1997 Report to the Legislature

High-Level Radioactive Waste Activities
Conducted Under Minnesota Statutes 116C.712

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Acronyms

CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
LWR	Light Water Reactor
MPC	Multipurpose Canister
MRS	Monitored Retrievable Storage
MTU	Metric tons uranium
PFS	Private Fuel Storage, Inc.
NSP	Northern States Power Company
NRC	U.S. Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act
OCRWM	U.S. DOE Office of Civilian Radioactive Waste Management
WIPP	Waste Isolation Pilot Plant

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Executive Summary

Debate continues to be intense at the federal level over the nation's struggling nuclear waste management policy. Argued both in congress and in court, a fundamental dispute between the administration and the nuclear utility industry has focused on when the government will remove waste from commercial reactor sites, which increasingly are running out of storage room.

Current law provides arguments for both sides of the debate over spent fuel storage. On one hand, the Nuclear Waste Policy Act establishes a statutory timetable for DOE to begin taking spent fuel from nuclear power plants, to minimize long-term storage at reactor sites. But because the law forbids DOE from taking spent fuel until a permanent repository is approved for construction, long-term storage at reactor sites appears to be the current policy by default.

Congress has been asked to determine which of those conflicting principles should take precedence, or whether other steps should be taken to mitigate the problems created by delays in the federal nuclear waste program. Legislation has passed both houses of Congress which would require construction of an interim storage facility near the proposed Yucca Mountain, Nevada repository site. President Clinton has promised to veto the legislation, believing it imperative to first conclude that Yucca Mountain is an acceptable site.

A federal Appeals Court has been asked to force DOE to meet the January 1998 deadline for starting to take waste from the utilities. The court has made two rulings that the DOE does have a legally binding obligation to meet the deadline, but has failed to provide a remedy. The utilities are likely to pursue breach of contract suits against DOE to at least recover costs of extended storage at reactor sites.

Meanwhile, DOE studies of Yucca Mountain have continued amid perennial controversy. The DOE hopes to complete viability assessments and receive approvals in time to allow waste disposal in the repository to begin in 2010.

Though the fate of the legislation to build a federal interim storage facility is uncertain, a private initiative led by Northern States Power has reached agreement on a tribal reservation site in Utah, and is seeking certification by the Nuclear Regulatory Commission that would permit construction and allow movement of at-reactor stored wastes in 2002.

In anticipation that the federal government will accept and move wastes at some point, planning for transportation has increased, though a federal transportation system to move commercial spent fuel is still years from being implemented.

I. Minnesota's Nuclear Waste Monitoring Program

The state High-level Radioactive Waste program was developed to ensure that Minnesota is prepared to respond to federal high-level nuclear waste storage, transportation, and disposal policy issues. At the time the legislation was enacted, the U.S. Department of Energy (DOE) was looking at Minnesota as a potential host state for a geologic high-level waste repository. The statute specified that the State Planning Agency (now Office of Strategic and Long Range Planning) was responsible for monitoring federal activities, and that it also provides staff to the Minnesota Governor's Nuclear Waste Council.

In 1987, Congress acted to remove Minnesota from consideration as a host state for a permanent repository and selected Yucca Mountain, Nevada as the single candidate site. As provided in the Minnesota law, the state's Nuclear Waste Council terminated at that point.

Although Minnesota was no longer being formally considered as a repository host state, the Council's duty to monitor the federal high-level radioactive waste program was assigned to Minnesota Planning. As an administrative unit within Minnesota Planning, the Minnesota Environmental Quality Board provides staff and manages the high-level waste program. It is funded by an assessment on state nuclear utilities, and is used to pay for actual state-incurred expenses.

Currently, the only high-level radioactive waste produced in Minnesota is spent fuel from Northern States Power Company's dual Prairie Island reactors and single Monticello reactor. Since NSP is the only nuclear utility in the state, it has been responsible for all payments under this assessment. The utility assessment terminates when the Department of Energy begins construction of a high-level waste disposal site in another state.

Low-level radioactive waste is, by definition, any waste which is not high-level. Though low-level waste is produced at Minnesota's nuclear power plants, it is regulated and managed separately from spent fuel. It is not monitored by this program. The Minnesota Pollution Control Agency manages the state's low-level radioactive waste program.

This annual report has been provided to the legislature for the past nine years. Previous editions are available at the Minnesota Legislative Reference Library.

II. Federal High-Level Waste Program

Viewed in a broad federal policy perspective, no major changes of concern to Minnesota occurred in the reporting period. There continues to be much federal activity and intense debate on many fronts related to nuclear wastes, but agreement on substantive change in fundamental policy remains elusive. So its business as usual at the U.S. Department of Energy, the federal agency with lead responsibility for dealing with nuclear waste. The

DOE, with the President's support, has steadfastly tried to maintain momentum toward development of the Yucca Mountain national waste repository, while leaving electric utilities and the states to struggle with how to manage the buildup of spent fuel at reactors. However, the DOE has moved to prepare a programmatic infrastructure to anticipate the very real possibility that a major change could occur, specifically a new congressional directive to develop an interim storage facility or a court order to honor acceptance contracts. Design and modal planning for transportation of commercial spent fuel by the DOE is ramping up to prepare for these contingencies.

While the DOE has responsibilities for both nuclear defense wastes and commercial spent fuel, the focus of this report is on federal programs for the disposal of commercial spent fuel generated by the nation's nuclear utilities. However, it is important to recognize that the two responsibilities are interrelated technically, politically, and administratively. Thus while the generators of commercial spent fuel, i.e., the nuclear utility industry, may appear to be the central players in the nuclear waste debate, the nation's defense infrastructure and its attendant industry are also central players, and have significant influence on many aspects of nuclear waste policy. (DOE has much less spent fuel than civilian nuclear utilities, about 2,600 tons, stored in four locations: Hanford in Washington, Idaho National Engineering Laboratory, Savannah River in South Carolina, and West Valley Site in New York.)

Nuclear utilities, which pay for most of the high-level waste disposal program through a fee on nuclear power, have grown increasingly concerned about the program's slow progress. Although some of the delays have been blamed on poor program management, DOE contends that tight funding has been a major barrier. DOE cannot spend the nuclear industry's nuclear waste fees without congressional approval, and until FY1995 the President had requested and Congress has appropriated only about half the fees collected. After the FY1995 boost, funding was sharply reduced in FY1996 and remains about the same in FY1997 and FY1998.

The following subsections address the status of repository development at Yucca Mountain, Nevada, interim storage facilities, and transportation planning.

A. Permanent Repository

Background

Under the Nuclear Waste Policy Act of 1982 (NWPA) and 1987 amendments, the Department of Energy (DOE) is studying the suitability of Yucca Mountain, Nevada, for housing a deep underground repository for spent nuclear fuel and other highly radioactive waste. The state of Nevada has fought DOE's efforts on the grounds that the site is unsafe,

pointing to potential volcanic activity, earthquakes, underground flooding, nuclear chain reactions, and fossil fuel and mineral deposits that might encourage future human intrusion. DOE contends that the evidence so far indicates that Yucca Mountain is likely to prove suitable and that studies of the site should continue.
The planned Yucca Mountain repository is not scheduled to open until 2010 at the earliest, more than a decade later than the 1998 goal specified by NWPA.

The safety of geologic disposal of highly radioactive waste, as planned in the United States, depends primarily on the characteristics of the rock formations from which a repository would be excavated. Because many geologic formations are believed to have remained undisturbed for millions of years, it appeared technically feasible to isolate radioactive materials from the environment until they decayed to safe levels. "There is no scientific or technical reason to think that a satisfactory geological repository cannot be built," according to the National Research Council.

But, as the Yucca Mountain controversy indicates, scientific confidence about the concept of deep geologic disposal has turned out to be difficult to apply to specific sites. Every high-level waste site that has been proposed by DOE and its predecessor agencies has faced allegations or discovery of unacceptable flaws, such as groundwater flow or earthquake vulnerability, that could release radioactivity into the environment. Much of the problem results from the inherent uncertainty involved in predicting geologic behavior for the 10,000-year period (or even longer) that nuclear waste is to be isolated. Opponents of geologic disposal have urged greater emphasis on new or alternative technologies that might allow entirely different approaches to high-level radioactive waste management.

Status
The major activity at the Yucca Mountain site has been the excavation of an "exploratory studies facility" (ESF) with a 25-foot-diameter tunnel boring machine. The ESF is to consist primarily of a five-mile tunnel with ramps leading to the surface at its north and south ends. The tunnel boring machine began excavating the north ramp in October 1994 and broke through to the surface at the south entrance April 25,1997. Underground studies are being conducted at several side alcoves that have been excavated off the main tunnel.

In response to budget cuts, DOE's revised waste program is aimed at opening the repository by 2010 under currently anticipated long-term funding constraints. The revised program relies on a simplified safety assessment of the Yucca Mountain site that could establish the basis for repository compliance with all major regulatory hurdles. Under the revised program plan, DOE is to complete a "viability assessment" of Yucca Mountain by Fall 1998, followed by an environmental impact statement in 2000. If the

site appears acceptable, DOE would recommend approval by the President in 2001 and, with presidential approval, submit a license application to NRC in 2002. DOE then hopes to receive the necessary NRC construction permit and operating license in time to allow waste disposal in the repository to begin in 2010. The repository is to be permanently closed in 2071, by which time the program's total cost (in 1994 dollars) will have reached $33 billion, according to a September 1995 DOE estimate.

If authorized, the repository will be developed at the Yucca Mountain site, about 100 miles northwest of Las Vegas in Nevada. The site is currently undergoing characterization to determine its suitability for hosting the repository, in accordance with 10 CFR Part 960, General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories. Because they were originally written to be generally applicable to multiple sites, DOE is proposing to revise relevant portions of the guidelines to be specifically applicable to the Yucca Mountain site.

Currently, a large-scale test to determine how the underground environment will respond to heating and cooling of high-level waste packages is scheduled to begin in December 1997. Other studies looking at radionuclide release, hydrology, and geochemistry are also scheduled for 1998. As well, a more in-depth review is being given to engineered barriers, in response to concerns about excessive reliance on natural barriers.

Although the statutory capacity of the repository is 70,000 MTU or equivalent of spent fuel and high- level waste, the repository may be physically capable of accommodating a larger capacity. Of the initial statutory capacity, 63,000 MTU will be utility waste and 7000 MTU will be government/military waste. A single repository that is capable of emplacing all of the Nation's nuclear waste is assumed at this time to be a cost-effective alternative to a second repository, the need for which is to be recommended by the Secretary of Energy to the President between 2007 and 2010. DOE records show that through 1994, 30,000 MTU of commercial spent fuel had been generated by utilities. Projections to 2035 show that 87,000 MTU will have been discharged by utility reactors, which assumes no new reactors and operation of 40 years.

B. Central Interim Storage

The DOE Plan

The 1987 NWPA amendments authorized construction of a monitored retrievable storage (MRS) facility to store spent fuel and prepare it for delivery to the repository. But because of fears that the MRS would reduce the need to open the permanent repository and become a de facto repository itself, the law forbids DOE from selecting an MRS site until recommending to the President that a repository be constructed (which is not scheduled to take place until 2001) although the search for an MRS site may begin at any time. In

addition, construction of an MRS facility may not begin until NRC has granted a construction license for the permanent repository, and construction or operation of the MRS must cease if repository construction is interrupted. No more than 10,000 metric tons of waste may be stored at the MRS before the permanent repository begins operating, and no more than 15,000 metric tons thereafter.

Other Remedies

Delays in the repository program have prompted renewed interest in an interim storage facility that would be available earlier than the MRS. Without such interim storage, large amounts of additional storage space must be constructed at nuclear power plant sites. But current law sharply limits the usefulness of the MRS facility as an interim storage site, because the longer the repository is delayed, the longer the MRS must be delayed as well. Responses to the perceived need for interim storage as soon as possible have been in the forms of a major legislative campaign to amend the NWPA to require federal interim storage immediately and utility initiatives to develop a private interim storage facility.

A federal facility, as required by the current legislation, would require DOE to begin to implement an interim storage facility at a site near Yucca Mountain, to be available as soon as 2002. See more discussion about new legislation on page 14.

A private storage facility is not a new idea. Two private central storage facilities already exist -- at former reprocessing plants in New York and Illinois. Both are pool storage facilities, and neither is currently accepting additional spent fuel. They were developed by reactor vendors, Westinghouse and General Electric. Under an agreement between Northern States Power and General Electric when the Monticello plant was built, 1058 Monticello spent fuel assemblies were shipped to Illinois between 1984 and 1987. Thirty dedicated rail shipments were made, generating controversy, particularly in Wisconsin. The shipments created space in the Monticello storage pool which NSP reports will allow operation of the reactor through its current license (2010) without storage expansion.

More recent initiatives have been discussed in several contexts, but the most prominent has been that proposed by a consortium of seven nuclear utilities, led by NSP. The group, Private Fuel Storage, applied to NRC June 25, 1997, for a license to build a commercial spent fuel storage facility on the Utah reservation of the Skull Valley Band of Goshutes. (The utility group is essentially the same entity that had negotiated with the Mescalero Apaches to build a private interim storage facility on the tribe's New Mexico reservation. Negotiations with the Tribe were not successful, and the project was abandoned in 1996.)

The Utah site is in a desert valley about 40 miles west of Salt Lake City. The license application would allow the storage of up to 40,000 metric tons in about 4,000 sealed canisters. The storage facility, which would begin receiving spent fuel beginning in 2002,

would cost about $130 million to license and construct. A dual purpose cask system would be certified separately, and deployed to transport spent fuel from reactor storage sites to the Utah facility, where it would remain until federal acceptance. The NRC has scheduled a preliminary hearing on PFS's application for January.

In the State of Utah, the plan faces major opposition from Gov. Mike Leavitt and other Utah leaders who vehemently oppose such a facility in the state, but the Goshutes' sovereignty over their reservation appears to preclude state authority to regulate or block it. In recent weeks, the Utah governor sought to have the road accessing the proposed site redesignated a state road so shipments could be blocked by the state. The local Tooele County government, which has expressed an interest in discussing the proposal, is unhappy with the state's strong-arm tactics. Tooele County, Utah already is the site of one of the nation's largest commercial landfills for low-level radioactive waste. Envirocare stores the waste, mainly soil and building debris, at its site near Clive.

Privately owned central storage facilities would require NRC licensing under the same regulations that would apply to a DOE-owned MRS facility.

Previous proposals for private storage facilities have required nuclear utilities to retain ownership of any spent fuel that they shipped to such sites. As a result, utilities would risk being required to take back their spent fuel if DOE were unable to begin accepting it before a storage facility closed. Although such private storage facilities would not necessarily solve nuclear utilities' long-term waste problems, they could provide an alternative for power plants that were facing state and local obstacles to the expansion of on-site storage.

A privately developed nuclear waste storage facility at the Yucca Mountain site was proposed by Sen. Grams during the 104th Congress (S. 1478). Under that plan, a consortium of nuclear utilities and other firms would receive money from the Nuclear Waste Fund to build a storage facility on DOE land at Yucca Mountain for at least 40,000 metric tons of commercial spent fuel. Once the facility authorized by S. 1478 were licensed by NRC, it would receive spent fuel taken by DOE from reactor sites, allowing DOE to fulfill its responsibilities under its contracts with nuclear utilities. Unlike the situation at other proposed private storage facilities, therefore, spent fuel sent to the private facility under S. 1478 would have been owned by DOE and no longer the responsibility of the utilities that generated it. DOE also would assume ownership of the storage facility before decommissioning, with costs to be paid from the Nuclear Waste Fund.
Though little information is available, a private interim spent fuel storage project, named Owl Creek Energy Project, is being planned at a site in central Wyoming.

The Mescalero Tribe of New Mexico had indicated, when its planning with the NSP consortium failed, that it intended to pursue a private storage facility on its on, but no current information on this intent is available.

A single, somewhat cryptic news report in July 1997 describes a joint US/Russian private venture that would develop dry cask storage for nuclear utilities on Wake Island, a Pacific atoll administered by the U.S. Army, though claimed by the Marshall Islands. Over the years there have been reports of other private initiatives which never seem to develop. It seems unlikely that the U.S. government or utilities will consider ocean transportation of commercial spent fuel, at least until current policies are shown to be completely unworkable.

C. Transportation Planning

More than 80,000 metric tons of spent nuclear fuel are expected to be discharged from today's nuclear power plants during their scheduled operating lives. Unless spent fuel is to be kept permanently at reactor sites, it will have to be transported elsewhere for long-term storage and disposal — a prospect that has generated considerable controversy along potential transportation routes.

The DOE Plan

The DOE will rely on private industry to provide the necessary services and equipment required to accept and transport commercial spent fuel to a DOE facility. These services and equipment will be procured by awarding one or more contracts, with each contract covering utility reactor sites in four regions in the continental United States. Each contractor will be responsible for all activities and services in its region, including the provision of transportation and storage cask/canister systems, storage modules, and ancillary equipment, as required, to accept commercial spent fuel and transport it to a designated federal facility for storage or disposal. Specific performance requirements for each Contractor will be set forth in detail in the procurement documents.

Transportation will be carried out using commercially available equipment and approved routes in compliance with Nuclear Regulatory Commission and Department of Transportation regulations. Cask/canister systems to be used for transportation and storage will not be specified by DOE. They will be developed by industry, certified by the Nuclear Regulatory Commission, and deployed to meet the waste delivery schedules. Interface requirements will be specified by DOE to ensure that the casks and canisters will be compatible with handling facilities at the federal facility.

Cask/canister systems differ in whether they employ casks or canisters; whether their functions include transportation, storage, and/or disposal; and how they are transported. In canister systems, spent fuel is sealed inside a canister and the sealed canister is placed

into an overpack for transportation, storage, or disposal. The use of canisters may reduce the number of times individual fuel assemblies have to be handled during transport, storage and disposal. Casks/canisters designed and certified for a single use only, such as for transportation or storage, are known as single purpose systems. Casks/canisters designed and certified for both storage and transportation are referred to as dual purpose canisters or transportable storage casks. Canisters designed and certified for transportation, storage, and disposal are known as multi-purpose canisters (MPCs).

The mix of cask/canisters to be deployed is largely unknown at this time. It will depend on the availability of technologies that are certified by the Nuclear Regulatory Commission prior to the start of DOE transportation operations.

Current Issues

The risk of transporting highly radioactive spent fuel from nuclear power plants to a central storage site or permanent underground repository is a major factor in the current nuclear waste debate. Controversy over the transportation of spent fuel and other highly radioactive nuclear waste has focused on the adequacy of Nuclear Regulatory Commission (NRC) standards for shipping casks, the potential consequences of transportation accidents, and the routes that nuclear waste shipments are likely to follow.

NRC requires that spent fuel shipping casks be able to survive a sequential series of tests that are intended to represent severe accident stresses. Studies for NRC and other federal agencies have found that casks meeting NRC's standards would survive nearly all transportation accidents without releasing large amounts of radioactive material. The safety record of more than 1,000 past shipments of spent fuel in the United States is consistent with those findings. Four accidents occurred during those previous U.S. shipments, and none released radioactive material, according to a federal database.

NRC's cask standards and the federal safety studies have been criticized by the State of Nevada and others who contend that severe accidents could release hazardous levels of radioactivity. They argue that NRC's cask tests do not adequately represent a number of credible accident scenarios, and that individual casks may be fatally compromised by manufacturing flaws and by loading and handling errors.

Because nuclear power plants and DOE waste storage sites are located throughout the nation, almost all states are expected to be traversed by nuclear waste shipments. Major east-west highway and rail lines in the central United States are likely to be the most heavily used, but numerous options are available under current regulations. The Department of Transportation (DOT) requires that highway shipments of spent fuel follow the quickest route on the interstate highway system, although states are allowed to designate alternative routes if they follow certain procedures.

Preliminary plans indicate that spent fuel transportation through Minnesota to a Nevada facility will involve only waste from Minnesota's and Wisconsin's reactor sites.

Transportation Cask Standards

For a cask design to receive an NRC license, it must be demonstrated to NRC's satisfaction that the cask could survive a sequential series of tests that are intended to simulate the stresses of a severe accident. The tests are a 30-foot drop onto an unyielding surface, a shorter drop onto a vertical steel bar, engulfment by fire for 30 minutes, and, finally, immersion in three feet of water. A separate, undamaged sample of the cask design must be able to survive submersion in the equivalent pressure of 50 feet of water. Furthermore, the cask must not leak for one hour under 200 meters of water.

To be judged successful in meeting those tests (except the 200 meter submersion), a cask must be found to release no more than a specified amount of each radioactive isotope in spent fuel. In addition, the tests must not allow spent fuel in the cask to undergo a nuclear chain reaction, or criticality. A 1987 analysis conducted by Lawrence Livermore National Laboratory for NRC found that a cask meeting those standards would survive about 99.4% of truck and rail accidents with minimal damage.

A cask's ability to survive those tests can be demonstrated in several ways. First, an actual, full-sized model of the cask can be subjected to all the tests in the sequence. Alternatively, the tests can be applied to small models of the casks (typically half- or quarter-scale). Finally, casks may be compared to previous licensed designs or analyzed with computer models. NRC decides what level of physical testing or analysis is necessary for each cask design.

Because NRC generally accepts the results of scale-model testing, expensive full-scale testing of entire spent fuel casks is rarely conducted, although such tests are sometimes required for specific cask components. For example, NRC may require quarter-scale drop tests for a particular cask design but require full-scale tests of the cask's impact limiters (cushioning material typically attached to each end). Computer analysis may be allowed for meeting the fire test and for criticality control. Various environmental and other groups have urged DOE to conduct full-scale testing on any cask designs to be used for Yucca Mountain shipments. DOE currently has committed to verifying its cask designs at least with scale-model testing, according to NRC.

Federally funded studies of nuclear waste transportation accident risks have concluded that current regulations provide an adequate margin of safety. The 1987 Lawrence Livermore study for NRC contains widely cited calculations of potential nuclear waste

transportation accident rates and severity. Often referred to as the "Modal Study," the Livermore report analyzed truck and rail accident rates and modeled the stresses that each type of accident would pose to hypothetical NRC-licensed transportation casks. The study concluded that extremely few accidents would pose a significant radiation hazard to the public, concurring with a previous NRC regulatory evaluations that "indicate that the expected radiological consequences from the shipment of 3000 metric tons of spent fuel per year is less than 1 latent cancer fatality every 2300 years."

Crash Tests

Catastrophic truck and rail accidents have been staged by U.S. and British laboratories to study the response of full-scale spent fuel casks. Those tests, which were designed primarily to verify computer models, yielded spectacular films and photographs that have been widely cited as strong evidence of nuclear waste transportation safety, because the casks survived without releasing their contents. However, critics have downplayed the significance of the crash tests in demonstrating transportation safety.

Potential Number of Waste Transportation Accidents

The Modal Study's probability calculations can be applied to the anticipated number of miles that all truck and rail casks would travel in transporting nuclear waste to Yucca Mountain. A 1996 study for the State of Nevada estimated that shipping 86,000 metric tons of nuclear waste to the site, the total expected from all currently and previously operating U.S. reactors, would require up to 76 million cask shipment miles over 30 years, assuming minimal rail use and small truck casks. In a mid-range case, which assumes moderate rail use, the Nevada study estimates that cask shipment miles would total 15.3 million for trains and 24.1 million for trucks. Multiplying the Modal Study's truck accident rate of 6.4 per million miles by the 24.1 million truck-cask miles projected by the Nevada study yields a total of 154.2 truck accidents over 30 years. If 99.4% of those accidents were within level one of strain and temperature, 153.4 of those accidents would result in little or no radiological hazard. An average of 0.6 truck accidents would reach no higher than level two, and an average of 0.3 accidents would reach level three or higher.

For rail shipments, the Modal Study estimated an accident rate of 12 for every million miles traveled per train. If each nuclear waste train were assumed to carry 10 waste casks, the 15.3 million rail cask miles from the Nevada study would translate into 1.5 million shipment miles. Multiplying that number by the accident rate produces an estimate of 18.4 accidents over 30 years. If 99.4% were level-one accidents, 18.3 of those accidents would create little or no radiological hazard. An average of 0.07 rail accidents would reach level two, and an average of 0.04 accidents would be more severe.

Although the vast majority of U.S. spent fuel has never been moved from the reactors that generated it, numerous shipments have taken place. Utilities have transported spent fuel among reactor sites for storage, and some has been shipped to commercial reprocessing and storage facilities. During the 1980s, spent fuel debris from the ruined Three Mile Island 2 reactor was shipped to the Idaho National Engineering Laboratory. DOE also has transported significant amounts of spent fuel from naval and research reactors. No known radiological harm to the public has resulted from those shipments, according to NRC. Of the thousands of shipments completed over the last 30 years, none has resulted in an identifiable injury through release of radioactive material.

NRC statistics show that 1,335 metric tons of spent fuel was commercially transported in the United States from 1979 through 1995, in 1,306 separate shipments. During that period, the distance traveled by all commercial nuclear waste shipments totaled 839,000 miles.

Foreign experience with spent fuel transportation has been similar. In more than 7,000 rail shipments of spent fuel in Britain through 1986, "there have been no accidents involving a release of radioactivity," according to a report by the Central Electricity Generating Board.

Critics of DOE's nuclear waste transportation plans, such as the State of Nevada, contend that the historically good safety record for spent fuel shipments is too short to be a reliable indicator of future safety. All the U.S. commercial spent fuel shipped from 1971 to 1995 is only a small fraction of the 86,000 metric tons that may eventually require transportation to a central storage site or repository. Over 30 years, such shipments would average nearly 3,000 metric tons per year, far higher than any previous U.S. annual total. The number of cask shipment miles would total at least 20 times the current total, according to the Nevada mileage estimate noted previously.

Emergency Response

When a nuclear waste transportation accident occurs, local emergency personnel are normally the first authorities on the scene. Their ability to take appropriate action, such as extinguishing fires and organizing evacuations, can be an important factor in mitigating an accident's consequences. Such state and local capability depends largely on adequate training and preparation.

Section 180c of the Nuclear Waste Policy Act requires DOE to provide technical assistance and funding to states for training public safety officials of units of local government along transportation routes for high-level waste and spent fuel. The training

is to cover routine shipments as well as response to transportation emergencies. Funding for the assistance program is to be provided from the Nuclear Waste Fund, which contains fees assessed on nuclear power generation.

DOE issued a policy proposal May 16, 1996, for implementing the technical assistance program. A local jurisdiction would be eligible for the grants beginning three years before nuclear waste shipments were to begin traversing it; eligibility would continue for each year that the route through the jurisdiction was to be used. Under the proposal, funding could be used for training new emergency personnel, refresher courses, and related equipment. Additional drills and exercises would be conducted by DOE in conjunction with states, Indian tribes, and local governments.

Under current law, nuclear waste shipments to Yucca Mountain are not expected to begin for at least another decade, giving DOE several years to select routes and prepare for local emergency response training. However, legislation such as S. 104 would require waste transportation to a Yucca Mountain interim storage facility to begin much sooner, raising questions about the readiness of local emergency officials. Options for ensuring emergency readiness for early waste transportation include increasing DOE's planned technical assistance grants so that emergency training could be completed more quickly, and sending trained emergency personnel along with each shipment until local personnel were ready.

The Department of Transportation provides annual grants to states, Indian tribes, and localities for emergency response planning and training for hazardous materials transportation accidents. Those grants, although not aimed specifically at shipments of highly radioactive material, would be expected to increase the general emergency response capabilities of local officials. DOT awarded $8 million in grants to all states and territories in FY1994.

III. Federal Legislation

The nuclear industry and its supporters want Congress to require DOE to build an interim storage facility that could begin receiving spent fuel from nuclear power plants as soon after the 1998 deadline as possible. Such a facility could reduce spent fuel storage costs, increase safety, and fulfill the federal government's legal obligations, supporters contend. But environmental, anti-nuclear power, and other groups warn that interim storage would result in earlier transportation of

unprecedented quantities of nuclear waste; they contend it would be safer to leave the waste in place until a permanent solution can be found.

The Nuclear Waste Technical Review Board, an independent scientific advisory body established by NWPA, issued a report in March 1996 that found "no compelling technical or safety reason to move spent fuel to a centralized storage facility for the next few years." In its March 1997 report, the Board recommended that selection of an interim storage site be deferred until Yucca Mountain's suitability as a permanent repository had been determined. The Board contends that DOE should place top priority on the underground repository, rather than interim storage.

Legislation to rewrite NWPA and require construction of an interim storage facility near Yucca Mountain was passed by the Senate April 15, 1997 (S. 104) by a vote of 65-34. A similar bill (H.R. 1270) was approved by the House Commerce Committee September 18, 1997, by a 43-3 vote. On a sequential referral, the House Resources Committee voted October 8 to report the bill unfavorably, and the House Committee on Transportation and Infrastructure agreed to be discharged of the legislation without taking formal action. The House version (H.R. 1270) passed October 30, 1997 by a vote of 307 to 120. A conference committee is expected to begin negotiations in January 1998. In addition to mandating interim storage, the bills would modify the licensing standards for a permanent underground repository, revise the program's funding mechanism, and make other program modifications.

As President Clinton has promised to veto the legislation, the votes in the two bodies are important. The House vote is well over the two-thirds needed to overturn a veto. The Senate vote is two votes shy of the margin it would need to override the promised veto.

The two measures are similar to legislation (S. 1936, H.R. 1020) that was considered in the 104th Congress but not enacted. The Senate passed its version in July 1996, four votes short of a veto override. However, the House version fail victim to election year politics and was not brought to the floor). There was further political posturing after the election, with the departure of DOE Secretary O'Leary and a major shuffle at DOE. The appointment and confirmation of the new Secretary Pena restabilized the administration's policies, including a promise to veto an interim storage initiative before Yucca Mountain was found suitable.

<u>The Details</u>

Consideration of nuclear waste legislation in the 105th Congress got underway February 5, 1997, with a hearing by the Senate Energy and Natural Resources Committee on S. 104. Then-Undersecretary of Energy Thomas P. Grumbly reiterated the Administration's determination to veto the bill in its current form, contending that it "virtually forces siting an interim storage facility in Nevada," even if a permanent repository cannot be built there. The Administration also contended that placing an interim storage facility in Nevada would undermine public confidence in the scientific objectivity of the ongoing

repository studies and divert funding from the repository program, and that the bill would set unrealistic deadlines.

A number of changes were made to S. 104 on the Senate floor to address those concerns. The primary modifications included increasing the role of the Environmental Protection Agency (EPA) in setting repository standards, greater time for local transportation planning, later deadlines for developing an interim storage facility, reducing the capacity of the storage facility, and reducing the bill's preemption of other laws. However, the Senate rejected an amendment that would have stopped construction of an interim storage facility at Yucca Mountain if the site were found unsuitable for permanent disposal. The House Commerce Committee included several modifications to H.R. 1270 that were similar to those in the Senate-passed bill.

Following are the major provisions of S. 104 and H.R. 1270 :

Interim Storage Facility. S. 104 would require DOE to construct a nuclear waste interim storage facility on the Nevada Test Site, near the planned Yucca Mountain repository. The interim storage facility would receive spent fuel from nuclear power plants, foreign research reactors, and naval reactors, as well as high-level radioactive waste from nuclear weapons production.

The Senate modified the deadlines in S. 104 as introduced to allow determinations to be made of Yucca Mountain's suitability for a permanent underground repository before construction of an interim storage facility would begin. Under the Senate-passed version, the President would determine whether the site were unsuitable for a permanent repository by March 1, 1999. If the site were not found unsuitable, then the Secretary of Energy would submit a license application to NRC for an interim storage facility at the site by April 30, 1999. NRC would have 32 months --until the end of January 2002 -- to make its final decision on issuing a storage license. DOE would begin receiving waste at the storage facility during FY2003.

If the President found Yucca Mountain unsuitable for a permanent repository, under the Senate-passed bill, then he would have 18 months to designate an alternative site for an interim storage facility. If such a site had not been approved by Congress within 2 years after the unsuitability determination -- by March 1, 2001 -- then Yucca Mountain would be designated as the interim storage site. The Secretary of Energy would be required to submit a license application for the site to NRC by March 31, 2001, and NRC would have to issue its determination by the end of January 2004.
S. 104 authorizes NRC to issue a 40-year license for the interim storage facility. The facility would be licensed to hold the amount of spent fuel that DOE would accept under the bill's annual shipment schedule -- up to 3,000 metric tons per year -- before a

permanent repository began operating. About 80,000 metric tons of spent fuel is projected to be generated by today's nuclear power plants through the end of their 40- year operating licenses.

As reported by the Commerce Committee, H.R. 1270 would require development of the Nevada interim storage facility in two phases. The first phase of the project, to begin operating by January 31, 2002, would receive up to 10,000 metric tons and be licensed by NRC for a 20-year period. DOE could begin construction after submitting a license application to NRC, although no waste could be received until the license was approved. The second phase would be licensed for a renewable term of up to 100 years, expanding storage capacity to 40,000 metric tons.

Permanent Underground Repository. DOE's efforts to develop a permanent repository at Yucca Mountain would continue under S. 104, with DOE required to apply to NRC for a repository construction permit by October 31, 2001. NRC would license the repository based on the repository's ability over the next 10,000 years to meet an "overall system performance standard" to be developed by EPA. The EPA standard would limit the lifetime cancer fatality risk posed by the repository to members of a nearby "critical group" to 1 in 1,000. EPA currently is preparing repository standards pursuant to the Energy Policy Act of 1992; because of the long decay period for some radioactive isotopes in nuclear waste, EPA has considered a compliance period as long as 100,000 years for nuclear waste repositories.

Under the Commerce version of H.R. 1270, NRC would be required to write new regulations for the repository based solely on the average radiation dose expected to be received by a member of the general population around Yucca Mountain; the average annual dose would be limited by the bill to 100 millirems, about a third of average individual exposure in the United States. NRC could reduce the exposure limit if it found, in consultation with EPA, that the statutory standard "would constitute an unreasonable risk to health and safety." EPA would be forbidden from issuing any standards for the Yucca Mountain repository. NRC would issue the license if it determined the exposure limit would be met for the first 1,000 years of repository operation, and that "there is likely to be compliance" for the subsequent 9,000 years.

EPA strongly objects to proposals to eliminate its standard-setting authority for Yucca Mountain and to the proposed statutory standard of 100 millirems. In an April 29, 1996, letter to Senate Minority Leader Daschle, EPA Administrator Carol Browner called the proposed 100 millirem standard "less protective than other U.S. standards and international advisory body recommendations."

Program Funding. The funding mechanism for the nuclear waste program would be

modified by both bills. Nuclear utilities currently must contribute to the Nuclear Waste Fund a fixed annual fee of a tenth of a cent (one mill) per kilowatt-hour generated, a fee that can be changed by the Secretary of Energy after congressional review. Congress makes annual appropriations from the Nuclear Waste Fund to DOE; previously the annual utility payments have greatly exceeded annual appropriations, leading to a large surplus that has reduced the federal deficit.

Under S. 104 as passed by the Senate, a variable fee would be established that would equal annual appropriations from the Nuclear Waste Fund for FY1999-FY2001 and after FY2006 -- except that the fees could rise no higher than the current level of one mill per kilowatt-hour. The existing mandatory fee of one mill per kilowatt-hour would be reduced by the amount of the variable fee paid. To compensate for the reduction in the mandatory fee, the bill would require utilities to hand over all deferred payments to the Nuclear Waste Fund by the end of FY2001. Such deferral of payments, currently totaling about $2 billion with interest, were allowed for spent fuel generated before enactment of NWPA.

H.R. 1270 as reported also would establish a variable fee for which annual collections could not exceed appropriations for civilian waste disposal, but the existing mandatory fee would be discontinued. To provide sufficient funding for concurrent development of the interim storage facility and the permanent repository, the variable annual fee would be capped at 1.5 mills per kilowatt-hour from FY1999 until disposal began at a permanent repository. The fee would average no more than 1 mill per kilowatt-hour during the entire period. After the repository opened, the annual fee would be capped at 1 mill per kilowatt-hour. All outstanding deferred payments would be due by the end of FY2002.

Preemption of Other Laws. S. 104 contains a general preemption of all state, local, and tribal requirements that conflict with the bill's provisions or that pose an "obstacle" to implementing the bill. Any state, local, and tribal requirements involving specified nuclear waste issues would be expressly preempted if they did not conform to the bill's requirements. Under H.R. 1270, if any law were "inconsistent with or duplicative of" the waste law or the Atomic Energy Act of 1954 (AEA), then only the waste law or AEA would apply. Laws by states or localities that posed "an obstacle" to implementation of the waste law would be preempted.

Transportation. Both bills would require DOE to develop facilities at Caliente, Nevada, to transfer nuclear waste casks from rail cars to heavy-haul trucks for delivery to the Yucca Mountain site. Both bills would require DOE to provide emergency training funds to states, localities, and Indian tribes along transportation routes. The more extensive transportation provisions in S. 104 would establish procedures and requirements for route selection, and would require that training funds be available for at least 3 years before

waste shipments begin, except in certain emergencies.

IV. Federal Budget

DOE cannot spend the nuclear industry's nuclear waste fees without congressional approval, and until FY1995 the President had requested and Congress has appropriated only about half the fees collected. After the FY1995 boost, funding was sharply reduced in FY1996 and remains about the same in FY1997 and FY1998.

Through the end of FY1996, utility nuclear waste fees and interest totaled about $10 billion, of which about $5 billion had been appropriated to the waste disposal program, according to DOE. Another $2 billion was owed by utilities for spent fuel generated before 1983.

In October, 1997, Congress appropriated $160 million from the Nuclear Waste Fund (utility funded) and $190 million from the Defense Nuclear Waste Disposal program (general revenues) to the DOE for continued work on nuclear waste disposal. This is viewed as keeping DOE on track for opening of Yucca Mountain in 2010. The appropriation does not include funding for the State of Nevada, which Congress previously accused of misusing federal funds to lobby against the Yucca Mountain site. However, it did include $5 million for local governments that could be affected.

V. Federal Lawsuit

In addition to legislative efforts, nuclear utilities and state officials filed two lawsuits in June 1994 to force DOE to meet the January 1998 deadline for starting to take nuclear waste from commercial reactor sites. DOE issued a determination May 3, 1995, that the 1998 deadline would not be legally binding if storage or disposal facilities were not ready in time. Under current law, DOE cannot begin building a "monitored retrievable storage" (MRS) facility until a permanent repository receives a Nuclear Regulatory Commission (NRC) construction permit, which is not expected until late 2004 at the earliest.

The U.S. Court of Appeals for the District of Columbia Circuit decided in favor of the utilities July 23, 1996, reversing DOE's determination that the 1998 deadline would not be binding if facilities were not available. However, the court called it "premature to determine the appropriate remedy" for DOE's anticipated failure to meet the 1998 statutory deadline. The case is Indiana Michigan Power Company, et al., v. Department of Energy and United States of America. Despite the court ruling, DOE notified utilities December 17, 1996, that it could not meet the NWPA deadline for the start of waste disposal operations.

In response, utilities and states filed two similar lawsuits January 31, 1997, seeking a remedy from the same Appeals Court for DOE's anticipated noncompliance; the Court on April 30, 1997, ordered DOE to respond quickly to the suits, and oral arguments were heard September 25, 1997. Potential remedies include payments to utilities for extended waste storage at reactor sites and suspension of waste fee payments to the federal government. The State of Minnesota enacted legislation in May 1997 allowing nuclear waste fees collected in the state to be placed in escrow until DOE began taking waste from reactor sites, if authorized by a federal court. Several other states have been considering similar action.

On November 14, 1997, the Appeals Court ruled that the Energy Department must take radioactive waste from nuclear power producers, but denied an industry call for a court order to force the government to start removing the deadly waste. Instead the U.S. Court of Appeals said utilities should use their contracts with the Energy Department to seek compensation or get the government to take the waste. Presumably, DOE compensation to utilities would come from the Nuclear Waste Fund, which would have to be appropriated by the Congress. The court also chided the Energy Department for claiming that "unavoidable delays" had prevented it from building a central storage site for the waste, which originally was to have been opened by January 1998. The Court's decision can be found in Appendix 1.

VI. State Activities

Nuclear Waste Strategy Coalition

Outraged at what they perceived as nothing short of a swindle, the nuclear industry and state regulators mounted a major campaign to secure storage space for spent fuel. Led by the Minnesota Department of Public Service, most of the parties to the federal lawsuit, and other state regulators and utilities, formed the Nuclear Waste Strategy Coalition in 1995. The coalition consists of 41 members from 24 states, including, in addition to the Minnesota Department of Public Service, the Minnesota Public Utilities Commission and NSP. **The Coalition's mission is to ensure the timely development of a cost-effective, safe and environmentally sound system for the permanent disposal of spent nuclear fuel and high-level radioactive waste.**

In addition to supporting legislative change and the lawsuits against DOE, **several state members of the Coalition have initiated efforts to escrow utility payments that would otherwise be paid into the federal Nuclear Waste Fund because the federal program is unlikely to result in the timely, cost-effective disposal of utilities' nuclear waste.** Though the federal Appeals Court did not address the question of

withholding payments to the Nuclear Waste Fund, the Coalition has stated that if the current legislative initiative fails, they will pursue the escrow option.

In watch dogging payments to the Nuclear Waste Fund, the Coalition released data in August 1997 showing that utility ratepayers and accrued interest added more than $1 billion to the fund in the year between June 1996 and June 1997. However, according to the Coalition, only 14 cents on the dollar was used for radioactive waste disposal programs. Payments from ratepayers during this time totaled $614 million and interest on earlier payments was $436 million. During this time, only $151 million was appropriated to the civilian nuclear waste program. The latest figure reported for total payments into the fund since its inception is $11 billion.

A 1997 paper by a state member of the Coalition, entitled "A Heightened Level of Frustration: The States Perspective On The Disposal of High Level Nuclear Waste," including an interesting table detailing a states' history of nuclear waste disposal, is included as Appendix 2 of this report.

Nevada

The state of Nevada, through its Agency for Nuclear Projects, the governor's office and its congressional delegation, has continued to object at every opportunity to the federal plans to dispose of nuclear waste at Yucca Mountain. The DOE had been supporting state participation in the repository review, but Congress, finding the state's role to be obstructive, has eliminated funding to the state, and reduced assistance to local government.

South Carolina

Over the objections of the state, DOE began shipping over 20 tons of spent foreign research reactor fuel (in 41 countries) from Europe and South America to the DOE Savannah River, S.C. facility. The highly enriched uranium fuel was provided to other nations as part of the "Atoms for Peace" program. Shipments will continue over 10 years, traveling first by ship to Charleston, S.C., then by rail to the DOE facility. It is being stored in pools, but will be moved to dry storage, and eventually to the repository. The state sued DOE to halt the shipments but did not prevail.

New Mexico

Though intended to only accept processed nuclear defense wastes, the DOE's Waste Isolation Pilot Plant (WIPP) has been constructed near Carlsbad, New Mexico, and after many years of controversy, it may open in 1998. The state has fought development of the facility through several state administrations, but the current governor supports the project. DOE plans to bury up to 6.2 million cubic feet of radioactive clothing, tools, equipment and other defense-related transuranic waste in a salt bed 2,150 feet

underground. Over its projected 35-year life span, WIPP is expected to receive some 37,700 waste shipments, which would pass through as many as eight states.

Council of State Governments

The Council of State Government's Midwestern High-Level Radioactive Waste Transportation Project has kept Midwestern state officials informed of developments within the federal Civilian Radioactive Waste Management System since 1989. Funded by a cooperative agreement with the U.S. DOE, the project is directed by a committee comprised of midwest state officials. The Minnesota agency representative on the committee is Mr. John Kerr of the Division of Emergency Management, Minnesota Department of Public Safety. He coordinates the indirect participation in committee activities with the Minnesota Departments of Public Service, Health and Transportation, and the EQB. Minnesota's legislative member of the committee is Senator Steve Novak. The CSG also publishes several reports yearly which are generally very helpful to the states.

National Conference of State Legislatures

The NCSL issues an annual Report on State Legislative Developments in Radioactive Materials Transportation. Its June 1997 report observes that most states that pass new legislation regulating radioactive waste transportation are adopting more oversight authority rather than less. As a lone exception, Arkansas has eliminated the need for a state permit to haul radioactive wastes through the state.

VII. Canadian Nuclear Waste Disposal Program

Canada's nuclear waste disposal program continues to be monitored because of the potential that Canadian disposal sites near Minnesota's northern border could be considered. This mirrors Canadian interests in the mid-1980's when several sites in northern Minnesota were being considered as potential candidate sites for a US national repository. Principle issues at that time were the potential for transboundary water pollution and application of the Boundary Waters Treaty of 1909.

The Canadian government, through an independent panel appointed by the Canadian Environmental Assessment Agency, has conducted three phases of public hearings to review Atomic Energy of Canada Limited's (AECL) proposed nuclear fuel waste management and disposal concept. The focus of the review has been an Environmental Impact Statement issued in 1994. MEQB staff have monitored the proceedings through comprehensive documentation made available through the independent panel. Canada's proposed disposal concept design includes sealing of waste in long-lasting (500 years) containers, placing the containers in a disposal vault excavated to a nominal depth

of 500 to 1000 meters in intrusive igneous (plutonic) rock of the Canadian Shield, surrounding the containers with a sealing material, and then eventually sealing all openings. Disposal technologies include a range of options to provide adaptability to physical conditions of the yet undetermined site location, and to allow for changes in criteria and standards. The concept anticipates a construction and operating schedule of 89 years, including an initial 20 years for identifying a host site.

To date, the public participation in the Canadian review process does not suggest that the Canadian concept is any less problematic than the similar US approach, though a distinctive difference is that the Canadian program is attempting first to gain public acceptance of their disposal concept before focusing on specific sites. Further, the government has firmly established that dry cask storage will be its policy and practice until a repository can be developed. Further, dry cask storage will be developed as needed at existing reactor sites, with no plans for a central interim storage facility.

The Canadian government's special review panel held its third and last phase of public hearings in the spring of 1997, and is currently preparing its report with recommendations regarding the acceptability of the disposal concept and on the steps that must be taken to ensure the safe long-term management of nuclear fuel wastes in Canada. Subsequently, if the government accepts the concept, presumably the 20 year siting process will begin, possibly within two to five years, followed by construction at a preferred site around 2025. The proposed implementation plan currently provides that a host community must accept the facility and will have the right to negotiate terms of commitments.

Minnesota's interest in Canada's nuclear waste management program has two aspects. In the near-term we must continue to monitor probable implementation of a repository siting process, and be prepared to inform their siting process of any concerns that may arise regarding potential impacts on Minnesota. Though the Canadian Shield (crystalline rock) search area covers much of Canada, it does extend to Minnesota's border in Manitoba and Ontario, so that sites adjacent to the Minnesota border could conceivably be considered. Much of the research and development on disposal has been conducted at two national laboratories, one of which is the Whiteshell Laboratories southeast of Winnipeg, approximately 45 miles from Minnesota's northern border with Manitoba. The Whiteshell Laboratories include the Underground Research Laboratory, which was constructed to provide a representative environment in which to conduct large-scale underground tests. The AECL emphasizes that the Whiteshell facility has not been investigated as a potential site. An additional field research area is at Atikokan, Ontario, approximately 35 miles north of Minnesota's northern border and the Boundary Waters Canoe Area.

A second potential, and longer term, consideration is that the crystalline rock being investigated by the Canadian government extends through the northern half of Minnesota.

The US DOE has no active program formally evaluating geologic formations in Minnesota, or anywhere else other than Yucca Mountain, for potential use for a repository site. It is likely that the U.S. will need a second repository at some point in the future, and the DOE has maintained an active funding and information sharing relationship with the Canadian disposal research and development program. While there is no public information basis for anticipating that the U.S. government will again look to Minnesota as a potential second repository host, the state should continue to monitor the DOE\AECL relationship and the Canadian waste disposal program. Similarly, there is no information basis for anticipating that spent fuel from the US or any other country could be sent to Canada's repository at any time in the future, or that such a scenario could suggest increased transportation of spent fuel through Minnesota.

VIII. Related Issues

In the past, this annual monitoring report has elicited inquiries from legislators regarding several issues related to nuclear waste management but which are generally outside the scope of the program. Four of these issues are briefly discussed in this section.

A. Policies in Other Countries

Worldwide, there are currently 439 commercial nuclear power reactors operating in 32 countries, with another 28 power reactors under construction. Nuclear reactors supply 17% of the world's electricity. Of the world's total domestic electricity generation with nuclear reactors, the largest producer is the US at 30%, followed by France at 16%, Japan at 12%, former USSR at 8%, Germany at 7%, Canada at 5%, Sweden at 3%, and all others collectively at 19%. There is uncertainty about the future of new nuclear power generation throughout the international market, but recent media reports of Chinese interest in nuclear power technology and aggressive policies in other Pacific Rim countries suggest that there may be significant development in that region. The growing debate on global warming may also be a factor in the future of nuclear power development, with renewed interest in both current and more advanced technologies.

All of the major countries generating nuclear energy, and therefore nuclear waste, have active waste management programs. A 1994 US General Accounting Office report on the programs in these countries made the following observations:

"*Governments around the world support the use of geologic repositories as the best method for disposing of highly radioactive waste, but no country has yet built an operational facility. All have encountered difficulties with their waste management programs, and most do not plan to have a repository until 2020 or later.*

"Progress on nuclear waste disposal is widely considered a prerequisite for any future growth of nuclear power.

"Opposition to geologic disposal affects all countries' programs.

"Other countries, in contrast to the US, have decided, for the foreseeable future, how they will store their waste until disposal.

"Other countries have less ambitious repository development schedules

"Waste producers in other nations are assigned greater responsibility than in the US.

"Other nations have taken a less detailed regulatory approach ..... allowing flexibility to respond to the conditions discovered as they proceed with their repository programs.

"Some countries are emphasizing engineered barriers ..... i.e., more robust containers, in contrast to the US DOE, which will rely primarily on the natural geology of the Yucca Mountain site to contain radiation.

"The most significant difference between the approaches of the United States and of the countries (reviewed) is that the other countries appear to have separated the issue of long-term waste disposal from considerations of temporary waste storage."

The report notes that nuclear programs in other countries are much smaller than the US program, and, for various reasons, are not constrained by pressure to begin removing waste from power plants. In stark contrast, DOE's repository development schedule appears to be based predominantly on the earliest possible acceptance and disposal of utilities' waste - rather than on the technical requirements of constructing a repository.

<u>Reprocessing</u>

The high-level waste from reprocessing UK, French, Japanese and German spent fuel is largely liquid. It consists of the highly-radioactive fission products and some transuranic elements with long-lived radioactivity. It generates a considerable amount of heat and requires cooling. This is vitrified into borosilicate (Pyrex) glass, encapsulated into heavy stainless steel cylinders about 1.3 m high and stored for eventual disposal deep underground.

Major commercial reprocessing plants are operating in France and UK, with capacity of almost 4700 tonnes per year and cumulative civilian experience of 55,000 tonnes over 40 years. These also undertake reprocessing for utilities in other countries, notably Japan, which has made over 140 shipments of spent fuel to Europe since 1979. At present most

Japanese spent fuel is reprocessed in Europe, with the vitrified waste and the recovered U and Pu being returned to Japan to be recycled as fuel. In future the plutonium will be returned as mixed oxide (MOX) fuel elements.

The Swedish Nuclear Program

Sweden's nuclear power program has experienced radical political changes. Sweden has twelve nuclear power reactors providing about half its electricity. Up to the late 1960s there was a focus on hydro electricity to power Sweden's industrial growth. In 1965 it was decided to supplement this with nuclear power, to avoid the uncertainties of oil prices and increase the security of supply. The policy was reinforced by the oil shocks of the early 1970s, at a time when Sweden depended on oil for about one fifth of its electricity.

In the mid 1970s the nuclear push became a political issue, and 1977 legislation was passed to ensure proper waste management. This provided the basis for Sweden's world leadership in management of spent fuel (for those countries not reprocessing it).

The 1979 accident at the Three Mile Island power station in USA contributed to a decision to call a public referendum in Sweden, to remove the issue from the election campaign late in 1979. The 1980 referendum canvassed three options for phasing out nuclear energy. A clear majority of voters favored running the existing plants and those under construction as long as they contributed economically, in effect to the end of their normal operating lives (assumed then to be 25 years). Parliament decided to embargo further expansion of nuclear power and aim for decommissioning the 12 plants by 2010.

The 1986 Chernobyl disaster (first recognized at a Swedish nuclear power station) created some pressure to progress the issue of nuclear decommissioning. In 1988 the government decided to begin the phase-out in 1995, but this decision was overturned in 1991 following pressure from the trade unions.

In 1994 the government appointed an Energy Commission which reported at the end of 1995 that a complete phase-out of nuclear power by 2010 would be economically and environmentally impossible. However, it thought that one unit might be shut down by 1998.

This gave rise to intense political maneuvering among the main political parties, all of them minority, with varied attitudes to industrial, nuclear and environmental issues. The Social Democrats are ruling a minority government but with any one of the other parties they have been able to get a majority in parliament.

Early in 1997 an agreement was forged between the Social Democrats and two of the

other parties which involved a decision to close one small reactor by mid 1998 and its twin by mid 2001, the second provided that alternatives are demonstrated. This was confirmed in June 1997 by parliamentary decision.

The reactors concerned are only 30 kilometers from the Danish capital, Copenhagen, and have been a source of irritation to the Danes on that account.

The positive aspect of this decision to close the two reactors is that the other ten reactors gain a reprieve beyond 2010, and may be able to run for about 40 years (ie closing 2012-2025). A phase-out program is to be decided before 2002.

Production from the closed plants is to be replaced by power from wood-fueled, combined heat power plants, some wind power and extensive conservation measures. It is accepted that increased natural gas consumption and some net electricity imports (e.g. from Danish and German coal-fired power stations) will also be needed.

B. Alternatives to Waste Disposal

The range of options available for additional spent fuel storage capacity include continuing the expansion of dry storage at reactor sites, construction of federal or private interim storage facilities, and reprocessing of spent fuel to extract plutonium and uranium. This section will elaborate further on only the reprocessing option.

Reassessing current U.S. policy and sending spent nuclear fuel to reprocessing plants has been suggested as an alternative to storing the material at reactor sites or a central facility. Possible reprocessing locations include a newly constructed facility in Great Britain and under used defense reprocessing facilities at DOE'S Savannah River Site.

Reprocessing of spent fuel could alleviate near-term storage problems and extract uranium and plutonium for use in new nuclear fuel. However, the highly radioactive waste produced by reprocessing would still require long-term storage and disposal, and the separation of plutonium would probably raise serious concerns about nuclear weapons proliferation.

British Nuclear Fuels Ltd. (BNFL) is urging Congress to authorize DOE to take spent fuel from nuclear power plants with severe on-site storage problems and ship it to BNFL's new Thermal Oxide Reprocessing Plant (THORP) in northern England. BNFL already is receiving spent fuel shipments from Japan and other countries, using a fleet of special ships. Under the BNFL proposal, DOE could send U.S.spent fuel to THORP to be stored for at least a decade and then reprocessed. The storage and reprocessing cost of $1million per metric ton would be paid from the Nuclear Waste Fund. If DOE storage and disposal

facilities became available before the U.S. spent fuel was reprocessed, the material could be returned and the reprocessing contract terminated. DOE would pay a termination fee covering BNFL's transportation and storage costs.

If the U.S. spent fuel were reprocessed, the plutonium (about 1 percent) and uranium (about 95 percent) would be separated from highly radioactive waste products. The resulting liquid high-level waste would be vitrified --dissolved in molten glass -- and poured into stainless steel canisters at a new facility that adjoins THORP. The uranium, plutonium, and waste canisters would then be returned to DOE, or, for an additional fee, BNFL could produce mixed-oxide (MOX) fuel from the plutonium and some of the uranium. Most U.S. nuclear plants could load at least a third of their reactor cores with MOX fuel.

The Senate Energy and Natural Resources Committee included a provision in a nuclear waste bill in the 104th Congress (S.1271) that could have been used to implement the BNFL reprocessing proposal. Utilities lacking spent fuel storage space would have been authorized to contract for "interim storage and conditioning" with "qualified entities." DOE would take title to "all spent nuclear fuel and high-level radioactive waste resulting from the treatment of that fuel." However, the controversial provision was dropped from the final bill as passed by the Senate (S. 1936).

A report by the operator of the Savannah River Site suggested that the site"s reprocessing facilities, which formerly extracted highly enriched uranium and plutonium primarily for defense needs, could economically reprocess spent fuel from commercial reactors. A new vitrification plant at the site could solidify the resulting high-level waste for disposal. However, questions have arisen about the ability of the 40-year-old SRS reprocessing facilities to meet current safety standards.

Reprocessing costs are intended to be offset at least partly by the value of the uranium and plutonium extracted from spent fuel, a value that depends primarily on the market price of newly mined uranium. Uranium has been relatively inexpensive since the early 1980s, but reprocessing supporters expect prices to rise in the future. The value of reprocessed uranium is difficult to assess. On the downside, reprocessed uranium contains a relatively high percentage of undesirable uranium isotopes and may be slightly contaminated with highly radioactive residues. However, it also usually has a higher percentage of the crucial isotope uranium-235 than found in natural uranium.

Reprocessing proponents maintain that waste disposal costs would be lowered by the reduction in waste volume and by the recycling of plutonium, which poses a long-term radioactive hazard. However, the waste-management benefits of reprocessing remain

largely undemonstrated. Most of the near-term radioactivity and heat in spent fuel would remain in the vitrified high-level waste, so the separation between waste canisters in a repository (and therefore total acreage requirements) might not be significantly reduced. Also, because plutonium can be recycled only a few times in today's reactors before becoming unusable, some reprocessed plutonium would eventually require permanent disposal unless advanced reactor technology became commercialized.

Reprocessing of U.S. commercial reactor fuel would require a substantial change in U.S. nuclear nonproliferation policy. Although the Clinton Administration does not attempt to block the United States' economically advanced allies from reprocessing civilian spent fuel, it "does not encourage the civil use of plutonium and, accordingly, does not itself engage in plutonium reprocessing for either nuclear power or nuclear explosive purposes." Supporters of the Administration policy contend that any U.S. reprocessing would undermine efforts to prevent non-nuclear-weapons nations from building plutonium stockpiles.

C. The Future of Nuclear Power Generation

Debate continues in a number of contexts which raise very fundamental questions about the future role of nuclear power generation, both nationally and internationally. Particularly in the U.S., a near-term solution to the waste disposal dilemma is considered to be the pivotal factor influencing perceptions and decisions about nuclear power. Costs, safety and proliferation concerns are important factors as well.

No nuclear plants have been ordered since 1978 and more than 100 reactors have been canceled, including all ordered after 1973. No units are currently under active construction; the Tennessee Valley Authority's Watts Bar 1 reactor, ordered in 1970 and licensed to operate in 1996, was the last U.S. nuclear unit to be completed.

The nuclear power industry's troubles include a slowdown in the rate of growth of electricity demand, high nuclear power plant construction costs, public concern about nuclear safety and waste disposal, and a changing regulatory environment.

High construction costs are perhaps the most serious obstacle to nuclear power expansion. Construction costs for reactors completed within the last decade have ranged from $2-$6 billion, averaging about $3,000 per kilowatt of electric generating capacity (in 1995 dollars). The nuclear industry predicts that new plant designs could be built for about half that amount, but construction costs would still substantially exceed the projected costs of coal- and gas-fired plants. Some in the industry have expressed optimism that continued growth of nuclear power in Asian countries will have a positive effect on the US market for new construction.

Of more immediate concern to the nuclear power industry is the outlook for existing nuclear reactors in a deregulated electricity market. Electric utility restructuring, which is currently underway in several states, could increase the competition faced by existing nuclear plants. High operating costs and the need for costly improvements and equipment replacements have resulted in the permanent shutdown during the past decade of eight U.S. commercial reactors before completion of their 40-year licensed operating periods. At least four more reactors are currently being considered for early shutdown. (Also see next section)

Nevertheless, electricity production from U.S. nuclear power plants is greater than that from oil, natural gas, and hydropower, and behind only coal, which accounts for 55% of U.S. electricity generation. Nuclear plants generate more than half the electricity in six states. Average operating costs of U.S. nuclear plants have dropped during the 1990s, and costly downtime has been steadily reduced. Licensed commercial reactors generated electricity at an average of 75% of their total capacity in 1996, slightly below the previous year's record.

Global warming that may be caused by fossil fuels -- the "greenhouse effect" -- is cited by nuclear power supporters as an important reason to develop a new generation of reactors. But the large obstacles noted above must still be overcome before electric utilities will risk ordering new nuclear units. Reactor manufacturers are working on designs for safer, less expensive nuclear plants, and the Nuclear Regulatory Commission (NRC) has approved new regulations intended to speed up the nuclear licensing process, consistent with the Energy Policy Act of 1992 (P.L. 102- 486). Even so, the Energy Information Administration forecasts that no new U.S. reactors will become operational before 2010, if any are ordered at all.

Driven by experience over the past 30 years, the DOE and the nuclear utility industry have cooperated to move toward a new generation of more standardized reactor design, intended to improve safety and reduce costs and construction lead times. Effectively, these are almost “off-the-shelf” designs which have been preapproved by the NRC.

For the Clinton Administration, "nuclear power is not high priority," according to a FY1995 DOE budget summary, but "the option should be kept open." That ambivalence is reflected in DOE's nuclear R& D budget under the Clinton Administration, which proposes to continue research on existing commercial nuclear plants while terminating development of advanced reactors.
Termination of DOE research on advanced reactors began in FY1995, when Congress accepted the Administration's plan to halt development of the advanced liquid metal reactor (ALMR), also called the Integral Fast Reactor (IFR). For FY1996, Congress

agreed to terminate research on the gas turbine modular helium reactor (GT-MHR). Congress and the Administration continued funding for improved versions of today's light water reactors (LWRs) through FY1997. But the Administration's FY1998 request declares the program completed and would provide only $5.5 million in termination costs for advanced LWR development.

The US Nuclear Regulatory Commission gave final design certification to two advanced reactor designs in May 1997. These are the first such generic certifications to be issued and will be valid for 15 years. The certification process anticipates that safety issues within the scope of the certified designs have been fully resolved and hence will not be open to legal challenge during licensing for particular plants.

Outside of the US, there are active research and development programs for advanced reactors in Japan, Canada, Germany, France and Russia. Advanced reactors have been built and brought on line in Japan, and are under construction in Russia.

D. Implications of Economic Deregulation

A January 1997 Nuclear Regulatory Commission technical paper on "Effects of Electric Industry Deregulation on Nuclear Power Plants concluded that economic deregulation and restructuring in the electric utility industry could potentially have profound impacts on the long-term ability of power reactor licensees to obtain adequate funds to operate and to decommission their plants safely.

After a year of review, the Nuclear Regulatory Commission recently issued its final policy statement on the Restructuring and Economic Deregulation of The Electric Utility Industry. The NRC initiated the policy effort due to concerns about the possible effects that rate deregulation and disaggregation resulting from various restructuring actions involving power reactor licensees could have on the protection of public and safety. Such changes may affect the licensing basis under which the NRC originally found a licensee to be financially qualified to construct, operate, or own its power plants, and to accumulate adequate funds to ensure decommissioning at the end of reactor life. Prior to issuance of this new policy statement, licensees had always been obligated to obtain advance approval from the NRC for any changes that would constitute a transfer of the license, and to report any information regarding financial qualification and decommissioning funding assurance that may have a significant implication for public health and safety.

The NRC believes that its regulatory framework is generally sufficient at this time to address the restructurings and reorganizations that will likely arise as a result of electric utility deregulation. Further**,** the NRC recognizes the primary role that state and federal

economic regulators have served, and in many cases will continue to serve, in setting rates that include appropriate levels of funding for safe operation and decommissioning. While the NRC intends to continue to defer to economic regulators in these rate related areas, the NRC reserves the right to take appropriate steps in order to assure a licensee's adequate accumulation of decommissioning funds.

The NRC's policy statement does not address any aspect of the management of spent nuclear fuel. Presumably, any general plant or independent storage licensee will have been judged to meet financial and decommissioning fund assurance requirements, and will be required to operate the storage facilities in a safe manner in compliance with the NRC license**.** Questions of who pays the cost of storage beyond January 1998 are left to the courts and state public utility commissions.

The industry and rate payer groups have expressed concern about "stranded costs" in a deregulated environment, which will be particularly challenging where nuclear units are forced to close prematurely, whether the result of rate deregulation or other reasons. The NRC and state PUC's also must deal with insufficient decommissioning funds for a prematurely closed nuclear unit. Relative to the federal nuclear waste program, contributions to the Nuclear Waste Fund are also diminished by plant closures.

Just as there are many unanswered questions about nuclear waste management in the existing regulated environment, the solutions become further complicated in a less regulated economic environment for nuclear utilities. It is clear that the industry and state regulators are hopeful that the DOE will accept and dispose of spent fuel pursuant to contract, and that the possibility of long term storage at reactor sites does not further complicate the role of nuclear utilities in a deregulated electricity market. It is much less clear how further delays in DOE acceptance of civilian spent fuel will affect nuclear utilities in an economically deregulated environment.