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Nuclear Energy Policy

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Summary

Nuclear energy issues facing Congress include reactor safety and regulation, radioactive waste management, research and development priorities, federal incentives for new commercial reactors, nuclear weapons proliferation, and security against terrorist attacks.

The earthquake and resulting tsunami that severely damaged Japan's Fukushima Daiichi nuclear power plant on March 11, 2011, raised questions in Congress about the disaster's possible implications for nuclear safety regulation, U.S. nuclear energy expansion, and radioactive waste policy. The tsunami knocked out electric power at the six-reactor plant, resulting in the overheating of several reactor cores, loss of cooling in spent fuel storage pools, major hydrogen explosions, and releases of radioactive material into the environment. The Nuclear Regulatory Commission (NRC) issued orders to U.S. nuclear plants March 12, 2012, to begin implementing safety improvements in response to Fukushima.

Significant incentives for new commercial reactors were included in the Energy Policy Act of 2005 (EPACT05, P.L. 109-58), such as tax credits and loan guarantees. Together with volatile fossil fuel prices and the possibility of greenhouse gas controls, the federal incentives for nuclear power helped spur renewed interest by utilities and other potential reactor developers. License applications for as many as 31 new reactors were announced, and NRC issued licenses for four reactors at two plant sites in early 2012. However, falling natural gas prices, safety concerns raised by the Fukushima accident, and other changing circumstances have made it unlikely that many more of the proposed nuclear projects will move toward construction in the near term.

Four U.S. reactors were permanently closed in 2013, and another shutdown has been announced for late 2014. Three reactors were closed because of the need for major repairs, and the other two because electricity prices fell below their generating costs.

DOE's nuclear energy research and development program includes advanced reactors, fuel cycle technology and facilities, and infrastructure support. The Obama Administration's FY2015 funding request for nuclear energy research and development totaled \$863.4 million. Including advanced reactors, fuel cycle technology, infrastructure support, and safeguards and security, the total nuclear energy request was \$25.0 million (2.9%) below the FY2014 funding level. The House approved \$826.7 million (H.R. 4923), while the Senate Subcommittee on Energy and Water Development Appropriations recommended \$777.0 million.

Disposal of highly radioactive waste has been one of the most controversial aspects of nuclear power. The Obama Administration halted work on a long-planned waste repository at Yucca Mountain, NV, and established the Blue Ribbon Commission on America's Nuclear Future (BRC) to recommend new approaches to the waste problem. The BRC issued its final report to the Secretary of Energy on January 26, 2012. In response to the BRC report, and to provide an outline for a new nuclear waste program, DOE issued a *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Waste* in January 2013. The DOE strategy calls for a new nuclear waste management entity to develop consent-based storage and disposal sites, similar to recommendations by the BRC. No funding has been requested or appropriated since FY2011 to continue NRC licensing of the Yucca Mountain repository, although the House voted to provide DOE with \$150.0 million and NRC \$55.0 million for Yucca Mountain licensing activities in FY2015.

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Most Recent Developments

Agreements for the first loan guarantees for nuclear power plants under the Energy Policy Act of 2005 were signed February 20, 2014, by Energy Secretary Ernest Moniz. The federal loan guarantees total $6.5 billion for two reactors being constructed at the Vogtle nuclear plant in Waynesboro, GA.[1] Southern Company, the plant's lead owner, estimated that its $3.46 billion share of the loan guarantee would reduce its present-value financing costs by up to $250 million. The guaranteed loans are to be issued by the U.S. Treasury's Federal Financing Bank.[2] The plant owners were not charged an upfront fee for the loan guarantees but are paying interest above the applicable Treasury rate.[3]

The Department of Energy's (DOE's) FY2015 funding request for nuclear energy research and development, submitted to Congress in early March 2014, totaled $863.4 million. Including advanced reactors, fuel cycle technology, infrastructure support, and safeguards and security, the total nuclear energy request is $25.0 million (2.9%) below the FY2014 funding level. The House approved its FY2015 Energy and Water appropriations bill (H.R. 4923) on July 10, 2014, with $826.7 million for nuclear energy. The Senate Subcommittee on Energy and Water Development Appropriations recommended $777.0 million on July 24, 2014.[4] Pending enactment of full-year appropriations, FY2015 funding for these programs is being provided by a continuing resolution (P.L. 113-164).

The first construction starts for new U.S. nuclear power reactors since the 1970s officially took place in March 2013 in South Carolina and Georgia. Pouring of the first "safety related" concrete, which marks the start of reactor construction, was completed on March 11, 2013, for V.C. Summer Unit 2 in Cayce, SC, and three days later for Vogtle Unit 3 in Georgia. The Nuclear Regulatory Commission (NRC) had issued combined construction permits and operating licenses (COLs) for two new reactors at the Vogtle site on February 9, 2012, and for two identical reactors at the Summer plant on March 30, 2012. Each of the new Westinghouse AP1000 reactors, scheduled for completion between 2017 and 2019, is expected to cost from $5 billion to $7 billion.

NRC approved a design certification September 16, 2014, for GE-Hitachi's Economic Simplified Boiling Water Reactor (ESBWR), following nine years of review. Like the Westinghouse AP1000, the ESBWR includes "passive" safety features that are designed to protect the reactor core from overheating after an accident. NRC is currently reviewing two COLs that would use the ESBWR design: Fermi 3 in Michigan and North Anna 3 in Virginia.[5]

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[1] Mirshak, Meg, "Energy Secretary Moniz Visits Vogtle to Finalize Loan Guarantee," *Augusta Chronicle*, February 21, 2014, http://chronicle.augusta.com/news/metro/2014-02-20/energy-secretary-moniz-visits-vogtle-finalize-loan-guarantee.

[2] Southern Company, "Southern Company Subsidiary, DOE Finalize Vogtle Nuclear Project Loan Guarantees," news release, February 20, 2014, http://www.prnewswire.com/news-releases/southern-company-subsidiary-doe-finalize-vogtle-nuclear-project-loan-guarantees-246395221.html.

[3] See CRS Insight.

[4] Senate Committee on Appropriations, "FY15 Subcommittee Reported Bill and Draft Report," July 24, 2014, http://www.appropriations.senate.gov/news/fy-2015-ew-subcommittee-reported-bill-and-draft-report.

[5] Nuclear Regulatory Commission, "NRC Certifies GE-Hitachi New Reactor Design," news release, September 16, 2014, http://www.nrc.gov/reading-rm/doc-collections/news/2014/.

Four U.S. reactors were permanently closed during 2013, and the shutdown of a fifth unit was announced for late 2014. Crystal River 3 in Florida was retired in February 2013 because of cracks in its concrete containment structure. The single-unit Kewaunee plant in Wisconsin closed in May 2013 because regional electricity prices had dropped below the reactor's generating costs. San Onofre 2 and 3 in California closed in June 2013 because of faulty steam generators (unit 1 had been shut previously). And the owner of the single-unit Vermont Yankee plant announced in August 2013 that the reactor would permanently close in the fourth quarter of 2014 for economic reasons. All of those units had substantial time remaining on their initial 40-year operating licenses or had received or applied for 20-year license extensions from NRC. The shutdowns prompted widespread discussion about the future of other aging U.S. reactors.

Continued operation of "at risk" nuclear generating capacity could be encouraged by regulations proposed by the Environmental Protection Agency (EPA) on June 2, 2014, to reduce carbon emissions at existing power plants. The EPA proposal would require states to reduce the "carbon intensity" (carbon emissions per megawatt-hour of electrical generation) of their existing fossil fuel-fired generating plants by 2030. The proposed standards assume that states will prevent the premature retirement of up to 6% of their existing nuclear capacity and also complete five reactors currently under construction. States could also respond to the standards by encouraging construction of additional reactors or the expansion of generating capacity at existing nuclear plants, among many other options.[6]

On March 12, 2012, NRC issued its first nuclear plant safety requirements based on lessons learned from the March 2011 Fukushima disaster in Japan. NRC ordered U.S. nuclear plant operators to begin implementing safety enhancements related to power blackouts, reactor containment venting, and monitoring the water levels of reactor spent fuel pools. The Fukushima nuclear plant was hit by an earthquake and tsunami that knocked out all electric power at the six-reactor plant, resulting in the overheating of the reactor cores in three of the units and a heightened overheating risk at several spent fuel storage pools at the site. The overheating of the reactor cores caused major hydrogen explosions and releases of radioactive material to the environment. NRC's response to the accident has been the subject of continuing congressional oversight.

After halting work on a long-planned nuclear waste repository at Yucca Mountain in Nevada, DOE issued a *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Waste* in January 2013. The DOE strategy calls for a new nuclear waste management entity to develop consent-based storage and disposal sites. A pilot interim spent fuel storage facility would be opened by 2021 and a larger-scale storage facility, which could be an expansion of the pilot facility, would begin receiving waste by 2025. A geologic disposal facility would open by 2048—fifty years after the initial planned opening date for the Yucca Mountain repository.[7] Legislation to redirect the nuclear waste program along similar lines was introduced by Senator Wyden on June 27, 2013 (S. 1240). The U.S. Court of Appeals for the District of Columbia Circuit ruled on August 13, 2013, that NRC must continue work on the Yucca Mountain license application as long as funding is available. The Court determined that NRC has at least $11.1 million in

[6] Environmental Protection Agency, "Clean Power Plan Proposed Rule," http://www2.epa.gov/carbon-pollution-standards/clean-power-plan-proposed-rule.

[7] DOE, *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Waste*, January 2013, http://energy.gov/sites/prod/files/Strategy%20for%20the%20Management%20and%20Disposal%20of%20Used%20Nuclear%20Fuel%20and%20High%20Level%20Radioactive%20Waste.pdf.

previously appropriated funds for that purpose.[8] In its FY2015 Energy and Water Development appropriations bill, the House voted to provide DOE $150.0 million and NRC $55.0 million for Yucca Mountain licensing activities. No funding was included in the draft bill approved by the Senate subcommittee.

Pursuant to a court ruling, DOE stopped collecting nuclear waste fees from nuclear power generators on May 16, 2014, eliminating about $750 million in annual revenues for the waste disposal program.[9] The Nuclear Waste Policy Act requires the Secretary of Energy to adjust the fees as necessary to cover the waste program's anticipated costs, but the U.S. Court of Appeals for the District of Columbia Circuit ruled that DOE's current waste plans are too vague to allow a reasonable estimate to be calculated and that DOE must therefore stop collecting the fee.[10]

NRC approved a final rule August 26, 2014, on continued storage of spent nuclear fuel.[11] The rule responds to a federal circuit court ruling on June 8, 2012, that struck down NRC's Waste Confidence Decision, which contains the agency's formal findings that waste generated by nuclear power plants will be disposed of safely. The court ruled that the Waste Confidence Decision required an environmental review under the National Environmental Policy Act and that NRC needed to consider the possibility that a permanent waste repository would never be built and examine potential problems with waste storage pools. In approving the storage rule, NRC ended its suspension of final licensing decisions for new reactors, spent fuel storage facilities, and license renewals.[12]

Nuclear Power Status and Outlook

After nearly 30 years in which no new orders had been placed for nuclear power plants in the United States, a series of license applications that began in 2007 prompted widespread speculation about a U.S. "nuclear renaissance." The renewed interest in nuclear power largely resulted from the improved performance of existing reactors, federal incentives in the Energy Policy Act of 2005 (P.L. 109-58), the possibility of carbon dioxide controls that could increase costs at fossil fuel plants, and volatile prices for natural gas—the favored fuel for new power plants for the past two decades.

Four of the proposed new U.S. reactors received licenses from the Nuclear Regulatory Commission (NRC) in early 2012. NRC approved combined construction permit and operating licenses (COLs) for Southern Company to build and operate two new Westinghouse AP1000

[8] U.S. Court of Appeals for the District of Columbia Circuit, In re: Aiken County et al., No. 11-1271, writ of mandamus, August 13, 2013, http://www.cadc.uscourts.gov/internet/opinions.nsf/BAE0CF34F762EBD985257BC6004DEB18/$file/11-1271-1451347.pdf.

[9] Hiruo, Elaine, "DOE Implements Court-Ordered Suspension of Nuclear Waste Fee," *NuclearFuel*, May 26, 2014.

[10] U.S. Court of Appeals for the District of Columbia Circuit, National Association of Regulatory Utility Commissioners v. U.S. Department of Energy, No. 11-1066, decided November 19, 2013, http://www.cadc.uscourts.gov/internet/opinions.nsf/2708C01ECFE3109F85257C280053406E/$file/11-1066-1466796.pdf.

[11] NRC, "Waste Confidence—Continued Storage of Spent Nuclear Fuel," proposed rule, 78 *Federal Register* 56776, September 13, 2013.

[12] NRC, "NRC Approves Final Rule on Spent Fuel Storage and Ends Suspension of Final Licensing Actions for Nuclear Plants and Renewals," news release, August 26, 2014, http://pbadupws.nrc.gov/docs/ML1423/ML14238A326.pdf.

reactors at the Vogtle nuclear power plant in Georgia on February 9, 2012. On March 30, 2012, NRC approved COLs for two additional AP1000 reactors at the existing V.C. Summer nuclear plant in South Carolina. Pouring of the first "safety related" concrete, which marks the start of reactor construction, was completed on March 11, 2013, for Summer Unit 2 and three days later for Vogtle Unit 3 (after several years of site preparation, component fabrication, and other preliminary work).

However, the future of all other proposed new U.S. reactors is uncertain. High construction cost estimates—a major reason for earlier reactor cancellations—continue to undermine nuclear power economics. A more recent obstacle to nuclear power growth has been the development of vast reserves of domestic natural gas from previously uneconomic shale formations, which has held gas prices low and reduced concern about future price spikes. Moreover, it is unclear at this point how much incentive might be provided to nuclear power by potential U.S. carbon controls.

Four U.S. reactors were permanently closed during 2013, and the shutdown of a fifth unit was announced for late 2014. Crystal River 3 in Florida was retired in February 2013 because of cracks in its concrete containment structure. The single-unit Kewaunee plant in Wisconsin closed in May 2013 because regional electricity prices had dropped below the reactor's generating costs. San Onofre 2 and 3 closed in June 2013 because of faulty steam generators (unit 1 had been shut previously). And the owner of the single-unit Vermont Yankee plant announced in August 2013 that the reactor would permanently close in the fourth quarter of 2014 for economic reasons. All of those units had substantial time remaining on their initial 40-year operating licenses or had received or applied for 20-year license extensions from NRC. The shutdowns prompted widespread discussion about the future of other aging U.S. reactors.

The March 11, 2011, earthquake and tsunami that severely damaged Japan's Fukushima Daiichi nuclear power plant could also affect plans for new U.S. reactors, although U.S. nuclear power growth was already expected to be modest in the near term. Following the Fukushima accident, preconstruction work was suspended on two planned reactors at the South Texas Project. Tokyo Electric Power Company (TEPCO), which owns the Fukushima plant, had planned to invest in the South Texas Project expansion, but TEPCO's financial condition plunged after the accident. New U.S. safety requirements resulting from the Fukushima disaster could raise investor concerns about higher costs. On the other hand, after the accident the Obama Administration reiterated its support for nuclear power expansion as part of its clean energy policy.[13]

The recent applications for new power reactors in the United States followed a long period of declining nuclear generation growth rates. Until the COLs were issued for the Vogtle and Summer projects, no nuclear power plants had been ordered in the United States since 1978, and more than 100 reactors had been canceled, including all ordered after 1973. The most recent U.S. nuclear unit to be completed was the Tennessee Valley Authority's (TVA's) Watts Bar 1 reactor, ordered in 1970 and licensed to operate in 1996. But largely because of better operation and capacity expansion at existing reactors, annual U.S. nuclear generation has risen by about 20% since the startup of Watts Bar 1.[14] The U.S. nuclear power industry currently comprises 100 licensed reactors (excluding the four permanently closed in 2013) at 62 plant sites in 31 states and

[13] Oral Testimony of Energy Secretary Steven Chu at the House Energy and Commerce Committee – As Prepared for Delivery, March 16, 2011, http://www.energy.gov/news/10178.htm.

[14] Energy Information Administration, *Electricity Data Browser*, "Net Generation for All Sectors, Annual," viewed September 4, 2013, http://www.eia.gov/electricity/data/browser.

generates about 19% of the nation's electricity.[15] TVA's board of directors voted August 1, 2007, to resume construction on Watts Bar 2, which had been suspended in 1985; the renewed construction project was to cost about $2.5 billion and be completed in 2013. However, TVA announced on April 5, 2012, that completing Watts Bar 2 would cost up to $2 billion more than expected and take until 2015.[16] At TVA's request, NRC in March 2009 reinstated the construction authorization for the two-unit Bellefonte (AL) nuclear plant, which had been deferred in 1988 and canceled in 2006.[17] The TVA board voted on August 18, 2011, to complete construction of Bellefonte 1 after the Watts Bar 2 project is finished. Completing Bellefonte 1 was projected at that time to cost $4.9 billion, with operation to begin by 2020.[18] Citing lower electricity sales, TVA on June 12, 2013, announced sharp cutbacks at the Bellefonte site.[19]

Annual electricity production from U.S. nuclear power plants is much greater than that from oil and hydropower and other renewable energy sources. Nuclear generation has been overtaken by natural gas in recent years, and it remains well behind coal, which accounted for about 39% of U.S. electricity generation in 2013.[20] Nuclear plants generated more than half the electricity in four states in 2012—New Hampshire, New Jersey, South Carolina, and Vermont—and 12 states generated 25%-50% of their electricity from nuclear power.[21] The 789 billion net kilowatt-hours of nuclear electricity generated in the United States during 2013[22] was about the same as the nation's entire electrical output in the early 1960s, when the oldest of today's operating U.S. commercial reactors were ordered.[23]

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 issues.

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 $3,900 per kilowatt of electric generating capacity (in 2011 dollars), far higher than commercial fossil fuel technologies. 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 if any reduction in cost.[24]

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[15] U.S. Nuclear Regulatory Commission, *Information Digest 2023-2014*, NUREG-1350, Vol. 25, August 20013, p. 32, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1350/v25/sr1350v25.pdf.

[16] Mary Powers, "Credit Agencies See Watts Bar-2 Cost Impact," *Nucleonics Week*, April 12, 2012, p. 1.

[17] Nuclear Regulatory Commission, "In the Matter of Tennessee Valley Authority (Bellefonte Nuclear Plant Units 1 and 2)," 74 *Federal Register* 10969, March 13, 2009.

[18] Tennessee Valley Authority, "TVA Board Implements Vision," press release, August 18, 2011, http://www.tva.com/news/releases/julsep11/board_meeting/index.htm.

[19] Tennessee Valley Authority, "TVA Announces Budget Reduction for Bellefonte Plant," press release, June 12, 2013, http://www.tva.com/news/releases/aprjun13/bellefonte_budget.html.

[20] Energy Information Administration, *Electric Power Monthly*, Net Generation by Energy Source, February 2014, http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_1_01. Net generation excludes electricity used for power plant operation.

[21] Nuclear Regulatory Commission, *Information Digest, 2013–2014*, op. cit.

[22] EIA, *Electricity Data Browser,* op. cit.

[23] All of today's 100 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.

[24] For a comparison of generating costs, see CRS Report RL34746, *Power Plants: Characteristics and Costs*, by Stan Mark Kaplan.

In contrast, average U.S. nuclear plant operating costs per kilowatt-hour dropped substantially since 1990, and expensive downtime has been steadily reduced. Licensed U.S. commercial reactors generated electricity at an average of 90% of their total capacity in 2013, according to the Energy Information Administration (EIA).[25]

Seventy-three commercial reactors have received 20-year license renewals from the Nuclear Regulatory Commission (NRC), giving them up to a total of 60 years of operation. License renewals for 19 additional reactors are currently under review, and more are anticipated, according to NRC.[26] However, as noted above, three reactors that have received license renewals, Vermont Yankee, Crystal River, and Kewaunee, are being permanently closed for economic reasons.

Possible New Reactors

Electric utilities and other firms have announced plans to apply for COLs for more than 30 reactors (see **Table 1**).[27] (For a discussion of COLs, see the "Licensing and Regulation" section below.)

As noted above, construction is currently underway on four of the proposed new reactors, at the Vogtle and Summer sites. COLs are being actively pursued for 14 additional reactors (shown in **Table 1**), whose owners have not committed to actual construction but are keeping the option available if conditions are more favorable in the future. The experience of the first few reactors to be constructed is likely to be crucial in determining whether a wave of subsequent units will move forward as the nuclear industry envisions.

The two new Vogtle reactors are scheduled to go on line in 2017 and 2018,[28] the same years now planned for startup of the new Summer units,[29] although possible delays of more than a year have been reported.[30] EIA estimates that construction costs of new nuclear power plants will average $5,335 per kilowatt of capacity, or about $6.1 billion for an AP1000 unit, not including interest costs.[31] The two Summer units are expected to cost about $11.6 billion in 2012 dollars, according to regulatory filings,[32] while the two Vogtle units are projected by their primary owner to cost a total of $13.35 billion.[33]

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[25] Energy Information Administration, *Electric Power Monthly*, "Capacity Factors for Utility-Scale Generators Not Primarily Using Fossil Fuels," February 2014, http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_6_07_b.

[26] Nuclear Regulatory Commission, "Status of License Renewal Applications and Industry Activities," May 5, 2014, http://www.nrc.gov/reactors/operating/licensing/renewal/applications.html.

[27] Nuclear Regulatory Commission, New Reactors, http://www.nrc.gov/reactors/new-reactors.html.

[28] Southern Company, "Smart Power," http://www.southerncompany.com/smart_energy/smart_power_vogtle-kemper.html.

[29] South Carolina Electric and Gas Company, "V.C. Summer Nuclear Station Units 2 and 3, Quarterly Report to the South Carolina Office of Regulatory Staff," June 30, 2013, http://www.scana.com/NR/rdonlyres/FD5FC097-3956-48A6-9098-2C2D115C8512/0/NNDQuarterlyReport2013Q2FINAL81413PUBLIC.pdf.

[30] Carr, Housely, "SCE&G Talks with Contractors on Summer Will Be 'Tense,' Analyst Says," *Nucleonics Week*, August 14, 2014, p. 5.

[31] Energy Information Administration, "Updated Capital Cost Estimates for Electricity Generation Plants," November 2010, http://www.eia.gov/oiaf/beck_plantcosts/index.html.

[32] South Carolina Electric & Gas Company, "Petitions for Updates and Revisions to the Capital Cost Schedule and the (continued...)

Duke Energy's Levy County project, with two AP1000 units, is scheduled by NRC to receive a final decision on its COL in mid-2015, although Duke has terminated its engineering, procurement, and construction (EPC) contract for the project. Duke said it did not foresee a need for the plant as soon as previously planned, but "continues to regard the Levy site as a viable option for future nuclear generation."[34] COLs for six reactors at four other sites—Fermi (MI), South Texas Project, William States Lee (SC), and North Anna (VA)—are scheduled to be issued by 2016. The joint venture developing the proposed South Texas Plant reactors, Nuclear Innovation North America (NINA), is focusing solely on the COL and a DOE loan guarantee.[35]

The proposed new reactors at the Fermi and North Anna sites reached a milestone on September 16, 2014, when NRC approved the design certification for GE-Hitachi's Economic Simplified Boiling Water Reactor (ESBWR), following nine years of review. The COLs that are currently under review for both those units would use the ESBWR design. Like the Westinghouse AP1000, the ESBWR includes "passive" safety features that are designed to protect the reactor core from overheating after an accident.[36]

As shown in **Table 1**, the remaining three projects that have not suspended their COLs, with a total of four proposed reactors, do not have firm licensing schedules from NRC. As a result, these reactors appear unlikely to be completed before the early 2020s. Some of these proposed nuclear projects may require additional partners in order to proceed to construction, according to company announcements.[37]

Several other COL applications have been suspended, withdrawn, or shifted to early site permits (ESPs) only. Entergy suspended further license review of its planned GE ESBWR reactors at River Bend, LA, and Grand Gulf, MS, although it still has a previously issued ESP for Grand Gulf. AmerenUE suspended review of a COL for its proposed new Callaway unit in Missouri, and Exelon withdrew its COL application for a proposed two-unit plant in Victoria County, TX. Most recently, Duke Energy suspended its application for two new AP1000s at its Shearon Harris plant in North Carolina, and Luminant suspended its COL for two Mitsubishi APWRs at Comanche Peak in Texas.

TVA decided to defer consideration of its COL application for two new Westinghouse AP1000 reactors at its Bellefonte plant in Alabama in favor of completing the first of two unfinished

(...continued)

Construction Schedule," before the Public Service Commission of South Carolina, February 29, 2012, http://www.scana.com/NR/rdonlyres/35AAED95-5226-416A-8DC2-0743BC93B911/0/2012PetitiontoUpdateCostSchedules.pdf. Total cost based on SCE&G ownership of 55%.

33 Southern Company, "Smart Power," http://www.southerncompany.com/smart_energy/smart_power_vogtle-kemper.html. Total cost based on Southern Company's 45.7% ownership.

34 Duke Energy, "Duke Energy Reaches Revised Multi-year Settlement with Florida Consumer Advocates," news release, August 1, 2013, http://www.duke-energy.com/news/releases/2013080101.asp.

35 NRG Energy, "NRG Energy, Inc. Provides Greater Clarity on the South Texas Nuclear Development Project," press release, April 19, 2011, http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9OTAwMzB8Q2hpbGRJRD0tMXxUeXBlPTM=&t=1.

36 Nuclear Regulatory Commission, "NRC Certifies GE-Hitachi New Reactor Design," news release, September 16, 2014, http://www.nrc.gov/reading-rm/doc-collections/news/2014/.

37 Jeff Beattie, "Southeast Utilities Seek Partners to Hedge Nuclear Bets," *Energy Daily*, October 5, 2010, p. 1.

Babcock & Wilcox reactors at the site. TVA had submitted a COL application for the Bellefonte AP1000s in October 2007 as part of the NuStart consortium.[38]

Constellation Energy announced October 9, 2010, that it was abandoning negotiations with DOE for a loan guarantee for the planned Calvert Cliffs 3 reactor, which Constellation had been developing as part of its UniStar joint venture with the French national utility EDF.[39] Constellation sold its share of UniStar to EDF so that EDF could seek another U.S. partner to continue the Calvert Cliffs project.[40] (For more discussion of Constellation's decision, see the "Loan Guarantees" section below.)

NRC anticipates that several more COL and other license applications will be submitted in the future. This includes a TVA plan to submit construction permit applications for small modular reactors (SMRs) of about 160 megawatts each at its Clinch River, TN, site.[41]

Table 1. Announced Nuclear Plant License Applications

Announced Applicant	Site	Reactor Type	Units	Status
COL issued				
Southern	Vogtle (GA)	Westinghouse AP1000	2	COL application submitted 3/13/08; engineering, procurement, and construction (EPC) contract signed 4/8/08; ESP and limited construction approved 8/26/09; conditional DOE loan guarantee announced 2/16/10; NRC hearing held 9/27-28/11; COL approved 2/9/12; first "safety-related concrete" poured 3/14/13
SCE&G	Summer (SC)	Westinghouse AP1000	2	COL submitted 3/31/08; EPC contract signed 5/27/08; COL approved 3/30/12; first "safety-related concrete" poured 3/11/13
COL scheduled for completion				
Duke Energy	Levy County (FL)	Westinghouse AP1000	2	COL submitted 7/30/08; application scheduled for completion in 2014; termination of EPC contract announced 8/1/13
DTE Energy	Fermi (MI)	GE ESBWR	1	COL submitted 9/18/08; application scheduled for completion in 2015
Nuclear Innovation North America	South Texas Project	Toshiba ABWR	2	COL submitted 9/20/07; EPC contract signed with Toshiba 2/12/09; NRG Energy halted further investment 4/19/11; application scheduled for completion in 2016

[38] Tennessee Valley Authority, "Single Nuclear Unit at the Bellefonte Plant Site," fact sheet, http://www.tva.gov/environment/reports/blnp/index.htm.

[39] Constellation Energy, "Constellation Energy Releases Statement Regarding U.S. Department of Energy Loan Guarantee," press release, October 9, 2010, http://ir.constellation.com/releasedetail.cfm?ReleaseID=516614.

[40] Letter from Michael J. Wallace, Vice Chairman and Chief Operating Officer, Constellation Energy, to Thomas Piquemal, Group Executive Vice President, Finance, EDF, October 15, 2010, http://files.shareholder.com/downloads/CEG/1036755503x0x410084/e27369a0-ce85-432f-bfad-e17ddce4f8f2/101510_-_EDF_letter.pdf; Unistar, "EDF and Constellation Energy Announce Comprehensive Agreement," press release, October 27, 2010, http://press.edf.com/press-releases/all-press-releases/2010/edf-and-constellation-energy-announce-comprehensive-agreement-82018.html&return=42873.

[41] NRC, "New Reactor Licensing Applications," August 15, 2014, http://www.nrc.gov/reactors/new-reactors/new-licensing-files/new-rx-licensing-app-legend.pdf.

Announced Applicant	Site	Reactor Type	Units	Status
Duke Energy	William States Lee (SC)	Westinghouse AP1000	2	COL submitted 12/13/07; application scheduled for completion in 2016
Dominion	North Anna	GE ESBWR	1	COL submitted 11/27/07; ESP approved 11/20/07; application scheduled for completion in 2016
COL schedule under revision				
FPL	Turkey Point (FL)	Westinghouse AP1000	2	COL submitted 6/30/09; preconstruction work being conducted
PPL	Bell Bend (PA)	Areva EPR	1	COL submitted 10/10/08, not scheduled for review
UniStar	Calvert Cliffs (MD)	Areva EPR	1	COL submitted 7/13/07 (Part 1), 3/13/08 (Part 2); Constellation withdrew from project 10/8/10; application not scheduled for review
Licensing suspended				
Entergy	Grand Gulf (MS)	Not specified	1	COL submitted 2/27/08; licensing suspended 1/9/09; ESP approved 3/27/07
Exelon	Victoria County (TX)	Not specified	2	COL application withdrawn and ESP application submitted 3/25/10; ESP application withdrawn 8/28/12
AmerenUE	Calloway (MO)	Areva EPR	1	COL submitted 7/24/08; license review suspended 6/23/09
Entergy	River Bend (LA)	Not specified	1	COL submitted 9/25/08; licensing suspended 1/9/09
TVA	Bellefonte	Westinghouse AP1000	2	COL submitted 10/30/07; licensing deferred 9/29/10
Unistar	Nine Mile Point (NY)	Areva EPR	1	COL submitted 9/30/08; licensing suspended 12/1/09
Duke Energy	Harris (NC)	Westinghouse AP1000	2	COL submitted 2/19/08; EPC contract signed 1/5/09; licensing suspended 5/2/13
Luminant Power	Comanche Peak (TX)	Mitsubishi US-APWR	2	COL submitted 9/19/08; review suspended 3/31/14
Total COL applications			**28**	
Total currently active COLs			**16**	

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

Note: Applications are for COLs unless otherwise specified.

Nuclear Power Plant Safety and Regulation

Safety

Worldwide concern about nuclear power plant safety rose sharply after the Fukushima accident, which is generally considered to be much worse than the March 1979 Three Mile Island accident in Pennsylvania but not as severe as the April 1986 Chernobyl disaster in the former Soviet Union. Total radioactive releases from the Fukushima accident have been estimated at 25 million curies,[42] compared with 140 million curies from Chernobyl[43] and 43,000 curies from Three Mile Island.[44]

The Fukushima disaster resulted in similar levels of radioactive contamination per square meter to that of Chernobyl, but the Fukushima contamination was much less widespread and affected a smaller number of people.[45] Timely evacuation of areas up to 30 kilometers (km, 18.6 miles) from the Fukushima Daiichi plant reduced radiation exposure from the accident. A health survey conducted by the Fukushima prefecture estimated the total dose to the prefecture's 435,788 people at less than 617 sieverts (61,700 rem), averaging no more than about 1.4 millisieverts (140 millirem) per person for the first 28 months after the accident.[46] For comparison, NRC limits the dose resulting from the use of radioactive materials to 100 millirem per year (1 millisievert) to any individual member of the public.[47] (For more background on the Fukushima accident, see CRS Report R41694, *Fukushima Nuclear Disaster*, by Mark Holt, Richard J. Campbell, and Mary Beth D. Nikitin)[48]

The Fukushima disaster has raised particular policy questions for the United States because, unlike Chernobyl, the Fukushima reactors are similar to common U.S. designs. Although the Fukushima accident resulted from a huge tsunami that incapacitated the power plant's emergency diesel generators, the accident dramatically illustrated the potential consequences of any natural catastrophe or other situation that could cause an extended "station blackout" – the loss of alternating current (AC) power. Safety issues related to station blackout include standards for

[42] World Nuclear Association, "Fukushima Accident 2011," September 2014, http://www.world-nuclear.org/info/Safety-and-Security/Safety-of-Plants/Fukushima-Accident-2011. Radioactivity units converted from 940 petabecquerels of Iodine-131 equivalent.

[43] World Nuclear Association, "Chernobyl Accident 1986," June 2013, http://www.world-nuclear.org/info/Safety-and-Security/Safety-of-Plants/Chernobyl-Accident.

[44] Nuclear Regulatory Commission, "Backgrounder on the Three Mile Island Accident," April 25, 2014, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html.

[45] French Institut de Radioprotection et de Surete Nucleaire (IRSN), Assessment on the 66th Day of Projected External Doses for Populations Living in the North-West Fallout Zone of the Fukushima Nuclear Accident, Report DRPH/2011-10, p. 27, http://hps.org/documents/irsn_fukushima_report.pdf.

[46] Organisation for Economic Co-operation and Development, Nuclear Energy Agency, *2013 NEA Annual Report*, p. 8. CRS calculations based on data in Table 3.

[47] NRC, "Radiation Protection and the NRC," http://www.nrc.gov/reading-rm/doc-collections/nuregs/brochures/br0322/#intro.

[48] See also Institute of Nuclear Power Operations, *Special Report on the Nuclear Accident at the Fukushima Daiichi Nuclear Power Station*, INPO 11-005, November 2011, available from the Nuclear Energy Institute at http://www.nei.org/resourcesandstats/documentlibrary/safetyandsecurity/reports/special-report-on-the-nuclear-accident-at-the-fukushima-daiichi-nuclear-power-station.

backup batteries, which had been required to provide power for 4-8 hours, and additional measures that may be required to assure backup power.

Safety concerns at U.S. reactors were also raised by hydrogen explosions at three of the Fukushima reactors—resulting from a high-temperature reaction between steam and nuclear fuel cladding—and the loss of cooling at the Japanese plant's spent fuel storage pools. Other safety issues that have been raised in the wake of Fukushima include the vulnerability of U.S. nuclear plants to earthquakes, floods, and other natural disasters, the availability of iodine pills to prevent absorption of radioactive iodine released during nuclear accidents, and the adequacy of nuclear accident emergency planning.

In response to such concerns, NRC on March 23, 2011, established a task force "made up of current senior managers and former NRC experts" to "conduct both short- and long-term analysis of the lessons that can be learned from the situation in Japan."[49] The Near-Term Task Force issued its report July 12, 2011, making recommendations ranging from specific safety improvements to broad changes in NRC's overall regulatory approach.[50] NRC staff subsequently identified several of those actions that "can and should be initiated without delay."[51] The NRC Commissioners largely agreed with the recommendations on October 18, 2011, and instructed the agency's staff to "strive to complete and implement the lessons learned from the Fukushima accident within five years—by 2016."[52] Tier 1 regulatory actions, which are now being implemented, include[53]

- *Seismic and flood hazard reevaluations and walkdowns*. Nuclear plant operators must evaluate the implications of updated seismic and flooding models, including all potential flooding sources. Plant operators must identify and verify the adequacy of flood and seismic protection features at their sites.
- *Station blackout regulatory actions*. NRC issued an order on March 12, 2012, that required U.S. reactors to implement mitigation strategies "that will allow them to cope without their permanent electrical power sources for an indefinite amount of time." Under the order, installed equipment at each plant must be sufficient to maintain or restore cooling until portable on-site equipment and supplies could take over. The portable on-site equipment would have to provide sufficient cooling until "sufficient offsite resources" could be brought in to maintain cooling indefinitely. Enough equipment and personnel would be required to protect all affected reactors at a multi-unit plant. NRC is currently preparing permanent regulations based on the mitigation strategies order.

[49] Nuclear Regulatory Commission, "Nuclear Regulatory Commission Directs Staff on Continuing Agency Response to Japan Events; Adjust Commission Schedule," press release, March 23, 2011, http://pbadupws.nrc.gov/docs/ML1108/ML110821123.pdf.

[50] Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, *Recommendations for Enhancing Reactor Safety in the 21st Century*, Nuclear Regulatory Commission, Washington, DC, July 12, 2011, http://pbadupws.nrc.gov/docs/ML1118/ML111861807.pdf.

[51] NRC, "Recommended Actions to Be Taken Without Delay from the Near-Term Task Force Report," SECY-11-0124, September 9, 2011.

[52] NRC, "Staff Requirements – SECY-11-0124 – Recommended Actions to Be Taken Without Delay from the Near-Term Task Force Report," October 18, 2011, http://pbadupws.nrc.gov/docs/ML1126/ML11269A204.pdf.

[53] NRC, "What Are the Lessons Learned from Fukushima?," September 10, 2014, http://www.nrc.gov/reactors/operating/ops-experience/japan-dashboard/priorities.html.

- *Reliable hardened vents for Mark I containments*. NRC on March 12, 2012, ordered nuclear plants to install "reliable, hardened" vents for the containments in Mark I reactors (the type at Fukushima). The vents would be designed to reduce containment pressure before damage occurred to the reactor core. NRC modified the order in June 2013 to require that the vents continue to function after core damage occurred, which could prevent hydrogen generated by overheated fuel cladding from leaking into the reactor building, as occurred at Fukushima. Because venting after core damage has occurred could release radioactive core material into the environment, NRC is also considering a requirement that vents include filters or that other strategies be implemented to reduce such emissions.
- *Spent fuel pool instrumentation*. NRC ordered nuclear plants on March 12, 2012, to install safety instrumentation to monitor spent fuel pool conditions, such as water level, temperature, and radiation levels, from the plant control room.
- *Strengthening and integrating accident procedures and capabilities*. NRC issued an Advanced Notice of Proposed Rulemaking on April 18, 2012, to require integrated emergency procedures, including clear command-and-control strategies and training qualifications for emergency decisionmakers.
- *Emergency preparedness regulatory actions*. NRC has asked nuclear plants how many workers would be needed to respond to large accidents affecting multiple reactors at the same site. In addition, plants were asked to assess and ensure the operability of emergency communications systems during such accidents.

The NRC staff slightly modified its proposals for top priority actions and divided the remaining Task Force proposals into two lower tiers, which were determined to require further assessment and potentially long-term study. Included in the lower-tier actions were requirements for emergency water supply systems for spent fuel pools, secure power for emergency communications and data systems, confirmation of seismic and flooding hazards, and modifications to NRC's regulatory process.[54]

Emergency Planning

Following the Three Mile Island accident, which revealed severe weaknesses in preparations for nuclear plant emergencies, Congress mandated that emergency plans be prepared for all licensed power reactors (P.L. 96-295, Sec. 109). NRC was required to develop standards for emergency plans and review the adequacy of each plant-specific plan in consultation with the Federal Emergency Management Agency (FEMA).

NRC's emergency planning requirements focus on a "plume exposure pathway emergency planning zone (EPZ)," encompassing an area within about 10 miles (16.1 km) of each nuclear plant. Within the 10-mile EPZ, a range of responses must be developed to protect the public from radioactive releases, including evacuation, sheltering, and the distribution of non-radioactive iodine (as discussed above). The regulations also require a 50-mile "ingestion pathway EPZ," in

[54] R.W. Borchardt, NRC Executive Director for Operations, "Prioritization of Recommended Actions to Be Taken in Response to Fukushima Lessons Learned," SECY-11-0137, October 3, 2011.

which actions are developed to protect food supplies.[55] Nuclear plants are required to conduct emergency preparedness exercises every two years. The exercises, which are evaluated by FEMA and NRC, may include local, state, and federal responders and may involve both the plume and ingestion EPZs.[56]

The size of the plume exposure EPZ has long been a subject of controversy, particularly after the 9/11 terrorist attacks on the United States, in which nuclear plants were believed to have been a potential target. Attention to the issue was renewed by the Fukushima accident, in which some of the highest radiation dose rates were measured beyond 10 miles from the plant.[57] Controversy over the issue intensified after NRC recommended the evacuation of U.S. citizens within 50 miles of the Fukushima plant on March 16, 2011. The NRC recommendation was based on computer models that, using meteorological data and estimates of plant conditions, found that potential radiation doses 50 miles from the plant could exceed U.S. protective action guidelines.[58]

In response to the 9/11 terrorist attacks, NRC modified its nuclear plant emergency planning requirements and began a comprehensive review of emergency planning regulations and guidance. An NRC final rule based on that review took effect December 23, 2011.[59] Among the changes included in the rule are new requirements for periodic updates of EPZ evacuation time estimates, mandatory backups for public alert systems, and protection of emergency responders during terrorist attacks. The new emergency planning regulations were prepared before the Fukushima accident, but the NRC staff recommended approval of the changes without waiting for further changes that might result from the lessons of the Japanese accident. Emergency planning changes resulting from Fukushima should be implemented later, the staff recommended.[60]

Domestic Reactor Safety Experience

Nuclear power safety has been a longstanding issue 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 one serious case, 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.

[55] 10 CFR 50.47, Emergency Plans.

[56] Nuclear Regulatory Commission, "Emergency Preparedness & Response," website, http://www.nrc.gov/about-nrc/emerg-preparedness.html.

[57] Japanese Ministry of Education, Culture, Sports, Science, and Technology (MEXT), "Readings of Integrated Dose at Monitoring Post out of 20 Km Zone of Fukushima Dai-ichi NPP," data series, http://www.mext.go.jp/english/incident/1304275.htm.

[58] Nuclear Regulatory Commission, "NRC Provides Protective Action Recommendations Based on U.S. Guidelines," press release, March 16, 2011, http://pbadupws.nrc.gov/docs/ML1108/ML110800133.pdf.

[59] Nuclear Regulatory Commission, "Enhancements to Emergency Planning Regulations," Final rule, *Federal Register*, November 23, 2011, p. 72560.

[60] Nuclear Regulatory Commission, "Final Rule: Enhancements to Emergency Preparedness Regulations," SECY-11-0053, April 8, 2011, http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2011/2011-0053scy.pdf.

NRC's oversight of the nuclear industry is a subject of contention as well; nuclear utilities often complain that they are subject to overly rigorous and inflexible regulation, but nuclear critics charge that NRC frequently relaxes safety standards when compliance may prove difficult or costly to the industry.

In 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 more than 3,500 reactor-years of operation in the United States,[61] 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.[62] A study of 32,000 people living within five miles of the reactor when the accident occurred found no significant increase in cancer rates through 1998, although the authors noted that some potential health effects "cannot be definitively excluded."[63]

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, medical patients, and nuclear industry workers.[64]

NRC announced April 7, 2010, that it had asked the National Academy of Sciences (NAS) to "perform a state-of-the-art study on cancer risk for populations surrounding nuclear power facilities." Unlike in previous studies, NAS is to examine cancer diagnosis rates, rather than cancer deaths, potentially increasing the amount of data. The new study would also use geographic units smaller than counties to determine how far members of the study group are located from reactors, to more clearly determine whether there is a correlation between cancer cases and distance from reactors. After issuing a report on methodologies for the study in 2012, NAS began planning a pilot study at seven nuclear facilities in late 2013.[65]

NRC's 1986 Safety Goal Policy Statement declared that nuclear power plants should not increase the risk of accidental or cancer deaths among the nearby population by more than 0.1%.[66] Later

[61] Nuclear Energy Institute, "Myths & Facts About Safety," viewed September 16, 2014, .http://www.nei.org/Knowledge-Center/Backgrounders/Fact-Sheets/Myths-Facts-About-Safety.

[62] Nuclear Regulatory Commission, "Backgrounder on the Three Mile Island Accident," April 25, 2014, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html.

[63] Evelyn O. Talbott et al., "Long Term Follow-Up of the Residents of the Three Mile Island Accident Area: 1979-1998," Environmental Health Perspectives, March 2003, pp. 341-348, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1241392.

[64] National Research Council, Committee to Assess the Health Risks from Exposure to Low Levels of Ionizing Radiation, *Beir VII: Health Risks from Exposure to Low Levels of Ionizing Radiation*, 2006. Available at http://www.nap.edu.

[65] National Academy of Sciences, Nuclear and Radiation Studies Board, "Analysis of Cancer Risks in Populations near Nuclear Facilities, Phase 2: Pilot Planning," http://nas-sites.org/cancerriskstudy/.

[66] NRC, "Safety Goals for the Operations of Nuclear Power Plants," policy statement, *Federal Register*, August 21, 1986, p. 30028, http://www.nrc.gov/reading-rm/doc-collections/commission/policy/51fr30028.pdf.

NRC guidance established a "subsidiary benchmark" for the probability of accidental core damage (fuel melting): Core damage frequency should average no more than one in 10,000 per reactor per year.[67] In addition, NRC set a benchmark that reactor containments should be successful at least 90% of the time in preventing major radioactive releases during a core-damage accident. Therefore, the benchmark probability of a major release from containment failure during a core melt accident would average less than one in 100,000 per reactor per year.[68] (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.[69]

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 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.[70] 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.[71]

Licensing and Regulation

For many years, a top priority of the U.S. 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.

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[67] NRC Staff Requirements Memorandum on SECY-89-102, "Implementation of the Safety Goals," Memorandum to James M. Taylor from Samuel J. Chilk, June 15, 1990, http://pbadupws.nrc.gov/docs/ML0037/ML003707881.pdf.

[68] 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," Revision 1, November 2002, http://www.nrc.gov/reading-rm/doc-collections/reg-guides/power-reactors/rg/01-174.

[69] 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.

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

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

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 license to run it. Each stage of the licensing process involved adjudicatory 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 provided a clear statutory basis for one-step nuclear licenses. Under the new process, NRC can issue combined construction permits and operating licenses (COLs) and allow completed plants to operate without delay if they meet all construction requirements—called "inspections, tests, analyses, and acceptance criteria," or ITAAC. NRC would hold preoperational hearings on the adequacy of plant construction only in specified circumstances.

DOE's Nuclear Power 2010 program had paid up to half the cost of several COLs and early site permits to test the revised licensing procedures. However, the COL process cannot be fully tested until construction of new reactors is completed. At that point, it could be seen whether completed plants would be able to operate without delays or whether adjudicable disputes over construction adequacy may arise. Section 638 of the Energy Policy Act of 2005 (EPACT05, P.L. 109-58) authorizes federal payments to the owner of a completed reactor whose operation is held up by regulatory delays. The nuclear industry has asked Congress to require NRC to use informal procedures in determining whether ITAAC have been met, eliminate mandatory hearings on uncontested issues before granting a COL, and make other changes in the licensing process.[72]

A fundamental concern in the nuclear regulatory debate is the performance of NRC in issuing and enforcing nuclear safety regulations. The nuclear industry and its supporters have regularly complained that unnecessarily stringent and inflexibly enforced nuclear safety regulations have burdened nuclear utilities and their customers with excessive costs. But many environmentalists, nuclear opponents, and other groups charge NRC with being too close to the nuclear industry, a situation that they say has resulted in lax oversight of nuclear power plants and routine exemptions from safety requirements.

Primary responsibility for nuclear safety compliance lies with nuclear plant owners, who are required to find any problems with their plants and report them to NRC. Compliance is also monitored directly by NRC, which maintains at least two resident inspectors at each nuclear power plant. The resident inspectors routinely examine plant systems, observe the performance of reactor personnel, and prepare regular inspection reports. For serious safety violations, NRC often dispatches special inspection teams to plant sites.

NRC's reactor safety program is based on "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.[73]

[72] Nuclear Energy Institute, *Legislative Proposal to Help Meet Climate Change Goals by Expanding U.S. Nuclear Energy Production*, Washington, DC, October 28, 2009, p. 5, http://www.nei.org/resourcesandstats/documentlibrary/newplants/policybrief/2009-nuclear-policy-initiative.

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

Reactor Security

Nuclear power plants have long been recognized as potential targets of terrorist attacks, and critics have long questioned the adequacy of requirements for 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.

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 that plant security must prepare for is specified in the "design basis threat" (DBT).

EPACT05 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 defend 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.[74] After much consideration, NRC voted February 17, 2009, to require all new nuclear power plants to incorporate design features that would ensure that, in the event of a crash by a large commercial aircraft, the reactor core would remain cooled or the reactor containment would remain intact, and radioactive releases would not occur from spent fuel storage pools.[75] The rule change was published in the Federal Register June 12, 2009.[76]

NRC rejected proposals that existing reactors also be required to protect against aircraft crashes, such as by adding large external steel barriers. However, NRC did impose some additional requirements related to aircraft crashes on all reactors, both new and existing, after the 9/11 terrorist attacks of 2001. In 2002, as noted above, NRC ordered all nuclear power plants to develop strategies to mitigate the effects of large fires and explosions that could result from aircraft crashes or other causes. An NRC regulation on fire mitigation strategies, along with requirements that reactors establish procedures for responding to specific aircraft threats, was approved December 17, 2008.[77] The fire mitigation rules were published in the Federal Register March 27, 2009.[78]

Other ongoing nuclear plant security issues include the vulnerability of spent fuel pools, which hold highly radioactive nuclear fuel after its removal from the reactor, standards for nuclear plant security personnel, and nuclear plant emergency planning. NRC's March 2009 security

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

[75] Nuclear Regulatory Commission, *Final Rule—Consideration of Aircraft Impacts for New Nuclear Power Reactors, Commission Voting Record*, SECY-08-0152, February 17, 2009.

[76] Nuclear Regulatory Commission, "Consideration of Aircraft Impacts for New Nuclear Power Reactors," Final Rule, 74 *Federal Register* 28111, June 12, 2009. This provision is codified at 10 CFR 50.150.

[77] Nuclear Regulatory Commission, "NRC Approves Final Rule Expanding Security Requirements for Nuclear Power Plants," press release, December 17, 2008, http://www.nrc.gov/reading-rm/doc-collections/news/2008/08-227.html.

[78] Nuclear Regulatory Commission, "Power Reactor Security Requirements," Final Rule, 74 *Federal Register* 13925, March 27, 2009.

regulations addressed some of those concerns and included a number of other security enhancements.

EPACT05 required NRC to conduct force-on-force security exercises at nuclear power plants every three years (which was NRC's previous policy), authorized firearms use by nuclear security personnel (preempting some state restrictions), established federal security coordinators, and required 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 dedicated 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 completion 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.[79] Decommissioning of the Connecticut Yankee plant cost $790 million and was approved by NRC on November 26, 2007.[80] NRC approved the cleanup of the decommissioned Rancho Seco reactor site in California on October 7, 2009.[81] The decommissioning of Rancho Seco was estimated to cost $500 million, excluding future demolition of the cooling towers and other remaining plant structures.[82] Total costs for decommissioning, spent fuel storage, and site restoration at the recently closed San Onofre units 2 and 3 are estimated at $4.1 billion.[83]

When a reactor is permanently shut down, the owner (licensee) has 30 days to notify NRC. The licensee then certifies with NRC when spent fuel has been permanently removed from the reactor vessel. By two years after shutdown, the licensee must submit a Post Shutdown Decommissioning Activities Report (PSDAR). The PSDAR specifies which of the two primary decommissioning options will be pursued:

- DECON: Plant and equipment are dismantled and removed, or decontaminated to the level required for release from NRC licensing.

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

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

[81] Nuclear Regulatory Commission, "NRC Releases Rancho Seco Nuclear Plant for Unconditional Use," press release, October 7, 2009, http://www.nrc.gov/reading-rm/doc-collections/news/2009/09-165.html.

[82] "20 Years Later, Rancho Seco Ready for Final Shutdown," *Sacramento County Herald*, June 9, 2009.

[83] Edison International, "SCE Submits Nuclear Plant Decommissioning Plan to Federal Regulator," news release, September 23, 2014, http://newsroom.edison.com/releases/sce-submits-nuclear-plant-decommissioning-plan-to-federal-regulator.

- SAFSTOR: The plant is placed in a safe, stable condition for future dismantlement and decontamination.

According to NRC, nine reactors are currently in SAFSTOR: Dresden 1 (IL), Indian Point 1 (NY), La Crosse (WI), Millstone 1 (CT), Peach Bottom 1 (PA), San Onofre 1 (CA), GE Vallecitios (CA), NS Savannah (MD), and Three Mile Island 2 (PA). Four units are in DECON: Fermi 1 (MI), Humboldt Bay (CA), and Zion 1 and 2 (IL).[84]

After nuclear reactors are decommissioned, the spent nuclear fuel (SNF) accumulated during their operating lives remains stored in pools or dry casks at the plant sites. About 5,900 metric tons of spent fuel is currently stored at 12 closed nuclear power plants and Vermont Yankee, which is to close in late 2014.[85] "Until this SNF is removed from these [at the time] nine sites, the sites cannot be fully decommissioned and made available for other purposes," DOE noted in a 2008 report.[86] President Obama's decision to terminate development of an underground spent fuel repository at Yucca Mountain, NV, has increased concerns about the ultimate disposition of spent fuel at decommissioned sites. (For more information, see CRS Report R42513, *U.S. Spent Nuclear Fuel Storage*, by James D. Werner.)

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). EPACT05 extended the availability of Price-Anderson coverage for new reactors and new DOE nuclear contracts through the end of 2025. (Existing reactors and contracts were already covered.)

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 with at least 100 megawatts of electric generating capacity must carry the maximum liability insurance reasonably available, which was raised from $300 million to $375 million on January 1, 2010.[87] Any damages exceeding $375 million are to be assessed equally against all 100-megawatt-and-above power reactors, up to $121.3 million per reactor (increased for inflation from $111.9 million on September 10, 2013).[88] Those assessments—called "retrospective premiums"—would be paid at an annual rate of no more than $19.0 million per reactor (up from $17.5 million), to limit the potential financial burden on reactor owners following a major accident. According to NRC, 104 commercial reactors,

[84] NRC, *Information Digest, 2013-2014*, NUREG-1350, Volume 25, Appendix C, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1350.

[85] Gutherman Technical Service, "2011 Used Fuel Data," January 14, 2012.

[86] DOE Office of Civilian Radioactive Waste Management, *Report to Congress on the Demonstration of the Interim Storage of Spent Nuclear Fuel from Decommissioned Nuclear Power Reactor Sites*, DOE/RW-0596, Washington, DC, December 2008, p. 1, http://www.energy.gov/media/ES_Interim_Storage_Report_120108.pdf.

[87] American Nuclear Insurers, "Need for Nuclear Liability Insurance," January 2010, http://www.nuclearinsurance.com/library/Nuclear%20Liability%20in%20the%20US.pdf.

[88] NRC, "Inflation Adjustments to the Price-Anderson Financial Protection Regulations," 79 *Federal Register* 41835, July 12, 2013.

including the four closed in 2013,[89] are currently covered by the Price-Anderson retrospective premium requirement.[90]

For each nuclear incident, the Price-Anderson liability system currently would provide up to $13.6 billion in public compensation. That total includes $121.3 million in retrospective premiums from each of the 104 currently covered reactors, totaling $12.6 billion, plus the $375 million in insurance coverage carried by the reactor that suffered the incident. On top of those payments, a 5% surcharge may also be imposed, raising the total per-reactor retrospective premium to $127.4 million and the total available compensation to about $13.6 billion. Under Price-Anderson, the nuclear industry's liability for an incident is capped at that amount, which varies over time depending on the number of covered reactors, the amount of available insurance, and the inflation adjustment. Payment of any damages above that liability limit would require congressional approval under special procedures in the act.

EPACT05 increased 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 is 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, in the event of a severe release a power plant with six 120-megawatt small modular reactors would be liable for retrospective premiums of up to $121.3 million, rather than $727.8 million (excluding the 5% surcharge).

The Price-Anderson Act also covers contractors who operate DOE nuclear facilities. EPACT05 set the liability limit on DOE contractors at $10 billion per accident, to be adjusted for inflation every five years. The first adjustment under EPACT, raising the liability limit to $11.961 billion, took effect October 14, 2009.[91] 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. EPACT05 limited the civil penalties against a nonprofit 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

[89] As of June 2014. See NRC, "Backgrounder on Nuclear Insurance and Disaster Relief," http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/nuclear-insurance.html. NRC can exempt shutdown reactors from the retrospective premiums after their spent fuel has sufficiently cooled. See NRC, "Exemption Requests to Reduce Liability Insurance Coverage for Decommissioning Reactors after Transfer of All Spent Fuel from a Spent Fuel Pool to Dry Cask Storage, SECY-04-0176, September 29, 2004, http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2004/.

[90] Reactors smaller than 100 megawatts must purchase an amount of liability coverage determined by NRC but are not subject to retrospective premiums. Total liability for those reactors is limited to $560 million, with the federal government indemnifying reactor operators for the difference between that amount and their liability coverage (Atomic Energy Act Sec. 170 b. and c.).

[91] Department of Energy, "Adjusted Indemnification Amount," 74 *Federal Register* 52793, October 14, 2009.

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. Projections that damages to the public from the Fukushima accident will greatly exceed the Price-Anderson liability limits prompted renewed calls for reexamination of the law.[92]

The U.S. government 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 (CSC) will not enter into force until at least five countries with a specified level of installed nuclear capacity have enacted implementing legislation. Such implementing language was included in the Energy Independence and Security Act of 2007 (P.L. 110-140, section 934), signed by President Bush 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, four countries have submitted the necessary instruments of ratification, but they do not have the required nuclear capacity for it to take effect.[93] Canada signed the convention on December 3, 2013, with the government announcing that it would be submitted to Parliament for approval. Ratification by Canada, which has a large nuclear reactor fleet, would put the convention into force 90 days later.[94]

Under the U.S. implementing legislation, the CSC 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. For example, U.S. nuclear equipment sales to the growing economies of China and India would be facilitated by those countries' participation in the CSC liability regime.

Federal Incentives for New Nuclear Plants

The nuclear power industry contends that support from the federal government would be needed for "a major expansion of nuclear energy generation."[95] Significant incentives for building new nuclear power plants were included in the Energy Policy Act of 2005 (EPACT05, P.L. 109-58), signed by President Bush on August 8, 2005. These include production tax credits, loan

[92] Ellen Vancko, Union of Concerned Scientists, "The Impact of Fukushima on the US Nuclear Power Industry," presentation to the Center for Strategic and International Studies Conference on Nuclear Safety and Fukushima, April 7, 2011, https://csis.org/files/attachments/110407_vancko_nuclear_safety_0.pdf.

[93] International Atomic Energy Agency, Latest Status of Convention on Supplementary compensation for Nuclear Damage, July 7, 2014, https://www.iaea.org/Publications/Documents/Infcircs/1998/infcirc567.shtml.

[94] Ostroff, Jim, "Nuclear Compensation Convention on the Verge of Taking Effect," *Nucleonics Week*, December 12, 2013, p. 1.

[95] Nuclear Energy Institute, "NEI Unveils Package of Policy Initiatives Needed to Achieve Climate Change Goals," press release, October 26, 2009, http://www.nei.org/newsandevents/newsreleases/nei-unveils-package-of-policy-initiatives-needed-to-achieve-climate-change-goals/.

guarantees, insurance against regulatory delays, and extension of the Price-Anderson Act nuclear liability system (discussed in the previous section on "Nuclear Accident Liability"). Relatively low prices for natural gas—nuclear power's chief competitor—and rising estimated nuclear plant construction costs have decreased the likelihood that new reactors would be built without federal support. Any regulatory delays and increased safety requirements resulting from the Fukushima accident could also pose an obstacle to nuclear construction plans.

As a result, numerous bills have been introduced in recent years to strengthen or add to the EPACT05 incentives (see "Legislation in the 113th Congress" at the end of this report). Nuclear power critics have denounced the federal support programs and proposals as a "bailout" of the nuclear industry, contending that federal efforts should focus instead on renewable energy and energy efficiency.[96]

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 credit is not adjusted for inflation.

The Treasury Department published interim guidance for the nuclear production tax credit on May 1, 2006.[97] Under the guidance, the 6,000 megawatts of eligible capacity (enough for about four or five reactors) are to be allocated among reactors that filed license applications by the end of 2008. If more than 6,000 megawatts of nuclear capacity ultimately qualify for the production tax credit, then the credit is to be allocated proportionally among any of the qualifying reactors that begin operating before 2021.

By the end of 2008, license applications had been submitted to NRC for more than 34,000 megawatts of nuclear generating capacity,[98] so if all those reactors were built before 2021 they would receive less than 20% of the maximum tax credit. However, the reactor licensing status shown in **Table 1** indicates that only four new units, totaling about 4,600 megawatts of capacity, are currently licensed for construction and likely to be completed before 2021. Eight other units, totaling about 10,300 megawatts, are scheduled to receive their licenses by 2016 and could possibly go into service by 2021.

The Nuclear Energy Institute (NEI) has urged Congress to remove the 6,000 megawatt capacity limit for the production tax credit, index it for inflation, and extend the deadline for plants to begin operation to the start of 2025. NEI also proposed that a 30% investment tax credit be available for new nuclear construction as an alternative to the production credit.[99]

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[96] Nuclear Information and Resource Service, "Senate Appropriators Lard President Obama's Stimulus Package with up to $50 Billion in Nuclear Reactor Pork," press release, January 30, 2009, http://www.nirs.org/press/01-30-2009/1.

[97] 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.

[98] Energy Information Administration, *Status of Potential New Commercial Nuclear Reactors in the United States*, February 19, 2009.

[99] Nuclear Energy Institute, *Legislative Proposal to Help Meet Climate Change Goals by Expanding U.S. Nuclear Energy Production*, Washington, DC, October 28, 2009, p. 4, http://www.nei.org/resourcesandstats/documentlibrary/newplants/policybrief/2009-nuclear-policy-initiative.

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. 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. Project sponsors will be required to pay the "subsidy cost" of the program, consisting of the estimated present value of likely future government payments. DOE published a final rule for the "standby support" program August 11, 2006.[100]

Under the program's regulations, a project sponsor may enter into a conditional agreement for standby support before NRC issues a combined operating license. The first six conditional agreements to meet all the program requirements, including the issuance of a COL and payment of the estimated subsidy costs, can be converted to standby support contracts. However, no applicant has pursued the incentive.[101]

Loan Guarantees

Title XVII of EPACT05 authorizes federal loan guarantees for up to 80% of construction costs for advanced energy projects that reduce greenhouse gas emissions, including new nuclear power plants. Under such loan guarantee agreements, the federal government would repay all covered loans if the borrower defaulted. This would reduce the risk to lenders and allow them to provide financing at low interest rates. The Title XVII loan guarantees are widely considered crucial by the nuclear industry to obtain financing for new reactors. However, opponents contend that nuclear loan guarantees provide an unjustifiable subsidy to a mature industry and shift investment away from environmentally preferable energy technologies.[102] The authorized ceiling on nuclear power plant loan guarantees is currently $18.5 billion.[103]

Agreements for the first loan guarantees for nuclear power plants under EPACT05 were signed February 20, 2014, by Energy Secretary Ernest Moniz. The federal loan guarantees total $6.5 billion for the two reactors being constructed at the Vogtle nuclear plant in Georgia—$3.46 billion for Southern Company, the plant's lead owner, and $3.06 billion for Oglethorpe Power Corporation. A further $1.8 billion loan guarantee for the Vogtle project, for the Municipal

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

[101] Freebairn, William, "Nuclear Tax Credits, Previously Low-Profile, Might Draw Scrutiny: Lobbysists," *Nucleonics Week*, May 17, 2012.

[102] Thomas B. Cochran and Christopher E. Paine, *Statement on Nuclear Developments Before the Committee on Energy and Natural Resources, United States Senate*, Natural Resources Defense Council, March 18, 2009, http://energy.senate.gov/public/index.cfm?FuseAction=Hearings.Testimony&Hearing_ID=f25ddd10-c1f5-9e2e-528e-c4321cca4c1b&Witness_ID=9f14a78d-58d0-43fb-bf5b-21426d1d888e.

[103] The FY2009 omnibus funding act (P.L. 111-8) increased DOE's total loan guarantee authority for specified technology categories to $47 billion, in addition to $4 billion in general authority provided in FY2007. Of the $47 billion, $18.5 billion continued to be reserved for nuclear power as provided in earlier appropriations, and $2 billion was for uranium enrichment. Previous time limits on the loan guarantee authority were eliminated. DOE later allocated an additional $2 billion to enrichment projects from the $4 billion in general authority.

Electric Authority of Georgia, has not been finalized. Southern Company estimated that its Vogtle loan guarantees would reduce its present-value financing costs by up to $250 million.[104]

Subsidy Costs

Title XVII requires the estimated future government costs resulting from defaults on guaranteed loans to be covered up-front by appropriations or by payments from project sponsors, such as the utility planning to build a plant. As specified by the Federal Credit Reform Act of 1990 (FCRA, contained in P.L. 101-508), these "subsidy costs" are calculated as the present value of the average possible future net costs to the government for each loan guarantee. If those calculations are accurate, the subsidy cost payments for all the guaranteed projects together should cover the future costs of the program, including default-related losses. However, the Congressional Budget Office has predicted that the up-front subsidy cost payments will prove too low by at least 1% and is scoring bills accordingly.[105] For example, appropriations bills that provide loan guarantee authorizations include an adjustment equal to 1% of the loan guarantee ceiling. (For more information on loan guarantee subsidy costs, see CRS Report R42152, *Loan Guarantees for Clean Energy Technologies: Goals, Concerns, and Policy Options*, by Phillip Brown.)

The guaranteed loans for the new Vogtle reactors are to be issued by the U.S. Treasury's Federal Financing Bank. No subsidy cost was charged for the Vogtle loan guarantees, which raised considerable comment, as the risk of the project is likely to be greater than zero. The methodology that may have led to such a result is discussed below.

In order to estimate credit subsidy costs for a loan transaction, certain information is required: (1) loan value, (2) loan term (years), (3) credit risk, including default rates and recovery rates, (4) loan interest rate, and (5) Treasury interest rate(s). Details of the credit subsidy cost calculations for each loan (i.e., default rates, recovery rates, and project credit rating) have not been made public. However, some aspects and considerations of the Vogtle project loans may provide some perspective regarding the zero credit subsidy fee assessment.

Defaults—net of recoveries—and interest are the two primary subsidy cost components that likely resulted in the zero subsidy fee calculation. The default subsidy represents the present value of expected government losses due to defaults less recoveries. Default rates and recovery rates—based on loan credit risk and other parameters—are applied to the outstanding principal balance for each payment period. Two aspects of the Vogtle loans may have contributed to either low default rates and/or high recovery rates: (1) strong financial condition and obligations of the borrowers, and (2) the possibility of costs being passed through to Georgia Power and Oglethorpe electricity consumers, thereby resulting in low repayment risk, and therefore a low default subsidy estimate. These characteristics raise questions about the need for federal credit support for this project. Nevertheless, it is likely that default-related losses to the government exist.

Interest rates for the Vogtle project loans range from 3.5% to 3.9%—higher than Treasury rates—for disbursements made in February 2014. It is possible that gains to the government from higher interest rates—relative to Treasury securities—offset any estimated default-related losses to the

[104] Southern Company, "Federal Loan Guarantees Mark Latest Milestone in Historic Vogtle Project," news release, February 20, 2014.

[105] Congressional Budget Office, *S. 1321, Energy Savings Act of 2007*, CBO Cost Estimate, Washington, DC, June 11, 2007, pp. 7-9, http://www.cbo.gov/ftpdocs/82xx/doc8206/s1321.pdf.

government, while also taking into account other payments from the borrower or costs to the government. Should this be the case, the FCRA-prescribed calculation methodology could result in a zero, or even a negative, credit subsidy cost.

The nuclear industry contends that historical experience indicates defaults are likely to be minimal and that nuclear plant subsidy costs should therefore be low.[106] However, nuclear power critics contend that nuclear power plants are likely to experience delays and cost overruns that could lead to much larger losses under the loan guarantee program. The Center for American Progress concluded that nuclear subsidy costs "should be at least 10 percent and possibly much more."[107]

Constellation Energy informed DOE on October 8, 2010, that it was withdrawing from loan guarantee negotiations on Calvert Cliffs 3, blaming "the Office of Management and Budget's inability to address significant problems with its methodology for determining the project's credit subsidy cost." Constellation's letter to DOE said OMB's "shockingly high" estimate of the subsidy cost for Calvert Cliffs 3 was 11.6%, or about $880 million. "Such a sum would clearly destroy the project's economics (or the economics of any nuclear project for that matter), and was dramatically out of line with both our own and independent assessments of what the figure should reasonably be," the letter stated.[108] Although OMB has not released its subsidy cost methodology, it may consider the default risk for a "merchant plant" such as Calvert Cliffs to be significantly higher than that of a rate-regulated plant such as Vogtle. A plant under traditional rate regulation is allowed to pass all prudently incurred costs through to utility ratepayers, while a merchant plant charges market rates for its power. A merchant plant, therefore, could potentially earn higher profits than a rate-regulated plant, but it also runs the risk of being unable to cover its debt payments if market rates for wholesale electric power drop too low or if its costs are higher than anticipated.

Nuclear Solicitations

DOE issued a solicitation for up to $20.5 billion in nuclear power and uranium enrichment plant loan guarantees on June 30, 2008.[109] According to the nuclear industry, 10 nuclear power projects applied for $93.2 billion in loan guarantees, and two uranium enrichment projects asked for $4.8 billion in guarantees, several times the amount available.[110]

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[106] Nuclear Energy Institute, "Loan Guarantees for the Vogtle Nuclear Power Project—Understanding the Credit Subsidy Cost," 2014, http://www.nei.org/Master-Document-Folder/Backgrounders/Fact-Sheets/Loan-Guarantees-for-the-Vogtle-Nuclear-Power-Proje?feed=factsheet.

[107] Richard Caperton, *Protecting Taxpayers from a Financial Meltdown*, Center for American Progress, Washington, DC, March 8, 2010, p. 2, http://www.americanprogress.org/issues/green/report/2010/03/08/7400/protecting-taxpayers-from-a-financial-meltdown/.

[108] Letter from Michael J. Wallace, Vice Chairman and Chief Operating Officer, Constellation Energy, to Dan Poneman, Deputy Secretary of Energy, October 8, 2010, http://media.washingtonpost.com/wp-srv/hp/ssi/wpc/constellationenergy.PDF?sid=ST2010100900005.

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

[110] Marvin S. Fertel, *Statement for the Record to the Committee on Energy and Natural Resources, U.S. Senate*, Nuclear Energy Institute, March 18, 2009, p. 9, http://energy.senate.gov/public/index.cfm?FuseAction=Hearings.Testimony&Hearing_ID=f25ddd10-c1f5-9e2e-528e-c4321cca4c1b&Witness_ID=4de5e2df-53fe-49ba-906e-9b69d3674e41.

In the uranium enrichment solicitation, DOE in July 2009 informed USEC Inc., which proposes to build a new plant in Ohio, that its technology needed further testing before a loan guarantee could be issued.[111] DOE notified Congress in March 2010 that it would reprogram $2 billion of its unused FY2007 loan guarantee authority toward uranium enrichment, increasing the uranium enrichment total to $4 billion. The move would potentially allow guarantees to be provided to both USEC and the other applicant in the uranium enrichment solicitation, the French firm Areva, which has proposed a plant in Idaho.[112] DOE offered a $2 billion conditional loan guarantee to Areva on May 20, 2010.[113]

DOE informed USEC in October 2011 that the centrifuge technology for its proposed new enrichment plant still needed further testing and offered to provide up to $300 million to help build a demonstration "train" of 720 centrifuges.[114] The FY2013 Continuing Appropriations Resolution (P.L. 112-175) included $100 million for the USEC demonstration program.[115] The FY2014 Consolidated Appropriations Act (P.L. 113-76, Sec. 321) provided up to $56 million for the program through special reprogramming authority.

DOE has recently provided other assistance to USEC. DOE agreed on May 15, 2012, to provide depleted uranium stockpiles (material left over from the enrichment process) to Energy Northwest for reenrichment at USEC's plant in Paducah, KY, for use as reactor fuel.[116] DOE agreed on March 13, 2012, to acquire low-enriched uranium from USEC in exchange for taking responsibility for low-value depleted uranium tails that USEC would otherwise have to dispose of, freeing $44 million of USEC's funds for the centrifuge project.[117] DOE announced June 13, 2012, that it would provide $88 million for the centrifuge demonstration program by taking over responsibility for disposal of additional depleted uranium from USEC. In return, DOE will take ownership of the equipment and technology used in the demonstration and lease it to USEC.[118]

Despite the DOE assistance, USEC filed for bankruptcy reorganization March 5, 2014. The U.S. Bankruptcy Court for the District of Delaware approved USEC's reorganization plan September 5, 2014, in which the company will be renamed Centrus Energy Corporation.[119] DOE's Oak

[111] Department of Energy, "800 to 1000 New Jobs Coming to Piketon," press release, July 28, 2009, http://www.lgprogram.energy.gov/press/072809.pdf.

[112] Maureen Conley, "DOE Finds $2 Billion More for SWU Plant Loan Guarantees," *NuclearFuel*, April 5, 2010, p. 3.

[113] Department of Energy, "DOE Offers Conditional Loan Guarantee for Front End Nuclear Facility in Idaho," press release, May 20, 2010, http://www.energy.gov/news/8996.htm.

[114] Maureen Conley, "Congress 'Frustrated' by Inaction on USEC Loan Guarantee," *NuclearFuel*, October 31, 2011, p. 8.

[115] All FY3013 figures are pre-sequester.

[116] USEC Inc., "Five-Party Arrangement Extends Paducah Gaseous Diffusion Plant Enrichment Operations," press release, May 15, 2012, http://www.usec.com/news/five-party-arrangement-extends-paducah-gaseous-diffusion-plant-enrichment-operations. The depleted uranium consists of "high assay" tails, which have relatively high levels of fissile U-235.

[117] USEC Inc., "Funding," web page, http://www.usec.com/american-centrifuge/what-american-centrifuge/plant/funding.

[118] Department of Energy, "Obama Administration Announces Major Step Forward for the American Centrifuge Plant," press release, June 13, 2012, http://energy.gov/articles/obama-administration-announces-major-step-forward-american-centrifuge-plant.

[119] USEC, "Court Confirms USEC Inc. Plan of Reorganization," news release, September 5, 2014, http://www.usec.com/news/court-confirms-usec-inc-plan-reorganization.

Ridge National Laboratory took over management of USEC's centrifuge demonstration project in April 2014, making USEC a subcontractor.[120]

DOE issued a draft solicitation for an additional $12.6 billion in nuclear loan guarantees on September 30, 2014, including new nuclear reactors, upgrades and uprates of existing nuclear reactors, and nuclear fuel facilities.[121]

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 and academia. As stated by the Massachusetts Institute of Technology 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."[122] The Obama Administration is including nuclear power as part of its clean energy strategy.

However, some environmental groups have contended 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.[123] They also contend that energy efficiency and renewable energy would be far more productive investments for reducing greenhouse gas emissions.[124]

Proposals to reduce carbon dioxide emissions – through taxation, a cap-and-trade system, or other regulatory controls – could significantly increase the cost of generating electricity with fossil fuels and improve the competitive position of nuclear power. A federal Clean Energy Standard that includes nuclear power, as proposed in President Obama's January 2011 State of the Union Address, could provide a similar boost to nuclear energy expansion. Utilities that have applied for nuclear power plant licenses have often cited the possibility of federal greenhouse gas controls or other mandates as one of the reasons for pursuing new reactors.

The Environmental Protection Agency (EPA) published a proposed rule on June 18, 2014, to address CO_2 emissions from existing power plants.[125] The potential effect of the proposed rule on

[120] Hiruo, Elaine, "Low Volume, Non-Production Costs Driving Net Loss, USEC Says," *NuclearFuel*, August 18, 2014.

[121] DOE, "Department of Energy Issues Draft Loan Guarantee Solicitation for Advanced Nuclear Energy Projects," news release, September 30, 2014, http://www.energy.gov/articles/department-energy-issues-draft-loan-guarantee-solicitation-advanced-nuclear-energy-projects.

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

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

[124] Travis Madsen, Tony Dutzik, and Bernadette Del Chiaro, et al., *Generating Failure: How Building Nuclear Power Plants Would Set America Back in the Race Against Global Warming*, Environment America Research and Policy Center, November 2009, http://www.environmentamerica.org/uploads/39/62/3962c378b66c4552624d09cbd8ebba02/Generating-Failure—Environment-America—Web.pdf.

[125] Environmental Protection Agency, "Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric (continued...)

nuclear power has become a significant policy question. The formula in the proposed rule for setting state CO_2 goals explicitly accounts for some existing nuclear capacity and reactors under construction, providing a potential incentive for states to try to keep those plants operating. However, EPA's proposed rule allows states to develop their own plans for meeting the CO_2 emission rate goals, making it difficult to predict how nuclear energy might ultimately fare.

The proposed EPA standards would set state-specific goals for the amount of CO_2 that could be emitted in 2030 for each megawatt-hour (MWh) of electricity generated. EPA projects that, under those proposed emissions rates, U.S. power plants would produce 30% less CO_2 by 2030 than they did in 2005 (the base year in President Obama's Climate Action Plan).[126]

The unadjusted baseline for the proposed standards was developed by dividing 2012 power plant CO_2 emissions in each state by the amount of electricity generated by fossil fuel-fired plants. In the case of Ohio, which EPA provided as an example, the unadjusted CO_2 emission rate for fossil plants in 2012 was 1,897 lbs./MWh (compared with the average rate for coal-fired plants of about 2,000 lbs./MWh). To develop the 2030 standard, EPA adjusted each state's baseline rate with four groups of actions, or "building blocks," that the agency determined states could reasonably achieve:

1. Increase efficiency of existing coal-fired steam units by 6%;
2. Replace some coal-fired generation with increased output from underutilized natural gas combined-cycle units;
3. Prevent projected losses of 6% of each state's existing nuclear generating capacity, complete five nuclear reactors currently under construction, and increase generation from renewable energy; and
4. Implement energy efficiency measures to reduce projected electricity demand.

The nuclear adjustment was made by calculating the projected annual electricity generation from reactors under construction within each state (if any), along with the electricity generated by 6% of each state's existing nuclear capacity, which EPA deems to be at risk of shutdown. These amounts are added to each state's total fossil fuel-fired electrical generation, resulting in a decrease in the CO_2 generation rate per megawatt-hour.[127]

In the Ohio example, the state has no reactors under construction but has two operating nuclear reactors, with total generating capacity of 2,150 megawatts. Six percent of that capacity is projected to generate 993,077 MWh per year, which EPA added to total generation from fossil fuel sources, renewable energy sources, and electricity generation avoided through efficiency measures, as described in the "building blocks." The increase in total electric generation spreads CO_2 emissions among more megawatt-hours, so the rate of CO_2/MWh goes down. The nuclear

(...continued)

Utility Generating Units," proposed rule, June 18, 2014, https://www.federalregister.gov/articles/2014/06/18/2014-13726/carbon-pollution-emission-guidelines-for-existing-stationary-sources-electric-utility-generating.

[126] Executive Office of the President, *The President's Climate Action Plan*, June 2013, http://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf.

[127] EPA, Office of Air and Radiation, *Goal Computation Technical Support Document*, June 2014, http://www2.epa.gov/sites/production/files/2014-06/documents/20140602tsd-goal-computation.pdf.

additions plus the other changes described above result in a proposed 2030 standard for Ohio of 1,338 lbs. of CO_2 per MWh—a 29.5% reduction from the unadjusted baseline.

Although the state standards for CO_2 emission rates would be binding, each state could meet them using whatever mix of options it chose. A state would not have to employ the same "building blocks" in its compliance plans that EPA used to calculate the standards. According to an EPA explanation, each state "is free to meet that goal in the way that works best for that state. It can rely more or less heavily on specific measures such as efficiency or renewable energy, or even pursue others such as increases in transmission efficiency or new gas generation."[128] Additional nuclear reactors beyond the five already under construction would also be an option.

Because of the state flexibility, the effect of the EPA proposal on nuclear power is inherently uncertain. EPA's emission rate methodology might encourage states to take steps to ensure that nuclear plants currently under construction were completed, and to prevent the shutdown of existing nuclear capacity, because if they did not, they would need to find alternative ways to meet the CO_2 emission rate standard. For example, if Ohio's two nuclear plants closed, the state would lose 993,077 MWh of zero-carbon electricity in its CO_2 rate formula and would need to increase other low-carbon electricity sources or take other steps beyond those already in the EPA building blocks.

The Nuclear Energy Institute, representing the nuclear industry, issued a statement praising the EPA proposal for recognizing "the need to maintain and expand the use of nuclear energy."[129] However, nuclear industry officials have expressed unhappiness that the nuclear "building block" includes only the 6% of existing nuclear capacity considered to be "at risk," rather than all existing nuclear capacity. According to a media report, the industry is concerned that including only 6% of existing nuclear in the state goal calculations would not provide states with enough incentive to prevent nuclear plants from being shut down and replaced by cheaper gas plants.[130] In the Ohio example, only 993,077 MWh of carbon-free generation would have to be replaced with other options if both the state's reactors were shut down, under the EPA proposal. But if all the state's nuclear electricity were included in the nuclear building block, then 16.95 million MWh (about 9% of the state's total 2012 generation) would have to be replaced if the Ohio reactors shut down (2,150 megawatts operating at 90% of capacity for a year).

On the other hand, a news release by the Nuclear Information and Resource Service, a group critical of the nuclear industry, contended that EPA's proposed rule "would encourage states to provide ratepayer subsidies for continued operation of nuclear reactors that cannot compete economically in the current electricity marketplace."[131]

[128] McCabe, Janet, "Understanding State Goals under the Clean Power Plan," *EPA Connect*, June 4, 2014, http://blog.epa.gov/epaconnect/2014/06/understanding-state-goals-under-the-clean-power-plan/.

[129] Nuclear Energy Institute, "Carbon Reduction Requires Big Role for Nuclear Energy," news release, June 2, 2014, http://www.nei.org/News-Media/Media-Room/News-Releases/Carbon-Reduction-Requires-Big-Role-for-Nuclear-Ene.

[130] Reeves, Dawn, "EPA May Revisit ESPS' Nuclear Provisions in Face of Industry Concerns," *Inside EPA.com*, June 13, 2014, http://insideepa.com/201406132474001/EPA-Daily-News/Daily-News/epa-may-revisit-esps-nuclear-provisions-in-face-of-industry-concerns/menu-id-95.html.

[131] Nuclear Information and Resource Service, "EPA Carbon Rule Offers Misguided Subsidies for Uneconomic, Aging and Dangerous Nuclear Reactors," news release, June 2, 2014, http://www.nirs.org/nukesandglobalwarming/epacarbonrulepr6214.pdf.

For more details, see CRS Report R43652, *State CO2 Emission Rate Goals in EPA's Proposed Rule for Existing Power Plants* .

Nuclear Power Research and Development

The Obama Administration's FY2015 funding request for nuclear energy research and development totaled $863.4 million. Including advanced reactors, fuel cycle technology, infrastructure support, and safeguards and security, the total nuclear energy request was $25.0 million (2.9%) below the FY2014 funding level. DOE's FY2015 nuclear R&D budget justification described the following major goals for the program:

- Improve the safety, reliability, and economics of nuclear power plants;
- Implement a "consent based" strategy for developing nuclear waste storage and disposal facilities;
- Develop improved waste management and fuel cycle technologies; and
- Understand and minimize the risks of nuclear proliferation and terrorism.

DOE's Office of Nuclear Energy would lead a major initiative announced in the FY2015 budget request to commercialize the Brayton cycle for commercial power plants. Called Supercritical Transformational Electric Power Generation (STEP), the initiative was proposed to be a joint effort by DOE's nuclear energy, fossil energy, and renewable energy programs. The Brayton cycle uses supercritical gas to drive electric generators rather than the steam cycle that dominates the industry today. DOE's budget justification predicted that Brayton-cycle power plants could reach efficiencies of up to 50%, compared with 33% for steam-cycle plants. The STEP program is to reach a 50-50 cost sharing agreement with the private sector in FY2015 to develop a 10 megawatt (electric) Brayton cycle pilot plant. Funding for the STEP initiative, provided within the nuclear energy budget, would total $27.5 million in FY2015.

The House Appropriations Committee had recommended $899.0 million for nuclear energy, $35.6 million above the Administration request. However, an amendment on the House floor (H.Amdt. 979) reduced the nuclear total by $73.3 million to provide more funding for the Corps of Engineers. The amendment did not specify how the reduction would be allocated among Nuclear Energy programs.

The Senate subcommittee draft report recommended $777.0 million for nuclear energy programs, $86.4 million below the request. The draft rejected the Administration's $97 million request for small modular reactor licensing support and cut the $100.5 million request for reactor concepts R&D by 45%.

The House Appropriations Committee report agreed with the Administration's $27.5 million request for the STEP initiative and authorized DOE to "modify" the 50% cost-sharing goal for qualifying pilot plants. The draft Senate report also recommended the full STEP request but cautioned that the program should "be limited in scope, schedule, and cost."

Reactor Concepts

The Reactor Concepts program area includes research on advanced reactors, including advanced small modular reactors, and research to enhance the "sustainability" of existing commercial light water reactors. The total FY2015 funding request for this program was $100.5 million, a reduction of $12.3 million from FY2014.

DOE proposed to combine the Small Modular Reactor (SMR) R&D and Advanced Reactor Concepts subprograms into the Advanced Reactor Technologies subprogram in FY2015. Funding for the combined subprogram would be $70.2 million, a reduction of $12.6 million from the combined subprograms in FY2014. Reactor concepts being developed by the Advanced Reactor Technology subprogram are generally classified as "Generation IV" reactors, as opposed to the existing fleet of commercial light water reactors, which are generally classified as generations II and III. Nuclear technology development under this program focuses on "fast reactors," using high-energy neutrons, fluoride salt-cooled high-temperature reactors, and high temperature gas-cooled reactors. International research collaboration in this area would continue under the Generation IV International Forum (GIF).

The House Appropriations Committee recommended $138.0 million for Reactor Concepts, $37.5 million more than the request and $25.0 million above FY2014. The committee agreed with the proposal to consolidate Advanced SMR research with Advanced Reactor Concepts. The House panel voted to boost funding for the Advanced Reactor Concepts subprogram to $101.0 million, adding funding for high temperature gas reactor research. As noted above, the House approved an amendment to reduce the Committee's recommended total nuclear funding level without specifying cuts in individual nuclear subprograms.

DOE's FY2015 request for the Light Water Reactor Sustainability subprogram was $30.3 million, $350,000 above the FY2014 appropriation. The House panel recommended $35.0 million. The program conducts research on extending the life of existing commercial light water reactors beyond 60 years, the maximum operating period currently licensed by the Nuclear Regulatory Commission (NRC). The program, which is cost-shared with the nuclear industry, studies the aging of reactor materials and analyzes safety margins of aging plants. This subprogram is also conducting research to understand the Fukushima disaster and to develop prevention and mitigation measures, according to the DOE justification.

The draft Senate bill and report would cut reactor concepts to $55.0 million, consisting of $49.2 million for the combined Advanced Reactor Technologies subprogram and $5.8 million for Light Water Reactor Sustainability. The draft report directed DOE to focus the Light Water Reactor Sustainability subprogram on "understanding of accident scenarios, such as those exhibited in the Fukushima Daiichi nuclear disaster."

Small Modular Reactor Licensing Support

Rising cost estimates for large conventional nuclear reactors—widely projected to be $6 billion or more—have contributed to growing interest in proposals for small modular reactors (SMRs). Ranging from about 40 to 300 megawatts of electrical capacity, such reactors would be only a fraction of the size of current commercial reactors, which typically exceed 1,000 megawatts. Several modular reactors would be installed together to make up a power block with a single control room, under most concepts. Current SMR proposals would use a variety of technologies, including high-temperature gas technology and the light water (LWR) technology used by today's commercial reactors.

DOE requested $97.0 million for FY2015 to provide technical support for licensing small modular reactors, $13 million below the FY2014 funding level. Under the program, DOE is to pay up to half the costs associated with NRC design certification and licensing of selected SMRs, as well as for economic studies and other analyses that would support SMR deployment in general.

A consortium led by Babcock & Wilcox (B&W) was announced by DOE in November 2012 as the first award recipient under the program. However, B&W announced April 14, 2014, that it would reduce its spending on the project to $15 million per year and delay its design certification application to NRC indefinitely, citing a lack of investors and customer contracts.[132] Because of the project's slowdown, DOE reportedly stopped paying matching funds to B&W after the first quarter of 2014.[133]

DOE selected a second SMR to receive assistance under the program in December 2013. The NuScale Power SMR has a generating capacity of only 45 megawatts. Under the company's current concept, up to 12 reactors would be housed in a single pool of water, which would provide emergency cooling. The NuScale SMR is intended to be ready for commercial operation by around 2025, according to DOE.[134] The DOE budget justification contends that reduced funding for the SMR program will be sufficient for both the B&W and NuScale projects in FY2015.

Because of the uncertainty about the B&W SMR project, the House Appropriations Committee cut the SMR program to $54.5 million, with all of the remaining funding directed to the NuScale project. However, the committee said that it "will consider additional funding according to developments." The Senate draft report recommended no new funding for SMR licensing support, citing the availability of $85.0 million in prior-year funds that could be reprogrammed for the NuScale project.

Small modular reactors would go against the overall trend in nuclear power technology toward ever-larger reactors intended to spread construction costs over a greater output of electricity. Proponents of small reactors contend that they would be economically viable despite their far lower electrical output because modules could be assembled in factories and shipped to plant sites, with minimal on-site fabrication, and because their smaller size would allow for simpler and more effective safety systems. In addition, although modular plants might have similar or higher costs per kilowatt-hour than conventional large reactors, their ability to be constructed in smaller increments could reduce electric utilities' financial commitment and risk.

[132] Babcock & Wilcox Company, "B&W Announces Restructuring of Small Modular Reactor Program," news release, April 14, 2014, http://www.babcock.com/news-room/Pages/BW-Announces-Restructuring-of-Small-Modular-Reactor-Program.aspx.

[133] McAuliffe, Michael, "B&W Says DOE Stops Matching Funds after SMR Program Slowdown," *Nucleonics Week*, August 14, 2014, p. 3.

[134] DOE Office of Nuclear Energy, "Small Modular Nuclear Reactors," http://www.energy.gov/ne/nuclear-reactor-technologies/small-modular-nuclear-reactors.

Fuel Cycle Research and Development

The Fuel Cycle Research and Development Program conducts "long-term, science-based" research on a wide variety of technologies for improving the management of spent nuclear fuel, according to the DOE budget justification. In general, the program is investigating ways to separate radioactive constituents of spent fuel for re-use or to be bonded into stable waste forms. The total FY2015 funding request for this program was $189.1 million, $2.9 million above the FY2014 appropriation.

The Administration requested a nearly one-third increase for the Used Nuclear Fuel R&D subprogram, from $60.0 million in FY2014 to $79.0 million in FY2015. This subprogram focuses on establishing a new spent fuel management system, consistent with the Administration's moves to terminate the previously authorized waste repository program at Yucca Mountain, NV. DOE released its Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste in January 2013 that calls for a "consent-based siting process" for nuclear storage and disposal facilities. The Used Fuel subprogram would also conduct waste transportation analyses and research on potential waste repositories, including salt caverns and deep boreholes, according to the DOE justification. DOE also proposed that Congress provide mandatory appropriations for the spent fuel management program beginning in FY2018 to supplement discretionary appropriations. (See the "Nuclear Waste Management" section for more details.)

Other major research areas in the Fuel Cycle R&D Program include the development of accident-tolerant fuels for existing commercial reactors, evaluation of fuel cycle options, development of improved technologies to prevent diversion of nuclear materials for weapons, and technology to increase nuclear fuel resources, such as uranium extraction from seawater.

The House Appropriations Committee recommended $182.0 million for Fuel Cycle R&D, $7.1 million below the request and $4.5 million below FY2014. The committee provided $60.1 million for accident-tolerant fuels research, $55.0 million for Used Nuclear Fuel Disposition, and $55.0 million for used-fuel disposition R&D, such as long-term dry cask storage.

The Senate draft report recommended $230.0 million for Fuel Cycle R&D, including $119.0 million for Used Nuclear Fuel Disposition. Within Used Fuel Disposition, $89.0 million would be provided for developing a consolidated spent fuel storage facility through a consent-based siting process. Such a storage facility could hold spent fuel from nuclear power plants until a permanent underground repository could be developed. The draft report also recommended $60.1 million for accident-tolerant fuels.

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 generated an average of about 75,000 cubic meters of low-level radioactive waste per year during the past decade, including contaminated components and materials resulting from reactor decommissioning.[135]

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, while states have the authority to develop disposal facilities for most commercial low-level waste. Under the Nuclear Waste Policy Act (NWPA, 42 U.S.C. 10101, 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 a geologic formation that has remained stable for hundreds of thousands of years. As amended in 1987, NWPA designated Yucca Mountain in Nevada as 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 even under the most optimistic scenarios will be missed by more than 20 years. DOE filed a license application with NRC for the proposed Yucca Mountain repository in June 2008.

The Obama Administration "has determined that developing the Yucca Mountain repository is not a workable option and the Nation needs a different solution for nuclear waste disposal," according to the DOE FY2011 budget justification. To develop alternative waste management strategies, the Administration established the Blue Ribbon Commission on America's Nuclear Future, which issued its final report to the Secretary of Energy on January 26, 2012.[136] The Blue Ribbon Commission recommended that future efforts to develop nuclear waste facilities follow a "consent based" approach and be carried out by a new organization, rather than DOE. The Commission said the new nuclear waste entity should have "assured access" to the Nuclear Waste Fund, which holds fees collected from nuclear power plant operators to pay for waste disposal. Under NWPA, those funds cannot be spent without congressional appropriations.

DOE released its *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste* in January 2013 in response to the Blue Ribbon Commission report. The strategy calls for a pilot interim storage facility for spent fuel from closed nuclear reactors to open by 2021 and a larger storage facility, possibly at the same site, to open by 2025. A site for a permanent underground waste repository would be selected by 2026, and the repository would open by 2048. Storage and disposal sites would be selected by a new waste management organization through a consent-based process, as recommended by the Blue Ribbon Commission.[137]

DOE's Office of Nuclear Energy (NE) currently is responsible for civilian waste management activities. NE's Fuel Cycle R&D Program (discussed in the "Nuclear Power Research and Development" section above) includes funding under the Used Nuclear Fuel Disposition subprogram to begin implementing the DOE waste management strategy. DOE requested $79.0

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[135] DOE, Manifest Information Management System, http://mims.doe.gov/GeneratorData.aspx. Annual low-level waste disposal volume varies considerably, ranging during the past decade from a high of 114,841 cubic meters in 2006 to a low of 35,216 cubic meters in 2013.

[136] Blue Ribbon Commission on America's Nuclear Future, *Report to the Secretary of Energy*, January 2012, http://brc.gov/sites/default/files/documents/brc_finalreport_jan2012.pdf.

[137] DOE, *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*, January 2013, http://energy.gov/sites/prod/files/Strategy%20for%20the%20Management%20and%20Disposal%20of%20Used%20Nuclear%20Fuel%20and%20High%20Level%20Radioactive%20Waste.pdf.

million for the Used Fuel subprogram in FY2015, $19.0 million above the FY2012 funding level, and no funding for Yucca Mountain.

In approving the Energy and Water Development Appropriations bill for FY2014 (H.R. 2609), the House Appropriations Committee excoriated the Obama Administration's termination of the Yucca Mountain project as "blatant political maneuverings." The House-passed FY2015 energy and water bill included $150.0 million for DOE and $55.0 million for NRC to continue Yucca Mountain licensing activities. The House provided no funding to implement DOE's alternative nuclear waste management strategy.

The Senate Appropriations subcommittee recommended $119.0 million in FY2015 for Used Fuel and did not mention Yucca Mountain. The subcommittee's draft bill included a provision from the previous year that would authorize DOE to conduct a pilot program to develop one or more high level radioactive waste storage facilities, with the consent of state, local, and tribal governments.

Senator Wyden, along with Senators Murkowski, Feinstein, and Alexander, introduced legislation June 27, 2013, to redirect the nuclear waste program (S. 1240) along the lines recommended by the Blue Ribbon Commission. The bill would establish an independent Nuclear Waste Administration to develop nuclear waste storage and disposal facilities. Siting of such facilities would require the consent of the affected state, local, and tribal governments. The Nuclear Waste Administration could spend nuclear waste fees collected after the bill's enactment without the need for further appropriation. Fee collection would halt after 2025 if a waste facility had not been opened. The Energy and Natural Resources Committee held a hearing on the bill July 30, 2013.

DOE had filed a license application with NRC for the proposed Yucca Mountain repository in June 2008 but filed a motion to withdraw the application on March 3, 2010. An NRC licensing panel rejected DOE's withdrawal motion June 29, 2010, on the grounds that NWPA requires full consideration of the license application by NRC. The full NRC Commission deadlocked on the issue September 9, 2011, leaving the licensing panel's decision in place and prohibiting DOE from withdrawing the Yucca Mountain application. However, the commission ordered at the same time that the licensing process be suspended because of "budgetary limitations."[138] No funding was provided in FY2012 or FY2013 or requested for FY2014 or FY2015 to continue Yucca Mountain licensing activities. However, the U.S. Court of Appeals for the District of Columbia Circuit ruled on August 13, 2013, that NRC must continue work on the Yucca Mountain license application as long as funding is available. The Court determined that NRC had at least $11.1 million in previously appropriated funds for that purpose.[139]

NWPA required DOE to begin taking waste from nuclear plant sites by January 31, 1998. Nuclear utilities, upset over DOE's failure to meet that deadline, have won two federal court decisions upholding the department's obligation to meet the deadline and to compensate utilities for any resulting damages. Utilities have also won several cases in the U.S. Court of Federal Claims. DOE estimates that liability payments would eventually exceed $20 billion if DOE were to begin

[138] Nuclear Regulatory Commission, "In the Matter of U.S. Department of Energy (High-Level Waste Repository)," CLI-11-07, September 9, 2011, http://www.nrc.gov/reading-rm/doc-collections/commission/orders/2011/2011-07cli.pdf.

[139] U.S. Court of Appeals for the District of Columbia Circuit, *In re: Aiken County et al*., No. 11-1271, writ of mandamus, August 13, 2013, http://www.cadc.uscourts.gov/internet/opinions.nsf/BAE0CF34F762EBD985257BC6004DEB18/$file/11-1271-1451347.pdf.

removing waste from reactor sites by 2020, the previous target for opening Yucca Mountain.[140] (For more information, see CRS Report R42513, *U.S. Spent Nuclear Fuel Storage*, by James D. Werner; CRS Report RL33461, *Civilian Nuclear Waste Disposal*, by Mark Holt; and CRS Report R40996, *Contract Liability Arising from the Nuclear Waste Policy Act (NWPA) of 1982*, by Todd Garvey.)

Pursuant to a court ruling, DOE reportedly stopped collecting nuclear waste fees from nuclear power generators on May 16, 2014, eliminating about $750 million in revenues for the waste disposal program.[141] NWPA requires the Secretary of Energy to adjust the fees as necessary to cover the waste program's anticipated costs, but the U.S. Court of Appeals for the District of Columbia Circuit ruled that DOE's current waste plans are too vague to allow a reasonable estimate to be calculated and that DOE must therefore stop collecting the fee.[142]

NRC approved a final rule August 26, 2014, on continued storage of spent nuclear fuel.[143] The rule responds to a federal circuit court ruling on June 8, 2012, that struck down NRC's Waste Confidence Decision, which contained the agency's formal findings that waste generated by nuclear power plants will be disposed of safely. The court ruled that the Waste Confidence Decision required an environmental review under the National Environmental Policy Act and that NRC needed to consider the possibility that a permanent waste repository would never be built and to examine potential problems with waste storage pools.

The Waste Confidence Decision, first issued in 1984 and since updated twice, resulted from a 1979 federal circuit court ruling that required NRC to determine whether waste from nuclear facilities would be safely managed after their licenses expired. After the Waste Confidence Decision was struck down in 2012, NRC suspended final licensing decisions for new reactors, spent fuel storage facilities, and license renewals. Upon approving the continued storage rule to replace the Waste Confidence Decision, NRC ended its licensing suspension.[144]

Nuclear Weapons Proliferation

Renewed interest in nuclear power in much of 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.

[140] Ibid., p. 80.

[141] Hiruo, Elaine, "DOE Implements Court-Ordered Suspension of Nuclear Waste Fee," *NuclearFuel*, May 26, 2014.

[142] U.S. Court of Appeals for the District of Columbia Circuit, National Association of Regulatory Utility Commissioners v. U.S. Department of Energy, No. 11-1066, decided November 19, 2013, http://www.cadc.uscourts.gov/internet/opinions.nsf/2708C01ECFE3109F85257C280053406E/$file/11-1066-1466796.pdf.

[143] NRC, "NRC Approves Final Rule on Spent Fuel Storage and Ends Suspension of Final Licensing Actions for Nuclear Plants and Renewals," news release, August 26, 2014, http://pbadupws.nrc.gov/docs/ML1423/ML14238A326.pdf.

[144] NRC, "Continued Storage of Spent Nuclear Fuel," final rule, 79 *Federal Register* 56238, September 19, 2014.

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 Global Nuclear Energy Partnership, now called the International Framework for Nuclear Energy Cooperation.[145]

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, and imposition of sanctions, Iran continues to develop enrichment capability at Natanz and at a site near Qom disclosed in September 2009. 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. International talks with Iran over its nuclear program are ongoing. The case of Iran raises perhaps the most critical current question 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.

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

Federal Funding for Nuclear Energy Programs

The following tables summarize current funding for DOE nuclear energy programs and NRC. The sources for the funding figures are Administration budget requests[146] and committee reports

[145] The organization approved a new mission statement with the name change at its June 2010 meeting in Ghana. Seehttp://www.ifnec.org/About/History.aspx.

[146] DOE, "FY 2015 Congressional Budget Request," DOE/CF-0098, Vol. 3, March 2014, http://energy.gov/cfo/ (continued...)

on the Energy and Water Development Appropriations Acts, which fund DOE and NRC. The House passed its version of the FY2015 Energy and Water bill (H.R. 4923, H.Rept. 113-486) on July 10, 2014. The Senate Subcommittee on Energy and Water Development Appropriations approved a draft FY2015 bill and report on July 24, 2014.[147] Pending enactment of full-year appropriations, FY2015 funding for these programs is being provided by a continuing resolution (P.L. 113-164).

Table 2. Funding for the Nuclear Regulatory Commission

(budget authority in millions of current dollars)

	FY2012 Approp.	FY2013 Approp.[a]	FY2014 Approp.	FY2015 Request	FY2015 House	FY2015 Senate Subcom.
Reactor Safety[b]	800.1[a]	—[c]	811.4	815.2	—[c]	—
Nuclear Materials and Waste	227.1	—	232.5	232.2	—	—
Yucca Mountain Licensing	0	0	0	0	55.0	0
Inspector General	10.9	10.9	12.0	12.1	12.1	12.1
Total NRC budget authority	1,038.1	1,036.0	1,055.9	1,059.5	1,064.5	1,059.5
—Offsetting fees	-909.5	-909.5	-930.7	-935.2	-890.3	-935.2
Net appropriation	**128.6**	**126.6**	**125.2**	**124.3**	**174.3**	**124.3**

a. FY2013 figures do not reflect March 1, 2013, sequester under P.L. 112-25.

b. Subcategories from NRC budget request.

c. Subcategories not specified.

Table 3. DOE Funding for Nuclear Activities (Selected Programs)

(budget authority in millions of current dollars)

	FY2012 Approp.	FY2013 Approp.	FY2014 Approp.	FY2015 Request	FY2015 House	FY2015 Senate Subcom.
Reactor Concepts	115.5	104.8	113.0	100.5	138.0	55.0
Small Modular Reactor Licensing	67.0	62.7	110.0	97.0	54.5	0
Fuel Cycle R&D	187.4	169.9	186.5	189.1	182.0	230.0
Nuclear Energy Enabling Technologies	74.9	67.9	71.1	78.2	101.0	73.5
International Nuclear	3.0	2.8	2.5	3.0	3.0	3.0

(...continued)

downloads/fy-2015-budget-justification; NRC, "Congressional Budget Justification: Fiscal Year 2015," NUREG-1100, Volume 30, March 2014, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1100/v30/.

[147] Senate Committee on Appropriations, "FY15 Subcommittee Reported Bill and Draft Report," July 24, 2014, http://www.appropriations.senate.gov/news/fy-2015-ew-subcommittee-reported-bill-and-draft-report.

	FY2012 Approp.	FY2013 Approp.	FY2014 Approp.	FY2015 Request	FY2015 House	FY2015 Senate Subcom.
Energy Cooperation						
Radiological Facilities Management	69.9	65.4	25.0	5.0	5.0	25.0
Idaho Facilities Management	155.0	145.0	196.6	185.9	206.0	185.9
Program Direction	91.0	85.1	90.0	73.1	73.0	73.1
Yucca Mountain repository	0	0	0	0	150.0	0
Total, Nuclear Energy[a]	765.4	708.4	889.2	863.4	826.7	777.0

a. Excludes funding provided under other accounts.

b. Nuclear energy total reduced by House floor amendment without specifying changes in subcategories.

Legislation in the 113th Congress

H.R. 259 (Pompeo)/S. 2279 (Lee)

Energy Freedom and Economic Prosperity Act. Terminates nuclear energy production tax credit, among other provisions. House bill introduced January 15, 2013; referred to Committee on Ways and Means. Senate bill introduced May 1, 2014; referred to Committee on Finance.

H.R. 1700 (Engel)

Nuclear Disaster Preparedness Act. Requires the President to issue guidance for federal response to nuclear disasters, covering specific topics listed in the bill. Introduced April 24, 2013; referred to Committee on Transportation and Infrastructure.

H.R. 2081 (Thornberry)

No More Excuses Energy Act of 2013. Includes provisions to prohibit NRC from considering nuclear waste storage when licensing new nuclear facilities, and to establish a tax credit for obtaining nuclear component manufacturing certification. Introduced May 21, 2013; referred to multiple committees.

H.R. 2609 (Frelinghuysen)/S. 1245 (Feinstein)

Energy and Water Development and Related Agencies Appropriations Act, 2014. Provides funding for DOE nuclear programs and NRC. House bill introduced July 2, 2013; reported as original measure by Committee on Appropriations July 2, 2013 (H.Rept. 113-135); passed House July 10, 2013, by vote of 227-198. Senate bill introduced June 27, 2013; reported as original measure by Committee on Appropriations June 27, 2013 (S.Rept. 113-47). FY2014 Energy and Water Development funding provided by Division D of P.L. 113-76, Consolidated Appropriations Act, 2014.

H.R. 2712 (Lowey)

Nuclear Power Licensing Reform Act of 2013. Requires evacuation planning within 50 miles of U.S. nuclear power plants and that reactor license renewals be subject to the same standards that would apply to new reactors. Introduced July 17, 2013; referred the Committee on Energy and Commerce.

H.R. 2861 (Lowey)

Requires NRC to distribute safety-related fines collected from nuclear facilities to the counties in which the facilities are located to maintain radiological emergency preparedness plans. Introduced July 30, 2013; referred to Committee on Energy and Commerce.

H.R. 3354 (Engel)

Dry Cask Storage Act. Requires spent fuel at nuclear power plants to be moved from spent fuel pools to dry casks after it has sufficiently cooled. Costs of the fuel transfers would be offset by a reduction in nuclear waste fees owed to the federal government. Introduced October 28, 2013; referred to Committee on Energy and Commerce.

H.R. 3766 (Ros-Lehtinen)

Requires congressional approval of U.S. peaceful nuclear cooperation agreements with countries that do not agree to forgo enrichment and reprocessing. Introduced December 12, 2013; referred to Committees on Foreign Affairs and Rules.

H.R. 3895 (Duncan)

Energy Exploration and Production to Achieve National Demand (EXPAND) Act. Among other provisions, repeals nuclear production tax credit, authorizes expedited nuclear licensing procedures, requires NRC to develop "technology neutral" guidelines for licensing advanced nuclear plants, requires an accelerated schedule for the Next Generation Nuclear Plant, and limits fees for uranium mining on federal lands. Introduced January 16, 2014; referred to multiple committees.

H.R. 4522 (Van Hollen)/S. 2271 (Murphy)

Establishes a Green Bank to finance clean energy, including nuclear projects. Both bills introduced April 30, 2014; House bill referred to Committee on Ways and Means and to Energy and Commerce for specific provisions; Senate bill referred to Committee on Finance.

H.R. 4869 (Lummis)

Department of Energy Research and Development Act of 2014. Authorizes DOE research and development programs, including nuclear energy. Introduced June 13, 2014; referred to Committee on Science, Space, and Technology.

H.R. 4923 (Simpson)

Energy and Water Development and Related Agencies Appropriations Act, 2015. Provides appropriations for DOE nuclear programs and NRC. Introduced June 20, 2014; reported as an original measure June 20, 2014, by the Committee on Appropriations (H.Rept. 113-486). Passed House July 10, 2014, by vote of 253-170.

H.R. 4956 (Walz)

American Energy Opportunity Act of 2014. Among other provisions, establishes the Carbon Free Technology and Nuclear Energy Reserve that could be used to offset the cost of loan guarantees for commercial nuclear power plants, the disposition and recycling or reprocessing of spent fuel from nuclear power plants, and the financing of long-term safe storage of spent fuel. Introduced June 24, 2014; referred to multiple committees.

H.R. 5322 (Blackburn)

Consolidate Heavy-handed and Outdated Programs Act of 2014. Consolidates nuclear energy programs under a new Department of Energy and the Environment. Introduced July 31, 2014; referred to multiple committees.

S. 1240 (Wyden)

Nuclear Waste Administration Act of 2013. Establishes an independent Nuclear Waste Administration to develop nuclear waste storage and disposal facilities. Siting of such facilities would require the consent of the affected state, local, and tribal governments. The Nuclear Waste Administration could spend nuclear waste fees collected after the bill's enactment without the need for further appropriation. Fee collection would halt after 2025 if a waste facility had not been opened. Introduced June 27, 2013; referred to Committee on Energy and Natural Resources. Full committee hearing held July 30, 2013.

S. 1519 (Vitter)

Nuclear Regulatory Commission Reorganization Plan Codification and Complements Act. Specifies functions and authorities of the Chairman and Commissioners of NRC. Specifies that any commissioner may request a vote on whether a particular issue should be reserved for the Chairman or handled by the full Commission. Introduced September 18, 2013; referred to Committee on Environment and Public Works.

S. 2324 (Boxer)

Safe and Secure Decommissioning Act of 2014. Prohibits NRC from waiving emergency preparedness and security requirements at nuclear reactors that are undergoing decommissioning until all of such a reactor's spent nuclear fuel has been transferred from storage pools into dry casks. Introduced May 13, 2014; referred to Committee on Environment and Public Works.

S. 2325 (Markey)

Dry Cask Storage Act of 2104. Requires each nuclear reactor to submit a plan to NRC for tranferring spent fuel currently stored in pools to dry casks within seven years. After the seven year period, additional spent fuel must be transferred to dry casks within a year after it has been determined to be sufficiently cool. Emergency planning zones must be expanded from 10 to 50 miles in radius around any reactor that is determined by NRC to be out of compliance with its spent fuel transfer plan. Introduced May 13, 2014; referred to Committee on Environment and Public Works.

S. 2326 (Sanders)/H.R. 4667 (Welch)

Nuclear Plant Decommissioning Act of 2014. Provides for consultation with state and local governments, and the consideration of state and local concerns, during NRC approval of post-shutdown decommissioning activities reports, and requires reactors undergoing decommissioning to comply with state laws and standards. Senate bill introduced May 13, 2014; referred to Committee on Environment and Public Works. House bill introduced May 15, 2014; referred to Committee on Energy and Commerce.

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