Order Code RL33558

CRS Report for Congress

Nuclear Energy Policy

Updated September 2, 2008

Mark Holt
Specialist in Energy Policy
Resources, Science, and Industry Division

Prepared for Members and
Committees of Congress

Nuclear Energy Policy

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, nuclear weapons proliferation, and security against terrorist attacks.

The Bush Administration has called for an expansion of nuclear power. For nuclear energy research and development — including advanced reactors, fuel cycle technology and facilities, nuclear hydrogen production, and infrastructure support — the Department of Energy (DOE) requested $1.419 billion, about 40% higher than the FY2008 appropriation of $1.033 billion. The FY2009 request included an 80% increase in assistance for new commercial reactor orders (Nuclear Power 2010), a 70% increase for nuclear spent fuel reprocessing R&D (the Advanced Fuel Cycle Initiative), and a 75% boost for a mixed-oxide (MOX) fuel fabrication facility to make fuel from surplus weapons plutonium. Those activities are funded by various appropriations accounts through DOE's Office of Nuclear Energy. The House Appropriations Committee recommended $1.317 billion for FY2009.

The Senate Appropriations Committee voted to fully fund the MOX project at the Administration's request of $487.0 million but place it under the National Nuclear Security Administration's Office of Defense Nuclear Nonproliferation. As a result, the Senate panel's funding total for the Office of Nuclear Energy is $803.0 million, $50.6 million below the comparable request and $120.1 million above the comparable FY2008 level.

Significant incentives for new commercial reactors were included in the Energy Policy Act of 2005 (P.L. 109-58), signed by the President on August 8, 2005. These include production tax credits, loan guarantees, insurance against regulatory delays, and extension of the Price-Anderson Act nuclear liability system. Together with higher fossil fuel prices and the possibility of greenhouse gas controls, the federal incentives for nuclear power have helped spur renewed interest by utilities and other potential reactor developers. Plans for as many as 31 reactor license applications have been announced.

Disposal of highly radioactive waste has been one of the most controversial aspects of nuclear power. The Nuclear Waste Policy Act of 1982 (P.L. 97-425), as amended in 1987, requires DOE to conduct a detailed physical characterization of Yucca Mountain in Nevada as a permanent underground repository for high-level waste. DOE submitted a license application for the Yucca Mountain repository to the Nuclear Regulatory Commission (NRC) on June 3, 2008, with the repository to open by 2020 at the earliest.

The FY2009 budget request for the nuclear waste program was $494.7 million; the House Appropriations Committee approved the full amount, and the Senate Appropriations Committee recommended $388.4 million. The FY2009 request is 28% above the FY2008 appropriation of $386.4 million, but the FY2008 level is about $50 million below the FY2007 level.

Contents

List of Tables

Nuclear Energy Policy

Most Recent Developments

The House Appropriations Committee on June 25 recommended $1.317 billion in FY2009 for nuclear energy research and development — including advanced reactors, fuel cycle technology and facilities, nuclear hydrogen production, and infrastructure support. The Department of Energy (DOE) had requested $1.419 billion, about 40% higher than the FY2008 appropriation of $1.033 billion. The FY2009 request, submitted February 4, 2008, included an 80% increase in assistance for new commercial reactor orders (Nuclear Power 2010), a 70% increase for nuclear spent fuel reprocessing R&D (the Advanced Fuel Cycle Initiative), and a 75% boost for a mixed-oxide (MOX) fuel fabrication facility to make fuel from surplus weapons plutonium. Those activities are funded by various appropriations accounts through DOE's Office of Nuclear Energy. The House panel recommended no funding for the Administration's Global Nuclear Energy Partnership (GNEP) on international nuclear fuel cycle cooperation.

The Senate Appropriations Committee voted July 10 (S.Rept. 110-416) to fully fund the MOX project at the Administration's request of $487.0 million but place it under the National Nuclear Security Administration's Office of Defense Nuclear Nonproliferation. As a result, the Senate panel's funding total for the Office of Nuclear Energy is $803.0 million, $50.6 million below the comparable request and $120.1 million above the comparable FY2008 level.

DOE submitted a license application for its proposed nuclear waste repository at Yucca Mountain, Nevada, to the Nuclear Regulatory Commission (NRC) on June 3, 2008, with the repository to open by 2020 at the earliest. The FY2009 budget request for the nuclear waste program was $494.7 million; the House Appropriations Committee approved the full amount, and the Senate Appropriations Committee recommended $388.4 million. The FY2009 request is 28% above the FY2008 appropriation of $386.4 million, but the FY2008 level is about $50 million below the FY2007 level.

Eleven applications for combined construction permits and operating licenses (COLs) for 18 new nuclear power units have been submitted to NRC (see **Table 1**). NRC is anticipating COL applications for as many as 31 new reactors through 2009. None of the applicants has yet committed to actual plant construction, although some preliminary contracts have been signed.

Nuclear Power Status and Outlook

The outlook for the U.S. nuclear power industry appears to have brightened after decades of uncertainty. No nuclear power plants have been ordered in the United States since 1978, and more than 100 reactors have been canceled, including all ordered after 1973. The most recent U.S. nuclear unit to be completed was TVA's Watts Bar 1 reactor, ordered in 1970 and licensed to operate in 1996. But nuclear power is now receiving renewed interest, prompted by higher fossil fuel prices, possible carbon dioxide controls, and new federal subsidies and incentives.

The U.S. nuclear power industry currently comprises 104 licensed reactors at 65 plant sites in 31 states and generates about 20% of the nation's electricity.[1] That number includes TVA's Browns Ferry 1, which restarted May 22, 2007, after a 22-year shutdown and $1.8 billion refurbishment. TVA's board of directors voted August 1, 2007, to resume construction on Watts Bar 2, which had been suspended in 1985; the project is to cost about $2.5 billion and be completed in 2013. Electricity production from U.S. nuclear power plants is greater than that from oil and hydropower, and about the same as natural gas, although it remains well behind coal, which accounts for about half of U.S. electricity generation. Nuclear plants generate more than half the electricity in six states. The record 843 billion kilowatt-hours of nuclear electricity generated in the United States during 2006[2] was more than the nation's entire electrical output in the early 1960s, when the oldest of today's operating U.S. commercial reactors were ordered.[3]

Reasons for the 30-year halt in U.S. nuclear plant orders included high capital costs, public concern about nuclear safety and waste disposal, and regulatory compliance costs.

High construction costs may pose the most serious obstacle to nuclear power expansion. Construction costs for reactors completed since the mid-1980s ranged from $2 to $6 billion, averaging more than $3,700 per kilowatt of electric generating capacity (in 2007 dollars). The nuclear industry predicts that new plant designs could be built for less than that if many identical plants were built in a series, but current estimates for new reactors show little change in cost.[4]

Average U.S. nuclear plant operating costs, however, dropped substantially since 1990, and costly downtime has been steadily reduced. Licensed commercial

---

[1] U.S. Nuclear Regulatory Commission, *Information Digest 2007-2008*, NUREG-1350, Vol. 19, August 2007, p. 34.

[2] "U.S. Units Shine, But World Nuclear Generation Lags in 2007," *Nucleonics Week*, February 14, 2008, p. 1.

[3] All of today's 104 operating U.S. commercial reactors were ordered from 1963 through 1973; see "Historical Profile of U.S. Nuclear Power Development," U.S. Council for Energy Awareness, 1992.

[4] CRS Report RL34546, *Wind Power in the United States: Technology, Economic, and Policy Issues*, by Jeffrey Logan and Stan Kaplan, p. 27.

reactors generated electricity at an average of 91% of their total capacity in 2007, according to industry statistics.[5]

Forty-eight commercial reactors have received 20-year license extensions from the Nuclear Regulatory Commission (NRC), giving them up to a total of 60 years of operation. License extensions for more than a dozen additional reactors are currently under review, and many others are anticipated, according to NRC.[6]

Existing nuclear power plants appear to hold a strong position in electricity wholesale markets. 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.[7] Although eight U.S. nuclear reactors were permanently shut down during the 1990s, none has been closed since 1998. Despite the shutdowns, annual U.S. nuclear electrical output increased by more than one-third from 1990 to 2006, 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.

Possible New Reactors

The improved performance of existing reactors, the possibility of carbon dioxide controls, and the relatively high cost of natural gas — the favored fuel for new power plants for most of the past 15 years — have prompted renewed electric industry consideration of the feasibility of building new reactors. Electric utilities and other firms have announced plans to apply for combined construction permits and operating licenses (COLs) for about 30 reactors (see **Table 1**). However, no firm 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.

---

[5] "U.S. Units Shine, But World Nuclear Generation Lags in 2007," *Nucleonics Week*, February 14, 2008, p. 1.

[6] [http://www.nrc.gov/reactors/operating/licensing/renewal/applications.html]

[7] 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].

Table 1. Announced Nuclear Plant License Applications

Announced Applicant	Site	Planned Application	Reactor Type	Units
Alternate Energy	Bruneau (ID)	2008	Areva EPR	1
Ameren	Callaway (MO)	Submitted July 28, 2008	Areva EPR	1
Amarillo Power	Near Amarillo (TX)	4Q 2008	Areva EPR	2
Dominion	North Anna (VA)	Submitted Nov. 27, 2007	GE ESBWR	1
DTE Energy	Fermi (MI)	4Q 2008	Not specified	1
Duke Energy	Cherokee (SC)	Submitted Dec. 13, 2007	Westing. AP1000	2
Energy Future (formerly TXU)	Comanche Peak (TX)	4Q 2008	Mitsubishi US-APWR	2
Entergy	River Bend (LA)	Sept. 2008	GE ESBWR	1
Exelon	Victoria County (TX)	Sept. 2008	GE ESBWR	2
FPL	Turkey Point (FL)	Early 2009	Not specified	2
NRG Energy	South Texas Project	Submitted Sept. 20, 2007	GE ABWR	2
NuStart	Grand Gulf (MS)	Submitted Feb. 27, 2008	GE ESBWR	1
	Bellefonte (AL)	Submitted Oct. 30, 2007	Westing. AP1000	2
PPL	Susquehanna (PA)	Late 2008	Areva EPR	1
Progress Energy	Harris (NC)	Submitted Feb. 19, 2008	Westing. AP1000	2
	Levy County (FL)	Submitted July 30, 2008	Westing. AP1000	2
SCE&G	Summer (SC)	Submitted Mar. 31, 2008	Westing. AP1000	2
Southern	Vogtle (GA)	Submitted Mar. 31, 2008	Westing. AP1000	2
UniStar (Constellation Energy and EDF)	Calvert Cliffs (MD)	Submitted July 13, 2007 (Part 1), Mar. 17, 2008 (Part 2)	Areva EPR	1
	Nine Mile Point (NY)	2008	Areva EPR	1
Total Units				**31**

Sources: NRC, *Nucleonics Week*, *Nuclear News*, Nuclear Energy Institute, company news releases.

Federal Support

Strong incentives for building new nuclear power plants were included in the Energy Policy Act of 2005 (EPACT05, P.L. 109-58), signed by the President on August 8, 2005. These include production tax credits, loan guarantees, insurance against regulatory delays, and extension of the Price-Anderson Act nuclear liability system (discussed in a separate section of this report).

Nuclear Production Tax Credit. EPACT05 provides a 1.8-cents/kilowatt-hour 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.

The Treasury Department published interim guidance for the nuclear tax credit on May 1, 2006.[8] Under the guidance, the 6,000 megawatts of eligible capacity will be allocated among reactors that file license applications by the end of 2008 or, after that date, until enough applications are filed to fulfill the eligible capacity. If license applications for more than 6,000 megawatts of nuclear capacity are submitted before the end of 2008, then the tax credit will be allocated proportionally among any of the qualifying reactors that begin operating before 2021.

As of August 2008, license applications had been submitted to NRC for more than 22,000 megawatts of nuclear capacity,[9] so if all those reactors were built before 2021 they would receive less than one-third of the maximum tax credit. However, the Energy Information Administration estimates that 8,000 megawatts of new nuclear capacity will ultimately qualify for the credit;[10] in this case the credit amount drops to 1.35 cents per kilowatt-hour once all the qualifying plants are on line.

Standby Support. Because the nuclear industry has often blamed licensing delays for past nuclear reactor construction cost overruns, EPACT05 authorizes the Secretary of Energy to provide "standby support," or regulatory risk insurance, to help pay the cost of regulatory delays at up to six new commercial nuclear reactors, subject to funding availability. For the first two reactors that begin construction, the DOE payments could cover all the eligible delay-related costs, such as additional interest, up to $500 million each. For the next four reactors, half of the eligible costs could be paid by DOE, with a payment cap of $250 million per reactor. Delays caused by the failure of a reactor owner to comply with laws or regulations would not be covered.

---

[8] Department of the Treasury, Internal Revenue Service, *Internal Revenue Bulletin*, No. 2006-18, "Credit for Production From Advanced Nuclear Facilities," Notice 2006-40, May 1, 2006, p. 855.

[9] Energy Information Administration, *Status of Potential New Commercial Nuclear Reactors in the United States*, July 17, 2008; Ameren Media Release, "AmerenUE Submits Combined Construction and Operating License Application for a Second Nuclear Generating Unit," July 28, 2008; PRNewswire, "Progress Energy Florida Files Nuclear Plant Application With NRC," August 1, 2008.

[10] For a discussion of the operation of the credit see EIA, *Annual Energy Outlook 2007*, p. 21. For the forecast of 8,000 MW of nuclear capacity on-line before 2021, see the *Annual Energy Outlook 2008*, p. 70.

DOE published a final rule for the "standby support" program August 11, 2006.[11] According to a DOE description of the final rule:

> Events that would be covered by the risk insurance include delays associated with the Nuclear Regulatory Commission's reviews of inspections, tests, analyses and acceptance criteria or other licensing schedule delays as well as certain delays associated with litigation in federal, state or tribal courts. Insurance coverage is not available for normal business risks such as employment strikes and weather delays. Covered losses would include principal and interest on debt and losses resulting from the purchase of replacement power to satisfy contractual obligations.[12]

The Standby Support program is being administered as part of DOE's Nuclear Power 2010 program, which is paying half the costs of nuclear plant licensing by two nuclear industry consortia. According to DOE's FY2009 budget justification, the first Standby Support applications are expected as early as FY2008.[13]

Loan Guarantees. EPACT05 also authorized federal loan guarantees for up to 80% of construction costs for advanced energy projects that reduce greenhouse gas emissions, including new nuclear power plants. The EPACT loan guarantees are widely considered crucial by the nuclear industry to obtain financing for new reactors. DOE issued guidelines for the initial round of loan guarantees on August 8, 2006. However, the initial round was limited to $2 billion and did not include nuclear power plants. The FY2007 continuing resolution (P.L. 110-5) provided initial administrative funding for the program and authorized up to $4 billion in loan guarantees (twice the Administration request). DOE issued final rules for the program October 4, 2007,[14] and invited 16 proposals from the initial solicitation to submit full applications.

DOE's proposed loan guarantee rules, published May 16, 2007, had been sharply criticized by the nuclear industry for limiting the guarantees to 90% of a project's debt. The industry contended that EPACT05 allows all of a project's debt to be covered, as long as debt does not exceed 80% of total construction costs. In its explanation of the proposed rules, DOE expressed concern that guaranteeing 100% of a project's debt could reduce lenders' incentive to perform adequate due diligence and therefore increase default risks. In the final rule, however, DOE agreed to guarantee up to 100% of debt, but only for loans issued by the Federal Financing Bank. Possible DOE losses resulting from defaults are to be covered by payments collected up-front from project sponsors.

The amount of loan guarantees to be available for nuclear power was the subject of considerable debate in the first session of the 110th Congress. Under the Federal

---

[11] Department of Energy, "Standby Support for Certain Nuclear Plant Delays," *Federal Register*, August 11, 2006, p. 46306.

[12] DOE press release, August 4, 2006 [http://nuclear.gov/home/08-04-06.html].

[13] DOE FY2009 Congressional Budget Request, Vol. 3, p. 643. [http://www.cfo.doe.gov/budget/09budget/Content/Volumes/Volume3a.pdf].

[14] Published October 23, 2007 (72 *Federal Register* 60116).

Credit Reform Act (FCRA), federal loan guarantees cannot be provided without an authorized level in an appropriations act. The Senate-passed version of omnibus energy legislation (H.R. 6) would have explicitly eliminated FCRA's applicability to DOE's planned loan guarantees under EPACT (Section 124(b)). That provision raised considerable controversy, because it would have given DOE essentially unlimited loan guarantee authority under EPACT, but it was dropped from the final legislation (P.L. 110-140).

The FY2008 omnibus funding act (P.L. 110-161) included statutory language by the Senate Appropriations Committee that does not refer to FCRA, providing "such sums" through FY2009.[15] The explanatory statement for the bill directed DOE to limit the loan guarantees for nuclear power plants to $18.5 billion through FY2009 — enough for several large reactors. An additional $2 billion in loan guarantee authority was provided for uranium enrichment plants, and $18 billion in authority was provided for non-nuclear energy technologies, such as renewable energy.[16]

DOE's FY2009 budget request proposed to extend the previously approved $38.5 billion in loan guarantee authority. Under the request, $20 billion would be available through FY2010 for technologies other than nuclear power plants, while the remaining $18.5 billion for nuclear power plants would be available through FY2011. The House Appropriations Committee increased DOE's loan guarantee authority to $47 billion, all to be available through FY2011, in addition to the previously authorized $4 billion. Of the $47 billion, $18.5 billion is for nuclear power, $18.5 is for energy efficiency and renewables, $6 billion is for coal, $2 billion is for carbon capture and sequestration, and $2 billion is for uranium enrichment. The Senate Appropriations Committee did not increase the $38.5 billion in loan guarantees authorized in the FY2008 funding act, but recommended that the time limits be removed entirely.

DOE issued a solicitation for up to $20.5 billion in nuclear-related loan guarantees on June 30, 2008.[17] Initial applications were filed in August by Constellation Energy for its proposed Calvert Cliffs 3 reactor and Dominion Virginia Power for North Anna 3. USEC Inc. filed a Part 1 application in July for its proposed American Centrifuge uranium enrichment plant in Ohio.[18]

Global Climate Change

Global climate change that may be caused by carbon dioxide and other greenhouse gas emissions is cited by nuclear power supporters as an important reason to develop a new generation of reactors. Nuclear power plants emit relatively little carbon dioxide, mostly from nuclear fuel production and auxiliary plant equipment. This "green" nuclear power argument has received growing attention in think tanks

---

[15] *Congressional Record*, December 17, 2007, p. H15585.

[16] Ibid., p. H15929.

[17] [http://www.lgprogram.energy.gov/keydocs.html]

[18] World Nuclear News, August 18, 2009. [http://www.world-nuclear-news.org/print.aspx?id=20446]

and academia. As stated by MIT in its major study *The Future of Nuclear Power*: "Our position is that the prospect of global climate change from greenhouse gas emissions and the adverse consequences that flow from these emissions is the principal justification for government support of the nuclear energy option."[19]

However, most environmental groups contend that nuclear power's potential greenhouse gas benefits are modest and must be weighed against the technology's safety risks, its potential for nuclear weapons proliferation, and the hazards of radioactive waste.[20] They also contend that energy efficiency and renewable energy would be far more economical options for reducing fossil fuel use.[21]

(For more on federal incentives and the economics of nuclear power, see CRS Report RL33442, *Nuclear Power: Outlook for New U.S. Reactors*, by Larry Parker and Mark Holt.)

Nuclear Power Research and Development

DOE's nuclear energy research and development program includes advanced reactors, fuel cycle technology and facilities, nuclear hydrogen production, and infrastructure support. The House Appropriations Committee on June 25, 2008, recommended $1.317 billion for those activities in FY2009. DOE had requested $1.419 billion, about 40% higher than the FY2008 appropriation of $1.033 billion. The FY2009 request includes an 80% increase in assistance for new commercial reactor orders (Nuclear Power 2010), a 70% increase for nuclear spent fuel reprocessing R&D (the Advanced Fuel Cycle Initiative), and a 75% boost for a mixed-oxide (MOX) fuel fabrication facility to make fuel from surplus weapons plutonium. Those activities are funded by various appropriations accounts through DOE's Office of Nuclear Energy.

The Senate Appropriations Committee voted July 10, 2008 (S.Rept. 110-416) to fully fund the MOX project at the Administration's request of $487.0 million but place it under the National Nuclear Security Administration's Office of Defense Nuclear Nonproliferation. As a result, the Senate panel's funding total for the Office of Nuclear Energy is $803.0 million, $50.6 million below the comparable request and $120.1 million above the comparable FY2008 level.

According to DOE's FY2009 budget justification, the nuclear energy R&D program is intended "to develop new nuclear energy generation technologies to meet energy and climate goals." 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.

---

[19] Interdisciplinary MIT Study, *The Future of Nuclear Power*, Massachusetts Institute of Technology, 2003, p. 79.

[20] Gronlund, Lisbeth, David Lochbaum, and Edwin Lyman, *Nuclear Power in a Warming World*, Union of Concerned Scientists, December 2007.

[21] Thomas, Stephen, et al, *The Economics of Nuclear Power*, Greenpeace, 2007.

The increased funding sought for the Advanced Fuel Cycle Initiative (AFCI) would help implement the Administration's Global Nuclear Energy Partnership (GNEP). GNEP is intended to develop technologies for recycling uranium and plutonium from spent nuclear fuel without creating pure plutonium that could be readily used for nuclear weapons. According to DOE's budget justification, such technologies could allow greater expansion of nuclear power throughout the world "with reduced risk of nuclear weapons proliferation."[22] But nuclear opponents dispute DOE's contention that nuclear recycling technology can be made sufficiently proliferation-resistant for widespread use.

The House Appropriations Committee sharply criticized GNEP as "rushed, poorly-defined, expansive, and expensive," and eliminated all funding for the program. On the other hand, the House panel dramatically boosted funding for advanced nuclear reactors, which the Administration had proposed cutting. The Senate Appropriations Committee did not mention GNEP, but provided $50.3 million of the Administration's proposed $122.1 million increase for AFCI.

Nuclear Power 2010. President Bush's specific mention of "emissions-free nuclear power" in his 2008 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 refill the nuclear construction pipeline have been 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 Nuclear Power 2010 Program, which includes the EPACT05 Standby Support Program discussed above, is intended to encourage near-term orders for advanced versions of existing commercial nuclear plants.

Two industry consortia have been receiving DOE assistance since 2004 to design and license new nuclear power plants. DOE requested $241.6 million for Nuclear Power 2010 for FY2009, an increase of $107.8 million from the FY2008 funding level. According to DOE's budget justification, the additional funding would be used to accelerate the first-of-a-kind design activities for the two reactors being planned by the two industry consortia, the Westinghouse AP1000 reactor and the General Electric Economic Simplified Boiling Water Reactor (ESBWR). The House Appropriations Committee recommended holding the program's FY2009 funding level to $157.3 million, which the panel said was DOE's previous planning level. The Senate Appropriations Committee recommended the full request.

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). Under the process, the Nuclear Regulatory Commission (NRC) may grant a combined construction permit and operating license (COL) that allows a completed plant to begin operation if all construction criteria have been met. Even if the licenses are granted by NRC, the industry consortia funded by DOE have

---

[22] Department of Energy, *FY 2009 Congressional Budget Request*, February 2008, Vol. 3, p. 691.

not committed to building new reactors. Two consortia are receiving Nuclear Power 2010 assistance:

- A consortium led by Dominion Resources that is preparing a COL for the GE ESBWR. The proposed reactor would be located at Dominion's existing North Anna plant in Virginia, where the company received an NRC early-site permit with DOE assistance. Dominion Energy submitted a COL application for a new unit at North Anna on November 27, 2007.

- A consortium called NuStart Energy Development, which includes Exelon and several other major nuclear utilities. NuStart announced on September 22, 2005, that it would seek a COL for two Westinghouse AP1000 reactors at the site of TVA's uncompleted Bellefonte nuclear plant in Alabama and for an ESBWR at the Grand Gulf plant in Mississippi. The Nuclear Power 2010 Program is providing funding for review and approval of the Bellefonte COL, which was submitted to NRC on October 30, 2007.

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 $70.0 million was requested for FY2009. The request is $44.9 million below the FY2008 funding level of $114.9 million, which was nearly triple the Administration's FY2008 budget request of $36.1 million. The House Appropriations Committee recommended an increase to $200.0 million, while the Senate panel recommended the requested level.

Most of the FY2009 request — $59.5 million — is for Next Generation Nuclear Plant (NGNP) research and development, which received an FY2008 appropriation of $114.1 million. Under DOE's current plans, NGNP will use Very High Temperature Reactor (VHTR) technology, which features helium as a coolant and coated-particle fuel that can withstand temperatures up to 1,600 degrees celsius. Phase I research on the NGNP is to continue until 2011, when a decision will be made on moving to the Phase II design and construction stage, according to the FY2009 DOE budget justification. The House Appropriations Committee provided $196.0 million "to accelerate work" on NGNP — all but $4.0 million of the Committee's total funding level for the Generation IV program.

EPACT05 authorizes $1.25 billion through FY2015 for NGNP development and construction (Title VI, Subtitle C). The authorization requires that NGNP be based on research conducted by the Generation IV program and be capable of producing electricity, hydrogen, or both.

Advanced Fuel Cycle Initiative. According to the DOE budget justification, AFCI is intended to 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 reuse in a nuclear reactor or for transmutation in a particle accelerator. Much of the program's research will focus on 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.

The FY2009 AFCI funding request is $301.5 million, nearly 70% above the FY2008 appropriation of $179.4 million but below the FY2008 request of $395.0 million. AFCI, the primary technology component of the GNEP program, includes R&D on reprocessing technology and fast reactors that could use reprocessed plutonium.

The House Appropriations Committee recommended cutting AFCI to $90.0 million in FY2009, eliminating all funding for GNEP. The remaining funds would be used for research on advanced fuel cycle technology, but none could be used for design or construction of new facilities. The Committee urged DOE to continue coordinating its fuel cycle research with other countries that already have spent fuel recycling capability, but not with "countries aspiring to have nuclear capabilities." The Senate Appropriations Committee recommended $229.7 million for AFCI, focusing on advanced fuel separation and fuel fabrication.

FY2009 funding of $10.4 million was requested for conceptual design work on an Advanced Fuel Cycle Facility (AFCF) to provide an engineering-scale demonstration of AFCI technologies, according to the budget justification. The FY2008 Consolidated Appropriations act rejected funding for development of AFCF, as did the House Appropriations Committee for FY2009.

Removing uranium from spent fuel would eliminate about 95% of the mass 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 could 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 fissioned in accelerators or fast reactors 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. Nevertheless, proponents believe the process is proliferation-resistant, because further purification would be required to make the plutonium useable for weapons and because the high radioactivity of the plutonium mixtures would make the material difficult to divert or work with.

Under the Administration's GNEP initiative, plutonium partially separated from the highly radioactive spent fuel from nuclear reactors would be recycled into new fuel to expand the future supply of nuclear fuel and potentially reduce the amount of radioactive waste to be disposed of in a permanent repository. Under the initial concept for GNEP, 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. 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. The Nuclear Nonproliferation Treaty guarantees the right of all participants to develop fuel cycle facilities, and a GNEP Statement of Principles

signed by the United States and 15 other countries on September 16, 2007, preserves that right, while encouraging the establishment of a "viable alternative to acquisition of sensitive fuel cycle technologies."[23]

Although GNEP is largely conceptual at this point, DOE issued a Spent Nuclear Fuel Recycling Program Plan in May 2006 that provided a general schedule for a GNEP Technology Demonstration Program (TDP),[24] which would develop the necessary technologies to achieve GNEP's goals. According to the Program Plan, the first phase of the TDP, running through FY2006, consisted of "program definition and development" and acceleration of AFCI. Phase 2, running through FY2008, was to focus on the design of technology demonstration facilities, which then were to begin operating during Phase 3, from FY2008 to FY2020. The National Academy of Sciences in October 2007 strongly criticized DOE's "aggressive" deployment schedule for GNEP and recommended that the program instead focus on research and development.[25]

As part of GNEP, AFCI is conducting R&D on an Advanced Burner Reactor (ABR) that could destroy recycled plutonium and other long-lived radioactive elements. DOE requested $18.0 million for the ABR program for FY2009, up from $11.7 million in FY2008. The program is expected to focus on developing a sodium-cooled fast reactor (SFR). The House Appropriations Committee recommended no FY2009 funding for the ABR. (For more information about GNEP and reprocessing, see CRS Report RL34579, *Advanced Nuclear Power and Fuel Cycle Technologies: Outlook and Policy Options*, by Mark Holt.)

Nuclear Hydrogen Initiative. In support of President Bush's program to develop hydrogen-fueled vehicles, DOE requested $16.6 million for FY2009 for the Nuclear Hydrogen Initiative, about 67% above the FY2008 funding level but below the FY2007 appropriation. The House Appropriations Committee provided the full FY2009 request, while the Senate panel recommended $10.0 million — slightly above the FY2008 level. According to DOE's FY2009 budget justification, the program will continue laboratory-scale experiments to allow selection by 2011 of a hydrogen-production technology for pilot-scale demonstration by 2013. Thermochemical and high-temperature electrolysis technologies being studied by the program would use high-temperature nuclear reactors to produce the heat needed to efficiently break the oxygen-hydrogen bond in water, according to the DOE request.

Mixed Oxide Fuel Fabrication Facility. DOE requested $487.0 million for the Mixed Oxide Fuel Fabrication Facility at the Savannah River Site in South Carolina — a 75% increase from the FY2008 funding level. The multi-billion-dollar facility is intended to convert surplus weapons plutonium into oxide form and then blend it with uranium oxide to produce fuel for nuclear power plants. The FY2008 Consolidated Appropriations act shifted funding for the project to the DOE nuclear

---

[23] See GNEP website at [http://www.gnep.energy.gov]

[24] DOE, *Spent Nuclear Fuel Recycling Plan*, Report to Congress, May 2006.

[25] National Academy of Sciences, *Review of DOE's Nuclear Energy Research and Development Program*, prepublication draft, October 2007.

energy program from the Defense Nuclear Nonproliferation account. For FY2009, DOE proposes to shift the program's funding to the Other Defense Activities account. The House Appropriations Committee provided the full request, but recommended that the funding remain under the nuclear energy account. The Senate Appropriations Committee also recommended the full request but transferred the project back to the nuclear nonproliferation program.

Integrated University Program. The Senate Appropriations Committee recommended the establishment of an Integrated University Program to support university research in the nuclear field and to provide grants to help maintain university nuclear science and engineering programs. Under the Committee recommendation, $15.0 million each would be appropriated to the Office of Nuclear Energy, the Office of Defense Nuclear Nonproliferation, and the Nuclear Regulatory Commission, for a total of $45.0 million.

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 2,800 reactor-years of operation in the United States,[26] 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. A study of 32,000 people living within 5 miles of the reactor when the accident

---

[26] *Nuclear Engineering International*, "Country averages as at end June 2007," December 2007, p. 34.

occurred found no significant increase in cancer rates through 1998, although the authors noted that some potential health effects "cannot be definitively excluded."[27]

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 unacceptably 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.

NRC's safety regulations are designed to keep the probability of accidental core damage (fuel melting) below one in 10,000 per year for each reactor. The regulations also are intended to ensure that reactor containments would be successful at least 90% of the time in preventing major radioactive releases during a core-damage accident. Therefore, the probability of a major release at any given reactor is intended to be below one in 100,000 per year.[28] (For the current U.S. fleet of about 100 reactors, that rate would yield an average of one core-damage accident every 100 years and a major release every 1,000 years.) On the other hand, some groups challenge the complex calculations that go into predicting such accident frequencies, contending that accidents with serious public health consequences may be more frequent.[29]

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 2006 report by the Chernobyl Forum organized by the International Atomic Energy Agency, the primary observable health consequence of the accident was a dramatic increase in childhood thyroid cancer. The Chernobyl Forum estimated that about 4,000 cases of thyroid cancer have occurred in children who after the accident drank milk contaminated with high levels of radioactive iodine, which concentrates in the thyroid. Although the Chernobyl Forum found only 15 deaths from those thyroid cancers, it estimated that about 4,000 other cancer deaths may have occurred among the 600,000 people with the highest radiation

---

[27] 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].

[28] U.S. NRC, Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," July 1998.

[29] Public Citizen Energy Program, "The Myth of Nuclear Safety" [http://www.citizen.org/cmep/energy_enviro_nuclear/nuclear_power_plants/reactor_safety/articles.cfm?ID=4454]

exposures, plus an estimated 1% increase in cancer deaths among persons with less exposure. The report estimated that about 77,000 square miles were significantly contaminated by radioactive cesium.[30] Greenpeace issued a report in 2006 estimating that 200,000 deaths in Belarus, Russia, and Ukraine resulted from the Chernobyl accident between 1990 and 2004.[31]

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.

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) is paying up to half the cost of combined construction and operating licenses for two advanced reactors. Also as discussed above, Section 638 of 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

---

[30] The Chernobyl Forum: 2003-2005, *Chernobyl's Legacy: Health, Environmental and Socio-Economic Impacts*, International Atomic Energy Agency, April 2006.

[31] Greenpeace. *The Chernobyl Catastrophe: Consequences on Human Health*, April 2006, p. 10.

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 reorganized and overhauled many of its procedures. The Commission has moved 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.[32]

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 against access to vital reactor areas 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 attacks, 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).

The Energy Policy Act of 2005 required 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 approved the DBT revision based on those requirements on January 29, 2007. The revised DBT does not require nuclear power plants to protect themselves against deliberate aircraft attacks. NRC contended that nuclear facilities were already required to mitigate the effects of large fires and explosions, no matter what the cause, and that active protection against airborne threats was being addressed by U.S. military and other agencies.[33] However, NRC is currently considering regulations that would specifically require new reactors to withstand damage from aircraft impact.[34]

EPACT05 also requires NRC to conduct force-on-force security exercises at nuclear power plants every three years (which was NRC's previous policy),

---

[32] For more information about the NRC reactor oversight process, see [http://www.nrc.gov/NRR/OVERSIGHT/ASSESS/index.html]

[33] NRC Office of Public Affairs, *NRC Approves Final Rule Amending Security Requirements*, News Release No. 07-012, January 29, 2007.

[34] Weil, Jenny, "Aircraft Impact Assessments Might Be Required for All New Plants," *Inside NRC*, July 21, 2008, p. 1.

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 RL34331, *Nuclear Power Plant Security and Vulnerabilities*, by Mark Holt and Anthony Andrews.)

Decommissioning

When nuclear power plants reach the end of 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 the Maine Yankee plant, 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.[35] Decommissioning of the Connecticut Yankee plant cost $790 million and was approved by NRC on November 26, 2007.[36]

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 extended 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, currently $300 million. Any damages exceeding that amount are to be assessed equally against all covered commercial reactors, up to $95.8 million per reactor. Those assessments — called "retrospective premiums" — would be paid at an annual rate of no more than $15 million per reactor, to limit the potential financial burden on reactor owners following a major accident. According to NRC,

---

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

[36] E-mail communication from Bob Capstick, Connecticut Yankee Atomic Power Company, August 28, 2008.

104 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 $10.8 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 104 currently covered reactors, totaling $10.3 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 $10.8 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 Energy Policy Act of 2005 raised the limit on per-reactor annual payments to $15 million from the previous $10 million, and required the annual limit to be adjusted for inflation every five years. As under previous law, the total retrospective premium limit of $95.8 million is to be adjusted every five years as well. 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 (excluding the 5% surcharge).

The Price-Anderson Act also covers contractors who operate hazardous DOE nuclear facilities. The Energy Policy Act of 2005 set the liability limit on DOE contractors at $10 billion per accident, to be adjusted for inflation every five years. The liability limit for DOE contractors previously had been the same as for commercial reactors, excluding the 5% surcharge, except when the limit for commercial reactors dropped because of a decline in the number of covered reactors. Price-Anderson authorizes DOE to indemnify its contractors for the entire amount of their liability, 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.

The Energy Policy Act of 2005 limits the civil penalties against a nonprofit contractor to the amount of management fees paid under that contract. Previously, Atomic Energy Act §234A specifically exempted seven nonprofit DOE contractors and their subcontractors from civil penalties and authorized DOE to automatically remit any civil penalties imposed on nonprofit educational institutions serving as DOE contractors. The Energy Policy Act eliminated the civil penalty exemption for future contracts by the seven listed nonprofit contractors and DOE's authority to automatically remit penalties on nonprofit educational institutions.

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 inappropriately subsidizes the nuclear power industry by reducing its insurance costs and protecting it from some of the financial consequences of the most severe conceivable accidents.

The United States is supporting the establishment of an international liability system that, among other purposes, would cover U.S. nuclear equipment suppliers conducting foreign business. The Convention on Supplementary Compensation for Nuclear Damage will not enter into force until at least five states with a specified level of installed nuclear capacity have enacted implementing legislation. Such implementing language is included in the Energy Independence and Security Act of 2007 (P.L. 110-140, section 934), signed by the President December 19, 2007. Supporters of the Convention hope that more countries will join now that the United States has acted. Aside from the United States, three countries have submitted the necessary instruments of ratification, but the remaining nine countries that so far have signed the convention do not have the required nuclear capacity for it to take effect.

Under the U.S. implementing legislation, the Convention on Supplementary Compensation would not change the liability and payment levels already established by the Price-Anderson Act. Each party to the convention would be required to establish a nuclear damage compensation system within its borders analogous to Price-Anderson. For any damages not covered by those national compensation systems, the convention would establish a supplemental tier of damage compensation to be paid by all parties. P.L. 110-140 requires the U.S. contribution to the supplemental tier to be paid by suppliers of nuclear equipment and services, under a formula to be developed by DOE. Supporters of the convention contend that it will help U.S. exporters of nuclear technology by establishing a predictable international liability system.

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 metric tons of highly radioactive spent nuclear fuel, for a nationwide total of about 2,000 metric tons per year. U.S. reactors also generate about 40,000 cubic meters of low-level radioactive waste per year, including contaminated components and materials resulting from reactor decommissioning.[37]

The federal government is responsible for permanent disposal of commercial spent fuel (paid for with a fee on nuclear power production) and federally generated radioactive waste, whereas states have the authority to develop disposal facilities for commercial low-level waste. Under the Nuclear Waste Policy Act (42 U.S.C. 10101,

---

[37] DOE, Manifest Information Management System [http://mims.apps.em.doe.gov]. Average annual utility disposal from 2002 through 2007.

et seq.), 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. Yucca Mountain in Nevada is the only candidate site for the national repository. The act required DOE to begin taking waste from nuclear plant sites by 1998 — a deadline that under DOE's latest schedule will be missed by more than 20 years.

After numerous delays, DOE submitted a license application to NRC for the proposed Yucca Mountain repository on June 3, 2008. If NRC approves the license application within four years and Congress provides sufficient funding, according to DOE, nuclear waste shipments to Yucca Mountain could begin by 2020.[38] The waste program is run by DOE's Office of Civilian Radioactive Waste Management (OCRWM).

The FY2009 OCRWM budget request was $494.7 million; the House Appropriations Committee approved the full amount, and the Senate Appropriations Committee recommended $388.4 million. The FY2009 request is more than $100 million (28%) above the FY2008 appropriation of $386.4 million, but the FY2008 level is about $50 million below the FY2007 level and more than $100 million below the Administration's FY2008 request. The FY2008 funding reductions required OCRWM to reduce its workforce by about 900, according to the program's director.[39]

Funding for the nuclear waste program is provided under two appropriations accounts. The Administration requested $247.4 million for FY2009 from the Nuclear Waste Fund, which holds fees paid by nuclear utilities. An additional $247.4 million was requested in 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 Appropriations Committee recommended the full amount for both accounts for FY2009, while the Senate panel recommended $195.4 million from the Waste Disposal account and $193.0 million from the defense account.

In addition to the funding issue, the Yucca Mountain program faces regulatory uncertainty. A ruling on July 9, 2004, by the U.S. Court of Appeals for the District of Columbia Circuit overturned a key aspect of the Environmental Protection Agency's (EPA's) regulations for the planned repository.[40] The three-judge panel ruled that EPA's 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.

---

[38] Edward F. Sproat, III, Director, DOE Office of Civilian Radioactive Waste Management, statement before the Subcommittee on Energy and Air Quality, House Committee on Energy and Commerce, July 15, 2008.

[39] Statement of Edward F. Sproat III, OCRWM Director, to the Energy and Water Development Subcommittee of the House Appropriations Committee, April 10, 2008.

[40] *Nuclear Energy Institute v. Environmental Protection Agency*, U.S. Court of Appeals for the District of Columbia Circuit, no. 01-1258, July 9, 2004.

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 announced February 17, 2006, that the technical work conducted by the geologists was sound but that some work would be redone or further corroborated before submission of a repository license application.

Further delays in the nuclear waste program could prove costly to the federal government because of breach-of-contract lawsuits over DOE's failure to begin accepting spent fuel by 1998 as required by NWPA. Nuclear plant operators already have been awarded several hundred million dollars, and DOE estimates the federal government's potential liability is about $7 billion.[41] (For further details, see CRS Report RL33461, *Civilian Nuclear Waste Disposal*, by Mark Holt.)

Nuclear Weapons Proliferation

Renewed interest in nuclear power throughout the world has led to increased concern about nuclear weapons proliferation, because technology for making nuclear fuel can also be used to produce nuclear weapons material. Of particular concern are uranium enrichment, a process to separate and concentrate the fissile isotope uranium-235, and nuclear spent fuel reprocessing, which can produce weapons-useable plutonium.

The International Atomic Energy Agency (IAEA) conducts a safeguards program that is intended to prevent civilian nuclear fuel facilities from being used for weapons purposes, but not all potential weapons proliferators belong to the system, and there are ongoing questions about its effectiveness. Several proposals have been developed to guarantee nations without fuel cycle facilities a supply of nuclear fuel in exchange for commitments to forgo enrichment and reprocessing, which was one of the original goals of the Bush Administration's GNEP program (discussed above under "Nuclear Power Research and Development").

Several situations have arisen throughout the world in which ostensibly commercial uranium enrichment and reprocessing technologies have been subverted for military purposes. In 2003 and 2004, it became evident that Pakistani nuclear scientist A.Q. Khan had sold sensitive technology and equipment related to uranium enrichment to states such as Libya, Iran, and North Korea. Although Pakistan's leaders maintain they did not acquiesce in or abet Khan's activities, Pakistan remains outside the Nuclear Nonproliferation Treaty (NPT) and the Nuclear Suppliers Group (NSG). Iran has been a direct recipient of Pakistani enrichment technology.

IAEA's Board of Governors found in 2005 that Iran's breach of its safeguards obligations constituted noncompliance with its safeguards agreement, and referred the case to the U.N. Security Council in February 2006. Despite repeated calls by the U.N. Security Council for Iran to halt enrichment and reprocessing-related activities,

---

[41] Statement of OCRWM Director Edward F. Sproat III to the House Budget Committee, October 4, 2007, p. 3.

and imposition of sanctions, Iran continues to develop enrichment capability at Natanz. Iran insists on its inalienable right to develop the peaceful uses of nuclear energy, pursuant to Article IV of the NPT. Interpretations of this right have varied over time. The IAEA Director General, Mohamed ElBaradei, has not disputed this inalienable right and, by and large, neither have U.S. government officials. However, the case of Iran raises perhaps the most critical question in this decade for strengthening the nuclear nonproliferation regime: How can access to sensitive fuel cycle activities (which could be used to produce fissile material for weapons) be circumscribed without further alienating non-nuclear weapon states in the NPT?

Leaders of the international nuclear nonproliferation regime have suggested ways of reining in the diffusion of such inherently dual-use technology, primarily through the creation of incentives not to enrich uranium or reprocess spent fuel. The international community is in the process of evaluating those proposals and may decide upon a mix of approaches. At the same time, there is debate on how to improve the IAEA safeguards system and its means of detecting diversion of nuclear material to a weapons program in the face of expanded nuclear power facilities worldwide.

India and Pakistan each pose a challenge to the international nonproliferation regime. Both tested nuclear weapons in May 1998, neither has signed the NPT, and only a limited number of civilian facilities are under IAEA safeguards in each country. In response to the nuclear tests, President Clinton imposed full restrictions on all non-humanitarian aid to both countries as mandated by Section 102 of the Arms Export Control Act. However, Congress and the President acted almost immediately to lift certain aid restrictions, and all remaining nuclear-related sanctions on Pakistan and India were removed in October 2001.

On July 18, 2005, President Bush announced he would "work to achieve full civil nuclear energy cooperation with India." Nonproliferation experts have argued that the potential costs of nuclear cooperation with India to U.S. and global nonproliferation policy may exceed the benefits. For example, the Nuclear Suppliers Group (NSG) would have to amend its guidelines to allow cooperation with a non-NPT state, potentially prompting some suppliers, such as China, to justify supplying other states outside the NPT regime, such as Pakistan. NSG met in August 2008 to consider the proposed provisions on India.

NSG also expressed concern that supplying nuclear fuel to India could free up its domestic production of nuclear material for weapons use. This could in turn lead to increased fissile material production for weapons in Pakistan. Supporters of the agreement argue that the U.S.-India nuclear cooperation would allow for India's increased participation in the nonproliferation regime by expanding the number of safeguarded facilities and promoting stricter export controls.

(For more information, see CRS Report RL34234, *Managing the Nuclear Fuel Cycle: Policy Implications of Expanding Global Access to Nuclear Power*, by Mary Beth Nikitin, Coordinator.)

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 FY2009 budget request February 4, 2008. For nuclear energy research and development — including advanced reactors, fuel cycle technology and facilities, nuclear hydrogen production, and infrastructure support — the Administration requested $1.419 billion, about 40% higher than the FY2008 appropriation of $1.033 billion. The FY2009 request included an 80% increase in assistance for new commercial reactor orders (Nuclear Power 2010), a 70% increase for nuclear spent fuel reprocessing R&D (the Advanced Fuel Cycle Initiative), and a 75% boost for a mixed-oxide (MOX) fuel fabrication facility to make fuel from surplus weapons plutonium. Those activities are funded by various appropriations accounts through DOE's Office of Nuclear Energy. The House Appropriations Committee on June 25, 2008, recommended $1.317 billion in FY2009 (no report filed).

The Senate Appropriations Committee voted July 10, 2008 (S.Rept. 110-416) to fully fund the MOX project at the Administration's request of $487.0 million but place it under the National Nuclear Security Administration's Office of Defense Nuclear Nonproliferation. As a result, the Senate panel's funding total for the Office of Nuclear Energy is $803.0 million, $50.6 million below the comparable request and $120.1 million above the comparable FY2008 level.

Final funding levels for FY2008 are provided in the Consolidated Appropriations Act, signed December 26, 2007 (P.L. 110-161). The accompanying funding tables can be found in the December 17, 2007, Congressional Record beginning on page H15940.

Table 2. Funding for the Nuclear Regulatory Commission

(budget authority in millions of current dollars)

	FY2008 Approp.	FY2009 Request	FY2009 House	FY2009 Senate Comm.	FY2009 Final
Nuclear Regulatory Commission					
— Reactor Safety	740.6	786.6	— [a]	— [a]	
— Nuclear Materials and Waste	147.7	184.0	—	—	
— Inspector General	8.7	9.0	10.9	9.3	
Total NRC budget authority	926.1	1,017.0	1,069.9	1,032.3	
— Offsetting fees	779.1	855.5	870.7	861.8	
Net appropriation	**147.0**	**161.5**	**199.2**	**170.5**	

a. Subcategories not specified.

Table 3. DOE Funding for Nuclear Activities

(budget authority in millions of current dollars)

	FY2008 Approp.	FY2009 Request	FY2009 House	FY2009 Senate Comm.	FY2009 Final
Nuclear Energy (selected programs)					
Integrated University Program	0	0	0	15.0	
Nuclear Power 2010	133.8	241.6	157.3	241.6	
Generation IV Nuclear Systems	114.9	70.0	200.0	70.0	
Nuclear Hydrogen Initiative	9.9	16.6	16.6	10.0	
Advanced Fuel Cycle Initiative	179.4	301.5	90.0	229.7	
MOX Fuel Fabrication Facility	278.8	487.0[b]	487.0	487.0[c]	
Radiological Facilities Management	48.1	38.7	62.4	41.0	
Idaho National Laboratory Infrastructure	239.3	222.2	291.2	239.5	
Program Direction	80.9	80.5	80.5	73.0	
Total, Nuclear Energy[d]	1,036.9	853.6	1,238.9	803.0	
Civilian Nuclear Waste Disposal[a]	386.4	494.7	494.7	388.4	

a. Funded by a 1-mill-per-kilowatt-hour fee on nuclear power, plus appropriations for defense waste disposal and homeland security.
b. Funded under Other Defense Activities.
c. Funded under Defense Nuclear Nonproliferation.
d. Excludes funding provided under other accounts.

Legislation in the 110th Congress

H.R. 994 (John Hall)/S. 649 (Clinton)

Requires NRC to conduct an independent safety assessment of the Indian Point nuclear power plant in New York. House bill introduced February 12, 2007; referred to Committee on Energy and Commerce. Senate bill introduced February 15, 2007; referred to Committee on Environment and Public Works.

H.R. 1133 (Berkley)

Freedom through Renewable Energy Expansion (FREE) Act. Repeals provisions of the Energy Policy Act of 2005 (P.L. 109-58) regarding the next

generation nuclear plant project. Introduced February 16, 2007; referred to multiple committees.

H.R. 2162 (Lowey)

Nuclear Power Licensing Reform Act of 2007. Requires that nuclear power plants before receiving an initial or renewed license be found not to pose an unreasonable threat because of safety or security vulnerabilities and have adequate evacuation plans approved by the relevant federal agencies and states within 50 miles of the facility. Introduced May 3, 2007; referred to Committee on Energy and Commerce.

H.R. 2282 (Schmidt)

Nuclear Waste Storage Prohibition Act. Prohibits DOE from using GNEP funds to store nuclear waste at any site where reprocessing facilities are not operating or under construction. Introduced May 10, 2007; referred to Committee on Energy and Commerce.

H.R. 2641 (Visclosky)/S. 1751 (Dorgan)

Energy and Water Development Appropriations for FY2008. Includes funding for DOE nuclear waste program and GNEP. Reported as an original measure by the House Committee on Appropriations June 11, 2007 (H.Rept 110-185) following committee markup June 6, 2007. Passed by House July 17, 2007, by vote of 312-112. Senate bill reported as an original measure by Senate Committee on Appropriations July 9, 2007 (S.Rept. 110-127) following committee markup June 28, 2007. Final FY2008 Energy and Water Development funding included in Consolidated Appropriations Act, signed December 26, 2007 (P.L. 110-161).

H.R. 2814 (Marchant)

Authorizes the Secretary of Energy to provide loan guarantees for 100% of the cost of construction of new domestic nuclear power production facilities. Introduced June 21, 2007; referred to Committees on Energy and Commerce and Science and Technology.

H.R. 3089 (Thornberry)

No More Excuses Energy Act of 2007. Prohibits NRC from denying nuclear power plant licenses based on waste disposal capacity and establishes tax credits for increasing nuclear reactor component manufacturing capacity. Introduced July 18, 2007; referred to Committees on Natural Resources, Ways and Means, and Energy and Commerce.

H.R. 3228 (Lowey)

Requires NRC to distribute safety-related fines paid by nuclear power plants to the counties around those plants to cover emergency preparedness expenses. Introduced July 30, 2007; referred to Committee on Energy and Commerce.

H.R. 3259 (Lowey)

Authorizes the Secretary of Homeland Security to designate no-fly zones around nuclear power plants. Introduced July 31, 2007; referred to Committee on Transportation and Infrastructure.

H.R. 3358 (Upton)

Renewing Our Commitment to Safe and Clean Power Act. Allows nuclear waste fees to offset appropriations for the nuclear waste disposal program, authorizes "infrastructure activities" as a use for the Nuclear Waste Fund, and requires NRC to determine that sufficient nuclear waste disposal capacity will exist for new reactors. Introduced August 3, 2007; referred to Committee on Energy and Commerce.

H.R. 3491 (Welch)

Requires NRC to conduct independent safety assessments of nuclear power plants in certain situations. Introduced September 6, 2007; referred to Committee on Energy and Commerce.

H.R. 4062 (Matheson)

Federal Accountability for Nuclear Waste Storage Act of 2007. Requires DOE to take title to spent fuel stored in dry casks at nuclear power plant sites. Introduced November 1, 2007; referred to Committee on Energy and Commerce.

H.R. 5437 (Ross)

American-Made Energy Act of 2008. Includes an investment tax credit for nuclear power plants. Introduced February 14, 2008; referred to multiple committees.

H.R. 5632 (Gordon)

Prohibits importation of certain low-level radioactive waste into the United States. Introduced March 13, 2008; referred to committees on Energy and Commerce and Ways and Means.

H.R. 5943 (Burgess)

Nuclear Used Fuel Prize Act of 2008. Authorizes the Secretary of Energy to establish monetary prizes for technical advances in spent nuclear fuel management. Introduced May 1, 2008; referred to Committee on Science and Technology.

H.R. 6001 (Buyer)

Main Street U.S.A. Energy Security Act of 2008. Includes provisions to transfer the DOE nuclear waste disposal program to an independent authority and to encourage nuclear power growth. Introduced May 8, 2008; referred to multiple committees.

H.R. 6132 (Barton)

Authorizes the Nuclear Waste Fund to be used for nuclear spent fuel recycling. Introduced May 22, 2008; referred to committees on Energy and Commerce and Budget.

H.R. 6135 (Upton)

Establishes scholarships for nuclear science and engineering students. Introduced May 22, 2008; referred to Committee on Science and Technology.

H.R. 6421 (Shuster)

Energy Independence Act. Includes tax credit for manufacturing capacity for nuclear reactor components, nuclear power plant investment tax credits, expansion

of DOE Nuclear Power 2010 and Standby Support programs, nuclear workforce training, modifications to licensing procedures, authorization for DOE to negotiate temporary storage agreements for nuclear spent fuel, waste disposal provisions for new reactors, and determination that spent fuel from future reactors can be safely managed and shall not be raised as a licensing issue. Introduced June 26, 2008; referred to multiple committees.

H.R. 6816 (Markey)/S. 3444 (Clinton)

Nuclear Facility and Material Security Act of 2008. Requires new nuclear power plants to be designed to withstand impact from large commercial aircraft, increased security measures for spent fuel storage pools, and other security measures. House bill introduced August 1, 2008; referred to Committee on Energy and Commerce. Senate bill introduced August 1, 2008; referred to Committee on Environment and Public Works.

H.R. 6817 (Matheson)

Fulfilling U.S. Energy Leadership Act of 2008. Includes studies of nuclear power's role in reducing greenhouse gas emissions and possible nuclear power cost reductions, reauthorizes Nuclear Power 2010 program, and authorizes nuclear workforce training. Introduced August 1, 2008; referred to multiple committees.

S. 37 (Domenici)

Nuclear Waste Access to Yucca Act. Permanently withdraws Yucca Mountain site from public use, authorizes nuclear waste interim storage facilities at Yucca Mountain, repeals the Yucca Mountain capacity limit, and makes other changes in the nuclear waste program. Introduced May 23, 2007; referred to Committee on Energy and Natural Resources.

S. 280 (Lieberman)

Climate Stewardship and Innovation Act of 2007. Includes provisions establishing research program on nuclear fuel cycles and a demonstration program to reduce nuclear power plant licensing costs. Introduced January 12, 2007; referred to Committee on Environment and Public Works.

S. 784 (Reid)

Federal Accountability for Nuclear Waste Storage Act of 2007. 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 March 6, 2007. Referred to Committee on Environment and Public Works.

S. 1008 (Sanders)

Requires the Nuclear Regulatory Commission to develop and implement procedures for independent safety assessments of nuclear power plants. Introduced March 28, 2007; referred to Committee on Environment and Public Works.

S. 2551 (Inhofe)

Provides for interim nuclear waste disposal license at Yucca Mountain site. Introduced January 24, 2008; referred to Committee on Environment and Public Works.

S. 3126 (Coleman)

Energy Resource Development Act of 2008. Includes reauthorization of Nuclear Power 2010 Program, expansion of federal loan guarantees, tax credits for expansion of nuclear reactor component manufacturing capacity, nuclear power plant investment tax credits, and nuclear workforce training. Introduced June 12, 2008; referred to Committee on Finance.

S. 3215 (Domenici)

Strengthening Management of Advanced Recycling Technologies Act of 2008. Requires DOE to offer cooperative agreements for licensing spent nuclear fuel recycling facilities. Introduced June 26, 2008; referred to Committee on Energy and Natural Resources.

S. 3258 (Dorgan)

Energy and Water Development and Related Agencies Appropriations Act, 2009. Provides funding for nuclear energy programs. Reported as an original measure from the Appropriations Committee July 14, 2008 (S.Rept. 110-416).