

CRS Issue Brief for Congress

Received through the CRS Web

Nuclear Energy Policy

Updated September 15, 2003

Mark Holt and Carl E. Behrens
Resources, Science, and Industry Division

CONTENTS

SUMMARY

MOST RECENT DEVELOPMENTS

BACKGROUND AND ANALYSIS

Overview of Nuclear Power in the United States

Nuclear Power Research and Development

Nuclear Power Plant Safety and Regulation

Safety

Domestic Reactor Safety

Reactor Safety in the Former Soviet Bloc

Licensing and Regulation

Reactor Security

Decommissioning

Nuclear Accident Liability

Nuclear Waste Management

Federal Funding for Nuclear Energy Programs

LEGISLATION

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, and the Price-Anderson Act nuclear liability system.

The Bush Administration has stressed the importance of nuclear power in the nation's energy policy. The Administration's FY2004 budget request includes \$35 million for a Department of Energy (DOE) effort to encourage deployment of new commercial nuclear power plants by 2010, about the same as the FY2003 appropriation. The Administration is also seeking \$4 million for the Nuclear Hydrogen Initiative, a new DOE program in which nuclear reactors would produce hydrogen to fuel motor vehicles. The House cut the Administration's nuclear energy request slightly (H.R. 2754, H.Rept. 108-212), while the Senate Appropriations Committee recommended a \$44.8 million increase (S. 1424, S.Rept. 108-105).

Energy legislation under consideration on the Senate floor (S. 14) would have authorized financial assistance for new nuclear power plants and funding to construct a demonstration reactor in Idaho to produce hydrogen. However, those provisions were not included in the energy legislation approved by the Senate July 31, 2003 (H.R. 6).

Price-Anderson coverage for new commercial reactors would be extended through August 1, 2012, by the Senate version of H.R. 6 and a bill approved by the Senate Environment and Public Works Committee April 9, 2003 (S. 156). A provision in the version of H.R. 6 passed by the House April 11, 2003, would extend Price-Anderson through August 1, 2017. S. 14 had provided

for a permanent extension.

The September 11, 2001, terrorist attacks on the United States raised questions about nuclear power plant security. Reactor security provisions are included in the House version of H.R. 6. Legislation to strengthen reactor security requirements (S. 1043) was approved by the Senate Environment and Public Works Committee on May 15, 2003.

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 conduct detailed physical characterization of Yucca Mountain in Nevada as a permanent underground repository for high-level waste. A resolution to allow work at Yucca Mountain to proceed despite state objections was signed by the President on July 23, 2002 (P.L. 107-200).

DOE is seeking sharply higher funding for the nuclear waste program for FY2004, contending that any less would prevent the Yucca Mountain repository from being ready to receive waste by 2010 as currently planned. The House agreed, voting to boost funding to \$765 million – \$174 million above the request. However, the Senate Appropriations committee voted to cut the request by \$166 million.

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 power plants currently are favored over nuclear reactors for new generating capacity. However, some electric utilities are seeking approval of sites for possible new reactors.

MOST RECENT DEVELOPMENTS

The FY2004 Energy and Water Development appropriations bill, containing funding for Department of Energy (DOE) nuclear programs, was approved by the House July 18 (H.R. 2754, H.Rept. 108-212) and by the Senate Appropriations Committee July 17 (S. 1424, S.Rept. 108-105). President Bush requested \$387.6 million for DOE nuclear energy research and development — including advanced reactors, fuel cycle technology, and nuclear hydrogen production. The House bill would cut the request slightly, while the Senate Appropriations Committee recommended a \$44.8 million increase. For DOE's civilian nuclear waste program, the Administration requested sharply higher funding for FY2004, contending that any less would prevent a planned national repository at Yucca Mountain, Nevada, from being ready to receive waste by 2010 as currently planned. The House agreed, voting to boost funding to \$765 million — \$174 million above the request. However, the Senate Appropriations committee voted to cut the request by \$166 million.

Omnibus energy legislation passed by the House on April 11 (H.R. 6) would extend the Price-Anderson Act through August 1, 2017. The Senate passed its version of H.R. 6 on July 31, 2003, extending Price-Anderson coverage for new commercial nuclear plants through August 1, 2012. Under Price-Anderson, commercial reactors must pay for any radiological damages to the public through a limited industry self-insurance system, and DOE nuclear contractors are indemnified by the federal government.

The Senate Environment and Public Works Committee on May 15 approved a bill (S. 1043) to strengthen security requirements at nuclear power plants. The bill would require the Nuclear Regulatory Commission (NRC) to issue regulations updating the “design basis threat” (DBT) that nuclear plants must be secured against. NRC on April 29 issued orders to nuclear power plants to meet a stronger DBT, although nuclear power critics charged that the new standard was compromised by nuclear industry pressure.

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 less than 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 more than half of U.S. electricity generation. Nuclear plants generate more than half the electricity in six states. The 772 billion kilowatt-hours of nuclear electricity generated in the United States during 2002 was more than the nation's entire electrical output in 1963, when the first of today's large-scale commercial reactors were being ordered.

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 89% of their total capacity in 2002, according to industry statistics.¹

Sixteen 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 14 more reactors are currently under review, and many others are anticipated, according to NRC.

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 occurred, 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 fossil fuel technologies.² 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 by more than one-third from 1990 to 2002, 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.

¹ "U.S. Units Exceed 89% Average Capacity Factor," *Nucleonics Week*, February 13, 2003, p. 1.

² "Production Costs Made Nuclear Cheapest Fuel in 1999, NEI Says," *Nucleonics Week*, January 11, 2001, p. 3.

A spike in fossil fuel prices and shortages of electricity during 2000-2001 helped encourage at least three 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.³ The Department of Energy (DOE) is implementing a program to encourage construction of new commercial reactors by 2010.

The Senate began debating an omnibus energy bill (S. 14) on May 6, 2003, that would have authorized loan guarantees and other financial assistance for building as much as 8,400 megawatts of new commercial nuclear generating capacity — or about six or seven reactors. Such financial assistance, which would be subject to appropriations, would be limited to half of eligible project costs. (For more details, see CRS Report RS21536, *Potential Cost of Nuclear Power Plant Construction Assistance in S. 14*). Also included in the nuclear title was a \$500 million authorization to construct a demonstration reactor in Idaho to produce hydrogen. However, S. 14 was set aside in favor of the Senate-passed version of an omnibus energy bill (H.R. 4) from the 107th Congress, which did not include the nuclear construction assistance. Omnibus energy legislation (H.R. 6) passed by the House on April 11, 2003, requires the Secretary of Energy to study the feasibility of locating a commercial nuclear power plant at a DOE site.

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. An air pollution bill introduced April 9, 2003, by Senator Carper (S. 843) would provide potentially valuable emissions allowances to owners of incremental nuclear power capacity. On May 19, 2003, New Hampshire became the first state to provide emissions credits for incremental nuclear generating capacity. But the large obstacles noted above must still be overcome before electric generating companies will risk ordering new nuclear units. (For more on the outlook for nuclear power, see CRS Report RL31064, *Nuclear Power: Prospects for New Commercial Reactors*.)

Nuclear Power Research and Development

For nuclear energy research and development — including advanced reactors, fuel cycle technology, and nuclear hydrogen production — the Administration requested \$277.1 million for FY2004, a \$17.1 million increase from the FY2003 appropriation. An additional \$113.4 million was requested for defense-related activities at the Idaho National Engineering and Environmental Laboratory (INEEL), which is being transferred to the nuclear energy program from DOE’s environmental management program, for a total of \$390.6 million.

³ 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.

The House cut the nuclear energy request to \$268.0 million, plus \$112.3 million for INEEL provided under “other defense activities.” The Senate Appropriations Committee boosted the request to \$437.4 million, without shifting any funds to “other defense activities.”

“Nuclear energy, which is already a vital component of our balanced energy portfolio, presents some of our most promising solutions to the world’s long-term energy challenges,” according to DOE’s FY2004 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 and economically uncompetitive.

Within the nuclear energy budget, the Administration requested \$48 million for the nuclear energy technologies program, which focuses on development of new reactors. That request is \$3.0 million above the FY2003 appropriation. The program includes \$35.0 million for an initiative to encourage construction of new commercial reactors by 2010 (“Nuclear Power 2010”) and \$9.7 million for advanced (“Generation IV”) reactor designs that could be ready for deployment after 2010. The House voted to cut the request to \$42.7 million, while the Senate Appropriations Committee recommended an increase to \$55.7 million. The Senate panel shifted funds for gas reactor technologies from Nuclear Power 2010 to the Generation IV program, with the funding directed toward development of a hydrogen-producing reactor at INEEL.

According to the DOE budget justification, the Nuclear Power 2010 program “will achieve near-term deployment of new power plants in the United States through cost-shared demonstration of the new, untested regulatory processes and cost-shared development of advanced reactor technologies.” The program seeks to deploy both a water-cooled reactor (similar to most existing commercial plants) and a gas-cooled reactor. The current phase of the initiative includes site approval, reactor design certification, license applications, detailed design work, and development of improved construction techniques. DOE is soliciting proposals for joint DOE/industry teams in which DOE will pay up to half the cost of these activities.

DOE’s Generation IV program is focusing on six advanced designs that could be deployed after 2010: two gas-cooled, one water-cooled, two liquid-metal-cooled, and one molten-salt concept. Some of these reactors would use plutonium recovered through reprocessing of spent nuclear fuel. The Administration’s May 2001 *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, because of plutonium’s potential use in nuclear bombs, undermines U.S. policy on nuclear weapons proliferation.

The development of plutonium-fueled reactors in the Generation IV program is closely related to the nuclear energy program’s Advanced Fuel Cycle Initiative (AFCI), for which \$63.0 million is requested for FY2004 – about \$5 million above the FY2003 appropriation. According to the budget justification, AFCI will “develop advanced proliferation-resistant fuel treatment and fabrication technologies that could be deployed by 2015,” as well as technologies that could reduce the long-term hazard of spent nuclear fuel. Such technologies would involve separation of plutonium, uranium, and other long-lived radioactive materials

from spent fuel for re-use in a nuclear reactor or for transmutation in a particle accelerator. AFCI includes a previously funded research program on accelerator transmutation called Advanced Accelerator Applications. The program also includes longstanding DOE work on electrometallurgical treatment of spent fuel from the Experimental Breeder Reactor II (EBR-II) at INEEL. The House approved \$58.5 million for the program, while the Senate Appropriations Committee recommended \$78.0 million.

In support of President Bush's program to develop hydrogen-fueled vehicles, DOE is requesting \$4.0 million in FY2004 for a new "Nuclear Hydrogen Initiative." According to DOE's budget justification, the program would investigate the use of high-temperature nuclear reactors to make hydrogen from water in a thermo-chemical process. According to DOE, "preliminary estimates indicate that hydrogen produced using nuclear-driven thermo-chemical processes would be only slightly more expensive than gasoline" and result in far less air pollution. Activities planned in FY2004 include development of a "roadmap" for developing nuclear hydrogen technologies and laboratory testing of thermo-chemical processes and related research. Even if the technology is successful, however, DOE officials have predicted that significant quantities of nuclear-produced hydrogen would not become available until 2020-2030.⁴ The House voted to cut the request to \$2.5 million, while the Senate panel recommended \$8.0 million, including support for the INEEL hydrogen reactor.

The Nuclear Energy Research Initiative (NERI) provides grants for research on innovative nuclear energy technologies. DOE is requesting \$12.0 million for NERI in FY2004, about half of the FY2003 appropriation. According to the budget justification, no new grants will be awarded in FY2003 and FY2004, with new program funding to be used only for completing previously initiated projects. The House voted to cut NERI to \$10.0 million, while the Senate panel urged the full request.

DOE proposes no new funding in FY2004 for the Nuclear Energy Plant Optimization program (NEPO), which received \$5.0 million in FY2003. The program supports cost-shared research by the nuclear power industry on ways to improve the productivity of existing nuclear plants. The House rejected the proposed elimination of NEPO, voting to provide \$4.0 million for the program. However, the Senate Appropriations Committee supported the Administration position.

The omnibus energy bills now under consideration, H.R. 6 and S. 14, include funding authorizations for DOE nuclear energy programs that are similar to the Administration funding request.

Nuclear Power Plant Safety and Regulation

Safety

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-relat-

⁴ EnergyWashington.com Daily Updates, February 5, 2003.

ed 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 quarter-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.

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. A recent study of 32,000 people living within 5 miles of the reactor when the accident occurred found no significant increase in cancer rates through 1998, although the authors note that some potential health effects "cannot be definitively excluded."⁵

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 risky. 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.

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

⁵ Talbott, Evelyn O., *et al.* "Long Term Follow-Up of the Residents of the Three Mile Island Accident Area: 1979-1998." *Environmental Health Perspectives*. Published online October 30, 2002. [<http://ehpnet1.niehs.nih.gov/docs/2003/5662/abstract.html>]

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 2002 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 from Chernobyl.⁶

The United States is providing direct assistance for upgrading the safety of remaining Soviet-designed reactors, a program being coordinated by DOE, NRC, the Agency for International Development (AID), and the Department of State. DOE is seeking \$14.1 million in FY2004 for improving the operation and physical condition of Soviet-designed nuclear power plants, an increase of \$2.5 million from FY2003. The House voted to cut the request to \$6.1 million, while the Senate Appropriations Committee recommended no new funding, with some activities to be continued under the nonproliferation and international security program.

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 required by NRC. The Energy Policy Act of 1992 largely implemented the industry's licensing goals, but no plants have been ordered.

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.

⁶ OECD Nuclear Energy Agency. *Chernobyl: Assessment of Radiological and Health Impacts*. 2002.

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.

Reactor Security

Nuclear power plants have long been recognized as potential targets of terrorist attacks, and critics have long questioned the adequacy of the measures required of nuclear plant operators to defend against such attacks. All commercial nuclear power plants licensed by NRC have a series of physical barriers to accessing the operating reactor area, and are required to maintain a trained security force to protect them. Following the September 11, 2001, terrorist attacks NRC activated its Emergency Response Center and advised all plant operators to go to the highest level of security alert. It also began a “top-to-bottom” review of its security requirements.

A key element in protecting nuclear plants is the requirement that simulated terrorist attack exercises, monitored by NRC, be carried out to test the ability of the plant operator to defend against them. The severity of attacks to be prepared for are specified in the form of a “design basis threat” (DBT). After more than a year’s review, on April 29, 2003, NRC changed the DBT to “represent the largest reasonable threat against which a regulated private guard force should be expected to defend under existing law.” The details of the revised DBT were not released to the public.

Several bills were introduced in the 107th Congress to change the way nuclear plants would be protected from terrorist attack, including proposals to create a federal force to replace private guards, but none was passed. In the 108th Congress several legislative proposals have been introduced, and one, the Nuclear Infrastructure Security Act of 2003 (S. 1043) was reported out on May 15, 2003, by the Senate Environment and Public Works Committee. (For details see CRS Report RS21131, *Nuclear Power Plants: Vulnerability to Terrorist Attack*.)

Decommissioning

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 radioactive material and contamination from reactor sites 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. 6 and an energy tax incentives bill (S. 1149) introduced by Senator Grassley on May 23, 2003, specify that dedicated nuclear decommissioning funds can be transferred to new reactor owners without incurring additional tax liabilities.

Nuclear Accident Liability

Liability for damages to the general public from nuclear incidents is addressed by the Price-Anderson Act (primarily Section 170 of the Atomic Energy Act of 1954, 42 U.S.C. 2210). The act was up for reauthorization on August 1, 2002, and it was extended for commercial reactors through December 31, 2003, by the FY2003 omnibus continuing resolution (P.L. 108-7). Even without an extension, existing reactors would continue to operate under the current Price-Anderson liability system, but new reactors would not be covered. Price-Anderson coverage for DOE nuclear contractors was extended through December 31, 2004, by the National Defense Authorization Act for FY2003 (P.L. 107-314).

Under Price-Anderson, the owners of commercial reactors must assume all liability for nuclear damages awarded to the public by the court system, and they must waive most of their legal defenses following a severe radioactive release (“extraordinary nuclear occurrence”). To pay any such damages, each licensed reactor must carry financial protection in the amount of the maximum liability insurance available, which was increased by the insurance industry from \$200 million to \$300 million on January 1, 2003. Any damages exceeding that amount are to be assessed equally against all covered commercial reactors, up to \$95.8 million per reactor (most recently adjusted for inflation on August 20, 2003). 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 two that are not operating, 105 commercial reactors are currently covered by the Price-Anderson retrospective premium requirement.

For each nuclear incident, therefore, the Price-Anderson liability system currently would provide up to \$10.9 billion in public compensation. That total includes the \$300 million in insurance coverage carried by the reactor that suffered the incident, plus the \$95.8 million in retrospective premiums from each of the 105 currently covered reactors, totaling \$10.4 billion. On top of those payments, a 5% surcharge may also be imposed, raising the total per-reactor retrospective premium to \$100.6 million, for an additional \$503 million. Under

Price-Anderson, the nuclear industry's liability for an incident 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 5 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, excluding the 5% surcharge, except when the limit for commercial reactors drops because of a decline in the number of covered reactors. Because the most recent adjustments have raised the commercial reactor liability limit to a record high, the liability limit for DOE contractors is currently the same as the commercial limit, minus the surcharge, or \$10.4 billion. Price-Anderson authorizes DOE to indemnify its contractors for the entire amount, so that damage payments for nuclear incidents 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.

In the 107th Congress, 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 have been raised to \$94 million and the limit on per-reactor annual payments raised to \$15 million, with both to be adjusted for inflation every 5 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 have been considered a single reactor. Therefore, a power plant with six 120-megawatt pebble-bed modular reactors would have been liable for retrospective premiums of up to \$94 million, rather than \$564 million. The liability limit on DOE contractors would have been 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 have remained the same, with a five-year inflation adjustment, and the limit for DOE contractors would have been 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 would have been considered a single reactor under Price-Anderson.

The House-passed Price-Anderson bill would have authorized 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 have been 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 have eliminated the civil penalty exemption for future contracts by 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 have limited 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 included similar provisions.

The House-Senate conference committee on H.R. 4 approved a compromise Price-Anderson subtitle September 12, 2002. The compromise version would have extended Price-Anderson indemnification authority for both NRC and DOE for 15 years, through August 1, 2017. The total retrospective premium per reactor would have been set at \$94 million, divided into annual payments of no more than \$15 million (with both limits to be adjusted for inflation every 5 years). The liability limit for DOE contractors would have been set at \$10 billion, adjusted for inflation every 5 years. Modular reactors of 100-300 megawatts would have been treated as a single reactor under Price-Anderson, up to a limit of 1,300 megawatts. The civil penalty exemption for nonprofit contractors would have been replaced with a nonprofit penalty limit. However, the 107th Congress adjourned without completing action on the measure.

In the 108th Congress, the Senate attached last year's Price-Anderson conference agreement to the FY2003 omnibus continuing resolution, but the enacted measure included only a simple extension through the end of this calendar year. Representative Heather Wilson introduced a Price-Anderson extension bill (H.R. 330) January 8, 2003, that also includes all the provisions of the H.R. 4 Price-Anderson conference agreement. An extension of Price-Anderson coverage for new commercial reactors through August 1, 2012 (S. 156) was approved by the Senate Environment and Public Works Committee April 9, 2003. H.R. 6, as passed by the House on April 11, 2003, includes provisions nearly identical to the Price-Anderson extension bill passed by the House in the 107th Congress. On the same day, the Senate Energy and Natural Resources Committee approved a permanent extension of Price-Anderson in an unnumbered Chairman's mark of omnibus energy legislation, subsequently introduced as S. 14. Except for the permanent extension, the Price-Anderson language in S. 14 is nearly identical to the H.R. 4 conference agreement in the 107th Congress. However, the Senate set aside S. 14 in favor of the provisions of H.R. 4 as passed by the Senate in the 107th Congress.

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.

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, any new DOE contracts signed during Price-Anderson expiration would have to use alternate indemnification authority.

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 tunnels 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 would have blocked repository construction at Yucca Mountain if a congressional resolution approving the site had not been enacted within 90 days of continuous session. The House passed a Yucca Mountain approval resolution (H.J.Res. 87) on May 8, 2002, by a 306-117 vote. The Senate approved the resolution by voice vote July 9 (following a 60-39 vote to consider S.J.Res. 34, the Senate version of the resolution), and the President signed it July 24, 2002 (P.L. 107-200).

The Administration requested \$591 million for the DOE civilian nuclear waste disposal program for FY2004, a 30% boost over FY2003. The increased budget is intended primarily to pay for preparing a construction permit application for a national nuclear waste repository at Yucca Mountain, Nevada. The additional funds are also needed for detailed repository design work, repository performance studies, and transportation planning, according to DOE. The Department contends that it cannot meet its 2010 target date for shipping nuclear waste to Yucca Mountain without receiving its entire FY2004 budget request for the program.

The House Appropriations Committee, contending that the nuclear waste program has suffered "chronic funding shortfalls," voted to provide an additional \$174 million for the program in FY2004, for a total of \$765 million, to which the House concurred. The Appropriations Committee report stressed that the additional funding should ensure that DOE could submit a license application for the repository to the Nuclear Regulatory Commission (NRC) by December 31, 2004. The Committee also directed DOE to prepare any plans and legislation necessary to allow shipments of spent nuclear fuel to Yucca Mountain to begin in 2007 – three years before the repository is scheduled to open. However, House Energy and Water Subcommittee Chairman Hobson promised in a floor colloquy to remove the report language about early shipments to Yucca Mountain.

The Senate Appropriations Committee voted to cut the Administration's request to \$425 million, setting up a potentially difficult confrontation with the House over the controversial program.

Between FY2005 and FY2010, nuclear waste funding will have to further increase to an average of \$1.3 billion per year to keep the repository on schedule, according to the DOE budget justification. The Administration is proposing that discretionary spending caps be adjusted to accommodate the program's higher future funding, although specific legislation has not been submitted.

Funding for the nuclear waste program comes from two sources. Under the FY2004 budget request, \$161.0 million would be provided from the Nuclear Waste Fund, which consists of fees paid by nuclear utilities, and \$430.0 million from the defense nuclear waste disposal account, which pays for disposing of high-level waste from the nuclear weapons program in the planned civilian repository. The House would boost the Nuclear Waste Fund portion of the request to \$335 million.

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

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 the nuclear programs. President Bush submitted his FY2004 funding request to Congress February 3, 2003. FY2003 funding was provided by a consolidated appropriations resolution signed February 20, 2003 (P.L. 108-7).

Table 1. Funding for the Nuclear Regulatory Commission
(budget authority* in millions of current dollars)

	FY2002 Approp.	FY2003 Approp.	FY2004 Request	FY2004 House	FY2004 Senate Comm.
Nuclear Regulatory Commission					
Reactor Safety	259.3	273.7	305.8	– **	–
Nuclear Materials Safety	58.8	60.3	71.2	–	–
Nuclear Waste Safety	68.3	73.2	70.1	–	–
International Nuclear Safety	5.0	5.2	5.4	–	–
Management and Support	161.0	165.8	166.2	–	–
Inspector General	6.2	6.8	7.3	7.3	7.3
(Homeland Security)	(36.0*)	(35.4)	(53.1)	–	–
TOTAL NRC BUDGET AUTHORITY	558.7	584.6	626.1	626.1	626.1
Offsetting fees	479.0	526.5	545.6	545.6	545.6
Net appropriation	79.6	58.1	80.5	80.5	80.5

* Additional \$36 million for nuclear plant security provided by FY2002 supplemental appropriations included in FY2002 Defense Appropriations Bill (P.L. 107-117), 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.

** Subcategories not specified.

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

	FY2002 Approp.	FY2003 Approp	FY2004 Request	FY2004 House	FY2004 Senate Comm.
Nuclear Energy (selected programs)					
University Reactor Assistance	17.5	18.5	18.5	19.5	22.0
Nuclear Energy Plant Optimization	7.0	5.0	0	4.0	0
Nuclear Energy Research Initiative	32.0	25.0	12.0	10.0	12.0
Nuclear Energy Technologies	12.0	45.0	48.0	42.7	55.7
Nuclear Hydrogen Initiative	—	—	4.0	2.5	8.0
Advanced Fuel Cycle Initiative	—	58.2	63.0	58.5	78.0
International Nuclear Safety**	21.1	11.6	14.1	6.1	0
Total, Nuclear Energy	250.5	261.7	390.6	268.0*	437.4
Nuclear Waste Fund Activities***	375.0	457.0	591.0	765.0	425.0

* Excludes \$112.3 million funded under “other defense activities.”

**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. 6 (Tauzin)

Includes extension of Price-Anderson Act nuclear liability system and reauthorization of nuclear R&D programs. Introduced April 7, 2003; referred to multiple committees. Incorporates H.R. 39, H.R. 238, H.R. 1531, H.R. 1644. Passed by House April 11, 2003, by vote of 247-145. Senate version, with text of H.R. 4 from the 107th Congress, passed July 31, 2003, by vote of 84-14.

H.R. 238 (Boehlert)

Energy Research, Development, Demonstration, and Commercial Application Act of 2003. Authorizes appropriations for nuclear energy research programs. Introduced January 8, 2003; referred to Committee on Science and Committee on Resources. Incorporated into H.R. 6.

H.R. 330 (H. Wilson)

Price-Anderson Amendments Act of 2003. Extends Price-Anderson Act nuclear accident liability system for 15 years and increases liability limits. Introduced January 8, 2003; referred to Committee on Energy and Commerce.

H.R. 1644 (Barton)

Energy Policy Act of 2003. Includes extension of Price-Anderson Act nuclear liability system and reauthorization of nuclear R&D programs. Introduced April 7, 2003; referred to multiple committees. Reported by Committee on Energy and Commerce April 8, 2003 (H.Rept. 108-65, Part 1).

H.R. 2754 (Hobson)

Energy and Water Development Appropriations for FY2004. Includes funding for DOE nuclear research and waste programs. Ordered reported as an original measure by the Committee on Appropriations July 16, 2003 (H.Rept. 108-212). Passed House July 18, 2003, by vote of 377-26.

S. 6 (Daschle)

Comprehensive Homeland Security Act of 2003. Includes provisions from S. 131 on nuclear facility security. Introduced January 7, 2003; referred to Committee on Judiciary.

S. 14 (Domenici)

Energy Policy Act of 2003. Provides federal assistance for new nuclear power plants, authorizes nuclear research funding, and extends Price-Anderson Act indefinitely. Introduced April 30, 2003; placed on Senate calendar. Identical to S. 1005, reported by Senate Energy and Natural Resources Committee May 6, 2003 (S.Rept. 108-43). Senate debate began May 6, 2003.

S. 131 (Reid)

Nuclear Security Act of 2003. Requires the federal government to study a wide variety of security threats to nuclear facilities and 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 review the security and emergency response plans at all nuclear power plants and other major nuclear facilities. An NRC employee is to be stationed at each nuclear facility as a "federal security coordinator." Introduced January 9, 2003; referred to Committee on Environment and Public Works.

S. 156 (Voinovich)

Price-Anderson Amendments Act of 2003. Extends Price-Anderson Act nuclear liability coverage for new commercial nuclear power plants through August 1, 2012. Introduced January 14, 2003; referred to Committee on Environment and Public Works. Ordered reported by committee April 9, 2003; amended to include nuclear power plant security provisions.

S. 843 (Carper)

Clean Air Planning Act of 2003. Provides emissions allowances for incremental nuclear power capacity. Introduced April 9, 2003; referred to Committee on Environment and Public Works.

S. 1043 (Inhofe)

Nuclear Infrastructure Security Act of 2003. Requires NRC to issue new regulations for “design basis threat” that nuclear power plant security must be able to defeat. Introduced May 12, 2003; referred to Committee on Environment and Public Works. Ordered reported May 15, 2003.

S. 1424 (Domenici)

Energy and Water Development Appropriations for FY2004. Includes funding for DOE nuclear energy and waste programs. Ordered reported as an original measure by the Committee on Appropriations July 17, 2003 (S.Rept. 108-105).