

# CRS Issue Brief for Congress

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## **Nuclear Energy Policy**

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### SUMMARY

Nuclear energy policy issues facing Congress include whether to provide federal incentives for a new generation of commercial reactors, radioactive waste management policy, 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. For nuclear energy research and development, the Administration is requesting \$389.9 million for FY2006. In addition to that funding, the Department of Energy (DOE) Office of Nuclear Energy, Science, and Technology would receive \$123.9 million for defense-related management and security at the Idaho National Laboratory (INL). The Nuclear Energy office's total FY2006 funding request of \$513.8 million is slightly above the FY2005 level. The FY2006 Energy and Water Development appropriations bill passed by the House May 24, 2005 (H.R. 2419, H.Rept. 109-86) would boost nuclear energy to \$515.1 million. The Senate version, passed July 1, 2005, would provide \$573.8 million (S.Rept. 109-84).

Significant incentives for new commercial reactors are included in the conference report on comprehensive energy legislation (H.R. 6, H.Rept. 109-190) enacted by Congress July 29, 2005. These include production tax credits, loan guarantees, insurance against regulatory delays, and extension of Price-Anderson. The conference report would also authorize \$1.25 billion for the design and construction of a nuclear-hydrogen cogeneration plant at INL.

The September 11, 2001, terrorist attacks on the United States raised questions about

nuclear power plant security. Several reactor security provisions are in the energy bill conference report approved by Congress, including requirements to revise the security threats that nuclear plant guard forces must be able to defeat, regular force-on-force security exercises at nuclear power plants, and the fingerprinting of nuclear facility workers.

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. Upon releasing the civilian nuclear waste program's FY2006 budget request, program officials announced that the opening of DOE's planned nuclear waste repository at Yucca Mountain, Nevada, would be delayed at least two years from the previous goal of 2010. The waste program's funding request of \$651.4 million is about 14% above the FY2005 level. The House voted an additional \$10 million for DOE to develop an interim nuclear waste storage site. The Senate voted to provide \$577.0 million, with no funding for interim storage.

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, and nuclear industry officials have predicted that the incentives in the H.R. 6 conference report would result in the first new U.S. reactor orders since 1978.

## MOST RECENT DEVELOPMENTS

Congress on July 29 enacted the conference report on the Energy Policy Act of 2005 (H.R. 6, H.Rept. 109-190), which provides strong incentives for the construction of new nuclear power plants. These include production tax credits, loan guarantees, insurance against regulatory delays, and extension of the Price-Anderson Act nuclear liability system.

The tax credit would be available for up to 6,000 megawatts of new nuclear capacity for the first eight years of operation, up to \$125 million annually per 1,000 megawatts. That capacity limit could accommodate five or six new commercial reactors, or it could be allocated among a greater number of reactors (with the tax credit pro-rated accordingly) by the Secretary of Energy. The Energy Information Administration (EIA) has previously concluded that the 1.8-cents/kilowatt-hour tax credit in the conference bill would stimulate construction of new commercial reactors.<sup>1</sup> Nuclear power plants would also be eligible for federal loan guarantees for up to 80% of construction costs.

Because the nuclear industry has often blamed past nuclear reactor construction cost overruns on licensing delays, the conference report authorizes the Secretary of Energy to pay for up to \$500 million in costs resulting from Nuclear Regulatory Commission (NRC) delays for the first two new reactors and up to \$250 million for the next four.

Reauthorization of the Price-Anderson Act nuclear liability system has been one of the top nuclear items on the energy agenda and is widely considered to be a prerequisite for new nuclear plant construction. The energy bill conference report extends Price-Anderson coverage for new reactors through 2025. Authorization of \$1.25 billion for the design and construction of a nuclear-hydrogen cogeneration plant at the Idaho National Laboratory is also included in the conference bill.

The conference report includes several provisions dealing with security at nuclear power plants. NRC is required to conduct “force on force” security exercises at each nuclear power plant at least once every three years (as is its current policy), and is required to revise the “design basis threat” that nuclear plant security forces must be able to defeat. Another measure authorizes NRC licensees, including guards at nuclear plants, to carry weapons, preempting some state restrictions. The conference bill also requires fingerprinting of nuclear plant workers for criminal background checks.

The Bush Administration on February 7 released its FY2006 budget request for nuclear energy programs. For DOE nuclear research and development — including advanced reactors, fuel cycle technology, and nuclear hydrogen production — the Administration requested \$389.9 million, about \$14.7 million above the FY2005 appropriation. In addition to that funding, the DOE Office of Nuclear Energy, Science, and Technology would receive \$123.9 million for defense-related management and security at INL. The Nuclear Energy office’s total FY2006 funding request of \$513.8 million is slightly above the FY2005 level. The FY2006 Energy and Water Development appropriations bill passed by the House May

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<sup>1</sup> Energy Information Administration, *Analysis of Five Selected Tax Provisions of the Conference Energy Bill of 2003*, February 2004.

24 (H.R. 2419, H.Rept. 109-86) would boost nuclear energy to \$515.1 million. The Senate version, passed July 1, would provide \$573.8 million (S.Rept. 109-84).

Upon releasing the DOE civilian nuclear waste program's FY2006 budget request, program officials announced that the opening of a planned nuclear waste repository at Yucca Mountain, Nevada, would be delayed at least two years from the previous goal of 2010. The waste program's funding request of \$651.4 million is about 14% above the FY2005 level but only about half the amount that last year's budget justification said would have been needed to open the repository by 2010. The House voted to provide an additional \$10 million for DOE to develop an interim nuclear waste storage site. The Senate voted to provide \$577.0 million, with no funding for interim storage.

## 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 unclear long-term future. No nuclear plants have been ordered in the United States 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 (TVA'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 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 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 record 824 billion kilowatt-hours of nuclear electricity generated in the United States during 2004<sup>2</sup> was more than the nation's entire electrical output in the early 1960s, when the first large-scale commercial reactors were being ordered.

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<sup>2</sup> Margaret L. Ryan, "World Nuclear Output, and U.S., Set Records in 2004," *Nucleonics Week*, February 10, 2005, p. 1.

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 an average of 89.6% of their total capacity in 2004, according to industry statistics.<sup>3</sup>

Thirty-three 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 16 more reactors are currently under review, and many others are anticipated, according to NRC (see website at [<http://www.nrc.gov/reactors/operating/licensing/renewal/applications.html>]).

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, headquartered in Chicago. Exelon and New Jersey-based Public Service Enterprise Group announced a merger on December 20, 2004, that would boost the combined firm's reactor fleet to 20.

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 competitive with those of fossil fuel technologies.<sup>4</sup> Although eight U.S. nuclear reactors were permanently shut down during the 1990s, none has been closed since 1998, and recent reactor sales could indicate greater industry interest in nuclear plants that previously had been considered marginal. Despite the shutdowns, annual U.S. nuclear electrical output increased by more than one-third from 1990 to 2004, according to the Energy Information Administration and industry statistics. The increase resulted primarily from reduced downtime at the remaining plants, the startup of five new units, and reactor modifications to boost capacity.

The good performance of existing reactors and the relatively high cost of natural gas — the favored fuel for new power plants for the past 15 years — have prompted renewed utility consideration of the feasibility of building new reactors. That apparently growing interest has helped intensify congressional debate about the federal role in encouraging the construction of new nuclear power plants.

Entergy, Dominion Resources, and Exelon have chosen sites in Mississippi, Virginia, and Illinois, respectively, for possible future nuclear units and filed early site permit applications with NRC (see [<http://www.nrc.gov/reactors/new-licensing/esp.html>]) in fall 2003. As discussed in the next section, the Department of Energy (DOE) is assisting those site-selection efforts and new reactor license applications as part of a program to encourage

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<sup>3</sup> Ibid.

<sup>4</sup> Energy Information Administration, *Nuclear Power: 12 percent of America's Generating Capacity, 20 percent of the Electricity*, July 17, 2003, at [<http://www.eia.doe.gov/cneaf/nuclear/page/analysis/nuclearpower.html>].

construction of new commercial reactors by 2010. Several additional sites are also under consideration.

Strong incentives for building new nuclear power plants are included in the Energy Policy Act of 2005 (H.R. 6, H.Rept. 109-190) passed by Congress July 29. Particularly significant is a tax credit for up to 6,000 megawatts of new nuclear capacity for the first eight years of operation, up to \$125 million annually per 1,000 megawatts. That capacity limit could make five or six new commercial reactors eligible for the 1.8-cents/kilowatt-hour tax credit, or the capacity could be allocated among a greater number of reactors (with the tax credit pro-rated accordingly) by the Secretary of Energy.

Because the nuclear industry has often blamed licensing delays for past nuclear reactor construction cost overruns, the conference report would authorize the Secretary of Energy to pay for up to \$500 million in costs resulting from NRC delays for the first two new reactors and up to \$250 million for the next four. Nuclear power plants would also be eligible for federal loan guarantees for up to 80% of construction costs. The Energy Information Administration (EIA) has previously concluded that the nuclear energy tax credit would stimulate construction of new commercial reactors,<sup>5</sup> and nuclear industry officials recently predicted that the tax credits and other incentives would prove effective.<sup>6</sup> Without such assistance, EIA has projected that no new reactors would be built by 2025.<sup>7</sup>

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. 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, nuclear hydrogen production, and infrastructure support — the Administration requested \$513.8 million for FY2006. Reimbursements of \$123.9 million from the Other Defense Activities appropriations account reduced the nuclear energy program’s net request in the Energy Supply and Conservation account to \$389.9 million.

The FY2006 Energy and Water Development Appropriations bill passed by the House May 24, 2005 (H.R. 2419, H.Rept. 109-86) would boost nuclear energy to \$515.1 million,

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<sup>5</sup> Energy Information Administration, *Analysis of Five Selected Tax Provisions of the Conference Energy Bill of 2003*, February 2004.

<sup>6</sup> Fialka, John J., “Energy Bill May Revive Nuclear Power in U.S.” *Wall Street Journal*, July 28, 2005, p. A4.

<sup>7</sup> Energy Information Administration, *Annual Energy Outlook 2005*, DOE/EIA-0383(2005), February 2005, p. 6.

\$5.2 million above the FY2005 appropriation. An additional reimbursement of \$13.5 million from the Naval Reactors account would leave a net appropriation of \$377.7 million under Energy Supply and Conservation. Much of the defense and naval reactors reimbursement covers defense-related management and security at the Idaho National Laboratory (INL), which has been transferred to the nuclear energy program from DOE's environmental management program. The nuclear energy program is run by DOE's Office of Nuclear Energy, Science, and Technology.

The House shifted an \$18.7 million uranium disposal program from the nuclear energy office to the National Nuclear Security Administration and applied most of the funding to other nuclear energy programs. An amendment adopted at the House Appropriations Committee markup transferred \$10 million from the "Nuclear Power 2010" program (discussed below) to the "weatherization" assistance program.

The Senate bill included a \$60 million boost from the Administration request, to a total of \$573.8 million. The measure would provide the requested \$123.9 million under Other Defense Activities, leaving \$449.9 million for Nuclear Energy under Energy Supply and Conservation.

"The benefits of nuclear power as an emissions free, reliable, and affordable source of energy are an essential element in the Nation's energy and environmental future," according to DOE's 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.

**Nuclear Power 2010.** President Bush's specific mention of "safe, clean nuclear energy" in his 2005 State of the Union Address indicated the Administration's interest in encouraging construction of new commercial reactors. DOE's efforts to restart the nuclear construction pipeline are focused on the Nuclear Power 2010 Program, which will pay up to half of the nuclear industry's costs of seeking regulatory approval for new reactor sites, applying for new reactor licenses, and preparing detailed plant designs. The program is intended to provide assistance for advanced versions of existing commercial nuclear plants that could be ordered within the next few years.

The Nuclear Power 2010 Program is helping three utilities seek NRC approval for potential nuclear reactor sites in Illinois, Mississippi, and Virginia. In addition, three industry consortia in 2004 applied for a total of \$650 million over the next several years to design and license new nuclear power plants and conduct a feasibility study. DOE awarded an initial \$13 million to the consortia in 2004. The FY2006 budget request included \$56.0 million for the program, a 12.9% boost over FY2005. After the \$10 million transfer adopted during committee markup, the House approved \$46.0 million for Nuclear Power 2010. The Senate bill includes a \$20 million increase from the budget request, to \$76.0 million.

The nuclear license applications under the Nuclear Power 2010 program would test the "one step" licensing process established by the Energy Policy Act of 1992 (P.L. 102-486). Even if the licenses are granted by NRC, the industry consortia funded by DOE have not committed to building new reactors, although the incentives included in the Energy Policy Act of 2005 may make construction more likely.

- Dominion Resources is leading a consortium that is seeking \$250 million over six years for a COL for an advanced General Electric reactor (after originally considering a Canadian design). The proposed reactor would be located at Dominion's existing North Anna plant in Virginia, where the company is seeking an NRC early site permit with DOE assistance. The \$500 million total cost would include "first of a kind" design and engineering work, to the level of detail necessary for firm construction cost estimates.
- A consortium called NuStart Energy Development, which includes Exelon and several other major nuclear utilities, is requesting \$400 million from DOE over seven years for a COL for "passively safe" Westinghouse or General Electric reactor designs. Various sites are under consideration, including two in the ESP program. First-of-a-kind design cost are included in the total \$800 million estimate. NuStart member Duke Power announced in February 2005 that it was considering submitting its own application for a COL.
- TVA is leading a consortium that requested \$2 million to study the feasibility of building a General Electric Advanced Boiling Water Reactor (ABWR) at the site of TVA's uncompleted Bellefonte nuclear plant in Alabama. Because the ABWR already has received NRC standard design certification and has been constructed in other countries, first-of-a-kind design work would not be needed.

According to news reports, the Dominion team will receive an initial DOE award of \$9 million, NuStart will be granted \$4 million, and, for the ABWR feasibility study, TVA will receive more than \$2 million.<sup>8</sup>

The advanced Westinghouse reactor under consideration by NuStart, the AP-1000, is also competing for a contract in China. If Westinghouse were to prevail over designs being offered by France and Russia, the four-reactor contract could help demonstrate the commercial viability of the new design, which received final design approval from NRC in September 2004. A preliminary commitment to provide almost \$5 billion in financial support for the proposed China reactor sale was approved February 18, 2005, by the Export-Import Bank of the United States. Critics contend that the tentative Ex-Im financing could provide unwarranted subsidies to the nuclear power industry and unwisely transfer U.S. nuclear technology to China.

**Generation IV.** Advanced commercial reactor technologies that are not yet close to deployment are the focus of DOE's Generation IV Nuclear Energy Systems Initiative, for which \$45.0 million was requested for FY2006, about 12.5% above FY2005. The House approved the same amount, and the Senate bill includes a \$15.0 million increase from the request, to \$60 million.

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<sup>8</sup> Tom Harrison, "Two Reactor Consortia Awarded DOE Funding," *NuclearFuel*, November 8, 2004, p. 1.

The Generation IV program is focusing on six advanced designs that could be commercially available around 2020-2030: 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. Generation IV technologies could also be used by the Nuclear Hydrogen Initiative (below).

**Advanced Fuel Cycle Initiative.** 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 the Administration requested \$70.0 million — 3.8% above the FY2005 level. According to the budget justification, AFCI will develop and demonstrate nuclear fuel cycles that could reduce the long-term hazard of spent nuclear fuel and recover additional energy. 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. The program includes longstanding DOE work on electrometallurgical treatment of spent fuel from the Experimental Breeder Reactor II (EBR-II) at INL.

The House added \$5.5 million to the AFCI budget request “to accelerate the development and selection of a separations technology no later than the end of FY2007 that can address the current inventories of commercial spent nuclear fuel, and prepare an integrated spent nuclear fuel recycling plan,” according to the Appropriations Committee report.

The Senate voted to add \$15 million to the budget request, with \$10 million for design of an Engineering Scale Demonstration of Uranium Extraction Technology (UREX) being developed by DOE's Savannah River Technology Center.

**Nuclear Hydrogen Initiative.** In support of President Bush's program to develop hydrogen-fueled vehicles, DOE requested \$20.0 million in FY2006 for the Nuclear Hydrogen Initiative, an increase of 124% from the FY2005 level. The House approved the same amount, and the Senate voted to provide \$30.0 million. According to DOE's FY2005 budget justification, “preliminary estimates ... indicate that hydrogen produced using nuclear-driven thermochemical or high-temperature electrolysis processes would be only slightly more expensive than gasoline” and result in far less air pollution.

An advanced reactor that would demonstrate co-production of hydrogen and electricity — the Next Generation Nuclear Plant (NGNP) — was allocated \$25.0 million from DOE's Generation IV program by the FY2005 omnibus appropriations conference report. “The conferees expect the Department to submit a budget in FY2006 that is consistent with the goal of demonstrating hydrogen production and electricity generation by 2015 at the Idaho National Laboratory,” according to the statement of managers. DOE's FY2006 budget justification for Generation IV says the research to be undertaken by the program “will help inform a decision on whether to proceed with a demonstration of the Next Generation Nuclear Plant.”

The Energy Policy Act of 2005 authorizes \$1.25 billion for a demonstration hydrogen-production reactor at INL.

**Other Reactor Research.** DOE again requested no new funding specifically for the Nuclear Energy Research Initiative (NERI), which provides grants for research on innovative nuclear energy technologies. According to the DOE budget justification, NERI projects will instead be pursued at the discretion of individual nuclear R&D programs. NERI received an appropriation of \$2.5 million for FY2005. New funding also was not requested for the Nuclear Energy Plant Optimization program (NEPO), which received \$2.5 million in FY2005. NEPO supports cost-shared research by the nuclear power industry on ways to improve the productivity of existing nuclear plants. The House agreed to eliminate the funding for both programs. The Senate bill also provided no separate funding for NERI and NEPO, but it allocated specific funding for NERI projects within other nuclear energy programs.

## 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-related shortcomings have been identified in the construction quality of some plants, plant operation and maintenance, equipment reliability, emergency planning, and other areas. In a relatively 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 loss of reactor cooling water. Davis-Besse remained closed for repairs and other safety improvements until NRC allowed the reactor to restart in March 2004.

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 2,500 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 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.”<sup>9</sup>

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. (For the current U.S. fleet of about 100 reactors, that rate would yield an average of one severe accident every 100 years.) 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 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.<sup>10</sup>

## 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

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<sup>9</sup> Evelyn O. Talbott 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, at [<http://ehp.niehs.nih.gov/docs/2003/5662/abstract.html>].

<sup>10</sup> OECD Nuclear Energy Agency, *Chernobyl: Assessment of Radiological and Health Impacts*, 2002.

Energy Policy Act of 1992 (P.L. 102-486) 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 of 1992 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 (discussed above) proposes to pay up to half the cost of at least one combined construction and operating license for an advanced reactor. The Energy Policy Act of 2005 authorizes federal payments to the owner of a completed reactor whose operation is delayed by regulatory action.

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's risk-informed reactor oversight system, inaugurated April 2, 2000, relies on a series of performance indicators to determine the level of scrutiny that each reactor should receive.

## **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 terrorist attacks

of September 11, 2001, NRC 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.

The Energy Policy Act of 2005 requires NRC to revise the DBT based on an assessment of terrorist threats, the potential for multiple coordinated attacks, possible suicide attacks, and other criteria. It also requires NRC to conduct force-on-force security exercises at nuclear power plants every three years (which is NRC’s current policy), authorizes firearms use by nuclear security personnel (preempting some state restrictions), establishes federal security coordinators, and requires fingerprinting of nuclear facility workers.

(For background on security issues, 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.

The tax treatment of decommissioning funds has been a continuing issue. The Energy Policy Act of 2005 provides favorable tax treatment to nuclear decommissioning funds, subject to certain restrictions.

## **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). 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). A further two-year extension for DOE contractors was approved by Congress on October 9, 2004, as part of the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (P.L. 108-375). The Energy Policy Act of 2005 extends Price-Anderson coverage for new reactors and new DOE nuclear contracts through the end of 2025.

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. According to NRC, 103 commercial reactors are currently covered by the Price-Anderson retrospective premium requirement.

For each nuclear incident, 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 103 currently covered reactors, totaling \$10.2 billion. On top of those payments, a 5% surcharge may also be imposed, raising the total per-reactor retrospective premium to \$100.6 million and the total available compensation to about \$10.7 billion. 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 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 had been 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. 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.

Under the Price-Anderson extension in the Energy Policy Act of 2005, the total retrospective premium for each reactor is set at the current level of \$95.8 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 1,300 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 \$95.8 million, rather than \$574.8 million. The liability limit on DOE contractors is set at \$10 billion per accident, also to be adjusted for inflation.

Although DOE is generally authorized to impose civil penalties on its contractors for violations of nuclear safety regulations, Atomic Energy Act §234A specifically exempted seven non-profit DOE contractors and their subcontractors. Under the same section, DOE automatically remitted any civil penalties imposed on non-profit educational institutions

serving as DOE contractors. The Price-Anderson extension eliminates 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 new law limits the civil penalties against a non-profit contractor to the amount of management fees paid under that contract.

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. Extension of the act was widely considered a prerequisite for new nuclear reactor construction in the United States. 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.

## **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.

Upon releasing the civilian nuclear waste program's FY2006 budget request, program officials announced that the opening of the planned Yucca Mountain repository would be delayed at least two years from the previous goal of 2010. The waste program's funding request of \$651.4 million is about 14% above the FY2005 level but only about half the amount that last year's budget justification said would have been needed to open the repository by 2010.

Delays in the Yucca Mountain project prompted the House Appropriations Committee to include language in its report on the FY2006 Energy and Water appropriations bill directing DOE "to begin the movement of spent fuel to centralized interim storage at one or more DOE sites within fiscal year 2006."<sup>11</sup> The bill as passed by the House (H.R. 2419) would add \$10 million to the Administration's nuclear waste funding request for that purpose. During floor debate, questions arose about potential conflicts between the committee report language and restrictions on DOE interim storage imposed by NWPA and state agreements. The Senate bill would provide \$577 million, without any report language on interim storage of spent fuel.

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<sup>11</sup> H.Rept. 109-86, May 18, 2005.

Last year, the FY2005 budget request for the nuclear waste program had assumed that Congress would enact legislation to offset most of the program's spending with revenue from a longstanding fee on nuclear power, which currently is not available without appropriation. Because last year's net appropriations request was relatively small, congressional appropriators had to scramble to find funding for the nuclear waste program when the Administration's fee-offset proposal was not enacted. For FY2006, the Administration is again proposing that nuclear waste funding be offset by fees, but the budget request does not assume the proposal will be enacted and therefore includes full funding through appropriations.

The delays in the Yucca Mountain program follow a July 9, 2004, ruling by the U.S. Court of Appeals for the District of Columbia Circuit that overturned a key aspect of the Environmental Protection Agency's (EPA's) regulations for the planned repository. The three-judge panel ruled that the 10,000-year compliance period was too short, but it rejected several other challenges to the rules. EPA is currently revising the regulations to comply with the court decision.

The quality of scientific work at Yucca Mountain was called into question by DOE's March 16, 2005, disclosure of e-mails from geologists indicating that some quality assurance documentation had been falsified. DOE currently is determining whether the problems affect the completeness and accuracy of information submitted to NRC in support of the planned Yucca Mountain license application.

Further delays in the nuclear waste program could prove costly under a settlement announced August 10, 2004, between the Department of Justice and Exelon Corporation, which had filed a breach-of-contract suit over DOE's failure to begin accepting spent fuel by 1998 as required by NWPA. Under the settlement, Exelon is to be reimbursed from the federal Judgment Fund for its spent fuel storage costs caused by the waste program delays. Exelon estimates that it will receive \$300 million if DOE begins accepting waste by 2010 as previously scheduled, and up to \$600 million if waste acceptance does not begin until 2015. The waste program is run by DOE's Office of Civilian Radioactive Waste Management (OCRWM).

(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 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 FY2006 funding request February 7, 2005. The House passed the FY2006 Energy and Water Development appropriations bill with nuclear program funding on May 24, 2005 (H.R. 2419, H.Rept. 109-86). The Senate approved its version of the bill July 1 by a vote of 92-3 (S.Rept. 109-84).

Funding for the Yucca Mountain program is provided under two appropriations accounts. The Administration sought \$300.0 million from the Nuclear Waste Disposal account, which draws on fees paid by nuclear utilities that are held in the Nuclear Waste

Fund. An additional \$351.5 million was requested under the Defense Nuclear Waste Disposal account, which pays for disposal of high-level waste from the nuclear weapons program in the planned Yucca Mountain repository. The House bill would add \$10 million to the Nuclear Waste Disposal account for a federal interim storage initiative. The Senate bill would provide \$300 million under Nuclear Waste Disposal and \$277 million under Defense Nuclear Waste Disposal, for a total of \$577 million.

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

	<b>FY2005 Approp.</b>	<b>FY2006 Request</b>	<b>FY2006 House</b>	<b>FY2006 Senate</b>
<b>Nuclear Regulatory Commission</b>				
Reactor Licensing	263.3	274.9	— *	— *
Reactor Inspection	179.8	194.3	—	—
Fuel Facility Licensing and Inspection	38.5	36.6	—	—
Nuclear Materials Lic. and Insp.	63.6	65.9	—	—
High-Level Waste Repository	68.5	69.1	—	—
Decommission. and Low-Level Waste	24.1	28.1	—	—
Spent Fuel Storage and Transportation	23.9	24.6	—	—
Infrastructure and Support	—	—	—	—
Inspector General	7.5	8.3	8.3	8.3
<b>TOTAL NRC BUDGET AUTHORITY</b>	<b>669.3</b>	<b>701.7</b>	<b>722.7</b>	<b>742.7</b>
<b>Offsetting fees</b>	<b>540.1</b>	<b>567.1</b>	<b>580.6</b>	<b>606.1</b>
<b>Net appropriation</b>	<b>128.6</b>	<b>134.6</b>	<b>134.6</b>	<b>136.6</b>

\* Subcategories not specified.

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

	<b>FY2005 Approp.</b>	<b>FY2006 Request</b>	<b>FY2006 House</b>	<b>FY2006 Senate</b>
<b>Nuclear Energy</b>				
University Reactor Assistance	23.8	24.0	24.0	24.0
Nuclear Energy Plant Optimization	2.5	0	0	0
Nuclear Energy Research Initiative	2.5	0	0	0
Nuclear Power 2010	49.6	56.0	46.0	76.0
Generation IV Nuclear Systems	39.7	45.0	45.0	60.0
Nuclear Hydrogen Initiative	8.9	20.0	20.0	30.0
Advanced Fuel Cycle Initiative	67.5	70.0	75.5	85.0
Nuclear R&D Infrastructure	248.7	237.7	243.5	237.7
Program Direction	60.4	61.1	61.1	61.1
Defense-Related Infrastructure*	124.3	123.9	136.4	123.9
Total, Nuclear Energy	509.9	513.8	515.1	573.8
<b>Civilian Nuclear Waste Disposal**</b>	<b>572.4</b>	<b>651.4</b>	<b>661.4</b>	<b>577.0</b>

\* Funded under "other defense activities" and naval reactors.

\*\* Funded by a 1-mill-per-kilowatt-hour fee on nuclear power, plus appropriations for defense waste disposal.

## LEGISLATION

### **H.R. 6 (Barton)**

Energy Policy Act of 2005. Omnibus energy legislation that provides incentives for new nuclear power plants, extends Price-Anderson nuclear liability system, authorizes nuclear R&D programs, and requires security measures at nuclear facilities. Introduced April 18, 2005; referred to multiple committees. Passed House April 21, 2005, by vote of 249-183. Passed Senate June 28, 2005, by vote of 85-12. Conference report (H.Rept. 109-90) passed House July 28, 2005, by vote of 275-156; passed Senate July 29 by vote of 74-26.

### **H.R. 526 (Berkley)**

Redirect the Nuclear Waste Fund established under the Nuclear Waste Policy Act of 1982 into research, development, and utilization of risk-decreasing technologies for the onsite storage and eventual reduction of radiation levels of nuclear waste, and for other purposes. Introduced February 2, 2005; referred to Committees on Energy and Commerce; Science; Ways and Means.

### **H.R. 966 (Saxton)**

Require the Nuclear Regulatory Commission to consider certain criteria in relicensing nuclear facilities, and to provide for an independent assessment of the Oyster Creek Nuclear Generating Station by the National Academy of Sciences prior to any relicensing of that facility. Introduced February 17, 2005; referred to Committee on Energy and Commerce.

### **H.R. 2419 (Hobson)**

Energy and Water Development Appropriations for FY2006. Includes funding for DOE nuclear programs. Introduced and reported as an original measure by the House Appropriations Committee May 18, 2005 (H.Rept. 109-86). Passed House May 24, 2005, by vote of 416-13. Passed Senate July 1, 2005, by vote of 92-3 (S.Rept. 109-84).

### **S. 10 (Domenici)**

Energy Policy Act of 2005. Includes provisions on electricity regulation and reliability, energy research and development, alternative fuels, and energy access to public lands. Introduced as an original bill and reported June 9, 2005, by the Committee on Energy and Natural Resources (S.Rept. 109-78). Ordered reported May 26 by a vote of 21-1. Text substituted for H.R. 6.

### **S. 387 (Hagel)**

Amend the Internal Revenue Code of 1986 to provide tax incentives for investment in greenhouse gas intensity reduction projects, including a production tax credit for nuclear-generated electricity. Introduced February 15, 2005; referred to Committee on Finance.

### **S. 388 (Hagel)**

Amend the Energy Policy Act of 1992 to direct the Secretary of Energy to carry out activities that promote the adoption of technologies that reduce greenhouse gas intensity, including advanced nuclear power plants, and to provide credit-based financial assistance and investment protection for projects that employ advanced climate technologies or systems. Introduced February 15, 2005; referred to Committee on Energy and Natural Resources.