TVA/OP/FUE--84/1

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SPENT NUCLEAR FUEL MANAGEMENT PROGRAM

INTEGRATED CASK STORAGE SYSTEMS FOR STORAGE, TRANSPORTATION, AND DISPOSAL OF SPENT NUCLEAR FUEL

The Tennessee Valley Authority (TVA) has been actively developing spent fuel management alternatives since the mid-1970s when it became apparent that there would be substantial delays in reprocessing. In 1979 TVA completed a comprehensive study of storage alternatives that concluded (1) it was desirable to utilize existing plant storage pools to the maximum extent practical and provide any additional storage that may be required at the power plant site, (2) spent fuel would be stored onsite for as long as necessary until DOE supplied further disposition, and (3) it was desirable to develop passive dry storage systems as alternatives to building new pool storage facilities. Since 1979 TVA has participated in conceptual design studies of dry storage vaults, silos, casks, and dry wells, and, with DOE and others, has undertaken limited demonstrations of rod consolidation and cask dry storage at TVA's Browns Ferry Nuclear Plant in Alabama.

When studying alternatives for onsite storage, it is apparent that factors affecting the choice of a particular technology are subject to a great deal of uncertainty. Moreover, the choice is quite sensitive to the scope of the problem being considered. But since the utility ratepayer must pay the full cost of spent fuel management, whether direct responsibility is with DOE or the utilities, it is essential to analyze the total back end of the fuel cycle. In cooperation with EPRI, TVA has utilized probability methods in a systems approach to evaluate the full scope of spent fuel management from reactor discharge to emplacement in a repository. We included the

full life cycle of any additional facilities. TVA developed the computer models that can be used to project the amount of spent fuel produced, when fuel can be shipped offsite, and the spent fuel management system's total cost. The Boeing Engineering and Construction Company under contract to EPRI has developed generic normalized facility cost data for available dry storage conceptual designs. The model and data will be available through EPRI so utilities can analyze alternatives appropriate to their particular circumstances and gain a better understanding of the risks and costs associated with various scenarios.

The model has been used by TVA to evaluate the development potential for integrated cask systems using our two-unit Sequoyah Nuclear Plant as an example. The effects of fuel rod consolidation, cask capacity, and whether the cask is used for storage, storage and shipment, or storage, shipment, and as a disposal container are considered. Sequoyah has a 10-percent probability of encroaching on full core reserve by mid-1994, and we expect to be placing fuel in additional onsite storage over about a 15-year period if we do not expand in-plant pool storage beyond the existing high density rack capacity. This takes into account uncertainty in when DOE will start accepting fuel at a rate equal to the discharge rate. There is about a 50-percent chance storage requirements will be above or below 530 metric tons, and there is a 10-percent chance that requirements will be as low as 230 or as high as 725 tons. For the median case with the integrated cask system, we estimate the potential overall savings to be about $75 million in 1983

dollars for large casks used for storage and transportation with consolidated fuel or $100 million if the cask can also be used for disposal. This corresponds to an overall spent fuel management saving of about 40 percent in terms of the current one-mill/kWh nuclear generation fee being paid to DOE for waste disposal. For all of the TVA plants the impact could be as much as one-half billion dollars which translated to a national basis would amount to several billions of dollars.

In this integrated concept a large part of the saving is in transportation and disposal costs which are outside the direct scope of utility responsibility under the Nuclear Waste Policy Act of 1982. The Government is responsible for transportation and disposal, as well as providing emergency away from reactor and monitored retrievable storage (MRS) facilities if they should be necessary. Although not included in existing contracts, DOE has acknowledged the possibility of credits to utilities that take action to reduce DOE's cost. But even without these credits it would be desirable for TVA to help reduce the overall spent fuel management cost since our ratepayers will bear the cost whether incurred directly for onsite storage or through the fee paid to DOE.

In conclusion, TVA believes the integrated storage cask concept is worthy of consideration as an alternative for spent fuel management. Placing spent fuel in a secure passive storage mode at an early date and avoiding unnecessary handling and repackaging reduces the potential for occupational and public radiological exposure. Therefore the notion of a universal cask used for storage, shipment, and disposal is appealing from a safety,

environmental, and public perception standpoint. The universal cask can also serve as a dispersed MRS, thus eliminating the need for redundant facilities, and it does not foreclose future options. It also appears that this concept would simplify repository design, ease retrievability, and provide greater flexibility in repository siting.

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TVA SPENT FUEL MANAGEMENT PROGRAM

COMPLETED ACTIVITIES

MID-1970S - REPROCESSING DELAYED - HIGH DENSITY RACKS INCORPORATED IN ALL TVA PLANT POOLS.

1978-79 - A. JOINT TVA/DOE STORAGE FACILITY PROPOSED.

B. POOL STORAGE FACILITY CONCEPTUAL DESIGNS.

C. TVA STUDY OF CENTRAL VS ONSITE FACILITIES.

1. PLAN TO KEEP SPENT FUEL ONSITE UNTIL DOE PROVIDES ALTERNATIVE.

2. STUDY AND ENCOURAGE DEVELOPMENT OF PASSIVE DRY STORAGE AND ROD CONSOLIDATION.

1980-82 - STUDIES COMMISSIONED.

1. GEC/ESL - VERTICAL CANYON.
2. TN/NUCHEM - HORIZON CANYON.
3. GA/EWE - MODREX.
4. EEI/W - DRYWELL.
5. BOEING - OPTIMIZED ONSITE CASK TRANSPORT.
6. BOEING - ONSITE TRANSPORTER.

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CURRENT ACTIVITIES

CASK DEMONSTRATION - 2-YEAR MONITORED DRY STORAGE IN TWO CASK DESIGNS.

A. TVA/GNS/DOE - CASTOR 1C, LICENSED IN FRG, NODULAR CAST IRON, 16 BWR ASSEMBLIES, 1-YEAR-OLD FUEL, COMPLEMENTARY TO WURGASSEN DEMONSTRATION.

B. TVA/DOE - REA 2303, STEEL-LEAD WITH WATER-GLYCOL NEUTRON SHIELD, 52 BWR ASSEMBLIES, 5-YEAR-OLD FUEL, NO OFFSITE TRANSPORT WITHOUT AN OVERPACK.

ROD CONSOLIDATION DEMONSTRATION.

A. TVA/DOE - 12 BWR ASSEMBLIES, 1.6 COMPACTION IN NEW CLOSER SPACED GRID, 2.0 IN "OPEN" CANISTER.

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TVA SPENT FUEL MANAGEMENT PROGRAM

ONGOING ACTIVITIES

FUEL PERFORMANCE STUDIES

A. TVA/EPRI/W/HEDL - LABORATORY EXPERIMENTS WITH IRRADIATED FUEL RODS TO DETERMINE THE ALLOWABLE TEMPERATURE LIMIT FOR SPENT FUEL IN DRY STORAGE IN AN AIR ENVIRONMENT.

B. COMPLEMENTARY TO STUDIES BEING CONDUCTED BY NRC AND BY DOE PNL.

ALTERNATIVE EVALUATION

COOPERATIVE PROGRAMS WITH EPRI/BOEING TO DEVELOP A DECISION ANALYSIS METHODOLOGY FOR ALTERNATIVE EVALUATIONS AND A NORMALIZED DATA FILE. THIS WORK IS NEARING COMPLETION.

INTEGRATED CASK SYSTEM

USING THE ABOVE METHODOLOGY AND DATA FILE, AN INITIAL ECONOMIC ANALYSIS HAS BEEN MADE OF THE INTEGRATED CASK SYSTEM IC STORAGE, TRANSPORT, AND DISPOSAL IN THE SAME CASK. RESULTS INDICATE POTENTIAL RATEPAYER SAVING OF HUNDREDS OF MILLIONS OF DOLLARS COMPARED TO ADDITIONAL ONSITE POOL STORAGE.

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FIGURE 1
SEQUOYAH NUCLEAR PLANT
PROBABILISTIC SPENT FUEL
STORAGE REQUIREMENTS FORECAST

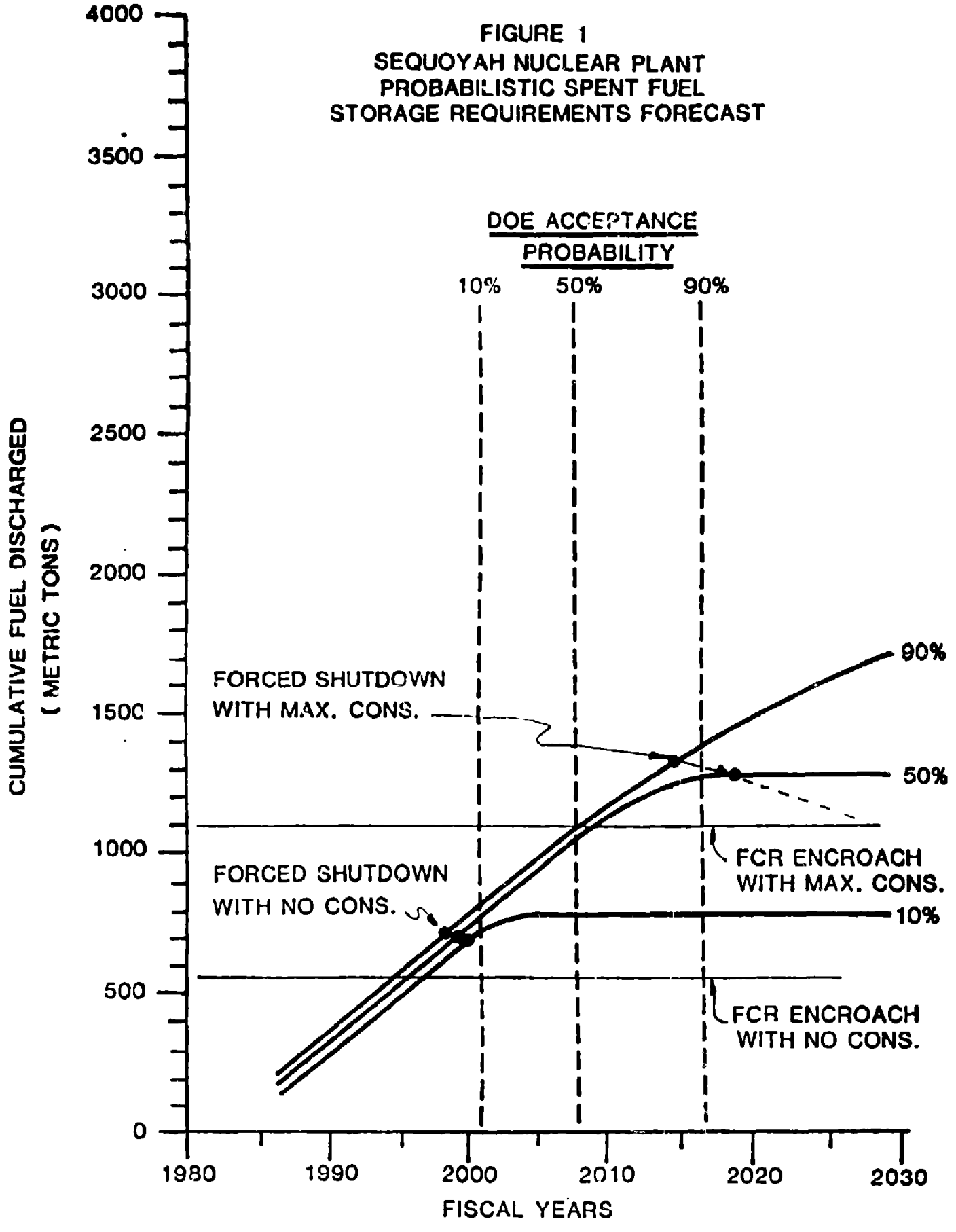

TABLE 1

TVA SPENT FUEL STORAGE NEEDS

	In-Plant Pool Storage Capacity (Metric Tons)	10% Prob. Full Core Reserve Encroachment (Fiscal Yr.)	Additional Spent Fuel Storage Needs (Metric Tons)			Expected Storage Loading Duration (Years)
			10% Prob. Less Than	Expected Value	10% Prob. Greater Than	
No Consolidation						
Sequoyah	640	1994.5	230	532	725	14.8
Watts Bar	605	1997.5	160	333	640	12.1
Browns Ferry	1,897	1999.0	0	371	650	6.9
Bellefonte	964	2009.0	0	35	200	1.0
Full (2.0) Consolidation						
Sequoyah	1,240	2008.5	0	33	175	2.1
Watts Bar	1,150	2010.5	0	19	130	0.9
Browns Ferry	3,700	Never	0	0	0	0
Bellefonte	1,871	Never	0	0	0	0

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FIGURE 2

DECISION FLOW NETWORK
OF
INTEGRATED CASK STORAGE SYSTEM

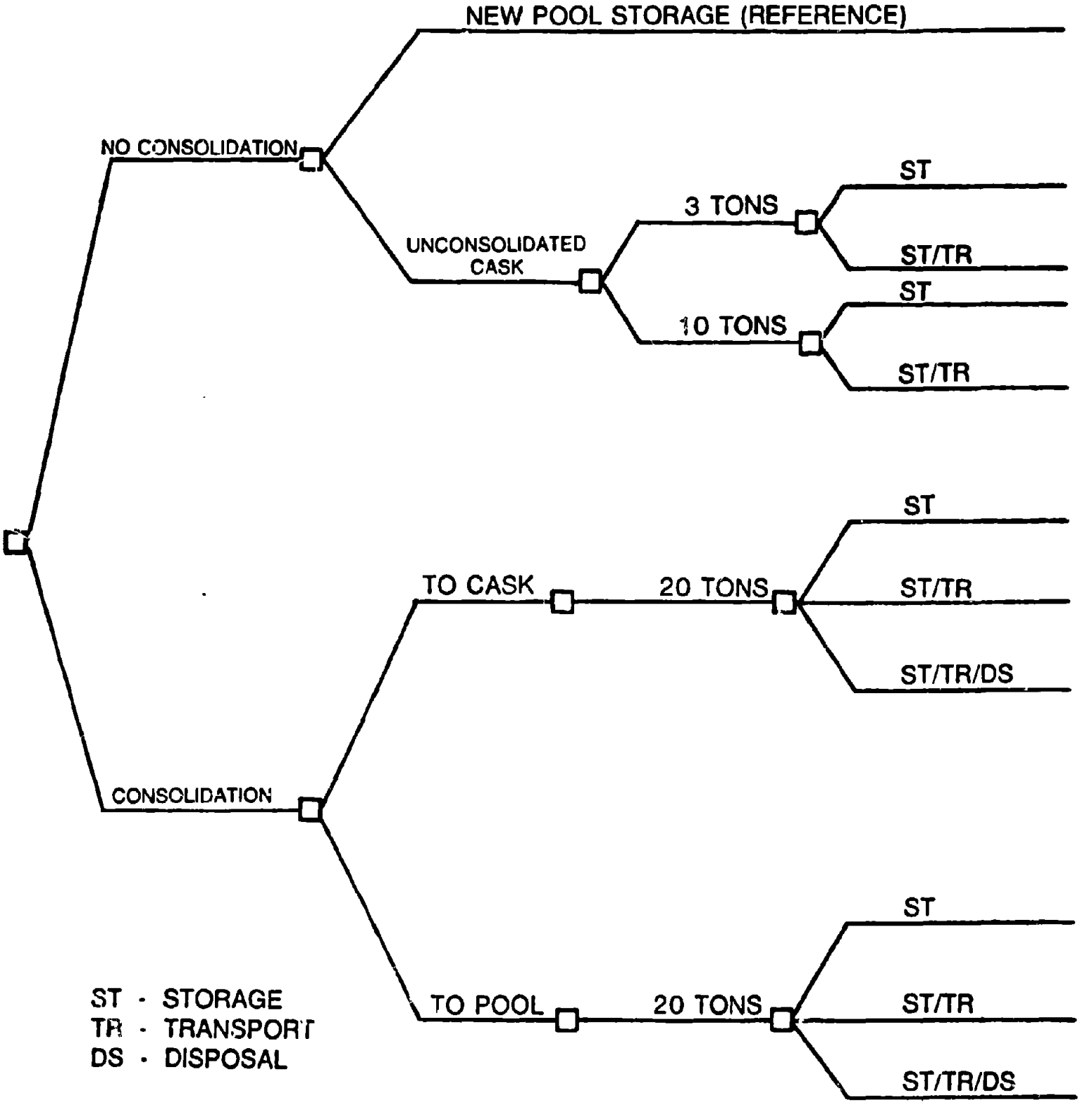

TABLE 2

SEQUOYAH NUCLEAR PLANT
NOMINAL SPENT FUEL MANAGEMENT COST
PRELIMINARY COMPARISON OF DRY CASK STORAGE TECHNOLOGY
WITH AND WITHOUT ROD CONSOLIDATION TO ADDITIONAL POOL STORAGE
(MILLIONS OF PRESENT WORTH 1983 DOLLARS)

	ONSITE COST					OFFSITE COST				
STORAGE TECHNOLOGY	CONSOLIDATION	ADDITIONAL HANDLING	FACILITY CAPITAL	O&M DECOMMISSIONING	TVA TOTAL	HANDLING SHIPMENT	HANDLING PACKAGING	DISPOSAL	DOE[1] TOTAL	TOTAL COST
NEW POOL (REFERENCE)	-	0.466	37.2	42.5	80	17.4	17.1	145[1]	180	260
UNCONSOLIDATED CASK										
3-TON ST	-	0.376	43.5	9.87	54	17.5	17.2	145	180	234
3-TON ST/TR	-	0.188	43.5	9.87	54	14.7	17.2	145	177	231
10-TON ST	-	0.221	19.3	3.57	23	8.09	16.4	145	169	192
10-TON ST/TR	-	0.103	19.3	3.57	23	5.87	16.4	145	167	190
CONSOLIDATED TO CASK[2]										
20-TON ST	13.0	0.103	10.5	3.57	27	5.34	8.13	145	158	185
20-TON ST/TR	13.0	-	10.5	3.57	27	4.12	8.13	145	157	184
20-TON ST/TR/DS*	13.0	-	15.9	3.57	32	4.12	-	131	135	167
CONSOLIDATED TO POOL[3]										
20-TON ST	12.8	0.103	-	-	13	5.34	8.13	145	158	171
20-TON ST/TR	12.8	0.103	-	-	13	5.34	8.13	145	158	171
20-TON ST/TR/DS	12.8	0.103	-	-	13	15.9	-	131	147	160

*ST/TR/DS INDICATES THAT THE SAME CASK IS USED FOR STORAGE, TRANSPORTATION, AND DISPOSAL.

1. BASED ON A NOMINAL ONE MILL/KWH, DOE'S TOTAL COST IN THE REFERENCE CASE CORRESPONDS TO ABOUT $180 MILLION WITH CHARGES CALCULATED THROUGH DIFFERENTIAL ANALYSIS.
2. OLDEST FUEL IS CONSOLIDATED AND PLACED DIRECTLY IN CASK.
3. POOL STORAGE IS INCREASED BY CONSOLIDATING FUEL AND RETURNING TO STORAGE RACK AND THEN TO CASK WHEN POOL IS FULL OR DOE ACCEPTS.

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CONCLUSIONS

1. CONSIDERABLE UNCERTAINTY REMAINS AS TO HOW MUCH ADDITIONAL SPENT FUEL STORAGE UTILITIES MUST PROVIDE AND FOR HOW LONG.

2. ROD CONSOLIDATION CAN SIGNIFICANTLY INCREASE STORAGE IN THOSE POWER PLANT POOLS ABLE TO ACCOMMODATE THE ADDITIONAL STRUCTURAL AND THERMAL LOADS.

3. A SYSTEMS APPROACH TO THE BACKEND OF THE FUEL CYCLE IS NEEDED TO MINIMIZE SPENT FUEL MANAGEMENT COSTS AND ENVIRONMENTAL IMPACTS.

4. DEVELOPMENT OF AN INTEGRATED STORAGE/TRANSPORT/DISPOSAL CASK SYSTEM IN CONJUNCTION WITH ROD CONSOLIDATION WOULD GREATLY SIMPLIFY AND REDUCE THE COST OF MANAGING SPENT FUEL.

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