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Nuclear Energy Policy

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CONTENTS

Nuclear Energy Policy

SUMMARY

Nuclear energy policy issues facing Congress include questions about radioactive waste management, research and development priorities, power plant safety and regulation, terrorism, the Price-Anderson Act accident liability system, nuclear weapons proliferation, plutonium disposition, and technology for producing nuclear fuel.

Federal funding for nuclear energy research and development was substantially reduced by the Clinton Administration, and the Bush Administration proposed further cuts. However, in the Energy and Water Development Appropriations Act for FY2002 (P.L. 107-66), Congress generally rejected those reductions. President Bush's FY2003 budget request includes $38.5 million for a Department of Energy (DOE) effort to encourage deployment of new commercial nuclear power plants by 2010.

Several bills have been introduced in the 107th Congress to encourage the growth of nuclear power. A number of nuclear provisions are included in comprehensive energy legislation (H.R. 4) passed by the House August 2, 2001, and by the Senate April 25, 2002.

The September 11, 2001, terrorist attacks on the United States raised questions about nuclear power plant security. Reactor security provisions were included in a Price-Anderson extension bill passed by the House November 27, 2001 (H.R. 2983). An extra $36 million for nuclear power plant security was provided by the FY2002 supplemental appropriations bill, included in the FY2002 Defense Appropriations Bill (H.R. 3338), passed by Congress December 20, 2001.

Disposal of highly radioactive waste has been one of the most controversial aspects of nuclear power. The Nuclear Waste Policy Act of 1982 (NWPA, P.L. 97-425), as amended in 1987, requires DOE to begin detailed physical characterization of Yucca Mountain in Nevada as a permanent underground repository for high-level waste.

President Bush recommended approval of the site February 15, 2002, and Nevada Governor Guinn on April 8, 2002, issued a "state veto" of the site, as allowed by NWPA. On May 8, 2002, the House passed a resolution that would overcome the "state veto" and allow further activity at Yucca Mountain to proceed (H.J. Res. 87). An identical resolution (S.J. Res. 34) was approved by the Senate Energy and Natural Resources Committee June 5, 2002.

Whether progress on nuclear waste disposal and other congressional action will revive the U.S. nuclear power industry's growth will depend primarily on economic considerations. Natural gas- and coal-fired powerplants currently are favored over nuclear reactors for new generating capacity. However, rising energy prices and electricity shortages have led some utilities to consider building new reactors.

A major part of DOE's budget goes to cleaning up facilities formerly used to produce nuclear weapons. Among the more controversial of these activities is the disposal of plutonium from dismantled weapons, which has stimulated conflict between DOE and South Carolina over plans to build a conversion facility at the Savannah River Site in that state.

MOST RECENT DEVELOPMENTS

President Bush's FY2003 budget request, submitted to Congress February 4, would provide $38.5 million for a Department of Energy (DOE) effort to encourage deployment of new commercial nuclear power plants by 2010. The overall budget request for nuclear energy supply programs is $249.8 million, similar to the FY2002 appropriation. A 40% increase is being sought for the DOE nuclear waste disposal program, to $526.7 million. According to DOE, the increase is needed for preparation of a license application to the Nuclear Regulatory Commission (NRC) for a proposed national nuclear waste repository at Yucca Mountain, Nevada. Funding for cleaning up contaminated DOE nuclear facilities would rise nearly 15%, to $6.7 billion, including an $800 million fund to pay for alternative cleanup strategies approved by environmental regulators. NRC is requesting a 5% spending increase, to $605.6 million.

President Bush recommended to Congress February 15 that a license application be submitted to NRC to build a nuclear waste repository at Yucca Mountain. Nevada Governor Guinn on April 8 exercised his right under the Nuclear Waste Policy Act to send Congress a notice of disapproval for the Yucca Mountain site. That so-called "state veto" blocks further action at the site unless a congressional resolution to approve the site is enacted into law within 90 days of continuous session after the state veto was received. The House passed a Yucca Mountain approval resolution (H.J. Res. 87) on May 8 by a 306-117 vote. An identical resolution (S.J. Res. 34) was approved by the Senate Energy and Natural Resources Committee June 5 by a vote of 13-10.

NRC announced February 14 that it would order nuclear power plants and other key nuclear facilities to implement enhanced security measures, in light of continued security threats. Some of the new measures were included in security recommendations issued to nuclear plants after the September 11, 2001, terrorist attacks on New York and Washington, D.C. NRC is continuing a "top to bottom" review of nuclear security regulations and procedures.

The Senate on April 25 approved its version of omnibus energy legislation (H.R. 4), which includes provisions to extend the Price-Anderson Act nuclear liability system 10 years for commercial reactors and indefinitely for DOE nuclear contractors. The bill would allow nuclear plants consisting of several small modules to be treated as a single reactor under the Price-Anderson system. The House approved a 15-year extension of the Price-Anderson Act on November 27, 2001 (H.R. 2983).

BACKGROUND AND ANALYSIS

Overview of Nuclear Power in the United States

The U.S. nuclear power industry, while currently generating about 20% of the nation's electricity, faces an uncertain long-term future. 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 most recent U.S. nuclear unit to be completed. The nuclear power industry's troubles include high nuclear power plant construction costs, public concern about nuclear safety and waste disposal, and regulatory compliance costs.

High construction costs are perhaps the most serious obstacle to nuclear power expansion. Construction costs for reactors completed since the mid-1980s have ranged from $2-$6 billion, averaging more than $3,000 per kilowatt of electric generating capacity (in 1997 dollars). The nuclear industry predicts that new plant designs could be built for about half that amount if many identical plants were built in a series, but such economies of scale have yet to be demonstrated.

Nevertheless, all is not bleak for the U.S. nuclear power industry, which currently comprises 103 licensed reactors at 65 plant sites in 31 states. (That number excludes the Tennessee Valley Authority's (TVA's) Browns Ferry 1, which has not operated since 1985; the TVA Board decided May 16, 2002, to spend about $1.8 billion to restart the reactor by 2007.) 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 dropped substantially during the past decade, and costly downtime has been steadily reduced. Licensed commercial reactors generated electricity at a record-high average of more than 88% of their total capacity in 2001, according to industry statistics.[1]

Ten commercial reactors have received 20-year license extensions from the Nuclear Regulatory Commission (NRC), giving them up to 60 years of operation. License extensions for 13 more reactors are currently under NRC review.[2]

Industry consolidation could also help existing nuclear power plants, as larger nuclear operators purchase plants from utilities that run only one or two reactors. Several such sales have been announced, including the March 2001 sale of the Millstone plant in Connecticut to Dominion Energy for a record $1.28 billion. The merger of two of the nation's largest nuclear utilities, PECO Energy and Unicom, completed in October 2000, consolidated the operation of 17 reactors under a single corporate entity, Exelon Corporation.

Existing nuclear power plants appear to hold a strong position in the ongoing restructuring of the electricity industry. In most cases, nuclear utilities have received favorable regulatory treatment of past construction costs, and average nuclear operating costs are currently estimated to be lower than those of competing technologies.[3] Although eight U.S. nuclear reactors have permanently shut down since 1990, recent reactor sales could indicate greater industry interest in nuclear plants that previously had been considered

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[1] "U.S. Nuclear Record Sustained as 2001 Output nears 800-Million MWH," *Nucleonics Week*, February 14, 2002, p. 1.

[2] "Florida Reactors Get License Extension," *The Energy Daily*, June 10, 2002.

[3] "Production Costs Made Nuclear Cheapest Fuel in 1999, NEI Says," *Nucleonics Week*, January 11, 2001, p. 3.

marginal. Despite the shutdowns, total U.S. nuclear electrical output increased nearly 25% from 1990 to 2000, according to the Energy Information Administration. The increase resulted primarily from reduced downtime at the remaining plants, the startup of five new units, and reactor modifications to boost capacity.

A spike in fossil fuel prices and shortages of electricity during 2000-2001 helped encourage at least two nuclear operating companies to consider building new commercial nuclear reactors. Exelon helped form an international consortium that may build a demonstration Pebble Bed Modular Reactor (PBMR) in South Africa, a reactor cooled by helium that is intended to be highly resistant to accidents. However, Exelon announced in April 2002 that it would leave the consortium after a feasibility study is completed. Entergy, Dominion Resources, and Exelon have chosen sites in Mississippi, Virginia, and Illinois, respectively, for possible future nuclear units.[4] The Department of Energy (DOE) included an initiative in its FY2003 budget request to encourage construction of new commercial reactors by 2010.

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 generating companies will risk ordering new nuclear units.

A nuclear energy bill by Senator Domenici, S. 472, is intended to overcome some of the obstacles to new reactors. Among the bill's provisions are a demonstration of the approval process for new reactor sites, the designation of nuclear power as "an environmentally preferable product" for government procurement purposes and as an "emission-free electricity source" under the Clean Air Act, the inclusion of nuclear power in any "greenhouse gas" incentive programs, and changes in nuclear licensing requirements and procedures.

Nuclear Power Research and Development

The Bush Administration's National Energy Policy, issued in May 2001, calls for "the expansion of nuclear energy in the United States." DOE's FY2003 budget request reflects that policy with a funding initiative to encourage construction of new commercial reactors by 2010 and additional funding for advanced reactor designs. However, the total funding request for nuclear energy supply programs, $249.8 million, would remain about the same as in FY2002.

DOE's "Nuclear Power 2010" initiative would receive $38.5 million in FY2003, an increase of $30.5 million over FY2002. According to the DOE budget justification, the program builds on efforts begun in FY2001 to "identify the technical, institutional and regulatory barriers to the deployment of new nuclear power plants by 2010." The program seeks to deploy both a water-cooled reactor (similar to most existing commercial plants) and

[4] Beattie, Jeff. "Entergy Names Mississippi Site for Possible New Reactor," *Energy Daily*, April 17, 2002. p. 4. Weil, Jenny. "Exelon Selects Clinton Site for Possible New Reactor," *Nucleonics Week*, May 2, 2002. p. 1.

a gas-cooled reactor (such as the PBMR). DOE would pay up to half the cost of site approval, reactor design certification, license applications, detailed design work, and development of improved construction techniques.

DOE is requesting $8.0 million in FY2003 – double the FY2002 level – for advanced reactor technologies that could be ready for deployment after 2010. A variety of concepts are under consideration, according to the budget justification, including reactors fueled by plutonium recovered through reprocessing of spent nuclear fuel.

The Administration's *National Energy Policy* report contends that plutonium recovery could reduce the long-term environmental impact of nuclear waste disposal and increase domestic energy supplies. However, opponents contend that the separation of plutonium from spent fuel poses unacceptable environmental risks and undermines U.S. policy on nuclear weapons proliferation.

DOE is requesting $18 million to study pyroprocessing technology and electrometallurgical treatment of spent fuel from the Experimental Breeder Reactor II in Idaho, a decrease of about $4.5 million from FY2002. No funding is requested for waste transmutation, which involves bombarding nuclear waste with neutrons from a fast reactor or particle accelerator to convert long-lived radioactive isotopes into radioisotopes with shorter half-lives.

A DOE program to support innovative nuclear energy research projects, the "nuclear energy research initiative" (NERI), would receive $25 million under the FY2003 request, a $7 million reduction from FY2002. No funding is requested for "nuclear energy plant optimization" (NEPO), a research program to improve the economic competitiveness of existing nuclear power plants.

Several nuclear research and development provisions are included in comprehensive energy legislation (H.R. 4) approved by the House August 2, 2001, and the Senate April 25, 2002. Both versions of the bill would authorize a DOE research program on nuclear waste reprocessing technology. The House and Senate versions of H.R. 4 also would authorize appropriations for NERI, NEPO, and the nuclear energy technologies program. The Senate version would specifically authorize the Administration's Nuclear Power 2010 initiative.

Senator Domenici's nuclear energy bill, S. 472, includes an extensive section on development of advanced reactor designs. DOE would be required to give Congress a research and development plan that would lead toward the selection in 2004 of one or more advanced nuclear energy systems for demonstration through a public and private partnership. The bill would authorize $50 million for the program in FY2002 and such sums as necessary through FY2006.

"Nuclear energy is the only expandable, large-scale electricity source that avoids air emissions and meets the energy demands of a growing, modern economy," according to the DOE FY2003 budget justification. However, opponents have criticized DOE's nuclear research program as providing wasteful subsidies to an industry that they believe should be phased out as unacceptably hazardous.

Future nuclear plant orders depend primarily on whether new designs can cut construction costs by more than half from their average of the past two decades. It is not yet clear whether that cost goal can be achieved. (For more about nuclear power plant costs, see CRS Report RL31064, *Nuclear Power: Prospects for New Commercial Reactors*.)

Nuclear Power Plant Safety and Regulation

Safety and Security

Controversy over safety has dogged nuclear power throughout its development, particularly following the March 1979 Three Mile Island accident in Pennsylvania and the April 1986 Chernobyl disaster in the former Soviet Union. In the United States, safety-related shortcomings have been identified in the construction quality of some plants, plant operation and maintenance, equipment reliability, emergency planning, and other areas. In a recent example, it was discovered in March 2002 that leaking boric acid had eaten a large cavity in the top of the reactor vessel in Ohio's Davis-Besse nuclear plant. The corrosion left only the vessel's half-inch-thick stainless steel inner liner to prevent a potentially catastrophic release of reactor cooling water.

NRC's oversight of the nuclear industry is an ongoing issue; nuclear utilities often complain that they are subject to overly rigorous and inflexible regulation, but nuclear critics charge that NRC frequently relaxes safety standards when compliance may prove difficult or costly to the industry. In the wake of the September 11, 2001, terrorist attacks against the United States, concerns about nuclear power plant security have received heightened attention.

Domestic Reactor Safety. In terms of public health consequences, the safety record of the U.S. nuclear power industry in comparison with other major commercial energy technologies has been excellent. In more than 2,250 reactor-years of operation in the United States, the only incident at a commercial power plant that might lead to any deaths or injuries to the public has been the Three Mile Island accident, in which more than half the reactor core melted. Public exposure to radioactive materials released during that accident is expected to cause fewer than five deaths (and perhaps none) from cancer over the following 30 years.

The relatively small amounts of radioactivity released by nuclear plants during normal operation are not generally believed to pose significant hazards, although some groups contend that routine emissions are unsafe. There is substantial scientific uncertainty about the level of risk posed by low levels of radiation exposure; as with many carcinogens and other hazardous substances, health effects can be clearly measured only at relatively high exposure levels. In the case of radiation, the assumed risk of low-level exposure has been extrapolated mostly from health effects documented among persons exposed to high levels of radiation, particularly Japanese survivors of nuclear bombing in World War II.

The consensus among most safety experts is that a severe nuclear power plant accident in the United States is likely to occur less frequently than once every 10,000 reactor-years of operation. These experts believe that most severe accidents would have small public

health impacts, and that accidents causing as many as 100 deaths would be much rarer than once every 10,000 reactor-years. On the other hand, some experts challenge the complex calculations that go into predicting such accident frequencies, contending that accidents with serious public health consequences may be more frequent.

Security and Emergency Planning. Nuclear power plant security has been an ongoing issue, but concerns were considerably increased following the terrorist attacks on New York and Washington, D.C. At NRC's recommendation, nuclear power plants in the United States went to the highest level of security immediately after the attacks. The NRC Emergency Operations Center was activated, as well as regional NRC emergency centers, all of which maintained constant contact with the nation's nuclear power plants.

NRC ordered all commercial reactors on February 26, 2002, to "implement interim compensatory security measures for the generalized high-level threat environment." Some of the required security measures had been included in NRC's previous security recommendations. Although most of the detailed security requirements are secret, NRC said they generally included:

- increase patrols at nuclear power plants;
- augmented security forces and capabilities;
- establishment of additional security posts;
- installation of additional physical barriers;
- vehicle checks at greater distances from vital facilities;
- enhanced plant security coordination with law enforcement and military authorities; and
- more restrictive controls on personnel access to nuclear plant sites.

In light of the unprecedented attacks, NRC Chairman Richard A. Meserve, with the support of the other Commissioners, ordered a staff review of NRC's security regulations and procedures. NRC received $36 million in FY2002 supplemental appropriations to pay for analyzing the "design basis threats" that nuclear plants must be able to prevent, strengthen personnel screening procedures for nuclear facilities, and improve emergency preparedness programs and emergency communication capabilities. The funding was included in the FY2002 Defense Appropriations bill (H.R. 3338), approved by Congress December 20, 2001. NRC is seeking an additional $29.3 million for FY2003 to continue its research effort on security threats.

NRC regulations require nuclear power plants to be designed and operated to prevent unauthorized intrusion and to withstand external attacks. However, reactor containment structures are not specifically designed to withstand the types of deliberate air crashes that were carried out September 11, according to an NRC fact sheet. Groups critical of the nuclear industry contend that such a crash could cause a reactor meltdown, but some industry officials have expressed confidence that no radioactive release would occur. NRC is currently analyzing the potential effects of airliner attacks on nuclear power plants. To prevent internal threats, background checks are required for unescorted access and computerized security doors monitor the movement of personnel throughout each reactor building. However, critics contend that existing personnel controls could be circumvented.

Nuclear plant security forces are tested periodically with mock attacks under NRC's Operational Safeguards Response Evaluation (OSRE) program. Several power plants are scheduled to test the industry-initiated Safeguards Performance Assessment (SPA) program, a security force self-assessment system that would replace the OSRE program. Implementation of the SPA program has drawn criticism from both the industry and its critics.

Since the September 11 terrorist attacks, a number of groups have intensified their criticism of NRC's nuclear plant security requirements as being inadequate against sophisticated assaults. A bill to extend the Price-Anderson Act nuclear liability system (H.R. 2983), approved by the House November 27, 2001, would require the federal government to study a wide variety of security threats to nuclear facilities and to determine which threats would come from enemies of the United States and therefore be the responsibility of the federal government and which threats should be guarded against by nuclear power plant owners. NRC would be required to issue new regulations to ensure that nuclear power plants would be prepared for the threats identified as their responsibility. Other provisions would require that NRC continue designing, implementing, and evaluating security exercises at nuclear plants, rather than relying on an industry self-assessment program, and require NRC to issue new security regulations for nuclear materials transportation.

NRC would be required to take over the security forces at nuclear power plants under companion bills introduced November 29, 2001, by Representative Markey and Senator Reid (H.R. 3382, S. 1746). Supporters of the measure contend that existing guard forces hired by reactor owners are inadequate, but NRC strongly opposes the provision on the grounds that directly providing reactor security would interfere with its primary mission as an independent safety regulator.

The legislation also would require NRC to establish stockpiles of potassium iodide (KI) tablets within at least 50 miles of nuclear power plants. A separate bill focused specifically on the KI issue was introduced by Representative Markey on November 13, 2001 (H.R. 3279). If taken quickly enough, the tablets can prevent radioactive iodine released during a nuclear accident from being absorbed in the thyroid gland. On December 20, 2001, NRC offered to supply potassium iodide tablets to states in which nuclear power plants are located or nearby. The Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (P.L. 107-188), signed June 12, 2002, requires the federal government to give KI tablets to state and local governments to stockpile at schools, hospitals, and other public facilities within 20 miles of nuclear power plants.

(For more information, see CRS Report RS21131, *Nuclear Powerplants: Vulnerability to Terrorist Attack*, and CRS Terrorism Electronic Briefing Book fact sheet on *Nuclear Power Plant Emergency Response*,
http://www.congress.gov/brbk/html/ebter138.html.)

Reactor Safety in the Former Soviet Bloc. The Chernobyl accident was by far the worst nuclear power plant accident to have occurred anywhere in the world. At least 31 persons died quickly from acute radiation exposure or other injuries, and thousands of additional cancer deaths among the tens of millions of people exposed to radiation from the accident may occur during the next several decades.

According to a November 1995 report by the Organization for Economic Cooperation and Development (OECD), the primary observable health consequence of the accident has been a dramatic increase in childhood thyroid cancer. About 1,000 cases of childhood thyroid cancer were reported in certain regions surrounding the destroyed reactor — a rate that is as much as a hundred times the pre-accident level, according to OECD. The death rate for accident cleanup workers also rose measurably, the organization reported. The OECD report estimated that about 50,000 square miles of land in Belarus, Ukraine, and Russia were substantially contaminated with radioactive cesium.

World concern in recent years has focused on the safety of 13 other Chernobyl-type reactors (called RBMKs) that are still operating in the former Soviet Union (the last operating Chernobyl unit was permanently closed at the end of 2000). Despite safety improvements made after the Chernobyl disaster, the RBMKs remain inherently unstable and dangerous, according to many Western experts. Also still operating in the former Soviet bloc are 10 early-model Soviet light water reactors (LWRs), which are similar to most Western reactors but suffer from major safety deficiencies, such as the lack of Western-style emergency cooling systems.

The United States is providing direct assistance for upgrading the safety of Soviet-designed reactors, a program being coordinated by DOE, NRC, the Agency for International Development (AID), and the Department of State. DOE is seeking $14.6 million in FY2003 for improving the operation and physical condition of Soviet-designed nuclear power plants, a decrease of $6.5 million from FY2002. The General Accounting Office estimates that $1.93 billion had been provided through November 1999 by the United States and other industrialized nations to improve the safety of Soviet-designed reactors. Of that amount, $753 was contributed by the European Union, $532 by the United States, $43 million by the International Atomic Energy Agency, and the remainder from 14 other countries.

Licensing and Regulation

For many years a top priority of the nuclear industry was to modify the process for licensing new nuclear plants. No electric utility would consider ordering a nuclear power plant, according to the industry, unless licensing became quicker and more predictable, and designs were less subject to mid-construction safety-related changes ordered by NRC. The Energy Policy Act of 1992 largely implemented the industry's licensing goals.

Nuclear plant licensing under the Atomic Energy Act of 1954 (P.L. 83-703; U.S.C. 2011-2282) had historically been a two-stage process. NRC first issued a construction permit to build a plant, and then, after construction was finished, an operating permit to run it. Each stage of the licensing process involved complicated proceedings. Environmental impact statements also are required under the National Environmental Policy Act.

Over the vehement objections of nuclear opponents, the Energy Policy Act (P.L. 102-486) provides a clear statutory basis for one-step nuclear licenses, which would combine the construction permits and operating licenses and allow completed plants to operate without delay if construction criteria are met. NRC would hold preoperational hearings on the adequacy of plant construction only in specified circumstances. DOE's Nuclear Power 2010 initiative proposes to pay up to half the cost of combined construction and operating licenses for a water-cooled and a gas-cooled reactor. The House-passed version of H.R. 4 would

specify that a reactor's 40-year operating period under a combined license would begin when the reactor is ready to operate, rather than when the license is issued prior to construction.

A fundamental concern in the nuclear regulatory debate is the performance of NRC in issuing and enforcing nuclear safety regulations. The nuclear industry and its supporters have regularly complained that unnecessarily stringent and inflexibly enforced nuclear safety regulations have burdened nuclear utilities and their customers with excessive costs. But many environmentalists, nuclear opponents, and other groups charge NRC with being too close to the nuclear industry, a situation that they say has resulted in lax oversight of nuclear power plants and routine exemptions from safety requirements.

Primary responsibility for nuclear safety compliance lies with nuclear plant owners, who are required to find any problems with their plants and report them to NRC. Compliance is also monitored directly by NRC, which maintains at least two resident inspectors at each nuclear power plant. The resident inspectors routinely examine plant systems, observe the performance of reactor personnel, and prepare regular inspection reports. For serious safety violations, NRC often dispatches special inspection teams to plant sites.

In response to congressional criticism, NRC has begun reorganizing and overhauling many of its procedures. The Commission is moving toward "risk-informed regulation," in which safety enforcement is guided by the relative risks identified by detailed individual plant studies. NRC began implementing a new reactor oversight system April 2, 2000, that relies on a series of performance indicators to determine the level of scrutiny that each reactor should receive. However, the Union of Concerned Scientists has questioned the validity of the individual plant studies on which risk-informed regulation is based.

Senator Domenici's nuclear energy bill, S. 472, would change a number of licensing requirements and procedures, including the elimination of foreign ownership restrictions, authorization of informal licensing hearings in place of adjudicatory proceedings, and elimination of automatic Justice Department antitrust reviews of license applications.

Decommissioning and Life Extension

When nuclear power plants end their useful lives, they must be safely removed from service, a process called decommissioning. NRC requires nuclear utilities to make regular contributions to special trust funds to ensure that money is available to remove all radioactive material from reactors after they are closed. Because no full-sized U.S. commercial reactor has yet been completely decommissioned, which can take several decades, the cost of the process can only be estimated. Decommissioning cost estimates cited by a 1996 DOE report, for one full-sized commercial reactor, ranged from about $150 million to $600 million in 1995 dollars. Disposal of large amounts of low-level waste, consisting of contaminated reactor components, concrete, and other materials, is expected to account for much of those costs.

Consolidation of the nuclear industry has raised questions about the tax treatment of decommissioning funds when a commercial reactor is sold. H.R. 4 specifies that dedicated nuclear decommissioning funds can be transferred without incurring additional tax liabilities.

For planning purposes, it is generally assumed that U.S. commercial reactors could be decommissioned at the end of their 40-year operating licenses, although several plants have been retired before their licenses expired and others could seek license renewals to operate longer. NRC rules that took effect June 13, 1992, allow plants to apply for a 20-year license extension, for a total operating life of 60 years. Industry officials have predicted that most currently operating reactors will seek NRC license extensions. Assuming a 40-year lifespan, without life extension, more than half of today's 103 licensed reactors could be decommissioned by the year 2016.

Nuclear Accident Liability

Liability for damages to the general public from nuclear accidents is addressed by the Price-Anderson Act (primarily Section 170 of the Atomic Energy Act of 1954, 42 U.S.C. 2210). The act is up for reauthorization on August 1, 2002, but existing nuclear plants will continue to operate under the current Price-Anderson liability system if no extension is enacted.

Under Price-Anderson, the owners of commercial reactors must assume all liability for accident damages awarded to the public by the court system, and they must waive most of their legal defenses following a severe accident ("extraordinary nuclear occurrence"). To pay any such damages, each licensed reactor must carry financial protection in the amount of the maximum liability insurance available, currently $200 million. Any damages exceeding that amount are to be assessed equally against all operating commercial reactors, up to $83.9 million per reactor. Those assessments – called "retrospective premiums" – would be paid at an annual rate of no more than $10 million per reactor, to limit the potential financial burden on reactor owners following a major accident. Including three that are not operating, 106 commercial reactors are currently covered by the Price-Anderson retrospective premium requirement.

For each accident, therefore, the Price-Anderson liability system currently would provide up to $9.09 billion in public compensation. That total includes the $200 million in insurance coverage carried by the reactor that had the accident, plus the $83.9 million in retrospective premiums from each of the 106 currently covered reactors. On top of those payments, a 5% surcharge may also be imposed, raising the total per-reactor retrospective premium to $88.1 million and total compensation to $9.5 billion. Under Price-Anderson, the nuclear industry's liability for an accident is capped at that amount, which varies depending on the number of covered reactors, the amount of available insurance, and an inflation adjustment that is made every five years. Payment of any damages above that liability limit would require congressional approval under special procedures in the act.

The Price-Anderson Act also covers contractors who operate hazardous DOE nuclear facilities. The liability limit for DOE contractors is the same as for commercial reactors, except when the limit for commercial reactors drops because of a decline in the number of covered reactors. Since 1998, the number of covered commercial reactors has dropped from 110 to 106, so the commercial liability limit has dropped from $9.43 billion to $9.09 billion. Under the law, however, the limit for DOE contractors does not decline and so remains at $9.43 billion. Price-Anderson authorizes DOE to indemnify its contractors for the entire amount, so that damage payments for accidents at DOE facilities would ultimately come from the Treasury. However, the law also allows DOE to fine its contractors for safety

violations, and contractor employees and directors can face criminal penalties for "knowingly and willfully" violating nuclear safety rules.

The House approved a 15-year extension of the Price-Anderson liability system November 27, 2001 (H.R. 2983). The total retrospective premium for each reactor would be raised to $94 million and the limit on per-reactor annual payments raised to $15 million, with both to be adjusted for inflation every five years. For the purposes of those payment limits, a nuclear plant consisting of multiple small reactors (100-300 megawatts, up to a total of 950 megawatts) would be considered a single reactor. Therefore, a power plant with six 120-megawatt pebble-bed modular reactors would be liable for retrospective premiums of up to $94 million, rather than $564 million. The liability limit on DOE contractors would be set at $10 billion per accident, also to be adjusted for inflation.

The Senate included provisions in H.R. 4 to extend Price-Anderson coverage for new commercial reactors for 10 years and indefinitely for DOE contractors. The liability limit for commercial reactors would remain the same, with a five-year inflation adjustment, and the limit for DOE contractors would be set at $10 billion with an inflation adjustment. Modular reactors of 100-300 megawatts built together in a plant of up to 1,300 megawatts could be considered a single reactor under Price-Anderson.

The House-passed Price-Anderson bill would authorize the federal government to sue DOE contractors to recover at least some of the compensation that the government had paid for any accident caused by intentional DOE contractor management misconduct. Such cost recovery would be limited to the amount of the contractor's profit under the contract involved, and no recovery would be allowed from nonprofit contractors.

Although DOE is generally authorized to impose civil penalties on its contractors for violations of nuclear safety regulations, Atomic Energy Act §234A specifically exempts seven non-profit DOE contractors and their subcontractors. Under the same section, DOE automatically remits any civil penalties imposed on non-profit educational institutions serving as DOE contractors. H.R. 2983 would for future contracts eliminate the civil penalty exemption for the seven listed non-profit contractors and DOE's authority to automatically remit penalties imposed on all non-profit educational institutions serving as contractors. However, the bill would limit the civil penalties against a non-profit contractor to the amount of discretionary fees (incentive fees above actual cost reimbursement) awarded by DOE under that contract. The Senate's Price-Anderson extension in H.R. 4 includes similar provisions.

In approving an identical measure on DOE contractor penalties during the 106th Congress (H.R. 3383, H.Rept. 106-695, Part 1), the House Commerce Committee contended that elimination of the civil penalty exemption was necessary to improve nuclear safety enforcement at facilities operated by exempt contractors. However, DOE warned in its March 1999 *Report to Congress on the Price-Anderson Act* [http://www.gc.doe.gov] that elimination of the exemption could discourage non-profit institutions from operating DOE nuclear facilities.

The Price-Anderson Act's limits on liability were crucial in establishing the commercial nuclear power industry in the 1950s. Supporters of the Price-Anderson system contend that it has worked well since that time in ensuring that nuclear accident victims would have a

secure source of compensation, at little cost to the taxpayer. However, opponents contend that Price-Anderson subsidizes the nuclear power industry by protecting it from some of the financial consequences of the most severe conceivable accidents. The 2001 Green Scissors Report, issued by a coalition of environmental and citizens groups, calls for the Price-Anderson Act to be repealed and for the nuclear industry to purchase all necessary risk insurance on the private market.

Without an extension of the law, any commercial nuclear reactor licensed after August 1, 2002, could not be covered by the Price-Anderson system, although coverage would continue for existing reactors. Because no new U.S. reactors are currently planned, missing the deadline for extension would have little short-term effect on the nuclear power industry. However, if Price-Anderson expired, DOE would have to use alternate indemnification authority for hazardous nuclear contracts signed after that time.

Nuclear Waste Management

One of the most controversial aspects of nuclear power is the disposal of radioactive waste, which can remain hazardous for thousands of years. Each nuclear reactor produces an annual average of about 20 tons of highly radioactive spent nuclear fuel and 50-200 cubic meters of low-level radioactive waste. Upon decommissioning, contaminated reactor components are also disposed of as low-level waste.

The federal government is responsible for permanent disposal of commercial spent fuel (paid for with a fee on nuclear power) and federally generated radioactive waste, while states have the authority to develop disposal facilities for commercial low-level waste. Spent fuel and other highly radioactive waste is to be isolated in a deep underground repository, consisting of a large network of chambers carved from rock that has remained geologically undisturbed for hundreds of thousands of years.

The Nuclear Waste Policy Act of 1982 (NWPA, P.L. 97-425) as amended, names Nevada's Yucca Mountain as the sole candidate site for a national geologic repository. Following the recommendation of Energy Secretary Abraham, President Bush on February 15, 2002, recommended to Congress that DOE submit an application to NRC to construct the Yucca Mountain repository. As allowed by NWPA, Nevada Governor Guinn submitted a "notice of disapproval" (or "state veto") to Congress April 8, 2002. The state veto blocks repository construction at Yucca Mountain unless a congressional resolution approving the site is passed by a majority vote within 90 days of continuous session and signed into law. The House passed a Yucca Mountain approval resolution (H.J. Res. 87) on May 8, 2002, by a 306-117 vote. An identical resolution (S.J. Res. 34) was approved by the Senate Energy and Natural Resources Committee, 13-10, on June 5, 2002. (For details about congressional procedures in response to the state veto, see CRS Report RL31135, *Nuclear Waste Repository Siting: Expedited Procedures for Congressional Approval*.)

The Bush Administration is seeking $524.7 million for the DOE civilian waste disposal program for FY2003, a 40% boost over FY2002. The increased budget is intended to pay for preparation of a Yucca Mountain repository construction permit application, which DOE expects to submit to NRC in FY2004 – a one-year delay from the previous schedule. The additional funds are also needed for detailed repository design work, repository performance

studies, and transportation planning, according to DOE. Despite the delay in submitting a construction application, DOE contends that it can still begin receiving waste at the site by 2010 as previously scheduled.

(For further details, see CRS Issue Brief IB92059, *Civilian Nuclear Waste Disposal*.)

Weapons Program Cleanup and Disposal

According to DOE's FY2003 budget justification, cleaning up contaminated nuclear sites under the existing regulatory system "is projected to cost in the range of $220 billion and take 70 years to complete. Costs continue to increase annually while schedules slip." A review ordered by Energy Secretary Abraham "indicates that the EM program has failed to significantly reduce the risk presented to the public and the environment by the Cold War's nuclear legacy," according to the justification.

Federal environmental laws make DOE sites subject to state and federal environmental regulation, including the imposition of fines and penalties. DOE has signed numerous legally binding compliance agreements with environmental regulators that establish specific cleanup deadlines and other requirements. However, DOE contends that many of those environmental requirements are overly costly, ineffective, and unnecessarily time-consuming. (For more details see CRS Report RL31307, *Appropriations for FY2003: Energy and Water Development*, section on Department of Energy "Environmental Management.")

Among the more controversial programs in the cleanup activities is the disposal of surplus plutonium from dismantled nuclear weapons, partly because it is being pursued in conjunction with plans to dispose of a similar amount of plutonium from dismantled Soviet weapons. The Clinton Administration proposed, as a means of disposing of weapons plutonium from the U.S. nuclear arsenal, a "dual track" strategy of mixing plutonium with uranium as mixed oxide (MOX) fuel for commercial power reactors, and vitrification (dissolving in glass) and disposal of the plutonium unsuited for fuel and the resulting fission products.

In July 1998 the Department of Energy issued a draft Environmental Impact Statement on the plutonium disposition program. An agreement with Russia signed in September 2000 set up a similar program for Russian plutonium disposal. However, in submitting its FY2003 budget request, DOE declared that it was eliminating the immobilization part of the two-track program for U.S. plutonium and that most of the plutonium originally destined for immobilization would instead be consumed as MOX fuel. Despite the agreement, several difficult issues remain in the program to dispose of Soviet plutonium. (For details on the Russian program, see CRS Issue Brief IB10091, *Nuclear Nonproliferation Issues.)*

As part of the U.S. program, construction of a plant to convert plutonium into MOX fuel was planned for DOE's Savannah River Site (SRS) in South Carolina. The plutonium is currently stored in several DOE sites, including the former weapons component fabrication facility at Rocky Flats in Colorado. DOE has agreed with Colorado authorities to close the Rocky Flats facility by 2006, and as part of the process of cleaning up the site has proposed starting to ship the plutonium located there to a temporary storage facility at SRS. However,

South Carolina Governor Jim Hodges objected to bringing the plutonium to SRS without an "ironclad" commitment for operating and funding the MOX facility, on the grounds that without it there was a risk that the unprocessed plutonium would be stored indefinitely in South Carolina.

The State of South Carolina has gone to federal court to block DOE's shipments of plutonium from Rocky Flats, but the suit was dismissed June 13, 2002. In the meantime, legislation has been introduced to set a schedule for the MOX plant construction and operation, including penalties of up to $100 million per year to be paid the state by DOE if the schedule is not followed. The bills were introduced in the House May 2, 2002, by Representative Graham (H.R. 4648) and in the Senate by Senators Thurmond and Allard (S. 2453).

Federal Funding for Nuclear Energy Programs

The following tables summarize current funding for DOE nuclear fission programs and uranium activities, and for the NRC. The sources for the funding figures are Administration budget requests and committee reports on the Energy and Water Development Appropriations Acts, which fund all nuclear programs. President Bush submitted his FY2003 funding request to Congress February 4, 2002.

Table 1. Funding for the Nuclear Regulatory Commission

(budget authority* in millions of current dollars)

	FY2001 Approp.	FY2002 Approp.	FY2003 Request		
Nuclear Regulatory Commission					
Reactor Safety	227.6	265.5	286.0	--	--
Nuclear Materials Safety	53.1	63.4	64.2	--	--
Nuclear Waste Safety	64.1	71.6	71.9	--	--
International Nuclear Safety	5.1	5.3	5.4	--	--
Management and Support	149.7	166.2	171.0	--	--
Inspector General	5.8	6.5	7.2	--	--
(Nuclear Plant Security)		(36.0*)	(29.3)	--	--
TOTAL NRC BUDGET AUTHORITY	**505.5**	**578.4**	**605.6**	**--**	--
Offsetting fees	**453.2**	**479.5**	**518.3**	**--**	--
Net appropriation	**52.3**	**99.0**	**87.3**	**--**	--

* Additional $36 million for nuclear plant security provided by FY2002 supplemental appropriations included in FY2002 Defense Appropriations Bill (H.R. 3338), approved by Congress December 20, 2001. The FY2002 supplemental security funding is not to be offset by fees. The security funding is included in the other NRC programs, so it should not be added to the NRC total as a separate funding category.

Table 2. DOE Funding for Nuclear Activities
(budget authority in millions of current dollars)

	FY2001 Approp.	FY2002 Approp.	FY2003 Request		
Nuclear Energy (selected programs)					
Program Direction	22.0	23.0	24.4	--	--
University Reactor Assistance	12.0	17.5	17.5	--	--
Nuclear Energy Plant Optimization	5.0	7.0	0	--	--
Nuclear Energy Research Initiative	35.0	32.0	25.0	--	--
Nuclear Energy Technologies	7.5	12.0	46.5	--	--
Infrastructure	92.2	82.5	119.1	--	--
Nuclear Facilities Management	34.9	30.3	–	--	--
Spent Fuel Pyroprocessing	–	–	18.2	--	--
International Nuclear Safety*	20.5	21.1	14.6	--	--
Total, Nuclear Energy	259.9	250.5	249.8	--	--
Uranium Facilities Maintenance and Remediation	422.5	418.4	382.2	--	--
Nuclear Waste Activities					
Environmental Management	6,966.1	7,144.0	7,142.0	--	--
Nuclear Waste Fund Activities**	390.4	375.0	524.7	--	--

* Funded under "Defense Nuclear Nonproliferation."
** Funded by a 1-mill-per-kilowatt-hour fee on nuclear power, plus appropriations for defense waste disposal.

LEGISLATION

H.R. 4 (Tauzin)

Securing America's Future Energy Act of 2001. Comprehensive energy bill that includes several nuclear energy provisions. Introduced July 27, 2001; referred to multiple committees. Passed House August 2, 2001, by vote of 240-189. Passed Senate April 25, 2002, with text of S. 517 as amended.

H.R. 2983 (Wilson)

Price-Anderson Reauthorization Act of 2001. Extends Price-Anderson Act nuclear accident liability system for 15 years and increases liability limits. Allows nuclear power plants consisting of multiple small units to be counted as a single reactor in assessing accident liability. Authorizes the federal government to recover at least some of any damages it was forced to pay on behalf of indemnified Department of Energy (DOE) nuclear contractors for accidents caused by intentional management misconduct. Requires NRC to issue new security regulations for nuclear power plants and the transportation of nuclear materials. Introduced October 2, 2001; referred to Committee on Energy and Commerce. Ordered reported by Committee October 31, 2001; approved by House November 27, 2001.

H.R. 3279 (Markey)

Requires NRC to ensure sufficient stockpiles of potassium iodide tablets for use after a nuclear accident. Introduced November 13, 2001; referred to Committee on Energy and Commerce.

H.R. 3382 (Markey)/S. 1746 (Reid)

Requires NRC to take over operation of nuclear power plant security forces and to ensure sufficient stockpiles of potassium iodide tablets for use after a nuclear accident. Introduced November 29, 2001. House bill referred to Committee on Energy and Commerce; Senate bill referred to Committee on Environment and Public Works.

H.R. 4648 (Graham)

Sets timetable for construction of MOX fuel facility to dispose of weapons-usable plutonium at the Savannah River Site, South Carolina. Introduced May 2, 2002; referred to Subcommittee on Energy and Air Quality, Committee on Energy and Commerce.

S. 472 (Domenici)/H.R. 1679 (Graham)

Nuclear Energy Electricity Supply Assurance Act of 2001. Authorizes nuclear energy research and development programs, provides incentives for increasing capacity at existing nuclear power plants, modifies nuclear licensing requirements, and extends the Price-Anderson Act nuclear liability system. Senate bill introduced March 7, 2001; referred to Energy and Natural Resources Committee. House bill introduced May 2, 2001; referred to Committees on Energy and Commerce and Science.

S. 1591 (Voinovich)

Nuclear Safety and Promotion Act of 2001. Reauthorizes Price-Anderson Act for 10 years, modifies nuclear power plant licensing requirements, and addresses potential shortages of skilled nuclear safety personnel at the Nuclear Regulatory Commission. Introduced October 30, 2001; referred to Committee on Environment and Public Works.

S. 4648 (Thurmond/Allard)

Sets timetable for construction of MOX fuel facility to dispose of weapons-usable plutonium at the Savannah River Site, South Carolina. Introduced May 2, 2002; referred to Committee on Energy and Natural Resources.