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Nuclear Energy Policy

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SUMMARY

Nuclear energy policy issues facing Congress include the implementation of federal incentives for new commercial reactors, radioactive waste management policy, research and development priorities, power plant safety and regulation, and security against terrorist attacks.

The Bush Administration has called for an expansion of nuclear power. For Department of Energy (DOE) nuclear energy research and development, the Administration is seeking $632.7 million for FY2007, an 18.1% increase from the FY2006 appropriation. The request would boost funding for the Advanced Fuel Cycle Initiative (AFCI) from $79.2 million in FY2006 to $243.0 million in FY2007. The higher AFCI funding would allow DOE to begin developing an engineering-scale facility to demonstrate new technology for separating plutonium and uranium in spent nuclear fuel, as part of the Administration's Global Nuclear Energy Partnership (GNEP).

Significant incentives for new commercial reactors are included in the Energy Policy Act of 2005 (P.L. 109-58), signed by the President August 8, 2005. These include production tax credits, loan guarantees, insurance against regulatory delays, and extension of the Price-Anderson Act nuclear liability system. The act also authorizes $1.25 billion for the design and construction of a nuclear-hydrogen cogeneration plant at Idaho National Laboratory.

The September 11, 2001, terrorist attacks on the United States raised concern about nuclear power plant security. The new Energy Policy Act includes several reactor security provisions, 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 a detailed physical characterization of Yucca Mountain in Nevada as a permanent underground repository for high-level waste. The opening of the Yucca Mountain repository has been delayed from the previous goal of 2010, and DOE currently has no announced schedule for the project. The Administration is requesting $544.5 million for the civilian nuclear waste program in FY2007, $50 million above the FY2006 level.

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 are currently favored over nuclear reactors for new generating capacity. However, some electric utilities are seeking approval of sites for new reactors, and nuclear industry officials have predicted that the incentives in the Energy Policy Act of 2005 will lead to the first new U.S. reactor orders since 1978.

MOST RECENT DEVELOPMENTS

The Bush Administration's February 6 budget request for FY2007 includes $632.7 million for Department of Energy (DOE) nuclear energy research and development, an 18.1% increase from the FY2006 appropriation. The request would boost funding for the Advanced Fuel Cycle Initiative (AFCI) from $79.2 million in FY2006 to $243.0 million in FY2007. The higher AFCI funding would allow DOE to begin developing an engineering-scale facility to demonstrate new technology for separating plutonium and uranium in spent nuclear fuel, as part of the Administration's Global Nuclear Energy Partnership (GNEP). The Administration is requesting $544.5 million for the civilian nuclear waste program in FY2007, $50 million above the FY2006 level. The Energy and Water Development Appropriations Act for FY2006 (P.L. 109-103, H.Rept. 109-275), funding DOE nuclear programs, was signed by the President on November 19.

President Bush on August 8 signed the Energy Policy Act of 2005 (P.L. 109-58), 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 is 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 prorated accordingly) by the Secretary of Energy. 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 energy act 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.

The Energy Policy Act 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. NRC's proposed revision was published in the *Federal Register* on November 7.

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; TVA is spending 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 near-record 818 billion kilowatt-hours of nuclear electricity generated in the United States during 2005[1] was more than the nation's entire electrical output in the early 1960s, when the first 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 an average of 89.4% of their total capacity in 2005, according to industry statistics.[2]

Thirty-nine 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 12 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

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[1] "World's Nuclear Performance in 2005 Close to 2004's," *Nucleonics Week*, Feb. 9, 2006, p. 1.

[2] Ibid.

are currently estimated to be competitive with those of fossil fuel technologies.[3] 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 2005, 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. During 2005, electric utilities announced plans to apply for combined construction permits and operating licenses (COLs) for 11 reactors; however, no commitments have been made to build them if the COLs are issued. The Department of Energy (DOE) is assisting with some of the COL applications and site-selection efforts as part of a program to encourage new commercial reactor orders by 2010, as discussed in the next section.

Strong incentives for building new nuclear power plants are included in the Energy Policy Act of 2005 (P.L. 109-58), signed by the President on August 8. 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 prorated accordingly) by the Secretary of Energy.

Because the nuclear industry has often blamed licensing delays for past nuclear reactor construction cost overruns, the new law 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,[4] and nuclear industry officials recently predicted that the tax credits and other incentives would prove effective.[5] Without such assistance, EIA has projected that no new reactors would be built by 2025.[6]

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

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[3] 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].

[4] Energy Information Administration, *Analysis of Five Selected Tax Provisions of the Conference Energy Bill of 2003,* February 2004.

[5] Fialka, John J., "Energy Bill May Revive Nuclear Power in U.S." *Wall Street Journal*, July 28, 2005, p. A4.

[6] Energy Information Administration, *Annual Energy Outlook 2005*, DOE/EIA-0383(2005), February 2005, p. 6.

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*, by Larry Parker and Mark Holt.)

Nuclear Power Research and Development

For nuclear energy research and development — including advanced reactors, fuel cycle technology, nuclear hydrogen production, and infrastructure support — DOE is requesting $632.7 million for FY2007, an 18.1% increase from the FY2006 appropriation. The request would boost funding for the Advanced Fuel Cycle Initiative (AFCI) from $79.2 million in FY2006 to $243.0 million in FY2007. The higher AFCI funding would allow DOE to begin developing an engineering-scale facility to demonstrate new technology for separating plutonium and uranium in spent nuclear fuel, as part of the Administration's Global Nuclear Energy Partnership (GNEP). The nuclear energy program is run by DOE's Office of Nuclear Energy, Science, and Technology.

According to DOE's budget justification, the nuclear energy R&D program is intended "to enable nuclear energy to fulfill its promise as a safe, advanced, inexpensive and environmentally benign approach to providing reliable energy to all of the world's people." Under the Administration's GNEP initiative, plutonium partially separated from spent nuclear fuel would be recycled into new fuel to expand the future supply of nuclear fuel and potentially reduce waste. The United States and other advanced nuclear nations would lease new fuel to other nations that agreed to forgo uranium enrichment, spent fuel recycling (also called reprocessing), and other fuel cycle facilities that could be used to produce nuclear weapons materials; see [http://www.gnep.energy.gov/.]. The leased fuel would then be returned to supplier nations for reprocessing. Solidified high-level reprocessing waste would be sent back to the nation that had used the leased fuel, along with supplies of fresh nuclear fuel, according to the GNEP concept.

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. Opponents are particularly concerned about GNEP's emphasis on spent fuel reprocessing, which they see as a weapons proliferation risk, even if weapons-useable plutonium is not completely separated from other spent fuel elements, as envisioned by the Administration.

Nuclear Power 2010. President Bush's specific mention of "clean, safe nuclear energy" in his 2006 State of the Union Address reiterated the Administration's interest in encouraging construction of new commercial reactors — for which there have been no U.S. orders since 1978. 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, two industry consortia are receiving DOE assistance over the next several years to design and license new nuclear power plants. DOE awarded the first funding to the consortia in 2004. The FY2006 Energy and Water appropriation included $65.3 million for the program, a $15.7 million boost over FY2005. DOE's FY2007 budget request includes $52.3 million for Nuclear Power 2010. DOE assistance under the program, including the early site permits, is planned to reach a multiyear total of $550 million.

The nuclear license applications under the Nuclear Power 2010 program are intended to 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. Loan guarantees and tax credits to encourage construction of new reactors are included in the Energy Policy Act of 2005 (P.L. 109-58). The 2005 act also authorizes DOE to provide compensation to the first six new reactors for regulatory delays beyond their control; the FY2007 budget request for the Nuclear Power 2010 Program includes $1.8 million to develop criteria for such assistance. The two consortia receiving COL assistance under the Nuclear Power 2010 program are

- A consortium led by Dominion Resources that is preparing 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.

- A consortium called NuStart Energy Development, which includes Exelon and several other major nuclear utilities, announced on September 22, 2005, that it would seek a COL for a Westinghouse design at the site of TVA's uncompleted Bellefonte nuclear plant in Alabama and for a General Electric design at the Grand Gulf plant in Mississippi. DOE has agreed to provide assistance to one of the two NuStart projects.

The advanced Westinghouse reactor selected 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 $31.4 million is being requested for FY2007 — 30% less than the FY2006 request and more than 40% below the final appropriation of $54.5 million. Most of the proposed reduction would come from the Next Generation Nuclear Plant (discussed below), which would drop from $40 million to $23.4 million.

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, using technologies being developed by the Advanced Fuel Cycle Initiative.

Advanced Fuel Cycle Initiative. The nuclear energy program's Advanced Fuel Cycle Initiative (AFCI) is the primary component of GNEP. DOE's $243 million budget request for AFCI for FY2007 makes up nearly all of the $250 million GNEP program (with the remaining $7 million requested for program direction). The FY2007 AFCI budget request is more than triple the FY2006 appropriation of $79.2 million.

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. Most of the proposed AFCI funding ($155 million) would be for an engineering-scale demonstration of a separations technology called UREX+, in which uranium and other elements are chemically removed from dissolved spent fuel, leaving a mixture of plutonium and other highly radioactive elements. Proponents believe the process is proliferation-resistant, because further purification would be required to make the plutonium useable for weapons.

Removing uranium from spent fuel would eliminate most of the volume of spent nuclear fuel that would otherwise require disposal in a deep geologic repository, which DOE is developing at Yucca Mountain, Nevada. The UREX+ process also would reduce the heat generated by nuclear waste — the major limit on the repository's capacity — by removing cesium and strontium for separate storage and decay over several hundred years. Plutonium and other long-lived elements would be destroyed in accelerators or fast reactors (such as the type under development by the Generation IV program) to reduce the long-term hazard of nuclear waste. Even if technically feasible, however, the economic viability of such waste processing has yet to be determined, and it still faces significant opposition on nuclear nonproliferation grounds, as noted above.

Nuclear Hydrogen Initiative. In support of President Bush's program to develop hydrogen-fueled vehicles, DOE is requesting $18.1 million in FY2007 for the Nuclear Hydrogen Initiative, a 25% reduction from the FY2006 level. 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.

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. During approximately 2,000 reactor-years of operation in the United States,[7] the only incident at a commercial nuclear 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."[8]

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

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[7] *Nuclear Engineering International*, "Country averages as at end September 2004," January 2005, p. 37.

[8] 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].

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.[9]

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 (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 were 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 combined construction and operating licenses for two advanced reactors. 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

[9] OECD Nuclear Energy Agency, *Chernobyl: Assessment of Radiological and Health Impacts*, 2002.

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 been 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. NRC's proposed DBT revision was published in the *Federal Register* on November 7, 2005. The new energy law also requires NRC to conduct force-on-force security exercises at nuclear power plants every three years (which was NRC's previous 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*, by Carl Behrens and Mark Holt.)

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. The first full-sized U.S. commercial reactors to be decommissioned were the Trojan plant in Oregon, whose decommissioning received NRC approval on May 23, 2005, and Maine Yankee, for which NRC approved most of the site cleanup on October 3, 2005. The Trojan decommissioning cost $429 million, according to reactor owner Portland General Electric, and the Maine Yankee decommissioning cost about $500 million.[10] Those costs are within the range estimated by a 1996 DOE report of about $150 million to $600 million in 1995 dollars.

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 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

[10] Sharp, David, "NRC Signs Off On Maine Yankee's Decommissioning," *Associated Press*, October 3, 2005.

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. Under the Nuclear Waste Policy Act (42 U.S.C. 10101 et seq.), Yucca Mountain in Nevada is the only candidate site for the national repository.

Energy Secretary Samuel Bodman told the House Appropriations Committee's Energy and Water Development Subcommittee on March 8, 2006, that construction of a repository at Yucca Mountain would probably not begin for at least five years. That scenario would push the opening of the repository well past DOE's previous goal of 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 FY2006."[11] The interim storage requirement was not included in the enacted Energy and Water bill, but the measure does provide $50 million for DOE to develop a spent nuclear fuel recycling plan. The detailed program plan is to be submitted by March 31, 2006, and a "site selection competition" for an integrated reprocessing facility is to begin by June 30, 2006. A reprocessing site is to be selected in FY2007, with construction to begin in FY2010. "The site competition should not be limited to DOE sites, but should be open to a wide range of other possible federal and non-federal sites on a strictly voluntary basis," according to the conference report. Applicants for a reprocessing facility can receive up to $5 million per site, up to a total of $20 million, to prepare detailed proposals.

In submitting its FY2007 budget request, the Administration announced that it was preparing draft legislation to address problems in the civilian nuclear waste program, possibly including provisions for interim storage. The Administration is requesting $544.5 million for the waste program in FY2007, $50 million above the FY2006 level. The waste program is run by DOE's Office of Civilian Radioactive Waste Management (OCRWM).

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 proposed a new standard on August 9, 2005, that would allow higher radiation exposure from the repository after 10,000 years.

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

[11] H.Rept. 109-86, May 18, 2005.

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 up to $600 million if waste acceptance does not begin until 2015. Several other utilities have also negotiated settlements, and the Tennessee Valley Authority on January 31, 2006, won a $34.9 million judgment from the U.S. Court of Federal Claims for waste storage costs incurred through September 2004. Numerous other utility claims are pending.[12]

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

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 FY2007 funding request February 6, 2006. The FY2006 energy and water conference report was approved by Congress on November 14, 2005, and signed into law on November 19, 2005 (H.Rept 109-275, P.L. 109-103).

Table 1. Funding for the Nuclear Regulatory Commission

(budget authority in millions of current dollars)

	FY2006 Approp.	FY2007 Request
Nuclear Regulatory Commission		
— Reactor Licensing	302.8	341.3
— Reactor Inspection	212.4	222.0
— Fuel Facility Licensing and Inspection	40.1	37.6
— Nuclear Materials	80.1	74.3
— High-Level Waste Repository	45.7	41.0
— Decommission. and Low-Level Waste	27.4	25.7
— Spent Fuel Storage and Transportation	24.8	26.5
— Inspector General	8.3	8.1
Total NRC budget Authority	**741.5**	**776.6**
— Offsetting fees	**624.7**	**627.7**
Net appropriation	**116.8**	**148.9**

[12] Hiruo, Elaine, and Tom Harrison. "TVA, Negotiated Settlements Add to Taxpayers' Yucca Mt. Bill." *NuclearFuel*. March 13, 2006. p. 11.

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

	FY2005 Approp.	FY2006 Approp.	FY2007 Request
Nuclear Energy (selected programs)			
University Reactor Assistance	23.8	26.7	0
Nuclear Power 2010	49.6	65.3	54.0
Generation IV Nuclear Systems	38.8	54.5	31.4
Nuclear Hydrogen Initiative	8.7	24.8	18.7
Advanced Fuel Cycle Initiative	66.4	79.2	243.0
Nuclear R&D Infrastructure[a]	249.0	241.1	220.9
Program Direction	60.1	60.5	67.6
Total, Nuclear Energy	503.8	535.7	632.7
Civilian Nuclear Waste Disposal[b]	572.4	495.0	544.5

a. Funded under "other defense activities" and naval reactors until FY2007. In FY2007 request, all infrastructure except $75.9 million for Idaho Sitewide Safeguards and Security is transferred to the Energy Supply and Conservation account.

b. Funded by a 1-mill-per-kilowatt-hour fee on nuclear power, plus appropriations for defense waste disposal and homeland security.

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. Signed by President August 8, 2005 (P.L. 109-58).

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). Signed by President November 19, 2005 (P.L. 109-103).

H.R. 4538 (Matheson)/S. 2099 (Reid)

Spent Nuclear Fuel On-Site Storage Security Act of 2005. Requires commercial nuclear power plants to transfer spent fuel from pools to dry storage casks and then convey title to the Secretary of Energy. Introduced December 14, 2005. House bill referred to Committee on Energy and Commerce; Senate bill referred to Committee on Environment and Public Works.

H.R. 4825 (Weller)/S. 2348 (Obama)

Nuclear Release Notice Act of 2006. Requires notification of federal and state agencies about releases of radioactive materials above allowable limits. Introduced March 1, 2006; referred to House Committee on Energy and Commerce and Senate Committee on Environment and Public Works.

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.