POTENTIAL SYSTEM AND ECONOMIC ADVANTAGES OF THE INTRODUCTION OF A SHORT LEGAL WEIGHT TRUCK CASK INTO THE FEDERAL WASTE MANAGEMENT SYSTEM

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ABSTRACT

In previously published work (1), the authors presented the concept and preliminary design specifications for a short legal weight truck cask (SLWT) designed to meet facility interface requirements at key, early waste acceptance reactors, and identified potential avoided costs and system benefits associated with the early introduction of the SLWT cask into the Federal Waste Management System (FWMS).

This paper briefly describes the earlier, conceptual findings, and describes a "proof of concept" analysis that was subsequently performed to estimate the degree of cost savings that could result from introducing the SLWT cask into the FWMS fleet to service waste acceptance operations only at certain identified reactors, as compared to operating a uniform fleet of full-size LWT casks to service all reactors. This paper briefly outlines a preliminary, comparative fleet size/composition analysis that was performed; then, for certain identified reactors, compares utility and U.S. Department of Energy (DOE) handling and shipment costs for *SLWT* and full-size LWT cask fleets. We conclude that significant operating cost savings could be contributed by the SLWT casks.

INTRODUCTION

In the early days of development of commercial nuclear power reactors in the U.S., the overall length and uranium loading of the fuel assemblies were considerably less than those of later generation facilities. In turn, some of these facilities were designed for handling shorter casks than currently-certified transportation casks. The spent fuel assemblies from these facilities are nearly all standard fuel within the definition in the Standard Contract (10 CFR 961) between the utilities and the U.S. Department of Energy (DOE) (the Big Rock Point fuel cross-section is outside the standard fuel dimension), and the utilities involved hold early delivery rights under DOE's oldest-fuel-first (OFF) allocation scenario. However, development of casks suitable for satisfying the acceptance and transportation requirements of some of these facilities is not currently underway in the DOE Cask Systems Development Program (CSDP). While the total MTU of these fuels is relatively small compared to the total program, the number of assemblies to be transported is significant, especially in the early years of operation according to the OFF allocation scenario. We therefore perceive a current need for DOE to develop an approach and to implement plans to satisfy the unique acceptance and transportation requirements of certain reactor facilities at which: a. Facility constraints may limit the size and weight of a transport cask that can be efficiently handled, and b. Fuel assembly characteristics may require special transport casks in order to optimize cask capacity (payload).

In a previously-published paper (1), the authors provided an assessment of the cask-handling capabilities at certain identified reactors, and provided a concept design and physical and material specifications of a "short" (140" internal cavity) legal weight truck cask (SLWT), with multiple baskets, which could reasonably satisfy the following objectives at eight of the reactor facilities considered: a. To minimize or eliminate modifications to facilities, tech specs and/or operating procedures, and the need for special equipment which would be required to accommodate full-size LWT casks (180" internal cavity); b. To optimize cask capacity; and c. To eliminate early system dependence on an anticipated, limited supply of full-size casks (existing and projected new designs) to satisfy the unique requirements of the eight early-generation reactors.

The SLWT cask described would enable efficient waste acceptance operations to take place at three reactor facilities which could not handle a full-size transport cask without making significant modifications and/or resorting to on-site dry transfer from a small transfer cask (Indian Point 1, La-Crosse, and Big Rock Point). For all of the eight "constrained" facilities described on Table I, utilization of the SLWT cask would significantly decrease at-reactor handling time, resulting in a system-wide increase in waste acceptance capability. System-wide efficiency would be further enhanced by SLWT cask capacity; the SLWT cask would have significantly greater transport capacity than both existing LWT casks (up to 5 to 6 times the capacity), and projected, new LWT casks (approximately 2 times the capacity).

In this paper we will compare the handling and shipment costs associated with the SLWT cask with those of existing LWT casks and of projected, new LWT cask designs.

APPROACH AND METHODOLOGY

An assessment was made of the size and composition of the fleet of legal weight truck transportation casks that will be required by the Federal Waste Management System (FWMS), both with and without the short LWT cask. The full-size LWT cask utilized in this preliminary analysis was assumed to be of a new design with a greater carrying capacity than that of currently-certified LWT casks (2 PWR/5BWR as compared to 1 PWR/2 BWR spent fuel assemblies).

This assessment of truck cask fleet size/composition requirements was made for each year of FWMS operation, according to the OFF allocation scenario, until the last of the fuel assemblies listed on Table I was "accepted" into the analysis. The purpose of this preliminary analysis was to establish the comparative size of both the full-size and the "mixed" LWT cask fleets, to assess the reasonableness of the acquisition schedule and cost for the mixed fleet, and to determine the useful life of the SLWT casks within the mixed fleet. This analysis revealed that all of the SLWT casks that

TABLE I
Comparison of Number of Trips for Alternative Cask Capacities

		Cask Capacities			No. of Trips		
Reactor (Generator & Storage Facility, Except as Noted	Total No. of Assemblies	Existing LWT(a)	Projected LWT(a)	Short LWT	Existing LWT	Projected LWT	Short LWT
Big Rock Point (c)	560	2(b)	8(b)	5	280	70	112
Humboldt Bay (c)	389	2	5	12	195	78	33
LaCrosse (c)	333	2	5	5	167	67	67
Yankee Rowe	533	1	2	4	533	267	134
Dresden 1	889	2	5	12	445	178	75
Indian Point 1 (d)	160	1	4	5	160	40	32
Haddam Neck (e)	1,450	1	2	4	1,450	725	363
San Onofre 1 (f)	665	1	2	4	665	333	167
Total Cask-Trips					3,895	1,758	983

a. Estimated assuming that basket designs would be modified as required.
b. Estimated assuming that double-stacking of fuel assemblies may be possible.
c. Special equipment and procedures required for full-size LWT cask.
d. Significant facility modifications and special equipment/procedures required for full-size LWT cask.
e. Of the 1,450 assemblies to be generated by Haddam Neck: 82 are stored at Morris.
f. Of the 665 assemblies generated by San Onofre 1: 395 are stored at San Onofre and 270 are stored at Morris.
Source: E. J. Bentz & Associates

would be required to service waste acceptance operations at the eight identified reactor facilities would need to be acquired within the early years of FWMS operation; that the overall acquisition schedule and cost for the mixed fleet appeared to be advantageous; and that the SLWT casks would enjoy a standard useful life within the fleet; the analysis also confirmed that the introduction of the SLWT casks improved the overall efficiency of the fleet (i.e., increased the utilization of the full-size LWT casks).

Comparative Cost Analysis

For the eight identified reactor facilities, the handling and shipment costs were assessed for each of three LWT cask fleets: a fleet of currently-certified casks (capacity 1 PWR/2 BWR spent fuel assemblies); a fleet of projected, higher-capacity (2/5) full-size casks (these analyses assumed that suitable baskets would be developed for the full-size casks -- see Table I); and a fleet of SLWT casks with multiple baskets, for which the carrying capacities for each of the eight reactors is identified on Table I.

The analysis included handling costs at the origin (reactor) and at the destination (Federal facility), and shipment costs. Cost estimating procedures were derived from other DOE-sponsored work (2, 3); DOE handling and transit time assumptions were modified to more conservative estimates by the authors. The procedures for estimating cask loading and unloading costs include variable costs per number of assemblies loaded/unloaded, in addition to fixed estimated costs per cask loading/unloading. Handling time and crew size assumptions are different for at-reactor loading and Federal-facility unloading.

The handling cost estimates presented in this paper reflect comparative cask processing times; their calculation includes time, crew size, and unit labor charges. At-reactor handling costs are borne by both the utility and by DOE; handling costs at the destination are borne solely by DOE. The DOE portion of the at-reactor handling costs is represented in the estimating procedure by a set of fixed, pick-up costs/cask, whereas the utility at-reactor handling costs were treated in this analysis as including both a set of fixed costs per cask -- representing cask entry to/exit from the reactor facility -- and variable costs reflecting the number of spent fuel assemblies loaded into each LWT cask design considered. The handling cost savings presented below as attributable to the higher-payload, SLWT casks are conservative estimates reflecting a fewer number of SLWT cask loadings; in order to remain conservative, the fixed loading costs per cask design were not varied, in spite of the authors' conviction that, for the eight reactors considered, SLWT cask processing time would be less than that of the full-size LWT casks. Comparative DOE unloading costs were estimated by the same procedure as described above.

Estimated shipment costs *include a truck* hauling charge, a second driver charge, a truck security cost, and demurrage charges. The major variables, per round trip, are the distances travelled, the loaded and unloaded cask weights, and estimated cask handling times at the reactor (for estimated demurrage charges). The comparative costs reported in this paper are based on the DOE-estimated mileage between the eight identified reactors and a generic, Eastern MRS (4). An analysis based on shipments to a Western Federal facility would be expected to result in increased cost savings resulting from the utilization of the SLWT casks.

FINDINGS

Number of Trips

The number of cask trips needed to transport the "short" fuel assembly inventory dramatically decreases with the use of the higher-capacity, SLWT casks. The comparative number of trips for three cask fleets is depicted on Table I, by reactor served. Figure 1 summarizes the required cask trips for the three cask designs considered: existing LWT casks; projected, improved-capacity full-size LWT casks; and the SLWT casks. The use of existing LWT casks would require almost four times as many trips as the SLWT casks; and the use of improved-capacity full-size LWT casks would require almost twice as many trips as the SLWT casks.

The significant reduction in the number of cask trips afforded by the higher-capacity, SLWT casks would result in significantly fewer cask-handling operations at both the reactor and the destination facility, and less incident-free radiation exposure to the public during shipment.

Shipment Cost Savings

Figure 1 also depicts the significant savings in shipment costs associated with the use of the SLWT casks; the estimated savings are more than $39 million ('92 constant dollars) compared to the existing LWT casks, and over $10.5 million compared to the projected, improved-capacity full-size LWT casks. These cost savings are attributable to the significant reduction in the number of required cask trips for the SLWT casks.

Total DOE Operating Cost Savings

DOE operating costs consist of shipment costs (above), at-reactor handling costs, and unloading costs at a Federal destination. All these costs are borne by DOE from waste fund allocations. The estimated DOE cost savings attributable to the use of the SLWT casks are depicted in Fig. 2. The utilization of the SLWT casks represents a significant economic advantage over the use of existing LWT casks (a savings of $85 million), and over the use of the projected, improved-capacity full-size LWT casks (a savings of $23 million). In each case, these savings alone would be more than sufficient to justify the acquisition of the SLWT cask fleet. In addition, the authors

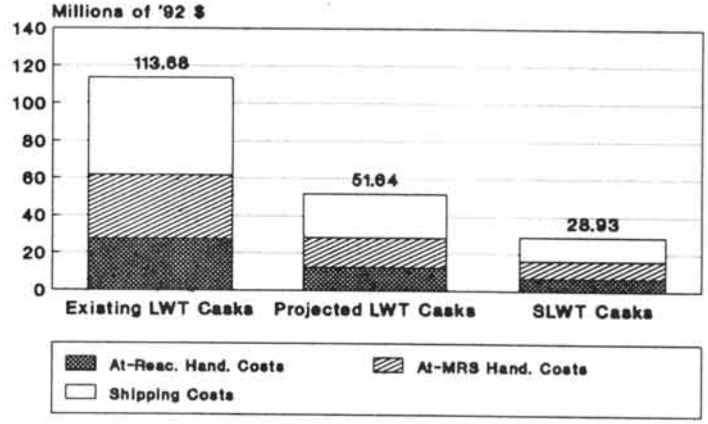

Fig. 2. Total DOE handling & shipping costs for three cask designs.

believe that the SLWT casks will be able to provide additional hauling services for the FWMS (other than of short fuel assemblies).

At-Reactor Cost Savings

The utilization of the SLWT casks also offers a significant economic advantage to the identified, "short" fuel utilities. The utilities are estimated to collectively realize a cost savings compared to the existing LWT casks of over $15 million, and to realize a savings compared to the projected, improved-capacity full-size LWT casks of over $4 million. In addition, reduced cask handling operations attributable to the use of the SLWT casks would be expected to reduce at-reactor occupational exposure.

Figure 3 summarizes the total DOE and Utility Costs for each of the three cask fleet design alternatives assessed.

Capital Cost Savings

Additional savings could be realized in the reduction in the capital cost of overall cask fleet acquisition. The preliminary investigations outlined earlier in this paper revealed that a significant reduction in overall truck cask fleet size (full-size LWT and SLWT casks) could result from the early introduction of the SLWT casks into the FWMS fleet. The SLWT casks

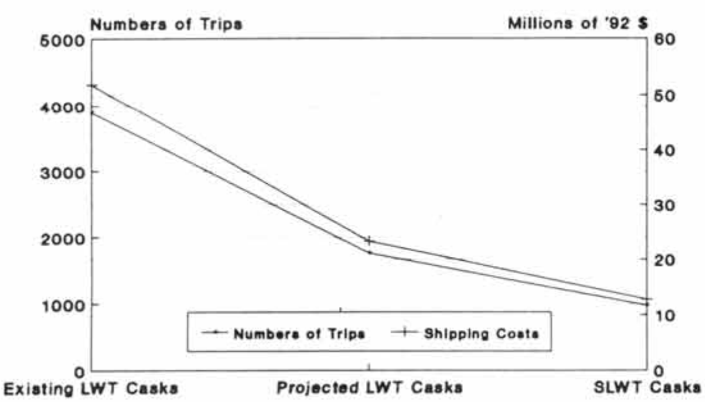

Fig. 1. Comparison of numbers of trips & shipping costs for three cask designs.

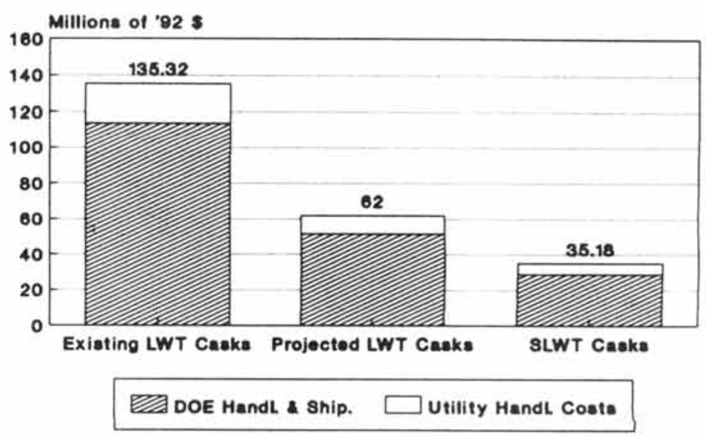

Fig. 3. Total handling & shipping costs for three cask designs.

considerably increased overall fleet utilization, enabling more efficient use of the full-size LWT casks, and resulting in a need for fewer numbers of full-size LWT casks. The analysis revealed that each SLWT cask acquired (up to an optimal number) replaced a full-size LWT cask on a greater than one-for-one basis. This is very evident with regard to both existing LWT casks and projected, improved-capacity full-size LWT casks. It appears that the introduction of the SLWT casks into the FWMS fleet would permit a rational leveling of the number of full-size LWT casks required to meet peak, short and mid-term needs, while avoiding the necessity for holding idle surplus full-size LWT cask capacity later in their physical cask life.

Avoided At-Reactor Dry Transfer Costs

The SLWT casks would enable the three identified early waste acceptance facilities offering severe limitations to full-size LWT casks to avoid the need for facility modifications or small-cask-to-large-cask dry transfer systems. This could result in additional, significant cost savings to those utilities.

CONCLUSIONS

The FWMS may realize significant cost savings for both DOE and the utilities by utilizing "short" LWT casks that have been designed to minimize handling and to optimize payload at eight identified early waste acceptance reactors -- in addition to facilitating access to those facilities and eliminating the potential need for at-reactor facility modifications or small-cask-to-large-cask dry transfer systems. These potential savings could be realized with respect to using the SLWT casks at these facilities instead of using either existing LWT casks or projected, improved-capacity full-size LWT casks.

The projected savings in transport handling and shipping costs realized by DOE alone would be more than sufficient to offset the cost of the acquisition of the projected SLWT cask fleet. These savings have been estimated without regard to additional potential uses of the SLWT cask fleet (other than for transport of "short" fuel assemblies). These potential savings could be realized in the early waste acceptance years. As mentioned above, there would be additional savings in handling system and operating costs realized by the utilities serviced by the SLWT casks.

There are additional savings anticipated for the FWMS associated with higher overall fleet utilization and reduced capital costs directly attributable to the introduction of the SLWT casks into the fleet in the early waste acceptance years.

The proposed introduction of the SLWT cask into the FWMS represents a projected significant reduction in the number of cask handling operations (both at reactor and at destination) and in the necessary number of cask trips, with associated projected reductions in incident-free occupational and public radiation exposure.

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