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Nuclear Energy Policy

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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, 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 for FY2002 (P.L. 107-66), Congress generally rejected those reductions.

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. House and Senate companion nuclear energy bills (H.R. 1679, S. 472) would encourage production from existing reactors, encourage construction of new nuclear plants, and modify licensing procedures. Nuclear energy provisions are also included in omnibus energy legislation introduced by Senator Daschle December 5, and in a comprehensive energy bill introduced by Senator Murkowski (S. 388).

The September 11, 2001, terrorist attacks on the United States raised questions about nuclear power plant security. The Nuclear Regulatory Commission (NRC) immediately recommended that U.S. reactors go to the highest security level and began evaluating plant security requirements. 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 (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.

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.

Concern about the spread, or proliferation, of nuclear weapons throughout the world has risen sharply since longtime rivals India and Pakistan conducted competing nuclear weapons tests in May 1998. Recent heightened tensions in Southeast Asia have focused attention on the effectiveness of the international nuclear nonproliferation regime. In addition, the September 11 attacks have raised new concerns about the potential for terrorists to detonate nuclear explosives or radioactive "dirty bombs."

MOST RECENT DEVELOPMENTS

After the September 11 terrorist attacks on New York and Washington, D.C., nuclear power plants in the United States went to the highest level of security at the recommendation of the Nuclear Regulatory Commission (NRC). 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. On December 20, NRC offered to supply potassium iodide tablets to states in which nuclear power plants are located or nearby. If taken quickly enough, the tablets can prevent radioactive iodine released during a nuclear accident from being absorbed in the thyroid gland.

The House approved a 15-year extension of the Price-Anderson Act nuclear liability system November 27 (H.R. 2983). The measure would raise the annual limit on payments to nuclear accident victims from $10 million to $15 million for each commercial reactor and allow nuclear plants consisting of several small modules to be treated as a single reactor under the Price-Anderson system. The bill would allow 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. In addition, the bill would require NRC to issue new security regulations for nuclear power plants and the transportation of nuclear materials.

FY2002 funding for DOE nuclear programs and NRC was approved by Congress November 1 and signed by the President November 12. The FY2002 Energy and Water Development Appropriations Bill (H.R. 2311, H. Rept. 107-258, P.L. 107-66) provides $250 million for DOE nuclear energy research and related programs, about 10% above the Bush Administration request. Conferees rejected the Senate's deep cuts in the DOE nuclear waste disposal program at Yucca Mountain, Nevada, but the appropriation of $375 million fell short of the Administration request. NRC's FY2002 total funding request of $513 million was boosted by $10 million to prepare for licensing new commercial reactors. An additional $36 million for NRC security-related expenses was provided in the FY2002 supplemental appropriations bill approved December 20 as part of the FY2002 Defense Appropriations (H.R. 3338).

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 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 (excluding one Tennessee Valley Authority unit that is indefinitely shut down). 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 1990s, and costly downtime has been steadily reduced. Licensed commercial reactors generated electricity at a record-high average of more than 87% of their total capacity in 2000, according to industry statistics. Comprehensive energy legislation (S. 388) introduced February 26, 2001, by Senator Murkowski would provide extra incentives for increased generation by existing nuclear plants. Nuclear power plants could receive 1 mill (a tenth of a cent) for each kilowatt-hour generated in any year that exceeded total generation in a specific base year, up to $2 million per reactor. Nuclear plants could also be reimbursed for 10% of any capital costs incurred in boosting their capacity by at least 1%, up to $1 million per reactor. A nuclear energy bill (S. 472) introduced by Senator Domenici March 7, 2001, would reimburse 10% of capital costs incurred in increasing capacity by at least 5%.

The Calvert Cliffs nuclear plant received the first 20-year license extension from the Nuclear Regulatory Commission (NRC) in March 2000; two more extensions have since been granted, and extensions for 12 additional reactors are under review. 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.[1] 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 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

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

resulted primarily from reduced downtime at the remaining plants, the startup of five new units, and reactor modifications to boost capacity.

Recent increases in fossil fuel prices and shortages of electricity have led at least two nuclear operating companies to consider building new commercial nuclear reactors. Exelon is participating in an international consortium that may build a demonstration Pebble Bed Modular Reactor in South Africa, a reactor cooled by helium that is intended to be highly resistant to accidents. Entergy is considering selecting U.S. sites for future nuclear units.[2]

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. The Energy Information Administration forecasts that no new U.S. reactors will become operational before 2010, at the earliest.

Senator Domenici's nuclear energy bill, 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

U.S. development of advanced reactors largely ended under the Clinton Administration, although some research has continued. In FY1995, Congress accepted the Clinton 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), although $5 million was provided in FY1999 for a joint U.S.-Russian program to develop the GT-MHR for destruction of surplus weapons plutonium. Funding for improved versions of today's light water reactors (LWRs) ended in FY1998.

The Bush Administration requested $18.1 million for FY2002 for a program to support innovative nuclear energy research projects, the "nuclear energy research initiative" (NERI), only about half the FY2001 level. The FY2002 Energy and Water Development Appropriations bill (H.R. 2311, H. Rept. 107-258, P.L. 107-66), signed into law November 12, 2001, provides $32 million for this program.

The new "nuclear energy technologies" program would have been reduced in the Administration request from $7.5 million in FY2001 to $4.5 million in FY2002; the enacted appropriations bill provides $12 million. The program is designed to produce a "Generation IV Technology Roadmap" for near-term commercial deployment of advanced nuclear power plants. Included in the FY2002 funding is $3 million for sharing the nuclear industry's costs

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[2] "Entergy Considers Picking Sites for Potential Plant Construction," *Nucleonics Week*, May 3, 2001, p. 1.

of applying to NRC for early site permits, combined operating licenses, and design certifications for new reactors and reactor technology, as well as $2 million for testing new reactor designs, fuels, and materials at DOE national laboratories. DOE issued an interim report on new technology deployment in May 2001 under the program.

Another $4.5 million was requested for "nuclear energy plant optimization" (NEPO), a research program to improve the economic competitiveness of existing nuclear power plants. That level is $500,000 below the FY2001 appropriation, but the final FY2002 bill includes $7 million for the program.

Several nuclear research and development provisions are included in comprehensive energy legislation (H.R. 4) approved by the House August 2. A DOE "advanced fuel recycling technology research and development program" would be authorized at $10 million in FY2002. The bill would authorize appropriations of $60 million for NERI, $15 million for NEPO, and $20 million for the nuclear energy technologies program for FY2002, with "such sums as are necessary" for the following two fiscal years.

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.

DOE justifies its efforts to encourage the continued operation of commercial U.S. nuclear plants as an important element in meeting national goals for reducing carbon dioxide emissions. Because nuclear plants directly emit no carbon dioxide, the continued operation of existing U.S. reactors avoids more than 620 million tons of carbon dioxide emissions each year, according to the FY2000 DOE budget justification. Opponents have criticized the nuclear energy research proposals as providing wasteful subsidies to an industry that they believe should be phased out.

Shutting down the ALMR program and its associated research facilities, particularly the Experimental Breeder Reactor II (EBR-II) in Idaho, is expected to take several years. Some ALMR facilities are being used for electrometallurgical treatment of EBR-II fuel, for which $45 million was appropriated in FY1999. Opponents of the program have expressed concern that such activities could help keep the ALMR/IFR program alive and have called for Congress to halt further funding. Supporters contend that the technology could convert unstable fuel elements into safer forms for storage and disposal. DOE issued a Record of Decision September 19, 2000, to use the electrometallurgical process for full-scale treatment of spent fuel at the Idaho site. Electrometallurgical treatment could be included in the DOE advanced fuel recycling program authorized by H.R. 4, and is provided $26 million in the FY2002 Energy and Water Development Appropriations bill.

Despite the federal cutbacks in developing new reactors, the recently tightening electricity supply situation has led to the first serious consideration of new U.S. reactor construction in many years. Substantial attention has focused on Exelon's participation in a consortium that is considering construction of an advanced "pebble bed" modular high-temperature gas-cooled reactor (PBMR) in South Africa, which could lead to construction

of similar reactors in the United States. The reactor's fuel would be encased within tennis-ball-sized spheres that would be designed to withstand maximum accident temperatures without damage. The consortium plans to decide whether to proceed with the South Africa project by autumn of 2002.

Future nuclear plant orders depend primarily on whether the PBMR and other 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.[3] (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 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. 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. Documented public exposure to radioactivity from nuclear power plant waste has also been minimal, although the potential long-term hazard of waste disposal remains controversial. 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.

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[3] Weil, Jenny. "Exelon Considering Demo Plant in U.S. to Prove PBMR Concept." *Platts Nucleonics Week*. December 13, 2001. p. 1.

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.

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 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. To prevent internal threats, background checks are required for unescorted access and computerized security doors monitor the movement of personnel throughout each reactor building.

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. (For more information, see 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. The FY2002 Energy and Water Development Appropriations bill provides DOE $10 million for improving the operation and physical condition of Soviet-designed nuclear power plants. 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. 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 controlled 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 to the public, 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 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 Price-Anderson.

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 to 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 licensed 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 $584 million. The liability limit on DOE contractors would be set at $10 billion per accident, also to be adjusted for inflation.

The mechanism for imposing fines on DOE contractors has become controversial since the 2000 startup of the National Nuclear Security Administration (NNSA) within DOE to administer the Department's nuclear defense programs. NNSA has a memorandum of understanding with DOE's Office of Environment, Safety, and Health (ESH) to continue inspecting facilities now administered by NNSA. ESH cannot directly impose penalties for violations at NNSA facilities but can recommend that they be imposed by the NNSA administrator.

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 same provisions were contained in H.R. 723, ordered reported by the House Energy and Commerce Committee on February 28, 2001.

In approving an identical measure during the 106th Congress (H.R. 3383, H.Rept. 106-695, Part 1), the 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.

Senator Daschle's omnibus energy bill (S. 1766) includes a permanent extension of Price-Anderson nuclear indemnification authority for DOE contractors. A 10-year extension of the Price-Anderson indemnification authority for NRC and DOE is included in Senator Murkowski's comprehensive energy bill, S. 388, and in Senator Domenici's nuclear energy proposal, S. 472. As recommended by NRC in an October 1998 report to Congress, the annual per-reactor limit on retrospective premiums would be doubled to $20 million under S. 388 and S. 472. All three measures would raise the accident liability limit for DOE nuclear contractors to $10 billion, subject to inflation. All three proposals also include the provisions of H.R. 723 on DOE contractor penalties.

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 existing reactors would continue to be covered. 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.

DOE is studying Nevada's Yucca Mountain as the site for such a geologic repository, as required by the Nuclear Waste Policy Act of 1982 (NWPA, P.L. 97-425) as amended. DOE issued a "viability assessment" in December 1998 that found no insurmountable problems with the site, and a final recommendation on the site's suitability is currently planned for FY2002, a delay from the previous goal of FY2001. A preliminary site suitability evaluation released by DOE August 21, 2001, found that the site could meet Environmental Protection Agency (EPA) standards.

The Bush Administration sought $445 million for the DOE civilian waste disposal program for FY2002, a 14% boost over FY2001. The increased budget was intended to fund the Yucca Mountain site recommendation and prepare for a repository construction permit application to the Nuclear Regulatory Commission (NRC) in FY2003. The House included all but $2 million of the request in the FY2002 Energy and Water Development bill, but the Senate voted to cut the program to $275 million. The final bill provides $375 million for the program.

As originally enacted, the 1982 nuclear waste law established procedures and timetables for DOE to examine candidate sites for at least one deep repository for commercial spent fuel (with the option of also taking government high-level waste), to begin operating by January 31, 1998. Nuclear utilities were required to sign a contract with DOE for disposal services. The Nuclear Waste Fund, consisting of revenues from a fee on nuclear power, was created to pay for the disposal program. However, DOE could not spend money from the fund without annual congressional appropriations. The waste repository was required to meet Environmental Protection Agency (EPA) standards and be licensed by NRC.

Controversy over implementation of the waste law led to fundamental revisions included in the Omnibus Budget Reconciliation Act of 1987 (P.L. 100-203). The revised waste law singled out Yucca Mountain as the only candidate site for a permanent waste repository.

DOE's current goal for opening the Yucca Mountain waste repository is 2010 — 12 years later than required by NWPA. With no federal storage or disposal facility available by the nuclear waste law's 1998 deadline, nuclear power plants must continue storing their waste at reactor sites much longer than originally anticipated. Most are expected to build additional on-site storage facilities, a move that has drawn strong state and local opposition in several recent cases. A federal appeals court ruled August 31, 2000, that nuclear power plant owners could sue DOE for damages resulting from the missed 1998 disposal deadline. (For more background, see CRS Report 96-212, *Civilian Nuclear Spent Fuel Temporary Storage Options*.)

H.R. 4 would authorize a DOE research program on spent fuel reprocessing "in support of evaluation of alternative national strategies for spent nuclear fuel." S. 388 and S. 472 would establish an Office of Spent Nuclear Fuel Research to conduct such research. Supporters of reprocessing research contend that such technology could extract valuable energy from spent fuel and reduce its long-lived hazardous constituents, such as plutonium. However, any treatment of spent fuel that involves separating plutonium for re-use is highly controversial because of plutonium's potential as a weapons material.

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

Nuclear Weapons Proliferation

The United States has been a leader of worldwide efforts to prevent the spread of nuclear weapons. To this end, the international community and many individual states have agreed to a range of treaties, laws, and agreements, known collectively as the nuclear nonproliferation regime, aimed at keeping nations that do not have nuclear weapons from acquiring them.

The nonproliferation regime has also been concerned with preventing terrorists from obtaining a nuclear weapon or the materials to craft one. The attacks on New York and Washington September 11 added a new level of reality to the threat that terrorists might acquire a nuclear weapon and explode it in a populated area.

Other nonproliferation concerns include a number of regional crisis points: the India-Pakistan arms race, North Korea, and the Middle East, primarily Iraq, Iran, and Israel. There is concern about China's actions in expanding its nuclear force, and of Chinese and Russian activities that may encourage proliferation in the other regions.

Disposing of plutonium and highly enriched uranium from dismantled Russian nuclear weapons, while preventing it from falling into the hands of terrorists or other proliferators, is another current focus of nonproliferation activities. In the longer term, the major question is fulfilling the pledge in the Nuclear Nonproliferation Treaty (NPT) by the nuclear weapons states, including the United States, to pursue complete nuclear disarmament, in the face of skepticism about the possibility, or even the wisdom, of achieving that goal.

Numerous U.S. agencies have programs related to nuclear nonproliferation, but the major activities are carried out by the Departments of State, Defense, and Energy. DOE's program is part of the National Nuclear Security Administration, which is responsible for the management of the U.S. nuclear weapons program.

The attacks of September 11 have increased interest in assuring that Russian nuclear materials do not fall into terrorists' hands, and some increase in funding DOE's non-proliferation activities in the Former Soviet Union has been promised by House and Senate appropriators.

For detailed discussion of nonproliferation policy, see CRS Issue Brief IB10091, *Nuclear Nonproliferation Issues.*

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 FY2002 funding request to Congress April 9, 2001. The House approved the FY2002 Energy and Water Development Appropriations bill June 28, 2001 (H.R. 2311, H.Rept. 107-112), and the Senate approved its version of the bill July 19, 2001 (S. Rept. 107-39). The Conference Report on the measure (H. Rept. 107-258) was approved by the House and Senate November 1, 2001, and signed into law November 12, 2001 (P.L. 107-66).

Table 1. Funding for the Nuclear Regulatory Commission

(budget authority in millions of current dollars)

	FY2001 Approp.	FY2002 Request	FY2002 House	FY2002 Senate	FY2002 Approp.
Nuclear Regulatory Commission					
Reactor Safety	219.2	231.4	– *	–	–
Nuclear Materials Safety	52.5	55.0	–	–	–
Nuclear Waste Safety	59.3	63.2	–	–	–
International Nuclear Safety	4.8	5.1	–	–	–
Management and Support	146.1	152.2	–	–	–
Inspector General	5.5	6.2	6.2	5.5	6.2
Nuclear Plant Security					36.0**
TOTAL NRC BUDGET AUTHORITY*	**487.3**	**513.1**	**523.1**	**522.4**	**559.1**

* Entirely offset by fees on NRC licensees through FY2000, plus payments from the Nuclear Waste Fund for repository licensing. FY2001 appropriation is offset 98%, FY2002 request and Conference Report figure is offset 96%, minus funding from the Nuclear Waste Fund, and offset for Senate FY2002 appropriation is slightly lower; House and Senate FY2002 subcategories are not specified.

** 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 supplemental security funding is not to be offset by fees.

Table 2. DOE Funding for Nuclear Activities

(budget authority in millions of current dollars)

	FY2001 Approp.	FY2002 Request	FY2002 House	FY2002 Senate	FY2002 Conf.
Nuclear Energy (selected programs)					
Advanced Radioisotope Power Systems	31.8	29.1	28.2	29.1	29.0
Program Direction	23.0	25.1	20.5	25.1	23.0
University Reactor Assistance	12.0	12.0	15.8	19.0	17.5
Nuclear Energy Plant Optimization	5.0	4.5	5.0	9.0	7.0

	FY2001 Approp.	FY2002 Request	FY2002 House	FY2002 Senate	FY2002 Conf.
Nuclear Energy Research Initiative	34.8	18.1	23.1	38.0	32.0
Nuclear Energy Technologies	7.5	4.5	4.5	14.0	12.0
Isotope Support	18.7	18.2	16.2	18.2	17.2
International Nuclear Safety*	19.4	13.8	10.0	19.5	10.0
Total, Nuclear Energy	243.6	223.1	224.1	264.1	250.5
Uranium Facilities Maintenance and Remediation	392.5	363.4	393.4	408.7	418.4
Nuclear Waste Activities					
Environmental Management	6,266.9	5,912.8	7,031.9	7,275.8	7,135.8
Nuclear Waste Fund Activities**	390.4	445.0	443.0	275.0	375.0

* 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. Text based on four reported bills: H.R. 2436 (Resources, H. Rept. 107-160); H.R. 2460 (Science, H. Rept. 107-177); H.R. 2511 (Ways and Means, H. Rept. 107-157); and H.R. 2587 (Energy and Commerce, H. Rept. 107-162, pts. 1-2). Passed House August 2, 2001, by vote of 240-189.

H.R. 723 (Barton)

Removes an exemption from civil penalties for nuclear safety violations at DOE facilities by non-profit contractors. Introduced February 26, 2001; referred to Energy and Commerce Committee. Approved by Committee February 28, 2001.

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.

S. 388 (Murkowski)

National Energy Security Act of 2001. Includes provisions to encourage increased generation by existing nuclear power plants, authorize nuclear research and development, and extend the Price-Anderson nuclear liability system. Introduced February 26, 2001; referred to Energy and Natural Resources Committee.

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. 597 (Bingaman)

Comprehensive and Balanced Energy Policy Act of 2001. Introduced March 22, 2001; referred to Committee on Energy and Natural Resources. Includes provisions extending Price-Anderson liability system for DOE nuclear contractors and authorizing nuclear research and development. Committee markup began August 2, 2001.

S. 919 (Thurmond)

Requires the Department of Energy to study the feasibility of developing commercial nuclear power plants at existing DOE nuclear sites. Introduced May 21, 2001; referred to Committee on Energy and Natural Resources.

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. 1766 (Daschle)

Energy Policy Act of 2002. Omnibus energy bill that includes Price-Anderson reauthorization and other nuclear energy provisions. Introduced December 6, 2001.