off-site shipments. A cask conceptual design study has recently been completed and subjected to peer review. However, no further activity is underway at the present time.

Research Reactor Spent Fuel.

A significant amount of spent fuel is produced in various research reactors throughout the United States. A number of these reactors are under the purvue of either the DOE or the National Bureau of Standards. Spent fuel is frequently shipped to the Savannah River Plant for reprocessing. In the past commercial casks were available for these shipments, but the availability of such systems has become limited recently. The DOE possesses some casks which have the capability of transporting these materials, but they are not certified by the NRC. Since most of the reactor operators are NRC licensees, NRC certification is required for the movement of this spent fuel. Activities have been underway to recertify the MH-1A cask for research reactors that use MTR-type fuels.

MISCELLANEOUS DOE MATERIALS

The DOE is also responsible for the transportation of radioactive materials that do not fit into the categories of defense waste, spent fuel, or commercial waste. These materials have characteristics which create specific transportation problems and are reviewed in the following sections.

DOE Beneficial-Use Materials.

The DOE Has developed a sewage solids irradiation system for treating these solids and rendering them safe for beneficial uses such as fertilizer and possibly even as cattle feed. This system uses cesium chloride waste capsules produced as part of the defense program at the Waste Encapsulation and Storage Facility (WESF) at Richland, Washington. Future activities may include developing a system which would use the thermally hotter strontium flouride capsules also produced at WESF in other beneficial uses activities. A shipping cask for transporting these capsules is being developed by SNL. This cask, called the SSITS (Sewage Solids Irradiator Transportation System), will be available in 1984.

Radioactive Sodium Waste.

The DOE and its predecessor agencies have studied the use of sodium as a coolant in many reactors and reactor related facilities. As a result large quantities of radioactive materials contaminated with sodium, or bulk sodium contaminated with radioactive materials have been produced and are in storage. Much of this waste was produced in the 1950's and 1960's and the waste container contents and sometimes the state of the waste container itself is subject to question. DOE is now considering the establishment of one or more sodium processing facilities which would be used to deactiviate the sodium and convert these wastes to either LLW or TRU wastes which could then be disposed of at waste disposal sites. Transportation of these multi-hazard and sometimes poorly defined waste forms has been subjected to a preliminary assessment by Atomics International for the TTC but no long term activities have been established.

CONCLUDING REMARKS

Coordinating the needs of programs with different management, budgets, schedules and direction but with similar transportation technology requirements has been a principal goal of the TTC. For example, each of the DOE programs with transportation problems and concerns has its own central mission. While each of these missions is unique and different, the transportation technology support required for many of the programs is similar or identical. For example, as illustrated above, similar high-level waste forms will be transported for both the West Valley Project and the Defense Waste Processing Facility. Radioactive materials can also be grouped into specific categories for transportation based upon physical parameters such as size, total nuclide content and specific activities. Often materials which are defense waste could be safely transported in the same packagings as similar commercial wastes. Some common groupings of radioactive materials cut across several transportation categories (eg. LLW can be LSA, Type A or Type B), but as mentioned some transportation categories can encompass several material groups. Thus, by coordinating transportation activities on the basis of common features between programs and/or between waste forms, the TTC is providing a framework which can lead to significant cost savings.