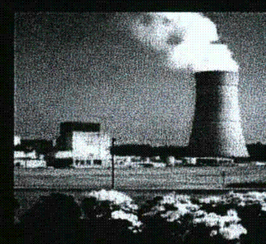
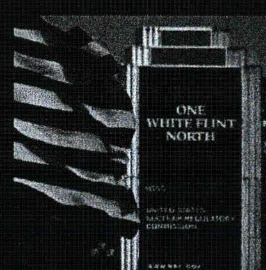
U.S.NRC

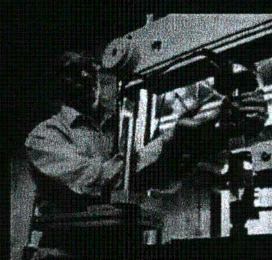
United States Nuclear Regulatory Commission

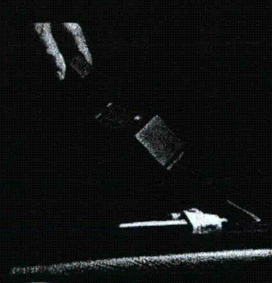
Protecting People and the Environment

2011–2012 INFORMATION DIGEST



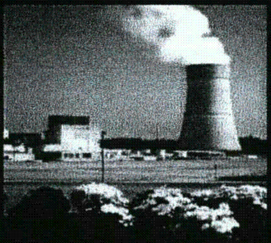


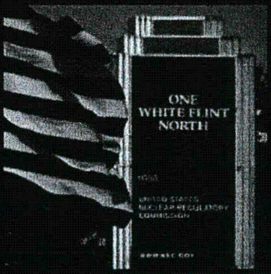




2011–2012

INFORMATION DIGEST





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Front Cover: (from top to bottom)

1. *Grand Gulf nuclear power plant. (Photo courtesy: Southern Nuclear)*
2. *NRC Headquarters in Rockville, MD.*
3. *Student at a research facility. (Photo courtesy: University of Wisconsin–Madison)*

Background. A blue glow of radiation, known as the "Cerenkov effect," from nuclear fuel in a nuclear reactor.

Back Cover: (from top to bottom)

1. *A fuel assembly traveler. (Photo courtesy: Westinghouse)*
2. *Gamma Knife® used for treating brain tumors. (Photo courtesy: Elekta)*
3. *Brunswick nuclear power plant. (Photo courtesy: Progress Energy)*

Inside Cover: (from top to bottom)

1. *Student at a research facility. (Photo courtesy: University of Wisconsin–Madison)*
2. *A nuclear gauge.*
3. *NRC-licensed teletherapy unit provides treatment to patient.*

ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) 2011–2012 Information Digest provides a summary of information about the NRC and the industry it regulates. It describes the agency's regulatory responsibilities and licensing activities and also provides general information on nuclear-related topics. It is updated annually.

The Information Digest includes NRC- and industry-related data in a quick reference format. Data include activities through 2010 or the most current data available at manuscript completion. The Web Link Index provides Web addresses for more information on major topics. The Digest also includes a tear-out reference sheet, the NRC Facts at a Glance.

The NRC reviewed information from industry and international sources but did not perform an independent verification. This edition contains adjustments to preliminary figures from the previous year. All information is final unless otherwise noted.

The NRC is the source for all photographs, graphics, and tables unless otherwise noted.

The agency welcomes comments or suggestions on the Information Digest. Please contact Ivonne Couret by mail at the Office of Public Affairs, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001 or by e-mail at OPA.Resource@nrc.gov.

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NRC: AN INDEPENDENT REGULATORY AGENCY

Top: Public meeting.

Middle: The NRC Chairman and Commissioners at a briefing.

Bottom: Nuclear power plant control room.

MISSION

The U.S. Nuclear Regulatory Commission (NRC) is an independent agency created by Congress. The mission of the NRC is to license and regulate the Nation's civilian use of byproduct, source, and special nuclear materials in order to protect public health and safety, promote the common defense and security, and protect the environment.

The NRC's regulations are designed to protect both the public and workers against radiation hazards from industries that use radioactive materials.

The NRC's scope of responsibility includes regulation of commercial nuclear power plants; research, test, and training reactors; nuclear fuel cycle facilities; medical, academic, and industrial uses of radioactive materials; and the transport, storage, and disposal of radioactive materials and wastes.

In addition, the NRC licenses the import and export of radioactive materials and works to enhance nuclear safety and security throughout the world.

Values

The NRC adheres to the principles of good regulation—independence, openness, efficiency, clarity, and reliability. The agency puts these principles into practice with effective, realistic, and timely regulatory actions.

Strategic Goals

Safety: Ensure adequate protection of public health and safety and the environment.

Security: Ensure adequate protection in the secure use and management of radioactive materials.

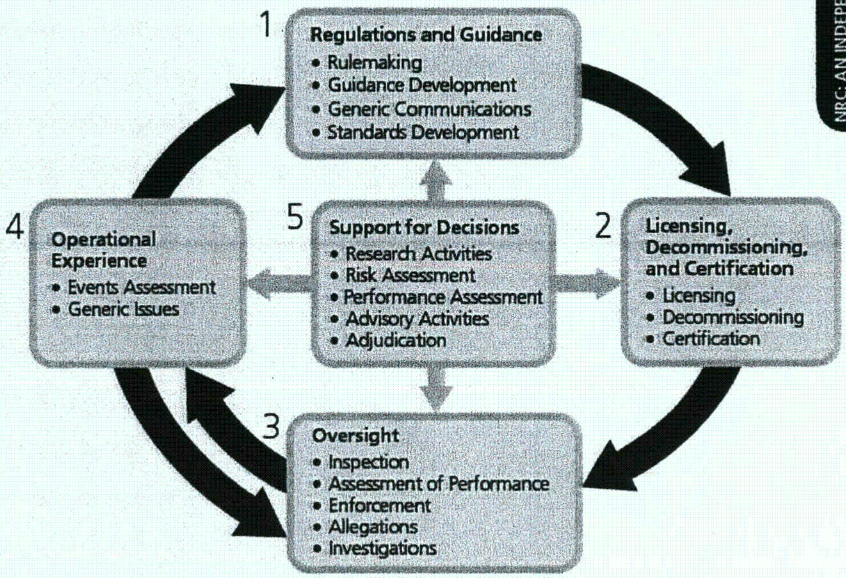
Strategic Outcomes

- Prevent the occurrence of any nuclear reactor accidents.
- Prevent the occurrence of any inadvertent criticality events.
- Prevent the occurrence of any acute radiation exposures resulting in fatalities.
- Prevent the occurrence of any releases of radioactive materials that result in significant radiation exposures.
- Prevent the occurrence of any releases of radioactive materials that cause significant adverse environmental impacts.
- Prevent any instances where licensed radioactive materials are used domestically in a manner hostile to the United States.

Statutory Authority

The NRC was established by the Energy Reorganization Act of 1974 to oversee the commercial nuclear industry. The agency took over regulation formerly carried out by the Atomic Energy Commission and began operations on January 18, 1975. As previously noted, the NRC regulates

How We Regulate



1. *Developing regulations and guidance for applicants and licensees.*
2. *Licensing or certifying applicants to use nuclear materials, operate nuclear facilities, and decommission facilities.*
3. *Inspecting and assessing licensee operations and facilities to ensure that licensees comply with NRC requirements and taking appropriate followup or enforcement actions when necessary.*
4. *Evaluating operational experience of licensed facilities and activities.*
5. *Conducting research, holding hearings, and obtaining independent reviews to support regulatory decisions.*

the civilian commercial, industrial, academic, and medical uses of nuclear materials. Effective regulation enables the Nation to use radioactive materials for beneficial civilian purposes while protecting the American people and their environment.

The NRC's regulations are contained in Title 10, *Energy*, of the *Code of Federal Regulations* (10 CFR). The following principal statutory authorities govern the NRC's work and can be found on the NRC Web site (see the Web Link Index):

- Atomic Energy Act of 1954, as amended (Pub. L. 83–703)
- Energy Reorganization Act of 1974, as amended (Pub. L. 93–438)
- Uranium Mill Tailings Radiation Control Act of 1978, as amended (Pub. L. 95–604)
- Nuclear Non-Proliferation Act of 1978 (Pub. L. 95–242)
- West Valley Demonstration Project Act of 1980 (Pub. L. 96–368)

- Nuclear Waste Policy Act of 1982, as amended (Pub. L. 97–425)
- Low-Level Radioactive Waste Policy Amendments Act of 1985 (Pub. L. 99–240)
- Diplomatic Security and Anti-Terrorism Act of 1986 (Pub. L. 107–56)
- Energy Policy Act of 1992 (Pub. L. 102–486)
- Energy Policy Act of 2005 (Pub. L. 109-58)

The NRC, licensees (those licensed by the NRC to use radioactive materials), and the Agreement States (States that assume regulatory authority over their own use of certain nuclear materials) share a common responsibility to protect public health and safety and the environment. Federal regulations and the NRC regulatory program are important elements in the protection of the public. However, because licensees are the ones using radioactive material, they bear the primary responsibility for safely handling and using these materials.

MAJOR ACTIVITIES

The NRC fulfills its responsibilities through the following licensing and regulatory activities:

- Licenses the design, construction, operation, and decommissioning of commercial nuclear power plants and other nuclear facilities, such as uranium enrichment facilities and research and test reactors.
- Licenses the possession, use, processing, handling, and importing and exporting of nuclear materials.
- Licenses the siting, design, construction, operation, and closure of low-level radioactive waste disposal sites in States under NRC jurisdiction.
- Licenses the construction, operation, and closure of a proposed geologic repository for high-level radioactive waste.
- Licenses the operators of nuclear reactors.
- Inspects licensed and certified facilities and activities.
- Certifies uranium enrichment facilities.
- Conducts light-water reactor safety research, using independent research, data, and expertise, to develop regulations and anticipate potential safety problems.
- Collects, analyzes, and disseminates information about the operational safety of commercial nuclear power reactors and certain nonreactor activities.
- Establishes safety and security policies, goals, rules, culture, regulations, and orders that govern licensed nuclear activities and interacts with other Federal agencies, including the U.S. Department of Homeland Security (DHS), on safety and security issues
- Investigates nuclear incidents and allegations concerning any matter regulated by the NRC.
- Enforces NRC regulations and the conditions of the NRC licenses, and may impose civil sanctions, including civil penalties, for violations.
- Conducts public hearings on matters of nuclear and radiological safety,

environmental concern, and common defense and security.

- Develops effective working relationships with State and Tribal governments regarding reactor operations and the regulation of nuclear materials.
- Directs the NRC program for response to incidents involving licensees and conducts a program of emergency preparedness and response for licensed nuclear facilities.
- Provides opportunities for public involvement in the regulatory process that include the following: holding open meetings, conferences, and workshops; soliciting public comments on petitions, proposed regulations and guidance documents, and draft technical reports; responding to requests for NRC documents under the Freedom of Information Act; reporting safety concerns; and providing access to thousands of NRC documents through the NRC Web site.
- Participates in Open Government initiatives that focus on open, accountable, and accessible government and engage the public in dialogue and interactions such as the use of social media and interactive high-value data sets.

The NRC hosts an annual Regulatory Information Conference attended by more than 3,000 people, including representatives from more than 30 foreign countries, the nuclear industry, and congressional staff.

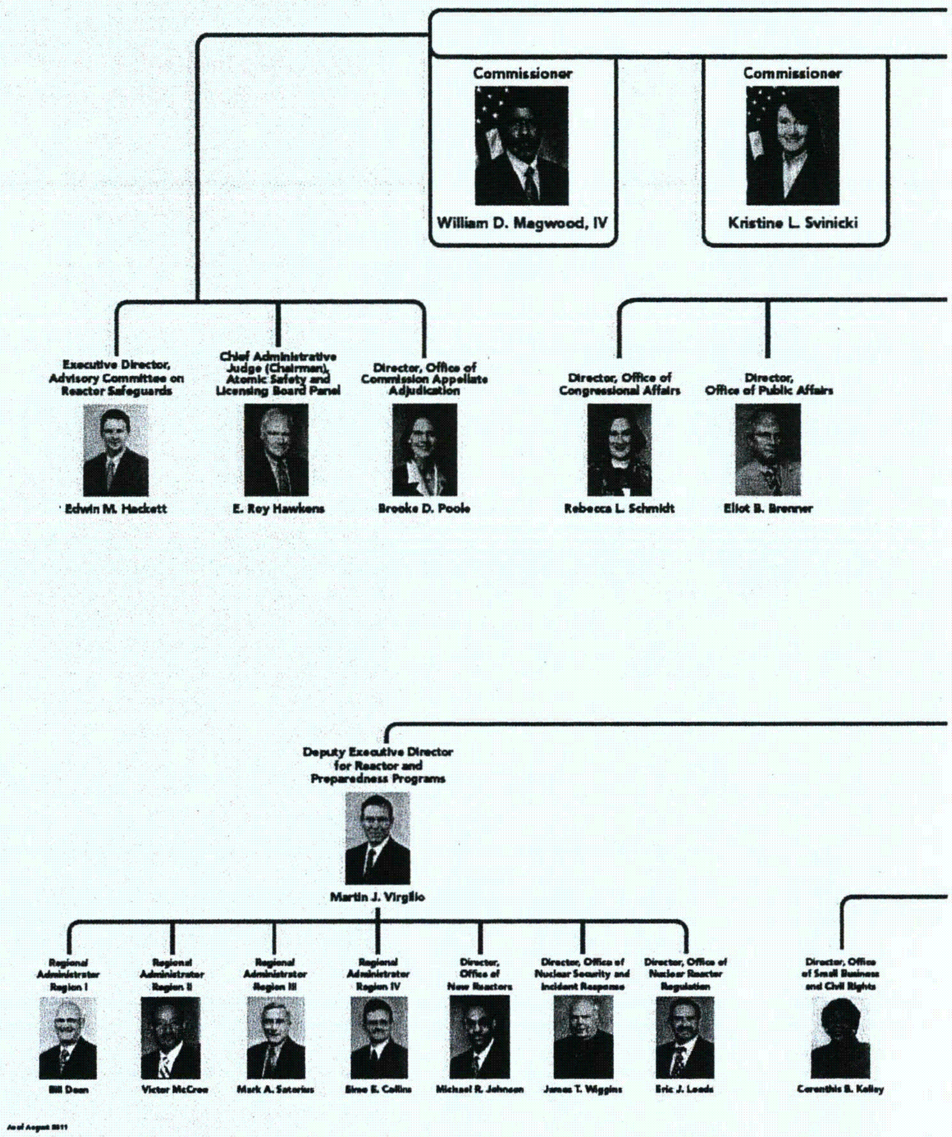
ORGANIZATIONS AND FUNCTIONS

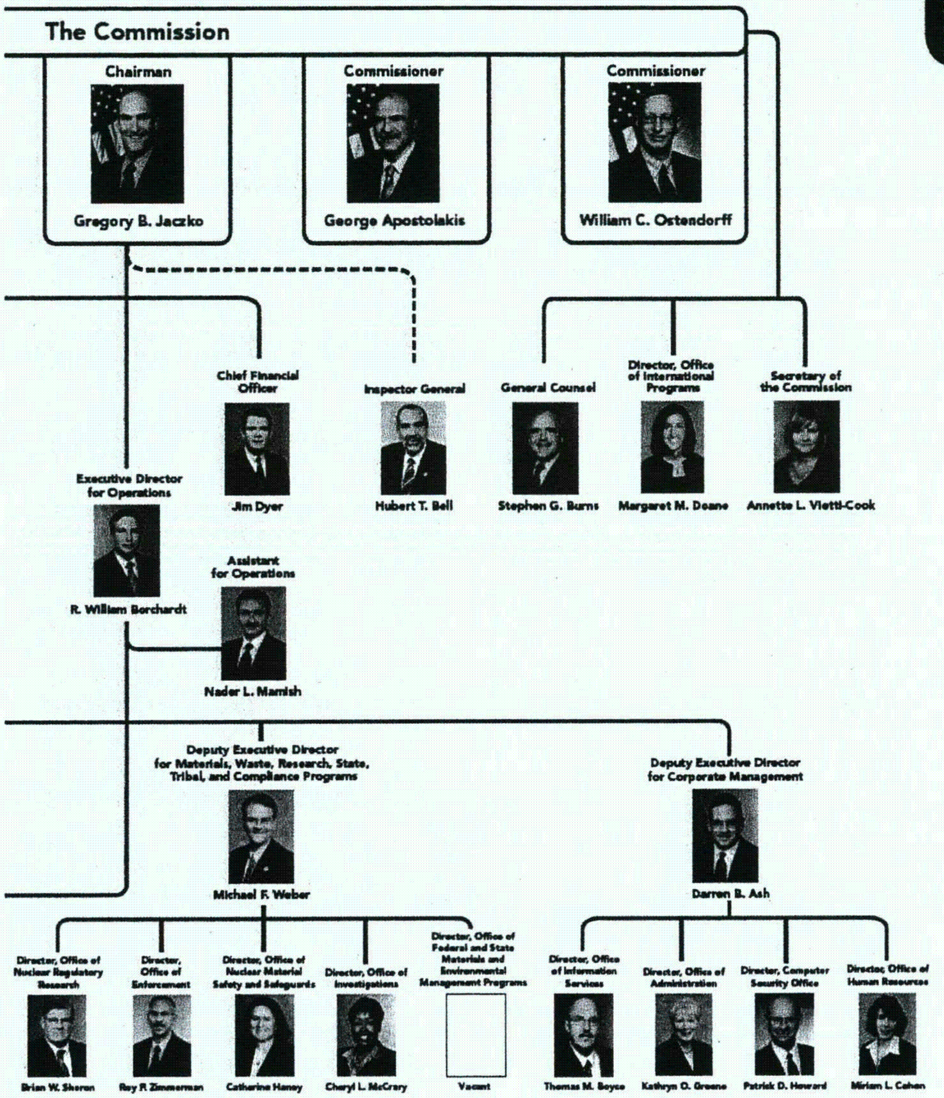
The NRC's Commission consists of five members nominated by the President and confirmed by the U.S. Senate for 5-year terms. The President designates one member to serve as Chairman, principal executive officer, and spokesperson of the Commission. The members' terms are staggered so that one Commissioner's term expires on June 30 every year. No more than three Commissioners can belong to the same political party. The members of the Commission are listed below. The Commission as a whole formulates policies and regulations governing nuclear reactor and materials

Commissioner Term Expiration

Commissioner	Expiration of Term
Gregory B. Jaczko, Chairman	June 30, 2013
Kristine L. Svinicki	June 30, 2012
George Apostolakis	June 30, 2014
William D. Magwood, IV	June 30, 2015
William C. Ostendorff	June 30, 2016

Figure 1. U.S. Nuclear Regulatory Commission Organizational Chart




The Commission
Chairman
Gregory B. Jaczko
Commissioner
George Apostolakis
Commissioner
William C. Ostendorff
Chief Financial Officer
Jim Dyer
Inspector General
Hubert T. Bell
General Counsel
Stephen G. Burns
Director, Office of International Programs
Margaret M. Doane
Secretary of the Commission
Annette L. Vietti-Cook
Executive Director for Operations
R. William Borchardt
Assistant for Operations
Nader L. Mamish
Deputy Executive Director for Materials, Waste, Research, State, Tribal, and Compliance Programs
Michael F. Weber
Deputy Executive Director for Corporate Management
Darren B. Ash
Director, Office of Nuclear Regulatory Research
Brian W. Sheron
Director, Office of Enforcement
Roy P. Zimmerman
Director, Office of Nuclear Material Safety and Safeguards
Catherine Haney
Director, Office of Investigations
Cheryl L. McCrary
Director, Office of Federal and State Materials and Environmental Management Programs
Vacant
Director, Office of Information Services
Thomas M. Boyce
Director, Office of Administration
Kathryn O. Greene
Director, Computer Security Office
Patrick D. Howard
Director, Office of Human Resources
Miriam L. Cohen

safety, issues orders to licensees, and adjudicates legal matters brought before it. The Executive Director for Operations carries out the policies and decisions of the Commission and directs the activities of the program and regional offices (see Figures 1 and 2).

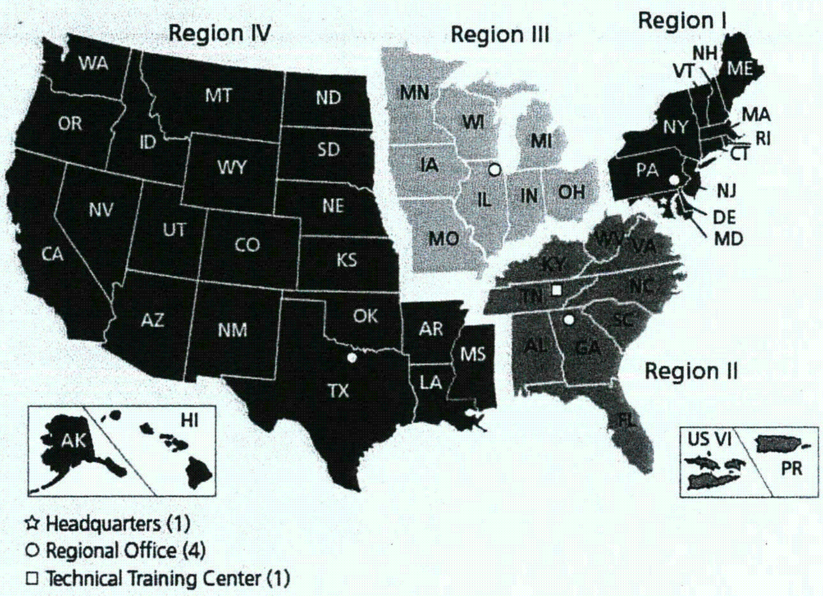
The NRC has its headquarters in Rockville, MD, and maintains four regional offices located in King of Prussia, PA; Atlanta, GA; Lisle, IL; and Dallas, TX.

The NRC includes the major program offices described below:

- **Office of Nuclear Reactor Regulation**—handles all licensing and inspection activities associated with the operation of existing nuclear power reactors and research and test reactors.
- **Office of New Reactors**—provides safety oversight of the design, siting, licensing, and construction of new commercial nuclear power reactors.
- **Office of Nuclear Material Safety and Safeguards**—regulates activities that provide for the safe and secure production of nuclear fuel used in commercial nuclear reactors; the safe storage, transportation, and disposal of high-level radioactive waste and spent nuclear fuel; and the transportation of radioactive materials regulated under the Atomic Energy Act of 1954, as amended.
- **Office of Federal and State Materials and Environmental Management Programs**—develops and oversees the regulatory framework for the safe and secure use of nuclear materials; medical, industrial, academic, and commercial applications; uranium recovery activities; low-level radioactive waste sites; and the decommissioning of previously operating nuclear facilities and power plants. Works with Federal agencies, States, and Tribal and local governments on regulatory matters.
- **Office of Nuclear Regulatory Research**—provides independent expertise and information for making timely regulatory judgments, anticipating problems of potential safety significance, and resolving safety issues. It helps develop technical regulations and standards and collects, analyzes, and disseminates information about the operational safety of commercial nuclear power plants and certain nuclear materials activities.
- **Office of Nuclear Security and Incident Response**—oversees agency security policy for nuclear facilities and users of radioactive material. It provides a safeguards and security interface with other Federal agencies and maintains the agency emergency preparedness and incident response program.

- **Regional Offices**—conduct inspection, enforcement (in conjunction with the Office of Enforcement), investigation, licensing, and emergency response programs for nuclear reactors, fuel facilities, and materials licensees.

Figure 2. NRC Regions



Nuclear Power Plants

- *Each regional office oversees the nuclear plants within its region, except that Region IV oversees the Grand Gulf plant in Mississippi and the Callaway plant in Missouri.*

Materials Licensees

- *Region I oversees licensees and Federal facilities located in Region I and Region II.*
- *Region III oversees licensees and Federal facilities located in Region III.*
- *Region IV oversees licensees and Federal facilities located in Region IV.*

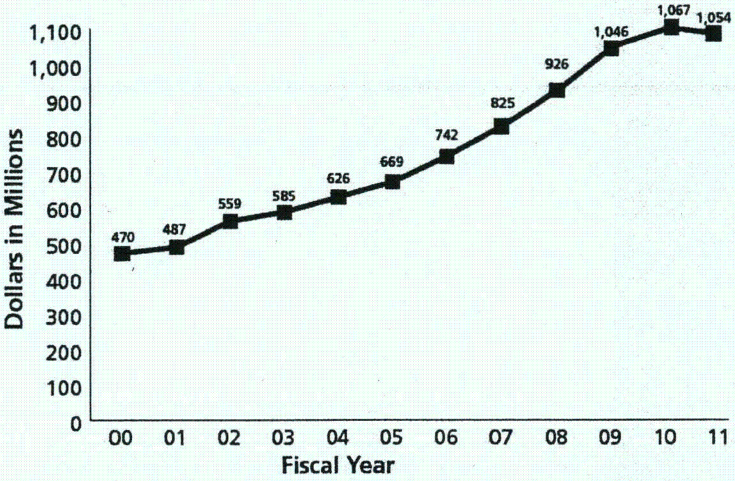
Nuclear Fuel Processing Facilities

- *Region II oversees all the fuel processing facilities in the region and those in Illinois, New Mexico, and Washington.*
- *In addition, Region II handles all construction inspectors' activities for new nuclear power plants and fuel cycle facilities in all regions.*

BUDGET

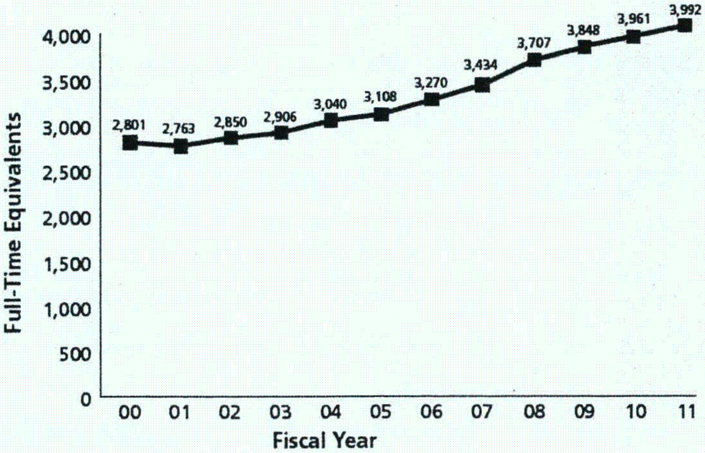
For fiscal year (FY) 2011 (October 1, 2010–September 30, 2011), Congress appropriated $1.0541 billion to the NRC. The NRC's FY 2011 personnel ceiling is 3,992 full-time equivalent (FTE) staff

Figure 3. NRC Budget Authority, FYs 2000–2011



Note: Dollars are rounded to the nearest million.

Figure 4. NRC Personnel Ceiling, FYs 2000–2011

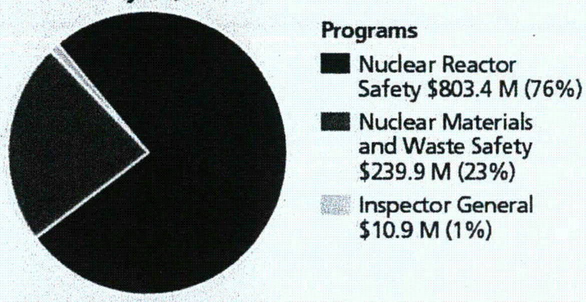


(see Figures 3, 4, and 5).

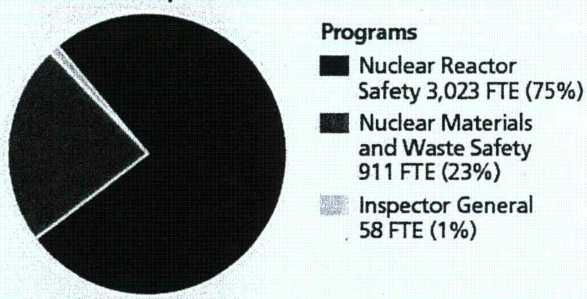
The Office of the Inspector General received its own appropriation of $10.9 million. The amount is included in the total NRC budget. The breakdown of the budget is shown in Figure 5.

Figure 5. Distribution of NRC FY 2011 Budget Authority and Staff (Dollars in Millions)

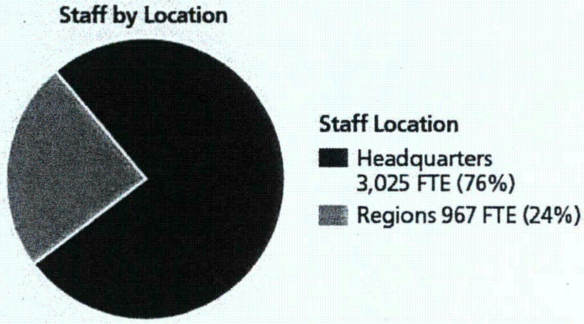
Total Authority: $1,054.1 Million



Total Staff: 3,992 FTE



Staff by Location

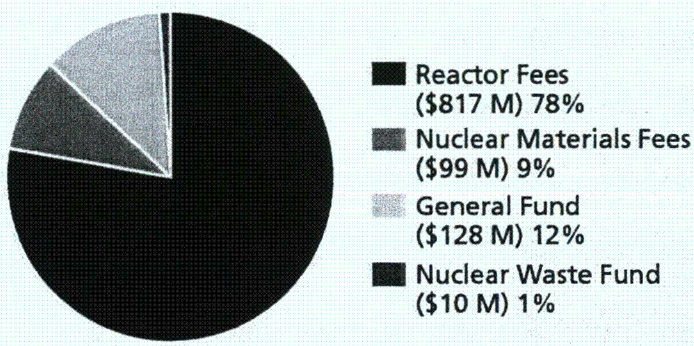


Note: Dollars and percentages are rounded to the nearest whole number.

By law, the NRC must recover, through fees billed to licensees, approximately 90 percent of its budget authority for FY 2011, less the amounts appropriated from the Nuclear Waste Fund for high-level radioactive waste activities and from general funds for waste-incidental-to-reprocessing and generic homeland security activities. The NRC collects fees each year by September 30 and transfers them to the U.S. Treasury (see Figure 6). The total budget amount to be recovered by the NRC in FY 2011 is approximately $915.8 million.

Figure 6. Recovery of NRC Budget, FY 2011*

Total Authority: $1,054 Million



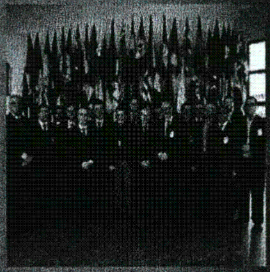
Class of Licensee	Annual Fees
Operating Power Reactor	$4,673,000**
Fuel Facility	$589,000 to $6,085,000
Uranium Recovery Facility	$7,300 to $772,000
Materials User	$1,600 to $476,000

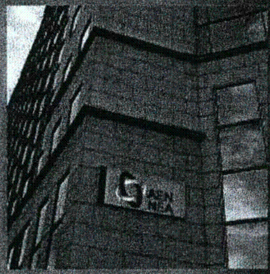
* Based on the final FY 2011 fee rule.

** Includes spent fuel storage/reactor decommissioning FY 2011 annual fee of $241,000.

Note: Percentages are rounded to the nearest whole number. M refers to million.

U.S. AND WORLDWIDE NUCLEAR ENERGY





Top: The NRC participates in the annual International Conference for the International Atomic Energy Agency (IAEA) in Vienna, Austria. (Photo courtesy: IAEA)

Middle: This Working Group Meeting of the Regulatory Cooperative Forum in 2010 focused on coordinating planned assistance to the Jordanian Nuclear Regulatory Commission in anticipation of Jordan's pursuit of a nuclear power program.

Bottom: Building of the Nuclear Energy Agency (NEA) in Issy-les-Moulineaux, France. (Photo courtesy: NEA)

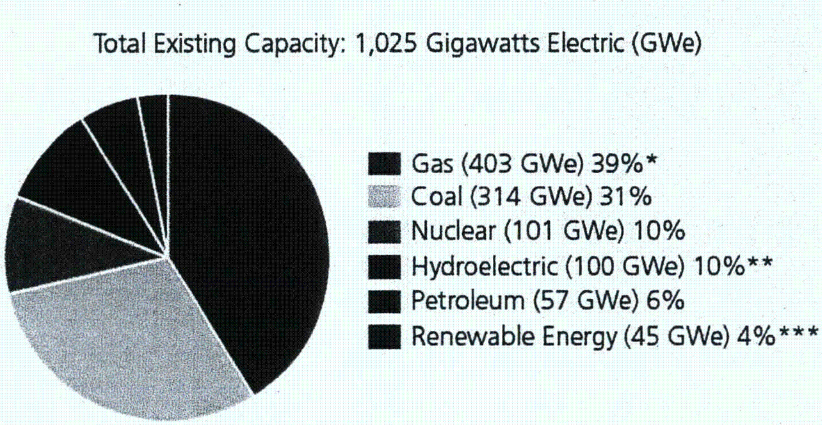
U.S. ELECTRICITY CAPACITY AND GENERATION

U.S. electric generating capacity totaled approximately 1,025 gigawatts electric (GWe) in 2009 (see Figure 7), up slightly from 2008 (1,010 GWe). In 2009, the existing nuclear generating capacity totaled 101 GWe, which translates to 10 percent of total electric capacity.

Since the 1970s, the Nation's utilities have used power uprates as a way to generate more electricity from existing nuclear plants. By January 2011, the NRC had approved 139 power uprates, resulting in a gain of approximately 6.020 GWe at existing plants. Collectively, these uprates have added the equivalent of six new reactors' worth of electrical generation at existing plants. Licensees responding to a December 2010 NRC survey indicated that they want to submit 35 power uprate applications in the next 5 years. If these applications are approved, the resulting uprates would add another 5.254 gigawatts (1,854 GWe) to the Nation's generating capacity (Figures 8 and 9).

As of April 2011, the 104 nuclear reactors licensed to operate accounted for 19.6 percent of U.S. net electric generation, providing 807 billion kilowatthours of electricity (see Figure 10).

Figure 7. U.S. Electric Existing Capacity by Energy Source, 2009



* Gas includes natural gas, blast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuel.

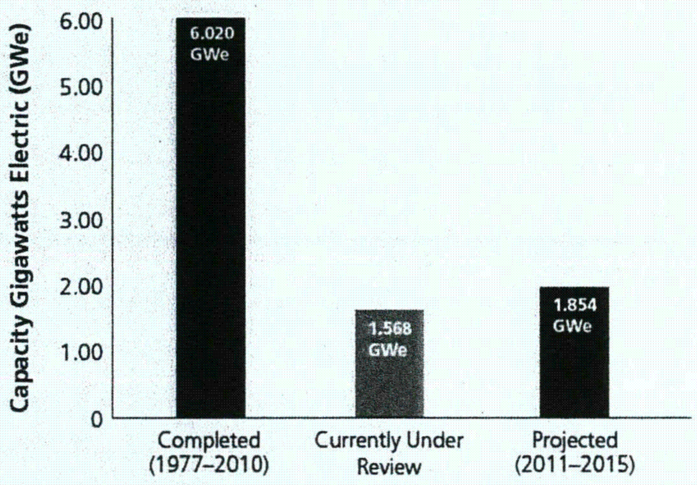
** Hydroelectric includes conventional hydroelectric and hydroelectric pumped storage.

*** Renewable energy includes geothermal, wood and nonwood waste, wind, solar energy, and miscellaneous technologies.

Note: Totals may not equal sum of components because of independent rounding. The amounts in parentheses are measured in gigawatts electric (a gigawatt is equal to 1,000 million watts), and the information used is summer existing capacity.

Source: U.S. Department of Energy/Energy Information Administration (DOE/EIA), "Electric Power Annual," Table 1.2, "Existing Capacity by Energy Source, 2009," January 21, 2011, www.eia.doe.gov

Figure 8. Power Uprates: Past, Current, and Future



Note: Power uprates have added the equivalent of six new reactors to the U.S. power grid.
Source: December 2010 survey of NRC licensees

Figure 9. Projected Electric Capacity Dependent on License Renewals

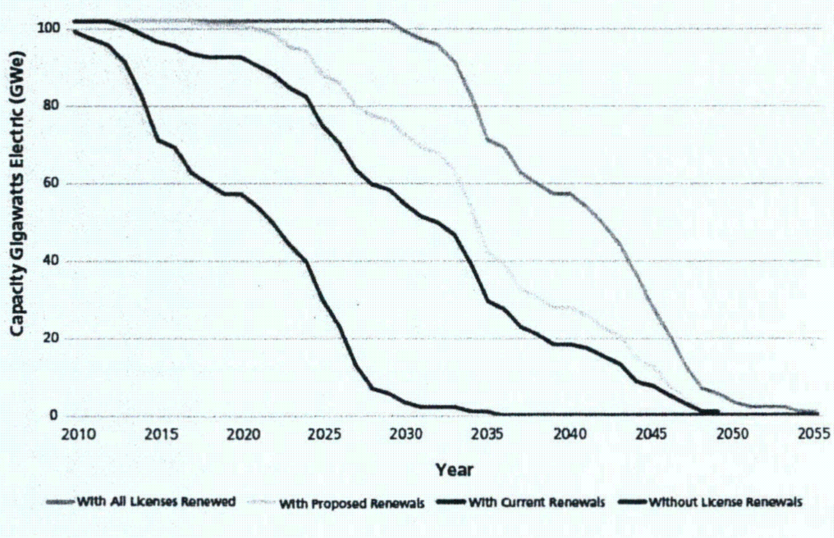
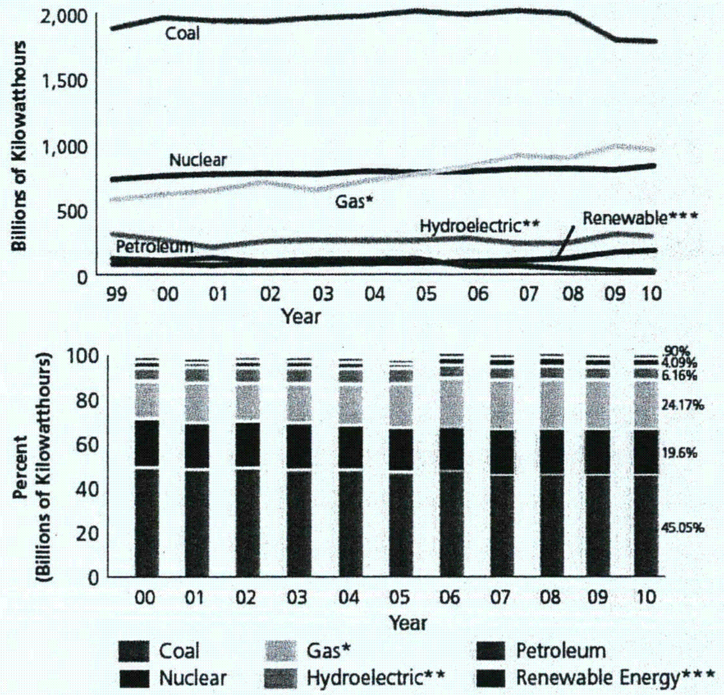


Figure 10. U.S. Net Electric Generation by Energy Source, 2000–2010



* Gas includes natural gas, blast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuel.
** Hydroelectric includes conventional hydroelectric and hydroelectric pumped storage.
*** Renewable energy includes geothermal, wood and nonwood waste, wind, and solar energy.
Source: DOE/EIA, "Monthly Energy Review," Table 7.2a, May 2011, www.eia.doe.gov

Table 1. U.S. Net Electric Generation by Energy Source, 2000–2010 (Billion Kilowatthours)

Year	Coal	Petroleum	Gas*	Hydroelectric**	Nuclear	Renewable Energy***
2000	1,966	111	614	270	754	81
2001	1,904	125	648	208	769	71
2002	1,933	95	702	256	780	79
2003	1,973	119	665	267	764	79
2004	1,977	120	726	260	788	83
2005	2,013	122	774	264	782	87
2006	1,990	64	829	283	787	96
2007	2,016	66	910	241	806	105
2008	1,986	46	895	248	806	126
2009	1,756	39	931	269	790	144
2010†	1,851	37	993	253	807	168

Note: See footnotes for Figure 10. † Based on preliminary data.
Source: DOE/EIA, "Monthly Energy Review," Table 7.2a, May 2011, www.eia.doe.gov

Table 2. U.S. Nuclear Power Reactor Average Net Capacity Factor and Net Generation, 2000–2010

Year	Number of Operating Reactors	Average Net Capacity Factor (Percent)	Net Generation of Electricity Billions of Kilowatthours	Percent of Total U.S. Capacity
2000	104	88	754	19.8
2001	104	89	769	20.6
2002	104	90	780	20.2
2003	104	88	764	19.7
2004	104	90	788	19.9
2005	104	89	782	19.3
2006	104	90	787	19.4
2007	104	92	806	19.4
2008	104	91	806	19.6
2009	104	90	799	20.2
2010*	104	92	806	20.2

* Based on preliminary data.

Note: Average capacity factor is based on net maximum dependable capacity. See Glossary for definition. Refer to Appendix A for the 2005–2010 average capacity factors for each reactor. Percentages are rounded to the nearest whole number.

Source: Licensee data as compiled by the NRC

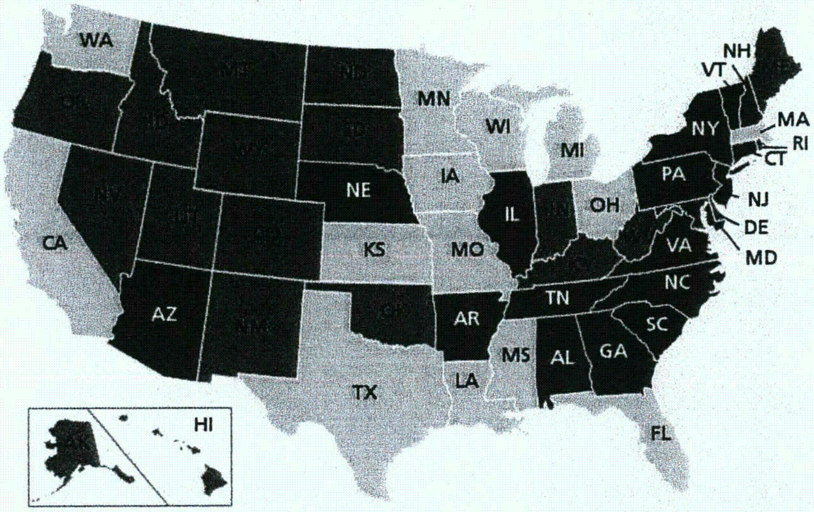
Thirty-one of the 50 States generate electicity from nuclear power plants. As of April 2009, four States (New Jersey, South Carolina, Connecticut, and Vermont) relied on nuclear power for more than 50 percent of their electricity. The data cited reflect the percentages of the total net generation in these States that were from nuclear sources. An additional 13 States relied on nuclear power for 25 to 50 percent of their electricity (see Figure 11).

Since 2000, net nuclear electric generation has increased by 6.6 percent, and coal-fired electric generation has decreased by 6.2 percent (see Table 1). Renewable energy has had the largest increase by 52 percent.

U.S. ELECTRICITY GENERATED BY COMMERCIAL NUCLEAR POWER

In 2010, net nuclear-based electric generation in the United States was a total of 806 billion kilowatthours and the average U.S. net capacity factor was 92 percent. Average U.S. net capacity factor—the ratio of electricity generated to the amount of energy that could have been generated—has increased by approximately 16 percent since 2000 (see Table 2).

Figure 11. Net Electricity Generated in Each State by Nuclear Power



Percent Net Generation from Nuclear Sources

None (19)

State	Net Capacity	Net Generation
Alaska	0	0
Colorado	0	0
Delaware	0	0
Hawaii	0	0
Idaho	0	0
Indiana	0	0
Kentucky	0	0
Maine	0	0
Montana	0	0
Nevada	0	0
North Dakota	0	0
New Mexico	0	0
Oklahoma	0	0
Oregon	0	0
Rhode Island	0	0
South Dakota	0	0
Utah	0	0
West Virginia	0	0
Wyoming	0	0

1% to 24% (14)

State	Net Capacity	Net Generation
California	7	16
Florida	7	15
Iowa	4	9
Kansas	9	19
Louisiana	8	17
Massachusetts	5	14
Michigan	13	22
Minnesota	11	24
Mississippi	8	23
Missouri	6	12
Ohio	6	11
Texas	5	10
Washington	4	6
Wisconsin	9	21

25% to 50% (13)

State	Net Capacity	Net Generation
Alabama	16	28
Arkansas	12	26
Arizona	15	27
Georgia	11	25
Illinois	26	49
Maryland	14	33
Nebraska	16	28
New Hampshire	30	44
New York	13	33
North Carolina	18	34
Pennsylvania	21	35
Tennessee	16	34
Virginia	14	40

More than 50% (4)

State	Net Capacity	Net Generation
Connecticut	26	53
New Jersey	22	56
South Carolina	27	52
Vermont	55	74

Note: Percentages are rounded to the nearest whole number. Units measured are in megawatts.
Net summer capacity data are from the State historical tables.

Source: DOE/EIA, "State Electricity Profiles," data from April 2011, www.eia.doe.gov

WORLDWIDE ELECTRICITY GENERATED BY COMMERCIAL NUCLEAR POWER

As of June 2011, there were 440 operating reactors (at least partially) in 29 countries and Taiwan with a total installed capacity of 375,274 GWe (see Figure 12). In addition, five nuclear power plants were in long-term shutdown, and 64 nuclear power plants were under construction.

See Appendix J for the number of nuclear power reactors by nation and Appendix K for nuclear power units by reactor type, worldwide.

The United States produced approximately 27 percent of the world's gross nuclear-generated electricity in 2010 (see Figure 13). France was the next highest producer at 17 percent. Based on preliminary data in 2010, France had the highest nuclear portion (74 percent) of total domestic energy generated. In the United States, nuclear energy accounted for nearly 20 percent of the domestic energy generated (see Figure 14).

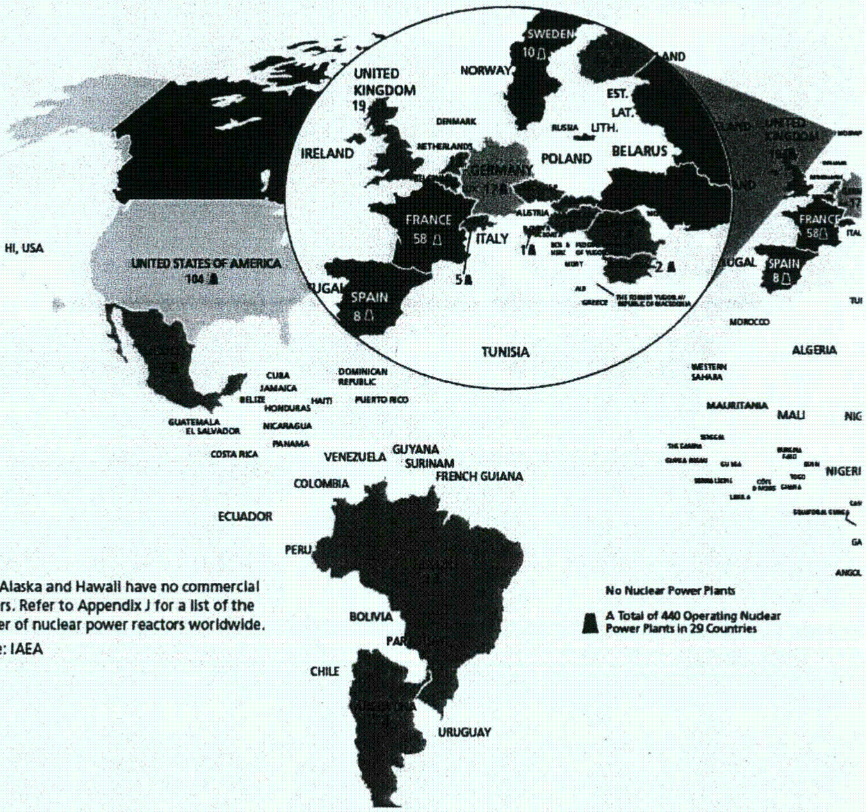
Reactors in the United States had the highest nuclear power production at 806,968 (GWe). France was the next highest producer at 407,900 (GWe) (see Table 3).

Table 3. Top Ten Countries with Most Commercial Nuclear Power Reactors and Total Nuclear Power Production, 2010

Country	Number of Operating Reactors	Nuclear Power Production (GWe)
United States	104	806,968
France	59	407,900
Japan	54	279,229
Russia	32	155,107
Korea, South	21	141,894
India	19	20,480
United Kingdom	19	56,440
Canada	18	85,219
Germany	17	133,012
Ukraine	15	83,800

Note: The country's short-form name is used.
Source: IAEA, Power Reactor Information System database

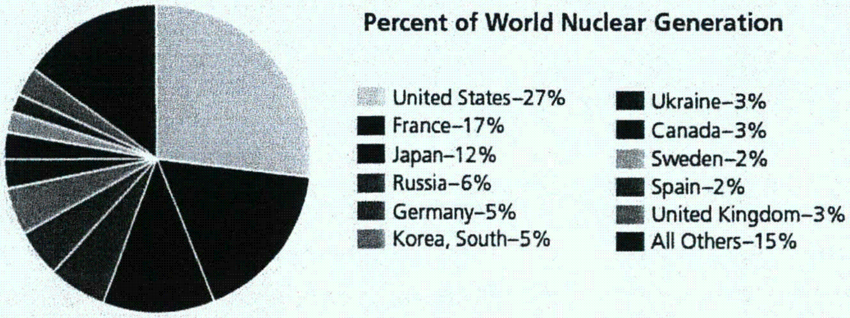
Figure 12. Operating Nuclear Power Plants Worldwide



Note: Alaska and Hawaii have no commercial reactors. Refer to Appendix J for a list of the number of nuclear power reactors worldwide.

Source: IAEA

Figure 13. Gross Nuclear Electric Power as a Percent of World Nuclear Generation, 2010



Note: Because of independent rounding, the figures may not add up to the total percentage. The country's short-form name is used.

Source: IAEA, Power Reactor Information System database, as of April 26, 2011

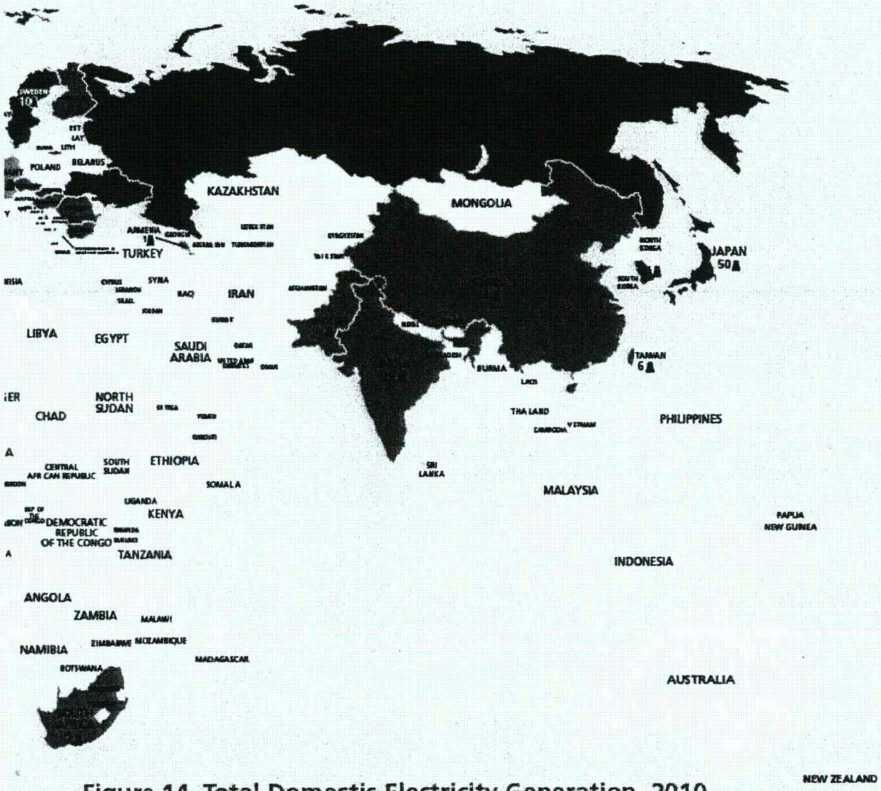
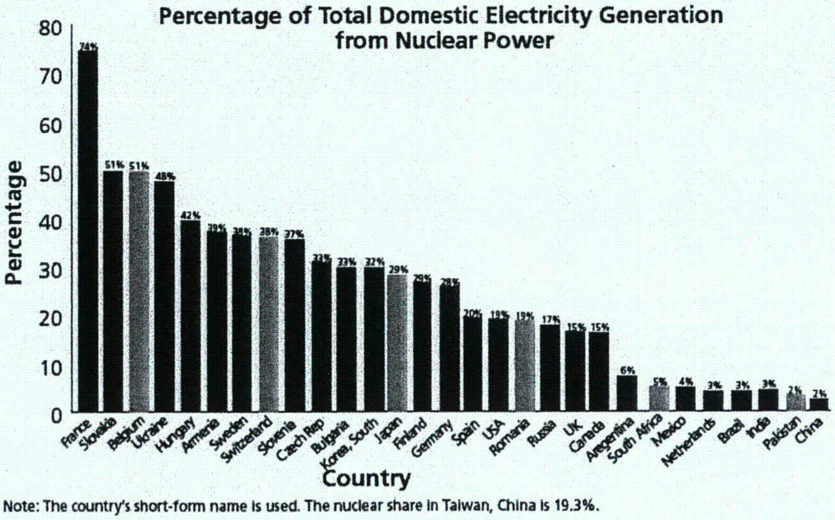


Figure 14. Total Domestic Electricity Generation, 2010



Note: The country's short-form name is used. The nuclear share in Taiwan, China is 19.3%.

Source: IAEA, Power Reactor Information System database, as of June 8, 2011

INTERNATIONAL ACTIVITIES

The NRC performs certain legislatively mandated international duties. These include licensing the import and export of nuclear materials and equipment and participating in activities supporting U.S. Government compliance with international treaty and agreement obligations. The NRC has bilateral programs of assistance or cooperation with 40 countries, including Taiwan, and the European Atomic Energy Community (see Table 4). The NRC has also supported U.S. Government nuclear safety initiatives with countries in Europe, Africa, Asia, and Latin America. In addition, the NRC actively cooperates with multinational organizations, such as the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA), a part of the Organisation for Economic Co-operation and Development. The NRC also has a robust international cooperative research program.

Since its inception, the agency has hosted over 340 foreign nationals in on-the-job training assignments at NRC Headquarters and the regional offices. The NRC's Foreign Assignee Program helps instill regulatory awareness, capabilities, and commitments in foreign assignees. It also helps to enhance the regulatory expertise of both foreign assignees and NRC staff. Additionally, the program improves international channels of communication through interaction with the international nuclear community and development of relationships with key personnel in foreign regulatory agencies.

Through its export/import authority, the NRC upholds the U.S. Government goals of limiting the proliferation of materials that could be used in weapons and supports the safe and secure use of civilian nuclear and radioactive materials worldwide. In addition to its direct export/import licensing role, the NRC consults with other U.S. Government agencies on international nuclear commerce activities falling under their authority. The NRC continues to work to strengthen the export/import regulations of nuclear equipment and materials, and to improve communication between domestic and international stakeholders.

The NRC assists in implementing the U.S. Government's international nuclear policies through developing legal instruments that address nuclear nonproliferation, safety, international safeguards, physical protection, emergency notification and assistance, spent fuel and waste management, and liability. The NRC also participates in the negotiation and implementation of U.S. bilateral agreements for peaceful nuclear cooperation under Section 123 of the U.S. Atomic Energy Act of 1954, as amended. The NRC also ensures licensee compliance with the U.S. Voluntary Safeguards Offer agreement and its additional protocol to the U.S.-IAEA Agreement for the Application of Safeguards in the United States.

The NRC also participates in a wide range of mutually beneficial international exchange programs that enhance the safety and security of peaceful nuclear activities worldwide. These low-cost, high-impact programs provide joint cooperative activities and

assistance to other countries to develop and improve regulatory organizations. The NRC engages in the following activities:

- Cooperates with countries with mature nuclear programs to ensure the timely exchange of applicable nuclear safety and security information relating to operating reactors and consults with these countries on new reactor-related activities.
- Ensures prompt notification to foreign partners about U.S. safety issues, notifies NRC program offices about foreign safety issues, and shares security information with selected countries.
- Initiates bilateral discussions in such regulatory areas as licensing, inspection, and enforcement with countries that have recently built facilities or have vendors of equipment that may be imported to the United States during the anticipated construction of new nuclear power plants.
- Participates in the Multinational Design Evaluation Program, which leverages the resources of interested regulatory authorities to review new designs of nuclear power reactors.

U.S. AND WORLDWIDE NUCLEAR ENERGY

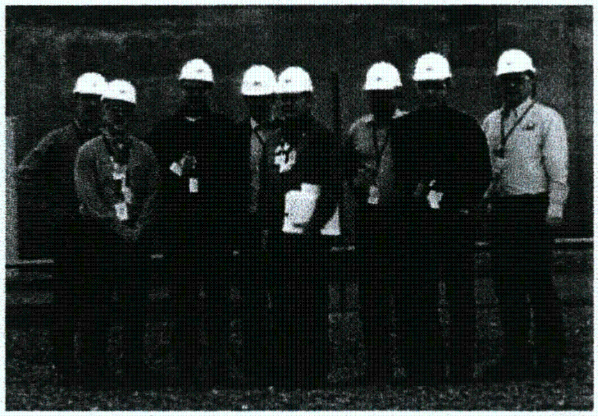
Table 4. Bilateral Information Exchange and Cooperation Agreements with the U.S. Nuclear Regulatory Commission

Agreement Country	Renewal Date
Argentina	2012
Armenia	2012
Australia	2013
Belgium	2014
Brazil	2014
Bulgaria*	2011
Canada	2012
China	2013
Croatia	2013
Czech Republic	2014
Egypt	1991
EURATOM	2014
Finland*	2011
France	2013
Germany	2012
Greece	2013
Hungary	2012
Indonesia	2013
Israel	2010
Italy	2015
Japan	2015
Kazakhstan	2014
Korea, South	2015
Lithuania	2010
Mexico	2012
Netherlands	2013
Peru	Open-Ended
Philippines	Open-Ended
Poland	2015
Romania	2016
Russia*	2001
Slovakia	2015
Slovenia	2015
South Africa	2010
Spain	2015
Sweden*	2011
Switzerland	2012
Ukraine	2016
United Arab Emirates	2015
United Kingdom	2013
Vietnam	2013

* In negotiation.

Note: The NRC also provides support to the American Institute in Taiwan. Egypt's agreement has been deferred until its regulatory body requests reinstatement. The country's short-form name is used.

EURATOM—The European Atomic Energy Community



The NRC hosted 20 of its international counterparts in October 2010 as part of IAEA's Integrated Regulatory Review Service, which compares a member country's nuclear regulatory approach to the international safety standards and good practices.

- Participates in a variety of conventions, treaties, and other legal and political instruments that together make up the international nuclear regime. For example, in 2010, the NRC supported the U.S. delegation to the Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons. The NRC also participated in the preparatory Organizational Meeting for the 2011 Review Meeting of the Convention on Nuclear Safety, and in the annual meeting of countries that implement the IAEA Code of Conduct on the Safety and Security of Radioactive Sources.
- Provides guidance about export/import licensing for nuclear materials and equipment published in 10 CFR Part 110, "Export and Import of Nuclear Equipment and Material." A final rule revised 10 CFR Part 110 in July 2010 to implement updates and clarifications to the regulation. The changes became effective in August 2010.
- Assists other countries in developing and improving regulatory programs through training, workshops, peer review of regulatory documents, working group meetings, and exchanges of technical information and specialists.
- Assists countries to ensure regulatory control over radioactive sources through development of standards and provision of training and workshops through a pilot program begun in 2008. In 2010, the program was expanded to include Latin America.
- Participates in the multinational programs of IAEA, NEA, and the European Union concerned with safety research and regulatory matters, radiation protection, risk assessment, emergency preparedness, waste management, transportation, safeguards, physical protection, security, standards development, training, technical assistance, and communications.
- Participates in the International Nuclear Regulators Association meetings to influence and enhance nuclear safety from the regulatory perspective. Association members are the most senior officials of well-established independent national

nuclear regulatory organizations. Current members are Canada, France, Germany, Japan, South Korea, Spain, Sweden, the United Kingdom, and the United States.

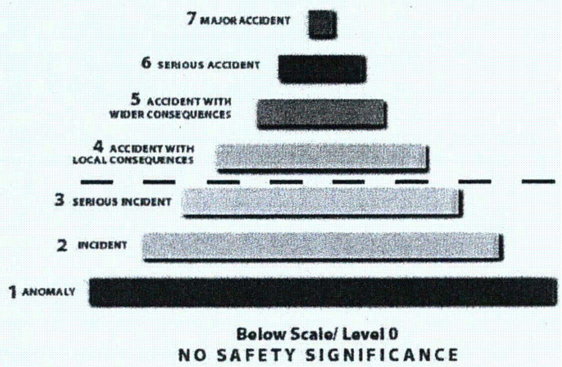
- Meets, through the NRC's Advisory Committee on Reactor Safeguards (ACRS), with other international advisory committees through annual working group meetings and plenary meetings every 4 years to exchange information.
- Participates in joint cooperative research programs through approximately 100 multilateral agreements with 30 countries and Taiwan to leverage access to foreign test facilities not otherwise available to the United States. Access to foreign test facilities expands the NRC's knowledge base and contributes to the efficient and effective use of the NRC's resources in conducting research on high-priority safety issues.
- In 2010, the NRC participated in an IAEA Integrated Regulatory Review Service (IRRS) An IRRS assesses a country's regulatory infrastructure against the international safety standards and good practices as determined by a team of international senior nuclear regulators and observers from around the world. The IRRS is carried out in three phases: a preliminary self-assessment, the peer review/mission, and a followup self-assessment and peer review.

Immediately after the March 11, 2011, earthquake and tsunami in Japan, a team of subject matter experts on reactor safety, protective measures, and international relations from the NRC and the U.S. Departments of Energy and of Health and Human Services traveled to Japan to help the Government of Japan assess and address the emergency at the Fukushima Dai-ichi nuclear power

International Nuclear Events Scale

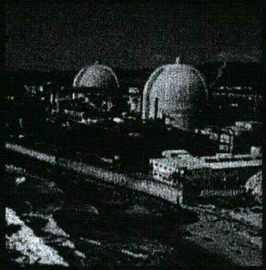
The International Nuclear Event Scale (INES) is a worldwide tool for communicating to the public in a consistent way the safety significance of nuclear and radiological events. The scale explains the significance of events from a range of activities, including industrial and medical use of radiation sources, operations at nuclear facilities, and transport of radioactive material.

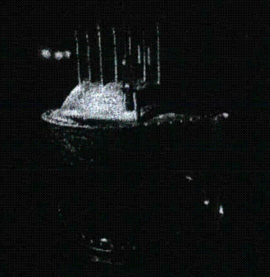
Events are classified on the scale at seven levels. Levels 1–3 are called "incidents" and Levels 4–7 "accidents." The scale is designed so that the severity of an event is about 10 times greater for each increase in level on the scale. Events without safety significance are called "deviations" and are classified as Below Scale or at Level 0.



plant. The NRC, which maintains a long working relationship with its regulatory counterpart, the Japanese Nuclear and Industrial Safety Agency (NISA), established a dialogue with NISA that developed into daily discussions about the status of the Fukushima Dai-ichi plant's reactors and related concerns. An NRC team was stationed in Tokyo on March 13, supported by additional experts working in the NRC Headquarters Operations Center. Approximately 30 staff members worked in Tokyo during the initial stages of the event on a rotating basis in coordination with their NISA counterparts and meeting with officials from the Japan Nuclear Energy Safety organizations; Tokyo Electric Power Company; the Ministry of Economy, Trade and Industry; the Ministry of Education, Culture, Sports, Science and Technology; and the Ministry of Foreign Affairs. The NRC has reduced its staff in Tokyo and has formed a task force to review the events in Japan. The task force will report findings and make recommendations for improvements to agency requirements, programs, and processes. The task force recommended short-term implementations to the Commission in July 2011. A longer term effort will address additional topics related to the Japan event.

NUCLEAR REACTORS





Top: San Onofre Nuclear Generating Station, located near San Clemente, CA. (Photo courtesy: SoCal Edison)

Middle: NRC employees lead an inspection of safety-related equipment intended for ultimate use in nuclear facilities to ensure compliance with NRC safety requirements.

Bottom: A reactor vessel head.

U.S. COMMERCIAL NUCLEAR POWER REACTORS

As of August 2011, 104 commercial nuclear power reactors were licensed to operate in 31 States (see Figure 15). These reactors have the following characteristics:

- 4 different reactor vendors
- 26 operating companies
- 80 different designs
- 65 sites

See Appendix A for a listing of reactors and their general licensing information and Appendix L for Native American Reservations or Trust lands near nuclear power plants.

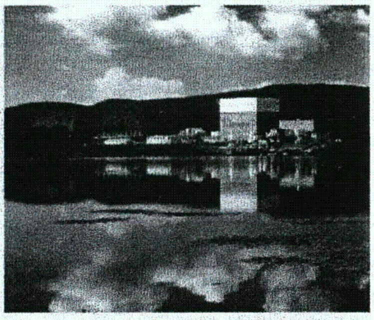
Diversity

Although there are many similarities, each reactor design can be considered unique. Figure 16 shows a typical pressurized-water reactor (PWR), and Figure 17 shows a typical boiling-water reactor (BWR). Currently there are 35 BWR and 69 PWR reactor designs.

Photo courtesy: Nuclear Management Co.

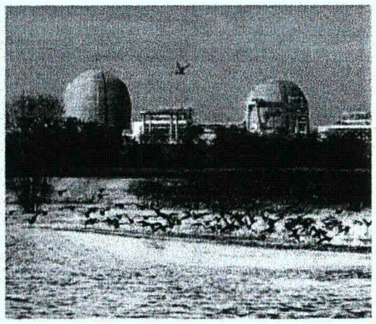
Prairie Island Nuclear Power Plant, located near Minneapolis, MN.

Photo courtesy: Entergy Nuclear



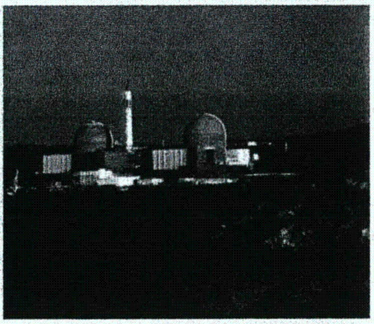
Vermont Yankee Nuclear Power Plant, located near Brattleboro, VT.

Photo courtesy: STP



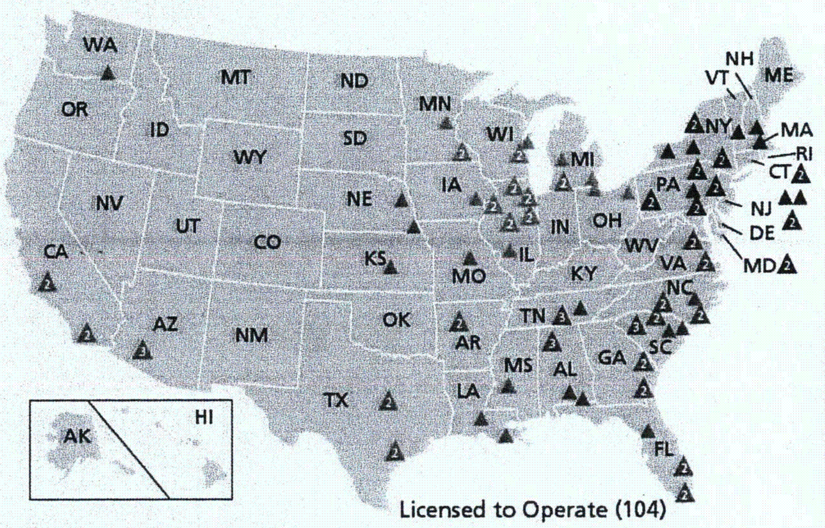
South Texas Project nuclear plant, located near Bay City, TX.

Photo courtesy: Entergy Nuclear



Indian Point Energy Center, located near New York City, NY.

Figure 15. U.S. Operating Commercial Nuclear Power Reactors



REGION I

CONNECTICUT
- ▲ Millstone 2 and 3

MARYLAND
- ▲ Calvert Cliffs 1 and 2

MASSACHUSETTS
- ▲ Pilgrim

NEW HAMPSHIRE
- ▲ Seabrook

NEW JERSEY
- ▲ Hope Creek
- ▲ Oyster Creek
- ▲ Salem 1 and 2

NEW YORK
- ▲ FitzPatrick
- ▲ Ginna
- ▲ Indian Point 2 and 3
- ▲ Nine Mile Point 1 and 2

PENNSYLVANIA
- ▲ Beaver Valley 1 and 2
- ▲ Limerick 1 and 2
- ▲ Peach Bottom 2 and 3
- ▲ Susquehanna 1 and 2
- ▲ Three Mile Island 1

VERMONT
- ▲ Vermont Yankee

REGION II

ALABAMA
- ▲ Browns Ferry 1, 2, and 3
- ▲ Farley 1 and 2

FLORIDA
- ▲ Crystal River 3
- ▲ St. Lucie 1 and 2
- ▲ Turkey Point 3 and 4

GEORGIA
- ▲ Edwin I. Hatch 1 and 2
- ▲ Vogtle 1 and 2

NORTH CAROLINA
- ▲ Brunswick 1 and 2
- ▲ McGuire 1 and 2
- ▲ Harris 1

SOUTH CAROLINA
- ▲ Catawba 1 and 2
- ▲ Oconee 1, 2, and 3
- ▲ Robinson 2
- ▲ Summer

TENNESSEE
- ▲ Sequoyah 1 and 2
- ▲ Watts Bar 1

VIRGINIA
- ▲ North Anna 1 and 2
- ▲ Surry 1 and 2

REGION III

ILLINOIS
- ▲ Braidwood 1 and 2
- ▲ Byron 1 and 2
- ▲ Clinton
- ▲ Dresden 2 and 3
- ▲ LaSalle 1 and 2
- ▲ Quad Cities 1 and 2

IOWA
- ▲ Duane Arnold

MICHIGAN
- ▲ Cook 1 and 2
- ▲ Fermi 2
- ▲ Palisades

MINNESOTA
- ▲ Monticello
- ▲ Prairie Island 1 and 2

OHIO
- ▲ Davis-Besse
- ▲ Perry

WISCONSIN
- ▲ Kewaunee
- ▲ Point Beach 1 and 2

REGION IV

ARKANSAS
- ▲ Arkansas Nuclear 1 and 2

ARIZONA
- ▲ Palo Verde 1, 2, and 3

CALIFORNIA
- ▲ Diablo Canyon 1 and 2
- ▲ San Onofre 2 and 3

KANSAS
- ▲ Wolf Creek 1

LOUISIANA
- ▲ River Bend 1
- ▲ Waterford 3

MISSISSIPPI
- ▲ Grand Gulf

MISSOURI
- ▲ Callaway

NEBRASKA
- ▲ Cooper
- ▲ Fort Calhoun

TEXAS
- ▲ Comanche Peak 1 and 2
- ▲ South Texas Project 1 and 2

WASHINGTON
- ▲ Columbia

Note: NRC-abbreviated reactor names listed.

▲ = 1 units ▲(2) = 2 units ▲(3) = 3 units

Figure 16. Typical Pressurized-Water Reactor

How Nuclear Reactors Work

In a typical design concept of a commercial PWR, the following process occurs:

1. *The core inside the reactor vessel creates heat.*
2. *Pressurized water in the primary coolant loop carries the heat to the steam generator.*
3. *Inside the steam generator, heat from the primary coolant loop vaporizes the water in a secondary loop, producing steam.*
4. *The steamline directs the steam to the main turbine, causing it to turn the turbine generator, which produces electricity.*

The unused steam is exhausted to the condenser, where it is condensed into water. The resulting water is pumped out of the condenser with a series of pumps, reheated, and pumped back to the steam generator. The reactor's core contains fuel assemblies that are cooled by water circulated using electrically powered pumps. These pumps and other operating systems in the plant receive their power from the electrical grid. If offsite power is lost, emergency cooling water is supplied by other pumps, which can be powered by onsite diesel generators. Other safety systems, such as the containment cooling system, also need electric power. PWRs contain between 150–200 fuel assemblies.

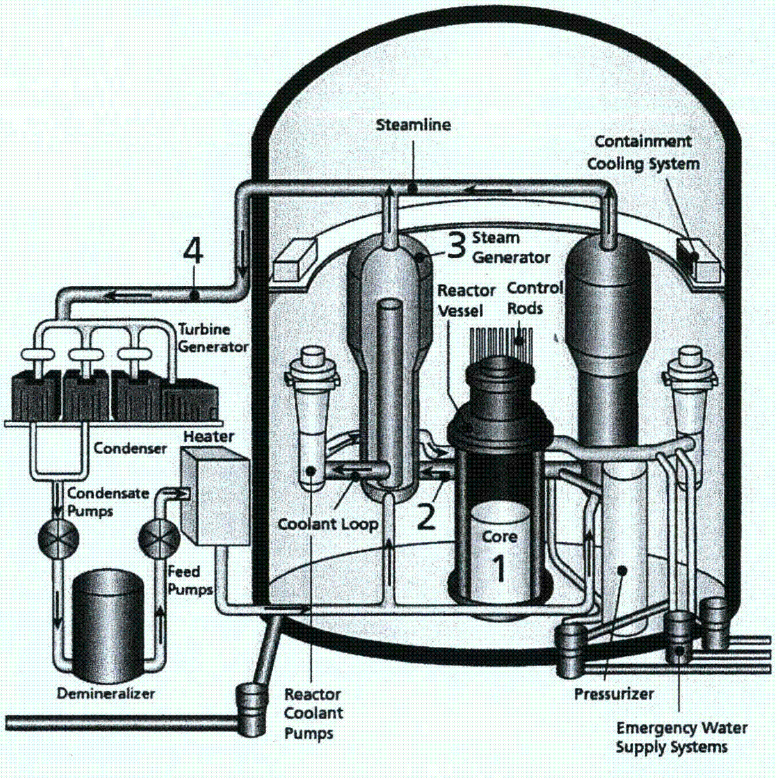


Figure 17. Typical Boiling-Water Reactor

How Nuclear Reactors Work

In a typical design concept of a commercial BWR, the following process occurs:

1. *The core inside the reactor vessel creates heat.*
2. *A steam-water mixture is produced when very pure water (reactor coolant) moves upward through the core, absorbing heat.*
3. *The steam-water mixture leaves the top of the core and enters the two stages of moisture separation where water droplets are removed before the steam is allowed to enter the steamline.*
4. *The steamline directs the steam to the main turbine, causing it to turn the turbine generator, which produces electricity.*

The unused steam is exhausted to the condenser, where it is condensed into water. The resulting water is pumped out of the condenser with a series of pumps, reheated, and pumped back to the reactor vessel. The reactor's core contains fuel assemblies that are cooled by water circulated using electrically powered pumps. These pumps and other operating systems in the plant receive their power from the electrical grid. If offsite power is lost, emergency cooling water is supplied by other pumps, which can be powered by onsite diesel generators. Other safety systems, such as the containment cooling system, also need electric power. BWRs contain between 370–800 fuel assemblies.

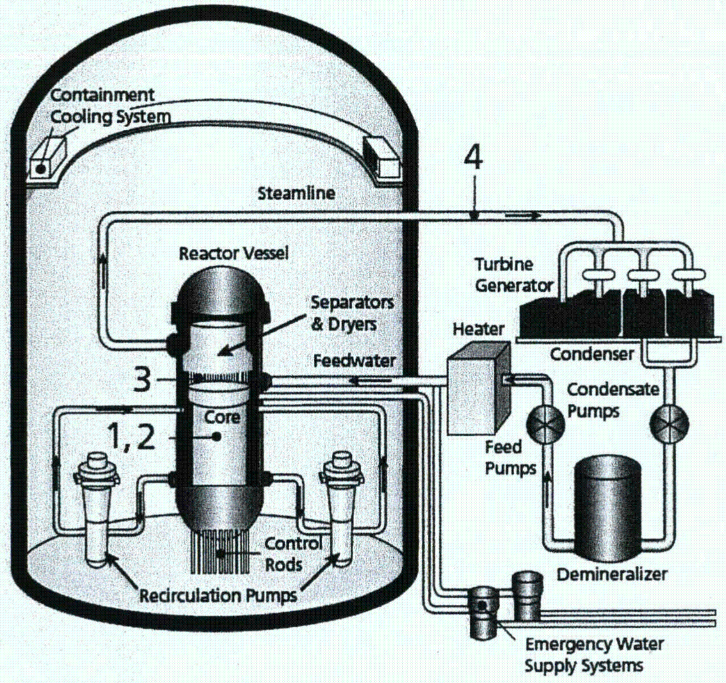
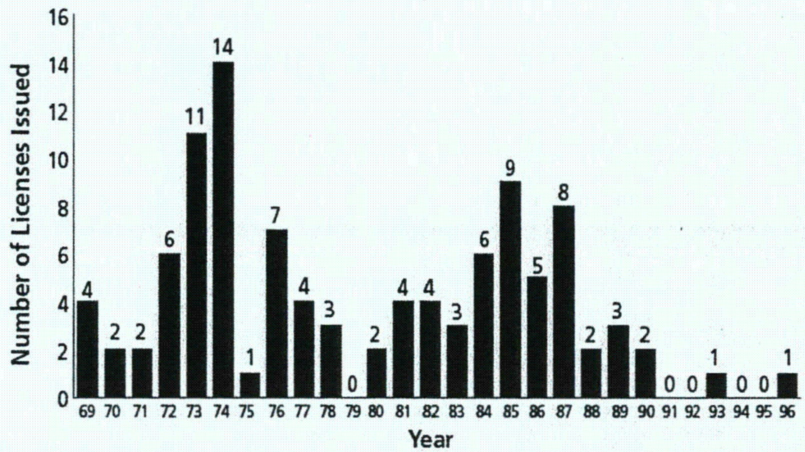


Figure 18. U.S. Commercial Nuclear Power Reactor Operating Licenses—Issued by Year



Note: No licenses were issued after 1996.

Table 5. U.S. Commercial Nuclear Power Reactor Operating Licenses—Issued by Year

1969	Dresden 2	1974	Arkansas Nuclear 1	1978	Arkansas Nuclear 2		Palo Verde 1
	Ginna		Browns Ferry 2		Hatch 2		River Bend 1
	Nine Mile Point 1		Brunswick 2		North Anna 1		Waterford 3
	Oyster Creek		Calvert Cliffs 1	1980	North Anna 2		Wolf Creek 1
1970	Point Beach 1		Cooper		Sequoyah 1	1986	Catawba 2
	Robinson 2		Cook 1	1981	Farley 2		Hope Creek 1
1971	Dresden 3		Duane Arnold		McGuire 1		Millstone 3
	Monticello		FitzPatrick		Salem 2		Palo Verde 2
1972	Palisades		Hatch 1		Sequoyah 2		Perry 1
	Pilgrim		Oconee 3	1982	LaSalle 1	1987	Beaver Valley 2
	Quad Cities 1		Peach Bottom 3		San Onofre 2		Braidwood 1
	Quad Cities 2		Prairie Island 1		Summer		Byron 2
	Surry 1		Prairie Island 2		Susquehanna 1		Clinton
	Turkey Point 3		Three Mile Island 1	1983	McGuire 2		Harris 1
1973	Browns Ferry 1	1975	Millstone 2		San Onofre 3		Nine Mile Point 2
	Fort Calhoun	1976	Beaver Valley 1		St. Lucie 2		Palo Verde 3
	Indian Point 2		Browns Ferry 3	1984	Callaway		Vogtle 1
	Kewaunee		Brunswick 1		Columbia	1988	Braidwood 2
	Oconee 1		Calvert Cliffs 2		Diablo Canyon 1		South Texas Project 1
	Oconee 2		Indian Point 3		Grand Gulf 1	1989	Limerick 2
	Peach Bottom 2		Salem 1		LaSalle 2		South Texas Project 2
	Point Beach 2		St. Lucie 1		Susquehanna 2		Vogtle 2
	Surry 2	1977	Crystal River 3	1985	Byron 1	1990	Comanche Peak 1
	Turkey Point 4		Davis-Besse		Catawba 1		Seabrook 1
	Vermont Yankee		D.C. Cook 2		Diablo Canyon 2	1993	Comanche Peak 2
			Farley 1		Fermi 2	1996	Watts Bar 1
					Limerick 1		

Note: Limited to reactors licensed to operate. Year is based on the date the initial full-power operating license was issued. NRC-abbreviated reactor names listed.

Experience

By the end of 2010, U.S. currently operating reactors accumulated nearly 3,100 years of operational experience. Reactors that are permanently shut down account for an additional 385 years of experience (see Figure 18 and Table 5).

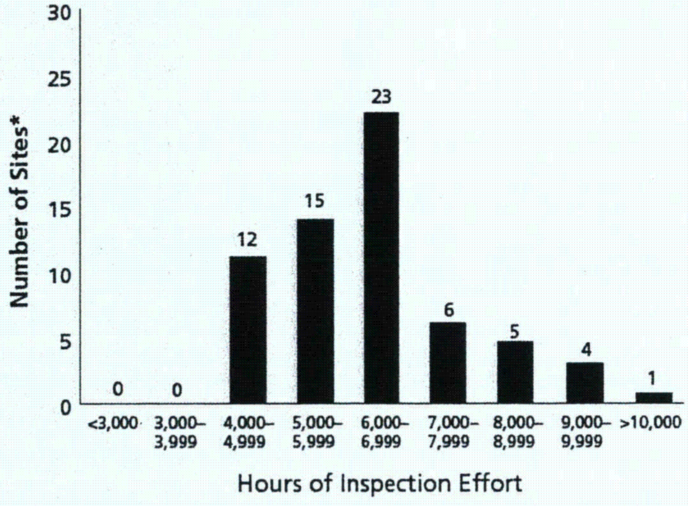
Principal Licensing, Inspection, and Enforcement Activities

The NRC conducts a variety of licensing and inspection activities:

- The NRC is reviewing an operating license application from the Tennessee Valley Authority for the Watts Bar Unit 2 reactor under construction near Spring City, TN.
- Typically, each power reactor requests about 10 separate license changes each year. The NRC completed more than 1,000 separate reviews in FY 2010.
- Currently, there are approximately 4,600 NRC-licensed reactor operators. Each operator must requalify every 2 years and apply for license renewal every 6 years.
- On average, the NRC expended approximately 6,490 hours of inspection-related effort at each operating reactor site during 2010 (see Figure 19).
- The NRC reviews applications for proposed new reactors and is developing an inspection program to oversee construction.
- The NRC reviews approximately 3,000 operating experience items, such as fire protection and access authorization programs, from licensed facilities annually.

NUCLEAR REACTORS

Figure 19. NRC Inspection Effort at Operating Reactors, 2010



Note: Data include calendar year 2010 hours for all activities related to baseline, plant-specific, generic safety issue, and allegation inspections.

* 66 total sites (Indian Point Units 2 and 3 are treated as separate sites for inspection effort).

- The NRC issues about 15 to 20 escalated enforcement actions per year to operating reactors for violations having a relatively high level of significance with regard to licensed activities affecting public health and safety. The primary enforcement actions, depending on the severity, are notices of violation, civil penalties, and orders.
- The NRC reviews approximately 600 allegations per year; allegations are assertions of impropriety associated with NRC-regulated activities.
- ACRS, an independent body of nuclear, engineering, and safety experts appointed by the Commission, reviews numerous safety issues for existing or proposed reactors and provides independent technical advice to the Commission. ACRS held 10 full Committee meetings and approximately 70 subcommittee meetings during 2010.
- The NRC oversees the decommissioning of 14 nuclear power reactors.

See Appendix B for permanently shutdown and decommissioning reactors and Appendix N for significant enforcement actions.

OVERSIGHT OF U.S. COMMERCIAL NUCLEAR POWER REACTORS

The NRC does not operate nuclear power plants. Rather, it regulates the operation of the Nation's 104 nuclear power plants by establishing regulatory requirements for their design, construction, and operation. To ensure that the plants are operated safely within these requirements, the NRC licenses the plants to operate, licenses the plant operators, establishes technical specifications for the operation of each plant, and inspects plants daily.

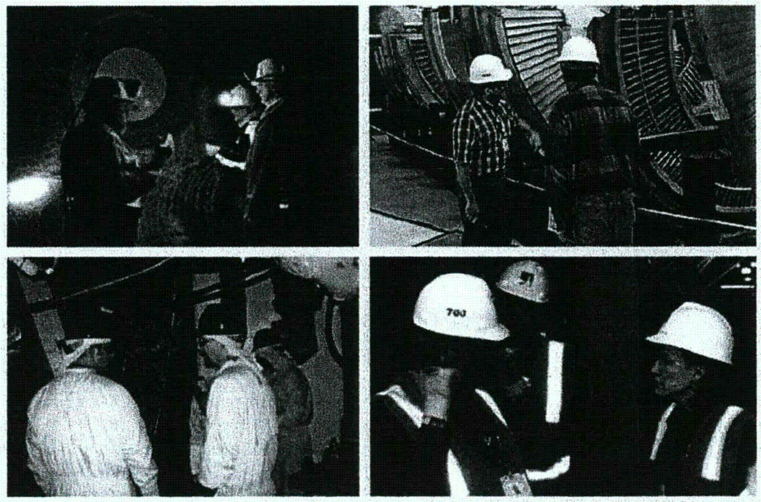
Reactor Oversight Process

The NRC provides continuous oversight of plants through its Reactor Oversight Process (ROP) to verify that they are being operated in accordance with NRC rules, regulations, and license requirements. The NRC has full authority to take action to protect public health and safety, up to and including shutting the plant down.

In general terms, the ROP uses both NRC inspection findings and performance indicators from licensees to assess the safety performance of each plant. The ROP recognizes that issues may have very low to high safety significance, but plants are expected to address all of them effectively. The NRC performs very detailed baseline-level inspections at each plant. If plant problems arise, NRC oversight increases. The agency may perform supplemental inspections and take additional actions to ensure that significant performance issues are addressed. The latest plant-specific inspection findings and performance indicator information can be found on the NRC's Web site (see the Web Link Index).

The ROP takes into account improvements in the performance of the nuclear industry over the past 30 years and improved approaches to inspecting and evaluating the safety performance of NRC-licensed plants. The improvements in plant performance can be attributed both to successful regulatory oversight and to efforts within the nuclear industry.

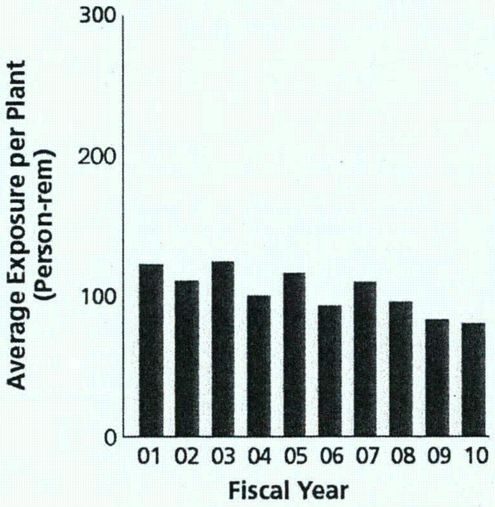
Resident Inspectors



The NRC has at least two full-time inspectors at each nuclear power plant site to ensure that facilities are meeting NRC regulations.

Figure 20. Industry Performance Indicators: Annual Industry Averages FYs 2001–2010—for 104 Plants

Collective Radiation Exposure



This indicator monitors the total radiation dose accumulated by plant personnel.

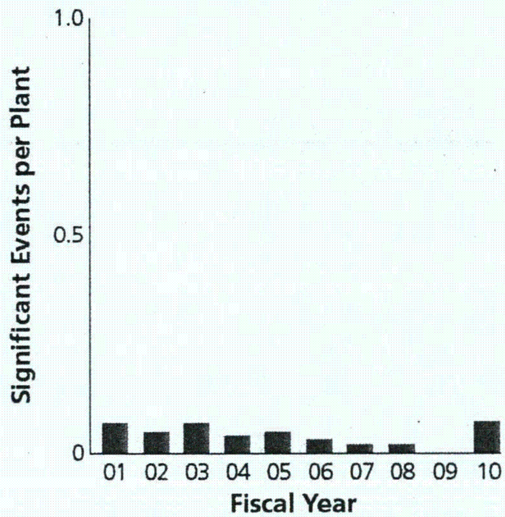
Further Explanation:
In 2010, those workers receiving a measurable dose of radiation received an average of about 0.1 rem. For comparison purposes, the average U.S. citizen receives 0.3 rem of radiation each year from natural sources (i.e., the everyday environment). See the definition of "exposure" in the Glossary.

Note: Data represent annual industry averages, with plants in extended shutdown excluded. Data are rounded for display purposes. These data may differ slightly from previously published data as a result of refinements in data quality.
Source: Licensee data as compiled by the NRC

Figure 20. Industry Performance Indicators: Annual Industry Averages
FYs 2001–2010—for 104 Plants (continued)

Significant events are events that meet specific NRC criteria, including degradation of safety equipment, a sudden reactor shutdown with complications, or an unexpected response to a sudden degradation of fuel or pressure boundaries. The NRC staff identifies significant events through detailed screening and evaluation of operating experience.

Significant Events



Safety system failures are any actual failures, events, or conditions that could prevent a system from performing its required safety function.

Safety System Failures

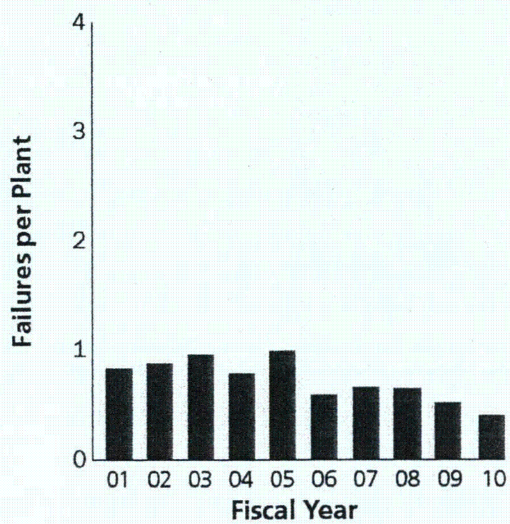
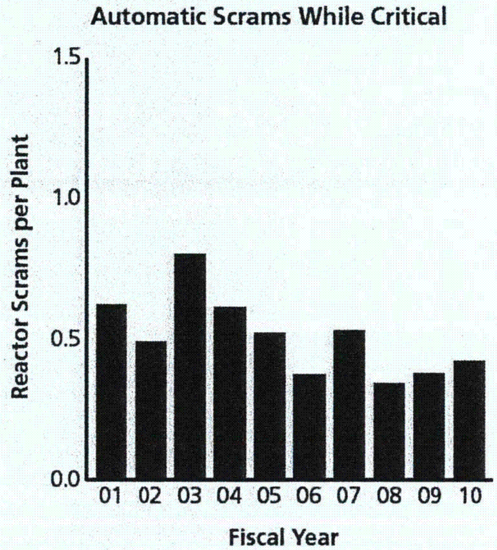
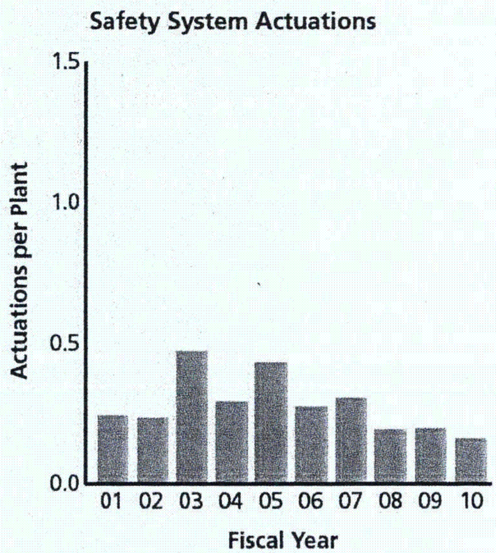


Figure 20. Industry Performance Indicators: Annual Industry Averages FYs 2001–2010—for 104 Plants (continued)



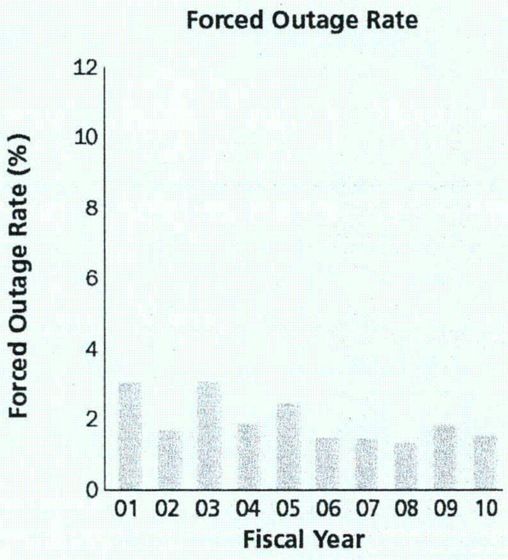
A reactor is said to be "critical" when it achieves a self-sustaining nuclear chain reaction such as when the reactor is operating. The sudden shutting down of a nuclear reactor by the rapid insertion of control rods, either automatically or manually by the reactor operator, is referred to as a "scram." This indicator measures the number of unplanned automatic scrams that occurred while the reactor was critical.



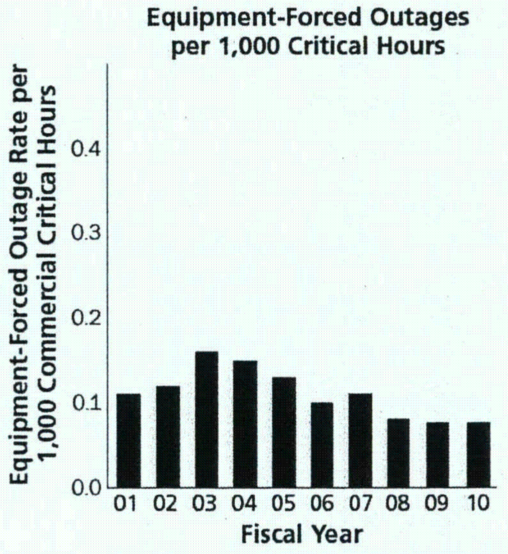
Safety system actuations are certain manual or automatic actions taken to start emergency core cooling systems or emergency power systems. These systems are specifically designed to either remove heat from the reactor fuel rods if the normal core cooling system fails or provide emergency electrical power if the normal electrical systems fail.

Figure 20. Industry Performance Indicators: Annual Industry Averages FYs 2001–2010—for 104 Plants (continued)

The forced outage rate is the number of hours that the plant is unable to operate (forced outage hours) divided by the sum of the hours that the plant is generating and transmitting electricity (unit service hours) and the hours that the plant is unable to operate (forced outage hours).



This indicator is the number of times the plant is forced to shut down because of equipment failures for every 1,000 hours that the plant is in operation and transmitting electricity.



The ROP is described on the NRC's Web site and in NUREG-1649, Revision 4, "Reactor Oversight Process," issued December 2006.

Industry Performance Indicators

In addition to evaluating the performance of each individual plant, the NRC compiles data on overall reactor industry performance using various industry-level performance indicators (see Figure 20).

See Appendix G for the industry performance indicators, which provide additional data for assessing trends in overall industry performance.

NEW COMMERCIAL NUCLEAR POWER REACTOR LICENSING

The NRC is reviewing new reactor applications using a licensing process that substantially improved the system used through the 1990s (see Figure 21). The NRC expects to review 20 combined construction and operating license (called a combined license or COL) applications for approximately 28 new reactors over the next several years and has in place the infrastructure and staff to support the necessary technical work (see Table 6, Figure 22, and the Web Link Index).

Construction and Operating License Applications

As of June 30, 2011, the NRC has received 18 COL applications for 28 new reactor units:

- Calvert Cliffs (MD)
- South Texas Project (TX)
- Bellefonte (AL)
- North Anna (VA)
- William States Lee III (SC)
- Shearon Harris (NC)
- Grand Gulf (MS)
- Vogtle (GA)
- V.C. Summer (SC)

Figure 21. New Reactor Licensing Process

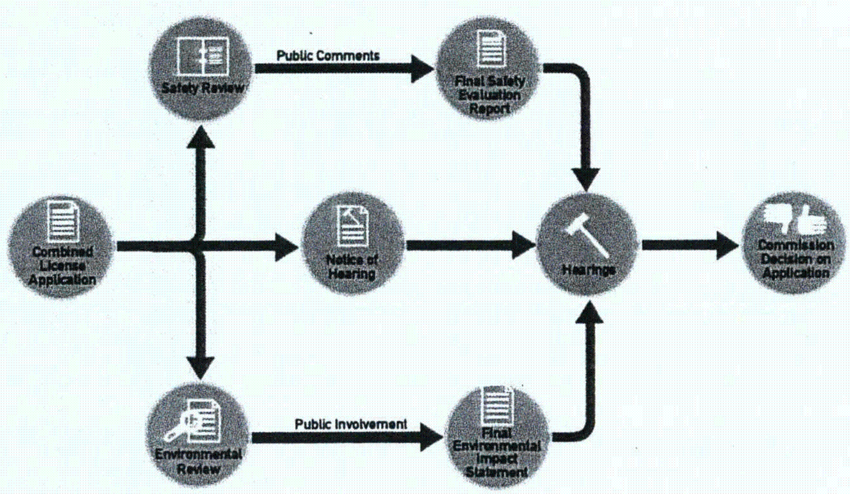


Table 6. U.S. New Nuclear Power Plant Applications

Company (Project/Docket #)	Date of Application	Design	Date Accepted	Site Under Consideration	State	Existing Op. Plant
Calendar Year (CY) 2007 Applications						
NRG Energy (52-012/013)	9/20/07	ABWR	11/29/07	South Texas Project (2 units)	TX	Y
NuStart Energy (52-014/015)	10/30/07	AP1000	1/18/08	Bellefonte (2 units)	AL	N
UNISTAR (52-016)	7/13/07 (Env.), 3/13/08 (Safety)	EPR	1/25/08 6/3/08	Calvert Cliffs (1 unit)	MD	Y
Dominion (52-017)*	11/27/07	US-APWR	1/28/08	North Anna (1 unit)	VA	Y
Duke (52-018/019)	12/13/07	AP1000	2/25/08	William Lee Nuclear Station (2 units)	SC	N
2007 TOTAL NUMBER OF APPLICATIONS = 5 TOTAL NUMBER OF UNITS = 8						
CY 2008 Applications						
Progress Energy (52-022/023)	2/19/08	AP1000	4/17/08	Harris (2 units)	NC	Y
NuStart Energy (52-024)	2/27/08	ESBWR	4/17/08	Grand Gulf (1 unit)	MS	Y
Southern Nuclear Operating Co. (52-025/026)	3/31/08	AP1000	5/30/08	Vogtle (2 units)	GA	Y
South Carolina Electric & Gas (52-027/028)	3/31/08	AP1000	7/31/08	Summer (2 units)	SC	Y
Progress Energy (52-029/030)	7/30/08	AP1000	10/6/08	Levy County (2 units)	FL	N
Detroit Edison (52-033)	9/18/08	ESBWR	11/25/08	Fermi (1 unit)	MI	Y
Luminant Power (52-034/035)	9/19/08	US-APWR	12/2/08	Comanche Peak (2 units)	TX	Y
Entergy (52-036)	9/25/08	ESBWR	12/4/08	River Bend (1 unit)	LA	Y
AmerenUE (52-037)	7/24/08	EPR	12/12/08	Callaway (1 unit)	MO	Y
UNISTAR (52-038)	9/30/08	EPR	12/12/08	Nine Mile Point (1 unit)	NY	Y
PPL Generation (52-039)	10/10/08	EPR	12/19/08	Bell Bend (1 unit)	PA	Y
2008 TOTAL NUMBER OF APPLICATIONS = 11 TOTAL NUMBER OF UNITS = 16						
CY 2009 Applications						
Florida Power & Light Co. (52-040/041)	6/30/09	AP1000	9/4/09	Turkey Point (2 units)	FL	Y
2009 TOTAL NUMBER OF APPLICATIONS = 1 TOTAL NUMBER OF UNITS = 2						
CY 2010 Applications						
No COL applications expected in CY 2010.						
2010 TOTAL NUMBER OF APPLICATIONS = 0 TOTAL NUMBER OF UNITS = 0						
CY 2011 Applications						
No COL applications expected in CY 2011.						
2011 TOTAL NUMBER OF APPLICATIONS = 0 TOTAL NUMBER OF UNITS = 0						
CY 2012 Applications						
No COL applications expected in CY 2012.						
2012 TOTAL NUMBER OF APPLICATIONS = 0 TOTAL NUMBER OF UNITS = 0						
CY 2013 Applications						
Two COL applications are expected in fourth quarter of CY 2013.						
2013 TOTAL NUMBER OF APPLICATIONS = 2 TOTAL NUMBER OF UNITS = 2						
2007–2013 TOTAL NUMBER OF APPLICATIONS = 20 TOTAL NUMBER OF UNITS = 28						

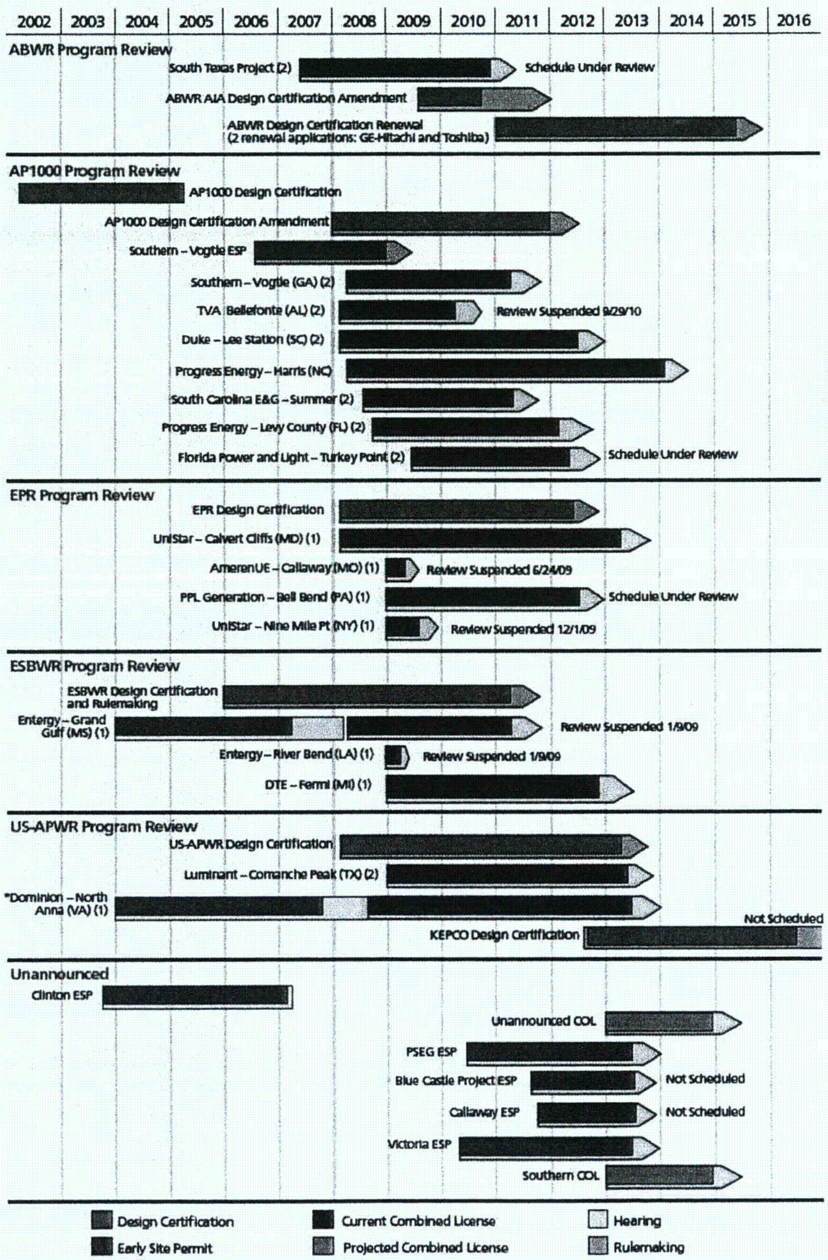
☐ – Accepted/Docketed ☐ – Expected

Note: Application updates in this table do not show all projects previously mentioned because of changes in intent status or conversion to an early site permit from a COL application. Data as of June 30, 2011.

* Design technology changed by the applicant on June 28, 2010.

Figure 22. New Reactor Licensing Schedule of Applications by Design

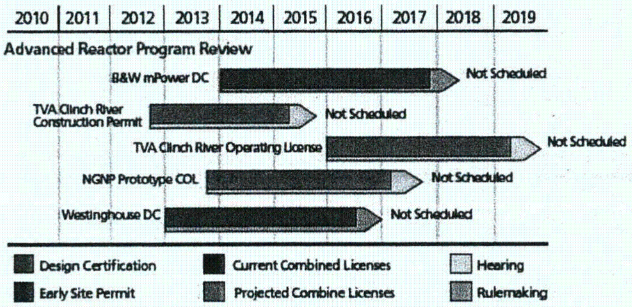
Estimated Schedules by Calendar Year (as of June 30, 2011)



* Design technology changed by the applicant on June 28, 2010.

Figure 22. New Reactor Licensing Schedule of Applications by Design (continued)

Estimated Schedules by Calendar Year (as of June 30, 2011)



Note: Lines depict approximate dates on schedule. Data on projected applications are based on information from potential applicants and are subject to change. Schedules depicted for future activities represent nominal assumed review durations based on submittal time frames in letters of intent from prospective applicants. Numbers in ( ) next to the COL name indicate the number of units per site. The acceptance review is included at the beginning of the COL review. The rules in 10 CFR Part 2, "Rules of Practice for Domestic Licensing Proceedings and Issuance of Orders," govern hearings on COLs.

- Callaway (MO)
- Levy County (FL)
- Victoria County Station (TX)
- Fermi (MI)
- Comanche Peak (TX)
- River Bend (LA)
- Nine Mile Point (NY)
- Bell Bend (PA)
- Turkey Point (FL)

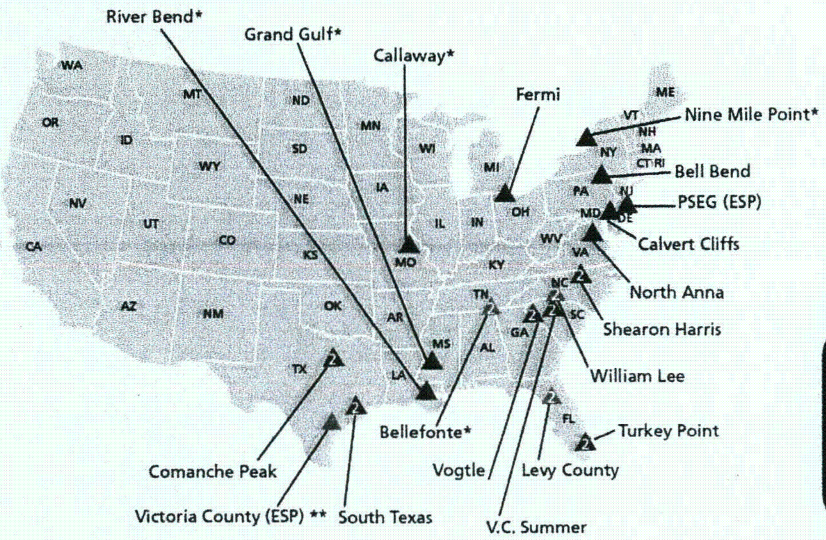
The NRC suspended or cancelled six COL application reviews due to changes in applicant business strategies (Grand Gulf, Callaway, Nine Mile Point, River Bend, Victoria County Station, and Bellefonte). As of June 2011, the NRC had 12 COL applications for 20 units under active review. Figure 23 shows the locations of the expected new reactor sites.

The staff expects to receive two additional COL applications by the end of CY 2013. For the current review schedule for reactor licensing applications, consult the NRC public Web site (see the Web Link Index).

Public Involvement

The NRC's new reactor licensing process offers many opportunities for public participation. Before it receives an application, the agency uses public meetings to talk to residents in the community near the location where a proposed new reactor may be built to explain how the NRC reviews an application and how the public may participate in the process. Next, the NRC listens to comments on which factors should be considered in the agency's environmental review of the application. The public may then comment on the NRC's draft environmental evaluation that is posted on the agency's Web site. In addition, the public is afforded the opportunity to legally challenge a license application through Atomic Safety and Licensing Board hearings that are announced in press releases and posted on the NRC Web site.

Figure 23. Locations of Applied-for New Nuclear Power Reactors



▲ A proposed new reactor at or near an existing nuclear plant

▲ A proposed reactor at a site that has not previously produced nuclear power

▲ = 1 unit ▲2 = 2 units

*Review suspended.

**COL application amended by applicant to ESP on March 25, 2010.

Note: Data as of June 30, 2011.

The NRC has tailored its new reactor licensing activities to review new applications effectively and efficiently.

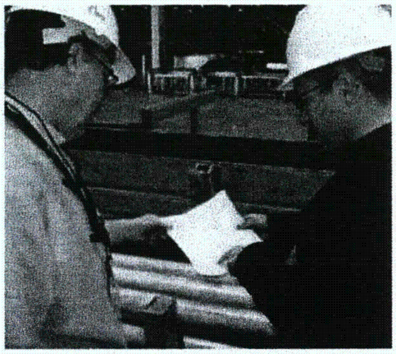
Early Site Permits

An early site permit (ESP) provides for early resolution of site safety, environmental protection, and emergency preparedness issues independent of a specific nuclear plant review. The ACRS reviews those portions of the ESP application that concern safety. Mandatory adjudicatory hearings associated with the ESPs are conducted after the completion of the NRC staff's technical review.

The NRC has issued ESPs to the following applicants:

- System Energy Resources, Inc. (Entergy), for the Grand Gulf site in Mississippi
- Exelon Generation Company, LLC, for the Clinton site in Illinois
- Dominion Nuclear North Anna, LLC, for the North Anna site in Virginia
- Southern Nuclear Operating Company, for the Vogtle site in Georgia (includes a limited work authorization)

On March 25, 2010, Exelon Nuclear Texas Holdings (Exelon) submitted an ESP application for the Victoria County Station site located in Victoria County, TX. The ESP application does not include a request for limited work authorization at this time. Exelon previously submitted a COL application for the Victoria County Station site on September 2, 2008, and requested that the COL application be withdrawn when the NRC formally accepts the Victoria County Station ESP application. On June 7, 2010, the NRC docketed the Victoria County ESP application.



NRC staff conducts a vendor inspection at the Tioga Pipe Supply Co., Inc., plant.

NRC staff participates in a site inspection of the proposed new plant in Levy County, FL.

PSEG Power, LLC, and PSEG Nuclear, LLC (PSEG), submitted an ESP application in May 2010 on a site located near the Hope Creek/Salem site. The NRC expects to receive two additional ESP applications by 2012.

Design Certifications

The NRC has issued design certifications (DCs) for four reactor designs that can be referenced in an application for a nuclear power plant. A DC is valid for 15 years from the date of issuance, but it can be renewed for an additional 15 years. The new reactor designs incorporate new elements such as passive safety systems and simplified system designs. These four designs are as follows:

- General Electric-Hitachi Nuclear Energy's (GEH's) Advanced Boiling-Water Reactor (ABWR)
- Westinghouse's System 80+
- Westinghouse's AP600
- Westinghouse's AP1000

The NRC is currently reviewing the following DC applications:

- AREVA's U.S. Evolutionary Power Reactor (EPR)
- Mitsubishi Heavy Industries' U.S. Advanced Pressurized-Water Reactor (US-APWR)

As of June 30, 2011, the NRC completed the technical reviews on a DC application and two DC amendments:

- GEH's Economic Simplified Boiling-Water Reactor (ESBWR)
- Westinghouse's AP1000 DC amendment

- STP Nuclear Operating Company's ABWR DC amendment to address the aircraft impact rule

The NRC expects to complete rulemaking activities for these applications by the end of 2012.

Design Certification Renewals

The NRC received two DC renewal applications for the ABWR from GEH and Toshiba in 2010. Renewals are good for 15 years.

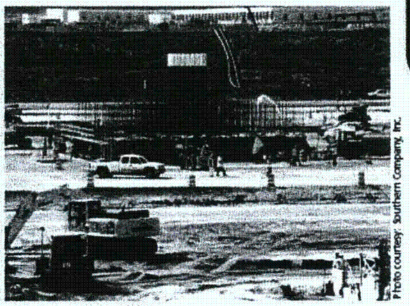
Advanced Reactor Designs

In addition, a range of advanced reactor designs and technologies have emerged that may be submitted to the NRC within the next several years. These technologies include small-sized light-water reactors, liquid-metal reactors, and high-temperature gas-cooled reactors. The NRC will focus its advanced reactor efforts on ensuring that the agency is prepared to address the multiple new technologies being proposed. The NRC has been actively working to develop the regulatory framework in preparation for future licensing application submittals.

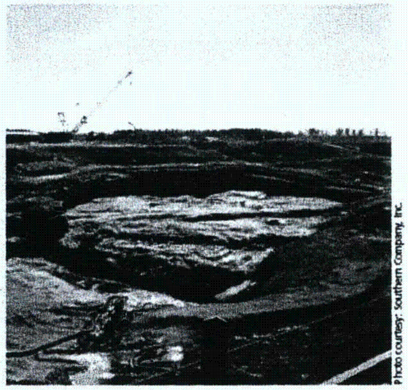
New Reactor Construction Inspections

The NRC established a special construction inspection organization in Region II in Atlanta, GA, to inspect licensee construction to ensure that it is performed in compliance with NRC-issued licenses and applicable regulations and to ensure that the as-built facility conforms to its COL. The NRC staff will examine the licensee's operational programs, such as security, radiation protection, and operator training and qualification, to ensure that the licensee is ready to operate the plant once it is built. The agency's construction site inspectors will verify a licensee's completion of inspections, tests, analyses, and acceptance criteria. The NRC will use these direct inspections and other methods to confirm that the licensee has completed these actions and has met the acceptance criteria included in a COL before allowing startup of the plant.

Starting with the new resident inspectors at the Vogtle site in



Preconstruction activity on limited work authorized at the Vogtle new reactor site.



Preconstruction excavation at the V.C. Summer new reactor site.

NUCLEAR REACTORS

April 2010, the NRC will continue to place several full-time inspectors at a site for the duration of the construction phase to oversee day-to-day activities of the licensee and its contractors.

On March 8, 2010, Southern Nuclear Operating Company began site construction at Vogtle Unit 3 under the limited work authorization issued in August 2009. Site activities authorized under the limited work authorization include preliminary construction activities.

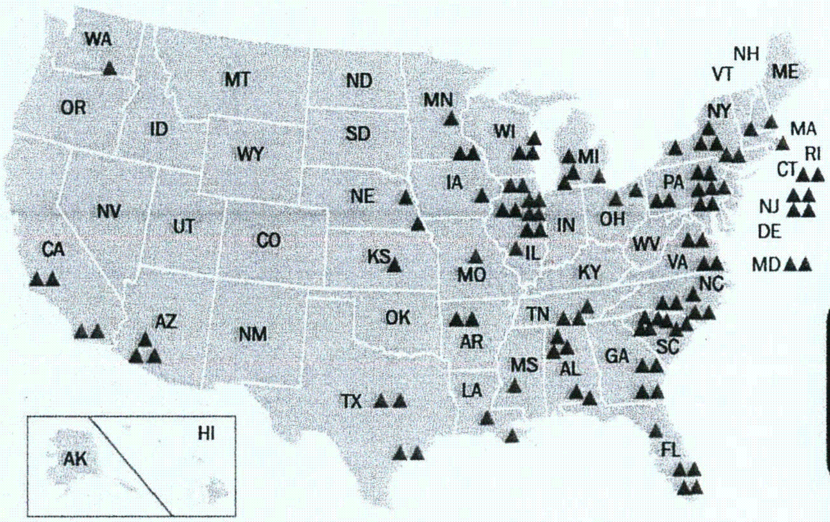
The agency also inspects vendor facilities to ensure that products and services furnished to new U.S. reactors meet quality and other regulatory requirements. The NRC has a vendor and quality assurance program and performs quality assurance inspections to ensure that licensees and their contractors meet the regulatory guidelines. To verify compliance with applicable regulations, the NRC inspects domestic and foreign vendors as well as the activities of applicants and licensees.

More information on the NRC's new reactor licensing activities is available on the NRC Web site (see the Web Link Index).

Public Participation in Regulatory Activities

The NRC conducts over 900 public meetings annually and provides opportunities for public involvement in the regulatory process by holding open meetings, conferences, and workshops and issuing rules, regulations, petitions, and technical reports for public comment.

Figure 24. License Renewals Granted for Operating Nuclear Power Reactors



Licensed to Operate (104)
▲ License Renewal Granted (71)
▲ Original License (41)

Note: Data as of July 29, 2011.

REACTOR LICENSE RENEWAL

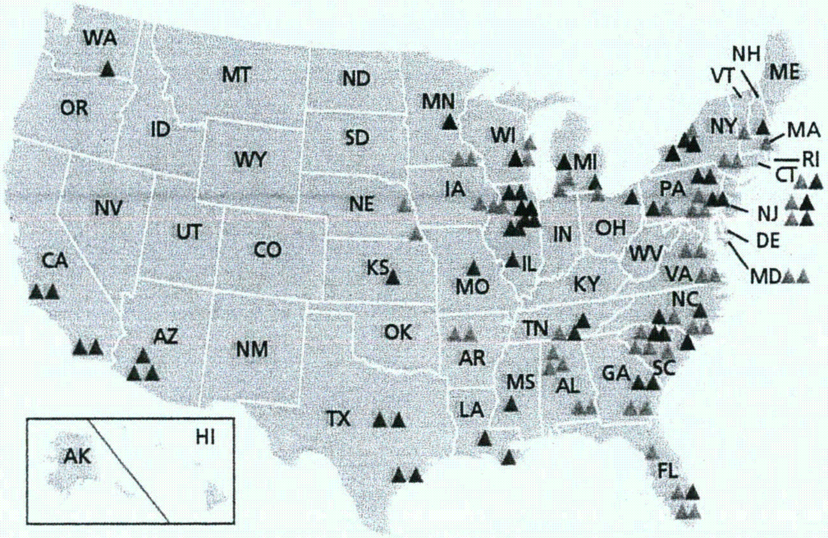
Based on the Atomic Energy Act of 1954, as amended, the NRC issues licenses for commercial power reactors to operate for 40 years. Under current regulations, licensees may renew their licenses for up to 20 years.

Economic and antitrust considerations, not limitations of nuclear technology, determined the original 40-year term for reactor licenses. However, because of this selected time period, some systems, structures, and components may have been engineered on the basis of an expected 40-year service life.

As of March 2011, approximately two-thirds of the 104 licensed reactor units either have received or are under review for license renewal. Of these, 71 units (at 41 sites) have received renewed licenses (see Figure 24). Figure 25 illustrates the years of commercial operation of operating power reactors. Figure 26 and Table 7 show the expiration dates of operating commercial nuclear licenses.

The decision to seek license renewal rests entirely with nuclear power plant owners and typically is based on the plant's economic situation and on whether it can meet NRC requirements.

**Figure 25. U.S. Commercial Nuclear Power Reactors—
Years of Operation by the End of 2011**



Years of Commercial Operation	Number of Reactors
△ 0–9	0
▲ 10–19	2
▲ 20–29	42
▲ 30–39	51
▲ 40 or more	9

Note: Ages have been rounded up to the end of the year.

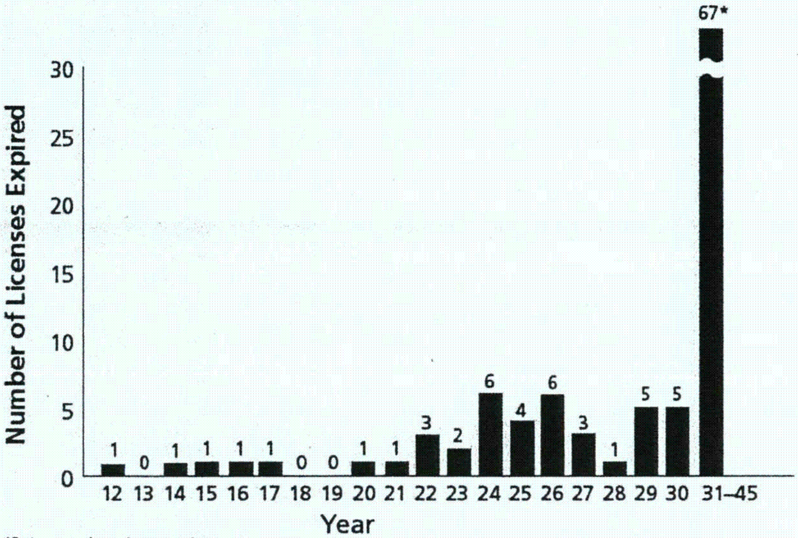
The license renewal review process provides continued assurance that the current licensing basis will maintain an acceptable level of safety for the period of extended operation.

The NRC will renew a license only if it determines that a currently operating plant will continue to maintain the required level of safety.

Over the plant's life, this level of safety is enhanced through maintenance of the plant and its licensing basis, with appropriate adjustments to address new information from industry operating experience.

The NRC regulations establish clear requirements for license renewal to ensure safe plant operation for extended plant life, as codified in 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." Environmental protection

Figure 26. U.S. Commercial Nuclear Power Reactor Operating Licenses—Expiration by Year



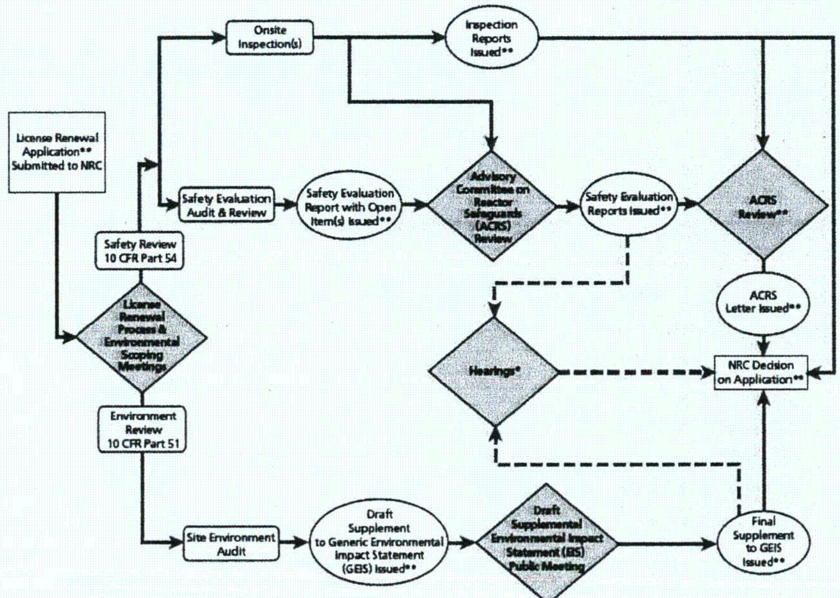
*Data exceed graph parameters.

Table 7. U.S. Commercial Nuclear Power Reactor Operating Licenses—Expiration by Year, 2011–2049

2012	Pilgrim
2013	Indian Point 2
2015	Indian Point 3
2016	Crystal River 3
2017	Davis-Besse
2020	Sequoyah 1
2021	Sequoyah 2
2022	LaSalle 1
	San Onofre 2
	San Onofre 3
2023	Columbia
	LaSalle 2
2024	Byron 1
	Callaway
	Diablo Canyon 1
	Grand Gulf 1
	Limerick 1
	Waterford 3
2025	Diablo Canyon 2
	Fermi 2
	River Bend 1
2026	Braidwood 1
	Byron 2
	Clinton
	Perry
2027	Braidwood 2
	South Texas Project 1
2028	South Texas Project 2
2029	Dresden 2
	Ginna
	Limerick 2
	Nine Mile Point 1
	Oyster Creek
2030	Comanche Peak 1
	Monticello
	Point Beach 1
	Robinson 2
	Seabrook
2031	Dresden 3
	Palisades
2032	Quad Cities 1
	Quad Cities 2
	Surry 1
	Turkey Point 3
	Vermont Yankee
2033	Browns Ferry 1
	Comanche Peak 2
	Fort Calhoun
	Kewaunee
	Oconee 1
	Oconee 2
	Peach Bottom 2
	Point Beach 2
	Prairie Island 1
	Surry 2
	Turkey Point 4
2034	Arkansas Nuclear 1
	Browns Ferry 2
	Brunswick 2
	Calvert Cliffs 1
	Cook 1
	Cooper
	Duane Arnold
	Hatch 1
	FitzPatrick
	Oconee 3
	Peach Bottom 3
	Prairie Island 2
	Three Mile Island 1
2035	Millstone 2
	Watts Bar 1
2036	Beaver Valley 1
	Browns Ferry 3
	Brunswick 1
	Calvert Cliffs 2
	St. Lucie 1
	Salem 1
2037	Cook 2
	Farley 1
2038	Arkansas Nuclear 2
	Hatch 2
	North Anna 1
2040	North Anna 2
	Salem 2
2041	Farley 2
	McGuire 1
2042	Summer
	Susquehanna 1
2043	Catawba 1
	Catawba 2
	McGuire 2
	St. Lucie 2
2044	Susquehanna 2
2045	Millstone 3
	Palo Verde 1
	Wolf Creek 1
2046	Nine Mile Point 2
	Harris 1
	Hope Creek
	Palo Verde 2
2047	Beaver Valley 2
	Palo Verde 3
	Vogtle 1
2049	Vogtle 2

Note: Limited to reactors licensed to operate. NRC-abbreviated reactor names listed. Data as of July 2011.

Figure 27. License Renewal Process



Opportunities for Public Interaction
* If a request for a hearing is granted
** Available at www.nrc.gov

requirements for license renewal are contained in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

The review of a renewal application proceeds along two paths—one for the review of safety issues and the other for environmental issues (see Figure 27). An applicant must provide the NRC with an evaluation that addresses the technical aspects of plant aging and describes the ways those effects will be managed. The applicant must also prepare for and evaluate the potential impact on the environment if the plant operates for up to an additional 20 years. The NRC reviews the application and verifies the safety evaluation through onsite inspections.

Public Involvement

Public participation is an important part of the license renewal process. Members of the public have several opportunities to question how aging will be managed during the period of extended operation. The NRC makes available to the public information provided by the applicant and holds several public meetings. The agency fully documents its technical and environmental review results and makes them publicly available. In addition, ACRS holds public meetings to discuss technical or safety issues related to plant designs or

a particular plant or site. Stakeholder concerns may be litigated in an adjudicatory hearing if any party that would be affected requests a hearing and submits an admissible contention.

For more information, visit the NRC Web site (see the Web Link Index).

RESEARCH AND TEST REACTORS

Nuclear research and test reactors (RTRs) are designed and used for research, testing, and education in nuclear engineering, physics, chemistry, biology, anthropology, medicine, materials sciences, and related fields. These reactors do not produce commercial electricity, but they help prepare people for nuclear-related careers in the fields of nuclear engineering, electric power, national defense, health services, research, and education.

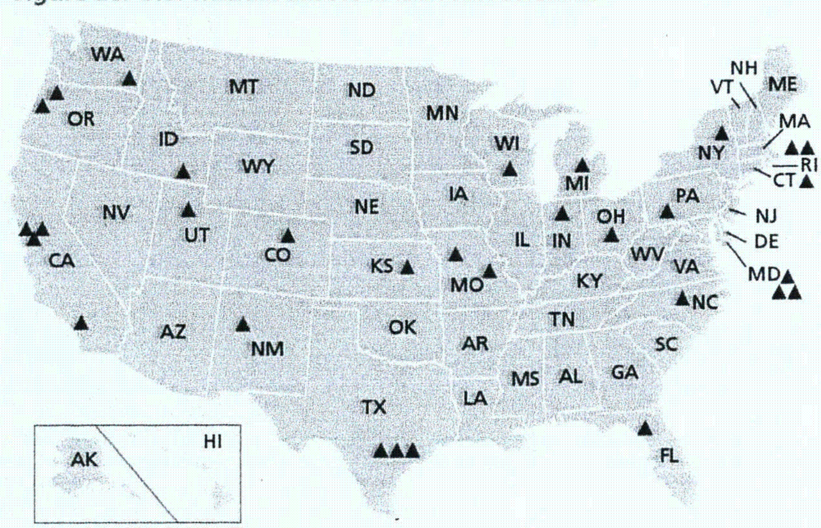
The largest U.S. RTR (at 20 megawatts thermal) is 75 times smaller than the smallest U.S. commercial power nuclear reactor (at 1,500 megawatts thermal). There are 43 licensed RTRs:

- 31 RTRs operating in 22 States (see Figure 28)
- 12 reactors shut down and in various stages of decommissioning

See Appendix E for a list of the 31 operating RTRs regulated by the NRC.

RTRs licensed to operate at a power level of 2 megawatts or greater are

Figure 28. U.S. Nuclear Research and Test Reactors



▲ Licensed/Currently Operating (31)

inspected annually. RTRs licensed to operate at power levels below 2 megawatts are inspected every 2 years.

Since 1958, 82 licensed RTRs have been decommissioned.

See Appendix F for a list of the 12 RTRs regulated by the NRC that are in the process of decommissioning.

Principal Licensing and Inspection Activities

The NRC's principal licensing and inspection activities related to RTRs include the following:

- licensing the 31 operating RTRs, including license renewals and license amendments
- licensing approximately 97 RTR operators
- requalifying each operator before renewal of his or her 6-year license
- conducting approximately 36 RTR inspections each year

NUCLEAR REGULATORY RESEARCH

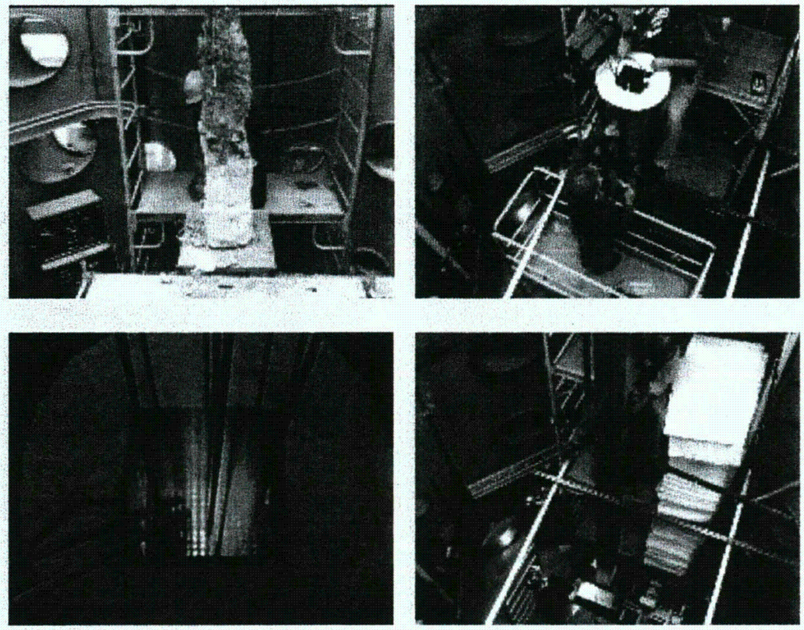
The NRC's research program supports the agency's regulatory mission by providing technical advice, tools, and information to identify and resolve safety issues, make regulatory decisions, and promulgate regulations and guidance. This includes conducting confirmatory experiments and analyses; developing technical bases that support the NRC's safety decisions; and preparing the agency for the future by evaluating the safety aspects of new technologies and designs for nuclear reactors, materials, waste, and security. The research program focuses on challenges as the industry continues to evolve, including potential new safety issues, management of aging and material degradation issues, technical issues associated with the deployment of new technologies and reactor designs, and retention of technical skills as experienced staff retires.

In the near term, research supports oversight of operating light-water reactors, the technology currently used in the United States. However, recent applications for advanced light-water reactors and preapplication activity regarding nonlight-water reactor vendors have prompted the agency to consider longer term research needs.

The NRC ensures protection of public health, safety, and the environment through research programs that do the following:

- Examine technical areas.
  - » material degradation (e.g., stress-corrosion cracking, aging management, degradation mitigation technologies, boric acid corrosion, and embrittlement)
  - » new and evolving technologies (e.g., new reactor technology, mixed oxide fuel performance, digital instrumentation and control, and safety-critical software)
  - » experience gained from operating reactors
  - » probabilistic risk assessment methods
  - » seismic and geotechnical hazards

Demonstration of Loss-of-Coolant Accident Experiment



The Sandia Fuel Project gathers data on the behavior of fuel assemblies in storage pools and reactor cores in a complete loss-of-coolant scenario. Electrically heated rods are inserted in commercially available PWR fuel assemblies and a prototypic spent fuel rack. As shown, the assembly is ignited in a zirconium cladding fire and later inspected for damage. The results represent actual fuel assembly responses and are used to support computer modeling codes for accident scenarios.

NUCLEAR REACTORS

  - » ability of equipment to function in a harsh environment (e.g., heat, radiation, humidity)
  - » structural integrity assessments of reactor component degradation (e.g., nondestructive evaluation techniques and protocols)
- Examine human factors issues, including safety culture and computerization and automation of control rooms.
- Develop and improve computer codes as computational abilities expand and additional experimental and operational data allow for more realistic simulation. These computer codes analyze a wide spectrum of technical areas, including severe accidents, radionuclide transport through the environment, health effects of radioactive releases, nuclear criticality, fire conditions in nuclear facilities, thermal-hydraulic performance of reactors, reactor fuel performance, and nuclear power plant risk assessment.

- Ensure the secure use and management of nuclear facilities and radioactive materials by investigating potential security vulnerabilities and possible compensatory actions.

The NRC dedicates about 7 percent of its personnel and about 15 percent of its contracting funds to research. This research enables the NRC's highly skilled, experienced experts to formulate sound technical solutions based on science and to support timely and realistic regulatory decisions.

The NRC research budget for FY 2011 is approximately $61 million. This includes contracts with national laboratories, universities, and other research organizations for greater expertise and access to research facilities. Figure 29 illustrates the primary areas of research.

The NRC directs about three-fourths of the research program toward maintaining the safety of existing operating reactors. The agency is also directing research in support of regulating new and advanced reactors.

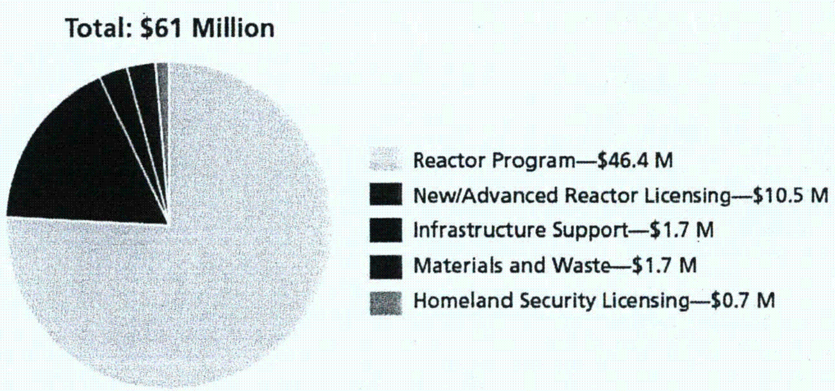
Radioactive waste programs and security are additional focus areas for research. Infrastructure support includes information technology and human resources.

The NRC also has cooperative agreements with universities and nonprofit organizations to research specific areas of interest to the agency.

See Appendix M for a list of cooperative agreements.

The NRC recently asked the National Academies to assess the feasibility of doing a study on the cancer risk for populations around nuclear power facilities. The NRC expects the feasibility study to be complete in the spring of 2012.

Figure 29. NRC Research Funding, FY 2011



Note: Totals may not equal sum of components because of independent rounding.

Nuclear Research at Universities

Universities and other academic institutions use nuclear material in laboratory experiments and to provide health physics support to other institutional nuclear materials users.

The State-of-the-Art Consequence Analysis (SOARCA) research project currently underway will develop realistic estimates of potential health effects from nuclear power plant accident scenarios that could involve releases of radioactive material into the environment. SOARCA improves methods and models for realistically evaluating plant responses during a severe accident.

The NRC collaborates with the international research community on both light-water and nonlight-water reactor technologies. These collaborations enable the agency to better leverage its resources, to initiate activities focused on evolutionary advances in existing technologies, and to determine the safety implications of new technologies. Collaboration is aided by the agency's leadership role in the standing committees and senior advisory groups of international organizations, such as IAEA and NEA.

The NRC also has research agreements with foreign governments for international cooperative research. The NRC is engaged in 100 cooperative research agreements with more than two dozen countries and NEA:

- Halden Reactor Project in Norway. For over 50 years, this collaboration has allowed for research and development of fuel, reactor internals, plant control and monitoring, human factors, and human reliability analysis.
- International Steam Generator Tube Integrity Program with Japan, South Korea, Canada, and others. This longstanding program models and predicts the impact of the aging and materials degradation process on tubing.