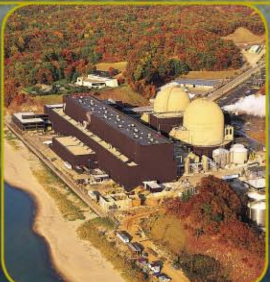
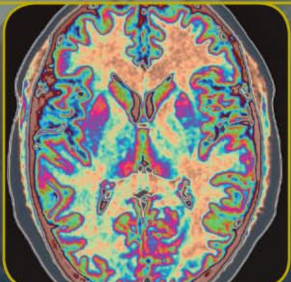
2006–2007

Information *Digest*





UNITED STATES NUCLEAR REGULATORY COMMISSION




www.nrc.gov

2006–2007

Information*Digest*

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Division of Planning, Budget, and Analysis

Office of the Chief Financial Officer

U.S. Nuclear Regulatory Commission

Washington, DC 20555-0001

Abstract

The "U.S. Nuclear Regulatory Commission (NRC) 2006–2007 Information Digest" (the digest) provides a summary of information about the U.S. Nuclear Regulatory Commission (NRC), including the agency's regulatory responsibilities and licensed activities, and general information on domestic and worldwide nuclear energy. Published annually, the digest is a compilation of nuclear- and NRC-related data designed to serve as a quick reference to major facts about the agency and the industry it regulates. In general, the data cover up to 2005 or data available at manuscript completion. Information on the generating capacity and average capacity factor for operating U.S. commercial nuclear power reactors is obtained from the NRC, as well as from various industry sources. Industry source information is reviewed by the NRC for consistency only, and no independent validation and/or verification is performed.

Comments and/or suggestions on the data presented are welcomed and should be directed to George Smolik or Karenina Newell, Division of Planning, Budget, and Analysis, Office of the Chief Financial Officer, United States Nuclear Regulatory Commission, Washington, DC 20555-0001. For detailed and complete information about tables and figures, refer to the source publications.

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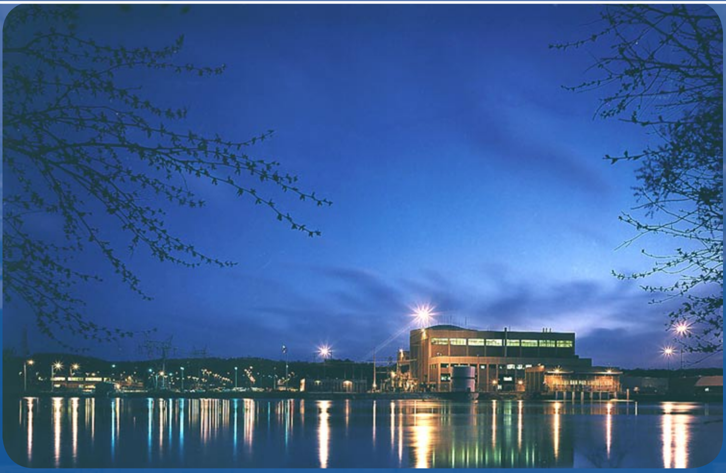
NRC AS A REGULATORY AGENCY



Fort Calhoun Nuclear Power Plant (NRC Image)

Mission, Goals, and Statutory Authority

Mission

The mission of the U.S. Nuclear Regulatory Commission (NRC) is to license and regulate the Nation's civilian use of byproduct, source, and special nuclear materials to ensure adequate protection of public health and safety, promote the common defense and security, and protect the environment. The NRC's scope of responsibility includes regulation of commercial nuclear power plants; research, test, and training reactors; nuclear fuel cycle facilities (also called fuel cycle facilities); medical, academic, and industrial uses of radioactive materials; and the transport, storage, and disposal of radioactive materials and wastes. The NRC's regulations are designed to protect the public and occupational workers from radiation hazards in those industries using radioactive materials.

Strategic Plan

The NRC's FY 2004 – FY 2009 Strategic Plan focuses on five goals:

Safety – Ensure protection of public health and safety and the environment.

Security – Ensure the secure use and management of radioactive materials.

Openness – Ensure openness in our regulatory process.

Effectiveness – Ensure that NRC actions are effective, efficient, realistic, and timely.

Excellence – Ensure excellence in agency management to carry out the NRC's strategic objective.

These goals support our ability to maintain the public health, safety, and trust. Under each goal, strategic outcomes provide a general barometer of whether the goals are being achieved. The NRC's Strategic Plan is available at http//www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1614/v3/index.html.

NRC voted one of the top 10 places to work.

Statutory Authority

The NRC was established by the Energy Reorganization Act of 1974. The agency began operations in 1975. The U.S. Energy Reorganization Act of 1974 separated the Atomic Energy Commission's regulatory functions from its military and promotional functions and assigned the regulatory functions to the NRC. The NRC thus inherited part of the Atomic Energy Commission's mission under the Atomic Energy Act of 1954 — to regulate the civilian commercial, industrial, academic, and medical uses of nuclear materials, in order to protect the public health and safety, and promote the common defense and security. In so doing, Congress defined the NRC's mission to enable the Nation to use radioactive materials for beneficial civilian purposes while ensuring that public health and safety, common defense and security, and the environment are protected. The NRC's regulations are issued under the U.S. Code of Federal Regulations (CFR), Title 10, Chapter 1.

The following principal statutory authorities govern the NRC's work:

- Atomic Energy Act of 1954, as amended
- Energy Reorganization Act of 1974, as amended
- Uranium Mill Tailings Radiation Control Act of 1978, as amended
- Nuclear Non-Proliferation Act of 1978
- Low-Level Radioactive Waste Policy Act of 1980, as amended
- West Valley Demonstration Project Act of 1980
- Nuclear Waste Policy Act of 1982, as amended
- Diplomatic Security and Anti-Terrorism Act of 1986
- Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990
- Energy Policy Act of 1992
- Energy Policy Act of 2005

The NRC, the Agreement States, and those who hold licenses to use radioactive 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. Because licensees actually use radioactive material, they have the ultimate responsibility to handle the use of materials.

Chairman
Dale E. Klein

Commissioner
Edward McGaffigan, Jr.

Major Activities

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

- Licensing the design, construction, operation, and decommissioning of nuclear plants and other nuclear facilities, such as nuclear fuel facilities, uranium enrichment facilities, and test and research reactors.
- Licensing the possession, use, processing, handling, and exporting of nuclear materials.
- Licensing the siting, design, construction, operation, and closure of low-level radioactive waste disposal sites under NRC jurisdiction and the construction, operation, and closure of a geologic repository for high-level radioactive waste.
- Licensing the operators of civilian nuclear reactors.
- Inspecting licensed and certified facilities and activities.
- Certifying privatized uranium enrichment facilities.
- Conducting research on light-water reactor safety to gain independent expertise and information for making timely regulatory judgments and for anticipating problems of potential safety significance.
- Developing and implementing rules and regulations that govern licensed nuclear activities.
- Investigating nuclear incidents and allegations concerning any matter regulated by the NRC.
- Enforcing NRC regulations and the conditions of NRC licenses.
- Conducting public hearings on matters of nuclear and radiological safety, environmental concern, and common defense and security.
- Developing effective working relationships with the States regarding reactor operations and the regulation of nuclear material.
- Developing policy and providing direction on issues involving security at nuclear facilities; and interfacing with other Federal agencies, including the Department of Homeland Security, on safety and security issues; and developing and directing the NRC program for response to incidents.

Commissioner
Jeffrey S. Merrifield

Commissioner
Gregory B. Jaczko

Commissioner
Peter B. Lyons

- Conducting a program of emergency preparedness and response for licensed nuclear facilities.
- Collecting, analyzing, and disseminating information about the operational safety of commercial nuclear power reactors and certain nonreactor activities.

Organizations and Functions

The NRC's Commission is composed of five members, with one member designated by the President to serve as Chairman. Each member is appointed by the President, with the consent of the U.S. Senate, to serve 5-year terms. The members' terms are normally staggered so that one Commissioner's term expires on June 30th every year. No more than three members of the Commission can be from the same political party. The members of the Commission are —

Commissioner Expiration of Term (as of 2006)

Commissioner	Expiration of Term
Dale E. Klein, Chairman	June 30, 2011
Edward McGaffigan, Jr.	June 30, 2010
Jeffrey S. Merrifield	June 30, 2007
Gregory B. Jaczko	June 30, 2008
Peter B. Lyons	June 20, 2009

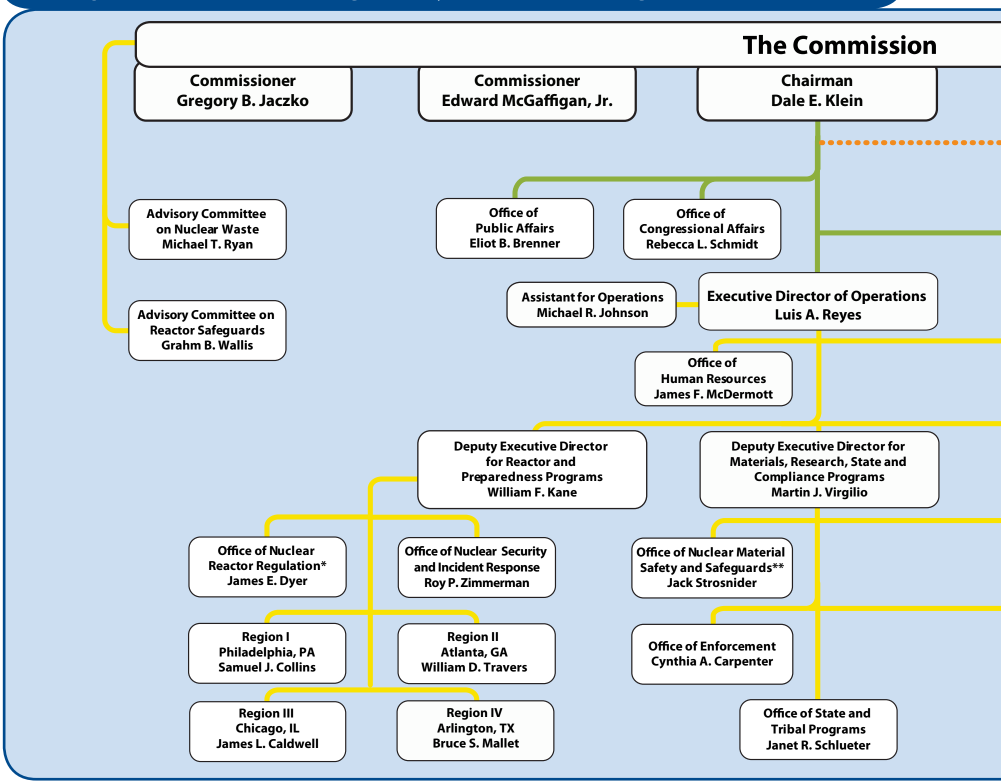
The Chairman serves as the principal executive officer and official spokesman of the Commission. The Executive Director for Operations carries out the program policies and decisions made by the Commission.

Figure 1 is an organization chart of the NRC. Figure 2 is a map with the NRCHeadquaters, Regions, and Training Center.

The NRC's major offices follow:

- Office of Nuclear Reactor Regulation* — Directs all licensing and inspection activities associated with the design, construction, and operation of nuclear power reactors and research and test reactors.
- Office of Nuclear Material Safety and Safeguards** — Directs all licensing and inspection activities associated with nuclear fuel cycle facilities, uses of nuclear materials, storage and transport of nuclear materials, management and disposal of low-level and high-level radioactive nuclear wastes, and decommissioning of facilities and sites.
- 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 and provides support for developing technical regulations and standards. 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 — Responsible for overall

Figure 1. **U.S. Nuclear Regulatory Commission Organization Chart**



* The Commission approved a reorganization of the Office of Nuclear Reactor Regulation. The Commission expects to implement the reorganization at the beginning of 2007.

** The Commission approved a reorganization of the Office of Nuclear Material Safety and Safeguards. The Commission expects to implement the reorganization in fall 2006.

agency policy and activities involving security at nuclear facilities. Provides safeguards and security interface with other Federal agencies and maintains the agency emergency preparedness and response program.

- Regional Offices — Conduct inspection, enforcement, investigation, licensing, and emergency response programs for nuclear reactors, fuel facilities, and materials licensees within regional boundaries that the Headquarters' offices originate.
- Office of Information Services — Responsible for the strategic use of information technology as a management tool across a spectrum of agency activities and for an agencywide approach to information management, capital planning and performance-based management of information technology, and information management service functions.
- Office of the Chief Financial Officer — Responsible for NRC's Planning, Budgeting and Performance Management process and for all of the NRC's financial management activities.
- Office of the Inspector General — Provides the Commission with an independent review and appraisal of NRC programs and operations to ensure their effectiveness, efficiency, and integrity.

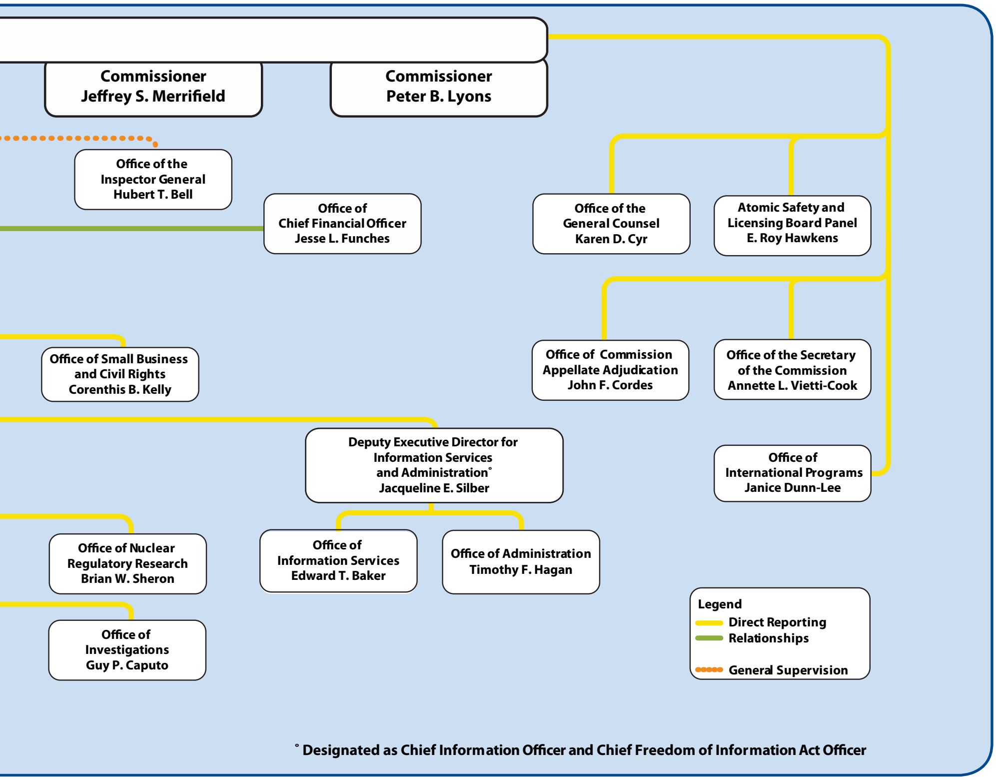
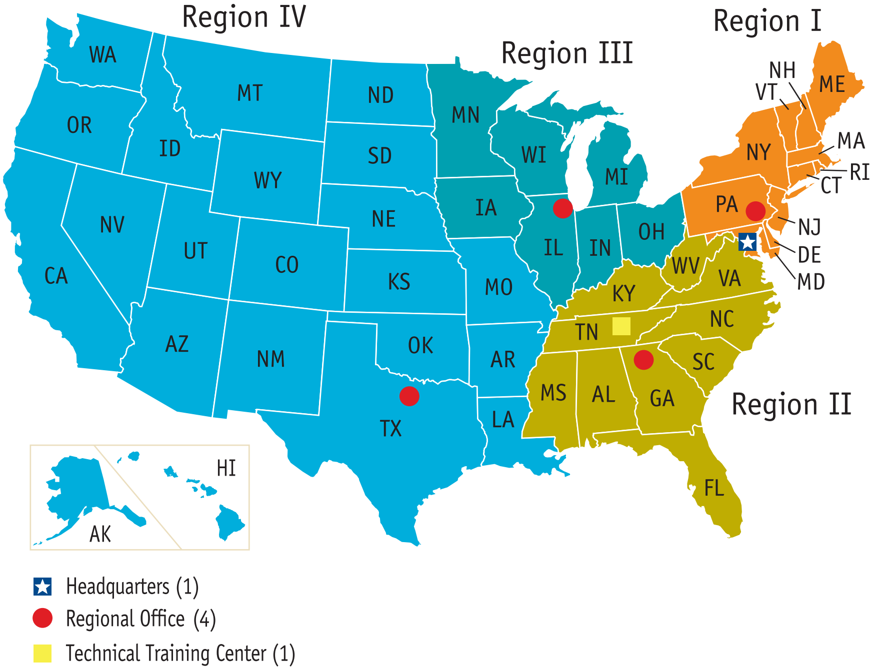


Figure 2. **NRC Regions**



Headquarters:
Rockville, Maryland
301-415-7000
1-800-368-5642

Operations Center:
Rockville, Maryland
301-816-5100

The NRC maintains an Operations Center that is a focal point for NRC communications with its licensees, State agencies, and other Federal agencies concerning operating events in the commercial nuclear sector. The Operations Center is staffed 24 hours a day by NRC operations officers.

Regional Offices:
The NRC has four regional offices located throughout the United States.

Region I:
King of Prussia, Pennsylvania
610-337-5000

Region II:
Atlanta, Georgia
404-562-4400

Region III:
Lisle, Illinois
630-829-9500

Region IV:
Arlington, Texas
817-860-8100

Resident Sites:
At least two NRC resident inspectors who report to the appropriate regional office are located at each nuclear power reactor site. (Refer to Figure 16 for a map of the U.S. operating commercial nuclear power reactors.)

Technical Training Center:
Chattanooga,Tennessee
423-855-6500

Source: Nuclear Regulatory Commission

NRC BUDGET

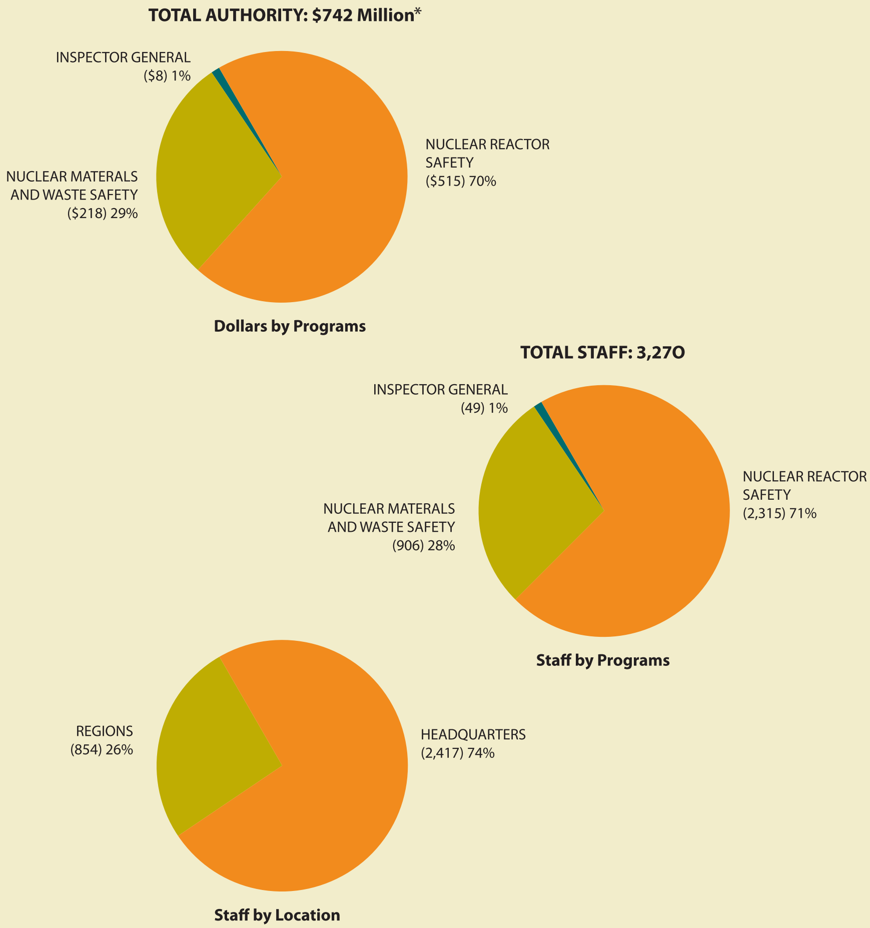
For FY 2006, Congress appropriated $742 million for the NRC. The NRC's FY 2006 personnel ceiling is 3,270 full-time equivalent (FTE) staff.

The NRC allocates funds and staff to the following programs (see Figure 3).

- Nuclear Reactor Safety
- Nuclear Materials and Waste Safety

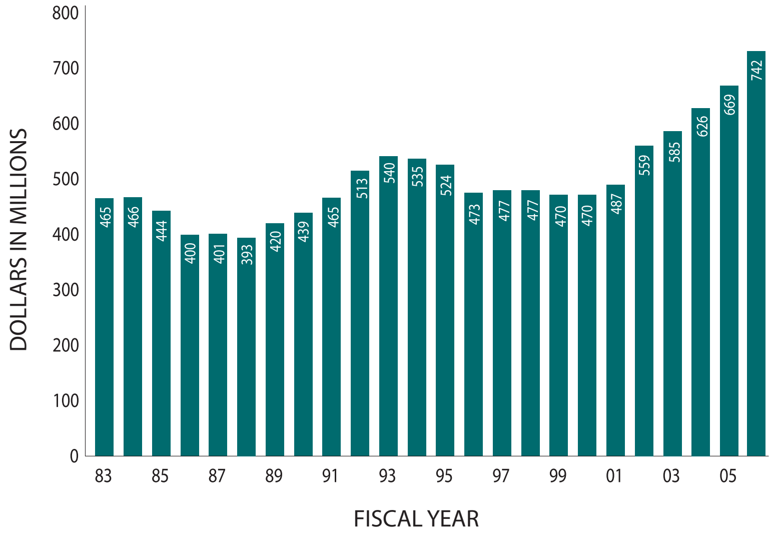
The Office of the Inspector General (OIG) receives its own appropriation, the amount of which is included in the NRC budget.

Figure 3. **Distribution of NRC FY 2006 Budget Authority and Staff (Dollars in Millions)**



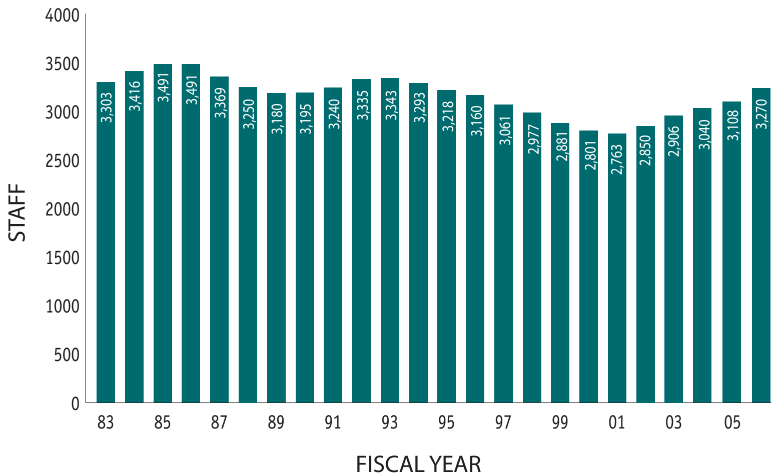
*Budget authority includes rescission.
Note: Dollars and percentages are rounded to the nearest whole number. Dollars are full costed.
Source: Nuclear Regulatory Commission

Figure 4. **NRC Budget Authority, FYs 1983–2006**



Note: Dollars are rounded to the nearest million.
Source: Nuclear Regulatory Commission

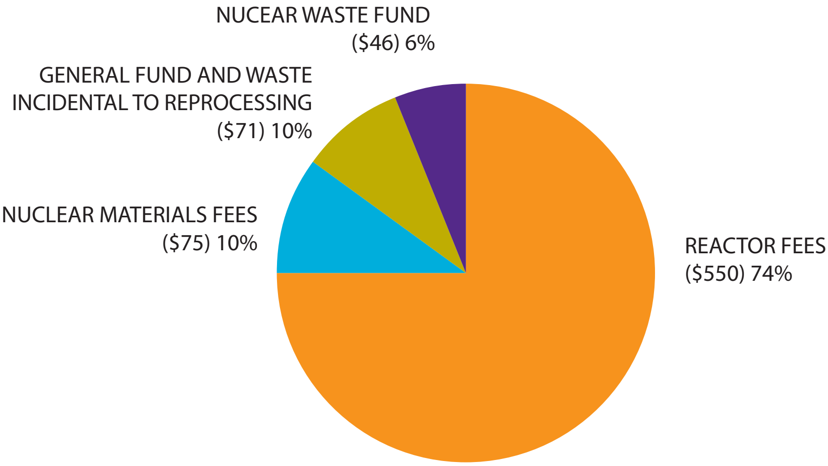
Figure 5. **NRC Personnel Ceiling, FYs 1983–2006**



Note: FYs 1983 – 2006 reflect FTEs.
Source: Nuclear Regulatory Commission

Figure 6. **Recovery of NRC Budget Authority, FY 2006***

TOTAL AUTHORITY: $742 Million



Dollars in Millions

The Omnibus Budget Reconciliation Act of 1990 (OBRA-90), as amended, required the NRC to recover 90 percent of its budget authority, less appropriations from the Nuclear Waste Fund, for FY 2005 by assessing fees to its licensees. The FY 2006 Energy and Water Development Appropations Act, extended this 90 percent fee recovery requirement through FY 2006. The NRC budget authority to be recovered from fees in FY 2006 is $624 million. The annual fees assessed to the major classes of NRC licensees in FY 2006 follow:

Class of Licensee	Range of Annual Fees
Operating Power Reactor	$3,704,000**
Fuel Facility	$440,000 to $5,420,000
Uranium Recovery Facility	$65,900
Materials User	$890 to $33,000

*Based on the final FY 2006 fee rule.
**Includes spent fuel storage/reactor decommissioning FY 2006 annual fee of $173,000.
Note: Percentages are rounded to the nearest whole number.
Source: Nuclear Regulatory Commission

U.S. AND WORLDWIDE ENERGY

D.C. Cook Nuclear Power Plant (Getty Images)

U.S. Electricity

Capacity, Capability, and Net Generation

U.S. electric generating capability totaled approximately 963 gigawatts in 2004. Nuclear energy accounted for approximately 10 percent of this capability (see Figure 7).

U.S. net electric generation totaled approximately 4,038 billion kilowatthours in 2005. Nuclear energy accounted for approximately 19 percent of this generation (see Figure 8).

In 2004, 104 nuclear reactors licensed to operate in 30 States generated approximately one-fifth of the Nation's electricity (see Table 1 and Figure 9).

- Three States (South Carolina, Connecticut, and Vermont) relied on nuclear power for more than 50 percent of their electricity.
- Fourteen additional states relied on nuclear power for 25 to 50 percent of their electricity (see Table 1).

Since 1994, nuclear electric generation has increased by 20 percent and coal-fired generation has increased by 20 percent, while electricity generated by all other sources has increased by 30 percent (see Figure 10 and Table 2).

In 2004, electricity from coal and nuclear sources accounted for 43 percent of the U.S. generating capability (see Figure 11 and Table 5).

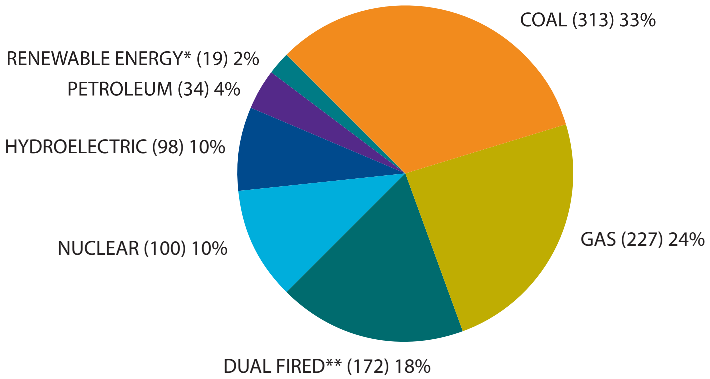
Average Production Expenses

The production expense data presented herein include all nuclear, fossil, and coal-fired utility-owned steam electric plants (see Table 4 and Figure 12).

In 2004, production expenses averaged $18.26 per megawatthour for nuclear reactors and $23.85 per megawatthour for fossil fuel plants.

Figure 7. **U.S. Electric Capacity and Capability by Energy Source, 2004**

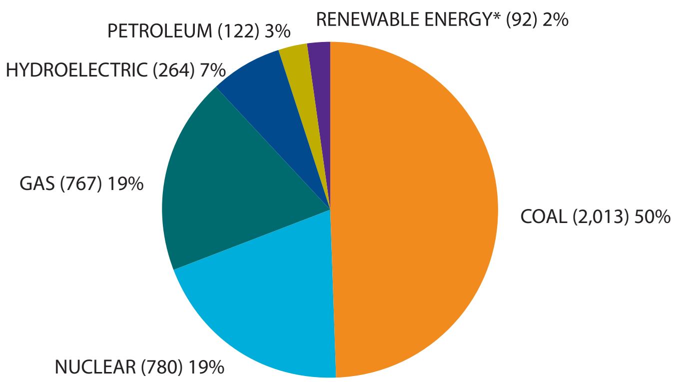
TOTAL CAPABILITY: 963 gigawatts



*Renewable energy includes geothermal, wood and wood waste, refuse, wind, solar energy and nonwood waste.
**Dual fired units can burn oil or gas.
Note: Net summer capability. Percentages are rounded to the nearest whole number. Numbers rounded to the nearest thousand.
Source: DOE/EIA Existing Capacity by Energy Source, Table 2.2, http://www.eia.doe.gov

Figure 8. **U.S. Electric Net Generation by Energy Source, 2005**

TOTAL GENERATION: 4,038 billion kilowatthours



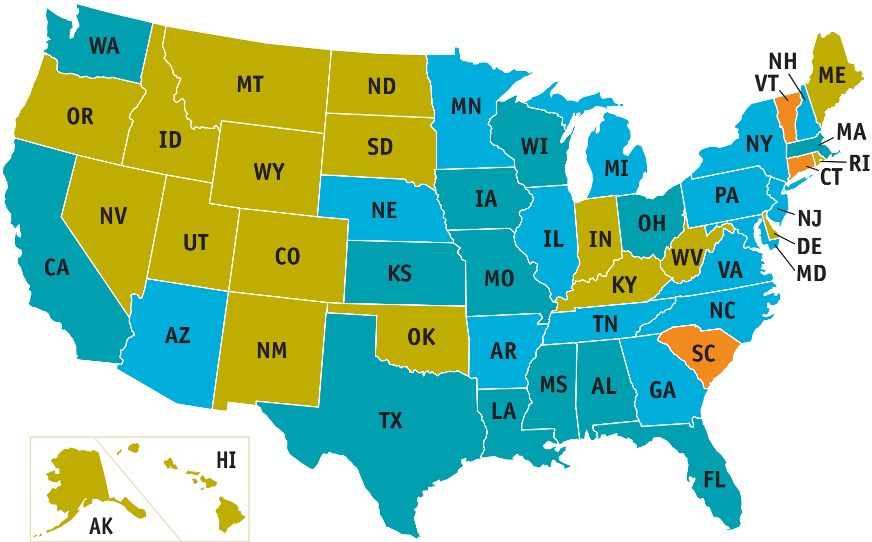
*Renewable energy includes geothermal, wood and nonwood waste, wind, and solar energy.
Renewable conventional hydroelectric power is included in hydroelectric power.
Note: Net summer capability. Percentages are rounded to the nearest whole number. Numbers rounded to the nearest thousand.
Source: DOE/EIA Monthly Energy Review, March 2006, Table 7.2a, http://www.eia.doe.gov

Table 1. **Electric Generating Capability and Electric Generation in Each State by Nuclear Power, 2004**

	Percent Net Nuclear			Percent Net Nuclear	
State	**Capability**	**Generation**	**State**	**Capability**	**Generation**
Alabama	16	23	Missouri	6	10
Arizona	16	30	Nebraska	18	32
Arkansas	14	27	New Hampshire	27	43
California	7	16	New Jersey	22	49
Connecticut	26	51	New York	13	30
Florida	8	14	North Carolina	18	32
Georgia	11	27	Ohio	6	11
Illinois	27	48	Pennsylvania	20	36
Iowa	5	11	South Carolina	29	52
Kansas	11	22	Tennessee	16	29
Louisiana	8	17	Texas	5	10
Maryland	14	28	Vermont	51	71
Massachusetts	5	13	Virginia	15	36
Michigan	13	26	Washington	4	9
Minnesota	14	25	Wisconsin	11	20
Mississippi	7	23	Others*	0	0

* The District of Columbia and19 States have no nuclear generating capability.
Notes: Net summer capability. Capability is the percent of electricity the State is capable of producing with nuclear energy. Percentages are rounded to the nearest whole number.
Source: DOE/EIA Electric Power Annual 2004, http://www.eia.doe.gov

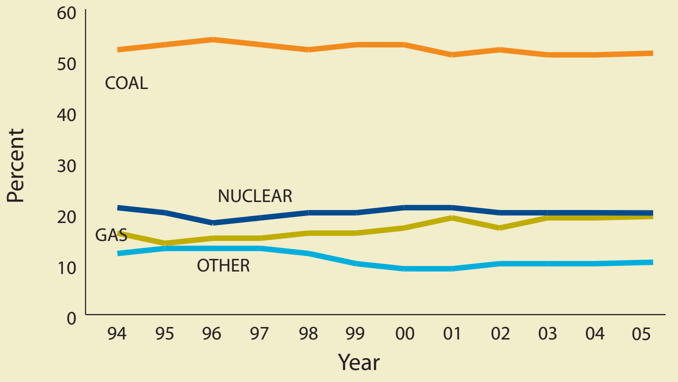
Figure 9. **Net Electricity Generated in Each State by Nuclear Power, 2004**

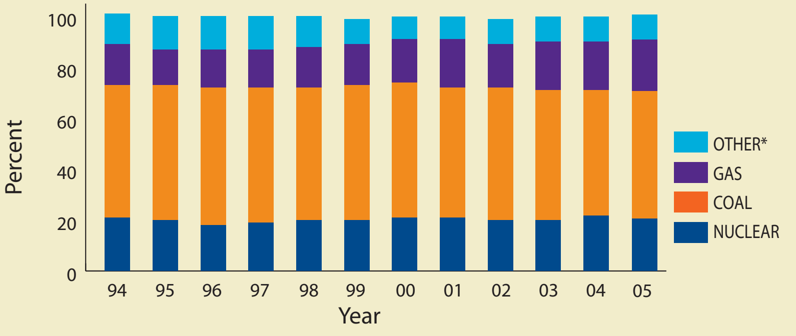


1% to 24% (13)	25% to 50% (15)	More than 50% (3)	None (19)
Alabama	Arizona	Connecticut	Alaska
California	Arkansas	South Carolina	Colorado
Florida	Georgia	Vermont	Delaware
Iowa	Illinois		Hawaii
Kansas	Maryland		Idaho
Louisiana	Michigan		Indiana
Massachusetts	Minnesota		Kentucky
Mississippi	Nebraska		Maine
Missouri	New Hampshire		Montana
Ohio	New Jersey		Nevada
Texas	New York		North Dakota
Washington	North Carolina		New Mexico
Wisconsin	Pennsylvania		Oklahoma
	Tennessee		Oregon
	Virginia		Rhode Island
			South Dakota
			Utah
			West Virginia
			Wyoming

Note: Percentages are rounded to the nearest whole number.
Source: DOE/EIA Electric Power Annual 2004, http://www.eia.doe.gov

Figure 10. **U.S. Net Electric Generation by Source, 1994–2005**





* Other includes petroleum and hydroelectric.

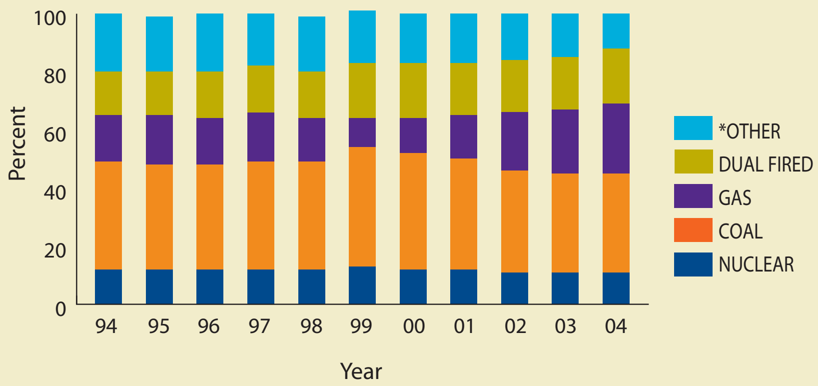
Source: DOE/EIA Monthly Energy Review (March 2006), Table 7.2a, http://eia.doe.gov

Table 2. **U.S. Net Electric Generation by Source, 1994–2005 (Billion Kilowatthours)**

Year	Coal	Petroleum	Gas	Hydroelectric	Nuclear
1994	1,692	106	478	257	640
1995	1,710	75	512	308	673
1996	1,796	82	470	344	675
1997	1,844	93	497	355	629
1998	1,873	127	549	319	674
1999	1,884	124	570	313	728
2000	1,965	109	611	269	754
2001	1,943	128	640	211	767
2002	1,936	96	705	256	772
2003	1,963	118	643	267	766
2004	1,976	117	715	262	789
2005	2,013	122	767	264	780

Source: DOE/EIA Monthly Energy Review (March 2006), Table 7.2a, http://eia.doe.gov

Figure 11. **U.S. Electric Generating Capability by Energy Source, 1994–2004**



* Other includes petroleum and hydroelectric

Note: Net summer capability. Table 5 includes revisions to years 1999 and 2000 and now includes dual fired units. Other includes dual fired units which can burn oil or gas. When there is more than one energy source used in a plant, the predominant energy source is reported. Percentages are rounded to the nearest whole number.

Source: DOE/EIA Electric Power Annual 2004, http://eia.doe.gov

Table 3. **U.S. Electric Generating Capability by Energy Source, 1994–2004 (Gigawatts)**

Year	Coal	Petroleum	Gas	Dual Fired	Hydroelectric	Nuclear
1994	301	70	134	123	96	99
1995	301	64	142	122	97	100
1996	302	70	135	129	94	101
1997	303	70	137	129	76	100
1998	300	63	125	130	94	97
1999	315	36	75	146	99	97
2000	315	36	98	150	98	88
2001	314	40	127	153	99	98
2002	315	38	174	162	100	99
2003	313	36	208	171	99	99
2004	313	34	227	172	98	100

Source: DOE/EIA Electric Power Annual 2004, http://eia.doe.gov

Table 4. U.S. Average Nuclear Reactor, Coal-Fired and Fossil Steam Plant Production Expenses, 1994-2004 (Dollars per Megawatthour)

Year	Operation and Maintenance	Fuel	Total Production Expenses
Nuclear			
1994	14.01	6.02	20.03
1995	13.49	5.74	19.23
1996	13.76	5.49	19.25
1997*	18.90	5.89	24.79
1998	16.19	5.42	21.61
1999	14.06	5.17	19.23
2000	13.34	4.95	18.29
2001	13.31	4.67	17.98
2002	13.58	4.60	18.18
2003	14.09	4.58	18.26
2004	13.68	4.58	18.26
Coal-Fired			
1994	4.32	14.88	19.20
1995	4.24	14.51	18.75
1996	4.03	14.20	18.23
1997*	3.96	14.03	17.99
Fossil-Steam**			
1998	4.59	16.01	20.60
1999	4.59	15.62	20.21
2000	4.76	17.69	22.45
2001	5.01	18.13	23.14
2002	5.22	16.11	21.23
2003	5.23	17.35	22.58
2004	5.64	18.21	23.85

*Data for 1997 and prior years were obtained from Utility Data Institute, Inc.
**Includes coal and fossil fuel. Plant production expenses are no longer available exclusively for coal-fired fuel.
Source: Federal Energy Regulatory Commission, FERC Form 1, "Annual Report of Major Electric Utilities, Licensees and Others" DOE/EIA – Electric Power Annual 2004.

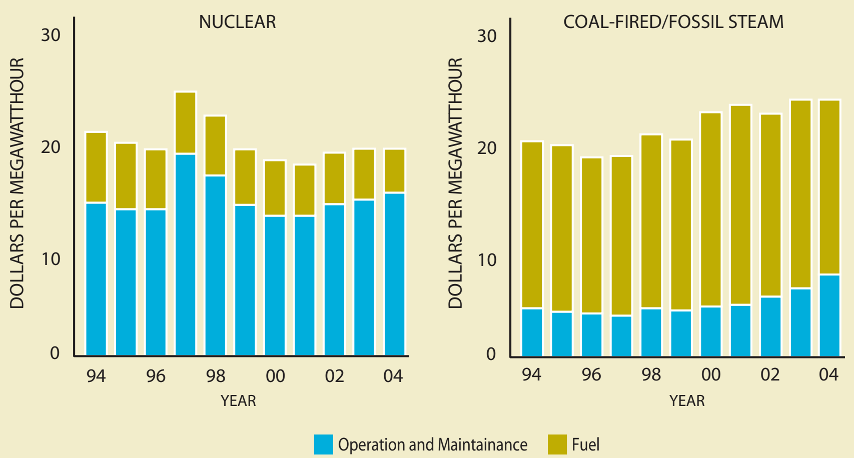
U.S. Electricity Generated by Commercial Nuclear Power

In 2005, net nuclear-based electric generation in the United States produced a total of 780 billion kilowatthours (see Table 5 and Figure 13).

In 2004, the average U.S. net capacity factor was 91 percent. It decreased to 89 perrcent in 2005. Since 1994, the average capacity factor has increased approximately 19 percent (see Table 5).

- Capacity factor is the ratio of electricity generated to the amount of energy that could have been generated (see Glossary).
- Ninety-six percent of U.S. commercial nuclear reactors operated above a capacity factor of 70 percent in 2005 (see Table 6).
- In 2005, Westinghouse Electric reactors had the highest average capacity factors compared to those of the other three vendors. The 48 Westinghouse reactors had an average capacity factor of 91 percent. The average capacity factors for the other three vendors were the following: 7 Babcock & Wilcox reactors—90 percent, 35 General Electric reactors—88 percent, and 14 Combustion Engineering—87 percent (see Table 6).

Figure 12. **U.S. Average Nuclear Reactor and Coal-Fired and Fossil Steam Plant Production Expenses, 1994–2004**



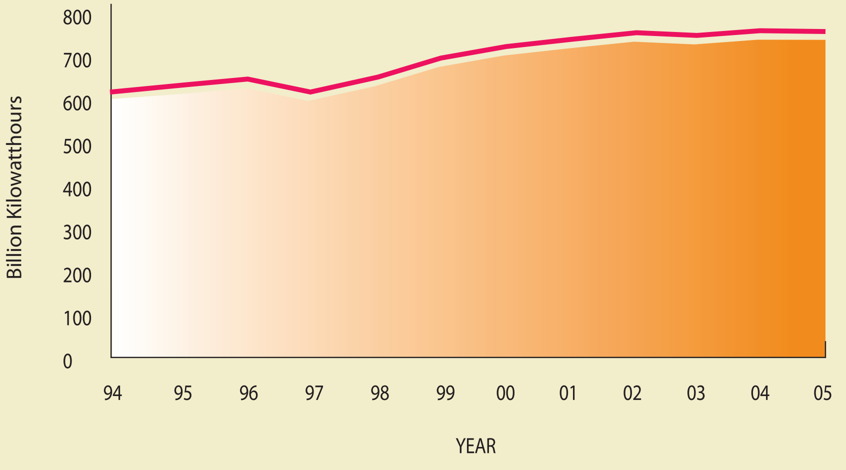
Source: Federal Energy Regulatory Commission, FERC Form 1, "Annual Report of Major Electric Utilities, Licensees and Others," DOE/EIA – Electric Power Annual 2004.

Table 5. **U.S. Nuclear Power Reactor Average Capacity Factor and Net Generation, 1994 – 2005**

Year	Number of Operating Reactors	Average Annual Capacity Factor (Percent)	Net Generation of Electricity: Billions of Kilowatthours	Net Generation of Electricity: Percent of Total U.S. Capacity
1994	109	75	640	19.7
1995	109	79	673	20.1
1996	110	77	675	19.6
1997	104	74	629	18.0
1998	104	78	674	18.6
1999	104	86	728	19.6
2000	104	88	754	19.8
2001	104	90	767	20.0
2002	104	91	772	20.0
2003	104	91	766	19.9
2004	104	91	789	19.6
2005	104	89	780	19.3

Note: Average annual capacity factor is based on net maximum dependable capacity.
See Glossary for definition.
Source: 1994 – 2005 net electricity based on March 2006 DOE/EIA – Monthly Energy Review Table 7.2a, and licensee data as compiled by the Nuclear Regulatory Commission.

Figure 13. **Net Generation of U.S. Nuclear Electricity, 1994–2005**



Note: Average annual capacity factor is based on net maximum dependable capacity.
See Glossary for definition.
Source: 1994 – 2005 Net Electricity based on March 2006 DOE/EIA – Monthly Energy Review Table 7.2a, and licensee data as compiled by the Nuclear Regulatory Commission.

Table 6. **U.S. Commercial Nuclear Power Reactor Average Capacity Factor by Vendor and Reactor Type, 2003 – 2005**

	Licensed to Operate			Average Capacity Factor (Percent)			Percent of Net Nuclear Generated		
Capacity Factor	**2003**	**2004**	**2005**	**2003**	**2004**	**2005**	**2003**	**2004**	**2005**
Above 70 Percent	100	102	99	N/A	N/A	N/A	99	99	99
50 to 70 Percent	2	1	4	N/A	N/A	N/A	1	1	1
Below 50 Percent	2	1	1	N/A	N/A	N/A	>1	>1	>1
Vendor:									
Babcock & Wilcox	7	7	7	76	89	90	5	6	6
Combustion Engineering	14	14	14	91	91	87	14	13	13
General Electric	35	35	35	89	89	88	33	33	33
Westinghouse Electric	48	48	48	90	90	91	48	48	48
Total	104	104	104				100	100	100
Reactor Type:									
Boiling Water Reactor	35	35	35	89	89	89	33	33	33
Pressurized Water Reactor	69	69	69	86	92	92	67	67	67
Total	104	104	104				100	100	100

Note: Average capacity factor is based on net maximum dependable capacity. See Glossary for definition. Refer to Appendix A for the 2000–2005 average capacity factors for each reactor. Percentages are rounded to the nearest whole number.
Source: Licensee data as compiled by the Nuclear Regulatory Commission

Worldwide Electricity Generated by Commercial Nuclear Power

In 2005, 444 operating reactors in 33 countries had a maximum dependable capacity of 371,942 megawatts electric (net MWe) (see Figure 14).

- Refer to Appendix J for a world list of nuclear power reactors and Appendix K for nuclear power units by reactor type, worldwide. Major producers of nuclear electricity during 2004 were the United States and France.
- Approximately 30 percent of the world's net nuclear-generated electricity was produced in the United States (see Figure 15).
- France produced approximately 16 percent of the world's net nuclear-generated electricity. The nuclear portion of its total domestic electricity generation was approximately 79 percent (see Figure 15). Of the countries cited here, reactors in South Korea (95 percent), United States (89 percent), Sweden (87 percent), and Germany (86 percent) had the highest average gross capacity factor in 2005 (see Table 8). Reactors in the United States had the greatest gross nuclear generation at 816 billion kilowatthours. France was the next highest producer at 452 billion killowatthours (see Table 7).
- Refer to Appendix L for a list of the top 50 units by gross capacity factor, worldwide, and Appendix M for a list of the top 50 units by gross generation, worldwide.

Over the past 10 years, the average annual gross capacity factor has increased 14 percentage points in the United States, increased 7 percentage points in Germany, increased 8 percentage points in Sweden, and decreased 11 percentage points in Japan (see Table 8).

Table 7. **Commercial Nuclear Power Reactor Average Gross Capacity Factor and Gross Generation by Selected Country, 2005**

Country	Number of Operating Reactors	Average Gross Capacity Factor (in percent)	Total Gross Nuclear Generation (in billions of kWh)	Number of Operating Reactors in Top 50 by Capacity Factor	Number of Operating Reactors in Top 50 by Generation
Canada	21	66	92	4	0
France	59	78	452	0	14
Germany	18	86	163	1	10
Japan	54	69	288	6	4
Russia	31	66	147	0	0
South Korea	20	95	146	9	0
Sweden	11	87	72	1	1
Ukraine	15	72	89	0	0
United States	104	89	816	20	20

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Table 8. **Commercial Nuclear Power Reactor Average Gross Capacity Factor by Selected Country, 1996–2005**

	Annual Gross Average Capacity Factor (Percent)									
Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Canada	65	61	50	52	50	53	53	54	64	66
France	74	72	73	71	72	73	75	75	77	78
Germany	79	83	79	88	87	87	83	84	87	86
Japan	80	82	83	79	79	79	77	59	70	69
Russia	**	**	**	61	67	67	67	70	68	66
South Korea	**	**	**	88	90	93	93	94	92	95
Sweden	79	75	78	78	66	84	75	77	89	87
Ukraine	**	**	**	65	69	74	75	78	76	72
United States	75	70	76	85	87	88	89	87	90	87*
	{77	73	78	86	88	90	91	89	91	89}*

*For comparison, the U.S. average gross capacity factor is used. The 2005 U.S. average net capacity factor is 89 percent. Brackets { } denote average net capacity factor. See Glossary for definition.
Note: Percentages are rounded to the nearest whole number.
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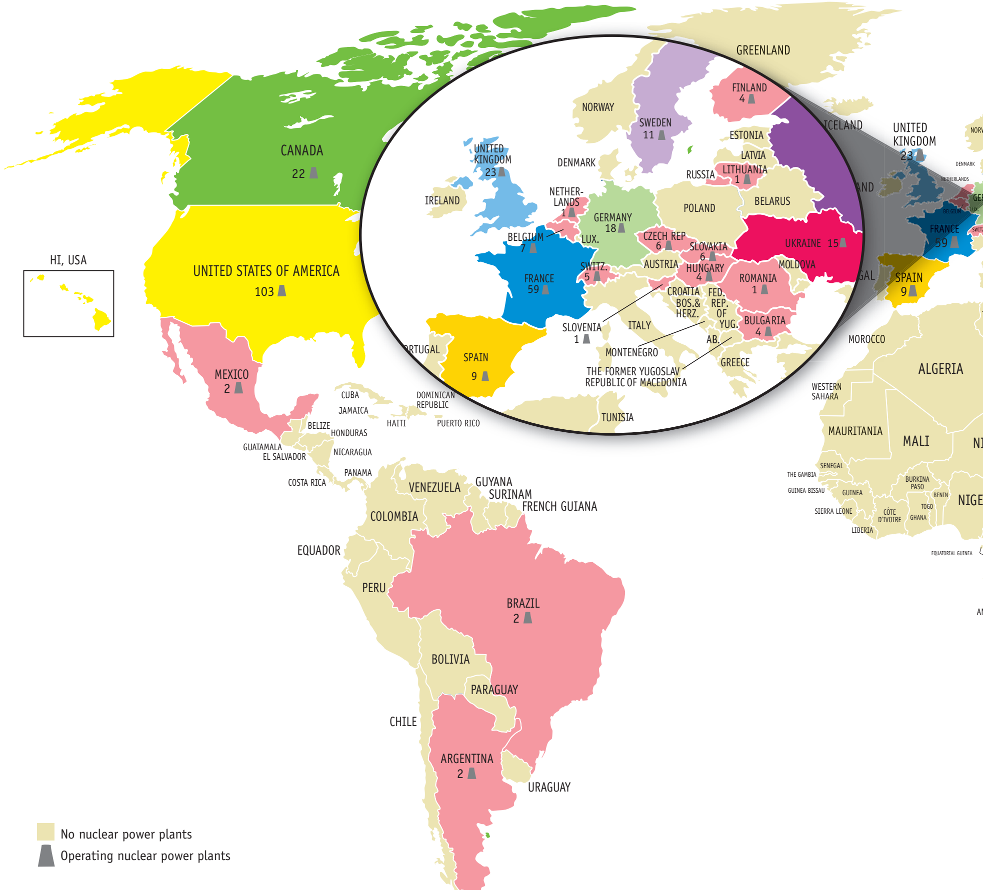
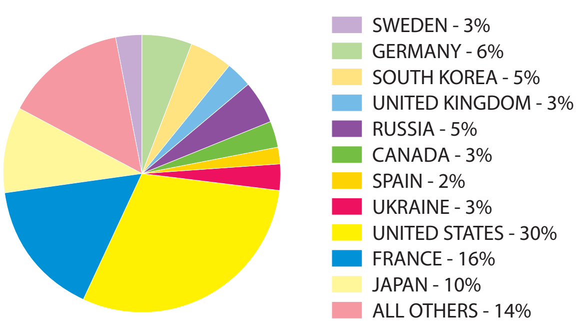
Figure 14. **Operating Nuclear**



Notes: There are no commercial reactors in Alaska or Hawaii. Refer to Appendix J for a world list of nuclear power reactors. See Figure 15 for key to percent of world nuclear generation.
Source: http://www.cia.gov/cia/publications/factbook/index.html

Figure 15. **Net Nuclear Electric Power as a Percent of World Nuclear**

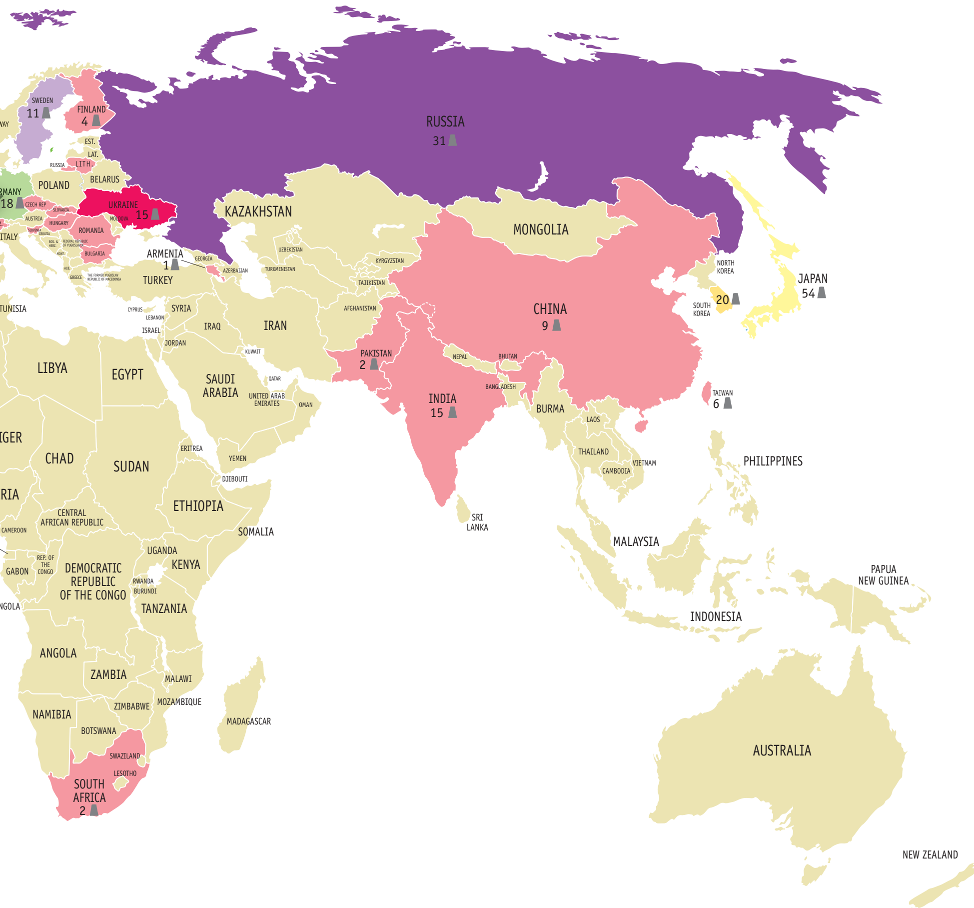
Percent of World Nuclear Generation



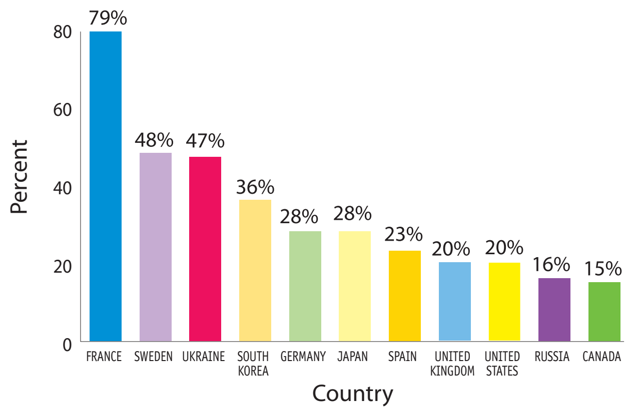
Total World Net Nuclear Electricity Generation: 2,523.11 billion kilowatthours

Source: DOE/EIA International Energy Information (http://www.eia.doe.gov)

Power Plants Worldwide, 2005



Generation and Total Domestic Net Nuclear Electricity Generation, 2004



U.S. AND WORLDWIDE ENERGY

International Activities

The NRC's legislatively mandated international responsibilities are to license the export and import of nuclear materials and equipment and to participate in activities that support U.S. Government compliance with international treaties and agreement obligations. The NRC also has programs of bilateral nuclear safety cooperation and assistance activities with 35 countries; it actively participates in multinational efforts such as the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA) and has a robust international cooperative research program.

The NRC licenses the exports and imports of nuclear facilities, major components, materials, and related commodities. It recently enhanced controls on the export and import of risk-significant radioactive sources as part of the Commission's comprehensive review of nuclear material security requirements. The enhancements include new specific export and import licensing requirements, advance notification procedures prior to shipment, verification of the recipient facility's licensing status, and review of the adequacy of the receiving country's controls on radioactive sources. These enhancements reduce the likelihood that risk-significant radioactive sources and/or quantities will be used in a "dirty bomb."

The NRC assists the U.S. Government's international policy and priority formulation through the development of legal instruments in the nuclear field to address vital issues such as nuclear non-proliferation, safety, safeguards, physical protection, security, radiation protection, spent fuel and waste management, nuclear safety research, and liability. Among the international treaties and agreement obligations that the NRC assists the U.S. Government in implementing are the Nuclear Non-Proliferation Treaty; U.S. bilateral agreements for Peaceful Nuclear Cooperation pursuant to Section 123 of the U.S. Atomic Energy Act of 1954, as amended; and such conventions as those on Nuclear Safety, the Safety of Spent Fuel Management the Safety of Radioactive Waste Management, and the Physical Protection of Nuclear Material. The NRC also ensures compliance by its licensees under the U.S. voluntary safeguards agreement with the IAEA.

The NRC also participates in a wide range of mutually beneficial programs to exchange information with counterparts in the international community and to enhance the safety and security of peaceful nuclear activities worldwide (see Table 9). This low-cost, high-impact program provides health and safety information and assistance to other countries, or joint cooperative activities, to develop and improve regulatory organizations and overall nuclear safety and security. These activities include the following:

- Ensuring prompt notification to foreign partners of U.S. safety problems that warrant action or investigation and notification of the NRC program offices of information about safety problems identified at foreign facilities.

Table 9. **Regulatory Authorities Providing for Bilateral Information Exchange and Cooperation on Nuclear Safety, Safeguards, Waste Management, and Radiological Protection**

Country	Agreement Renewal Date	Country	Agreement Renewal Date
Argentina	2002	Kazakhstan	2004
Armenia	2002	Republic of Korea	2005
Australia	2003	Lithuania	2005
Belgium	2003	Mexico	2002
Brazil	2004	The Netherlands	2003
Canada	2002	Peru	1990
China	2004	Philippines	1993
Czech Republic	2005	Romania	2005
Egypt	1991	Russia	2001
Finland	2001	Slovak Republic	2005
France	2003	Slovenia	2005
Germany	2002	South Africa	2005
Greece	2003	Spain	2005
Hungary	2001	Sweden	2001
Indonesia	2004	Switzerland	2002
Israel	2005	Ukraine	2006
Italy	2005	United Kingdom	2002
Japan	2003		

Note: The NRC also provides support to the American Institute of Taiwan.

- Assisting Russia, Ukraine, Armenia, Kazakhstan, Georgia, Azerbaijan, Iraq, India, and Pakistan to improve regulatory programs. These assistance efforts are carried out through a variety of training, workshops, peer review of regulatory documents, working group meetings, and technical information and specialist exchanges.

The NRC participates in the multinational programs of the IAEA and the NEA concerned with safety research and regulatory matters, radiation protection, risk assessment, emergency preparedness, waste management, transportation, safeguards, physical protection, security, standards development, training and technical assistance.

The NRC engages in joint cooperative research programs through over 100 multilateral agreements in over 22 countries to leverage access to foreign test facilities not otherwise available in 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.

NRC Commissioner Jeffrey S. Merrifield (right) and NRC Executive Director for Operations Luis A. Reyes (left) at the International Atomic Energy Agency.

OPERATING NUCLEAR REACTORS

http://www.nrc.gov/reactors.html

Engineer in Nuclear Power Station (Getty Images)

U.S. Commercial Nuclear Power Reactors

As of June 2005, 104 commercial nuclear power reactors[1] are licensed to operate in 31 States (see Figure 16):

- 4 reactor vendors
- 34 licensees
- 80 different designs
- 65 sites

Diversity—Although there are many similarities, each reactor design can be considered unique. A typical pressurized water reactor is shown in Figure 17 and a typical boiling water reactor is shown in Figure 18.

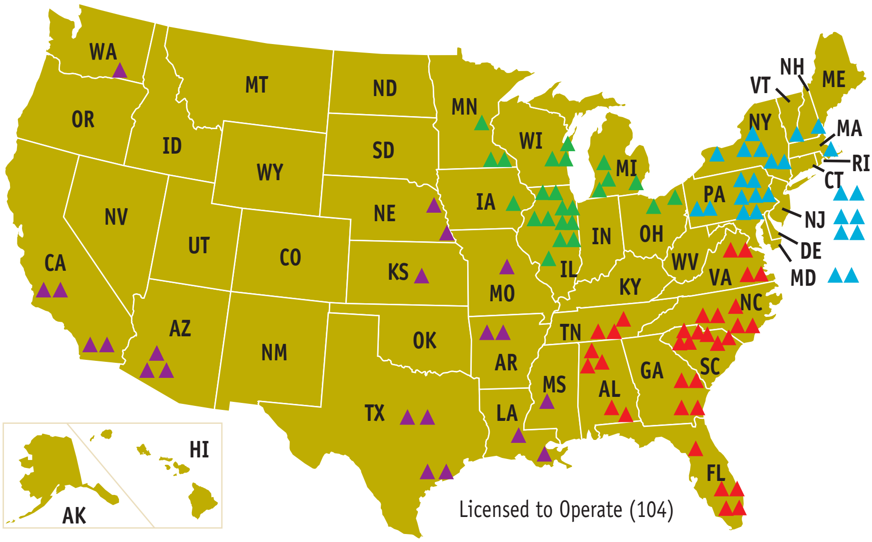
Experience—The 104 reactors licensed to operate during 2005 have accumulated 2,460 reactor-years of experience (see Figure 19 and Table 11). An additional 385 reactor-years of experience have been accumulated by permanently shutdown reactors.

Principal Licensing and Inspection Activities

- The NRC uses performance indicators and reactor and facility inspections as the basis for its independent determination of licensee compliance with NRC regulations (see Figure 20).
- Approximately 15 separate license changes are requested per power reactor each year:
  - More than 1,741 separate reviews were completed by the NRC in FY 2004.
- Approximately 4,700 reactor/senior operators are licensed by the NRC:
  - Each operator must requalify every 2 years and apply for license renewal every 6 years.
- Approximately 3,000 source documents concerning events are reviewed by the NRC annually.
- The NRC oversees the decommissioning of nuclear power reactors. Refer to Appendix F for their decommissioning status.
- On average, approximately 5,500 hours of inspection effort were expended at each operating reactor site during 2005 (see Figure 21).

1 Includes Browns Ferry Unit 1, which has no fuel loaded and requires Commission approval to restart.
Refer to Appendices A–F for a listing of currently operating, formerly operating, research, and test reactors and canceled U.S. commercial nuclear power reactors.

Figure 16. **U.S. Operating Commercial Nuclear Power Reactors**



REGION I

CONNECTICUT
- Millstone 2 and 3

MARYLAND
- Calvert Cliffs 1 and 2

MASSACHUSETTS
- Pilgrim 1

NEW HAMPSHIRE
- Seabrook 1

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

NEW YORK
- James A. 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
- Joseph M. 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
- Shearon Harris 1

SOUTH CAROLINA
- Catawba 1 and 2
- Oconee 1, 2, and 3
- H.B. 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
- La Salle County 1 and 2
- Quad Cities 1 and 2

IOWA
- Duane Arnold

MICHIGAN
- D.C. Cook 1 and 2
- Fermi 2
- Palisades

MINNESOTA
- Monticello
- Prarie Island 1 and 2

OHIO
- Davis-Besse
- Perry 1

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

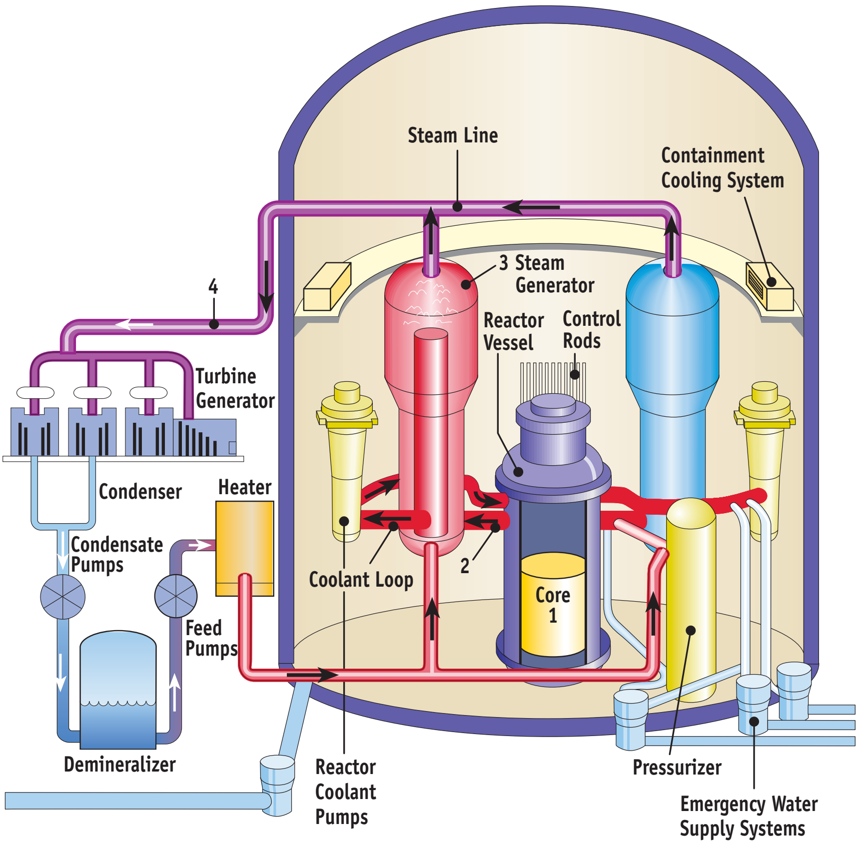
WASHINGTON
- Columbia Generating Station

Note: Includes Browns Ferry Unit 1, which has no fuel loaded and requires Commission approval to restart.
Source: Nuclear Regulatory Commission

Figure 17. **Typical Pressurized Water Reactor**

HOW NUCLEAR REACTORS WORK

In a typical commercial pressurized light-water reactor (1) the reactor core 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 steam line 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 (see Figure 33) which are cooled by water, which is force-circulated by electrically powered pumps. 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 and can be powered by onsite desel generators. Pressurized-water reactors contain between 150–200 fuel assemblies. For more information on nuclear reactor fuel, see Figure 28.

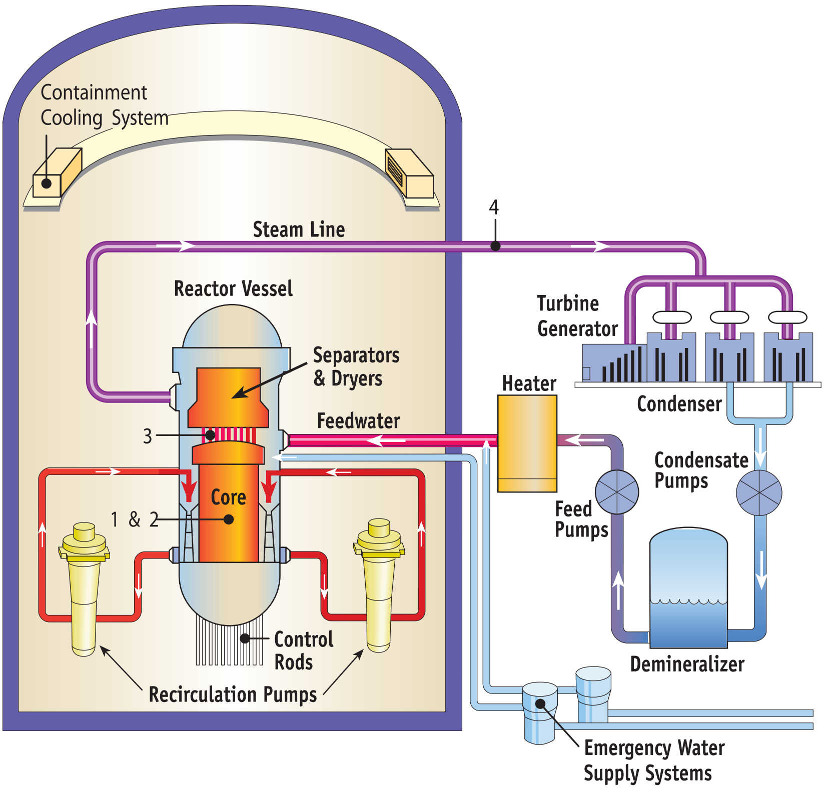


Source: Nuclear Regulatory Commission

Figure 18. **Typical Boiling Water Reactor**

HOW NUCLEAR REACTORS WORK

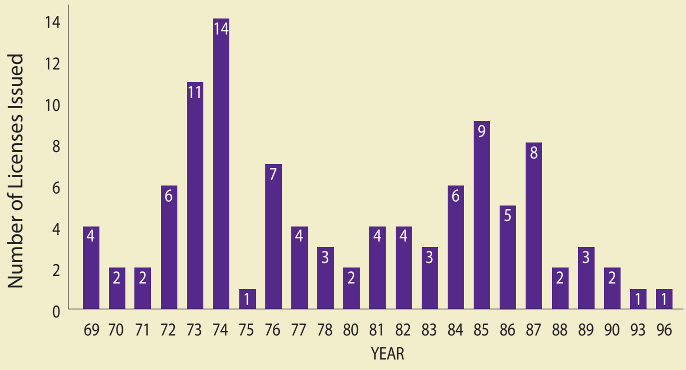
In a typical commercial boiling water reactor (1) the reactor core creates heat, (2) a steam-water mixture is produced when very pure water (reactor coolant) moves upward through the core absorbing heat, (3) the steam-water mixture leaves the top of the core and enters the two stages of moisture separation where water droplets are removed before the steam is allowed to enter the steam line, (4) the steam line 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 (see Figure 33) which are cooled by water, which is force-circulated by electrically powered pumps. 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 and can be powered by onsite diesel generators. Boiling water reactors contain between 370–800 fuel assemblies. For more information on nuclear reactor fuel, see Figure 28.



Source: Nuclear Regulatory Commission

OPERATING NUCLEAR REACTORS

Figure 19. **U.S. Commercial Nuclear Power Reactor Operating Licenses Issued by Year**



Note: No licenses issued after 1996.

Table 10. **U.S. Commercial Nuclear Power Reactor Operating—Licenses Issued by Year**

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

Source: Data as compiled by the Nuclear Regulatory Commission
Note: Limited to reactors licensed to operate.
Year is based on the date the initial full-power operating license was issued.

Oversight of U.S. Commercial Nuclear Power Reactors

Reactor Oversight Process

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 the design, construction and operation of such plants. To ensure that the plants are operated safely within these requirements, the NRC licenses the plants to operate, licenses the plant operators, and establishes technical specifications for the operation of each plant.

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 and regulations. The NRC has full authority to take whatever action is necessary to protect public health and safety and may demand immediate licensee actions, up to and including a plant shutdown.

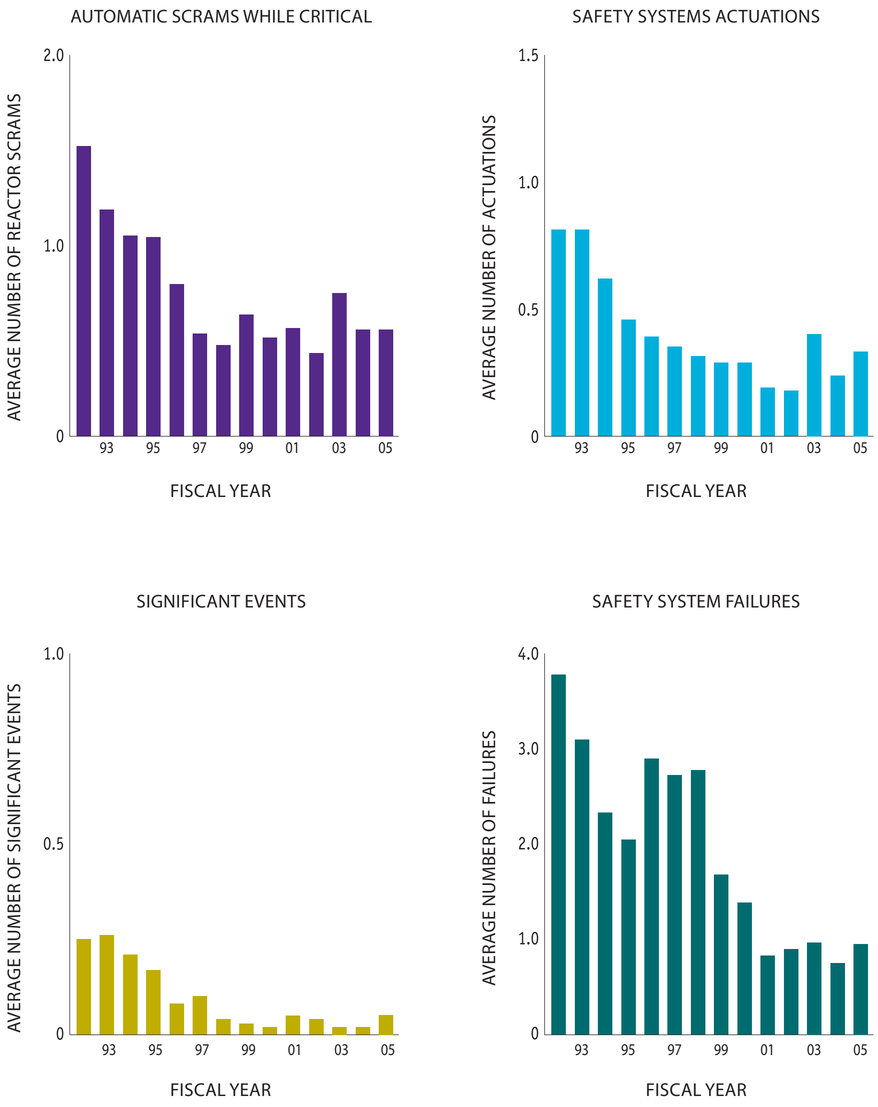
The ROP is described on the NRC's Web site and in NUREG-1649, Revision 3, "Reactor Oversight Process." In general terms, the ROP uses both inspection findings and performance indicators (PIs) to assess the performance of each plant within a regulatory framework of seven cornerstones of safety. The ROP recognizes that issues of very low safety significance inevitably occur, and plants are expected to effectively address these issues. The NRC performs a baseline level of inspection at each plant. The NRC may perform supplemental inspections and take additional actions to ensure that significant performance issues are addressed. A summary of the NRC's inspection effort for 2005 is shown in Figure 21. The latest plant-specific inspection findings and PI information can be found on the NRC's Web site.

The ROP takes into account improvements in the performance of the nuclear industry over the past 25 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 efforts within the nuclear industry and to successful regulatory oversight.

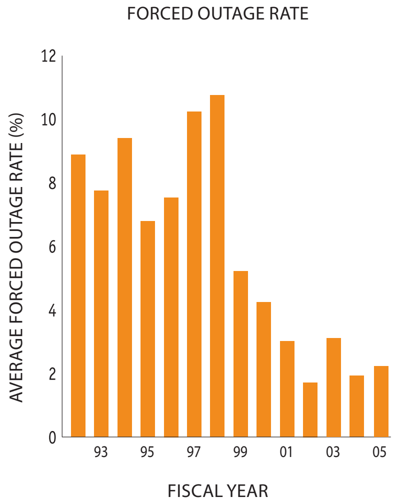
Industry Performance Indicators

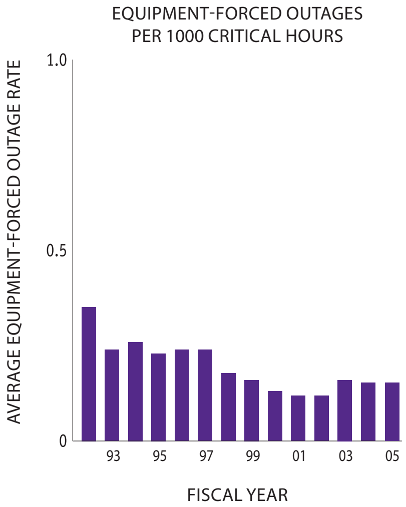
In addition to evaluating the performance of each individual plant, the NRC compiles data on overall performance using various industry-level performance indicators, as shown in Figure 21 and Appendix G. The indicators can provide additional data for assessing trends in industry performance.

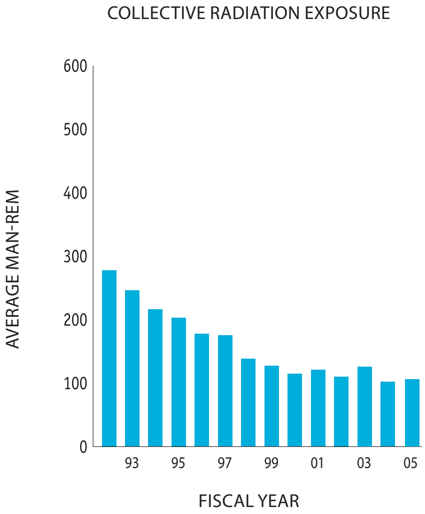
Figure 20. **NRC Performance Indicators:**



Annual Industry Averages, FYs 1992–2005



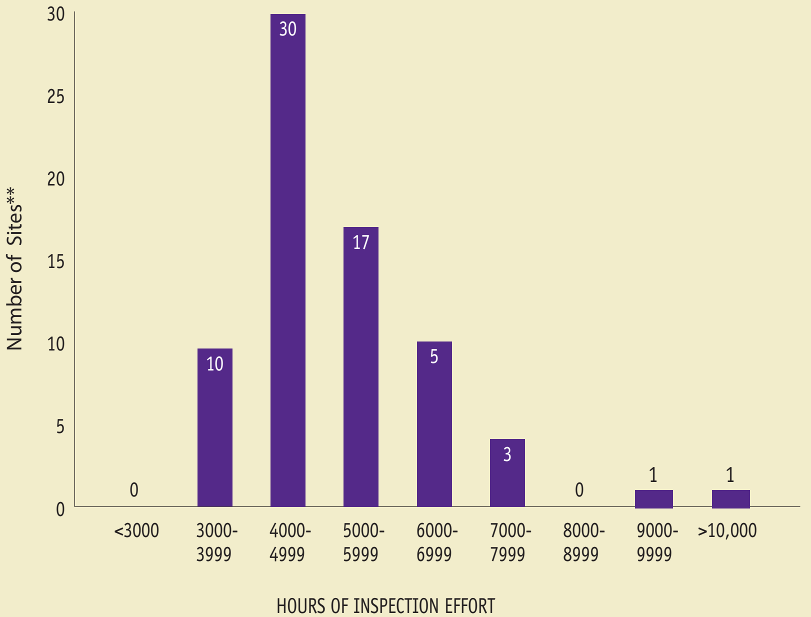




Note: Data represent Annual industry averages, with plants in extended shutdown excluded. Data are rounded for display purposes. These data may differ slightly from previously published datd as a result of refinements in data quality.

Source: Licensee data as compiled by the Nuclear Regulatory Commission.

Figure 21. **NRC Inspection Effort at Operating Reactors, 2005***



*Data include regular and nonregular hours for all activities related to baseline, plant-specific, generic safety issues, and allegation inspections (does not include effort for performance assessment).

**67 total sites (Indian Point 2, Indian Point 3, Millstone 2, Millstone 3, Hope Creek, and Salem are treated as separate sites for inspection effort.)

Source: Nuclear Regulatory Commission.

Future U.S. Commercial Nuclear Power Reactor Licensing

The NRC expects and is preparing to perform new reactor licensing work in response to the Energy Policy Act of 2005 and associated Administration initiatives. The Act, whose overall goal is to promote "secure, affordable, and reliable energy," recognizes that the country's aging electric power supply system must expand and be replaced with clean energy sources.

The NRC staff is engaged in numerous ongoing interactions with vendors and utilities regarding prospective new reactor applications and licensing activities. Based on these interactions, the staff expects to receive a significant number of new reactor combined license (COL) applications over the next several years and is currently developing the infrastructure necessary to support the application reviews. As of July 2006, the staff is preparing to receive up to 18 COLs for a total of 26 new nuclear units over the next few years.

The NRC is performing several activities to ensure that it is prepared to review new applications. These activities include reviewing industry's guidelines for a COL application and assessing the actions necessary to prepare for receipt of a COL application; developing a COL application regulatory guide; updating NUREG-0800, "Standard Review Plan," and associated regulatory guides; developing strategies for optimizing the review of the applications to be received; performing rulemaking activities for the 10 CFR Part 52 licensing process; developing a construction inspection program framework and subsequent inspection program for new construction activities; and continuing our activities in the pre-application and design certification review processes. The staff is preparing to receive the first COL application in 2007.

The NRC is performing preapplication reviews for AREVA's Evolutionary Power Reactor (EPR) and the Pebble Bed Modular Reactor sponsored by PBMR (Pty) Ltd.

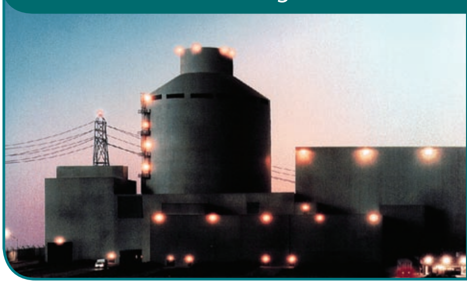
The NRC is currently performing the design certification review of General Electric's (GE) Economic Simplified Boiling Water Reactor (ESBWR) design. In the past, the NRC has provided design certifications for four reactor designs that can be referenced in an application for a nuclear power plant. These designs include the following:

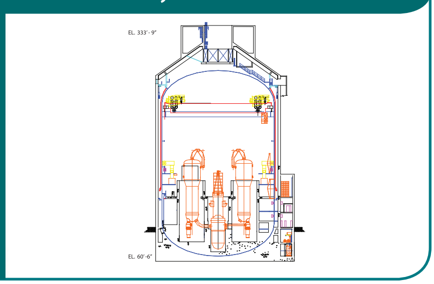
- GE Nuclear Energy's Advanced Boiling Water Reactor design
- Westinghouse's System 80+ design
- Westinghouse's AP600 design
- Westinghouse's AP1000 design

The NRC is currently reviewing three applications for early site permits (ESPs). The three applicants are Dominion Nuclear North Anna, LLC, for the North Anna site in Virginia; Exelon Generation Company, LLC, for the Clinton site in Illinois; and System Energy Resources, Inc., for the Grand Gulf site in Mississippi. An ESP provides for early resolution of site safety, environmental protection, and emergency preparedness issues, independent of a specific nuclear plant review. Mandatory adjudicatory hearings associated with the ESPs will be conducted after the completion of the NRC staff's technical review.

Additional information on the NRC's new reactor licensing activities is available on the NRC's Web site at http://www.nrc.gov/reactors/new-reactor-licensing.html.

Westinghouse AP1000 Certified January 2006





Reactor License Renewal

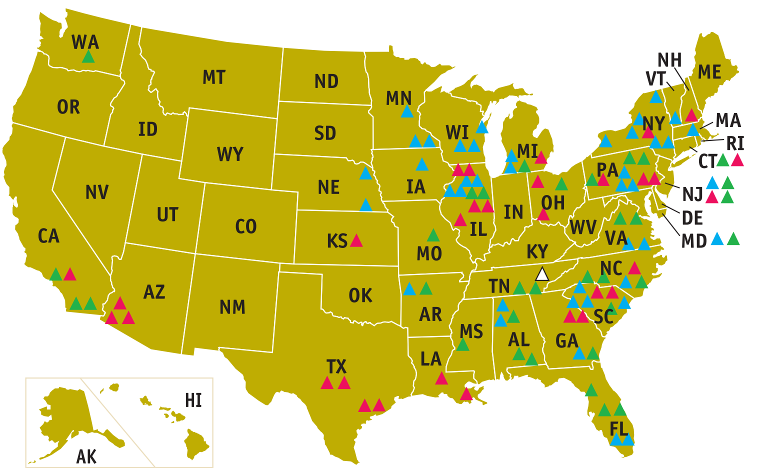
Based on the Atomic Energy Act, the NRC issues licenses for commercial power reactors to operate for 40 years and allows these licenses to be renewed for up to an additional 20 years.

The original 40-year term for reactor licenses was based on economic and antitrust considerations, not on limitations of nuclear technology. Due to this selected time period, however, some structures and components may have been engineered on the basis of an expected 40-year service life.

As of July 2006, approximately one-half of the licensed plants have either received or are under review for license renewal. The age of operating reactors is illustrated in Figure 22. Figure 23 and Table 11 list the expiration dates of operating commercial nuclear licenses.

The decision whether to seek license renewal rests entirely with nuclear power plant owners and typically is based on the plant's economic situation and whether it can meet NRC requirements. Extending reactor operating licenses beyond their current 40-year terms will provide a viable approach for electric utilities to ensure the adequacy of future electricity-generating capacity that offers significant economic benefits when compared to the construction of new reactors (see Figure 23 and Table 12).

Figure 22. **U.S. Commercial Nuclear Power Reactors —Years of Operation**



YEARS OF COMMERCIAL OPERATION	NUMBER OF REACTORS
△ 0-9	1
▲ 10-19	21
▲ 20-29	42
▲ 30-36	40

Source: Nuclear Regulatory Commission

License renewal rests on the determination that current operating plants continue to maintain an adequate level of safety. Over the plant's life, this level of safety has been enhanced through maintenance of the licensing basis, with appropriate adjustments to address new information from industry operating experience. Additionally, the NRC's regulatory activities have provided ongoing assurance that the current licensing basis will continue to provide an acceptable level of safety. The license renewal review process was developed to provide continued assurance that this level of safety will be maintained for the period of extended operation if a renewed license is issued.

The NRC has issued regulations establishing clear requirements for license renewal to assure safe plant operation for extended plant life (codified in 10 CFR Parts 51 and 54). The review of a renewal application proceeds along two paths—one for the review of safety issues and the other for environmental issues. 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 an evaluation of 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 evaluations through inspections.

Public participation is an important part of the license renewal process. There are several opportunities for members of the public to question how aging will be managed during the period of extended operation. Information provided by the applicant is made available to the public. A number of public meetings are held, and all NRC technical and environmental review results are fully documented and made publicly available. Concerns may be litigated in an adjudicatory hearing if any party that would be adversely affected requests a hearing.

The NRC Web site (http://www.nrc.gov) provides information on the plants that have received renewed licenses and the renewal applications that are under review. The Web site also provides information on the license renewal regulations and process.

The NRC has conducted research providing the technical bases to ensure that critical reactor components, safety systems, and structures provide adequate reliability as reactors age. Research results continue to be useful in assessing safety implications of age-related degradation during the 40-year license and in supporting safety decisions associated with license renewal.

Figure 23. U.S. Commercial Nuclear Power Reactor Operating Licenses —Expiration Date by Year Assuming Construction Recapture

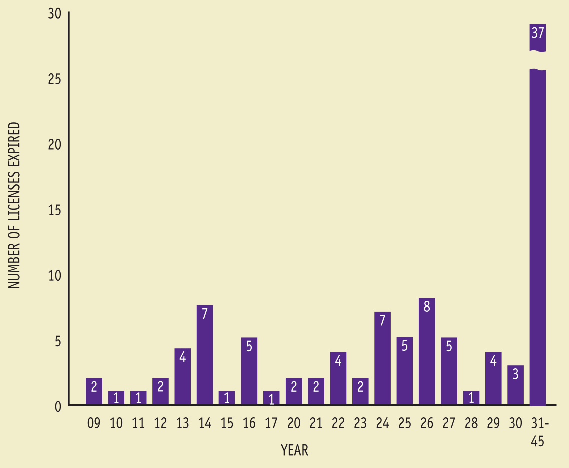


Table 11. U.S. Commercial Nuclear Power Reactor Operating Licenses— Expiration Date by Year, 2009–2045

2009	Nine Mile Point 1 Oyster Creek
2010	Monticello
2011	Palisades
2012	Pilgrim 1 Vermont Yankee
2013	Browns Ferry 1 Indian Point 2 Kewaunee Prairie Island 1
2014	Browns Ferry 2 Brunswick 2 Cooper Duane Arnold James A. FitzPatrick Prairie Island 2 Three Mile Island 1
2015	Indian Point 3
2016	Beaver Valley 1 Browns Ferry 3 Brunswick 1 Crystal River 3 Salem 1
2017	Davis-Besse
2020	Salem 2 Sequoyah 1
2021	Diablo Canyon 1 Sequoyah 2
2022	La Salle County 1 San Onofre 2 San Onofre 3 Susquehanna 1
2023	La Salle County 2 Columbia Generating St.
2024	Byron 1 Callaway Grand Gulf 1 Limerick 1 Palo Verde 1 Susquehanna 2 Waterford 3
2025	Diablo Canyon 2 Fermi 2 Palo Verde 2 River Bend 1 Wolf Creek 1
2026	Braidwood 1 Byron 2 Clinton Hope Creek 1 Nine Mile Point 2 Perry 1 Seabrook 1 Shearon Harris 1
2027	Beaver Valley 2 Braidwood 2 Palo Verde 3 South Texas Project 1 Vogtle 1
2028	South Texas Project 2
2029	Limerick 2 Dresden 2 Ginna Vogtle 2
2030	Comanche Peak 1 Robinson 2 Point Beach1
2031	Dresden 3
2032	Turkey Point 3 Surry 1 Quad Cities 1 Quad Cities 2
2033	Comanche Peak 2 Fort Calhoun Oconee 1 Oconee 2 Peach Bottom 2 Point Beach 2 Turkey Point 4 Surry 2
2034	Arkansas Nuclear 1 Calvert Cliffs 1 D.C. Cook 1 Edwin Hatch 1 Oconee 3 Peach Bottom 3
2035	Watts Bar Millstone 2
2036	Calvert Cliffs 2 St. Lucie 1
2037	Joseph m. Farley 1 D.C. Cook 2
2038	Arkansas Nuclear 2 Edwin Hatch 2 North Anna 2
2040	North Anna 2
2041	Joseph M Farley 2 McGuire 1
2042	Summer
2043	Catawba 1 Catawba 2 McGuire 2 St. Lucie 2
2045	Millstone 3

Year assumes that the maximum number of years for construction recapture has been added to the current expiration date. This column is limited to reactors eligible for construction recapture. See Glossary for definition.
Note: Limited to reactors licensed to operate.
Source: Data as compiled by the Nuclear Regulatory Commission. Data as of December 2005.

U.S. Nuclear Research and Test Reactors

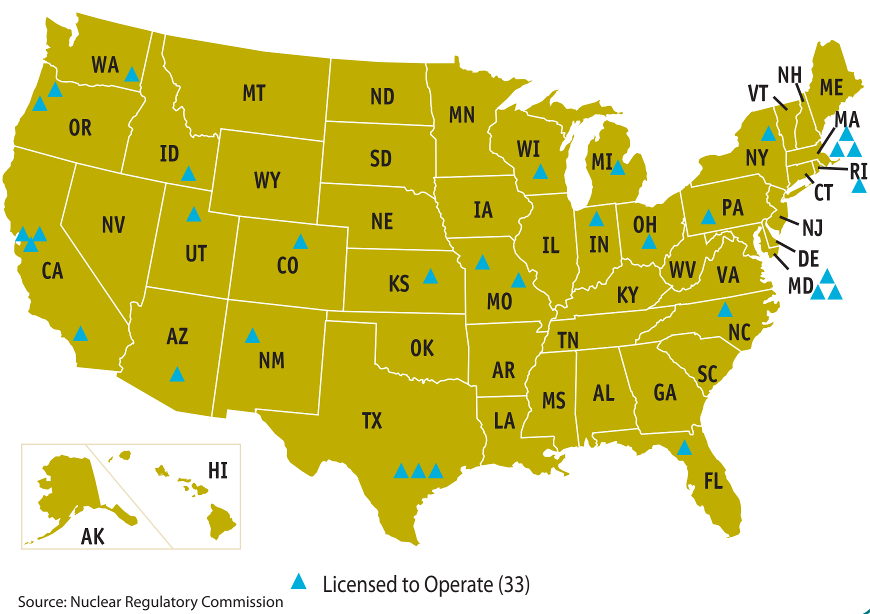
Nuclear research and test reactors are designed and utilized for research, testing, and educational purposes:

- In the performance of research and testing in the areas of physics, chemistry, biology, medicine, materials sciences, and related fields.
- In educating people for nuclear-related careers in the power industry, national defense, health service industry, research, and education.
- There are 50 licensed research and test reactors:
  - 33 reactors operating in 22 States (see Figure 24)
  - 17 reactors permanently shut down under decommissioning
- Since 1958, 76 licensed research and test reactors have been decommissioned.
- Refer to Appendix E for listing of operating research and test reactors regulated by the NRC.
- Refer to Appendix F for listing of decommissioning research and test reactors regulated by the NRC.

Principal Licensing and Inspection Activities

- The NRC licenses approximately 300 research and test reactor operators. Each operator is requalified before renewal of a 6-year license.
- The NRC conducts approximately 45 research and test reactor inspections each year.

Figure 24. **U.S. Nuclear Research and Test Reactors**



Source: Nuclear Regulatory Commission

Nuclear Regulatory Research

The NRC's research program, conducted by the Office of Nuclear Regulatory Research (RES), furthers the regulatory mission of the NRC by providing technical advice, technical tools, and information for identifying and resolving safety issues, making regulatory decisions, and promulgating regulations and guidance. In addition, RES conducts independent experiments and analyses, develops technical bases for supporting realistic safety decisions by the NRC, and prepares the NRC for the future by evaluating the safety aspects of current and new reactor designs and technologies.

The challenges that face RES include changes in practices and performance of the regulated industry, the emergence of new safety issues as the industry continues to mature, the availability of new technologies, development of new reactor design, knowledge management, and public awareness of and involvement in the regulatory process. Accordingly, the NRC must have highly skilled, independent experts with access to facilities to formulate sound technical solutions and to support timely and realistic regulatory decisions.

The NRC's current research program focuses on supporting the NRC strategic performance goals: safety, security, openness, effectiveness, and excellence in agency management. To ensure protection of public health and safety and the environment, RES's programs include research into material degradation issues (e.g., stress-corrosion cracking and boric acid corrosion), high-level waste transportation, storage, and disposal, new and evolving technologies (e.g., new reactor technology, mixed oxide fuel performance), operating experience, and probabilistic risk assessment (PRA) technologies. RES also develops and maintains computer codes for use in analyzing severe accidents, environmental effects, nuclear criticality, fire conditions, thermal hydraulic performance of reactors, fuel performance, and PRA. These computer codes continue to evolve as computational abilities expand and additional operational data allows for more realistic modeling.

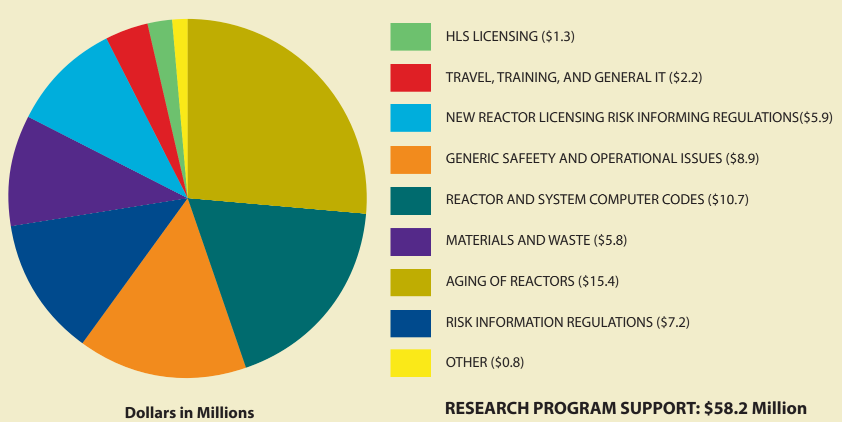
To ensure the secure use and management of radioactive materials, RES is investigating potential vulnerabilities to malicious attack and compensatory actions of nuclear facilities. To ensure openness in the regulatory process, RES conducts public meetings and participates with the Office of Nuclear Reactor Regulation in the annual Regulatory Information Conference to bring together diverse groups of stakeholders and discuss the latest trends in cutting-edge research. To ensure that the NRC's actions are effective, efficient, realistic, and timely, RES participates in information exchanges and cooperative research, both domestic and international, to share positions on technical and policy issues, enhance the effective and efficient use of agency resources, avoid duplication of effort, and share facilities wherever possible. To enhance management excellence, RES manages human capital by using innovative recruitment, development, and retention strategies. Additionally, RES encourages knowledge management initiatives to support staff development and networking. This achieves a high-quality, diverse work force, which supports providing high-quality research products.

The NRC provides RES with funding to manage cooperative agreements with universities and nonprofit organizations for research in specific areas of interest to the agency(see Figure 25). These cooperative agreements include Ohio State University for work on risk importance of digital systems, the Electric Power Research Institute for work on irradiation-assisted stress corrosion cracking, and the University of Maryland for work on PRA techniques in risk- informed and performance-based regulations.

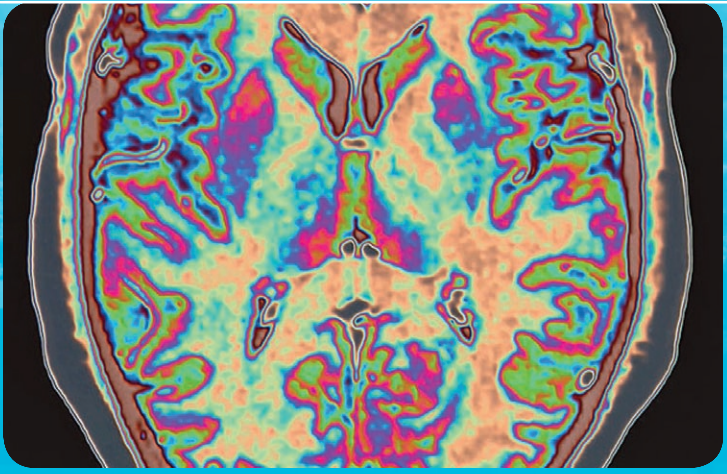
The NRC also provides RES with funding to manage grants with universities and non-profit organizations for research in specific areas of interest to the agency. These grants include the National Council on Radiation Protection and the International Council on Radiation Protection for work on radiation protection issues and Pennsylvania State University for work on fuel cladding behavior.

Additionally, the NRC provides RES with funding to manage agreements with foreign governments for international cooperative research in specific areas of interest to the agency. These research agreements include the Halden Reactor Project in Norway for research and development of fuel, reactor internals, plant control and monitoring, and human factors; the Cabri Water Loop Project in France for fuels research; the Studsvik Cladding Integrity Project in Sweden for fuels research; and the MAterial SCAling (MASCA) Project conducted in Russia for research on chemical and fission product effects in the reactor vessel during a severe accident.

Figure 25. **NRC Research Funding, FY 2006**



NUCLEAR MATERIALS SAFETY



MRI scan of brain (Imagesource.com)

http://www.nrc.gov/materials.html

Uranium Milling

A uranium mill is a chemical plant designed to extract uranium from mined ore. The mined ore is brought by truck to the milling facility where the ore is crushed and leached. In most cases, sulfuric acid is used as the leaching agent, but alkaline leaching can also be used. The leaching agent extracts not only uranium from the ore but also several other constituents like molybdenum, vanadium, selenium, iron, lead, and arsenic. The product produced from the mill is referred to as "yellow cake" (U_3O_8) because of its yellowish color.

As defined in the NRC regulations of 10 CFR Part 40, uranium milling is any activity that results in the production of byproduct material as defined in this part. The regulations in 10 CFR Part 40 defines byproduct material the same as Section 11e.(2) of the Atomic Energy Act as, "the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content," but adds "including discrete surface wastes resulting from uranium solution extraction processes."

Uranium is extracted from ore at uranium mills and at in situ leach (ISL) facilities (the NRC-licensed heap leach and ion-exchange facilities no longer operate). In both cases, an extraction process concentrates the uranium into yellow cake, and the process waste is byproduct material. The yellow cake is sent to a conversion facility for processing in the next step in the manufacture of nuclear fuel. The uranium milling and disposal of byproduct material by NRC licensees is regulated under 10 CFR Part 40, Appendix A.

Conventional mills crush the pieces of ore and extract 90 to 95 percent of the uranium from the ore. Mills are typically located in areas of low population density, and they process ores from mines within about 50 kilometers (30 miles) of the mill. Most mills in the United States are in decommissioning.

ISL facilities are another means of extracting uranium from underground. ISL facilities recover from low grade ores the uranium that may not be economically recoverable by other methods. In this process, a leaching agent such as oxygen with sodium carbonate is injected through wells into the ore body to dissolve the uranium. The leach solution is pumped from the formation, and ion exchange is used to separate the uranium from the solution. About 12 such ISL facilities exist in the United States. Of these, four are licensed by the NRC, and the rest are licensed by Texas, an Agreement State.

Table 12. **Locations of Uranium Milling Facilities**

Licensee **In Situ Leach Facilities**	**Site Name/Location**
Cogema Mining, Inc.	Irigaray/ChR, Wyoming
Crow Butte Resources, Inc.	Crow Butte, Nebraska
Hydro Resources, Inc.	Crown Point, New Mexico
Power Resources, Inc.	Smith Ranch, Highlands, Ruth, and North Butte, Wyoming
Conventional Uranium Milling Facilities	
Umetco Minerals Corp.	Gas Hills, Wyoming
Western Nuclear, Inc.	Split Rock, Wyoming
Pathfinder Mines Corp.	Lucky Mc, Wyoming
American Nuclear Corp.	ANC, Wyoming
Pathfinder Mines Corp.	Shirley Basin, Wyoming
Exxon Mobil Corp.	Highlands, Wyoming
Bear Creek Uranium Co.	Bear Creek, Wyoming
Kennecott Uranium Corp.	Sweetwater, Wyoming
Homestake Mining Co.	Homestake, New Mexico
Rio Algom Mining, LLC	Ambrosia Lake, New Mexico
UNC Mining & Milling	Churchrock, New Mexico

Note: The facilities listed are under the authority of the NRC to produce byproduct material.

U.S. Fuel Cycle Facilities

The NRC licenses and inspects all commercial nuclear fuel facilities involved in the enriching, processing, and fabrication of uranium ore into reactor fuel.

There are seven major fuel fabrication and production facilities and two gaseous diffusion uranium enrichment facilities licensed to operate in eight States. In addition, one proposed gas centrifuge uranium enrichment facility has been approved, and one is currently undergoing a license review has been approved. Also, there is one proposed mixed oxide fuel fabrication facility that has been approved for construction but has not yet been constructed (see Table 13).

Table 13. **Major U.S. Fuel Cycle Facility Sites**

Uranium Hexafluoride Production Facilities	
Honeywell International, Inc.	Metropolis, Illinois
Uranium Fuel Fabrication Facilities (see Figure 28)	
Global Nuclear Fuels-Americas, LLC	Wilmington, North Carolina
Westinghouse Electric Company, LLC Columbia Fuel Fabrication Facility	Columbia, South Carolina
Nuclear Fuel Services, Inc.	Erwin, Tennessee
AREVA NP, Inc. Mt. Athos Road Facility	Lynchburg, Virginia
BWX Technologies Nuclear Products Division	Lynchburg, Virginia
AREVA NP, Inc.	Richland, Washington
Gaseous Diffusion Uranium Enrichment Facilities (see Figure 27)	
U.S. Enrichment Corporation	Paducah, Kentucky
U.S. Enrichment Corporation	Piketon, Ohio*
Proposed Gas Centrifuge Uranium Enrichment Facilities (see Figure 27)	
U.S. Enrichment Corporation	Piketon, Ohio
Proposed Mixed Oxide Fuel Fabrication Facilities	
Duke Cogema Stone & Webster	Aiken, South Carolina

The NRC regulates 10 other facilities that possess significant quantities of special nuclear material (other than reactors) or process source material (other than uranium recovery facilities).
*Currently in cold standby and not used for enrichment.

USEC, Inc., submitted an application for a Lead Cascade Facility in February 2003, and a license for the facility was issued in February 2004. The Lead Cascade is a test facility intended to provide operational information on the machines and auxiliary systems as they would be used in commercial production of enriched uranium. The Lead Cascade Facility is located at the Portsmouth Gaseous Diffusion Plant site in Piketon, Ohio, and is expected to begin operation in late 2006.

USEC, Inc., submitted a license application for the American Centrifuge Plant (ACP) in August 2004. The ACP would be an expansion of the Lead Cascade Facility for commercial production of enriched uranium. The NRC issued the final Environmental Impact Statement in April 2006. The Safety EvaluationReport (SER) is expected to be issued in late 2006.

The NRC recently approved an application for construction of a mixed oxide fuel fabrication facility at the Department of Energy's Savannah River Site.

The Department of Energy announced plans to construct this MOX facility through a contract with the consortium (known as DCS) of Duke Engineering & Services, COGEMA Inc., and Stone & Webster. A separate NRC approval is necessary before DCS can possess special nuclear material and operate the facility. The facility is intended to convert surplus U.S. weapons-grade plutonium, supplied by the Department of Energy, into fuel for use in commercial nuclear reactors. Such use would render the plutonium essentially inaccessible and unattractive for weapons use.

Principal Licensing and Inspection Activities

- The NRC issues approximately 80 new licenses, license renewals, license amendments, and safety and safeguards reviews for fuel cycle facilities annually.
- The NRC routinely conducts safety, safeguards, and environmental protection inspections of approximately 10 fuel cycle facilities or sites.

Figure 26. **Typical Uranium Enrichment Facility**

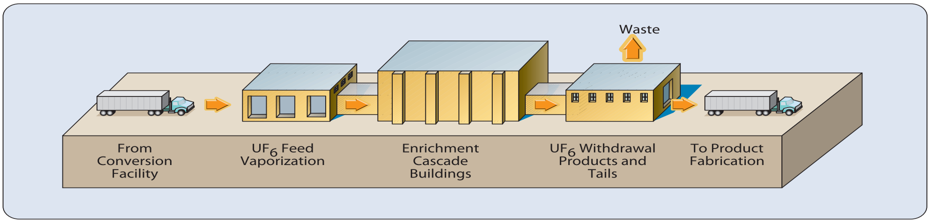
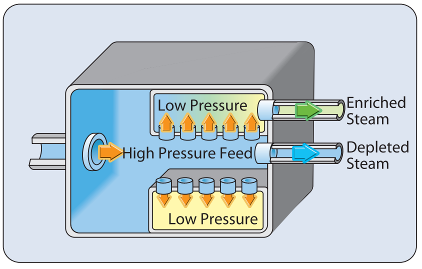


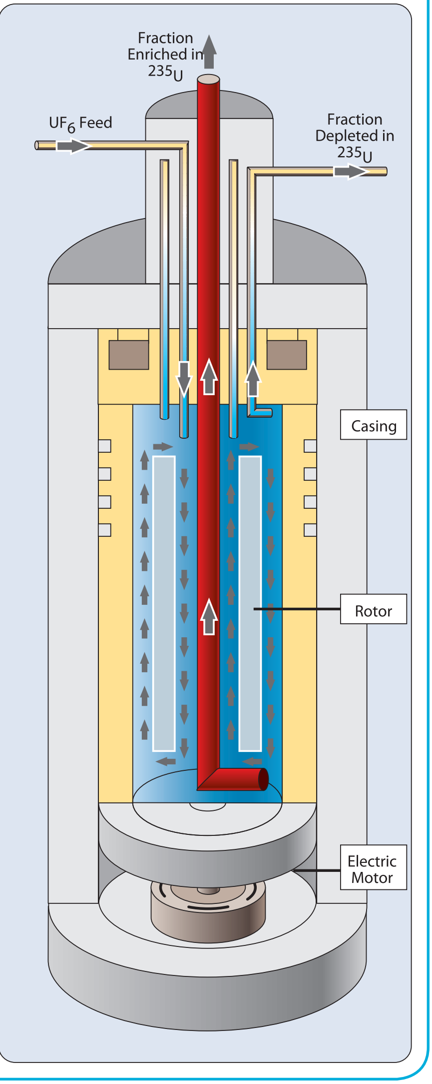
Figure 27. **Two Enrichment Processes**

A. Gas Diffusion Process



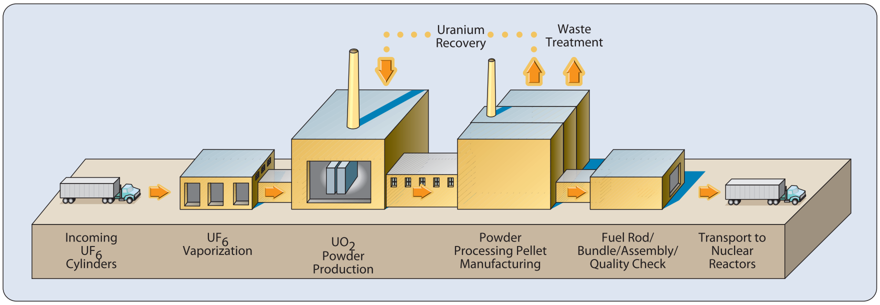
The gaseous diffusion method uses molecular diffusion to effect separation. The isotopic separation is accomplished by diffusing uranium, which has been combined with fluorine to form UF_6 gas, through a porous membrane (barrier) and utilizing the different molecular velocities of the two isotopes to achieve separation.

B. Gas Centrifuge Process



The gas centrifuge process uses a large number of rotating cylinders in a series and parallel configurations. Gas is introduced and rotated at a high speed, concentrating the component of higher molecular weight towards the outer wall of the cylinder and the lower molecular weight component towards the axis. The enriched and the depleted gas are removed by scoops.

Figure 28. **Typical Fuel Fabrication Plant**



Fabrication is the final step in the process used to produce uranium fuel. It begins with the conversion of enriched uranium hexafluoride (UF_6) gas to a uranium dioxide solid. Nuclear fuel must maintain both its chemical and physical properties under the extreme conditions of heat and radiation present inside an operating reactor vessel. Fabrication of commercial light-water reactor fuel consists of three basic steps:

1. chemical conversion of UF_6 to uranium dioxide (UO_2) powder;
2. ceramic process that converts uranium oxide powder to small pellets; and
3. mechanical process that loads the fuel pellets into rods and constructs finished fuel assemblies.

After the UF_6 is chemically converted to UO_2, the powder is blended, milled, and pressed into ceramic fuel pellets about the size of a fingertip. The pellets are stacked into long tubes made of material called "cladding" (such as zirconium alloys). After careful inspection, the resulting fuel rods are bundled into fuel assemblies for use in reactors. The cladding material provides one of multiple barriers to contain the radioactive fission products produced during the nuclear chain reaction.

Following final assembly operations, the completed fuel assembly (about 12-feet long) is washed, inspected, and finally stored in a special rack until it is ready for shipment to a nuclear power plant site.

Fuel fabrication facilities mechanically and chemically process the enriched uranium into nuclear reactor fuel.

NUCLEAR MATERIALS SAFETY

U.S. Materials Licenses

Approximately 22,000 licenses are issued for medical, academic, industrial, and general uses of nuclear materials (see Table 14).

- Approximately 4,500 licenses are administered by the NRC.
- Approximately 17,400 licenses are administered by the 34 States that participate in the NRC Agreement States Program. An NRC Agreement State is one that has signed an agreement with the NRC that authorizes the State to regulate materials within that State (see Table 14).

Reactor-produced radionuclides are used extensively throughout the United States for civilian and military industrial applications, basic and applied research, manufacture of consumer products, civil defense activities, academic studies, and medical diagnosis, treatment, and research. The NRC and Agreement State regulatory programs are designed to ensure that licensees safely use these materials and do not endanger public health and safety or cause damage to the environment.

Medical and Academic — The NRC and Agreement States issue licenses to hospitals and physicians for the use of certain radioactive materials in diagnosing and treating patients. In nuclear medicine, diagnostic procedures include in vitro tests (the addition of radioactive materials to lab samples taken from patients) and in vivo tests (direct administration of radioactive drugs to patients). Therapeutic treatments include the use of drugs to treat certain medical conditions such as hyperthyroidism and certain forms of cancer.

The NRC issues licenses to academic institutions for educational and research purposes. Licensed activities include receipt of radioactive material, classroom demonstrations by qualified instructors, supervised laboratory research by students, and the use of certain neutron sources and source material in subcritical assemblies.

The facilities, personnel, program controls and equipment in each application are reviewed to ensure the safety of the public, patients, and occupationally exposed workers.

Industrial — Radionuclides are used in a number of industrial and commercial applications, including industrial radiography, gauging devices, gas chromatography, well logging, and smoke detectors. The radiography process uses radiation sources to determine structural defects in metallic castings and welds. Portable and fixed gauges use a radiation detector and indicator to measure density and thickness of an object. Such measurements determine the thickness of paper products, fluid levels of oil and chemical tanks, moisture and density of soils and material at construction sites, and in manufacture items such as satellites and missiles. Gas chromatography uses low-energy sources for identifying the constituent elements of substances. It is used to determine the components of complex mixtures such as petroleum products, smog and cigarette smoke, and in biological and medical research to identify the components of complex proteins and enzymes. Well-logging devices use a radioactive source to trace the position of materials previously placed in a well. This process is used extensively for oil, gas, coal, and mineral exploration.

Table 14. **U.S. Materials Licenses by State**

State	Number of Licenses		
	NRC	Agreement States	
Alabama	18	437	yes
Alaska	56	0	yes
Arizona	11	330	yes
Arkansas	7	248	yes
California	47	2,029	yes
Colorado	20	353	yes
Connecticut	193	0	
Delaware	60	0	
District of Columbia	41	0	yes
Florida	15	1,606	yes
Georgia	16	526	yes
Hawaii	59	0	yes
Idaho	82	0	
Illinois	37	742	yes
Indiana	278	0	
Iowa	2	177	yes
Kansas	12	301	yes
Kentucky	10	435	yes
Louisiana	10	551	yes
Maine	2	129	yes
Maryland	61	610	yes
Massachusetts	27	513	yes
Michigan	536	0	
Minnesota	13*	200	yes
Mississippi	5	320	yes
Missouri	297	0	
Montana	77	0	
Nebraska	3	149	yes
Nevada	3	275	yes
New Hampshire	4	79	yes
New Jersey	510	0	
New Mexico	14	193	yes
New York	38	1,505	yes
North Carolina	18	673	yes
North Dakota	10	64	yes
Ohio	50	817	yes
Oklahoma	26	245	yes
Oregon	4	484	yes
Pennsylvania	697	0	
Rhode Island	1	59	yes
South Carolina	15	369	yes
South Dakota	41	0	
Tennessee	23	601	yes
Texas	43	1,630	yes
Utah	11	183	yes
Vermont	38	0	
Virginia	386	0	
Washington	19	429	yes
West Virginia	182	0	
Wisconsin	29	342	yes
Wyoming	78	0	
Others**	152	0	
Total	**4,528**	**17,604**	

*As of August 2006 (Minnesota Agreement State effective March 31, 2006).
**"Others" includes U.S. territories such as Puerto Rico, Virgin Islands, and Guam.
Note: Agreement States data are latest available as of February 8, 2005. NRC data as of March 29, 2006.
For updates, please refer to STP web site, http://www.hsrd.ornl.gov/nrc/USALicenses020805.pdf.

General Licenses — A general licensee is a person or organization that acquires, uses, or possesses a generally licensed device and has received the device through an authorized transfer by the device manufacturer/distributor, or by change of company ownership where the device remains in use at a particular location.

A generally licensed device is a device containing radioactive material that is typically used to detect, measure, gauge, or control the thickness, density, level, or chemical composition of various items. Examples of such devices are gas chromatographs (detector cells), density gauges, fill-level gauges, and static-elimination devices. The NRC registers and tracks generally licensed devices to increase control and accountability of the devices and to prevent them from becoming orphan sources.

Principal Licensing and Inspection Activities

- The NRC issues approximately 3,400 new licenses, renewals, or license amendments for materials licenses annually.
- The NRC conducts approximately 1,500 health and safety inspections of its nuclear materials licensees annually.

Nuclear Gauges

Fixed Gauges — The cross-section shows a fixed fluid gauge installed on a process pipe (see Figure 29). Such devices are widely used in beverage, food, plastics, process, and chemical industries to measure the densities, flow rates, levels, thicknesses, and weights of a wide variety of materials and surfaces.

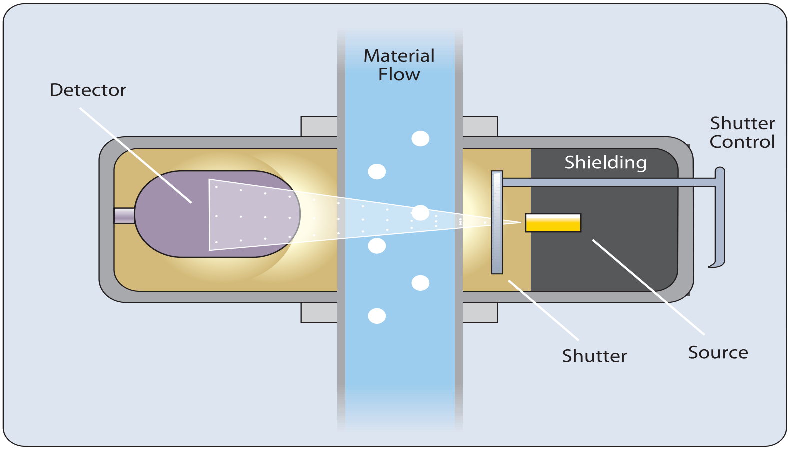
Nuclear gauges are used as nondestructive devices to measure physical properties of products and industrial processes to ensure environment, quality control, and low-cost fabrication, construction, and installations.

Fixed gauges consist of a radioactive source that is contained in a source holder safely. When the source holder's shutter is opened manually or by activating a remote electrical button, a beam of radiation is directed at the material or product being processed or controlled. A detector mounted opposite to the source measures the radiation passing through the media of the material or the product. The required information is shown on a local readout or is displayed on a computer monitor. The type and strength of radiation energy are selected to ensure that the passage of the radiation does not cause any detectable changes in the material and does not radioactively contaminate the material.

Portable Gauges — A radioactive source or sources and detector mounted together in a portable shielded device. When the device is being used, it is placed on the object to be measured, and the source is either inserted into the object or the gauge relies on a reflection of radiation from the source to bounce back to the bottom of the gauge. The detector in the gauge measures the radiation, either directly from the inserted source or the reflected radiation.

The amount of radiation that the detector measures indicates the thickness, density, moisture content, or some other property that is displayed on a local read out or on a computer monitor. The top of the gauge has sufficient shielding to protect the operator while the source is exposed, and when the measuring process is completed, the source is retracted or a shutter closes, minimizing exposure from the source.

Figure 29. **Cross-Section of a Fixed Fluid Gauge**



Source: Nuclear Regulatory Commission

NUCLEAR MATERIALS SAFETY

Teletherapy Devices

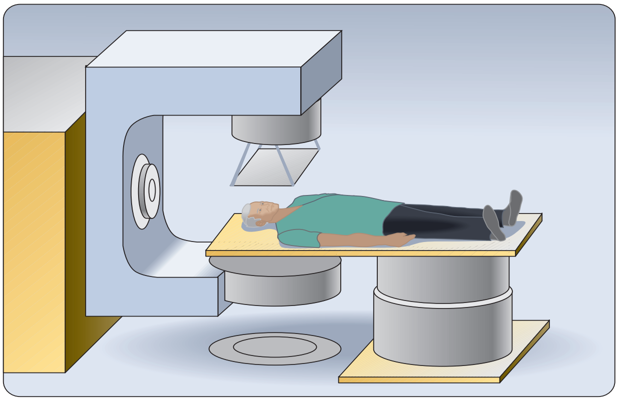
Teletherapy is one of the primary radiation oncology treatment modalities. Teletherapy devices provide external high-radiation beams for treatment of cancerous tumors. Both the primary tumor and the areas to which cancer may have spread (regional lymphatic) may be treated at the same time.

The cobalt-60 source is in the equipment's head, which is surrounded by lead or depleted uranium shielding, with a port for treatment (see Figure 30).

Treatment distance between the source and the skin of the patient is 80 to 120 centimeters. Cesium-137 teletherapy units were formerly used by a few facilities. Few, if any, of these units remain, as the average penetrating energy is approximately half of that provided by the cobalt sources.

Linear accelerators are replacing the cobalt-60 units. A 4 MeV linear accelerator can provide about the same energy as a cobalt-60 unit but with a higher output (100 to 300 rad/min). Higher energy accelerators are now being used (6 MeV to 30 MeV). These higher energy photons provide greater dose depth. Also, the high-energy electrons may be used directly in some cases.

Figure 30. **Cobalt-60 Teletherapy Unit**



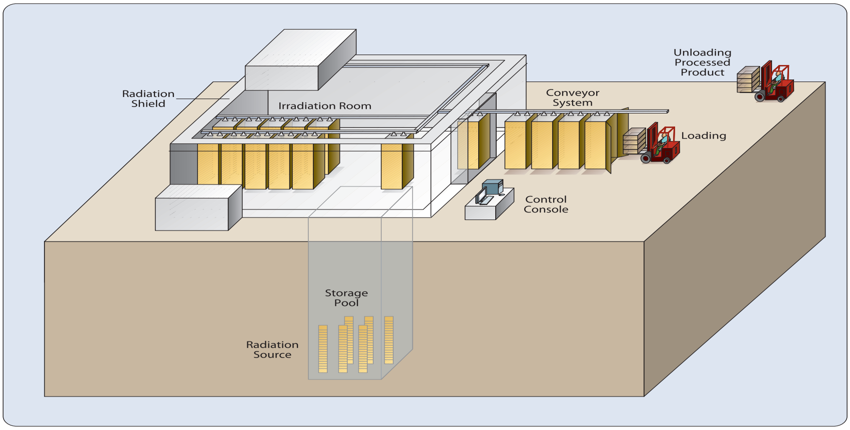
Source: Nuclear Regulatory Commission

Commercial Product Irradiators

Figure 31 shows a typical large commercial gamma irradiator that may be used for sterilization of medical supplies and equipment, disinfestation of food products, insect eradication through a sterile male release program, chemical and polymer synthesis and modifications or extension of the shelf-life of poultry and perishable products.

When this type of irradiator is in use, the cobalt-60 sealed source is raised out of the pool water and exposed to the product within a radiation volume that is maintained as inaccessible during use by an entry control system.

Figure 31. **Commercial Gamma Irradiator**



Source: Nuclear Regulatory Commission

NUCLEAR MATERIALS SAFETY

RADIOACTIVE WASTE

Transportation of Radioactive Material (Brand X Pictures)

http://www.nrc.gov/waste.html

U.S. Low-Level Radioactive Waste Disposal

Commercial low-level waste disposal facilities must be licensed by either the NRC or Agreement States in accordance with health and safety requirements. The facilities are to be designed, constructed, and operated to meet safety standards. The operator of the facility must also extensively characterize the site on which the facility is located and analyze how the facility will perform for thousands of years into the future. Current low-level waste disposal uses shallow land disposal sites with or without concrete vaults.

The NRC has developed a classification system for low-level waste based on its potential hazards and has specified disposal and waste form requirements for each of the three general classes of waste — A, B, and C. Class A waste contains lower concentrations of radioactive material than Class C waste. Class A waste accounts for approximately 90 percent of the total volume of low-level waste. Determination of the classification of waste, however, is a complex process. For more information, see 10 CFR Part 61.

The volume and radioactivity of waste vary from year to year based on the types and quantities of waste shipped each year. Waste volumes currently are several 100,000 cubic feet from reactor facilities undergoing decommissioning. Cleanup of contaminated sites accounts for several million cubic feet of low-level radioactive waste each year.

The Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) of 1985 authorized the following:

- Formation of 10 regional compacts (see Table 15)
- Exclusion of waste generated outside a compact

Active Licensed Disposal Facilities

- Barnwell, South Carolina
- Hanford, Washington
- Clive, Utah (restricted to Class A waste)

Closed Disposal Facilities

- Beatty, Nevada — closed 1993
- Sheffield, Illinois — closed 1978
- Maxey Flats, Kentucky — closed 1977
- West Valley, New York — closed 1975

Table 15. **U.S. Low-Level Waste Compacts**

Compact	States
Appalachian	Delaware
	Maryland
	Pennsylvania
	West Virginia
Atlantic	New Jersey
	South Carolina*
Central	Arkansas
	Kansas
	Louisiana
	Nebraska
	Oklahoma
Central Midwest	Illinois
	Kentucky
Midwest	Indiana
	Iowa
	Minnesota
	Missouri
	Ohio
	Wisconsin
Northwest	Alaska
	Hawaii
	Idaho
	Montana
	Oregon
	Utah*
	Washington*
	Wyoming
Rocky Mountain	Colorado
	Nevada
	New Mexico
Southeast	Alabama
	Florida
	Georgia
	Mississippi
	Tennessee
	Virginia
Southwestern	Arizona
	California
	North Dakota
	South Dakota
Texas	Texas
	Vermont
Unaffiliated	Connecticut
	Maine
	Massachusetts
	Michigan
	New Hampshire
	New York
	North Carolina
	Rhode Island

Note: Data as of March 2006.

*There are three active, licensed low-level waste disposal facilities located in Agreement States.

Barnwell, located in Barnwell, South Carolina - Currently, Barnwell accepts waste from all U.S. generators except those in Rocky Mountain and Northwest compacts. Beginning in 2008, Barnwell will only accept waste from the Atlantic Compact states (Connecticut, New Jersey, and South Carolina). Barnwell is licensed by the State of South Carolina to receive waste in Classes A-C.

Hanford, located in Hanford, Washington - Hanford accepts waste from the Northwest and Rocky Mountain compacts. Hanford is licensed by the State of Washington to receive waste in Classes A-C.

Envirocare, located in Clive, Utah - Envirocare accepts waste from all regions of the United States. Envirocare is licensed by the State of Utah for Class A waste only.

Source: Low-level Radioactive Waste Forum

U.S. High-Level Radioactive Waste Management: Disposal and Storage

The Yucca Mountain Decision

Policies of the United States that govern permanent disposal of high-level radioactive waste are defined by the Nuclear Waste Policy Act of 1982, as amended, and the Energy Policy Act of 1992. These acts specify that high-level radioactive waste will be disposed of underground in a deep geologic repository and that Yucca Mountain, Nevada, will be the single candidate site for characterization as a potential geologic repository (see Figure 32).

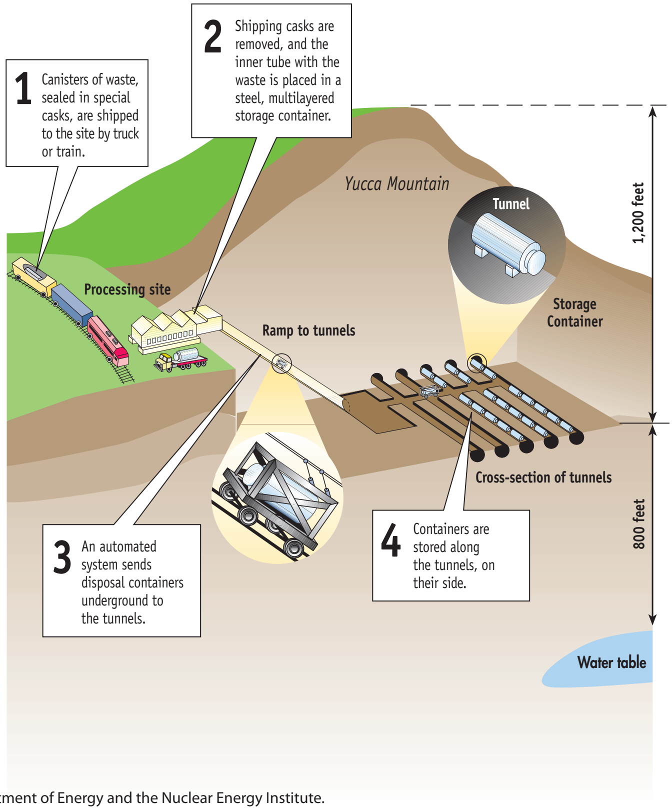
Under these two acts, the NRC is one of three Federal agencies that have key roles to perform in disposal of spent nuclear fuel and other high-level radioactive waste. In brief, the three agencies have the following roles:

- The Department of Energy (DOE) has responsibility for developing permanent disposal capacity for spent fuel and other high-level radioactive waste.
- The Environmental Protection Agency (EPA) has responsibility for issuing environmental standards for evaluating safety of a geologic repository at Yucca Mountain.
- The NRC has responsibility for issuing regulations that implement the EPA's standards; deciding whether to license the proposed repository; and ensuring that DOE, if granted a license, safely constructs and operates the repository.

For many years, the NRC has engaged the DOE in pre-license application activities, consistent with a public pre-licensing agreement. Through open public dialogue with the DOE, the NRC has actively sought to increase its confidence that a license application from the DOE will be complete and of sufficient quality for the NRC to conduct an informed safety review.

On February 15, 2002, after receiving a recommendation from the Secretary of Energy, the President notified Congress that he considered Yucca Mountain qualified for a construction permit application. Congress approved the recommendation, and on July 23, 2002, the President signed a joint Congressional resolution directing the DOE to prepare an application for constructing a repository at Yucca Mountain. At this time, the DOE expects to submit a license application to the NRC in 2008. The NRC will issue a license to the DOE only if the DOE can demonstrate that it can safely construct and operate a repository in compliance with the NRC's regulations.

Figure 32. **The Yucca Mountain Disposal Plan**



Source: Department of Energy and the Nuclear Energy Institute.

The NRC's regulations provide that decisions about the licensing of a geologic repository will occur in three phases. In the first phase, the DOE must submit a license application to the NRC. Once the DOE submits an application, if the NRC accepts it for review, the law allows the NRC 4 years to make a decision. Within that timeframe, the NRC must complete its safety review, conduct a public hearing before an independent licensing board, and decide whether to allow construction of the repository.

Should the NRC authorize construction, the process enters a second phase. As construction of the repository nears completion, the DOE must update its license to receive high-level radioactive waste. The NRC must again complete a safety review, conduct a public hearing before an independent licensing board, and decide whether the DOE can safely receive and dispose of waste at the repository. If the NRC grants the license, the DOE will begin placing high-level radioactive waste in the repository. In the third phase, when the repository is full, the DOE will apply for a license amendment to decommission and permanently close the repository.

Spent Fuel Storage

The U.S. Energy Information Administration's 2002 survey found that approximately 46,000 metric tons of spent nuclear fuel were stored at commercial nuclear power reactors. Projected spent fuel discharges could bring this amount to about 53,000 metric tons by the year 2006.

- All operating nuclear power reactors are storing spent fuel in NRC-licensed onsite spent fuel pools (SFPs) (see Figure 33).
- Most reactors were not designed to store the full amount of spent fuel generated during their operational life. Utilities originally planned for spent fuel to remain in SFPs for a few years after discharge and then to be sent to a reprocessing facility. However, the U.S. Government declared a moratorium on reprocessing in 1977. Although the ban was later lifted, reprocessing was eliminated as a feasible option. Consequently, utilities expanded the storage capacity of their SFPs by using high-density storage racks.
- The NRC authorizes storage of spent fuel at an independent spent fuel storage installation (ISFSI) under two licensing options: site-specific licensing and general licensing. Currently, there are 42 licensed/operating ISFSIs in the United States (see Figure 34).
- Under a site-specific license, an applicant submits a license application to the NRC, and the NRC performs a technical review of all of the safety aspects of the proposed ISFSI. If the application is approved, the NRC issues a license. A spent fuel storage license contains technical requirements and operating conditions for the ISFSI and specifies what the licensee is authorized to store at the site. The license expires 20 years from the date of issuance, with a renewal option.
- A general license authorizes the nuclear power reactor licensee to store spent fuel in dry storage systems approved by the NRC at a site that is licensed to operate a nuclear power reactor. Several dry storage designs have received Certificates of Compliance or NRC approvals. A Certificate of Compliance expires 20 years from the date of issuance, with a reapproval option. General licensees are required to perform evaluations on their sites to demonstrate that a site is adequate for storing spent fuel in dry casks. These evaluations must show that the Certificate of Compliance conditions and technical specifications can be met prior to use of the dry storage system.
- With respect to public involvement, stakeholders can and do participate in the NRC licensing process. The Atomic Energy Act of 1954, as amended, and the NRC's regulations contain provisions for public hearings and other means, such as petitions and rulemaking requests, for the public to challenge NRC decisions and licensing actions.
- Appendix I lists dry spent fuel storage licensees.
- Additional information on storage of spent fuel at an ISFSI is available on the

NRC's Web site at http://www.nrc.gov/waste/spent-fuel-storage.html.

- The NRC is responsible for approving transportable dry storage systems, also called dual-purpose casks (see Figure 35).
- Additional information on transportation of spent fuel is available on the NRC's Web site at http://www.nrc.gov/waste/spent-fuel-transp.html.

U.S. Nuclear Materials Transportation and Safeguards

The NRC reviews and licenses the design of containers used to transport radioactive materials; conducts transport-related safety inspections; performs quality assurance inspections of designers, fabricators, and suppliers of approved transportation containers; and carries out safeguards inspections of nuclear materials licensees.

Under a memorandum of understanding, the NRC requires licensed materials to be shipped in accordance with the hazardous materials transportation safety regulations of the Department of Transportation.

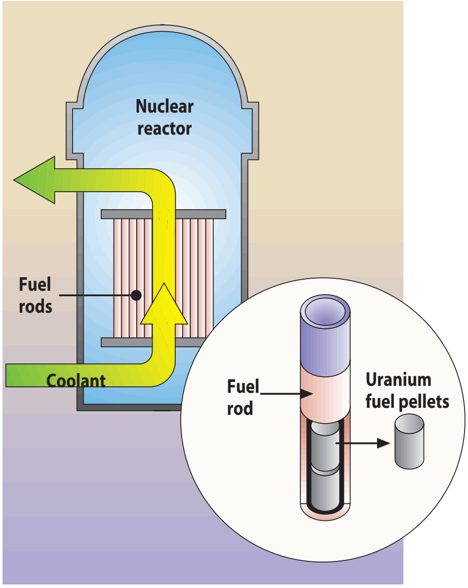
Both the NRC and the DOE continue joint operation of a national database and information support system to track movement of domestic and foreign nuclear materials under safeguards control.

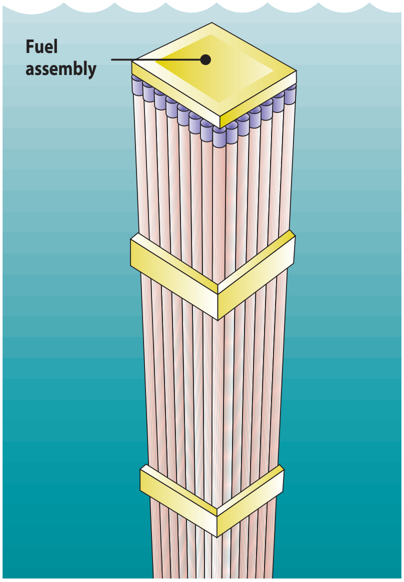
Principal Licensing and Inspection Activities

- The NRC examines transport-related safety during approximately 1,000 safety inspections of fuel, reactor, and materials licensees annually.
- The NRC reviews, evaluates, and certifies approximately 100 new, renewal, or amended container-design applications for the transport of nuclear materials annually.
- The NRC reviews and evaluates approximately 150 license applications for the import/export of nuclear materials from the United States annually.
- The NRC conducts comprehensive physical protection and materials control and accounting license reviews and conducts inspections at the major fuel fabrication facilities annually.
- The NRC inspects about 20 dry storage and transport package licensees annually.
- Additional information on materials transportation is available on the NRC's Web site at http://www.nrc.gov/materials/transportation.html.

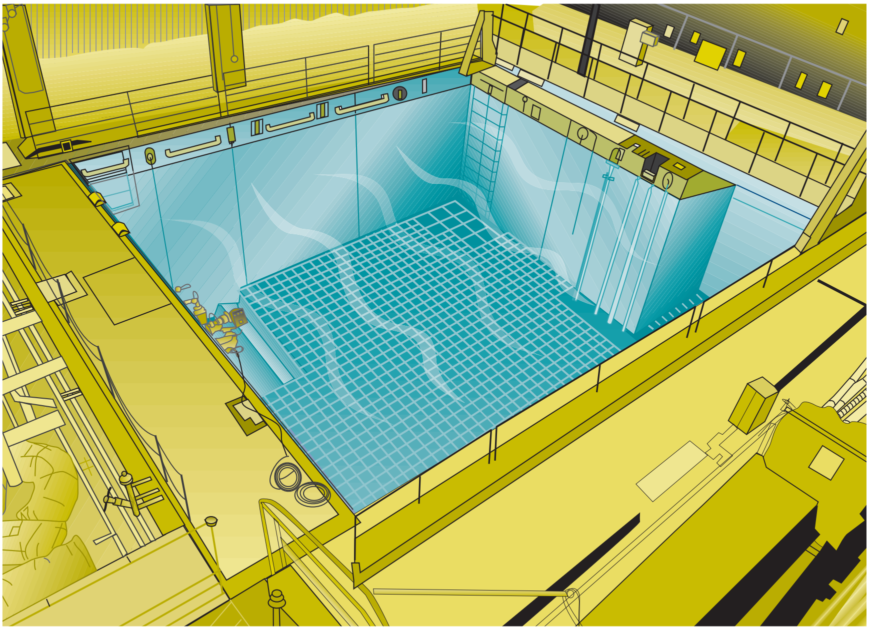
Figure 33. **Spent Fuel Generation and Storage After Use**

1 Nuclear reactors are powered by enriched U^{235} fuel. Fission generates heat, which produces steam that turns turbines to produce electricity. A reactor rated at several hundred megawatts may contain 100 or more tons of fuel in the form of bullet-sized pellets loaded into long rods.





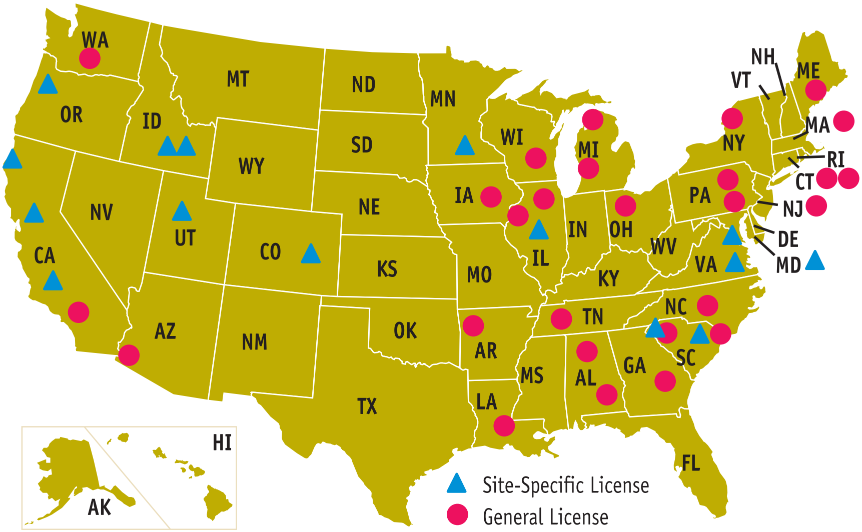
2 After about 6 years, spent fuel assemblies — typically 14 feet long and containing nearly 200 fuel rods — are removed from the reactor and allowed to cool in storage pools for a few years. At this point, the 900-pound assemblies contain only about one-fifth the original amount of U^{235}.



3 Commercial light-water nuclear reactors store spent fuel outside the primary containment in a steel-lined, seismically designed concrete pool. The spent fuel is cooled while in the spent fuel storage pool by water that is force-circulated using electrically powered pumps. Makeup water to the pool is provided by other pumps that can be powered from an onsite emergency diesel generator. Support features, such as water and radiation level detectors, are also provided. Spent fuel is stored in the spent fuel storage pool until it can be transferred on site to a dry-cask storage location (see Figure 34) or transported off site to a high-level radioactive waste disposal site. Pressurized-water reactors contain between 150-200 fuel assemblies. Boiling-water reactors contain between 378-800 fuel assemblies.

Source: Department of Energy and the Nuclear Energy Institute

Figure 34. **Licensed/Operating Independent Spent Fuel Storage Installations**



ALABAMA
- ● Brown's Ferry
- ● Farley

ARIZONA
- ● Palo Verde

ARKANSAS
- ● Arkansas Nuclear

CALIFORNIA
- ▲ Diablo Canyon
- ▲ Rancho Seco
- ● San Onofre
- ▲ Humboldt Bay

COLORADO
- ▲ Fort St. Vrain

CONNECTICUT
- ● Haddam Neck
- ● Millstone

GEORGIA
- ● Hatch

IDAHO
- ▲ DOE: TMI-2 Fuel Debris
- ▲ Idaho Spent Fuel Facility

ILLINOIS
- ▲ GE Morris
- ● Dresden
- ● Quad Cities

IOWA
- ● Duane Arnold

LOUISIANA
- ● River Bend

MAINE
- ● Maine Yankee

MARYLAND
- ▲ Calvert Cliffs

MASSACHUSETTS
- ● Yankee Rowe

MICHIGAN
- ● Big Rock Point
- ● Palisades

MINNESOTA
- ▲ Prairie Island

NEW JERSEY
- ● Oyster Creek

NEW YORK
- ● James A. FitzPatrick

NORTH CAROLINA
- ● McGuire

OHIO
- ● Davis-Besse

OREGON
- ▲ Trojan

PENNSYLVANIA
- ● Susquehanna
- ● Peach Bottom

SOUTH CAROLINA
- ●▲ Oconee
- ●▲ H.B. Robinson

TENNESSEE
- ● Sequoyah

UTAH
- ▲ Private Fuel Storage

VIRGINIA
- ▲ Surry
- ▲ North Anna

WASHINGTON
- ● Columbia Generating Station

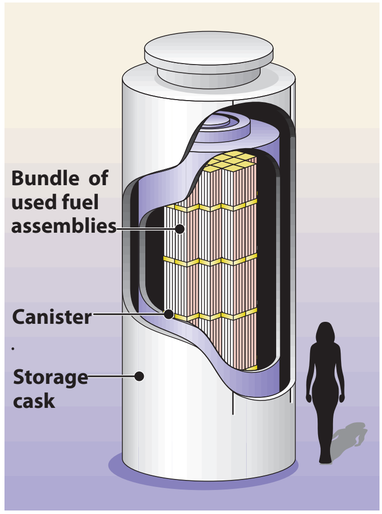
WISCONSIN
- ● Point Beach

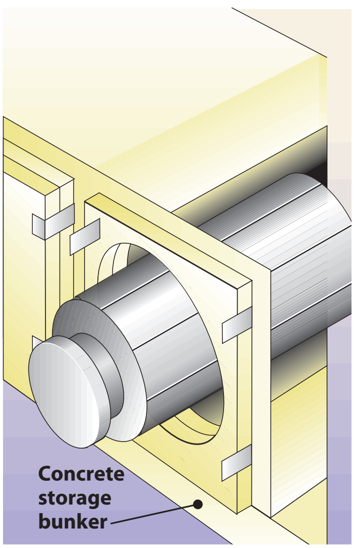
Data as of March 2005
Source: Nuclear Regulatory Commission

Figure 35. **Dry Storage of Spent Fuel**

At some nuclear reactors across the country, spent fuel is kept on site, above ground, in systems basically similar to the ones shown here.

1 Once the spent fuel has cooled, it is loaded into special canisters which are designed to hold pressurized-water reactor (PWR) and boiling-water reactor (BWR) assemblies. Water and air are removed. The canister is filled with inert gas, welded shut, and rigorously tested for leaks. It is then placed in a cask for storage or transportation. In addition, NRC has approved the storage of up to 40 PWR assemblies and up to 68 BWR assemblies in dry storage cask storage systems.





2 The canisters can also be stored in above-ground concrete bunkers, each of which is about the size of a one-car garage. Eventually they may be transported elsewhere for storage.

Source: Department of Energy and the Nuclear Energy Institute

RADIOACTIVE WASTE

Decommissioning

Decommissioning is the safe removal of a facility from service and reduction of residual radioactivity to a level that permits release of the property and termination of the license (see Glossary). The NRC rules on decommissioning establish site release criteria and provide for unrestricted and, under certain conditions, restricted release of a site.

The NRC regulates the decontamination and decommissioning of materials and fuel cycle facilities, power reactors, research and test reactors, and uranium recovery facilities, with the ultimate goal of license termination. Approximately 200 materials licenses are terminated each year. Most of these license terminations are routine, and the sites require little, if any, remediation to meet the NRC's unrestricted release criteria. The decommissioning program focuses on termination of licenses that are not routine because the sites involve more complex decommissioning activities. Currently, there are 17 nuclear power reactors, 14 research and test reactors, 38 complex decommissioning materials facilities, 3 fuel cycle facilities (partial decommissioning), and 12 uranium safe storage under NRC jurisdiction. Table 17, Appendix B, and Appendix F list complex decommissioning sites and permanently shutdown and decommissioning nuclear power reactors and research and test reactors. NUREG-1814, "Annual Decommissioning Report," provides additional information on the NRC's Decommissioning Program.

Decommissioning of Trojan Nuclear Power Plant Cooling Tower

Source: Nuclear Energy Institute

Table 16. **Complex Decommissioning Sites**

Company	**Location**
AAR Manufacturing, Inc. (Brooks & Perkins)	Livonia, MI
Army, Department of, Jefferson Proving Ground	Jefferson, IN
Army, Department of, Ft. Belvoir	Ft. Belvoir, VA
Army, Department of, Ft. McClellan	Ft. McClellan, AL
Babcock & Wilcox SLDA	Vandergrift, PA
Battelle Columbus Laboratories	Columbus, OH
Cabot Corporation	Reading, PA
Combustion Engineering/Westinghouse	Windsor, CT
Combustion Engineering/Westinghouse	Festus, MO
Curtis-Wright	Cheswick, PA
Dow Chemical Company	Bay City and Midland, MI
Eglin AFB	Walton County, FL
Englehard Minerals	Great Lakes, IL
Fansteel, Inc.	Muskogee, OK
Hartley and Hartley (SCA Holdings) Landfill	Bay County, MI
Heritage Minerals	Lakehurst, NJ
Homer Laughlin China	Newell, WV
Kaiser Aluminum	Tulsa, OK
Kerr-McGee	Cimarron and Cushing, OK
Mallinckrodt	St. Louis, MO
Molycorp, Inc.	Washington, PA
NWI Breckenridge	Breckenridge, MI
Pathfinder	Sioux Falls, SD
Quehanna	Media, PA
Royersford Wastewater Treatment Facility	Royersford, PA
Safety Light Corporation	Bloomsburg, PA
Salmon River	Salmon, ID
Shieldalloy Metallurgical Corporation	Newfield, NJ
Stepan Chemical Corporation	Maywood, NJ
Superior Steel/Superbolt	Carnegie, PA
UCAR (Union Carbide)	Lawrenceberg, TN
UNC Naval Products	New Haven, CT
Westinghouse Electric Corporation	Churchville, PA
Westinghouse Electric Corporation	Waltz Mill, PA
Westinghouse Electric Corporation	Blairsville, PA
West Valley Demonstration Project	West Valley, NY
Whittaker Corporation	Greenville, PA

Source: Nuclear Regulatory Commission

APPENDICES

Prairie Island Nuclear Power Plant (NRC image library)

Abbreviations Used In Appendices

ABB-CE	Asea Brown Boveri-Combustion Engineering
AC	Allis Chalmers
ACE	ACEOWEN, Ateliers de Constructions Electriques de Charleroi S.A. (ACEC) and Cocerill Ougree-Providence (COP); with Westinghouse (Belgium)
ACLF	ACECO/Creusot-loire/Framatome/Westinghouse-Europe
AE	Architect-Engineer
AEC	Atomic Energy Commission
AECL	Atomic Energy of Canada, Ltd.
AEE	Atomenergoexport
AEP	American Electric Power
AGN	Aerojet-General Nucleonics
AI	Atomics International
ASEA	Asea Brown Boveri-Asea Atom
B&R	Burns & Roe
B&W	Babcock & Wilcox
BALD	Baldwin Associates
BECH	Bechtel
BLH	Baldwin Lima Hamilton
BRRT	Brown & Root
BWR	Boiling Water Reactor
CE	Combustion Engineering
COMB	Combustion Engineering
COMM. OP.	Date of Commercial Operation
CON TYPE	Containment Type
DRYAMB	Dry, Ambient Pressure
DRYSUB	Dry, Subatmospheric
HTG	High-Temperature Gas-Cooled
ICECND	Wet, Ice Condenser
LMFB	Liquid Metal Fast Breeder
MARK 1	Wet, Mark I
MARK 2	Wet, Mark II
MARK 3	Wet, Mark III
OCM	Organic Cooled & Moderated
PTHW	Pressure Tube, Heavy Water
SCF	Sodium Cooled, Fast
SCGM	Sodium Cooled, Graphite Moderated
CP	Construction Permit
CP ISSUED	Date of Construction Permit Issuance
CPPR	Construction Permit Power Reactor
CWE	Commonwealth Edison Company
CX	Critical Assembly
DANI	Daniel International
DBDB	Duke & Bechtel
DER	Design Electric Rating
DOE	Department of Energy
DPR	Demonstration Power Reactor
DUKE	Duke Power Company
EVESR	ESADA (Empire States Atomic Development Associates) Vallecitos Experimental Superheat Reactor
EBSO	Ebasco
EXP. DATE	Expiration Date of Operating License
FENOC	FirstEnergy Nuclear Operating Co.
FLUR	Fluor Pioneer
FRAM	Framatome
G&H	Gibbs & Hill
GA	General Atomic
GCR	Gas-Cooled Reactor
GE	General Electric
GETR	General Electric Test Reactor
GHDR	Gibbs & Hill & Durham & Richardson
GIL	Gilbert Associates
GPC	Georgia Power Company
HIT	Hitachi

HTG	High-Temperature Gas-Cooled
HWR	Pressurized Heavy-Water Reactor
IES	Iowa Electric
ISFSI	Spent Fuel Storage Installation
JONES	J.A. Jones
KAIS	Kaiser Engineers
kW	Kilowatt
KWU	Kraftwerk Union, Siemens AG
LIC. TYPE:	License Type
CP	Construction Permit
OL-FP	Operating License-Full Power
OL-LP	Operating License-Low Power
MAE	Ministry of Atomic Energy, Russian Federation
MDC	Maximum Dependable Capacity-Net
MHI	Mitsubishi Heavy Industries, Ltd.
MW	Megawatts
MWe	Megawatts Electrical
MWh	Megawatthour
MWt	Megawatts Thermal
NIAG	Niagara Mohawk Power Corporation
NPF	Nuclear Power Facility
NSP	Northern States Power Company
NSSS	Nuclear Steam System Supplier & Design Type
1	GE Type 1
2	GE Type 2
3	GE Type 3
4	GE Type 4
5	GE Type 5
6	GE Type 6
2LP	Westinghouse Two-Loop
3LP	Westinghouse Three-Loop
4LP	Westinghouse Four-Loop
CE	Combustion Engineering
CE80	CE Standard Design
LLP	B&W Lowered Loop
RLP	B&W Raised Loop
OCM	Office of the Commission
OL	Operating License
OL ISSUED	Date of Latest Full Power Operating License
PECO	Philadelphia Energy Company
PG&E	Pacific Gas & Electric Company
PHWR	Pressurized Heavy-Water-Moderated Reactor
PSE	Pioneer Services & Engineering
PTHW	Pressure Tube Heavy Water
PUBS	Public Service Electric & Gas Company
PWR	Pressurized-Water Reactor
R	Research
S&L	Sargent & Lundy
S&W	Stone & Webster
SBEC	Southern Services & Bechtel
SCGM	Sodium Cooled Graphite Moderated
SSI	Southern Services Incorporated
STP	South Texas Project
TNPG	The Nuclear Power Group
TOSH	Toshiba
TR	Test Reactor
TRIGA	Training Reactor and Isotopes Production, General Atomics
TVA	Tennessee Valley Authority
TXU	Texas Utilities
UE&C	United Engineers & Constructors
USEC	U.S. Enrichment Corporation
UTR	Universal Training Reactor
VT	Vermont
WDCO	Westinghouse Development Corporation
WEST	Westinghouse Electric
WMT	Waste Management Tank

APPENDIX A
U.S. Commercial Nuclear Power Reactors

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
Arkansas Nuclear One 1 Entergy Operations 6 miles WNW of Russellville, AR 050-00313	IV	PWR-DRYAMB B&W LLP BECH BECH	2568	0841	12/06/1968 05/21/1974 12/19/1974 05/20/2034	OL-FP DPR-51	87.3 93.9 89.7 92.0 92.4 77.9
Arkansas Nuclear One 2 Entergy Nuclear 6 miles WNW of Russellville, AR 050-00368	IV	PWR-DRYAMB COMB CE BECH BECH	3026	0996	12/06/1972 09/01/1978 03/26/1980 07/17/2038	OL-FP NPF-6	69.9 105.3 106.5 90.4 98.6 91.2
Beaver Valley 1 FirstEnergy Nuclear Operating Company 17 miles W of McCandless, PA 050-00334	I	PWR-DRYAMB WEST 3LP S&W S&W	2689	0821	06/26/1970 07/02/1976 10/01/1976 01/29/2016	OL-FP DPR-66	82.7 83.3 97.2 83.2 92.6 101.4
Beaver Valley 2 FirstEnergy Nuclear Operating Company 17 miles W of McCandless, PA 050-00412	I	PWR-DRYAMB WEST 3LP S&W S&W	2689	0831	05/03/1974 08/14/1987 11/17/1987 05/27/2027	OL-FP NPF-73	86.5 98.8 90.7 91.2 100.2 91.8
Braidwood 1 Exelon 24 miles SSW of Joilet, IL 050-00456	III	PWR-DRYAMB WEST 4LP S&L CWE	3586.6	1178	12/31/1975 07/02/1987 07/29/1988 10/17/2026	OL-FP NPF-72	96.4 93.4 104.3 97.2 94.8 99.6
Braidwood 2 Exelon 24 miles SSW of Joilet, IL 050-00457	III	PWR-DRYAMB WEST 4LP S&L CWE	3586.6	1152	12/31/1975 05/20/1988 10/17/1988 12/18/2027	OL-FP NPF-77	98.4 98.2 93.5 96.3 100.8 94.3
Browns Ferry 1 Tennessee Valley Authority 10 miles NW of Decatur, AL 050-00259	II	BWR-MARK 1 GE 4 TVA TVA	3293	1065	05/10/1967 12/20/1973 08/01/1974 12/20/2013	OL-FP DPR-33	0.0 0.0 0.0 0.0 0.0 0.0

U.S. Commercial Nuclear Power Reactors (continued)

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
Browns Ferry 2 Tennessee Valley Authority 10 miles NW of Decatur, AL 050-00260	II	BWR-MARK 1 GE 4 TVA TVA	3458	1118	05/10/1967 08/02/1974 03/01/1975 06/28/2014	OL-FP DPR-52	89.1 99.1 85.9 91.0 85.5 99.6 89.9
Browns Ferry 3 Tennessee Valley Authority 10 miles NW of Decatur, AL 050-00296	II	BWR-MARK 1 GE 4 TVA TVA	3458	1114	07/31/1968 08/18/1976 03/01/1977 07/02/2016	OL-FP DPR-68	92.6 100.1 94.6 95.6 88.9 93.8
Brunswick 1 Carolina Power and Light, Co. 2 miles N of Southport, NC 050-00325	II	BWR-MARK 1 GE 4 UE&C BRRT	2923	0938	02/07/1970 11/12/1976 03/18/1977 09/08/2016	OL-FP DPR-71	93.7 101.7 93.2 100.8 86.1 94.4
Brunswick 2 Carolina Power and Light, Co. 2 miles N of Southport, NC 050-00324	II	BWR-MARK 1 GE 4 UE&C BRRT	2923	0900	02/07/1970 12/27/1974 11/03/1975 12/27/2014	OL-FP DPR-62	99.0 92.1 99.6 98.9 98.1 86.0
Byron 1 Exelon 17 miles SW of Rockford, IL 050-00454	III	PWR-DRYAMB WEST 4LP S&L CWE	3586.6	1164	12/31/1975 02/14/1985 09/16/1985 10/31/2024	OL-FP NPF-37	95.7 102.0 96.5 94.2 101.5 94.2
Byron 2 Exelon 17 miles SW of Rockford, IL 050-00455	III	PWR-DRYAMB WEST 4LP S&L CWE	3586.6	1136	12/31/1975 01/30/1987 08/21/1987 11/06/2026	OL-FP NPF-66	103.1 99.2 96.3 101.1 96.4 95.7
Callaway AmerenUE 10 miles SE of Fulton, MO 050-00483	IV	PWR-DRYAMB WEST 4LP BECH DANI	3565	1137	04/16/1976 10/18/1984 12/19/1984 10/18/2024	OL-FP NPF-30	87.2 101.1 85.1 97.4 78.4 80.6

APPENDIX A
U.S. Commercial Nuclear Power Reactors (continued)

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
Calvert Cliffs 1 Nuclear Power Plant, Inc. 40 miles S of Annapolis, MD 050-00317	I	PWR-DRYAMB COMB CE BECH BECH	2700	0873	07/07/1969 07/31/1974 05/08/1975 07/31/2034	OL-FP DPR-53	89.0 103.2 64.3 101.8 91.3 99.5
Calvert Cliffs 2 Nuclear Power Plant, Inc. 40 miles S of Annapolis, MD 050-00318	I	PWR-DRYAMB COMB CE BECH BECH	2700	0862	07/07/1969 08/13/1976 04/01/1977 08/13/2036	OL-FP DPR-69	100.8 84.8 102.3 81.9 99.9 93.9
Catawba 1 Duke Energy Power Company, LLC 6 miles NNW of Rock Hill, SC 050-00413	II	PWR-ICECND WEST 4LP DUKE DUKE	3411	1129	08/07/1975 01/17/1985 06/29/1985 12/05/2043	OL-FP NPF-35	90.0 100.9 95.9 82.7 97.9 92.8
Catawba 2 Duke Energy Power Company, LLC 6 miles NNW of Rock Hill, SC 050-00414	II	PWR-ICECND WEST 4LP DUKE DUKE	3411	1129	08/07/1975 05/15/1986 08/19/1986 12/05/2043	OL-FP NPF-52	90.6 86.7 102.9 94.2 89.1 102.1
Clinton AmerGen Energy Co. 6 miles E of Clinton, IL 050-00461	III	BWR-MARK 3 GE 6 S&L BALD	3473	1043	02/24/1976 04/17/1987 11/24/1987 09/29/2026	OL-FP NPF-62	84.3 96.7 85.5 96.8 87.5 95.1
Columbia Generating Station Energy Northwest 12 miles NW of Richland, WA 050-00397	IV	BWR-MARK 2 GE 5 B&R BECH	3486	1122	03/19/1973 04/13/1984 12/13/1984 12/20/2023	OL-FP NPF-21	88.5 85.1 92.6 78.5 91.1 83.9
Comanche Peak 1 TXU Generation Company LP 4 miles N of Glen Rose, TX 050-00445	IV	PWR-DRYAMB WEST 4LP G&H BRRT	3458	1150	12/19/1974 04/17/1990 08/13/1990 02/08/2030	OL-FP NPF-87	95.2 83.8 87.3 101.4 89.5 91.5

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
Comanche Peak 2 TXU Electric & Gas 4 miles N of Glen Rose, TX 050-00446	IV	PWR-DRYAMB WEST 4LP BECH BRRT	3458	1150	12/19/1974 04/06/1993 08/03/1993 02/02/2033	OL-FP NPF-89	87.8 98.1 87.3 82.5 99.2 91.6
Cooper Nebraska Public Power District 23 miles S of Nebraska City, NE 050-00298	IV	BWR-MARK 1 GE 4 B&R B&R	2381	0756	06/04/1968 01/18/1974 07/01/1974 01/18/2014	OL-FP DPR-46	97.3 70.6 77.8 94.4 67.8 92.9 89.0
Crystal River 3 Florida Power Corp. 7 miles NW of Crystal River, FL 050-00302	II	PWR-DRYAMB B&W LLP GIL JONES	2568	0838	09/25/1968 01/28/1977 03/13/1977 12/03/2016	OL-FP DPR-72	97.2 89.2 99.9 90.1 99.2
Davis-Besse FirstEnergy Nuclear Operating Co. 21 miles ESE of Toledo, OH 050-00346	III	PWR-DRYAMB B&W RLP BECH	2772	0873	03/24/1971 04/22/1977 07/31/1978 04/22/2017	OL-FP NPF-3	87.4 99.5 12.0 -0.9 74.6 93.6
D.C. Cook 1 Indiana/Michigan Power Co. 11 miles S of Benton Harbor, MI 050-00315	III	PWR-ICECND WEST 4LP AEP AEP	3304	1016	03/25/1969 10/25/1974 08/28/1975 10/25/2034	OL-FP DPR-58	1.5 89.0 88.4 73.8 99.0 90.5
D.C. Cook 2 Indiana/Michigan Power Co. 11 miles S of Benton Harbor, MI 050-00316	III	PWR-ICECND WEST 4LP AEP AEP	3468	1077	03/25/1969 12/23/1977 07/01/1978 12/23/2037	OL-FP DPR-74	0.0 51.4 85.8 82.8 75.4 83.9 99.8
Diablo Canyon 1 Pacific Gas & Electric Co. 12 miles WSW of San Luis Obispo, CA 050-00275	IV	PWR-DRYAMB WEST 4LP PG&E PG&E	3338	1087	04/23/1968 11/02/1984 05/07/1985 09/22/2021	OL-FP DPR-80	83.3 99.8 74.0 100.7 75.6 87.3

APPENDIX A
U.S. Commercial Nuclear Power Reactors (continued)

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
Diablo Canyon 2 Pacific Gas & Electric Co. 12 miles WSW of San Luis Obispo, CA 050-00323	IV	PWR-DRYAMB WEST 4LP PG&E PG&E	3411	1087	12/09/1970 08/26/1985 03/13/1986 04/26/2025	OL-FP DPR-82	96.2 90.9 97.5 80.9 84.0 99.2
Dresden 2 Exelon 9 miles E of Morris, IL 050-00237	III	BWR-MARK 1 GE 3 S&L UE&C	2957	0867	01/10/1966 02/20/1991 06/09/1970 12/22/2029	OL-FP DPR-19	101.3 89.8 101.1 90.2 77.6 86.8
Dresden 3 Exelon 9 miles E of Morris, IL 050-00249	III	BWR-MARK 1 GE 3 S&L UE&C	2957	0867	10/14/1966 01/12/1971 11/16/1971 01/12/2031	OL-FP DPR-25	90.6 93.7 95.5 81.4 93.5 84.5 92.6
Duane Arnold Nuclear Management Company 8 miles NW of Cedar Rapids, IA 050-00331	III	BWR-MARK 1 GE 4 BECH BECH	1912	0563	06/22/1970 02/22/1974 02/01/1975 02/21/2014	OL-FP DPR-49	97.5 77.9 92.5 81.0 99.8 92.1
Edwin I. Hatch 1 Southern Nuclear Operating Co. 11 miles N of Baxley, GA 050-00321	II	BWR-MARK 1 GE 4 BECH GPC	2804	0869	09/30/1969 10/13/1974 12/31/1975 08/06/2034	OL-FP DPR-57	84.5 99.2 88.4 95.3 90.3 91.9
Edwin I. Hatch 2 Southern Nuclear Operating Co. 11 miles N of Baxley, GA 050-00366	II	BWR-MARK 1 GE 4 BECH GPC	2804	0883	12/27/1972 06/13/1978 09/05/1979 06/13/2038	OL-FP NPF-5	89.5 85.6 97.4 90.0 97.0 87.0
Fermi 2 The Detroit Edison Co. 25 miles NE of Toledo, OH 050-00341	III	BWR-MARK 1 GE 4 S&L DANI	3430	1111	09/26/1972 07/15/1985 01/23/1988 03/20/2025	OL-FP NPF-43	86.2 89.8 97.5 83.4 86.6 90.0

APPENDIX A
U.S. Commercial Nuclear Power Reactors (continued)

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
Fort Calhoun Omaha Public Power District 19 miles N of Omaha, NE 050-00285	IV	PWR-DRYAMB COMB CE GHDR GHDR	1500	0476	06/07/1968 08/09/1973 09/26/1973 08/09/2033	OL-FP DPR-40	92.8 84.2 91.0 84.0 97.3 69.8
R.E. Ginna Nuclear Power Plant, LLC 20 miles NE of Rochester, NY 050-00244	I	PWR-DRYAMB WEST 2LP GIL BECH	1520	0498	04/25/1966 09/19/1969 07/01/1970 09/18/2029	OL-FP DPR-18	90.5 101.9 91.4 88.6 98.6 91.7
Grand Gulf 1 Entergy Operations, Inc. 25 miles S of Vicksburg, MS 050-00416	IV	BWR-MARK 3 GE 6 BECH BECH	3833	1270	09/04/1974 11/01/1984 07/01/1985 06/16/2022	OL-FP NPF-29	100.6 93.6 95.1 98.5 91.7 90.6
H.B. Robinson 2 Carolina Power and Light Co. 26 miles from Florence, SC 050-00261	II	PWR-DRYAMB WEST 3LP EBSO EBSO	2339	0710	04/13/1967 09/23/1970 03/07/1971 07/31/2030	OL-FP DPR-23	104.0 92.2 93.7 103.5 92.1 92.8
Hope Creek 1 PSEG Nuclear, LLC 18 miles SE of Wilmington, DE 050-00354	I	BWR-MARK 1 GE 4 BECH BECH	3339	1049	11/04/1974 07/25/1986 12/20/1986 04/11/2026	OL-FP NPF-57	80.3 87.8 79.0 65.4 83.5
Indian Point 2 Entergy Nuclear Operation 24 miles N of New York City, NY 050-00247	I	PWR-DRYAMB WEST 4LP UE&C WDCO	3216	0979	10/14/1966 09/28/1973 08/01/1974 09/28/2013	OL-FP DPR-26	12.1 93.5 90.7 99.1 87.5 103.2
Indian Point 3 Entergy Nuclear Operations 24 miles N of New York City, NY 050-00286	I	PWR-DRYAMB WEST 4LP UE&C WDCO	3216	0991	08/13/1969 12/12/1975 08/30/1976 12/12/2015	OL-FP DPR-64	99.5 93.9 98.3 88.2 100.5 92.6

APPENDIX A
U.S. Commercial Nuclear Power Reactors (continued)

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
James A. FitzPatrick Entergy Nuclear Operations 8 miles NE of Oswego, NY 050-00333	I	BWR-MARK 1 GE 4 S&W S&W	2536	0844	05/20/1970 10/17/1974 07/28/1975 10/17/2014	OL-FP DPR-59	84.4 99.6 92.6 96.4 87.1 95.4
Joseph M. Farley 1 Southern Nuclear Operating Co. 18 miles SE of Dothan, AL 050-00348	II	PWR-DRYAMB WEST 3LP SSI DANI	2775	0851	08/16/1972 06/25/1977 12/01/1977 06/25/2037	OL-FP NPF-2	71.5 87.6 99.0 90.5 85.9 99.3
Joseph M. Farley 2 Southern Nuclear Operating Co. 18 miles SE of Dothan, AL 050-00364	II	PWR-DRYAMB WEST 3LP SSI BECH	2775	0860	08/16/1972 03/31/1981 07/30/1981 03/31/2041	OL-FP NPF-8	100.0 78.2 87.6 100.0 89.0 84.1
Dominion Energy Kewaunee, Inc. 27 miles E of Green Bay, WI 050-00305	III	PWR-DRYAMB WEST 2LP PSE PSE	1772	0560	08/06/1968 12/21/1973 06/16/1974 12/21/2013	OL-FP DPR-43	82.7 77.3 99.8 88.1 78.8 62.1
La Salle County 1 Exelon 11 miles SE of Ottawa, IL 050-00373	III	BWR-MARK 2 GE 5 S&L CWE	3489	1118	09/10/1973 04/17/1982 01/01/1984 04/17/2022	OL-FP NPF-11	99.6 101.2 91.7 92.4 92.2 100.2
La Salle County 2 Exelon 11 miles SE of Ottawa, IL 050-00374	III	BWR-MARK 2 GE 5 S&L CWE	3489	1120	09/10/1973 02/16/1983 10/19/1984 12/16/2023	OL-FP NPF-18	92.4 99.5 92.4 91.0 101.0 90.7
Limerick 1 Exelon 21 miles NW of Philadelphia, PA 050-00352	I	BWR-MARK 2 GE 4 BECH BECH	3458	1134	06/19/1974 08/08/1985 02/01/1986 10/26/2024	OL-FP NPF-39	89.5 101.2 93.5 100.9 95.1 99.2

APPENDIX A
U.S. Commercial Nuclear Power Reactors (continued)

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
Limerick 2 Exelon 21 miles NW of Philadelphia, PA 050-00353	I	BWR-MARK 2 GE 4 BECH BECH	3458	1134	06/19/1974 08/25/1989 01/08/1990 06/22/2029	OL-FP NPF-85	99.0 92.3 100.8 9.4 99.2 91.2
McGuire 1 Duke Energy Power Company, LLC 17 miles N of Charlotte, NC 050-00369	II	PWR-ICECND WEST 4LP DUKE DUKE	3411	1100	02/23/1973 07/08/1981 12/01/1981 06/12/2041	OL-FP NPF-9	103.4 90.1 94.4 102.9 85.3 93.1
McGuire 2 Duke Energy Power Company, LLC 17 miles N of Charlotte, NC 050-00370	II	PWR-ICECND WEST 4LP DUKE DUKE	3411	1100	02/23/1973 05/27/1983 03/01/1984 03/03/2043	OL-FP NPF-17	87.5 102.5 92.5 93.7 103.4 88.7
Millstone 2 Dominion Generation 3.2 miles WSW of New London, CT 050-00336	I	PWR-DRYAMB COMB CE BECH BECH	2700	0882	12/11/1970 09/26/1975 12/26/1975 07/31/2035	OL-FP DPR-65	57.9 81.7 95.6 81.3 80.3 97.8 88.8
Millstone 3 Dominion Generation 3.2 miles WSW of New London, CT 050-00423	I	PWR-DRYSUB WEST 4LP S&W S&W	3411	1155	08/09/1974 01/31/1986 04/23/1986 11/25/2045	OL-FP NPF-49	99.9 82.1 88.3 100.8 88.3 86.4
Monticello Nuclear Management Co. 30 miles NW of Minneapolis, MN 050-00263	III	BWR-MARK 1 GE 3 BECH BECH	1775	0569	06/19/1967 01/09/1981 06/30/1971 09/08/2010	OL-FP DPR-22	83.6 76.5 99.0 91.8 100.7 89.8
Nine Mile Point 1 Constellation Nuclear 6 miles NE of Oswego, NY 050-00220	I	BWR-MARK 1 GE 2 NIAG S&W	1850	0621	04/12/1965 12/26/1974 12/01/1969 08/22/2009	OL-FP DPR-63	94.3 88.5 99.1 80.4 91.7 84.6

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
Nine Mile Point 2 Point Nuclear Station, LLC 6 miles NE of Oswego, NY 050-00410	I	BWR-MARK 2 GE 5 S&W S&W	3467	1135	06/24/1974 07/02/1987 03/11/1988 10/31/2026	OL-FP NPF-69	81.1 90.3 85.8 95.5 86.3 99.7
North Anna 1 Dominion Generation 40 miles NW of Richmond, VA 050-00338	II	PWR-DRYSUB WEST 3LP S&W S&W	2893	0925	02/19/1971 04/01/1978 06/06/1978 04/01/2038	OL-FP NPF-4	92.0 87.9 100.8 80.5 91.3 95.0
North Anna 2 Dominion Generation 40 miles NW of Richmond, VA 050-00339	II	PWR-DRYSUB WEST 3LP S&W S&W	2893	0917	02/19/1971 08/21/1980 12/14/1980 08/21/2040	OL-FP NPF-7	101.8 74.4 68.6 90.4 91.7 87.0
Oconee 1 Duke Energy Power Company, LLC 30 miles W of Greenville, SC 050-00269	II	PWR-DRYAMB B&W LLP DBDB DUKE	2568	0846	11/06/1967 02/06/1973 07/15/1973 02/06/2033	OL-FP DPR-38	84.9 94.0 89.2 70.8 97.7 90.7
Oconee 2 Duke Energy Power Company, LLC 30 miles W of Greenville, SC 050-00270	II	PWR-DRYAMB B&W LLP DBDB DUKE	2568	0846	11/06/1967 10/06/1973 09/09/1974 10/06/2033	OL-FP DPR-47	100.9 90.2 89.2 102.1 76.3 89.9
Oconee 3 Duke Energy Power Company, LLC 30 miles W of Greenville, SC 050-00287	II	PWR-DRYAMB B&W LLP DBDB DUKE	2568	0846	11/06/1967 07/19/1974 12/16/1974 07/19/2034	OL-FP DPR-55	88.5 72.8 100.7 85.2 77.2 97.7
Oyster Creek AmerGen Energy Co., LLC 9 miles S of Toms River, NJ 050-00219	I	BWR-MARK 1 GE 2 B&R B&R	1930	0619	12/15/1964 07/02/1991 12/01/1969 04/09/2009	OL-FP DPR-16	71.9 96.4 92.8 96.9 89.3 99.1

APPENDIX A
U.S. Commercial Nuclear Power Reactors (continued)

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
Palisades Nuclear Management Co. 5 miles S of South Haven, MI 050-00255	III	PWR-DRYAMB COMB CE BECH BECH	2565	0767	03/14/1967 02/21/1971 12/31/1971 03/24/2011	OL-FP DPR-20	80.2 89.6 36.8 99.6 91.6 79.3 98.9
Palo Verde 1 Arizona Public Service Company 36 miles W of Phoenix, AZ 050-00528	IV	PWR-DRYAMB COMB CE80 BECH BECH	3990	1243	05/25/1976 06/01/1985 01/28/1986 12/31/2024	OL-FP NPF-41	100.4 87.8 89.1 97.2 84.6 66.3
Palo Verde 2 Arizona Public Service Company 36 miles W of Phoenix, AZ 050-00529	IV	PWR-DRYAMB COMB CE80 BECH BECH	3990	1314	05/25/1976 04/24/1986 09/19/1986 12/09/2025	OL-FP NPF-51	87.2 92.6 92.0 72.2 92.4 81.9
Palo Verde 3 Arizona Public Service Company 36 miles W of Phoenix, AZ 050-00530	IV	PWR-DRYAMB COMB CE80 BECH BECH	3990	1247	05/25/1976 11/25/1987 01/08/1988 03/25/2027	OL-FP NPF-74	90.3 83.9 102.0 87.5 75.0 83.9
Peach Bottom 2 Exelon 17.9 miles S of Lancaster, PA 050-00277	I	BWR-MARK 1 GE 4 BECH BECH	3514	1112	01/31/1968 10/25/1973 07/05/1974 08/08/2033	OL-FP DPR-44	88.8 97.9 92.3 95.4 90.6 98.2
Peach Bottom 3 Exelon 17.9 miles S of Lancaster, PA 050-00278	I	BWR-MARK 1 GE 4 BECH BECH	3514	1112	01/31/1968 07/02/1974 12/23/1974 07/02/2034	OL-FP DPR-56	99.5 89.0 100.8 91.3 102.1 90.6
Perry 1 FirstEnergy Nuclear Operating Co. 7 miles NE of Painesville, OH 050-00440	III	BWR-MARK 3 GE 6 GIL KAIS	3758	1235	05/03/1977 11/13/1986 11/18/1987 03/18/2026	OL-FP NPF-58	93.9 71.6 92.2 79.0 94.3 70.9

APPENDIX A
U.S. Commercial Nuclear Power Reactors (continued)

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
Pilgrim 1 Entergy Nuclear 4 miles SE of Plymouth, MA 050-00293	I	BWR-MARK 1 GE 3 BECH BECH	2028	0685	08/26/1968 09/15/1972 12/01/1972 06/08/2012	OL-FP DPR-35	93.7 89.9 100.9 83.0 98.7 91.3
Point Beach 1 Nuclear Management Co. 13 miles NNW of Manitowoc, WI 050-00266	III	PWR-DRYAMB WEST 2LP BECH BECH	1540	0512	07/19/1967 10/05/1970 12/21/1970 10/05/2030	OL-FP DPR-24	92.3 82.9 89.0 96.8 80.7 81.2
Point Beach 2 Nuclear Management Co. 13 miles NNW of Manitowoc, WI 050-00301	III	PWR-DRYAMB WEST 2LP BECH BECH	1540	0518	07/25/1968 03/08/1973 10/01/1972 03/08/2033	OL-FP DPR-27	78.4 96.8 89.3 82.5 97.1 71.8
Prairie Island 1 Nuclear Management Co. 28 miles SE of Minneapolis, MN 050-00282	III	PWR-DRYAMB WEST 2LP FLUR NSP	1650	0522	06/25/1968 04/05/1974 12/16/1973 08/09/2013	OL-FP DPR-42	98.9 79.6 95.6 100.5 78.5 98.8
Prairie Island 2 Nuclear Management Co. 28 miles SE of Minneapolis, MN 050-00306	III	PWR-DRYAMB WEST 2LP FLUR NSP	1650	0522	06/25/1968 10/29/1974 12/21/1974 10/29/2014	OL-FP DPR-60	91.1 93.4 93.9 92.7 101.6 84.0
Quad Cities 1 Exelon 20 miles NE of Moline, IL 050-00254	III	BWR-MARK 1 GE 3 S&L UE&C	2957	0867	02/15/1967 12/14/1972 02/18/1973 12/14/2032	OL-FP DPR-29	91.3 99.6 76.2 89.9 85.4 82.7
Quad Cities 2 Exelon 20 miles NE of Moline, IL 050-00265	III	BWR-MARK 1 GE 3 S&L UE&C	2511	0867	02/15/1967 12/14/1972 03/10/1973 12/14/2032	OL-FP DPR-30	92.1 93.1 87.5 92.0 81.1 92.7

APPENDIX A
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Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
River Bend 1 Entergy Nuclear Operations, Inc. 24 miles NNW of Baton Rouge, LA 050-00458	IV	BWR-MARK 3 GE 6 S&W S&W	3091	0968	03/25/1977 11/20/1985 06/16/1986 08/29/2025	OL-FP NPF-47	89.4 95.3 100.1 89.2 87.3 92.1
Salem 1 PSEG Nuclear, LLC 18 miles S of Wilmington, DE 050-00272	I	PWR-DRYAMB WEST 4LP PUBS UE&C	3459	1174	09/25/1968 08/13/1976 06/30/1977 08/13/2016	OL-FP DPR-70	92.2 80.3 89.8 93.5 72.0 92.0
Salem 2 PSEG Nuclear, LLC 18 miles S of Wilmington, DE 050-00311	I	PWR-DRYAMB WEST 4LP PUBS UE&C	3459	1130	09/25/1968 05/20/1981 10/13/1981 04/18/2020	OL-FP DPR-75	86.3 99.5 87.5 81.9 88.4
San Onofre 2 Southern California Edison Co. 4 miles SE of San Clemente, CA 050-00361	IV	PWR-DRYAMB COMB CE BECH BECH	3438	1070	10/18/1973 09/07/1982 08/08/1983 02/16/2022	OL-FP NPF-10	90.7 101.3 90.8 103.6 85.7 95.3
San Onofre 3 Southern California Edison Co. 4 miles SE of San Clemente, CA 050-00362	IV	PWR-DRYAMB COMB CE BECH BECH	3438	1080	10/18/1973 09/16/1983 04/01/1984 11/15/2022	OL-FP NPF-15	101.6 60.0 100.9 90.9 73.6 100.1
Seabrook 1 FPL Energy Seabrook 13 miles S of Portsmouth, NH 050-00443	I	PWR-DRYAMB WEST 4LP UE&C UE&C	3587	1159	07/07/1976 03/15/1990 08/19/1990 10/17/2026	OL-FP NPF-86	78.1 85.9 91.8 91.3 99.9 93.1
Sequoyah 1 Tennessee Valley Authority 9.5 miles NE of Chattanooga, TN 050-00327	II	PWR-ICECND WEST 4LP TVA TVA	3411	1150	05/27/1970 09/17/1980 07/01/1981 09/17/2020	OL-FP DPR-77	78.3 91.8 100.9 72.9 92.0 100.0

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
Sequoyah 2 Tennessee Valley Authority 9.5 miles NE of Chattanoogo, TN 050-00328	II	PWR-ICECND WEST 4LP TVA TVA	3411	1127	05/27/1970 09/15/1981 06/01/1982 09/15/2021	OL-FP DPR-79	92.3 101.6 86.6 83.6 95.6 90.4
Shearon Harris 1 Carolina Power and Light Co. 20 miles SW of Raleigh, NC 050-00400	II	PWR-DRYAMB WEST 3LP EBSO DANI	2900	0900	01/27/1978 01/12/1987 05/02/1987 10/24/2026	OL-FP NPF-63	91.0 71.3 99.4 91.8 88.7 100.6
South Texas Project 1 STP Nuclear Operating Co. 12 miles SSW of Bay City, TX 050-00498	IV	PWR-DRYAMB WEST 4LP BECH EBSO	3853	1280	12/22/1975 03/22/1988 08/25/1988 08/20/2027	OL-FP NPF-76	88.0 78.2 94.4 99.2 60.6 98.5 88.0
South Texas Project 2 STP Nuclear Operating Co. 12 miles SSW of Bay City, TX 050-00499	IV	PWR-DRYAMB WEST 4LP BECH EBSO	3853	1280	12/22/1975 03/28/1989 06/19/1989 12/15/2028	OL-FP NPF-80	96.1 87.1 75.0 79.3 91.6 88.5
St. Lucie 1 Florida Power & Light Co. 12 miles SE of Ft. Pierce, FL 050-00335	II	PWR-DRYAMB COMB CE EBSO EBSO	2700	0839	07/01/1970 03/01/1976 12/21/1976 03/01/2036	OL-FP DPR-67	102.0 91.3 94.1 102.1 85.8 82.8
St. Lucie 2 Florida Power & Light Co. 12 miles SE of Ft. Pierce, FL 050-00389	II	PWR-DRYAMB COMB CE EBSO EBSO	2700	0839	05/02/1977 06/10/1983 08/08/1983 04/06/2043	OL-FP NPF-16	92.3 91.3 101.0 80.1 92.0 85.5
Summer South Carolina Electric & Gas Co. 26 miles NW of Columbia, SC 050-00395	II	PWR-DRYAMB WEST 3LP GIL DANI	2900	0966	03/21/1973 11/12/1982 01/01/1984 08/06/2022	OL-FP NPF-12	74.9 79.9 87.2 86.9 97.2 88.3

APPENDIX A
U.S. Commercial Nuclear Power Reactors (continued)

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
Surry 1 Dominion Generation 17 miles NW of Newport News, VA 050-00280	II	PWR-DRYSUB WEST 3LP S&W S&W	2546	0799	06/25/1968 05/25/1972 12/22/1972 05/25/2032	OL-FP DPR-32	93.1 83.7 100.8 76.4 92.0 96.4
Surry 2 Dominion Generation 17 miles NW of Newport News, VA 050-00281	II	PWR-DRYSUB WEST 3LP S&W S&W	2546	0799	06/25/1968 01/29/1973 05/01/1973 01/29/2033	OL-FP DPR-37	92.9 94.1 91.4 78.6 100.5 92.6
Susquehanna 1 PPL Susquehanna, LLC 7 miles NE of Berwick, PA 050-00387	I	BWR-MARK 2 GE 4 BECH BECH	3489	1135	11/02/1973 11/12/1982 06/08/1983 07/17/2022	OL-FP NPF-14	85.4 98.6 82.9 96.3 80.3 94.6
Susquehanna 2 PPL Susquehanna, LLC 7 miles NE of Berwick, PA 050-00388	I	BWR-MARK 2 GE 4 BECH BECH	3489	1140	11/02/1973 06/27/1984 02/12/1985 03/23/2024	OL-FP NPF-22	81.3 97.3 86.3 95.6 85.5 100.0 88.7
Three Mile Island 1 AmerGen Energy Co. 10 miles SE of Harrisburg, PA 050-00289	I	PWR-DRYAMB B&W LLP GIL UE&C	2568	0810	05/18/1968 04/19/1974 09/02/1974 04/19/2014	OL-FP DPR-50	77.4 103.5 78.7 104.1 90.0 102.2 95.2
Turkey Point 3 Florida Power & Light Co. 25 miles S of Miami, FL 050-00250	II	PWR-DRYAMB WEST 3LP BECH BECH	2300	0693	04/27/1967 07/19/1972 12/14/1972 07/19/2032	OL-FP DPR-31	93.4 91.0 102.4 89.7 77.7 95.5
Turkey Point 4 Florida Power & Light Co. 25 miles S of Miami, FL 050-00251	II	PWR-DRYAMB WEST 3LP BECH BECH	2300	0693	04/27/1967 04/10/1973 09/07/1973 04/10/2033	OL-FP DPR-41	91.9 100.6 96.4 91.6 99.9 69.8

APPENDIX A
U.S. Commercial Nuclear Power Reactors (continued)

Unit, Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net Summer Capacity (MW)	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	2000-2005* Average Capacity Factor (Percent)
Vermont Yankee Entergy Nuclear 5 miles S of Brattleboro, VT 050-00271	I	BWR-MARK 1 GE 4 EBSO EBSO	1912	0506	12/11/1967 02/28/1973 11/30/1972 03/21/2012	OL-FP DPR-28	101.5 93.4 88.7 100.3 86.8 91.9
Vogtle 1 Southern Nuclear Operating Co. 26 miles SE of Augusta, GA 050-00424	II	PWR-DRYAMB WEST 4LP SBEC GPC	3565	1152	06/28/1974 03/16/1987 06/01/1987 01/16/2027	OL-FP NPF-68	91.2 100.9 85.9 93.3 100.4 91.4
Vogtle 2 Southern Nuclear Operating Co. 26 miles SE of Augusta, GA 050-00425	II	PWR-DRYAMB WEST 4LP SBEC GPC	3565	1149	06/28/1974 03/31/1989 05/20/1989 02/09/2029	OL-FP NPF-81	102.4 94.0 83.6 96.7 90.8 85.4
Waterford 3 Entergy Nuclear Operations, Inc. 20 miles W of New Orleans, LA 050-00382	IV	PWR-DRYAMB COMB CE EBSO EBSO	3716	1087	11/14/1974 03/16/1985 09/24/1985 12/18/2024	OL-FP NPF-38	89.8 101.3 94.0 88.9 101.1 82.6
Watts Bar 1 Tennessee Valley Authority 10 miles S of Spring City, TN 050-00390	II	PWR-ICECND WEST 4LP TVA TVA	3459	1121	01/23/1973 02/07/1996 05/27/1996 11/09/2035	OL NPF-90	92.4 97.7 92.1 87.1 100.1 89.7
Wolf Creek 1 Wolf Creek Nuclear Operating Corp. 3.5 miles NE of Burlington, KS 050-00482	IV	PWR-DRYAMB WEST 4LP BECH DANI	3565	1166	05/31/1977 06/04/1985 09/03/1985 03/11/2025	OL-FP NPF-42	88.3 101.0 88.6 87.1 98.9 86.4

*Note: Average Capacity Factors are listed in year order starting with 2000.
Source: Nuclear Regulatory Commission and licensee data as compiled by the Nuclear Regulatory Commission.

APPENDIX B

U.S. Commercial Nuclear Power Reactors Formerly Licensed to Operate (Permanently Shut Down)

Unit Location	Reactor Type WMt	NSSS Vendor	OL Issued Shut Down	Decommissioning Alternative Selected Current Status
Big Rock Point Charleviox, MI	BWR 240	GE	05/01/1964 08/29/1997	DECON DECON/In Progress
GEBonus * Punta Higuera, PR	BWR 50	COMB	04/02/1964 06/01/1968	ENTOMB ENTOMB
CVTR ** Parr, SC	PTHW 65	WEST	11/27/1962 01/01/1967	SAFSTOR SAFSTOR
Dresden 1 Morris, IL	BWR 700	GE	09/28/1959 10/31/1978	SAFSTOR SAFSTOR
Elk River * Elk River, MN	BWR 58	AC/S&L	11/06/1962 02/01/1968	DECON DECON Completed
Fermi 1 Newport, MI	SCF 200	COMB	05/10/1963 09/22/1972	SAFSTOR SAFSTOR
Fort St. Vrain Platteville, CO	HTG 842	GA	12/21/1973 08/18/1989	DECON DECON Completed
GE VBWR Pleasanton, CA	BWR 50	GE	08/31/1957 12/09/1963	SAFSTOR SAFSTOR
Haddam Neck Meriden, CT	PWR 1825	WEST	12/27/1974 12/05/1996	DECON DECON/In Progress
Hallam * Hallam, NE	SCGM 256	BLH	01/02/1962 09/01/1964	ENTOMB ENTOMB

APPENDIX B

U.S. Commercial Nuclear Power Reactors Formerly Licensed to Operate (Permanently Shut Down) (continued)

Unit **Location**	**Reactor** **Type** **WMt**	**NSSS** **Vendor**	**OL Issued** **Shut Down**	**Decommissioning** **Alternative Selected** **Current Status**
Humboldt Bay 3 Eureka, CA	BWR 200	GE	08/28/1962 07/02/1976	SAFSTOR SAFSTOR
Indian Point 1 Buchanan, NY	PWR 615	B&W	03/26/1962 10/31/1974	SAFSTOR SAFSTOR
La Crosse Genoa, WI	BWR 165	AC	07/03/1967 04/30/1987	SAFSTOR SAFSTOR
Maine Yankee Wiscasset, ME	PWR 2700	COMB	06/29/1973 12/06/1996	DECON DECON Completed
Millstone 1 Waterford, CT	BWR 2011	GE	10/31/1986 07/21/1998	SAFSTOR SAFSTOR
Pathfinder Sioux Falls, SD	BWR 190	AC	03/12/1964 09/16/1967	DECON Completed
Peach Bottom 1 Peach Bottom, PA	HTG 115	GA	01/24/1966 10/31/1974	SAFSTOR SAFSTOR
Piqua * Piqua, OH	OCM 46	AI	08/23/1962 01/01/1966	ENTOMB ENTOMB
Rancho Seco Herald, CA	PWR 2772	B&W	08/16/1974 06/07/1989	DECON DECON in progress
San Onofre 1 San Clemente, CA	PWR 1347	WEST	03/27/1967 11/30/1992	DECON DECON in progress

APPENDIX B

U.S. Commercial Nuclear Power Reactors Formerly Licensed to Operate (Permanently Shut Down) (continued)

Unit Location	Reactor Type WMt	NSSS Vendor	OL Issued Shut Down	Decommissioning Alternative Selected Current Status
Saxton Saxton, PA	PWR 23.5	WEST	11/15/1961 05/01/1972	DECON DECON Completed
Shippingport * Shippingport, PA	PWR 236	WEST	N/A 1982	DECON DECON Completed
Shoreham Wading River, NY	BWR 2436	GE	04/21/1989 06/28/1989	DECON DECON Completed
Three Mile Island 2 Londonderry Township, PA	PWR 2770	B&W	02/08/1978 03/28/1979	(1)
Trojan Rainier, OR	PWR 3411	WEST	11/21/1975 11/09/1992	DECON DECON Completed
Yankee-Rowe Franklin County, MA	PWR 0600	WEST	12/24/1963 10/01/1991	DECON DECON in progress
Zion 1 Zion, IL	PWR 3250	WEST	10/19/1973 02/21/1997	SAFSTOR SAFSTOR
Zion 2 Zion, IL	PWR 3250	WEST	11/14/1973 09/19/1996	SAFSTOR SAFSTOR

*AEC/DOE owned; not regulated by the NRC.
**Holds byproduct license from State of South Carolina.
Notes: See Glossary for definitions of decommissioning alternatives.
1 Three Mile Island 2 has been placed in a post-defueling monitored storage mode until Unit 1 permanently ceases operation, at which time both units are planned to be decommissioned.
Source: DOE Integrated Data Base for 1990; U.S. Spent Fuel and Radioactive Waste, Inventories, Projections, and Characteristics (DOE/RW-0006, Rev. 6), and U.S. Nuclear Regulatory Commission, Nuclear Power Plants in the World, Edition #6

APPENDIX C
Canceled U.S. Commercial Nuclear Power Reactors

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status
Allens Creek 1 Houston Lighting & Power Company 4 miles NW of Wallis, IN	BWR 1150	1982 Under CP Review
Allens Creek 2 Houston Lighting & Power Company 4 miles NW of Wallis, IN	BWR 1150	1976 Under CP Review
Atlantic 1 & 2 Public Service Electric & Gas Company Floating Plants off the Coast of NJ	PWR 1150	1978 Under CP Review
Bailly Northern Indiana Public Service Company 12 miles NNE of Gary, IN	BWR 645	1981 With CP
Barton 1 & 2 Alabama Power & Light 15 miles SE of Clanton, Alabama	BWR 1159	1977 Under CP Review
Barton 3 & 4 Alabama Power & Light 15 miles SE of Clanton, Alabama	BWR 1159	1975 Under CP Review
Bellefonte 1 & 2 Tennessee Valley Authority 6 miles NE of Scottsboro, AL	PWR 1235	(1) With CP
Black Fox 1 & 2 Public Service Company of Oklahoma 3.5 miles South of Inola, Oklahoma	BWR 1150	1982 Under CP Review
Blue Hills 1 & 2 Gulf States Utilities Company SW tip of Toledo Bend Reservoir, County, Texas	PWR 918	1978 Under CP Review
Callaway 2 Union Electric Company 10 miles SE of Fulton, MO	PWR 1150	1981 With CP
Cherokee 1 Duke Power Company 6 miles SSW of Blacksburg, SC	PWR 1280	1983 With CP
Cherokee 2 & 3 Duke Power Company 6 miles SSW of Blacksburg, SC	PWR 1280	1982 With CP
Clinch River Project Management Corp.; DOE; TVA 23 miles West of Knoxville, in Oak Ridge, TN	LMFB 350	1983 Under CP Review

APPENDIX C
Canceled U.S. Commercial Nuclear Power Reactors (continued)

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status
Clinton 2 Illinois Power Company 6 miles East of Clinton, IL	BWR 933	1983 With CP
Davis-Besse 2 & 3 Toledo Edison Company 21 miles ESE of Toledo, OH	PWR 906	1981 Under CP Review
Douglas Point 1 & 2 Potomac Electric Power Company 5.7 miles SSE of Quanitico, VA	BWR 1146	1977 Under CP Review
Erie 1 & 2 Ohio Edison Company Berlin, OH	PWR 1260	1980 Under CP Review
Forked River 1 Jersey Central Power & Light Company 2 miles South of Forked River, NJ	PWR 1070	1980 With CP
Fort Calhoun 2 Omaha Public Power District 19 miles North of Omaha, NE	PWR 1136	1977 Under CP Review
Fulton 1 & 2 Philadelphia Electric Company 17 miles South of Lancaster, PA	HTG 1160	1975 Under CP Review
Grand Gulf 2 Entergy Operations, Incorporated 25 miles South of Vicksburg, MS	BWR 1250	1990 With CP
Greene County Power Authority of the State of NY 20 miles North of Kingston, MS	PWR 1191	1980 Under CP Review
Greenwood 2 & 3 Detroit Edison Company Greenwood Township, MS	PWR 1200	1980 Under CP Review
Hartsville A1 & A2 Tennessee Valley Authority 5 miles SE of Hartsville, TN	BWR 1233	1984 With CP
Hartsville B1 & B2 Tennessee Valley Authority 5 miles SE of Hartsville, TN	BWR 1233	1982 With CP
Haven 1 (formerly Koshkonong) Wisconsin Electric Power Company 4.2 miles SSW of Fort Atkinson, WI	PWR 900	1980 Under CP Review
Haven 2 (formerly Koshkonong) Wisconsin Electric Power Company 4.2 miles SSW of Fort Atkinson, WI	PWR 900	1978 Under CP Review

APPENDIX C
Canceled U.S. Commercial Nuclear Power Reactors (continued)

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status
Hope Creek 2 Public Service Electric & Gas Company 18 miles SE of Washington, DE	BWR 1067	1981 With CP
Jamesport 1 & 2 Long Island Lighting Company 65 miles East of New York City, NY	PWR 1150	1980 With CP
Marble Hill 1 & 2 Public Service of Indiana 6 miles NE of New Washington, IN	PWR 1130	1985 With CP
Midland 1 Consumers Power Company South of City of Midland, MI	PWR 492	1986 With CP
Midland 2 Consumers Power Company South of City of Midland, MI	PWR 818	1986 With CP
Montague 1 & 2 Northeast Nuclear Energy Company 1.2 miles SSE of Turners Falls, MA	BWR 1150	1980 Under CP Review
New England 1 & 2 New England Power Company 8.5 Miles East of Westerly, RI	PWR 1194	1979 Under CP Review
New Haven 1 & 2 New York State Electric & Gas Corporation	PWR 1250	1980 Under CP Review
North Anna 3 Virginia Electric & Power Company 40 miles NW of Richmond, VA	PWR 907	1982 With CP
North Anna 4 Virginia Electric & Power Company 40 miles NW of Richmond, VA	PWR 907	1980 With CP
North Coast 1 Puerto Rico Water Resources Authority 4.7 miles ESE of Salinas, PR	PWR 583	1978 Under CP Review
Palo Verde 4 & 5 Arizona Public Service Company 36 miles West of Pheonix, AZ	PWR 1270	1979 Under CP Review
Pebble Springs 1 & 2 Portland General Electric Company 55 miles WSW of Tri Cities (Kenewick-Pasco-Rich- land), OR	PWR 1260	1982 Under CP Review
Perkins 1, 2, & 3 Duke Power Company 10 miles North of Salisbury , NC	PWR 1280	1982 Under CP Review

APPENDIX C
Canceled U.S. Commercial Nuclear Power Reactors (continued)

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status
Perry 2 Cleveland Electric Illuminating Co. 7 miles NE of Painsville, OH	BWR 1205	1994 Under CP Review
Phipps Bend 1 & 2 Tennessee Valley Authority 15 miles SW of Kingsport, TN	BWR 1220	1982 With CP
Pilgrim 2 Boston Edison Company 4 miles SE of Plymouth, MA	PWR 1180	1981 Under CP Review
Pilgrim 3 Boston Edison Company 4 miles SE of Plymouth, MA	PWR 1180	1974 Under CP Review
Quanicassee 1 & 2 Consumers Power Company 6 miles East of Essexville, MI	PWR 1150	1974 Under CP Review
River Bend 2 Gulf States Utilities Company 24 miles NNW of Baton Rouge, LA	BWR 934	1984 With CP
Seabrook 2 Public Service Co. of New Hampshire 13 Miles South of Portsmouth, NH	PWR 1198	1988 With CP
Shearon Harris 2 Carolina Power & Light Company 20 miles SW of Raleigh, NC	PWR 900	1983 With CP
Shearon Harris 3 & 4 Carolina Power & Light Company 20 miles SW of Raleigh, NC	PWR 900	1981 With CP
Skagit/Hanford 1 & 2 Puget Sound Power & Light Company 23 miles SE of Bellingham, WA	PWR 1277	1983 Under CP Review
Sterling Rochester Gas & Electric Corporation 50 miles East of Rochester, NY	PWR 1150	1980 With CP
Summit 1 & 2 Delmarva Power & Light Company 15 Miles SSW of Wilmington, DE	HTG 1200	1975 Under CP Review
Sundesert 1 & 2 San Diego Gas & Electric Company 16 miles SW of Blythe, CA	PWR 974	1978 Under CP Review
Surry 3 & 4 Virginia Electric & Power Company 17 miles NW of Newport News, VA	PWR 882	1977 With CP

APPENDIX C
Canceled U.S. Commercial Nuclear Power Reactors (continued)

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status
Tyrone 1 Northern States Power Company 8 miles NE of Durond, WI	PWR 1150	1981 Under CP Review
Tyrone 2 Northern States Power Company 8 miles NE of Durond, WI	PWR 1150	1974 With CP
Vogtle 3 & 4 Georgia Power Company 26 miles SE of Augusta, GA	PWR 1113	1974 With CP
Washington Nuclear 1 Energy Northwest 10 miles East of Aberdeen, WA	PWR 1266	1995 With CP
Washington Nuclear 3 Energy Northwest 16 miles East of Aberdeen, WA	PWR 1242	1995 With CP
Washington Nuclear 4 Energy Northwest 10 miles East of Aberdeen, WA	PWR 1218	1982 With CP
Washington Nuclear 5 Energy Northwest 16 miles East of Aberdeen, WA	PWR 1242	1982 With CP
Watts Bar 2 Tennessee Valley Authority 10 miles South of Spring City, TN	PWR 1165	(1) With CP
Yellow Creek 1 & 2 Tennessee Valley Authority 15 miles East of Corinth, MS	BWR 1285	1984 With CP
Zimmer 1 Cincinnati Gas & Electric Company 25 miles SE of Cincinnati, OH	BWR 810	1984 With CP

Note: Cancellation is defined as public announcement of cancellation or written notification to the NRC.
Only docketed applications are indicated.
1 Bellefonte 1 and 2, Watts Bar 2 and Washington Nuclear 1 have not been formally cancelled; however TVA has stopped construction and is presently evaluating options (e.g., cancellation or conversion).
Source: DOE/EIA Commercial Nuclear Power 1991 (DOE/EIA-0438 (91)), Appendix E (page 105) and Nuclear Regulatory Commission

APPENDIX D
U.S. Commercial Nuclear Power Reactors by Licensee

Utility	Unit
AmerenUE	Callaway
AmerGen Energy Company	Clinton Oyster Creek Three Mile Island 1
Arizona Public Service Company	Palo Verde 1, 2, & 3
Carolina Power & Light	Brunswick 1 & 2 H.B. Robinson 2 Shearon Harris 1
Calvert Cliffs Nuclear Power Plant, Inc.	Calvert Cliffs 1 & 2
R.E. Ginna Nuclear Power Plant, LLC	Ginna
Nine Mile Point Nuclear Station, LLC	Nine Mile Point 1 & 2
Detroit Edison Company	Fermi 2
Dominion Generation	Millstone 2 & 3
Virginia Electric & Power Company	North Anna 1 & 2 Surry 1 & 2
Duke Energy Power Company, LLC	Catawba 1 & 2 McGuire 1 & 2 Oconee 1, 2, & 3
Energy Northwest	Columbia
Entergy Nuclear Operations, Inc.	Arkansas Nuclear 1 & 2 James A. FitzPatrick Grand Gulf 1 Pilgrim 1 River Bend 1 Vermont Yankee Waterford 3 Indian Point 2 & 3

APPENDIX D
U.S. Commercial Nuclear Power Reactors by Licensee (continued)

Utility	Unit
Exelon Generation Co., LLC	Braidwood 1 & 2 Byron 1 & 2 Dresden 2 & 3 La Salle County 1 & 2 Limerick 1 & 2 Peach Bottom 2 & 3 Quad Cities 1 & 2
FirstEnergy Nuclear Operating Company	Beaver Valley 1 & 2 Davis-Besse Perry 1
Florida Power & Light Company	St. Lucie 1 & 2 Turkey Point 3 & 4
Florida Power Corporation	Crystal River 3
FPL Energy Seabrook	Seabrook 1
Indiana/Michigan Power Company	D.C. Cook 1 & 2
Nebraska Public Power District	Cooper*
FPL Energy Duane Arnold, LLC	Duane Arnold
Dominion Energy Kewanunee, Inc.	Kewaunee
Nuclear Management Company, LLC	Monticello Palisades Point Beach 1 & 2 Prairie Island 1 & 2
Omaha Public Power District	Fort Calhoun
Pacific Gas & Electric Company	Diablo Canyon 1 & 2
PPL Susquehanna, LLC	Susquehanna 1 & 2
PSEG Nuclear, LLC	Hope Creek 1 Salem 1 & 2
South Carolina Electric & Gas Company	Summer

APPENDIX D
U.S. Commercial Nuclear Power Reactors by Licensee (continued)

Utility	Unit
Southern California Edison Company	San Onofre 2 & 3
Southern Nuclear Operating Company	Edwin I. Hatch 1& 2 Joseph M. Farley 1 & 2 Vogtle 1 & 2
STP Nuclear Operating Company	South Texas Project 1 & 2
Tennessee Valley Authority	Browns Ferry 1, 2, & 3 Sequoyah 1 & 2 Watts Bar 1
TXU Generation Company, LP	Comanche Peak 1 & 2
Wolf Creek Nuclear Operating Corporation	Wolf Creek 1

*Cooper is managed by Entergy Nuclear Operations, Inc.
Source: Nuclear Regulatory Commission

APPENDIX E

U.S. Nuclear Research and Test Reactors (Operating) Regulated by the NRC

Licensee Location	Reactor Type OL Issued	Power Level (kW)	License Number Docket Number
Aerotest San Ramon, CA	TRIGA (Indus) 07/02/1965	250	R-98 50-228
Armed Forces Radiobiology Research Institute Bethesda, MD	TRIGA 06/26/1962	1,100	R-84 50-170
Dow Chemical Company Midland, MI	TRIGA 07/03/1967	300	R-108 50-264
General Electric Company Sunol, CA	Nuclear Test 10/31/1957	100	R-33 50-73
Idaho State University Pocatello, ID	AGN-201 #103 10/11/1967	0.005	R-110 50-284
Kansas State University Manhattan, KS	TRIGA 10/16/1962	250	R-88 50-188
Massachusetts Institute of Technology Cambridge, MA	HWR Reflected 06/09/1958	5,000	R-37 50-20
National Institute of Standards & Technology Gaithersburg, MD	Nuclear Test 05/21/1970	20,000	TR-5 50-184
North Carolina State University Raleigh, NC	Pulstar 08/25/1972	1,000	R-120 50-297
Ohio State University Columbus, OH	Pool 02/24/1961	500	R-75 50-150
Oregon State University Corvallis, OR	TRIGA Mark II 03/07/1967	1,100	R-106 50-243
Pennsylvania State University University Park, PA	TRIGA 07/08/1955	1,100	R-2 50-5
Purdue University West Lafayette, IN	Lockheed 08/16/1962	1	R-87 50-182

APPENDIX E
U.S. Nuclear Research and Test Reactors (Operating) Regulated by the NRC (continued)

Licensee Location	Reactor Type OL Issued	Power Level (kW)	License Number Docket Number
Reed College Portland, OR	TRIGA Mark I 07/02/1968	250	R-112 50-288
Rensselaer Polytechnic Institute Troy, NY	Critical Assembly 07/03/1964	0.1	CX-22 50-225
Rhode Island Atomic Energy Commission Narragansett, RI	GE Pool 07/23/1964	2,000	R-95 50-193
Texas A&M University College Station, TX	AGN-201M #106 08/26/1957	0.005	R-23 50-59
Texas A&M University College Station, TX	TRIGA 12/07/1961	1,000	R-128 50-128
U.S. Geological Survey Denver, CO	TRIGA Mark I 02/24/1969	1,000	R-113 50-274
University of Arizona Tucson, AZ	TRIGA Mark I 12/05/1958	110	R-52 50-113
University of California/Davis Sacramento, CA	TRIGA 08/13/1998	2,300	R-130 50-607
University of California/Irvine Irvine, CA	TRIGA Mark I 11/24/1969	250	R-116 50-326
University of Florida Gainesville, FL	Argonaut 05/21/1959		R-56 50-83
University of Massachusetts/Lowell Lowell, MA	GE Pool 12/24/1974	1,000	R-125 50-223
University of Maryland College Park, MD	TRIGA 10/14/1960	250	R-70 50-166
University of Missouri/Rolla Rolla, MO	Pool 11/21/1961	200	R-79 50-123

APPENDIX E
U.S. Nuclear Research and Test Reactors (Operating) Regulated by the NRC (continued)

Licensee Location	Reactor Type OL Issued	Power Level (kW)	License Number Docket Number
University of Missouri/Columbia Columbia, MO	Tank 10/11/1966	10,000	R-103 50-186
University of New Mexico Albuquerque, NM	AGN-201M#112 09/17/1966	0.005	R-102 50-252
University of Texas Austin, TX	TRIGA Mark II 01/17/1992	1,100	R-92 50-602
University of Utah Salt Lake City, UT	TRIGA Mark I 09/30/1975	100	R-126 50-407
University of Wisconsin Madison, WI	TRIGA 11/23/1960	1,000	R-74 50-156
Washington State University Pullman, WA	TRIGA 03/06/1961	1,000	R-76 50-27
Worcester Polytechnic Institute Worcester, MA	GE 12/16/1959	10	R-61 50-134

Source: Nuclear Regulatory Commission

APPENDIX F
U.S. Research and Test Reactors (Under Decommissioning) Regulated by the NRC

Licensee Location	Reactor Type Power Level (kW)	OL Issued Shutdown	Decommissioning Alternative Selected Current Status
Cornell University Ithaca, NY	TRIGA Mark II 500	01/11/1962 4/21/2003	DECON DECON in progress
Cornell University Ithaca, NY	Tank (ZPR) 0.1	12/11/62 2/12/97	DECON DECON in progress
General Atomics San Diego, CA	TRIGA Mark F 1,500	7/01/60 9/7/94	DECON SAFSTOR
General Atomics San Diego, CA	TRIGA Mark I 250	5/03/58 12/17/96	DECON DECON
General Electric Company Sunol, CA	GETR (Tank) 50,000	1/7/59 6/26/85	SAFSTOR SAFSTOR
General Electric Company Sunol, CA	EVESR 17,000	11/12/63 2/1/67	SAFSTOR SAFSTOR
National Aeronautics and Space Administration Sandusky, OH	Test 60,000	5/2/62 7/7/73	DECON DECON in progress
National Aeronautics and Space Administration Sandusky, OH	Mockup 100	6/14/61 7/7/73	DECON DECON in progress
University of Buffalo Buffalo, NY	Pulstar 2,000	3/24/61 7/23/96	DECON SAFSTOR
University of Illinois Urbana-Champaign, IL	TRIGA 1,500	7/22/69 4/12/99	DECON DECON
University of Michigan Ann Arbor, MI	Pool 2,000	09/13/57 1/29/04	DECON DECON in progress

APPENDIX F
U.S. Research and Test Reactors (Under Decommissioning) Regulated by the NRC (continued)

Licensee Location	Reactor Type Power Level (kW)	OL Issued Shutdown	Decommissioning Alternative Selected Current Status
University of Washington Seattle, WA	Argonaut 100	3/31/61 6/30/88	DECON DECON in progress
Veterans Administration Omaha, NE	TRIGA 20	6/26/59 11/05/01	DECON SAFSTOR[1]
Viacom Waltz Mill, PA	Tank 20,000	6/19/59 3/25/63	SAFSTOR SAFSTOR

1 Plans to commence DECON once fuel removed from site.
Source: Nuclear Regulatory Commission

APPENDIX G

NRC Performance Indicators: Annual Industry Averages, FYs 1991–2005

Indicator	1991	1992	1993	1994	1995	1996	1997
Automatic Scrams	1.57	1.52	1.18	1.05	1.04	0.80	0.54
Safety System Actuations	1.06	0.81	0.81	0.62	0.46	0.39	0.35
Significant Events	0.40	0.25	0.26	0.21	0.17	0.08	0.10
Safety System Failures	3.44	3.78	3.09	2.32	2.03	2.89	2.71
Forced Outage Rate	7.90	8.89	7.79	9.40	6.76	7.54	10.21
Equipment Forced Outage Rate	0.36	0.35	0.24	0.26	0.23	0.24	0.24
Collective Radiation Exposure	286.00	277.00	244.00	215.00	202.00	178.00	176.00

Indicator	1998	1999	2000	2001	2002	2003	2004	2005
Automatic Scrams	0.48	0.64	0.52	0.57	0.44	0.75	0.56	0.47
Safety System Actuations	0.31	0.29	0.29	0.19	0.18	0.41	0.24	0.38
Significant Events	0.04	0.03	0.04	0.07	0.05	0.07	0.04	0.05
Safety System Failures	2.76	1.68	1.40	0.82	0.88	0.96	0.77	0.96
Forced Outage Rate	10.73	5.20	4.24	3.00	1.70	3.04	1.88	2.44
Equipment Forced Outage Rate	0.18	0.16	0.13	0.11	0.12	0.16	0.15	0.13
Collective Radiation Exposure	140.00	128.00	115.00	123.00	111.00	125.00	100.00	118.00

Source: Licensee data as compiled by the Nuclear Regulatory Commission

APPENDIX H
Dry Spent Fuel Storage Designs: NRC-Approved for General Use

Vendor	Docket #	Storage Design Model
General Nuclear Systems, Inc.	72-1018	CASTOR V/21
NAC International, Inc.	72-1002	NAC S/T
NAC International, Inc.	72-1003	NAC-C28 S/T
BNL Fuel Solutions, Corporation	72-1007	VSC-24
Holtec International	72-1008	HI-STAR 100
Holtec International	72-1014	HI-STORM 100
NAC International, Inc.	72-1025	NAC-MPC
NAC International, Inc.	72-1015	NAC-UMS
Transnuclear, Inc.	72-1005 72-1027 72-1021 72-1004 72-1029	TN-24 TN-68 TN-32, 32A, 32B NUHOMS-24P, 24PH3 NUHOMS-61BT NUHOMS-52B NUHOMS-32PT NUHOMS-24PT Advanced NUHOMS
BNFL Fuel Solutions	72-1026	Fuel Solutions

Source: Nuclear Regulatory Commission data as of December 31, 2004 (10 CFR 72.214)

APPENDIX I
Dry Spent Fuel Storage Licensees

Reactor Utility	Date Issued	Vendor	Storage Model	Docket#
Surry 1, 2 Virginia Electric & Power Company	07/02/1986	Generals Nuclear Systems, Incorporated Transnuclear, Incorporated NAC International, Incorporated Westinghouse, Incorporated	CASTOR V/21 TN-32 NAC-128 CASTOR X/33 MC-10	72-2
H. B. Robinson 2 Carolina Power & Light Company	08/13/1986 Under General License 09/06/2005	Transnuclear, Incorporated Transnuclear, Incorporated	NUHOMS-7P NUHOMS-24P	72-3 72-60
Oconee 1, 2, 3 Duke Energy Company	01/29/1990 Under General License 03/05/1999	Transnuclear, Incorporated	NUHOMS-24P	72-4 72-80
Fort St. Vrain* Department of Energy	11/04/1991	FW Energy Applications, Incorporated	Modular Vault Dry Store	72-9
Calvert Cliffs 1, 2 Calvert Cliffs Nuclear Power Plant	11/25/1992	Transnuclear, Incorporated	NUHOMS-24P NUHOMS-32P	72-8
Palisades Nuclear Management Company, LLC	Under General License 05/11/1993	BNFL Fuel Solutions	VSC-24 NUHOMS-32PT	72-7
Prairie Island 1, 2 Nuclear Management Company, LLC	10/19/1993	Transnuclear, Incorporated	TN-40	72-10
Point Beach 1, 2 Nuclear Management Company, LLC	Under General License 05/26/1996	BNFL Fuel Solutions	VSC-24 NUHOMS-32PT	72-5
Davis-Besse First Energy Nuclear Operating Company	Under General License 01/01/1996	Transnuclear, Incorporated	NUHOMS-24P	72-14

APPENDIX I
Dry Spent Fuel Storage Licensees (continued)

Reactor Utility	Date Issued	Vendor	Storage Model	Docket#
Arkansas Nuclear 1,2 Entergy Operations, Inc.	Under General License 12/17/1996	BNFL Fuel Solutions Holtec International	VSC-24 HI-STORM 100	72-13
North Anna Virginia Electric & Power Company	06/30/1998	Transnuclear, Incorporated	TN-32	72-16
Trojan Portland General Electric Corp.	03/31/1999	Holtec International	HI-STORM 100	72-17
INEEL ISFSI TMI-2 Fuel Debris, Department of Energy	03/19/1999	Transnuclear, Incorporated	NUHOMS-12T	72-20
Susquehana Pennsylvania Power & Light	Under General License 10/18/1999	Transnuclear, Incorporated	NUHOMS-52B NUHOMS-61BT	72-28
Peach Bottom 2, 3 Exelon Generating Company	Under General License 06/12/2000	Transnuclear, Incorporated	TN-68	72-29
Hatch 1, 2 Southern Nuclear Operating	Under General License 07/06/2000	Holtec International	HI-STAR 100 HI-STORM 100	72-36
Dresden 1, 2, 3 Exelon Generating	Under General License 07/10/2000	Holtec International	HI-STAR 100 HI-STORM 100	72-37
Rancho Seco Sacramento Municipal Utility District	06/30/2000	Transnuclear, Incorporated	NUHOMS-24P	72-11
McGuire Duke Power	Under General License 02/01/2001	Transnuclear, Incorporated	TN-32	72-38

APPENDIX I
Dry Spent Fuel Storage Licensees (continued)

Reactor Utility	Date Issued	Vendor	Storage Model	Docket#
Big Rock Point Consumers Energy	Under General License 11/18/2002	BNFL Fuel Solutions	Fuel Solutions W74	72-43
James A. FitzPatrick Entergy Nuclear Operations, Incorporated	Under General License 04/25/2002	Holtec International	HI-STORM 100	72-12
Maine Yankee Maine Yankee Atomic Power Company	Under General License 08/24/2002	NAC International, Incorporated	NAC-UMS	72-30
Columbia Generating Station Energy North West	Under General License 09/02/2002	Holtec International	HI-STORM 100	72-35
Oyster Creek AmeriGen Energy Company	Under General License 04/11/2002	Transnuclear, Incorporated	NUHOMS-61BT	72-15
Yankee Rowe Yankee Atomic Electric	Under General License 06/26/2002	NAC International, Incorporated	NAC-MPC	72-31
Duane Arnold Nuclear Management Corporation	Under General License 09/01/2003	Transnuclear, Incorporated	NUHOMS-61BT	72-32
Palo Verde Arizona Public Service Company	Under General License 03/15/2003	NAC International, Incorporated	NAC-UMS	72-44
San Onofre Southern California Edison Company	Under General License 10/03/2003	Transnuclear, Incorporated	NUHOMS-24PT	72-41
Diablo Canyon Pacific Gas & Electric	03/22/2004	Holtec International	HI-STORM 100	72-26

APPENDIX I
Dry Spent Fuel Storage Licensees (continued)

Reactor Utility	Date Issued	Vendor	Storage Model	Docket#
Haddam Neck CT Yankee Atomic Power	Under General License 05/21/2004	NAC International, Incorporated	NAC-MPC	72-39
Sequoyah Tennessee Valley Authority	Under General License 07/13/2004	Holtec International	HI-STORM 100	72-34
Idaho Spent Fuel Facility Foster Wheeler Environmental Corp.	11/30/2004	Multiple	Multiple	72-25
Humboldt Bay Pacific Gas & Electric Co.	Under General License 11/30/2005	Holtec International	HI-STORM 100HB	72-27
Private Fuel Storage Facility	Under General License 02/21/2006	Holtec International	HI-STORM 100	72-22
Browns Ferry TVA	Under General License 08/21/2005	Holtec International	HI-STORM 100S	72-52
Farley Southern Nuclear Operating Co.	Under General License 08/25/2005	Transnuclear, Incorporated	NUHOMS-32PT	72-42
Millstone Dominion Generation	Under General License 02/15/2005	Transnuclear, Incorporated	NUHOMS-32PT	72-47
Quad Cities Exelon	Under General License 12/02/2005	Holtec International	HI-STORM 100S	72-53
River Bend Entergy	Under General License 12/29/2005	Holtec International	HI-STORM 100S	72-49

*Plant is undergoing decommissioning and was transferred to DOE on June 4, 1999.
Source: Nuclear Regulatory Commission

APPENDIX J
World List of Nuclear Power Reactors

Country	In Operation		Under Construction, on Order, or Construction Halted		Total	
	Number of Units	Net MWe	Number of Units	Net MWe	Number of Units	Net MWe
Argentina	2	935	1	692	3	1,627
Armenia	1	376	0	0	1	376
Belgium	7	5,801	0	0	7	5,801
Brazil	2	1,901	1	1,275	3	3,176
Bulgaria	4	2,722	0	0	4	2,722
Canada	22	15,164	0	0	22	15,164
China	9	6,694	4	4,000	13	10,694
China, Taiwan	6	4,884	2	2,600	8	7,484
Czech Republic	6	3,472	0	0	6	3,472
Finland	4	2,656	1	1,600	5	4,256
France	59	63,363	0	0	59	63,363
Germany	17	20,303	0	0	17	20,303
Hungary	4	1,755	0	0	4	1,755
India	15	3,040	8	3,632	23	6,672
Iran	0	0	1	915	1	915
Japan	54	46,285	3	2,416	57	48,701
Lithuania	1	1,185	0	0	1	1,185
Mexico	2	1,360	0	0	2	1,360
Netherlands	1	449	0	0	1	449
North Korea	0	0	2	2,000	2	2,000
Pakistan	2	425	1	300	3	725
Romania	1	706	4	2,566	5	3,272
Russia	31	21,743	4	3,575	35	25,318
Slovakia	6	2,442	2	810	8	3,252
Slovenia	1	656	0	0	1	656
South Africa	2	1,800	0	0	2	1,800
South Korea	20	16,810	6	6,800	26	23,610

APPENDIX J
World List of Nuclear Power Reactors (continued)

Country	In Operation: Number of Units	In Operation: Net MWe	Under Construction, on Order, or Construction Halted: Number of Units	Under Construction, on Order, or Construction Halted: Net MWe	Total: Number of Units	Total: Net MWe
Spain	9	7,581	0	0	9	7,581
Sweden	10	8,916	0	0	10	8,916
Switzerland	5	3,220	0	0	5	3,220
Ukraine	14	12,157	4	3,800	18	15,957
United Kingdom	23	11,852	0	0	23	11,852
United States	104	101,289	1	1,177	105	102,466
Total	444	371,942	45	38,158	489	410,100

Note: Operable, under construction or on order (30 MWe and over) or construction halted as of December 31, 2005.
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APPENDIX K
Nuclear Power Units by Reactor Type, Worldwide

Reactor Type	In Operation: Number of Units	In Operation: Net MWe	Total: Number of Units	Total: Net MWe
Pressurized light-water reactors	266	241,390	294	268,666
Boiling light-water reactors	93	83,043	96	87,947
Gas-cooled reactors, all types	22	10,664	22	10,664
Heavy-water reactors, all types	45	23,649	55	28,205
Graphite-moderated light-water reactors	16	11,404	17	12,329
Liquid metal cooled fast-breeder reactors	2	793	5	2,289
Total	444	371,942	489	410,100

Note: Operable, under construction, on order (30 MWe and over) as of December 31, 2005.
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APPENDIX L
Top 50 Reactors by Capacity Factor, Worldwide

Nation	Unit	Reactor Type	Vendor	2005 Gross Generation (MWh)	2005 Gross Capacity Factor (Percent)
South Korea	Kori-4	PWR	West	8,725,790	104.85
South Korea	Yonggwang-3	PWR	KHIC-CE	9,122,369	104.14
South Korea	Ulchin-1	PWR	Fram	8,638,270	103.8
South Korea	Yonggwang-1	PWR	West	8,637,865	103.8
South Korea	Wolsong-3	PHWR	AECL	6,407,130	102.29
United States	Calvert Cliffs-1	PWR	CE	7,951,392	101.99
Japan	Hamaoka-5	BWR	Toshiba	11,740,500	101.86
United States	Limerick-1	BWR	GE	10,270,300	100.81
United States	Catawba-2	PWR	West	10,626,121	100.67
Japan	Hamaoka-4	BWR	Toshiba	9,996,123	100.36
United States	Shearon-Harris	PWR	West	8,437,220	100.33
United States	Sequoyah-1	PWR	West	10,419,384	100.29
United States	San Onofre-3	PWR	CE	9,899,450	100.27
Japan	Tomari-1	PWR	Mitsubishi	5,085,602	100.27
United States	North Anna-1	PWR	West	8,525,568	100.23
Japan	Ohi-4	PWR	Mitsubishi	10,324,221	99.88
United States	LaSalle-1	BWR	GE	10,198,967	99.85
China	Daya Bay-1	PWR	Fram	8,602,747	99.8
United States	Nine Mile Point-2	BWR	GE	10,376,067	99.67
Canada	Bruce-8	PHWR	AECL	7,310,221	99.35
United States	Farley-1	PWR	West	7,776,091	99.18
Spain	Almaraz-2	PWR	West	8,536,655	99.18
United States	Beaver Valley-1	PWR	West	7,703,480	99.06
United States	Braidwood-1	PWR	West	10,745,465	98.76
Canada	Darlington-3	PHWR	AECL	8,077,568	98.7
Finland	Olkiluoto-1	BWR	ABB	7,488,860	98.26
United States	FitzPatrick	BWR	GE	7,298,116	98.13

APPENDIX L
Top 50 Reactors by Capacity Factor, Worldwide (continued)

Nation	Unit	Reactor Type	Vendor	2005 Gross Generation (MWh)	2005 Gross Capacity Factor (Percent)
United States	Cook-2	PWR	West	9,720,540	97.94
Canada	Pickering-7	PHWR	AECL	4,627,940	97.83
United States	Indian Point-2	PWR	West	9,141,179	97.80
Belgium	Tihange-3	PWR	ACECOWEN	9,122,520	97.78
Taiwan	Kuosheng-1	BWR	GE	8,411,128	97.48
Sweden	Forsmark-3	BWR	ABB	10,189,898	96.94
Switzerland	Beznau-1	PWR	West	3,225,905	96.91
United States	Diablo Canyon-2	PWR	West	9,873,322	96.83
Japan	Kashiwazaki-6	BWR	Toshiba	11,490,834	96.74
Taiwan	Maanshan-1	PWR	West	8,048,860	96.53
United States	Surry-1	PWR	West	7,106,513	96.35
South Korea	Wolsong-4	PHWR	AECL	6,030,862	96.29
United States	Calvert Cliffs-2	PWR	CE	7,417,304	96.22
South Korea	Ulchin-4	PWR	KHIC-CE	8,422,652	96.15
United States	River Bend	BWR	GE	8,340,172	96.07
Canada	Darlington-1	PHWR	AECL	7,861,632	96.06
South Korea	Wolsong-2	PHWR	AECL	6,016,227	96.05
Mexico	Laguna Verde-2	BWR	GE	5,668,139	95.86
South Korea	Kori-2	PWR	West	5,456,642	95.83
Finland	Loviisa-2	PWR	AEE	4,275,198	95.69
Germany	Isar-1	BWR	Siemens	7,629,573	95.50
Japan	Sendai-1	PWR	Mitsubishi	7,444,934	95.49
United States	Peach Bottom-2	BWR	GE	9,878,700	95.41

Note: U.S. units believed to belong on this list, but which have not supplied their gross generation, are Calvert Cliffs-2, Seabrook, Point Beach-2, Fort Calhoun, and Susquehanna-2.
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APPENDIX M

Top 50 Reactors by Generation, Worldwide

Nation	Unit	Reactor Type	Vendor	2005 Gross Generation (MWh)	2005 Gross Capacity Factor (Percent)
Germany	Brokdorf	PWR	Siemens	11,987,315	95.03
Japan	Hamaoka-5	BWR	Toshiba	11,740,500	101.86
Germany	Isar-2	PWR	Siemens	11,715,563	90.67
Germany	Neckar-2	PWR	Siemens	11,577,100	94.74
Japan	Kashiwazaki-6	BWR	Toshiba	11,490,834	96.74
Germany	Grohnde	PWR	Siemens	11,490,188	91.72
Germany	Emsland	PWR	Siemens	11,487,437	93.67
Germany	Philipps-burg-2	PWR	Siemens	11,418,640	89.4
France	Paluel-1	PWR	Fram	11,027,123	91.09
Lithuania	Ignalina-2	RBMK	Minatom	10,970,500	83.49
Germany	Gundremmin-gen-B	BWR	Siemens	10,826,679	91.96
U.S.	Braidwood-1	PWR	West	10,745,465	98.76
France	Chooz-B2	PWR	Fram	10,728,460	80.79
Germany	Grafenrhein-feld	PWR	Siemens	10,671,160	90.57
France	Belleville-1	PWR	Fram	10,665,693	89.33
U.S.	Catawba-2	PWR	West	10,626,121	100.67
Germany	Gundremmin-gen-C	BWR	Siemens	10,514,139	89.3
U.S.	Grand Gulf-1	BWR	GE	10,485,162	91.65
France	Cattenom-4	PWR	Fram	10,419,573	87.33
U.S.	Sequoyah-1	PWR	West	10,419,384	100.29
U.S.	South Texas-2	PWR	West	10,417,145	90.43
U.S.	South Texas-1	PWR	West	10,380,112	90.11
U.S.	Nine Mile Point-2	BWR	GE	10,376,067	99.67
France	Golfech-2	PWR	Fram	10,341,618	86.61
Japan	Ohi-4	PWR	Mitsubishi	10,324,221	99.88

APPENDIX M
Top 50 Reactors by Generation, Worldwide (continued)

Nation	Unit	Reactor Type	Vendor	2005 Gross Generation (MWh)	2005 Gross Capacity Factor (Percent)
U.S.	Limerick-1	BWR	GE	10,270,300	100.81
France	Cattenom-3	PWR	Fram	10,239,546	85.82
U.S.	LaSalle-1	BWR	GE	10,198,967	99.85
Sweden	Forsmark-3	BWR	ABB	10,189,898	96.94
France	Civaux-1	PWR	Fram	10,147,485	74.21
U.S.	Byron-1	PWR	West	10,127,693	93.09
France	Paluel-4	PWR	Fram	10,124,403	83.63
France	Flamanville-2	PWR	Fram	10,115,237	83.55
France	St.Alban-1	PWR	Fram	10,074,969	83.28
U.S.	Byron-2	PWR	West	10,070,179	95.01
France	Civaux-2	PWR	Fram	10,059,649	73.57
U.S.	Braidwood-2	PWR	West	10,002,283	94.33
Japan	Hamaoka-4	BWR	Toshiba	9,996,123	100.36
U.S.	Palo Verde-2	PWR	CE	9,941,022	79.47
U.S.	San Onofre-3	PWR	CE	9,899,450	100.27
U.S.	Peach Bottom-2	BWR	GE	9,878,700	95.41
U.S.	Diablo Canyon-2	PWR	West	9,873,322	96.83
France	Cattenom-1	PWR	Fram	9,810,215	82.22
U.S.	Palo Verde-3	PWR	CE	9,749,157	81.35
France	Cattenom-2	PWR	Fram	9,728,199	81.54
U.S.	Cook-2	PWR	West	9,720,540	97.94
U.S.	Catawba-1	PWR	West	9,675,275	91.66
U.S.	Vogtle-1	PWR	West	9,659,370	90.75
Germany	Kruemmel	BWR	Siemens	9,647,953	83.69
France	Belleville-2	PWR	Fram	9,629,538	80.65

Note: U.S. units believed to belong on this list but do not disclose gross generation are Seabrook and Susquehanna-2.
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APPENDIX N
Quick Reference Metric Conversion Tables

SPACE AND TIME

Quantity	From Inch-Pound Units	To Metric Units	Multiply by
Length	mi (statute)	km	1.609 347
	yd	m	*0.914 4
	ft (int)	m	*0.304 8
	in	cm	*2.54
Area	mi^2	km^2	2.589 998
	acre	m^2	4 046.873
	yd^2	m^2	0.836 127 4
	ft^2	m^2	*0.092 903 04
	in^2	cm^2	*6.451 6
Volume	acre foot	m^3	1 233.489
	yd^3	m^3	0.764 554 9
	ft^3	m^3	0.028 316 85
	ft^3	L	28.316 85
	gallon	L	3.785 412
	fl oz	mL	29.573 53
	in^3	cm^3	16.387 06
Velocity	mi/h	km/h	1.609 347
	ft/s	m/s	*0.304 8
Acceleration	ft/s^2	m/s^2	*0.304 8

NUCLEAR REACTION AND IONIZING RADIATION

Quantity	From Inch-Pound Units	To Metric Units	Multiply by
Activity (of a radionuclide)	curie (Ci)	MBq	*37,000.0
	dpm	Bq (becquerel)	0.016 667
Absorbed dose	rad	Gy (gray)	*0.01
	rad	cGy	*1.0
Dose equivalent	rem	Sv (sievert)	*0.01
	rem	mSv	*10.0
	mrem	mSv	*0.01
	mrem	µSv	*10.0
Exposure(X-rays and gamma rays)	roentgen (R)	C/kg (coulomb)	0.000 258

HEAT

Quantity	From Inch-Pound Units	To Metric Units	Multiply by
Thermodynamic temperature	°F	°K	*°K = (°F + 59.67)/1.8
Celsius temperature	°F	°C	*°C = (°F–32)/1.8
Linear expansion coefficient	°F–1	°K-1 or °C-1	*1.8
Thermal conductivity	(Btu • in)/(ft^2 • h • °F)	W/(m • °C)	0.144 227 9
Coefficient of heat transfer	Btu / (ft^2 • h • °F)	W/(m^2 • °C)	5.678 263
Heat capacity	Btu/°F	kJ/°C	1.899 108
Specific heat capacity	Btu/(lb • °F)	kJ/(kg •°C)	*4.186 8
Entropy	Btu/°F	kJ/°C	1.899 108
Specific entropy	Btu/(lb • °F)	kJ/(kg •°C)	*4.186 8
Specific internal energy	Btu/lb	kJ/kg	*2.326

MECHANICS

Quantity	From Inch-Pound Units	To Metric Units	Multiply by
Mass (weight)	ton (short) lb (avdp)	t (metric ton) kg	*0.907 184 74 *0.453 592 37
Moment of mass	lb • ft	kg • m	0.138 255
Density	ton (short)/yd^3 lb/ft^3	t/m^3 kg/m^3	1.186 553 16.018 46
Concentration (mass)	lb/gal	g/L	119.826 4
Momentum	lb • ft/s	kg •m/s	0.138 255
Angular momentum	lb • ft^2/s	kg •m^2/s	0.042 140 11
Moment of Inertia	lb • ft^2	kg •m^2	0.042 140 11

MECHANICS

Quantity	From Inch-Pound Units	To Metric Units	Multiply by
Force	kip (kilopound)	kN (kilonewton)	4.448 222
	lbf	N (newton)	4.448 222
Moment of Force, torque	lbf • ft	N • m	1.355 818
	lbf • in	N • m	0.122 984 8
Pressure	atm (std)	kPa (kilopascal)	*101.325
	bar	kPa	*100.0
	lbf/in^2 (formerly psi)	kPa	6.894 757
	inHg (32°F)	kPa	3.386 38
	ftH2O (39.2°F)	kPa	2.988 98
	inH2O (60°F)	kPa	0.248 84
	mmHg (0°C)	kPa	0.133 322
Stress	kip/in^2 (formerly ksi)	MPa	6.894 757
	lbf/in^2 (formerly psi)	MPa	0.006 894 757
	lbf/in^2 (formerly psi)	kPa	6.894 757
	lbf/ft^2	kPa	0.047 880 26
Energy, work	kwh	MJ	*3.6
	calth	J (joule)	*4.184
	Btu	kJ	1.055 056
	ft • lbf	J	1.355 818
	therm (US)	MJ	105.480 4
Power	Btu/s	kW	1.055 056
	hp (electric)	kW	*0.746
	Btu/h	W	0.293 071 1

To convert from metric units to inch-pound units, divide the metric unit by the conversion factor.
* Exact conversion factors
Note: The information contained in this table is intended to familiarize NRC personnel with commonly used SI units and provide a quick reference to aid in the understanding of documents containing SI units. The conversion factors provided have not been approved as NRC guidelines for development of licensing actions, regulations, or policy.
Source: Federal Standard 376A (May 5, 1983), Preferred Metric Units for General Use by the Federal Government; and International Commission of Radiation Units and Measurements, ICRU Report 33 (1980), Radiation Quantities and Unit

Glossary

AGREEMENT STATE: A State that has signed an agreement with the NRC allowing the State to regulate the use of radioactive material within that State.

BOILING WATER REACTOR (BWR): A nuclear reactor in which water, used as both coolant and moderator, is allowed to boil in the core.

CAPABILITY: The maximum load that a generating station can carry under specified conditions for a given period of time without exceeding approved limits of temperature and stress. Net summer capability is used in the digest. Measured in watts except as noted otherwise.

CAPACITY FACTOR (Gross): The ratio of the gross electricity generated, for the period of time considered, to the energy that could have been generated at continuous full-power operation during the same period.

CAPACITY FACTOR (Net): The ratio of the net electricity generated, for the period of time considered, to the energy that could have been generated at continuous full-power operation during the same period.

CASK: A heavily shielded container used to store and/or ship radioactive materials. Lead and steel are common materials used in the manufacture of casks.

COMPACT: A group of two or more States formed to dispose of low-level radioactive waste on a regional basis. Forty-four States have formed 10 compacts.

CONSTRUCTION RECAPTURE: The maximum number of years that could be added to the license expiration date to recover the period from the construction permit to the date when the operating license was granted. A licensee is required to submit an application for such a change.

CONTAMINATION: The deposition of unwanted radioactive material on the surfaces of structures, areas, objects, or personnel.

DECOMMISSION: Safely removing a facility from reducing residual radioactivity to a level that permits the release of the property for unrestricted and, under certain conditions, restricted use.

DECON: A method of decommissioning in which the equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations.

DECONTAMINATION: The reduction or removal of contaminated radioactive material from a structure, area, object, or person.

ENTOMB: A method of decommissioning in which radioactive contaminants are encased in a structurally long-lived material, such as concrete. The entombment structure is appropriately maintained, and continued surveillance is carried out until the radioactivity decays to a level permitting unrestricted release of the property.

FISCAL YEAR: The 12-month period, from October 1 through September 30, used by the Federal Government in budget formulation and execution. The fiscal year is designated by the calendar year in which it ends.

FUEL CYCLE: The series of steps involved in supplying fuel for nuclear power reactors.

FULL-TIME EQUIVALENT: A measurement equal to one staff person working a full-time work schedule for 1 year.

GENERATION (Gross): The total amount of electric energy produced by a generating station as measured at the generator terminals. Measured in watthours except as noted otherwise.

GENERATION (Net): The gross amount of electric energy produced minus the electric energy consumed at a generating station for station use. Measured in watthours except as noted otherwise.

GIGAWATT: One billion watts.

GIGAWATTHOUR: One billion watthours.

HIGH-LEVEL WASTE: High-level radioactive waste (HLW) means (1) irradiated (spent) reactor fuel; (2) liquid waste resulting from the operation of the first cycle solvent extraction system, and the concentrated wastes from subsequent extraction cycles, in a facility for reprocessing irradiated reactor fuel; and (3) solids into which such liquid wastes have been converted. HLW is primarily in the form of spent fuel discharged from commercial nuclear power reactors. It also includes some reprocessed HLW from defense activities and a small quantity of reprocessed commercial HLW.

KILOWATT (KW): One thousand watts.

LOW-LEVEL WASTE: Low-level radioactive waste (LLW) is a general term for a wide range of wastes. Industries; hospitals and medical, educational, or research institutions; private or Government laboratories; and nuclear fuel cycle facilities (e.g., nuclear power reactors and fuel fabrication plants) using radioactive materials generate low-level wastes as part of their normal operations. These wastes are generated in many physical and chemical forms and levels of contamination.

MAXIMUM DEPENDABLE CAPACITY (Gross): Dependable main-unit gross capacity, winter or summer, whichever is smaller. The dependable capacity varies because the unit efficiency varies during the year because of temperature variations in cooling water. It is the gross electrical output as measured at the output terminals of the turbine generator during the most restrictive seasonal conditions (usually summer). Measured in watts except as noted otherwise.

MAXIMUM DEPENDABLE CAPACITY (Net): Gross maximum dependable capacity minus the normal station service loads. Measured in watts except as noted otherwise.

MEGAWATT (MW): One million watts.

MEGAWATTHOUR (MWh): One million watthours.

METRIC TON: Approximately 2,200 pounds.

NET SUMMER CAPABILITY: The steady hourly output that generating equipment is expected to supply to system load exclusive of auxiliary power, as demonstrated by tests at the time of summer peak demand. Measured in watts except as noted otherwise.

NONPOWER REACTOR: A nuclear reactor used for research, training, and test purposes and for the production of radioisotopes for medical and industrial uses.

POSSESSION-ONLY LICENSE: A form of license that allows possession but not operation.

PRESSURIZED-WATER REACTOR (PWR): A nuclear reactor in which heat is transferred from the core to a heat exchanger via water kept under high pressure without boiling the water.

PRODUCTION EXPENSE: Production expenses are a component of generation expenses and include costs associated with operation, maintenance, and fuel.

RADIOACTIVITY: The rate at which radioactive material emits radiation. Measured in units of becquerels or disintegrations per second.

SAFSTOR: A method of decommissioning in which the nuclear facility is placed and maintained in such condition that the nuclear facility can be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use.

SPENT NUCLEAR FUEL: Fuel that has been removed from a nuclear reactor because it can no longer sustain power production for economic or other reasons.

URANIUM FUEL FABRICATION FACILITY: A facility that (1) manufactures reactor fuel containing uranium for any of the following: (i) preparation of fuel materials; (ii) formation of fuel materials into desired shapes; (iii) application of protective cladding; (iv) recovery of scrap material; and (v) storage associated with such operations; or (2) conducts research and development activities.

URANIUM HEXAFLUORIDE PRODUCTION FACILITY: A facility that receives natural uranium in the form of ore concentrate and converts it into uranium hexafluoride (UF_6).

VIABILITY ASSESSMENT: A DOE decisionmaking process to judge the prospects for geologic disposal of high-level radioactive wastes at Yucca Mountain based on (1) specific design work on the critical elements of the repository and waste package, (2) a total system performance assessment that will describe the probable behavior of the repository, (3) a plan and cost estimate for the work required to complete a license application, and (4) an estimate of the costs to construct and operate the repository.

WATT: An electrical unit of power, the rate of energy transfer equivalent to 1 ampere flowing under a pressure of 1 volt at unity power factor.

WATTHOUR: An electrical energy unit of measure equal to 1 watt of power supplied to, or taken from, an electrical circuit steadily for 1 hour.

WHEELING SERVICE: The movement of electricity from one system to another over transmission facilities of intervening systems. Wheeling service contracts can be established between two or more systems.

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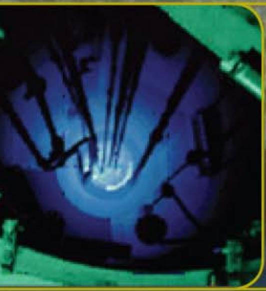

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