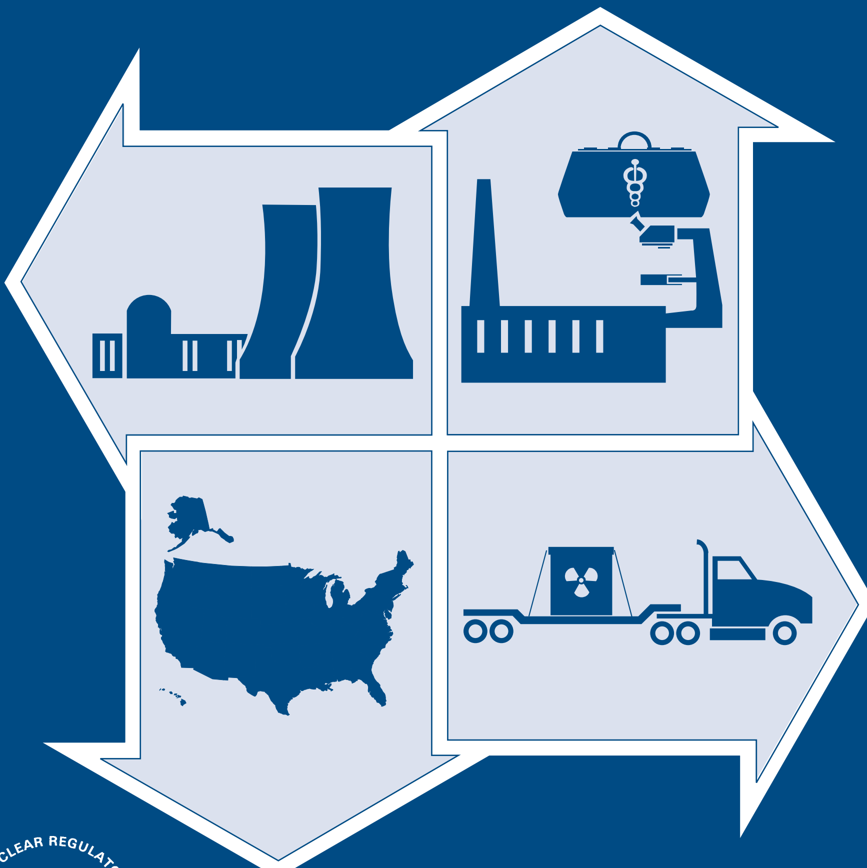
UNITED STATES NUCLEAR REGULATORY COMMISSION

INFORMATION DIGEST



Office of the Chief Financial Officer

2003 Edition

NUREG-1350, Volume 15

AVAILABILITY OF REFERENCE MATERIALS IN NRC PUBLICATIONS

NRC Reference Material

As of November 1999, you may electronically access NUREG-series publications and other NRC records at NRC's Public Electronic Reading Room at http://www.nrc.gov/reading-rm.html. Publicly released records include, to name a few, NUREG-series publications; *Federal Register* notices; applicant, licensee, and vendor documents and correspondence; NRC correspondence and internal memoranda; bulletins and information notices; inspection and investigative reports; licensee event reports; and Commission papers and their attachments.

NRC publications in the NUREG series, NRC regulations, and *Title 10, Energy*, in the Code of *Federal Regulations* may also be purchased from one of these two sources.

1. The Superintendent of Documents
   U.S. Government Printing Office
   Mail Stop SSOP
   Washington, DC 20402–0001
   Internet: bookstore.gpo.gov
   Telephone: 202-512-1800
   Fax: 202-512-2250
2. The National Technical Information Service
   Springfield, VA 22161–0002
   www.ntis.gov
   1–800–553–6847 or, locally, 703–605–6000

A single copy of each NRC draft report for comment is available free, to the extent of supply, upon written request as follows:

Address: Office of the Chief Information Officer,
Reproduction and Distribution
Services Section
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: DISTRIBUTION@nrc.gov
Facsimile: 301–415–2289

Some publications in the NUREG series that are posted at NRC's Web site address http://www.nrc.gov/reading-rm/doc-collections/nuregs are updated periodically and may differ from the last printed version. Although references to material found on a Web site bear the date the material was accessed, the material available on the date cited may subsequently be removed from the site.

Non-NRC Reference Material

Documents available from public and special technical libraries include all open literature items, such as books, journal articles, and transactions, *Federal Register* notices, Federal and State legislation, and congressional reports. Such documents as theses, dissertations, foreign reports and translations, and non-NRC conference proceedings may be purchased from their sponsoring organization.
Copies of industry codes and standards used in a substantive manner in the NRC regulatory process are maintained at—

The NRC Technical Library
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852–2738

These standards are available in the library for reference use by the public. Codes and standards are usually copyrighted and may be purchased from the originating organization or, if they are American National Standards, from—
American National Standards Institute
11 West 42nd Street
New York, NY 10036–8002
www.ansi.org
212–642–4900

Legally binding regulatory requirements are stated only in laws; NRC regulations; licenses, including technical specifications; or orders, not in NUREG-series publications. The views expressed in contractor-prepared publications in this series are not necessarily those of the NRC.

The NUREG series comprises (1) technical and administrative reports and books prepared by the staff (NUREG–XXXX) or agency contractors (NUREG/CR–XXXX), (2) proceedings of conferences (NUREG/CP–XXXX), (3) reports resulting from international agreements (NUREG/IA–XXXX), (4) brochures (NUREG/BR–XXXX), and (5) compilations of legal decisions and orders of the Commission and Atomic and Safety Licensing Boards and of Directors' decisions under Section 2.206 of NRC's regulations (NUREG–0750).

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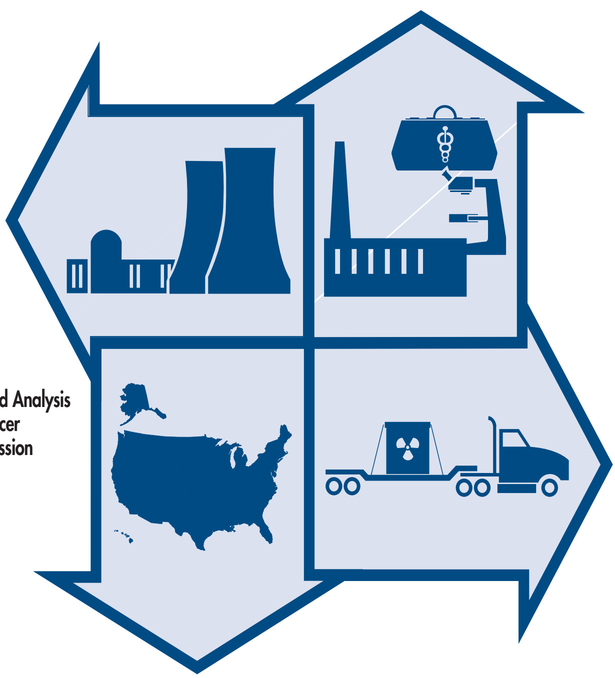
INFORMATION DIGEST

2003 Edition



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Abstract

The "United States Nuclear Regulatory Commission Information Digest" (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 world-wide 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 2002 or data available at manuscript completion. Information on 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 JoAnne M. Johnson or Alesha Bellinger, 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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Tables *(Continued)*

For More Information...

The U.S. Nuclear Regulatory Commission (NRC) offers a variety of programs to make the agency, licensee, and nuclear industry information available to the public.

The NRC's World Wide Web site (www.nrc.gov) contains a wide variety of information about the agency's regulatory programs. The areas covered include the licensing of power and research reactors, nuclear materials, and radioactive waste; agency radiation protection and emergency response activities; and the background and current status of all ongoing regulatory initiatives. The site also provides access to many publicly available agency documents and information collections, press releases, organizational charts and descriptions, headquarters and regional locations and addresses, the agency telephone directory, current agency regulations, planning and financial management reports, and areas devoted specifically to public comments and participation in the agency's regulatory process. To help the public locate information, the site provides an alphabetically arranged topical index of contents, a search engine, a site contents page arranged by program area, and a text menu of site contents. The agency also welcomes comments on its site. They can be submitted to nrcweb@nrc.gov.

The Electronic Reading Room on the NRC Web site allows the public to use the Internet to search for records that the NRC has already released to the public. This site uses the NRC's Agencywide Documents Access and Management System (ADAMS) to search two electronic libraries: the Public Legacy Library and the Publicly Available Records System (PARS) Library. When available, the Public Legacy Library will contain a selection of bibliographic descriptions and some full text files of NRC records released to the public prior to Fall 1999. Records in this library were copied from the NRC Bibliographic Retrieval System (BRS) and the Nuclear Documents System (NUDOCS), the two systems previously used by the public to search for NRC records. The BRS will remain available for searching until all of the records are in the Public Legacy Library. By contrast, PARS Library, contains all NRC publicly available records released since Fall 1999. The PARS Library contains both full-text and image records, and the public can perform full-text searches of the database, and can view, download, and print the files from there.

The NRC's Public Document Room (PDR) at NRC headquarters in Rockville, Maryland (OWFN 01-F21), has a complete collection of more than two million NRC documents released prior to the Fall of 1999 that are still retained as agency documents. The public may view documents at the PDR, and reference librarians are available to help in identifying, retrieving, organizing, and evaluating NRC documents from various resources and formats, including the Electronic Reading Room. Members of the public may also access the Electronic Reading Room libraries from computer terminals in the PDR. The PDR also provides

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For More Information... *(Continued)*

reproduction services and, for a fee, the public can order copies of any of the records in the PDR or the Legacy and the Public PARS libraries.

Records indexed in the Public Legacy Library are maintained by the PDR in paper, microfiche or both. Additional microfiche collections of NRC documents released between January 1981 and the fall of 1999 are also maintained in certain libraries under the Government Printing Office's Federal Depository Library Program (FDLP), and in some other libraries throughout the country. For more information, contact the PDR by telephone at their toll-free number (800) 397-4209 or their local number (301) 415-4737. The PDR may also be contacted by Telecommunication Device for the Deaf (TDD) at (301) 415-8322 or toll-free at (800) 635-4512; Internet email at pdr@nrc.gov; fax (301) 415-3548; or U.S. Mail to: PDR, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

The public may also use the Freedom of Information Act (FOIA) and Privacy Act (PA) to obtain information that the NRC has not made publicly available. Submit FOIA or PA requests in writing to: FOIA/PA Officer, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. The FOIA requires the NRC to give the public access to records unless the information is exempt from disclosure (e.g., classified as national security, business proprietary, personal privacy, or investigative). A request must specifically state that it is a FOIA request, and it must adequately describe the specific records or type of records sought so that the NRC staff can conduct a search for the requested records by exerting a reasonable amount of effort. Disclosure will be made by providing a copy of the documents requested or by making copies of the requested documents available in the NRC's Headquarters Public Document Room. Detailed information concerning NRC policies and procedures for obtaining access to information under the FOIA and PA is available in Title 10, Part 9, of the *Code of Federal Regulations*, which is available in any public library. Information can also be found on the Internet at the FOIA/PA homepage, reached through the "FOIA Requests" link at the NRC's Web site www.nrc.gov.

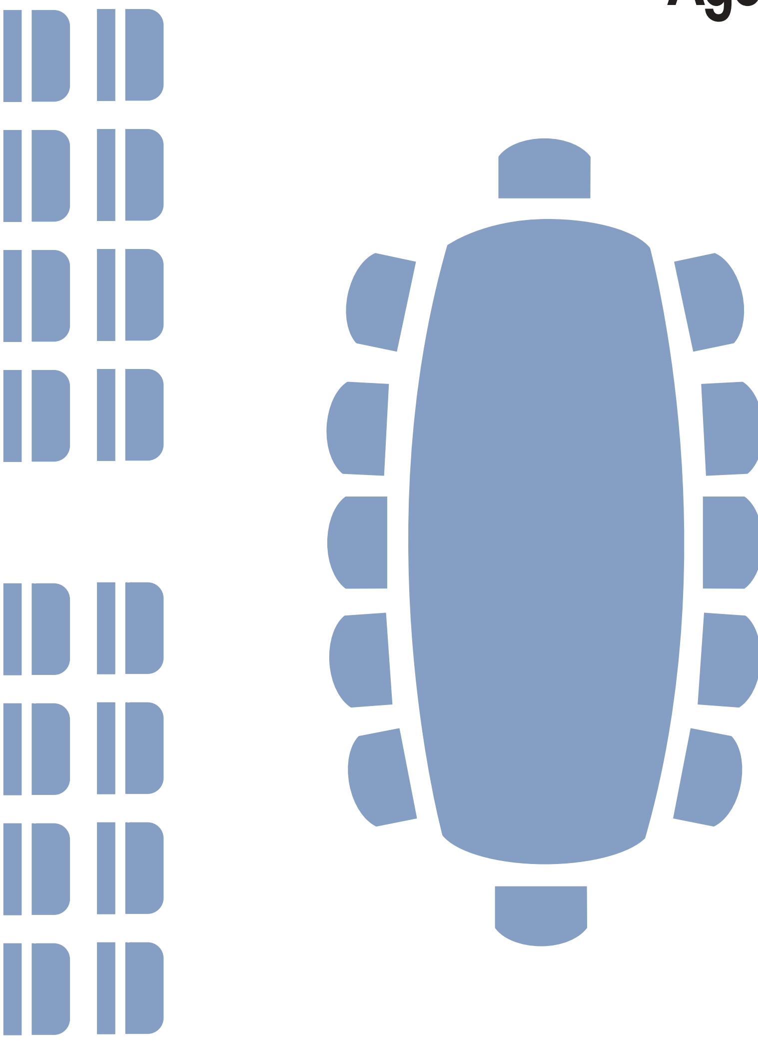
The agency makes the majority of its regulatory and technical publications available for sale at both the Government Printing Office and the National Technical Information Service. Copies of agency publications are also routinely sent to U.S. Depository Libraries throughout the United States and the Commonwealth of Puerto Rico.

The NRC announces the schedules of staff meetings that are open to the public. Public notice will be made via the Internet using the NRC's Web site at http://www.nrc.gov/public-involve/public-meetings/meeting-schedule.html. Commission and Advisory Committee meetings, Open Predecisional Enforcement Conferences, and Atomic Safety and Licensing Board hearings that are published in the *Federal Register* are also noticed at this site. Recorded information about Commission meetings is available at (301) 415-1292.

The NRC is required to answer inquires from small entities concerning information on, advice about, and compliance with the statutes and regulations that affect them. The NRC is expected to interpret and apply the law, or regulations implementing the law, to specific sets of facts that are specified by the small entity. The NRC is required to establish a program to receive and respond to these types of inquiries. To help small entities obtain information quickly, the NRC has established a toll-free telephone number at (800) 368-5642.

To learn more about these and other sources of public information about agency activities, send for a free copy of the “Citizen’s Guide to U.S. Nuclear Regulatory Commission Information” (NUREG/BR-0010, Rev. 3), ATTN: Reproduction and Distribution Services Branch, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

NRC as a Regulatory Agency



Mission, Goals, and Statutory Authority

Mission

The mission of the U.S. Nuclear Regulatory Commission (NRC) is to regulate the Nation's civilian use of byproduct, source, and special nuclear materials to ensure adequate protection of public health and safety, to promote the common defense and security, and to protect the environment. The NRC's scope of responsibility includes regulation of commercial nuclear power plants; research, test, and training reactors; fuel cycle facilities; medical, academic, and industrial uses of nuclear materials; and the transport, storage, and disposal of nuclear materials and wastes.

Strategic and Performance Goals

The NRC has developed strategic goals consistent with its mission. These strategic goals are supported by performance goals, which represent outcomes the NRC plans to achieve over the period covered by the strategic plan (FY 2000 - FY 2005).

Strategic Goals: The NRC will conduct an effective regulatory program that allows our Nation to use nuclear materials safely for civilian purposes and in a manner that protects the public and the environment by working to achieve the following strategic goals:

- Prevent radiation-related deaths and illnesses, promote the common defense and security, and protect the environment in the use of civilian nuclear reactors. (Nuclear Reactor Safety)
- Prevent radiation-related deaths and illnesses, promote the common defense and security, and protect the environment in the use of source, byproduct, and special nuclear material. (Nuclear Materials Safety)
- Prevent significant adverse impacts from radioactive waste to the current and future public health and safety and the environment, and promote the common defense and security. (Nuclear Waste Safety)
- Support U.S. interests in the safe and secure use of nuclear materials and in nuclear nonproliferation. (International Nuclear Safety Support)

The safe and secure use of nuclear materials for civilian purposes is the responsibility of NRC licensees[1] and Agreement State licensees, and the regulatory oversight of licensees is the responsibility of the NRC and the Agreement States. Thus, achieving these strategic goals requires the collective efforts of the NRC, the Agreement States, and licensees.

Performance Goals: The protection of public health and safety remains paramount among the NRC's goals and will drive the agency's decisions. However, the NRC recognizes that it must consider other key issues, including the

[1] "Licensees" as used in this strategic plan include persons required to be licensed (as defined in Section 11(s) of the Atomic Energy Act, as amended) as well as, where appropriate, applicants for licenses, certificate of compliance holders and applicants for certificates of compliance, contractors (including subcontractors, suppliers, consultants, and vendors), and all persons who are subject to the NRC's regulatory jurisdiction.

effect of the NRC's decisions on the public's trust in the agency's regulatory process, the industries we regulate, and our own effectiveness and efficiency. The agency has established performance goals to support the strategic goals for the Nuclear Reactor Safety, Nuclear Materials Safety, and Nuclear Waste Safety arenas: maintain safety, protect the environment and the common defense and security; increase public confidence; make NRC activities and decisions more effective, efficient, and realistic; and reduce unnecessary regulatory burden.

Collectively, these outcome-based performance goals are the key contributors to the strategic goals. The performance goals and their associated measures reflect the agency's move toward more outcome-based performance. Agency work (programs and activities) is being planned, managed, monitored, and assessed according to their contribution to the achievement of these performance goals, with public health and safety as the primary consideration. This assessment will form the basis to identify whether existing programs are successfully achieving the goals or whether revised or new initiatives are needed. Resources will accordingly be allocated to the work that is necessary to achieve the performance goals. The strategic plan is being used as one of the primary tools to communicate and institutionalize these changes.

NRC concluded the triennial update of the Fiscal Year 2000-2005 Strategic Plan and provided it to the Office of Management and Budget (OMB) and Congress on September 29, 2000. The Fiscal Year 2003-2008 Strategic Plan update is underway. The Strategic Plan is published as NUREG-1614, Vol. 2, Part 1, and is available on the Web at http://www.nrc.gov/NRC/NUREGS/SR1614/V2/index.html

Corporate Management Strategies

The NRC has established overarching corporate management strategies that help the agency work more effectively, both within and across strategic arenas. These strategies also help the support offices better serve their customers within the agency to help them achieve the agency's goals. The NRC's corporate management strategies describe the means by which the agency will conduct business to successfully implement the strategic plan and accomplish its mission:

- Employ innovative and sound business practices.
- Sustain a high-performing, diverse workforce.
- Provide proactive information technology and information management services and
- Communicate strategic change.

Statutory Authority

The NRC was created as an independent agency by the Energy Reorganization Act of 1974, which abolished the Atomic Energy Commission (AEC) and moved the AEC's regulatory function to the NRC. This act, along with the Atomic Energy Act of 1954, as amended, provides the foundation for regulation of the Nation's commercial

Mission, Goals, and Statutory Authority *(Continued)*

nuclear power industry. NRC regulations are issued under the *United States 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
- West Valley Demonstration Project Act of 1980
- Nuclear Waste Policy Act of 1982
- Low-Level Radioactive Waste Policy Amendments Act of 1985
- Diplomatic Security and Anti-Terrorism Act of 1986
- Nuclear Waste Policy Amendments Act of 1987
- Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990
- Energy Policy Act of 1992
- Low-Level Radioactive Waste Policy Amendments Act of 1995

The NRC and its licensees share a common responsibility to protect public health and safety. Federal regulations and the NRC regulatory program are important elements in the protection of the public. NRC licensees, however, have the primary responsibility for the safe use of nuclear materials.

Principles of Good Regulation

The NRC adheres to the following principles of good regulation:

- **Independence** — Nothing but the highest possible standards of ethical performance and professionalism should influence regulation. However, independence does not imply isolation. The NRC will seek all available facts and opinions from licensees and other interested members of the public. The many and possibly conflicting public interests involved must be considered. Final decisions must be based on objective, unbiased assessments of all information and must be documented with reasons explicitly stated.

- **Openness** — Nuclear regulation is the public's business, and it must be transacted publicly and candidly. The public must be informed about and have the opportunity to participate in the regulatory processes as required by law. Open channels of communication must be maintained with Congress, other Government agencies, licensees, and the public, as well as with the international nuclear community.

- **Efficiency** — The American taxpayer, the rate-paying consumer, and licensees are all entitled to the best possible management and administration of regulatory activities. The highest technical and managerial competence is required and must be a constant agency goal. NRC must establish means to evaluate and continually upgrade its regulatory capabilities. Regulatory activities should be consistent with the degree of risk reduction they achieve. Where several effective alternatives are available, the option which minimizes the use of resources should be adopted. Regulatory decisions should be made without undue delay.

- **Clarity** — Regulations should be coherent, logical, and practical. There should be a clear nexus between regulations and agency goals and objectives, whether explicitly or implicitly stated. Agency positions should be readily understood and easily applied.

- **Reliability** — Regulations should be based on the best available knowledge from research and operational experience. Systems interactions, technological uncertainties, and the diversity of licensees and regulatory activities must all be taken into account so that risks are maintained at an acceptably low level. Once established, regulation should be perceived by all stakeholders to be reliable and not unjustifiably in a state of transition. Regulatory actions should always be fully consistent with written regulations and should be promptly, fairly, and decisively administered so as to lend stability to the nuclear operational and planning processes.

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 cycle 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 the geologic repositories 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, common defense and security, and antitrust matters
- 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 Office of Homeland Security, on safety and security issues, and developing and directing the NRC program for response to incidents
- 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, by and with the advice and consent of the Senate, and serves a term of five years. The members' terms are 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. As of July 2003, there are two vacancies on the Commission. The three members of the Commission are:

Commissioner	Expiration of Term
Nils J. Diaz, Chairman	June 30, 2006
Edward McGaffigan, Jr.	June 30, 2005
Jeffrey S. Merrifield	June 30, 2007

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.

The NRC's major program offices follow.

- **Nuclear Reactor Regulation** — Directs all licensing and inspection activities associated with the design, construction, and operation of nuclear power reactors and nonpower reactors

- **Nuclear Material Safety and Safeguards —** Directs all licensing inspection and environmental activities associated with nuclear fuel cycle facilities, uses of nuclear materials, storage and transport of nuclear materials, safeguarding of nuclear materials, management and disposal of low-level and high-level radioactive nuclear wastes, and decontamination and decommissioning of facilities and sites

- **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 reactors and certain nuclear materials activities

- **Office of Nuclear Security and Incident Response** — Responsible for overall agency policy and activities involving security at nuclear facilities. Provides safeguards and security interface with other federal agencies and maintains the agency incident 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 the Chief Information Officer** — Responsible for the strategic use of information technology as a management tool across a spectrum of agency activities and for an agency-wide approach to information management, capital planning and

Organizations and Functions *(Continued)*

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

- **Inspector General** — Provides the Commission with an independent review and appraisal of NRC programs and operations to ensure their effectiveness, efficiency, and integrity

Figure 1 is an organization chart of the NRC.

NRC Locations

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 as illustrated in Figure 2.

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

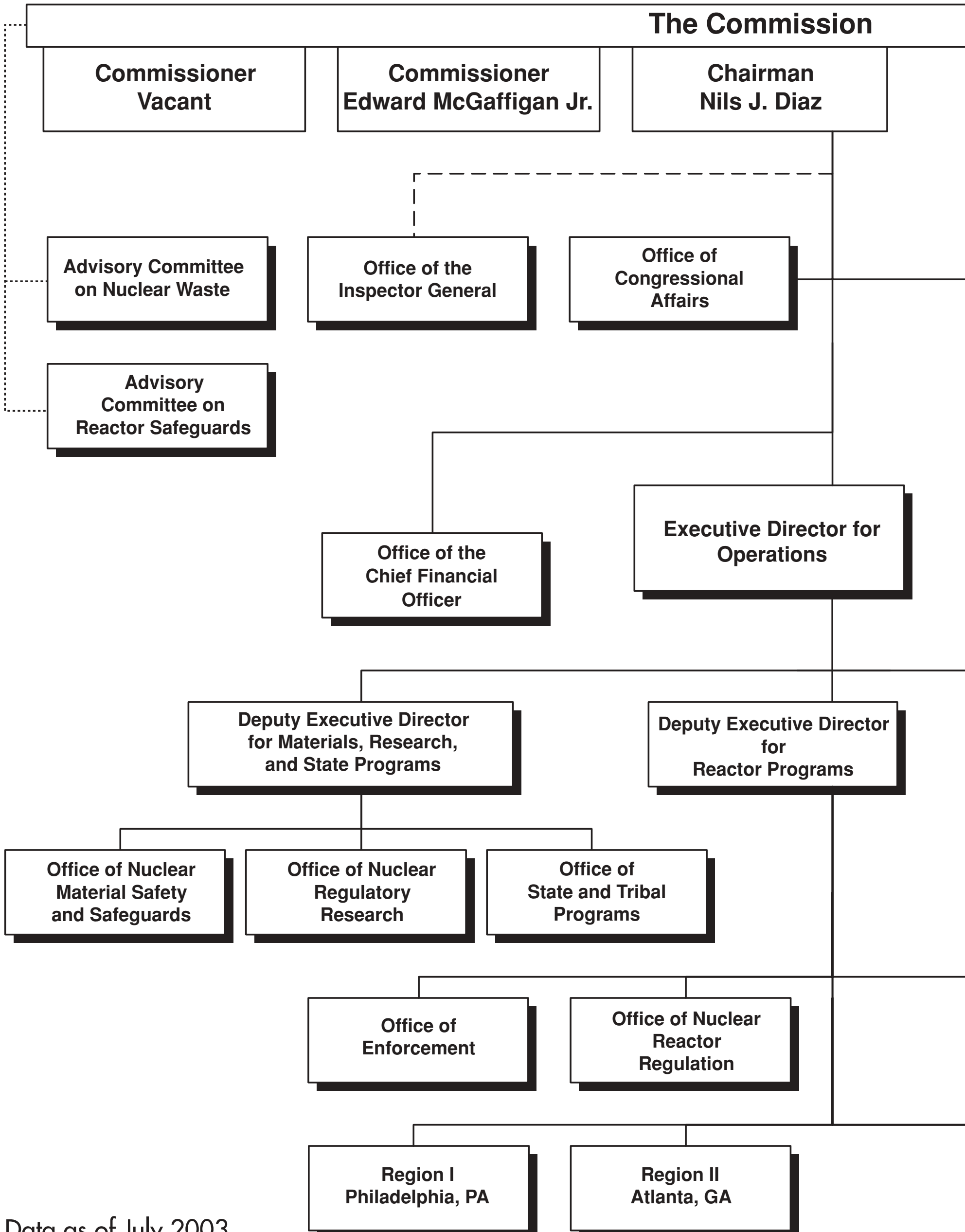
Resident Sites:

At least two NRC resident inspectors who report to the appropriate regional office are located at each nuclear power reactor site. (Refer to Figure 18 for a map of the U.S. commercial nuclear power reactor sites.)

Technical Training Center:

Chattanooga,Tennessee
423-855-6500

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



Data as of July 2003

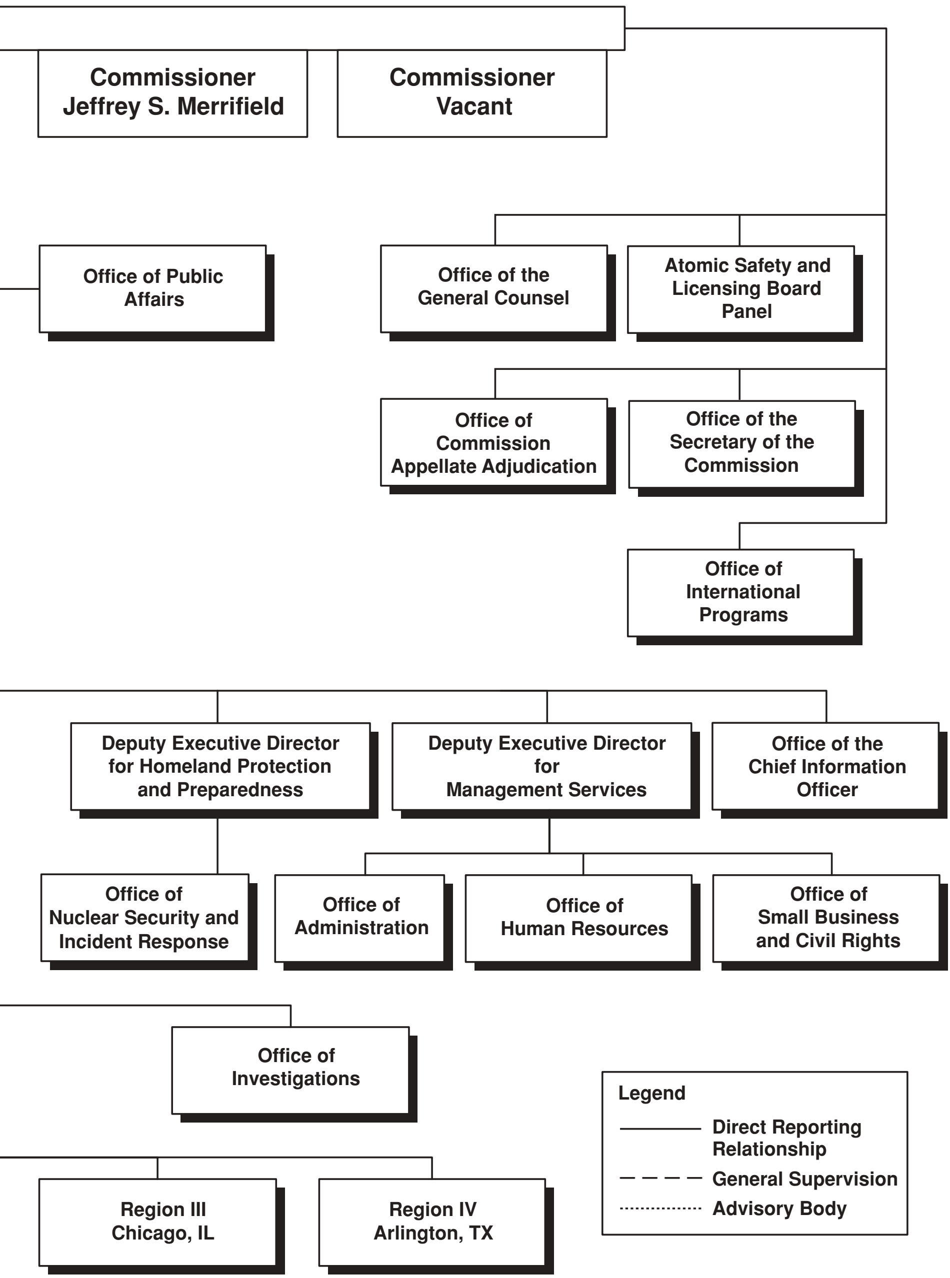
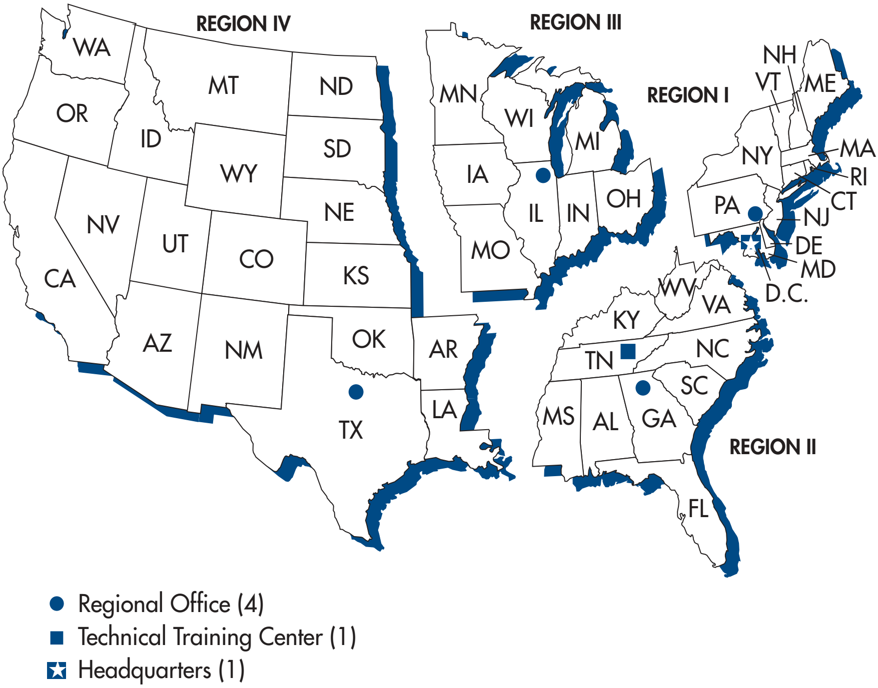

Commissioner
Jeffrey S. Merrifield
Commissioner
Vacant
Office of Public Affairs
Office of the General Counsel
Atomic Safety and Licensing Board Panel
Office of Commission Appellate Adjudication
Office of the Secretary of the Commission
Office of International Programs
Deputy Executive Director for Homeland Protection and Preparedness
Deputy Executive Director for Management Services
Office of the Chief Information Officer
Office of Nuclear Security and Incident Response
Office of Administration
Office of Human Resources
Office of Small Business and Civil Rights
Office of Investigations
Region III Chicago, IL
Region IV Arlington, TX
Legend
Direct Reporting Relationship
General Supervision
Advisory Body

Figure 2. **NRC Regions**



Note: Alaska and Hawaii are included in Region IV.
Source: Nuclear Regulatory Commission

NRC Fiscal Year 2003 Resources

Appropriation

For Fiscal Year (FY) 2003, Congress appropriated $584.9 million for the NRC ($584.6 million after government-wide rescission). The NRC's FY 2003 personnel ceiling is 2,906 full-time equivalent (FTE) staff.

The NRC allocates funds and staff to the following strategic arenas (see Figure 3):

- Nuclear Reactor Safety
- Nuclear Materials Safety
- Nuclear Waste Safety
- International Nuclear Safety Support
- Management and Support

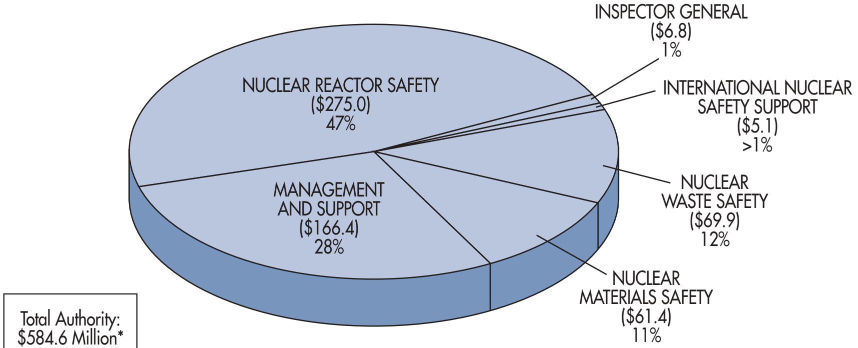
The Office of the Inspector General (OIG) receives its own appropriation, the amount of which is included in the NRC appropriation.

Civil Penalties

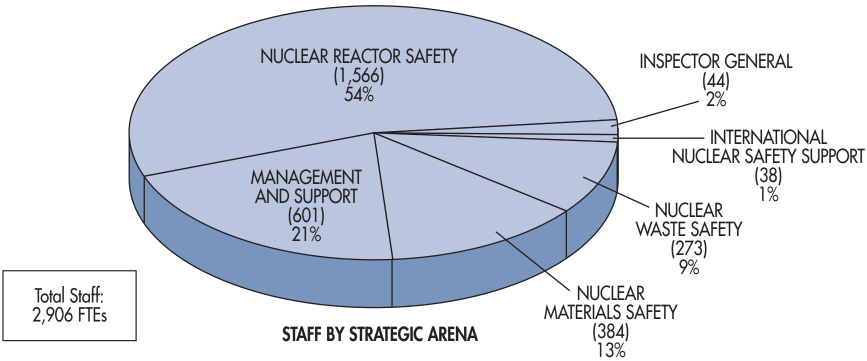
The NRC's enforcement program supports the agency's overall safety mission in protecting the public and the environment. Consistent with that purpose, the NRC uses enforcement action as a deterrent to emphasize the importance of compliance with regulatory requirements and to encourage prompt identification and prompt, comprehensive correction of violations. The NRC's enforcement program is governed by the NRC Enforcement Policy, published as NUREG-1600. The available primary enforcement sanctions are: notices of violation; civil penalties; orders to modify, suspend, or revoke licenses; and orders restricting individuals from participating in licensed activities. The NRC ranks violations according to their level of significance. Violations are assigned a severity level, ranging from Severity Level IV for those of more than minor concern to Severity Level I for the most significant, or they are associated with findings assessed through the Significance Determination Process (a key element of the reactor oversight process, or ROP) which are assigned a color of green, white, yellow, or red based on increasing risk significance. Civil penalties are normally assessed for Severity Level I and II violations and knowing and conscious violations of the reporting requirements of Section 206 of the Energy Reorganization Act. Civil penalties are also considered for Severity Level III violations. Although civil penalties are not normally used for violations associated with the ROP, civil penalties (and the use of severity levels) are considered for issues that are willful, have the potential to impact the regulatory process, or have actual consequences. The NRC imposes different levels of civil penalties based on a combination of the type of licensed activity, the type of licensee, the severity level or significance of the violation, and other criteria, including identification, corrective action, and discretion. In FY 2002, the NRC assessed approximately $490,000 in civil penalties. These civil penalties are deposited in the U.S. Treasury and are not used by the NRC.

Source: U.S. Nuclear Regulatory Commission

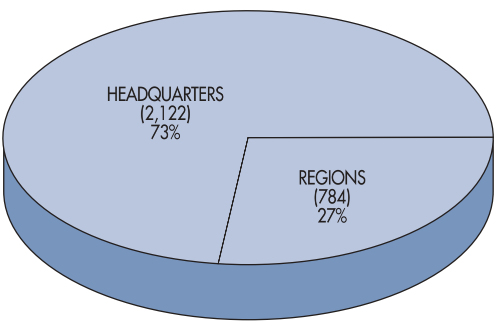
Figure 3. **Distribution of NRC FY 2003 Budget Authority (Dollars in Millions) and Staff**



DOLLARS BY STRATEGIC ARENA



STAFF BY STRATEGIC ARENA



STAFF BY LOCATION

*Budget authority includes rescission.

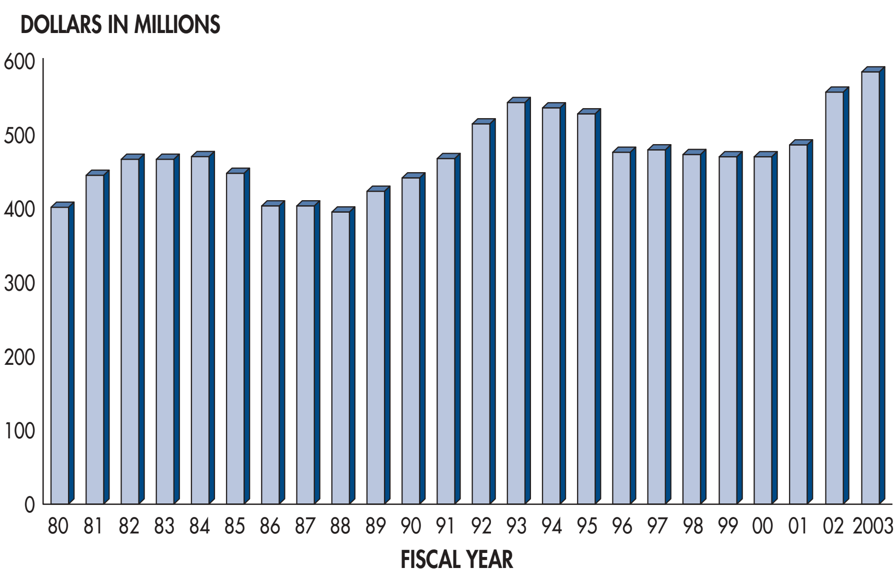
Note: Percentages are rounded to the nearest whole number.

Source: Nuclear Regulatory Commission

Table 1. **NRC Budget Authority (Dollars in Millions), FYs 1980–2003**

Fiscal Year	Actual Dollars	Fiscal Year	Actual Dollars
1980	399	1992	513
1981	441	1993	540
1982	466	1994	535
1983	465	1995	524
1984	466	1996	473
1985	444	1997	477
1986	400	1998	477
1987	401	1999	470
1988	393	2000	470
1989	420	2001	487
1990	439	2002	559
1991	465	2003	585

Figure 4. **NRC Budget Authority, FYs 1980–2003**



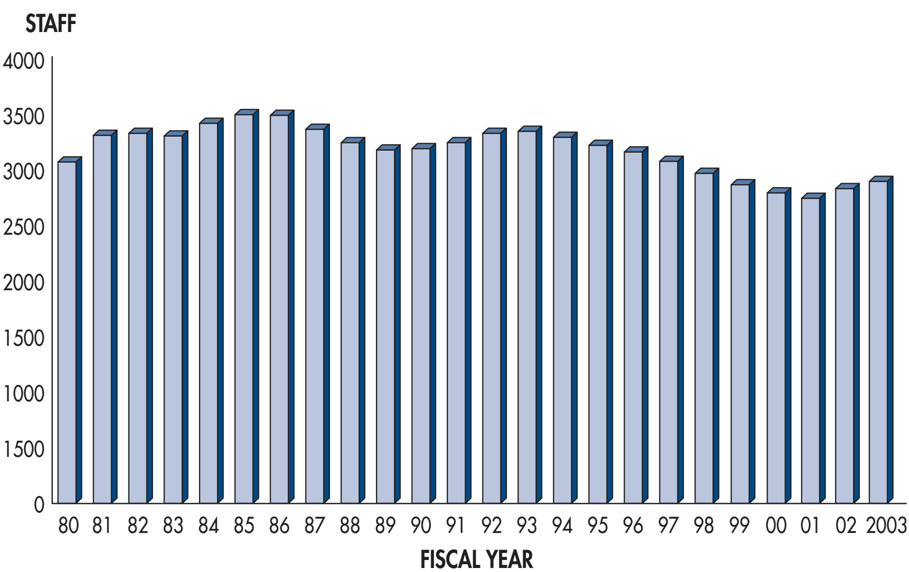
Note: Dollars are rounded to the nearest million.

Source (Table 1 and Figure 4): Nuclear Regulatory Commission

Table 2. **NRC Personnel Ceiling, FYs 1980–2003**

Fiscal Year	Staff	Fiscal Year	Staff
1980	3,066	1992	3,335
1981	3,300	1993	3,343
1982	3,325	1994	3,293
1983	3,303	1995	3,218
1984	3,416	1996	3,160
1985	3,491	1997	3,061
1986	3,491	1998	2,977
1987	3,369	1999	2,881
1988	3,250	2000	2,801
1989	3,180	2001	2,763
1990	3,195	2002	2,850
1991	3,240	2003	2,906

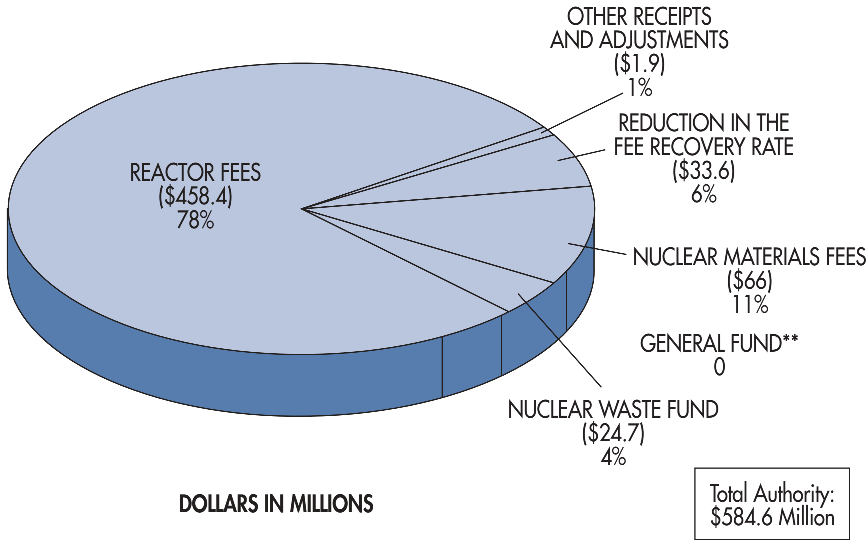
Figure 5. **NRC Personnel Ceiling, FYs 1980–2003**



Note (Table 2 and Figure 5): FYs 1980–1982 data reflect permanent full-time positions, at end-of-year strength. FY 1983–2003 reflect full-time equivalents (FTEs).

Source (Table 2 and Figure 5): Nuclear Regulatory Commission

Figure 6. **Recovery of NRC Budget Authority, FY 2003***



The Omnibus Budget Reconciliation Act of 1990 (OBRA-90), as amended, required the NRC to recover 100 percent of its budget authority, less appropriations from the Nuclear Waste Fund, for FYs 1991–2000 by assessing fees to its licensees. The FY 2001 Energy and Water Development Appropriations Act amended OBRA-90 to decrease the NRC's fee recovery amount. This reduction is being phased in at two percent per year beginning in FY 2001 through FY 2005. In 2003, the fee recovery amount is reduced to 94 percent. The NRC budget authority to be recovered from fees in FY 2003 is $526.3 million. The annual fees assessed to the major classes of NRC licensees in FY 2002 follow:

Class of Licensee	Range of Annual Fees
Operating Power Reactor	$3,251,000***
Fuel Facility	$559,000 to $5,836,000
Uranium Recovery Facility	$6,200 to $63,700
Transportation Approval	$7,100 to $76,200
Materials User	$730 to $24,700

*Based on the Final FY 2003 fee rule.

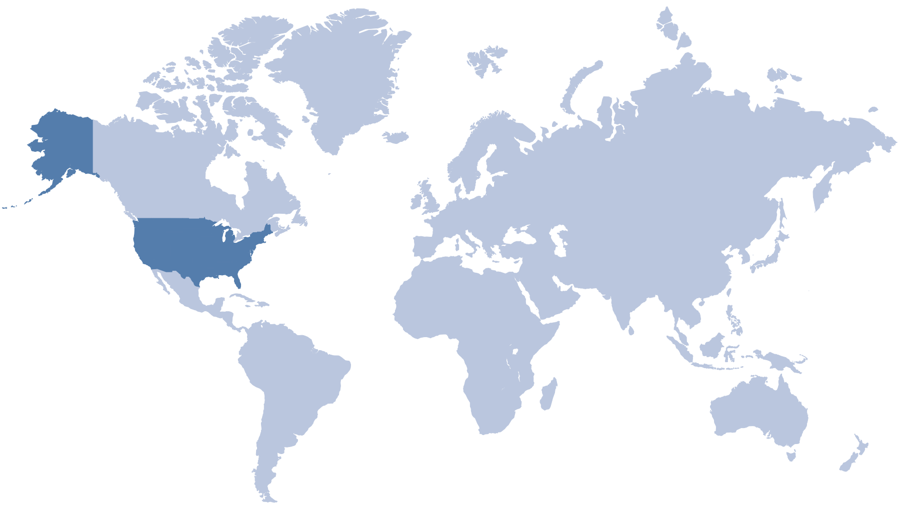
**General Fund appropriations are for activities related to homeland security.

***Includes Spent Fuel Storage/Reactor Decommissioning FY 2003 annual fee of $319,000.

Note: Percentages are rounded to the nearest whole number.

Source: U.S. Nuclear Regulatory Commission

U.S. and Worldwide Energy



U.S. Electricity

Capability and Net Generation:

U.S. electric generating capability totaled approximately 848 gigawatts in 2001. Nuclear energy accounted for approximately 12 percent of this capability (see Figure 7).

U.S. net electric generation totaled approximately 3,861 billion kilowatthours in 2002. Nuclear energy accounted for approximately 20 percent of this generation (see Figure 8).

In 2002, 104 nuclear reactors licensed to operate in 31 States generated approximately one-fifth of the Nation's electricity (see Figure 8).

– Six states relied on nuclear power for more than 50 percent of their electricity, a decrease of one over the previous year.

– Ten additional states relied on nuclear power for 25 to 50 percent of their electricity.

Since 1991, nuclear electric generation has increased by 21 percent and coal-fired generation has increased 18 percent, while electricity generated by all other sources has increased by 25 percent (see Table 4 and Figure 10).

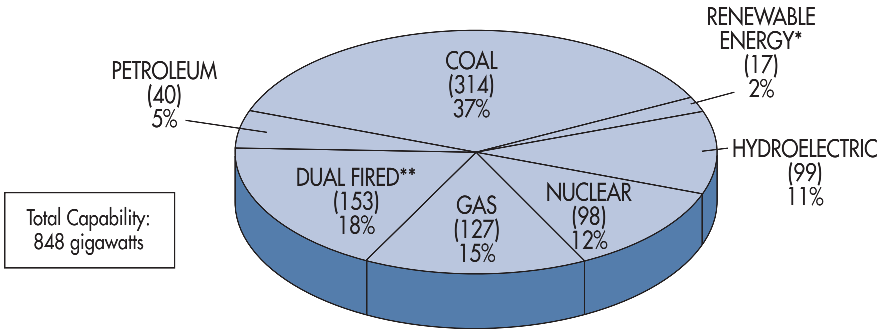
In 2001, electricity from coal and nuclear sources accounted for 47 percent of the U.S. generating capability (see Table 5 and Figure 11).

Average Production Expenses

The production expense data presented herein include all nuclear, fossil, and coal-fired utility-owned steam electric plants (see Table 6 and Figure 12).

In 2001, production expenses averaged $17.98 per megawatthour for nuclear reactors and $23.14 per megawatthour for fossil fuel plants.

Figure 7. **U.S. Electric Capacity by Energy Source, 2001**



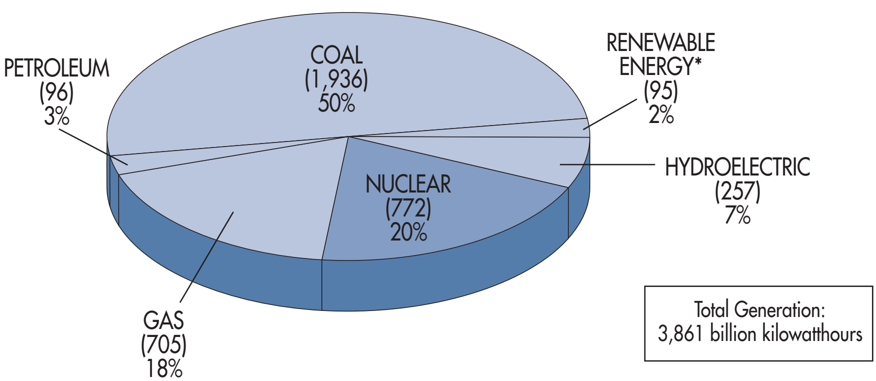
* Renewable energy includes geothermal, wood and wood waste, refuse, wind, solar energy and nonwood waste.

** 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, 2002**



* Renewable energy includes geothermal, wood, and nonwood waste, wind, and solar energy. Renewable conventional hydroelectric power is included in hydroelectric power.

Source: http://www.eia.doe.gov, DOE/EIA Monthly Energy Review, (Mar 2003), Table 7.2

Numbers rounded to the nearest thousand.

Table 3. **Electric Generating Capability and Electric Generation in Each State by Nuclear Power, 2001**

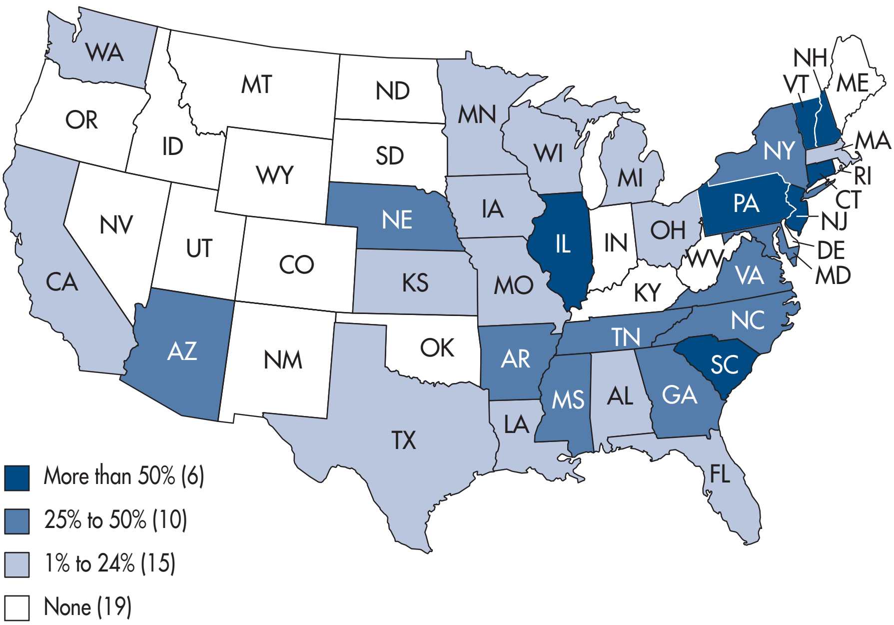
State	Percent Net Nuclear Capability	Percent Net Nuclear Generation
Alabama	21	24
Arizona	22	32
Arkansas	18	31
California	8	17
Connecticut	36	51
Florida	9	17
Georgia	14	28
Illinois	27	52
Iowa	6	9
Kansas	11	23
Louisiana	10	20
Maryland	14	28
Massachusetts	6	13
Michigan	15	24
Minnesota	15	24
Mississippi	11	19
Missouri	6	11
Nebraska	21	29
New Hampshire	41	58
New Jersey	20	51
New York	14	28
North Carolina	18	32
Ohio	7	11
Pennsylvania	24	38
South Carolina	33	55
Tennessee	17	30
Texas	5	10
Vermont	52	76
Virginia	17	35
Washington	4	10
Wisconsin	11	20
Others*	0	0

*19 States and the District of Columbia 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 2001 http://www.eia.doe.gov.

Figure 9. **Net Electricity Generated in Each State by Nuclear Power, 2001**



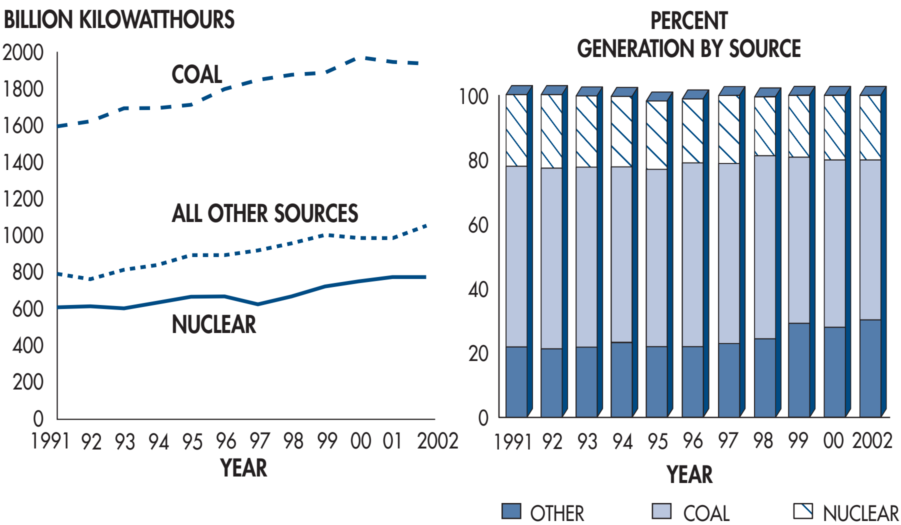
Note: There are no commercial reactors in Alaska or Hawaii. Percentages are rounded to the nearest whole number.

Source: DOE/EIA Electric Power Annual 2001 http://www.eia.doe.gov.

Table 4. **U.S. Net Electric Generation (Billion Kilowatthours) by Source, 1991–2002**

Year	Coal	Petroleum	Gas	Hydroelectric	Nuclear
1991	1,590	119	393	285	613
1992	1,621	99	418	249	619
1993	1,690	112	428	276	610
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

Figure 10. **U.S. Net Electric Generation by Source, 1991–2002**

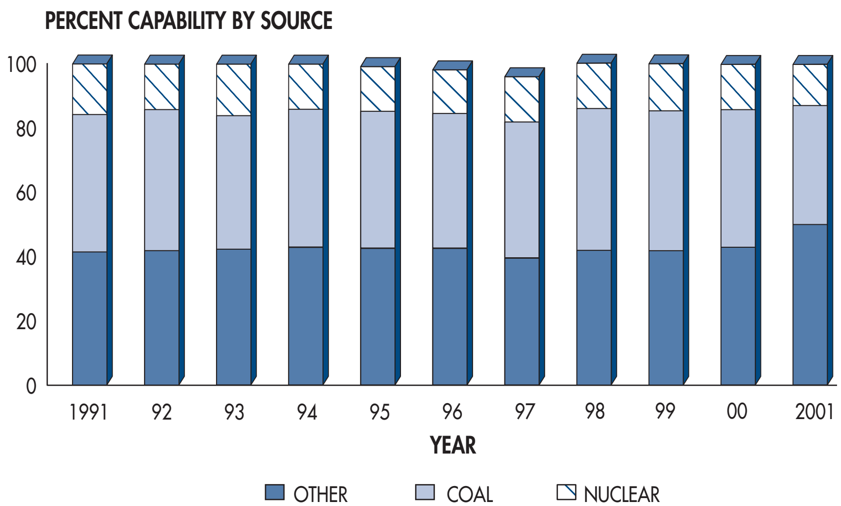


Source (Table 4 and Figure 10): DOE/EIA Monthly Energy Review, (March 2003), Table 7.2 http://eia.doe.gov.

Table 5. **U.S. Electric Generating Capability (Gigawatts) by Energy Source, 1991–2001**

Year	Coal	Petroleum	Gas	Dual Fired	Hydroelectric	Nuclear
1991	300	72	126	114	92	100
1992	301	72	127	119	93	99
1993	301	70	132	120	96	99
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

Figure 11. **U.S. Electric Generating Capability by Energy Source, 1991–2001**



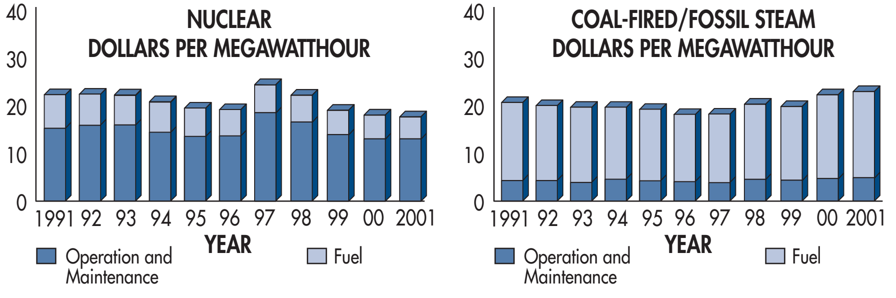
Note (Table 5 and Figure 11): Net summer capability. Table 5 includes revisions to years 1999 and 2000 and now includes dual fired units. Other includes dual fired units which can burn oil or gas. When there is more than one energy source used in a plant, the predominant energy source is reported. Percentages are rounded to the nearest whole number.

Source (Table 5 and Figure 11): DOE/EIA Electric Power Annual 2001, Table 1 http://eia.doe.gov.

Table 6. **U.S. Average Nuclear Reactor and Coal-Fired/Fossil Steam Plant Production Expenses (Dollars per Megawatthour), 1991-2001**

Year	Operation and Maintenance	Fuel	Total Production Expenses
Nuclear:			
1991	14.72	6.75	21.47
1992	15.35	6.24	21.59
1993	15.26	6.02	21.28
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
Coal-Fired:			
1991	4.39	15.85	20.24
1992	4.33	15.37	19.70
1993	4.32	15.31	19.63
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

Figure 12. **U.S. Average Nuclear Reactor, Coal-Fired and Fossil Steam Plant Production Expenses, 1991–2001**



Source: Federal Energy Regulatory Commission, FERC Form 1, "Annual Report of Major Electric Utilities, Licensees and Others"

*Data for 1997 and prior years was obtained from Utility Data Institute, Inc.

**Includes coal and fossil fuel. Plant production expenses are no longer available exclusively for coal-fired fuel.

U.S. Electricity Generated by Commercial Nuclear Power

In 2002, net nuclear-based electric generation in the United States produced a total of 772 billion kilowatthours (see Table 7 and Figure 13).

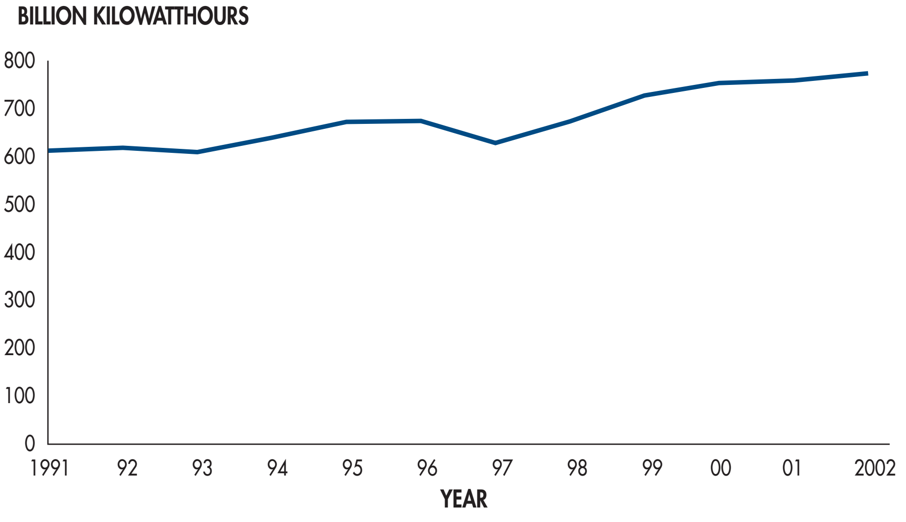
In 2001, the average U.S. net capacity factor was 90 percent. It increased to 91 percent in 2002. Since 1991, the average capacity factor has increased 28 percent (see Table 7).

- Capacity factor is the ratio of electricity generated to the amount of energy that could have been generated (see Glossary).
- Ninetysix percent of U.S. commercial nuclear reactors operated above a capacity factor of 70 percent in 2002 (see Table 8).
- In 2002, Combustion Engineering (CE) reactors had the highest average capacity factors compared to those of the other three vendors. The 14 CE reactors had an average capacity factor of 94 percent. The average capacity factors for the other three vendors were the following: 7 Babcock & Wilcox reactors — 84 percent, 35 General Electric reactors — 93 percent, and 48 Westinghouse reactors — 91 percent, (see Table 8).

Table 7. **U.S. Nuclear Power Reactor Average Capacity Factor and Net Generation, 1991–2002**

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.
1991	111	71	613	20.0
1992	110	71	619	20.1
1993	109	73	610	19.1
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

Figure 13. **Net Generation of U.S. Nuclear Electricity, 1991–2002**



Note (Table 7 and Figure 13): Average annual capacity factor is based on net maximum dependable capacity. See Glossary for definition.

Source (Table 7 and Figure 13): 1991-2002 Net Electricity based on Mar 2003 DOE/EIA - Monthly Energy Review Table 7.2, and licensee data as compiled by the Nuclear Regulatory Commission.

Table 8. **U.S. Commercial Nuclear Power Reactor Average Capacity Factor by Vendor and Reactor Type, 2000–2002**

Capacity Factor	Licensed to Operate 2000	2001	2002	Percent of Net Nuclear Generated 2000	2001	2002
Above 70 Percent	99	101	100	99	99	99
50 to 70 Percent	2	1	2	1	1	1
Below 50 Percent	3	2	2	>1	>1	>1
Total	104	104	104	100	100	100

	Licensed to Operate 2000	2001	2002	Average Capacity Factor (Percent) 2000	2001	2002	Percent of Net Nuclear Generated 2000	2001	2002
Vendor:									
Babcock & Wilcox	7	7	7	93	88	84	6	6	6
Combustion Engineering	14	14	14	91	87	94	14	13	14
General Electric	35	35	35	88	89	93	33	33	33
Westinghouse Electric	48	48	48	87	91	91	47	48	47
Total	104	104	104				100	100	100
Reactor Type:									
Boiling-Water Reactor	35	35	35	88	89	92	35	33	33
Pressurized-Water Reactor	69	69	69	89	90	89	65	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 1997–2002 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 2002, 444 operating reactors in 33 countries had a maximum dependable capacity of 363,844 megawatts electric (net MWe).

- 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 2001 were the United States and France.

- Approximately 31 percent of the world's net nuclear-generated electricity was produced in the United States (see Figure 14).

- France produced approximately 16 percent of the world's net nuclear-generated electricity. The nuclear portion of its total domestic electricity generation was approximately 77 percent (see Figure 14).

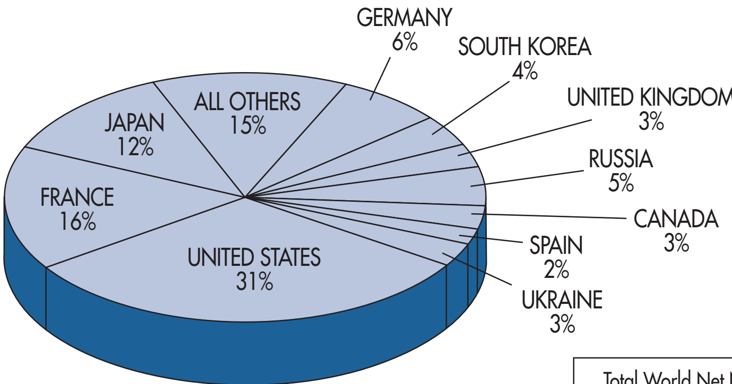
Of the countries cited here, reactors in South Korea (93 percent), U.S. (89 percent), and the Germany (83 percent) had the highest gross capacity factors in 2002. Reactors in the United States had the greatest gross generation at 812 thousand gigawatthours. France was the next highest producer at 435 MWH (see Table 9).

- Refer to Appendix L for a list of the top fifty units by gross capacity factor, worldwide, and Appendix M for a list of the top fifty units by gross generation, worldwide.

Over the past ten years, the average annual gross capacity factor has increased 29 percentage points in the United States, 13 percentage points in Germany, and increased 19 percentage points in France (see Table 10).

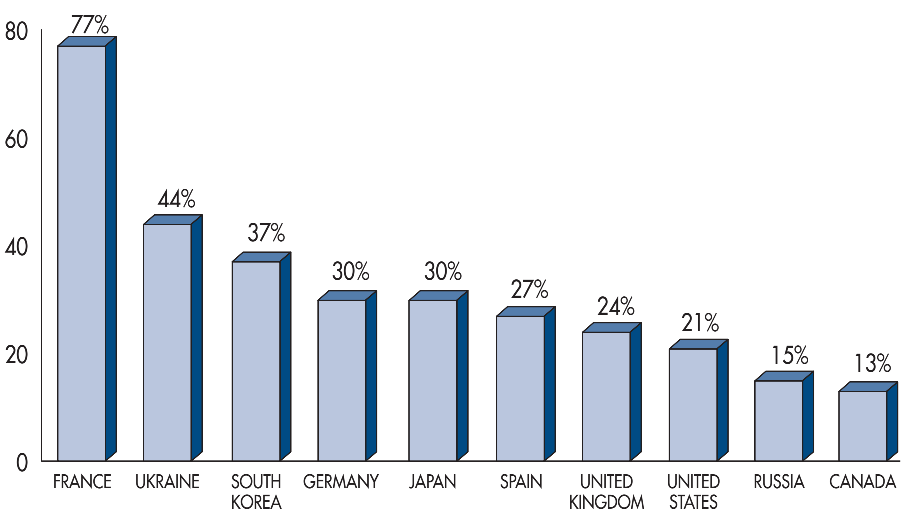
Figure 14. **Net Nuclear Electric Power as a Percent of World Nuclear Generation and Total Domestic Net Nuclear Electricity Generation, 2001**

PERCENT OF WORLD NUCLEAR GENERATION



Total World Net Nuclear Electricity Generation: 2,520.7 Billion Kilowatthours

PERCENT OF TOTAL DOMESTIC NET NUCLEAR ELECTRICITY GENERATION



Note: Percentages are rounded to the nearest whole number.

Source: DOE/EIA International Energy Information, Tables 2.6, 2.7, 2.8, 6.1 http://www.eia.doe.gov.

Table 9. **Commercial Nuclear Power Reactor Average Gross Capacity Factor and Gross Generation by Selected Country, 2002**

Country	Number of Operating Reactors	Average Gross Capacity Factor (Percent)	Total Gross Nuclear Generation (Billion Kilowatthours)	Number of Operating Reactors in Top 50 by Capacity Factor	Number of Operating Reactors in Top 50 by Generation
Canada	21	53	76	1	0
France	59	75	435	0	10
Germany	19	83	165	3	10
Japan	53	77	319	9	6
Russia	30	67	140	0	0
South Korea	18	93	117	4	0
Sweden	11	75	69	0	0
Ukraine	13	75	78	0	0
United States	104	89	812	26	21

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Table 10. **Commercial Nuclear Power Reactor Average Gross Capacity Factor by Selected Country, 1992–2002**

	Average Gross Annual Capacity Factor (Percent)										
Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Canada	68	70	76	68	65	61	50	52	50	53	53
France	63	69	67	71	74	72	73	71	72	73	75
Germany	72	69	72	71	79	83	79	88	87	87	83
Japan	72	73	74	79	80	82	83	79	79	79	77
Russia	**	**	**	**	**	**	**	61	67	67	67
South Korea	**	**	**	**	**	**	**	88	90	93	93
Sweden	67	62	76	73	79	75	78	78	66	84	75
Ukraine	**	**	**	**	**	**	**	65	69	74	75
United States	69 {71	71 73	73 75	77 79	75 77	70 73	76 78	85 86	87 88	88 90	89 91}*

*For comparison, U.S. average gross capacity factor is used. The 2002 U.S. average net capacity factor is 91 percent. Brackets { } denote average net capacity factor. See Glossary for definition.

**Data not available.

Note: Percentages are rounded to the nearest whole number.

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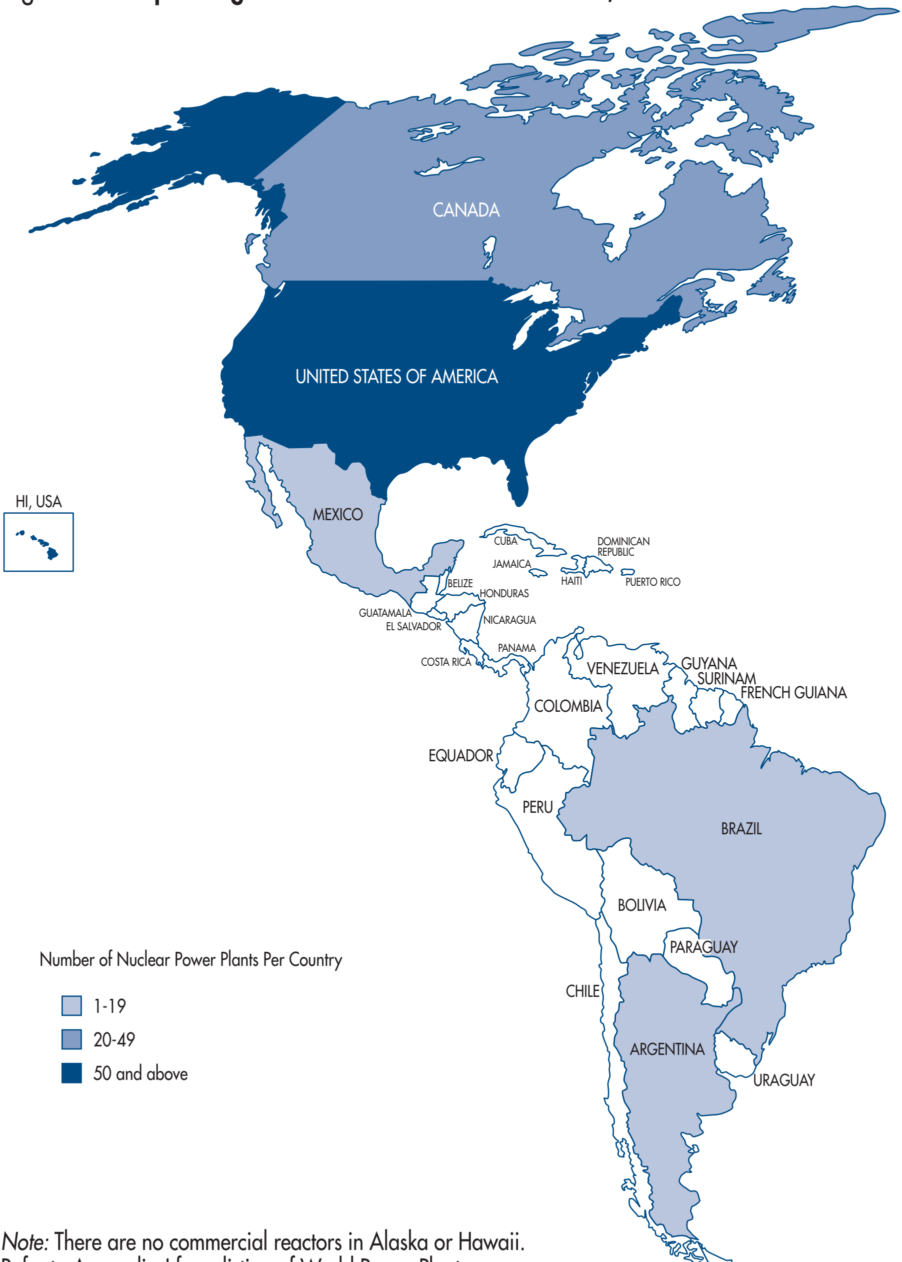
Licensee data as compiled by the Nuclear Regulatory Commission.

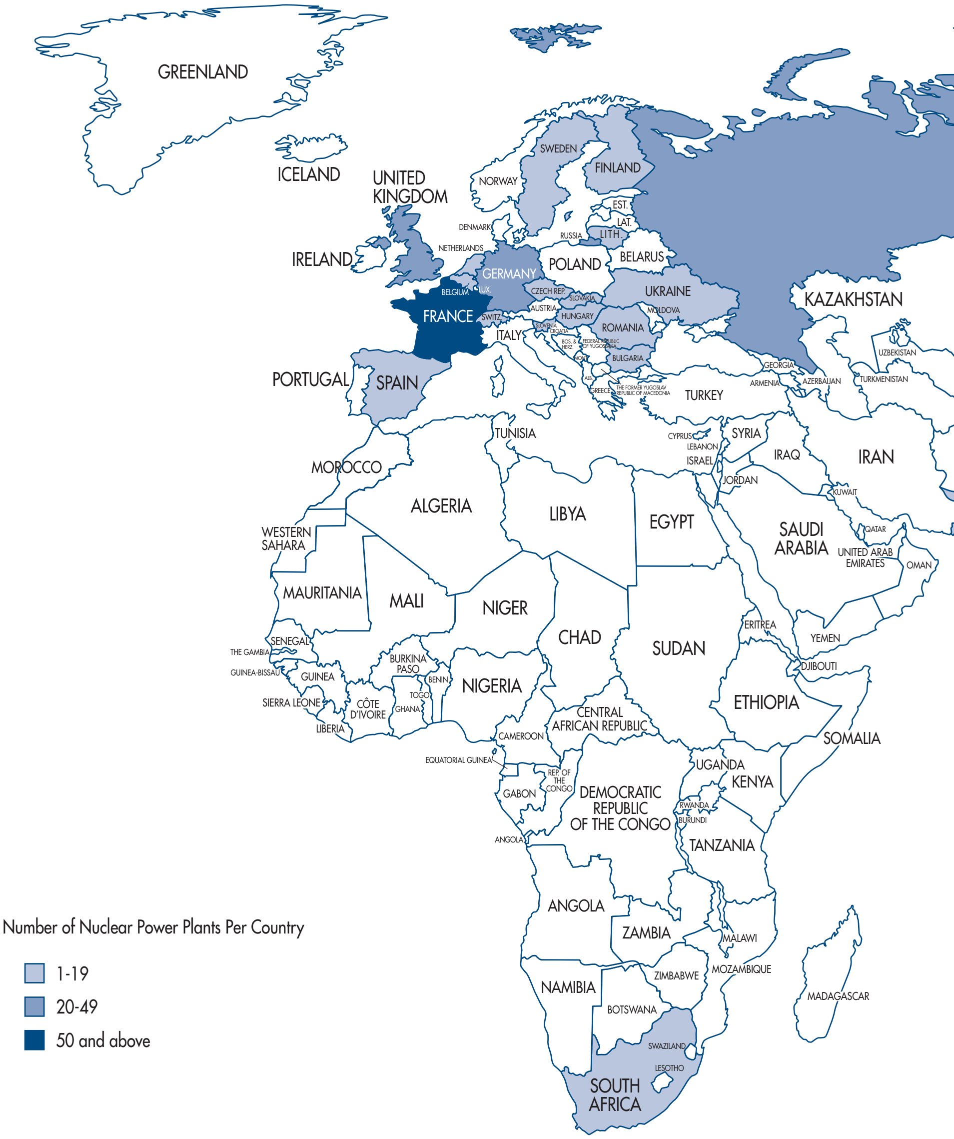
Figure 15. **Operating Nuclear Power Plants Worldwide, 2002**



Note: There are no commercial reactors in Alaska or Hawaii.
Refer to Appendix J for a listing of World Power Plants.

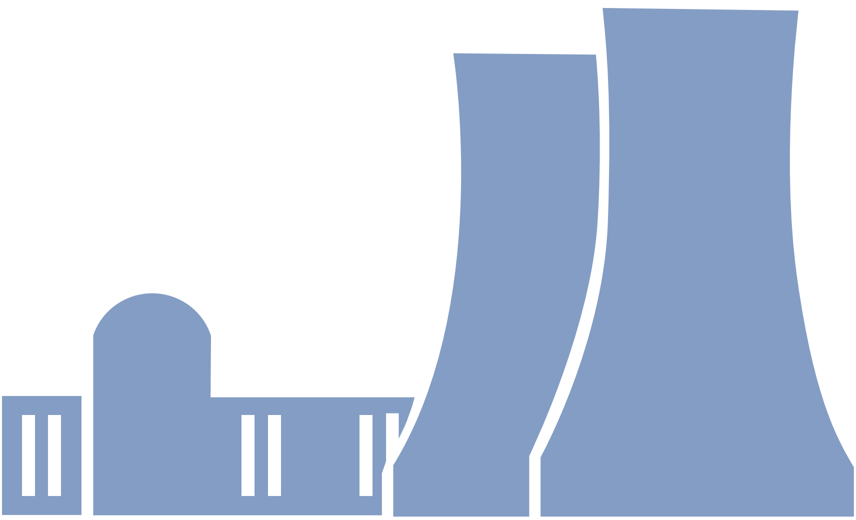
Source: http://www.cia.gov/cia/publications/factbook/index.html

Figure 16. **Operating Nuclear Power Plants Worldwide (continued)**




RUSSIA
MONGOLIA
KYRGYZSTAN
TAJIKISTAN
AFGHANISTAN
CHINA
NORTH KOREA
JAPAN
SOUTH KOREA
PAKISTAN
NEPAL
BHUTAN
BANGLADESH
INDIA
BURMA
TAIWAN
LAOS
THAILAND
VIETNAM
CAMBODIA
PHILIPPINES
SRI LANKA
MALAYSIA
PAPUA NEW GUINEA
INDONESIA
AUSTRALIA
NEW ZEALAND

Operating Nuclear Reactors



U.S. Commercial Nuclear Power Reactors

There are as of December 2002, 104 commercial nuclear power reactors licensed to operate in 31 States (see Figures 18, 19, 20, 21, and 22):

- The above number 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.

Diversity — Although there are many similarities, each reactor design can be considered unique. A typical light-water reactor is shown in Figure 17:

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

Experience—The 104 reactors licensed to operate during 2002 have accumulated 2,256 reactor-years of experience (see Table 11 and Figure 23). An additional 357 reactor-years of experience have been accumulated by permanently shutdown reactors.

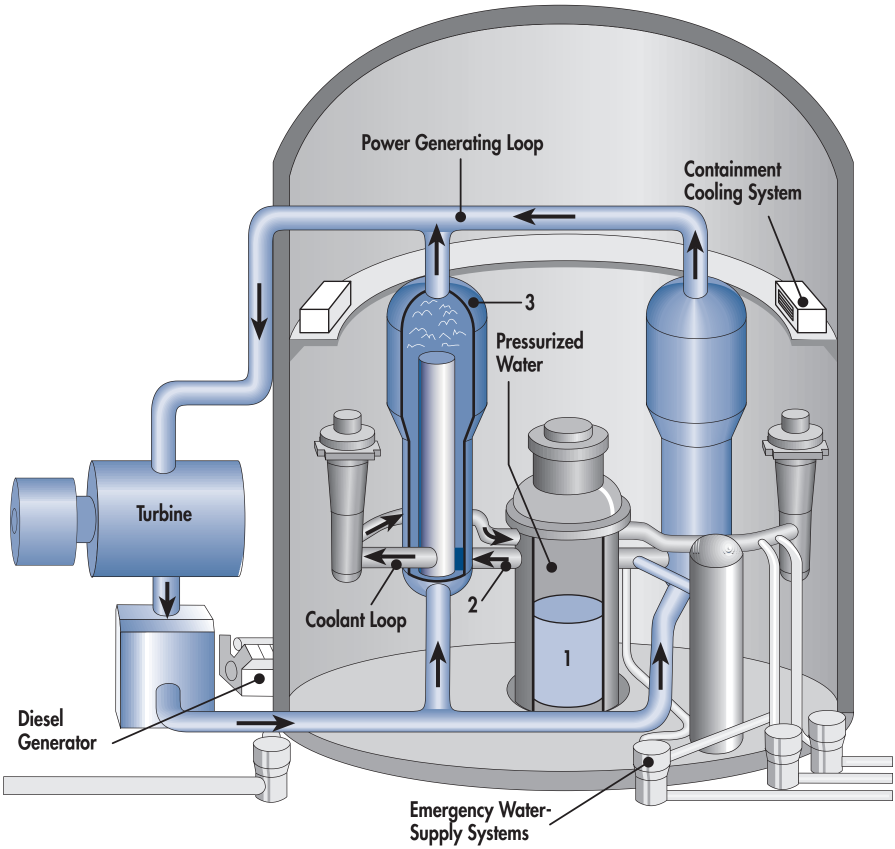
Principal Licensing and Inspection Activities

- The NRC depends primarily on reactor and facility inspections as the basis for its independent determination of licensee compliance with NRC regulations.
- On average, approximately 3,100 hours of inspection effort were expended at each operating reactor during FY 2002 (see Figure 24).
- Approximately 15 separate license changes are requested per power reactor each year:
  - More than 1,500 separate reviews were completed by the NRC in FY 2002.
- Approximately 4,500 reactor operators are licensed by the NRC:
  - Each operator is requalified before renewal of a 6-year license.
- 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 B for their decommissioning status.

Figure 17. **Typical Nuclear Reactor**

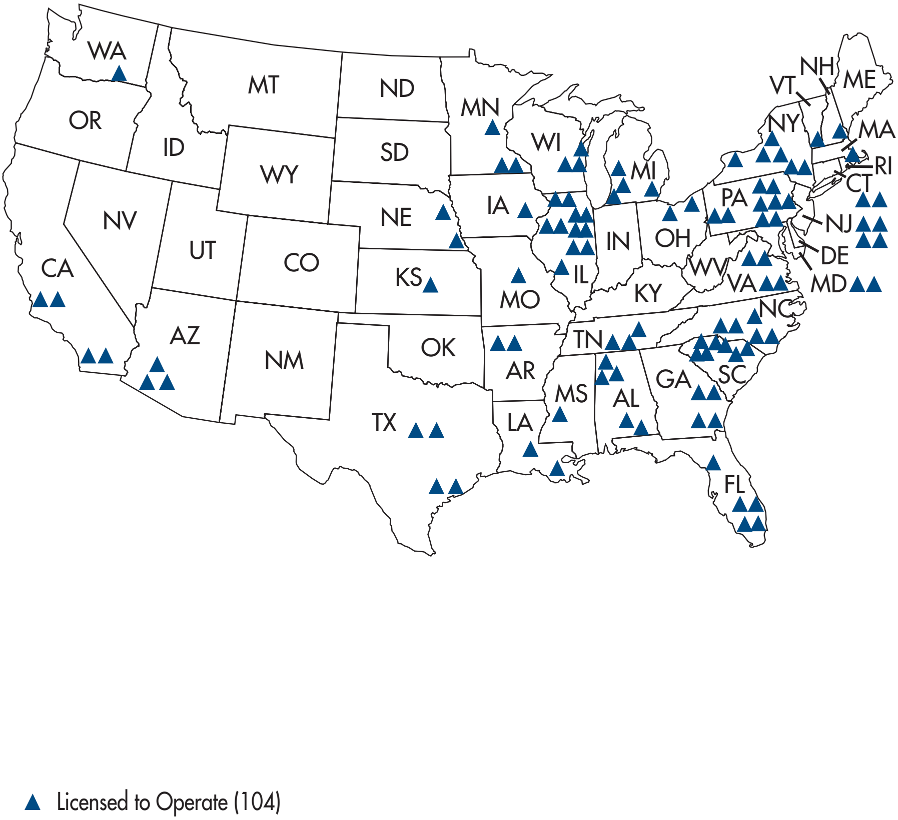
How Nuclear Reactors Work

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, and (3) the steam generator vaporizes the water in a secondary loop to drive the turbine, which produces electricity. Boiling-water reactors are similar to pressurized-water reactors but use the same loop to cool the reactor and to deliver steam to the turbine. The reactor's core is 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 building air coolers, also need electric power.



Source: Nuclear Regulatory Commission

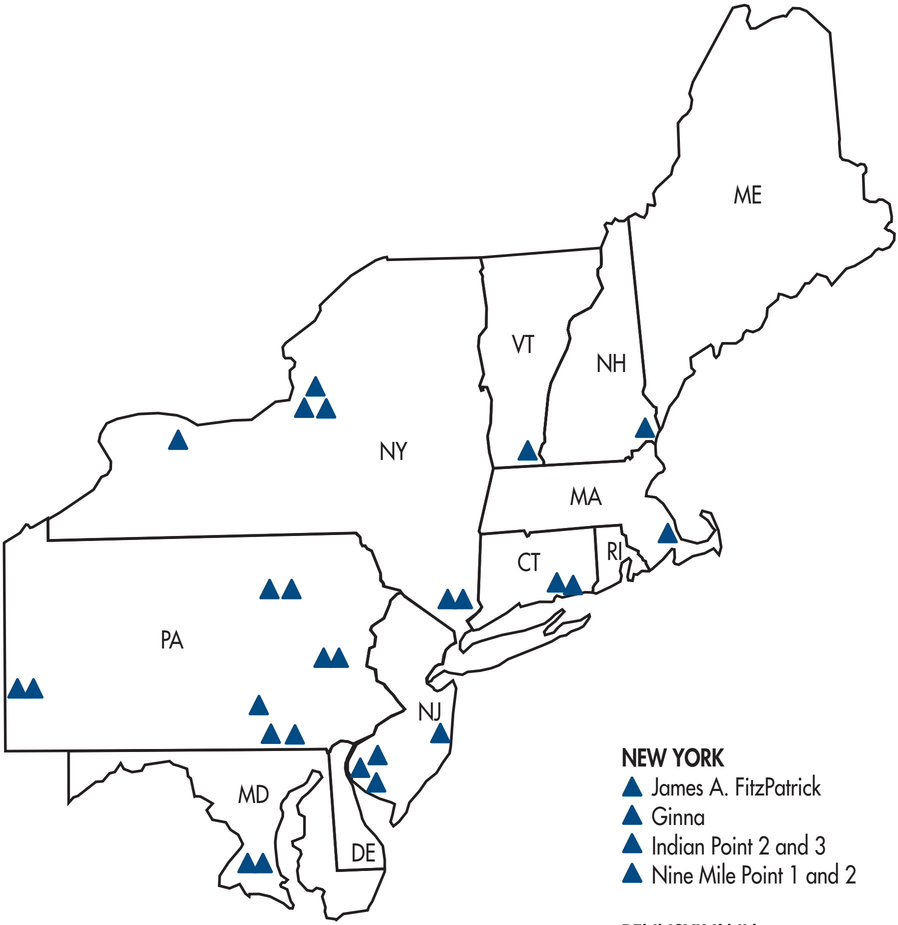
Figure 18. **U.S. Commercial Nuclear Power Reactors**



Note: Includes Browns Ferry Unit 1, which has no fuel loaded and requires Commission approval to restart. There are no commercial reactors in Alaska or Hawaii.

Source: Nuclear Regulatory Commission

Figure 19. **NRC Region I Commercial Nuclear Power Reactors**



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

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

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

▲ Licensed to Operate (26)

Source: Nuclear Regulatory Commission

Figure 20. **NRC Region II Commercial Nuclear Power Reactors**

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

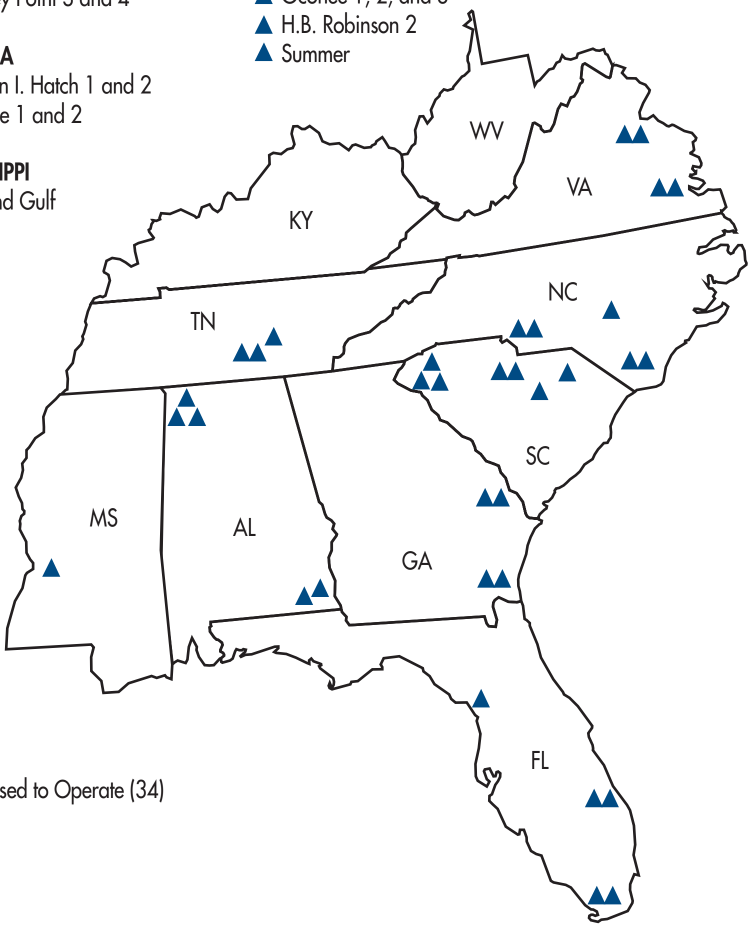
MISSISSIPPI
- ▲ Grand Gulf

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



▲ Licensed to Operate (34)

Source: Nuclear Regulatory Commission

Figure 21. **NRC Region III Commercial Nuclear Power Reactors**

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

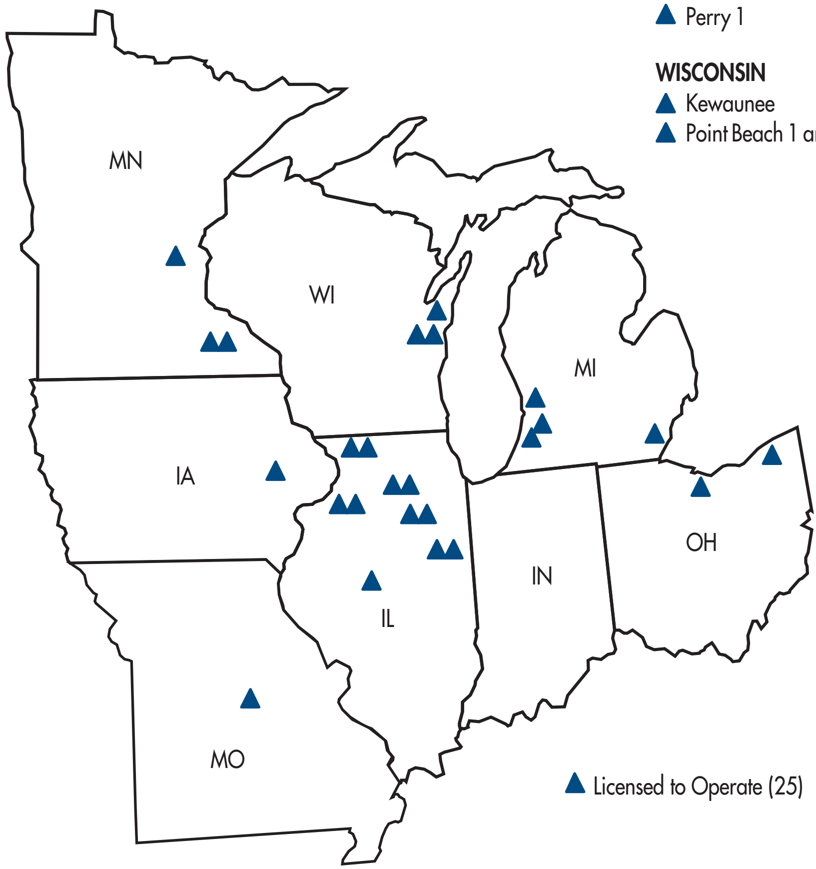
MICHIGAN
- ▲ D.C. Cook 1 and 2
- ▲ Fermi 2
- ▲ Palisades

MINNESOTA
- ▲ Monticello
- ▲ Prarie Island 1 and 2

MISSOURI
- ▲ Callaway

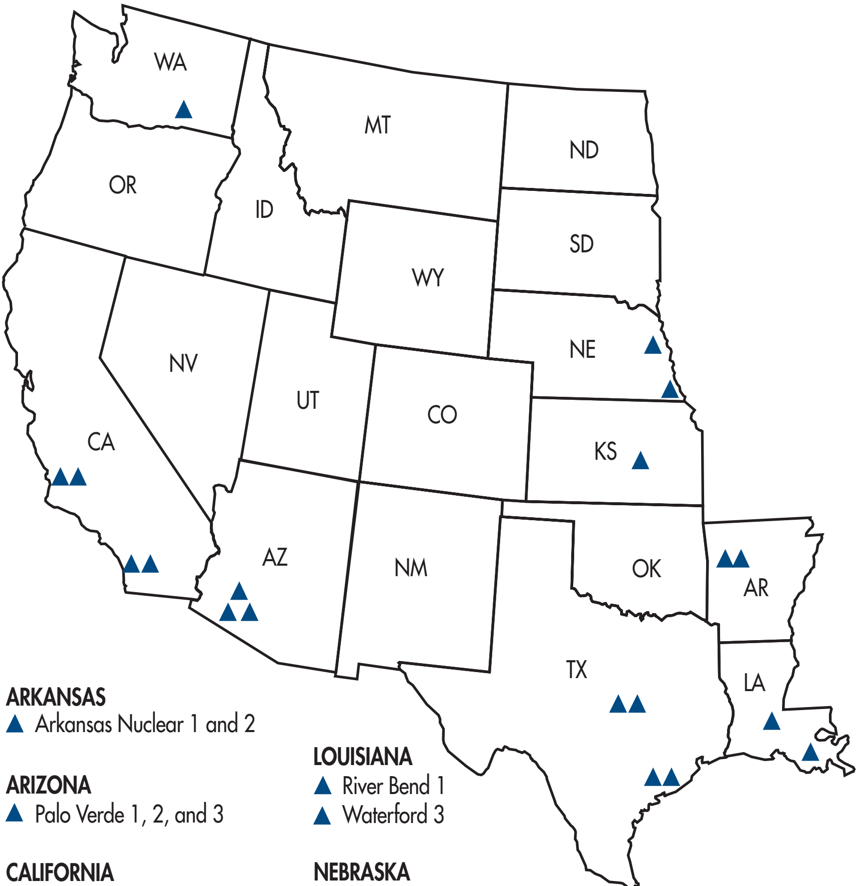
OHIO
- ▲ Davis-Besse
- ▲ Perry 1

WISCONSIN
- ▲ Kewaunee
- ▲ Point Beach 1 and 2



Source: Nuclear Regulatory Commission

Figure 22. **NRC Region IV Commercial Nuclear Power Reactors**



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

NEBRASKA
▲ Cooper
▲ Fort Calhoun

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

WASHINGTON
▲ Columbia Generating Station*

▲ Licensed to Operate (19)

*Formerly Washington Nuclear 2

Note: There are no commercial reactors in Alaska or Hawaii.

Source: Nuclear Regulatory Commission

Table 11. **U.S. Commercial Nuclear Power Reactor Operating Licenses Issued by Year**

Year	Reactor Name	Number of Licenses Issued	Total Number of Operating Licenses
1969	Dresden 2	4	4
	Ginna		
	Nine Mile Point 1		
	Oyster Creek		
1970	H.B. Robinson 2	2	6
	Point Beach 1		
1971	Dresden 3	2	8
	Monticello		
1972	Palisades	6	14
	Pilgrim 1		
	Quad Cities 1		
	Quad Cities 2		
	Surry 1		
	Turkey Point 3		
1973	Browns Ferry 1	11	25
	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	14	39
	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	1	40
1976	Beaver Valley 1	7	47
	Browns Ferry 3		
	Brunswick 1		
	Calvert Cliffs 2		
	Indian Point 3		
	Salem 1		
	St. Lucie 1		
1977	Crystal River 3	4	51
	Davis-Besse		
	D.C. Cook 2		
	Joseph M. Farley 1		
1978	Arkansas Nuclear 2	3	54
	Edwin I. Hatch 2		
	North Anna 1		
1980	North Anna 2	2	56
	Sequoyah 1		
1981	Joseph M. Farley 2	4	60
	McGuire 1		
	Salem 2		
	Sequoyah 2		
1982	La Salle County 1	4	64
	San Onofre 2		
	Summer		
	Susquehanna 1		
1983	McGuire 2	3	67
	San Onofre 3		
	St. Lucie 2		
1984	Callaway	6	73
	Diablo Canyon 1		
	Grand Gulf 1		
	La Salle County 2		
	Susquehanna 2		
	Washington Nuclear 2		
1985	Byron 1	9	82
	Catawba 1		
	Diablo Canyon 2		
	Fermi 2		
	Limerick 1		
	Palo Verde 1		
	River Bend 1		
	Waterford 3		
	Wolf Creek 1		

(Continued on page 46)

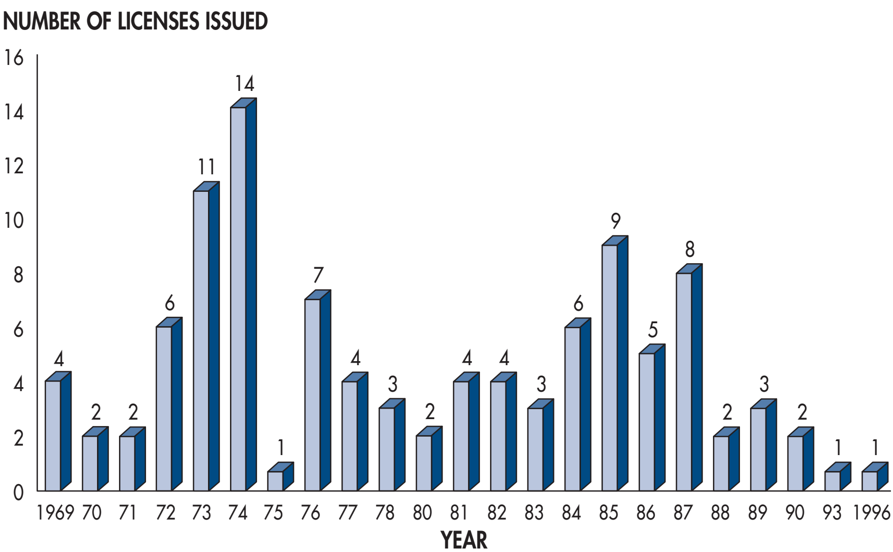
Table 11. **U.S. Commercial Nuclear Power Reactor Operating Licenses Issued by Year** *(Continued)*

Year	Reactor Name	Number of Licenses Issued	Total Number of Operating Licenses
1986	Catawba 2	5	87
	Hope Creek 1		
	Millstone 3		
	Palo Verde 2		
	Perry 1		
1987	Beaver Valley 2	8	95
	Braidwood 1		
	Byron 2		
	Clinton		
	Nine Mile Point 2		
	Palo Verde 3		
	Shearon Harris 1		
	Vogtle 1		
1988	Braidwood 2	2	97
	South Texas Project 1		
1989	Limerick 2	3	100
	South Texas Project 2		
	Vogtle 2		
1990	Comanche Peak 1		
	Seabrook	2	102
1993	Comanche Peak 2	1	103
1996	Watts Bar 1	1	104

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.

Figure 23. **U.S. Commercial Nuclear Power Reactor Operating Licenses Issued by Year**



Note: No licenses issued after 1996.

Oversight of U.S. Commercial Nuclear Power Reactors

Reactor Oversight Process

The NRC itself 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.

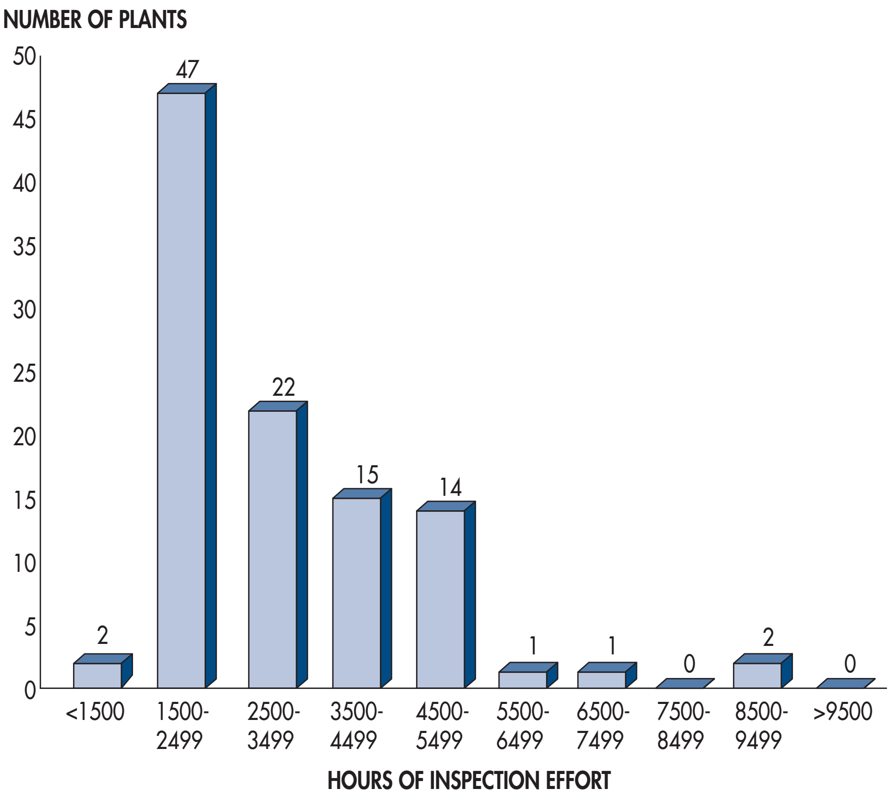
The ROP is described on the NRC's web site and in NUREG-1649, Revision 3, "Reactor Oversight Process." In general terms, the ROP uses both inspection findings and performance indicators (PIs) to assess the performance of each plant within a regulatory framework of seven cornerstones of safety. The ROP 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 significant performance issues are addressed. A summary of the NRC's inspection effort is shown in Figure 24. The latest plant-specific inspection findings and PI information can be found on the NRC's web site.

In FY 2000, the NRC integrated its previously distinct programs for inspection, assessment, and enforcement into the current ROP. The ROP takes into account improvements in the performance of the nuclear industry over the past twenty-five years and improved approaches of 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 successful regulatory oversight.

The ROP is more risk-informed, objective, predictable, understandable, and focused on the areas of greatest safety significance. Key features of the ROP are a risk-informed regulatory framework, risk-informed inspections, a significance determination process to evaluate inspection findings, performance indicators, a streamlined assessment process, and more clearly defined actions the NRC takes for plants based on their performance. The NRC incorporated lessons learned from a pilot program of the ROP conducted at nine reactor sites in 1999 and began implementation of the ROP for all plants in April 2000. The NRC continues to refine the ROP as experience is gained.

(Continued on page 49)

Figure 24. **NRC Inspection Effort at Operating Reactors, FY 2002***



*FY 2002 data include regular and overtime hours. Includes Browns Ferry 1.

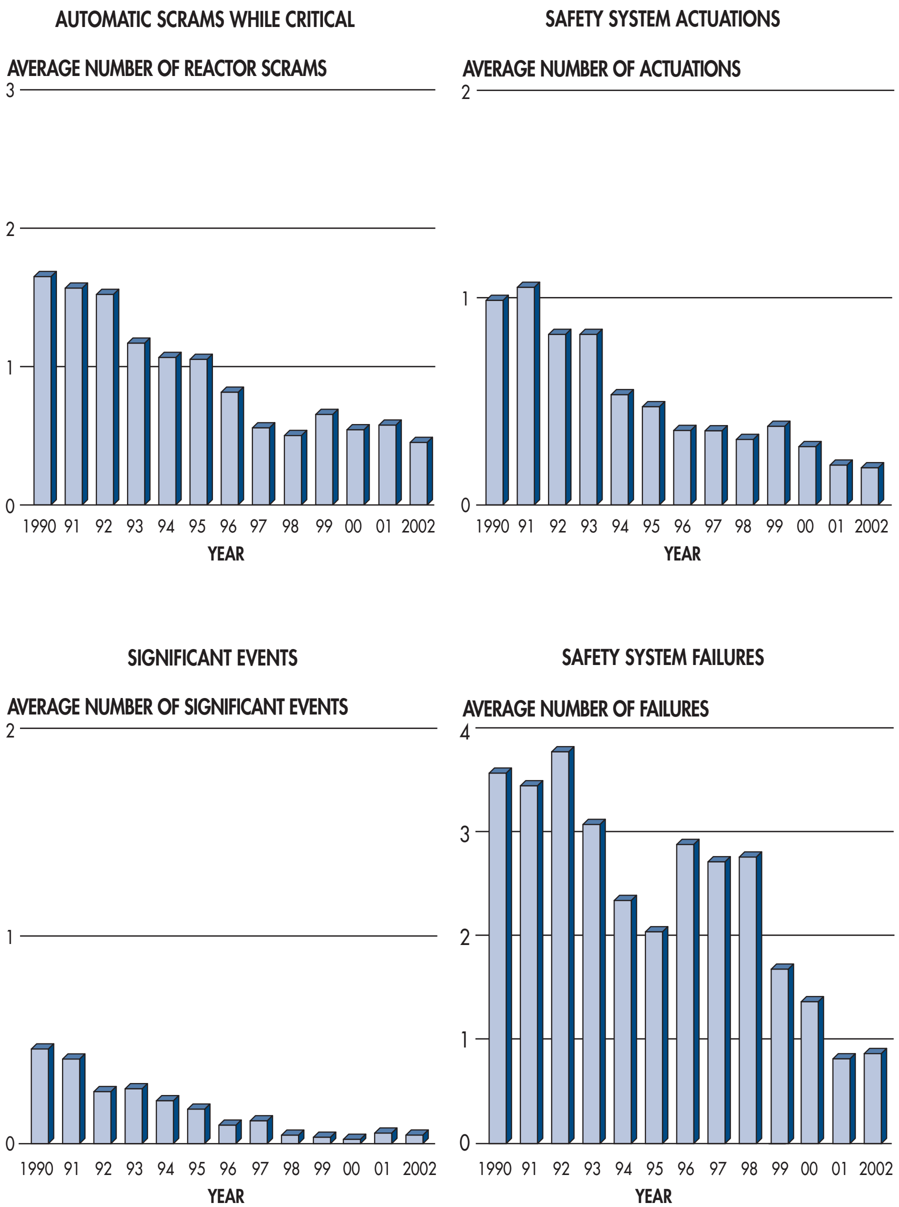
Source: Nuclear Regulatory Commission

Oversight of U.S. Commercial Nuclear Power Reactors *(Continued)*

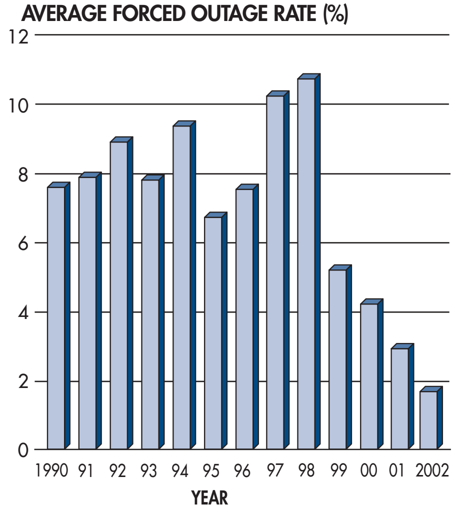
Industry Performance Indicators

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 25 and Appendix G. The indicators can provide additional data for assessing trends in industry performance.

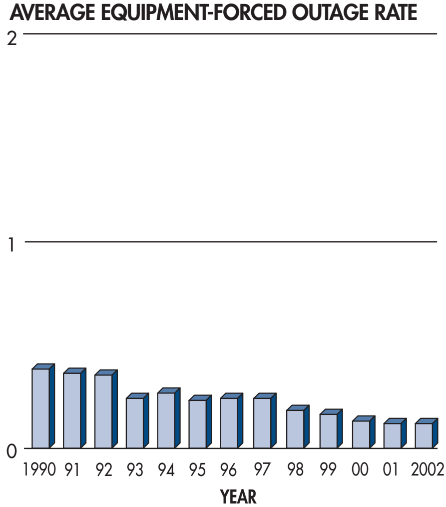
Figure 25. **NRC Performance Indicators; Annual Industry Averages, 1990–2002**



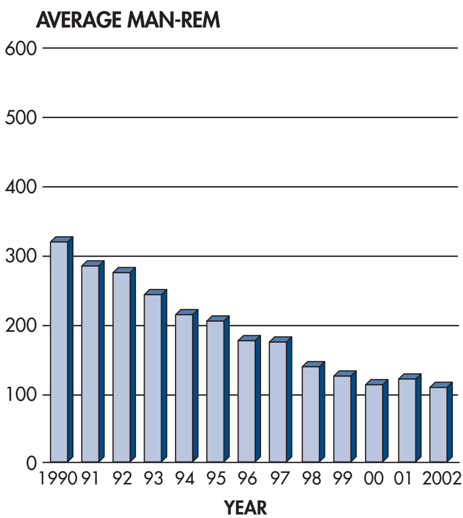
FORCED OUTAGE RATE



EQUIPMENT-FORCED OUTAGES PER 1000 CRITICAL HOURS



COLLECTIVE RADIATION EXPOSURE



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

Source: Licensee data as compiled by the Nuclear Regulatory Commission

Future U.S. Commercial Nuclear Power Reactor Licensing

Reactor Aging and License Renewal:

Based on the Atomic Energy Act, the NRC issues licenses for commercial power reactors to operate for up to 40 years and allows these licenses to be renewed for another 20 years. The first 40-year operating license will expire in the year 2006. Approximately 10 percent of the remaining operating plants will expire by the end of the year 2010, and more than 40 percent will expire by the year 2015. The age of operating reactors and their average maximum dependable capacity is illustrated in Figure 26.

The decision whether to seek license renewal rests entirely with nuclear power plant owners, and will be 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.

In December 1991, the NRC issued the rule and associated documentation that describe the requirements a licensee must be able to demonstrate for the NRC to make a determination that the plant can continue to be operated for up to 20 additional years beyond the expiration of its 40-year license. The NRC issued an amendment to the license renewal rule that became effective on June 7, 1995. The amendment to the rule provides a more stable and predictable regulatory process for license renewal by focusing the license renewal safety review on the management of the adverse effects of aging on certain systems, structures, and components during the period of extended operation.

In a separate rulemaking, the NRC revised the scope of environmental effects for license renewal to enhance the agency's environmental review process for reactor license renewal. The final, revised rule became effective on September 5, 1996.

The NRC has developed improved regulatory guidance and standard review plans to standardize the content of license renewal applications and improve the efficiency and effectiveness of the NRC's evaluation for both the safety and environmental reviews.

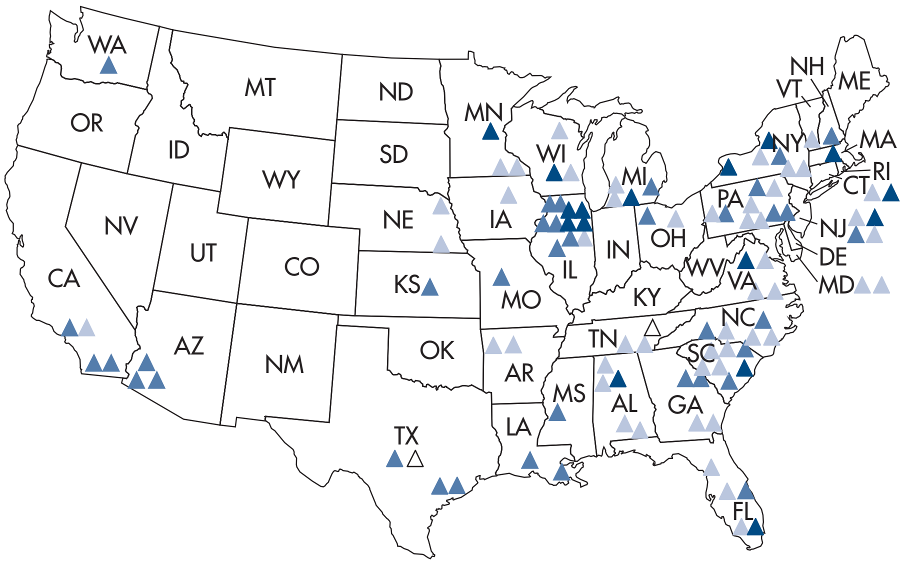
The first license renewal application was submitted in April 1998 by Baltimore Gas and Electric (BGE) for its Calvert Cliffs units.

In total, 14 units received renewed licenses including Calvert Cliffs Units 1 and 2, Oconee Units 1, 2, and 3, Arkansas Nuclear One Unit 1, Edwin I. Hatch Units 1 and 2, Turkey Point Units 3 and 4, North Anna Units 1 and 2, and Surry Units 1 and 2.

License renewal applications are currently under review for 16 additional units including McGuire Units 1 and 2, Catawba Units 1 and 2, Peach Bottom Units 2 and 3, St. Lucie Units 1 and 2, Fort Calhoun Station Unit 1, H.B. Robinson Nuclear Plant Unit 2, R.E. Ginna Nuclear Power Plant Unit 1, V.C. Summer Nuclear Station Unit 1, Dresden Units 2 and 3, and Quad Cities Units 1 and 2.

(Continued on page 56)

Figure 26. **U.S. Commercial Nuclear Power Reactors—Years of Operation**



YEARS OF COMMERCIAL OPERATION	NUMBER OF REACTORS	AVERAGE CAPACITY (MDC)
△ 0–9	2	1,137
▲ 10–19	41	1,103
▲ 20–29	42	865
▲ 30–34	10	681

Note: There are no commercial reactors in Alaska or Hawaii. Calculated data as of 12/02.
Source: Nuclear Regulatory Commission

Table 12. **U.S. Commercial Nuclear Power Reactor Operating Licenses—Expiration Date by Year**

Year	Reactor Name	Number of Licenses Expired
2009	Dresden 2	4
	Ginna	
	Nine Mile Point 1	
	Oyster Creek	
2010	H.B. Robinson 2	3
	Monticello	
	Point Beach 1	
2011	Dresden 3	2
	Palisades	
2012	Pilgrim 1	4
	Quad Cities 1	
	Quad Cities 2	
	Vermont Yankee	
2013	Browns Ferry 1	7
	Fort Calhoun	
	Indian Point 2	
	Kewaunee	
	Peach Bottom 2	
	Point Beach 2	
	Prairie Island 1	
2014	Browns Ferry 2	9
	Brunswick 2	
	Cooper	
	D. C. Cook 1	
	Duane Arnold	
	James A. FitzPatrick	
	Peach Bottom 3	
	Prairie Island 2	
	Three Mile Island 1	
2015	Indian Point 3	2
	Millstone 2	
2016	Beaver Valley 1	6
	Browns Ferry 3	
	Brunswick 1	
	Crystal River 3	
	Salem 1	
	St. Lucie 1	
2017	Davis-Besse	3
	D.C. Cook 2	
	Joseph M. Farley 1	
2018	Arkansas Nuclear 2	1
2020	Salem 2	2
	Sequoyah 1	
2021	Diablo Canyon 1	4
	Joseph M. Farley 2	
	McGuire 1	
	Sequoyah 2	
2022	La Salle County 1	5
	San Onofre 2	
	San Onofre 3	
	Summer	
	Susquehanna 1	
2023	La Salle County 2	4
	McGuire 2	
	St. Lucie 2	
	Columbia Generating Station	
2024	Byron 1	8
	Callaway	
	Catawba 1	
	Grand Gulf 1	
	Limerick 1	
	Palo Verde 1	
	Susquehanna 2	
	Waterford 3	
2025	Diablo Canyon 2	6
	Fermi 2	
	Millstone 3	
	Palo Verde 2	
	River Bend 1	
	Wolf Creek 1	
2026	Braidwood 1	9
	Byron 2	
	Catawba 2	
	Clinton	
	Hope Creek 1	
	Nine Mile Point 2	
	Perry 1	
	Seabrook 1	
	Shearon Harris 1	
2027	Beaver Valley 2	5
	Braidwood 2	
	Palo Verde 3	
	South Texas Project 1	
	Vogtle 1	

Year	Reactor Name	Number of Licenses Expired
2028	South Texas Project 2	1
2029	Limerick 2	2
	Vogtle 2	
2030	Comanche Peak 1	1
2032	Turkey Point 3	2
	Surry 1	
2033	Comanche Peak 2	5
	Oconee 1	
	Oconee 2	
	Turkey Point 4	
	Surry 2	
2034	ANO 1	4
	Calvert Cliffs 1	
	Edwin Hatch 1	
	Oconee 3	

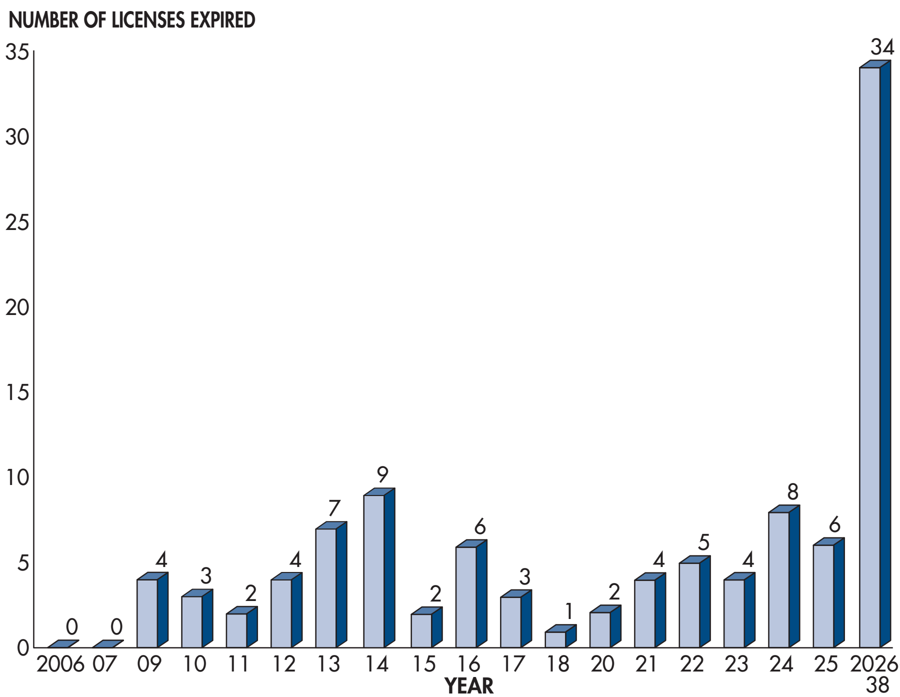
Year	Reactor Name	Number of Licenses Expired
2035	Watts Bar	1
2036	Calvert Cliffs 2	1
2038	North Anna 1	1
2040	North Anna 2	1
2048	Edwin Hatch 2	1

*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 April 2003.

Figure 27. **U.S. Commercial Nuclear Power Reactor Operating Licenses — Expiration Date by Year Assuming Construction Recapture**



Future U.S. Commercial Nuclear Power Reactor Licensing *(Continued)*

The Babcock and Wilcox, Westinghouse, and Boiling Water Reactor Owners Groups have established generic license renewal programs that have developed and submitted technical reports for NRC approval. The Nuclear Energy Institute has established working groups to interact with the NRC on improvements to the license renewal rule implementation guidance, and resolution of generic renewal issues.

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.

New Nuclear Reactor Licensing

In 1989, the NRC introduced a new licensing process (10 CFR Part 52) as an alternative to the traditional two-step licensing process in Part 50. Part 52 sets forth the process for review of Early Site Permits (ESP), Standard Design Certifications, and Combined Licenses for nuclear power facilities. A combined license involves issuance of a combined construction permit and a conditional operating license for a nuclear power facility.

The NRC has implemented modifications to the organizational structure with the creation of the New Reactor Licensing Project Office (NRLPO) to process new plant applications within the Office of Nuclear Reactor Regulation (NRR) and the creation of the Advanced Reactor Group within the Office of Nuclear Regulatory Research.

NRLPO will perform several activities to ensure that NRC is prepared to review new applications. These activities include assessing the actions necessary to prepare for ESP applications; updating current rulemaking activities for 10 CFR Parts 51 and 52 licensing processes; performing a review of the construction inspection program for construction of new power plant reactivation; and performing pre-application and new application reviews.

NRLPO is working with the Advanced Reactor Group to perform pre-application reviews currently ongoing and anticipated which include: General Atomics' Gas Turbine-Modular Helium Reactor design, Framatome's European designed boiling water reactor or pressurized water reactor; and the International Reactor Innovative and Secure design also known as IRIS.

NRC staff is currently reviewing Westinghouse's design certification application for their AP1000 passive advanced light-water reactor design. In the past, NRC has provided design certifications for three reactor designs that can be referenced in an application for a nuclear power plant. These designs include:

1. GE Nuclear Energy's Advanced Boiling Water Reactor design;
2. Westinghouse's System 80+ design; and
3. Westinghouse's AP600 design.

An ESP provides for resolution of site safety, environmental protection, and emergency preparedness issues, independent of a specific nuclear plant review. Three companies have indicated that they will apply for early site permits in 2003. They are Exelon Generation Company, Dominion Generation, and Entergy Operations, Incorporated.

Additional information on the advanced reactors mentioned above is available on the NRC's Web Site at http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/next-gen-reactors.html.

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

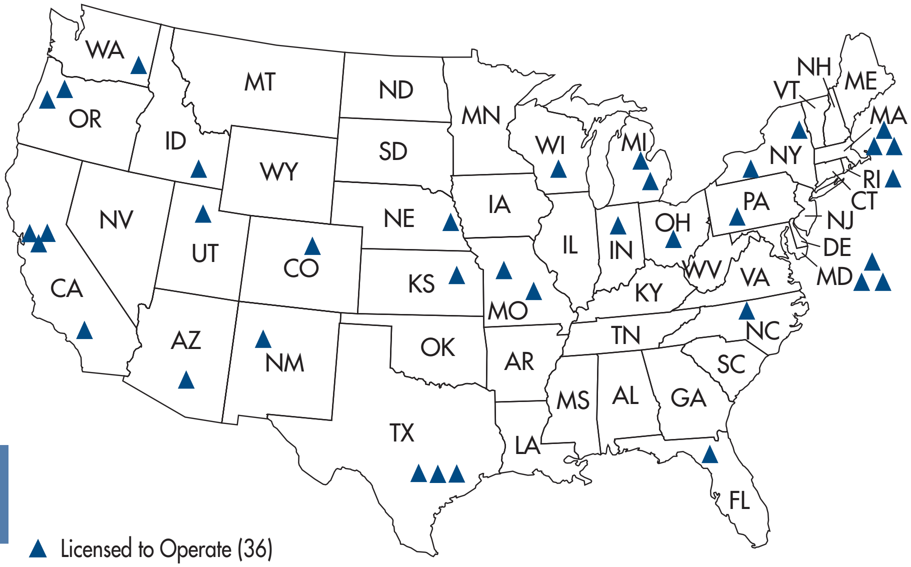
There are 36 research and test reactors licensed to operate in 23 States (see Figure 28):

- 13 research and test reactors are being decommissioned.
- 6 research and test reactors have possession-only licenses.
- Since 1958, 73 licensed research and test reactors have been decommissioned.
- Refer to Appendix E for a listing of U.S. nuclear research and test reactors with operating licenses.

Principal Licensing and Inspection Activities

- The NRC licenses approximately 285 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 28. **U.S. Nuclear Research and Test Reactor Sites**



Note: There are no research and test reactors in Alaska or Hawaii.

Source: Nuclear Regulatory Commission

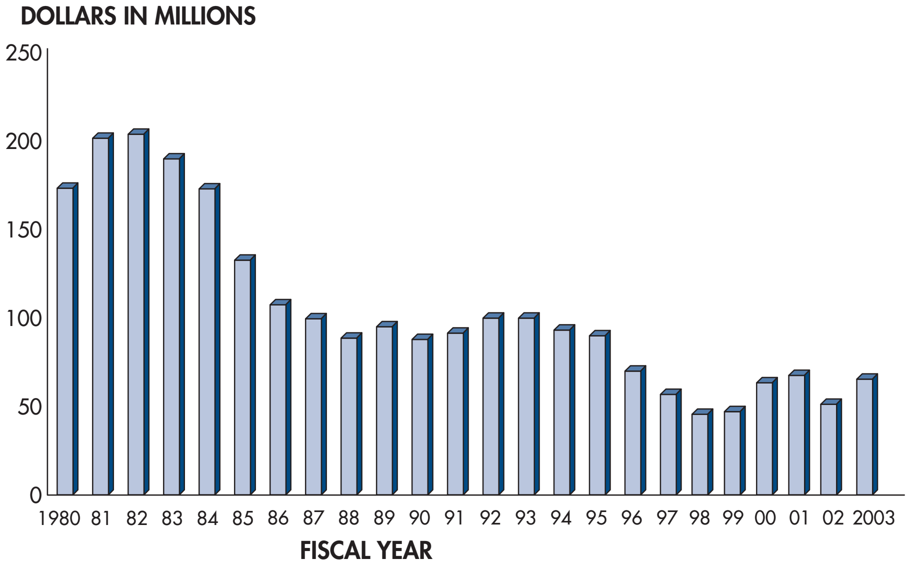
Nuclear Regulatory Research

Nuclear Regulatory Research

NRC's regulatory research program seeks to provide independent information and expertise to support realistic safety decisionmaking, to assess the safety significance of potential technical issues, to prepare the agency for the future by evaluating potential safety issues involving new designs and technology. As such, the research program is both confirmatory of existing safety margins and anticipatory of future concerns. The challenges and influences that govern NRC's regulatory research program include changes in the practices and performance of the regulated industry, increased economic pressures on licensees, emergence of new safety issues as the industry continues to mature, availability of new technologies, and public awareness and involvement in the regulatory process. The NRC's research program is key to providing the capability to face these challenges. Accordingly, the NRC must have highly skilled, independent expertise, and accurate information necessary to formulate sound technical solutions and make timely and realistic regulatory judgments.

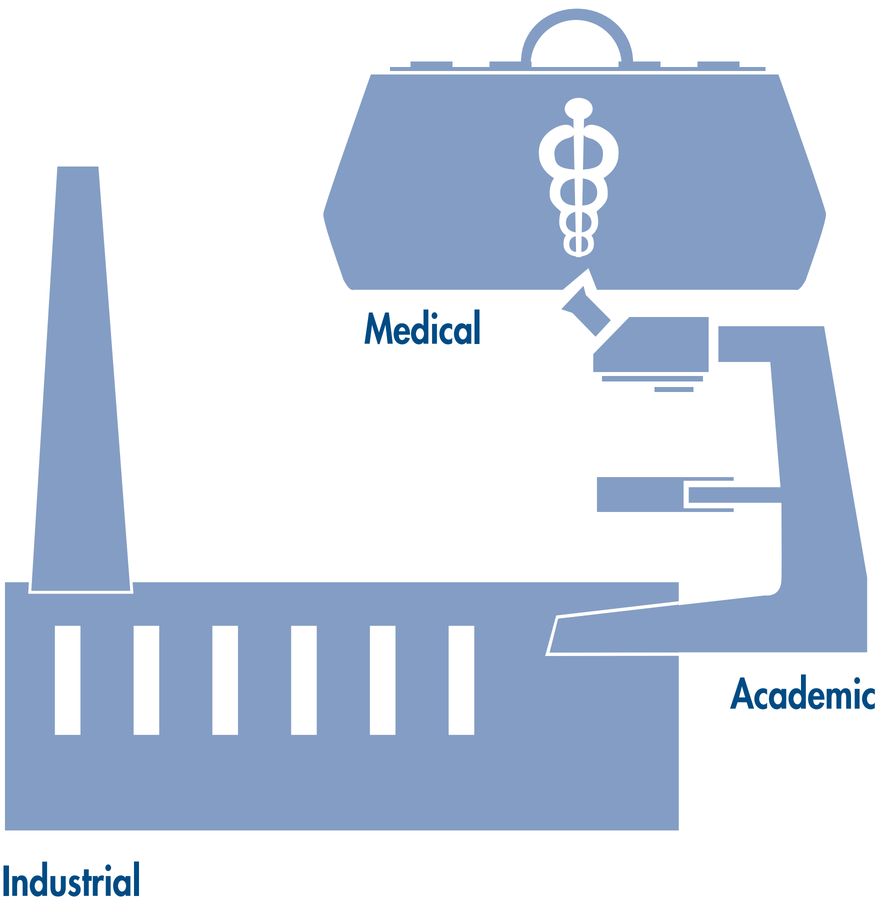
Although the significant reduction of the research program over the years reflects a changing environment and maturing industry, it is also presenting a challenge to the ability to address issues in the future. The current NRC research program focuses on supporting the NRC's review of emerging technologies (e.g., digital instrumentation and control systems), and including research that addresses advanced reactor designs, understanding and resolving nuclear plant aging issues arising out of operating experience, decommissioning licensed facilities, understanding the risks associated with nuclear facilities, including providing an independent review of operating experience to identify potential safety concerns, and providing the technical basis to support the NRC to move to a more risk-informed regulatory framework.

Figure 29. **Research Budget Trends, FY 1980–2003**



The NRC research program provides the independent expertise and information necessary for making timely regulatory judgments, anticipating problems of potential safety significance for which new or expanded knowledge can assist NRC in pursuing its mission, and provides support for developing regulations and regulatory guides pertaining to Commission policy or technical requirements. Over the years, the research program has been significantly reduced to reflect the changing environment and the maturing industry.

Nuclear Materials Safety



U.S. Fuel Cycle Facilities

The NRC licenses and inspects all commercial nuclear fuel facilities involved in the processing and fabrication of uranium ore into reactor fuel. A typical fuel fabrication plant is illustrated in Figure 30.

There are seven major fuel fabrication and production facilities licensed to operate in six States (see Figure 31):

- **Uranium Fuel Fabrication Facilities:**
  - Global Nuclear Fuel Americas, LLC (Wilmington, North Carolina)
  - Westinghouse Electric Company, LLC Nuclear Fuel Division (Columbia, South Carolina)
  - Nuclear Fuel Services, Inc. (Erwin, Tennessee)
  - Framatome Fuels (Lynchburg, Virginia)
  - BWX Technologies Nuclear Fuel Division (Lynchburg, Virginia)
  - Framatome ANP Richland, Inc. (Richland, Washington)
- **Uranium Hexafluoride Production Facility:**
  - Honeywell International, Inc. (Metropolis, Illinois)

In addition, NRC regulates the two gaseous diffusion uranium enrichment facilities, which are leased by the United States Enrichment Corporation from the Department of Energy (DOE). NRC promulgated regulations for the gaseous diffusion plants in 10 CFR Part 76 in September 1994. The two plants came under NRC regulation on March 3, 1997.

- **Gaseous Diffusion Enrichment Facilities:**
  - U. S. Enrichment Corporation (Paducah, Kentucky)
  - U. S. Enrichment Corporation (Portsmouth, Ohio)*

NRC regulates 11 other facilities that possess significant quantities of special nuclear material (other than reactors) or process source material (other than uranium recovery facilities).

NRC is also engaged in a cooperative effort with the DOE on processing and solidification of high-level radioactive waste for long-term isolation. Since 1980, the West Valley Demonstration Project Act has required NRC to oversee the protection of public safety for the high-level waste vitrification demonstration project at the Western New York Nuclear Center, West Valley, New York. Under a joint project between the DOE and the New York State Energy Research and Development Authority, the West Valley Demonstration Project began converting liquid high-level waste into glass logs in July 1996.

*Currently in cold standby and not used for enrichment.

- **Proposed Mixed Oxide Fuel Fabrication Facility:**
  - Duke Cogema Stone & Webster (Aiken, South Carolina)

The Nuclear Regulatory Commission is reviewing an application for construction of a mixed oxide (MOX) 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 of Duke Engineering & Services, COGEMA Inc., and Stone & Webster (known as DCS). If NRC authorizes construction, DCS could build and operate the MOX facility. 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.

DCS submitted a revised environmental report on the MOX facility in December 2002, and submitted a request for authorization to construct the facility in October 2002.

NRC is conducting public meetings on the proposal and will prepare an environmental impact statement. NRC will also conduct a technical evaluation of the application to determine whether it meets NRC requirements.

Principal Licensing and Inspection Activities:

- NRC issues approximately 84 new, renewal, license amendments, and safety and safeguards reviews for fuel cycle facilities annually.
- NRC routinely conducts safety, safeguards, and environmental protection inspections of approximately 14 fuel cycle facilities or sites.

Figure 30. **Typical Fuel Fabrication Plant**

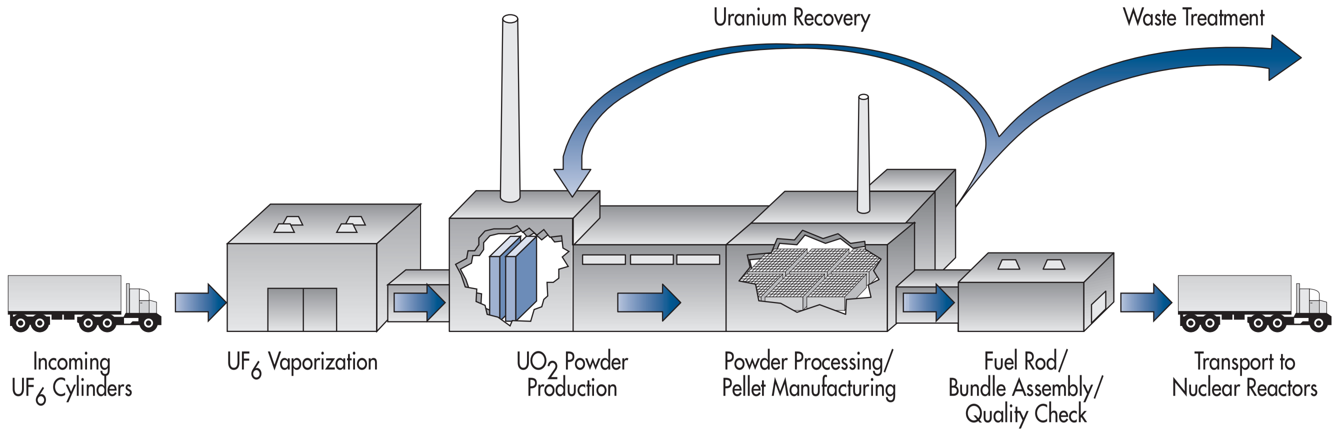
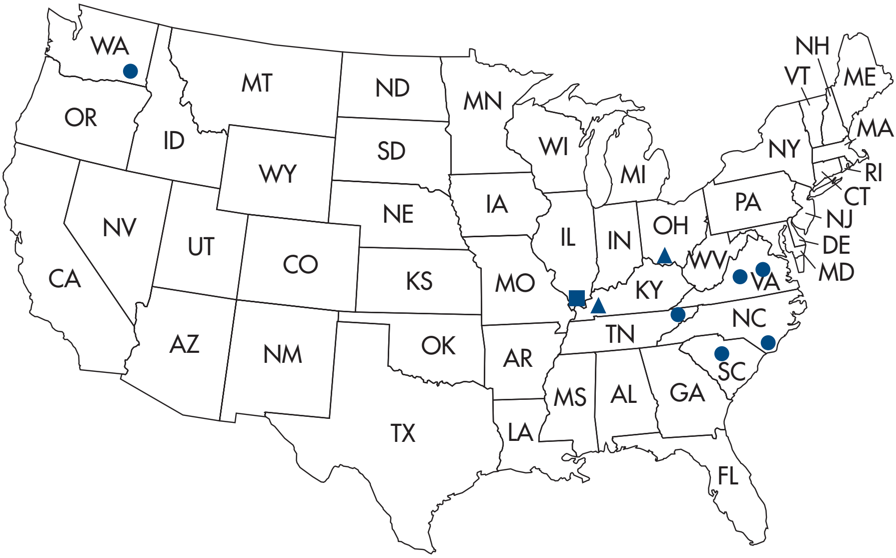


Figure 31. **Major U.S. Fuel Cycle Facility Sites**



- ● Uranium Fuel Fabrication Facility (6)
- ■ Uranium Hexafluoride Production Facility (1)
- ▲ Gaseous Diffusion Enrichment Facility (2)

Note: There are no fuel cycle facilities in Alaska and Hawaii.

Source: Nuclear Regulatory Commission

U.S. Materials Licenses

Approximately 21,000 licenses are issued for medical, academic, industrial, and general uses of nuclear materials (see Table 13):

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

- Approximately 4,800 licenses are administered by the NRC.

- Approximately 16,600 licenses are administered by the 32 States that participate in the Agreement States Program. An Agreement State is one that has signed an agreement with the NRC that authorizes the State to regulate the use of radioactive materials within that State (see Figure 32). Minnesota is actively working toward becoming an Agreement State. Wisconsin is expected to become an Agreement State on August 11, 2003.

Medical and Academic — The NRC and Agreement States issue licenses to hospitals and physicians for the use of radioactive materials in diagnosing and treating patients. Academic institutions use radioactive materials for education and biomedical research. The facilities, personnel, program controls and equipment in each application are reviewed to ensure the safety of the public, patients, and occupationally exposed workers. 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.

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 sub-critical assemblies.

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 on the indicator. 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.

General Licenses — A general licensee is a person or organization that acquires, uses, or possesses a generally licensed device (GLD) 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 chromatography (detector cells), density gauges, fill-level gauges, and static elimination devices. 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

- NRC issues approximately 4,200 new licenses, renewals, or license amendments for materials licenses annually.

- NRC conducts approximately 1,100 health and safety inspections of its nuclear materials licensees annually.

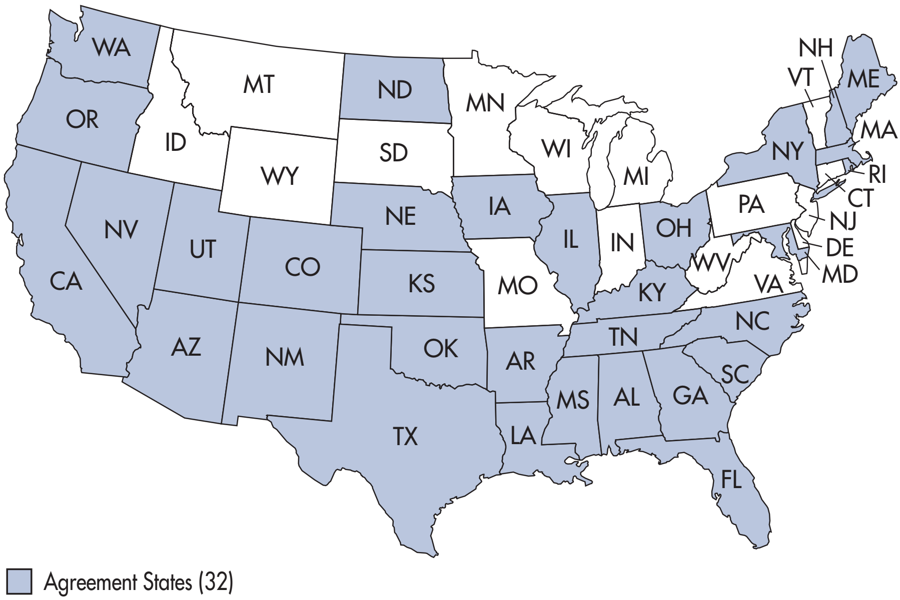
Table 13. **U.S. Materials Licenses by State**

State	Number of Licenses NRC	Agreement States	State	Number of Licenses NRC	Agreement States
Alabama	16	426	Montana	75	0
Alaska	48	0	Nebraska	4	143
Arizona	11	319	Nevada	2	236
Arkansas	8	266	New Hampshire	5	82
California	46	2,175	New Jersey	508	0
Colorado	21	337	New Mexico	14	218
Connecticut	188	0	New York	60	1,385
Delaware	57	0	North Carolina	17	711
District of Columbia	42	0	North Dakota	9	61
Florida	14	1,395	Ohio	60	751
Georgia	15	506	Oklahoma	31	262
Hawaii	58	0	Oregon	7	426
Idaho	72	0	Pennsylvania	730	0
Illinois	39	737	Rhode Island	1	57
Indiana	278	0	South Carolina	14	369
Iowa	1	183	South Dakota	41	0
Kansas	13	313	Tennessee	20	546
Kentucky	9	454	Texas	44	1,550
Louisiana	12	534	Utah	9	200
Maine	2	131	Vermont	34	0
Maryland	61	573	Virginia	380	0
Massachusetts	30	553	Washington	20	404
Michigan	513	0	West Virginia	183	0
Minnesota	162	0	Wisconsin	263	0
Mississippi	6	322	Wyoming	85	0
Missouri	302	0	Others*	157	0
			Total	**4,797**	**16,625**

*"Others" includes territories such as Puerto Rico, Virgin Islands, and Guam.

Note: Agreement States data are latest available as of February 2003. NRC data as of March 20, 2003.

Figure 32. **NRC Agreement States**



Note: Minnesota and Pennsylvania have applications pending. Wisconsin is expected to become the 33rd Agreement State in August 2003.

Alaska and Hawaii are not Agreement States.

Source: Nuclear Regulatory Commission

Nuclear Gauges

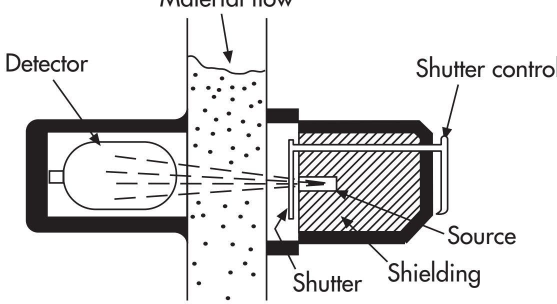
Fixed Gauges — The cross section shows a fixed fluid gauge installed on a process pipe (see Figure 33). Such devices are widely used in beverage, food, plastics, process and chemical industries to measure the densities, flow rates, levels, thicknesses, and weights of a wide variety of materials and surfaces.

Nuclear gauges are used as non-destructive devices to measure physical properties of products and industrial proceses 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 holders' 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 read out 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 — consist of 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 the detector measures indicates the thickness, density, moisture content or some other property which 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 33. **Cross Section of a Fixed Fluid Gauge**



Teletherapy Devices

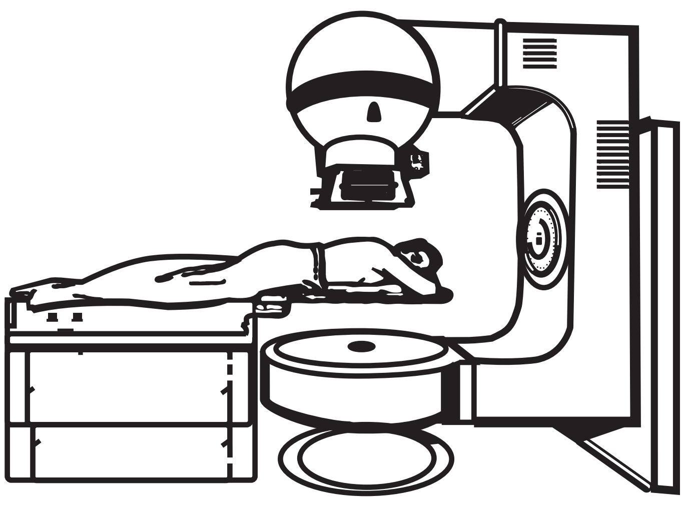
Teletherapy is one of the primary radiation oncology treatment modalities. Teletherapy devices provide external high radiation beams for treatment of cancerous tumors. Both the primary tumor and the areas to which cancer may have spread (regional lympatic) may be treated at the same time.

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 34).

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 34. **Cobalt-60 Teletherapy Unit**

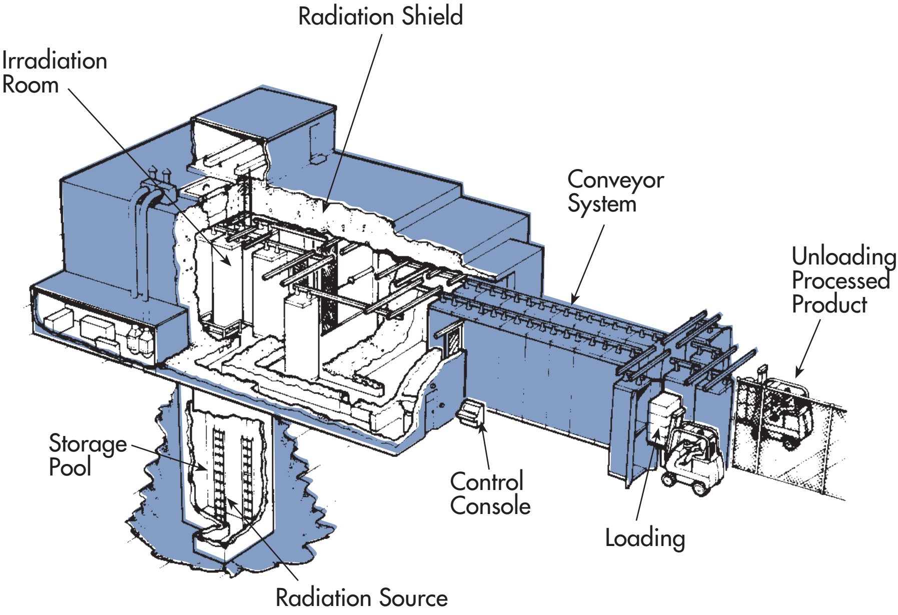


Commercial Product Irradiators

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

In this type of irradiator, when 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 inaccessible during use by an entry control system.

Figure 35. **Commercial Gamma Irradiator**



Uranium Milling

A uranium mill is a chemical plant designed to extract uranium from mined ore. The mined ore is brought to the milling facility via truck 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 not only extracts 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. Part 40 defines byproduct material the same as Section 11e.(2) of the Atomic Energy Act, "...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 facilities (the NRC-licensed heap leach and ion-exchange facilities no longer operate). In both processes, 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, three are in standby mode, and one is in operation.

In situ leach (ISL) facilities are another means of extracting uranium from underground. ISLs recover uranium from low grade ores 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, 6 are licensed by the NRC, and the rest are licensed by Texas, an Agreement State.

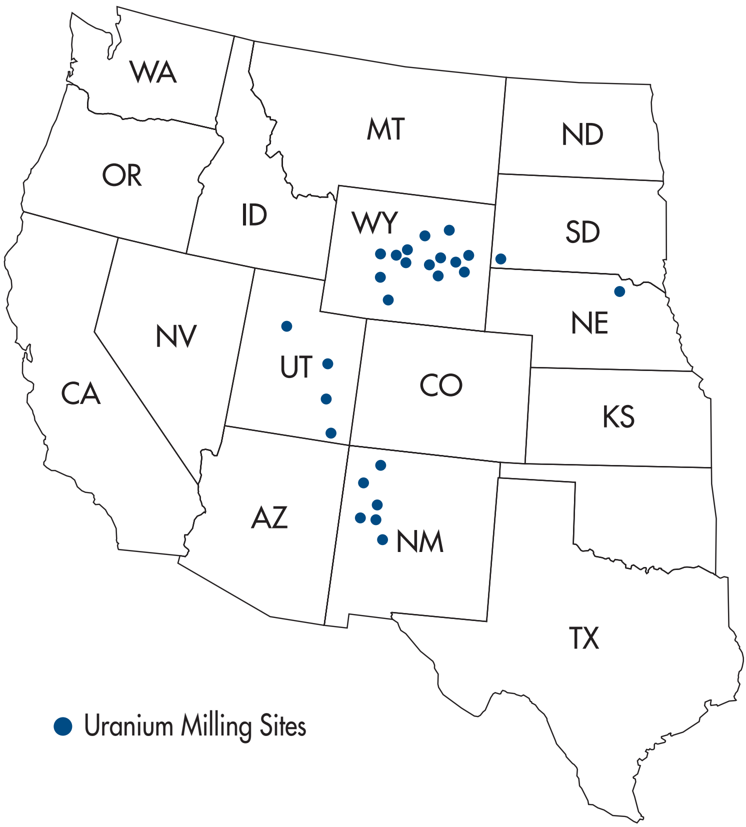
Table 14. **Locations of Uranium Milling Facilities**

The following uranium milling facilities are licensed by the NRC.

Licensee	Site Name/Location
In Situ Leach Facilities	
Cogema Mining, Inc.	Irigaray/ChR, Wyoming
Power Resources, Inc.	Highlands, Wyoming
Crow Butte Resources, Inc.	Crow Butte, Nebraska
Rio Algom Mining Corp.	Smith Ranch, Wyoming
Hydro Resources, Inc.	Crown Point, New Mexico
Power Resources, Inc.	Ruth and North Butte, Wyoming
Conventional Uranium Milling Facilities	
International Uranium Corp.	White Mesa, Utah
Umetco Minerals Corp.	Gas Hills, Wyoming
Western Nuclear Inc.	Split Rock, Wyoming
Tennessee Valley Authority*	Edgemont, South Dakota
Pathfinder Mines Corp.	Lucky Mc, Wyoming
American Nuclear Corp.	ANC, Wyoming
Pathfinder Mines Corp.	Shirley Basin, Wyoming
Petrotomics Co.	Shirley Basin, Wyoming
Rio Algom Mining Corp.	Lisbon, Utah
Exxon Mobil Corp.	Highlands, Wyoming
Bear Creek Uranium Co.	Bear Creek, Wyoming
Kennecott Uranium Corp.	Sweetwater, Wyoming
Plateau Resources Ltd.	Shootaring, Utah
Homestake Mining Co.	Homestake, New Mexico
Kennecott Energy Co.	L-Bar, New Mexico
Rio Algom Mining LLC.	Ambrosia Lake, New Mexico
UNC Mining & Milling	Churchrock, New Mexico
Atlantic Richfield Co.*	Bluewater, New Mexico
Part 40 Byproduct Material Disposal Site	
Envirocare of Utah Inc.	Envirocare, Utah
Ion-Exchange Facility	
U.S. Energy Corp.	Green Mt.-IX, Wyoming

*Specific licenses terminated; disposal area under general license to the U.S. Department of Energy for long-term care.

Figure 36. **Locations of Uranium Milling Facilities**



Source: U.S. Nuclear Regulatory Commission.

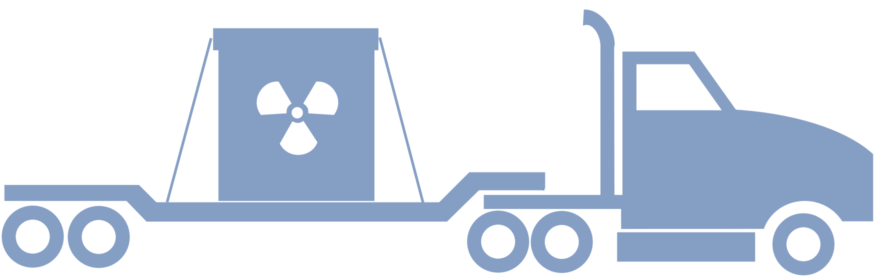
International Activities

International Activities

The NRC 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. 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:

- Assisting in United States government international policy and priority formulation by developing legal instruments in the nuclear field to address vital issues such as nuclear non-proliferation, safety, safeguards, physical security, radiation protection, spent fuel and waste management, nuclear safety research, and liability.
- Contributing to the implementation of national nuclear policy by supporting presidential summits and the International Nuclear Regulators Association.
- Licensing imports and exports of nuclear facilities, major components, material, and related commodities.
- Ensuring prompt notification to foreign partners of U.S. safety problems that warrant action or investigation.
- Providing for bilateral information exchange and cooperation on nuclear safety, physical security, safeguards, waste management, and radiological protection with the regulatory authorities of: Argentina, Armenia, Belgium, Brazil, Canada, China, Czech Republic, Egypt, Finland, France, Germany, Greece, Hungary, Indonesia, Israel, Italy, Japan, Kazakhstan, Lithuania, Mexico, Netherlands, Peru, Philippines, Republic of Korea (South Korea), Romania, Russia, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Taiwan, Ukraine, and the United Kingdom.
- Assisting Russia, Ukraine, Armenia, Kazakhstan, and certain Central and Eastern European countries (Bulgaria, Lithuania) that use Soviet-designed reactors to improve nuclear safety regulation. These assistance efforts are carried out primarily through training, workshops, and peer review of regulatory documents, working group meetings, and technical information and specialist exchanges.
- Participating in the programs of the International Atomic Energy Agency (IAEA), and the Organization for Economic Cooperation and Development's Nuclear Energy Agency concerned with safety research and regulatory matters, radiation protection, risk assessment, waste management, transportation, safeguards, physical protection, standards, training, and technical assistance.
- Implementing IAEA safeguards at NRC-licensed nuclear facilities in the U.S. and helping strengthen and maintain IAEA effectiveness worldwide.
- Sharing technical information, funding, technical support, and results of specific joint research projects and programs.

Radioactive Waste



U.S. Low-Level Radioactive Waste Disposal

Commercial low-level waste disposal facilities must be licensed by either 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. NRC's requirements place restrictions on the types of waste that can be disposed of. 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% 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 facilities operating in reactor decommissioning. Clean up of contaminated sites accounts for several million cubic feet each year of low level radioactive waste.

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

- Formation of ten regional compacts
- Exclusion of waste generated outside a compact

Active, Licensed Disposal Facilities

- Barnwell, South Carolina (access authorized for all low-level waste generators until 2008. Access limited to Atlantic compact after 2008)
- Hanford, Washington (restricted access to only the Northwest and Rocky Mountain compacts)
- Clive, Utah (restricted to mostly Class A waste)

Other Disposal Facilities

Closed Sites

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

Figure 37. **Low-Level Waste Disposal Site**

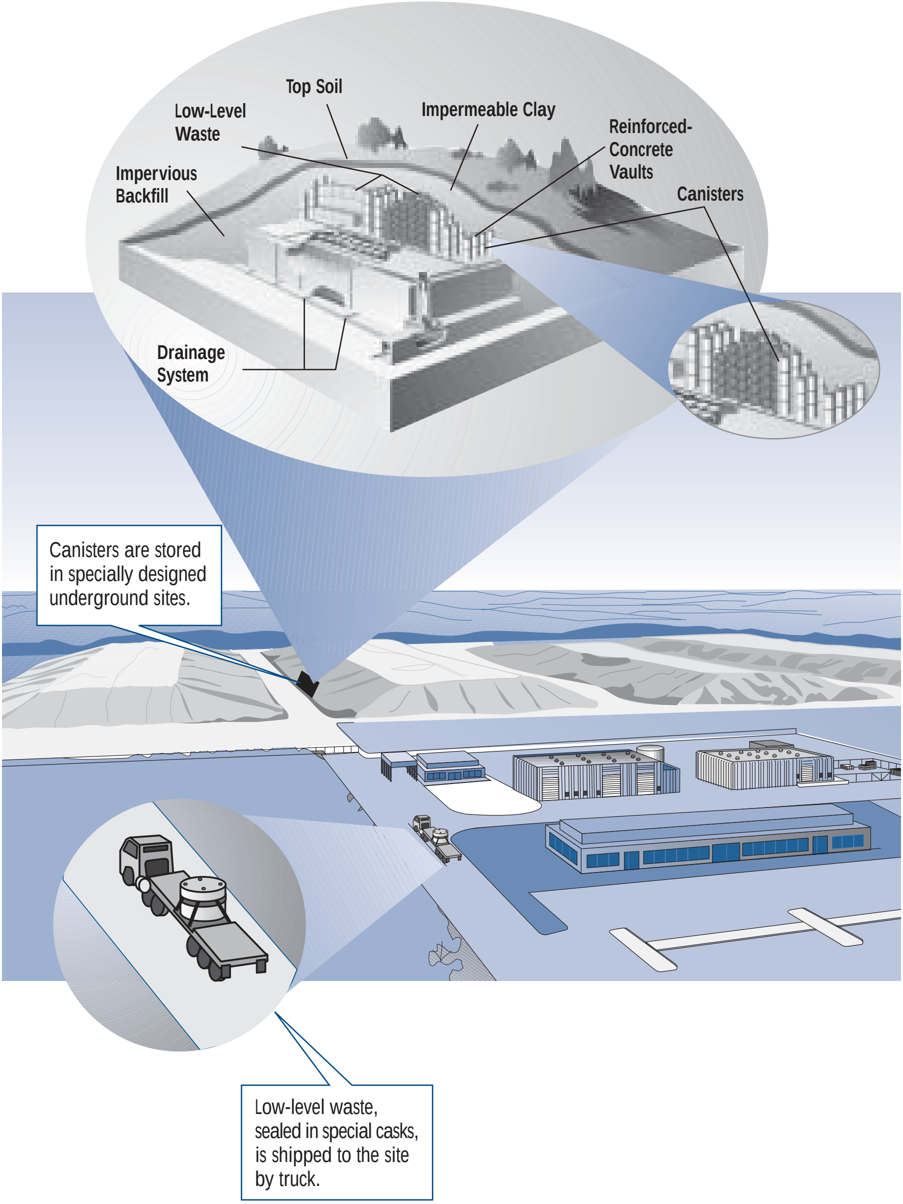
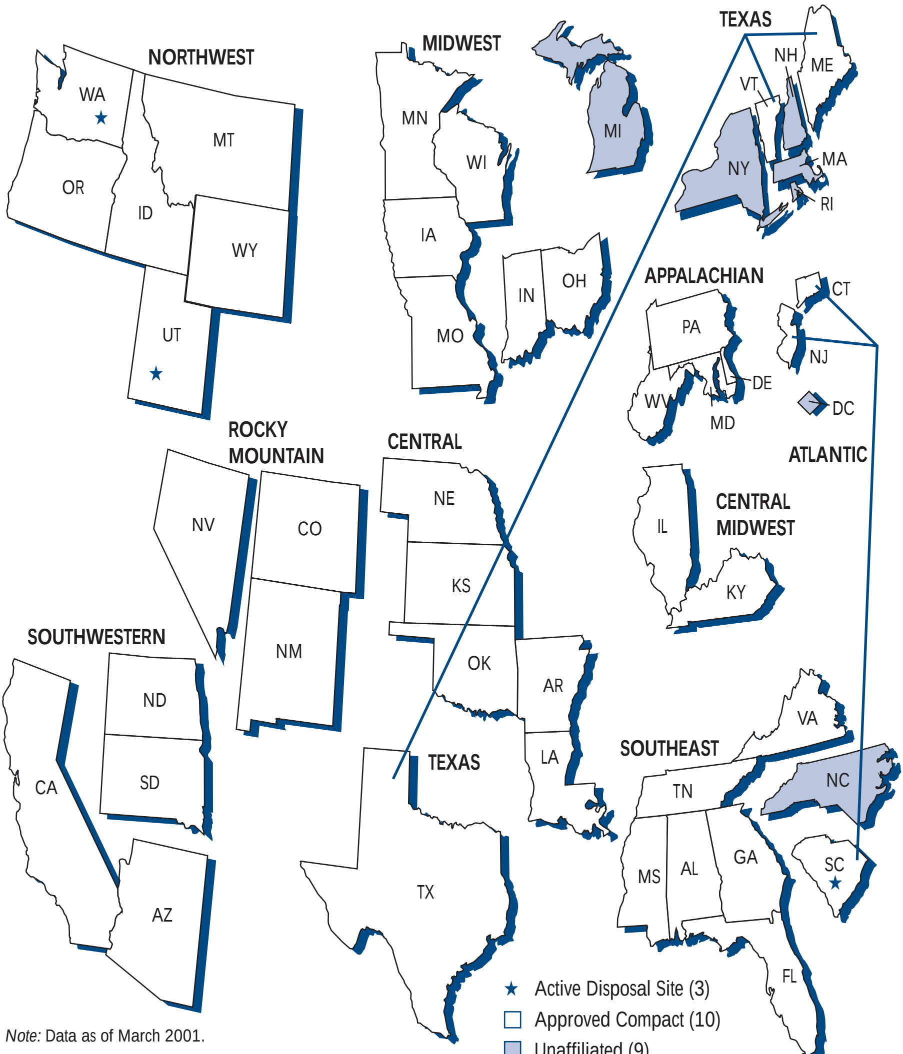


Figure 38. **U.S. Low-Level Waste Compacts**



Note: Data as of March 2001.

Alaska and Hawaii belong to the Northwest Compact.
Puerto Rico is unaffiliated.

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: Nuclear Regulatory Commission

U.S. High-Level Radioactive Waste Disposal

The Yucca Mountain Disposal Plan

The Nuclear Waste Policy Act (NWPA) of 1982 and the Nuclear Waste Policy Amendments Act of 1987 specify a detailed approach for the disposal of high-level radioactive waste with the Department of Energy (DOE) having operational responsibility and the NRC having regulatory responsibility for the transportation, storage, and geologic disposal of the waste.

- The disposal of high-level radioactive waste requires a determination of acceptable health and environmental impacts over thousands of years.
- Current plans call for the ultimate disposal of the waste in solid form in a licensed, deep, geologic structure.
- The Amendments Act redirected DOE to investigate only one potential high-level waste repository at Yucca Mountain, Nevada. DOE released it's Viability Assessment in December 1998, and concluded that Yucca Mountain remains a promising site for a geological repository and that work should proceed to support a decision on whether to recommend the site to the President for development as a repository. (See Figure 39 for a conceptual design of the Yucca Mountain disposal plan.)
- In February, 2002, DOE recommended to the president that the Yucca Mountain site be developed as a long-term geologic repository for high-level waste. On February 15, 2002, the President approved and forwarded the DOE recommendation to the Congress.
- Within 60 days of the Presidential recommendation to Congress, the NWPA permits the State of Nevada to submit to Congress a "...notice of disapproval."

  The State formally issued a "...Notice of Disapproval of the Yucca Mountain Project" to Congress on April 9, 2002.
- Upon receipt of the "Notice of Disapproaval from the State, the NWPA prescribes that the Congress has 90 days (of continuous session) to pass a resolution either supporting or not supporting the recommendation that DOE develop a license application for the Yucca Mountain site. In July, 2002, Congress voted to override the objection of the State. On July 23, 2002, the President signed a joint resolution from Congress that permits the DOE to submit a license application to the NRC, DOE has stated that it intends to submit a license application to the NRC in December 2004.

Spent Fuel Storage

In 1997, approximately 36,600 metric tons of spent nuclear fuel was stored at commercial nuclear power reactors. By the year 2005, this amount is expected to increase to 52,000 metric tons:

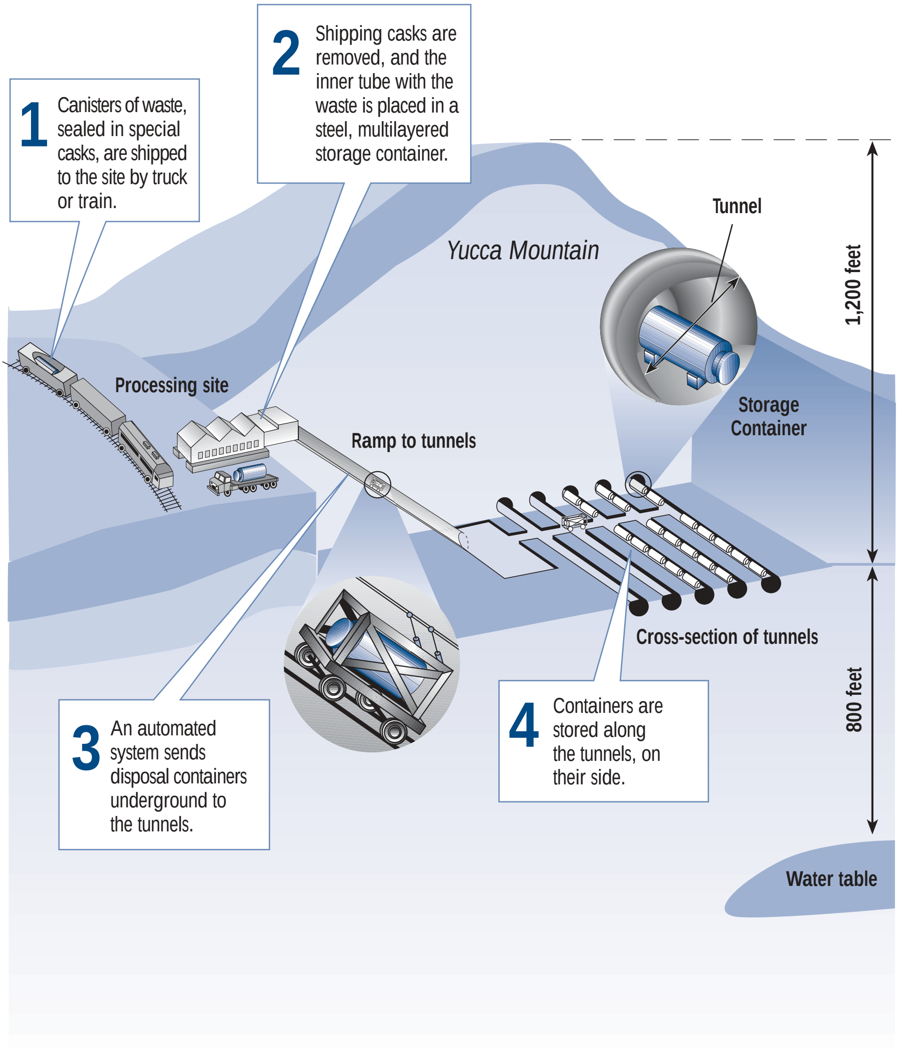
- All of the operating nuclear power reactors are storing used fuel under NRC license in spent fuel pools (SFPs) (see Figure 40).
- Most U.S. nuclear power plants were not originally designed to have a storage

(Continued)

capacity for all the spent fuel produced by their reactors. Utilities originally planned for spent fuel to remain in the SFP 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. This has been only a short-term solution and many utilities have reached, or will soon reach, their SFP storage capacity. (See Figure 41)

- In 1990, the NRC amended its regulations to authorize licensees to store spent fuel at reactor sites in dry storage systems approved by the NRC. Fourteen dry storage designs have received certificates of compliance as a result of this rule change (see Appendix H).
- Currently, there are 27 operating independent spent fuel storage installation sites (ISFSIs) in the U.S. (See Figure 42).
- Refer to NUREG-1571, "Information Handbook on Independent Spent Fuel Storage Installations" (December 1996), for a general overview.
- Refer to Appendix I for a list of NRC Dry Spent Fuel Storage Licensees.
- The NRC is responsible for approving transportable dry storage systems, also called dual purpose casks (see Figure 43).

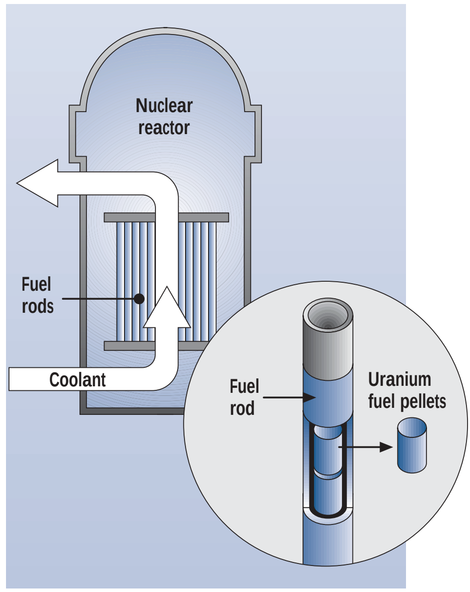
Figure 39. **The Yucca Mountain Disposal Plan**

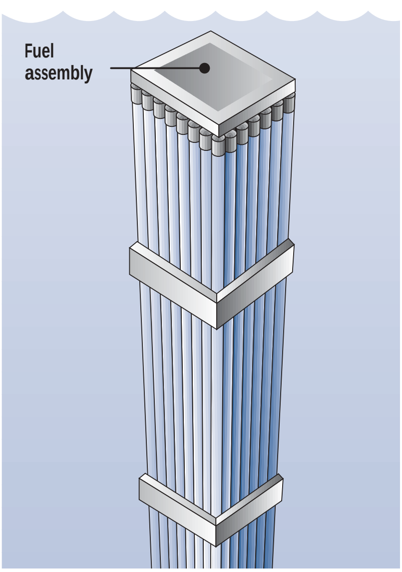


Source: Department of Energy and the Nuclear Energy Institute

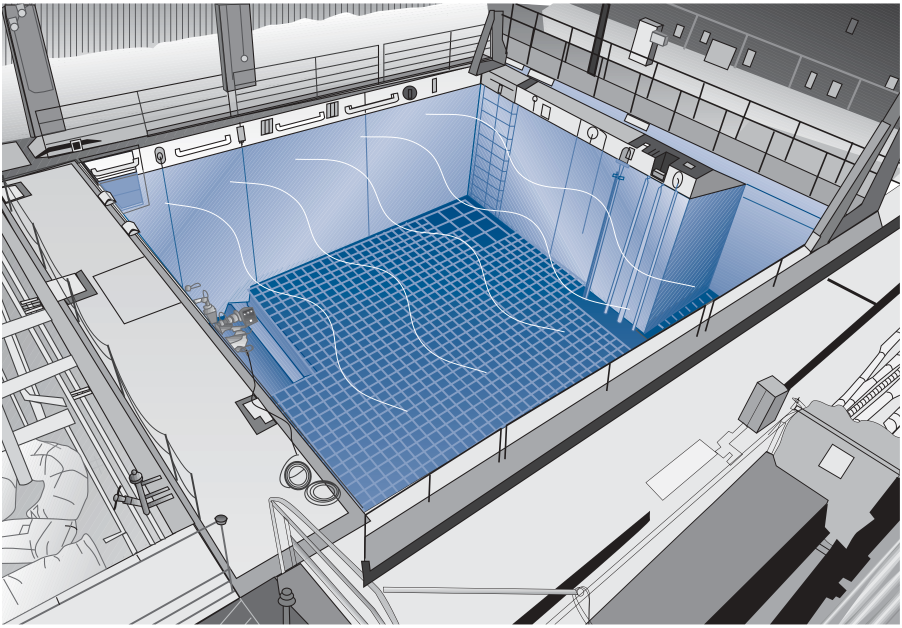
Figure 40. **Spent Fuel Generation and Storage After Use**

1 Nuclear reactors are powered by enriched uranium-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.





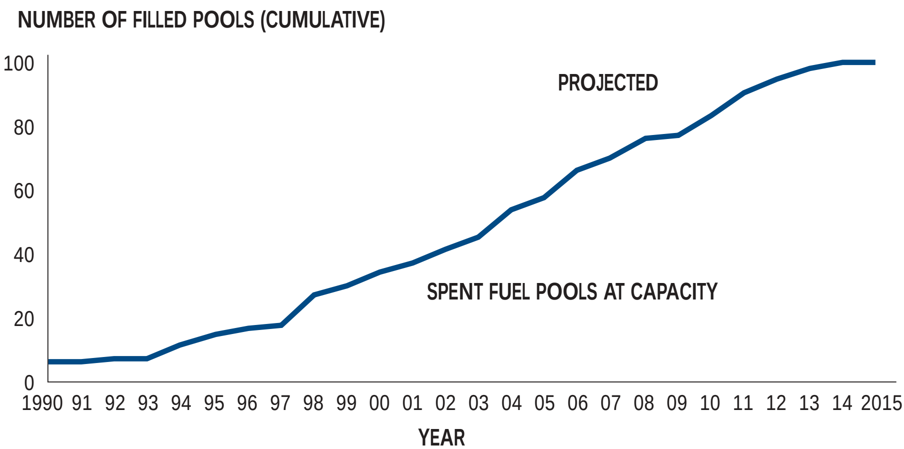
2 After about six years, spent fuel assemblies—typically 14 feet long and containing nearly 200 fuel rods—are removed from the reactor and allowed to cool in storage pools for a few years. At this point, the 900-pound assemblies contain only about one-fifth the original amount of U-235.



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 43) or transported off site to a high-level radioactive waste disposal site.*

Source: Department of Energy and the Nuclear Energy Institute

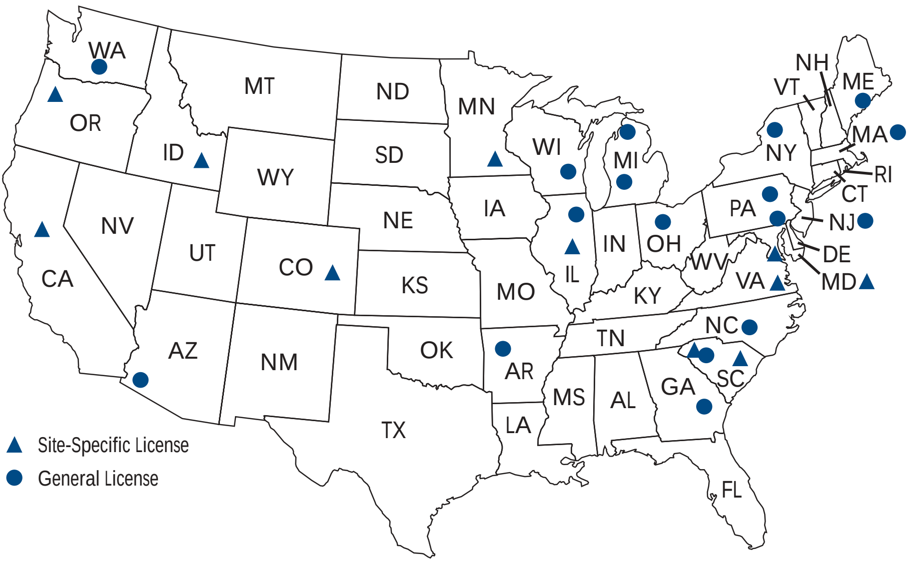
Figure 41. **Nuclear Fuel Storage Pool Capacity**



Note: All operating nuclear power reactors are storing used fuel under NRC license in spent fuel pools. Some operating nuclear reactors are using dry cask storage. Information is based on loss of full-core reserve in the spent fuel pools.

Source: Energy Resources International and DOE/RW-0431 – Revision 1

Figure 42. **Licensed / Operating Independent Spent Fuel Storage Installations**



ARIZONA
- ● Palo Verde

ARKANSAS
- ● Arkansas Nuclear

CALIFORNIA
- ▲ Rancho Seco

COLORADO
- ▲ Fort St. Vrain

GEORGIA
- ● Hatch

IDAHO
- ▲ DOE: TMI-2 Fuel Debris

ILLINOIS
- ▲ GE Morris
- ● Dresden

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

VIRGINIA
- ▲ Surry
- ▲ North Anna

WASHINGTON
- ● Columbia Generating Station

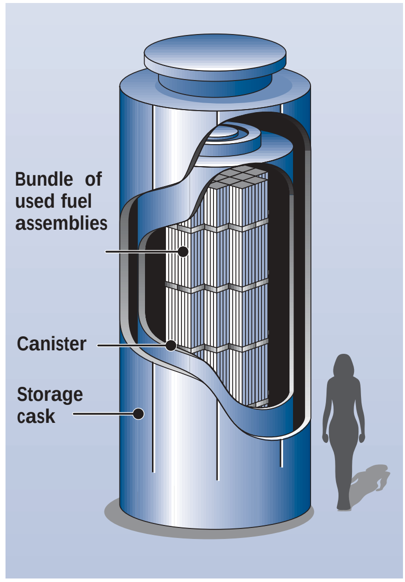
WISCONSIN
- ● Point Beach

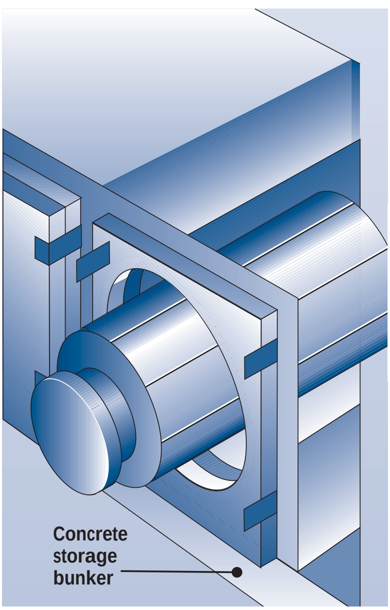
Data as of February 2003
Source: Nuclear Regulatory Commission

Figure 43. **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 and Boiling-Water Reactor assemblies. Water and air are removed. The canister is filled with inert gas, welded shut, and rigorously tested for leaks. It may then be placed in a "cask" for storage or transportation.





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.

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 Department of Energy 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

- NRC examines transport-related safety during approximately 1,000 safety inspections of fuel, reactor, and materials licensees annually.

- NRC reviews, evaluates, and certifies approximately 100 new, renewal, or amended container-design applications for the transport of nuclear materials annually.

- NRC reviews and evaluates approximately 100 license applications for the export of nuclear materials from the United States annually.

- NRC conducts comprehensive physical protection and materials control and accounting license reviews and conducts inspections at the major fuel fabrication facilities annually.

- NRC inspects about 20 dry storage and transport package licensees annually.

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).

Nuclear Power Reactors:

In July 1996, the NRC issued a revised rule for power reactor decommissioning. The rule is intended to clarify the applicability of certain regulations to permanently shutdown nuclear power reactors and to provide for public participation in the decommissioning process. In 1997, the NRC issued rules for site release criteria. The rules provided for unrestricted and, under certain conditions, restricted release of a site.

Other Sites and Facilities:

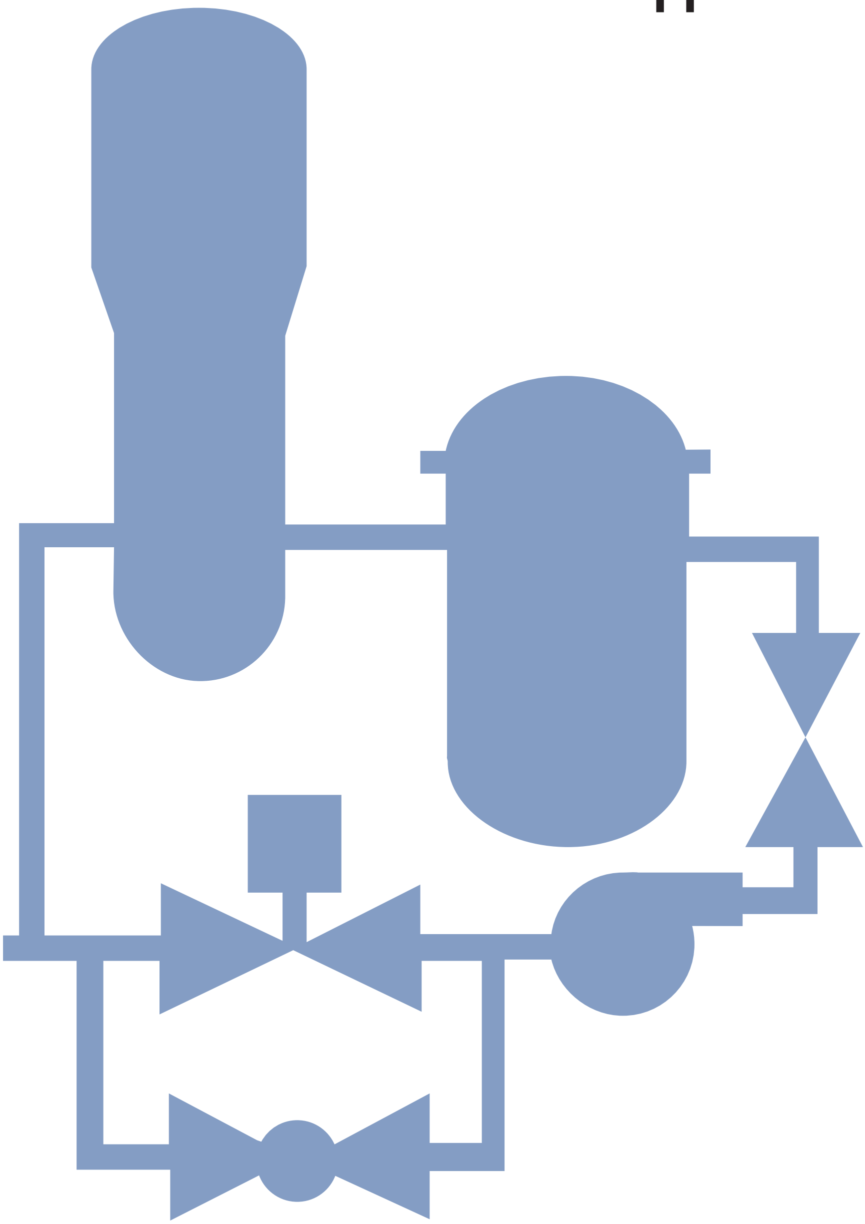
Over the last 40 years, operations at licensed nuclear facilities have caused radiological contamination at a number of sites. This contamination must be reduced or stabilized in a timely and efficient manner to ensure protection of the public and the environment before the sites can be released and the license terminated. The NRC's Site Decommissioning Management Plan (SDMP) lists 22 sites and 5 complex decommissioning sites that require special attention to resolve issues, and to prompt timely decommissioning at these sites (see Table 15). The list is updated periodically and is available on the NRC web site. The staff has completed a rebaselining of the sites listed in the SDMP. The purpose of the rebaselining effort was to establish milestones and schedules for completing decommissioning and license termination at the site.

Table 15. Site Decommissioning Management Plan and Other Complex Sites List

Company	Location
SDMP Sites	
AAR Manufacturing, Inc. (Brooks & Perkins)	Livonia, MI
Army, Department of, Jefferson Proving Ground	Jefferson, IN
Babcock & Wilcox	Parks Township, PA
Babcock & Wilcox SLDA	Vandergrift, PA
Cabot Corporation	Reading, PA
Dow Chemical Company	Bay City and Midland, MI
Fansteel, Inc.	Muskogee, OK
Hartley and Hartley (Kawkawlin) Landfill	Bay County, MI
Heritage Minerals	Lakehurst, NJ
Kaiser Aluminum	Tulsa, OK
Kerr-McGee	Cimarron, OK
Kerr-McGee	Cushing, OK
Michigan Department of Natural Resources (MDNR)	Lansing, MI
Molycorp, Inc.	Washington, PA
Molycorp, Inc.	York, PA
Permagrain Products	Media, PA
Safety Light Corporation	Bloomsburg, PA
Sequoyah Fuels Corporation	Gore, OK
Shieldalloy Metallurgical Corporation	Newfield, NJ
Watertown GSA	Watertown, MA
Westinghouse Electric Corporation	Waltz Mill, PA
Whittaker Corporation	Greenville, PA
Complex Decommissioning Sites	
KVWPCA	Vandergrift, PA
UCAR (Union Carbide)	Lawrenceberg, TN
MallincKrodt	St. Louis, MO
Combustion Engineering / Westinghouse	Windsor, CT
Combustion Engineering / Westinghouse	Festus, MO

Source: Nuclear Regulatory Commission

Appendices



Abbreviations Used In Appendices

ABB-CE	Asea Brown Boveri-Combustion Engineering
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
ASEA	Asea Brown Boveri-Asea Atom
B&R	Burns & Roe
B&W	Babcock & Wilcox
BALD	Baldwin Associates
BECH	Bechtel
BRRT	Brown & Root
BWR	Boiling-Water Reactor
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
EBSO	Ebasco
EXP. DATE	Expiration Date of Operating License
FENOC	FirstEnergy Nuclear Operating Co.
FRAM	Framatome
FLUR	Fluor Pioneer
G&H	Gibbs & Hill
GCR	Gas-Cooled Reactor
GE	General Electric
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
JONES	J. A. Jones
KAIS	Kaiser Engineers
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.
MWe	Megawatts Electrical
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
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
SCGM	Sodium Cooled Graphite Moderated
S&L	Sargent & Lundy
S&W	Stone & Webster
SBEC	Southern Services & Bechtel
SSI	Southern Services Incorporated
STP	South Texas Project
TXU	Texas Utilities
TNPG	The Nuclear Power Group
TOSH	Toshiba
TR	Test Reactor
TVA	Tennessee Valley Authority
UE&C	United Engineers & Constructors
UTR	Universal Training Reactor
VT	Vermont
WDCO	Westinghouse Development Corporation
WEST	Westinghouse Electric

U.S. Commercial Nuclear Power Reactors

Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
Arkansas Nuclear 1 Entergy Nuclear 6 MI WNW of Russellville, AR 050-00313	IV	PWR-DRYAMB B&W LLP BECH BECH	2568	0836	12/06/1968 05/21/1974 12/19/1974 05/20/2034	OL-FP DPR-51	99.0 82.6 91.7 87.3 93.9 89.7
Arkansas Nuclear 2 Entergy Nuclear 6 MI WNW of Russellville, AR 050-00368	IV	PWR-DRYAMB COMB CE BECH BECH	2815	0858	12/06/1972 09/01/1978 03/26/1980 07/17/2018	OL-FP NPF-6	92.6 86.9 82.8 69.9 105.3 106.5
Beaver Valley 1 FirstEnergy Nuclear Operating Company 17 MI W of McCandless, PA 050-00334	I	PWR-DRYSUB WEST 3LP S&W S&W	2689	0821	06/26/1970 07/02/1976 10/01/1976 01/29/2016	OL-FP DPR-66	56.3 33.2 86.1 82.7 83.3 97.2
Beaver Valley 2 FirstEnergy Nuclear Operating Company 17 MI W of McCandless, PA 050-00412	I	PWR-DRYSUB WEST 3LP S&W S&W	2689	0831	05/03/1974 08/14/1987 11/17/1987 05/27/2027	OL-FP NPF-73	85.7 16.9 80.1 86.5 98.8 90.7
Braidwood 1 Exelon 24 MI SSW of Joilet, IL 050-00456	III	PWR-DRYAMB WEST 4LP S&L CWE	3586	1161	12/31/1975 07/02/1987 07/29/1988 10/17/2026	OL-FP NPF-72	83.9 78.6 101.0 96.4 93.4 104.3
Braidwood 2 Exelon 24 MI SSW of Joilet, IL 050-00457	III	PWR-DRYAMB WEST 4LP S&L CWE	3586	1154	12/31/1975 05/20/1988 10/17/1988 12/18/2027	OL-FP NPF-77	85.5 97.4 92.0 98.4 98.2 93.5
Browns Ferry 1 Tennessee Valley Authority 10 MI NW of Decatur, AL 050-00259	II	BWR-MARK1 GE 4 TVA TVA	3293	0	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
Browns Ferry 2 Tennessee Valley Authority 10 MI NW of Decatur, AL 050-00260	II	BWR-MARK1 GE 4 TVA TVA	3458	1118	05/10/1967 08/02/1974 03/01/1975 06/28/2014	OL-FP DPR-52	89.7 98.9 89.1 99.1 85.9 91.0

(Continued)

Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
Browns Ferry 3 Tennessee Valley Authority 10 MI NW of Decatur, AL 050-00296	II	BWR-MARK 1 GE 4 TVA TVA	3458	1118	07/31/1968 08/18/1976 03/01/1977 07/02/2016	OL-FP DPR-68	91.4 80.8 99.4 92.6 100.1 94.6
Brunswick 1 Carolina Power and Light, Co. 2 MI N of Southport, NC 050-00325	II	BWR-MARK 1 GE 4 UE&C BRRT	2558	0820	02/07/1970 11/12/1976 03/18/1977 09/08/2016	OL-FP DPR-71	102.1 83.6 97.4 93.7 101.7 93.2
Brunswick 2 Carolina Power and Light, Co. 2 MI N of Southport, NC 050-00324	II	BWR-MARK 1 GE 4 UE&C BRRT	2558	0811	02/07/1970 12/27/1974 11/03/1975 12/27/2014	OL-FP DPR-62	91.7 95.4 85.8 99.0 92.1 99.6
Byron 1 Exelon 17 MI SW of Rockford, IL 050-00454	III	PWR-DRYAMB WEST 4LP S&L CWE	3586	1163	12/31/1975 02/14/1985 09/16/1985 10/31/2024	OL-FP NPF-37	74.0 77.6 92.0 95.7 102.0 96.5
Byron 2 Exelon 17 MI SW of Rockford, IL 050-00455	III	PWR-DRYAMB WEST 4LP S&L CWE	3586	1131	12/31/1975 01/30/1987 08/21/1987 11/06/2026	OL-FP NPF-66	94.0 85.7 94.8 103.1 99.2 96.3
Callaway AmerenUE 10 MI SE of Fulton, MO 050-00483	III	PWR-DRYAMB WEST 4LP BECH DANI	3565	1125	04/16/1976 10/18/1984 12/19/1984 10/18/2024	OL-FP NPF-30	90.9 84.8 87.2 101.1 85.1 85.1
Calvert Cliffs 1 Constellation Nuclear 40 MI S of Annapolis, MD 050-00317	I	PWR-DRYAMB COMB CE BECH BECH	2700	0825	07/07/1969 07/31/1974 05/08/1975 07/31/2034	OL-FP DPR-53	97.9 81.9 96.8 89.0 103.2 64.3
Calvert Cliffs 2 Constellation Nuclear 40 MI S of Annapolis, MD 050-00318	I	PWR-DRYAMB COMB CE BECH BECH	2700	0835	07/07/1969 11/30/1976 04/01/1977 08/13/2036	OL-FP DPR-69	81.2 97.7 86.6 100.8 84.8 102.3

Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
Catawba 1 Duke Energy Nuclear, LLC 6 MI 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 12/06/2024	OL-FP NPF-35	92.8 88.2 91.7 90.0 100.9 95.9
Catawba 2 Duke Energy Nuclear, LLC 6 MI 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 02/24/2026	OL-FP NPF-52	86.8 85.2 89.5 90.6 86.7 102.9
Clinton AmerGen Energy Co. 6 MI E of Clinton, IL 050-00461	III	BWR-MARK 3 GE 6 S&L BALD	2894	1022	02/24/1976 04/17/1987 11/24/1987 09/29/2026	OL-FP NPF-62	0.0 0.0 57.7 84.3 96.7 85.5
Columbia Generating Station Energy Northwest 12 MI NW of Richland, WA 050-00397	IV	BWR-MARK 2 GE 5 B&R BECH	3486	1107	03/19/1973 04/13/1984 12/13/1984 12/20/2023	OL-FP NPF-21	63.0 68.1 62.8 88.5 85.1 92.6
Comanche Peak 1 TXU Generation Company LP 4 MI 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	94.1 86.2 85.4 95.2 83.8 87.3
Comanche Peak 2 TXU Electric & Gas 4 MI 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	80.0 95.3 86.9 87.8 98.1 87.3
Cooper Nebraska Public Power District 23 MI S of Nebraska City, NE 050-00298	IV	BWR-MARK 1 GE 4 B&R B&R	2381	0764	06/04/1968 01/18/1974 07/01/1974 01/18/2014	OL-FP DPR-46	81.5 75.2 97.3 70.6 77.8 94.4
Crystal River 3 Florida Power Corp. 7 MI NW of Crystal River, FL 050-00302	II	PWR-DRYAMB B&W LLP GIL JONES	2544	0834	09/25/1968 01/28/1977 03/13/1977 12/03/2016	OL-FP DPR-72	0.0 88.2 88.9 97.2 89.2 99.9

(Continued)

Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
Davis-Besse FirstEnergy Nuclear Operating Co. 21 MI ESE of Toledo, OH 050-00346	III	PWR-DRYAMB B&W RLP BECH	2772	0882	03/24/1971 04/22/1977 07/31/1978 04/22/2017	OL-FP NPF-3	93.9 78.1 96.4 87.4 99.5 12.0
D.C. Cook 1 Indiana/Michigan Power Co. 11 MI S of Benton Harbor, MI 050-00315	III	PWR-ICECND WEST 4LP AEP AEP	3250	1000	03/25/1969 10/25/1974 08/28/1975 10/25/2014	OL-FP DPR-58	51.9 0.0 0.0 1.5 89.0 88.4
D.C. Cook 2 Indiana/Michigan Power Co. 11 MI S of Benton Harbor, MI 050-00316	III	PWR-ICECND WEST 4LP AEP AEP	3411	1090	03/25/1969 12/23/1977 07/01/1978 12/23/2017	OL-FP DPR-74	63.3 0.0 0.0 51.4 85.8 82.8
Diablo Canyon 1 Pacific Gas & Electric Co. 12 MI 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	87.1 98.0 87.5 83.3 99.8 74.0
Diablo Canyon 2 Pacific Gas & Electric Co. 12 MI 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	93.3 84.5 88.7 96.2 90.9 97.5
Dresden 2 Exelon 9 MI E of Morris, IL 050-00237	III	BWR-MARK 1 GE 3 S&L UE&C	2957	0850	01/10/1966 02/20/1991 06/09/1970 12/22/2009	OL-FP DPR-19	82.5 79.1 92.1 101.3 89.8 101.1
Dresden 3 Exelon 9 MI E of Morris, IL 050-00249	III	BWR-MARK 1 GE 3 S&L UE&C	2527	0850	10/14/1966 01/12/1971 11/16/1971 01/12/2011	OL-FP DPR-25	59.5 88.2 90.6 93.7 95.5 81.4
Duane Arnold Nuclear Management Company 8 MI NW of Cedar Rapids, IA 050-00331	III	BWR-MARK 1 GE 4 BECH BECH	1658	0565	06/22/1970 02/22/1974 02/01/1975 02/21/2014	OL-FP DPR-49	91.2 82.3 80.1 97.5 77.9 92.5

Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
Edwin I. Hatch 1 Southern Nuclear Operating Co. 11 MI N of Baxley, GA 050-00321	II	BWR-MARK 1 GE 4 BECH GPC	2763	0856	09/30/1969 10/13/1974 12/31/1975 08/06/2034	OL-FP DPR-57	85.7 96.5 81.1 84.5 99.2 88.4
Edwin I. Hatch 2 Southern Nuclear Operating Co. 11 MI N of Baxley, GA 050-00366	II	BWR-MARK 1 GE 4 BECH GPC	2763	0870	12/27/1972 06/13/1978 09/05/1979 06/13/2038	OL-FP NPF-5	84.2 80.6 94.4 89.5 85.6 97.4
Fermi 2 The Detroit Edison Co. 25 MI NE of Toledo, OH 050-00341	III	BWR-MARK 1 GE 4 S&L DANI	3430	1089	09/26/1972 07/15/1985 01/23/1988 03/20/2025	OL-FP NPF-43	63.6 67.8 100.3 86.2 89.8 97.5
Fort Calhoun Omaha Public Power District 19 MI N of Omaha, NE 050-00285	IV	PWR-DRYAMB COMB CE GHDR GHDR	1500	0478	06/07/1968 08/09/1973 09/26/1973 08/09/2013	OL-FP DPR-40	91.2 77.8 85.6 92.8 84.2 91.0
Ginna Rochester Gas & Electric Corp. 20 MI NE of Rochester, NY 050-00244	I	PWR-DRYAMB WEST 2LP GIL BECH	1520	0480	04/25/1966 09/19/1969 07/01/1970 09/18/2009	OL-FP DPR-18	92.6 104.1 84.0 90.5 101.9 91.4
Grand Gulf 1 Entergy Nuclear 25 MI S of Vicksburg, MS 050-00416	II	BWR-MARK 3 GE 6 BECH BECH	3833	1207	09/04/1974 11/01/1984 07/01/1985 11/01/2024	OL-FP NPF-29	102.9 82.0 79.9 100.6 93.6 95.1
H.B. Robinson 2 Carolina Power and Light Co. 26 MI from Florence, SC 050-00261	II	PWR-DRYA MB WEST 3LP EBSO EBSO	2300	0683	04/13/1967 09/23/1970 03/07/1971 07/31/2010	OL-FP DPR-23	103.6 87.9 95.0 104.0 92.2 93.7
Hope Creek 1 PSEG Nuclear, LLC 18 MI SE of Wilmington, DE 050-00354	I	BWR-MARK1 GE 4 BECH BECH	3339	1049	11/04/1974 07/25/1986 12/20/1986 04/11/2026	OL-FP NPF-57	70.9 92.3 85.3 80.3 87.8 96.2

(Continued)

Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
Indian Point 2 Entergy Nuclear 24 MI N of New York City, NY 050-00247	I	PWR-DRYAMB WEST 4LP UE&C WDCO	3071	0951	10/14/1966 09/28/1973 08/01/1974 09/28/2013	OL-FP DPR-26	38.4 23.0 88.5 12.1 93.5 90.7
Indian Point 3 Entergy Nuclear 24 MI N of New York City, NY 050-00286	I	PWR-DRYAMB WEST 4LP UE&C WDCO	3025	0979	08/13/1969 04/05/1976 08/30/1976 12/15/2015	OL-FP DPR-64	51.3 89.8 86.0 99.5 93.9 98.3
James A. FitzPatrick Entergy Nuclear 8 MI NE of Oswego, NY 050-00333	I	BWR-MARK 1 GE 4 S&W S&W	2536	0813	05/20/1970 10/17/1974 07/28/1975 10/17/2014	OL-FP DPR-59	94.7 73.2 93.5 84.4 99.6 92.6
Joseph M. Farley 1 Southern Nuclear Operating Co. 18 MI SE of Dothan, AL 050-00348	II	PWR-DRYAMB WEST 3LP SSI DANI	2775	0833	08/16/1972 06/25/1977 12/01/1977 06/25/2017	OL-FP NPF-2	75.2 78.9 97.4 71.5 87.6 99.0
Joseph M. Farley 2 Southern Nuclear Operating Co. 18 MI SE of Dothan, AL 050-00364	II	PWR-DRYAMB WEST 3LP SSI BECH	2775	0842	08/16/1972 03/31/1981 07/30/1981 03/31/2021	OL-FP NPF-8	101.1 84.7 71.7 100.0 78.2 87.6
Kewaunee Nuclear Management Co. 27 MI E of Green Bay, WI 050-00305	III	PWR-DRYAMB WEST 2LP PSE PSE	1650	0511	08/06/1968 12/21/1973 06/16/1974 12/21/2013	OL-FP DPR-43	52.8 78.4 98.8 82.7 77.3 99.8
La Salle County 1 Exelon 11 MI SE of Ottawa, IL 050-00373	III	BWR-MARK 2 GE 5 S&L CWE	3489	1111	09/10/1973 04/17/1982 01/01/1984 04/17/2022	OL-FP NPF-11	0.0 30.8 88.3 99.6 101.2 91.7
La Salle County 2 Exelon 11 MI SE of Ottawa, IL 050-00374	III	BWR-MARK 2 GE 5 S&L CWE	3489	1111	09/10/1973 02/16/1983 10/19/1984 12/16/2023	OL-FP NPF-18	0.0 0.0 73.1 92.4 99.5 92.4

Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
Limerick 1 Exelon 21 MI 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	95.3 77.6 98.1 89.5 101.2 93.5
Limerick 2 Exelon 21 MI 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	85.0 93.5 85.0 99.0 92.3 100.8
McGuire 1 Duke Power 17 MI N of Charlotte, NC 050-00369	II	PWR-ICECND WEST 4LP DUKE DUKE	3411	1100	02/23/1973 07/08/1981 12/01/1981 06/12/2021	OL-FP NPF-9	70.8 80.9 89.1 103.4 90.1 94.4
McGuire 2 Duke Power 17 MI N of Charlotte, NC 050-00370	II	PWR-ICECND WEST 4LP DUKE DUKE	3411	1100	02/23/1973 05/27/1983 03/01/1984 03/03/2023	OL-FP NPF-17	67.2 92.1 89.2 87.5 102.5 92.5
Millstone 2 Dominion Generation 3.2 MI WSW of New London, CT 050-00336	I	PWR-DRYAMB COMB CE BECH BECH	2700	0871	12/11/1970 09/26/1975 12/26/1975 07/31/2015	OL-FP DPR-65	0.0 0.0 57.9 81.7 95.6 81.3
Millstone 3 Dominion Generation 3.2 MI WSW of New London, CT 050-00423	I	PWR-DRYSUB WEST 4LP S&W S&W	3411	1131	08/09/1974 01/31/1986 04/23/1986 11/25/2025	OL-FP NPF-49	0.0 34.0 82.7 99.9 82.1 88.3
Monticello Nuclear Management Co. 30 MI NW of Minneapolis, MN 050-00263	III	BWR-MARK 1 GE 3 BECH BECH	1775	0578	06/19/1967 01/09/1981 06/30/1971 09/08/2010	OL-FP DPR-22	76.8 82.4 91.8 83.6 76.5 99.0

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Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
Nine Mile Point 1 Constellation Nuclear 6 MI NE of Oswego, NY 050-00220	I	BWR-MARK 1 GE 2 NIAG S&W	1850	0565	04/12/1965 12/26/1974 12/01/1969 08/22/2009	OL-FP DPR-63	54.5 87.9 72.0 94.3 88.5 99.1
Nine Mile Point 2 Constellation Nuclear 6 MI NE of Oswego, NY 050-00410	I	BWR-MARK 2 GE 5 S&W S&W	3467	1120	06/24/1974 07/02/1987 03/11/1988 10/31/2026	OL-FP NPF-69	91.7 71.4 89.3 81.1 90.3 85.8
North Anna 1 Dominion Generation 40 MI 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	91.5 90.5 103.8 92.0 87.9 100.8
North Anna 2 Dominion Generation 40 MI 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	99.7 89.0 91.4 101.8 74.4 68.6
Oconee 1 Duke Energy Nuclear, LLC 30 MI 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	43.0 77.1 83.8 84.9 94.0 89.2
Oconee 2 Duke Energy Nuclear, LLC 30 MI 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	79.2 72.1 84.4 100.9 90.2 89.2
Oconee 3 Duke Energy Nuclear, LLC 30 MI 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	62.7 79.8 99.4 88.5 72.8 100.7
Oyster Creek AmerGen Energy Co., LLC 9 MI 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	93.6 74.3 99.4 71.9 96.4 92.8

Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
Palisades Nuclear Management Co. 5 MI S of South Haven, MI 050-00255	III	PWR-DRYAMB COMB CE BECH BECH	2530	0730	03/14/1967 02/21/1991 12/31/1971 03/24/2011	OL-FP DPR-20	90.8 80.0 80.2 89.6 36.8 99.6
Palo Verde 1 Arizona Nuclear Power Project 36 MI W of Phoenix, AZ 050-00528	IV	PWR-DRYAMB COMB CE80 BECH BECH	3800	1243	05/25/1976 06/01/1985 01/28/1986 12/31/2024	OL-FP NPF-41	98.6 87.4 88.7 100.4 87.8 89.1
Palo Verde 2 Arizona Nuclear Power Project 36 MI W of Phoenix, AZ 050-00529	IV	PWR-DRYAMB COMB CE80 BECH BECH	3876	1243	05/25/1976 04/24/1986 09/19/1986 12/09/2025	OL-FP NPF-51	85.6 101.8 90.0 87.2 92.6 92.0
Palo Verde 3 Arizona Nuclear Power Project 36 MI W of Phoenix, AZ 050-00530	IV	PWR-DRYAMB COMB CE80 BECH BECH	3876	1247	05/25/1976 11/25/1987 01/08/1988 03/25/2027	OL-FP NPF-74	86.5 87.6 100.3 90.3 83.9 102.0
Peach Bottom 2 Exelon 17.9 MI S of Lancaster, PA 050-00277	I	BWR-MARK 1 GE 4 BECH BECH	3458	1093	01/31/1968 10/25/1973 07/05/1974 08/08/2013	OL-FP DPR-44	100.0 75.9 98.8 88.8 97.9 92.3
Peach Bottom 3 Exelon 17.9 MI S of Lancaster, PA 050-00278	I	BWR-MARK 1 GE 4 BECH BECH	3458	1093	01/31/1968 07/02/1974 12/23/1974 07/02/2014	OL-FP DPR-56	79.0 90.1 89.4 99.5 89.0 100.8
Perry 1 FirstEnergy Nuclear Operating Co. 7 MI 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	80.2 96.7 89.8 93.9 71.6 92.2
Pilgrim 1 Entergy 4 MI SE of Plymouth, MA 050-00293	I	BWR-MARK 1 GE 3 BECH BECH	1998	0653	08/26/1968 09/15/1972 12/01/1972 06/08/2012	OL-FP DPR-35	73.4 73.4 76.2 93.7 89.9 100.9

(Continued)

Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
Point Beach 1 Nuclear Management Co. 13 MI NNW of Manitowoc, WI 050-00266	III	PWR-DRYAMB WEST 2LP BECH BECH	1519	0510	07/19/1967 10/05/1970 12/21/1970 10/05/2010	OL-FP DPR-24	19.4 54.9 78.4 92.3 82.9 89.0
Point Beach 2 Nuclear Management Co. 13 MI NNW of Manitowoc, WI 050-00301	III	PWR-DRYAMB WEST 2LP BECH BECH	1519	0512	07/25/1968 03/08/1973 10/01/1972 03/08/2013	OL-FP DPR-27	19.0 77.5 80.0 78.4 96.8 89.3
Prairie Island 1 Nuclear Management Co. 28 MI 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	78.4 89.7 89.0 98.9 79.6 95.6
Prairie Island 2 Nuclear Management Co. 28 MI 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	81.2 78.6 100.5 91.1 93.4 93.9
Quad Cities 1 Exelon 20 MI NE of Moline, IL 050-00254	III	BWR-MARK 1 GE 3 S&L UE&C	2957	0855	02/15/1967 12/14/1972 02/18/1973 12/14/2012	OL-FP DPR-29	82.6 42.1 94.1 91.3 99.6 76.2
Quad Cities 2 Exelon 20 MI NE of Moline, IL 050-00265	III	BWR-MARK 1 GE 3 S&L UE&C	2957	0855	02/15/1967 12/14/1972 03/10/1973 12/14/2012	OL-FP DPR-30	39.0 50.6 97.9 92.1 93.1 87.5
River Bend 1 Entergy Nuclear 24 MI NNW of Baton Rouge, LA 050-00458	IV	BWR-MARK 3 GE 6 S&W S&W	3039	0966	03/25/1977 11/20/1985 06/16/1986 08/29/2025	OL-FP NPF-47	83.2 95.1 69.6 89.4 95.3 100.1
Salem 1 PSEG Nuclear, LLC 18 MI S of Wilmington, DE 050-00272	I	PWR-DRYAMB WEST 4LP PUBS UE&C	3459	1096	09/25/1968 08/13/1976 06/30/1977 08/13/2016	OL-FP DPR-70	0.0 63.1 82.7 92.2 80.3 89.8

Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
Salem 2 PSEG Nuclear, LLC 18 MI S of Wilmington, DE 050-00311	I	PWR-DRYAMB WEST 4LP PUBS UE&C	3459	1092	09/25/1968 05/20/1981 10/13/1981 04/18/2020	OL-FP DPR-75	25.5 80.9 82.0 86.3 99.5 87.5
San Onofre 2 Southern California Edison Co. 4 MI 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	70.5 89.1 87.9 90.7 101.3 90.8
San Onofre 3 Southern California Edison Co. 4 MI 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	72.1 95.8 88.9 101.6 60.0 100.9
Seabrook 1 FPL Energy Seabrook 13 MI S of Portsmouth, NH 050-00443	I	PWR-DRYAMB WEST 4LP UE&C UE&C	3411	1155	07/07/1976 03/15/1990 08/19/1990 10/17/2026	OL-FP NPF-86	78.3 82.7 85.8 78.1 85.9 91.8
Sequoyah 1 Tennessee Valley Authority 9.5 MI NE of Chattanooga, TN 050-00327	II	PWR-ICECND WEST 4LP TVA TVA	3411	1125	05/27/1970 09/17/1980 07/01/1981 09/17/2020	OL-FP DPR-77	85.1 87.8 101.6 78.3 91.8 100.9
Sequoyah 2 Tennessee Valley Authority 9.5 MI NE of Chattanoogo, TN 050-00328	II	PWR-ICECND WEST 4LP TVA TVA	3411	1126	05/27/1970 09/15/1981 06/01/1982 09/15/2021	OL-FP DPR-79	89.2 97.3 91.8 92.3 101.6 86.6
Shearon Harris 1 Carolina Power and Light Co. 20 MI SW of Raleigh, NC 050-00400	II	PWR-DRYAMB WEST 3LP EBSO DANI	2775	0900	01/27/1978 01/12/1987 05/02/1987 10/24/2026	OL-FP NPF-63	78.3 93.4 96.2 91.0 71.3 99.4
South Texas Project 1 STP Nuclear Operating Co. 12 MI SSW of Bay City, TX 050-00498	IV	PWR-DRYAMB WEST 4LP BECH EBSO	3800	1250	12/22/1975 03/22/1988 08/25/1988 08/20/2027	OL-FP NPF-76	90.1 98.4 88.0 78.2 94.4 99.2

(Continued)

Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
South Texas Project 2 STP Nuclear Operating Co. 12 MI SSW of Bay City, TX 050-00499	IV	PWR-DRYAMB WEST 4LP BECH EBSO	3800	1250	12/22/1975 03/28/1989 06/19/1989 12/15/2028	OL-FP NPF-80	91.0 90.1 89.4 96.1 87.1 75.0
St. Lucie 1 Florida Power & Light Co. 12 MI 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 03/01/2016	OL-FP DPR-67	77.8 94.9 88.9 102.0 91.3 94.1
St. Lucie 2 Florida Power & Light Co. 12 MI 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 04/06/2023	OL-FP NPF-16	88.4 90.8 98.1 92.3 91.3 101.0
Summer South Carolina Electric & Gas Co. 26 MI 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	87.5 101.8 88.2 74.9 79.9 87.2
Surry 1 Dominion Generation 17 MI NW of Newport News, VA 050-00280	II	PWR-DRYSUB WEST 3LP S&W S&W	2546	0810	06/25/1968 05/25/1972 12/22/1972 05/25/2032	OL-FP DPR-32	80.4 78.4 104.4 93.1 83.7 100.8
Surry 2 Dominion Generation 17 MI NW of Newport News, VA 050-00281	II	PWR-DRYSUB WEST 3LP S&W S&W	2546	0815	06/25/1968 01/29/1973 05/01/1973 01/29/2033	OL-FP DPR-37	91.9 100.0 83.7 92.9 94.1 91.4
Susquehanna 1 PPL Susquehanna, LLC 7 MI NE of Berwick, PA 050-00387	I	BWR-MARK 2 GE 4 BECH BECH	3489	1105	11/02/1973 11/12/1982 06/08/1983 07/17/2022	OL-FP NPF-14	95.2 68.9 92.3 85.4 98.6 82.9
Susquehanna 2 PPL Susquehanna, LLC 7 MI NE of Berwick, PA 050-00388	I	BWR-MARK 2 GE 4 BECH BECH	3489	1111	11/02/1973 06/27/1984 02/12/1985 03/23/2024	OL-FP NPF-22	80.6 94.7 81.3 97.3 86.3 95.6

Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
Three Mile Island 1 AmerGen Energy Co. 10 MI SE of Harrisburg, PA 050-00289	I	PWR-DRYAMB B&W LLP GIL UE&C	2568	0802	05/18/1968 04/19/1974 09/02/1974 04/19/2014	OL-FP DPR-50	86.0 97.7 77.4 103.5 78.7 104.1
Turkey Point 3 Florida Power & Light Co. 25 MI 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	86.5 89.1 100.7 93.4 91.0 102.4
Turkey Point 4 Florida Power & Light Co. 25 MI 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	89.7 101.8 94.5 91.9 100.6 96.4
Vermont Yankee Entergy Nuclear 5 MI S of Battleboro, VT 050-00271	I	BWR-MARK 1 GE 4 EBSO EBSO	1593	0510	12/11/1967 02/28/1973 11/30/1972 03/21/2012	OL-FP DPR-28	95.5 71.9 90.9 101.5 93.4 88.7
Vogtle 1 Southern Nuclear Operating Co. 26 MI SE of Augusta, GA 050-00424	II	PWR-DRYAMB WEST 4LP SBEC GPC	3565	1148	06/28/1974 03/16/1987 06/01/1987 01/16/2027	OL-FP NPF-68	81.2 99.6 93.5 91.2 100.9 85.9
Vogtle 2 Southern Nuclear Operating Co. 26 MI 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	101.3 80.2 87.0 102.4 94.0 83.6
Waterford 3 Entergy Nuclear 20 MI W of New Orleans, LA 050-00382	IV	PWR-DRYAMB COMB CE EBSO EBSO	3390	1075	11/14/1974 03/16/1985 09/24/1985 12/18/2024	OL-FP NPF-38	71.4 89.3 79.0 89.8 101.3 94.0
Watts Bar 1 Tennessee Valley Authority 10 MI S of Spring City, TN 050-00390	II	PWR-ICECND WEST 4LP TVA TVA	3411	1125	01/23/1973 02/07/1996 05/27/1996 11/09/2035	OL NPF-90	77.7 94.7 84.4 92.4 97.7 92.1

(Continued)

Unit Operating Utility Location Docket Number	NRC Region	Con Type NSSS AE Constructor	Licensed MWt	Net MDC	CP Issued OL Issued Comm. Op Exp. Date	License Type & Number	1997-2002* Average Capacity Factors (Percent)
Wolf Creek 1 Wolf Creek Nuclear Operating Corp. 3.5 MI NE of Burlington, KS 050-00482	IV	PWR-DRYAMB WEST 4LP BECH DANI	3565	1165	05/31/1977 06/04/1985 09/03/1985 03/11/2025	OL-FP NPF-42	82.7 101.5 89.3 88.3 101.0 88.6

**Note:* Average capacity factors are listed in year order starting with 1997.

Source: Nuclear Regulatory Commission and licensee data as compiled by the Nuclear Regulatory Commission.

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

Unit Location	Reactor Type MWt	OL Issued Shut Down	Decommissioning Alternative Selected Current Status
Big Rock Point Charleviox, MI	BWR 240	05/01/1964 08/29/1997	DECON DECON
Bonus * Punta Higuera, PR	BWR 50	04/02/1964 06/01/1968	ENTOMB ENTOMB
CVTR ** Parr, SC	PTHW 65	11/27/1962 01/01/1967	SAFSTOR SAFSTOR
Dresden 1 Morris, IL	BWR 700	09/28/1959 10/31/1978	SAFSTOR SAFSTOR
Elk River * Elk River, MN	BWR 58	11/06/1962 02/01/1968	DECON DECON Completed
Fermi 1 Newport, MI	SCF 200	05/10/1963 09/22/1972	SAFSTOR SAFSTOR
Fort St. Vrain Platteville, CO	HTG 842	12/21/1973 08/18/1989	DECON DECON Completed
GE VBWR Pleasanton, CA	BWR 50	08/31/1957 12/09/1963	SAFSTOR SAFSTOR
Haddam Neck Meriden, CT	PWR 1825	12/27/1974 12/05/1996	DECON DECON
Hallam * Hallam, NE	SCGM 256	01/02/1962 09/01/1964	ENTOMB ENTOMB
Humboldt Bay 3 Eureka, CA	BWR 200	08/28/1962 07/02/1976	SAFSTOR SAFSTOR
Indian Point 1 Buchanan, NY	PWR 615	03/26/1962 10/31/1974	SAFSTOR SAFSTOR
La Crosse Genoa, WI	BWR 165	07/03/1967 04/30/1987	SAFSTOR SAFSTOR
Maine Yankee Wiscasset, ME	PWR 2700	06/29/1973 12/06/1996	DECON DECON
Millstone 1 Waterford, CT	BWR 2011	10/31/1986 07/21/1998	SAFSTOR SAFSTOR
Pathfinder Sioux Falls, SD	BWR 190	03/12/1964 09/16/1967	SAFSTOR DECON Completed

(Continued)

Unit Location	Reactor Type MWt	OL Issued Shut Down	Decommissioning Alternative Selected Current Status
Peach Bottom 1 Peach Bottom, PA	HTG 115	01/24/1966 10/31/1974	SAFSTOR SAFSTOR
Piqua * Piqua, OH	OCM 46	08/23/1962 01/01/1966	ENTOMB ENTOMB
Rancho Seco Herald, CA	PWR 2772	08/16/1974 06/07/1989	DECON DECON in progress
San Onofre 1 San Clemente, CA	PWR 1347	03/27/1967 11/30/1992	DECON DECON in progress
Saxton Saxton, PA	PWR 23.5	11/15/1961 05/01/1972	DECON DECON in progress
Shippingport * Shippingport, PA	PWR 236	N/A 1982	DECON DECON Completed
Shoreham Wading River, NY	BWR 2436	04/21/1989 06/28/1989	DECON DECON Completed
Three Mile Island 2 Londonderry Township, PA	PWR 2770	02/08/1978 03/28/1979	(1)
Trojan Rainier, OR	PWR 3411	11/21/1975 11/09/1992	DECON DECON in progress
Yankee-Rowe Franklin County, MA	PWR 0600	12/24/1963 10/01/1991	DECON DECON in progress
Zion 1 Zion, IL	PWR 3250	10/19/1973 02/21/1997	SAFSTOR SAFSTOR
Zion 2 Zion, IL	PWR 3250	11/14/1973 09/19/1996	SAFSTOR SAFSTOR

* AEC/DOE owned; not regulated by 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 Nuclear Regulatory Commission

Canceled U.S. Commercial Nuclear Power Reactors

Unit Utility	Con Type MWe per Unit	Canceled Date Status
Allens Creek 1 Houston Lighting & Power Company	BWR 1150	1982 Under CP Review
Allens Creek 2 Houston Lighting & Power Company	BWR 1150	1976 Under CP Review
Atlantic 1 & 2 Public Service Electric & Gas Company	PWR 1150	1978 Under CP Review
Bailly Northern Indiana Public Service Company	BWR 645	1981 With CP
Barton 1 & 2 Alabama Power & Light	BWR 1159	1977 Under CP Review
Barton 3 & 4 Alabama Power & Light	BWR 1159	1975 Under CP Review
Bellefonte 1 & 2 Tennessee Valley Authority	PWR 1235	(1) With CP
Black Fox 1 & 2 Public Service Company of Oklahoma	BWR 1150	1982 Under CP Review
Blue Hills 1 & 2 Gulf States Utilities Company	PWR 918	1978 Under CP Review
Callaway 2 Union Electric Company	PWR 1150	1981 With CP
Cherokee 1 Duke Power Company	PWR 1280	1983 With CP
Cherokee 2 & 3 Duke Power Company	PWR 1280	1982 With CP
Clinch River Project Management Corp.; DOE; TVA	LMFB 350	1983 Under CP Review
Clinton 2 Illinois Power Company	BWR 933	1983 With CP
Davis-Besse 2 & 3 Toledo Edison Company	PWR 906	1981 Under CP Review
Douglas Point 1 & 2 Potomac Electric Power Company	BWR 1146	1977 Under CP Review
Erie 1 & 2 Ohio Edison Company	PWR 1260	1980 Under CP Review

(Continued)

Unit Utility	Con Type MWe per Unit	Canceled Date Status
Forked River 1 Jersey Central Power & Light Company	PWR 1070	1980 With CP
Fort Calhoun 2 Omaha Public Power District	PWR 1136	1977 Under CP Review
Fulton 1 & 2 Philadelphia Electric Company	HTG 1160	1975 Under CP Review
Grand Gulf 2 Entergy Operations, Incorporated	BWR 1250	1990 With CP
Greene County Power Authority of the State of NY	PWR 1191	1980 Under CP Review
Greenwood 2 & 3 Detroit Edison Company	PWR 1200	1980 Under CP Review
Hartsville A1 & A2 Tennessee Valley Authority	BWR 1233	1984 With CP
Hartsville B1 & B2 Tennessee Valley Authority	BWR 1233	1982 With CP
Haven 1 Wisconsin Electric Power Company	PWR 900	1980 Under CP Review
Haven 2 (formerly Koshkonong 2) Wisconsin Electric Power Company	PWR 900	1978 Under CP Review
Hope Creek 2 Public Service Electric & Gas Company	BWR 1067	1981 With CP
Jamesport 1 & 2 Long Island Lighting Company	PWR 1150	1980 With CP
Marble Hill 1 & 2 Public Service of Indiana	PWR 1130	1985 With CP
Midland 1 Consumers Power Company	PWR 492	1986 With CP
Midland 2 Consumers Power Company	PWR 818	1986 With CP
Montague 1 & 2 Northeast Nuclear Energy Company	BWR 1150	1980 Under CP Review
New England 1 & 2 New England Power Company	PWR 1194	1979 Under CP Review

Unit Utility	Con Type MWe per Unit	Canceled Date Status
New Haven 1 & 2 New York State Electric & Gas Corporation	PWR 1250	1980 Under CP Review
North Anna 3 Virginia Electric & Power Company	PWR 907	1982 With CP
North Anna 4 Virginia Electric & Power Company	PWR 907	1980 With CP
North Coast 1 Puerto Rico Water Resources Authority	PWR 583	1978 Under CP Review
Palo Verde 4 & 5 Arizona Public Service Company	PWR 1270	1979 Under CP Review
Pebble Springs 1 & 2 Portland General Electric Company	PWR 1260	1982 Under CP Review
Perkins 1, 2, & 3 Duke Power Company	PWR 1280	1982 Under CP Review
Perry 2 Cleveland Electric Illuminating Co.	BWR 1205	1994 Under CP Review
Phipps Bend 1 & 2 Tennessee Valley Authority	BWR 1220	1982 With CP
Pilgrim 2 Boston Edison Company	PWR 1180	1981 Under CP Review
Pilgrim 3 Boston Edison Company	PWR 1180	1974 Under CP Review
Quanicassee 1 & 2 Consumers Power Company	PWR 1150	1974 Under CP Review
River Bend 2 Gulf States Utilities Company	BWR 934	1984 With CP
Seabrook 2 Public Service Co. of New Hampshire	PWR 1198	1988 With CP
Shearon Harris 2 Carolina Power & Light Company	PWR 900	1983 With CP
Shearon Harris 3 & 4 Carolina Power & Light Company	PWR 900	1981 With CP
Skagit/Hanford 1 & 2 Puget Sound Power & Light Company	PWR 1277	1983 Under CP Review

(Continued)

Appendix C. Canceled U.S. Commercial Nuclear Power Reactors *(Continued)*

Unit Utility	Con Type MWe per Unit	Canceled Date Status
Sterling Rochester Gas & Electric Corporation	PWR 1150	1980 With CP
Summit 1 & 2 Delmarva Power & Light Company	HTG 1200	1975 Under CP Review
Sundesert 1 & 2 San Diego Gas & Electric Company	PWR 974	1978 Under CP Review
Surry 3 & 4 Virginia Electric & Power Company	PWR 882	1977 With CP
Tyrone 1 Northern States Power Company	PWR 1150	1981 Under CP Review
Tyrone 2 Northern States Power Company	PWR 1150	1974 With CP
Vogtle 3 & 4 Georgia Power Company	PWR 1113	1974 With CP
Washington Nuclear 1 Energy Northwest	PWR 1266	1995 With CP
Washington Nuclear 3 Energy Northwest	PWR 1242	1995 With CP
Washington Nuclear 4 Energy Northwest	PWR 1218	1982 With CP
Washington Nuclear 5 Energy Northwest	PWR 1242	1982 With CP
Watts Bar 2 Tennessee Valley Authority	PWR 1165	(1) With CP
Yellow Creek 1 & 2 Tennessee Valley Authority	BWR 1285	1984 With CP
Zimmer 1 Cincinnati Gas & Electric Company	BWR 810	1984 With CP

Note: Cancellation is defined as public announcement of cancellation or written notification to 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
Ameren UE	Callaway
AmerGen Energy Company	Clinton
AmerGen Energy Company	Oyster Creek
AmerGen Energy Company	Three Mile Island 1
Arizona Public Service Company	Palo Verde 1, 2, & 3
Carolina Power & Light	Brunswick 1 & 2
Carolina Power & Light	H. B. Robinson 2
Carolina Power & Light	Shearon Harris 1
Constellation Nuclear	Calvert Cliffs 1 & 2
Constellation Nuclear	Nine Mile Point 1 & 2
Detroit Edison Company	Fermi 2
Dominion Generation	Millstone 2 & 3
Dominion Generation	North Anna 1 & 2
Dominion Generation	Surry 1 & 2
Duke Energy Nuclear, LLC	Catawba 1 & 2
Duke Energy Nuclear, LLC	McGuire 1 & 2
Duke Energy Nuclear, LLC	Oconee 1, 2, & 3
Energy Northwest	Columbia
Entergy Nuclear Generation Company	Pilgrim 1
Entergy Nuclear Generation Company	Arkansas Nuclear 1 & 2
Entergy Nuclear Generation Company	James A. FitzPatrick
Entergy Nuclear Generation Company	Grand Gulf 1
Entergy Nuclear Generation Company	River Bend 1
Entergy Nuclear Generation Company	Vermont Yankee
Entergy Nuclear Generation Company	Waterford 3
Entergy Nuclear Operations, Inc.	Indian Point 2 & 3
Exelon Generation Co., LLC	Braidwood 1 & 2
Exelon Generation Co., LLC	Byron 1 & 2
Exelon Generation Co., LLC	Dresden 2 & 3
Exelon Generation Co., LLC	La Salle County 1 & 2
Exelon Generation Co., LLC	Limerick 1 & 2
Exelon Generation Co., LLC	Peach Bottom 2 & 3
Exelon Generation Co., LLC	Quad Cities 1 & 2
FirstEnergy Nuclear Operating Company	Beaver Valley 1 & 2
FirstEnergy Nuclear Operating Company	Davis-Besse
FirstEnergy Nuclear Operating Company	Perry 1
Florida Power & Light Company	St. Lucie 1 & 2

(Continued)

Utility	Unit
Florida Power & Light Company	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
Nuclear Management Company	Duane Arnold
Nuclear Management Company	Kewaunee
Nuclear Management Company	Monticello
Nuclear Management Co.	Palisades
Nuclear Management Company	Point Beach 1 & 2
Nuclear Management Company	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
PSEG Nuclear, LLC	Salem 1 & 2
Rochester Gas & Electric Corporation	Ginna
South Carolina Electric & Gas Company	Summer
Southern California Edison Company	San Onofre 2 & 3
Southern Nuclear Operating Company	Joseph M. Farley 1 & 2
Southern Nuclear Operating Company	Edwin I. Hatch 1& 2
Southern Nuclear Operating Company	Vogtle 1 & 2
STP Nuclear Operating Company	South Texas Project 1 & 2
Tennessee Valley Authority	Browns Ferry 1, 2, & 3
Tennessee Valley Authority	Sequoyah 1 & 2
Tennessee Valley Authority	Watts Bar 1
TXU Generation Company, LP	Comanche Peak 1 & 2
Wolf Creek Nuclear Operating Corporation	Wolf Creek 1

Source: Nuclear Regulatory Commission

U.S. Nuclear Research and Test Reactors Regulated by NRC

Licensee Location	Reactor Type	OL Issued Docket Number	License Number
Aerotest San Ramon, CA	TRIGA (Indus)	07/02/1965 50-228	R-98
Armed Forces Radiobiology Research Institute Bethesda, MD	TRIGA	06/26/1962 50-170	R-84
Cornell University Ithaca, NY	TRIGA Mark II 01/11/1962	01/11/1962 50-157	R-80
Dow Chemical Company Midland, MI	TRIGA	07/03/1967 50-264	R-108
General Electric Company Sunol, CA	Nuclear Test	10/31/1957 50-73	R-33
Idaho State University Pocatello, ID	AGN-201 #103	10/11/1967 50-284	R-110
Kansas State University Manhattan, KS	TRIGA	10/16/1962 50-188	R-88
Massachusetts Institute of Technology Cambridge, MA	HWR Reflected	06/09/1958 50-20	R-37
University of California/Davis Sacramento, CA	TRIGA	08/13/1998 50-607	R-130
National Institute of Standards & Technology Gaithersburg, MD	Nuclear Test	05/21/1970 50-184	TR-5
North Carolina State University Raleigh, NC	Pulstar	08/25/1972 50-297	R-120
Ohio State University Columbus, OH	Pool	02/24/1961 50-150	R-75
Oregon State University Corvallis, OR	TRIGA Mark II	03/07/1967 50-243	R-106
Pennsylvania State University University Park, PA	TRIGA	07/08/1955 50-5	R-2

(Continued)

Licensee Location	Reactor Type	OL Issued Docket Number	License Number
Purdue University West Lafayette, IN	Lockheed	08/16/1962 50-182	R-87
Reed College Portland, OR	TRIGA Mark I	07/02/1968 50-288	R-112
Rensselaer Polytechnic Institute Troy, NY	Critical Assembly	07/03/1964 50-225	CX-22
Rhode Island Atomic Energy Commission Narragansett, RI	GE Pool	07/23/1964 50-193	R-95
Texas A&M University College Station, TX	AGN-201M #106	08/26/1957 50-59	R-23
Texas A&M University College Station, TX	TRIGA	12/07/1961 50-128	R-128
U.S. Geological Survey Denver, CO	TRIGA Mark I	02/24/1969 50-274	R-113
University of Arizona Tucson, AZ	TRIGA Mark I	12/05/1958 50-113	R-52
University of California/ Irvine Irvine, CA	TRIGA Mark I	11/24/1969 50-326	R-116
University of Florida Gainesville, FL	Argonaut	05/21/1959 50-83	R-56
University of Massachusetts/Lowell Lowell, MA	GE Pool	12/24/1974 50-223	R-125
University of Maryland College Park, MD	TRIGA	10/14/1960 50-166	R-70
University of Michigan Ann Arbor, MI	Pool	09/13/1957 50-2	R-28
University of Missouri/Rolla Rolla, MO	Pool	11/21/1961 50-123	R-79
University of Missouri/Columbia Columbia, MO	Tank	10/11/1966 50-186	R-103

Licensee Location	Reactor Type	OL Issued Docket Number	License Number
University of New Mexico Albuquerque, NM	AGN-201M#112	09/17/1966 50-252	R-102
University of Texas Austin, TX	TRIGA Mark II	01/17/1992 50-602	R-92
University of Utah Salt Lake City, UT	TRIGA Mark I	09/30/1975 50-407	R-126
University of Wisconsin Madison, WI	TRIGA	11/23/1960 50-156	R-74
Veterans Administration Omaha, NE	TRIGA	06/26/1959 50-131	R-57
Washington State University Pullman, WA	TRIGA	03/06/1961 50-27	R-76
Worcester Polytechnic Institute Worcester, MA	GE	12/16/1959 50-134	R-61

Source: Nuclear Regulatory Commission

Appendix F

Research and Test Reactors Under Decommissioning

Licensee Location	Reactor Type OL Issued Power Level (kW)	License Number Docket Number	License Type Shutdown	Decommissioning Alternative Current Status
CBS Corporation Waltz Mill, PA	Tank 6/19/59 20,000	TR-2 50-22	DA 3/25/63	SAFSTOR SAFSTOR
General Atomics San Diego, CA	TRIGA Mark F 7/01/60 1,500	R-67 50-163	DA 9/7/94	DECON DECON
General Atomics San Diego, CA	TRIGA Mark I 5/03/58 250	R-38 50-89	DA 12/17/96	DECON DECON
Georgia Institute of Technology Atlanta, Georgia	Tank 12/29/64	R-97 50-160	DA 7/1/97	DECON DECON
Iowa State University Ames, IA	Argonaut 10/16/62	R-59 50-116	DA 5/15/98	DECON DECON
Manhattan College Riverdale, NY	ZPR 3/24/64 0.0001	R-94 50-199	DA 12/96	SAFSTOR SAFSTOR
University of Illinois Urbana, IL	TRIGA 7/22/69 1,500	R-111 50-151	DA 4/12/99	DECON DECON
University of Washington Seattle, Washington	Argonaut 3/31/61 100	R-73 50-139	DO 6/30/88	DECON DECON
University of Virginia Charlottesville, VA	Pool 9/24/74	R-123 50-396	DA 1/88	DECON DECON
University of Virginia Charlottesville, VA	Pool 6/24/60 2,000	R-66 50-62	DA 6/30/98	DECON DECON
National Aeronautics and Space Administration Sandusky, OH	Test 5/2/62 60,000	TR-3 50-30	DA 7/7/73	DECON DECON
National Aeronautics and Space Administration Sandusky, OH	Mockup 6/14/61 100	R-93 50-185	DA 7/7/73	DECON DECON
Cornell University Ithaca, NY	Tank (ZPR) 12/11/62 0.1	R-89 50-97	POL 2/12/97	(1)

Licensee Location	Reactor Type OL Issued Power Level (kW)	License Number Docket Number	License Type Shutdown	Decommissioning Alternative Current Status
General Electric Company Sunol, CA	GETR (Tank) 1/7/59 50,000	TR-1 50-70	POL 6/26/85	(1)
General Electric Company Sunol, CA	EVESR 11/12/63 17,000	DR-10 50-183	POL 2/1/67	(1)
State University of New York Buffalo, NY	Pulstar 3/24/61 2,000	R-77 50-57	POL 7/23/96	(1)

Note: Decommissioning Order (DO) or Amendment (DA) or with Possession Only Amendment (POL) (no authority to operate the reactor)

(1) Decommissioning alterative and status is not relevant to facility with a POL and not under a DO or DA.

Source: Nuclear Regulatory Commission

NRC Performance Indicators: Annual Industry Averages, Fiscal Years 1990–2002

Indicator	1990	1991	1992	1993	1994	1995
Automatic Scrams	1.61	1.57	1.52	1.18	1.05	1.04
Safety System Actuations	0.99	1.06	0.81	0.81	0.62	0.46
Significant Events	0.45	0.40	0.25	0.26	0.21	0.17
Safety System Failures	3.58	3.44	3.78	3.09	2.32	2.03
Forced Outage Rate	7.60	7.90	8.89	7.79	9.40	6.76
Equipment Forced Outage Rate	0.38	0.36	0.35	0.24	0.26	0.23
Collective Radiation Exposure	320.00	286.00	277.00	244.00	215.00	202.00

Indicator	1996	1997	1998	1999	2000	2001	2002
Automatic Scrams	0.80	0.54	0.48	0.64	0.52	0.57	0.44
Safety System Actuations	0.39	0.35	0.31	0.29	0.29	0.19	0.18
Significant Events	0.08	0.10	0.04	0.03	0.02	0.05	0.04
Safety System Failures	2.89	2.71	2.76	1.67	1.37	0.81	0.86
Forced Outage Rate	7.54	10.21	10.73	5.20	4.24	3.00	1.70
Equipment Forced Outage Rate	0.24	0.24	0.18	0.16	0.13	0.12	0.12
Collective Radiation Exposure	178.00	176.00	140.00	128.00	115.00	123.00	111.00

Source: Licensee data as compiled by the Nuclear Regulatory Commission

Dry Spent Fuel Storage Designs: NRC Approved for General Use

Vendor	Storage Design Model	Certificate of Compliance Issue Date
General Nuclear Systems, Incorporated	CASTOR V/21	08/17/1990
NAC International, Inc.	NAC S/T	08/17/1990
NAC International, Inc.	NAC-C28 S/T	08/17/1990
BNL Fuel Solutions, Corporation	VSC-24	05/03/1993
Holtec International	HI-STAR 100	10/04/1999
Holtec International	HI-STORM 100	05/31/2000
NAC International, Inc.	NAC-MPC	04/10/2000
NAC International, Inc.	NAC-UMS	11/20/2000
Transnuclear, Inc.	TN-24 TN-68 TN-32A and TN-32B NUHOMS-24P NUHOMS-61BT NUHOMS-52B	11/04/1993 05/30/2000 02/20/2001 09/12/2001 09/12/2001 09/12/2001
BNFL Fuel Solutions	Fuel Solutions	02/15/2001

Note: PWR - Pressurized-Water Reactor; BWR - Boiling-Water Reactor

Source: Nuclear Regulatory Commission (10 CFR 72.214), data as of 12/31/2002.

Appendix I

Dry Spent Fuel Storage Licensees

Reactor Name Utility	Date Issued	Vendor	Storage Model
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-I28 CASTOR X/33 MC-10
H. B. Robinson 2 Carolina Power & Light Company	08/13/1986	Transnuclear, Incorporated	NUHOMS-7P
Oconee 1, 2, 3 Duke Energy Company	01/29/1990 Under General License 03/05/1999	Transnuclear, Incorporated	NUHOMS-24P
Fort St. Vrain* Department of Energy	11/04/1991	FW Energy Applications, Incorporated	Modular Vault Dry Store
Calvert Cliffs 1, 2 Calvert Cliffs Nuclear Power Plant	11/25/1992	Transnuclear, Incorporated	NUHOMS-24P
Palisades Nuclear Management Company, LLC	Under General License 05/11/93	BNFL Fuel Solutions	VSC-24
Prairie Island 1, 2 Nuclear Management Company, LLC	10/19/1993	Transnuclear, Incorporated	TN-40
Point Beach 1, 2 Nuclear Management Company, LLC	Under General License 05/26/96	BNFL Fuel Solutions	VSC-24
Davis-Besse First Energy Nuclear Operating Company	Under General License 01/01/96	Transnuclear, Incorporated	NUHOMS-24P
Arkansas Nuclear 1, 2 Entergy Operations, Inc	Under General License 12/17/96	BNFL Fuel Solutions Holtec International	VSC-24 HI-STORM 100
North Anna Virginia Electric & Power Company	06/30/1998	Transnuclear, Incorporated	TN-32
Trojan Portland General Electric Corp	03/31/1999	Holtec International	HI-STORM 100
Department of Energy; TMI-2 Fuel Debris	03/19/1999	Transnuclear, Incorporated	NUHOMS-12T
Susquehana Pennsylvania Power & Light	Under General License 10/18/99	Transnuclear, Incorporated Incorporated	NUHOMS-52B

Reactor Name Utility	Date Issued	Vendor	Storage Model
Peach Bottom 2, 3 Exelon Generating Company	Under General License 06/12/2000	Transnuclear, Incorporated	TN-68
Hatch 1, 2 Southern Nuclear Operating	Under General License 07/06/2000	Holtec International	HI-STAR 100 HI-STORM 100
Dresden 1, 2, 3 Exelon Generating	Under General License 07/10/2000	Holtec International	HI-STAR 100 HI-STORM 100
Rancho Seco Sacramento Municipal Utility District	06/30/2000	Transnuclear, Incorporated	NUHOMS-24 P
McGuire Duke Power	Under General License 02/01/2001	Transnuclear Incorporated	TN-32
Big Rock Point Consumers Energy	Under General License 11/18/02	BNFL Fuel Solutions	Fuel Solutions W74
James A. FitzPatrick Entergy Nuclear Operations, Incorporated	Under General License 04/25/02	Holtec International	HI-STORM 100
Maine Yankee Maine Yankee Atomic Power Company	Under General License 08/24/02	NAC International, Incorporated	NAC-UMS
Columbia Generating Station Energy North West	Under General License 09/02/02	Holtec International	HI-STORM 100
Oyster Creek AmeriGen Energy Company	Under General License 04/11/02	Transnuclear, Incorporated	NUHOMS-61BT
Yankee Rowe Yankee Atomic Electric	Under General License 06/26/02	NAC International, Incorporated	NAC-MPC NAC-STC

*Plant undergoing decommissioning. Transferred to DOE 6/4/99.
Source: Nuclear Regulatory Commission

World List of Nuclear Power Reactors

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
Argentina	2	1,018	1	692	3	1,710
Armenia	1	376	0	0	1	376
Belgium	7	5,680	0	0	7	5,680
Brazil	2	1,901	1	1,275	3	3,176
Bulgaria	4	2,722	0	0	4	2,722
Canada	22	15,113	0	0	22	15,113
China	7	5,426	4	3,338	11	8,764
China, Taiwan	6	4,884	2	2,700	8	7,584
Czech Republic	4	1,648	2	1,962	6	3,610
Finland	4	2,656	0	0	4	2,656
France	59	63,203	0	0	59	63,203
Germany	20	22,594	0	0	20	22,594
Hungary	4	1,755	0	0	4	1,755
India	14	2,548	8	3,580	22	6,128
Iran	0	0	1	915	1	915
Japan	53	44,041	5	4,842	58	48,883
Lithuania	2	2,370	0	0	2	2,370
Mexico	2	1,364	0	0	2	1,364
Netherlands	1	452	0	0	1	452
North Korea	0	0	2	2000	2	2000
Pakistan	2	425	0	0	2	425
Romania	1	655	4	2,480	5	3,135
Russia	27	20,799	6	5,275	33	26,074
Slovakia	6	2,512	2	880	8	3,392
Slovenia	1	656	0	0	1	656
South Africa	2	1,800	0	0	2	1,800
South Korea	18	14,970	4	4,000	22	18,970
Spain	9	7,565	0	0	9	7,565
Sweden	11	9,460	0	0	11	9,460
Switzerland	5	3,220	0	0	5	3,220
Ukraine	13	11,195	5	4,750	18	15,945
United Kingdom	31	11,802	0	0	31	11,802
United States	104	99,034	3	3,603	107	102,637
Total	**444**	**363,844**	**50**	**42,292**	**494**	**406,136**

Note: Operable, under construction or on order (30 MWe and over) or construction halted as of December 31, 2002.

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Nuclear Power Units by Reactor Type, Worldwide

Reactor Type	2002			
	In Operation		Total	
	Number of Units	Net MWe	Number of Units	Net MWe
Pressurized light-water reactors	262	236,236	293	264,169
Boiling light-water reactors	93	81,071	98	87,467
Gas-cooled reactors, all types	30	10,614	30	10,614
Heavy-water reactors, all types	44	22,614	54	27,818
Graphite-moderated light-water reactors	13	12,545	14	13,470
Liquid metal cooled fast-breeder reactors	2	793	5	2,573
Total	**444**	**363,844**	**494**	**406,136**

Note: Operable, under construction, on order (30 MWe and over) as of 12/31/02.

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Appendix L

Top Fifty Reactors by Capacity Factor, Worldwide

Country	Unit	Reactor Type	Vendor	2002 Gross Capacity Factor (Percent)	2002 Gross Generation (MWh)
South Korea	Kori-4	PWR	West	105.97	8,818,928
U.S.	Palo Verde-3	PWR	CE	103.16	11,810,700
South Korea	Yonggwang-2	PWR	West	102.52	8,531,375
U.S.	Limerick-2	BWR	GE	101.56	10,347,300
U.S.	Catawba-2	PWR	West	101.40	10,703,078
U.S.	Braidwood-1	PWR	West	101.25	11,016,414
U.S.	San Onofre-3	PWR	CE	101.22	9,992,601
U.S.	St. Lucie-2	PWR	CE	101.18	7,817,640
U.S.	North Anna-1	PWR	West	100.85	8,578,384
U.S.	Crystal River-3	PWR	B&W	100.75	7,660,500
U.S.	Surry-1	PWR	West	100.67	7,425,221
Japan	Ikata-2	PWR	MHI	100.30	4,973,180
Japan	Kashiwazaki-6	BWR	Toshiba	100.00	11,878,060
Japan	Ohi-3	PWR	MHI	99.99	10,335,700
Japan	Fukushima II-1	BWR	Toshiba	99.94	9,630,107
Japan	Kashiwazaki-4	BWR	Hitachi	99.91	9,627,200
Japan	Fukushima I-5	BWR	Toshiba	99.81	6,854,898
U.S.	Dresden-2	BWR	GE	99.33	7,909,547
U.S.	Shearon-Harris	PWR	West	99.07	8,331,211
South Korea	Wolsong-1	PHWR	AECL	99.07	5,889,887
U.S.	Sequoyah-1	PWR	West	98.98	10,283,509
U.S.	South Texas-1	PWR	West	98.90	11,392,862
Germany	Isar-1	BWR	Siemens	98.51	7,870,476
India.	Kakrapar-1	PHWR	NPC	98.48	1,898,000
U.S.	Pilgrim	BWR	GE.	98.33	5,995,318
U.S.	Indian Point-3	PWR	West	98.23	8,716,670
Spain	Almaraz-2	PWR	West	98.15	8,448,565
Spain	Garona	BWR	GE	97.86	3,994,663
U.S.	Turkey Point-3	PWR	West	97.81	6,512,056
Taiwan	Maanshan-1	PWR	West	97.78	8,152,330
U.S.	Farley-1	PWR	West	97.73	7,602,647

Country	Unit	Reactor Type	Vendor	2002 Gross Capacity Factor (Percent)	2002 Gross Generation (MWh)
U.S.	Oconee-3	PWR	B&W	97.68	7,795,364
Spain	Asco-1	PWR	West	97.67	8,795,650
U.S.	Peach Bottom-3	BWR	GE	97.47	9,895,800
Canada	Darlington-4	PHWR	AECL	97.20	7,961,088
U.S.	Monticello	BWR	GE	97.01	5,211,386
India	Narora-2	PHWR	NPC	96.98	1,869,000
Germany	Emsland	PWR	Siemens	96.72	11,861,836
Finland	Olkiluoto-2	BWR	Asea	96.63	7,364,346
India	Rajasthan-4	PHWR	L&T	96.51	1,860,000
Taiwan	Kuosheng-1	BWR	GE	96.51	8,327,071
South Korea	Kori-3	PWR	West	96.10	7,997,361
Germany	Obrigheim	PWR	Siemens	95.79	2,995,675
U.S.	Susquehanna-2	BWR	GE	95.76	9,621,231
U.S.	Hatch-2	BWR	GE	95.55	7,733,927
U.S.	St.Lucie-1	PWR	CE	95.38	7,286,190
U.S.	Diablo Canyon-2	PWR	West	95.34	9,721,308
Finland	Olkiluoto-1	BWR	Asea	95.29	7,261,880
U.S.	Beaver Valley-1	PWR	West	95.20	7,402,804
U.S.	Kewaunee	PWR	West	95.13	4,691,600

Note: U.S. units believed to belong on this list, but which have not supplied their gross generation, are Entergy's River Bend and Arkansas Nuclear One-2 and Constellation's Calvert Cliffs-2.

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Top Fifty Reactors by Generation, Worldwide

Country	Unit	Reactor Type	Vendor	2002 Gross Generation (MWh)	2002 Gross Capacity Factor (Percent)
Germany	Isar-2	PWR	Siemens	12,165,787	94.16
Germany	Brokdorf	PWR	Siemens	11,921,940	94.51
Japan	Kashiwazaki-6	BWR	Toshiba	11,878,060	100.00
Germany	Emsland	PWR	Siemens	11,861,836	96.72
U.S.	Palo Verde-3	PWR	CE	11,810,700	103.16
Germany	Philippsburg-2	PWR	Siemens	11,650,328	91.22
Germany	Grohnde	PWR	Siemens	11,428,761	91.23
U.S.	South Texas-1	PWR	West.	11,392,862	98.90
France	Cattenom-4	PWR	Fram.	11,106,833	93.09
U.S.	Braidwood-1	PWR	West.	11,016,414	101.25
Germany	Gundremmingen-C	BWR	Siemens.	10,824,976	91.94
Germany	Biblis B	PWR	Siemens	10,744,560	94.35
U.S.	Catawba-2	PWR	West	10,703,078	101.40
U.S.	Palo Verde-2	PWR	CE	10,578,100	92.39
U.S.	Grand Gulf-1	BWR	GE.	10,507,907	91.85
Germany	Gundremmingen-B	BWR	Siemens	10,503,144	89.21
Germany	Neckar-2	PWR	Siemens	10,488,900	87.72
Germany	Grafenrheinfeld	PWR	Siemens	10,432,479	88.54
U.S.	Perry	BWR	GE.	10,394,724	90.51
France	Civauz-1	PWR	Fram	10,367,380	75.82
U.S.	Limerick-2	BWR	GE	10,347,300	101.56
Japan	Ohi-3	PWR	MHI	10,335,700	99.99
U.S.	Sequoyah-1	PWR	West	10,283,509	98.98
France	Golfech-2	PWR	Fram	10,280,007	86.10
U.S.	Palo Verde-1	PWR	CE	10,272,208	89.72
France	Chooz-B2	PWR	Fram.	10,224,250	76.99
U.S.	Catawba-1	PWR	West	9,993,828	94.68
U.S.	San Onofre-3	PWR	CE	9,992,601	101.22

Country	Unit	Reactor Type	Vendor	2002 Gross Generation (MWh)	2002 Gross Capacity Factor (Percent)
France	Belleville-1	PWR	Fram.	9,990,633	83.67
France	Chooz-B1	PWR	Fram.	9,927,757	74.76
U.S.	Peach Bottom-3	PWR	GE	9,895,800	97.47
France	Cattenom-3	PWR	Fram.	9,864,282	82.68
Brazil	Angra-2	PWR	Siemens	9,841,746	83.22
France	Belleville-2	PWR	Fram.	9,763,095	81.77
France	Paluel-4	PWR	Fram.	9,754,011	80.57
U.S.	Braidwood-2	PWR	West	9,751,566	91.97
U.S.	Diablo Canyon-2	PWR	West	9,721,308	95.34
Britain	Sizewell B-1	PWR	West	9,709,000	88.67
U.S.	Fermi-2	BWR	GE	9,707,438	91.21
U.S.	Seabrook	PWR	West	9,674,850	92.50
Switzerland	Leibstadt	BWR	GE	9,635,307	91.66
Japan	Fukushima II-1	BWR	Toshiba	9,630,107	99.94
Japan	Kashiwazaki-4	BWR	Hitachi	9,627,200	99.91
U.S.	Susquehanna-2	BWR	GE	9,621,231	95.76
France	Golfech-1	PWR	Fram.	9,614,997	80.53
U.S.	Limerick-1	BWR	GE	9,600,800	94.24
Japan	Ohi-4	PWR	MHI	9,594,014	92.81
U.S.	Watts Bar-1	PWR	West.	9,507,386	89.70
Japan	Genkai-3	PWR	MHI	9,502,272	91.93
U.S.	Browns Ferry-3	BWR	GE	9,481,620	93.71

Note: U.S. units believed to belong on this list but do not disclose gross generation are Exelon's Byron 1 and 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- and gamma rays)	roentgen (R)	C/kg (coulomb)	0.000 258

*Exact conversion factors

HEAT

Quantity	From Inch-Pound Units	To Metric Units	Multiply by
Thermodynamic temperature	°F	°K	*°K = (°F + 459.67)/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/m3 kg/m3	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
Force	kip (kilopound) lbf	kN (kilonewton) N (newton)	4.448 222 4.448 222

*Exact conversion factors

(Continued)

MECHANICS *(Continued)*

Quantity	From Inch-Pound Units	To Metric Units	Multiply by
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
	ftH_2O (39.2°F)	kPa	2.988 98
	inH_2O (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
	cal_{th}	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 ten 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: The process of safely removing a facility from service followed by 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.

(Continued)

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.

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 that includes 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.

(Continued)

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; enriches it, either by gaseous diffusion or gas centrifuge methods; 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: The 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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RADIOACTIVE WASTE

APPENDICES