Exhibit 4

THE TRANSPORTATION OF SPENT NUCLEAR FUEL AND HIGH-LEVEL WASTE:

A Systematic Basis for Planning and Management at National, Regional, and Community Levels

September 10, 1996

Prepared for
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ABBREVIATIONS

BN	Burlington Northern Railroad
BWR	Boiling Water Reactor
CCP	"Current Capabilities" Scenario
CNW	Chicago and North Western Railroad
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EIS	Environmental Impact Statement
EM	Environmental Management
FICA	Facility Interface Capabilities Assessment
FRA	Federal Railroad Administration
GA	General Atomics
GE	General Electric
GTW	Grand Trunk Western Railroad
HANF	Hanford
HLW	High-Level Radioactive Waste
HM164	Hazardous Materials Regulation 164
HTG	High Temperature Gas
INEL	Idaho National Engineering Laboratory
LWT	Legal-Weight Truck
MPC	Multi Purpose Canister
MSC	Miscellaneous Spent Nuclear Fuel
MTU	Metric Tons of Uranium
MXR	"Maximum Rail" Scenario
NAC	Nuclear Assurance Corporation
NRC	Nuclear Regulatory Commission
NSP	Northern States Power
NSTI	Near-Site Transport Infrastructure
OCRWM	Office of Civilian Radioactive Waste Management
O-D	Origin-Destination
PSG&E	Public Service Gas & Electric
PWR	Pressurized Water Reactor
RSA	Regional Servicing Agent
RSC	Research Reactor Fuel
SF	Santa Fe Railroad
SNF	Spent Nuclear Fuel
SP	Southern Pacific Transportation Company
SRS	Savannah River Site
TMI	Three Mile Island
UP	Union Pacific Railroad
TVA	Tennessee Valley Authority
WVDP	West Valley Demonstration Project

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SUMMARY

To describe a national shipment campaign in a fashion which provides the inputs needed for risk and impact analysis as well as the information needed for coordinated planning and management requires an integrated assessment process for systematic consideration of at least the following factors:

- Waste origins, storage locations, and shipment sites
- Waste inventory: current and projected
- Waste acceptance startup and rate
- Priorities for waste acceptance and pickup
- Waste shipment groups
- Transportation cask options
- Transportation mode and cask choices by shipment site
- Routing criteria and routing options

Consideration of these factors enables one to provide useful information in response to basic questions regarding the shipment campaign in prospect under legislation proposed in the 104th Congress: e.g., How many cask shipments are expected? In which acceptance/pickup years? On which rail and highway routes? Through which states and communities? Sections 1 through 15 of this report discuss the factors in an integrated assessment process for a national shipment campaign, the assumptions used in this analysis, and the sources and bases for these assumptions. Sections 16 through 20 discuss the results of alternative scenarios involving three sets of transportation mode and cask choices, and two regional routing options. Section 21 illustrates a process for assembly of additional information on route features needed in risk analysis and management of transportation operations.

Three alternative sets of transportation cask choices at 80 shipment sites are considered:

- An assessment of *current capabilities* for cask loading and near-site transportation suggests that 32 commercial plant sites could choose to ship by legal-weight truck—either in currently-available casks for highway transport of uncanistered fuel or in a high-capacity cask such as the GA-4/9, if and when available.

- An *MPC base case* scenario of transportation choices could reduce to 17 the number of commercial sites shipping by legal-weight truck, and encourage 14 sites to use large-capacity rather than smaller capacity rail casks. However, implementation of the MPC base case requires investments to improve loading capabilities and/or near-site transportation at many sites, plus provision of as-yet-uncertified high-capacity transportation casks and canisters.

- A *maximum rail* scenario of transportation choices could reduce to three the number of commercial sites shipping by legal-weight truck. The maximum rail scenario is almost identical to the scenario assumed by DOE in its recent strategy study for transport to a potential repository at Yucca Mountain.

The *current capabilities* scenario results in 79,300 legal-weight truck casks shipped 62.3 million miles on 13,700 miles of the nation's public highways, *plus* 12,600 rail casks shipped 14.0 million miles

on 18,800 miles of the nation's railroads. The high-capacity legal-weight truck cask, if available and used consistently, could reduce highway transport to 31,400 casks shipped 14.7 million miles. Implementation of the *MPC base case* scenario with high-capacity truck casks could further reduce highway transport to 6,300 casks shipped 5.7 million miles over 10,200 miles of the nation's public highways. These reductions, however, would require investments to improve loading and/or near-site transportation capabilities at 29 sites, and would also involve increases in rail cask shipments (10 percent), rail cask shipment miles (9 percent), and rail route miles affected (13 percent). Implementation of the *maximum rail* scenario would further reduce highway transport to 1,150 high-capacity casks shipped 1.0 million miles over 4,200 miles of the nation's public highways. These reductions would require further investment in loading and/or near-site transportation capabilities at 14 sites, and it would also involve further increases in rail cask shipments (9 percent), rail cask shipment miles (10 percent) and rail route miles affected (11 percent).

Different phases of the 30-year shipment campaign affect different portions of the nation's rail and highway networks to different extents. For example, truck shipment comprises 35 percent of the 86,600 metric tons shipped under the *current capabilities* scenario of transportation choices, but 66 percent of the 4,400 metric tons shipped in the first three years of the 30-year shipment campaign. Truck shipment comprises 11 percent of the MTU shipped under the *MPC base case* scenario, but 27 percent in the first three years. These differences reflect the loading and near-site transportation capabilities of sites storing fuel with high-priority for acceptance and pickup.

Perspectives on a national shipment campaign tend to correlate with one's position as an origin, corridor or destination community for shipments of highly-toxic and long-lived radioactive materials. Under the *MPC base case* scenario (default routing), seven states comprising two percent of the nation's population are neither origins, corridors nor the destination for shipments of SNF or HLW. Another seven states comprising 18 percent of the nation's population are origins for such shipments but not corridors for shipments from other states. Still another seven states plus the District of Columbia are corridors but not origins for such shipments; these comprise seven percent of the nation's population. Twenty-eight states comprising 71 percent of the nation's population are both origins for SNF or HLW shipments and corridors for shipments originating elsewhere. The major corridor states under the MPC base case scenario (default routing) are Utah (65 sites), Nebraska (60 sites), Wyoming (58 sites), Illinois (47 sites), Iowa (32 sites), Kansas (28 sites), Missouri (27 sites) and Indiana (25 sites).

All shipments converge in Nevada, the destination state and intended permanent storage location for the nation's SNF and HLW. Nevada has about 0.5 percent of the nation's population. Under default routing, truck shipments enter the state on I-15, either from California moving north alongside the Las Vegas Strip, or from Arizona moving southwest through the Moapa Indian Reservation. Accessing US-95 at the interchange locally known as the "Spaghetti Bowl," truck shipments move northwest through rapidly developing Las Vegas suburbs, entering the Nevada Test Site at the Lathrop Wells, in the Nye County community of Amargosa Valley. Rail shipments enter the state on the Union Pacific railroad, either from California moving north alongside the Strip and through Las Vegas and the Moapa Indian Reservation, or from Utah south to the Lincoln County community of Caliente. At Caliente, rail casks would be transferred to heavy-haul trucks for shipment along U.S. highways and state roads, accessing the Nevada Test Site via a newly constructed road across the Nellis Air Force Range (a 162-mile journey), or continuing on public highways along a circuitous route north and west of the Nellis Air Force Range.

Many departures from default routing could occur as states consider designated alternative routes for "highway route-controlled quantities" of SNF and HLW, and as utilities consider alternative railheads for rail shipments and carriers consider implications for rail freight traffic. These departures have implications, some major, others minor, for the national routing system for SNF and HLW shipments—which route segments are affected, when and to what degree. One major option is a "consolidated southern" routing in which truck shipments from the East and Midwest are oriented to I-40 through St. Louis, Oklahoma City, and Albuquerque rather than to I-80 and I-70, and rail shipments are oriented to the Santa Fe lines through Kansas City, Amarillo and Barstow rather than to the Union Pacific through Nebraska and Wyoming or the Southern Pacific through Kansas and Colorado.

The assessment compares cask shipments under default and consolidated southern routing for five rail and five highway route segments in four states (Wyoming, Colorado, New Mexico, and Nevada). Consolidated southern routing could eliminate or substantially reduce rail and highway cask shipments on the selected Wyoming and Colorado route segments and on the Nevada route segments for shipments from the north. At the same time, however, consolidated southern routing would increase rail and highway shipments on route segments through New Mexico, Arizona and California (east of Barstow), and on the Nevada route segments for shipments from the south and alongside the Las Vegas Strip.

The national shipment campaign in prospect under legislation proposed in the 104th Congress involves 80 sites shipping on different schedules, by different modes, using large portions of the nation's major rail and highway systems, over a 30+ year period, through many states and communities which may have widely varying perspectives on the potential risks and impacts, and widely varying resources for planning and coordination with other affected states and with the relevant federal agencies. Policy considerations to limit, divert or manage impacts need to be combined with an integrated assessment process which provides all parties with systematically-developed information on the implications of the shipment campaign at national, regional, and community levels.

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INTRODUCTION

The 1982 Nuclear Waste Policy Act (NWPA) formalized the goal that spent nuclear fuel (SNF) and high-level radioactive waste (HLW) from roughly 80 temporary storage locations in 36 states should be transported to one or perhaps two permanent geologic repositories for permanent disposal. 1987 amendments to the NWPA specified that Yucca Mountain (NV) was to be the site for the nation's single prospective geologic repository and the ultimate destination for these highly-toxic and long-lived materials.

Less clear since 1987 has been the strategy for managing waste until the time that the permanent repository is available. Should it continue to be stored at its current "temporary" locations, and shipped to the permanent repository when it is available? If so, federal government acceptance could be delayed 10, 20 or even more years beyond the 1998 acceptance date promised in 1982. Should it be transported to a centralized above-ground storage facility (which under current law cannot be in the same state as the permanent repository) to await a second shipment to the geologic disposal site? If so, the federal government would have to find a suitable site outside Nevada, and persuade its stakeholders that centralized storage would not become de facto a permanent above-ground repository.

Legislation proposed in the 104th Congress* would deal with these questions by shipping waste early and to Nevada. The legislation directs DOE to accept spent nuclear fuel at specified annual rates beginning not later than November 1999 for transport to a specified destination—a centralized above-ground storage facility on the Nevada Test Site, adjacent to Yucca Mountain. A viability assessment completed in 1998 is intended to provide some assurance that the wastes shipped to Nevada for above-ground storage could ultimately be disposed at a Yucca Mountain geologic repository, and that a second shipment to another interim or permanent site will not be necessary.

Neither Congress nor DOE has developed a plan for implementing the transportation and storage provisions of the proposed legislation. It is uncertain, for example, when shipments would begin, how rapidly they would proceed, what shipment priorities might be, what transportation/storage casks might be available, how utilities would choose among available casks, what routes would prove most acceptable, etc. How would these questions be resolved, and who would be involved in their resolution, at what stage and with what authority, responsibility and capability? How will the risks, "real" and "perceived," be addressed, assessed, and effectively managed? Even the role and accountability of DOE is uncertain, given its recent initiative to privatize the entire civilian spent fuel transportation system, leaving decisions about shipping containers, modes and routes largely up to private contractors.

Though occasional shipments of spent fuel and other highly-radioactive materials (e.g., cesium, naval reactor fuel) have been safely conducted and effectively managed, no land-based shipment campaign of the scale implied by proposed legislation has been conducted in the U.S. or elsewhere. How best to plan for and effectively manage such a campaign in our participatory federal system of governance of the 1990's has not been decided. It is generally assumed that such a campaign would require the coordinated participation of several federal and many state, local, and private agencies—each responsive to its own constituencies. It is acknowledged that these agencies would need to participate in an extensive array of

* Senate bill 1936 (S. 1936), a substitute for the earlier Senate bill 1271. A companion bill (H.R. 1020) is under consideration in the House of Representatives.

activities over many months, years, even decades. It is generally acknowledged that a detailed description of the national shipment campaign, including an inventory of key local conditions potentially affected, is required as the basis for coordinated planning and management. But, though proposed legislation would make an unprecedented national shipment campaign a near-term prospect, such a detailed description is not available as a resource for the many parties which would expect to participate in its coordinated planning and management.

One way to reduce uncertainty is to develop scenarios which reflect specific assumptions regarding relevant factors, and which then provide detailed information (e.g., shipments by cask type, origin, route segment, and year) needed as the basis for planning and management. One purpose of this report is to describe several possible scenarios for the shipment campaign in prospect under S. 1936, and the direct consequences of these scenarios—prospective cask shipments of particular types on particular rail and highway routes in particular years. In the process, the report identifies the several factors and assumptions that underlie any scenario for a national campaign for shipment of SNF and HLW. These factors, combined in an integrated assessment process, suggest the type of information base needed in the planning and management of national shipment campaign—the inputs needed for analysis of risks and impacts, and for identification and resolution of issues ranging from overall campaign efficiency, to regional routing options, to issues specific to particular communities or route segments.

This study applied an integrated assessment system to develop scenarios considering three sets of potential utility transportation choices, two alternative routing strategies and two alternative truck cask options. It will be apparent in review of the factors and assumptions that many other scenarios for the prospective shipment campaign are possible. The integrated assessment process supports the consistent development of alternative scenarios with comparable outputs at the national, regional, and route-segment level.

As introduction to the scenarios, this section discusses the *activities* involved in planning and managing a national shipment campaign, the *agencies* which must coordinate to conduct these activities. the *information* needed as a basis for coordinated planning and management, and the *factors* that must be considered in generating this information.

Activities

To identify the range of activities involved in planning and managing a national shipment campaign, one might consider DOE's May 10, 1996 notice of proposed policies and procedures for implementing section 180(c) of the Nuclear Waste Policy Act regarding training for safe routine transportation and emergency response training.[1] A review of this notice, which summarizes and responds to previous stakeholder comments on the subject, provides a useful list of the activities which will be involved in the transportation of SNF and HLW from about 80 origin sites across the country, along numerous highway and rail routes, across many jurisdictions and communities, over a 30-year period to an interim or permanent storage site in Nevada. The list of activities, only a few of which DOE proposes to support with 180(c) funds, includes:

- route selection
- alternative route analysis
- route risk analysis
- route inspection (highway and rail)
- contingency routing plans
- transportation infrastructure improvements

- shipment notification
- shipment tracking
- shipment escorting
- provision of public information on routing and shipments
- preparation and enforcement of transportation operations protocols
- carrier and shipper compliance reviews
- assessment of state and local capabilities regarding safe routine transport and emergency response
- enhancement and maintenance of state and local emergency preparedness
- enhancement and maintenance of emergency response and recovery capabilities
- awareness training for first-on-scene and first responder personnel
- specialized training for emergency management and recovery personnel
- public information training for route community liaison personnel
- training for hospital personnel, if and as necessary
- waste acceptance scheduling (start date and annual rate)
- waste acceptance prioritization
- transportation cask design, certification, production, and delivery
- cask loading (wet or dry)
- accident notification
- safe parking designation and procedures
- provision of equipment for emergency response, inspection, first response personnel

Agencies

If the activities involved in nuclear waste transportation are numerous and varied, the actors are numerous and varied as well—adding to the need for federal agencies as well as potentially affected states and local governments to have a sound description of and an effective role in planning the shipment campaign in prospect. The actors, whose respective roles and responsibilities have been much discussed but not decided, include federal, state, local agencies as well as utility shippers, contract carriers, and others.

- Federal agencies include:

  — DOE/OCRWM (Office of Civilian Radioactive Waste Management) . . . manager of the Nuclear Waste Fund and responsible for high-level waste management strategy.

  — DOE/EM (Environmental Management) . . . responsible for HLW in the DOE complex, and for the Nevada Test Site Area 25, designated as the site for centralized above-ground storage in proposed legislation.

  — DOT/RSPA (Research and Special Programs Administration) . . . responsible for implementation guidelines for HMTUSA (the Hazardous Materials Transportation Uniform Safety Act).

  — DOT/FHWA (Federal Highway Administration) . . . responsible for implementation of HM164, and for inspection of highway shipments.

  — DOT/FRA (Federal Railroad Administration) . . . responsible for rail inspections and regulation, and for special studies regarding rail shipments.

- NRC (Nuclear Regulatory Commission) . . . responsible for certification of storage and transportation canisters and casks.

- FEMA (Federal Emergency Management Agency) . . . responsible for emergency management and response in transport of radiological materials.

- Coast Guard/Corps of Engineers . . . responsible for regulation of barge shipments and intermodal transfer at barge terminals.

- State agencies include state police and highway patrols, emergency management agencies, utility regulatory commissions, agencies responsible for route designation, radiological health agencies, environmental regulation agencies, etc.

- State agencies need to coordinate with their counterparts in adjacent states and with Indian tribes, perhaps via regional groups.

- State agencies also need to coordinate with local jurisdictions (especially police, fire, and transportation departments) and with utility (and DOE) shippers and their selected carriers.

- Operating under federal and state guidelines, various private organizations are likely to be directly responsible for cask fabrication, truck transport, and/or rail transport. Furthermore, DOE could convey to private industry contractors broad responsibility for planning and managing campaigns for transporting high-level nuclear waste from various sections of the country. A May 28, 1996 notice in the Federal Register[2] indicates that DOE/OCRWM anticipates contracting with private industry for:

  — virtually all aspects of spent fuel acceptance
  — supplying transportation (and storage) casks
  — transportation to a designated storage facility
  — any required intermodal transport or heavy-haul
  — handling uncanistered spent fuel, as necessary.

  Under such contracts—DOE anticipates two or more contractors serving four regions—the private companies would be permitted to:

  — alter the order of spent fuel acceptance (presumably in consultation with utilities) and/or
  — recommend preferred transportation routes (presumably in consultation with states).

Assessment and Management Information Needs

However roles and responsibilities are decided, any federal, state, local agency or contractor will need certain information as a basis for planning, coordination, and management:

— how many cask shipments are expected?
— containing what types of SNF or HLW?
— in what types of casks?
— in which acceptance year?
— from which storage locations?
— by what mode? (rail, highway, barge)
— on which rail or highway route segments?

In sum, though they may focus on topics or geographic areas of particular relevance to their own responsibilities or contributions, any participating agency will need to plan and manage with reference to a detailed description of the shipment campaign, consistently developed at national, regional, and community levels.

Assessment System Factors

To generate such information for a transportation scenario, however, requires an assessment system in which explicit assumptions are made and information systematically generated regarding at least the following factors:

- Waste origins and storage locations (section 1)
- Current and projected inventory (section 2)
- Waste acceptance startup and rate (section 3)
- Priorities for waste acceptance and pickup (section 4)
- Waste shipment groups (section 5)
- Cask options (section 6)
- Transportation choices and choice factors (sections 7 through 11)
- Annual cask shipments (section 12)
- Routing criteria, mapping, and segmentation (sections 13 and 14)
- Routing options: origin-destination pairs (section 15)

Combined in an integrated assessment system, these factors generate information regarding:

- Routes and cask shipments over the 30-year (life of operations) national campaign (section 16).
- Routes and cask shipments at the Nevada destination—the end of the funnel (section 17).
- Regional routing alternatives and consequences for particular routes in various states (section 18).
- Annual cask shipments and the routes involved in various phases of the campaign (section 19).
- Transportation operations requirements—cask shipment miles, cask shipment miles per MTU shipped, cask shipments per route mile affected (section 20).

Assessment of risks, impacts, and policy options requires systematically-assembled information on key features along affected routes, as illustrated in section 21.

Scenarios Considered in this Study

Using an integrated assessment system, this study describes the national shipment campaign for scenarios which differ in utility transportation choices (three alternative sets), routing strategy (a base case and a consolidated southern routing strategy across central and western states) and cask options (two rail casks, plus one of two legal-weight truck casks). Figure 1 summarizes the factors varied and held constant in these scenarios, providing references to relevant sections of the report.

The integrated assessment system can be used to describe in similar dimensions and detail any national shipment campaign which could emerge—e.g., scenarios reflecting a different current or projected inventory, different acceptance rates or priorities for pickup, alternative cask options, different utility transportation choices and/or alternative routing criteria.

Figure I-1. The Transportation of SNF and HLW: Key Assess System Factors and Variables

	SPENT NUCLEAR FUEL	HIGH-LEVEL WASTE
1.WASTE ORIGINS	124 commercial reactors in 34 states Spent fuel from research reactors: General Atomics.... priority ranking DOE: 8 sites Domestic non-DOE: 8 sites Foreign: 3 temp storage sites in US	4 major DOE sites: Hanford (WA) Idaho Nat Eng Lab (ID) Savannah River (SC) West Valley Demo Proj (NY)
STORAGE LOCATIONS	82 pools assoc with individual reactors 20 pools joined by transfer canals 11 pools shared by two reactors 7 pools at offsite locations (3 DOE) 14 onsite dry strg facil (ex & planned)	Same 4 major DOE sites
SHIPMENT SITES	83 sites (4 DOE) in 36 states	Same 4 major DOE sites
2.INVENTORY	Nov'94: 10809 MTU in 59418 BWR assemblies 19149 MTU in 44602 PWR assemblies 86 MTU in HTG, RSC, MSC SNF 30044 MTU total Cumul: 30,682 MTU in 169,675 BWR assemblies 55,931 MTU in 129,517 PWR assemblies 86 MTU in HTG, RSC, MSC, SNF 86,699 MTU total	13789-28372 canisters of vitrified HLW Hanford: 7067-15000 canisters INEL: 704-8500 canisters SRS: 5717-4572 canisters WVDP: 300 canisters
3.ACCEPTANCE START	Annual estimates, w/o specified start yr	Year 15: ie 2015 if 2000 start yr
ACCEPTANCE RATE	Years 1-5: 9100 MTU Years 6-10: 15000 MTU Years 11-15: 15000 MTU	Years 15-20: 4000 canisters Years 21-25: 4500 canisters Years 26-30: 5000 canisters
4.ACCEPTANCE PRIORITY	Oldest fuel (current & projected) first No within utility reallocations No among utility trades	Generally: 1. WVDP 2. SRS 3. HANF 4. INEL
5.SHIPMENT GROUPS	Among acceptance years? No Among assembly types? Yes Among reactor types? No Among waste origins? No	Not applicable (canistered waste)
6.CASK OPTIONS	R125: similar to DOE's 125-ton MPC R75: similar to DOE's 75-ton MPC LWT: legal-weight truck cask T4/9: the GA-4/9 cask, used if available T1/2: similar to the NAC LWT	R100: an adaption of DOE's 125-ton MPC
7.CASK LOADING FACTORS	Design crane capacity (tons) Operating crane capacity (tons) Cask set-down area (max cask option) Cask length requirement (max cask option)	Assume adequate to load R100
8.NEAR-SITE INFRASRUC	Onsite rail ? Operating onsite rail ? Onsite rail upgrade cost Distance to offsite railhead	Assume adequate to ship R100
9.OTHER TRANSPORTATION CHOICE FACTORS	Federal policies Utility choice criteria Changes at or near utility sites	DOE policy Changes at or near DOE sites
10.TRANSP CHOICE DECISION	Four case examples: *Monticello* Big Rock Point *Point Beach* Salem/Hope Creek *Enrico Fermi*	Factors 6-8 determine

Figure I-1 (Cont).

	SPENT NUCLEAR FUEL	HIGH-LEVEL WASTE
11.TRANSP CHOICE SCENARIOS	Current capabilities MPC base case Maximum rail	All rail shipment, using R100
12.CASK SHIPMENTS	BWR/PWR assemblies in shipment group/ cask capacity (partially-filled cask=1) Non-BWR/PWR MTU in shipment group/ MTU per cask (BWR/PWR)	Canisters in shipment group/ 5 canisters per cask (partially-filled cask=1)
13.ROUTING CRITERIA Default route/ highway:	HM 164; max use of interstate hwys; Min transit time; two drivers; Pop centers not avoided.	NA
Default route/ rail:	Nearest railhead or designated barge; Min carrier transfer; min transit time; Pop centers not avoided	Same as SNF
Consolidated southern route/ Highway	Uses Interstate 40 west of Okla City, Interstate 15 north to Las V & Yucca Mtn	NA
Consolidated southern route/ rail:	Uses Sante Fe lines west of Kansas City, Union Pacific north to intermodal transfer	Same as SNF
14.ROUTE IDENTIFICATION & MAPPING	Locate designated route segments Identify on base highway/rail maps Route segmentation	Same as SNF
15.ROUTING CASE EXAMPLES	Oyster Creek (NJ) to Yucca Mtn (NV) Fermi (MI) to Yucca Mtn (NV) Browns Ferry (AL) to Yucca Mtn (NV) Cooper Station (NE) to Yucca Mtn (NV) Grand Gulf (MS) to Yucca Mtn (NV) Diablo Canyon (CA) to Yucca Mtn (NV)	NA
16. NATIONAL SHIPMENT CAMPAIGN	Life of Operations Cask Shipments Default routing 3 transportation choice scenarios	Year 15-30 cask shipments Sames as SNF
17. NEVADA IMPLICATIONS	Life of operations cask shipments Default routing Nevada route segments 3 transportation choice scenarios	Year 15-30 cask shipments Same as SNF Same as SNF
18. REGIONAL ROUTING OPTIONS	Life of operations cask shipments Default and So consol routing Selected route segments in: Wyoming (UP and I-80) Colorado (SP and I-70) New Mexico (SF and I-40) Nevada (UP and I-15) 3 transportation choice scenarios	Year 15-30 cask shipments Same as SNF
19.NATL SHIPMENT CAMPAIGN: ANNUAL SHIPMENTS	Current capabil choices/default routing Year 1 cask shipments by origin: Year 2 cask shipments by origin: Year 3 cask shipments by origin: Year 20 cask shipments by origin: Maximum rail choices/default routing Year 20 cask shipments by origin:	All rail shipment/default routing: Year 1 cask shipments by origin: Year 2 cask shipments by origin: Year 3 cask shipments by origin: Year 20 cask shipments by origin:

Figure I-1 (Cont).

20. TRANSP OPER REQUIREMENTS	Life of operations and years 1-3 Cask shipment miles (total and per MTU) Cask shipments per route mile 2 transportation choice scenarios	Year 15-30 cask shipments Cask shipments miles (total) Same as SNF Same as SNF
21.ROUTE FEATURES	Illustrative: Key route characteristics Route conditions Key facilities alongside Administrative boundaries Segment-specific management policies	Same as SNF

1. WASTE ORIGINS, STORAGE LOCATIONS AND SHIPMENT SITES

In common practice, a reactor name may be used to refer to any of several facilities at a site, or to the site itself. Thus, the term "Calvert Cliffs" may be used to refer to either or both of Baltimore Gas and Electric's two nuclear powerplants, to the joined spent fuel pools at those reactors, to the site's concrete module dry storage facility, or the site itself on the Patuxent River near Lusby in Calvert County. In assessment, however, it is useful to maintain a distinction between the facilities which generate spent fuel, the facilities where this waste is temporarily stored, and the sites from which such waste may be shipped to a centralized or permanent storage facility. The same applies to high-level waste at DOE's defense sites and to other nuclear waste requiring geologic disposal.

Spent Fuel Origins and Storage Locations

In its Acceptance Priority Ranking reports,[3] DOE identifies SNF by the reactor from which it was discharged and by its current storage location. For example:

- The 136 BWR assemblies discharged from the Oyster Creek reactor in Ocean County, New Jersey on May 1, 1972 are now stored at Oyster Creek—meaning the spent fuel pool associated with the Oyster Creek reactor.

- The 85 BWR assemblies discharged from the Quad Cities 2 reactor in Rock Island County, Illinois on December 22, 1974 are now stored at Quad Cities 1—meaning the joined spent fuel storage pools for Quad Cities reactors 1 and 2.

- The 509 BWR assemblies discharged from the Dresden 2 reactor near Morris, Illinois on February 19, 1972 are now stored at Morris—meaning that they have been moved to the nearby General Electric spent fuel storage facility.

- The 102 PWR assemblies discharged from the Robinson 2 reactor in Hartsville, South Carolina on May 4, 1974 are now stored at the Brunswick 1 PWR pool—meaning that they have been transported to Southport, North Carolina for storage in the portion of the Brunswick 1 spent fuel pool designed for BWR assemblies.

Thus, there is a distinction between spent fuel origins and storage locations. Origins are nuclear reactors. Storage locations are spent fuel pools which are sometimes shared among two reactors, or joined by a transfer canal, or, increasingly, on-site dry storage facilities such as those at Surry or Calvert Cliffs, or off-site pools such as those are Morris, or the Idaho National Engineering Lab (INEL). Tables 1-1 and 1-2 present the list of spent fuel origins and storage locations used in this assessment.

In aggregate, DOE's listing of spent fuel discharges describes where spent fuel from particular reactors is now stored, and where spent fuel at particular storage locations came from. For example:

- The 2,200 BWR assemblies discharged through November 1994 from the Peachbottom 3 reactor near York, Pennsylvania are all stored at the Peachbottom 3 spent fuel pool, which has capacity to store 3,814 BWR assemblies.

- Of the 808 PWR assemblies discharged through November 1994 from the Oconee 3 reactor in the western corner of South Carolina, 444 (55 percent) are now stored at the Oconee 3 spent fuel pool, 244 (30.2 percent) are in dry storage facilities at the Oconee site, 58 (7.2 percent) are stored at the Oconee 1 spent fuel pool shared by the Oconee 1 and Oconee 2 reactors, and 62 (7.7 percent) are stored at the McGuire 2 spent fuel pool in North Carolina.

- Of the 3,217 spent fuel assemblies stored at GE's Morris facility in Gundy County, Illinois in November 1994, 1,054 (32.8 percent) are BWR assemblies discharged from the Copper Station reactor in Nebraska, 1,058 (32.9 percent) are BWR assemblies discharged from the Monticello reactor in Minnesota, 753 (23.4 percent) are BWR assemblies from the nearby Dresden 2 reactor, 270 (8.4 percent) are PWR assemblies from the San Onofre 1 reactor in California, and 82 (2.5 percent) are PWR assemblies from the Haddam Neck reactor in Connecticut.

- Of the 1,018 spent fuel assemblies stored at INEL in November 1994, 744 (73.1 percent) are HTG assemblies from Fort St. Vrain in Colorado, 177 are PWR assemblies from the damaged Three Mile Island 2 reactor in Pennsylvania, 69 (6.8 percent) are PWR assemblies from the Surry 1 and 2 reactors in Virginia, 18 (1.8 percent) are PWR assemblies from the Turkey Point 3 reactor in Florida, 6 (0.6 percent) are PWR assemblies from the Point Beach 1 reactor in Wisconsin, and 4 are BWR assemblies from Dresden 1 in Illinois and Peachbottom 2 in Pennsylvania.

Waste Origin and Storage Location Assumptions

- **The Current Inventory of Spent Nuclear Fuel**

  As mentioned, spent fuel discharges through November 1994 are identified in DOE Acceptance Priority Ranking reports by the reactor from which the fuel was discharged and by the current storage location. In this assessment, the 30,044 MTU discharged through November 1994 are assumed to remain at their November 1994 storage location until accepted by DOE for transport to an interim or permanent storage facility. We have not attempted to project future transfers of spent fuel among storage locations.

- **Projected Inventory of Spent Nuclear Fuel**

  For the no-new-reactor-orders case in which nuclear reactors are assumed to operate at an assumed percentage of capacity through their NRC license term, DOE forecasts annual discharges through 2042 by the reactor from which the fuel is discharged.[4] In this assessment, we have identified the pool location to which the fuel would be discharged. For example, projected discharges from the Point Beach 2 reactor near Two Creeks, Wisconsin would go to the Point Beach 1 pool shared by Point Beach reactors 1 and 2, while projected discharges from the Comanche Peak 2 reactor near Glen Rose, Texas would go to the Comanche Peak 1 and 2 pools which are connected by a transfer canal. However, we have not attempted to project future transfers of this fuel either to onsite dry storage facilities or to pools at other sites owned by the same utility, or to pools at sites such as Morris or INEL.

- **High-Level Waste Origins and Storage Locations**

  For HLW generated at defense sites, DOE forecasts the projected number of canisters (containing vitrified HLW) which will require disposal in a geologic repository.[5] In this assessment, we assume that the HLW is vitrified, canistered, and stored until pick up at the site at which it was generated.

Shipment Sites

Route analysis requires the identification of a point of origin for each shipment—the place from which the legal-weight truck, heavy-haul truck, rail or barge shipment begins. This assessment associates each storage location with a shipment origin (Table 1-3). For example, spent fuel stored at the separate pools at Arkansas Nuclear's reactors 1 and 2 or at the Arkansas Nuclear dry storage facility all have the same shipment origin. Similarly, spent fuel stored at the connected pools at Calvert Cliffs reactors 1 and 2 or at the Calvert Cliffs dry storage facility all have the same shipment origin.

As will be discussed in Sections 7 and 8, transportation choices are keyed both to the facilities at the storage location (e.g., the characteristics of the separate, shared or joined spent fuel pools, or of the dry storage facility) *and* to the characteristics of near-site infrastructure (e.g., the availability of onsite rail, the distance to an offsite railhead, and the characteristics of the community along the heavy-haul route).

Table 1-1. Originators of Spent Nuclear Fuel or High-Level Waste

#	WASTE ORIGINS:	COMPANY:	STATE	WASTE TYPE	WASTE TYPE	DESIGN CAPAC (MWE)	UTIL STRTUP YEAR	UTIL SHUTD YEAR
1	ARKANSAS NUCLEAR 1	ARKANSAS POWER & LIGHT	AK	PWR	COMM	850	1974	2014
2	ARKANSAS NUCLEAR 2	ARKANSAS POWER & LIGHT	AK	PWR	COMM	912	1978	2018
3	BEAVER VALLEY 1	DUQUESNE LIGHT COMPANY	PA	PWR	COMM	835	1976	2016
4	BEAVER VALLEY 2	DUQUESNE LIGHT COMPANY	PA	PWR	COMM	857	1987	2027
5	BELLEFONTE 1	TENNESSEE VALLEY AUTHORITY	AL	PWR	COMM	1235	????	????
6	BELLEFONTE 2	TENNESSEE VALLEY AUTHORITY	AL	PWR	COMM	1235	????	????
7	BIG ROCK 1	CONSUMERS POWER COMPANY	MI	BWR	COMM	72	1962	2000
8	BRAIDWOOD 1	COMMONWEALTH EDISON CO.	IL	PWR	COMM	1175	1987	2026
9	BRAIDWOOD 2	COMMONWEALTH EDISON CO.	IL	PWR	COMM	1175	1988	2027
10	BROWNS FERRY 1	TENNESSEE VALLEY AUTHORITY	AL	BWR	COMM	1065	1973	2013
11	BROWNS FERRY 2	TENNESSEE VALLEY AUTHORITY	AL	BWR	COMM	1065	1974	2014
12	BROWNS FERRY 3	TENNESSEE VALLEY AUTHORITY	AL	BWR	COMM	1065	1977	2016
13	BRUNSWICK 1	CAROLINA POWER & LIGHT	NC	BWR	COMM	821	1976	2016
14	BRUNSWICK 2	CAROLINA POWER & LIGHT	NC	BWR	COMM	821	1974	2014
15	BYRON 1	COMMONWEALTH EDISON CO.	IL	PWR	COMM	1120	1985	2024
16	BYRON 2	COMMONWEALTH EDISON CO.	IL	PWR	COMM	1120	1987	2026
17	CALLAWAY 1	UNION ELECTRIC CO.	MO	PWR	COMM	1171	1984	2024
18	CALVERT CLIFFS 1	BALTIMORE GAS & ELECTRIC CO.	MD	PWR	COMM	845	1975	2014
19	CALVERT CLIFFS 2	BALTIMORE GAS & ELECTRIC CO.	MD	PWR	COMM	845	1976	2016
20	CATAWBA 1	DUKE POWER COMPANY	SC	PWR	COMM	1145	1985	2024
21	CATAWBA 2	DUKE POWER COMPANY	SC	PWR	COMM	1145	1986	2026
22	CLINTON 1	ILLINOIS POWER CO.	IL	BWR	COMM	933	1987	2026
23	COMANCHE PEAK 1	TEXAS UTILITIES ELECTRIC CO.	TX	PWR	COMM	1150	1990	2030
24	COMANCHE PEAK 2	TEXAS UTILITIES ELECTRIC CO.	TX	PWR	COMM	1150	1993	2033
25	COOK 1	INDIANA MICHIGAN POWER CO.	MI	PWR	COMM	1030	1975	2014
26	COOK 2	INDIANA MICHIGAN POWER CO.	MI	PWR	COMM	1100	1978	2017
27	COOPER STATION	NEBRASKA PUBLIC POWER DISTRICT	NB	BWR	COMM	778	1974	2014
28	CRYSTAL RIVER 3	FLORIDA POWER CORPORATION	FL	PWR	COMM	825	1977	2016
29	DAVIS-BESSE 1	TOLEDO EDISON CO.	OH	PWR	COMM	906	1977	2017
30	DIABLO CANYON 1	PACIFIC GAS & ELECTRIC CO.	CA	PWR	COMM	1086	1984	2008
31	DIABLO CANYON 2	PACIFIC GAS & ELECTRIC CO.	CA	PWR	COMM	1119	1985	2010
32	DRESDEN 1	COMMONWEALTH EDISON CO.	IL	BWR	COMM	200	1960	1978
33	DRESDEN 2	COMMONWEALTH EDISON CO.	IL	BWR	COMM	794	1970	2006
34	DRESDEN 3	COMMONWEALTH EDISON CO.	IL	BWR	COMM	794	1971	2011
35	DUANE ARNOLD	IOWA ELEC LGT & PWR (IES UTIL)	IO	BWR	COMM	538	1974	2014
36	ENRICO FERMI 2	DETROIT EDISON CO.	MI	BWR	COMM	1093	1985	2025
37	FARLEY 1	ALABAMA POWER & LIGHT	AL	PWR	COMM	829	1977	2017
38	FARLEY 2	ALABAMA POWER & LIGHT	AL	PWR	COMM	829	1981	2021
39	FITZPATRICK	POWER AUTHORITY OF NEW YORK STATE	NY	BWR	COMM	821	1975	2014
40	FORT CALHOUN	OMAHA PUBLIC POWER DISTRICT	NB	PWR	COMM	486	1973	2008
41	FORT ST VRAIN	PUBLIC SERVICE CO. OF COLORADO	CO	HTG	COMM	330	1979	1989
42	GINNA	ROCHESTER GAS & ELECTRIC	NY	PWR	COMM	490	1969	2009
43	GRAND GULF 1	SYSTEM ENERGY RESOURCES	MS	BWR	COMM	1250	1984	2022
44	HADDAM NECK	CONNECTICUTT YANKEE ATOMIC POWER	CT	PWR	COMM	582	1967	2007
45	HARRIS 1	CAROLINA POWER & LIGHT	NC	PWR	COMM	940	1987	2026
46	HATCH 1	GEORGIA POWER COMPANY	GA	BWR	COMM	777	1974	2014
47	HATCH 2	GEORGIA POWER COMPANY	GA	BWR	COMM	784	1978	2018
48	HOPE CREEK	PUBLIC SERVICE ELECTRIC & GAS CO	NJ	BWR	COMM	1118	1986	2025
49	HUMBOLDT BAY	PACIFIC GAS & ELECTRIC CO.	CA	BWR	COMM	65	1963	1976
50	INDIAN POINT 1	CONSOLIDATED EDISON OF NY	NY	PWR	COMM	265	1962	1980
51	INDIAN POINT 2	CONSOLIDATED EDISON OF NY	NY	PWR	COMM	873	1973	2013
52	INDIAN POINT 3	PORT AUTHORITY OF NEW YORK	NY	PWR	COMM	965	1976	2015
53	KEWAUNEE	WISCONSIN PUBLIC SERVICE CO.	WI	PWR	COMM	535	1974	2013
54	LACROSSE	DAIRYLAND POWER COOP.	WI	BWR	COMM	50	1968	1987
55	LASALLE 1	COMMONWEALTH EDISON CO.	IL	BWR	COMM	1122	1982	2022
56	LASALLE 2	COMMONWEALTH EDISON CO.	IL	BWR	COMM	1122	1984	2023
57	LIMERICK 1	PHILADELPHIA ELECTRIC CO.	PA	BWR	COMM	1055	1985	2024
58	LIMERICK 2	PHILADELPHIA ELECTRIC CO.	PA	BWR	COMM	1055	1989	2029
59	MAINE YANKEE	MAINE YANKEE ATOMIC	ME	PWR	COMM	825	1972	2008
60	MCGUIRE 1	DUKE POWER COMPANY	NC	PWR	COMM	1180	1981	2021
61	MCGUIRE 2	DUKE POWER COMPANY	NC	PWR	COMM	1180	1983	2023
62	MILLSTONE 1	NORTHEAST UTILITY SVC CO.	CT	BWR	COMM	660	1970	2010
63	MILLSTONE 2	NORTHEAST UTILITY SVC CO.	CT	PWR	COMM	870	1975	2015
64	MILLSTONE 3	NORTHEAST UTILITY SVC CO.	CT	PWR	COMM	1150	1986	2025
65	MONTICELLO	NORTHERN STATES POWER CO.	MN	BWR	COMM	545	1971	2010
66	NINE MILE POINT 1	NIAGRA MOHAWK POWER CO.	NY	BWR	COMM	620	1969	2009
67	NINE MILE POINT 2	NIAGRA MOHAWK POWER CO.	NY	BWR	COMM	1080	1987	2026
68	NORTH ANNA 1	VIRGINIA POWER	VA	PWR	COMM	907	1978	2018
69	NORTH ANNA 2	VIRGINIA POWER	VA	PWR	COMM	907	1980	2020
70	OCONEE 1	DUKE POWER COMPANY	SC	PWR	COMM	887	1973	2013
71	OCONEE 2	DUKE POWER COMPANY	SC	PWR	COMM	887	1973	2013
72	OCONEE 3	DUKE POWER COMPANY	SC	PWR	COMM	886	1974	2014

Source: Spent Fuel Storage Requirements: 1994-2042 (DOE/RW-0431-Rev.1: June 1995)

Table 1-1 (Cont).

#	WASTE ORIGINS:	COMPANY:	STATE	WASTE TYPE	WASTE TYPE	DESIGN CAPAC (MWE)	UTIL STRTUP YEAR	UTIL SHUTD YEAR
73	OYSTER CREEK 1	GPU NUCLEAR CORP	NJ	BWR	COMM	650	1969	2009
74	PALISADES	CONSUMERS POWER CO.	MI	PWR	COMM	805	1971	2007
75	PALO VERDE 1	ARIZONA PUBLIC SERVICE CO.	AZ	PWR	COMM	1270	1985	2024
76	PALO VERDE 2	ARIZONA PUBLIC SERVICE CO.	AZ	PWR	COMM	1270	1986	2025
77	PALO VERDE 3	ARIZONA PUBLIC SERVICE CO.	AZ	PWR	COMM	1270	1987	2027
78	PEACHBOTTOM 2	PHILADELPHIA ELECTRIC CO.	PA	BWR	COMM	1065	1974	2008
79	PEACHBOTTOM 3	PHILADELPHIA ELECTRIC CO.	PA	BWR	COMM	1065	1974	2008
80	PERRY 1	CLEVELAND ELEC ILLUMINATING CO.	OH	BWR	COMM	1265	1986	2026
81	PILGRIM 1	BOSTON EDISON CO.	MA	BWR	COMM	655	1972	2012
82	POINT BEACH 1	WISCONSIN ELECTRIC POWER CO.	WI	PWR	COMM	497	1970	2010
83	POINT BEACH 2	WISCONSIN ELECTRIC POWER CO.	WI	PWR	COMM	497	1972	2013
84	PRAIRIE ISLAND 1	NORTHERN STATES POWER CO.	MN	PWR	COMM	530	1973	2013
85	PRAIRIE ISLAND 2	NORTHERN STATES POWER CO.	MN	PWR	COMM	530	1974	2014
86	QUAD CITIES 1	COMMONWEALTH EDISON CO.	IL	BWR	COMM	789	1972	2012
87	QUAD CITIES 2	COMMONWEALTH EDISON CO.	IL	BWR	COMM	789	1972	2012
88	RANCHO SECO 1	SACRAMENTO MUNICIPAL UTILITY DIST.	CA	PWR	COMM	918	1974	1989
89	RIVER BEND 1	GULF STATES UTILITIES CO.	LA	BWR	COMM	936	1985	2025
90	ROBINSON 2	CAROLINA POWER & LIGHT	SC	PWR	COMM	700	1970	2010
91	SALEM 1	PUBLIC SERVICE ELECTRIC & GAS CO	NJ	PWR	COMM	1115	1976	2016
92	SALEM 2	PUBLIC SERVICE ELECTRIC & GAS CO	NJ	PWR	COMM	1115	1981	2020
93	SAN ONOFRE 1	SOUTHERN CALIF EDISON	CA	PWR	COMM	436	1967	1992
94	SAN ONOFRE 2	SOUTHERN CALIF EDISON	CA	PWR	COMM	1070	1982	2013
95	SAN ONOFRE 3	SOUTHERN CALIF EDISON	CA	PWR	COMM	1080	1983	2013
96	SEABROOK 1	NORTH ATLANTIC ENERGY SERVICE	NH	PWR	COMM	1150	1990	2026
97	SEQUOYAH 1	TENNESSEE VALLEY AUTHORITY	TN	PWR	COMM	1148	1980	2020
98	SEQUOYAH 2	TENNESSEE VALLEY AUTHORITY	TN	PWR	COMM	1148	1981	2021
99	SHOREHAM	LONG ISLAND LIGHTING CO.	NY	BWR	COMM	849	1986	1987
100	SOUTH TEXAS 1	HOUSTON LIGHTING & POWER CO.	TX	PWR	COMM	1250	1988	2027
101	SOUTH TEXAS 2	HOUSTON LIGHTING & POWER CO.	TX	PWR	COMM	1250	1989	2028
102	ST LUCIE 1	FLORIDA POWER & LIGHTING CO.	FL	PWR	COMM	830	1976	2016
103	ST LUCIE 2	FLORIDA POWER & LIGHTING CO.	FL	PWR	COMM	804	1983	2023
104	SUMMER 1	SOUTH CAROLINA ELECTRIC & GAS	SC	PWR	COMM	900	1982	2022
105	SURRY 1	VIRGINIA POWER	VA	PWR	COMM	788	1972	2012
106	SURRY 2	VIRGINIA POWER	VA	PWR	COMM	788	1973	2013
107	SUSQUEHANNA 1	PENNSYLVANIA POWER & LIGHT	PA	BWR	COMM	1065	1982	2022
108	SUSQUEHANNA 2	PENNSYLVANIA POWER & LIGHT	PA	BWR	COMM	1065	1984	2024
109	THREE MILE ISLAND 1	GPU NUCLEAR CORP	PA	PWR	COMM	819	1974	2014
110	TROJAN	PORTLAND GENERAL ELECTRIC CO.	OR	PWR	COMM	1130	1975	1992
111	TURKEY POINT 3	FLORIDA POWER & LIGHTING CO.	FL	PWR	COMM	693	1972	2007
112	TURKEY POINT 4	FLORIDA POWER & LIGHTING CO.	FL	PWR	COMM	693	1973	2007
113	VERMONT YANKEE 1	VERMONT YANKEE NUCLEAR POWER	VT	BWR	COMM	514	1972	2012
114	VOGTLE 1	GEORGIA POWER CO.	GA	PWR	COMM	1069	1987	2027
115	VOGTLE 2	GEORGIA POWER CO.	GA	PWR	COMM	1069	1989	2029
116	WASHINGTON NUCLEAR 2	WASH PUBLIC POWER SUPPLY SYSTEM	WA	BWR	COMM	1100	1984	2023
117	WASHINGTON NUCLEAR 3	WASH PUBLIC POWER SUPPLY SYSTEM	WA	BWR	COMM	1250	????	????
118	WATERFORD 3	LOUISIANNA POWER & LIGHT	LA	PWR	COMM	1104	1985	2024
119	WATTS BAR 1	TENNESSEE VALLEY AUTHORITY	TN	PWR	COMM	1165	????	????
120	WATTS BAR 2	TENNESSEE VALLEY AUTHORITY	TN	PWR	COMM	1165	????	????
121	WOLF CREEK 1	WOLF CREEK NUCLEAR OPERATING CORP.	KS	PWR	COMM	1150	1985	2025
122	YANKEE-ROWE 1	YANKEE ATOMIC ELECTRIC CO.	MA	PWR	COMM	175	1960	1991
123	ZION 1	COMMONWEALTH EDISON CO.	IL	PWR	COMM	1085	1973	2013
124	ZION 2	COMMONWEALTH EDISON CO.	IL	PWR	COMM	1085	1973	2013
125	GENERAL ATOMICS	GENERAL ATOMICS	CA	RSH	DFNS	NA	????	????
126	HANFORD	DOE/HANFORD	WA	HLW	DFNS	NA	????	????
127	INEL	DOE/INEL	ID	HLW	DFNS	NA	????	????
128	SAVANNAH RIVER	DOE/SAVANNAH RIVER	SC	HLW	DFNS	NA	????	????
129	WEST VALLEY	DOE/WEST VALLEY	NY	HLW	DFNS	NA	????	????

Source: Spent Fuel Storage Requirements: 1994-2042 (DOE/RW-0431-Rev.1: June 1995)

Table 1-2. Storage Locations for Spent Nuclear Fuel and High-Level Waste

	STORAGE LOCATIONS:	WASTE TYPE	UTIL STRTUP YEAR	UTIL SHUTD YEAR	STRG CAPAC (ASSEMBLIES) LICEN	STRG CAPAC (ASSEMBLIES) MAX	FULL CORE ASMB	NOTES:
1	ARKANSAS NUCLEAR 1	PWR	1974	2014	968	948	177	
2	ARKANSAS NUCLEAR 2	PWR	1978	2018	988	933	177	
3	ARKANSAS NUCLEAR DRY STRG	PWR	1995	2015	192	192	NA	VSC-24 under gnrl lic, starting 1995
4	BEAVER VALLEY 1	PWR	1976	2016	833	1621	157	
5	BEAVER VALLEY 2	PWR	1987	2027	1088	1088	157	
6	BELLEFONTE 1	PWR	????	????	1058	1058	205	
7	BELLEFONTE 2	PWR	????	????	1058	1058	205	
8	BIG ROCK 1	BWR	1962	2000	441	441	84	
9	BRAIDWOOD 1&2	PWR	1987	2027	2870	2834	193	
10	BROWNS FERRY 1-2	BWR	1973	2014	3471	6942	764	
11	BROWNS FERRY 3	BWR	1977	2016	3471	3471	764	
12	BRUNSWICK 1	BWR	1976	2016	1803	1767	560	
13	BRUNSWICK 1 BWR POOL	PWR	1976	2016	NA	160	NA	
14	BRUNSWICK 2	BWR	1974	2014	1839	1767	560	
15	BRUNSWICK 2 BWR POOL	PWR	1974	2014	NA	144	NA	
16	BYRON 1&2	PWR	1985	2026	2870	2824	193	
17	CALLAWAY 1	PWR	1984	2024	1340	1340	193	
18	CALVERT CLIFFS 1-2	PWR	1975	2016	1830	1778	217	
19	CALVERT DRY STORAGE	PWR	1991	2011	1152	1152	NA	NUHOMS-24 under 1992 site specific lic
20	CATAWBA 1	PWR	1985	2024	1419	2615	193	
21	CATAWBA 2	PWR	1986	2026	1418	2615	193	
22	CLINTON 1	BWR	1987	2026	2512	2512	624	
23	COMANCHE PEAK 1-2	PWR	1990	2030	1693	1289	193	
24	COOK 1&2	PWR	1975	2017	2050	3613	193	
25	COOPER STATION	BWR	1974	2014	2366	2366	548	
26	CRYSTAL RIVER 3	PWR	1977	2016	1357	1357	177	
27	DAVIS-BESSE 1	PWR	1977	2017	735	720	177	
28	DAVIS-BESSE DRY STRG	PWR	1995	2015	192	192	NA	NUHOMS-24 under gnrl lic, starting 1995
29	DIABLO CANYON 1	PWR	1984	2010	1324	1324	193	
30	DIABLO CANYON 2	PWR	1985	2010	1324	1317	193	
31	DRESDEN 1	BWR	1960	1978	720	720	464	
32	DRESDEN 2	BWR	1970	2006	3537	3537	724	
33	DRESDEN 3	BWR	1971	2011	3537	3537	724	
34	DUANE ARNOLD	BWR	1974	2014	2050	1898	368	
35	ENRICO FERMI 2	BWR	1985	2025	2383	2383	764	
36	FARLEY 1	PWR	1977	2017	1407	1407	157	
37	FARLEY 2	PWR	1981	2021	1407	1407	157	
38	FITZPATRICK	BWR	1975	2014	2797	2797	560	
39	FORT CALHOUN	PWR	1973	2008	729	1083	133	
40	FORT ST VRAIN	HTG	1979	1989	1482	0	0	
41	FORT ST VRAIN DRY STRG	HTG	1991	2011	1482	1482	NA	Foster Wheeler MVDS under 1991 site specific lic
42	GINNA	PWR	1969	2009	1016	1083	121	
43	GRAND GULF 1	BWR	1984	2022	2324	3872	800	
44	HADDAM NECK	PWR	1967	2007	1172	1167	157	
45	HARRIS 1-2	PWR	1987	2026	4184	1128	157	
46	HARRIS 1-2 BWR POOL	BWR	1987	2026	NA	1573	NA	
47	HATCH 1-2	BWR	1974	2018	3181	5830	560	
48	HOPE CREEK	BWR	1986	2026	4006	3998	764	
49	HUMBOLDT BAY	BWR	1963	1976	486	485	184	
50	INDIAN POINT 1	PWR	1962	1980	756	756	120	
51	INDIAN POINT 2	PWR	1973	2013	1374	1374	193	
52	INDIAN POINT 3	PWR	1976	2015	1345	1340	193	
53	KEWAUNEE	PWR	1974	2013	990	990	121	
54	LACROSSE	BWR	1968	1987	440	440	72	
55	LASALLE 1-2	BWR	1982	2023	5153	7780	764	
56	LIMERICK 1-2	BWR	1985	2029	2040	6798	764	
57	MAINE YANKEE	PWR	1972	2008	1476	1464	217	
58	MCGUIRE 1	PWR	1981	2021	1463	1581	193	
59	MCGUIRE 2	PWR	1983	2023	1463	1460	193	
60	MILLSTONE 1	BWR	1970	2010	3229	3229	580	
61	MILLSTONE 2	PWR	1975	2015	1072	1299	217	
62	MILLSTONE 3	PWR	1986	2025	756	756	193	
63	MONTICELLO	BWR	1971	2010	2237	2229	484	
64	NINE MILE POINT 1	BWR	1969	2009	2776	2560	532	
65	NINE MILE POINT 2	BWR	1987	2026	4049	2528	764	
66	NORTH ANNA 1&2	PWR	1978	2020	1737	1677	157	
67	NORTH ANNA DRY STRG	PWR	1998	2018	256	256	NA	TN-32 under 1998 site specific lic
68	OCONEE 1&2	PWR	1973	2013	1312	1311	177	
69	OCONEE 3	PWR	1974	2014	825	818	177	
70	OCONEE DRY STORAGE	PWR	1990	2010	960	960	NA	NUHOMS-24 under 1990 site specific lic
71	OYSTER CREEK 1	BWR	1969	2009	2600	2600	560	
72	OYSTER CREEK DRY STRG	BWR	1996	2016	416	416	NA	NUHOMS-52 under gnrl lic, starting 1996

Table 1-2 (Cont).

	STORAGE LOCATIONS:	WASTE TYPE	UTIL STRTUP YEAR	UTIL SHUTD YEAR	STRG CAPAC (ASSEMBLIES) LICEN	MAX	FULL CORE ASMB	NOTES:
73	PALISADES	PWR	1971	2007	892	888	204	
74	PALISADES DRY STRG	PWR	1993	2013	48	48	NA	NUHOMS-24 under gnrl lic, starting 1996
75	PALO VERDE 1	PWR	1985	2024	665	1323	241	
76	PALO VERDE 2	PWR	1986	2025	665	1323	241	
77	PALO VERDE 3	PWR	1987	2027	665	1322	241	
78	PEACHBOTTOM 2	BWR	1974	2008	3819	3819	764	
79	PEACHBOTTOM 3	BWR	1974	2008	3819	3814	764	
80	PERRY 1	BWR	1986	2026	4020	4020	748	
81	PILGRIM 1	BWR	1972	2012	2320	2875	580	
82	POINT BEACH 1&2	PWR	1970	2013	1502	1500	121	
83	POINT BEACH DRY STRG	PWR	1995	2015	192	192	NA	VSC-24 under gnrl lic, starting 1995
84	PRAIRIE ISLAND 1&2	PWR	1973	2014	1386	1378	121	
85	PRAIRIE ISLAND DRY STRG	PWR	1993	2013	320	320	NA	TN-40 under 1993 site specific lic
86	QUAD CITIES 1-2	BWR	1972	2012	7554	7533	724	
87	RANCHO SECO 1	PWR	1974	1989	1080	1080	177	
88	RANCHO SECO DRY STRG	PWR	1996	2016	561	561	NA	NUHOMS-MP187 under 1996 site specific lic
89	RIVER BEND 1	BWR	1985	2025	2680	3172	624	
90	ROBINSON 2	PWR	1970	2010	544	537	157	
91	ROBINSON DRY STRG	PWR	1986	2006	56	56	NA	NUHOMS-07 under 1986 site specific lic
92	SALEM 1	PWR	1976	2016	1170	1117	193	
93	SALEM 2	PWR	1981	2020	1170	1139	193	
94	SAN ONOFRE 1	PWR	1967	1992	216	216	157	
95	SAN ONOFRE 2	PWR	1982	2013	1542	1542	217	
96	SAN ONOFRE 3	PWR	1983	2013	1542	1542	0	
97	SEABROOK 1	PWR	1990	2026	1236	1236	193	
98	SEQUOYAH 1&2	PWR	1980	2021	1386	2091	193	
99	SHOREHAM	BWR	1986	1987	2436	2685	560	
100	SOUTH TEXAS 1	PWR	1988	2027	1969	1958	193	
101	SOUTH TEXAS 2	PWR	1989	2028	1969	1958	193	
102	ST LUCIE 1	PWR	1976	2016	1706	1705	217	
103	ST LUCIE 2	PWR	1983	2023	1584	1076	217	
104	SUMMER 1	PWR	1982	2022	1276	1276	157	
105	SURRY 1&2	PWR	1972	2013	1044	1044	157	
106	SURRY DRY STORAGE	PWR	1986	2006	533	533	NA	CASTOR-32 (& other) under 1986 site spec lic
107	SUSQUEHANNA 1-2	BWR	1982	2024	2840	5680	764	
108	SUSQUEHANNA DRY STRG	BWR	1997	2017	416	416	NA	NUHOMS-52 under gnrl lic, starting 1997
109	THREE MILE ISLAND 1	PWR	1974	2014	752	1284	177	
110	TROJAN	PWR	1975	1992	1408	1395	193	
111	TURKEY POINT 3	PWR	1972	2007	1404	1376	157	
112	TURKEY POINT 4	PWR	1973	2007	1404	1376	0	
113	VERMONT YANKEE 1	BWR	1972	2012	2870	2860	368	
114	VOGTLE 1-2	PWR	1987	2029	2386	2283	193	
115	WASHINGTON NUCLEAR 2	BWR	1984	2023	2658	2654	764	
116	WATERFORD 3	PWR	1985	2024	1088	1070	217	
117	WATTS BAR 1&2	PWR	????	????	1312	1294	193	
118	WOLF CREEK 1	PWR	1985	2025	1340	1327	193	
119	YANKEE-ROWE 1	PWR	1960	1991	721	721	76	
120	ZION 1&2	PWR	1973	2013	2112	2929	193	
121	HANFORD SNF STRG	PWR	????	????	????	????	NA	
122	HANFORD SNF STRG	BWR	????	????	????	????	NA	
123	INEL SNF STRG	PWR	????	????	????	????	NA	
124	INEL SNF STRG	BWR	????	????	????	????	NA	
125	INEL SNF STRG	HTG	????	????	????	????	NA	
126	SAVANNAH RIVER SNF STRG	PWR	????	????	????	????	NA	
127	SAVANNAH RIVER SNF STRG	BWR	????	????	????	????	NA	
128	WEST VALLEY SNF STRG	PWR	????	????	????	????	NA	
129	WEST VALLEY SNF STRG	BWR	????	????	????	????	NA	
130	MORRIS OPERATION	PWR	????	2002	????	380	NA	
131	MORRIS OPERATION	BWR	????	2002	????	2928	NA	
132	GENERAL ATOMICS	RSH	????	????	????	????	NA	
	TOTAL							

Source: Spent Fuel Storage Requirements: 1994-2042 (DOE/RL-0431.... June 1995
Spent Nuclear Fuel Discharges From US Reactors: 1994 (SR/CNEAF/96-01..... Feb 1996)
1-2: Joined pools; 1&2: Shared pools.... later shutdown reactor date applies
Max pool capacities: generally from SFSR; SNFD as noted
Dry storage capacities: generally from SFSR; SNFD or PIC as noted

Table 1-3. Spent Nuclear Fuel and High-Level Waste Shipment Sites

	SHIPMENT SITE:	WASTE TYPE
1	ARKANSAS NUCLEAR	PWR
2	BEAVER VALLEY	PWR
3	BELLEFONTE	PWR
4	BIG ROCK	BWR
5	BRAIDWOOD	PWR
6	BROWNS FERRY	BWR
7	BRUNSWICK	BWR
		PWR
8	BYRON	PWR
9	CALLAWAY	PWR
10	CALVERT CLIFFS	PWR
11	CATAWBA	PWR
12	CLINTON	BWR
13	COMANCHE PEAK	PWR
14	COOK	PWR
15	COOPER STATION	BWR
16	CRYSTAL RIVER	PWR
17	DAVIS-BESSE	PWR
18	DIABLO CANYON	PWR
19	DRESDEN	BWR
20	DUANE ARNOLD	BWR
21	ENRICO FERMI	BWR
22	FARLEY	PWR
23	FITZPATRICK	BWR
24	FORT CALHOUN	PWR
25	FORT ST VRAIN	HTG
26	GINNA	PWR
27	GRAND GULF	BWR
28	HADDAM NECK	PWR
29	HARRIS	PWR
		BWR
30	HATCH	BWR
31	HOPE CREEK	BWR
32	HUMBOLDT BAY	BWR
33	INDIAN POINT	PWR
34	KEWAUNEE	PWR
35	LACROSSE	BWR
36	LASALLE	BWR
37	LIMERICK	BWR
38	MAINE YANKEE	PWR
39	MCGUIRE	PWR
40	MILLSTONE	BWR
41	MONTICELLO	BWR
42	NINE MILE POINT	BWR
43	NORTH ANNA	PWR
43	NORTH ANNA	PWR
44	OCONEE	PWR
45	OYSTER CREEK	BWR
46	PALISADES	PWR
47	PALO VERDE	PWR

	FUEL STRG LOCATIONS	WASTE TYPE
48	PEACHBOTTOM	BWR
49	PERRY	BWR
50	PILGRIM	BWR
51	POINT BEACH	PWR
52	PRAIRIE ISLAND	PWR
53	QUAD CITIES	BWR
54	RANCHO SECO	PWR
55	RIVER BEND	BWR
56	ROBINSON	PWR
57	SALEM	PWR
58	SAN ONOFRE	PWR
59	SEABROOK	PWR
60	SEQUOYAH	PWR
61	SHOREHAM	BWR
62	SOUTH TEXAS	PWR
63	ST LUCIE	PWR
64	SUMMER	PWR
65	SURRY	PWR
67	SUSQUEHANNA	BWR
68	THREE MILE ISLAND	PWR
69	TROJAN	PWR
70	TURKEY POINT	PWR
71	VERMONT YANKEE	BWR
72	VOGTLE	PWR
73	WASH NUCLEAR	BWR
74	WATTS BAR	PWR
75	WATERFORD	PWR
76	WOLF CREEK	PWR
77	YANKEE-ROWE	PWR
78	ZION	PWR
79	HANFORD	PWR
		BWR
		HLW
80	INEL	PWR
		BWR
		HTG
		HLW
		NRF
81	SAVANNAH	PWR
		BWR
		HLW
		FRF
82	WEST VALLEY	BWR
		PWR
		HLW
83	MORRIS	BWR
		PWR
84	GENERAL ATOMICS	RSH
		MSC

Waste Types:

BWR: Assemblies from boiling water reactors
PWR: Assemblies from pressurized water reactors
HTG: Assemblies from high-temp gas reactors
MSC: Miscellaneous spent fuel discharges thru Nov 1994 (@GA)
RSH: Spent fuel for research, thru Nov 1994 (@GA)
NRF: Naval reactor fuel
FRF: Foreign research fuel
HLW: High-level defense waste (not spent fuel)

2. THE INVENTORY OF SPENT NUCLEAR FUEL AND HIGH-LEVEL WASTE

The radioactive wastes which require geologic disposal and which could be shipped to a centralized storage facility at the Nevada Test Site (Area 25) to await permanent disposal are in three broad categories: SNF from commercial power plants, HLW from the nation's defense complex, and other wastes requiring geologic disposal. It is convenient to consider the current and projected inventory of these wastes with reference to their key relevant information sources. This, however, introduces some minor anomalies. For example, a portion of research and miscellaneous spent fuel is included in the current inventory of commercial SNF, since it is included in the key information source (prioritized spent fuel discharges) for this category. Also, the consideration of other wastes requires special attention to avoid double-counting.

2.1 Spent Nuclear Fuel from Commercial Plants

The Current SNF Inventory

Through November 1994, 30,044 metric tons of SNF had been permanently discharged from U.S. reactors, and had received priority ranking for acceptance by DOE (see Table 2-1). Of the November 1994 total,

- About 10,809 MTU (36.0 percent) was in 59,400 assemblies discharged from 41 commercial boiling water reactors. The average BWR assembly weighs .182 tons or 364 pounds.
- About 19,149 MTU (63.7 percent) was in 44,600 assemblies discharged from 78 commercial pressurized water reactors. The average PWR assembly weighs .429 tons or 869 pounds.
- About 86 MTU (0.3 percent) was discharges from the high-temperature gas reactor at Fort St. Vrain, Colorado, or discharges of research or miscellaneous spent fuel.

Ranked spent fuel discharges do not include naval reactor fuel, foreign research fuel, or spent fuel discharged from defense reactors. Nor does it include the HLW that have accumulated at defense sites.

The Future SNF Inventory

DOE has projected annual spent fuel discharges from 1994 through 2042 at commercial reactors,[4] under a case which assumes no-new-reactor orders and operations through the current NRC license term (with no early shut downs and no license extensions). The projected discharges include 56,655 MTU in 19,900 BWR and 36,800 PWR assemblies.

In this assessment, 1994 discharges are the "actuals" reported in DOE's 1995 Acceptance Priority Ranking through November 28, 1994. The differences between the actuals for 1994 and DOE's 1994 projections are included in the projected discharges for 1995, so that the projections for 1994 through 2042 are consistent with DOE's forecast for the no-new-orders, NRC license term case.

DOE's forecast is presented by the reactor from which the assemblies are discharged. This assessment identifies the pool location (separate, shared, or joined) to which the fuel would be discharged, but does not attempt to project future transfers of spent fuel to onsite dry storage facilities or to pools at other sites owned by the same utility or others.

The Total SNF Inventory

Combining projected spent fuel discharges with those through November 28, 1994, the total inventory includes 86,699 MTU in 30,700 BWR and 55,900 PWR assemblies. This total, however, does not include projections of spent fuel from research reactors, or projected naval reactor fuel, foreign research fuel, or HLW from defense facilities.

Alternative Inventory Projections

Alternative projections of waste requiring geologic disposal could be considered in alternative scenarios. Some of the contingencies that might be considered in alternative scenarios are briefly discussed below:

- **Reactors licensed for startup after 1993.**

  DOE's forecast for the no-new-orders, NRC license term case includes discharges for five reactors scheduled for startup after 1993, the base year for the DOE forecast:

  — Bellefonte 1, projected to discharge 2,193 PWR assemblies and 913 MTU between 2000 and 2039.

  — Bellefonte 2, projected to discharge 2,076 PWR assemblies and 864 MTU between 2003 and 2042.

  — Comanche Peak 2, projected to discharge 2,081 PWR assemblies and 856 MTU between 1994 and 2033.

  — Watts Bar 1, projected to discharge 1,725 PWR assemblies and 800 MTU between 1996 and 2035.

  — Watts Bar 2, projected to discharge 1,648 PWR assemblies and 763 MTU between 1998 and 2037.

  It is possible, even likely, that the above plants, though licensed, will never operate. In this case, projected discharges would be reduced by 9,723 PWR assemblies or 4,196 MTU, about 17.4 percent of the total inventory of 55,900 PWR assemblies in the no-new-orders case, and about 4.8 percent of total projected MTU.

- **Reactors shut down before their NRC license term**

  The economics of generating nuclear power in increasingly competitive electric power markets, as well as the cost of dealing with aging nuclear reactors[6] and/or problems in providing onsite storage capacity, could persuade utilities to shut down some reactors before their NRC license

term. The transportation effects of such decisions, which would reduce the revenue base for the nuclear waste fund, and complicate the financing of plant decommissioning, could be considered in an alternative inventory scenario.

- **Reactor license extensions**

  Extension of operating licenses beyond the standard 40-year term has been periodically considered by the NRC and utilities. Extensions would be contingent on the solution of problems associated with aging reactors and onsite storage, but could augment the nuclear waste fund as well as funds for decommissioning. The transportation effects of possible license extensions could be considered in an alternative inventory scenario.

2.2 High-Level Wastes from the Defense Complex

High-level waste is generated by the chemical reprocessing of spent research and production reactor fuel, irradiated targets and naval propulsion fuel. It exists in a variety of physical or chemical forms, all of which must be stored behind heavy shielding and usually in underground tanks or bins. Since DOE decided in 1992 to phase out the domestic reprocessing of irradiated nuclear fuel for the recovery of enriched uranium or plutonium, little additional generation of HLW is expected.

Current DOE plans are to immobilize HLW through a vitrification process, and to package it in canisters for storage at the four sites where it was produced (Hanford, INEL, Savannah River, West Valley) and for shipment to the geologic repository for disposal. The canisters are expected to be about 2 feet in diameter and from 10 to 15 feet in length. However, since pretreatment and waste minimization processes at the INEL and Hanford sites have not yet been finalized, the dimensions and number of canisters to be produced from those sites is less certain than at Savannah River and West Valley.

DOE's Integrated Data Base Report[5] (the source for the above summary) provides a projection of the number of canisters of HLW expected to be produced at each of the four sites, noting that "projected inventories. . .(are) based on certain assumptions, and therefore should be considered only as current best estimates." An alternative projection, with substantially higher production estimates for Hanford and INEL, is provided in DOE's Waste Management Programmatic EIS.[7] This assessment combines the canister production rate from the first source with the canister production totals from the second (Figure 2-1). It is assumed that the canisters would be stored at the sites where they are produced, awaiting shipment to a centralized storage or permanent disposal facility.

2.3 Other Wastes Requiring Geologic Disposal

A variety of other radioactive wastes require permanent geologic disposal. Under DOE waste management plans or DOE agreements with states such as Idaho, these wastes could be shipped to a centralized above-ground facility for storage while awaiting permanent disposal. A recent DOE document[8] provides the best available information on the inventory of such wastes, which could total about 2,700 MTU, about 9.0 percent of the commercial spent fuel discharged through November 1994. This section briefly discusses the categories and projected inventory of "other wastes requiring geologic disposal," but the schedule, packages, and routes by which they would be shipped to Nevada are not included in this assessment.

- **Naval Reactor Fuel**

  Spent fuel from the power plants of the Navy's submarines and aircraft carriers is being shipped to INEL for storage, but, under an October 1995 agreement with the State of Idaho, must be removed from the state by 2035. The current inventory of such fuel at INEL is about 10.23 MTU, and an additional 55 tons may be accumulated.

- **Defense Production Reactor Fuel**

  About 2,100 MTU of SNF has been generated at Hanford's weapons production reactors (reactors N and K) and about 150 MTU at Savannah River. Prior to DOE's 1992 decision, this spent fuel would have been reprocessed—producing enriched uranium or plutonium as well as HLW. Under the 1992 decision, however, it will be packaged for shipment to a permanent geologic repository, perhaps via a centralized above-ground storage facility.

- **Spent Fuel from Research Reactors: DOE**

  Spent fuel has been discharged from research reactors at INEL (about 263.9 MTU), Savannah River (about 56.3 MTU), Hanford (about 32.4 MTU), Oak Ridge (about 1.8 MTU), and elsewhere (Battelle, Sandia, Los Alamos, Argonne-East: about 2.3 MTU). This material, which is in assemblies generally about one-quarter of the size of BWR assemblies will require geologic disposal.

- **Spent Fuel from Research Reactors: Non-DOE**

  About 5.5 MTU from non-DOE research reactors (about 90 percent from research reactors at universities, about 10 percent from research reactors at other federal agencies or commercial sites) will require geologic disposal. This total does not include the 3.2 MTU of spent fuel from the General Atomics research reactor near San Diego, which has acceptance priority under the standard contract.

- **Spent Fuel from Research Reactors: Foreign**

  About 21.7 MTU of spent fuel provided for research in foreign countries is being returned to the U.S. (arriving at various ports of entry) for management and disposal at a geologic repository. The fuel may be shipped for storage at DOE facilities (e.g., Hanford, INEL, Savannah River) pending subsequent transportation to a centralized storage or disposal site.

Table 2-1. Spent Nuclear Fuel: Discharges, Assemblies, MTIHM
Current Inventory: Discharges Through November 28, 1994
Future Additions: Discharges 1995 through 2042

	DISCHG	ASSMBL	MTU	MTU/A	LBS/A	A/DSCHG	MTU/D
CURRENT:							
BWR	411	59418	10809	0.182	364	145	26
PWR	843	44602	19149	0.429	859	53	23
HTG	6	2208	24	0.011	22	368	4
RSC	32	72	3	0.044	89	2	0
MSC	3	0	59	NA	0	0	NA
SUM	1295	106300	30044	0.283	565	82	23
FUTURE:							
BWR	1872	110257	19873	0.180	360	59	11
PWR	3552	84915	36782	0.433	866	24	10
HTG	0	0	0	NA	0	NA	NA
RSC	0	0	0	NA	0	NA	NA
MSC	0	0	0	NA	0	NA	NA
SUM	5424	195172	56655	0.290	581	36	10
TOTAL:							
BWR	2283	169675	30682	0.181	362	74	13
PWR	4395	129517	55931	0.432	864	29	13
HTG	6	2208	24	0.011	22	368	4
RSC	32	72	3	0.044	89	2	0
MSC	3	0	59	NA	0	0	NA
SUM	6719	301472	86699	0.288	575	45	13

		DISCHG	ASSMBL	MTU	MTU/A	LBS/A	A/DSCHG	MTU/D
BWR:	Current	411	59418	10809	0.182	364	145	26
	Future	1872	110257	19873	0.180	360	59	11
	Total	2283	169675	30682	0.181	362	74	13
PWR:	Current	843	44602	19149	0.429	859	53	23
	Future	3552	84915	36782	0.433	866	24	10
	Total	4395	129517	55931	0.432	864	29	13
HTG:	Current	6	2208	24	0.011	22	368	4
	Future	0	0	0	NA	0	NA	NA
	Total	6	2208	24	0.011	22	368	4
RSC:	Current	32	72	3	0.044	89	2	0
	Future	0	0	0	NA	0	NA	NA
	Total	32	72	3	0.044	89	2	0
MSC:	Current	3	0	59	NA	0	0	NA
	Future	0	0	0	NA	0	NA	NA
	Total	3	0	59	NA	0	0	NA
SUM:	Current	1295	106300	30044	0.283	565	82	23
	Future	5424	195172	56655	0.290	581	36	10
	Total	6719	301472	86699	0.288	575	45	13

Source: DOE Acceptance Priority Ranking: Nov 28, 1994
Spent Fuel Storage Req: 1994-2042 (Tables B.1a & 1b),
via PIC: DISCHG, ACCPT94V, ACCPT95X

Figure 2-1a. Cumulative Projected Production of HLW Canisters at West Valley, Savannah River, Hanford, and Idaho National Engineering Lab

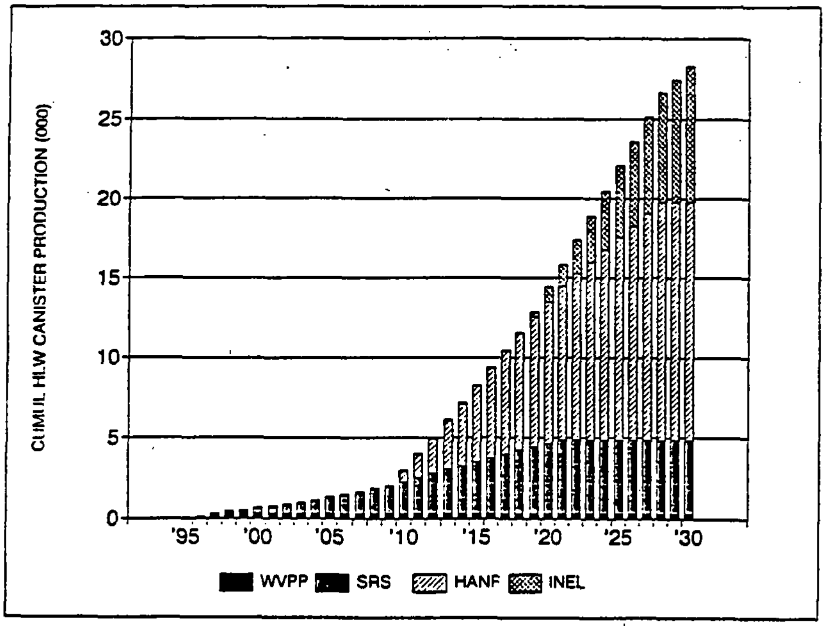
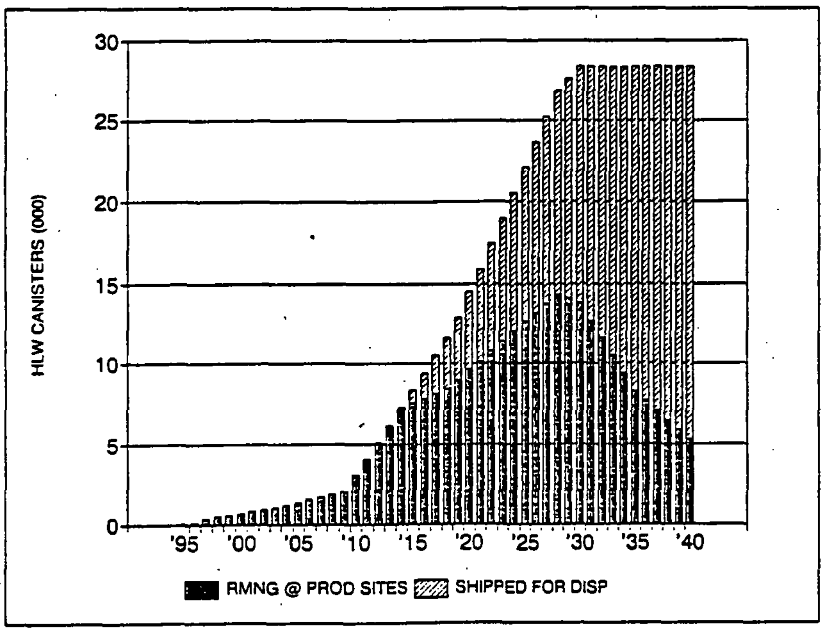


Figure. 2-1b. Cumulative Projected HLW Canisters—Shipped and Remaining at Production Sites



3. ACCEPTANCE STARTUP AND RATE

When the federal government is obligated to take title to SNF, and the annual rate at which it must pick up waste for transportation to and management at a federally-licensed facility are matters of current legal and legislative controversy:

Acceptance Startup Year

DOE has argued that acceptance would begin when a federally-licensed facility is available.[9] Since current legislation does not authorize construction of a centralized above-ground storage facility in Nevada, and since the suitability of Yucca Mountain as a permanent disposal site is uncertain, a date at which acceptance would begin cannot be specified.

Industry, on the other hand, has argued that the standard contract established by the NWPA requires the federal government to begin acceptance in 1998, in return for payments to the nuclear waste fund of 1 mill per kilowatt hour of nuclear generated electricity.[10]

This assessment does not specify the acceptance start year; acceptance begins in "year 1" and extends through "year 31". Assuming a 1998 startup year, and the acceptance rate specified in proposed legislation (see below), at least 84,100 MTU of SNF would be accepted by the end of the year 2027 (the 30th acceptance year)—reducing spent fuel in temporary storage to about 850 MTU. This spent fuel, plus about 1,610 MTU generated between 2027 and 2042 (under DOE's no-new-orders, NRC license term forecast[4]) is included in the "31st acceptance year," though in fact the fuel would be accepted in small quantities over a 22-year period between 2028 and 2050.

Changing the startup year to 2003, 84,100 MTU of SNF would not be accepted until the end of the year 2032 (the 30th acceptance year)—at which point the SNF in temporary storage would be about 1,715 MTU. This spent fuel, plus about 750 MTU generated between 2032 and 2042, is included in the "31st acceptance year", though in fact the fuel would be accepted in small quantities over a 17-year period between 2033 and 2050.

Acceptance Rate

DOE has suggested[11] that spent fuel would be accepted at a rate of 400 MTU in the first acceptance year, 600 MTU in the second, and 900 MTU in years three through ten. Only after year 10, other DOE reports[12] suggest, would acceptance and pick up increase to 3,000 MTU annually.

By contrast, proposed legislation would require acceptance of at least 1,200 MTU in the first and second acceptance years, 2,000 MTU in the third and fourth acceptance years, 2,700 MTU in the fifth acceptance year, and 3,000 MTU in the sixth and subsequent acceptance years.

This assessment uses the acceptance rate required by proposed legislation. The implication is that at least 9,100 MTU would be accepted for pickup and transport to a centralized storage facility over the first five acceptance years, and 15,000 MTU over each subsequent five-year period. Compared with acceptance rates implied by DOE reports, proposed legislation (e.g., S-1936) would increase pick up by

5,400 MTU over the first five years, by 10,500 MTU over the second five years, and by 3,000 MTU over the third five years.

SNF Acceptance and Pick Up (MTU)

	DOE	S-1936	Difference
Years 1 - 5	3,700	9,100	5,400
Years 6 - 10	4,500	15,000	10,500
Years 11 - 15	12,000	15,000	3,000
Years 16 - 20	15,000	15,000	0
Years 1 - 15	20,200	39,100	18,900

Shipment of High-Level Wastes

This assessment assumes that the start date for shipment of canisters of vitrified high-level waste from DOE defense sites in year 15—that is, 15 years after the start date for spent fuel shipments, or 2015 assuming that spent fuel shipments begin in the year 2000. Once begun, this assessment assumes that HLW canisters would be shipped at an annual rate of 800 in the first five years, 900 in the second five, and 600 in subsequent years. At these rates, shipments would continue through 2049, roughly 20 years beyond the conclusion of SNF shipments.

Would a permanent geologic repository be available in year 15 (i.e., in 2015 if SNF shipments begin in the year 2000, in 2025 if SNF shipments begin in 2010), and could or would HLW be shipped to Nevada for centralized above-ground storage while awaiting permanent disposal? The answer is uncertain. The October 1995 settlement agreement between the State of Idaho and the DOE suggests (Section C3) that all HLW as well as naval reactor fuel and foreign research reactor fuel must be moved out of Idaho (i.e., to Nevada) by January 2035, and a possible interpretation of proposed legislation would allow shipment of HLW for centralized above-ground storage if a geologic repository is unavailable. As mentioned, this assessment assumes HLW shipments begin year 15 after the start of SNF shipments, whether the Nevada destination is a centralized storage facility or a permanent repository.

4. ACCEPTANCE PRIORITY

Spent Fuel Discharges and Prioritization

The first spent fuel permanently discharged from a commercial nuclear plant occurred on June 21, 1968 and included five assemblies from the Big Rock Point boiling water reactor in northern Michigan. These assemblies, plus 80 others discharged from Big Rock in the late 1960s and early 1970s, are now stored at West Valley, in western New York State. The next spent fuel discharge from a commercial nuclear plant occurred on September 6, 1969 and included 94 assemblies from the Dresden 1 boiling water reactor in northeastern Illinois. These assemblies have been transferred for storage in the Dresden 2 and 3 spent fuel pools. The most recent spent fuel discharge in the current listing occurred on November 28, 1994 and included 204 assemblies from the Fitzpatrick boiling water reactor, north of Syracuse, New York, near the southeast corner of Lake Ontario.

Overall, there have been 1,108 discharges from commercial nuclear reactors through November 28, 1994—each of which is ranked for acceptance by year, month and day, and many of which have been subsequently separated into portions stored at various temporary locations. Assuming that DOE accepts "oldest-fuel-first," spent fuel would be picked up in the order in which it was discharged. This is the assumption in this assessment, though utilities are free to apply priorities to other fuel in their system, or to sell or auction priorities to other utilities. Also, proposed legislation might give priority to fuel at shut down reactors, which might help certain utilities to shut down their spent fuel pools earlier, and avoid the significant expense of continued pool operations at shut-down plants.

The Use of Spent Fuel Priorities

Though difficult to predict, some examples illustrate how utilities might use the priorities of spent fuel in their system:

- Pacific Gas and Electric has 29.2 MTU in BWR assemblies stored at Humboldt Bay, whose reactor was shut down in 1976, and 427.7 MTU in PWR assemblies stored at Diablo Canyon, whose reactors are scheduled for shut down in 2008 and 2010. The spent fuel at Humboldt Bay was discharged in the early and mid-1970's, giving it priority for pickup in the first two acceptance years, while that at Diablo Canyon was discharged after 1985, giving it priority for pickup in years 7 to 12.

  Pacific Gas and Electric could use the priority of its fuel at Humboldt Bay to empty and shut down the Humboldt Bay pool, thus avoiding the expense of its continued operation. Or, it could use the priority of its fuel at Humboldt Bay to ship from Diablo Canyon, thus providing additional pool capacity at the still-operating Diablo Canyon plants.

- Consumers Power Company has 44.7 MTU in BWR assemblies stored at Big Rock (whose reactor is scheduled for shut down in the year 2000), and 316.8 MTU in PWR assemblies stored at Palisades (whose reactor is scheduled for shut down in 2007). While Consumers Power has 181.1 MTU of spent fuel with rankings which qualify for pickup in the first five acceptance years, almost all (91.9 percent) is stored at Palisades rather than at the Big Rock spent fuel pool.

Consumers Power could choose to use the priority of fuel in its system to empty the Big Rock pool after the Big Rock reactor shuts down in 2000, thus eliminating the expense of its continued operation. The Palisades dry storage facility would be required to enable its reactor to continue operation through its NRC license term.

- Northern States Power has 198.7 MTU in BWR assemblies stored at Morris, 147.5 MTU in BWR assemblies stored at Monticello (whose plant is scheduled for shut down in 2010), and 502.0 MTU stored at Prairie Island, whose plants are scheduled for shut down in 2013 and 2014, but which has very limited onsite storage capacity (wet or dry) to support continued plant operations. While Northern States Power has 191.8 MTU of spent fuel with rankings which qualify for pickup in the first three acceptance years, over half is stored at Morris (46.9 percent) or Monticello (5.0 percent) rather than at Prairie Island.

Northern States could choose to use the priority of its spent fuel at Morris and Monticello to ship from Prairie Island, making additional storage capacity available there. While the capacity limitations at the Monticello spent fuel pool are much less severe than those at Prairie Island, the dimensions of the pool at Monticello (which was designed for BWR assemblies) preclude the transfer of PWR assemblies from Prairie Island. With confidence regarding an acceptance/shipment start date, Northern States might choose to purchase priority positions from one or more utilities with more sufficient onsite storage capacity.

5. SHIPMENT GROUPS

Spent Fuel Forms and Ages

Spent fuel discharged from boiling water reactors is in 52 different types of assemblies.[13] As of July 1, 1996, 8.6 percent of the MTU discharged from boiling water reactors is over 20 years old, 41.4 percent is between 10 and 20 years old, and 50.0 percent is less than 10 years old.

Spent fuel discharged from pressurized water reactors is in 54 different types of assemblies. As of July 1, 1996, 5.3 percent of the MTU discharged from boiling water reactors is over 20 years old, 37.4 percent is between 10 and 20 years old, and 57.3 percent is less than 10 years old.

Under an oldest-fuel-first acceptance prioritization, spent fuel which is over 20 years old on July 1, 1996 would be picked up in the first and second acceptance years. Spent fuel which is between 10 and 20 years old would be picked up in the second through seventh acceptance years, while fuel less than 10 years old would be picked up in the seventh through twelfth acceptance years. If acceptance begins in January 1998, the 40 PWR assemblies discharged from the Trojan plant in May 1986 would be picked up in 2005—meaning that Portland General Electric will have stored these assemblies in an operating spent fuel pool for 19 years, and for 13 years after the Trojan plant shut down in 1992.

Criteria for Cask Loading

How would the discharges at various storage locations be grouped for loading into transportation casks for shipment in a particular acceptance year?

- Would discharges whose priority ranking places them in different acceptance years be mixed in the same transportation cask? Under an oldest-fuel-first acceptance prioritization, the assumption in this assessment is "no."

- Would BWR or PWR discharges of different assembly types be mixed in the same transportation cask? The assumption in this assessment is "yes, as necessary." Thus, for example, the 335 assemblies at Big Rock, which include seven BWR assembly types fabricated by three companies (General Electric, Siemens and Nuclear Fuel Services), could be mixed in the same transportation cask if they fall into the same acceptance year.

- Would BWR and PWR assemblies be mixed in the same transportation cask? The question arises at storage locations such as Brunswick and Harris, whose pools have sections for storage of BWR and PWR assemblies, and at locations such as Morris, West Valley, and INEL, where BWR, PWR, and (in the case of INEL) HTG assemblies have been shipped for temporary storage. The assumption in this assessment is "no"—BWR and PWR assemblies would not be mixed in the same transportation cask.

- Would BWR or PWR assemblies discharged from different reactors be mixed in the same transportation cask? The question arises at Morris, which stores BWR assemblies discharged from Cooper Station and Dresden 2, or at McGuire 2, which stores PWR assemblies discharged

from the three Oconee reactors as well as the McGuire 2 reactor, or at INEL, which stores PWR assemblies discharged at TMI 2, Surry 1 and 2, Turkey Point 3, and Point Beach. The assumption in this assessment is "no"—BWR or PWR assemblies discharged from different reactors would not be mixed in the same transportation cask.

Among the four shipment grouping criteria discussed above, the last may be considered too restrictive in its application in certain cases. An example is the BWR assemblies stored in the joined Hatch 1 and 2 spent fuel pools, near the Altamaha River about 75 miles west of Savannah, Georgia. These pools contain about 900 BWR assemblies of the 8G5 type, about 750 of the 8GP type, and about 1,450 of the 8GB type,[13] each of which has been discharged in substantial numbers from both the Hatch 1 and Hatch 2 reactors. There may be no impediment in mixing such assemblies in the same transportation cask, if they fall into the same acceptance year.

While shipment grouping is considered in this assessment, it is a factor which as a limited effect on the number of transportation casks shipped from a particular site in a particular acceptance year. More elaborate grouping criteria sometimes result in a few additional one or two partially-filled casks shipped from a particular site in a particular acceptance year.

6. CASK OPTIONS

Rail Transport Casks

Several casks are potentially available for rail shipment of SNF or HLW, some of which may also be used for above-ground storage of these materials:

- The NAC STC cask, designed by Nuclear Assurance Corporation, would have a capacity of 26 PWR assemblies at least 6½ years old, or 57 BWR assemblies at least eight years old. The cask would weigh at least 125 tons loaded. The PWR version has been certified by NRC for storage and transport, while the BWR version was scheduled for license submission in the fall of 1995. No NAC STC casks have been fabricated and none are currently available for delivery to storage or shipment sites. It is estimated that fabrication and delivery would take about two years after the order for a certified cask is made.

- The IF-300 cask, designed by General Electric, has a capacity of 7 PWR or 18 BWR assemblies. The cask weighs about 70 tons loaded. Four such casks have been fabricated. Two have been used by Carolina Power and Light for transfer of PWR and BWR assemblies among their Robinson, Brunswick, and Harris facilities. Two are owned by Vectra Technologies, formerly Pacific Nuclear Corporation. The IF-300 is certified for transport only, and no new fabrication is permitted under its current NRC certificate of compliance, which expired in May 1995.

- The TN-8 and TN-9 casks, designed by Transnuclear Inc., have capacities for 3 PWR or 7 BWR assemblies. Assemblies transported in TN-8/9 casks are uncanistered—meaning that, on arrival at its destination, the transportation cask must be moved to a spent fuel pool, where bare fuel assemblies are removed for pool storage or canistering. Though four such casks are available, they are not currently certified for use in the U.S. The TN-8 and TN-9 casks weigh just under 40 tons loaded. They are designed for transport only, not for storage, and the current certificate of compliance expired in May 1996.

- The Hi-Star 100 cask, designed by Holtec International, has a capacity of 24 PWR and 68 BWR assemblies. It is designed for storage as well as transport. None are currently available, as its NRC license application is currently under review. The cask weight, empty or loaded, is currently considered proprietary.

- The Vectra MP-187 cask, designed by Vectra Technologies for storage as well as transport, would have a capacity of 24 PWR assemblies. Its NRC license application is currently under review. The cask is intended for storage and transport of spent fuel at the Rancho Seco plant (near Sacramento, California) which was shut down in 1989.

- The small MPC (multiple-purpose canister) cask, designed by Westinghouse Electric for transport, storage, and (possibly) permanent disposal, would have a capacity of 12 PWR or 24 BWR assemblies. The large MPC cask, also designed by Westinghouse Electric for transport, storage, and (possibly) permanent disposal, would have a capacity of 21 PWR or 40 BWR assemblies.

Through FY 1995, MPC cask design and licensing was supported by DOE via the Nuclear Waste Fund, but this support was not continued in appropriations for FY 1995. While the U.S. Navy is considering an adaptation of the MPC design for the transport and storage of naval reactor fuel, the schedule for its design and licensing for use with SNF is uncertain. It appears unlikely that such casks could be delivered for a 1998 acceptance date.

- DOE has expressed its intention to adapt the MPC design for transport and storage of five canisters of vitrified HLW, each of which would be about 2 feet in diameter and 10 to 15 feet in length.[14] (The 48" diameter cavity of the MPC-75 might accommodate four two-foot diameter canisters, while the 58" diameter cavity of the MPC-125 might accommodate six two-foot diameter canisters.)[15] DOE has not begun detailed design or licensing of such a cask, however.

Dry Storage of Canistered Spent Fuel

Several designs for dry storage of canistered spent fuel have been approved by NRC. In these designs, spent fuel canisters are loaded and sealed in an operating spent fuel pool, then inserted into a nearby concrete or metal facility for onsite storage. The Electric Power Research Institute is currently developing a "dry transfer" facility, by which the sealed canisters could be transferred to a transport cask without return to a spent fuel pool. If successful, dry transfer could enable certain spent fuel pools to be shut down, even while spent fuel remains onsite in dry storage. Dry storage designs include:

- The NUHOMS concrete modules, designed by Vectra Technologies for storage of canistered PWR or BWR assemblies. The NUHOMS-7 design was licensed in 1986 and has a capacity of 7 PWR assemblies, while the NUHOMS-24P design was licensed in 1989 for storage of 24 PWR assemblies. A standardized version of the NUHOMS-24P and NUHOMS-52B (for 52 BWR assemblies) received an NRC certificate of compliance in January 1995.[16] The NUHOMS-7 design is in use at Robinson 2, while the NUHOMS-24P design is in use at Oconee, Calvert Cliffs, and Rancho Seco.

- The VSC-24 ventilated cask, designed by Pacific Sierra Nuclear for storage of 24 PWR assemblies. The design received its NRC certificate of compliance in 1993 and is in use at the Palisades nuclear plant, about 40 miles west of Kalamazoo near the eastern shore of Lake Michigan.

Legal-Weight Truck Transport Casks

Several designs are potentially available for legal-weight truck shipment of SNF and HLW. In contrast to dry storage casks and recently-designed rail casks, legal-weight truck casks are designed to transport uncanistered assemblies—meaning that, on its arrival at its destination, the cask must be placed in a spent fuel pool or hot cell, where the assemblies are removed for pool storage or canistered for dry storage.

- The GA-4 and GA-9 casks, designed by General Atomics, would have capacity for four PWR or nine BWR assemblies. The design is currently in review by NRC. The cask would weigh 27 tons, loaded. Adding the truck and transportation tackle, shipments would barely meet legal highway weight (80,000 lbs.).

There is some question whether General Atomics would find it advantageous to produce the GA-4/9 casks for a shipment campaign which emphasizes rail transport and reduces the inventory shipped by truck. Ironically, the number of smaller capacity truck shipments in a shipment campaign emphasizing rail transport could be as large or larger than the number truck shipments in a campaign which uses the higher capacity GA-4/9 casks combined with less rail transport.

- The NLI-1/2 cask designed by National Lead Industries, but not currently certified for domestic use, and the NAC-LWT cask designed by Nuclear Assurance Corporation have capacity to transport a single 860 pound PWR assembly or two 360 pound BWR assemblies. Such casks have been used in most spent fuel transport to date. These casks weigh 24 to 26 tons loaded.

Transport Cask Options: This Assessment

This assessment limits the array of transport cask options to essentially four:

- A 75-ton rail transport and storage cask similar to the MPC-75 design.
- A 125-ton rail transport and storage cask similar to the MPC-125 design.
- A high-capacity legal-weight truck transport cask similar to the GA-4/9 designs.
- A standard legal-weight truck transport cask similar to the NLI-1/2 or NAC-LWT designs.
- In addition, we have included a 100+ ton rail transport and storage cask for canisters of vitrified HLW—an adaption of the MPC-75/125 designs.

Note that, with the exception of the standard legal-weight truck transport casks, none of the above cask options are licensed by NRC, in production, or currently-available for delivery and use. The GA-4/9 cask design is in review in NRC, but, even if it is licensed, its production is uncertain. Despite considerable DOE investment in the 1990's, the designs for the MPC-75 and 125 casks are conceptual, and have not yet been submitted to NRC for licensing.

This assessment considers the high-capacity and standard capacity truck casks as alternatives for legal-weight truck transport. We estimate truck shipments using either cask, but do not attempt to estimate the mix of high and standard capacity casks that could be used in legal-weight truck shipments.*

* Map presentation of annual cask shipments (Sections 16-20) assume the use of standard capacity legal-weight truck casks in the "current capabilities" scenario, and the high-capacity, legal-weight truck cask in the "MPC base case" and "maximum rail" transportation choice scenarios.

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7. CASK LOADING

Key Factors in Cask Loading

The facilities at each storage location must be able to load the cask option selected. The key requirements include:

- A crane at the spent fuel pool with operating capacity to safely lift the loaded cask.
- A cask loading area in the spent fuel pool of sufficient dimension to accommodate the upended cask and with a floor capable of supporting the cask during loading.
- A pool depth sufficient to maintain necessary water coverage while assemblies are moved over the upended cask during loading.
- A receiving area of sufficient dimension to accommodate the loading of the upended cask onto the rail car or truck, and a receiving area door of sufficient height to accommodate the rail car or truck along with its horizontally-positioned transport cask.
- In addition, sites with canistered spent fuel stored in concrete modules or vaults (e.g., Robinson, Oconee, Calvert Cliffs, Palisades, Rancho Seco) must have facilities necessary to remove the canisters and load them (wet or dry) into the selected transport cask.

DOE's "FICA" Database

DOE's "Facility Interface Capability Assessment (FICA)" project[17] assessed the capability of each commercial SNF storage facility to handle shipping casks. The assessment, which was conducted in the late 1980s and has not been systematically updated, found one or more limitations at many storage locations (particularly in handling larger and heavier rail casks). Some limitations, however, might be overcome by modifications to facility licenses, administrative controls or physical aspects of the facility.

Application of FICA Data in this Assessment

This assessment has reviewed the FICA data to consider the capability of each storage location to handle the cask options selected (Table 7-1). The key considerations were operating crane capacity, cask loading area dimensions, and pool depth. The assessment recognizes that facilities at some locations have been upgraded since the FICA assessment—particularly with regard to operating crane capacity at sites where onsite dry storage has been developed. The assessment also recognizes that facility limitations are often not absolute; current limitations may be eliminated or reduced through modification of facility licenses, administrative controls or physical aspects of the cask-handling building.

At the same time, the utility must decide that it is advantageous to invest in the changes necessary to enable their facilities to handle cask option "A" rather than cask options "B," or cask option "B" rather than cask options "C" or "D." These decisions "at the margin" will be made in the context of other factors (near-site rail infrastructure, site community characteristics, utility choice criteria) which are discussed in the following sections.

Table 7-1. Cask Loading Factors: by Storage Location

	FUEL STRG LOCATION:	CASK LOADG FACTOR: CRD	CRO	CDI	CLG
1	ARKANSAS NUCLEAR 1	100	100	R125	R125
2	ARKANSAS NUCLEAR 2	100	100	R125	R125
3	ARKANSAS NUCLEAR DRY STRG	NA	NA	NA	NA
4	BEAVER VALLEY 1	125	60	R125	R125
5	BEAVER VALLEY 2	125	100	R125	R125
6	BELLEFONTE 1	ND	ND	ND	ND
7	BELLEFONTE 2	ND	ND	ND	ND
8	BIG ROCK 1	75	24	LWT	LWT
9	BRAIDWOOD 1	125	110	R125	R125
10	BROWNS FERRY 1-2	125	106	R75	LWT
11	BROWNS FERRY 3	125	106	R75	LWT
12	BRUNSWICK 1	125	75	R125	R125
13	BRUNSWICK 1 PWR POOL	125	75	R125	R125
14	BRUNSWICK 2	125	75	R125	R125
15	BRUNSWICK 2 PWR POOL	125	75	R125	R125
16	BYRON 1	125	110	R125	R125
17	CALLAWAY 1	150	125	R125	R125
18	CALVERT CLIFFS 1-2	150	25	R125	R75
19	CALVERT DRY STORAGE	NA	NA	NA	NA
20	CATAWBA 1	125	125	R125	R125
21	CATAWBA 2	125	125	R125	R125
22	CLINTON 1	125	100	R125	R125
23	COMANCHE PEAK 1	130	130	R125	R125
24	COOK 1	150	60	R125	R125
25	COOPER STATION	100	100	LWT	LWT
26	CRYSTAL RIVER 3	120	72	R125	R125
27	DAVIS-BESSE 1	140	125	R125	R125
28	DAVIS-BESSE DRY STRG	NA	NA	NA	NA
29	DIABLO CANYON 1	125	67	R125	R125
30	DIABLO CANYON 2	125	67	R125	R125
31	DRESDEN 1	75	24	LWT	R125
32	DRESDEN 2	75	75	LWT	LWT
33	DRESDEN 3	75	75	LWT	LWT
34	DUANE ARNOLD	100	85	R125	R75
35	ENRICO FERMI 2	125	100	R125	LWT
36	FARLEY 1	125	125	R125	R125
37	FARLEY 2	125	125	R125	R125
38	FITZPATRICK	125	62	R125	R75
39	FORT CALHOUN	75	40	R125	R125
40	FORT ST VRAIN	50	50	LWT	R125
41	FORT ST VRAIN DRY STRG	NA	NA	NA	NA
42	GINNA	40	30	R125	LWT
43	GRAND GULF 1	150	125	R125	R125
44	HADDAM NECK	100	100	R75	LWT
45	HARRIS 1	150	75	R125	R125
46	HARRIS 1 BWR POOL	150	97	LWT	LWT
47	HATCH 1-2	125	125	R125	LWT
48	HOPE CREEK	150	130	R125	R125
49	HUMBOLDT BAY	75	60	R125	R125
50	INDIAN POINT 1	75	60	LWT	LWT
51	INDIAN POINT 2	40	32	R75	LWT
52	INDIAN POINT 3	75	40	R75	LWT
53	KEWAUNEE	125	120	LWT	LWT
54	LACROSSE	50	36	LWT	LWT
55	LASALLE 1-2	125	100	R125	R125
56	LIMERICK 1-2	125	110	R125	R125
57	MAINE YANKEE	125	125	R125	R125
58	MCGUIRE 1	125	100	LWT	R125
59	MCGUIRE 2	125	100	LWT	R125
60	MILLSTONE 1	110	110	LWT	R125
61	MILLSTONE 2	100	100	R125	R125
62	MILLSTONE 3	125	125	R125	R125
63	MONTICELLO	85	85	LWT	LWT
64	NINE MILE POINT 1	125	100	R125	LWT
65	NINE MILE POINT 2	125	100	R125	LWT
66	NORTH ANNA 1&2	125	105	R125	R125
67	NORTH ANNA DRY STRG	NA	NA	NA	NA
68	OCONEE 1&2	100	100	LWT	R125
69	OCONEE 3	100	100	LWT	R125
70	OCONEE DRY STORAGE	NA	NA	NA	NA
71	OYSTER CREEK 1	100	100	R125	R75
72	OYSTER CREEK DRY STRG	NA	NA	NA	NA
73	PALISADES	100	25	LWT	LWT
74	PALISADES DRY STORAGE	NA	NA	NA	NA
75	PALO VERDE 1	150	150	R125	R125
76	PALO VERDE 2	150	150	R125	R125
77	PALO VERDE 3	150	150	R125	R125
78	PEACHBOTTOM 2	125	100	R75	LWT
79	PEACHBOTTOM 3	125	100	R75	LWT
80	PERRY 1	125	125	R125	R125
81	PILGRIM 1	100	26	R75	LWT
82	POINT BEACH 1&2	125	125	R75	R125
83	POINT BEACH DRY STRG	NA	NA	NA	NA
84	PRAIRIE ISLAND 1&2	125	125	R125	R125
85	PRAIRIE ISLAND DRY STRG	NA	NA	NA	NA
86	QUAD CITIES 1	125	75	R125	LWT
87	RANCHO SECO 1	100	97	R125	R125
88	RANCHO SECO DRY STRG	NA	NA	NA	NA
89	RIVER BEND 1	125	125	R125	R125
90	ROBINSON 2	125	77	R75	R125
91	ROBINSON DRY STORAGE	NA	NA	NA	NA
92	SALEM 1	110	110	R125	R125
93	SALEM 2	110	110	R125	R125
94	SAN ONOFRE 1	105	70	R75	LWT
95	SAN ONOFRE 2	125	125	R125	R125
96	SAN ONOFRE 3	125	125	R125	R125
97	SEABROOK 1	125	125	R125	R125
98	SEQUOYAH 1	125	80	R125	R125
99	SHOREHAM	125	123	R75	LWT
100	SOUTH TEXAS 1	150	150	R125	R125
101	SOUTH TEXAS 2	150	150	R125	R125
102	ST LUCIE 1	105	25	R125	R125
103	ST LUCIE 2	150	100	R125	R125
104	SUMMER 1	125	125	R125	R125
105	SURRY 1&2	125	125	R125	R125
106	SURRY DRY STORAGE	NA	NA	NA	NA
107	SUSQUEHANNA 1-2	125	125	R125	R125
108	SUSQUEHANNA DRY STRG	NA	NA	NA	NA
109	THREE MILE ISLAND 1	110	110	R75	R125
110	TROJAN	125	100	R125	R125
111	TURKEY POINT 3	105	25	R125	R75
112	TURKEY POINT 4	105	25	R125	R75
113	VERMONT YANKEE 1	110	110	LWT	LWT
114	VOGTLE 1-2	125	91	R125	R125
115	WASH NUCLEAR 2	125	125	R125	LWT
116	WATTS BAR 1&2	ND	ND	ND	ND
117	WATERFORD 3	125	125	R125	LWT
118	WOLF CREEK 1	150	125	R125	R125
119	YANKEE-ROWE 1	75	37	R75	R125
120	ZION 1&2	125	110	R125	LWT
121	HANFORD SNF STRG	ND	ND	ND	ND
122	HANFORD SNF STRG	ND	ND	ND	ND
123	INEL SNF STRG	ND	ND	ND	ND
124	INEL SNF STRG	ND	ND	ND	ND
125	INEL SNF STRG	ND	ND	ND	ND
126	SAVANNAH RV SNF STRG	ND	ND	ND	ND
127	SAVANNAH RV SNF STRG	ND	ND	ND	ND
128	WEST VALLEY SNF STRG	ND	ND	ND	ND
129	WEST VALLEY SNF STRG	ND	ND	ND	ND
130	MORRIS	125	68	R125	R125
131	MORRIS	125	68	R125	R125
132	GENERAL ATOMICS	ND	ND	ND	ND

Cask Loading Factors:
- CRD: design crane capacity (tons)
- CRD: operating crane capacity (tons)
- CDI: cask set-down (loading) diameter (max cask option)
- CLG: cask length (loading) req (max cask option)

Shipment Cask Options:
- R125: Large MPC for up to 21 PWR or 40 BWR
- R75: Small MPC for up to 12 PWR or 24 BWR
- LWT: Legal-weight truck casks.... GA-4/9 if avail, NLI-1/2 or NAC LWT otherwise

8. NEAR-SITE INFRASTRUCTURE

Sites with Onsite Rail

At many storage locations, a rail line extends to the plant site and to the cask receiving area in the fuel handling building and/or the dry storage facility or barge loading platform. At some such locations, however, the onsite rail line requires upgrading for spent fuel rail shipments.

Sites without Onsite Rail

Locations without onsite rail may choose to transport the rail cask by heavy-haul truck or barge to an offsite railhead where the cask can be loaded onto a rail car for cross-country shipment. Such a decision, however, can introduce complications which could persuade a utility to choose to ship by legal-weight truck, or at least to hesitate before choosing to ship by rail.

- The additional load/unload operation in heavy-haul truck or barge transport is both costly and logistically complex.
- Heavy-haul truck transport involves state regulatory agencies in ways that legal-highway-weight transport does not.
- The communities along the heavy-haul route may object to such shipments.

Branch Rail Line Abandonments

Due to branch rail line abandonments, a number of storage locations which had onsite rail when the reactor was constructed do not have onsite rail now, or may not have onsite rail by the time a national shipment campaign begins. For example:

- The Central Railroad of New Jersey branch rail line, which provided onsite rail access when the Oyster Creek plant was constructed in 1969, has since been abandoned. The nearest currently available railhead is on the Conrail line at Lakehurst, New Jersey, and would be reached via a somewhat circuitous 30-mile heavy-haul truck shipment.
- The Elgin Joliet and Eastern branch rail line which has provided onsite rail access to General Electric's storage facility at Morris, Illinois is being considered for abandonment. The nearest available offsite railhead is on the Santa Fe Railroad at Coal City, and would be reached via a seven-mile heavy-haul truck shipment.

DOE's "NSTI" Database

DOE's Near-Site Transportation Infrastructure (NSTI) project[18] assessed the existing capabilities and upgrade potentials of transportation networks near 76 spent fuel storage sites. The assessment was conducted in 1989, and has not been systematically updated. Also, the NSTI final report makes clear that it does not recommend which transportation mode or shipping route should be used at the 76 sites, or

imply that the utility or plant operator for any facility or transportation system has expressed the intention of completing the upgrades assessed (Table 8-1).

Onsite Rail, Plus Rail Cask Loading

In fact, the utility's transportation choice will not be made on the basis of either near-site transportation or storage facility infrastructure, but on the combination of these factors with other considerations. This assessment generally assumes that a site will ship by rail if onsite rail is available and if the storage location facilities are able to load a 75 or 125-ton rail cask. In other words, it is generally assumed that a utility will find it advantageous to ship by rail if the additional investment required is small. For example,

- Arkansas Nuclear 1 and 2, located near Russellville, Arkansas, about 65 miles northwest of Little Rock, is a site which has operating onsite rail, and two separate pools—each capable of loading casks up to 9'6" in diameter and 19'2" in length, and each with an operating crane capacity of 100 tons. In this case, rail shipment using 75-ton casks would appear to require limited additional investment in pool facilities or near-site infrastructure, and it is assumed that this would be the choice of Arkansas Power and Light.

- Perry, located on the south shore of Lake Erie about 35 miles northeast of Cleveland, has operating onsite rail with modest upgrade requirements and two separate pools—each capable of loading casks up to 10'0" in diameter and 20'11" in length, and each with an operating crane capacity of 125 tons. In this case, rail shipment using 125-ton casks would appear to require limited additional investment in pool facilities or near-site infrastructure, and it is assumed this would be the choice of Cleveland Electric Illuminating Company.

No Onsite Rail or Rail Cask Loading

This assessment generally assumes that a site will ship by truck if on-site rail is not available and if current storage location facilities are unable to load a 75 or 125-ton rail cask. In other words, it is generally assumed that a utility will ship by legal-weight truck if the additional cost (in facility upgrades or logistical complication) to ship by rail is large. For example:

- Indian Point, located on the Hudson River about 35 miles north of Times Square, does not have onsite rail, though an offsite railhead is less than five miles distant. The pool at reactor #1, which was shut down in 1980, is capable of loading casks only 3'1" in diameter and 12'11" in length. The pools at reactors 2 and 3 are capable of loading casks of only 7'6" and 8'0" in diameter and 15'10" to 16'2" in length. The operating capacities of the pool cranes are 40 tons or less. In this case, rail shipment would appear to require substantial investment in pool dimensions, crane capacity and heavy-haul logistics. It is assumed that Consolidated Edison would avoid this investment, and ship by legal-weight truck.

- Ginna, located on Lake Ontario about 15 miles east of Rochester, New York, does not have onsite rail, though an offsite railhead is less than five miles distant. Its pools is capable of loading casks of 8'7" in diameter, but only 16'9" in length, and its operating crane capacity is only 30 tons. In this case, rail shipment would appear to require substantial investment in pool dimensions, crane

capacity and heavy-haul logistics. It is assumed that Rochester Gas and Electric would avoid this investment, and ship by legal-weight truck.

Near-Site Transportation/Cask Loading Combinations

Many sites have combinations of characteristics that complicate the utility's transportation choice:

- Onsite rail is available but pool facilities are unable to load a 75 or 125-ton rail cask.
- Pool facilities are sufficient but onsite rail is unavailable, or, if available, requires expensive upgrading.
- Pool dimensions are sufficient, but operating crane capacity is insufficient to lift a loaded 75- or 125-ton rail cask.
- Crane capacity could be improved, but requires substantial investment in equipment and drop tests.
- An offsite railhead is available but would require an additional loading (to a heavy-haul truck), plus highway travel through nearby communities, plus state heavy-haul permits.

In such circumstances, utilities must choose among available transportation cask options and make the consequent investment in pool facilities or near-site infrastructure to support the choice. DOE/OCRWM, which is responsible for the national shipment campaign, has an interest in and influence on the utility's choice, but cannot force utility investment beyond what the utility considers reasonable and appropriate. Each utility also has an interest in the success of the national shipment campaign—that is, an interest beyond minimizing the cost of moving spent fuel off its particular sites. In sum, choices among available transportation cask options will be made pool by pool and site by site, based on each utility's choice criteria and in the context of federal policy and the various facility, site and transportation network circumstances at the time the choice must be made. For planning purposes, this assessment specifies the available cask options (section 6), and considers three sets of possible utility transportation choices (section 11). Before reviewing the transportation scenarios, we consider several other choice factors—federal policy, utility choice criteria, and changing circumstances.

Table 8-1. Near-Site Infrastructure: by Storage Location

		NEAR-SITE FACTOR:			
	FUEL STRG LOCATION:	OSR	OP?	OS$	OFD
1	ARKANSAS NUCLEAR 1	Y	Y	0	0
2	ARKANSAS NUCLEAR 2	Y	Y	0	0
3	ARKANSAS NUCLEAR DRY STRG	Y	Y	0	0
4	BEAVER VALLEY 1	Y	Y	0	0
5	BEAVER VALLEY 2	Y	Y	0	0
6	BELLEFONTE 1	ND	ND	ND	ND
7	BELLEFONTE 2	ND	ND	ND	ND
8	BIG ROCK 1	N	NA	0	13
9	BRAIDWOOD 1	Y	Y	10	0
10	BROWNS FERRY 1-2	N	NA	20	9
11	BROWNS FERRY 3	N	NA	20	9
12	BRUNSWICK 1	Y	Y	0	0
13	BRUNSWICK 1 PWR POOL	Y	Y	0	0
14	BRUNSWICK 2	Y	Y	0	0
15	BRUNSWICK 2 PWR POOL	Y	Y	0	0
16	BYRON 1	Y	Y	0	0
17	CALLAWAY 1	N	NA	0	15
18	CALVERT CLIFFS 1-2	N	NA	0	37
19	CALVERT DRY STORAGE	N	NA	0	37
20	CATAWBA 1	Y	N	0	0
21	CATAWBA 2	Y	N	0	0
22	CLINTON 1	Y	N	0	0
23	COMANCHE PEAK 1	Y	Y	125	0
24	COOK 1	Y	N	100	0
25	COOPER STATION	Y	Y	0	0
26	CRYSTAL RIVER 3	Y	Y	80	0
27	DAVIS-BESSE 1	Y	Y	0	0
28	DAVIS-BESSE DRY STRG	Y	Y	0	0
29	DIABLO CANYON 1	N	NA	0	19
30	DIABLO CANYON 2	N	NA	0	19
31	DRESDEN 1	Y	Y	25	0
32	DRESDEN 2	Y	Y	25	0
33	DRESDEN 3	Y	Y	25	0
34	DUANE ARNOLD	Y	Y	0	0
35	ENRICO FERMI 2	Y	N	125	0
36	FARLEY 1	Y	Y	45	0
37	FARLEY 2	Y	Y	45	0
38	FITZPATRICK	Y	Y	10	0
39	FORT CALHOUN	N	NA	0	6
40	FORT ST VRAIN	Y	N	100	0
41	FORT ST VRAIN DRY STRG	Y	N	100	0
42	GINNA	N	NA	0	4
43	GRAND GULF 1	N	NA	0	24
44	HADDAM NECK	N	NA	0	14
45	HARRIS 1	Y	Y	0	0
46	HARRIS 1 BWR POOL	Y	Y	0	0
47	HATCH 1-2	Y	Y	0	0
48	HOPE CREEK	N	NA	0	23
49	HUMBOLDT BAY	Y	Y	150	0
50	INDIAN POINT 1	N	NA	0	3
51	INDIAN POINT 2	N	NA	0	3
52	INDIAN POINT 3	N	NA	0	3
53	KEWAUNEE	N	NA	0	10
54	LACROSSE	Y	N	100	0
55	LASALLE 1-2	Y	Y	0	0
56	LIMERICK 1-2	Y	N	50	0
57	MAINE YANKEE	Y	Y	0	0
58	MCGUIRE 1	Y	N	0	0
59	MCGUIRE 2	Y	N	0	0
60	MILLSTONE 1	Y	N	115	0
61	MILLSTONE 2	Y	N	115	0
62	MILLSTONE 3	Y	N	115	0
63	MONTICELLO	Y	Y	0	0
64	NINE MILE POINT 1	Y	Y	125	0
65	NINE MILE POINT 2	Y	Y	125	0
66	NORTH ANNA 1&2	Y	Y	50	0

Near-Site Infrastructure Considerations:
- OSR: onsite rail (yes, no, not applic)
- OP?: onsite rail operating? (yes, no, not applic)
- OS$: onsite rail upgrade cost (000$)
- OFD: distance to offsite rail (miles)

		NEAR-SITE FACTOR:			
	FUEL STRG LOCATION:	OSR	OP?	OS$	OFD
67	NORTH ANNA DRY STRG	Y	Y	50	0
68	OCONEE 1&2	N	NA	0	35
69	OCONEE 3	N	NA	0	35
70	OCONEE DRY STORAGE	N	NA	0	35
71	OYSTER CREEK 1	N	NA	0	30
72	OYSTER CREEK DRY STRG	N	NA	0	30
73	PALISADES	N	NA	10	13
74	PALISADES DRY STORAGE	N	NA	10	13
75	PALO VERDE 1	Y	Y	0	0
76	PALO VERDE 2	Y	Y	0	0
77	PALO VERDE 3	Y	Y	0	0
78	PEACHBOTTOM 2	N	NA	0	35
79	PEACHBOTTOM 3	N	NA	0	35
80	PERRY 1	Y	Y	40	0
81	PILGRIM 1	N	NA	0	12
82	POINT BEACH 1&2	N	NA	0	16
83	POINT BEACH DRY STRG	N	NA	0	16
84	PRAIRIE ISLAND 1&2	Y	N	25	0
85	PRAIRIE ISLAND DRY STRG	Y	N	25	0
86	QUAD CITIES 1	Y	N	0	0
87	RANCHO SECO 1	Y	N	0	0
88	RANCHO SECO DRY STRG	Y	N	0	0
89	RIVER BEND 1	Y	N	175	0
90	ROBINSON 2	Y	Y	0	0
91	ROBINSON DRY STORAGE	Y	Y	0	0
92	SALEM 1	N	NA	0	23
93	SALEM 2	N	NA	0	23
94	SAN ONOFRE 1	Y	Y	200	0
95	SAN ONOFRE 2	Y	Y	200	0
96	SAN ONOFRE 3	Y	Y	200	0
97	SEABROOK 1	Y	N	135	0
98	SEQUOYAH 1	Y	Y	10	0
99	SHOREHAM	N	NA	0	10
100	SOUTH TEXAS 1	Y	Y	85	0
101	SOUTH TEXAS 2	Y	Y	85	0
102	ST LUCIE 1	N	NA	0	10
103	ST LUCIE 2	N	NA	0	10
104	SUMMER 1	Y	Y	0	0
105	SURRY 1&2	N	NA	0	30
106	SURRY DRY STORAGE	N	NA	0	30
107	SUSQUEHANNA 1-2	Y	Y	0	0
108	SUSQUEHANNA DRY STRG	Y	Y	0	0
109	THREE MILE ISLAND 1	Y	Y	0	0
110	TROJAN	Y	Y	0	0
111	TURKEY POINT 3	N	NA	0	30
112	TURKEY POINT 4	N	NA	0	30
113	VERMONT YANKEE 1	Y	Y	75	0
114	VOGTLE 1-2	Y	N	25	0
115	WASH NUCLEAR 2	Y	Y	0	0
116	WATTS BAR 1&2				
117	WATERFORD 3	Y	Y	25	0
118	WOLF CREEK 1	Y	N	10	0
119	YANKEE-ROWE 1	N	NA	0	7
120	ZION 1&2	Y	Y	0	0
121	HANFORD SNF STRG	ND	ND	ND	ND
122	HANFORD SNF STRG	ND	ND	ND	ND
123	INEL SNF STRG	ND	ND	ND	ND
124	INEL SNF STRG	ND	ND	ND	ND
125	INEL SNF STRG	ND	ND	ND	ND
126	SAVANNAH RV SNF STRG	ND	ND	ND	ND
127	SAVANNAH RV SNF STRG	ND	ND	ND	ND
128	WEST VALLEY SNF STRG	ND	ND	ND	ND
129	WEST VALLEY SNF STRG	ND	ND	ND	ND
130	MORRIS	Y	Y	0	0
131	MORRIS	Y	Y	0	0
132	GENERAL ATOMICS	ND	ND	ND	ND

Shipment Cask Options:
- R125: Large MPC for up to 21 PWR or 40 BWR
- R75: Small MPC for up to 12 PWR or 24 BWR
- LWT: Legal-weight truck casks.... GA-4/9 if avail, NLI-1/2 or NAC LWT otherwise

9. OTHER TRANSPORTATION CHOICE FACTORS

Utility transportation choice decisions will reflect factors in addition to current near-site infrastructure and pool capabilities—e.g., federal policy, utility choice criteria, changes in near-site infrastructure cask handling capabilities, or site community characteristics.

Federal Policies

Federal policies affect utility transportation choices. For example,

- Via the nuclear waste fund, DOE has invested in the design of the GA-4/9 cask and the MPC 75 and 125-ton casks, and has set the parameters for these designs. However, as of FY 1996, DOE withdrew its financial support for design, and indicated that it does not intend to support certification or fabrication of these or other transportation or transportation/storage casks.

- Via the nuclear waste fund, DOE could fund modifications to spent fuel pools or near-site infrastructure at origin sites—modifications which would enable these sites to choose transportation options considered more desirable from the perspective of the national shipment campaign. However, in its draft scope for acquisition of transportation services,[2] DOE states that "OCRWM will not fund any on-site infrastructure modifications or improvements to the purchasers' facilities" (page 1).

- In its May 28, 1996 notice,[2] DOE proposes to delegate major responsibilities for waste acceptance, transportation and storage to contractors operating under competitive fixed price contracts. The resulting transportation choices negotiated with utilities could be quite different from those reached under another decision framework.

- DOE intends to provide the final route links to a permanent repository or centralized storage site in Nevada, and has conducted major studies of alternative heavy-haul and rail routes for this link. In the process, DOE would enable origin sites to choose rail over legal-weight truck transport, without, however, providing an incentive for origin sites to ship by rail.

Utility Choice Criteria

Utilities will have different sets of transportation choice criteria, based on their financial positions, their nuclear waste and other transportation experiences, their relationships with nearby communities, etc. Given the same origin site circumstances, utility "A" might choose to upgrade for rail shipment while utility "B," approaching the same decision from a different perspective, might choose to avoid upgrades and ship by truck.

Changes At or Near Origin Sites

Changes at or near origin sites will affect utility transportation choices at the time those choices must be made—generally, five to ten years from now. For example,

- The development of dry storage facilities often involves investment to enable pools to handle sealed spent fuel canisters, if not loaded transportation/storage casks. The resulting capabilities, many of which were not anticipated in DOE's 1989 FICA study, will be available for off-site transportation as well.

- While mainline railroads are receiving increasing freight traffic, branch lines—some serving nuclear plant sites—are being abandoned. For example,

  — The branch line of the Central Railroad which extended along US-9 through the Oyster Creek (New Jersey) site when the plant was constructed in the late 1960s has since been abandoned. Rail casks would now be heavy-hauled to Conrail's railhead in Lakehurst, New Jersey, along a 30-mile route which avoids the towns of Forked River, Tom's River, and Pinewold. Or, rail casks might be heavy-hauled across US-9 for barge shipment to an off-site railhead.

  — Burlington Northern's rail spur to the Cooper Station plant site on the Missouri River about 60 miles south of Omaha may be abandoned when it is no longer needed for shipments to Morris. Rail shipments might be heavy-hauled 30 miles to a Burlington Northern railhead in Nebraska City, or barged down the Missouri River through St. Joseph and Kansas City to a Union Pacific railhead in Boonville, Missouri.

  — The Elgin, Joliet, and Eastern rail spurs to the Morris and Dresden sites about 40 miles southwest of Chicago may be abandoned, as may Conrail's spur to West Valley, about 35 miles south of Buffalo, New York.

- Community conditions (resident population, community character, etc.) in near-site communities may also change, affecting the utility's transportation choice.

10. TRANSPORTATION CHOICES

Given the factors discussed in Sections 6 through 9, how would the transportation choice actually be made? Using Monticello, Big Rock Point, Point Beach, Salem/Hope Creek, and Enrico Fermi as case study sites, this section illustrates the transportation choice decision as it might be addressed by utilities. Section 11 presents three scenarios of transportation choices for all shipment sites. Appendix A compares the three transportation choice scenarios considered in this assessment with two developed by DOE.

Monticello

Given the cask options identified in Section 6, and the factors discussed in Sections 7 through 9, how would Northern States Power (NSP) choose to ship from its Monticello plant, located on the Mississippi River about 35 miles northwest of Minneapolis? Monticello has operating onsite rail which does not require upgrade for shipment of spent nuclear fuel. It has the operating crane capacity (85 tons) but currently has neither the cask set-down diameter (6'4") nor the maximum cask length (16'5") required to load a small MPC.

- Would NSP upgrade its spent fuel pool loading area and depth in order the ship by small MPC using its onsite rail?

- Would NSP avoid upgrade investments and ship by legal-weight truck, probably using Interstate 94 towards Minneapolis and Interstate 494 to circle the city on its western side?

The current capabilities and MPC base case scenarios assume that NSP chooses to ship by legal-weight truck. The maximum rail scenario, as well as scenarios identified by DOE, assume that NSP chooses to upgrade in order to ship by small MPC.

Big Rock Point

Given the cask options identified in Section 6, and the factors discussed in sections 7 through 9, how would Consumers Power Company choose to ship from its Big Rock Point plant, located on the upper reaches of Lake Michigan? Big Rock does not have onsite rail; rail shipments would require heavy-haul to the Tuscola and Saginaw Bay railhead in Petoskey about 13 miles east of the plant site. Neither the operating crane capacity (24 tons) nor cask set-down diameter (5'11") nor maximum cask length (15'11") at Big Rock Point currently meet requirements for loading a small MPC.

- Would Consumer's Power upgrade its crane and spent fuel loading area and depth in order to heavy-haul small rail casks for shipment from Petoskey?

- Would Consumers Power avoid investment in cask handling upgrades and heavy-haul operations, choosing to ship by legal-weight truck, probably south on I-75 to Flint, then southwest on I-69 through Lansing and west on I-95 through Battle Creek and Kalamazoo?

The current capabilities and MPC base case scenarios assume that Consumers Power chooses to ship by legal-weight truck. The maximum rail scenario (as well as DOE's Transportation Strategy Study

2) assumes that Consumers Power will upgrade its facilities and heavy-haul to Petoskey in order to ship small MPCs by rail.

Point Beach

Given the cask options identified in Section 6, and the factors discussed in Sections 7 through 9, how would Wisconsin Electric Power choose to ship from its Point Beach plant site, located on the western shore of Lake Michigan about 85 miles north of Milwaukee? Point Beach does not have onsite rail; rail shipment would require heavy-haul to a railhead, such as the Fox Valley and Western railhead Wisconsin Central in Kewaunee.[19] It has the operating crane capacity (125 tons) and maximum cask length (18'8") but not the cask set-down diameter (7'10") required to load a large MPC.

- Would Wisconsin Electric upgrade the cask set-down area in its spent fuel loading area in order to heavy-haul large rail casks for shipment from Kewaunee?
- Would Wisconsin Electric ship by legal-weight truck in order to avoid the cost of heavy-hauling small MPC casks to the Kewaunee railhead?

The current capabilities scenario assumes that Wisconsin Electric chooses to ship by legal-weight truck, via I-43 from Manitowoc through Sheboygan to Milwaukee. The MPC base case and maximum rail scenarios (as well as scenarios identified by DOE) assume that Wisconsin Electric chooses to upgrade its cask loading area and heavy-haul off site in order to ship large MPCs by rail.

Salem and Hope Creek

Given the cask options identified in Section 6, and the factors discussed in Sections 7 through 9, how would Public Service Gas and Electric (PSG&E) choose to ship from its Salem and Hope Creek plants on the New Jersey side of the Delaware River, about 12 miles south of Wilmington, Delaware? The sites do not have onsite rail; rail shipment would require heavy-haul 23 miles north to a railhead on the West Jersey Railroad in the Town of Salem. Hope Creek has the cask set-down diameter (11'0"), maximum cask length (19'9") and operating crane capacity (130 tons) required to load a large MPC. Salem has the cask set-down diameter (10'0") and maximum cask length (21'4") but insufficient operating crane capacity (110 tons) to load a large MPC.

- Would PSG&E upgrade operating crane capacity at its Salem facilities in order to heavy-haul large rail casks 23 miles for shipment by rail?
- Would PSG&E ship by legal-weight truck in order to avoid the cost of heavy-hauling or barging small MPC casks?

The current capabilities scenario assumes that PSG&E chooses to ship by legal-weight truck from both its Hope Creek and Salem plants. The MPC base case and maximum rail scenarios assume that PSG&E upgrades operating crane capacity at Salem in order to use the large MPC cask, which in the MPC base case would be heavy-hauled 23 miles to the Salem railhead on the West Jersey railroad, and in the maximum rail scenario would be barged up the Delaware River to a Conrail railhead in Wilmington.

Enrico Fermi

Given the cask options identified in Section 6 and the factors discussed in Section 7 through 9, how would Detroit Edison Company choose to ship from its Enrico Fermi plant on the western shore of Lake Erie, about midway between Detroit, Michigan and Toledo, Ohio? The Fermi site has onsite rail which is not operating and would require significant investment to upgrade for shipment of spent nuclear fuel. While its cask set-down diameter (9'0") meets requirements for a large MPC, its operating crane capacity (100 tons) currently meets requirements only for the small MPC, and its maximum cask length (14'9") currently meets requirements for neither the large nor small MPC.

- Would Detroit Edison upgrade the rail spur, the maximum cask length in its spent fuel loading facilities and its operating crane capacity in order to ship large MPC casks by rail?

- Would it ship by legal-weight truck in order to avoid or postpone some or all of these expenses?

The current capabilities scenario assumes that Detroit Edison chooses to ship by legal-weight truck, probably using I-275 to access I-94 for travel across the southern portion of the state. The MPC base case scenario assumes that Detroit Edison upgrades it facilities and rail spur in order to ship large MPCs north to Detroit and west through Lansing and Battle Creek on Grand Trunk Western rail lines. The maximum rail scenario assumes that Detroit Edison upgrades its facilities but not its rail spur at Fermi, choosing to barge rail casks east across Lake Erie to a railhead in Buffalo.

Table 10-1. Transportation Choice Factors and Scenarios: By Storage Location

		CASK LOADG FACTOR:				NEAR-SITE FACTOR:				TRANSP CHOICE:				
FUEL STRG LOCATION:	WASTE TYPE	CRD	CRO	CDI	CLG	OSR	OP?	OS$	OFD	CCP	MPC	MXR	TS2	APD
MONTICELLO	BWR	85	85	LWT	LWT	Y	Y	0	0	LWT	LWT	R75	R75	R75
BIG ROCK 1	BWR	75	24	LWT	LWT	N	NA	0	13	LWT	LWT	R75	R75	LWT
POINT BEACH 1&2	PWR	125	125	R75	R125	N	NA	0	16	LWT	R125	R125	R125	R125
POINT BEACH DRY STRG	PWR	NA	NA	NA	NA	N	NA	0	16	LWT	R125	R125	R125	R125
HOPE CREEK	BWR	150	130	R125	R125	N	NA	0	23	LWT	R125	R125	R125	R125
SALEM 1	PWR	110	110	R125	R125	N	NA	0	23	LWT	R125	R125	R125	R75
SALEM 2	PWR	110	110	R125	R125	N	NA	0	23	LWT	R125	R125	R125	R75
ENRICO FERMI 2	BWR	125	100	R125	LWT	Y	N	125	0	LWT	R125	R125	R125	R125

Site/Facility Charac: CRD: design crane capacity (tons)
CRD: operating crane capacity (tons)
CDI: cask set-down (loading) diameter (max cask option)
CLG: cask length (loading) req (max cask option)

OSR: onsite rail (yes, no, not applic)
OP?: onsite rail operating? (yes, no, not applic)
OS$: onsite rail upgrade cost (000$)
OFD: distance to offsite rail (miles)

Shipment Cask Options: R125: Large MPC for up to 21 PWR or 40 BWR
R75: Small MPC for up to 12 PWR or 24 BWR
LWT: Legal-weight truck casks.... GA-4/9 if avail, NLI-1/2 or NAC LWT otherwise

Transp Choice: MPC: MPC "Base Case" (NWPO: Jan 1994)
CCP: Current Capabilities (NWPO: May 1996)
MXR: Maximum Rail (NWPO: May 1996)

TR2: NV Transp Stategy, Study 2 (DOE: Feb 1996, Table F-3 & PIC)
APD: MPC Prelim Evaluation (DOE: Mar 1993, Appendix D)

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11. TRANSPORTATION MODE AND CASK CHOICES: THREE SCENARIOS

Considering the factors discussed in sections 8, 9, and 10, this assessment identifies three transportation choice scenarios, each specifying the assumed utility choice among available cask options (see Section 7) for each storage location (see Section 2). These scenarios, detailed in Table 11-1, assume that the utility's transportation choice does not change during the shipment campaign.

The MPC Base Case Scenario

The "MPC base case" set of utility transportation choices reflects previous work conducted by the state of Nevada to represent the most likely highway and rail routes for shipments of nuclear waste to Yucca Mountain using DOE's proposed Multi-Purpose Canister system for nuclear waste storage, transportation, and disposal.[20] For this assessment, the previous MPC base case transportation choice assumptions were reviewed; rail shipments by small and large MPC were specified; transportation choices for defense sites (e.g., Hanford, INEL, SRS, West Valley) and certain other storage locations (e.g., General Atomics research fuel) were specified.

In the MPC base case scenario, spent fuel stored at 17 commercial plant sites (listed below) is shipped by legal-weight truck; all other commercial plant sites ship by small or large MPC. If the high-capacity GA-4/9 cask is not available, the scenario assumes that legal-weight truck shipments would use a cask similar in capacity to the NLI-1/2 or NAC LWT.

Big Rock	Haddam Neck	Peachbottom
Crystal River	Humboldt Bay	Pilgrim
Fitzpatrick	Indian Point	St. Lucie
Fort Calhoun	LaCrosse	Vermont Yankee
Fort St. Vrain	Monticello	Yankee Rowe
Ginna	Palisades	

Spent fuel stored at Hanford, INEL, and West Valley, as well as research fuel stored at sites such as General Atomics are shipped by legal-weight truck in the MPC base case scenario. However, HLW vitrified and stored in canisters at Hanford, INEL and Savannah River is shipped by rail in an MPC adapted for this purpose.

The Current Capabilities Scenario

Assuming that utilities may be reluctant to make major investments to upgrade cask loading capabilities or near-site infrastructure, the current capabilities scenario identifies 15 additional commercial sites which could choose to ship by legal-weight truck, and assumes that the high-capacity GA-4/9 cask is not available:

Browns Ferry	Dresden/Morris	Oconee
Calvert Cliffs	Fermi	Oyster Creek
Cook	Grand Gulf	Point Beach
Cooper Station	Hope Creek/Salem	Surry
Diablo Canyon	Kewaunee	Turkey Point

Furthermore, the current capabilities scenario identifies 14 sites which might choose to ship by small MPC, rather than by large MPC as assumed in the MPC base case:

Arkansas Nuclear	Duane Arnold	Nine Mile Point
Beaver Valley	Harris	North Anna
Braidwood	La Salle	Rancho Seco
Byron	Limerick	Zion
Clinton	McGuire	

Obviously, the current capabilities scenario generates a larger number of shipments with greater highway impacts than does the MPC base case.

The Maximum Rail Scenario

Considering the upgrade potentials at each storage location, and assuming effective incentives for utilities to make the upgrades, the "maximum rail scenario" identifies 14 commercial sites (of the 17 which ship by truck in the MPC base case) which might ship by rail:

Big Rock	LaCrosse	Fitzpatrick
Crystal River	Monticello	Palisades
Fort Calhoun	Pilgrim	Peachbottom
Haddam Neck	Vermont Yankee	St. Lucie
Humboldt Bay	Yankee Rowe	

The sites in columns 1 and 2 above are assumed to upgrade for shipment by small MPC, while those in column 3 are assumed to upgrade for shipment by large MPC. The upgrades reduce the number of commercial sites which ship by truck to three: Ginna, Indian Point, Fort St. Vrain—all of which are assumed to use the high-capacity GA-4/9 cask.

In addition, the maximum rail scenario assumes that Three Mile Island upgrades for shipment by large MPC, rather than by small MPC as in the MPC base case.

DOE's Transportation Choice Assumptions

While DOE has not estimated annual shipments by route segment, several DOE studies consider transportation choices on a site-by-site basis: a 1996 "preliminary transportation strategy study for a potential Nevada repository",[21] and a 1993 evaluation of the use of MPCs in DOE's waste management system.[22] Appendix A reviews the transportation choice assumptions in these DOE studies, comparing them with the transportation choice scenarios outlined above.

Table 11-1. Utility Transportation Choice Scenarios: by Storage Location

	FUEL STRG LOCATION:	TRANSP CHOICE: CCP	MPC	MXR
1	ARKANSAS NUCLEAR 1	R75	R125	R125
2	ARKANSAS NUCLEAR 2	R75	R125	R125
3	ARKANSAS NUCLEAR DRY STRG	R75	R125	R125
4	BEAVER VALLEY 1	R75	R125	R125
5	BEAVER VALLEY 2	R75	R125	R125
6	BELLEFONTE 1	R125	R125	R125
7	BELLEFONTE 2	R125	R125	R125
8	BIG ROCK 1	LWT	LWT	R75
9	BRAIDWOOD 1	R75	R125	R125
10	BROWNS FERRY 1-2	LWT	R125	R125
11	BROWNS FERRY 3	LWT	R125	R125
12	BRUNSWICK 1	R75	R75	R75
13	BRUNSWICK 1 PWR POOL	R75	R75	R75
14	BRUNSWICK 2	R75	R75	R75
15	BRUNSWICK 2 PWR POOL	R75	R75	R75
16	BYRON 1	R75	R125	R125
17	CALLAWAY 1	LWT	R125	R125
18	CALVERT CLIFFS 1-2	LWT	R125	R125
19	CALVERT DRY STORAGE	LWT	R125	R125
20	CATAWBA 1	R125	R125	R125
21	CATAWBA 2	R125	R125	R125
22	CLINTON 1	R75	R125	R125
23	COMANCHE PEAK 1	R125	R125	R125
24	COOK 1	LWT	R125	R125
25	COOPER STATION	LWT	R75	R75
26	CRYSTAL RIVER 3	LWT	LWT	R75
27	DAVIS-BESSE 1	R125	R125	R125
28	DAVIS-BESSE DRY STRG	R125	R125	R125
29	DIABLO CANYON 1	LWT	R125	R125
30	DIABLO CANYON 2	LWT	R125	R125
31	DRESDEN 1	LWT	R75	R75
32	DRESDEN 2	LWT	R75	R75
33	DRESDEN 3	LWT	R75	R75
34	DUANE ARNOLD	R75	R125	R125
35	ENRICO FERMI 2	LWT	R125	R125
36	FARLEY 1	R125	R125	R125
37	FARLEY 2	R125	R125	R125
38	FITZPATRICK	LWT	LWT	R125
39	FORT CALHOUN	LWT	LWT	R75
40	FORT ST VRAIN	LWT	LWT	LWT
41	FORT ST VRAIN DRY STRG	LWT	LWT	LWT
42	GINNA	LWT	LWT	LWT
43	GRAND GULF 1	LWT	R125	R125
44	HADDAM NECK	LWT	LWT	R75
45	HARRIS 1	R75	R125	R125
46	HARRIS 1 BWR POOL	R75	R125	R125
47	HATCH 1-2	R125	R125	R125
48	HOPE CREEK	LWT	R125	R125
49	HUMBOLDT BAY	LWT	LWT	R75
50	INDIAN POINT 1	LWT	LWT	LWT
51	INDIAN POINT 2	LWT	LWT	LWT
52	INDIAN POINT 3	LWT	LWT	LWT
53	KEWAUNEE	LWT	R125	R125
54	LACROSSE	LWT	LWT	R75
55	LASALLE 1-2	R75	R125	R125
56	LIMERICK 1-2	R75	R125	R125
57	MAINE YANKEE	R125	R125	R125
58	MCGUIRE 1	R75	R125	R125
59	MCGUIRE 2	R75	R125	R125
60	MILLSTONE 1	R75	R75	R75
61	MILLSTONE 2	R75	R75	R75
62	MILLSTONE 3	R75	R75	R75
63	MONTICELLO	LWT	LWT	R75
64	NINE MILE POINT 1	R75	R125	R125
65	NINE MILE POINT 2	R75	R125	R125
66	NORTH ANNA 1&2	R75	R125	R125
67	NORTH ANNA DRY STRG	R75	R125	R125
68	OCONEE 1&2	LWT	R125	R125
69	OCONEE 3	LWT	R125	R125
70	OCONEE DRY STORAGE	LWT	R125	R125
71	OYSTER CREEK 1	LWT	R125	R125
72	OYSTER CREEK DRY STRG	LWT	R125	R125
73	PALISADES	LWT	LWT	R125
74	PALISADES DRY STORAGE	LWT	LWT	R125
75	PALO VERDE 1	R125	R125	R125
76	PALO VERDE 2	R125	R125	R125
77	PALO VERDE 3	R125	R125	R125
78	PEACHBOTTOM 2	LWT	LWT	R125
79	PEACHBOTTOM 3	LWT	LWT	R125
80	PERRY 1	R125	R125	R125
81	PILGRIM 1	LWT	LWT	R75
82	POINT BEACH 1&2	LWT	R125	R125
83	POINT BEACH DRY STRG	LWT	R125	R125
84	PRAIRIE ISLAND 1&2	R125	R125	R125
85	PRAIRIE ISLAND DRY STRG	R125	R125	R125
86	QUAD CITIES 1	R75	R75	R75
87	RANCHO SECO 1	R75	R125	R125
88	RANCHO SECO DRY STRG	R75	R125	R125
89	RIVER BEND 1	R125	R125	R125
90	ROBINSON 2	R75	R75	R75
91	ROBINSON DRY STORAGE	R75	R75	R75
92	SALEM 1	LWT	R125	R125
93	SALEM 2	LWT	R125	R125
94	SAN ONOFRE 1	R125	R125	R125
95	SAN ONOFRE 2	R125	R125	R125
96	SAN ONOFRE 3	R125	R125	R125
97	SEABROOK 1	R125	R125	R125
98	SEQUOYAH 1	R125	R125	R125
99	SHOREHAM	NA	NA	NA
100	SOUTH TEXAS 1	R125	R125	R125
101	SOUTH TEXAS 2	R125	R125	R125
102	ST LUCIE 1	LWT	LWT	R125
103	ST LUCIE 2	LWT	LWT	R125
104	SUMMER 1	R125	R125	R125
105	SURRY 1&2	LWT	R125	R125
106	SURRY DRY STORAGE	LWT	R125	R125
107	SUSQUEHANNA 1-2	R125	R125	R125
108	SUSQUEHANNA DRY STRG	R125	R125	R125
109	THREE MILE ISLAND 1	R75	R75	R125
110	TROJAN	R125	R125	R125
111	TURKEY POINT 3	LWT	R125	R125
112	TURKEY POINT 4	LWT	R125	R125
113	VERMONT YANKEE 1	LWT	LWT	R75
114	VOGTLE 1-2	R75	R75	R75
115	WASH NUCLEAR 2	R125	R125	R125
116	WATTS BAR 1&2	R125	R125	R125
117	WATERFORD 3	R125	R125	R125
118	WOLF CREEK 1	R125	R125	R125
119	YANKEE-ROWE 1	LWT	LWT	R75
120	ZION 1&2	R75	R125	R125
121	HANFORD SNF STRG	LWT	LWT	LWT
122	HANFORD SNF STRG	LWT	LWT	LWT
123	INEL SNF STRG	LWT	LWT	LWT
124	INEL SNF STRG	LWT	LWT	LWT
125	INEL SNF STRG	LWT	LWT	LWT
126	SAVANNAH RV SNF STRG	LWT	LWT	LWT
127	SAVANNAH RV SNF STRG	LWT	LWT	LWT
128	WEST VALLEY SNF STRG	LWT	LWT	R125
129	WEST VALLEY SNF STRG	LWT	LWT	R125
130	MORRIS	LWT	R125	R125
131	MORRIS	LWT	R125	R125
132	GENERAL ATOMICS	LWT	LWT	LWT

Transp Choice: CCP: Current Capabilities (NWPO: May 1996)
MPC: MPC "Base Case" (NWPO: Jan 1994)
MXR: Maximum Rail (NWPO: May 1996)

Shipment Cask Options: R125: Large MPC for up to 21 PWR or 40 BWR
R75: Small MPC for up to 12 PWR or 24 BWR
LWT: Legal-weight truck casks.... GA-4/9 if avail, NLI-1/2 or NAC LWT otherwise

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12. CASK SHIPMENTS

The assessment of shipment groups (section 5) determines the assemblies and MTU to be picked up for shipment from a particular storage location in a particular acceptance year. The identification of cask options (section 6) determines the transportation casks available under the particular scenario, and the transportation choice assessment (sections 7 through 11) determines the cask option selected for shipment from each storage location.

The next step in the assessment process is to determine the number of cask shipments from each storage location in each acceptance/pickup year.

- Cask shipments of spent fuel from BWR or PWR reactors are estimated by dividing the number of assemblies in the shipment group by the assembly capacity of the selected cask—rounding up to accommodate any fractions required to ship all assemblies in the group.
- Cask shipments of other spent fuel (e.g., spent fuel from research reactors or HTG assemblies from the Fort St. Vrain reactor) are estimated by dividing the MTU in the shipment group by the average MTU per cask for BWR and PWR assemblies shipped during the same period—generally about .40 MTU per T-1/2 cask, 1.655 MTU per T-4/9 cask, 4.28 MTU per R75 cask and 7.41 MTU per R125 cask. In effect, the assumption is that casks for HTG, research and other wastes will be as efficient as those designed for transport of BWR and PWR assemblies.
- Cask shipments for HLW assume that an MPC-like cask to accommodate five two-foot diameter canisters will be designed and certified for transport of HLW. The estimated shipments of HLW canisters from a particular site is thus divided by five—rounding up to accommodate any remaining canisters in the shipment group.

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13. ROUTING CRITERIA

Having determined the number of shipments of a particular cask type from each site each acceptance year, we must then determine the highway or rail shipment route. Aggregating shipments from each origin site, a community along a particular route segment in Pennsylvania, or in Indiana or Missouri could then understand, for example, that in the second acceptance year it should expect "x" shipments of certain cask types originating from certain storage locations, while in the fifth acceptance year it should expect "y" shipments from a somewhat different set of storage locations. This information should help state and local agencies conduct their planning in the context of the national shipment campaign.

In most cases, the routing decision will be made by the carrier, under certain constraints. Most notable is the requirement (based on 49 CFR§397.101(a), referred to as HM 164), that in transporting radioactive waste by truck, drivers must reduce transit time by using interstate highways or state-designated alternative routes.

In addition to the HM 164 requirement, we also assume that certain routing practices will be followed by shippers and carriers. For example, we assume that shippers will generally choose the closest Class I (highest volume) rail carrier, and that rail carriers will prefer Class A (highest volume) mainline rail segments.

Default (Quickest) Routes

To assist in identifying possible routes for waste shipments, DOE (through the Oak Ridge National Laboratory) has developed and made available two computer-assisted models, HIGHWAY and INTERLINE. In determining the truck shipment routes for this study, the HIGHWAY model[23] was used to calculate the "quickest route" (minimizing travel time) subject to HM 164 requirements. In determining the rail shipment routes, the INTERLINE model[24] was used to calculate the quickest route. In both cases, the models were run without other special limitations, such as avoidance of population centers and recognition of the BN/Santa Fe merger or the anticipated UP/SP merger.*

Consolidated Southern Routes

A second alternative for each route scenario was also developed to consolidate the rail and highway shipments into fewer routes, both to minimize the number of affected communities and to avoid certain seasonal weather conditions or problematic highway segments (e.g., the Eisenhower Tunnel and Glenwood Canyon on I-70 west of Denver). The consolidated route orients truck shipments from the Northeast, Southeast, and Midwest to I-40 in Oklahoma City, generally avoiding I-70 west of Kansas City and I-80 west of Omaha. Compared to their roles under the default routing criteria, I-44 between St. Louis and Oklahoma and I-70 east of St. Louis play more significant roles as a feeders to the consolidated southern route across the western states.

* BN: Burlington Northern; UP: Union Pacific; SP: Southern Pacific

The consolidated route orients rail shipments from the Northeast, Southeast, and Midwest to the Santa Fe rail lines extending southwest from Kansas City through Amarillo and across New Mexico, and Arizona to Daggett in southeastern California. It thereby avoids the UP and SP lines west of Kansas City and Omaha. The route increases feeder shipments along the Burlington Northern lines between Chicago and Kansas City, and on the Norfolk Southern lines between Cleveland and Kansas City, but reduces shipments on the Chicago and North Western lines between Chicago and Omaha. Otherwise, it has limited effects on routing patterns east of the Missouri River.

14. ROUTE IDENTIFICATION AND MAPPING

As currently developed, the HIGHWAY and INTERLINE models describe, but do not map, shipment routes. Figure 14-1 presents the HIGHWAY description of a cross-country truck shipment route to Yucca Mountain, using Oyster Creek (NJ) as the trip origin for illustration purposes:

- The first line of the output shows the origin ("OYSTER CREEK NP, NJ") and the departure date and time.

- The second line shows (reading from left to right):
  - — the distance to the nearest "node" or intersection (12.0 miles);
  - — the route to that intersection (U.S. Highway 9, or "U9");
  - — the name of the node ("TOMS RIVER" at the intersection of "TGSP," or the Garden State Parkway, and "X82," or exit 82, in "NJ");
  - — the cumulative distance from the origin (12.0 miles);
  - — the cumulative time required to complete travel from the origin to this node ("0:16"); and
  - — the date and time of arrival at the node ("2/01 @ 16:19").

- Each line thereafter includes similar information for subsequent links in the route from Oyster Creek to Yucca Mountain.

- According to the model output, the 2,688-mile route from eastern New Jersey to southern Nevada would pass through Pennsylvania, Ohio, Indiana, Illinois, Iowa, Nebraska, Colorado, and Utah; travel time at an average speed of 53.4 miles per hour would be just over 2 days (50.4 hours).

Figure 14-2 presents the INTERLINE description of a cross-country rail route to Yucca Mountain, again using Oyster Creek (NJ) as the trip origin for illustration purposes:

- For each node along the route, the listing indicates the rail carrier, the node number and name, the state in which the node is located, and the cumulative route distance.

- According to the model output, the default rail route under the MPC base case from Oyster Creek to Yucca Mountain would use Conrail lines to travel to Chicago where shipments would be transferred to the Chicago and North Western to Fremont, Nebraska, and from there on the UP to Caliente or Valley. The total travel distance, excluding new rail construction* or heavy-haul segments at either end, is 2,847 miles.

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* Note that INTERLINE assumes construction of a rail spur from Valley to Yucca Mountain, operated by the U.S. government (USG). In this analysis, we assume construction and use of an intermodal transfer facility and a heavy-haul route for all rail shipments.

Mapping HIGHWAY or INTERLINE Route Descriptions

In route mapping, each segment in the model output is identified on a master map of the nation's major highways or railroads. The mapped route can then be shown in relation to state boundaries, county boundaries, or other more detailed information. Mapped routes for all shipment origins reveal combined shipment impacts for each route segment (see Figure 14-1).

Figure 14-1. HIGHWAY Model Output (Oyster Creek to Yucca Mountain: LWT Truck Base Case Route)

Routing through:

0.0			OYSTER CREEK	NP			NJ	0.0	0:00	2/01 @ 16:03
12.0	U9		TOMS RIVER	NW	TGSP	X82	NJ	12.0	0:16	2/01 @ 16:19
2.0	TGSP		PLEASANT PLNS	S	TGSP	X83	NJ	14.0	0:18	2/01 @ 16:21
12.0	TGSP$		GLENDOLA	SW	TGSP	I195	NJ	26.0	0:31	2/01 @ 16:34
30.0	I195		ALLENTOWN	NW	TNJT	I195	NJ	56.0	1:04	2/01 @ 17:07
10.0	INJT$		HEDDING	SE	TNJT	I276	NJ	66.0	1:15	2/01 @ 17:17
7.0	I276#		BRISTOL	N	I276	X29	PA	73.0	1:23	2/01 @ 17:25
31.0	I276$		PORT KENNEDY	SE	I276	I76	PA	104.0	1:56	2/01 @ 17:59
166.0	I76 $		BREEZEWOOD	SW	I70	I76	PA	270.0	5:27	2/01 @ 21:30
86.0	I70 $	I76 $	YOUNGWOOD	SW	I70	I76	PA	356.0	7:01	2/01 @ 23:04
39.0	I70		LABORATORY	NE	I70	I79	PA	395.0	7:44	2/01 @ 23:46
3.0	I70	I79	WASHINGTON	N	I70	I79	PA	398.0	7:47	2/01 @ 23:49
27.0	I70		WHEELING	SE	I470	I70	WV	425.0	8:17	2/02 @ 0:19
12.0	I470		ST CLAIRSVILLE	E	I470	I70	OH	437.0	8:30	2/02 @ 0:32
116.0	I70		COLUMBUS	E	I270	I70	OH	553.0	11:06	2/02 @ 3:08
21.0	I270		COLUMBUS	W	I270	I70	OH	574.0	11:29	2/02 @ 3:31
157.0	I70		INDIANAPOLIS	E	I465	I70	IN	731.0	14:50	2/02 @ 6:52
5.0	I465		INDIANAPOLIS	SE	I465	I74	IN	736.0	14:56	2/02 @ 6:58
13.0	I465	I74	INDIANAPOLIS	SW	I465	I70	IN	749.0	15:10	2/02 @ 7:12
132.0	I70		TEUTOPOLIS	NW	I57	I70	IL	881.0	17:34	2/02 @ 10:36
6.0	I57	I70	EFFINGHAM	SW	I57	I70	IL	887.0	18:11	2/02 @ 11:12
78.0	I70		EDWARDSVILLE	SE	I270	I55	IL	965.0	19:36	2/02 @ 12:37
29.0	I270		ST LOUIS	NW	I270	I70	MO	994.0	20:07	2/02 @ 13:09
227.0	I70		KANSAS CITY	SE	I435	I70	MO	1221.0	24:45	2/02 @ 17:47
33.0	I435		KANSAS CITY	W	I435	I70	KS	1254.0	25:21	2/02 @ 18:22
47.0	I70 $	TKST$	TOPEKA	E	I470	I70	KS	1301.0	26:12	2/02 @ 19:14
5.0	I470$	TKST$	TOPEKA	S	I335	I470	KS	1306.0	26:18	2/02 @ 19:19
7.0	I470		TOPEKA	W	I470	I70	KS	1313.0	26:25	2/02 @ 19:27
1049.0	I70		COVE FORT	W	I15	I70	UT	2362.0	48:53	2/03 @ 16:54
242.0	I15		LAS VEGAS				NV	2604.0	54:17	2/03 @ 21:18
86.0	U95		AMARGOSA VALLY		U95	S373	NV	2690.0	55:59	2/03 @ 23:00

Figure 14-2. INTERLINE Model Output, Rail Base Case, Oyster Cr to Yucca Mtn.

RR	NODE	STATE	DIST	
CR	1275-TOMS RIVER	NJ	0.	
CR	1337-TRENTON	NJ	83.	
CR	1454-CONSHOHOCKEN	PA	116.	
CR	1525-READING	PA	160.	
CR	2350-HARRISBURG	PA	213.	
CR	2291-ALTOONA	PA	355.	
CR	2254-JOHNSTOWN	PA	391.	
CR	2066-BESSEMER	PA	458.	
CR	2124-PITTSBURGH	PA	471.	
CR	2125-ROCHESTER	PA	497.	
CR	2798-ALLIANCE	OH	553.	
CR	2763-RAVENNA	OH	570.	
CR	2728-CLEVELAND	OH	611.	
CR	2633-ELYRIA	OH	638.	
CR	3442-TOLEDO	OH	717.	
CR	3526-GOSHEN	IN	839.	
CR	3525-ELKHART	IN	849.	
CR	4022-SOUTH BEND	IN	864.	
CR	4067-PORTER	IN	909.	
CR	4070-GARY	IN	925.	
CR	4073-CLARKE	IN	929.	
CR	4074-INDIANA HARBOR	IN	932.	
CR	4232-SOUTH CHICAGO	IL	939.	
CR	4217-CHICAGO	IL	952.	
				TRANSFER
CNW	4217-CHICAGO	IL	952.	
CNW	4234-PROVISO	IL	966.	
CNW	4311-DE KALB	IL	1008.	
CNW	4324-NELSON	IL	1053.	
CNW	10304-CLINTON	IA	1086.	
CNW	10289-CEDAR RAPIDS	IA	1167.	
CNW	10265-MARSHALLTOWN	IA	1234.	
CNW	10246-NEVADA	IA	1261.	
CNW	10271-AMES	IA	1272.	
CNW	10176-MISSOURI VALLEY	IA	1405.	
CNW	10198-CALIFORNIA JCT	IA	1411.	
CNW	11340-FREMONT	NE	1439.	
				TRANSFER
UP	11340-FREMONT	NE	1439.	
UP	11406-GRAND ISLAND	NE	1548.	
UP	11410-GIBBON	NE	1574.	
UP	11352-NORTH PLATTE	NE	1652.	
UP	11358-O FALLONS	NE	1701.	
UP	13703-JULESBURG	CO	1769.	
UP	13465-CHEYENNE	WY	1915.	
UP	13462-LARAMIE	WY	1967.	
UP	13494-GRANGER	WY	2243.	
UP	13568-OGDEN	UT	2382.	
UP	13595-SALT LAKE CITY	UT	2417.	
UP	13630-LYNNDYL	UT	2530.	
UP	14766-VALLEY	NV	2847.	
				TRANSFER
USG	14766-VALLEY	NV	2847.	
USG	16333-YUCCA MOUNTAIN	NV	2946.	

15. SIX ROUTING CASE EXAMPLES

This section describes possible routes to Yucca Mountain from six shipment origin sites. The level of description may be termed "regional" rather than "national" or "local." Key routes, rail carriers, and urban centers are identified, but local features are not. The sites selected are among those which are assumed to make different transportation choices under the current capabilities and maximum rail scenarios, and/or different near-site options for accessing a railhead under the MPC base case and maximum rail scenarios. The description focuses on the possible route, not on the cask options, the transportation choice or the routing criteria. The question of the number and type of prospective shipments along particular route segments is addressed in sections 17 and 18.

Oyster Creek (NJ) to Yucca Mountain (NV)

How might shipments from the Oyster Creek (NJ) nuclear plant, located in Ocean County near Barnegat Bay about 55 miles due east of Philadelphia, travel to Yucca Mountain? Under the "current capabilities" scenario, the transportation choice of GPU Nuclear for shipments from Oyster Creek is legal-weight truck—using the high-capacity GA-9 cask if available, or a transportation cask for two BWR assemblies otherwise:

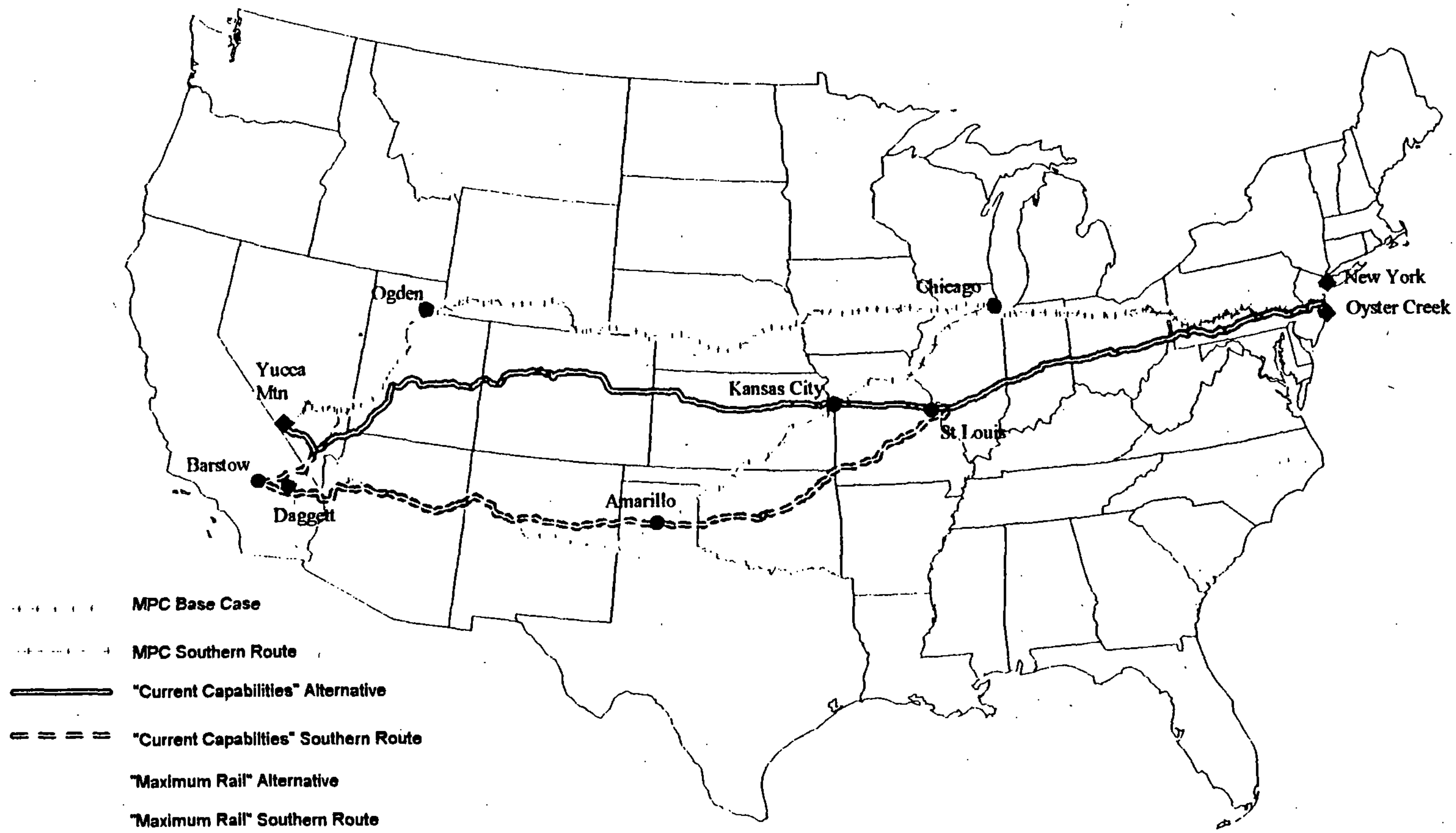
- The "default route" for truck shipments from Oyster Creek would use US 9 and SR-539 to access the Garden State Parkway (a state highway, constructed to interstate standards) northbound at Forked River. The route then continues to I-195 north of Allenwood, to the New Jersey Turnpike and I-276 north of Philadelphia, and to the Pennsylvania Turnpike (I-70 and I-76) through Pennsylvania. From Youngwood in western Pennsylvania, the route continues on I-70 (except for bypasses around major cities) to I-15 in Utah, then through Las Vegas to US 95 and Yucca Mountain.

  The "consolidated southern" option for truck shipments from Oyster Creek would depart from the default route east of St. Louis, continuing on I-70/255 (rather than the I-270 bypass) through East St. Louis, then via I-44 through Tulsa, Oklahoma. From there, the route would follow I-35 to Oklahoma City, I-40 to Barstow, California and I-15 to Las Vegas, US 95 and Yucca Mountain.

Under the "MPC base case" and "maximum rail" scenarios, GPU Nuclear's transportation choice for shipments from Oyster Creek is a large rail cask similar to DOE's 125-ton MPC, containing up to 40 BWR assemblies. However, while the MPC base case assumes heavy-haul transport to the Conrail railhead at Toms River (NJ), the maximum rail scenario would involve barge shipment to Conrail facilities in New York City.[19]

- The "default route" for rail shipments uses different Conrail lines from Toms River (NJ) or New York City to Trenton (NJ).

Figure 15-1. Alternative Nuclear Waste Transportation Routes: Oyster Creek NP



- From Trenton, the default route for rail shipments uses Conrail lines to Chicago (via Conshohocken, PA, Pittsburgh, Cleveland, and Toledo). In Chicago, shipments are transferred to the Chicago and North Western line for travel to Fremont, NB. In Fremont, shipments are transferred to the Union Pacific line for transport (via Grand Island, Cheyenne, Ogden, and Salt Lake City) to an intermodal facility at Caliente or Valley, Nevada.

- The consolidated southern route for rail shipments would depart from the default route in Chicago. In Chicago, shipments would be transferred to the merged Burlington Northern and Southern Pacific lines for travel to Daggett, California (via Kansas City, Amarillo, and Flagstaff). In Daggett, rail shipments would be transferred to the Union Pacific for travel north through Las Vegas to an intermodal transfer facility at Valley or Caliente.

Fermi (MI) to Yucca Mountain (NV)

How might shipments from the Fermi (MI) nuclear plant, located at the western end of Lake Erie, between Toledo and Detroit, travel to Yucca Mountain? Under the "current capabilities" scenario, the transportation choice of Detroit Edison for shipments from Fermi is legal-weight truck—using the high-capacity GA-9 cask if available, or a transportation cask for two BWR assemblies otherwise:

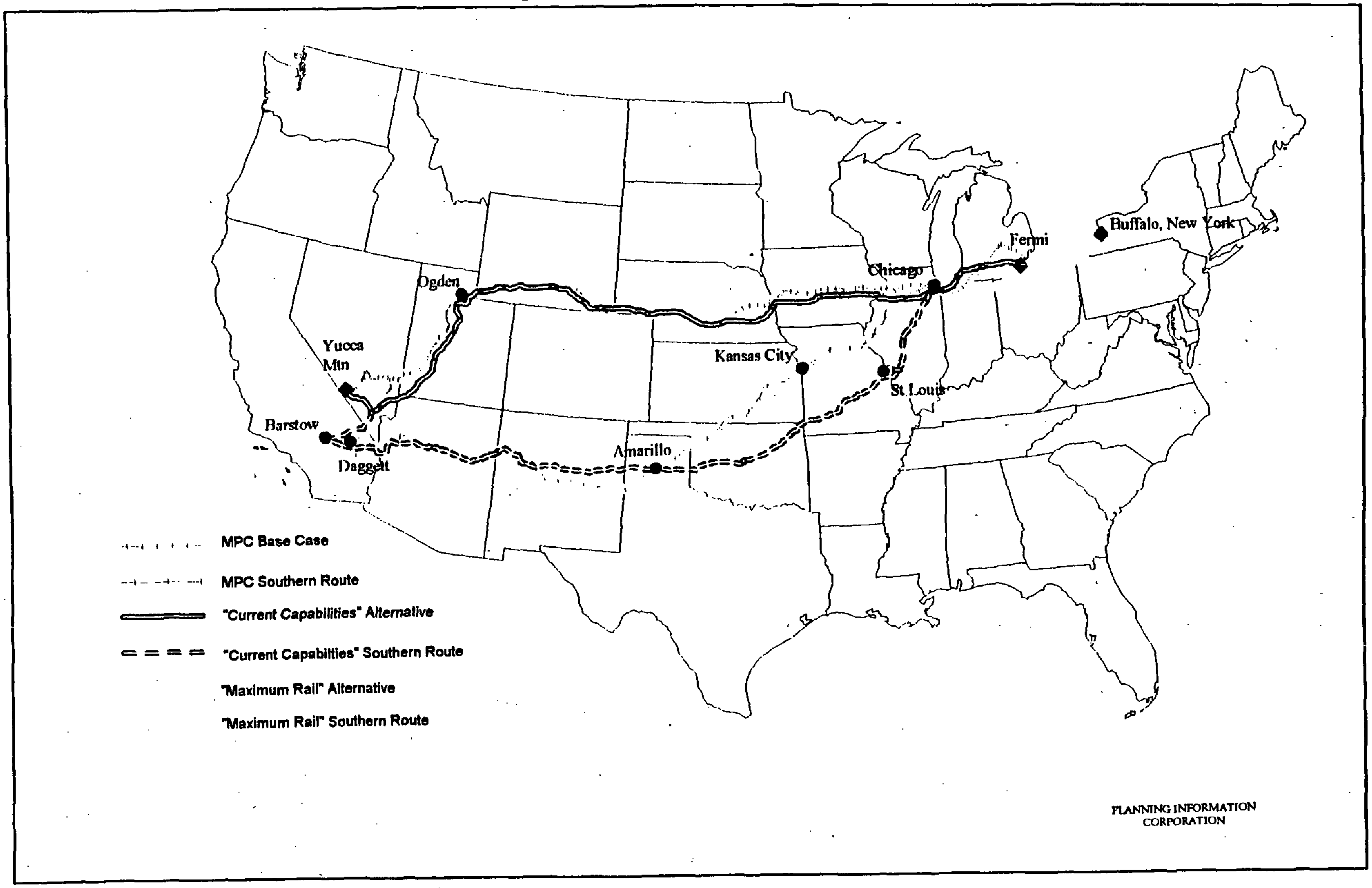
- The "default route" for truck shipments from Fermi would use Interstate 275 (the Detroit metro beltway) to access Interstate 94, which is used to travel across the State of Michigan, passing near Ann Arbor, Jackson, Battle Creek, Kalamazoo, and other cities and towns. The route links with I-80 east of Gary, Indiana, which is used to travel past Chicago and across Iowa, Nebraska, and Wyoming. In Salt Lake City, the default route then links with I-15, which is used for travel south through St. George (UT) and Las Vegas to Yucca Mountain.

- The consolidated southern route for truck shipments from Fermi departs from the default route west of Joliet, Illinois, where, rather than continuing west on I-80, it would access I-55 for travel through Springfield to St. Louis. In St. Louis, the southern route would access I-44 for travel west through Oklahoma City, Amarillo, Albuquerque, and Flagstaff to Barstow, California. In Barstow, the route would access I-15 for travel north to Las Vegas and Yucca Mountain.

Under the "MPC base case" and "maximum rail" scenarios, the transportation choice of Detroit Edison for shipments from Fermi is a large rail cask similar to DOE's 125-ton MPC, containing up to 40 BWR assemblies. However, while the MPC base case assumes use of a substantially upgraded on-site rail spur, the maximum rail scenario would involve barge shipment from the western end of Lake Erie to Conrail facilities in Buffalo (NY) at the eastern end.[19]

- The "default route" for rail shipments from Fermi would use the Grand Trunk Western (GTW) line through Detroit to Blue Island, Illinois where shipments would transfer to the Indiana Harbor Belt line. From Blue Island, the route would travel to the Argo and Proviso yards near Chicago, transferring to the Chicago & North Western (CNW) for transport through Cedar Rapids, Iowa to the UP line at Fremont, Nebraska. From Fremont, Union Pacific lines would be used for travel across Nebraska, Wyoming, and Utah to intermodal facilities at Caliente or Valley.

Figure 15-2. Alternative Nuclear Waste Transportation Routes: Fermi NP



- The consolidated southern route for rail shipments from Fermi would depart from the default roue at the Argo yards near Chicago, where, rather than transferring to the Chicago and Northwestern line, shipments would be transferred to the consolidated Burlington Northern and Santa Fe lines for travel southwest through Galesburg (IL), Kansas City, Amarillo, and Flagstaff to Daggett (CA). In Daggett, rail shipments would be transferred to the UP for travel north through Las Vegas to an intermodal transfer facility at Valley or Caliente.

- Rail shipments from Buffalo (after barge shipment from Fermi, under the maximum rail scenario) would use Conrail lines for travel along the southern shore of Lake Erie through Erie (PA), Cleveland, and Toledo. Shipments would continue on Conrail through Elkhart and South Bend (IN) to the Argo yards near Chicago, where the route would link with routes for rail shipments directly from Fermi.

Browns Ferry (AL) to Yucca Mountain (NV)

How might shipments from the Browns Ferry plants, located across the Tennessee River from the City of Decatur, travel to Yucca Mountain? Under the 'current capabilities" scenario, the transportation choice of the Tennessee Valley Authority for shipments from Browns Ferry is legal-weight truck—using the high-capacity GA-9 cask if available, or a transportation cask for two BWR assemblies otherwise:

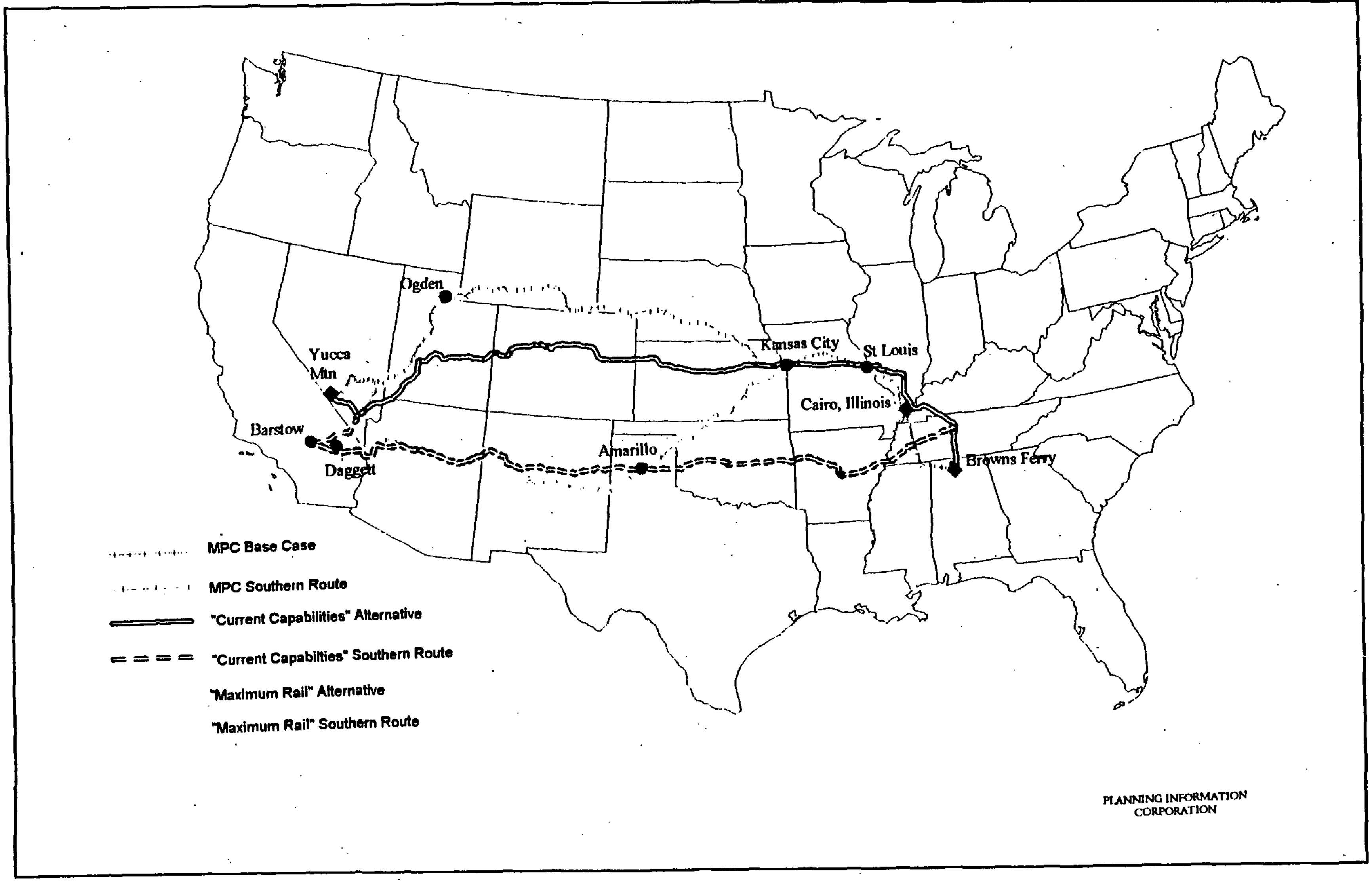
- The "default route" for truck shipments from Browns Ferry would use I-65 to travel north to Nashville, where it would link to I-24 for travel across southwestern Kentucky and southern Illinois to St. Louis. In St. Louis the default route would access I-70 for travel across Missouri to Kansas City, across Kansas and eastern Colorado to Denver, and across western Colorado (through the Eisenhower tunnel and Glenwood Canyon) into Utah. About 160 miles south of Salt Lake City, I-70 links with I-15, which is used for travel south through St. George and Las Vegas to Yucca Mountain.

- The consolidated southern option for truck shipments from Browns Ferry departs from the default route in Nashville, where, rather than continuing west on I-24, it would access I-40 for travel west through Memphis, Little Rock, Oklahoma City, Amarillo, and Albuquerque to Barstow, California. In Barstow, the route would access I-15 for travel north to Las Vegas and Yucca Mountain.

Under the "MPC base case" and "maximum rail" scenarios, the transportation choice of Tennessee Valley Authority for rail shipments from Browns Ferry is a large rail cask similar to DOE's 125-ton MPC, containing up to 40 BWR assemblies. However, while the MPC base case involves heavy-haul transport across the Tennessee River to a Norfolk Southern railhead in Decatur, the maximum rail scenario involves barge shipment down the Tennessee River to Paducah, Kentucky and down the Ohio river to the Illinois Central railhead at Cairo, Illinois:[19]

- The "default route" for rail shipment from Decatur uses Norfolk Southern lines for travel across northern Alabama and Tennessee to Cairo (IL), St. Louis, and Kansas City. In Kansas City, shipments would be transferred to the UP for travel across Nebraska and Wyoming, through Ogden and Salt Lake City (UT) to an intermodal facility at Caliente or Valley.

Figure 15-3. Alternative Nuclear Waste Transportation Routes: Browns Ferry NP



- The consolidated southern route from Decatur would depart from the default route in Kansas City, where, instead of transferring to the UP, shipments would be transferred to the merged Burlington Northern and Santa Fe lines for travel to Daggett, CA (via Amarillo and Flagstaff). In Daggett, rail shipments would be transferred to the UP for travel north through Las Vegas to an intermodal facility at Valley or Caliente.

- Under the maximum rail scenario, rail shipment on the default or consolidated southern route would begin in Cairo, after barge shipment along the Tennessee and Ohio Rivers.

Cooper Station (NE) to Yucca Mountain (NV)

How might shipments from the Cooper Station site, on the Missouri River about 65 miles south of Omaha, travel to Yucca Mountain? Under "current capabilities" scenario, the transportation choice of Nebraska Public Power for shipments from Cooper Station is legal-weight truck—using the high-capacity GA-9 cask if available, or a transportation cask for two BWR assemblies otherwise:

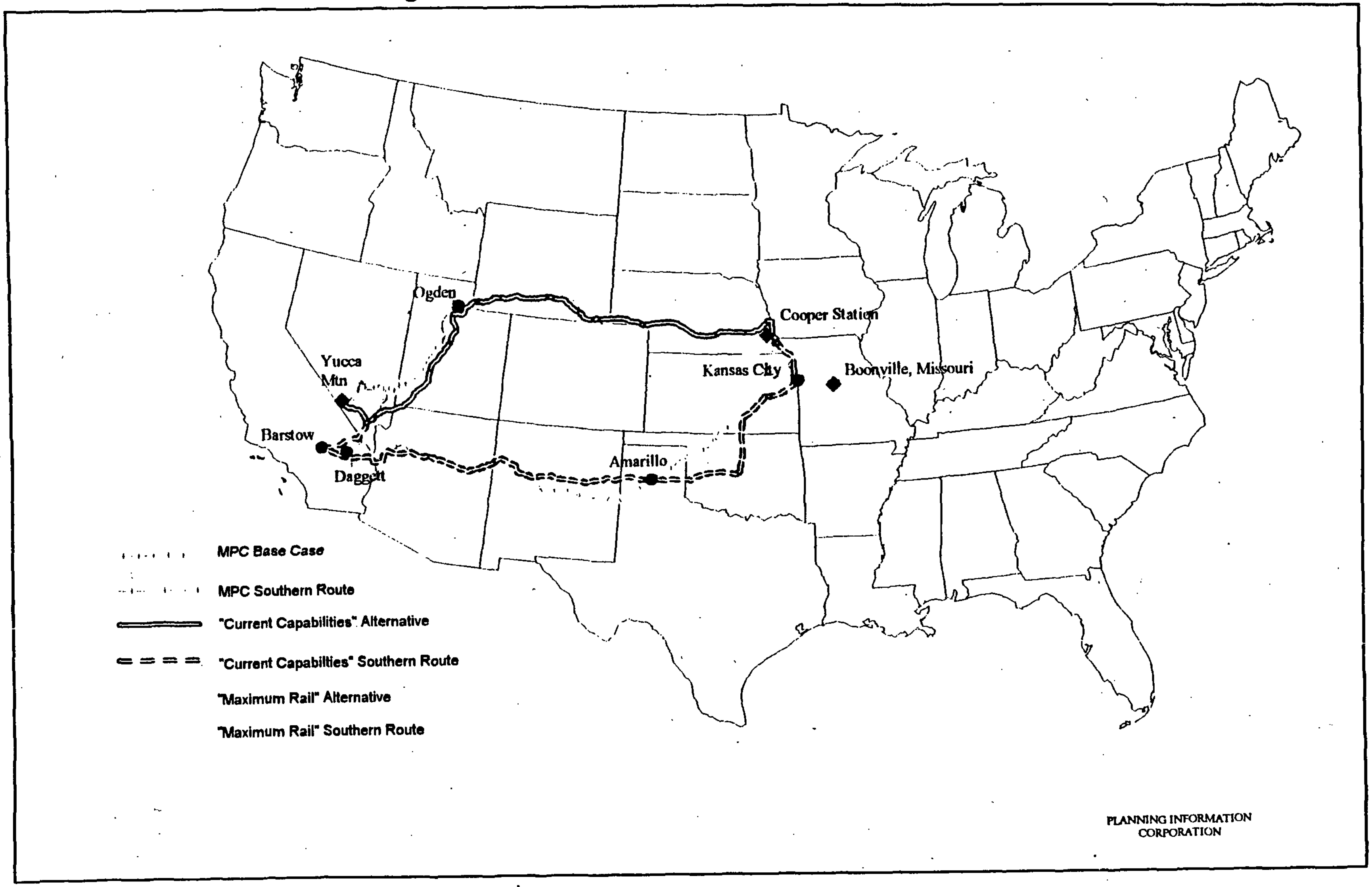
- The "default route" for truck shipments from Cooper Station would follow US 135 west and US 75 north to link with I-80 in Omaha. From Omaha, the route would use I-80 for travel across Nebraska, Wyoming, and Utah, linking with I-15 in Salt Lake City, for travel south through St.. George and Las Vegas to Yucca Mountain.

- The consolidated southern route for truck shipments from Cooper Station would follow US 135 east across the Missouri River, and US 59 south to I-29, continuing south on I-29 through St.. Joseph (MO) to Kansas City. In Kansas City, the southern route would access I-35, which it would follow south through Wichita (KS) to Oklahoma City, where it would access I-40 for continued travel west.

Under the "MPC base case" and "maximum rail" scenarios, Nebraska Public Power's transportation choice for shipments from Cooper Station is a small rail cask similar to DOE's 75-ton MPC, containing up to 24 BWR assemblies. However, while the "MPC base case" assumes heavy-haul transport north to a Burlington Northern railhead in Nebraska City (about 50 miles east of Lincoln), or across the Missouri River and south to a Burlington Northern railhead at Phelps City (MO), the maximum rail scenario assumes barge shipment down the Missouri River to a UP railhead in Boonville, about 120 miles east of Kansas City and about 20 miles west of Columbia (MO):[19]

- The "default route" for rail shipments from Cooper Station involves heavy-haul north to the Burlington Northern railhead at Nebraska City. Burlington Northern lines would be used for travel to Omaha, where shipments would be transferred to the UP railroad for travel west across Nebraska, Wyoming, and Utah, then south through Ogden and Salt Lake City to an intermodal facility at Caliente or Valley.

Figure 15-4. Alternative Nuclear Waste Transportation Routes: Cooper Station NP



- The consolidated southern route for rail shipments from Cooper Station involves heavy-haul east across the Missouri River to the Burlington Northern railhead at Phelps City (MO). The route uses Burlington Northern lines for travel southeast to Kansas City, and Santa Fe lines (now merged with Burlington Northern) for travel southwest and west to Daggett, California, where shipments would be transferred to the UP for travel north through Las Vegas to an intermodal facility at Valley or Caliente.

- Default route rail shipments from Boonville (after barge shipment from Cooper Station) would use UP lines for travel through Kansas City to Gibbon (NE), about 120 miles west of Lincoln, then west across Nebraska and Wyoming, and south from Ogden (UT) to an intermodal facility at Caliente or Valley.

- Consolidated southern route rail shipments from Boonville would transfer to Santa Fe lines in Kansas City, using these for travel through Amarillo to Daggett, California, where they would transfer back to UP lines for travel north through Las Vegas to an intermodal facility at Valley or Caliente.

Grand Gulf (MS) to Yucca Mountain (NV)

How might shipments from the Grand Gulf (MS) nuclear plant, located on the Mississippi River about 30 miles south of Vicksburg, travel to Yucca Mountain? Under the "current capabilities scenario, the transportation choice of Systems Energy Resources for shipments from Grand Gulf is legal-weight truck—using the high-capacity GA-9 cask if available, or a transportation cask for two BWR assemblies otherwise:

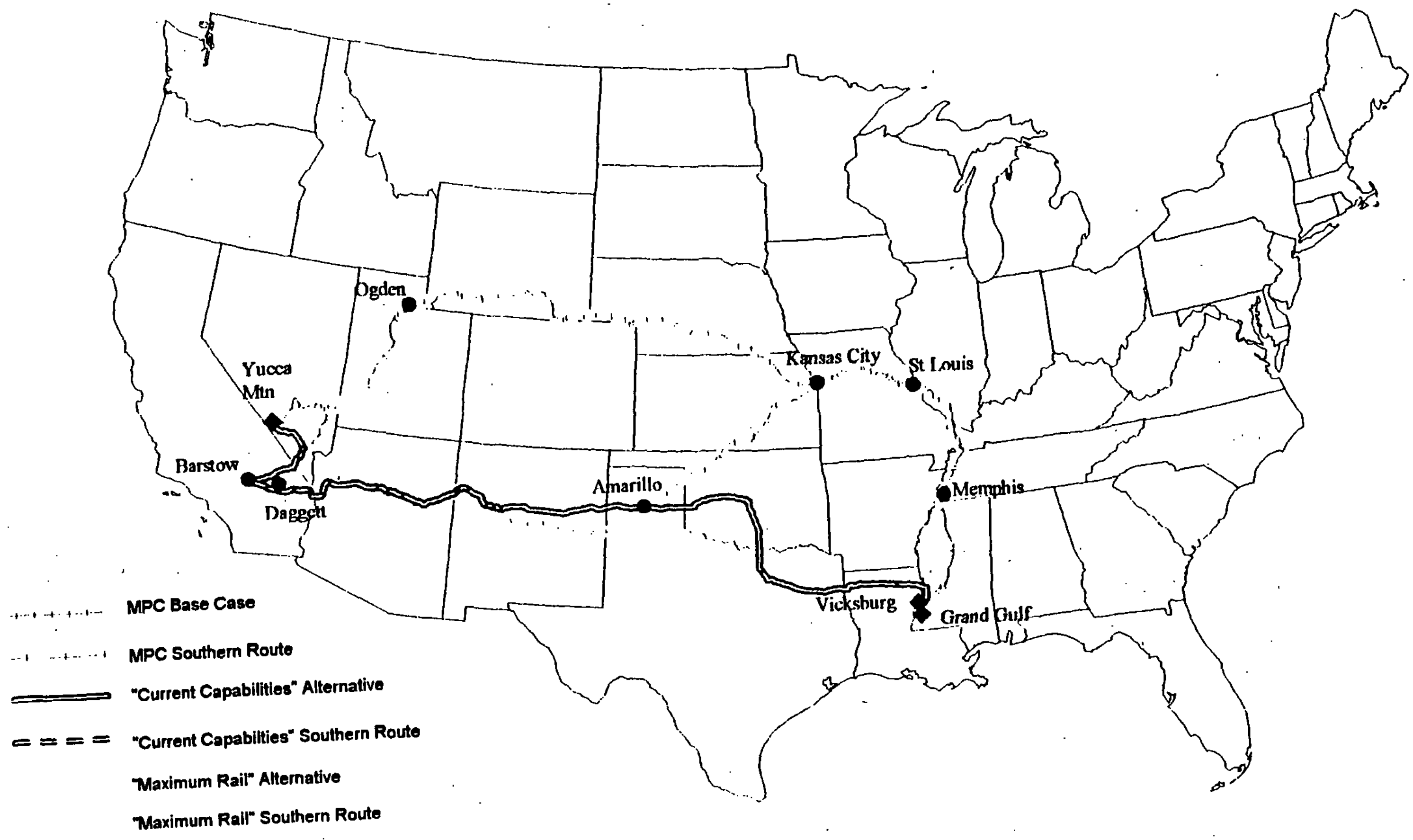
- The default and consolidated southern route for truck shipments from Grand Gulf would follow US 61 north to Vicksburg, where it would link with I-20 for travel west through Shreveport (LA) to Dallas and Fort Worth, where it would access I-35 north to Oklahoma City and I-40 for continued travel west to Barstow, California, where it would access I-15 for travel north through Las Vegas to Yucca Mountain.

Under the MPC base case and maximum rail scenarios, the transportation choice of Systems Energy Resources for shipments from Grand Gulf is a large rail cask similar to DOE's 125-ton MPC, containing up to 40 BWR assemblies:

- The "default route" for rail shipments from Grand Gulf involves heavy-haul north on US 61 and east on I-20 to the Illinois Central railhead at Jackson (MS). The route uses Illinois Central lines for travel north through Memphis to St.. Louis, where shipments would be transferred to UP lines for travel west to Kansas City and across Nebraska, Wyoming, and Utah, then south from Ogden through Salt Lake City to the intermodal facility at Caliente or Valley.

- The consolidated southern route for rail shipments from Grand Gulf departs from the default route in Kansas City where, instead of continuing on the UP, shipments would be transferred to Santa Fe lines for travel southwest to Amarillo and west to Daggett, California, where they would be transferred back to UP lines for travel north through Las Vegas to an intermodal facility at Valley or Caliente.

Figure 15-5. Alternative Nuclear Waste Transportation Routes: Grand Gulf NP



Diablo Canyon (CA) to Yucca Mountain (NV)

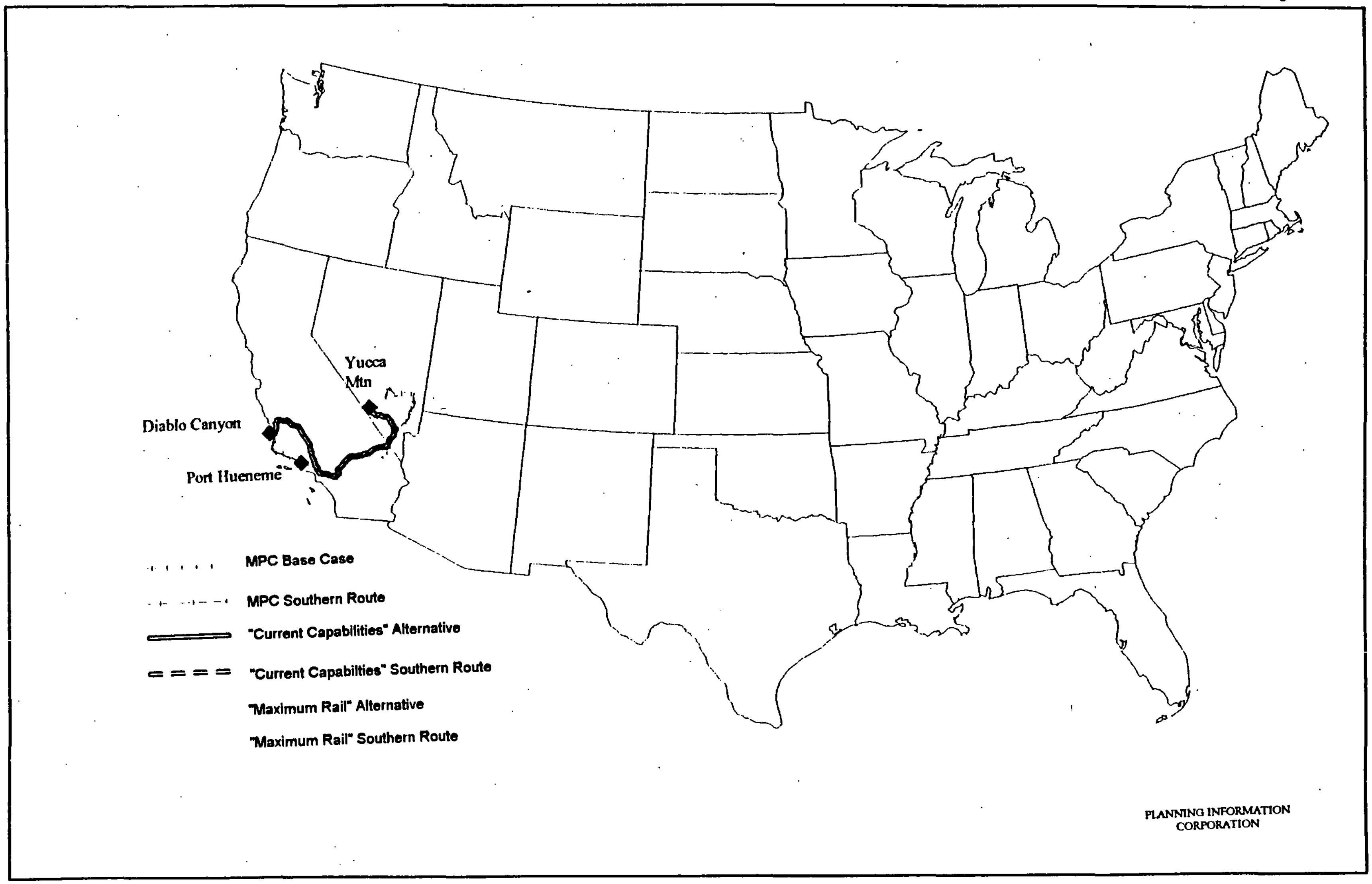
How might shipments from the Diablo Canyon (CA) nuclear plant, located on the Pacific Ocean near San Luis Obispo, about 85 miles northwest of Santa Barbara, travel to Yucca Mountain? Under the "current capabilities" scenario, the transportation choice of Pacific Gas and Electric for shipments from Diablo Canyon is legal-weight truck—using the high-capacity GA-4 cask if available, or a transportation cask for a single PWR assembly otherwise:

- The route for truck shipments from Diablo Canyon would follow US-101 north through San Luis Obispo to Paso Robles, and CA 46 east to access I-5 at Lost Hills. The route would follow I-5 southeast towards Los Angeles, accessing I-210 (Foothill Parkway) for passage across LA's northern suburbs—Burbank, Glendale, Pasadena, Glendora, etc. The route accesses I-10 (San Bernadino Freeway) near Pomona, which is used for travel east through Montclair and Ontario to I-15, which is used for travel north through Las Vegas to Yucca Mountain.

Under the MPC base case and maximum rail scenarios, Pacific Gas and Electric's transportation choice for shipments from Diablo Canyon is a large rail cask similar to DOE's 125-ton MPC, containing up to 21 PWR assemblies. However, while the MPC base case assumes heavy-haul transport to the Southern Pacific railhead in San Luis Obispo, the maximum rail scenario involves a 150-mile barge shipment south to Point Conception and east through the Santa Barbara Channel to the railhead of the Ventura County Railway Company at Port Hueneme near Oxnard:[19]

- Rail shipments from San Luis Obispo would use Santa Fe lines for travel through Santa Barbara, Ventura, Oxnard, Burbank, and east Los Angeles to San Bernadino, where they would be transferred to the UP for travel north through Las Vegas to an intermodal facility at Valley or Caliente.

Figure 15-6. Alternative Nuclear Waste Transportation Routes: Diablo Canyon NP



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16. THE NATIONAL SHIPMENT CAMPAIGN: LIFE OF OPERATIONS

What are the overall effects of the national shipment campaign, aggregated for each origin site and all major rail and highway segments over the entire prospective 30-year shipment campaign? What are the effects under the "current capabilities" scenario of transportation choices, or under the "MPC base case" or "maximum rail" scenarios? What are the effects of using a high capacity cask for legal-weight truck shipments,* rather than the currently-available casks limited to one PWR or 2 BWR assemblies?

This section uses maps to present the rail and highway segments affected, and tables to present the total (life of operations) cask shipments in the 30-year shipment campaign. Both maps and tables reflect factors discussed in previous sections—e.g., the current and projected inventory, the acceptance rate and pickup schedule. Under these assumptions, shipments of HLW from DOE sites begin in year 17 and extend through year 44; only those shipments in years 17 through 31 (54 percent of the total) are included in this summary. Subsequent sections consider implications for Nevada (section 17), regional routing alternatives (section 18), the phasing of shipments during the 30-year campaign (section 19), and transportation operations variables (section 20).

Mapping Routes and Cask Shipments

To visualize the cask shipment findings of a multi-faceted assessment process, this study has developed a map presentation in which route segments are scaled according to the number of projected shipments on each segment over the 30-year shipment campaign. The scale is consistent among cask options and among transportation choice scenarios. That is, in this presentation, 100 prospective cask shipments are shown at the same map scale whether the shipments are truck casks containing 1 PWR or 2 BWR assemblies, high-capacity truck casks containing 4 PWR or 9 BWR assemblies, a small rail cask containing 12 PWR or 24 BWR assemblies or a large rail cask containing 21 PWR or 40 BWR assemblies.** The amount of waste shipped in these casks ranges from about 800 pounds in the case of the small truck cask to about 14,800 pounds in the case of the large rail cask, a factor of 18. Another map presentation might be developed to show the amount of waste shipped, rather than the number of cask shipments.

Rail and Highway Routes Affected

Figure 16-1 shows the rail and highway routes affected by default routing under the current capabilities scenario of transportation choices, scaling the routes according to the number of projected shipments on each segment over the 30-year shipment campaign. Figures 16-2 and 16-3 present similar results for the "MPC base case" and "maximum rail" scenarios of transportation choices. Over the 30-year shipment campaign (and assuming default routing), about 18,800 miles of the nation's railroads carry

* A cask similar to the GA-4/9 cask designed by General Atomics, with capacity for 4 PWR or 9 BWR uncanistered assemblies.

** Also, no attempt has been made to project rail consists. The maps indicate the number of casks shipped on each rail route segment, not the number of trains containing cask shipments.

shipments of SNF or HLW, a figure which increases to 21,200 miles under the MPC base case and to 23,500 under the maximum rail scenario of transportation choices.* Rail rather than highway shipment from certain sites (e.g., Turkey Point, FL, Diablo Canyon, CA, Kewanee, WI) adds significantly to total affected rail route mileage, but from other sites (e.g., Dresden, IL, Browns Ferry, AL) has much less effect.

Over the 30-year shipment campaign (again, assuming default routing) about 13,700 miles of the nation's highways carry shipments of SNF or HLW, a figure which decreases to 10,200 miles under the MPC base case and to 4,200 under the maximum rail scenario of transportation choices. Rail rather than highway shipment from certain sites (e.g., Grand Gulf, MS, Surry, VA, Peachbottom, PA) significantly reduces highway route mileage, but from other sites (e.g., Calvert Cliffs, MD, Salem, NJ) has much less effect.

Total Cask Shipments

Table 16-1 presents total cask shipments over the 30-year campaign, under the current capabilities, MPC base case and maximum rail scenarios. Rail cask shipments of SNF** increase from about 9,900 in the current capabilities scenario of transportation choices to about 11,200 under the MPC base case and 14,100 under the maximum rail scenario. The changes reflect both the number of sites shipping by rail (and their projected inventory) and the type of rail cask used. Compared to the current capabilities scenario, the MPC base case and maximum rail scenarios include more rail shipment sites (*increasing* the number of rail cask shipments) making greater use of the large MPC (*reducing* the number of rail cask shipments). Shipments of uncanistered fuel in currently-available legal-weight truck casks are estimated at 79,300 under the current capabilities scenario of transportation choices, a figure which decreases to 26,100 under the MPC base case and to 4,700 under the maximum rail scenario. The decreases reflect the number of sites shipping by truck rather than by rail, and the projected inventory requiring shipment.

The high-capacity legal-weight truck cask (if available and consistently used throughout the 30-year shipment campaign) dramatically reduces the number of truck cask shipments from 79,300 to 31,400 under the current capabilities scenario, from 26,100 to 6,300 under the MPC base case, and from 4,700 to 1,150 under the maximum rail scenario. Even so, truck cask shipments of SNF would comprise about 71 percent of total cask shipments under the current capabilities scenario, about 31 percent under the MPC base case scenario, and over 6 percent under the maximum rail scenario of transportation choices.

The Use of Affected Rail and Highway Routes

How intensively would the nation's rail and highway networks be used by the national shipment campaign? Over the 30-year campaign, each affected rail route mile would receive an average of about 1,500 cask shipments under the current capabilities scenario, with similar figures for a somewhat more extensive affected rail route network under the MPC base case and maximum rail scenarios. More intensively used rail route segments, however, could receive up to 8.5 times the national average.

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* Route mileage excludes 162 miles of heavy-haul from an intermodal transfer facility at Caliente.

** An additional 2,700 rail cask shipments of HLW are expected between years 17 and 31.

Over the 30-year shipment campaign, each affected rail route mile would receive an average of 13,700 cask shipments under the current capabilities scenario (using currently-available legal-weight truck casks), or about 1,500 shipments (using the high-capacity legal-weight truck cask) under the MPC base case, or about 700 under the maximum rail scenario. Again, more intensively used highway route segments could receive up to six times the national average.

A State-Level Review

Perspectives on nuclear waste transportation are highly correlated with the degree to which waste will be shipped out of, through or to one's own community—that is, the degree to which one's community serves as an origin, corridor or destination for shipments of these highly-toxic and long-lived radioactive materials. Origin communities have lived with nuclear sites for years, even decades, have directly benefited from the electricity and jobs produced, and, with shipment, have the opportunity to rid themselves of the resulting wastes. Corridor communities provide transportation routes for wastes whose origin and destination are elsewhere. Under safe, routine conditions, waste shipments will not linger in corridor communities, but they require attention by public officials and raise anxieties among residents. Destination communities receive the wastes generated elsewhere. In the case of spent nuclear fuel and high-level waste, there is only one prospective destination community, and the waste received, even if safely contained, will remain toxic for centuries.

Under the MPC base case scenario of transportation choices (assuming default routing) only seven states are neither origins, corridors, nor the destination for shipments of SNF or HLW (see Figure 16-4). Together, these jurisdictions comprise 2.4 percent of the nation's population. Another seven states located along the perimeter of the country are origins but not corridors for shipments of SNF and HLW. Together, these states comprise 18 percent of the nation's population. It should be observed, however, that many communities within these states will consider themselves as corridors rather than as origins for shipments of nuclear waste. Still another seven states (three east of the Mississippi River) plus the District of Columbia are corridors but not origins for shipments of SNF and HLW. Together, these states comprise seven percent of the nation's population.

Most states are both origins and corridors for prospective shipments of SNF and HLW under the MPC base case scenario of transportation choices with default routing. Together, these 28 states comprise 71 percent of the nation's population. Five of the 28 are origins for shipments from one (or in the case of Nebraska, two) nuclear site, but are corridors for shipments from 20 sites or more. These states are Iowa, Kansas, Missouri, Nebraska, and Arizona. Together, they comprise 6.2 percent of the nation's population.

Under the MPC base case scenario with default routing, 8 states are corridors for shipments from 25 or more sites. These states, including five with commercial reactors and two east of the Mississippi, comprise 11 percent of the nation's population. Illinois is a corridor state for 47 sites and an origin state for eight sites.

Nevada is the destination state, the end of the funnel for the national shipment campaign and the intended permanent disposal site for the nation's SNF and HLW. Nevada has 0.5 percent of the nation's population. Similar to origin-only states, parts of Nevada are likely to consider themselves more as corridors than as the destination for shipments of SNF and HLW. But these communities are corridors

for all shipment sites, and are in the destination state where the wastes will be permanently stored, not an origin state that has previously chosen to developed nuclear power and is now removing the resulting wastes. Section 17 provides additional detail regarding cask shipments into the destination state.

Table 16-1. Route Miles Affected and Cask Shipments
- **Life of Operations (YR 1-31) . . . Default Routing**
- **Currently-Available and High-Capacity Truck Cask**

	RAIL	HWY:T1/2	TOT:T1/2	HWY:T4/9	TOT:T4/9
ROUTE MILES:					
Current Capabilities	18805	13695	32500	13695	32500
MPC Base Case	21210	10224	31434	10224	31434
Maximum Rail	23507	4178	27685	4178	27685
CASK SHIPMENTS:					
Current Capabilities	12636	79345	91981	31370	44006
MPC Base Case	13916	26093	40009	6322	20238
Maximum Rail	16792	4722	21514	1150	17942
CASK SHIP PER RT-MILE:					
Current Capabilities	1496	13356	6493	3154	2194
MPC Base Case	1463	6505	3103	1536	1487
Maximum Rail	1494	2764	1686	703	1375

Table 16-2. States by Origin/Corridor Status

Neither Origins Nor Corridors	Origin Only States	Corridor Only States	Major Corridor States*	
Rhode Island	Michigan	Indiana	Utah	(65/0)
District of Columbia	Wisconsin	Kentucky	Nebraska	(60/2)
Delaware	Maine	Oklahoma	Wyoming	(58/0)
Alaska	New Jersey	West Virginia	Illinois	(47/8)
Hawaii	Florida	New Mexico	Iowa	(32/1)
Montana	Louisiana	Utah	Kansas	(28/1)
North Dakota	Washington	Wyoming	Missouri	(27/1)
South Dakota			Indiana	(25/0)
Percent of U.S. population:	18 percent	7 percent	11 percent	

* (60/2): corridor for 60 sites, origin for 2.

Figure 16-1. Life of Operations Rail and Highway Cask Shipments
Current Capabilities Transportation Choices/Default Routing

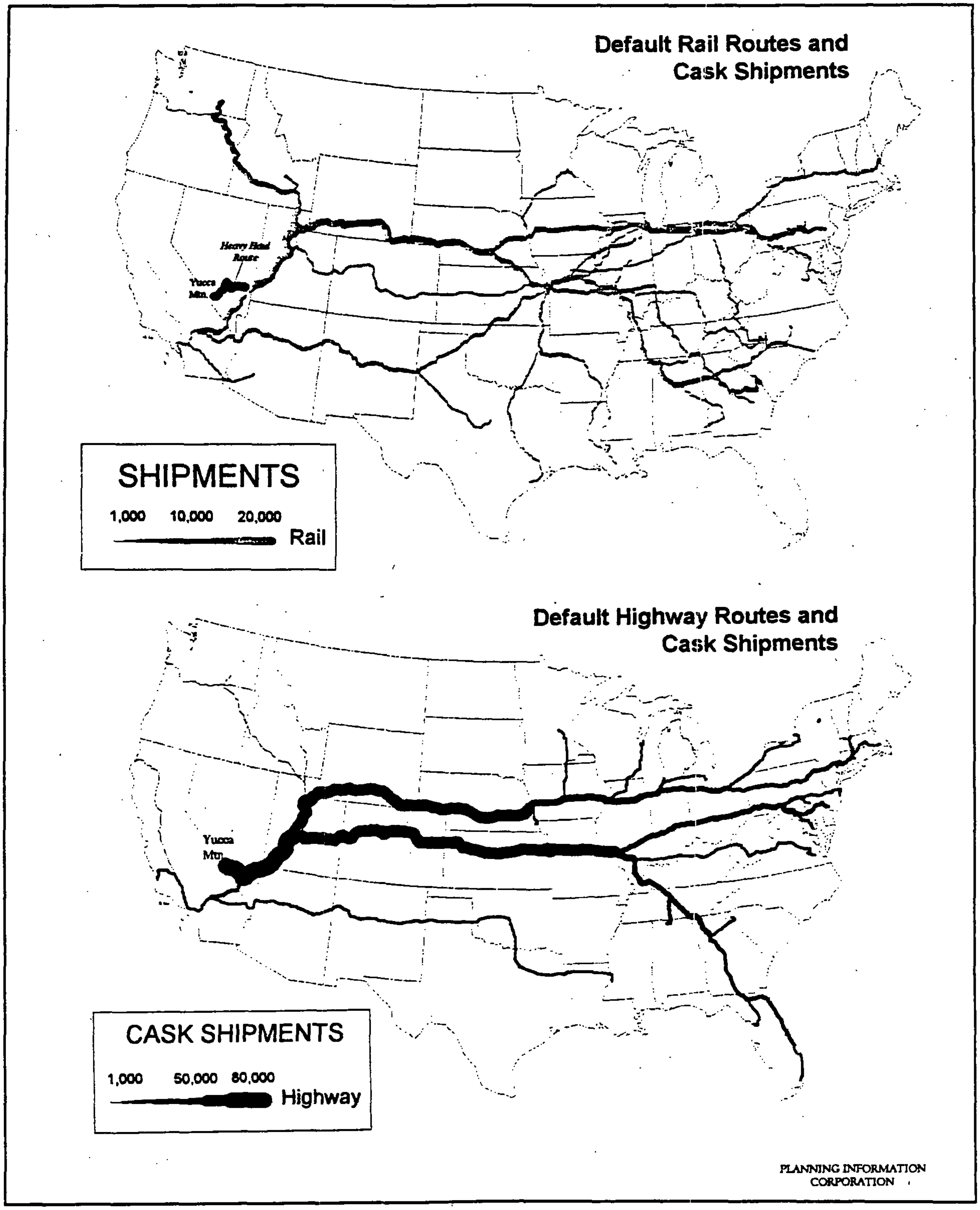


Figure 16-2. Life of Operations Rail and Highway Cask Shipments MPC Base Case Transportation Choices/Default Routing

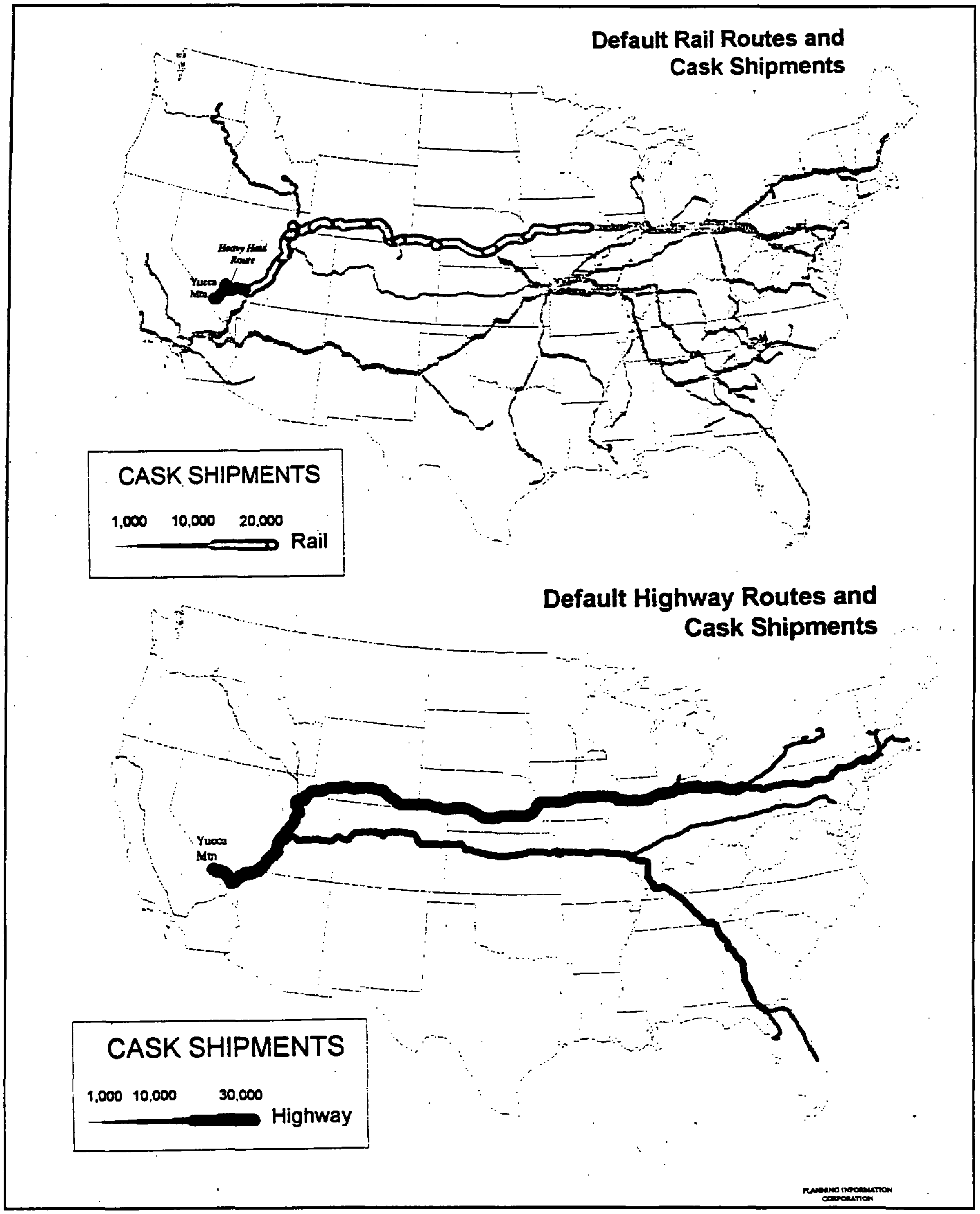
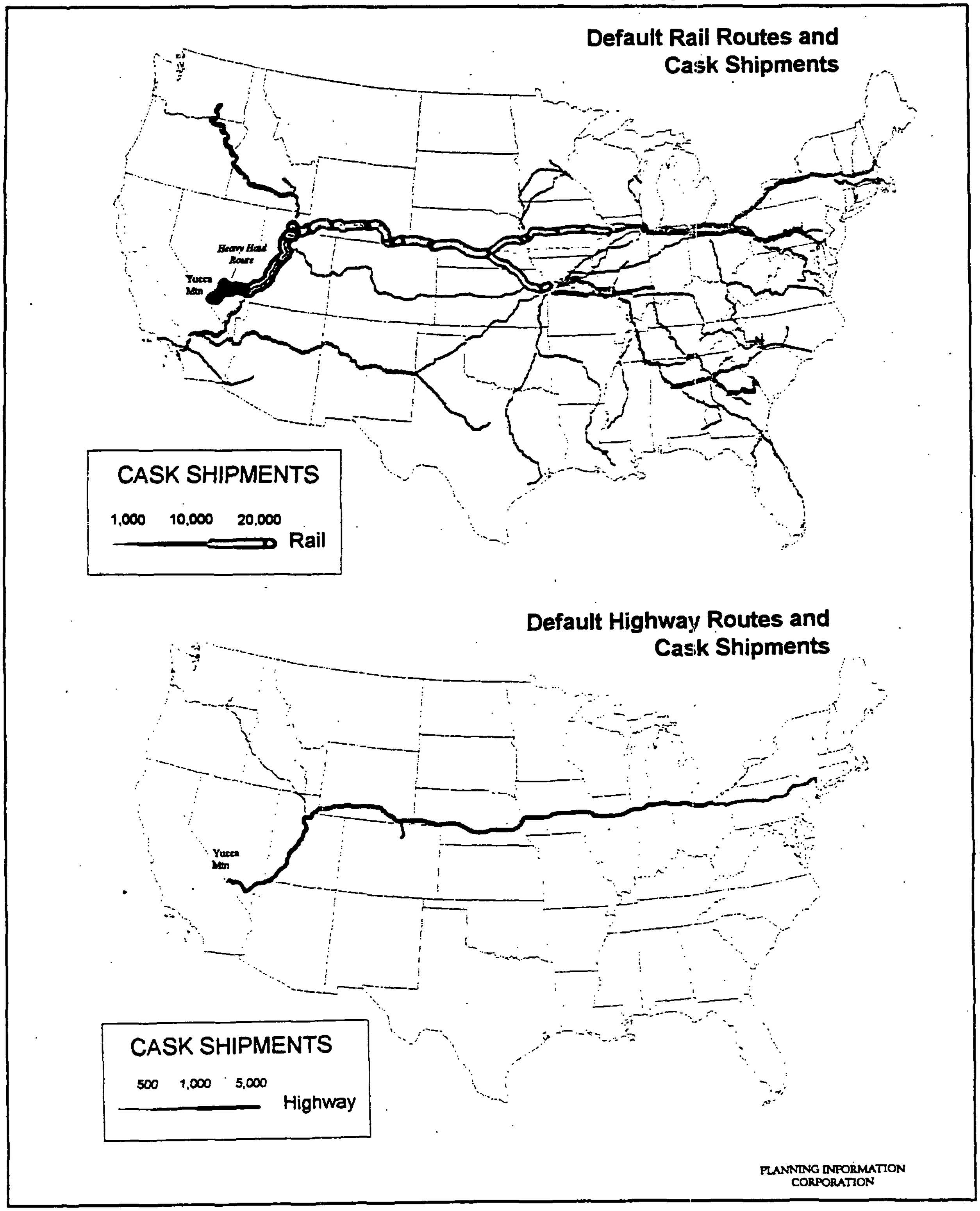


**Figure 16-3. Life of Operations Rail and Highway Cask Shipments
Maximum Rail Transportation/Default Routing**



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17. NEVADA IMPLICATIONS: THE END OF THE FUNNEL

The end of the funnel for the prospective national shipment campaign is Nevada, where rail and truck shipments from 80 sites in 35 states would converge. Under default routing, rail shipments would move on the Union Pacific rail line north from California or south from Utah to an intermodal transfer facility at the Lincoln County community of Caliente. From Caliente, shipments would continue by heavy-haul truck along U.S. highways and state roads, accessing NTS Area 25 via a newly constructed road across a corner of the Nellis Air Force Range, or continuing on public highways along a circuitous route north and west of the Nellis Air Force Range. Truck shipments would move on Interstate 15 north from California or south from Utah and Arizona to a major interchange with US-95/93 in the heart of Las Vegas, locally known as "the Spaghetti Bowl." From the Spaghetti Bowl, truck shipments would continue northwest on US-95, entering the Nevada Test Site at Lathrop Wells in the Nye County community of Amargosa Valley.

Figure 17-1 shows the rail and highway routes affected by default routing under the current capabilities scenario of transportation choices, scaling the routes according to the number of projected shipments on each segment over the 30-year shipment campaign. Figures 17-2 and 17-3 present similar information for the "MPC base case" and "maximum rail" scenarios of transportation choices.

Table 17-1 presents total cask shipments over the 30-year shipment campaign, under the current capabilities, MPC base case and maximum rail scenarios. Under the current capabilities scenario assuming default routing, Nevada would receive about 12,600 rail cask shipments, of which about 9.2 percent would move north from California through Las Vegas. The state would also receive about 79,300 truck shipments (31,300 using the high-capacity T-4/9 cask) of uncanistered fuel, of which about 8.3 percent would move north from California to the Spaghetti Bowl.

Under the MPC base case scenario of transportation choices, rail cask shipments into the state would increase from 12,600 to about 13,900 while truck cask shipments would decrease from 79,300 to 26,100 (from 31,300 to 6,300 using the high-capacity T-4/9 cask). Assuming default routing, the portion of rail and truck shipments moving north into the state from California or south from Utah would change only slightly.

Under the maximum rail scenario of transportation choices, rail cask shipments would increase to 16,800 while truck cask shipments would decrease to 4,700 (to 1,200 using the high-capacity T-4/9 cask). Again, assuming default routing, the portion of rail and truck shipments moving north into the state from California or south from Utah would change only slightly.

Part of a strategy to limit the impacts of transportation shipments in Nevada could involve efforts to avoid Las Vegas, the major urban center of the state. Such a strategy would emphasize rail shipment from the north (where shipments can be intercepted at Caliente) rather than rail shipment from the south or truck shipment on I-15, from the north or south. Among the alternatives considered in this assessment, the maximum rail scenario using default routing (combined with truck shipment using the high-capacity T-4/9 cask) goes the farthest towards this objective. Unfortunately implementation of the maximum rail scenario requires an expensive and not yet devised set of incentives for the choice of rail over truck

shipment, and for large rail over small rail shipment. Furthermore, default routing has implications for corridor communities "upstream" in the route system for shipments of SNF and HLW, which we address in the next section. In addition, even if these arrangements and commitments could be made, it is difficult to envision that they could be implemented in time for a shipment campaign beginning in 1998.

Table 17-1. Life of Operations Rail and Highway Cask Shipments Nevada Rail and Highway Route Segments

	CURRENT CAPABIL	MPC BASE CASE	MAXIMUM RAIL
Rail Segments:			
NV: UP @ UT line	11485	12399	15405
NV: UP @ LV Strip	1151	1517	1387
Hwy Segments:			
NV: I-15 @ Moapa	72768	6277	1150
NV: I-15 @ Strip	6577	45	0

Figure 17-1. Life of Operations Rail & Highway Shipments in Southern NV Region Current Capabilities Transportation Choices/Default Routing

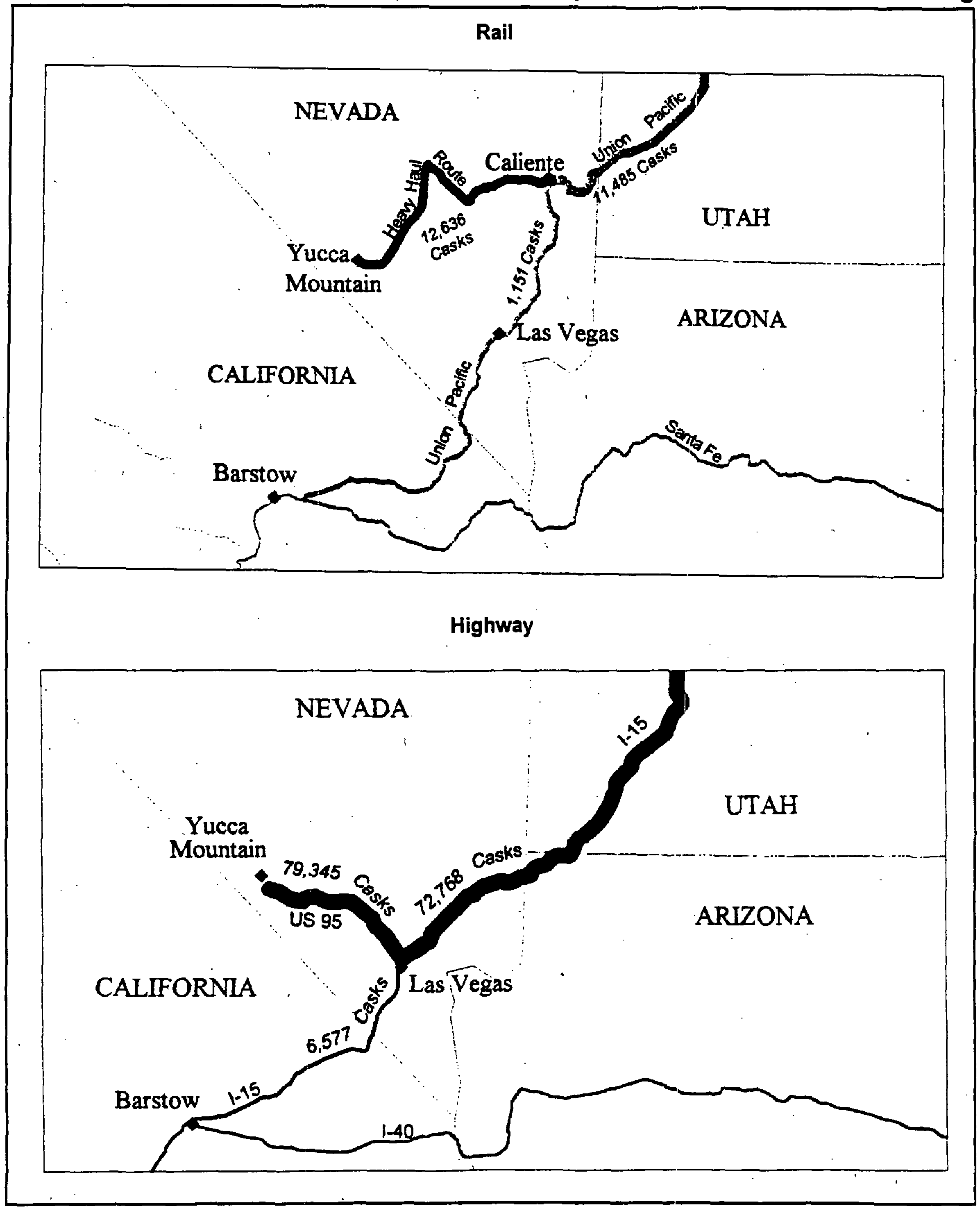


Figure 17-2. Life of Operations Rail & Highway Shipments in Southern NV Region MPC Base Case Choices/Default Routing

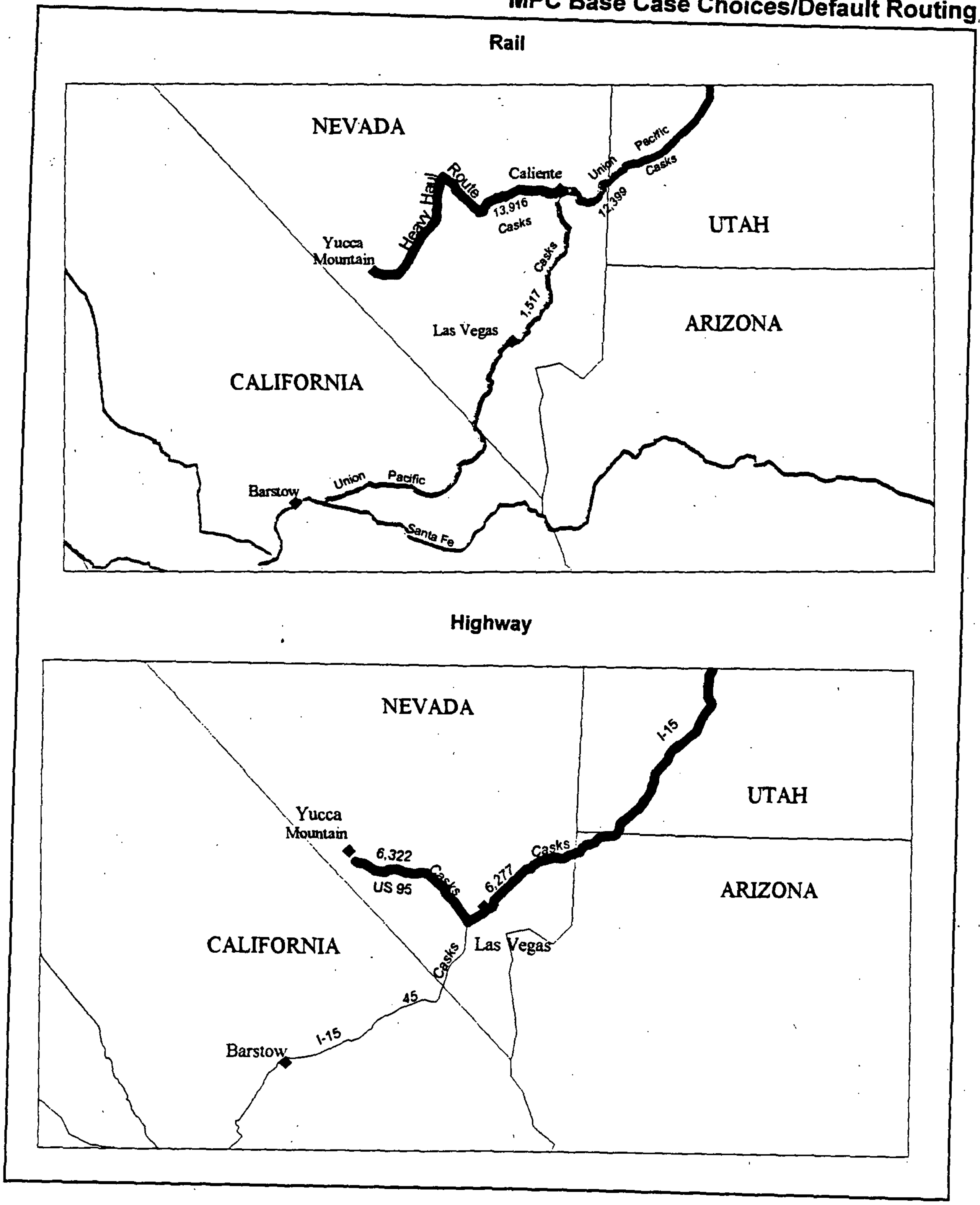
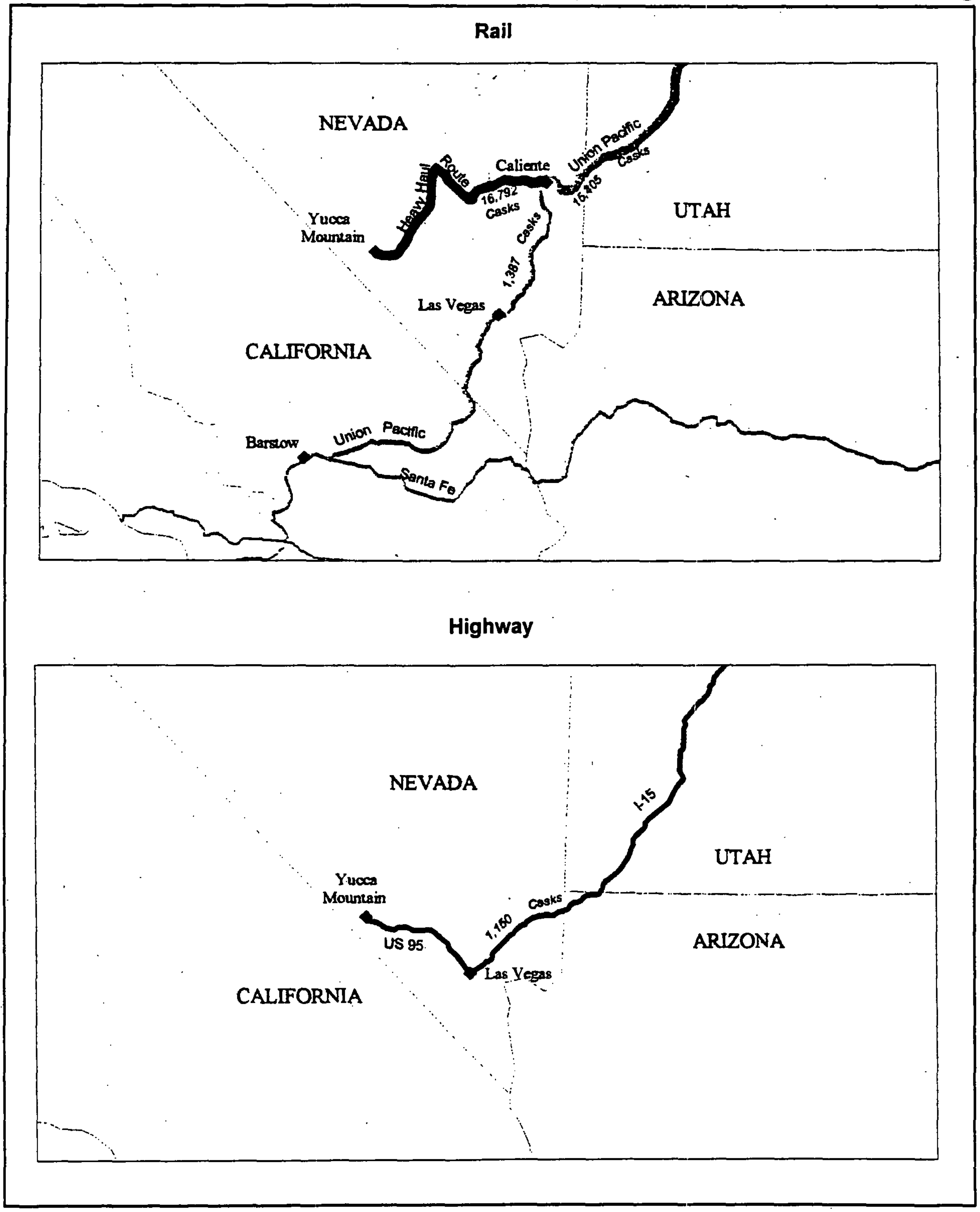


Figure 17-3. Life of Operations Rail & Highway Shipments in Southern NV Region Maximum Rail Transportation Choices/Default Routing



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18. REGIONAL ROUTING ALTERNATIVES

The maps presented in Section 16 can be viewed from many different national, regional, or local perspectives. National perspectives may involve the overall safety or cost efficiency of the national shipment campaign, while regional perspectives may seek to limit impacts on certain centers of population and commerce, and local perspectives may focus on certain facilities (e.g., a hospital or elementary school) or route conditions (e.g., a hazardous interchange) or special events (e.g., the upcoming winter Olympics in Salt Lake City). Under HM164, for example, states may choose to designate alternative routes for shipment of "highway route controlled quantities" of hazardous materials, including SNF and HLW. In a national shipment campaign, such designations have system effects which require coordination with "upstream" and "downstream" states. Rail routes are generally determined by rail carriers, in negotiation with utility shippers and DOE. But the choice to heavy-haul to one railhead rather than another at the origin site, or changes in railroad ownership, can substantially alter a 2,000 mile cross-country route.

The use of Interstate 43, which extends south from Green Bay through Milwaukee and southwest to Beloit, WI provides an example of possible regional perspectives on the routing of SNF shipments. In the current capabilities scenario, I-43 is used to move wastes away from the Kewaunee and Point Beach sites in Wisconsin. In northern Illinois, where the Byron and Zion plants are located, I-43 connects to I-80 via I-39 in Rockford and I-88 in Moline, However, since Byron and Zion ship by rail in the current capabilities scenario, the connecting segments in Illinois are used only by shipments originating in Wisconsin. These circumstances, which are just one example of hundreds involved in a national shipment campaign, could affect the perspective of various state agencies and local communities in Wisconsin and Illinois.

Consolidated Southern Routing

A major alternative to the default routing criteria reflected in the results presented in Sections 16 and 17, is a "consolidated southern" option which would concentrate cross-country rail shipments on the Santa Fe rail line rather than the Union Pacific and Southern Pacific, and concentrate cross-country highway shipments on I-40 rather than I-80 or I-70. To illustrate the effects of regional routing alternatives, we have compared cask shipment estimates under default and consolidated southern routing options for five rail and five highway route segments in four states—Wyoming, Colorado, New Mexico, and Nevada (see Figures 18-1 through 18-3):

- The Wyoming route segments are along the Union Pacific line near Rawlins in south-central Wyoming, and along a nearby segment of I-80.

- The Colorado segments are along the Southern Pacific rail line near Glenwood Springs in western Colorado, and along a nearby segment of I-70.

- The New Mexico segments are along the Santa Fe rail line near Grants in northwestern New Mexico, and along a nearby segment of I-40.

Figure 18-1a. Life of Operations Rail and Highway Cask Shipments Current Capabilities Transportation Choices/Default Routing

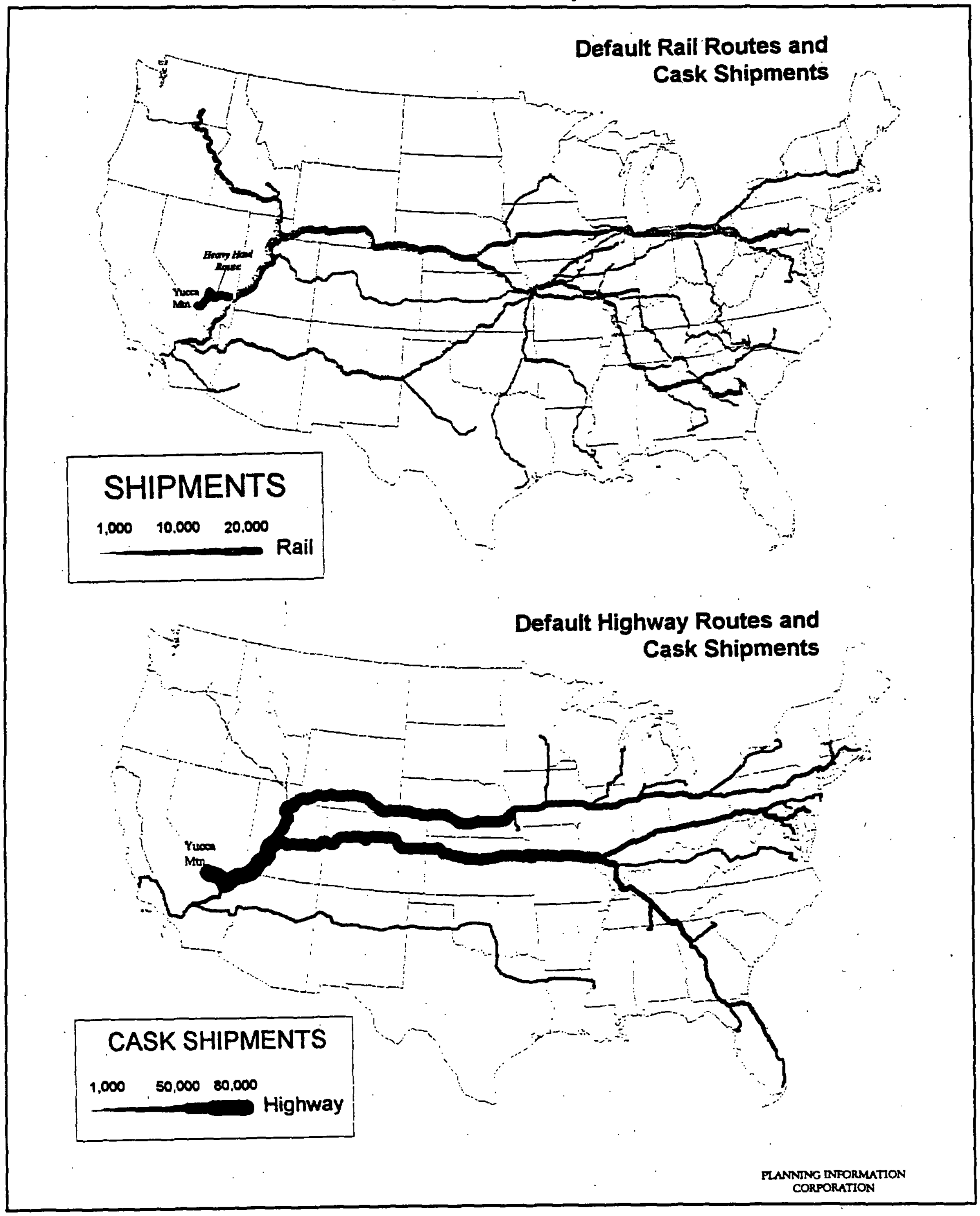


Figure 18-1b. Life of Operations Rail and Highway Cask Shipments
Current Capabilities Transportation Choices/Consolidated Southern Routing

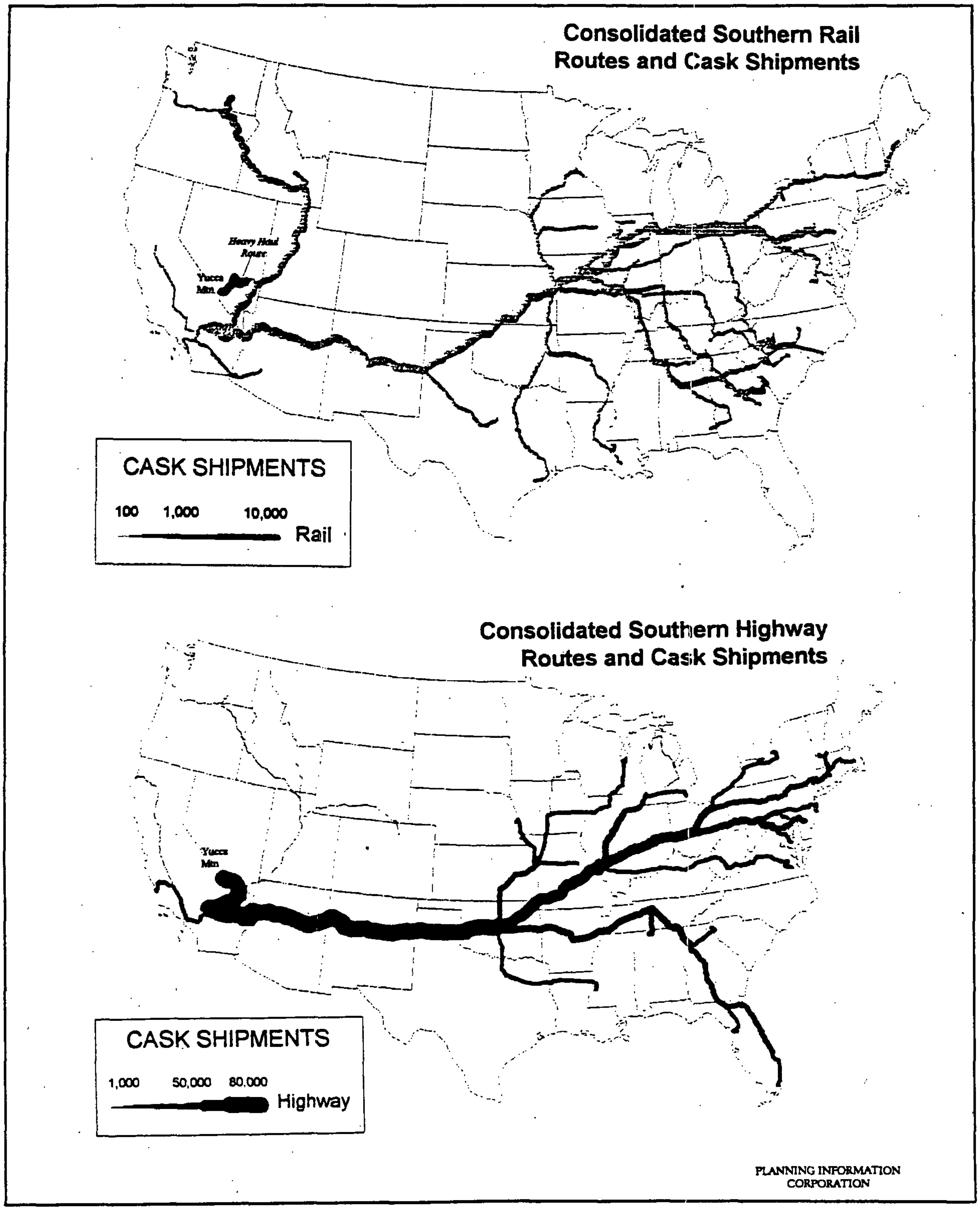
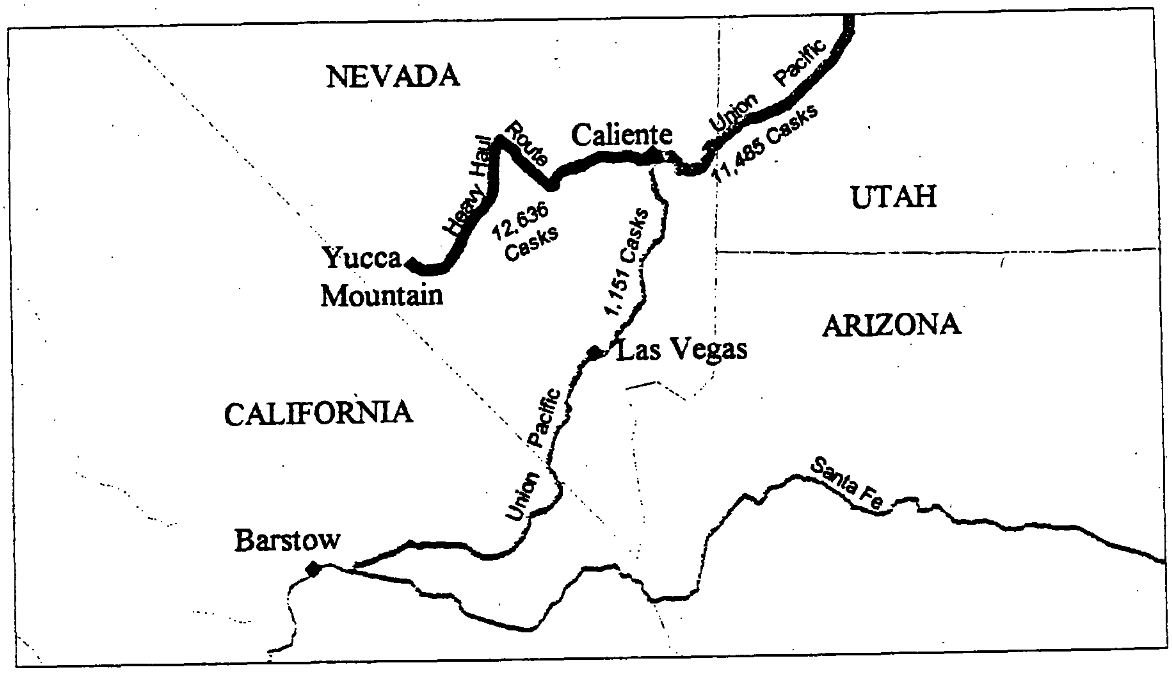


Figure 18-1a (NV). Life of Operations Rail and Highway Cask Shipments in (NV) Current Capabilities Transportation Choices/Default Routing

Rail



Highway

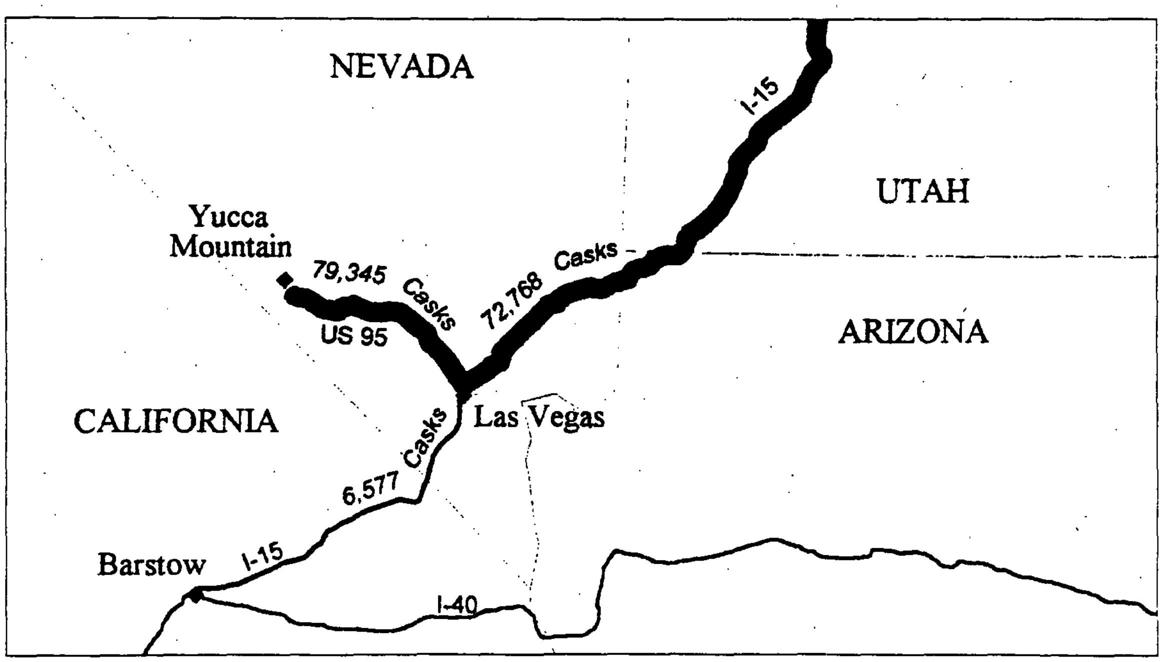


Figure 18-1b (NV). Life of Operations Rail and Highway Cask Shipments in (NV) Current Capabilities Transportation Choices/Consolidated Southern Routing

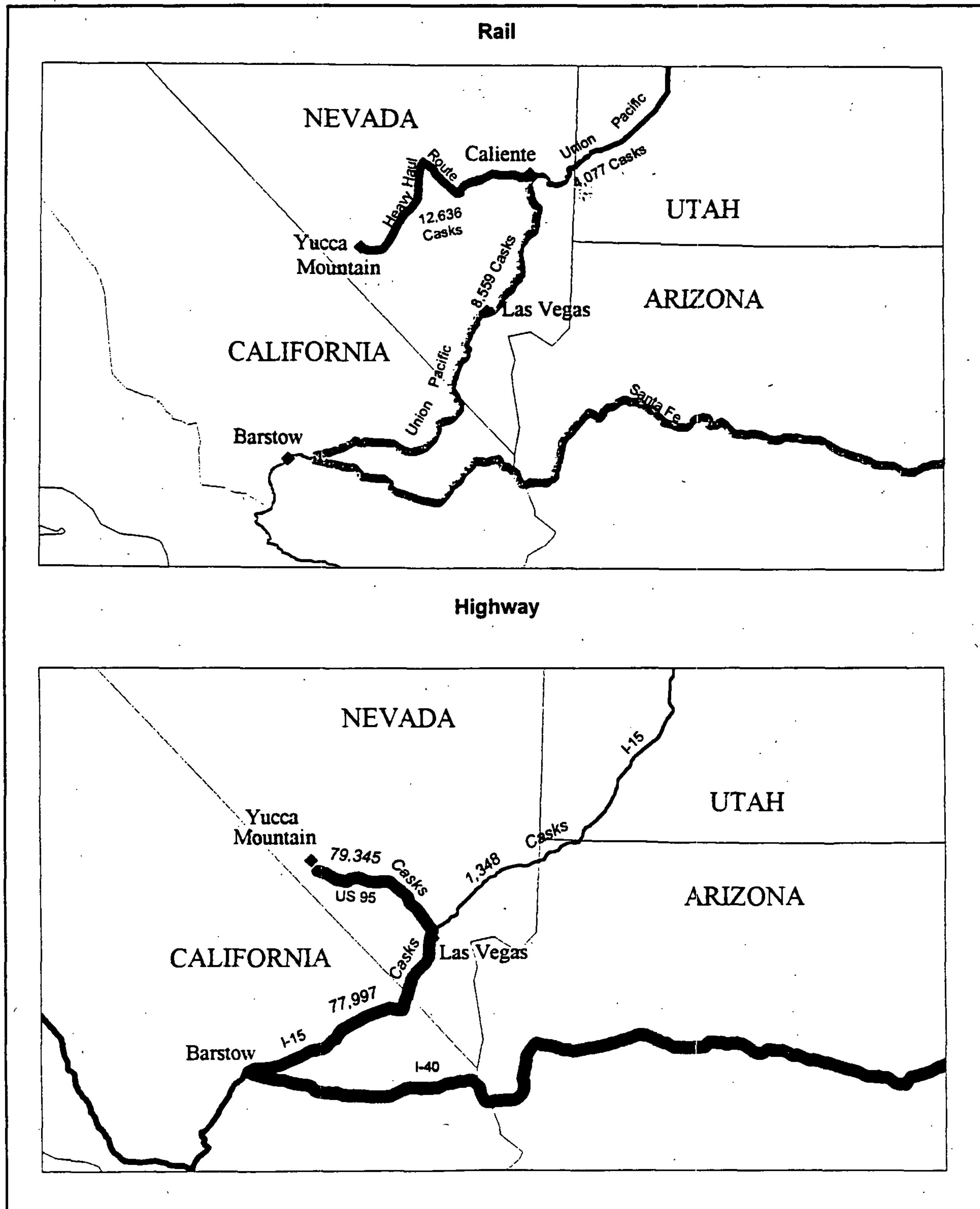


Figure 18-2a. Life of Operations Rail and Highway Cask Shipments MPC Base Case Transportation Choices/Default Routing

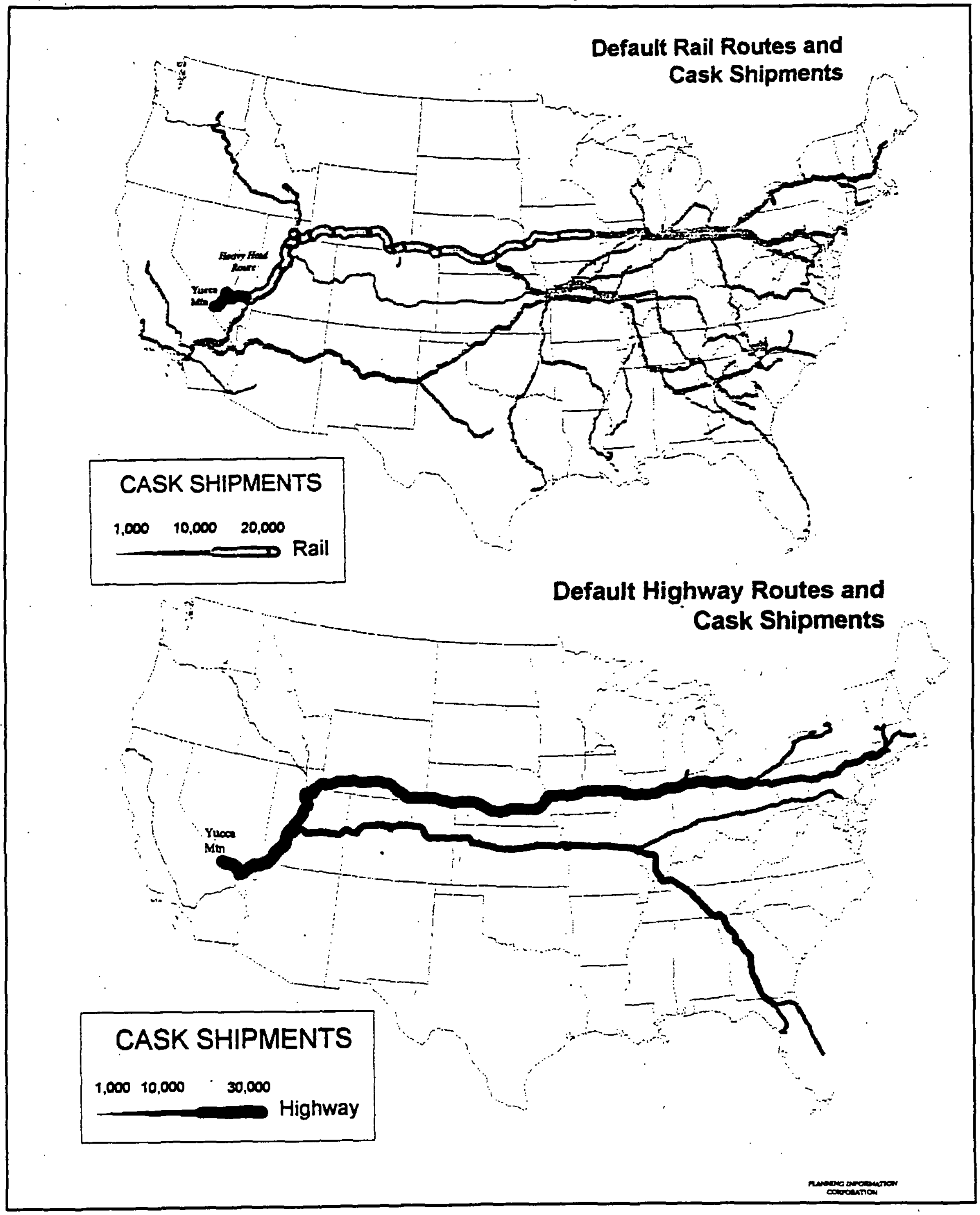


Figure 18-2b. Life of Operations Rail and Highway Cask Shipments MPC Base Case Transportation Choices/Consolidated Southern Routing

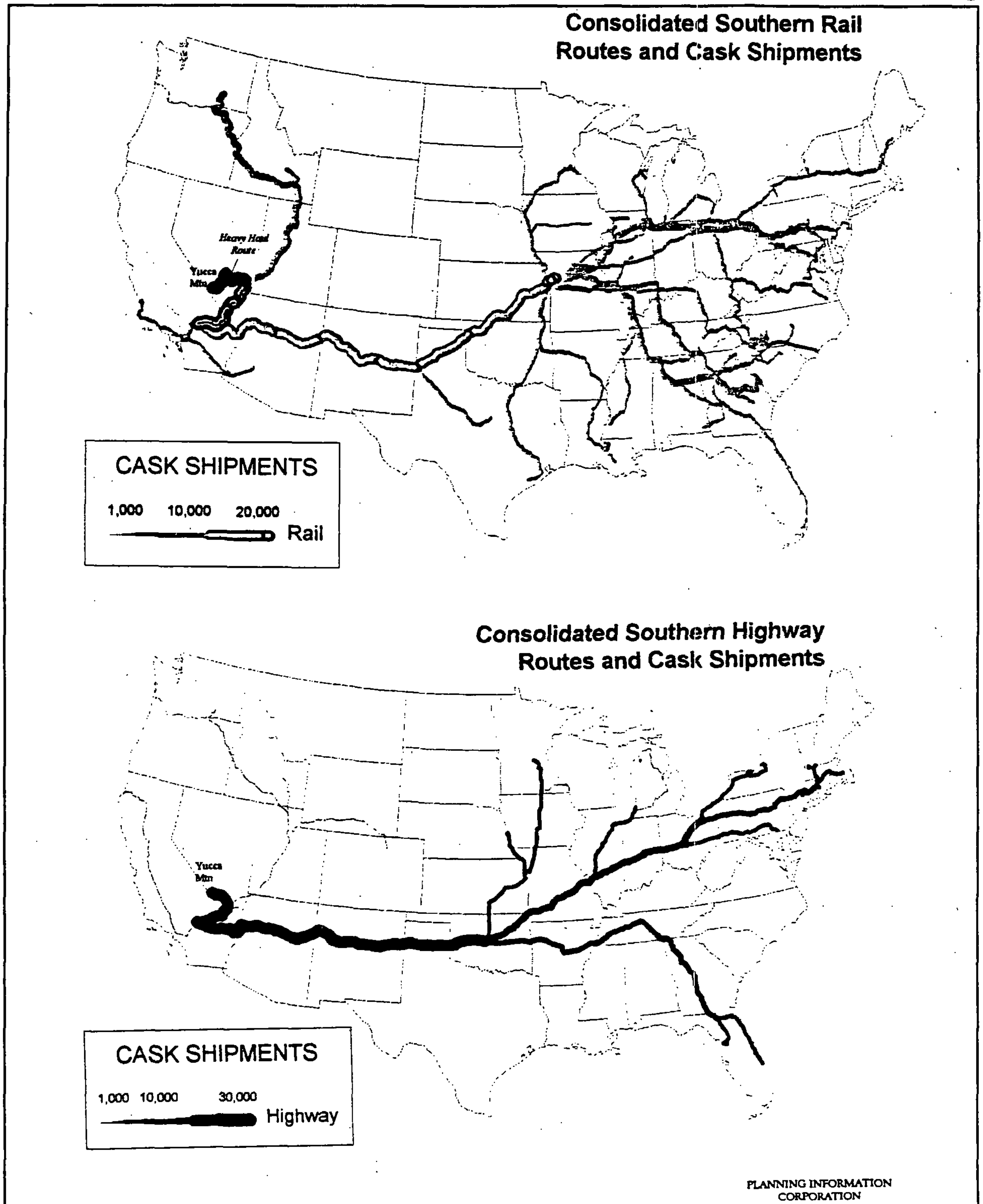


Figure 18-2a (NV). Life of Operations Rail and Highway Cask Shipments in (NV) MPC Base Case Transportation Choices/Default Routing

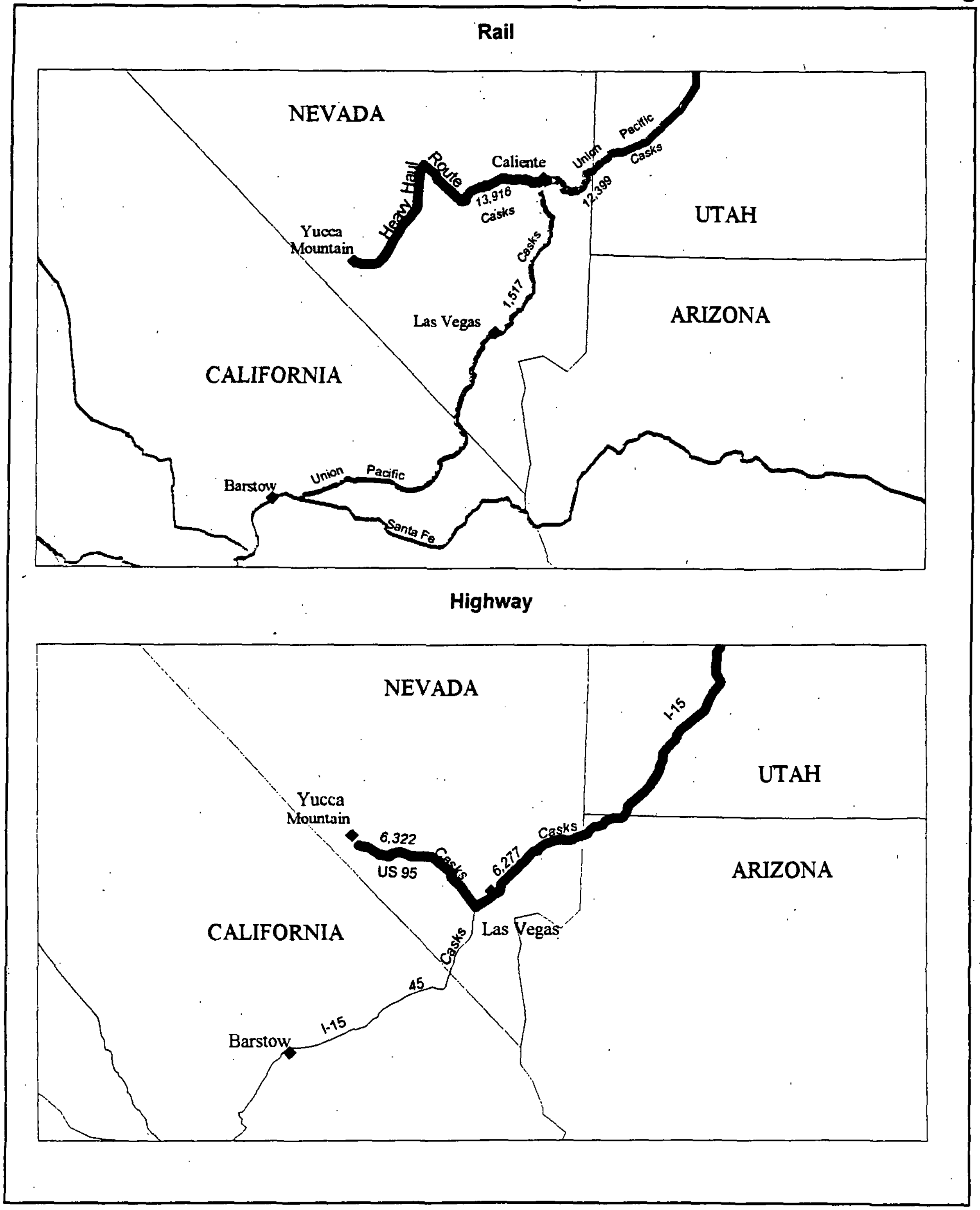
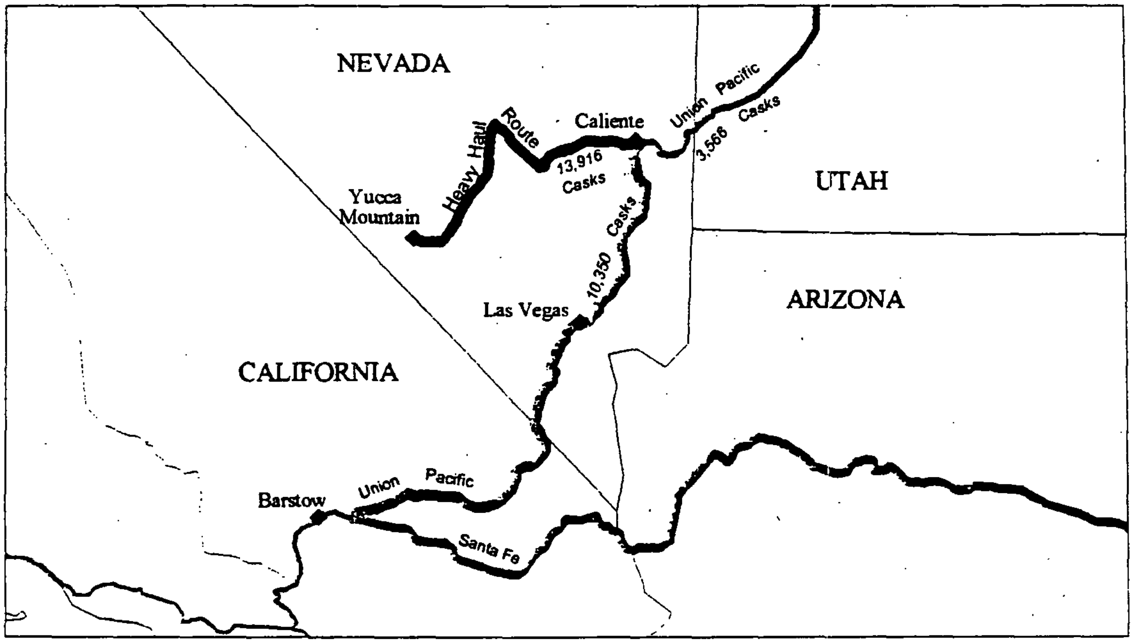


Figure 18-2b (NV). Life of Operations Rail and Highway Cask Shipments in (NV) MPC Base Case Transportation Choices/Consolidated Southern Routing

Rail



Highway

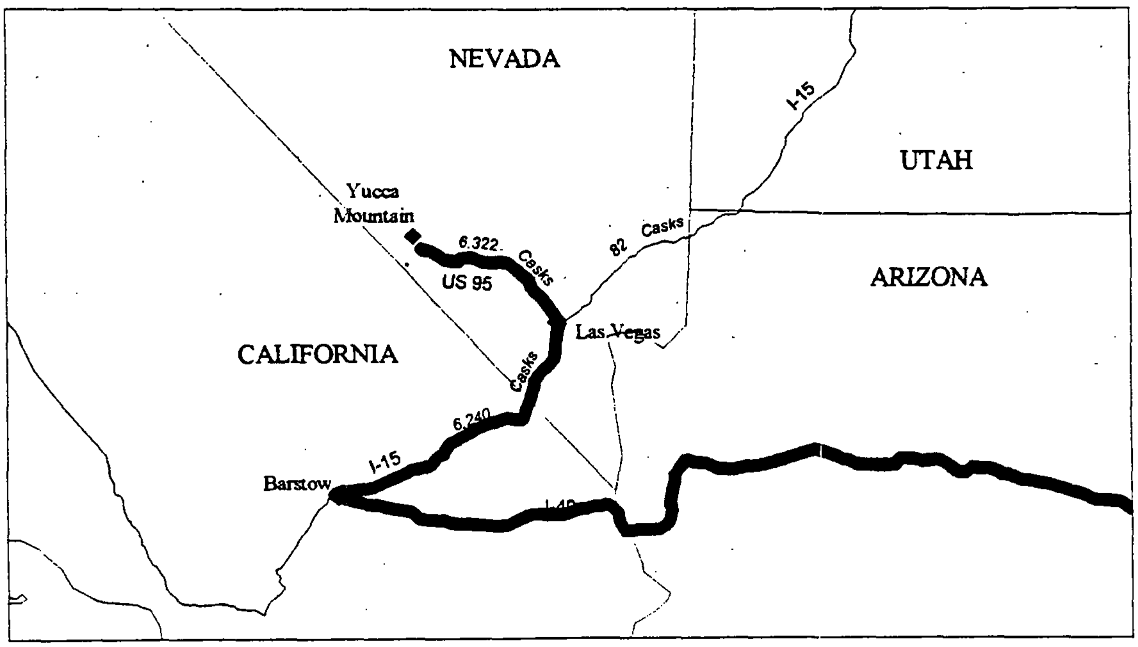


**Figure 18-3a. Life of Operations Rail and Highway Cask Shipments
Maximum Rail Transportation Choices/Default Routing**

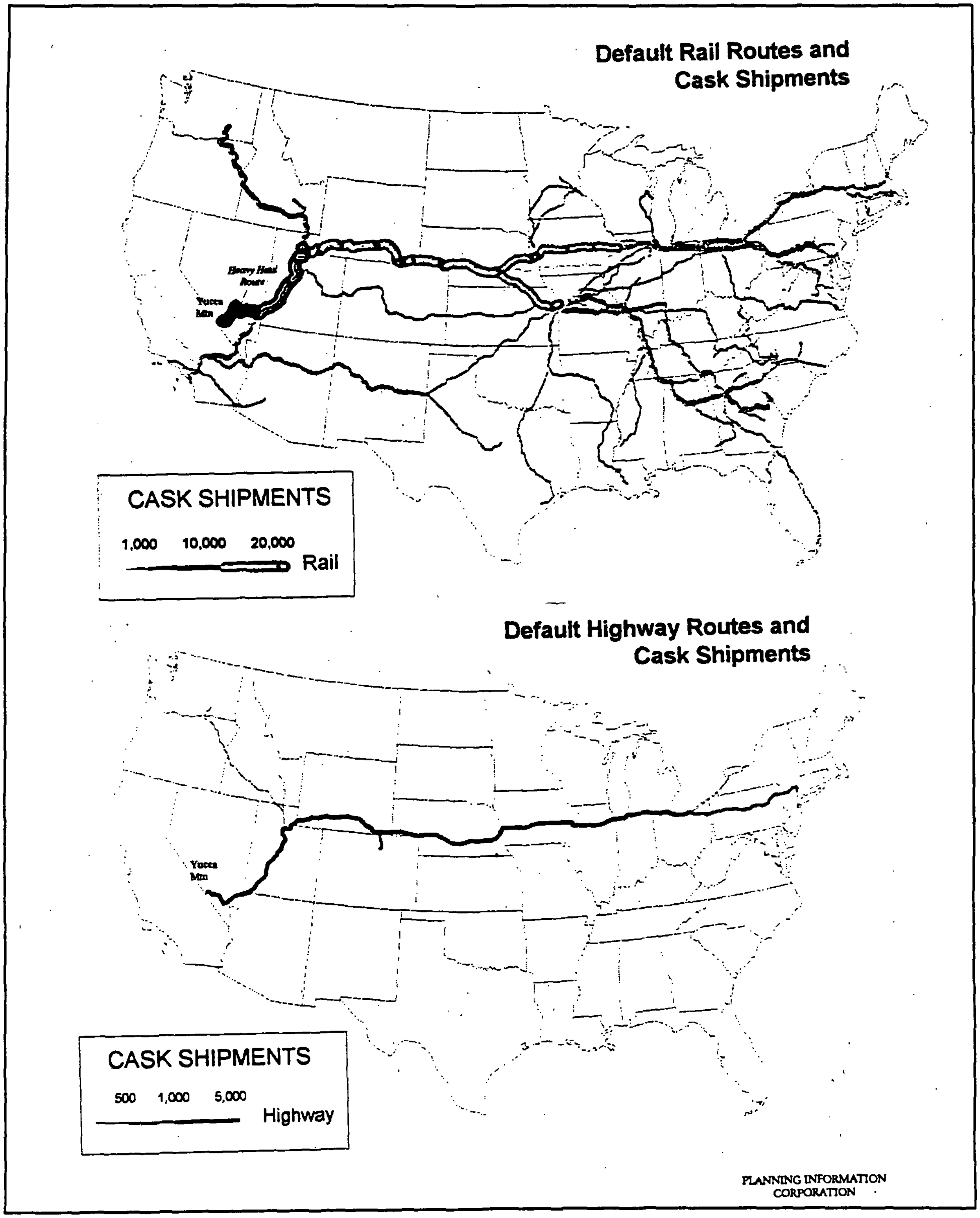


Figure 18-3b. Life of Operations Rail and Highway Cask Shipments Maximum Rail Transportation Choices/Consolidated Southern Routing

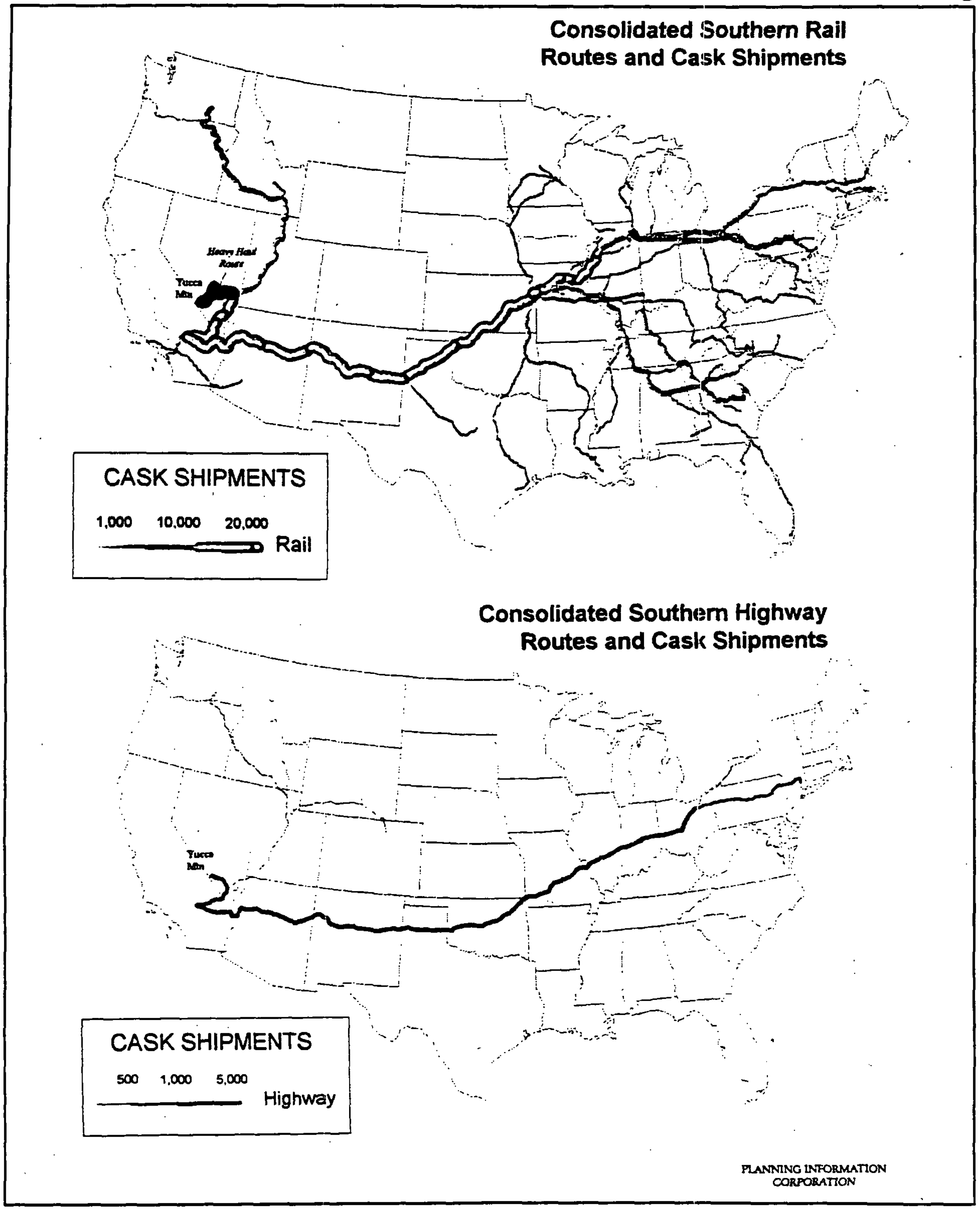


Figure 18-3a (NV). Life of Operations Rail and Highway Cask Shipments in (NV) Maximum Rail Transportation Choices/Default Routing

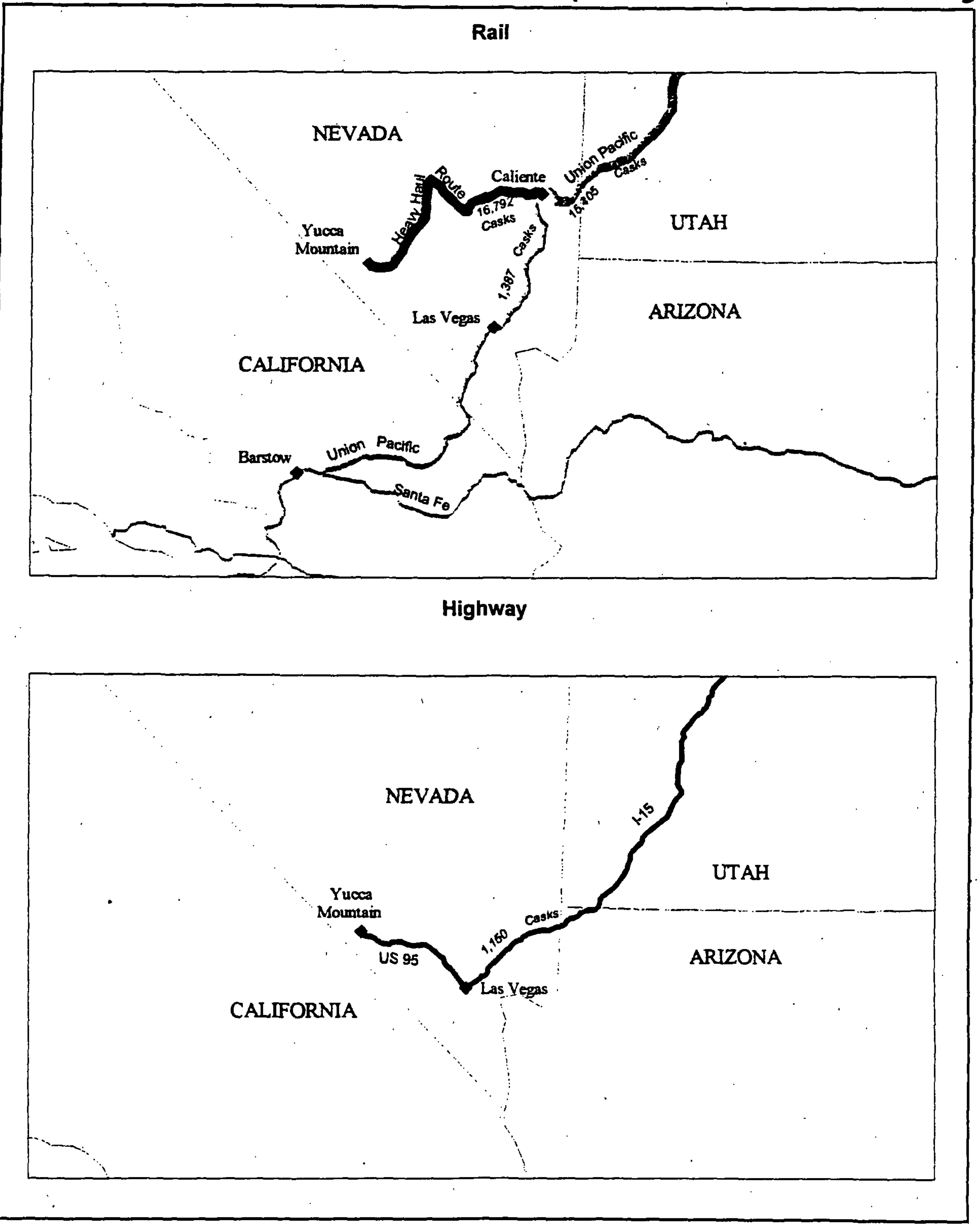
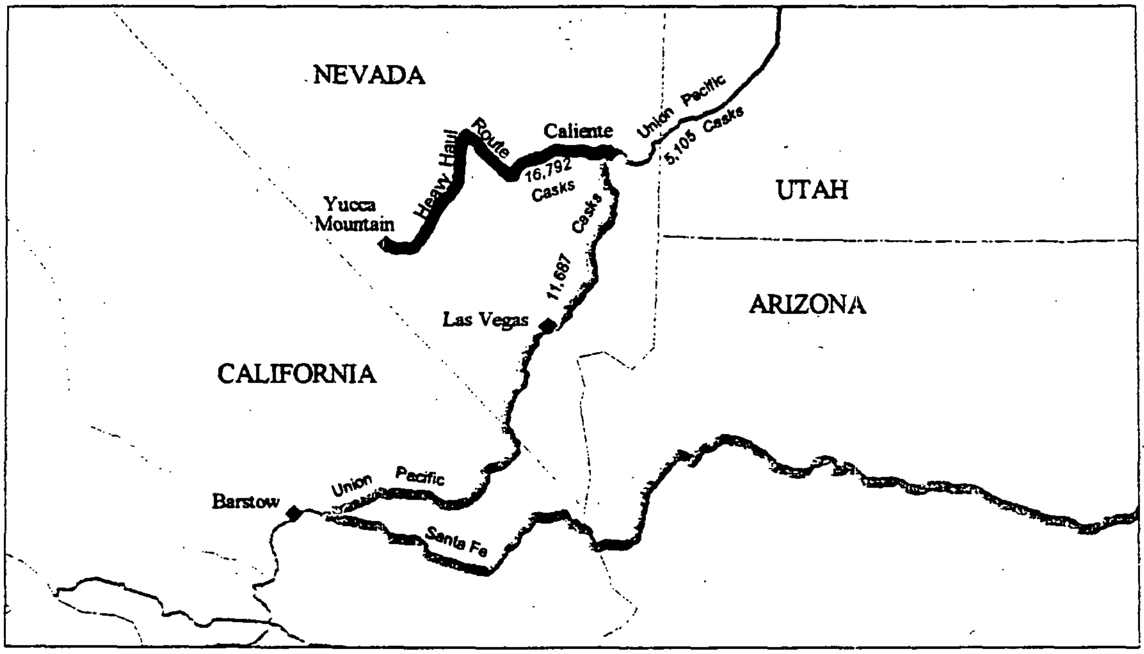
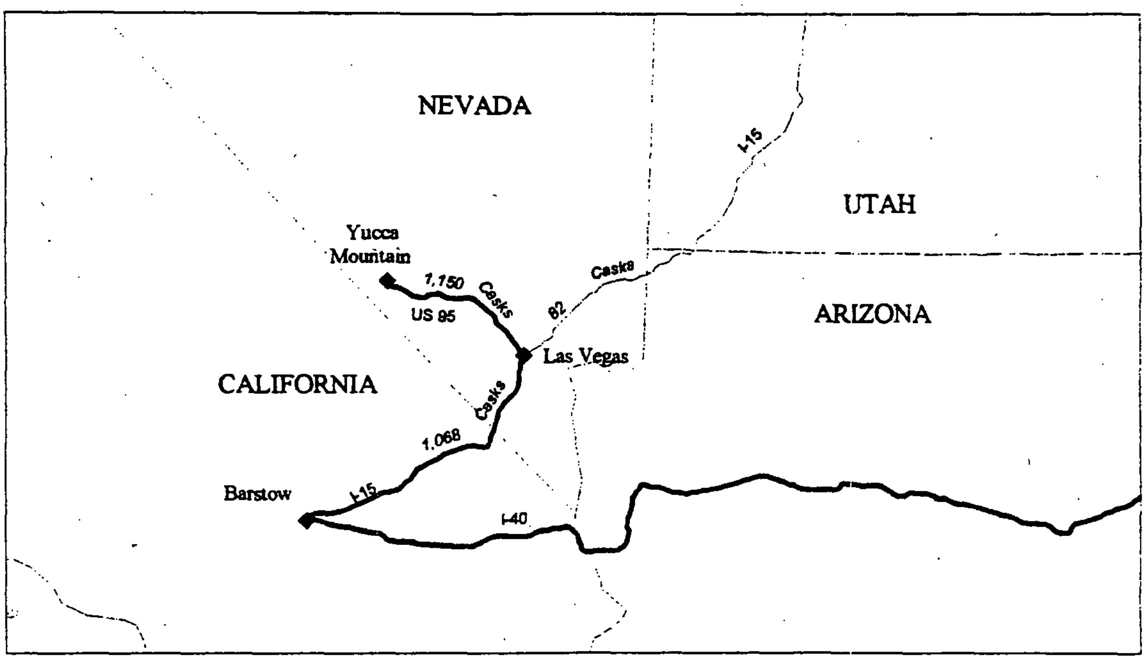


Figure 18-3b (NV). Life of Operations Rail and Highway Cask Shipments in (NV) Maximum Rail Transportation Choices/Consolidated Southern Routing

Rail



Highway



- One pair of Nevada segments are the Union Pacific line and a segment of I-15 near the Las Vegas Strip. A second pair of Nevada segments are the Union Pacific rail line near the Utah-Nevada border, and a segment of I-15 as it crosses the Moapa Indian Reservation northeast of Las Vegas.

Under all three scenarios of transportation choices (as indicated in Table 18-1), consolidated southern routing would eliminate rail and highway shipments through Wyoming and Colorado, and substantially reduce rail and highway shipments from Utah into Nevada. At the same time, however, consolidated southern routing would substantially increase rail and highway shipments through New Mexico, through California east of Barstow and into Nevada along the Las Vegas Strip. Though not presented in table 17-1, consolidated southern routing has effects further east in the national routing system for SNF and HLW—e.g., in Chicago, Kansas City, and St. Louis. Other routing options would also have systems effects, increasing rail or highway shipments through certain communities, and reducing shipments through others.

Table 18-1. Life of Operations Rail and Highway Cask Shipments Default and Consolidated Southern Routing 5 Rail and 5 Highway Cask Segments

	CURRENT CAPABILITIES			MPC BASE CASE			MAXIMUM RAIL		
	Default Routing	Consol So. Rtg	Change	Default Routing	Consol So. Rtg	Change	Default Routing	Consol So. Rtg	Change
Rail Segments:									
Wyo: UP	8286	0	-8286	9315	0	-9315	11114	0	-11114
Col: SP	362	0	-362	79	0	-79	214	0	-214
NV: UP @ UT line	11485	4077	-7408	12399	3566	-8833	15405	5105	-10300
NM: SF	770	9418	8648	808	10202	9394	631	11959	11328
NV: UP @ LV Strip	1151	8559	7408	1517	10360	8843	1387	11687	10300
Hwy Segments:									
Wyo: I-80	31109	54	-31055	14319	10	-14309	1083	10	-1073
Col: I-70	39496	0	-39496	9877	0	-9877	0	0	0
NV: I-15 @ Moapa	72768	1348	-71420	6277	82	-6195	1150	82	-1068
NM: I-40	3630	74181	70551	0	24186	24186	0	1073	1073
NV: I-15 @ Strip	6577	77997	71420	45	6240	6195	0	1068	1068

19. THE NATIONAL SHIPMENT CAMPAIGN: ANNUAL SHIPMENTS

What are the annual impacts of the national shipment campaign for the nation's network of major railroads and highways? Do the impacts vary from year 1 to year 2, or 3, for example, or from year 1 to year 10 to year 20? These questions are relevant to the planning and management of a national shipment campaign. For example, DOE's May 28, 1996 notice regarding the acquisition of transportation services indicates (pg. 1) that "Initially, spent-fuel delivered to the Federal site would be canistered. . .but at some point* . . . the contractor may be required to handle uncanistered spent-fuel." What modifications in the oldest-fuel-first prioritization for spent fuel acceptance and pickup (see Section 5) would be necessary to limit pickup to canistered fuel in the first two acceptance years?

Another concern is the preparedness of state, local, and tribal officials to manage risk and respond to emergencies associated with SNF and HLW shipments. Compounding this concern is the current Congressional intent to accelerate the first shipments of SNF and HLW, perhaps as early as 1998 or 1999. Further complicating the planning process are the initiatives to privatize the transportation process, through a series of contracts with regional servicing agents (RSAs). Finally, many analysts share the belief that the number of shipments should be reduced by using higher-volume rail and truck containers that are yet to be developed or licensed, and by improvements to waste-handling infrastructure that could be expensive to complete.

The scenarios developed for this assessment reveal significant differences between the overall campaign and its initial shipment years. In the current capabilities scenario, for example, about 35 percent of the MTU would be shipped by truck, a percentage which increases to 66 percent in the initial three shipment years. In the MPC base case scenario of transportation choices, about 11 percent of total MTU would be shipped by truck, a percentage which increases to 27 percent in the initial three shipment years—even more if improvements in loading capacity and/or near-site infrastructure were not implemented with casks available for the startup of the shipment campaign.

Figures 18-1, 18-2 and 18-3 present origin sites and affected rail and highway routes (default routing) under the current capabilities scenario of transportation choices in years 1, 2, and 3 of the prospective shipment campaign. While it is possible that the special arrangements and improvements implied by the MPC base case and maximum rail scenarios could be implemented by year 1, it can also be argued that the current capabilities are likely to be operative in the initial years, regardless of the strategy for the overall shipment campaign.

Figures 18-4 and 18-5 present origin sites and affected rail and highway routes (default routing) in year 20 of the prospective shipment campaign—in this case comparing affected routes and cask shipments under the current capabilities and maximum rail scenarios of transportation choices.

* RSA Phase C contract years 3-5 (see "Timing of RSA Phases": VU-Graph Presentations for July 9, 1996 Presolicitation Conference, ref 2).

Year 1 Routes and Cask Shipments

Figure 19-1 shows the likely pattern of shipments comprising the 1,200 MTU first-year requirement of S. 1936, assuming the oldest-fuel-first priority acceptance ranking described above. The default routing is essentially unconstrained, as might be developed by an RSA or by DOE contract carriers. Shipments would be made from 8 sites with rail access and 20 sites with truck-only access:

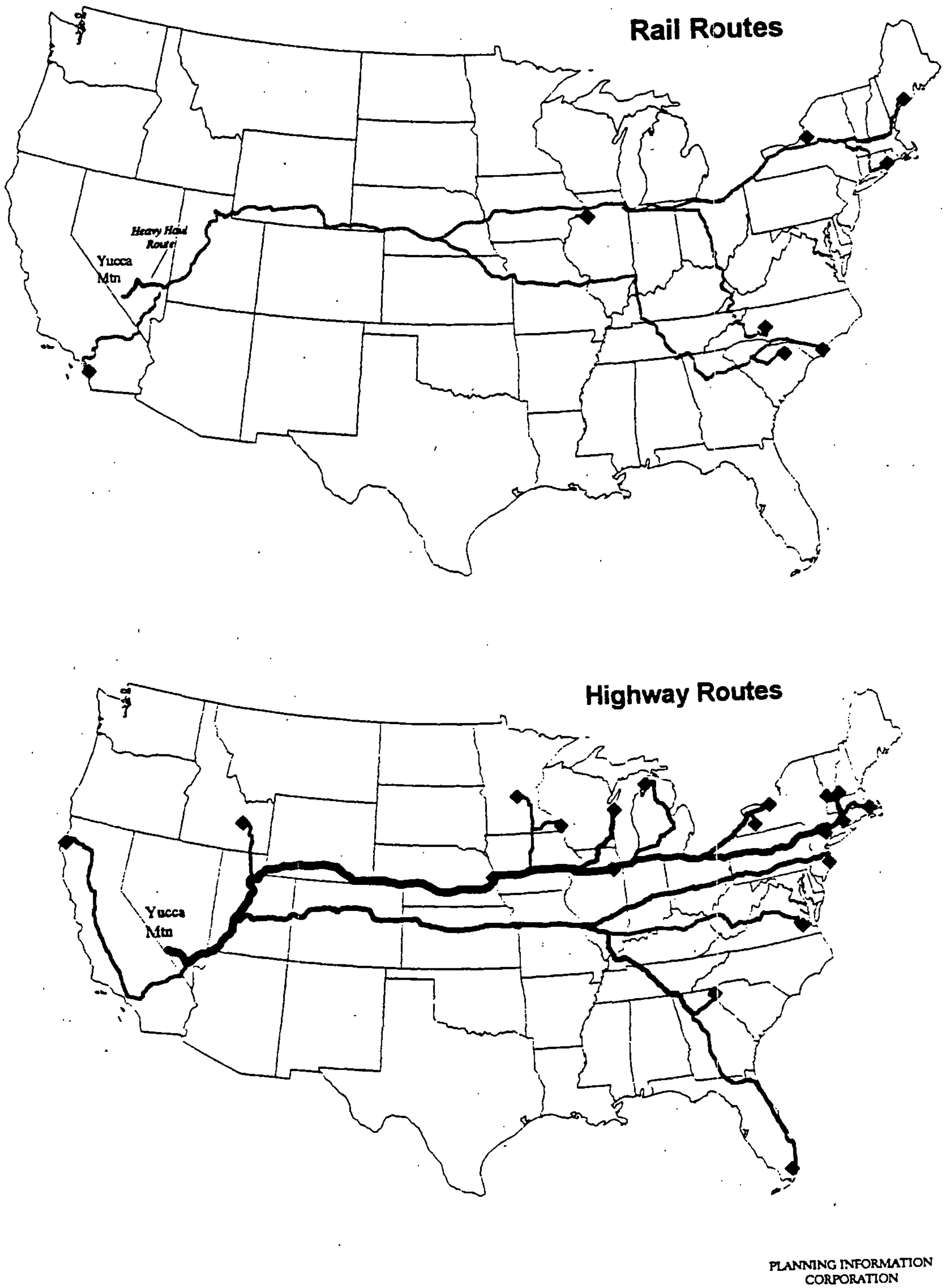
Rail Shipments

Origin	Casks
CA: San Onofre	2
CT: Millstone	12
IL: Quad Cities	7
NC: Brunswick	14
NC: McGuire	2
ME: Maine Yankee	11
NY: Nine Mile Point	15
SC: Robinson	1
TOTAL	64

Truck Shipments

Origin	Casks
CA: Humboldt Bay	87
CT: Haddam Neck	131
FL: Turkey Point	90
ID: INEL	6
IL: Braidwood	9
IL: Dresden	344
IL: Morris	755
MA: Pilgrim	10
MA: Yankee Rowe	73
MI: Big Rock Point	9
MN: Monticello	12
NE: Ft. Calhoun	25
NJ: Oyster Creek	246
NY: Ginna	118
NY: Indian Point	160
NY: West Valley	83
SC: Oconee	35
VA: Surry	44
VT: Vermont Yankee	189
WI: LaCrosse	28
WI: Point Beach	151
TOTAL	2,605

Figure 19-1. Year 1 Cask Shipments by Route and Origin
Current Capabilities Transportation Choices/Default Routing



Year 2 Routes and Cask Shipments

In the second year, the shipment schedule shows an increased number of shipment origin sites (13 railroad, 24 truck), as shown in Figure 19-2. The weight of SNF is the same as in year 2 (at least 1,200 MTU) and the number of casks is somewhat lower than year 1:

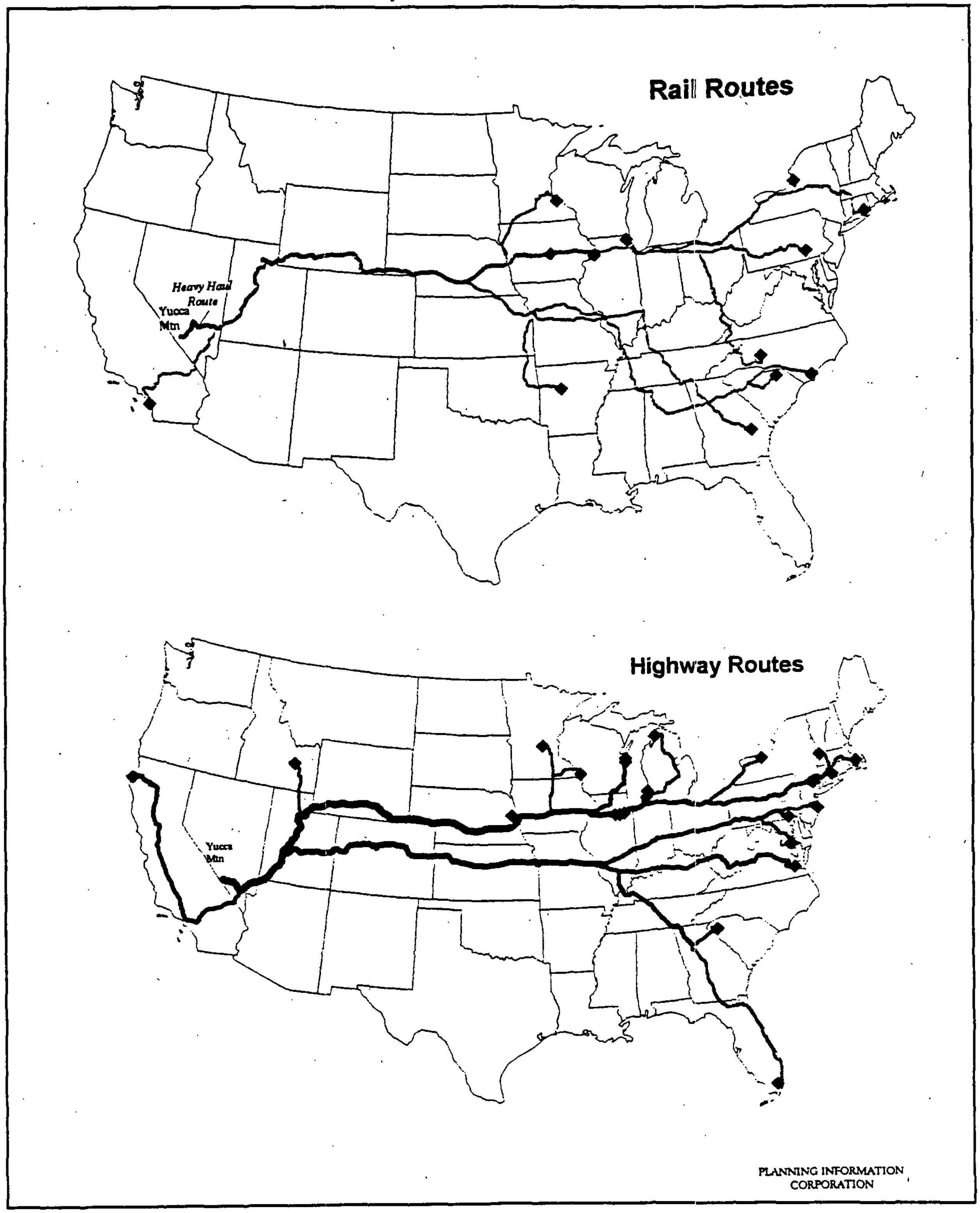
Rail Shipments

Origin	Casks
AR: Arkansas Nuclear	5
CA: San Onofre	2
CT: Millstone	13
GA: Hatch	1
IA: Duane Arnold	8
IL: Quad Cities	21
IL: Zion	9
MN: Prairie Island	6
NC: Brunswick	10
NC: McGuire	9
NY: Nine Mile Point	18
PA: Three Mile Island	3
SC: Robinson	1
TOTAL	106

Truck Shipments

Origin	Casks
CA: Humboldt Bay	109
CT: Haddam Neck	101
FL: Turkey Point	95
ID: INEL	17
IL: Braidwood	11
IL: Dresden	184
IL: Morris	235
MA: Pilgrim	66
MA: Yankee Rowe	40
MD: Calvert Cliffs	32
MI: Big Rock Point	11
MI: Cook	63
MI: Palisades	205
MN: Monticello	13
NE: Ft. Calhoun	36
NJ: Oyster Creek	28
NY: Ginna	37
NY: Indian Point	72
PA: Peach Bottom	187
SC: Oconee	26
VA: Surry	226
WI: Kewaunee	56
WI: LaCrosse	13
WI: Point Beach	119
TOTAL	1,982

Figure 19-2. Year 2 Cask Shipments by Route and Origin
Current Capabilities Transportation Choices/Default Routing



Year 3 Routes and Cask Shipments

In year three, the volume of shipment increases from 1,200 to 2,000 MTU, increasing both the number of casks and the number of shipment sites (18 rail and 27 truck), as shown in Figure 19-3. However, we still assume the current capabilities scenario and unconstrained routing.

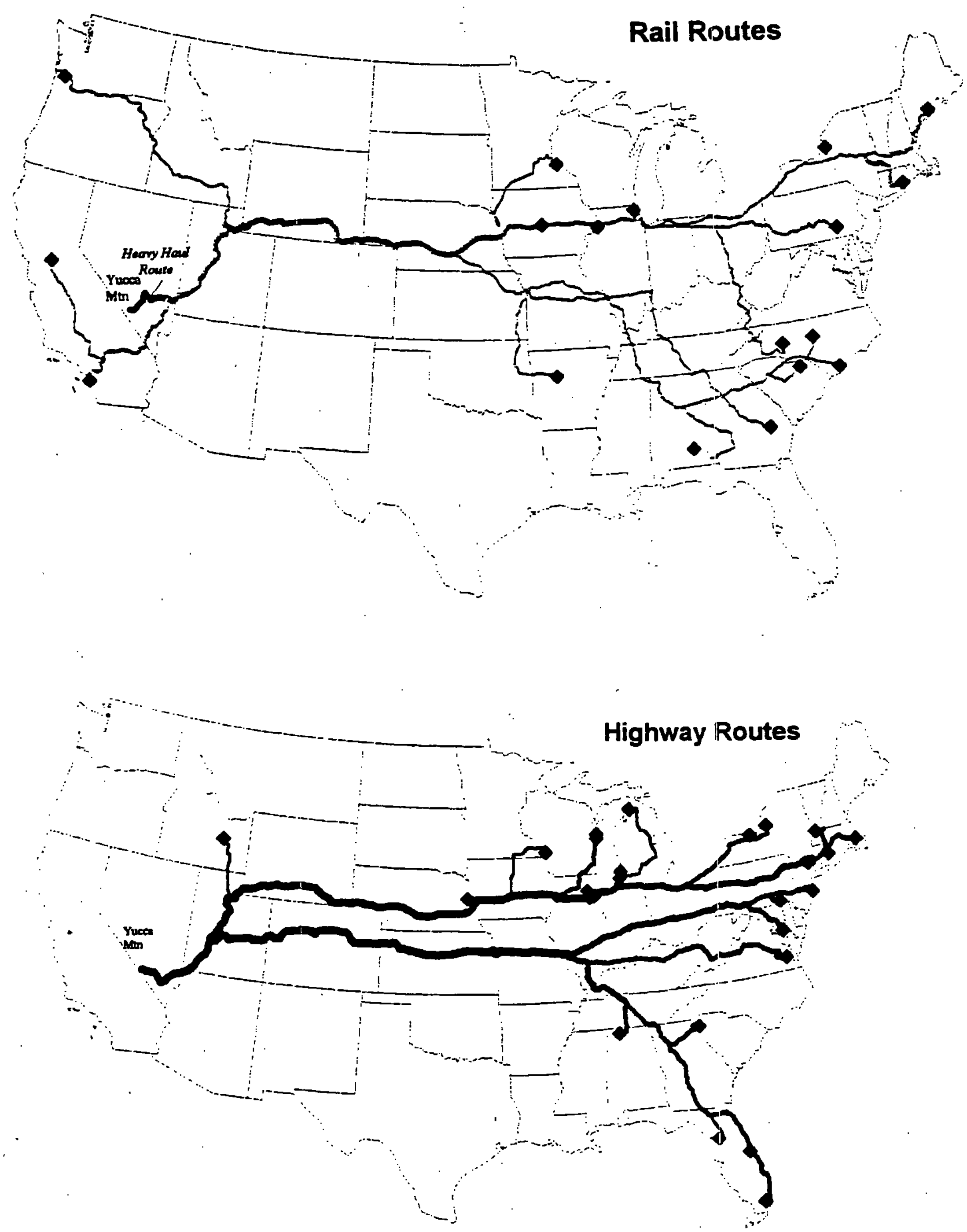
Rail Shipments

Origin	Casks
AL: Farley	3
AR: Arkansas Nuclear	6
CA: Rancho Seco	7
CA: San Onofre	2
CT: Millstone	22
GA: Hatch	1
IA: Duane Arnold	6
IL: Quad Cities	27
IL: Zion	17
ME: Maine Yankee	10
MN: Prairie Island	6
NC: Brunswick	17
NC: Harris	6
NC: McGuire	16
NY: Nine Mile Point	8
OR: Trojan	1
PA: Three Mile Island	15
SC: Robinson	1
TOTAL	171

Truck Shipments

Origin	Casks
AL: Browns Ferry	165
CT: Haddam Neck	100
FL: Crystal River	2
FL: St. Lucie	52
FL: Turkey Point	151
ID: INEL	31
IL: Braidwood	23
IL: Dresden	451
IL: Morris	68
MA: Pilgrim	214
MA: Yankee Rowe	76
MD: Calvert Cliffs	184
MI: Big Rock Point	23
MI: Cook	64
MI: Palisades	68
NE: Ft. Calhoun	96
NJ: Oyster Creek	148
NY: FitzPatrick	134
NY: Ginna	122
NY: Indian Point	124
PA: Peach Bottom	342
SC: Oconee	215
VA: Surry	165
VT: Vermont Yankee	109
WI: Kewaunee	41
WI: LaCrosse	16
WI: Point Beach	125
TOTAL	3,309

Figure 19-3. Year 3 Cask Shipments by Route and Origin Current Capabilities Transportation Choices/Default Routing



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Year 20 Routes and Cask Shipments

After several years, it is possible that the utilities and RSAs (or DOE) would implement changes in containers and transportation infrastructure to improve the efficiency and cost-effectiveness of shipments. Figures 19-4 and 19-5 compare the current capabilities (CCP) and the maximum rail (MXR) scenarios in year 20 of the transportation program postulated in this analysis. Under the CCP scenario, rail shipments would be made from 37 sites and truck shipments from 27 sites; under the MXR scenario, 62 of 64 sites would be rail-capable. Modes are indicated as T1 and T2 for legal weight one- or two-assembly containers, or R75 and R125 for the small and large rail containers.

Origin	CCP Scenario Mode	CCP Scenario Casks	MXR Scenario Mode	MXR Scenario Casks
AL: Browns Ferry	T2	112	R125	6
AL: Farley	R125	6	R125	6
AR: Arkansas Nuc.	R75	11	R125	7
AZ: Palo Verde	R125	10	R125	10
CA: Diablo Canyon	T1	213	R125	11
CA: San Onofre	R125	5	R125	5
CT: Haddam Neck	T1	41	R75	4
FL: Crystal River	T1	66	R75	6
FL: St. Lucie	T1	139	R125	8
FL: Turkey Point	T1	88	R125	5
GA: Hatch	R125	10	R125	10
GA: Vogtle	R75	14	R75	14
IA: Duane Arnold	R75	6	R125	3
IL: Braidwood	R75	15	R125	9
IL: Byron	R75	20	R125	12
IL: Dresden	T2	439	R75	43
IL: La Salle	R75	19	R125	10
IL: Quad Cities	R75	15	R75	15
IL: Zion	R75	6	R125	4
KS: Wolf Creek	R125	4	R125	4
LA: River Bend	R125	5	R125	5
LA: Waterford	R125	5	R125	5
MA: Pilgrim	T2	74	R75	8
MD: Calvert Cliffs	T1	81	R125	4
ME: Maine Yankee	R125	3	R125	3
MI: Cook	T1	148	R125	8
MI: Fermi	T2	97	R125	5
MI: Palisades	T1	56	R125	3
MN: Monticello	T2	68	R75	7
MN: Prairie Island	R125	3	R125	3
MS: Grand Gulf	T2	140	R125	7
NC: Brunswick	R125	15	R125	15
NC: Harris	R75	4	R125	3
NC: McGuire	R75	20	R125	7
NE: Ft. Calhoun	T1	43	R75	4
NH: Seabrook	R125	4	R125	4
NJ: Hope Creek	T2	15	R125	7
NJ: Oyster Creek	T2	89	R125	5
NJ: Salem	T1	137	R125	8
NY: FitzPatrick	T2	100	R125	5
NY: Ginna	T1	38	T4	10
NY: Indian Point	T1	139	T4	18
OH: Davis-Besse	R125	3	R125	3
OH: Perry	R125	7	R125	7
PA: Beaver Valley	R75	11	R125	7
PA: Peach Bottom	T2	119	R125	6
PA: Susquehanna	R125	13	R125	13
PA: Three Mile Isld	R75	6	R125	4
SC: Catawba	R125	9	R125	9
SC: Oconee	T1	223	R125	12
SC: Robinson	R75	4	R75	4
SC: Savannah River	R	18	R	18
SC: Summer	R125	4	R125	4
TN: Sequoyah	R75	7	R125	5
TN: Watts Bar	R125	6	R125	6
TX: Comanche Peak	R125	13	R125	13
TX: South Texas	R125	7	R125	7
VA: North Anna	R75	6	R125	3
VA: Surry	T1	107	R125	6
VT: Vermont Yankee	T2	64	R75	7
WA: Hanford	R	143	R	143
WA: WNP	R125	4	R125	4
WI: Kewaunee	T1	37	R125	2
WI: Point Beach	T1	52	R125	4
TOTALS				
Truck		2,925		28
Rail		461		595

Figure 19-4. Year 20 Cask Shipments by Route and Origin
Current Capabilities Transportation Choices/Default Routing

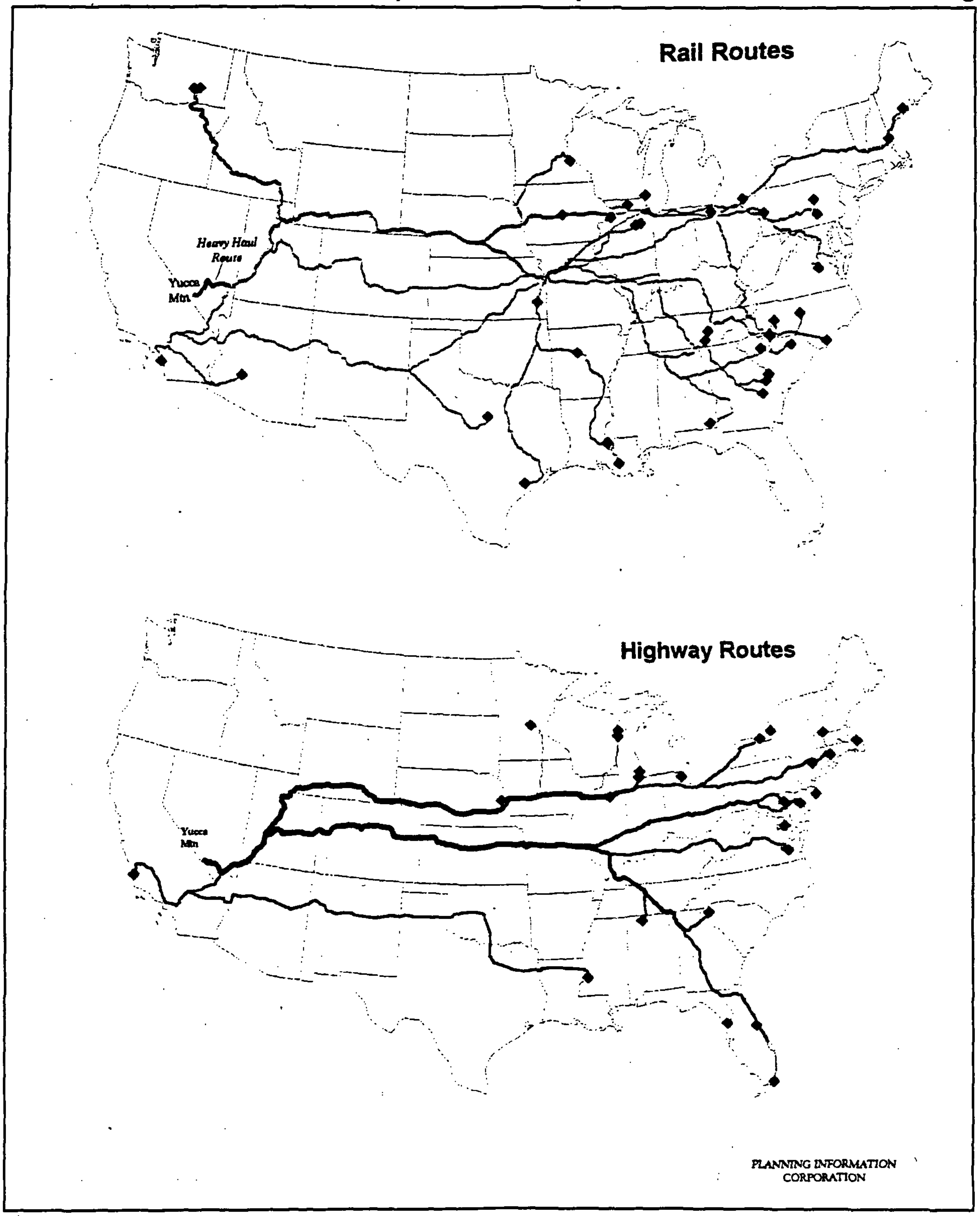
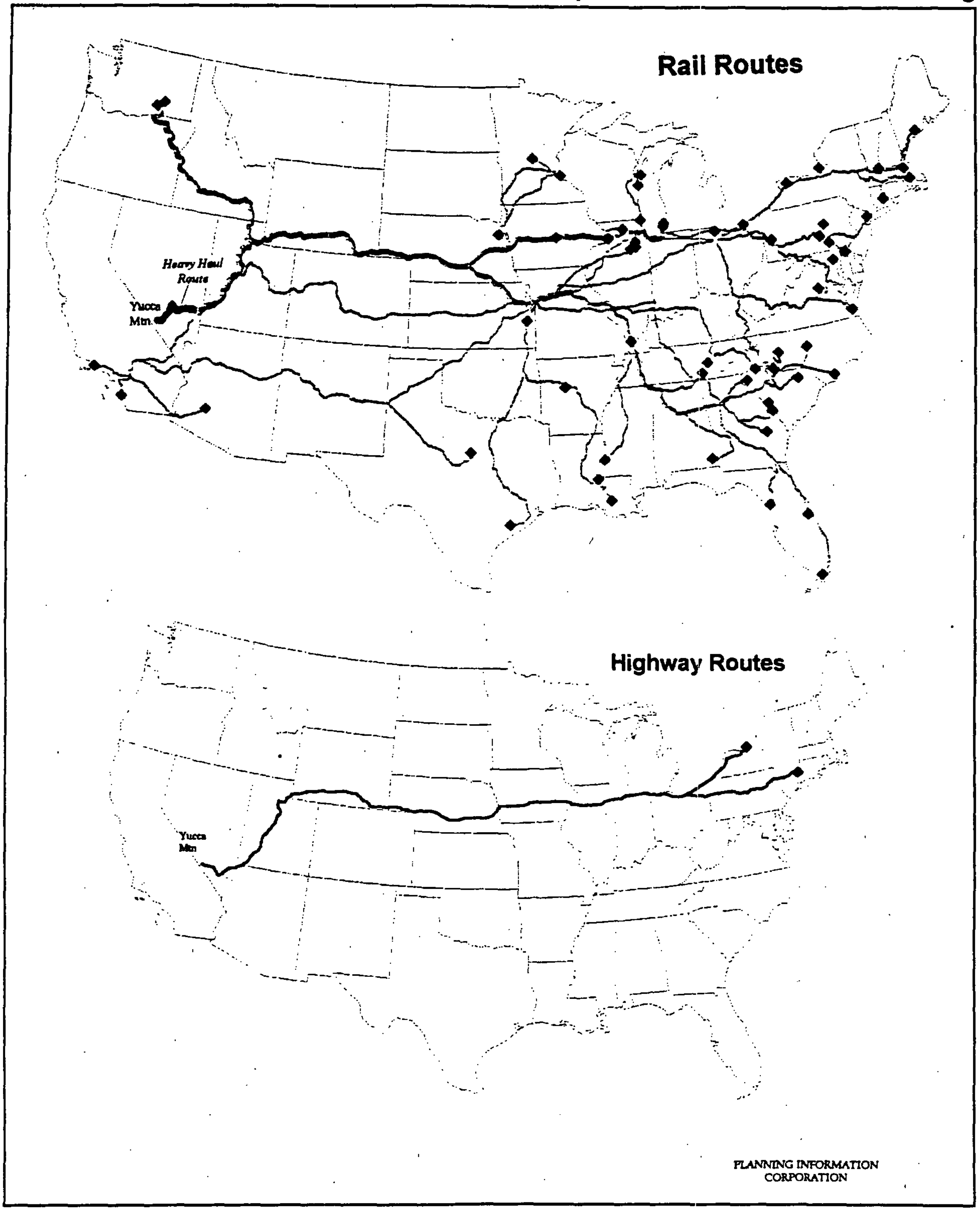


Figure 19-5. Year 20 Cask Shipments by Route and Origin
Maximum Rail Transportation Choices/Default Routing



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20. TRANSPORTATION OPERATIONS REQUIREMENTS

Planning and managing a national shipment campaign requires reliable information on total metric tons shipped, total cask shipments, affected rail and highway route mileage, and total cask shipment miles. These variables yield useful indexes for comparing scenarios for the national shipment campaign: e.g., cask shipments per MTU shipped, cask shipments per affected route mile. Presented on an overall basis in this section, these measures may in other contexts be reviewed on a year-by-year or sub-region basis.

MTU Shipped

Given the inventory assumptions discussed in Section 2 above, about 86,600 MTU of SNF would be shipped to a centralized storage facility in Nevada. Given the acceptance rate assumptions discussed in Section 3, about 4,440 MTU would be shipped in the first three acceptance years. Given current capabilities transportation choices discussed in Section 11, about 36 percent of total MTU would be shipped via public highways, about 66 percent in the first three acceptance years. (This assumes, of course, that the centralized storage facility would be capable of receiving legal-weight truck shipments and reloading its bare fuel into storage canisters and casks.) Given the MPC base case scenario of transportation choices, about 11 percent of total MTU would be shipped by public highways, about 27 percent in the first three acceptance years. (This assumes the implementation of policies required to persuade utilities and/or regional servicing agents to upgrade loading facilities and near-site infrastructure.)

Cask Shipments

Given the cask options discussed in Section 6 and the "current capabilities" transportation choices discussed in section 11, about 92,000 cask shipments would be made over the 30-year shipment campaign, of which 86 percent would be on public highways by legal-weight truck. If the high-capacity GA-4/9 legal-weight truck were available and used throughout the shipment campaign, total cask shipments would be reduced to about 31,400, including about 71 percent by legal-weight truck.

During the first three acceptance years, about 8,200 casks shipments should be expected under the current capabilities scenario, almost all (96 percent) by legal-weight truck. Again, the high-capacity GA-4/9 cask, if available and used during the initial years, would reduce cask shipments substantially, from 8,200 to about 2,200. Even so, about 85 percent of the casks shipments would be by legal-weight truck on public highways. The MPC base case scenario of transportation choices, if implemented, would reduce total cask shipments from 92,000 to about 40,000 and the portion involving legal-weight truck shipments on public highways would be reduced from 86 percent to 65 percent. If, in addition, the high-capacity GA-4/9 cask were available and used, total casks shipments could be further reduced to 20,200, and the LWT portion of total cask shipment could be reduced to 31 percent.

Route Miles Affected

Given the transportation choices discussed in Section 11, and the default routing criteria discussed in Section 14, about 18,800 miles of railroad* and about 13,700 miles of public highways would receive shipments of SNF and/or HLW during the national shipment campaign. The MPC base case scenario of transportation choices increases the mileage of railroads impacted, from 18,800 to 21,200, and reduces the mileage of public highways impacted—from 13,700 to about 10,200. Total route mileage, however, is similar in the two cases—about 32,500 rail and highway route miles in the current capabilities scenario versus about 31,400 route miles in the MPC base case.

Route mileage impacted is the basic measure by which DOE proposes to allocate the variable amounts to be distributed to states for training local emergency responders and/or rail and highway inspectors.[25] In addition to a base amount provided to any affected state for planning and coordination, the variable amount would be allocated to response areas of an 80-mile radius, with no double counting of rail or highway routes within a response area (pg. 14). Wyoming, for example, with over 400 I-80 route miles and another 400 miles of UP railroad impacted under default routing, might receive variable funds for 2½ response areas. Nevada, where cask shipments could impact I-15, US-95, and the UP railroad, might receive variable funds for two response areas. The route mileage measure does not reflect the number of casks shipments along particular segments, or the amount of radioactive material in those shipments.

Cask Shipment Miles

Cask shipment miles, the product of cask shipments and distance from each origin site, is a measure which adjusts route mileage for the number of cask shipments expected along each segment. Given the cask options discussed in Section 6 and the current capabilities scenario of transportation choices discussed in Section 11, the national campaign would involve about 76 million cask shipment miles, 5 million in the first three acceptance years. Of these, 82 percent would be legal-weight truck shipments on public highways, 95 percent in the first three acceptance years.

The high-capacity GA-4/9 cask, if available and used, would substantially reduce total cask shipment miles, from 76 to 29 million, and from 5.1 million to 1.4 million over the first three acceptance years. The legal-weight truck portion of total cask shipment miles would be reduced (from 82 to 51 percent, from 95 to 82 percent in the first three acceptance years), but would still comprise a substantial majority of total cask shipment miles.

The MPC base case scenario of transportation choices, if implemented, would further reduce cask shipment miles, from 29 to 21 million and from 1.4 million to 1.0 million over the first three acceptance years. In the process, the legal-weight truck portion of total cask shipment miles would be reduced from 51 percent to about 27 percent, and from 82 percent to 66 percent in the first three acceptance years.

Identified by route segment, information on cask shipment miles would assist state and local officials to estimate route-specific accident and incident rates, allocate shipment monitoring and escorting efforts, estimate radiation exposure for corridor populations, etc.

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* Excluding the 162-mile heavy-haul route from Caliente to Yucca Mountain.

Cask Shipment Miles Per MTU Shipped

Cask shipment miles per MTU shipped is a measure of the amount of radioactive material in shipments expected along particular routes, or along all affected routes. It is one measure of the efficiency of the overall shipment campaign, or of its effects in particular corridor segments.

Given the current capabilities scenario of transportation choices, the average cask shipment mileage per MTU shipped is about 2,400 miles, about 4,300 over the first three acceptance years. On average, each MTU shipped by legal-weight truck requires 5,900 cask shipment miles, compared with about 430 cask shipment miles when shipped by rail.

The high-capacity GA-4/9 cask, if available and used, would substantially reduce cask shipment miles per MTU shipped, from 2,400 to about 820. The reduction reflects the reduction in cask shipment miles required to ship an MTU on public highways by legal-weight truck.

The MPC base case scenario of transportation choices, if implemented, would also effect a substantial reduction in cask shipment miles per MTU shipped. This reduction reflects the mix of rail and truck shipment in the MPC base case scenario. Cask shipment miles per MTU shipped by legal-weight truck is actually higher in the MPC base case than in the current capabilities scenario. Sites which are more difficult to upgrade for rail shipment are among those most distant from the Yucca Mountain destination.

Cask Shipments Per Route Mile Affected

How many cask shipments are expected over each route mile affected by the national shipment campaign? How many cask shipments are expected over particular route segments?

Given the current capabilities scenario of transportation choices (Section 11) and default routing criteria (Section 13) each affected rail route mile should expect about 1,500 rail cask shipments over the 30-year shipment campaign, and each affected highway route mile should expect about 13,400 LWT cask shipments.

The high-capacity GA-4/9 legal-weight truck cask, if available and used, would reduce cask shipments along each affected highway route mile from 13,400 to about 3,200.

The MPC base case scenario of transportation choices would reduce cask shipments along each affected highway route mile from about 13,400 to about 6,500, and shipments along each affected rail route mile (more rail route mileage is affected in the MPC base case) from 1,500 to about 1,460 rail casks.

Table 20-1. MTU Shipped, Cask Shipments, Route Miles Affected Cask Shipment Miles Life of Operations and Shipment Years 1 through 3 . . . Default Routing

	LIFE OF OPERATIONS (YR 1-31)......					SHIPMENT YEARS 1-3......				
	RAIL	HWY:T1/2	TOT:T1/2	HWY:T4/9	TOT:T4/9	RAIL	HWY:T1/2	TOT:T1/2	HWY:T4/9	TOT:T4/9
MTU SHIPPED:										
Current Capabilities	55593	31045	86638	31045	86638	1495	2944	4439	2944	4439
MPC Base Case	76844	9855	86699	9855	86699	3240	1200	4440	1200	4440
Maximum Rail	84704	1995	86699	1995	86699	4185	255	4440	255	4440
CASK SHIPMENTS:										
Current Capabilities	12636	79345	91981	31370	44006	327	7856	8183	1855	2182
MPC Base Case	13916	26093	40009	6322	20238	574	3352	3926	791	1365
Maximum Rail	16792	4722	21514	1150	17942	781	692	1473	181	962
ROUTE MILES AFFECTED:										
Current Capabilities	18805	13695	32500	13695	32500	18805	13695	32500	13695	32500
MPC Base Case	21210	10224	31434	10224	31434	21210	10224	31434	10224	31434
Maximum Rail	23507	4178	27685	4178	27685	23507	4178	27685	4178	27685
CASK SHIPMENT MILES:MIL										
Current Capabilities	14.0	62.3	76.3	14.7	28.7	0.8	18.2	19.1	4.3	5.1
MPC Base Case	15.3	24.1	39.4	5.7	21.0	1.4	8.2	9.6	1.9	3.3
Maximum Rail	16.8	4.0	20.8	1.0	17.8	1.9	1.7	3.6	0.4	2.4
CASK SHIP MI PER MTU:										
Current Capabilities	425	5892	2384	1391	823	2491	2322	2328	2322	2347
MPC Base Case	345	6749	1073	1593	539	2442	2458	2455	2458	2451
Maximum Rail	362	5790	487	1472	439	2471	2476	2473	2416	2461
CASK SHIP PER RT-MILE:										
Current Capabilities	1496	13356	6493	3154	2194	43	1332	586	314	158
MPC Base Case	1463	6505	3103	1536	1487	75	438	513	103	178
Maximum Rail	1494	2764	1686	703	1375	103	91	194	23	126

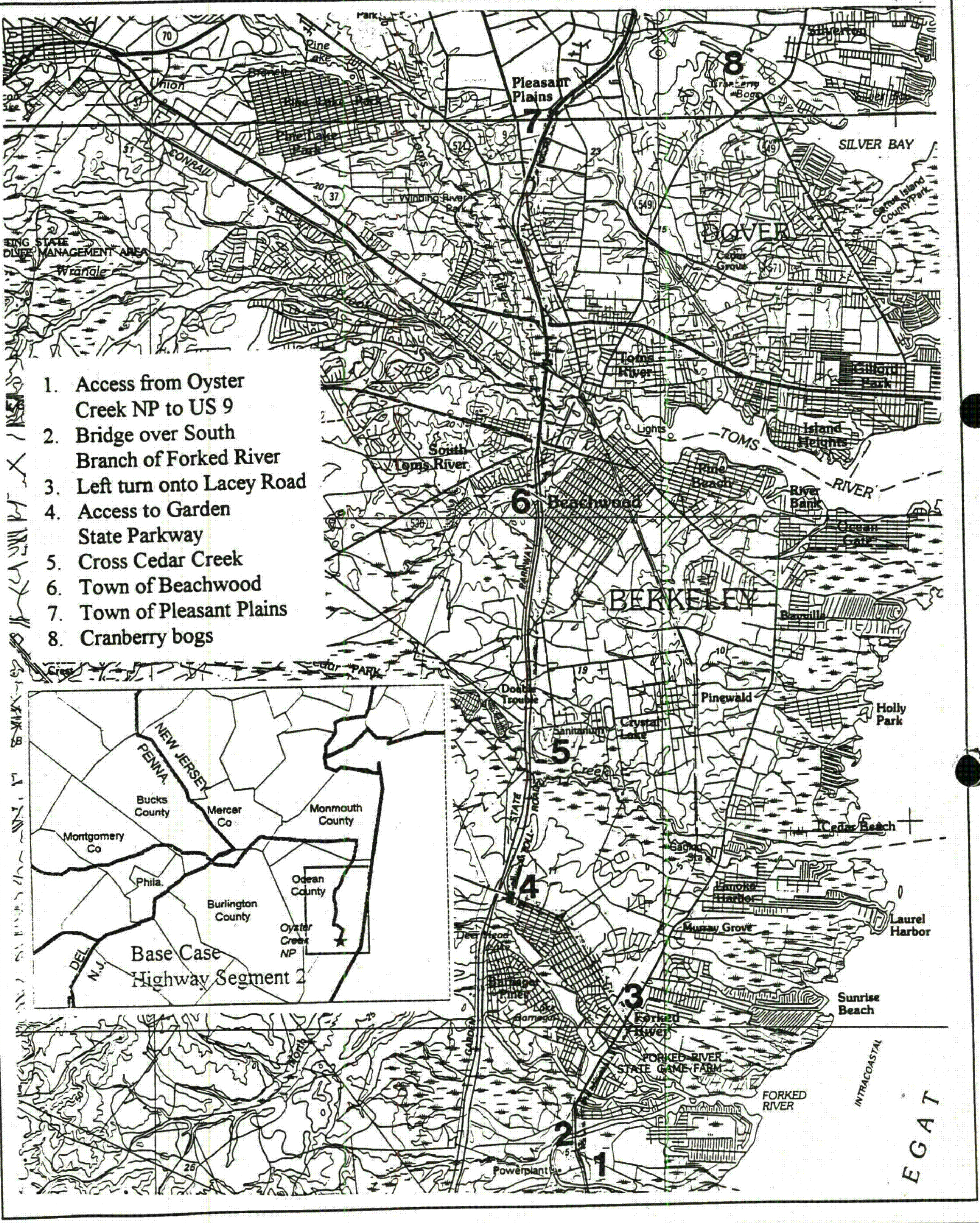
21. ROUTE FEATURES

The routing and cask shipment results presented in Sections 16 through 20 are in a sense only the first part of the information base required in planning and managing a national campaign for shipment of spent fuel and high-level waste. The second part is information regarding key features on or along the routes identified. The "key features" may include:

- Features of the route itself—e.g., bridges, intersections, grades, road geometry.
- Route conditions—e.g., pavement and bridge conditions, average daily and peak traffic flows, traffic service levels, accident rates.
- Route segments particularly affected by seasonal traffic, special event traffic, scheduled construction projects, or seasonal weather conditions.
- Facilities along routes which may require consideration in transportation options—e.g., schools, hospitals, sports stadiums, weighing stations, rest areas.
- Administrative boundaries—e.g., state, county, and city boundaries, state patrol and highway maintenance zones.
- Socioeconomic conditions—e.g., resident population, per capita income, workplace employment.
- Route-segment specific transportation management policies—e.g., state-designated routes, rush hour avoidance zones, designated rest or staging areas, safe havens.

Much of the relevant route-specific information must be assembled from various state and local sources. Other elements may be generated in process, as shippers coordinate with federal, state and local agencies in planning and managing a national shipment campaign. A geographically-referenced information base could help organize information on a complex and evolving array of topics and alternatives in origin and corridor communities, as well as provide a record of segment-specific policies and agreements among relevant stakeholders. The following figure[26] suggests how geographically-referenced information regarding route features might be developed, maintained and shared (in hard-copy or electronic form) among stakeholders in a national shipment campaign.

Figure 21-1. Oyster Creek Highway Route Features



APPENDIX A: TRANSPORTATION CHOICE SCENARIOS: DOE ASSUMPTIONS

While DOE has not estimated annual shipments by route segment, several DOE studies consider transportation choices on a site-by-site basis: a 1996 "preliminary transportation strategy study for a potential Nevada repository",[21] and a 1993 evaluation of the use of MPCs in DOE's high-level waste management system.[22] This appendix reviews the transportation choice assumptions in the two DOE studies, comparing them with those in the scenarios developed for this report.

Transportation Strategy Study 2

This study,[21] prepared as a basis for evaluating transportation options to a potential repository in Nevada, includes in Table F3 an estimate of the number of casks and MTU shipped from each commercial site and the four defense sites over the life of the program. The estimates are not annualized or keyed to proposed acceptance schedules or prioritization policies. Also, while the number of cask shipments is presented, the type of casks shipped is not.

To provide a basis for comparison, we have estimated the types of casks implied by Table F3 of DOE's Transportation Strategy Study 2 (see Table A-2): Data on the number of assemblies and MTU at each reactor was assembled (Ref #13, Table B6), aggregated for shipment sites, and used to calculate the average MTU per assembly at each site. The number of assemblies implied by the MTU in Table F3 was estimated by dividing MTU by the average MTU per assembly. The implied assemblies per cask was estimated by dividing assemblies by the number of casks identified in Table F3. The type of casks implied by Table F3 was identified by comparing estimated assemblies per cask with the capacity (in PWR or BWR assemblies) of small and large MPCs.

DOE's Transportation Strategy Study 2 implies that 11 sites which ship by truck in Nevada's MPC Base Case would instead ship by rail: Sites in columns 1 and 2 below would ship by small MPC, while those in column 3 would ship by large MPC.

Big Rock	LaCrosse	Palisades
Crystal River	Pilgrim	Peachbottom
Fort Calhoun	Vermont Yankee	St. Lucie
Humboldt Bay	Yankee Rowe	

Also, DOE's Transportation Strategy 2 implies that Three Mile Island would ship by large MPC, rather than by small MPC, as assumed in Nevada's MPC base case.

The transportation choices implied by DOE's study are, with the exception of a single site (Haddam Neck, assumed to ship by truck in the DOE study), identical to the "maximum rail scenario" discussed in Section 11 above, and could be implemented only through a set of incentives such as those discussed in the maximum rail scenario. Compared to Nevada's MPC base case, the transportation choices implied by DOE's study would significantly reduce highway impacts and total cask shipments, in the process increasing reliance on rail shipment. However, the necessary investments to improve cask

loading capabilities and near-site infrastructure could be greater than those required under the MPC base case scenario of transportation choices, and substantially greater than under the current capabilities scenario.

Evaluation of Using MPCs

This study,[22] prepared as part of DOE's MPC initiative, includes in Appendix D a set of shipment projections "based on the assumption that individual utilities will request the largest cask they can effectively handle" (page D-1). The study did not include shipments of HLW or spent fuel from defense sites. Nor did it explain the basis for its judgement that 83 storage locations could effectively handle a large MPC, while 19 could effectively handle a small MPC, and only 14 require canistered truck shipments. Perhaps it refers to locations that, with incentives, could be upgraded to effectively handle the cask types specified. The study did consider storage locations, reaching different judgements for storage locations at the same site (e.g., Millstone 1 versus Millstone 2 and 3, San Onofre 1 versus San Onofre 2 and 3, St. Lucie 1 versus St. Lucie 2).

The MPC evaluation assumes ten storage locations would ship by truck (or require special handling: heavy-haul, cask-to-cask transfer, barge) which the transportation strategy study assumes will be shipped by rail:

Big Rock	Humboldt Bay	Callaway
Dresden 1	LaCrosse	Oconee
Fort Calhoun	Yankee Rowe	Point Beach
		San Onofre 1

The transportation strategy study assumes that the locations in columns 1 and 2 above would ship by small MPC, while those in column 3 would ship by large MPC.

The 1993 MPC evaluation and the 1996 transportation strategy study reach differing rail cask conclusions at thirteen sites:

Arkansas Nuclear	Rancho Seco	Brunswick
Duane Arnold	Salem	Dresden 2 and 3
Oyster Creek	Three Mile Island 1	Quad Cities
Palisades	Turkey Point	Robinson
		Vogtle

The transportation strategy study assumes that the locations in columns 1 and 2 would ship by large rail; the MPC evaluation assumes these locations would ship by small rail. The transportation strategy study assumes that the locations in column 3 would ship by small rail; the MPC evaluation assumes these locations would ship by large rail.

Table A-1. Utility Transportation Choice Scenarios: by Storage Location

	FUEL STRG LOCATION:	TRANSP CHOICE: TS2	APD
1	ARKANSAS NUCLEAR 1	R125	R75
2	ARKANSAS NUCLEAR 2	R125	R75
3	ARKANSAS NUCLEAR DRY STRG	R125	R75
4	BEAVER VALLEY 1	R125	R125
5	BEAVER VALLEY 2	R125	R125
6	BELLEFONTE 1	R125	R125
7	BELLEFONTE 2	R125	R125
8	BIG ROCK 1	R75	LWT
9	BRAIDWOOD 1	R125	R125
10	BROWNS FERRY 1-2	R125	R125
11	BROWNS FERRY 3	R125	R125
12	BRUNSWICK 1	R75	R125
13	BRUNSWICK 1 PWR POOL	R75	R125
14	BRUNSWICK 2	R75	R125
15	BRUNSWICK 2 PWR POOL	R75	R125
16	BYRON 1	R125	R125
17	CALLAWAY 1	R125	LWT
18	CALVERT CLIFFS 1-2	R125	R125
19	CALVERT DRY STORAGE	R125	R125
20	CATAWBA 1	R125	R125
21	CATAWBA 2	R125	R125
22	CLINTON 1	R125	R125
23	COMANCHE PEAK 1	R125	R125
24	COOK 1	R125	R125
25	COOPER STATION	R75	R75
26	CRYSTAL RIVER 3	R75	R75
27	DAVIS-BESSE 1	R125	R125
28	DAVIS-BESSE DRY STRG	R125	R125
29	DIABLO CANYON 1	R125	R125
30	DIABLO CANYON 2	R125	R125
31	DRESDEN 1	R75	LWT
32	DRESDEN 2	R75	R125
33	DRESDEN 3	R75	R125
34	DUANE ARNOLD	R125	R75
35	ENRICO FERMI 2	R125	R125
36	FARLEY 1	R125	R125
37	FARLEY 2	R125	R125
38	FITZPATRICK	R125	R125
39	FORT CALHOUN	R75	LWT
40	FORT ST VRAIN	LWT	LWT
41	FORT ST VRAIN DRY STRG	LWT	LWT
42	GINNA	LWT	LWT
43	GRAND GULF 1	R125	R125
44	HADDAM NECK	LWT	LWT
45	HARRIS 1	R125	R125
46	HARRIS 1 BWR POOL	R125	R125
47	HATCH 1-2	R125	R125
48	HOPE CREEK	R125	R125
49	HUMBOLDT BAY	R75	LWT
50	INDIAN POINT 1	LWT	LWT
51	INDIAN POINT 2	LWT	LWT
52	INDIAN POINT 3	LWT	LWT
53	KEWAUNEE	R125	R125
54	LACROSSE	R75	T
55	LASALLE 1-2	R125	R125
56	LIMERICK 1-2	R125	R125
57	MAINE YANKEE	R125	R125
58	MCGUIRE 1	R125	R125
59	MCGUIRE 2	R125	R125
60	MILLSTONE 1	R75	R75
61	MILLSTONE 2	R75	R75
62	MILLSTONE 3	R75	R125
63	MONTICELLO	R75	R75
64	NINE MILE POINT 1	R125	R125
65	NINE MILE POINT 2	R125	R125
66	NORTH ANNA 1&2	R125	R125
67	NORTH ANNA DRY STRG	R125	R125
68	OCONEE 1&2	R125	LWT
69	OCONEE 3	R125	LWT
70	OCONEE DRY STORAGE	R125	LWT
71	OYSTER CREEK 1	R125	R75
72	OYSTER CREEK DRY STRG	R125	R75
73	PALISADES	R125	R75
74	PALISADES DRY STORAGE	R125	R75
75	PALO VERDE 1	R125	R125
76	PALO VERDE 2	R125	R125
77	PALO VERDE 3	R125	LWT
78	PEACHBOTTOM 2	R125	LWT
79	PEACHBOTTOM 3	R125	LWT
80	PERRY 1	R125	R125
81	PILGRIM 1	R75	R75
82	POINT BEACH 1&2	R125	R125
83	POINT BEACH DRY STRG	R125	R125
84	PRAIRIE ISLAND 1&2	R125	R125
85	PRAIRIE ISLAND DRY STRG	R125	R125
86	QUAD CITIES 1	R75	R125
87	RANCHO SECO 1	R125	R75
88	RANCHO SECO DRY STRG	R125	R75
89	RIVER BEND 1	R125	R125
90	ROBINSON 2	R75	R125
91	ROBINSON DRY STORAGE	R75	R125
92	SALEM 1	R125	R75
93	SALEM 2	R125	R75
94	SAN ONOFRE 1	R125	LWT
95	SAN ONOFRE 2	R125	R125
96	SAN ONOFRE 3	R125	R125
97	SEABROOK 1	R125	R125
98	SEQUOYAH 1	R125	R125
99	SHOREHAM	NA	NA
100	SOUTH TEXAS 1	R125	R125
101	SOUTH TEXAS 2	R125	R125
102	ST LUCIE 1	R125	R125
103	ST LUCIE 2	R125	R125
104	SUMMER 1	R125	R125
105	SURRY 1&2	R125	R125
106	SURRY DRY STORAGE	R125	R125
107	SUSQUEHANNA 1-2	R125	R125
108	SUSQUEHANNA DRY STRG	R125	R125
109	THREE MILE ISLAND 1	R125	R75
110	TROJAN	R125	R125
111	TURKEY POINT 3	R125	R75
112	TURKEY POINT 4	R125	R75
113	VERMONT YANKEE 1	R75	R75
114	VOGTLE 1-2	R75	R125
115	WASH NUCLEAR 2	R125	R125
116	WATTS BAR 1&2	R125	R125
117	WATERFORD 3	R125	R125
118	WOLF CREEK 1	R125	R125
119	YANKEE-ROWE 1	R75	LWT
120	ZION 1&2	R125	R125
121	HANFORD SNF STRG	LWT	LWT
122	HANFORD SNF STRG	LWT	LWT
123	INEL SNF STRG	LWT	LWT
124	INEL SNF STRG	LWT	LWT
125	INEL SNF STRG	LWT	LWT
126	SAVANNAH RV SNF STRG	LWT	LWT
127	SAVANNAH RV SNF STRG	LWT	LWT
128	WEST VALLEY SNF STRG	R125	LWT
129	WEST VALLEY SNF STRG	R125	LWT
130	MORRIS	R125	R125
131	MORRIS	R125	R125
132	GENERAL ATOMICS	LWT	LWT

Shipment Cask Options:
R125: Large MPC for up to 21 PWR or 40 BWR
R75: Small MPC for up to 12 PWR or 24 BWR
LWT: Legal-weight truck casks.... GA-4/9 if a NLI-1/2 or NAC LWT otherwise

Transp Choice: TR2: NV Transp Strategy, Study 2 (DOE: Feb'96, Tbl F-3), PIC
APD: MPC Prelim Evaluation (DOE: Mar 1993, Appendix D)

Table A-2. Cask Types Implied by DOE's Transportation Strategy Study 2

SITE#	NUCLEAR REACTOR SITES:	DOE TR2:TBL F3 CASKS	DOE TR2:TBL F3 MTU	PIC EVALUATION: REAC TYPE	PIC EVALUATION: MTU/A	PIC EVALUATION: A/CASK	PIC EVALUATION: EST C-TYPE
1	ARKANSAS NUCLEAR 1,2	128	1151	PWR	0.44	20	R125
2	BEAVER VALLEY 1,2	106	1015	PWR	0.46	21	R125
3	BELLEFONTE 1,2	0	0	PWR	NA	NA	???
4	BIG ROCK	40	63	BWR	0.13	12	R75
5	BRAIDWOOD 1,2	119	1049	PWR	0.42	21	R125
6	BROWNS FERRY 1,2,3	210	1537	BWR	0.19	39	R125
7	BRUNSWICK 1,2	207	915	BWR	0.18	24	R75
8	BYRON 1,2	130	1147	PWR	0.42	21	R125
9	CALLAWAY 1	75	640	PWR	0.44	19	R125
10	CALVERT CLIFFS 1,2	145	1143	PWR	0.38	21	R125
11	CATAWBA 1,2	128	1193	PWR	0.43	22	R125
12	CLINTON 1	65	453	BWR	0.18	38	R125
13	COMANCHE PEAK 1,2	105	918	PWR	0.45	19	R125
14	COOK 1,2	146	1350	PWR	0.44	21	R125
15	COOPER STATION	106	458	BWR	0.19	23	R75
16	CRYSTAL RIVER 3	89	491	PWR	0.46	12	R75
17	DAVIS-BESSE 1	58	509	PWR	0.47	19	R125
18	DIABLO CANYON 1,2	133	1191	PWR	0.45	20	R125
19	DRESDEN 1,2,3	355	1424	BWR	0.17	23	R75
20	DUANE ARNOLD	64	457	BWR	0.18	39	R125
21	ENRICO FERMI 2	77	501	BWR	0.18	36	R125
22	FARLEY 1,2	123	1140	PWR	0.46	20	R125
23	FITZPATRICK	73	519	BWR	0.18	39	R125
34	FORT CALHOUN	89	381	PWR	0.36	12	R75
25	FORT ST VRAIN	???	???	HTG	0.01	NA	LWT
26	GINNA	???	???	PWR	0.38	NA	LWT
27	GRAND GULF 1	121	852	BWR	0.18	39	R125
28	HADDAM NECK	???	???	PWR	0.41	NA	LWT
29	HARRIS 1	69	598	PWR	0.45	19	R125
29	HARRIS 1 BWR POOL	???	???	BWR	0.19	NA	R125
30	HATCH 1,2	184	1332	BWR	0.18	39	R125
31	HOPE CREEK	101	717	BWR	0.19	38	R125
32	HUMBOLDT BAY	17	29	BWR	0.07	23	R75
33	INDIAN POINT 1,2,3	???	???	PWR	0.43	NA	LWT
34	KEWAUNEE	59	466	PWR	0.39	21	R125
35	LACROSSE	14	38	BWR	0.11	24	R75
36	LASALLE 1,2	176	1262	BWR	0.18	39	R125
37	LIMERICK 1,2	165	1129	BWR	0.18	37	R125
38	MAINE YANKEE	91	717	PWR	0.38	21	R125
39	MCGUIRE 1,2	151	1419	PWR	0.44	22	R125
40	MILLSTONE 1,2,3	347	1734	BWR	0.26	19	R75
41	MONTICELLO	95	394	BWR	0.18	23	R75
42	NINE MILE POINT 1,2	148	1030	BWR	0.19	38	R125
43	NORTH ANNA 1,2	131	1149	PWR	0.46	19	R125
44	OCONEE 1,2,3	204	1897	PWR	0.46	20	R125
45	OYSTER CREEK 1	92	651	BWR	0.18	39	R125
46	PALISADES	69	575	PWR	0.40	21	R125
47	PALO VERDE 1,2,3	204	1687	PWR	0.41	20	R125
48	PEACHBOTTOM 2,3	225	1602	BWR	0.18	38	R125
49	PERRY 1	86	605	BWR	0.18	38	R125
50	PILGRIM 1	117	506	BWR	0.19	23	R75
51	POINT BEACH 1,2	107	837	PWR	0.39	20	R125
52	PRAIRIE ISLAND 1,2	106	807	PWR	0.38	20	R125
53	QUAD CITIES 1,2	314	1347	BWR	0.18	23	R75
54	RANCHO SECO 1	24	228	PWR	0.46	21	R125
55	RIVER BEND 1	69	488	BWR	0.18	38	R12[illegible]
56	ROBINSON 2	70	345	PWR	0.44	11	R75
57	SALEM 1,2	123	1136	PWR	0.46	20	R125
58	SAN ONOFRE 1,2,3	175	1469	PWR	0.40	21	R125
59	SEABROOK 1	47	439	PWR	0.46	20	R125
60	SEQUOYAH 1,2	103	979	PWR	0.46	21	R125
61	SHOREHAM	0	0	BWR	NA	NA	NA
62	SOUTH TEXAS 1,2	76	808	PWR	0.54	20	R125
63	ST. LUCIE 1,2	147	1151	PWR	0.38	21	R125
64	SUMMER 1	59	525	PWR	0.45	20	R125
65	SURRY 1,2	120	1085	PWR	0.46	20	R125
66	SUSQUEHANNA 1,2	211	1470	BWR	0.18	39	R125
67	THREE MILE ISLAND 1	56	523	PWR	0.46	20	R125
68	TROJAN	38	359	PWR	0.46	21	R125
69	TURKEY POINT 3,4	107	1011	PWR	0.46	21	R125
70	VERMONT YANKEE 1	138	602	BWR	0.18	24	R75
71	VOGTLE 1,2	218	1024	PWR	0.46	10	R75
72	WASHINGTON NUCLEAR 2,3	81	555	BWR	0.18	38	R125
73	WATERFORD 3	75	597	PWR	0.41	19	R125
74	WATTS BAR 1,2	32	300	PWR	0.46	20	R125
75	WOLF CREEK 1	63	575	PWR	0.46	20	R125
76	YANKEE-ROWE 1	45	127	PWR	0.24	12	R75
77	ZION 1,2	144	1375	PWR	0.46	21	R1[illegible]
	Sub-Total	8385	60195		0.28	25	[illegible]

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