U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC

2018–2019 Information Digest

U.S. NRC

2018–2019 Information Digest

NUREG-1350, Volume 30

August 2018

U.S. Nuclear Regulatory Commission
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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 Library at 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 Publishing Office
   Washington, DC 20402-0001
   Internet: bookstore.gpo.gov
   Telephone: (202) 512-1800
   Fax: (202) 512-2104

2. **The National Technical Information Service**
   5301 Shawnee Road
   Alexandria, VA 22312-0002
   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: **U.S. Nuclear Regulatory Commission**
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Facsimile: (301) 415-2289

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Non-NRC Reference Material

Documents available from public and special technical libraries include all open literature items, such as books, journal articles, 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 contractorprepared 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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Washington, DC 20555-0001

www.nrc.gov

NRC

2018–2019

Information Digest

Section Photo Captions:

Section 1: NRC: An Independent Regulatory Agency

1. The Prairie Island nuclear power plant in Minnesota.

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3. An NRC inspector conducts routine inspections of plant equipment to ensure the plant is meeting NRC regulations.

Section 2: Nuclear Energy in the U.S. and Worldwide

1. A satellite photograph captures the sunrise over the Earth.

2. The NRC participates in the annual General Conference for the International Atomic Energy Agency in Vienna, Austria.

3. The United Nations General Assembly meets in New York to discuss, among other topics, world nuclear matters.

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3. A spray pond at the Palo Verde nuclear plant in the middle of the Arizona desert allows the plant to efficiently dispense heat from water used to cool some plant components.

Section 4: Nuclear Materials

1. Physicians use yttrium-90 microspheres to treat liver cancers.

2. A moisture density gauge indicates whether a foundation is suitable for constructing a building or roadway.

3. A worker displays a small ceramic fuel pellet.

Section 5: Radioactive Waste

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2. A transport package is placed inside a conveyance vehicle.

3. A worker inspects a dry cask storage facility.

Section 6: Security and Emergency Preparedness

1. Biometric access control locks within a nuclear facility provide another layer of protection.

2. Barbed wire provides an added layer of security while protecting a nuclear facility from intruders.

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Section 7: Appendices

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2. Permanent removal of a major component as part of the decommissioning process of the Trojan site near Ranier, OR.

3. NRC regulations are contained in Title 10, "Energy," of the Code of Federal Regulations*, Chapter 1, Parts 1 to 199. Not shown is Parts 51 to 199.*

Section 8: Glossary

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2. An icon of the World Wide Web and url address link.

3. A graphical representation of the global reach of the Internet.

Abstract

The U.S. Nuclear Regulatory Commission (NRC) has published the Information Digest annually since 1989. The Information Digest provides information about the agency and the industries it regulates. It describes the agency's responsibilities and activities and provides general information on nuclear-related topics. The Information Digest includes NRC and industry data in an easy-to-read format. Infographics help explain the information with visual aids.

The 2018–2019 Information Digest includes NRC data in the appendices and non-NRC data (e.g., International Atomic Energy Agency, Energy Information Administration, and U.S. Department of Energy data) that were updated as of July 1, 2018, including data associated with maps and graphics. The next Information Digest that will contain updated data will be published in August 2019. The Digest is an annual publication, with updates to certain data every 2 years. The Information Digest will direct readers to the most current information, which is available online.

The NRC reviews the information from industry and international sources but does not independently verify it. The Web Link Index provides sources for more information on major topics. The NRC is the source of all photographs, graphics, and tables unless otherwise noted. All information is final unless otherwise noted. Any corrections and updates will appear in the digital version of the publication on the NRC Web site at *https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1350/*.

The NRC welcomes comments or suggestions on the Information Digest. To submit comments, write to the Office of Public Affairs at U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or at opa.resource@nrc.gov.

NRC resident inspectors perform routine inspection activities to ensure nuclear power plants operate according to NRC regulations.

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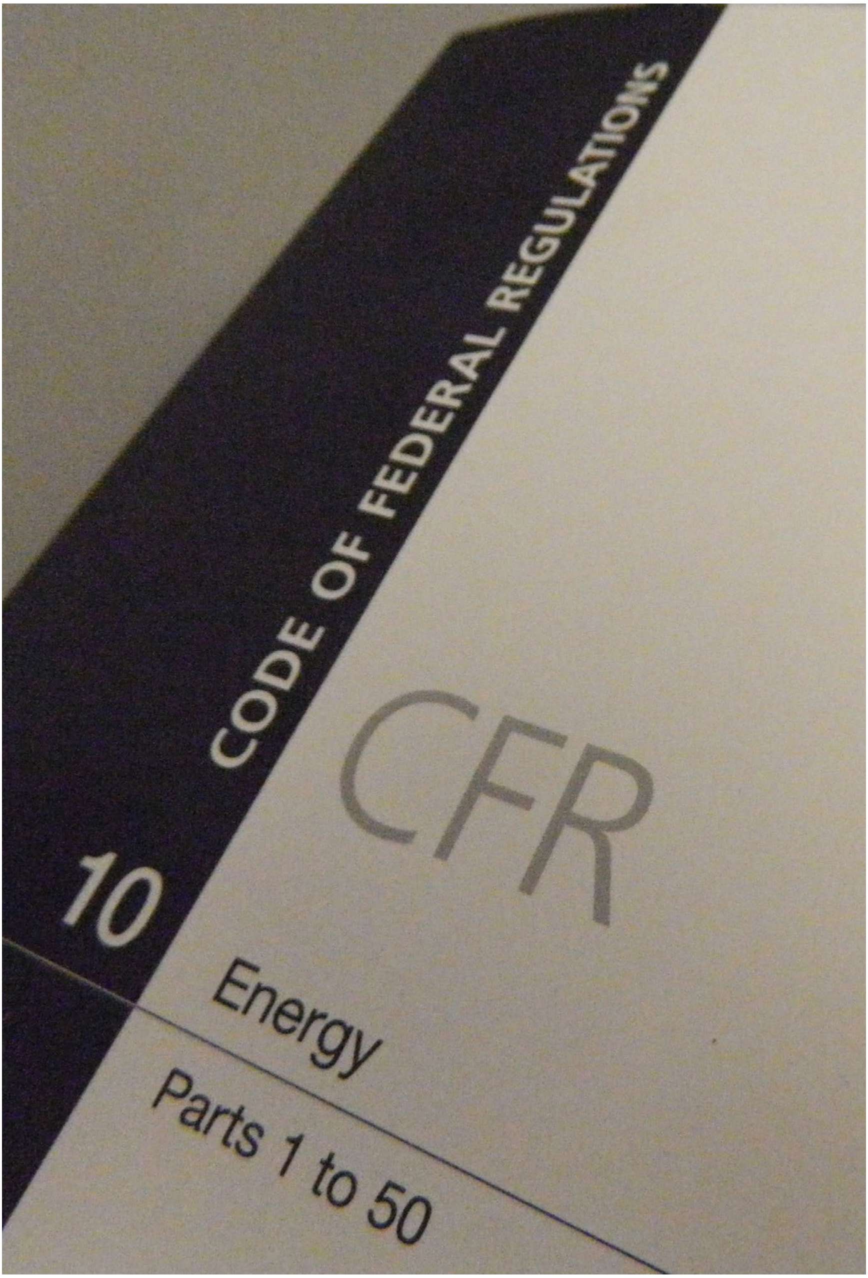

NRC regulations are contained in Title 10, "Energy," of the Code of Federal Regulations, *Chapter 1, Parts 1 to 199. Not shown is Parts 51 to 199.*

Mission Statement

The NRC licenses and regulates the Nation's civilian use of radioactive materials to provide reasonable assurance of adequate protection of public health and safety, and to promote the common defense and security, and to protect the environment.

Commission

Chairman Kristine L. Svinicki	Term ends June 30, 2022
Commissioner Jeff Baran	Term ends June 30, 2023
Commissioner Stephen G. Burns	Term ends June 30, 2019
Commissioner Annie Caputo	Term ends June 30, 2021
Commissioner David A. Wright	Term ends June 30, 2020

Locations

Headquarters:

U.S. Nuclear Regulatory Commission — 301-415-7000, 800-368-5642
Rockville, MD

Regional Offices:

Region I—King of Prussia, PA	610-337-5000, 800-432-1156
Region II—Atlanta, GA	404-997-4000, 800-577-8510
Region III—Lisle, IL	630-829-9500, 800-522-3025
Region IV—Arlington, TX	817-860-8100, 800-952-9677

Headquarters Operations Center:

Rockville, MD — 301-816-5100

The NRC maintains a staffed, 24-hour Operations Center that coordinates incident response with Federal, State, Tribal, and local agencies.

Training and Professional Development:

Technical Training Center, Chattanooga, TN	423-855-6500
Professional Development Center, Rockville, MD	301-287-0556

Resident Sites:

At least two NRC resident inspectors, who report to the appropriate regional office, are located at each nuclear power plant site.

NRC Fiscal Year 2018 Budget

- Total authority: $937 million ($922 million enacted budget with $15 million carryover authority)
- Total authorized staff: 3,186 full-time equivalents
- Estimated fees to be recovered: $790.3 million
- Separate appropriation for the Office of the Inspector General: $12.9 million
- Total research budget: $42 million
  - Reactor Program: $30 million
  - New/Advanced Reactor Licensing: $11 million
  - Materials and Waste: $1 million

What Does the NRC Do?

- Regulation and guidance—rulemaking
- Licensing, decommissioning, and certification
- Oversight and enforcement
- Emergency preparedness and response
- Policymaking
- Research
- Incident response

NRC Governing Legislation

The NRC was established by the Energy Reorganization Act of 1974. The most significant laws that govern the regulatory process of the agency are in Appendix W to this Information Digest. The NRC's regulations are found in Title 10, "Energy," of the Code of Federal Regulations (10 CFR). The text of many laws may be found in NUREG-0980, "Nuclear Regulatory Legislation."

NRC by the Numbers

U.S. Electricity Generated by Commercial Nuclear Power

NRC-licensed nuclear reactors generate about 20 percent of U.S. gross electricity, or about 805 billion kilowatt-hours.

Nuclear Reactors

- 99 commercial nuclear power plants operating in 30 States at 59 sites
  - 65 pressurized-water reactors and 34 boiling-water reactors
- Four reactor fuel vendors
- 23 parent operating companies
- About 80 different designs
- About 6,550 total inspection hours at each operating reactor site in 2017
- Licensees expected to shut down or not seek license renewal include:
  - Oyster Creek (Exelon) plans to shut down in October 2018.
  - Pilgrim Nuclear Power Station (Entergy) will close by end of May 2019.
  - Three Mile Island Unit 1 (Exelon) plans to shut down in September 2019.
  - Davis Besse (FirstEnergy) plans to shut down in May 2020.
  - Perry (FirstEnergy) plans to shut down in May 2021.
  - Indian Point Nuclear Generating Station, Units 2 and 3 (Entergy), will close in 2020 and 2021, respectively.
  - Beaver Valley, Units 1 and 2 (FirstEnergy), will close in May and October 2021, respectively.
  - Palisades Nuclear Plant (Entergy) will close by May 2022.
  - Diablo Canyon, Units 1 and 2 (Pacific Gas & Electric) intends to close by August 2025.

Reactor License Renewal

Commercial power reactor operating licenses are valid for 40 years and may be renewed for additional 20-year terms.

- 13 reactors operate under their original license.
- 89 reactors were issued renewal licenses, including 3 reactors permanently shut down.
- Four sites have license renewal applications in review.
- Three sites have submitted letters of intent to request initial license renewal.
- On February 9, 2018, the license renewal application for Diablo Canyon Units 1 and 2 was withdrawn.

Subsequent License Renewal

This type of licensing would allow plants to operate from 60 to 80 years.

- One site has a subsequent license renewal application in review.
- Three sites have submitted letters of intent to request subsequent license renewal.

Early Site Permits for New Reactors

- Five early site permits (ESPs) were issued and one application docketed:
  - System Energy Resources, Inc., for the Grand Gulf site in Mississippi
  - Exelon Generation Company, LLC, for the Clinton site in Illinois
  - Dominion Nuclear North Anna, LLC, for the North Anna site in Virginia
  - Southern Nuclear Operating Company, for the Vogtle site in Georgia
  - PSEG Power, LLC, and PSEG Nuclear, LLC, for a site in New Jersey
  - The NRC is reviewing one ESP application from the Tennessee Valley Authority (TVA) for two or more small modular reactor (SMR) modules at the Clinch River Nuclear Site in Roane County, TN.

Combined License—Construction and Operating for New Reactors

- Since June 2007, the NRC has received and docketed 18 combined license (COL) applications for 28 new, large light-water reactors.
- The NRC suspended or canceled 10 COL application reviews at the request of the applicants (Bell Bend, PA; Bellefonte, AL; Callaway, MO, Calvert Cliffs, MD; Comanche Peak, TX; Grand Gulf, MS; Nine Mile Point, NY; River Bend, LA; Shearon Harris, NC; and Victoria County Station, TX).
- As of July 1, 2018, the NRC has issued COLs for 14 reactors at Fermi, MI; North Anna, VA; South Texas Project, TX; Turkey Point, FL; V.C. Summer, SC; and Vogtle, GA. On July 31, 2017, South Carolina Electric & Gas (SCE&G) announced plans to cease construction on V.C. Summer nuclear power plant, Units 2 and 3, and requested the NRC withdraw the COLs by letter dated December 27, 2017. By letter dated January 25, 2018, Duke Energy requested termination of the COLs Levy County Units 1 and 2, in Florida. The NRC approved the termination on April 26, 2018. In June 2018, Nuclear Innovation North America submitted a letter requesting that the COLs for South Texas Project, Units 3 and 4, be withdrawn.

Reactor Design Certification

- Five reactor design certifications (DCs) have been issued:
  - General Electric-Hitachi Nuclear Energy's ABWR (Advanced Boiling-Water Reactor)
  - Westinghouse Electric Company's System 80+
  - Westinghouse Electric Company's AP600
  - Westinghouse Electric Company's AP1000
  - General Electric-Hitachi Nuclear Energy's ESBWR (Economic Simplified Boiling-Water Reactor)
- Three DC applications are under review for the APR1400, US-APWR (Advanced Pressurized-Water Reactor) designs, and NuScale designs.
- One DC application for US-EPR (Evolutionary Pressurized-Water Reactor) is suspended at the request of the applicant.
- One DC renewal application is under review for the ABWR design.

Nuclear Research and Test Reactors

- 31 licensed research and test reactors operate in 21 States.

Nuclear Materials

Materials Licensing

- The NRC and the Agreement States have approximately 19,300 licensees for medical, academic, industrial, and general users of nuclear materials.
  - The NRC regulates approximately 2,800 licenses.
  - 37 Agreement States regulate approximately 16,500 licenses.
- Wyoming has submitted a final application and Vermont has submitted a draft application to become Agreement States.
- The NRC issues approximately 1,600 new licenses, renewals, or amendments for existing materials licenses annually. The NRC conducts approximately 900 health, safety, and security inspections of materials licensees each year.

Nuclear Fuel Cycle

- 11 uranium recovery sites are licensed by the NRC:
  - 10 in situ recovery sites
  - One conventional mill in standby status with the potential to restart in the future
- 11 fuel cycle facilities are licensed by the NRC:
  - One uranium hexafluoride conversion facility ("ready-idle" status)
  - Five uranium fuel fabrication facilities
  - Two gas centrifuge uranium enrichment facilities (one operating and one construction pending)
  - One mixed-oxide fuel fabrication facility (under construction and review)
  - One uranium enrichment laser separation facility (construction decision pending)
  - One depleted uranium deconversion facility (construction decision pending)
- The NRC issues about 60 fuel cycle facility licensing actions per year, including amendments; renewals; new licenses; and safety, environmental, and safeguards reviews.

National Source Tracking System

The National Source Tracking System, also known as NSTS, tracks more than 76,000 sources held by about 1,400 NRC and Agreement State licensees. Of those sources, about 52 percent are Category 1 sources and 48 percent are Category 2. The majority are cobalt-60, the most widely used isotope in large sources.

Domestic Safeguards

The NRC and the U.S. Department of Energy use the Nuclear Materials Management and Safeguards System (NMMSS) to track transfers and inventories of source and special nuclear material. Licensees that import and export source material, and licensees that possess foreign-obligated source material, must report transfers and inventories to NMMSS. More than 300 licensees report to the NMMSS database. These licensees verify their inventories on an annual basis through a process of reconciliation that checks their reported transactions against their previous year's ending inventory.

Radioactive Waste

Low-Level Radioactive Waste

- 10 regional compacts
- Four licensed disposal facilities

High-Level Radioactive Waste Management

Spent Nuclear Fuel Storage

- 79 licenses for independent spent fuel storage installations in 34 States:
  - 15 site-specific licenses
  - 64 general licenses

Transportation—Principal Licensing and Inspection Activities

- 1,000 safety inspections of fuel, reactor, and materials licensees are conducted annually.
- 50–70 new, renewed, or amended container-design applications for the transport of nuclear materials are reviewed annually.
- 150 license applications for the import and export of nuclear materials from the United States are reviewed annually.
- More than 3 million packages of radioactive materials are shipped each year in the United States by road, rail, air, or water. This represents less than 1 percent of the Nation's yearly hazardous material shipments.

Decommissioning

Approximately 100 materials licenses are terminated each year. The NRC's decommissioning program focuses on the termination of licenses that are not routine and that require complex activities.

- 20 nuclear power reactors in various stages of decommissioning (DECON or SAFSTOR)
- Four research and test reactors permanently shut down and in various stages of decommissioning
- 13 complex materials sites in various stages of decommissioning
- Two fuel cycle facilities (one partial decommissioning)
- 11 NRC-licensed uranium recovery facilities in various stages of decommissioning

Security and Emergency Preparedness

- Every 2 years, each operating nuclear power plant performs a full-scale emergency preparedness exercise inspected by the NRC and evaluated by the Federal Emergency Management Agency (FEMA).
- Plants conduct additional emergency drills between full-scale exercises to maintain their preparedness and proficiency in responding to emergencies.
- Every 3 years, each nuclear plant undergoes a force-on-force security inspection. These inspections include mock combat drills. The NRC spends about 16,000 hours a year scrutinizing security at nuclear power plants, including 8,000 hours of force-on-force inspections.

Nuclear Reactors

Power Reactors

- Confirmed implementation of post-Fukushima safety enhancements related to the mitigating strategies, spent fuel pool instrumentation, and severe-accident-capable hardened containment vent orders; completed post-Fukushima flood and seismic hazard reevaluation activities for over three-quarters of reactor sites; completed all post-Fukushima activities for approximately one-half of reactor sites
- Completed more than 1,300 licensing actions and other licensing tasks, while also reviewing a number of nuclear power plant license renewal applications
- Issued combined licenses for Turkey Point Units 6 and 7 (FL)
- Continued oversight of construction at two new reactors at Vogtle (GA)
- Completed all required inspection and assessment activities of the Reactor Oversight Process, including initiating four inspections in response to safety-significant events
- Participated in Eagle Horizon 2017 and 2018, a national-level exercise that tested the NRC's ability to relocate senior managers during a Continuity of Operations event
- Continued to conduct force-on-force security inspections at U.S. nuclear power plants, testing licensees' abilities to protect against the design-basis threat
- Executed the first series of full-implementation cyber security inspections
- Published extensive research results on a variety of topics related to operating facility safety, severe accident analysis, improved methods for risk assessment, reliability of examination methods for primary system boundary components, seismic analysis guidelines, and fire phenomena for electrical faults
- Strengthened nuclear safety cooperation through more than 100 active international agreements, including new international partnerships under the recently created Radiation Protection Analysis Program
- Completed the regulatory basis for the proposed Emergency Preparedness for Small Modular Reactors and Other New Technologies rulemaking
- Completed the regulatory basis for the proposed Regulatory Improvements for Power Reactors Transitioning to Decommissioning rulemaking

Nonpower Reactors

- Issued a construction permit for Northwest Medical Isotopes, LLC, for a medical isotope production facility in Missouri
- Issued 10-year renewed research and test reactor (RTR) licenses for GE Hitachi's Vallecitos Nuclear Center, Massachusetts Institute of Technology, and Pennsylvania State University

Materials and Waste

- Issued the Agreement State Policy Statement, which describes the respective roles and responsibilities of the NRC and Agreement States in the administration of programs carried out under Section 274 of the Atomic Energy Act of 1954, as amended
- Completed approximately 1,600 radioactive materials licensing actions
- Completed the acceptance review for the consolidated interim storage facility application from Holtec International, Inc.
- Completed 11 Integrated Materials Performance Evaluation Program reviews of Agreement States, finding all adequate to protect public health and safety
- Finalized a memorandum of understanding with the U.S. National Park Service for coordination of response actions involving radioactive materials at the Great Kills Park site in Staten Island, NY
- Completed a comprehensive revision to the Category I fuel cycle security inspection program, including risk-informing and consolidating the inspection procedures for more efficient implementation
- Delivered to the Commission the draft rule package for Cyber Security at Fuel Cycle Facilities rulemaking in the fall of 2017
- Led an interagency task force effort to develop the 2018 quadrennial report to the President and Congress relating to the security of radiation sources in the U.S.

- Completed an indepth evaluation of the NRC patient release program, which concluded that current regulations are protective of public health and safety
- Completed the modified small quantities protocol rulemaking through a revision of 10 CFR Part 75, "Safeguards on Nuclear Material-Implementation of US/IAEA Agreement"
- Completed all activities involving technical issues associated with Generic Letter 2015-01, "Treatment of Natural Phenomena Hazards in Fuel Cycle Facilities"
- Issued NRC Information Notice 2018-01, "Noble Fission Gas Releases during Spent Fuel Casks Loading Operations"
- Approved a final rule amending requirements for medical uses of radioactive materials (10 CFR Part 35," Medical Use of Byproduct Material"), which included amending the definition of medical events associated with permanent implant brachytherapy, and changes to training and experience requirements for various users
- Deployed a portal called the Licensing Support Network (LSN) library for searching and analyzing 3.69 million discovery documents related to the U.S. Department of Energy's (DOE's) application for authorization to construct a high-level nuclear waste geologic repository at Yucca Mountain, NV
- Provided two public training webinars on the LSN library and multiple short training clips available on the NRC's YouTube channel

Agencywide

- Continued to reprioritize the agency's work, increase efficiency and effectiveness, and improve the ability to adapt to a changing work environment
- Pursued substantial rulemaking activities on topics including decommissioning of nuclear reactors; mitigation of beyond-design-basis events; performance-based emergency core cooling system acceptance criteria; enhanced weapons, firearms background checks, and security event notifications; cyber security for fuel facilities; enhanced security for special nuclear material; low-level radioactive waste disposal; medical use of byproduct material; and the modified small quantities protocol
- Issued the fiscal year (FY) 2018 proposed fee rule, held a public meeting to support stakeholder outreach, and incorporated the comments received into the final fee rule

International Activities

- Continued representing the NRC as part of U.S. delegations, negotiating agreements for civil nuclear cooperation (Section 123 Agreements)
- Participated in various U.S. Government nuclear safety and security initiatives in collaboration with U.S. executive branch agencies through activities such as meetings of the Nuclear Suppliers Group, International Atomic Energy Agency (IAEA) Board of Governors, Group of Seven (G7) Nuclear Safety and Security Group, and Joint Standing Committees on Nuclear Energy Cooperation
- Participated as part of U.S. Government delegations to international meetings addressing implementation of treaties and conventions, including the Sixth Review Meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management and the Treaty on the Non-Proliferation of Nuclear Weapons Preparatory Committee meeting
- Participated in the IAEA Annual Meeting of the Standing Advisory Group on Technical Assistance and Cooperation and International Conference on Nuclear Security
- Supported numerous IAEA regulatory peer review missions, including the Integrated Regulatory Review Service and the International Physical Protection Advisory Service
- Arranged assistance projects for more than 100 countries
- Assisted several countries in creating national registries of radioactive sources and provided ongoing support to countries that developed registries through the NRC's Radiation Sources Regulatory Partnership

- Continued regulatory program development assistance, through the NRC's International Regulatory Development Partnership, for about 30 countries considering or operating civilian nuclear power programs

Administration

- Processed 687 Freedom of Information Act (FOIA) requests and 205 appeals in FY 2017, with 60 FOIA requests and three FOIA appeals in the backlog by the end of FY 2017
- Issued 81 escalated enforcement actions, nine actions involving civil penalties, and 62 escalated notices of violation without a proposed civil penalty
- Closed 96 investigations in FY 2017; in 94 percent (90 investigations), developed sufficient information to reach a conclusion regarding substantiated or unsubstantiated allegations of willful wrongdoing
- Continued to conduct agency outreach to audiences interested in NRC activities, including through the use of social media
- Awarded and maintained a portfolio of more than 610 contracts and interagency agreements with obligations in excess of $290 million in FY 2017
- Received 81 proposals for the Integrated University Program and awarded 46 grants in FY 2017: 16 faculty development, 12 scholarship, 13 fellowship, and five trade school/community college scholarships; awarded $15 million in grants to 34 academic institutions
- Awarded $2.34 million in grants to seven Minority Serving Institutions in FY 2017

Public Meetings and Involvement

- Hosted the annual Regulatory Information Conference, where thousands of participants from around the world discussed the latest technical issues
- Conducted approximately 1,000 public meetings in the Washington, DC, area and around the country addressing a full range of NRC issues
- Conducted 10 full committee meetings of the Advisory Committee on Reactor Safeguards and approximately 40 subcommittee meetings in calendar year 2017
- Held two public meetings of the Advisory Committee on the Medical Uses of Isotopes in calendar year 2017

News and Information

- Continued to use the NRC Web site and free listserv subscription services at *https://www.nrc.gov/public-involve/listserver.html* to post and distribute NRC news releases
- Continued using social media to share information with the public using platforms that address the major categories of social communication, with a focus on social networking and microblogging (Facebook and Twitter)
- Gained more than 900 followers on Twitter and sent approximately 480 tweets; gained nearly 1,300 page likes and published more than 170 posts on Facebook
- Issued 182 news releases in FY 2017

For more information on the agency's accomplishments, go to *https://www.nrc.gov/reading-rm/doc-collections/congress-docs/*.

Contact Us

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License Fee Help Desk
301-415-7554
e-mail: fees.resource@nrc.gov

Mailing Address
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Delivery Address
NRC Storage and Distribution Facility
4934 Bolling Brook Parkway
Rockville, MD 20852

Report a Concern

Emergency

Report an emergency involving a nuclear facility or radioactive materials, including:

- any accident involving a nuclear reactor, nuclear fuel facility, or radioactive materials
- lost or damaged radioactive materials
- any threat, theft, smuggling, vandalism, or terrorist activity involving a nuclear facility or radioactive materials

Call the NRC's 24-Hour
Headquarters Operations Center:
301-816-5100

We accept collect calls. We record all calls to this number.

Non-Emergency

This includes any concern involving a nuclear reactor, nuclear fuel facility, or radioactive materials.

You may send an e-mail to allegations@nrc.gov. However, because e-mail transmission may not be completely secure, if you are concerned about protecting your identity, it is preferable that you contact us by telephone or in person. You may contact any NRC employee (including a resident inspector) or call:

NRC's Toll-Free Safety Hotline:
800-695-7403

Calls to this number are not recorded between the hours of 7 a.m. and 5 p.m. eastern time. However, calls received outside these hours are answered by the Headquarters Operations Center on a recorded line.

Some materials and activities are regulated by Agreement States, and concerns should be directed to the appropriate State radiation control program, which can be found at *https://scp.nrc.gov/allegations.html*.

The NRC's Office of the Inspector General

The Office of the Inspector General (OIG) at the NRC established the OIG Hotline to provide NRC employees, other government employees, licensee and utility employees, contractor employees, and the public with a means of confidentially reporting suspicious activity to OIG concerning fraud, waste, abuse, and employee or management misconduct. Mismanagement of agency programs or danger to public health and safety may also be reported through the hotline.

It is not OIG policy to attempt to identify people contacting the OIG Hotline. People may contact OIG by telephone, through an online form, or by mail. There is no caller identification feature associated with the hotline or any other telephone line in the Inspector General's office. No identifying information is captured when you submit an online form. You may provide your name, address, or telephone number, if you wish.

Call the OIG Hotline:
800-233-3497, TDD: 800-270-2787
7 a.m.–4 p.m. (eastern time)
After hours, please leave a message.

NRC

NRC: AN INDEPENDENT REGULATORY AGENCY

About the NRC

The U.S. Nuclear Regulatory Commission (NRC) is an independent agency created by Congress. The NRC regulates the Nation's civilian commercial, industrial, academic, and medical uses of nuclear materials.

The NRC's scope of responsibility includes regulating commercial nuclear power plants; research and test reactors; nuclear fuel cycle facilities; medical, academic, and industrial uses of radioactive materials; the decommissioning of licensed facilities and sites; and the transport, storage, and disposal of radioactive materials and wastes. The agency issues licenses for and oversees the use of radioactive materials and certifies nuclear reactor designs, spent fuel storage casks and transportation packages. The agency also licenses the import and export of radioactive materials and works closely with its international counterparts to enhance nuclear safety and security worldwide. To fulfill its responsibilities, the NRC performs five principal regulatory functions, as seen in Figure 1. How We Regulate.

Mission Statement

The NRC licenses and regulates the Nation's civilian use of radioactive materials to provide reasonable assurance of adequate protection of public health and safety, and to promote the common defense and security, and to protect the environment.

Vision

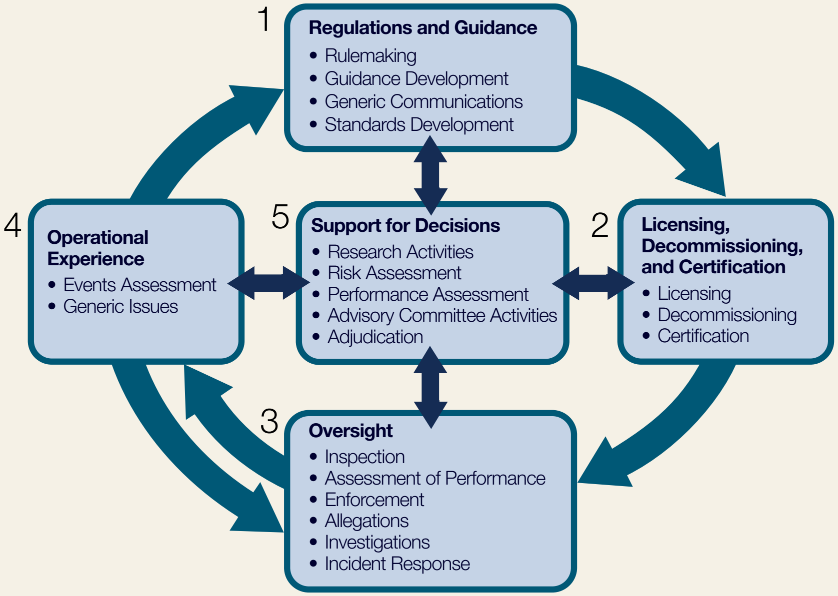
Demonstrate the Principles of Good Regulation in performing our mission.

To be successful, the NRC must not only excel in carrying out its mission but must do so in a manner that engenders the trust of the public and stakeholders. The Principles of Good Regulation—independence, openness, efficiency, clarity, and reliability—guide the agency. They affect how the NRC reaches decisions on safety, security, and the environment; how the NRC performs administrative tasks; and how its employees interact with each other as well as external stakeholders. By adhering to these principles and values, the NRC maintains its regulatory competence, conveys that competence to stakeholders, and promotes trust in the agency. The agency puts these principles into practice with effective, realistic, and timely actions.

Principles of Good Regulation

Independence:	*Nothing but the highest possible standards of ethical performance and professionalism should influence regulation.*
Openness:	*Nuclear regulation is the public's business, and it must be transacted publicly and candidly.*
Efficiency:	*The highest technical and managerial competence is required and must be a constant agency goal.*
Clarity:	*Regulations should be coherent, logical, and practical. Agency positions should be readily understood and easily applied.*
Reliability:	*Regulations should be based on the best available knowledge from research and operational experience.*

Figure 1. How We Regulate



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

Strategic Goals

Safety: Ensure the safe use of radioactive materials.

Security: Ensure the secure use of radioactive materials.

Statutory Authority

The Energy Reorganization Act of 1974 created the NRC from a portion of the former Atomic Energy Commission. The new agency was to independently oversee—but not promote—the commercial nuclear industry so the United States could benefit from the use of radioactive materials while also protecting people and the environment. The agency began operations on January 18, 1975. The NRC's regulations can be found in Title 10, "Energy," of the *Code of Federal Regulations* (10 CFR). The principal statutory authorities that govern the NRC's work can be found on the NRC's Web site (see the Web Link Index for more information).

The NRC, its licensees (those licensed by the NRC to use radioactive materials), and the Agreement States (States that assume regulatory authority over certain nuclear materials) share responsibility for protecting public health and safety and the environment. Federal regulations and the NRC's regulatory program play a key role. Ultimately, however, the licensees bear the primary responsibility for safely handling and using radioactive materials.

See the complete list of the NRC's authorizing legislation in Appendix W.

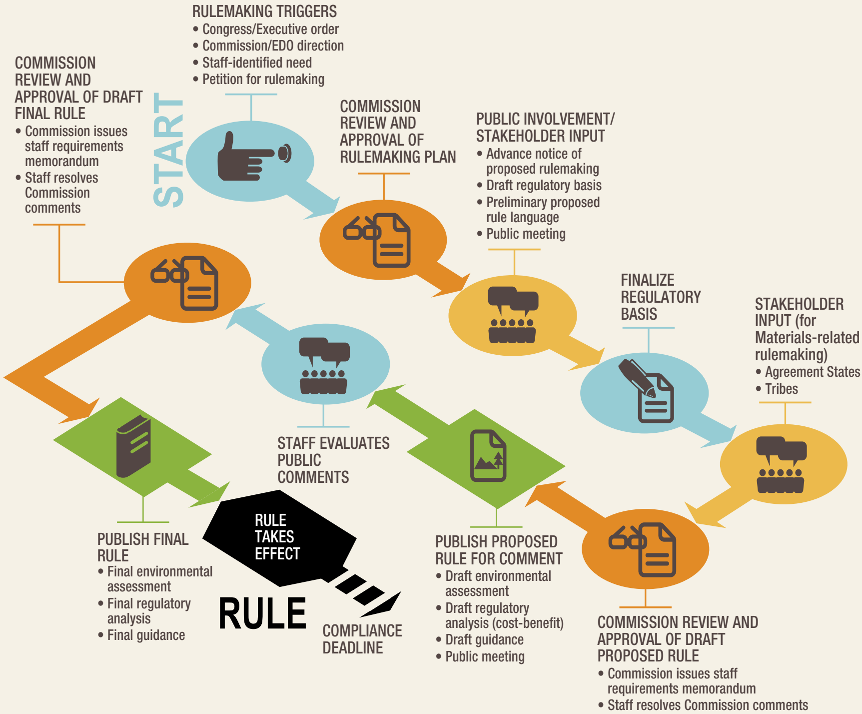
Major Activities

The NRC fulfills its responsibilities by doing the following:

- licensing the design, construction, operation, and decommissioning of commercial nuclear power plants and other nuclear facilities
- licensing the possession, use, processing, handling, exporting, and importing of nuclear materials
- licensing the siting, design, construction, operation, and closure of low-level radioactive waste (LLW) disposal sites in States under NRC jurisdiction
- certifying the design, construction, and operation of commercial transportation casks
- licensing the design, construction, and operation of spent fuel storage casks and interim storage facilities for spent fuel and high-level radioactive waste

- licensing nuclear reactor operators
- licensing uranium enrichment facilities
- conducting research to develop regulations and to anticipate potential reactor and other nuclear facility safety issues
- collecting, analyzing, and disseminating information about the safe operation of commercial nuclear power reactors and certain nonreactor activities
- issuing safety and security regulations, policies, goals, and orders that govern nuclear activities
- interacting with other Federal agencies, foreign governments, and international organizations on safety and security issues
- conducting criminal, civil, and administrative investigations of alleged violations by NRC licensees
- inspecting NRC licensees to ensure adequate performance of safety and security programs
- enforcing NRC regulations and the conditions of NRC licenses and imposing, when necessary, civil sanctions and penalties
- conducting public hearings on nuclear and radiological safety and security and on environmental concerns
- implementing international legal commitments made by the U.S. Government in treaties and conventions
- developing effective working relationships with State and Tribal governments
- maintaining an effective incident response program and overseeing required emergency response activities at NRC-licensed facilities
- implementing lessons learned from the March 2011 nuclear accident in Japan to enhance safety at U.S. commercial nuclear facilities
- involving the public in the regulatory process through meetings, conferences, and workshops; providing opportunities for commenting on proposed new regulations, petitions, guidance documents, and technical reports; providing ways to report safety concerns; and providing documents under the Freedom of Information Act and through the NRC's Web site (see Figure 2. A Typical Rulemaking Process)
- engaging and informing the public through social media platforms and by providing interactive, high-value data sets (data in a form that allows members of the public to search, filter, or repackage information)

Figure 2. A Typical Rulemaking Process



The process of developing regulations is called rulemaking. The NRC initiates a new rule or a change to an existing rule when there is a need to do so to protect public health and safety. Additionally, any member of the public may petition the NRC to develop, change, or rescind a rule. The Commission directs the staff to begin work on a new rulemaking activity through approval of a staff rulemaking plan.

Proposed Rules

NRC regulations (rules) provide licensees with requirements that, if met, will result in the adequate protection of workers, the public, and the environment. The impetus for a proposed rule could be a direction from the Commission to the NRC staff or a petition for rulemaking submitted by a member of the public. Each proposed rule that involves significant matters of policy is sent to the NRC Commission for approval.

If approved, the proposed rule is published in the Federal Register *and usually contains the following items:*

1. *the background information about the proposed rule*
2. *an address for submitting comments*
3. *the date by which comments should be received in order to ensure consideration by the staff*
4. *an explanation indicating why the rule change is thought to be needed*
5. *the proposed text to be changed*

Usually, the public is given 75 to 90 days to provide written comments. Not all rules are issued for public comment. Generally, those excepted from public comment concern agency organization, procedure, or practice; are interpretive rules (e.g., guidance interpreting current regulations); or are rules for which delaying their publication to receive comments would be contrary to the public interest and impracticable.

Final Rules

Once the public comment period has closed, the staff analyzes the comments, makes any needed changes, and prepares a draft final rule for Commission approval. Once approved, the final rule is published in the Federal Register *and usually becomes effective 30 days later.*

Direct Final Rulemakings

When appropriate, the NRC can shorten the traditional rulemaking process by using a direct final rulemaking process. This process is only used for regulatory changes that the NRC believes are noncontroversial.

Advance Notice of Proposed Rulemakings

For especially important or complex rules, the NRC may publish an advance notice of proposed rulemaking and conduct one or more public meetings. The notice requests public comment well in advance of the proposed rulemaking stage. The notice describes the need for the proposed action but discusses only broad concepts.

Rulemaking Information

The public can access a centralized, Web-based tracking and reporting system, which provides real-time updates on all NRC rulemaking activities on the NRC Web site at https://www.nrc.gov/about-nrc/regulatory/rulemaking/rules-petitions.html.

Organizations and Functions

The NRC's Commission has five members nominated by the President of the United States and confirmed by the U.S. Senate for 5-year terms. The members' terms are staggered so one Commissioner's term expires on June 30 of each year. The President designates one member to serve as Chairman. The Chairman is the principal executive officer and spokesperson of the agency. No more than three Commissioners can belong to the same political party. The Commission as a whole formulates policies and regulations governing the safety and security of nuclear reactors and materials, issues orders to licensees, and adjudicates legal matters brought before it. The Executive Director for Operations carries out the policies and decisions of the Commission and directs the activities of the program and regional offices (see Figure 3. NRC Organizational Chart).

Commissioner Term Expiration*

Kristine L. Svinicki
Chairman
June 30, 2022

Jeff Baran
June 30, 2023

Stephen G. Burns
June 30, 2019

Annie Caputo
June 30, 2021

David A. Wright
June 30, 2020

** Commissioners listed by seniority.*

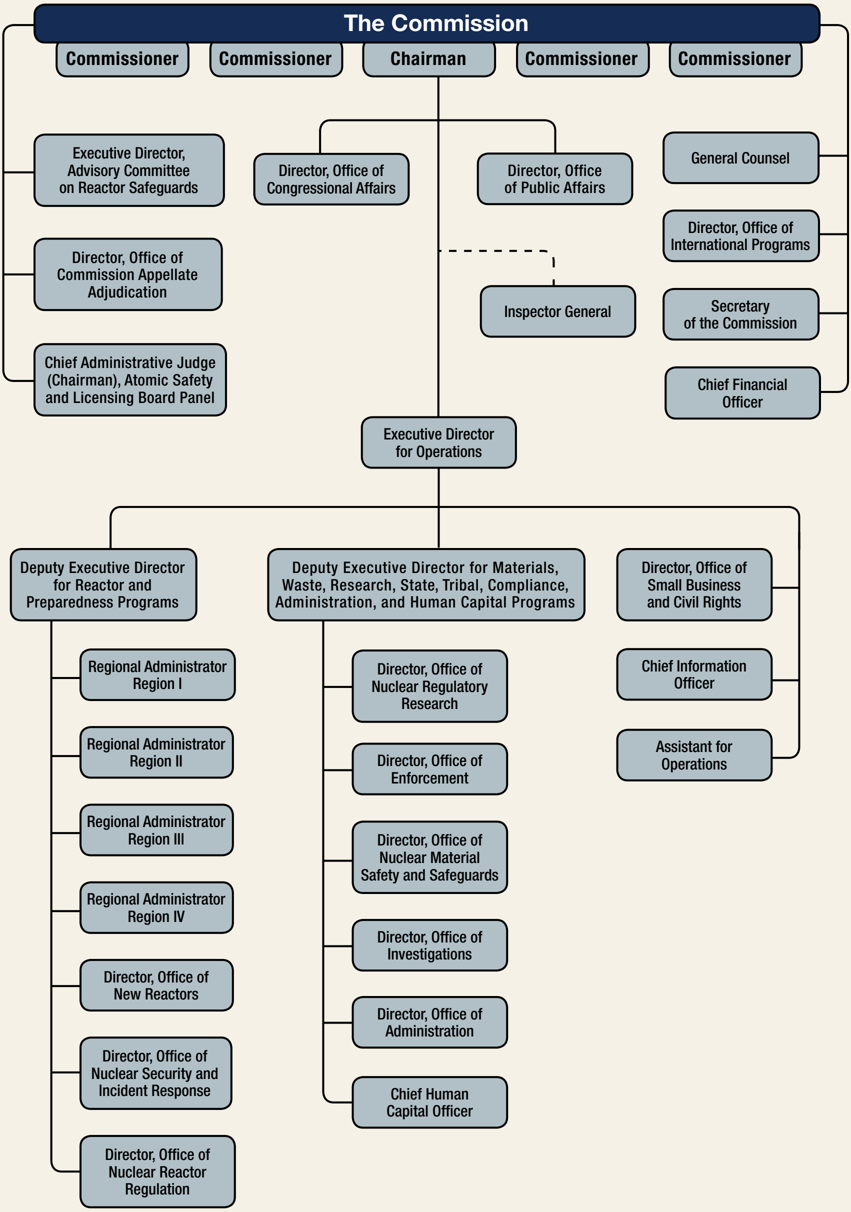
The NRC is headquartered in Rockville, MD, and has four regional offices. They are located in King of Prussia, PA; Atlanta, GA; Lisle, IL; and Arlington, TX. The NRC's corporate offices provide centrally managed activities necessary for agency programs to operate and achieve goals. Corporate support is needed for a succesful regulatory program. The NRC has the following major program offices:

The **Office of Nuclear Reactor Regulation** handles all licensing and inspection activities for existing nuclear power reactors and research and test reactors.

The **Office of New Reactors** oversees the design, siting, licensing, and construction of new commercial nuclear power reactors.

The **Office of Nuclear Regulatory Research** provides independent expertise and information for making timely regulatory judgments, anticipating potentially significant safety problems, and resolving safety issues. It helps develop technical regulations and standards and collects, analyzes, and disseminates information about the safety of commercial nuclear power plants and certain nuclear materials activities.

Figure 3. NRC Organizational Chart



Note: For the most recent information, go to the NRC Organization Chart at *https://www.nrc.gov/about-nrc/organization.html* .

The **Office of Nuclear Material Safety and Safeguards** regulates the production of commercial nuclear fuel; uranium-recovery activities; decommissioning of nuclear facilities; and the use of radioactive materials in medical, industrial, academic, and commercial applications. It regulates safe storage, transportation, and disposal of low- and high-level radioactive waste and spent nuclear fuel. The office also works with other Federal agencies, States, and Tribal and local governments on regulatory matters.

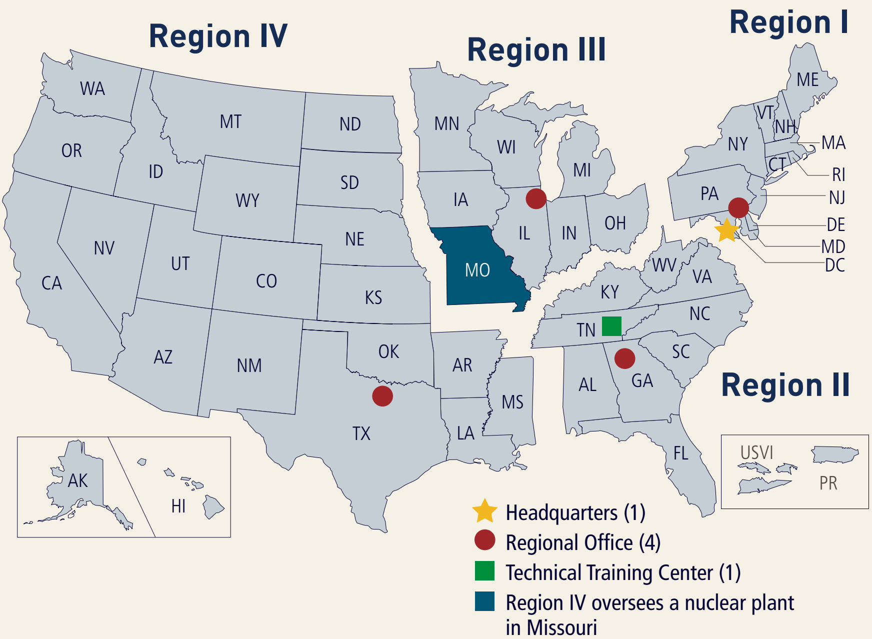
The **Office of Nuclear Security and Incident Response** initiates and oversees the implementation of agency security policy for nuclear facilities and users of radioactive material and coordinates with other Federal agencies and international organizations on security issues. This office also maintains the NRC's emergency preparedness and incident response programs.

The NRC **regional offices** conduct inspections and investigations, take enforcement actions (in coordination with the Office of Enforcement), and maintain incident response programs for nuclear reactors, fuel facilities, and materials licensees. In addition, the regional offices carry out licensing for certain materials licensees (see Figure 4. NRC Regions).

The **advisory committees,** including the Advisory Committee on Reactor Safeguards (ACRS) and the Advisory Committee on the Medical Uses of Isotopes (ACMUI), are independent of the NRC staff. The ACRS reports directly to the Commission, which appoints its members. The advisory committees are structured to provide a forum where experts representing many technical perspectives can provide independent advice that is factored into the Commission's decision-making process. Most committee meetings are open to the public, and any member of the public may request an opportunity to make an oral statement during committee meetings.

The NRC Headquarters complex is located in Rockville, MD.

Figure 4. NRC Regions



Nuclear Power Plants

- Each regional office oversees the plants in its region—except for the Callaway plant in Missouri, which Region IV oversees.

Materials Licensees

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

Nuclear Fuel Processing Facilities

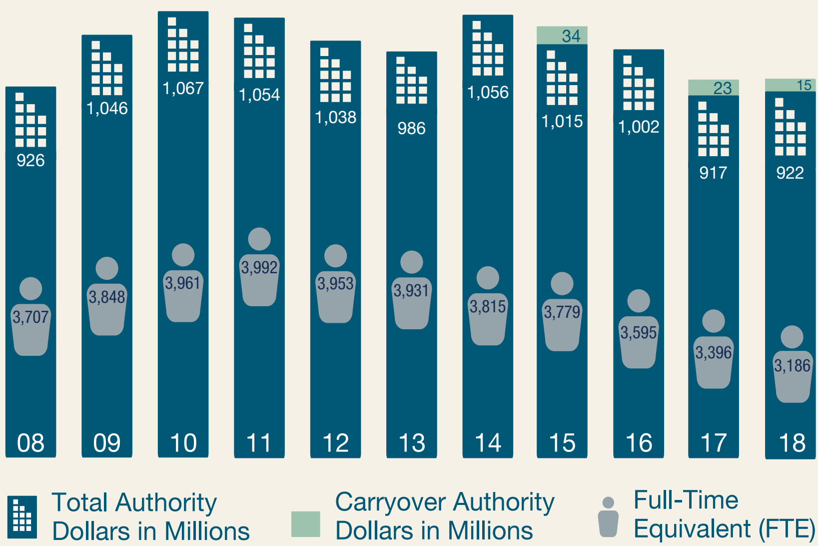
- Region II oversees all the fuel processing facilities in all regions.
- Region II also handles all construction inspection activities for new nuclear power plants and fuel cycle facilities in all regions.

Fiscal Year 2018 Budget

For fiscal year (FY) 2018 (October 1, 2017, through September 30, 2018), the NRC's budget is $922 million. The NRC has 3,186 full-time equivalents (FTE) in FY 2018; this includes the Office of the Inspector General (see Figure 5. NRC Total Authority, FYs 2008–2018). The Office of the Inspector General received its own appropriation of $12.9 million. This amount is included in the total NRC budget.

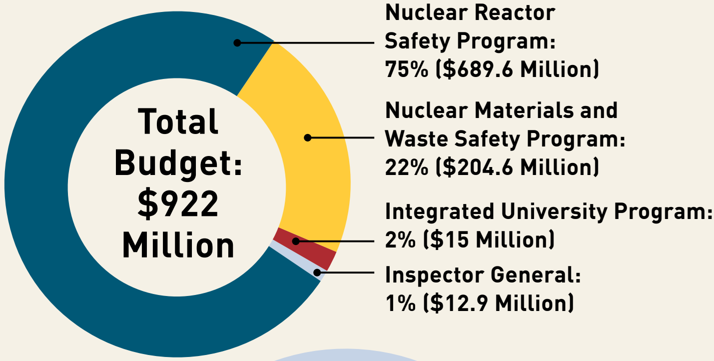
The breakdown of the budget is shown in Figure 6. NRC FY 2018 Distribution of Enacted Budget Authority; Recovery of NRC Budget. By law, the NRC must recover, through fees billed to licensees, approximately 90 percent of its budget authority, less the amounts appropriated from general funds for Waste-Incidental-to-Reprocessing activities, Generic Homeland Security activities, Defense Nuclear Facilities Safety Board activities, and Advanced Reactors Regulatory Readiness activities. The NRC collects fees each year by September 30 and transfers them to the U.S. Treasury. The agency estimates that it will recover $790.3 million in fees in FY 2018.

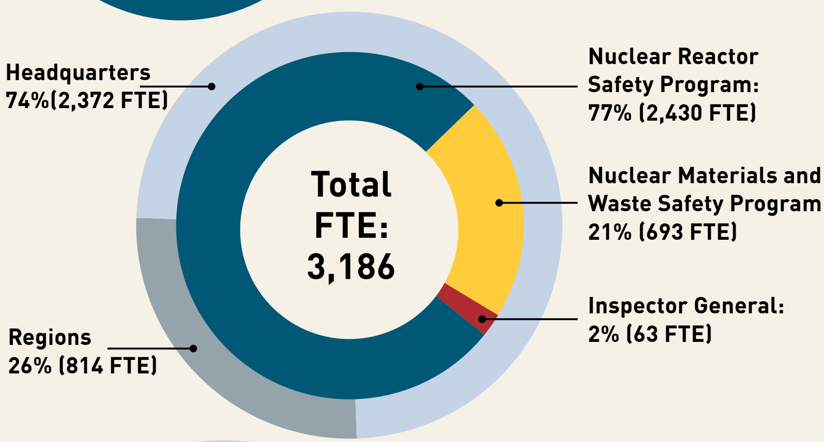
Figure 5. NRC Total Authority, FYs 2008–2018

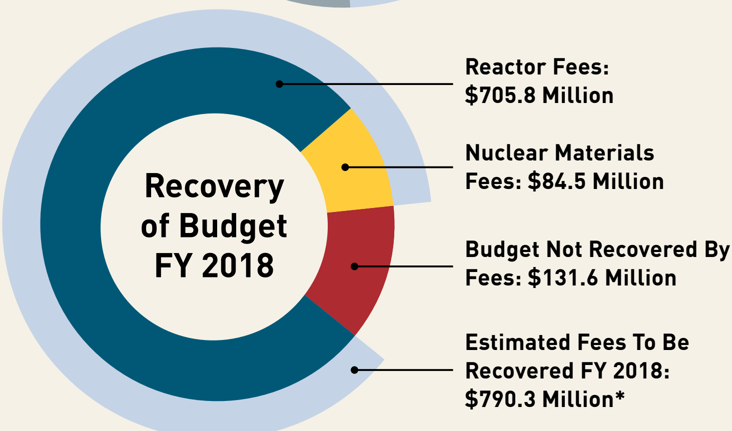


Note: Dollars are rounded to the nearest million.

Figure 6. NRC FY 2018 Distribution of Enacted Budget Authority; Recovery of NRC Budget







* Recovered fees do not include the use of prior year carryover where fees were previously collected.
Notes: The NRC incorporates corporate and administrative costs proportionately within programs. Numbers are rounded. Enacted budget for FY 2018.

NUCLEAR ENERGY IN THE U.S. AND WORLDWIDE

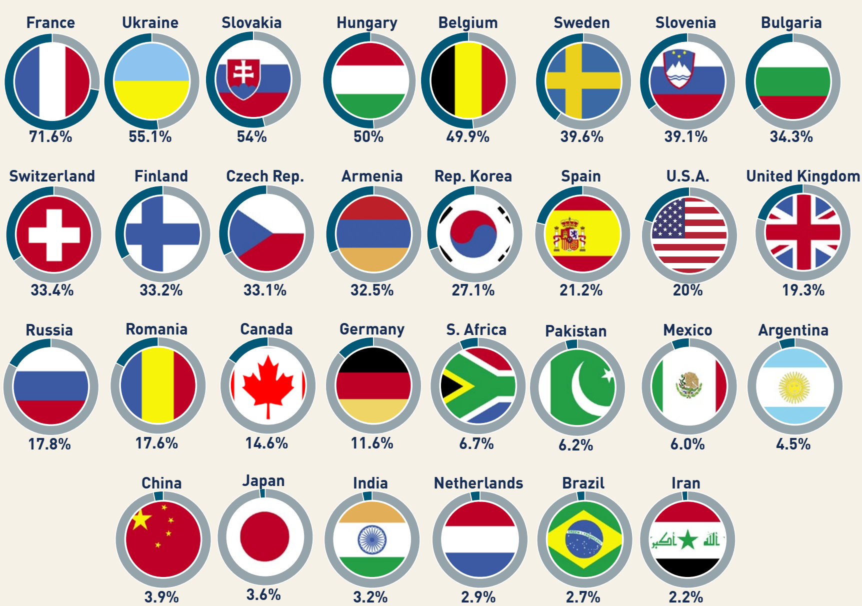
Worldwide Electricity Generated by Commercial Nuclear Power

Nuclear reactor technology was first developed in the 1940s initially for producing weapons, but President Dwight D. Eisenhower's Atoms for Peace program shifted the focus to power generation, scientific research, and the production of medical and industrial isotopes. Today, nuclear technology is global, and nuclear-generated power is a part of the worldwide energy portfolio.

As of May 2018, there were 450 operating reactors in 30 countries with a total installed capacity of 393,843 megawatts electric (MWe). In addition, 58 reactors were under construction. Based on preliminary data from 2017, France had the highest portion (71.6 percent) of total domestic energy generated by nuclear power (Figure 7. Nuclear Share of Electricity Generated by Country).

See Appendix R for the number of nuclear power reactor units by nation and Appendix S for nuclear power reactor units by reactor type, worldwide.

Figure 7. Nuclear Share of Electricity Generated by Country



Note: Each country's short-form name is used.
Source: IAEA, Power Reactor Information System database, as of May 2018

In addition to generating electricity, nuclear materials and technology are used worldwide for many other peaceful purposes, such as:

- Radioactive isotopes help diagnose and treat medical conditions.
- Irradiation makes food safer and last longer and assists in making pest-resistant seed varieties with higher yields.
- Nuclear gauges maintain quality control in industry.
- Radioactive isotopes date objects and identify elements.

The NRC engages in international activities to exchange regulatory information related to the safe and secure civilian use of nuclear materials and technologies.

International Activities

The NRC's international activities support the agency's domestic mission, as well as broader U.S. domestic and international interests. They are wide ranging and address these issues:

See Appendices X, Y, and Z for lists of international activities.

- convention and treaty implementation
- nuclear nonproliferation
- export and import licensing for nuclear materials and equipment
- international safeguards support and assistance
- international safety and security cooperation and assistance
- international safety and security information exchanges
- cooperative safety research
- physical protection
- emergency notification and assistance
- liability

The NRC works with multinational organizations, such as the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA) and bilaterally with regulators in other countries through cooperation and research agreements. These interactions allow the NRC to share and learn the best regulatory safety and security practices. In addition, joint research projects give the NRC access to research facilities not available in the United States.

The NRC also works with other U.S. agencies to implement conventions and treaties by participating in interagency groups devoted to establishing and enforcing rules, regulations, and policies.

Conventions and Treaties

All countries that ratify nuclear-related conventions and treaties must take actions to implement them. Their actions help ensure high levels of safety and security.

For example, the NRC actively participates in and provides leadership for the implementation of the Convention on Nuclear Safety (CNS). The objectives of the Convention are to maintain a high level of nuclear safety worldwide, to prevent accidents with radiological consequences, and to mitigate such consequences should they occur. The Convention is an important part of the evolving global nuclear safety regime.

See Appendix X for a list of conventions and treaties and Appendix Z for a list of export and import licenses.

In addition, the NRC actively participates in and supports the implementation of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The Joint Convention establishes an international peer review process and provides incentives for nations to take appropriate steps to bring their nuclear activities into compliance with general safety standards and practices. Both the CNS and the Joint Convention are important parts of the evolving global nuclear safety regime.

Other examples include the NRC's international cooperation and assistance activities, as well as import and export licensing of nuclear materials and equipment. These activities fulfill obligations undertaken according to Articles II, III, and IV of the Treaty on the Non-Proliferation of Nuclear Weapons, which, for instance, gives all parties to the Treaty the right to participate in the fullest possible exchange of equipment, materials, and scientific and technological information for the peaceful uses of nuclear energy.

Export and Import Licensing

The NRC reviews applications to license exports and imports of nuclear materials and equipment to determine that such exports and imports will be in the best interest of the United States and will be consistent with agreements for the peaceful use of nuclear materials (Section 123 Agreements). The NRC's export and import regulations are found in 10 CFR Part 110, "Export and Import of Nuclear Equipment and Material."

The NRC participates in meetings of the Nuclear Suppliers Group and the Code of Conduct on the Safety and Security of Radioactive Sources (see the Web Link Index for the Code of Conduct) to ensure that U.S. export and import controls are appropriate.

Bilateral Cooperation and Assistance

The NRC has information-sharing agreements with other countries, as well as Taiwan and the European Atomic Energy Community (see Appendix X for the list of bilateral information exchange and cooperation agreements with the NRC).

Cooperation

There are a wide range of programs that enhance the safety and security of peaceful nuclear activities worldwide. With countries that have mature nuclear power or radioactive materials programs, the NRC focuses on sharing information and best practices. With countries that have new programs, the NRC focuses on helping develop and improve their regulatory activities.

See Appendix Y for a list of multilateral organizations in which the NRC participates.

Some of the benefits of consulting with other countries include:

- awareness of reactor construction activities that could apply to new reactors being built in the United States
- prompt notification to foreign partners of U.S. safety issues
- sharing of safety and security information

Assistance

The NRC offers bilateral training, workshops, and peer reviews of regulatory documents to assist more than 60 countries as they develop or enhance their national nuclear regulatory infrastructures and programs. The NRC also supports and participates in regional working group meetings to exchange technical information among specialists. If asked, the NRC will respond directly to countries looking for help to improve their controls of radioactive material.

Photo courtesy of IAEA

The NRC participates in the annual General Conference for the International Atomic Energy Agency in Vienna, Austria.

Foreign Assignee Program

The NRC provides on-the-job training to foreign nationals at NRC Headquarters and the regional offices. The NRC's Foreign Assignee Program allows the NRC staff to exchange information with regulators from around the world. This helps both organizations better understand each other's regulatory programs, capabilities, and commitments. It also helps to enhance the expertise of both foreign assignees and the NRC staff. The program also fosters relationships between the NRC and key officials in other countries. Since its inception in 1975, the NRC has hosted more than 400 foreign assignees.

Foreign Trainee Program

The NRC provides opportunities for engineers, scientists, and regulatory personnel from other countries to attend NRC training courses at the Technical Training Center. On a regular basis, some two dozen regulatory staff members from other countries attend NRC training courses.

Multilateral Cooperation and Assistance

The NRC plays an active role in the different programs and committee work of global organizations. The agency works with multiple regulatory counterparts through IAEA, OECD/NEA, and other multilateral organizations on issues related to:

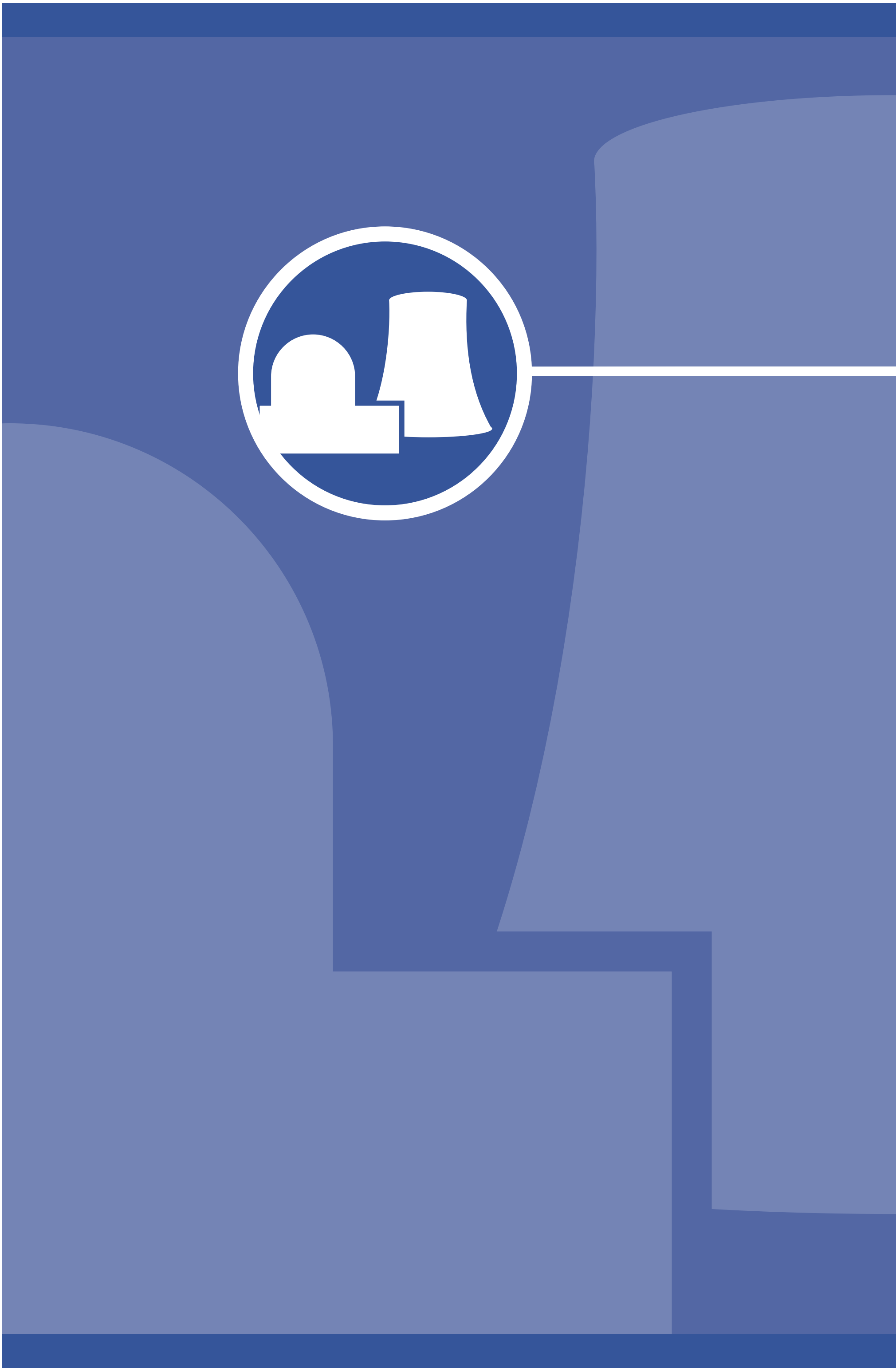
- safety research and development of standards
- radiation protection
- risk assessment
- emergency preparedness
- waste management
- transportation
- safeguards, physical protection, and security
- technical assistance
- training, communications, and public outreach

International Cooperative Research

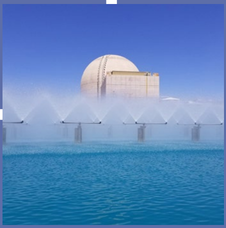
The NRC participates in international cooperative research programs to share U.S. operating experience and to learn from the experiences of other countries. The NRC also participates in international efforts to improve the security of radioactive materials and the management of radioactive waste.

The NRC participates in cooperative research programs with many countries and organizations. This helps leverage access to foreign research data and test facilities otherwise unavailable to the United States.

The United Nations General Assembly meets in New York to discuss, among other topics, world nuclear matters.



NUCLEAR REACTORS



U.S. Electricity Generated by Commercial Nuclear Power

In 2017, NRC-licensed nuclear reactors generated 20 percent of U.S. gross electricity, or about 805 billion kilowatt-hours (see Figure 8. U.S. Gross Electric Generation by Energy Source, 2017, and Figure 9. U.S. Electric Share and Generation by Energy Source, 2012–2017).

Since the 1970s, the Nation's utilities have asked permission to generate more electricity from existing nuclear plants. The NRC regulates how much heat a commercial nuclear reactor may generate. This amount of heat, or power level, is used with other data in many analyses that demonstrate the safety of the nuclear power plant. This power level is included in the plant's license and technical specifications. The NRC must review and approve any licensee's requested change to a license or technical specification. Increasing a commercial nuclear power plant's maximum operational power level is called a power uprate.

The NRC has approved power uprates that have collectively added the equivalent of seven new reactors' worth of electrical generation to the power grid. The NRC expects a few more power uprate applications through 2018.

See Glossary for information on the electric power grid.

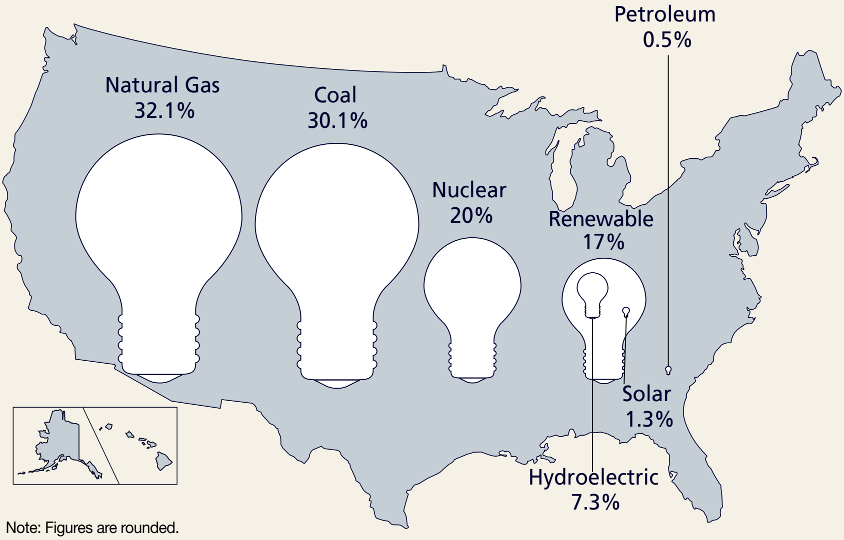
According to the U.S. Energy Information Administration (EIA), in 2017, each of the following States generated more than 40,000 thousand megawatt-hours of electricity from nuclear power: Illinois, Pennsylvania, South Carolina, Alabama, North Carolina, and New York. Illinois ranked first in the Nation in both generating capacity and net electricity generation from nuclear power. Illinois nuclear power plants accounted for 12 percent of the Nation's nuclear power generation. The 2017 data cited reflect the total net generation electricity from nuclear sources in each of these States (see Figure 10. Gross Electricity Generated in Each State by Nuclear Power). As of June 2018, 30 of the 50 States generate electricity from nuclear power plants.

U.S. Commercial Nuclear Power Reactors

Power plants convert heat into electricity using steam. At nuclear power plants, the heat to make the steam is created when atoms split apart in a process called fission. When the process is repeated over and over, it is called a chain reaction. The heat from fission creates steam to turn a turbine. As the turbine spins, the generator turns and its magnetic field produces electricity.

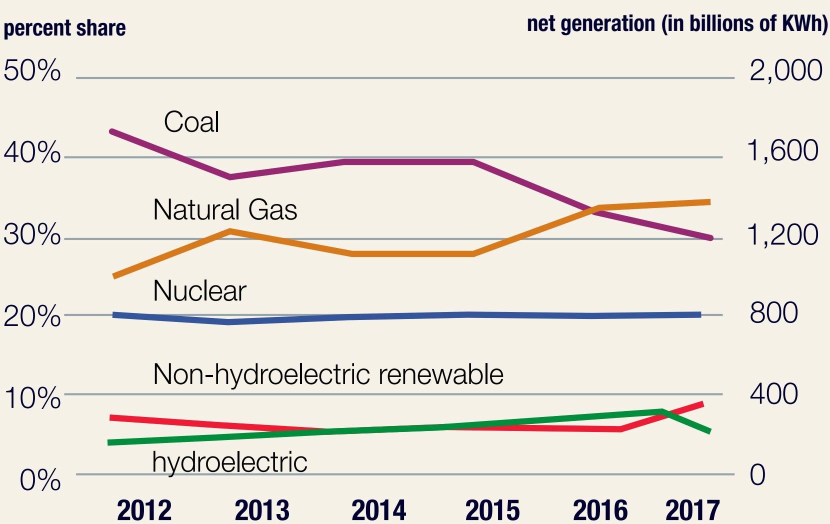
Nuclear power plants are very complex. There are many buildings at the site and many different systems. Some of the systems work directly to make electricity. Some of the systems keep the plant working correctly and safely. All nuclear power plants have a containment structure with reinforced concrete about 4 feet (1.2 meters) thick that

Figure 8. U.S. Gross Electric Generation by Energy Source, 2017



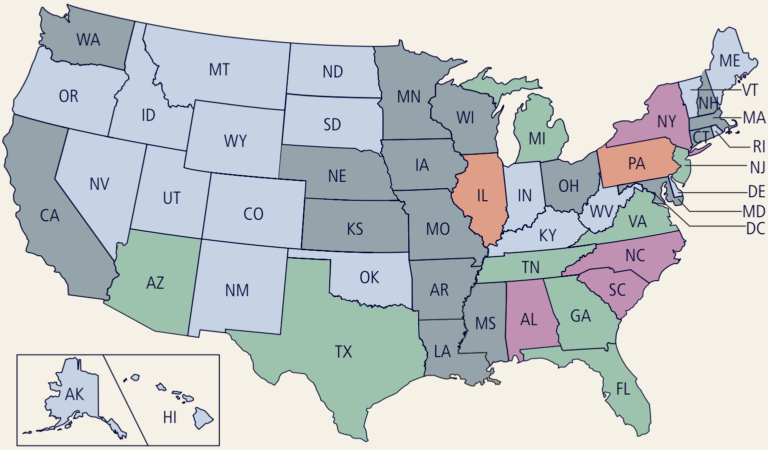
Note: Figures are rounded.
Source: DOE/EIA, June 22, 2018 , *https://www.eia.gov* - Table 7.2A Electricity Net Generation: Total (All Sectors)

Figure 9. U.S. Electric Share and Generation by Energy Source, 2012–2017



Note: Figures are rounded.
Source: DOE/EIA, June 22, 2018 , *https://www.eia.gov* - Table 7.2A Electricity Net Generation: Total (All Sectors)

Figure 10. Gross Electricity Generated in Each State by Nuclear Power



Total Nuclear Power Generated (in thousand megawatt-hours)

None	< less than 20,000	20,001 to 40,000	40,001 to 60,000	> more than 60,001+
20 States	16 States	8 States	4 States	2 States

Note: *U.S. Territories not pictured. American Samoa, Guam, Northern Mariana Islands, Puerto Rico, U.S. Virgin Islands, and Minor Outlying Islands do not generate nuclear power.

Total Nuclear Power Generated by State (in thousand megawatt-hours)

Illinois	97,191
Pennsylvania	83,199
S. Carolina	54,344
Alabama	42,651
N. Carolina	42,374
New York	42,167
Texas	38,581
New Jersey	34,032
Georgia	33,708
Michigan	32,381
Arizona	32,340
Tennessee	31,817
Virginia	30,533
Florida	29,146
California	17,901
Ohio	17,687
Connecticut	16,499
Louisiana	15,409
Maryland	15,106
Minnesota	13,904
Arkansas	12,691
Kansas	10,647
New Hampshire	9,990
Wisconsin	9,648
Washington	8,128
Missouri	8,304
Nebraska	6,912
Mississippi	7,364
Massachusetts	5,047
Iowa	5,213

Source: DOE/EIA, "Monthly Nuclear Utility Generation by State and Reactor," Annual December 2017, EIA-923 and EIA-860 Reports, *https://www.eia.gov* houses the reactor. To keep reactors performing efficiently, operators remove about one-third or half of the fuel every year or two and replace it with fresh fuel. Used fuel is stored and cooled in deep pools on site. The process of removing used fuel and adding fresh fuel is known as refueling.

See Appendix E for a list of parent companies of U.S. commercial operating nuclear power reactors, Appendix A for a list of reactors and their general licensing information, Appendix T for Native American Reservations and Trust lands near nuclear power plants, and Appendix J for radiation doses and regulatory limits.

The United States has two types of commercial reactors. Pressurized-water reactors are known as PWRs. They keep water under pressure so it heats but does not boil. Water from the reactor and the water that is turned into steam are in separate pipes and never mix. In boiling-water reactors, or BWRs, the water heated in the reactor actually boils and turns into steam to turn the generator. In both types of plants, the steam is turned back into water and can be used again in the process.

The NRC regulates commercial nuclear power plants that generate electricity. There are several operating companies and vendors and many different types of reactor designs. Of these designs, only PWRs and BWRs are currently in commercial operation in the United States. Although commercial U.S. reactors have many similarities, each one is considered unique (see Figure 11. U.S. Operating Commercial Nuclear Power Reactors).

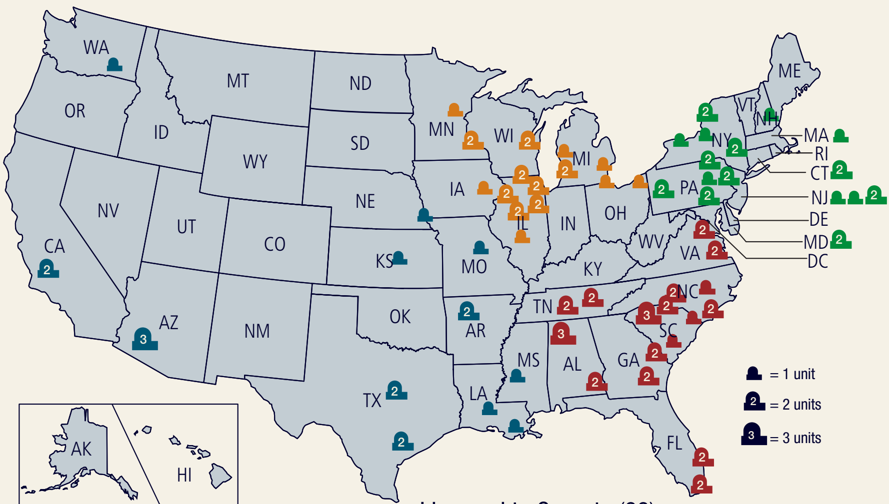
See Glossary for typical PWR and BWR designs.

Resident Inspectors

Since the late 1970s, the NRC has maintained its own sets of eyes and ears at the Nation's nuclear power plants. These onsite NRC staff are referred to as resident inspectors. Each plant has at least two such inspectors, and their work is at the core of the agency's reactor inspection program. On a daily basis, these highly trained and qualified professionals scrutinize activities at the plants and verify adherence to Federal safety requirements. Oversight includes inspectors visiting the control room and reviewing operator logbook entries, visually assessing areas of the plant, observing tests of (or repairs to) important systems or components, interacting with plant employees, and checking corrective action documents to ensure that problems have been identified and appropriate fixes implemented.

Resident inspectors promptly notify plant operators of any safety-significant issues the inspectors find so they are corrected, if necessary, and communicated to NRC management. If problems are significant enough, the NRC will consider whether enforcement action is warranted. More information about the NRC's Reactor Oversight Process and the resident inspector program is available on the agency's Web site (see Figure 12. Day in the Life of an NRC Resident Inspector).

Figure 11. U.S. Operating Commercial Nuclear Power Reactors



Licensed to Operate (99)

REGION I

CONNECTICUT
- Millstone 2 and 3

MARYLAND
- Calvert Cliffs 1 and 2

MASSACHUSETTS
- Pilgrim

NEW HAMPSHIRE
- Seabrook

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

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

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

REGION II

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

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

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

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

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

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

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

REGION III

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

IOWA
- Duane Arnold

MICHIGAN
- Cook 1 and 2
- Fermi 2
- Palisades

MINNESOTA
- Monticello
- Prairie Island 1 and 2

OHIO
- Davis-Besse
- Perry

WISCONSIN
- Point Beach 1 and 2

REGION IV

ARKANSAS
- Arkansas Nuclear 1 and 2

ARIZONA
- Palo Verde 1, 2, and 3

CALIFORNIA
- Diablo Canyon 1 and 2

KANSAS
- Wolf Creek 1

LOUISIANA
- River Bend 1
- Waterford 3

MISSISSIPPI
- Grand Gulf

MISSOURI
- Callaway

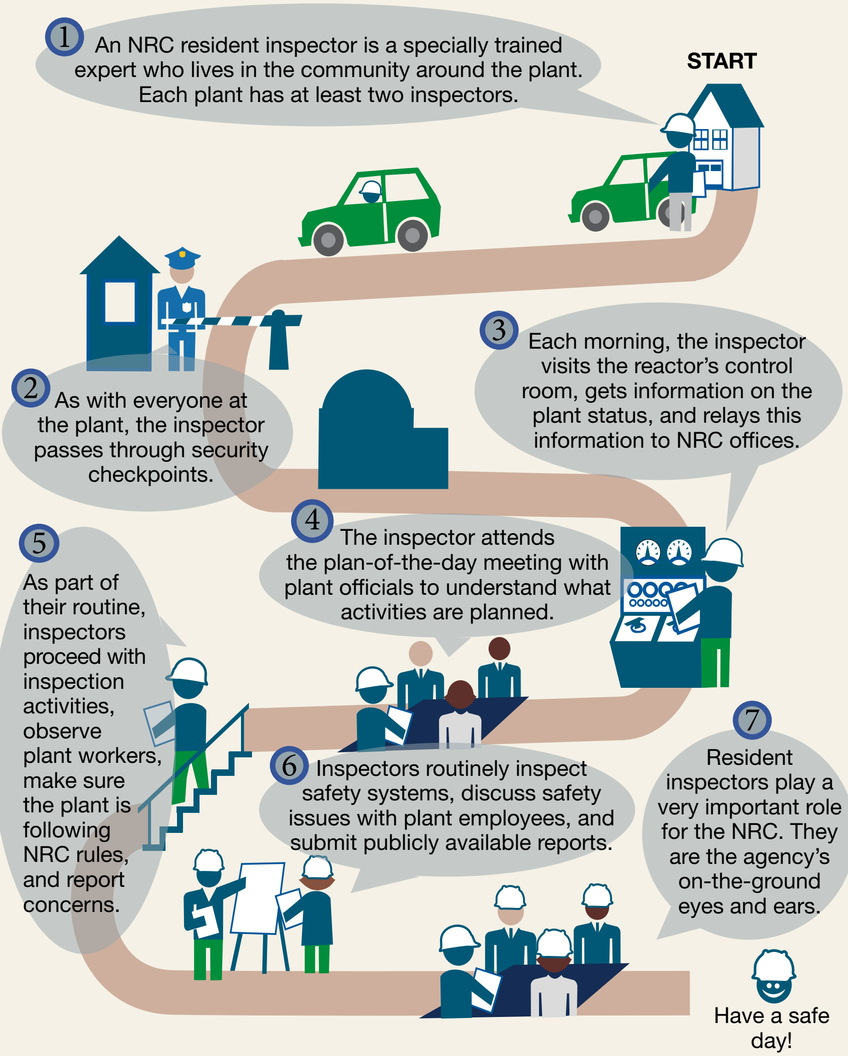
NEBRASKA
- Cooper

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

WASHINGTON
- Columbia

Note: NRC-abbreviated reactor names listed. Data are as of June 2018. For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

Figure 12. Day in the Life of an NRC Resident Inspector



Learn more about resident inspectors. Watch the videos on the NRC YouTube Channel at *https://www.youtube.com/user/NRCgov.*

Post-Fukushima Dai-ichi Nuclear Accident

On March 11, 2011, a 9.0-magnitude earthquake struck off the coast of Japan and created a 45-foot (13.7-meter) tsunami. The reactors at the Fukushima Dai-ichi facility survived the earthquake but were damaged by the tsunami that arrived almost an hour later. Without power from the grid and with the tsunami knocking out backup power, three of the plant's reactors suffered catastrophic failures.

The NRC sent experts to Japan in the days and weeks after the accident, and other agency staff reviewed the lessons from the accident. The review concluded that U.S. plants can operate safely while NRC actions, based on those lessons, enhance safety at U.S. commercial nuclear power plants. At the front lines of this effort were the agency's resident inspectors and regional staff. They have inspected and monitored U.S. reactors as the plants work on these enhancements. This work will continue to ensure plants have the required resources, plans, and training (see Figure 13. NRC Post-Fukushima Safety Enhancements and the Web Link Index).

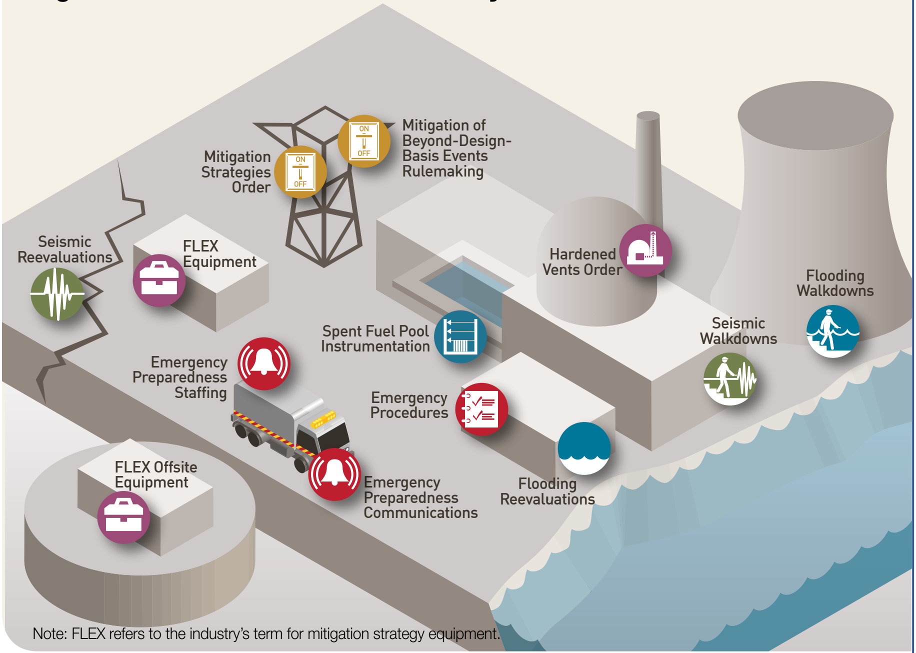
Principal Licensing, Inspection, and Enforcement Activities

The NRC's commercial reactor licensing and inspection activities include:

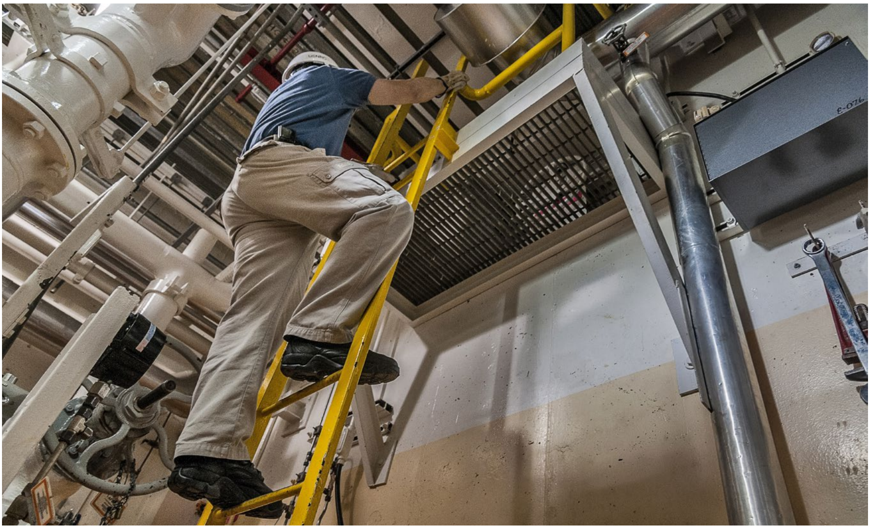
- reviewing separate license change requests from power reactor licensees
- performing inspection-related activities at each operating reactor site
- ensuring the qualifications of NRC-licensed reactor operators, who must requalify every 2 years and ask the NRC to renew their license every 6 years
- reviewing applications for proposed new reactors
- inspecting construction activities
- reviewing operating experience items each year and distributing lessons learned that could help licensed facilities operate more effectively
- issuing notices of violation, civil penalties, or orders to operating reactors for significant violations of NRC regulations on public health and safety
- investigating allegations of inadequacy or impropriety associated with NRC-regulated activities
- incorporating independent advice from the ACRS, which holds both full committee meetings and subcommittee meetings during each year to examine potential safety issues for existing or proposed reactors

See Appendix C for a list of reactors undergoing decommissioning and permanently shut down and Appendix V for a list of significant enforcement actions.

Figure 13. NRC Post-Fukushima Safety Enhancements



Note: FLEX refers to the industry's term for mitigation strategy equipment.



An NRC inspector conducts routine inspections of plant equipment to ensure the plant is meeting NRC regulations.

Oversight of U.S. Commercial Nuclear Power Reactors

The NRC establishes requirements for the design, construction, operation, and security of U.S. commercial nuclear power plants. The agency ensures the plants operate safely and securely within these requirements by licensing the plants to operate, licensing control room personnel, establishing technical specifications for operating each plant, and inspecting plants daily.

Reactor Oversight Process

The NRC's Reactor Oversight Process (ROP) verifies that U.S. reactors are operating in accordance with NRC rules, regulations, and license requirements. If reactor performance declines, the NRC increases its oversight to protect public health and the environment. This can range from conducting additional inspections to shutting a reactor down.

The NRC staff uses the ROP to evaluate NRC inspection findings and performance records for each reactor and uses this information to assess the reactor's safety performance and security measures. Every 3 months, through the ROP, the NRC places each reactor in one of five categories. The top category is "fully meeting all safety cornerstone objectives," while the bottom is "unacceptable performance" (see Figure 14. Reactor Oversight Action Matrix Performance Indicators). NRC inspections start with detailed baseline-level activities for every reactor. As the number of issues at a reactor increases, the NRC's inspections increase. The agency's supplemental inspections and other actions (if needed) ensure licensees promptly address significant performance issues. The latest reactor-specific inspection findings and historical performance information can be found on the NRC's Web site (see the Web Link Index).

The ROP is informed by 50 years of improvements in nuclear industry performance. The process continues to improve approaches to inspecting and evaluating the safety and security performance of NRC-licensed nuclear plants. More ROP information is available on the NRC's Web site and in NUREG-1649, Revision 6, "Reactor Oversight Process"(see Figure 15. Reactor Oversight Framework).

Figure 14. Reactor Oversight Action Matrix Performance Indicators

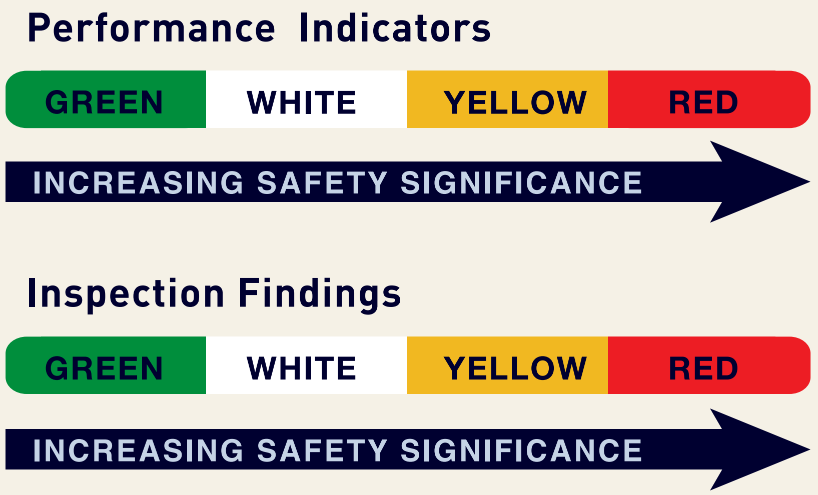
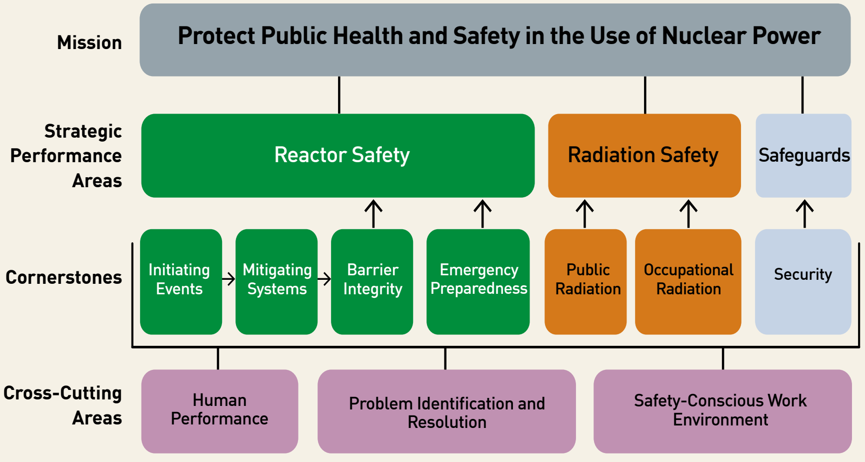


Figure 15. Reactor Oversight Framework



Reactor License Renewal

The Atomic Energy Act of 1954, as amended, authorizes the NRC to issue 40-year initial licenses for commercial power reactors. The Act also allows the NRC to renew licenses. Under the NRC's current regulations, the agency can renew reactor licenses for 20 years at a time. Congress set the original 40-year term after considering economic and antitrust issues, as opposed to nuclear technology issues. Some parts of a reactor, however, may have been engineered based on an expected 40-year service life. These parts must be maintained and monitored during the additional period of operation, and licensees may choose to replace some components (see Figure 16. License Renewals Granted for Operating Nuclear Power Reactors).

See Appendices F and G for power reactor operating licenses issued and expired by year.

For current reactors grouped by how long they have operated, see Figure 17. U.S. Commercial Nuclear Power Reactors—Years of Operation by the End of 2018. Nuclear power plant owners typically seek license renewal based on a plant's economic situation and on whether it can continue to meet NRC requirements in the future (see Figure 18. License Renewal Process).

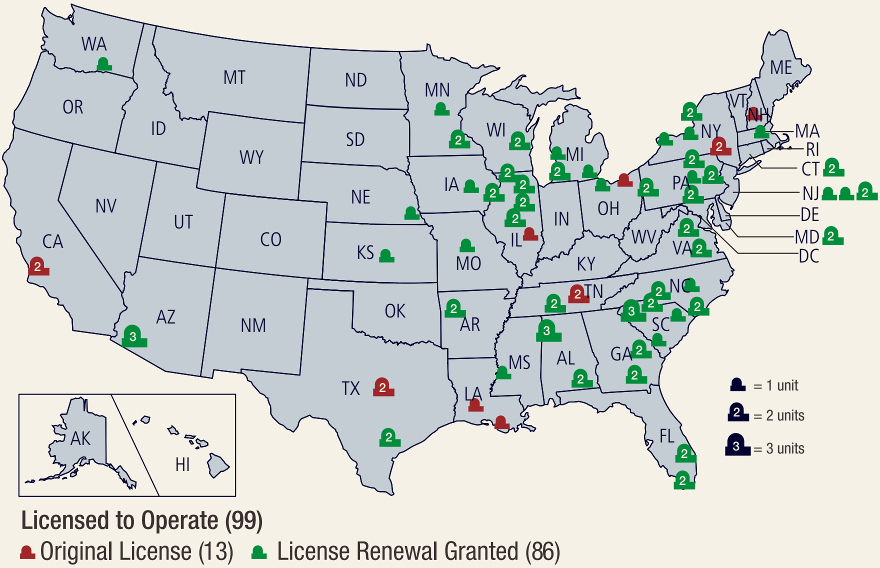
The NRC reviews a license renewal application on two tracks: safety and environmental impacts. The safety review evaluates the licensee's plans for managing aging plant systems during the renewal period. For the environmental review, the agency uses the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437) to evaluate impacts common to all nuclear power plants, then prepares a supplemental environmental impact statement for each individual plant. The supplement examines impacts unique to the plant's site. The public has two opportunities to contribute to the environmental review—at the beginning and when the draft report is published.

The NRC considered the environmental impacts of the continued storage of spent nuclear fuel during rulemaking activities and published its final Continued Storage Rule and supporting generic environmental impact statement in 2014. The rule addresses the environmental impacts of the continued storage of spent nuclear fuel beyond a reactor's licensed operating life before ultimate disposal (previously referred to as "waste confidence"). The environmental impacts of continued storage of spent nuclear fuel are incorporated into each environmental review for license renewal.

Subsequent License Renewal

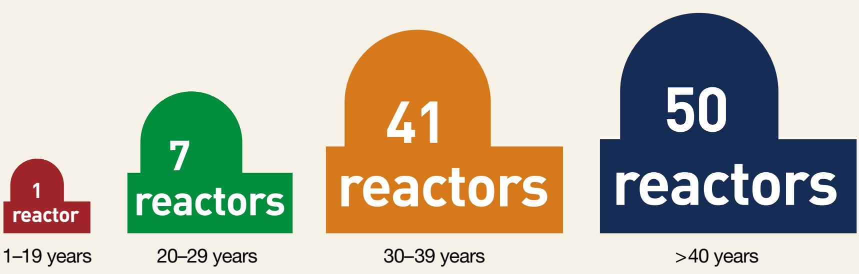
The NRC staff developed guidance and a standard review plan for "subsequent license renewals" that would allow plants to operate for more than 60 years (the 40 years of the original license plus 20 years in the initial license renewal). The Commission determined the agency's existing regulations are adequate for subsequent license renewals, but the new guidance would help licensees develop aging management programs appropriate for the 60-year to 80-year period.

Figure 16. License Renewals Granted for Operating Nuclear Power Reactors



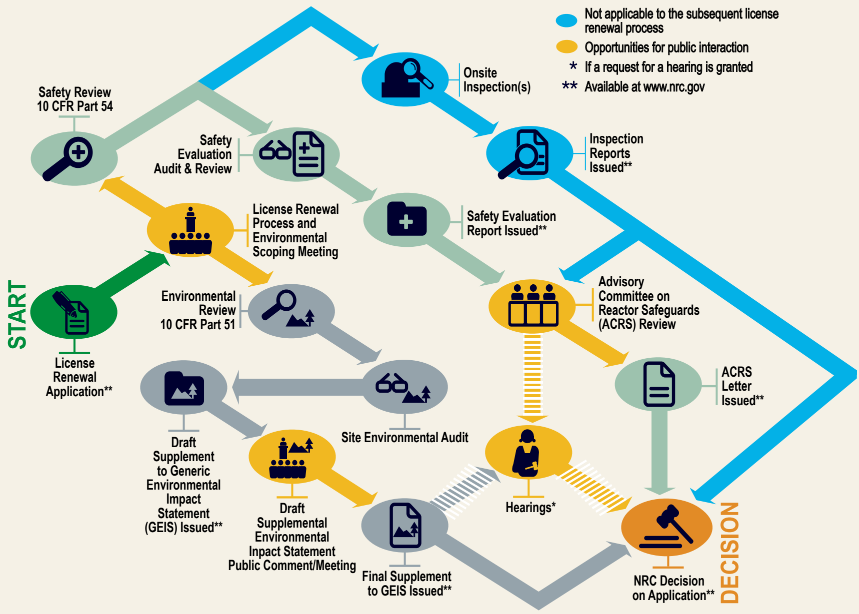
Note: The NRC has issued a total of 89 license renewals; three of these units have permanently shut down. Data are as of May 2018. For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

Figure 17. U.S. Commercial Nuclear Power Reactors—Years of Operation by the End of 2018



Note: Ages are based on operating license issued date and have been rounded up to the end of the year. For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

Figure 18. License Renewal Process



The NRC published the final guidance documents in the summer of 2017. The agency is reviewing an application for subsequent license renewal of the Turkey Point reactors in Florida. The NRC has also received letters of intent for Peach Bottom to apply for subsequent license renewal in 2018, Surry to apply in 2019, and North Anna to apply in 2020.

Public Involvement

The public plays an important role in the license renewal process. Members of the public have several opportunities to contribute to the environmental review. The NRC shares information provided by the applicant and holds public meetings. The agency fully and publicly documents the results of its technical and environmental reviews. In addition, ACRS public meetings often discuss technical or safety issues related to reactor designs or a particular plant or site. Individuals or groups can raise legal arguments against a license renewal application in an Atomic Safety and Licensing Board (ASLB) hearing if they would be affected by the renewal and meet basic requirements for requesting a hearing. (For more information, see the Web Link Index.)

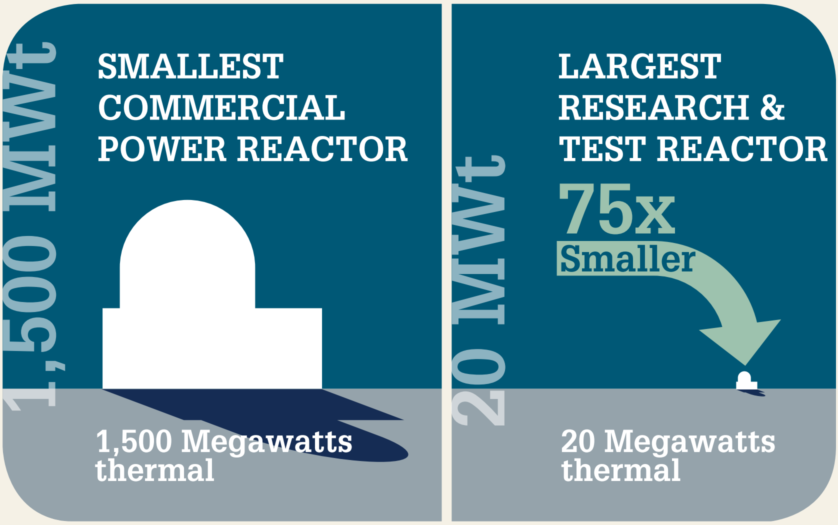
Research and Test Reactors

Nuclear research and test reactors (RTRs), also called “nonpower” reactors, are primarily used for research, training, and development to support science and education in nuclear engineering, physics, chemistry, biology, anthropology, medicine, materials sciences, and related fields. These reactors do not produce electricity. Most U.S. RTRs are at universities or colleges.

The largest U.S. RTR (which produces 20 megawatts thermal (MWt)) is one-75th the size of the smallest U.S. commercial power nuclear reactor (which produces 1,500 MWt). The NRC regulates currently operating RTRs (see Figure 19. Size Comparison of Commercial and Research Reactors and Figure 20. U.S. Nuclear Research and Test Reactors). The U.S. Department of Energy (DOE) also uses research reactors, but they are not regulated by the NRC.

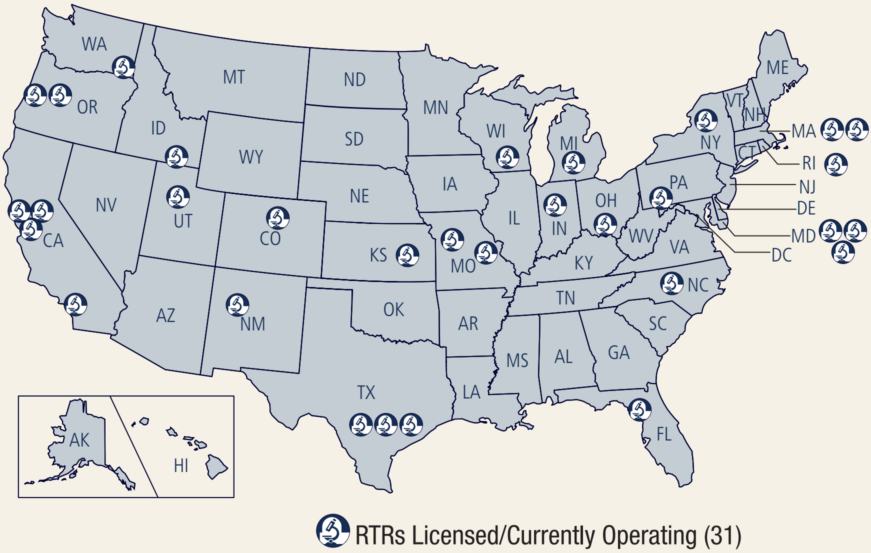
NRC inspectors visit each RTR facility at least once a year to conduct varying levels of oversight. RTRs licensed to produce 2 MWt or more receive a full NRC inspection every year. Those licensed to produce less than 2 MWt receive a full inspection every 2 years.

Figure 19. Size Comparison of Commercial and Research Reactors



Note: Nuclear research and test reactors, also known as “nonpower” reactors, do not produce commercial electricity.

Figure 20. U.S. Nuclear Research and Test Reactors



Note: For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

Principal Licensing and Inspection Activities

The NRC's RTR licensing and inspection activities include:

- licensing the operating sites, including license renewals and license amendments
- overseeing decommissioning
- licensing operators
- overseeing operator relicensing programs
- overseeing security programs
- conducting inspections each year, based on inspection frequency and procedures for operating RTRs

See Appendices H and I for a list of research and test reactors regulated by the NRC that are operating or are in the process of decommissioning.

New Commercial Nuclear Power Reactor Licensing

New reactors are often considered to be any reactors proposed in addition to the current fleet of operating reactors (see Figure 21. The Different NRC Classifications for Types of Reactors).

See Appendix B for a list of new nuclear power plant licensing applications in the United States.

The NRC's current review of new power reactor license applications improves on the process used through the 1990s (see Figure 22. New Reactor Licensing Process). In 2012, the NRC issued the first combined construction permit and operating license (called a combined license, or COL) under the new licensing process. The NRC continues to review applications submitted by prospective licensees, and (when appropriate) issues standard design certifications, early site permits (ESPs), limited work authorizations, construction permits, operating licenses, and COLs for facilities in a variety of projected locations throughout the United States. The NRC has implemented the Commission's policies on new reactor safety through rules, guidance, staff reviews, and inspection.

See Glossary for typical PWR and BWR designs.

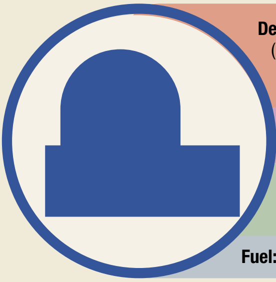
The NRC's ongoing design certification, COL, and ESP reviews are incorporating lessons learned from the Fukushima accident. The environmental impacts of continued storage of spent nuclear fuel are incorporated into each environmental review for new reactor licensing. The NRC considered these impacts in a rulemaking and published its final Continued Storage Rule and supporting generic environmental impact statement in September 2014. Section 5 discusses the Continued Storage Rule in more detail.

Combined License Applications—Construction and Operating

By issuing a COL, the NRC authorizes the licensee to construct and (with specified conditions) operate a nuclear power plant at a specific site, in accordance with established laws and regulations. If the Commission finds that the acceptance criteria are met, a COL is valid for 40 years. A COL can be renewed for additional 20-year terms (see Figure 23. Locations of New Nuclear Power Reactor Applications). For the current review schedule for active licensing applications, consult the NRC's Web site (see the Web Link Index).

Figure 21. The Different NRC Classifications for Types of Reactors

Operating Reactors



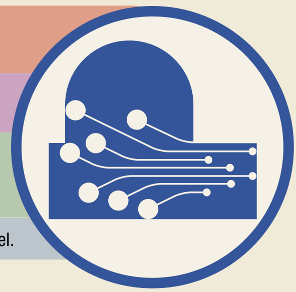
Design: The U.S. fleet consists mainly of large reactors that use regular water ("light" water, as opposed to "heavy" water that has a different type of hydrogen than commonly found in nature) for both cooling the core and facilitating the nuclear reaction.

Capacity: The generation base load of these plants is 1,500 MWt (495 MWe) or higher.

Safety: These reactors have "active" safety systems powered by alternating current (ac) and require an operator to shut down.

Fuel: These reactors require enriched uranium.

Advanced Reactors



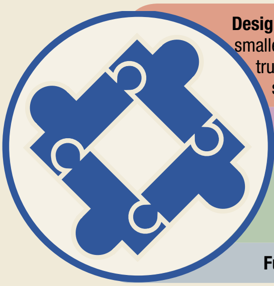
Design: Advanced reactors are a new generation of nonlight-water reactors. They use coolants including molten salts, liquid metals, and even gases such as helium.

Capacity: These plants range in power from very small reactors to a power level comparable to existing operating reactors.

Safety: These reactors are expected to provide enhanced margins of safety and use simplified, inherent, and passive means to ensure safety. They may not require an operator to shut down.

Fuel: These reactors could use enriched uranium, thorium, or used nuclear fuel.

Small Modular Reactors



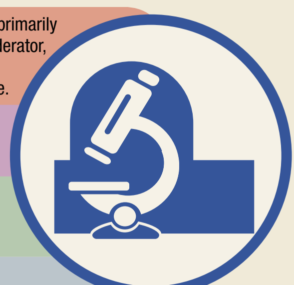
Design: Small modular reactors (SMRs) are similar to light-water reactors but are smaller, compact designs. These factory-fabricated reactors can be transported by truck or rail to a nuclear power site. Additional SMRs can be installed on site to scale or meet increased energy needs.

Capacity: These reactors are about one-third the size of typical reactors with generation base load of 1,000 MWt (300 MWe) or less.

Safety: These reactors can be installed underground, providing more safety and security. They are built with passive safety systems and can be shut down without an operator.

Fuel: These reactors require enriched uranium.

Research and Test Reactors



Design: Research and test reactors—also called "nonpower" reactors—are primarily used for research, training, and development. They are classified by their moderator, the material used to slow down the neutrons, in the nuclear reaction. Typical moderators include water (H_2O), heavy water (D_2O), polyethylene, and graphite.

Capacity: These current licensed facilities range in size from 5 watts (less than a night light) to 20 MWt (equivalent to 20 standard medical X-ray machines).

Safety: All NRC-licensed research and test reactors have a built-in safety feature that reduces reactor power during potential accidents before an unacceptable power level or temperature can be reached.

Fuel: Reactors may also be classified by the type of fuel used, such as MTR (plate-type fuel) or TRIGA fuel. TRIGA fuel is unique in that a moderator (hydrogen) is chemically bonded to the fuel.

Figure 22. New Reactor Licensing Process

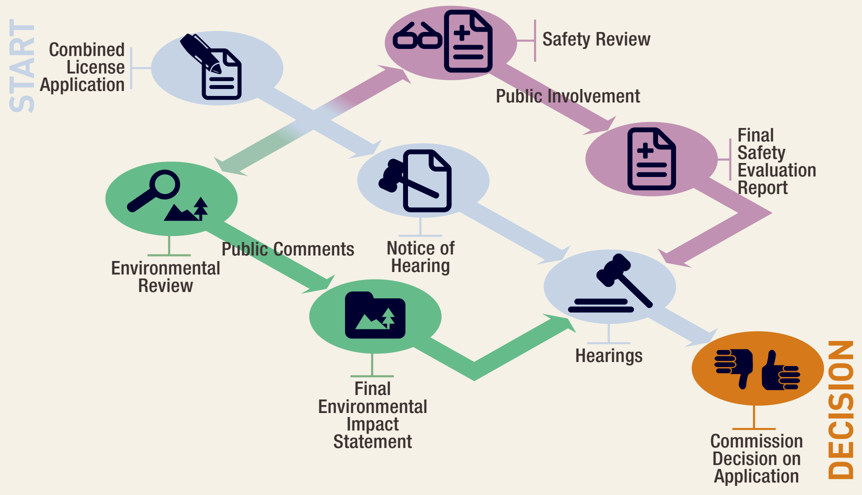
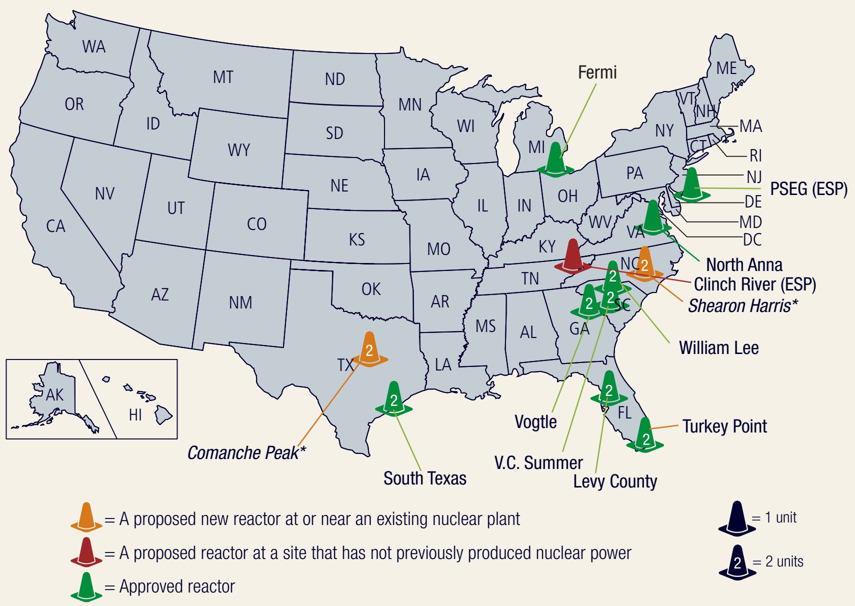


Figure 23. Locations of New Nuclear Power Reactor Applications



** Review suspended*

Note: On July 31, 2017, South Carolina Electric & Gas (SCE&G) announced its decision to cease construction on V.C. Summer nuclear power plant, Units 2 and 3; and the licensee has requested that the COLs be withdrawn. As of October 2017, Duke Energy has announced plans to cancel reactors at Levy County, FL, and William States Lee, SC. Applications were withdrawn for Calvert Cliffs, Grand Gulf, Nine Mile Point, Victoria County, and Callaway (COL and ESP). In June 2018, Nuclear Innovation North America submitted a letter requesting that the COLs South Texas Project, Units 3 and 4, be withdrawn. NRC-abbreviated reactor names listed. Data are as of July 2018. For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

Public Involvement

Even before the NRC receives an application, the agency holds a public meeting to talk to the community near the proposed reactor location. The agency explains the review process and outlines how the public may participate in the process. After the application is submitted, the NRC asks the public to comment on which factors the agency should consider in its environmental review under the National Environmental Policy Act. The NRC later posts a draft environmental evaluation on the agency's Web site and asks for public input. There is no formal opportunity for public comment on the staff's safety evaluation, but members of the public are welcome to attend public meetings and make comments. Individuals or groups can raise legal arguments against a new reactor application in an ASLB hearing if they would be affected by the new reactor and meet basic requirements for requesting a hearing. The NRC announces opportunities to request these hearings in press releases, in the *Federal Register,* and on the NRC's Web site.

Early Site Permits

An ESP review examines whether a piece of land is suitable for a nuclear power plant. The review covers site safety, environmental protection, and emergency preparedness. The ACRS reviews safety-related portions of an ESP application. As with COL reviews, the public participates in the environmental portion of the NRC's ESP review, and the public can challenge an application in a hearing.

Design Certifications

The NRC issues certifications for reactor designs that meet basic requirements for ensuring safe operation. Utilities can cite a certified design when applying for a nuclear power plant COL. The certification is valid for 15 years from the date issued and can be renewed for an additional 15 years. The new reactor designs under review incorporate new elements such as passive safety systems and simplified system designs. The five certified designs are—

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

The NRC is reviewing three applications for design certifications for the APR1400, U.S. Advanced Pressurized-Water Reactor, (US-APWR) and NuScale designs.

Design Certification Renewals

The NRC is reviewing a GEH application to renew the ABWR design certification. GEH submitted its application in 2010.

Advanced Reactor Designs

Several companies are considering advanced reactor designs and technologies and are conducting preapplication activities with the NRC. These technologies are cooled by liquid metals, molten salt mixtures, or inert gases. Advanced reactors can also consider fuel materials and designs that differ radically from today's enriched-uranium dioxide pellets with zirconium cladding. While developing the regulatory framework for advanced reactor licensing, the NRC is examining policy issues in areas such as security and emergency preparedness.

Small Modular Reactors

Small modular reactors (SMRs) use water to cool the reactor core in the same way as today's large light-water reactors. SMR designs also use the same enriched uranium fuel as today's reactors. However, SMR designs are considerably smaller and bundle several reactors together in a single containment. Each SMR module generates 300 MWe (1,000 MWt) or less, compared to today's large designs that can generate 1,000 MWe (3,300 MWt) or more per reactor. The NRC's discussions to date with SMR designers involve modules generating less than 200 MWe (660 MWt).

New Reactor Construction Inspections

NRC inspectors based in the agency's Region II office in Atlanta, GA, monitor reactor construction activity. These expert staff members ensure licensees carry out construction according to NRC license specifications and related regulations.

The NRC staff examines the licensee's operational programs in areas such as security, radiation protection, and operator training and qualification. Inspections at a construction site verify that a licensee has completed required inspections, tests, and analyses and has met associated acceptance criteria. The NRC's onsite resident construction inspectors oversee day-to-day licensee and contractor activities. In addition, specialists at NRC Region II's Center for Construction Inspection periodically visit the sites to ensure the facilities are being constructed using the approved design.

The NRC's Construction Reactor Oversight Process assesses all of these activities. Before the agency will allow a new reactor to start up, NRC inspectors must confirm that the licensee has met all of the acceptance criteria in its COL.

The agency also inspects domestic and overseas factories and other vendor facilities. This ensures new U.S. reactors receive high-quality products and services that meet the NRC's regulatory requirements. The NRC's Web site has more information on new reactor licensing activities (see the Web Link Index).

New Commercial Nonpower Production and Utilization Facility Licensing

Doctors worldwide rely on a steady supply of molybdenum-99 (Mo-99) to produce technetium-99m in hospitals, which is used in radiopharmaceuticals in approximately 50,000 medical diagnostic procedures daily in the United States. The NRC supports the national policy objective of establishing a reliable, domestically available supply of this medical radioisotope by reviewing license applications for Mo-99 production facilities submitted in accordance with the provisions of Title 10 of the *Code of Federal Regulations*. Since 2013, the NRC staff has received two construction permit applications for nonpower production and utilization facilities, from SHINE Medical Technologies, Inc. (SHINE), and Northwest Medical Isotopes, LLC. The proposed facilities would irradiate low-enriched uranium targets in utilization facilities, such as SHINE's proposed accelerator-driven subcritical operating assemblies, then separate Mo-99 from other fission products in hot cells contained within a production facility. The NRC approved the construction permits for SHINE in February 2016, and for Northwest Medical Isotopes in May 2018.

The NRC staff conducts safety and environmental reviews on these construction permit applications, which will also be the subject of both a mandatory hearing and an independent review by the ACRS. If the NRC issues these construction permits, each facility must also submit an application for, and be granted, an operating license.

The NRC anticipates receiving additional construction permit applications, operating license applications, materials license applications, and license amendment requests in the coming years from other potential Mo-99 producers.

Ahead of the issuance of any permit or license, the NRC continues to develop necessary infrastructure programs for these facilities, including inspection procedures for construction and operation. The agency provides updates on the status of these licensing reviews through NRC-hosted public meetings, Commission meetings, and interagency interactions.

Technetium-99m (99mTc) is produced by the decay of molybdenum-99 (99Mo) and is used in diagnostic nuclear medical imaging procedures.

Nuclear Regulatory Research

The NRC's research supports the agency's mission by providing technical advice, tools, methods, data, and information. This research can identify, explore, and resolve safety issues, as well as provide information supporting licensing decisions and new regulations and guidance. The NRC's research includes:

- independently confirming other parties' work through experiments and analyses
- developing technical support for agency safety decisions
- preparing for the future by evaluating the safety implications of new technologies and designs for nuclear reactors, materials, waste, and security

The research program focuses on the challenges of an evolving industry, as well as on retaining technical skills when experienced staff members retire. The NRC's research covers the light-water reactor technology developed in the 1960s and 1970s, today's advanced light-water reactor designs, and fuel cycle facilities. The agency has longer term research plans for more exotic reactor concepts, such as those cooled by high-temperature gases or molten salts. The NRC's research programs examine a broad range of subjects, such as:

- material performance (such as environmentally assisted degradation and cracking of metallic alloys, aging management of reactor components and materials, boric-acid corrosion, radiation effects on concrete, alkali-silica reaction in concretes, and embrittlement of reactor pressure vessel steels)
- events disrupting heat transfer from a reactor core, criticality safety, severe reactor accidents, how radioactive material moves through the environment, and how that material could affect human health (sometimes using NRC-developed computer codes for realistic simulations)
- computer codes used to analyze fire conditions in nuclear facilities, to examine how reactor fuel performs, and to assess nuclear power plant risk
- new and evolving technologies (such as additive manufacturing and accident-tolerant fuel)
- experience gained from operating reactors
- digital instrumentation and controls (such as analyzing digital system components, security aspects of digital systems, and probabilistic assessment of digital system performance)
- enhanced risk-assessment methods, tools, and models to support the increased use of probabilistic risk assessment in regulatory applications
- earthquake and flooding hazards

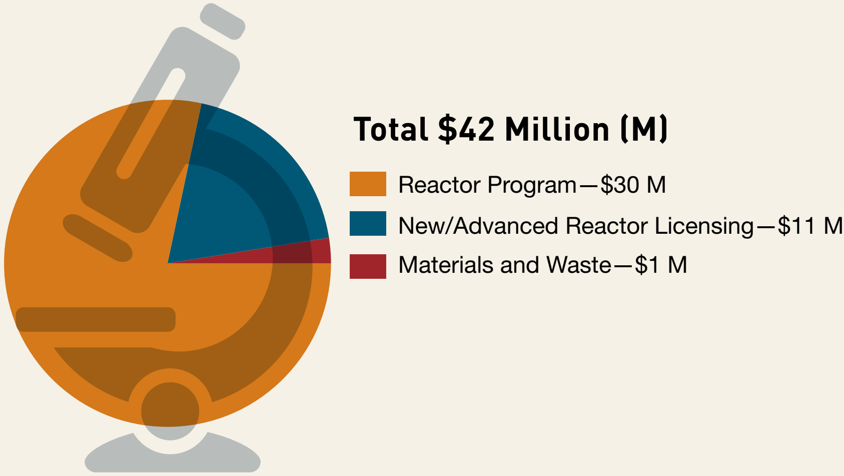
- ultrasonic testing and other nondestructive means of inspecting reactor components and dry cask storage systems and developing and accessing ultrasonic testing simulation tools to optimize examination procedure variables
- the human side of reactor operations, including safety culture, and computerization and automation of control rooms

The Office of Nuclear Regulatory Research also plans, develops, and manages research on fire safety and risk, including modeling, and evaluates potential security vulnerabilities and possible solutions (see the Web Link Index for more information on specific NRC research projects and activities).

The NRC's research program involves about 5 percent of the agency's personnel and uses about 11 percent of its contracting funds. The NRC's $42 million research budget for FY 2018 includes contracts with national laboratories, universities, research organizations, and other Federal agencies (e.g., the National Institute of Standards and Technology, the U.S. Army Corps of Engineers, and the U.S. Geological Survey). NRC research funds support access to a broader group of experts and international research facilities. Figure 24. NRC Research Funding, FY 2018, illustrates the primary areas of research.

The majority of the NRC's research program supports maintaining operating reactor safety and security. The remaining research budget supports regulatory activities for new and advanced reactors, industrial and medical use of nuclear materials, and nuclear fuel cycle and radioactive waste programs. The NRC cooperates with universities and nonprofit organizations on research for the agency's specific interests.

Figure 24. NRC Research Funding, FY 2018



Note: Dollars are rounded to the nearest million.

The NRC's international cooperation in research areas leverages agency resources, facilitates work on advancing existing technologies, and determines any safety implications of new technologies. The NRC's leadership role in international organizations such as the IAEA and the OECD/NEA helps guide the agency's collaborations.

See Appendix U for States with Integrated University Grants Program recipients.

The NRC maintains international cooperative research agreements with more than two dozen foreign governments. This work covers technical areas from severe accident research and computer code development to materials degradation, nondestructive examination, fire risk, and human-factors research. Cooperation under these agreements is more efficient than conducting research independently.

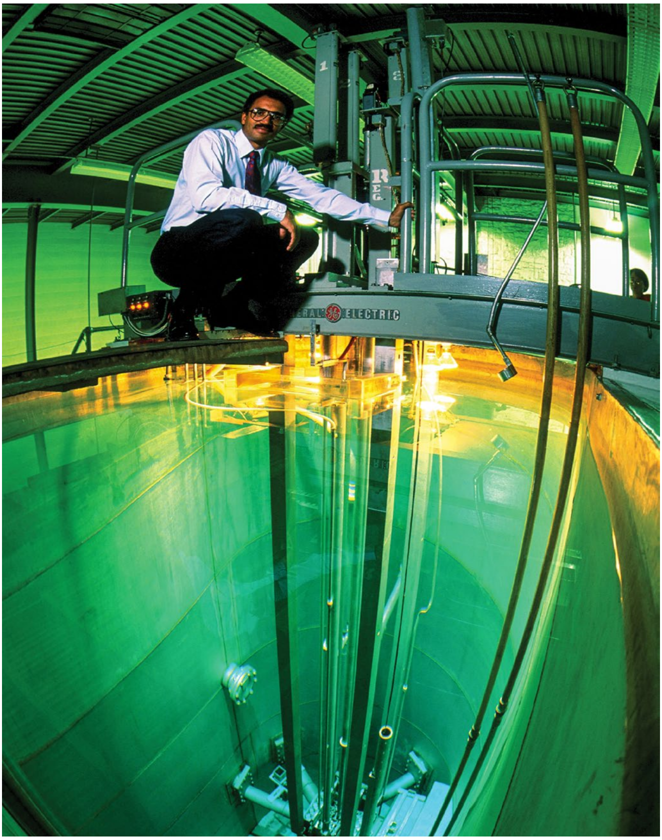
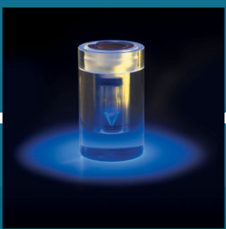
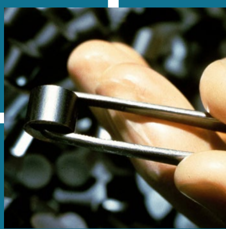


Photo courtesy: University of Wisconsin–Madison

Professor Douglass Henderson of the University of Wisconsin-Madison standing above the pool of the University's TRIGA research reactor.

NUCLEAR MATERIALS





The NRC regulates each phase of the nuclear fuel cycle—the steps needed to turn uranium ore into fuel for nuclear power plants—as well as storing and disposing of the fuel after it is used in a reactor. In some States, the NRC also regulates nuclear materials used for medical, industrial, and academic purposes. Work includes reviewing applications for and issuing new licenses, license renewals, and amendments to existing licenses. The NRC also regularly conducts health, safety, and security inspections.

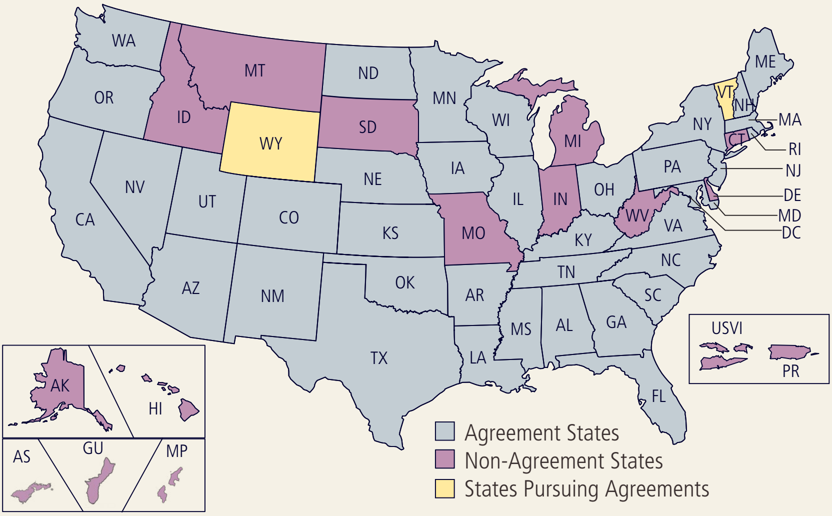
Materials Licenses

See Appendix L for a list of the number of materials licenses by State.

States have the option to regulate certain radioactive materials under agreements with the NRC. Those that do are called Agreement States (see Figure 25. Agreement States). These States develop regulations and appoint officials to ensure nuclear materials are used safely and securely. Agreement States must adopt rules consistent with the NRC's. Only the NRC regulates nuclear reactors, fuel fabrication facilities, consumer product distribution, and certain amounts of what is called "special nuclear material"—that is, radioactive material that can fission or split apart.

Radioactive materials, or radionuclides, are used for many purposes. They are used in civilian and military industrial applications; basic and applied research; the manufacture of consumer products; academic studies; and medical diagnosis, treatment, and research. They can be produced in a reactor or an accelerator—a machine that propels charged particles. The NRC does not regulate accelerators but does license the use of radioactive materials produced in accelerators.

Figure 25. Agreement States



Note: For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

Medical and Academic

The NRC and Agreement States review the facilities, personnel, program controls, and equipment involved in using radioactive materials in medical and academic settings. These reviews ensure the safety of the public, patients, and workers who might be exposed to radiation from those materials. The NRC regulates only the use of radioactive material, which is why the NRC does not regulate x-ray machines or other devices that produce radiation without using radioactive materials.

Medical

The NRC and Agreement States license hospitals and physicians to use radioactive materials in medical treatments and diagnoses. The NRC also develops guidance and regulations for licensees. These regulations require licensees to have experience and special training, focusing on operating equipment safely, controlling the radioactive material, and keeping accurate records. To help the NRC stay current, the agency sponsors the Advisory Committee on the Medical Uses of Isotopes. This expert committee includes scientists, physicians, and other health care professionals who have experience with medical radionuclides.

Nuclear Medicine

Doctors use radioactive materials to diagnose or treat about one-third of all patients admitted to hospitals. This branch of medicine is known as nuclear medicine, and the radioactive materials are called radiopharmaceuticals.

Two types of radiopharmaceutical tests can diagnose medical problems. In vivo tests (within the living) administer radiopharmaceuticals directly to patients. In vitro tests (within the glass) add radioactive materials to lab samples taken from patients.

Photo courtesy: Sirtex

Photo courtesy: Nordion

Samples from two manufacturers of yttrium-90 (Y-90), SIR-Spheres® (left) andTheraSphere® (right). Vial containing millions of Y-90 microspheres used to treat liver cancers.

Radiation Therapy

Doctors also use radioactive materials and radiation-producing devices to treat medical conditions. They can treat hyperthyroidism and some cancers, for example, and can also ease the pain caused by bone cancer. Radiation therapy aims to deliver an accurate radiation dose to a target site while protecting surrounding healthy tissue. To be most effective, treatments often require several exposures over a period of time. When used to treat malignant cancers, radiation therapy is often combined with surgery or chemotherapy.

There are three main categories of radiation therapy:

1. External beam therapy (also called teletherapy) is a beam of radiation directed to the target tissue. Several different types of machines are used in external beam therapy. Treatment machines regulated by the NRC contain high-activity radioactive sources (usually cobalt-60) that emit photons to treat the target site.
2. Brachytherapy treatments use sealed radioactive sources placed near or even directly in cancerous tissue. The radiation dose is delivered at a distance of up to an inch (up to 2.54 centimeters) from the target area.
3. Therapeutic radiopharmaceuticals deliver a large radiation dose inside the body. Different radioactive materials can be given to patients and will concentrate in different regions or organ systems.

Academic

The NRC issues licenses to academic institutions for education and research. For example, qualified instructors may use radioactive materials in classroom demonstrations. Scientists in many disciplines use radioactive materials for laboratory research.

Industrial

The NRC and Agreement States issue licenses that specify the type, quantity, and location of radioactive materials to be used. Radionuclides can be used in industrial radiography, gauges, well logging, and manufacturing. Radiography uses radiation sources to find structural defects in metal and welds. Gas chromatography uses low-energy radiation sources to identify the chemical elements in an unknown substance. This process can determine the components of complex mixtures, such as petroleum products, smog, and cigarette smoke. (It can also be used in biological and medical research to identify the parts that make up complex proteins and enzymes.) Well-logging devices use radioactive sources and detection equipment to make a record of geological formations from inside a well. This process is used extensively for oil, gas, coal, and mineral exploration.

Nuclear Gauges

Nuclear gauges are used to measure the physical properties of products and industrial processes nondestructively as a part of quality control. Gauges use radiation sources to determine the thickness of paper products, fluid levels in oil and chemical tanks, and the moisture and density of soils and material at construction sites. Gauges may be fixed or portable.

See Glossary for illustrations of fixed and portable gauges.

The measurement indicates the thickness, density, moisture content, or some other property that is displayed on a gauge readout or on a computer monitor. The top of the gauge has shielding to protect the operator while the radioactive source is exposed. When the measuring process is completed, the source is retracted or a shutter closes, minimizing exposure from the source. A fixed gauge has a radioactive source shielded in a container. When the user opens the container's shutter, a beam of radiation hits the material or product being processed or controlled. A detector mounted opposite the source measures the radiation passing through the product. The gauge readout or computer monitor shows the measurement. The material and process being monitored dictate the type, energy, and strength of radiation used.

Fixed fluid gauges are used by the beverage, food, plastics, and chemical industries. Installed on a pipe or the side of a tank, these gauges measure the densities, flow rates, levels, thicknesses, and weights of a variety of materials and surfaces. A portable gauge uses both a shielded radioactive source and a detector. The gauge is placed on the object to be measured. Some gauges rely on radiation from the source to reflect back to the bottom of the gauge. Other gauges insert the source into the object. The detector in the gauge measures the radiation either directly from the inserted source or from the reflected radiation.

The moisture density gauge, shown at right, is a portable gauge that places a gamma source under the surface of the ground through a tube. Radiation is transmitted directly to the detector on the bottom of the gauge, allowing accurate measurements of compaction. Industry uses such gauges to monitor the structural integrity of roads, buildings, and bridges. Airport security uses nuclear gauges to detect explosives in luggage.

A moisture density gauge indicates whether a foundation is suitable for supporting a building or roadway.

Commercial Irradiators

The U.S. Food and Drug Administration and other agencies have approved the irradiation of food. Commercial irradiators expose food and spices, as well as products such as medical supplies, blood, and wood flooring, to gamma radiation. This process can be used to eliminate harmful germs and insects or for hardening or other purposes. The gamma radiation does not leave radioactive residue or make the treated products radioactive. The radiation can come from radioactive materials (e.g., cobalt-60), an x-ray tube, or an electron beam.

See Glossary for information and illustrations of commercial irradiators.

The NRC and Agreement States license about 50 commercial irradiators. Up to 10 million curies of radioactive material can be used in these types of irradiators. NRC regulations protect workers and the public from this radiation.

Two main types of commercial irradiators are used in the United States: underwater and wet-source-storage panoramic models. Underwater irradiators use sealed sources (radioactive material encased inside a capsule) that remain in the water at all times, providing shielding for workers and the public. The product to be irradiated is placed in a watertight container, lowered into the pool, irradiated, and then removed. Wet-source-storage panoramic irradiators also store radioactive sealed sources in water. However, the sources are raised into the air to irradiate products that are automatically moved in and out of the room on a conveyor system. Sources are then lowered back into the pool. For this type of irradiator, thick concrete walls and ceilings or steel barriers protect workers and the public when the sources are lifted from the pool.

Transportation

More than 3 million packages of radioactive materials are shipped each year in the United States by road, rail, air, or water. This represents less than 1 percent of the Nation's yearly hazardous material shipments. The NRC and the U.S. Department of Transportation (DOT) share responsibility for regulating the safety of radioactive material shipments. The vast majority of these shipments consist of small amounts of radioactive materials used in industry, research, and medicine. The NRC requires such materials to be shipped in accordance with DOT's safety regulations.

Truck carries transport package for research reactor fuel.

Material Security

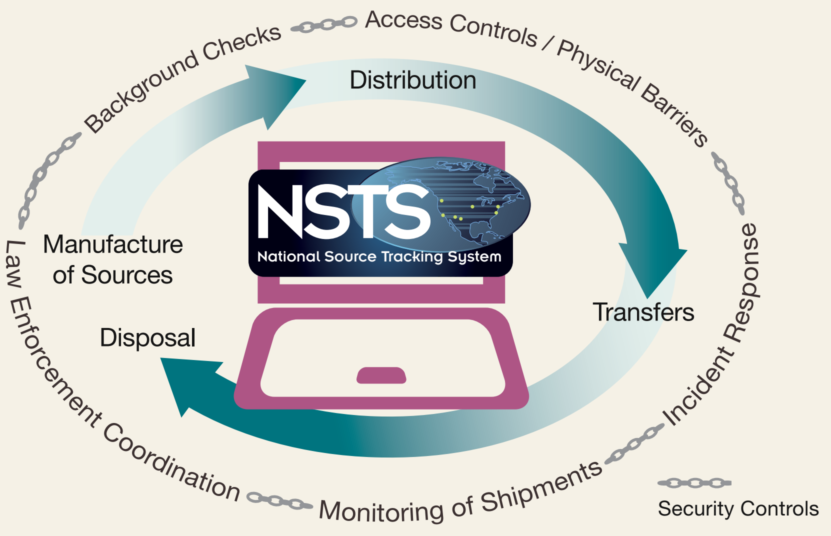
To monitor the manufacture, distribution, and ownership of the most high-risk sources, the NRC set up the National Source Tracking System (NSTS) in January 2009. Licensees use this secure Web-based system to enter information on the receipt or transfer of tracked radioactive sources (see Figure 26. Life-Cycle Approach to Source Security). The NRC and the Agreement States use the system to monitor where high-risk sources are made, shipped, and used.

Sources tracked in the system are known as Category 1 and Category 2 sources. They have the potential to cause permanent injury and even death if they are not handled safely and securely, in compliance with NRC requirements. The majority of these sources are cobalt-60.

See Glossary for definitions of the categories of radioactive sources.

The NRC and the Agreement States have increased controls on the most sensitive radioactive materials. Stronger physical-security requirements and stricter limits on who can access the materials give the NRC and the Agreement States added confidence in their security. The NRC has also joined with other Federal agencies, such as the U.S. Department of Homeland Security (DHS) and DOE's National Nuclear Security Administration, to set up an additional layer of voluntary protection. Together, these activities help make potentially dangerous radioactive sources even more secure and less vulnerable to malevolent uses.

Figure 26. Life-Cycle Approach to Source Security



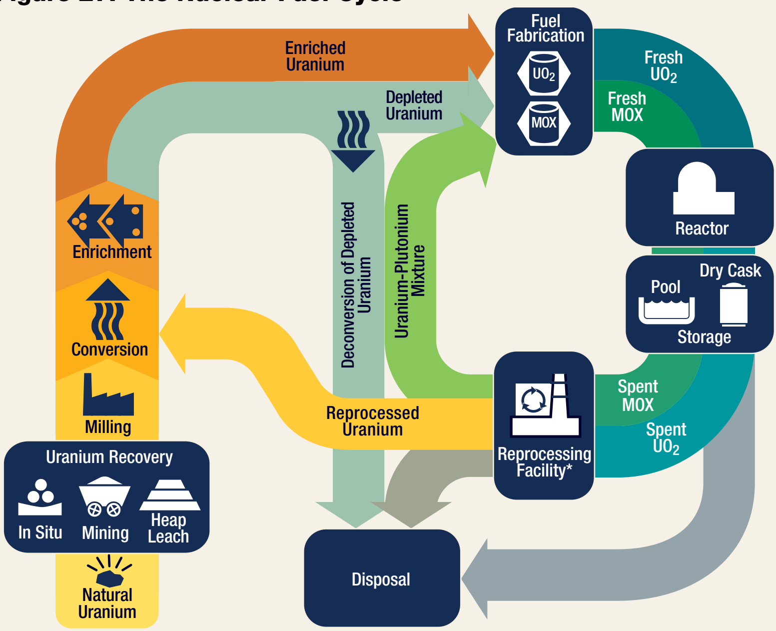
Nuclear Fuel Cycle

The typical nuclear fuel cycle uses uranium in different chemical and physical forms. Figure 27. The Nuclear Fuel Cycle illustrates the stages, which include uranium recovery, conversion, enrichment, and fabrication, to produce fuel for nuclear power plants. Uranium is recovered or extracted from ore, converted, and enriched. Then the enriched uranium is manufactured into pellets. These pellets are placed into fuel assemblies to power nuclear reactors.

Uranium Recovery

The NRC does not regulate conventional mining but does regulate the processing of uranium ore, known as milling. This processing can be done at three types of uranium recovery facilities: conventional mills, in situ recovery facilities, and heap leach facilities. Once this processing is done, the uranium is in a powder form known as yellowcake, which is packed into 55-gallon (208-liter) drums and transported to a fuel cycle facility for further processing. The NRC has an established regulatory framework for uranium recovery facilities. This framework ensures they are licensed, operated, decommissioned, and monitored to protect the public and the environment.

Figure 27. The Nuclear Fuel Cycle



* Reprocessing of spent nuclear fuel, including mixed-oxide (MOX) fuel, is not practiced in the United States.
Note: The NRC has no regulatory role in mining uranium.

Conventional Uranium Mill

A conventional uranium mill is a chemical plant that extracts uranium from ore. Most conventional mills are located away from population centers and within about 30 miles (50 kilometers) of a uranium mine. In a conventional mill, the process of uranium extraction from ore begins when ore is hauled to the mill and crushed. Sulfuric acid dissolves and removes 90 to 95 percent of the uranium from the ore. The uranium is then separated from the solution, concentrated, and dried to form yellowcake.

In Situ Recovery

In situ recovery is another way to extract uranium—in this case, directly from underground ore. In situ facilities recover uranium from ores that cannot be processed economically using other methods. In this process, a solution of native ground water, typically mixed with oxygen or hydrogen peroxide and sodium bicarbonate or carbon dioxide, is injected into the ore to dissolve the uranium. The solution is then pumped out of the rock and the uranium separated to form yellowcake (see Figure 28. The In Situ Uranium Recovery Process).

Heap Leach Facility

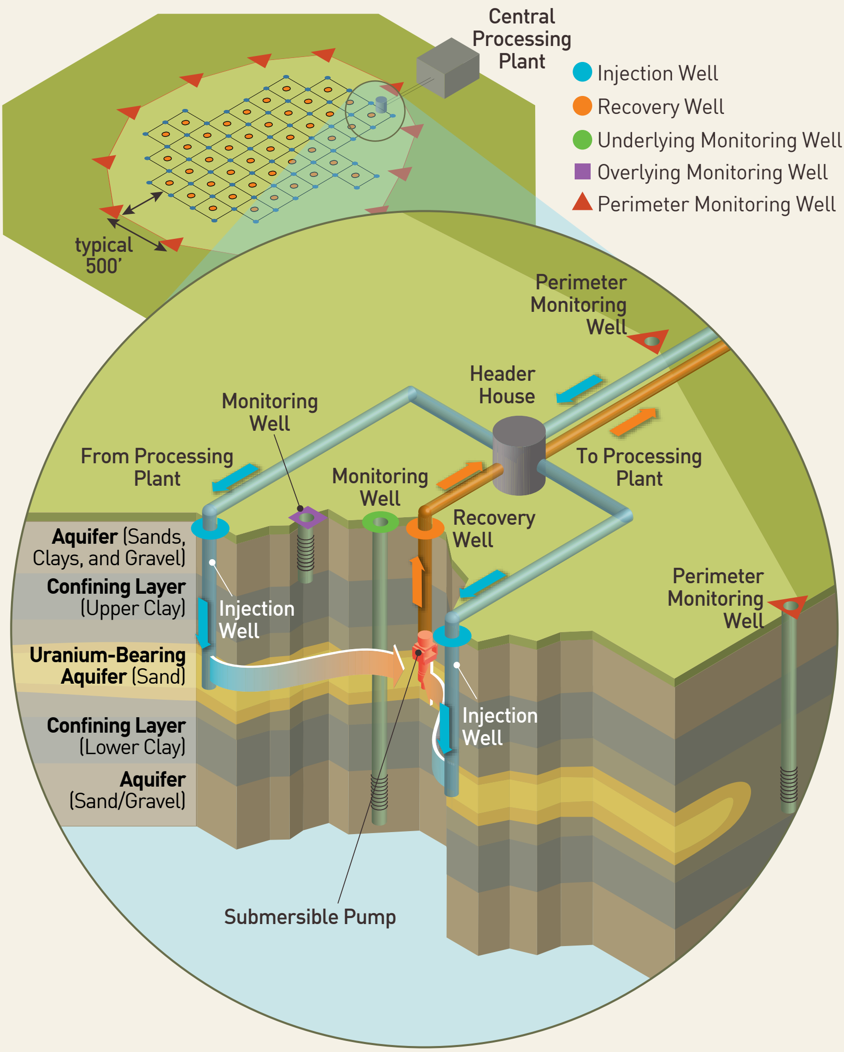
Heap leach facilities also extract uranium from ore. At these facilities, the ore is placed in piles or heaps on top of liners. The liners prevent uranium and other chemicals from moving into the ground. Sulfuric acid is dripped onto the heap and dissolves uranium as it moves through the ore. Uranium solution drains into collection basins, where it is piped to a processing plant. At the plant, uranium is extracted, concentrated, and dried to form yellowcake. The NRC does not currently license any heap leach facilities.

See Glossary for definition and illustration of heap leach recovery process.

Licensing Uranium Recovery Facilities

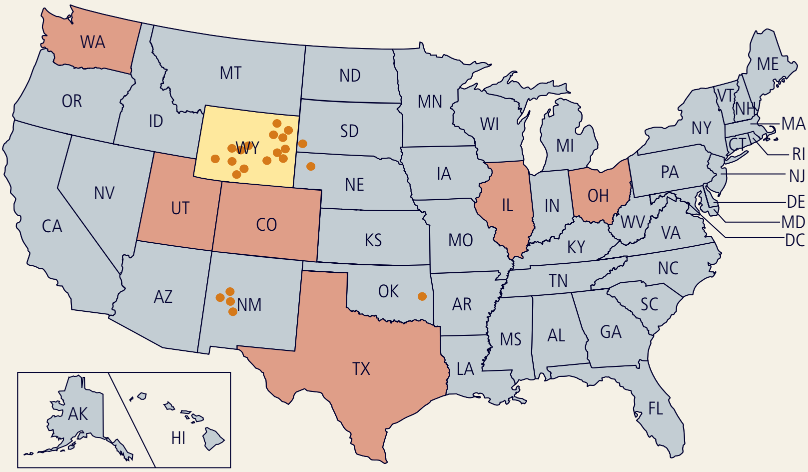
The NRC continues to receive applications to build new uranium recovery facilities and to expand or restart existing facilities. The current status of applications can be found on the NRC's Web site (see the Web Link Index). Existing facilities and new potential sites are located in Wyoming, New Mexico, Nebraska, South Dakota, and Oregon and in the Agreement States of Texas, Colorado, and Utah (see Figure 29. Locations of NRC-Licensed Uranium Recovery Facility Sites).

Figure 28. The In Situ Uranium Recovery Process



Injection wells ● pump a solution of native ground water, typically mixed with oxygen or hydrogen peroxide and sodium bicarbonate ore carbon dioxide into the aquifer (ground water) containing uranium ore. The solution dissolves the uranium from the deposit in the ground and is then pumped back to the surface through recovery wells ●, all controlled by the header house. From there, the solution is sent to the processing plant. Monitoring wells ● ■ ▲ are checked regularly to ensure the injection solution is not escaping from the wellfield. Confining layers keep ground water from moving from one aquifer to another.

Figure 29. Locations of NRC-Licensed Uranium Recovery Facility Sites



States with authority to license uranium recovery facility sites
States where the NRC has retained authority to license uranium recovery facilities
Final Agreement State application received
NRC-licensed uranium recovery facility sites (22)

Note: For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

The NRC takes into account the views of stakeholders, including Native American Tribal governments, to address their concerns with licensing new uranium recovery facilities. The NRC is also responsible for the following actions:

- inspecting and overseeing both active and inactive uranium recovery facilities
- ensuring the safe management of mill tailings (waste) at facilities that the NRC requires to be located and designed to minimize radon release and disturbance by weather or seismic activity
- enforcing requirements to ensure cleanup of active and closed uranium recovery facilities
- applying stringent financial requirements to ensure funds are available for decommissioning
- making sure licensees follow requirements for underground disposal of mill tailings and provide liners for tailings impoundments
- monitoring to prevent ground water contamination
- monitoring and overseeing decommissioned facilities

See Glossary for more information on mill tailings.

Fuel Cycle Facilities

The NRC licenses all commercial fuel cycle facilities involved in conversion, enrichment, and fuel fabrication (see Figure 30. Locations of NRC-Licensed Fuel Cycle Facilities, and Figure 31. Simplified Fuel Fabrication Process).

See Glossary for more information on enrichment processes.

The NRC reviews applications for licenses, license amendments, and renewals. The agency also routinely inspects licensees' safety, safeguards, security, and environmental protection programs.

These facilities turn the uranium that has been removed from ore and made into yellowcake into fuel for nuclear reactors. In this process, the conversion facility converts yellowcake into uranium hexafluoride (UF_6). Next, an enrichment facility heats the solid UF_6 enough to turn it into a gas, which is "enriched," or processed to increase the concentration of the isotope uranium-235.

The enriched uranium gas is mechanically and chemically processed back into a solid uranium dioxide (UO_2) powder. The powder is blended, milled, pressed, and fused into ceramic fuel pellets about the size of a fingertip. The pellets are stacked into tubes or rods that are about 14 feet (4.3 meters) long and made of material such as zirconium alloys; this material is referred to as cladding. These fuel rods are made to maintain both their chemical and physical properties under the extreme conditions of heat and radiation present inside an operating reactor.

After careful inspection, the fuel rods are bundled into fuel assemblies for use in reactors. The assemblies are washed, inspected, and stored in a special rack until ready for shipment to a nuclear power plant. The NRC inspects this operation to ensure it is conducted safely.

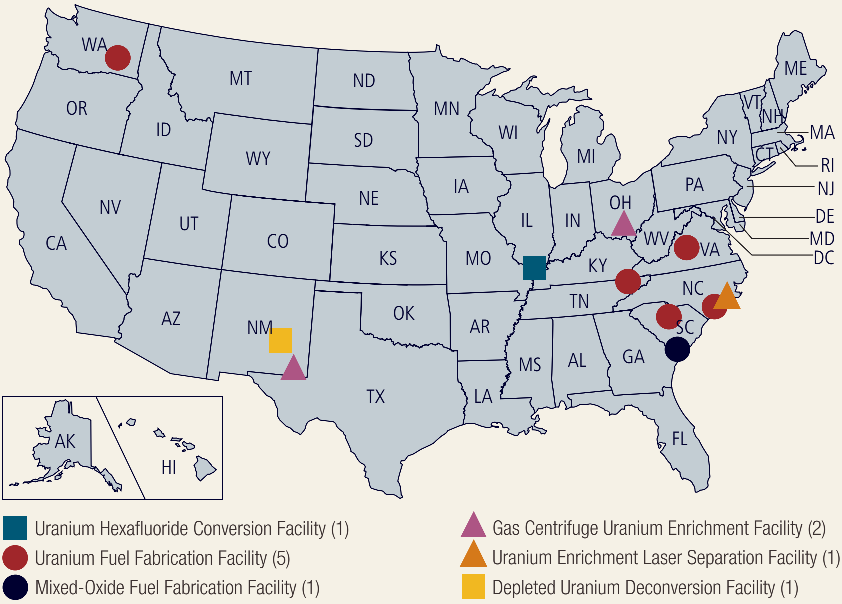
See Appendix M for major U.S. fuel cycle facility sites.

Domestic Safeguards Program

The NRC's domestic safeguards program for fuel cycle facilities and transportation is aimed at ensuring that special nuclear material (such as plutonium or enriched uranium) is not stolen and does not pose a risk to the public from sabotage or terrorism. Through licensing and inspections, the NRC verifies that licensees apply safeguards to protect special nuclear material.

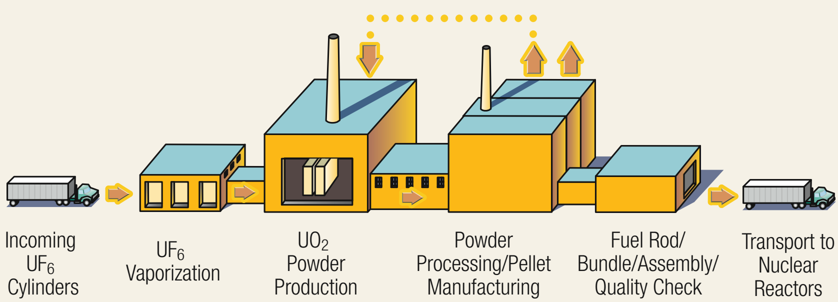
The NRC and DOE developed the Nuclear Materials Management and Safeguards System (NMMSS) to track transfers and inventories of special nuclear material, source material from abroad, and other material. The NRC has issued licenses authorizing facilities to possess special nuclear material in quantities ranging from a single pound to multiple tons. These licensees verify and document their inventories in the NMMSS database. The NRC and Agreement States have licensed several hundred additional sites that possess special nuclear material in smaller quantities. Licensees possessing small amounts of special nuclear material must confirm their inventory annually in the NMMSS database.

Figure 30. Locations of NRC-Licensed Fuel Cycle Facilities



Note: There are no fuel cycle facilities in Alaska or Hawaii.
For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

Figure 31. Simplified Fuel Fabrication Process

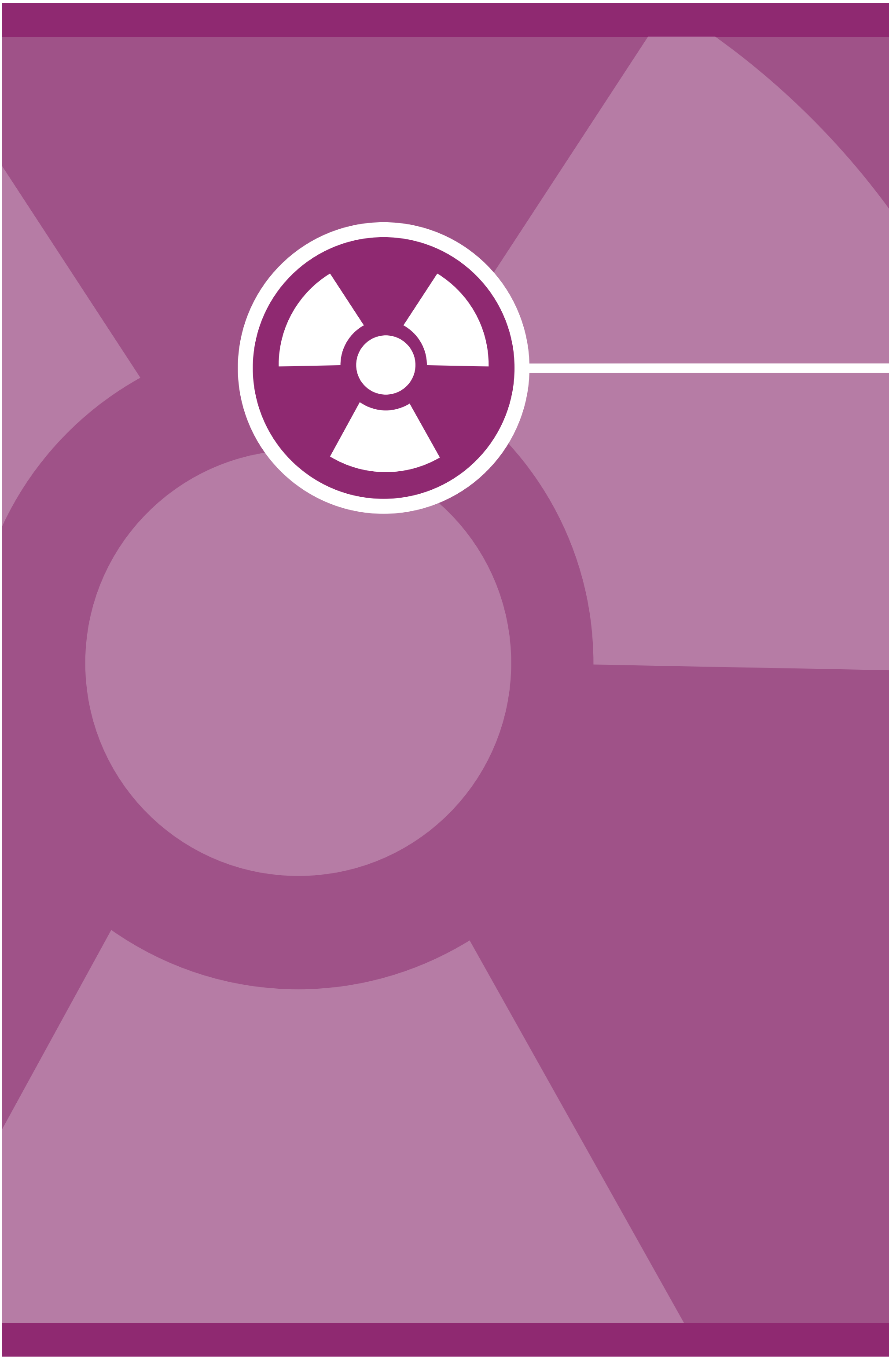


Fabrication of commercial light-water reactor fuel consists of the following three basic steps:

(1) the chemical conversion of UF_6 to UO_2 powder

(2) a ceramic process that converts UO_2 powder to small ceramic pellets

(3) a mechanical process that loads the fuel pellets into rods and constructs finished fuel assemblies



RADIOACTIVE WASTE

Photo courtesy: NAC International

Low-Level Radioactive Waste Disposal

Low-level radioactive waste (LLW) includes items contaminated with radioactive material or exposed to neutron radiation. This waste typically consists of contaminated protective shoe covers and clothing, wiping rags, mops, filters, reactor water treatment residues, equipment and tools, medical waste, and laboratory animal carcasses and tissue. Some LLW is quite low in radioactivity—even as low as just above background levels found in nature. Some licensees, notably hospitals, store such waste on site until it has decayed and lost most of its radioactivity. Then it can be disposed of as ordinary trash. Other LLW, such as parts of a reactor vessel from a nuclear power plant, is more radioactive and requires special handling. Waste that does not decay fairly quickly is stored until amounts are large enough for shipment to an LLW disposal site in containers approved by DOT and the NRC.

Commercial LLW can be disposed of in facilities licensed by either the NRC or Agreement States. The facilities are designed, constructed, and operated to meet NRC safety standards. The facility operator analyzes how the facility will perform in the future based on the environmental characteristics of the site. Current LLW disposal uses shallow land disposal sites with or without concrete vaults (see Figure 32. Low-Level Radioactive Waste Disposal).

Determining the classification of waste is a complex process. The NRC classifies LLW based on its potential hazards. The NRC has specified disposal and waste requirements for three classes of waste—Class A, B, and C—with progressively higher concentrations of radioactive material. Class A waste, the least radioactive, accounts for approximately 96 percent of the total volume of LLW in the United States. A fourth class of LLW, called "greater-than-Class-C waste," is not generally acceptable for near-surface disposal. Under the Low-Level Radioactive Waste Policy Amendments Act of 1985, DOE is responsible for disposal of greater-than-Class-C waste.

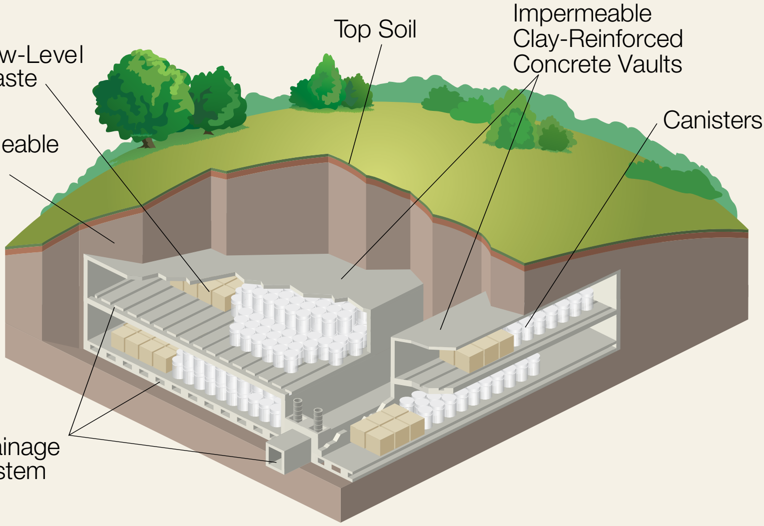
The volume and radioactivity of waste varies from year to year. Waste volumes currently include several million cubic feet each year from operating and decommissioning reactor facilities and from cleanup of contaminated sites.

The LLW Policy Amendments Act gave the States responsibility for LLW disposal. The Act authorized States to:

- form regional compacts, with each compact to provide for LLW disposal site access
- manage LLW import to, and export from, a compact
- exclude waste generated outside a compact

See Appendix P for regional compacts and closed LLW sites.

Figure 32. Low-Level Radioactive Waste Disposal



This LLW disposal site accepts waste from States participating in a regional disposal agreement.

The States have licensed four active LLW disposal facilities:

- EnergySolutions' Barnwell facility, located in Barnwell, SC—Previously, Barnwell accepted LLW from all U.S. generators of LLW. Barnwell now accepts waste only from the Atlantic Compact States of Connecticut, New Jersey, and South Carolina. The State of South Carolina licensed Barnwell to receive Class A, B, and C waste.
- EnergySolutions' Clive facility, located in Clive, UT—Clive accepts waste from all regions of the United States. The State of Utah licensed Clive for Class A waste only.
- US Ecology's Richland facility, located in Richland, WA, on the Hanford Nuclear Reservation—Richland accepts waste from the Northwest Compact States (Alaska, Hawaii, Idaho, Montana, Oregon, Utah, Washington, and Wyoming) and the Rocky Mountain Compact States (Colorado, Nevada, and New Mexico). The State of Washington licensed Richland to receive Class A, B, and C waste.
- Waste Control Specialists' Andrews facility, located in Andrews, TX—Andrews accepts waste from the Texas Compact, which consists of Texas and Vermont. It also accepts waste from out-of-compact generators on a case-by-case basis. The State of Texas licensed Andrews to receive Class A, B, and C waste.

High-Level Radioactive Waste Management

Spent Nuclear Fuel Storage

Commercial spent nuclear fuel, although highly radioactive, is stored safely and securely throughout the United States. Spent fuel is stored in pools and in dry casks at sites with operating nuclear power reactors. Several storage facilities do not have operating power reactors but are safely storing spent fuel. Waste can be stored safely in pools or casks for 100 years or more. The NRC licenses and regulates the storage of spent fuel, both at commercial nuclear power plants and at separate storage facilities.

See Appendices N and O for information about dry spent fuel storage and licensees.

Most reactor facilities were not designed to store the full amount of spent fuel that the reactors would generate during their operational lives. Facilities originally planned to store spent fuel temporarily in deep pools of continuously circulating water, which cools the spent fuel assemblies. After a few years, the facilities were expected to send the spent fuel to a reprocessing plant. However, in 1977, the U.S. Government declared a moratorium on reprocessing spent fuel in the United States. Although the Government later lifted the restriction, reprocessing has not resumed in the United States.

See Glossary for information on fuel reprocessing (recycling).

As a result, facilities expanded their storage capacity by using high-density storage racks in their spent fuel pools. To provide supplemental storage, some fuel assemblies are stored in dry casks on site (see Figure 33. Spent Fuel Generation and Storage After Use). These facilities are called independent spent fuel storage installations (ISFSIs) and are licensed by the NRC. These large casks are typically made of leak-tight, welded, and bolted steel and concrete surrounded by another layer of steel or concrete. The spent fuel sits in the center of the cask in an inert gas. Dry cask storage shields people and the environment from radiation and keeps the spent fuel inside dry and nonreactive (see Figure 34. Dry Storage of Spent Nuclear Fuel).

The NRC regulates facilities that store spent fuel in two different ways. The NRC may grant site-specific licenses after a safety review of the technical requirements and operating conditions for an ISFSI. The NRC has issued a general license authorizing nuclear power reactor licensees to store spent fuel on site in dry storage casks that the NRC has certified. Following a similar safety review, the NRC may issue a Certificate of Compliance and add the cask to a list of approved systems through a rulemaking. The agency issues licenses and certificates for terms not to exceed 40 years, but they can be renewed for up to an additional 40 years (see Figure 35. Licensed and Operating Independent Spent Fuel Storage Installations by State).

The NRC holds public meetings around the country, where NRC staff members provide information about the agency's role and mission and about the performance of area nuclear power plants.

Public Involvement

The public can participate in decisions about spent fuel storage, as it can in many licensing and rulemaking decisions. The Atomic Energy Act of 1954, as amended, and the NRC's own regulations call for public meetings about site-specific licensing actions and allow the public to comment on Certificate of Compliance rulemakings. Members of the public may also file petitions for rulemaking. Additional information on ISFSIs is available on the NRC's Web site (see the Web Link Index).

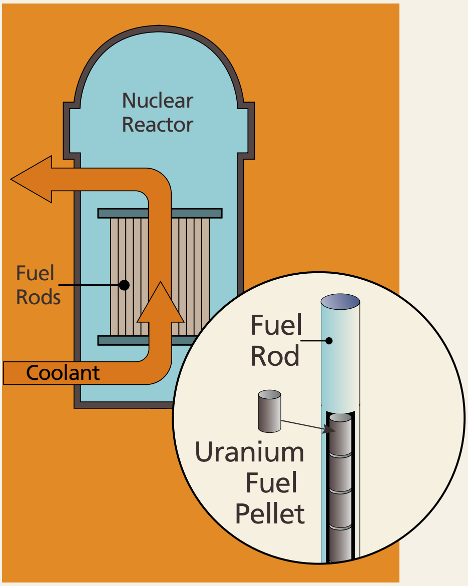
Spent Nuclear Fuel Disposal

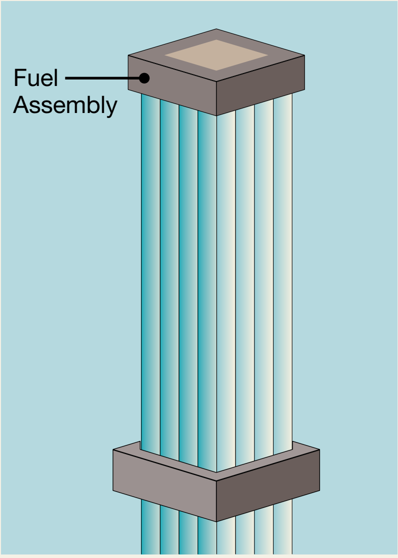
The current U.S. policy governing permanent disposal of high-level radioactive waste is defined by the Nuclear Waste Policy Act of 1982, as amended, and the Energy Policy Act of 1992. These acts specify that high-level radioactive waste will be disposed of underground in a deep geologic repository licensed by the NRC. Because the timing of repository availability is uncertain, the NRC looked at potential environmental impacts of storing spent fuel over three possible timeframes: the short term, which includes 60 years of continued storage after a reactor's operating license has expired; the medium term, or 160 years after license expiration; and indefinite, which assumes a repository never becomes available. The NRC's findings—that any environmental impacts can be managed—appear in the 2014 report NUREG-2157, "Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel."

The NRC adopted those findings into NRC regulations in a Continued Storage Rule. This rule provides an important basis for issuing new or renewed licenses for nuclear power plants and spent fuel storage facilities.

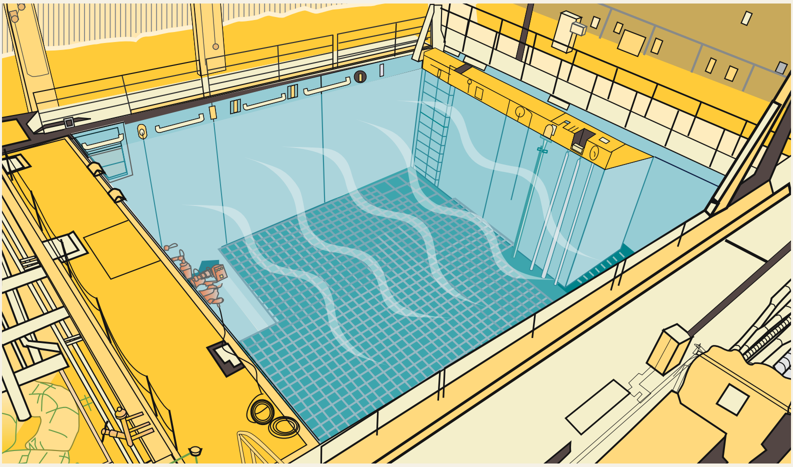
Figure 33. Spent Fuel Generation and Storage After Use

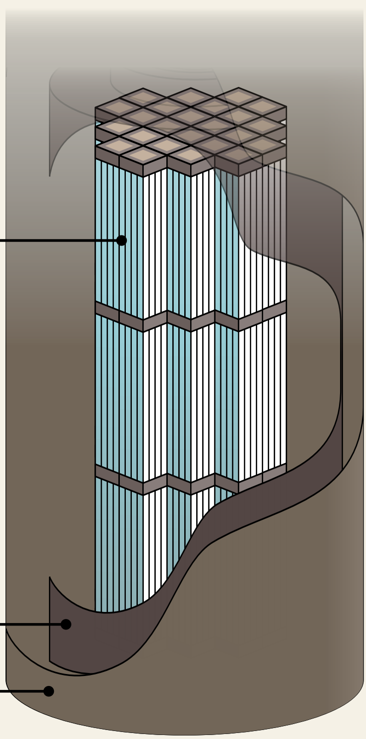
1 A nuclear reactor is powered by enriched uranium-235 fuel. Fission (splitting of atoms) generates heat, which produces steam that turns turbines to produce electricity. A reactor rated at several hundred megawatts may contain 100 or more tons of fuel in the form of bullet-sized pellets loaded into long metal rods that are bundled together into fuel assemblies. Pressurized-water reactors (PWRs) contain between 120 and 200 fuel assemblies. Boiling-water reactors (BWRs) contain between 370 and 800 fuel assemblies.





2 After 5–6 years, spent fuel assemblies (which are typically 14 feet [4.3 meters] long and which contain nearly 200 fuel rods for PWRs and 80–100 fuel rods for BWRs) are removed from the reactor and allowed to cool in storage pools. At this point, the 900-pound (409-kilogram) assemblies contain only about one-fifth the original amount of uranium-235.



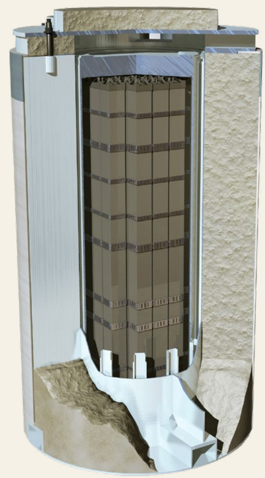


***3** Commercial light-water nuclear reactors store spent radioactive fuel in a steel-lined, seismically designed concrete pool under about 40 feet (12.2 meters) of water that provides shielding from radiation. Pumps supply continuously flowing water to cool the spent fuel. Extra water for the pool is provided by other pumps that can be powered from an onsite emergency diesel generator. Support features, such as water-level monitors and radiation detectors, are also in the pool. Spent fuel is stored in the pool until it is transferred to dry casks on site (as shown in Figure 34) or transported off site for interim storage or disposal.*

Figure 34. Dry Storage of Spent Nuclear Fuel

At nuclear reactors across the country, spent fuel is kept on site, typically above ground, in systems basically similar to the ones shown here. The NRC reviews and approves the designs of these spent fuel storage systems before they can be used.

1 Once the spent fuel has sufficiently cooled, it is loaded into special canisters that are designed to hold nuclear fuel assemblies. Water and air are removed. The canister is filled with inert gas, welded shut, and rigorously tested for leaks. It is then placed in a cask for storage or transportation. The dry casks are then loaded onto concrete pads.



2 The canisters can also be stored in aboveground concrete bunkers, each of which is about the size of a one-car garage.

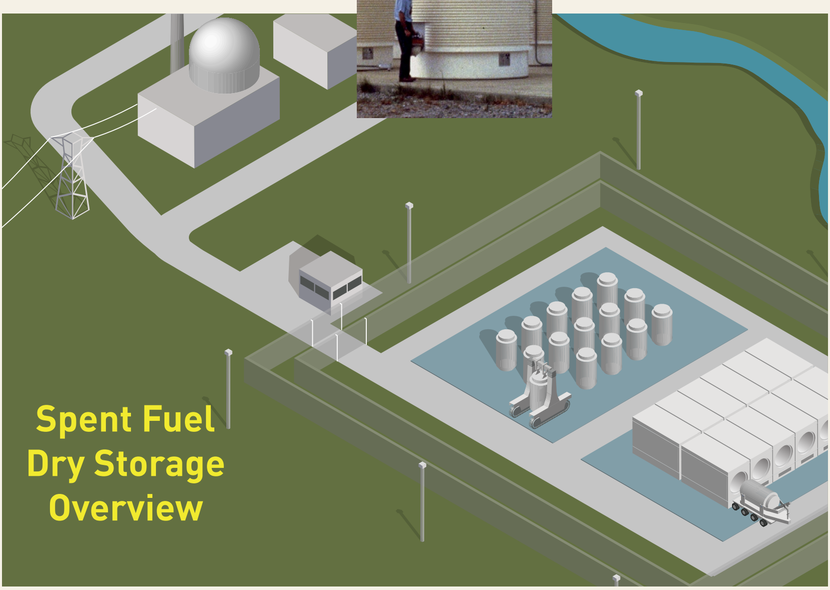
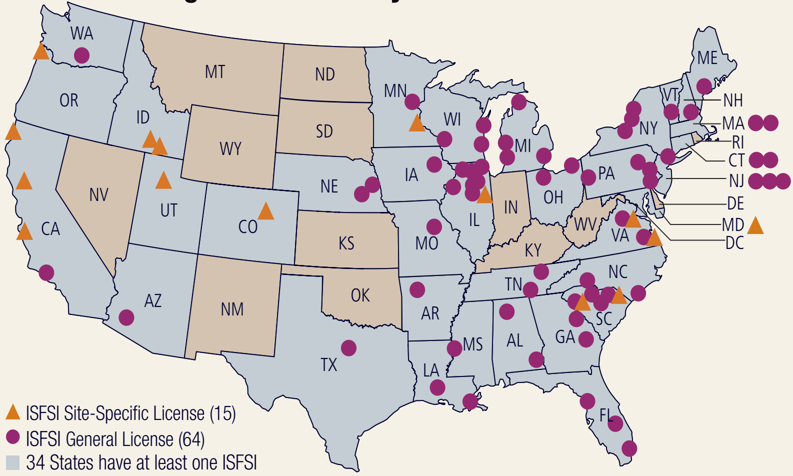


Figure 35. Licensed and Operating Independent Spent Fuel Storage Installations by State



ALABAMA
- ● Browns Ferry
- ● Farley

ARIZONA
- ● Palo Verde

ARKANSAS
- ● Arkansas Nuclear

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

COLORADO
- ▲ Fort St. Vrain

CONNECTICUT
- ● Haddam Neck
- ● Millstone

FLORIDA
- ● Crystal River
- ● St. Lucie
- ● Turkey Point

GEORGIA
- ● Hatch
- ● Vogtle

IDAHO
- ▲ DOE: Three Mile Island-2 (Fuel Debris)
- ▲ DOE: Idaho Spent Fuel Facility

ILLINOIS
- ● Braidwood
- ● Byron
- ● Clinton
- ▲ GEH Morris (Wet)
- ● Dresden
- ● La Salle
- ● Quad Cities
- ● Zion

IOWA
- ● Duane Arnold

LOUISIANA
- ● River Bend
- ● Waterford

MAINE
- ● Maine Yankee

MARYLAND
- ▲ Calvert Cliffs

MASSACHUSETTS
- ● Yankee Rowe
- ● Pilgrim

MICHIGAN
- ● Big Rock Point
- ● Palisades
- ● Cook
- ● Fermi

MINNESOTA
- ● Monticello
- ▲ Prairie Island

MISSISSIPPI
- ● Grand Gulf

MISSOURI
- ● Callaway

NEBRASKA
- ● Cooper
- ● Ft. Calhoun

NEW HAMPSHIRE
- ● Seabrook

NEW JERSEY
- ● Hope Creek
- ● Salem
- ● Oyster Creek

NEW YORK
- ● Indian Point
- ● FitzPatrick
- ● Ginna
- ● Nine Mile Point

NORTH CAROLINA
- ● Brunswick
- ● McGuire

OHIO
- ● Davis-Besse
- ● Perry

OREGON
- ▲ Trojan

PENNSYLVANIA
- ● Limerick
- ● Susquehanna
- ● Peach Bottom
- ● Beaver Valley
- ● Three Mile Island

SOUTH CAROLINA
- ●▲ Oconee
- ●▲ Robinson
- ● Catawba
- ● Summer

TENNESSEE
- ● Sequoyah
- ● Watts Bar

TEXAS
- ● Comanche Peak

UTAH
- ▲ Private Fuel Storage*

VERMONT
- ● Vermont Yankee

VIRGINIA
- ●▲ Surry
- ●▲ North Anna

WASHINGTON
- ● Columbia

WISCONSIN
- ● Point Beach
- ● Kewaunee
- ● LaCrosse

* Facility licensed only, never built or operated.

Alaska and Hawaii are not pictured and have no sites. Data are current as of May 2018. NRC-abbreviated site names listed. For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

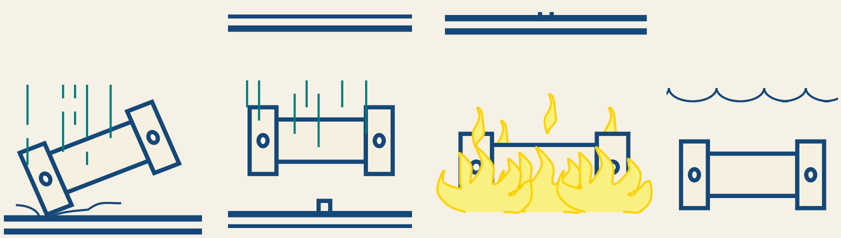
Transportation

The NRC is also involved in the transportation of spent nuclear fuel. The NRC establishes safety and security requirements in collaboration with DOT, certifies transportation cask designs, and conducts inspections to ensure that requirements are being met. Spent fuel transportation casks are designed to meet the following safety criteria under both normal and accident conditions:

- prevent the loss or dispersion of radioactive contents
- shield everything outside the cask from the radioactivity of the contents
- dissipate the heat from the contents
- prevent nuclear criticality (a self-sustaining nuclear chain reaction) from occurring inside the cask

Transportation casks must be designed to survive a sequence of tests, including a 30-foot (9-meter) drop onto an unyielding surface, a puncture test, a fully engulfing fire at 1,475 degrees Fahrenheit (802 degrees Celsius) for 30 minutes, and immersion under water. This very severe test sequence, akin to the cask striking a concrete pillar along a highway at high speed and being engulfed in a severe and long-lasting fire and then falling into a river, simulates conditions more severe than 99 percent of vehicle accidents (see Figure 36. Ensuring Safe Spent Fuel Shipping Containers).

Figure 36. Ensuring Safe Spent Fuel Shipping Containers



The impact (free drop and puncture), fire, and water immersion tests are considered in sequence to determine their cumulative effects on a given package.

To ensure the safe transportation of spent fuel and other nuclear materials, each year the NRC takes the following actions:

- conducts transportation safety inspections of fuel, reactor, and materials licensees
- reviews, evaluates, and certifies new, renewed, or amended transportation package design applications
- conducts inspections of cask vendors and manufacturers to ensure the quality of dry cask design and fabrication
- reviews and evaluates license applications for the export or import of nuclear materials

Additional information on materials transportation is available on the NRC's Web site (see the Web Link Index).

Photo courtesy: NAC International

A transport package is placed inside a conveyance vehicle.

Decommissioning

Decommissioning is the safe removal of a nuclear facility from service and the reduction of residual radioactivity to a level that permits release of the property and termination of the license. NRC rules establish site-release criteria and provide for unrestricted and (under certain conditions) restricted release of a site. The NRC also requires all licensees to maintain financial assurance that funds will be available when needed for decommissioning.

See Appendices C, I, and Q for licensees undergoing decommissioning.

The NRC regulates the decontamination and decommissioning of nuclear power plants, materials and fuel cycle facilities, research and test reactors, and uranium recovery facilities, with the ultimate goal of license termination (see Figure 37. Reactor Decommissioning Overview Timeline and Figure 38. Power Reactor Decommissioning Status).

Reactor Decommissioning

When a nuclear power plant operator decides to cease operations, it must submit to the NRC a "post-shutdown decommissioning activities report" (PSDAR). This may be submitted before shutting down, or no later than 2 years following permanent cessation of operations. The PSDAR includes detailed plans for decommissioning the facility, as well as an estimate of what decommissioning will cost.

The first stage of decommissioning for a nuclear power plant is a transition from operating status to a permanently shutdown condition. This involves revising the NRC's requirements for operating reactors and license amendments to change the plant's licensing basis to reflect its decommissioning status. These changes are in areas such as personnel, spent fuel management, physical and cyber security, emergency preparedness, and incident response. The NRC is developing new regulations that will make this transition from operations to decommissioning more efficient.

The NRC allows a licensee up to 60 years to decommission a nuclear power plant. This may include extended periods of inactivity (called SAFSTOR), during which residual radioactivity is allowed to decay, making eventual cleanup easier and more efficient. A facility is said to be in DECON when active demolition and decontamination is underway. Active decommissioning of a nuclear power plant takes about 10 years on average.

NRC oversight and inspection continue throughout the entire process. Two years before decommissioning is completed, the plant operator must submit a "license termination plan," detailing procedures for the final steps. The NRC inspects and verifies that the site is sufficiently decontaminated before terminating the license and releasing the site for another use.

Figure 37. Reactor Decommissioning Overview Timeline

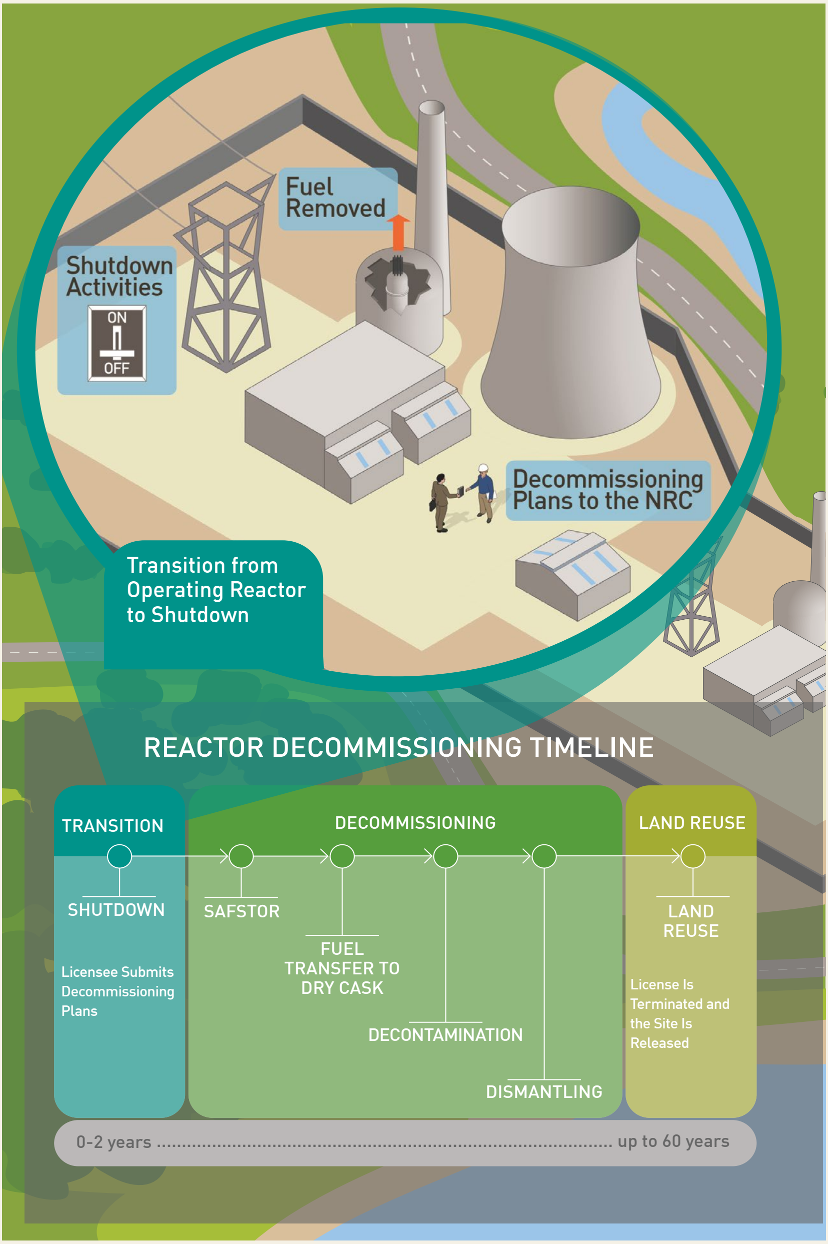
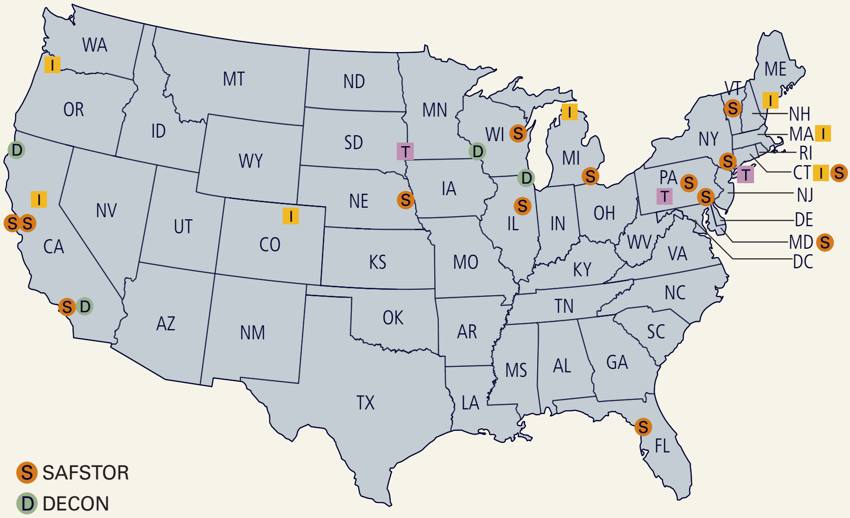


Figure 38. Power Reactor Decommissioning Status



S SAFSTOR

D DECON

Decommissioning Completed

I ISFSI (Independent Spent Fuel Storage Installation) only

T License Terminated (no fuel on site)

CALIFORNIA
- S GE EVESR
- S GE VBWR
- D Humboldt Bay 3
- I Rancho Seco
- S San Onofre 1
- D San Onofre 2 and 3

COLORADO
- I Fort St. Vrain *(DOE License)*

CONNECTICUT
- S Millstone 1
- I Haddam Neck

FLORIDA
- S Crystal River 3

ILLINOIS
- S Dresden 1
- D Zion 1 and 2

MARYLAND
- S N.S. Savannah

MASSACHUSETTS
- I Yankee Rowe

MAINE
- I Maine Yankee

MICHIGAN
- S Fermi 1
- I Big Rock Point

NEBRASKA
- S Fort Calhoun

NEW YORK
- S Indian Point 1
- T Shoreham

OREGON
- I Trojan

PENNSYLVANIA
- T Saxton
- S Peach Bottom 1
- S Three Mile Island 2

SOUTH DAKOTA
- T Pathfinder

VERMONT
- S Vermont Yankee

WISCONSIN
- D LaCrosse
- S Kewaunee

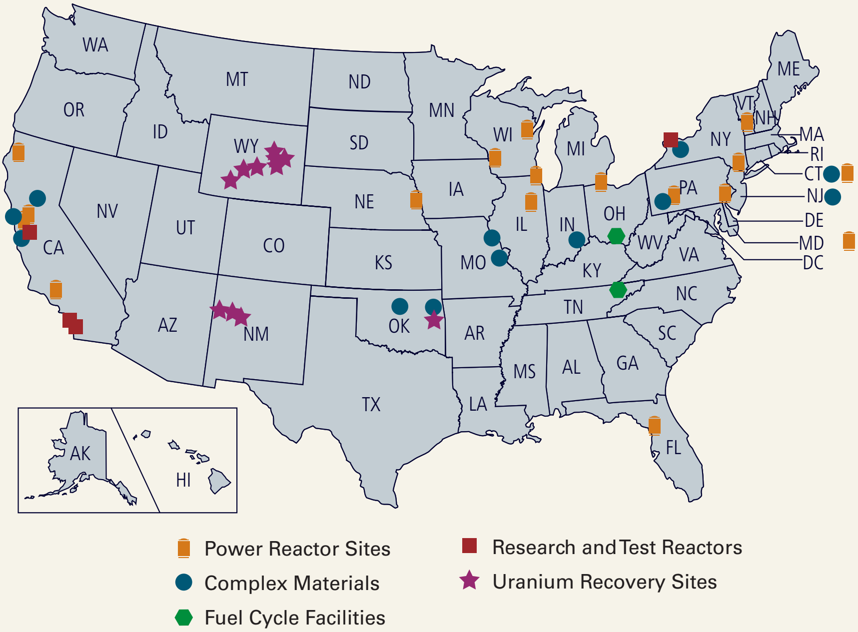
Alaska and Hawaii are not pictured and have no sites.
Notes: ISFSIs are also located at all sites undergoing decommissioning or in SAFSTOR. GE Bonus, Hallam, and Piqua decommissioned reactor sites are part of the DOE nuclear legacy. For more information, visit DOE's Office of Legacy Management LM Sites Web page at *https://www.energy.gov/lm/sites/lm-sites*. CVTR, Elk River, and Shippingport decommissioned reactor sites were either decommissioned before the formation of the NRC or were not licensed by the NRC. Licensees have announced their intention to permanently cease operations for the following: Oyster Creek (2018), Pilgrim (2019), Three Mile Island (2019), Davis Besse (2020), Perry (2021), Indian Point (2020 and 2021), Beaver Valley (2021), Palisades (2022), and Diablo Canyon (2024 and 2025). NRC-abbreviated reactor names are listed. For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

Decommissioning of Materials Licenses

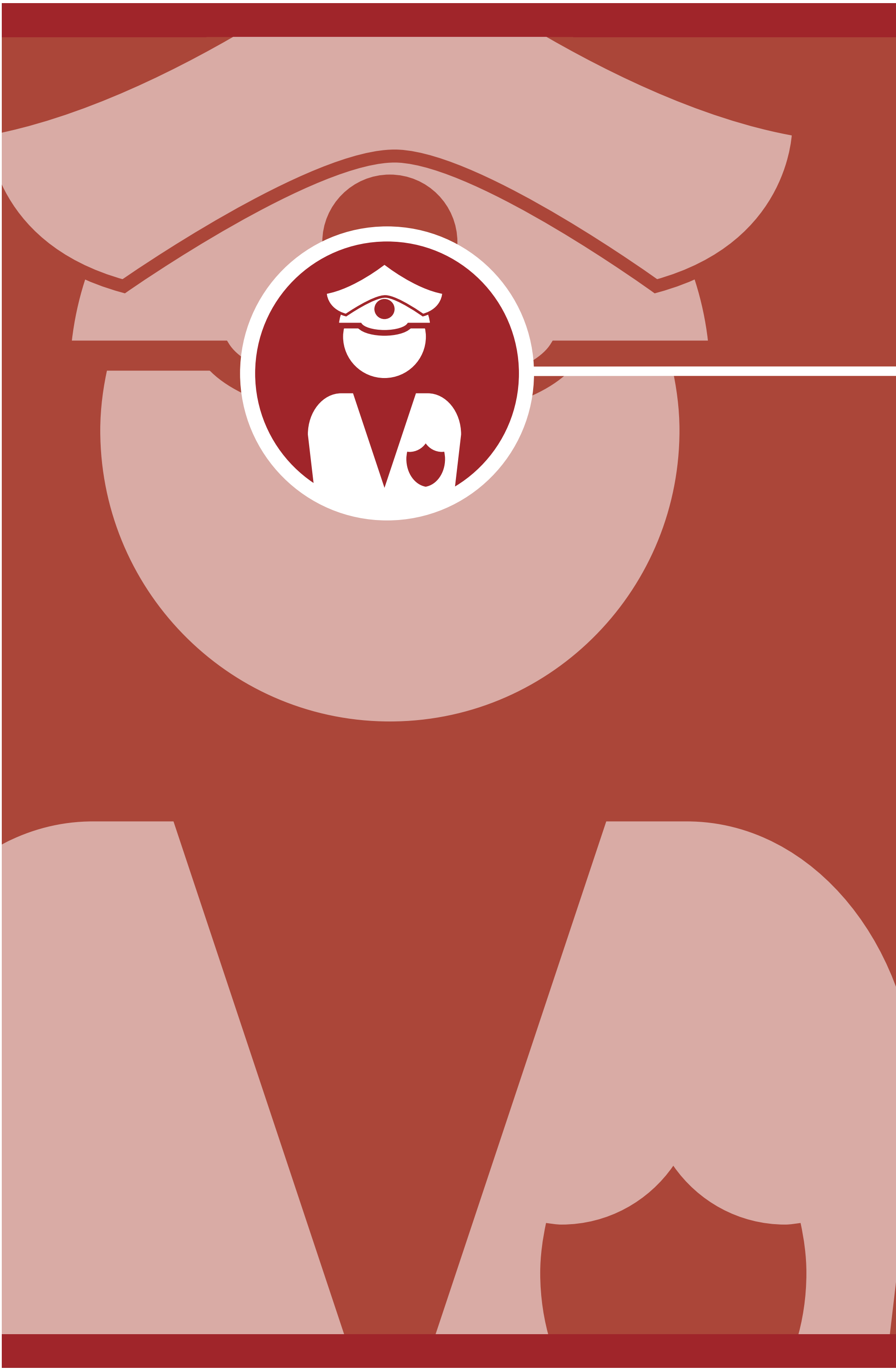
The NRC terminates approximately 100 materials licenses each year. Most of these license terminations are routine, and the sites require little or no cleanup to meet the NRC's criteria for unrestricted access. The decommissioning program focuses on the termination of licenses for research and test reactors, uranium recovery facilities, fuel cycle facilities, and sites involving more complex decommissioning activities. These facilities typically were manufacturing or industrial sites that processed uranium, radium, or thorium or were military bases. They are required to begin decommissioning within 2 years of ending operations, unless the NRC approves an alternative schedule. (See Figure 39. Locations of NRC-Regulated Sites Undergoing Decommissioning.)

SECY-17-0111,"The *Status of the Decommissioning Program—2017 Annual Report,"* contains additional information on the decommissioning programs of the NRC and Agreement States. More information is on the NRC's Web site (see the Web Link Index).

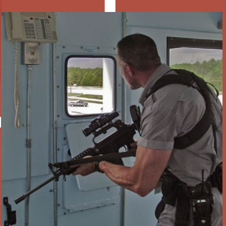
Figure 39. Locations of NRC-Regulated Sites Undergoing Decommissioning



Note: For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.



SECURITY AND EMERGENCY PREPAREDNESS



Overview

Nuclear security is a high priority for the NRC. For decades, effective NRC regulation and strong partnerships with Federal, State, Tribal, and local authorities have ensured effective implementation of security programs at nuclear facilities and radioactive materials sites across the country. In fact, nuclear power plants are likely the best protected private sector facilities in the United States. However, given today's threat environment, the agency recognizes the need for continued vigilance and high levels of security.

In recent years, the NRC has made many enhancements to the security of nuclear power plants. Because nuclear power plants are inherently robust structures, these additional security upgrades (see Figure 40. Security Components) largely focus on:

- well-trained and armed security officers
- high-tech equipment and physical barriers
- greater standoff distances for vehicle checks
- intrusion detection and surveillance systems
- tested emergency preparedness and response plans
- restrictive site-access control, including background checks and fingerprinting of workers

The NRC also coordinates and shares threat information with DHS, the U.S. Department of Defense, the Federal Bureau of Investigation, intelligence agencies, and local law enforcement.

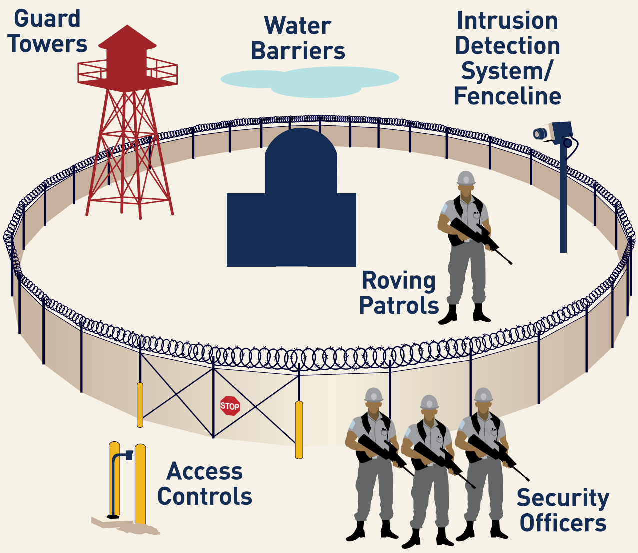
Facility Security

Under NRC regulations, nuclear power plants and fuel facilities that handle highly enriched uranium must be able to defend successfully against a set of threats the agency calls the design-basis threat (DBT). This includes threats to a plant's or facility's physical security, personnel security, and cyber security. The NRC does not make details of the DBT public because of security concerns. However, the agency continuously evaluates this set of threats against real-world intelligence to ensure the DBT remains current.

To test the adequacy of a facility's defenses against the DBT, the NRC conducts rigorous force-on-force inspections at each facility every 3 years. During these inspections, a highly trained mock adversary force "attacks" a nuclear facility. Beginning in 2004, the NRC made these exercises more realistic, more challenging, and more frequent.

Publicly available portions of security-related inspection reports are on the NRC's Web site (see the Web Link Index). For security reasons, inspection reports are not available for the NRC-licensed fuel facilities that handle highly enriched uranium.

Figure 40. Security Components



Protecting nuclear facilities requires all of the security features to come together and work as one.

Cyber Security

Nuclear facilities use digital and analog systems to monitor, control, and run various types of equipment, as well as to obtain and store vital information. Protecting these systems and the information they contain from sabotage or malicious use is called cyber security. The reactor control systems of nuclear plants are isolated from the Internet, but for added security, all nuclear power plants licensed by the NRC must have a cyber security program.

In 2013, the NRC began regular cyber security inspections of nuclear power plants under new regulations designed to guard against the cyber threat. The experience that the NRC gained in developing the cyber security requirements for nuclear power plants provided a basis for developing similar cyber security requirements for nonreactor licensees and other nuclear facilities.

The NRC's cyber security team includes technology and threat experts who constantly evaluate and identify emerging cyber-related issues that could possibly endanger plant systems. The team also makes recommendations to other NRC offices and programs on cyber security issues. In October 2014, the NRC joined other independent regulatory agencies to create the Cyber Security Forum for Independent and Executive Branch Regulators. According to its mission statement, the forum aims to "increase the overall effectiveness and consistency of regulatory authorities' cyber security efforts pertaining to U.S. critical infrastructure, much of which is operated by industry and overseen by a number of federal regulatory authorities."

Materials Security

Radioactive materials must be secured to reduce the possibility that terrorists could use them to make a radiological dispersal device, sometimes called an RDD or dirty bomb. The NRC has established rules to provide the requirements for the physical protection of certain types and quantities of radioactive material. Additionally, the NRC works with the Agreement States, other Federal agencies, IAEA, and licensees to protect radioactive materials from theft and malicious use.

In 2009, the NRC deployed the National Source Tracking System, designed to track the most risk-sensitive radioactive materials in sources. Other improvements allow U.S. Customs and Border Protection agents to promptly validate whether radioactive materials coming into the United States are properly licensed by the NRC or an Agreement State. In addition, the NRC improved and upgraded the joint NRC-DOE database tracking the movement and location of certain forms and quantities of special nuclear material.

Emergency Preparedness

Operators of nuclear facilities are required to develop and maintain effective emergency plans and procedures to protect the public in the unlikely event of an emergency. Emergency preparedness plans include public information, preparations for evacuation, instructions for sheltering, and other actions to protect the residents near nuclear power plants in the event of a serious incident.

The NRC includes emergency preparedness in its inspections and monitors performance indicators associated with emergency preparedness. Nuclear power plant operators must conduct full-scale exercises with the NRC, the Federal Emergency Management Agency (FEMA), and State and local officials at least once every 2 years. Some of these exercises include security and terrorism-based scenarios. These exercises test and maintain the skills of the emergency responders and identify areas that need to be addressed. Nuclear power plant operators also conduct their own emergency response drills.

Emergency Planning Zones

The NRC defines two emergency planning zones (EPZs) around each nuclear power plant. The exact size and configuration of the zones vary from plant to plant, based on local emergency response needs and capabilities, population, land characteristics, access routes, and jurisdictional boundaries. The zone boundaries are flexible, and the NRC may expand these zones during an emergency if circumstances warrant.

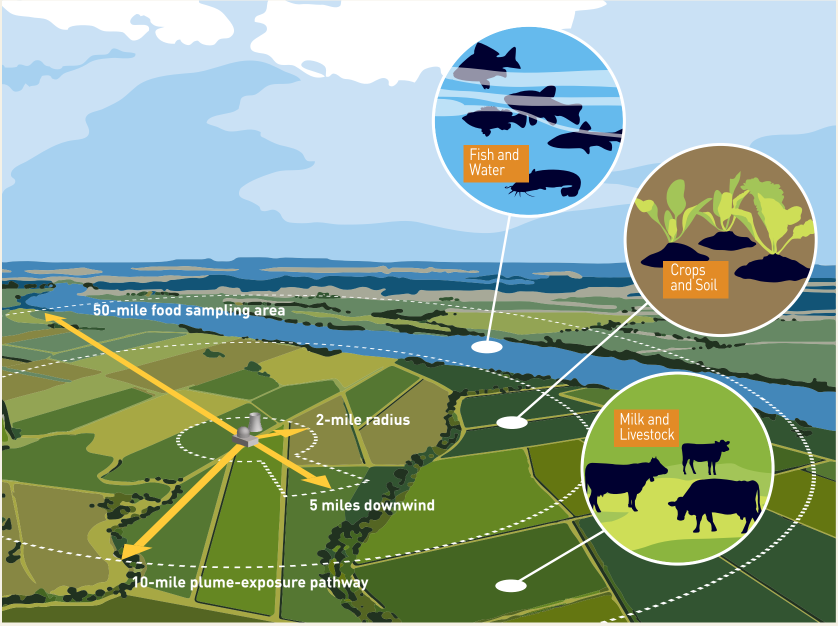
For a typical EPZ around a nuclear plant, see Figure 41. Emergency Planning Zones. The two types of EPZs are the plume-exposure pathway and ingestion pathway. The plume-exposure pathway covers a radius of about 10 miles (16 kilometers) from the plant and is the area of greatest concern for the public's exposure to and inhalation of airborne radioactive contamination.

Research has shown the most significant impacts of an accident would be expected in the immediate vicinity of a plant, and any initial protective actions, such as evacuations or sheltering in place, should be focused there. The ingestion pathway, or food safety sampling area, extends to a radius of about 50 miles (80 kilometers) from the plant and is the area of greatest concern for the ingestion of food and liquid contaminated by radioactivity.

Protective Actions

During an actual nuclear power plant accident, the NRC would use radiation dose projection models to predict the nature and extent of a radiation release. The dose calculations would account for weather conditions to project the extent of radiation exposure to the nearby population. The NRC would confer with appropriate State and county governments on its assessment results. Plant personnel would also provide assessments. State and local officials in communities within the EPZ have detailed plans to protect the public during a radiation release. These officials make their protective action decisions, including decisions to order evacuations, based on these and other assessments.

Figure 41. Emergency Planning Zones



Note: A 2-mile ring around the plant is identified for evacuation, along with a 5-mile zone downwind of the projected release path.

Evacuation, Sheltering, and the Use of Potassium Iodide

Protective actions considered for a radiological emergency include evacuation, sheltering, and the preventive use of potassium iodide (KI) supplements to protect the thyroid from radioactive iodine, which can cause thyroid cancer.

Under certain conditions, it may be preferable to evacuate the public away from further exposure to radioactive material. However, a complete evacuation of the 10-mile (16-kilometer) zone around a nuclear power plant is not likely to be needed in most cases. The release of radioactive material from a plant during a major incident would move with the wind, not in all directions surrounding the plant. The release would also expand and become less concentrated as it traveled away from a plant. For these reasons, evacuations can be planned based on the anticipated path of the release.

Under some conditions, people may be instructed to take shelter in their homes, schools, or office buildings. Depending on the type of structure, sheltering can significantly reduce someone's dose when compared to staying outside. In certain situations, KI may be used as a supplement to sheltering. It may be appropriate to shelter when the release of radioactive material is known to be short term or is controlled by the nuclear power plant operator.

The risk of an offsite radiological release is significantly lower and the types of possible accidents significantly fewer at a nuclear power reactor that has permanently ceased operations and removed fuel from the reactor vessel. Nuclear power plants that have begun decommissioning may therefore apply for exemptions from certain NRC emergency planning requirements. Once the exemptions are granted, State and local agencies may apply their comprehensive emergency plans—known as all-hazard plans—to respond to incidents at the plant. Additional information on emergency preparedness is available on the NRC's Web site (see Web Link Index).

Incident Response

Quick communication among the NRC, other Federal and State agencies, and the nuclear industry is critical when responding to any incident. The NRC staff supports several Federal incident response centers where officials can coordinate assessments of event-related information. The NRC Headquarters Operations Center, located in the agency's headquarters in Rockville, MD, is staffed around the clock to disseminate information and coordinate response activities. The NRC also reviews intelligence reports and assesses suspicious activity to keep licensees and other agencies up to date on current threats.

During an exercise in the agency's Headquarters Operation Center, the NRC reactor safety team looks at simulated projected core temperature levels.

The NRC works within the National Response Framework to respond to events. The framework guides the Nation in its response to complex events that might involve a variety of agencies and hazards. Under this framework, the NRC retains its independent authority and ability to respond to emergencies involving NRC-licensed facilities or materials. The NRC may request support from DHS in responding to an emergency at an NRC-licensed facility or involving NRC-licensed materials. DHS may lead and manage the overall Federal response to an event, according to Homeland Security Presidential Directive 5, "Management of Domestic Incidents." In this case, the NRC would provide technical expertise and help share information among the various organizations and licensees. In response to an incident involving possible radiation releases, the NRC activates its incident response program at its Headquarters Operations Center and one of its four Regional Incident Response Centers. Teams of specialists at these centers evaluate event information, independently assess the potential impact on public health and safety, and evaluate possible recovery strategies.

The NRC staff provides expert consultation, support, and assistance to State and local public safety officials and keeps the public informed of agency actions. Meanwhile, other NRC experts evaluate the effectiveness of protective actions the licensee has recommended to State and local officials. If needed, the NRC will dispatch a team of technical experts from the responsible regional office to the site. This team would assist the NRC's resident inspectors who work at the plant. The Headquarters Operations Center would continue to provide around-the-clock communications, logistical support, and technical analysis throughout the response.

Emergency Classifications

Emergencies at nuclear facilities are classified according to the risk posed to the public. These classifications help guide first responders on the actions necessary to protect the population near the site. Nuclear power plants use these four emergency classifications:

Notification of Unusual Event: Events that indicate a potential degradation in the level of safety or indicate a security threat to the plant are in progress or have occurred. No release of radioactive material requiring offsite response or monitoring is expected unless further degradation occurs.

Alert: Events that involve an actual or potential substantial degradation in the level of plant safety or a security event that involves probable life-threatening risk to site personnel or damage to site equipment are in progress or have occurred. Any releases of radioactive material are expected to be limited to a small fraction of the limits set forth by the U.S. Environmental Protection Agency (EPA).

Site Area Emergency: Events that may result in actual or likely major failures of plant functions needed to protect the public or hostile action that results in intentional damage or malicious acts are in progress or have occurred. Any releases of radioactive material are not expected to exceed the limits set forth by the EPA except near the site boundary.

General Emergency: Events that involve actual or imminent substantial core damage or melting of reactor fuel with the potential for loss of containment integrity or hostile action that results in an actual loss of physical control of the facility are in progress or have occurred. Radioactive releases can be expected to exceed the limits set forth by the EPA for more than the immediate site area.

Nuclear materials and fuel cycle facility licensees use these emergency classifications:

Alert: Events that could lead to a release of radioactive materials are in progress or have occurred. The release is not expected to require a response by an offsite response organization to protect residents near the site.

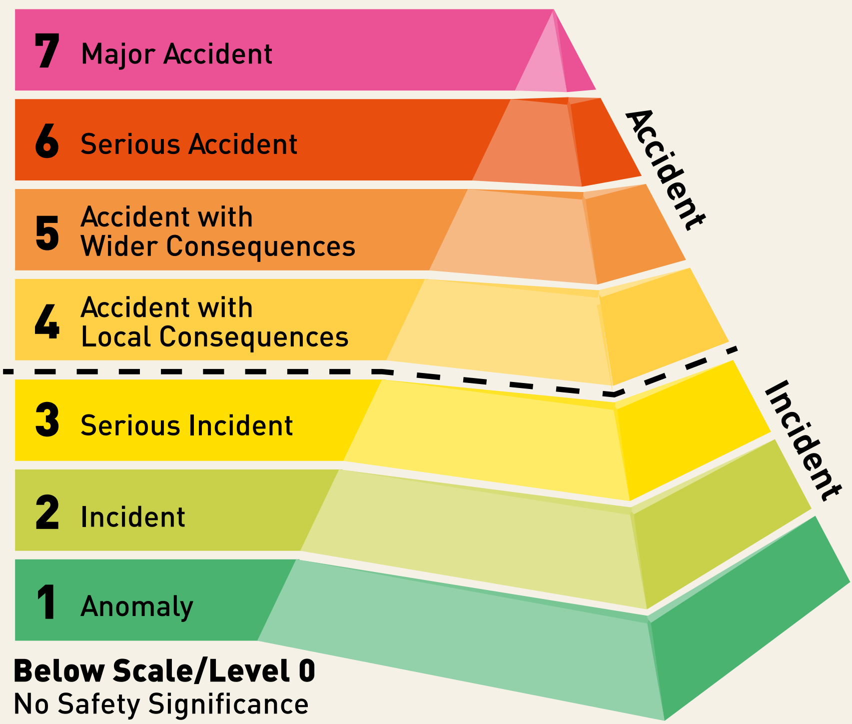
Site Area Emergency: Events that could lead to a significant release of radioactive materials are in progress or have occurred. The release could require a response by offsite response organizations to protect residents near the site.

International Emergency Classifications

IAEA uses the International Nuclear and Radiological Event Scale (INES) as a tool for promptly and consistently communicating to the public the safety significance of reported nuclear and radiological incidents and accidents worldwide (see Figure 42. The International Nuclear and Radiological Event Scale).

The scale can be applied to any event associated with nuclear facilities, as well as to the transport, storage, and use of radioactive material and radiation sources. Licensees are not required to classify events or provide offsite notifications using the INES. But the NRC has a commitment to transmit to IAEA an INES-based rating for an applicable event occurring in the United States rated at Level 2 or above, or events attracting international public interest.

Figure 42. The International Nuclear and Radiological Event Scale

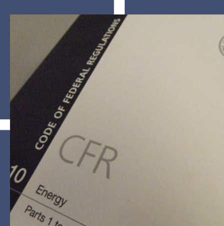


INES events are classified on the scale at seven levels. Levels 1–3 are called incidents and Levels 4–7 are called accidents. The scale is designed so that the severity of an event is about 10 times greater for each increase in level on the scale. Events without safety significance are called deviations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

Source: https://www.iaea.org/topics/emergency-preparedness-and-response-epr/international-nuclear-radiological-event-scale-ines

NRC

APPENDICES



This edition of the Digest provides a snapshot of data; for the most current information and data collection, please visit the NRC Web site Dataset Index Web page at https://www.nrc.gov/reading-rm/doc-collections/datasets/.

Abbreviations

ABWR	advanced boiling-water reactor
AC	Allis Chalmers
ac	alternating current
ACRS	Advisory Committee on Reactor Safeguards
ADAMS	Agencywide Documents Access and Managment System
ADR	Alternative Dispute Resolution
AEC	Atomic Energy Commission (U.S.)
AEP	American Electric Power Company
AGN	solid homogeneous core (Aerojet-General Nucleonics)
AP1000	Advanced Passive 1000 Megawatt (Westinghouse pressurized-water reactor)
AP600	Advanced Passive 600 Megawatt (Westinghouse pressurized-water reactor)
ASLB	Atomic Safety and Licensing Board
B&R	Burns & Roe
B&W	Babcock & Wilcox
BALD	Baldwin Associates
BECH	Bechtel
BRRT	Brown & Root
BWR	boiling-water reactor
CB&I	Chicago Bridge & Iron
CE	Combustion Engineering
CFR	*Code of Federal Regulations*
CNS	Convention on Nuclear Safety
Co.	company
COL	combined license
Comm. Op.	date of commercial operation
Con Type	containment type
DRYAMB	dry, ambient pressure
DRYSUB	dry, subatmospheric
ICECND	wet, ice condenser
MARK 1	*wet, MARK I*
MARK 2	*wet, MARK II*
MARK 3	*wet, MARK III*
CP Issued	date of construction permit issuance
CPPNM	Convention on the Physical Protection of Nuclear Material
CT	computerized tomography
CP	civil penalty
CVTR	Carolinas Virginia Tube Reactor
CWE	Commonwealth Edison Company
DANI	Daniel International
DBDB	Duke & Bechtel
DBT	design-basis threat
DC	design certification
DHS	Department of Homeland Security (U.S.)
DOE	Department of Energy (U.S.)
DOT	Department of Transportation (U.S.)
DUKE	Duke Power Company
EBSO	Ebasco
EDO	Executive Director for Operations
EIA	Energy Information Administration (DOE)
EP	emergency preparedness
EPA	Environmental Protection Agency (U.S.)
EPR	Evolutionary Pressurized-Water Reactor
EPZ	emergency planning zone
ESBWR	Economic Simplified Boiling-Water Reactor
ESP	early site permit
EVESR	ESADA (Empire States Atomic Development Associates) Vallecitos Experimental Superheat Reactor
Exp. Date	expiration date of operating license
FBR	fast breeder reactor
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FLUR	Fluor Pioneer
FOIA	Freedom of Information Act
FR	*Federal Register*
FTE	full-time equivalent
FW	Foster Wheeler
FY	fiscal year
G&H	Gibbs & Hill
GA	General Atomics
GCR	gas-cooled reactor
GE	General Electric
GEH	General Electric-Hitachi Nuclear Energy
GEIS	generic environmental impact statement
GETR	General Electric Test Reactor
GIL	Gilbert Associates
GL	general license
GPC	Georgia Power Company
GW	gigawatt
GWh	gigawatt-hour(s)
Gy	gray
HLW	high-level waste
HTG	high-temperature gas (reactor)
HWR	heavy-water reactor
IAEA	International Atomic Energy Agency
INES	International Nuclear Event Scale
ISFSI	independent spent fuel storage installation
ISR	in situ recovery
IUP	Intergrated University Program
KAIS	Kaiser Engineers
kW	kilowatt(s)
kWh	kilowatt-hour(s)
KI	potassium iodide
LLP	B&W lowered loop
LLW	low-level radioactive waste
LMFB	liquid metal fast breeder (reactor)
LOCA	loss-of-coolant-accident
LR Issued	license renewal issued
LSN	Licensing Support Network

LWGR	light-water-cooled graphite-moderated reactor
Mo-99	molybdenum-99
MOX	mixed oxide
MW	megawatt(s)
MWe	megawatt(s) electric
MWh	megawatt-hour(s)
MWt	megawatt(s) thermal
NEA	Nuclear Energy Agency
NMMSS	Nuclear Materials Management and Safeguards System
NOV	notice of violation
NRC	Nuclear Regulatory Commission (U.S.)
NSP	Northern States Power Company
NSSS	nuclear steam system supplier and design type
GE 2	*GE Type 2*
GE 3	*GE Type 3*
GE 4	*GE Type 4*
GE 5	*GE Type 5*
GE 6	*GE Type 6*
WEST 2LP	*Westinghouse Two-Loop*
WEST 3LP	*Westinghouse Three-Loop*
WEST 4LP	*Westinghouse Four-Loop*
NSTS	National Source Tracking System
OECD	Organisation for Economic Co-operation and Development
OIG	Office of the Inspector General
OL	operating license
OL Issued	date of latest full power operating license
PG&E	Pacific Gas & Electric Company
PHWR	pressurized heavy water reactor
PRA	probabilistic risk assessment
PRIS	Power Reactor Information System
PSDAR	**p**ost-shutdown decommissioning activities report
PSEG	Public Service Electric and Gas Company
PWR	pressurized-water reactor
Rad	radiation absorbed dose
RDD	radiological dispersal devise
RIC	Regulatory Information Conference
RLP	B&W raised loop
ROP	Reactor Oversight Process
RSS	rich site summary
RTR	research and test reactor
S&L	Sargent & Lundy
S&W	Stone & Webster
SCF	sodium-cooled fast (reactor)
SDP	significance determination process
SI	Système Internationale (d'unités) (International System of Units)
SL	severity level
SL	site-specific license
SMR	small modular reactor
SOARCA	State-of-the-Art Reactor Consequence Analyses
SSI	Southern Services Incorporated
STP	South Texas Project
TMI-2	Three Mile Island, Unit 2
Sv	sievert
TRIGA	Training Reactor and Isotopes Production, General Atomics
TVA	Tennessee Valley Authority
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
UE&C	United Engineers & Constructors
UF6	uranium hexafluoride
US-APWR	U.S. [version of] Advanced Pressurized-Water Reactor
VBWR	Vallecitos Boiling-Water Reactor
WDCO	Westinghouse Development Corporation
WEST	Westinghouse Electric
WNA	World Nuclear Association
Y-90	yttrium-90

State and Territory Abbreviations

Alabama	AL	Kentucky	KY	Ohio	OH
Alaska	AK	Louisiana	LA	Oklahoma	OK
American Samoa	AS	Maine	ME	Oregon	OR
Arizona	AZ	Maryland	MD	Pennsylvania	PA
Arkansas	AR	Massachusetts	MA	Puerto Rico	PR
California	CA	Michigan	MI	Rhode Island	RI
Colorado	CO	Minnesota	MN	South Carolina	SC
Connecticut	CT	Mississippi	MS	South Dakota	SD
Delaware	DE	Missouri	MO	Tennessee	TN
District of Columbia	DC	Montana	MT	Texas	TX
Florida	FL	Nebraska	NE	Utah	UT
Georgia	GA	Nevada	NV	Vermont	VT
Guam	GU	New Hampshire	NH	Virgin Islands	VI
Hawaii	HI	New Jersey	NJ	Virginia	VA
Idaho	ID	New Mexico	NM	Washington	WA
Illinois	IL	New York	NY	West Virginia	WV
Indiana	IN	North Carolina	NC	Wisconsin	WI
Iowa	IA	North Dakota	ND	Wyoming	WY
Kansas	KS	Northern Mariana Islands	MP		

QUICK-REFERENCE METRIC CONVERSION TABLES

SPACE AND TIME

Quantity	From Inch-Pound Units	To Metric Units	Multiply by
Length	mi (statute)	km	1.609347
	yd	m	*0.9144
	ft (int)	m	*0.3048
	in.	cm	*2.54
Area	mi^2	km^2	2.589998
	acre	m^2	4,046.873
	yd^2	m^2	0.8361274
	ft^2	m^2	*0.09290304
	in^2	cm^2	*6.4516
Volume	acre foot	m^3	1,233.489
	yd^3	m^3	0.7645549
	ft^3	m^3	0.02831685
	ft^3	L	28.31685
	gal	L	3.785412
	fl oz	mL	29.57353
	in^3	cm^3	16.38706
Velocity	mi/h	km/h	1.609347
	ft/s	m/s	*0.3048
Acceleration	ft/s^2	m/s^2	*0.3048

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	becquerel (Bq)	0.016667
Absorbed dose	rad	gray (Gy)	*0.01
	rad	cGy (centigray)	*1.0
Dose equivalent	rem	sievert (Sv)	*0.01
	rem	mSv	*10.0
	mrem	mSv	*0.01
	mrem	µSv (microsievert)	*10.0
Exposure (x-rays and gamma rays)	roentgen (R)	C (coulomb)/kg	0.000258

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	1/°F	1/K or 1/°C	*1.8
Thermal conductivity	(Btu • in.)/(ft^2 • h • °F)	W/(m • °C)	0.1442279
Coefficient of heat transfer	Btu/(ft^2 • h • °F)	W/(m^2 • °C)	5.678263
Heat capacity	Btu/°F	kJ/°C	1.899108
Specific heat capacity	Btu/(lb • °F)	kJ/(kg • °C)	*4.1868

QUICK-REFERENCE METRIC CONVERSION TABLES

HEAT (continued)

Quantity	From Inch-Pound Units	To Metric Units	Multiply by
Entropy	Btu/°F	kJ/°C	1.899108
Specific entropy	Btu/(lb • °F)	kJ/(kg • °C)	*4.1868
Specific internal energy	Btu/lb	kJ/kg	*2.326

MECHANICS

Quantity	From Inch-Pound Units	To Metric Units	Multiply by
Mass (weight)	ton (short)	t (metric ton)	*0.90718474
	lb (avdp)	kg	*0.45359237
Moment of mass	lb • ft	kg • m	0.138255
Density	ton (short)/yd^3	t/m^3	1.186553
	lb/ft^3	g/m^3	16.01846
Concentration (mass)	lb/gal	g/L	119.8264
Momentum	lb • ft/s	kg • m/s	0.138255
Angular momentum	lb • ft^2/s	kg • m^2/s	0.04214011
Moment of inertia	lb • ft^2	kg • m^2	0.04214011
Force	kip (kilopound)	kN (kilonewton)	4.448222
	lbf	N (newton)	4.448222
Moment of force, torque	lbf • ft	N • m	1.355818
	lbf • in.	N • m	0.1229848
Pressure	atm (std)	kPa (kilopascal)	*101.325
	bar	kPa	*100.0
	lbf/in^2 (formerly psi)	kPa	6.894757
	inHg (32 °F)	kPa	3.38638
	ftH_2O (39.2 °F)	kPa	2.98898
	inH_2O (60 °F)	kPa	0.24884
	mmHg (0 °C)	kPa	0.133322
Stress	kip/in^2 (formerly ksi)	MPa	6.894757
	lbf/in^2 (formerly psi)	MPa	0.006894757
	lbf/in^2 (formerly psi)	kPa	6.894757
	lbf/ft2	kPa	0.04788026
Energy, work	kWh	MJ	*3.6
	cal^{th}	J (joule)	*4.184
	Btu	kJ	1.055056
	ft • lbf	J	1.355818
	therm (U.S.)	MJ	105.4804
Power	Btu/s	kW	1.055056
	hp (electric)	kW	*0.746
	Btu/h	W	0.2930711

* Exact conversion factors

Notes: The information contained in this table is intended to familiarize readers with commonly used International System of Units (SI) units and provide a quick reference to aid understanding of documents containing SI units. The conversion factors listed here have not been approved as NRC guidelines for the development of licensing actions, regulations, or policy.

To convert from metric units to inch-pound units, divide the metric unit by the conversion factor.

Sources: Federal Standard 376B, “Preferred Metric Units for General Use by the Federal Government,” and International Commission on Radiation Units and Measurements, ICRU Report 33, “Radiation Quantities and Units,” issued 1980.

APPENDIX A

Commercial Nuclear Power Reactors

Operating Reactors

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
Arkansas Nuclear One, Unit 1 Entergy Operations, Inc. London, AR (6 miles WNW of Russellville, AR) 05000313 *https://www.nrc.gov/info-finder/reactors/ano1.html*	IV	PWR-DRYAMB B&W LLP BECH BECH	2,568 DPR-51	12/06/1968 05/21/1974 12/19/1974 06/20/2001 05/20/2034	102 56 98 82 72 87
Arkansas Nuclear One, Unit 2 Entergy Operations, Inc. London, AR (6 miles WNW of Russellville, AR) 05000368 *https://www.nrc.gov/info-finder/reactors/ano2.html*	IV	PWR-DRYAMB CE BECH BECH	3,026 NPF-6	12/06/1972 09/01/1978 03/26/1980 06/30/2005 07/17/2038	93 91 85 94 89 70
Beaver Valley Power Station, Unit 1 FirstEnergy Nuclear Operating Co. Shippingport, PA (17 miles W of McCandless, PA) 05000334 *https://www.nrc.gov/info-finder/reactors/bv1.html*	I	PWR-DRYAMB WEST 3LP S&W S&W	2,900 DPR-66	06/26/1970 07/02/1976 10/01/1976 11/05/2009 01/29/2036	92 86 86 90 91 99
Beaver Valley Power Station, Unit 2 FirstEnergy Nuclear Operating Co. Shippingport, PA (17 miles W of McCandless, PA) 05000412 *https://www.nrc.gov/info-finder/reactors/bv2.html*	I	PWR-DRYAMB WEST 3LP S&W S&W	2,900 NPF-73	05/03/1974 08/14/1987 11/17/1987 11/05/2009 05/27/2047	91 97 98 90 97 90
Braidwood Station, Unit 1 Exelon Generation Co., LLC Braceville, IL (20 miles SSW of Joliet, IL) 05000456 *https://www.nrc.gov/info-finder/reactors/brai1.html*	III	PWR-DRYAMB WEST 4LP S&L CWE	3,645 NPF-72	12/31/1975 07/02/1987 07/29/1988 01/27/2016 10/17/2046	91 95 103 93 90 98
Braidwood Station, Unit 2 Exelon Generation Co., LLC Braceville, IL (20 miles SSW of Joliet, IL) 05000457 *https://www.nrc.gov/info-finder/reactors/brai2.html*	III	PWR-DRYAMB WEST 4LP S&L CWE	3,645 NPF-77	12/31/1975 05/20/1988 10/17/1988 01/27/2016 12/18/2046	93 98 96 91 95 98
Browns Ferry Nuclear Plant, Unit 1 Tennessee Valley Authority Limestone County, AL (10 miles S of Athens, AL) 05000259 *https://www.nrc.gov/info-finder/reactors/bf1.html*	II	BWR-MARK 1 GE 4 TVA TVA	3,952 DPR-33	05/10/1967 12/20/1973 08/01/1974 05/04/2006 12/20/2033	88 94 90 94 83 97

APPENDIX A
Commercial Nuclear Power Reactors
Operating Reactors (continued)

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
Browns Ferry Nuclear Plant, Unit 2 Tennessee Valley Authority Limestone County, AL (10 miles S of Athens, AL) 05000260 *https://www.nrc.gov/info-finder/reactors/bf2.html*	II	BWR-MARK 1 GE 4 TVA TVA	3,952 DPR-52	05/10/1967 06/28/1974 03/01/1975 05/04/2006 06/28/2034	99 79 98 85 94 83
Browns Ferry Nuclear Plant, Unit 3 Tennessee Valley Authority Limestone County, AL (10 miles S of Athens, AL) 05000296 *https://www.nrc.gov/info-finder/reactors/bf3.html*	II	BWR-MARK 1 GE 4 TVA TVA	3,952 DPR-68	07/31/1968 07/02/1976 03/01/1977 05/04/2006 07/02/2036	83 89 88 92 80 93
Brunswick Steam Electric Plant, Unit 1 Duke Energy Progress, LLC Southport, NC (20 miles S of Wilmington, NC) 05000325 *https://www.nrc.gov/info-finder/reactors/bru1.html*	II	BWR-MARK 1 GE 4 UE&C BRRT	2,923 DPR-71	02/07/1970 09/08/1976 03/18/1977 06/26/2006 09/08/2036	77 92 89 93 83 93
Brunswick Steam Electric Plant, Unit 2 Duke Energy Progress, LLC Southport, NC (20 miles S of Wilmington, NC) 05000324 *https://www.nrc.gov/info-finder/reactors/bru2.html*	II	BWR-MARK 1 GE 4 UE&C BRRT	2,923 DPR-62	02/07/1970 12/27/1974 11/03/1975 06/26/2006 12/27/2034	98 73 98 81 92 82
Byron Station, Unit 1 Exelon Generation Co., LLC Byron, IL (17 miles SW of Rockford, IL) 05000454 *https://www.nrc.gov/info-finder/reactors/byro1.html*	III	PWR-DRYAMB WEST 4LP S&L CWE	3,645 NPF-37	12/31/1975 02/14/1985 09/16/1985 11/19/2015 10/31/2044	88 96 97 88 97 89
Byron Station, Unit 2 Exelon Generation Co., LLC Byron, IL (17 miles SW of Rockford, IL) 05000455 *https://www.nrc.gov/info-finder/reactors/byro2.html*	III	PWR-DRYAMB WEST 4LP S&L CWE	3,645 NPF-66	12/31/1975 01/30/1987 08/02/1987 11/19/2015 11/06/2046	94 86 94 94 86 46
Callaway Plant, Unit 1 Union Electric Co. Fulton, MO (25 miles ENE of Jefferson City, MO) 05000483 *https://www.nrc.gov/info-finder/reactors/call.html*	IV	PWR-DRYAMB WEST 4LP BECH DANI	3,565 NPF-30	04/16/1976 10/18/1984 12/19/1984 03/06/2015 10/18/2044	103 77 89 96 87 77

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

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Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
Calvert Cliffs Nuclear Power Plant, Unit 1 Calvert Cliffs Nuclear Power Plant, LLC Exelon Generation Co., LLC Lusby, MD (40 miles S of Annapolis, MD) 05000317 *https://www.nrc.gov/info-finder/reactors/calv1.html*	I	PWR-DRYAMB CE BECH BECH	2,737 DPR-53	07/07/1969 07/31/1974 05/08/1975 03/23/2000 07/31/2034	81 97 91 97 89 97
Calvert Cliffs Nuclear Power Plant, Unit 2 Calvert Cliffs Nuclear Power Plant, LLC Exelon Generation Co., LLC Lusby, MD (40 miles S of Annapolis, MD) 05000318 *https://www.nrc.gov/info-finder/reactors/calv2.html*	I	PWR-DRYAMB CE BECH BECH	2,737 DPR-69	07/07/1969 08/13/1976 04/01/1977 03/23/2000 08/13/2036	101 81 100 86 95 91
Catawba Nuclear Station, Unit 1 Duke Energy Carolinas, LLC York, SC (18 miles S of Charlotte, NC) 05000413 *https://www.nrc.gov/info-finder/reactors/cat1.html*	II	PWR-ICECND WEST 4LP DUKE DUKE	3,411 NPF-35	08/07/1975 01/17/1985 06/29/1985 12/05/2003 12/05/2043	89 96 86 88 97 90
Catawba Nuclear Station, Unit 2 Duke Energy Carolinas, LLC York, SC (18 miles S of Charlotte, NC) 05000414 *https://www.nrc.gov/info-finder/reactors/cat2.html*	II	PWR-ICECND WEST 4LP DUKE DUKE	3,411 NPF-52	08/07/1975 05/15/1986 08/19/1986 12/05/2003 12/05/2043	92 86 100 86 88 96
Clinton Power Station, Unit 1 Exelon Generation Co., LLC Clinton, IL (23 miles SSE of Bloomington, IL) 05000461 *https://www.nrc.gov/info-finder/reactors/clin.html*	III	BWR-MARK 3 GE 6 S&L BALD	3,473 NPF-62	02/24/1976 04/17/1987 11/24/1987 N/A 09/29/2026	100 82 97 87 89 84
Columbia Generating Station Energy Northwest Hanford Reservation in Benton County, WA (12 miles NW of Richland, WA) 05000397 *https://www.nrc.gov/info-finder/reactors/wash2.html*	IV	BWR-MARK 2 GE 5 B&R BECH	3,544 NPF-21	03/19/1973 04/13/1984 12/13/1984 05/22/2012 12/20/2043	97 80 98 78 92 77
Comanche Peak Nuclear Power Plant, Unit 1 Comanche Peak Power Co., LLC. Vistra Operating Co., LLC Glen Rose, TX (40 miles SW of Fort Worth, TX) 05000445 *https://www.nrc.gov/info-finder/reactors/cp1.html*	IV	PWR-DRYAMB WEST 4LP G&H BRRT	3,612 NPF-87	12/19/1974 04/17/1990 08/13/1990 N/A 02/08/2030	98 94 85 100 92 91

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

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Commercial Nuclear Power Reactors
Operating Reactors (continued)

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
Comanche Peak Nuclear Power Plant, Unit 2 Comanche Peak Power Co., LLC. Vistra Operating Co., LLC Glen Rose, TX (40 miles SW of Fort Worth, TX) 05000446 *https://www.nrc.gov/info-finder/reactors/cp2.html*	IV	PWR-DRYAMB WEST 4LP BECH BRRT	3,612 NPF-89	12/19/1974 04/06/1993 08/03/1993 N/A 02/02/2033	91 99 93 88 100 68
Cooper Nuclear Station Nebraska Public Power District Brownville, NE (23 miles S of Nebraska City, NE) 05000298 *https://www.nrc.gov/info-finder/reactors/cns.html*	IV	BWR-MARK 1 GE 4 B&R B&R	2,419 DPR-46	06/04/1968 01/18/1974 07/01/1974 11/29/2010 01/18/2034	87 97 88 97 84 99
Davis-Besse Nuclear Power Station, Unit 1 FirstEnergy Nuclear Operating Co. Oak Harbor, OH (21 miles ESE of Toledo, OH) 05000346 *https://www.nrc.gov/info-finder/reactors/davi.html*	III	PWR-DRYAMB B&W RLP BECH B&W	2,817 NPF-3	03/24/1971 04/22/1977 07/31/1978 12/08/2015 04/22/2037	91 95 74 97 79 97
Diablo Canyon Nuclear Power Plant, Unit 1 Pacific Gas & Electric Co. Avila Beach, CA (12 miles WSW of San Luis Obispo, CA) 05000275 *https://www.nrc.gov/info-finder/reactors/diab1.html*	IV	PWR-DRYAMB WEST 4LP PG&E PG&E	3,411 DPR-80	4/23/1968 11/02/1984 05/07/1985 Withdrawn 11/02/2024	84 95 87 87 98 81
Diablo Canyon Nuclear Power Plant, Unit 2 Pacific Gas & Electric Co. Avila Beach, CA (12 miles WSW of San Luis Obispo, CA) 05000323 *https://www.nrc.gov/info-finder/reactors/diab2.html*	IV	PWR-DRYAMB WEST 4LP PG&E PG&E	3,411 DPR-82	12/09/1970 08/26/1985 03/13/1986 Withdrawn 08/26/2025	97 82 86 95 88 95
Donald C. Cook Nuclear Plant, Unit 1 Indiana Michigan Power Co. Bridgman, MI (13 miles S of Benton Harbor, MI) 05000315 *https://www.nrc.gov/info-finder/reactors/cook1.html*	III	PWR-ICECND WEST 4LP AEP AEP	3,304 DPR-58	03/25/1969 10/25/1974 08/28/1975 08/30/2005 10/25/2034	104 78 94 78 82 72
Donald C. Cook Nuclear Plant, Unit 2 Indiana Michigan Power Co. Bridgman, MI (13 miles S of Benton Harbor, MI) 05000316 *https://www.nrc.gov/info-finder/reactors/cook2.html*	III	PWR-ICECND WEST 4LP AEP AEP	3,468 DPR-74	03/25/1969 12/23/1977 07/01/1978 08/30/2005 12/23/2037	91 85 101 79 71 104

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Commercial Nuclear Power Reactors
Operating Reactors (continued)

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
Dresden Nuclear Power Station, Unit 2 Exelon Generation Co., LLC Morris, IL (25 miles SW of Joliet, IL) 05000237 *https://www.nrc.gov/info-finder/reactors/dres2.html*	III	BWR-MARK 1 GE 3 S&L UE&C	2,957 DPR-19	01/10/1966 02/20/1991[A] 06/09/1970 10/28/2004 12/22/2029	104 85 98 83 91 84
Dresden Nuclear Power Station, Unit 3 Exelon Generation Co., LLC Morris, IL (25 miles SW of Joliet, IL) 05000249 *https://www.nrc.gov/info-finder/reactors/dres3.html*	III	BWR-MARK 1 GE 3 S&L UE&C	2,957 DPR-25	10/14/1966 01/12/1971 11/16/1971 10/28/2004 01/12/2031	91 89 95 89 84 91
Duane Arnold Energy Center NextEra Energy Duane Arnold, LLC Palo, IA (8 miles NW of Cedar Rapids, IA) 05000331 *https://www.nrc.gov/info-finder/reactors/duan.html*	III	BWR-MARK 1 GE 4 BECH BECH	1,912 DPR-49	06/22/1970 02/22/1974 02/01/1975 12/16/2010 02/21/2034	83 89 79 88 79 88
Edwin I. Hatch Nuclear Plant, Unit 1 Southern Nuclear Operating Co. Baxley, GA (20 miles S of Vidalia, GA) 05000321 *https://www.nrc.gov/info-finder/reactors/hat1.html*	II	BWR-MARK 1 GE 4 BECH GPC	2,804 DPR-57	09/30/1969 10/13/1974 12/31/1975 01/15/2002 08/06/2034	89 94 89 101 93 97
Edwin I. Hatch Nuclear Plant, Unit 2 Southern Nuclear Operating Co., Inc. Baxley, GA (20 miles S of Vidalia, GA) 05000366 *https://www.nrc.gov/info-finder/reactors/hat2.html*	II	BWR-MARK 1 GE 4 BECH GPC	2,804 NPF-5	12/27/1972 06/13/1978 09/05/1979 01/15/2002 06/13/2038	98 89 99 91 101 95
Fermi, Unit 2 DTE Electric Company Newport, MI (25 miles NE of Toledo, OH) 05000341 *https://www.nrc.gov/info-finder/reactors/ferm2.html*	III	BWR-MARK 1 GE 4 S&L DANI	3,486 NPF-43	09/26/1972 03/20/1985 01/23/1988 12/15/2016 03/20/2045	54 62 82 69 86 82
Grand Gulf Nuclear Station, Unit 1 Entergy Operations, Inc. Port Gibson, MS (20 miles S of Vicksburg, MS) 05000416 *https://www.nrc.gov/info-finder/reactors/gg1.html*	IV	BWR-MARK 3 GE 6 BECH BECH	4,408 NPF-29	09/04/1974 11/01/1984 07/01/1985 12/01/2016 11/01/2044	70 86 82 93 47 58

A: The Atomic Energy Commission (AEC) issued a provisional operating license (OL) on 12/22/1969, allowing commercial operation. The NRC issued a full-term OL on 02/20/1991.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

APPENDIX A
Commercial Nuclear Power Reactors
Operating Reactors (continued)

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
H.B. Robinson Steam Electric Plant, Unit 2 Duke Energy Progress, Inc. Hartsville, SC (26 miles NW of Florence, SC) 05000261 *https://www.nrc.gov/info-finder/reactors/rob2.html*	II	PWR-DRYAMB WEST 3LP EBSO EBSO	2,339 DPR-23	04/13/1967 07/31/1970 03/07/1971 04/19/2004 07/31/2030	85 85 86 85 95 88
Hope Creek Generating Station, Unit 1 PSEG Nuclear, LLC Hancocks Bridge, NJ (18 miles SE of Wilmington, DE) 05000354 *https://www.nrc.gov/info-finder/reactors/hope.html*	I	BWR-MARK 1 GE 4 BECH BECH	3,902 NPF-57	11/04/1974 07/25/1986 12/20/1986 07/20/2011 04/11/2046	93 80 102 83 85 94
Indian Point Nuclear Generating, Unit 2 Entergy Nuclear Indian Point 2, LLC Entergy Nuclear Operations, Inc. Buchanan, NY (24 miles N of New York, NY) 05000247 *https://www.nrc.gov/info-finder/reactors/ip2.html*	I	PWR-DRYAMB WEST 4LP UE&C WDCO	3,216 DPR-26	10/14/1966 09/28/1973 08/01/1974 N/A 09/28/2013	90 77 93 77 53 73
Indian Point Nuclear Generating, Unit 3 Entergy Nuclear Indian Point 3, LLC Entergy Nuclear Operations, Inc. Buchanan, NY (24 miles N of New York, NY) 05000286 *https://www.nrc.gov/info-finder/reactors/ip3.html*	I	PWR-DRYAMB WEST 4LP UE&C WDCO	3,216 DPR-64	08/13/1969 12/12/1975 08/30/1976 N/A 12/12/2015	100 94 98 86 102 73
James A. FitzPatrick Nuclear Power Plant Exelon Generation Co., LLC Scriba, NY (6 miles NE of Oswego, NY) 05000333 *https://www.nrc.gov/info-finder/reactors/fitz.html*	I	BWR-MARK 1 GE 4 S&W S&W	2,536 DPR-59	05/20/1970 10/17/1974 07/28/1975 09/08/2008 10/17/2034	84 89 79 96 76 80
Joseph M. Farley Nuclear Plant, Unit 1 Southern Nuclear Operating Co. Columbia, AL (18 miles S of Dothan, AL) 05000348 *https://www.nrc.gov/info-finder/reactors/far1.html*	II	PWR-DRYAMB WEST 3LP SSI DANI	2,775 NPF-2	08/16/1972 06/25/1977 12/01/1977 05/12/2005 06/25/2037	91 90 102 86 86 100
Joseph M. Farley Nuclear Plant, Unit 2 Southern Nuclear Operating Co. Columbia, AL (18 miles S of Dothan, AL) 05000364 *https://www.nrc.gov/info-finder/reactors/far2.html*	II	PWR-DRYAMB WEST 3LP SSI BECH	2,775 NPF-8	08/16/1972 03/31/1981 07/30/1981 05/12/2005 03/31/2041	104 91 89 98 90 91

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APPENDIX A
Commercial Nuclear Power Reactors
Operating Reactors (continued)

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
LaSalle County Station, Unit 1 Exelon Generation Co., LLC Marseilles, IL (11 miles SE of Ottawa, IL) 05000373 *https://www.nrc.gov/info-finder/reactors/lasa1.html*	III	BWR-MARK 2 GE 5 S&L CWE	3,546 NPF-11	09/10/1973 04/17/1982 01/01/1984 10/19/2016 04/17/2042	97 95 93 99 89 96
LaSalle County Station, Unit 2 Exelon Generation Co., LLC Marseilles, IL (11 miles SE of Ottawa, IL) 05000374 *https://www.nrc.gov/info-finder/reactors/lasa2.html*	III	BWR-MARK 2 GE 5 S&L CWE	3,546 NPF-18	09/10/1973 12/16/1983 10/19/1984 10/19/2016 12/16/2043	103 88 95 83 95 88
Limerick Generating Station, Unit 1 Exelon Generation Co., LLC Limerick, PA (21 miles NW of Philadelphia, PA) 05000352 *https://www.nrc.gov/info-finder/reactors/lim1.html*	I	BWR-MARK 2 GE 4 BECH BECH	3,515 NPF-39	06/19/1974 08/08/1985 02/01/1986 10/20/2014 10/26/2044	85 101 91 100 93 100
Limerick Generating Station, Unit 2 Exelon Generation Co., LLC Limerick, PA (21 miles NW of Philadelphia, PA) 05000353 *https://www.nrc.gov/info-finder/reactors/lim2.html*	I	BWR-MARK 2 GE 4 BECH BECH	3,515 NPF-85	06/19/1974 08/25/1989 01/08/1990 10/20/2014 06/22/2049	95 94 99 89 101 86
McGuire Nuclear Station, Unit 1 Duke Energy Carolinas, LLC Huntersville, NC (17 miles N of Charlotte, NC) 05000369 *https://www.nrc.gov/info-finder/reactors/mcg1.html*	II	PWR-ICECND WEST 4LP DUKE DUKE	3,411 NPF-9	02/23/1973 07/08/1981 12/01/1981 12/05/2003 06/12/2041	105 82 82 95 89 90
McGuire Nuclear Station, Unit 2 Duke Energy Carolinas, LLC Huntersville, NC (17 miles N of Charlotte, NC) 05000370 *https://www.nrc.gov/info-finder/reactors/mcg2.html*	II	PWR-ICECND WEST 4LP DUKE DUKE	3,411 NPF-17	02/23/1973 05/27/1983 03/01/1984 12/05/2003 03/03/2043	82 95 94 87 97 86
Millstone Power Station, Unit 2 Dominion Nuclear Connecticut, Inc. Waterford, CT (3.2 miles WSW of New London, CT) 05000336 *https://www.nrc.gov/info-finder/reactors/mill2.html*	I	PWR-DRYAMB CE BECH BECH	2,700 DPR-65	12/11/1970 09/26/1975 12/26/1975 11/28/2005 07/31/2035	83 95 85 85 93 85

APPENDIX A
Commercial Nuclear Power Reactors
Operating Reactors (continued)

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
Millstone Power Station, Unit 3 Dominion Nuclear Connecticut, Inc. Waterford, CT (3.2 miles WSW of New London, CT) 05000423 *https://www.nrc.gov/info-finder/reactors/mill3.html*	I	PWR-DRYSUB WEST 4LP S&W S&W	3,650 NPF-49	08/09/1974 01/31/1986 04/23/1986 11/28/2005 11/25/2045	100 87 87 97 83 89
Monticello Nuclear Generating Plant, Unit 1 Northern States Power Company-Minnesota Monticello, MN (30 miles NW of Minneapolis, MN) 05000263 https://www.nrc.gov/info-finder/reactors/mont.html	III	BWR-MARK 1 GE 3 BECH BECH	2,004 DPR-22	06/19/1967 01/09/1981[B] 06/30/1971 11/08/2006 09/08/2030	101 50 78 78 93 86
Nine Mile Point Nuclear Station, Unit 1 Nine Mile Point Nuclear Station, LLC Scriba, NY (6 miles NE of Oswego, NY) 05000220 *https://www.nrc.gov/info-finder/reactors/nmp1.html*	I	BWR-MARK 1 GE 2 NIAG S&W	1,850 DPR-63	04/12/1965 12/26/1974[C] 12/01/1969 10/31/2006 08/22/2029	87 88 98 88 96 87
Nine Mile Point Nuclear Station, Unit 2 Nine Mile Point Nuclear Station, LLC Scriba, NY (6 miles NE of Oswego, NY) 05000410 *https://www.nrc.gov/info-finder/reactors/nmp2.html*	I	BWR-MARK 2 GE 5 S&W S&W	3,988 NPF-69	06/24/1974 07/02/1987 03/11/1988 10/31/2006 10/31/2046	83 99 87 100 92 101
North Anna Power Station, Unit 1 Virginia Electric & Power Co. Mineral (Louisa County), VA (40 miles NW of Richmond, VA) 05000338 *https://www.nrc.gov/info-finder/reactors/na1.html*	II	PWR-DRYSUB WEST 3LP S&W S&W	2,940 NPF-4	02/19/1971 04/01/1978 06/06/1978 03/20/2003 04/01/2038	89 89 100 91 89 99
North Anna Power Station, Unit 2 Virginia Electric & Power Co. Mineral (Louisa County), VA (40 miles NW of Richmond, VA) 05000339 *https://www.nrc.gov/info-finder/reactors/na2.html*	II	PWR-DRYSUB WEST 3LP S&W S&W	2,940 NPF-7	02/19/1971 08/21/1980 12/14/1980 03/20/2003 08/21/2040	99 85 92 99 87 89

B: The AEC issued a provisional OL on 09/08/1970, allowing commercial operation. The NRC issued a full-term OL on 01/09/1981.
C: The AEC issued a provisional OL on 08/22/1969, allowing commercial operation. The NRC issued a full-term OL on 12/26/1974.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

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Operating Reactors (continued)

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
Oconee Nuclear Station, Unit 1 Duke Energy Carolinas, LLC Seneca, SC (30 miles W of Greenville, SC) 05000269 *https://www.nrc.gov/info-finder/reactors/oco1.html*	II	PWR-DRYAMB B&W LLP DBDB DUKE	2,568 DPR-38	11/06/1967 02/06/1973 07/15/1973 05/23/2000 02/06/2033	90 91 91 96 83 95
Oconee Nuclear Station, Unit 2 Duke Energy Carolinas, LLC Seneca, SC (30 miles W of Greenville, SC) 05000270 *https://www.nrc.gov/info-finder/reactors/oco2.html*	II	PWR-DRYAMB B&W LLP DBDB DUKE	2,568 DPR-47	11/06/1967 10/06/1973 09/09/1974 05/23/2000 10/06/2033	102 82 101 89 98 88
Oconee Nuclear Station, Unit 3 Duke Energy Carolinas, LLC Seneca, SC (30 miles W of Greenville, SC) 05000287 *https://www.nrc.gov/info-finder/reactors/oco3.html*	II	PWR-DRYAMB B&W LLP DBDB DUKE	2,568 DPR-55	11/06/1967 07/19/1974 12/16/1974 05/23/2000 07/19/2034	86 97 92 97 91 97
Oyster Creek Nuclear Generating Station Exelon Generation Co., LLC Forked River, NJ (9 miles S of Toms River, NJ) 05000219 *https://www.nrc.gov/info-finder/reactors/oc.html*	I	BWR-MARK 1 GE 2 B&R B&R	1,930 DPR-16	12/15/1964 07/02/1991[D] 12/10/1969 04/08/2009 04/09/2029	88 106 90 109 95 113
Palisades Nuclear Plant Entergy Nuclear Operations, Inc. Covert, MI (5 miles S of South Haven, MI) 05000255 *https://www.nrc.gov/info-finder/reactors/pali.html*	III	PWR-DRYAMB CE BECH BECH	2,565.4 DPR-20	03/14/1967 02/21/1991[E] 12/31/1971 01/17/2007 03/24/2031	74 85 86 89 99 86
Palo Verde Nuclear Generating Station, Unit 1 Arizona Public Service Company Wintersburg, AZ (50 miles W of Phoenix, AZ) 05000528 *https://www.nrc.gov/info-finder/reactors/palo1.html*	IV	PWR-DRYAMB CE 80-2L BECH BECH	3,990 NPF-41	05/25/1976 06/01/1985 01/28/1986 04/21/2011 06/01/2045	100 85 90 94 83 85
Palo Verde Nuclear Generating Station, Unit 2 Arizona Public Service Company Wintersburg, AZ (50 miles W of Phoenix, AZ) 05000529 *https://www.nrc.gov/info-finder/reactors/palo2.html*	IV	PWR-DRYAMB CE 80-2L BECH BECH	3,990 NPF-51	05/25/1976 04/24/1986 09/19/1986 04/21/2011 04/24/2046	90 91 90 85 95 86

D: The AEC issued a provisional OL on 04/09/1969, allowing commercial operation. The NRC issued a full-term OL on 07/02/1991.

E: The AEC issued a provisional OL on 03/24/1971, allowing commercial operation. The NRC issued a full-term OL on 02/21/1991.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX A
Commercial Nuclear Power Reactors
Operating Reactors (continued)

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012– 2017* Capacity Factor (Percent)
Palo Verde Nuclear Generating Station, Unit 3	IV	PWR-DRYAMB	3,990	05/25/1976	88
Arizona Public Service Company		CE80-2L	NPF-74	11/25/1987	79
Wintersburg, AZ		BECH		01/08/1988	101
(50 miles W of Phoenix, AZ)		BECH		04/21/2011	85
05000530				11/25/2047	85
https://www.nrc.gov/info-finder/reactors/palo3.html					92
Peach Bottom Atomic Power Station, Unit 2	I	BWR-MARK 1	4,016	01/31/1968	88
Exelon Generation Co., LLC		GE 4	DPR-44	10/25/1973	100
Delta, PA		BECH		07/05/1974	88
(17.9 miles S of Lancaster, PA)		BECH		05/07/2003	99
05000277				08/08/2033	96
https://www.nrc.gov/info-finder/reactors/pb2.html					92
Peach Bottom Atomic Power Station, Unit 3	I	BWR-MARK 1	4,016	01/31/1968	103
Exelon Generation Co., LLC		GE 4	DPR-56	07/02/1974	85
Delta, PA		BECH		12/23/1974	103
(17.9 miles S of Lancaster, PA)		BECH		05/07/2003	75
05000278				07/02/2034	95
https://www.nrc.gov/info-finder/reactors/pb3.html					86
Perry Nuclear Power Plant, Unit 1	III	BWR-MARK 3	3,758	05/03/1977	92
FirstEnergy Nuclear Operating Co.		GE 6	NPF-58	11/13/1986	73
Perry, OH		GIL		11/18/1987	96
(35 miles NE of Cleveland, OH)		KAIS		N/A	83
05000440				03/18/2026	91
https://www.nrc.gov/info-finder/reactors/perr1.html					85
Pilgrim Nuclear Power Station	I	BWR-MARK 1	2,028	08/26/1968	98
Entergy Nuclear Operations, Inc.		GE 3	DPR-35	06/08/1972	74
Plymouth, MA		BECH		12/01/1972	97
(38 miles SE of Boston, MA)		BECH		05/29/2012	85
05000293				06/08/2032	92
https://www.nrc.gov/info-finder/reactors/pilg.html					86
Point Beach Nuclear Plant, Unit 1	III	PWR-DRYAMB	1,800	07/19/1967	100
NextEra Energy Point Beach, LLC		WEST 2LP	DPR-24	10/05/1970	84
Two Rivers, WI		BECH		12/21/1970	90
(13 miles NW of Manitowoc, WI)		BECH		12/22/2005	92
05000266				10/05/2030	86
https://www.nrc.gov/info-finder/reactors/poin1.html					86
Point Beach Nuclear Plant, Unit 2	III	PWR-DRYAMB	1,800	07/25/1968	89
NextEra Energy Point Beach, LLC		WEST 2LP	DPR-27	03/08/1973[F]	93
Two Rivers, WI		BECH		10/01/1972	90
(13 miles NW of Manitowoc, WI)		BECH		12/22/2005	94
05000301				03/08/2033	86
https://www.nrc.gov/info-finder/reactors/poin2.html					85

F: AEC issued a provisional OL on 11/18/1971. The NRC issued a full-term OL on 03/08/1973.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

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Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
Prairie Island Nuclear Generating Plant, Unit 1	III	PWR-DRYAMB	1,677	06/25/1968	81
Northern States Power Co.—Minnesota		WEST 2LP	DPR-42	04/05/1974[G]	90
Welch, MN		FLUR		12/16/1973	84
(28 miles SE of Minneapolis, MN)		NSP		06/27/2011	77
05000282				08/09/2033	81
https://www.nrc.gov/info-finder/reactors/prai1.html					88
Prairie Island Nuclear Generating Plant, Unit 2	III	PWR-DRYAMB	1,677	06/25/1968	74
Northern States Power Co.—Minnesota		WEST 2LP	DPR-60	10/29/1974	59
Welch, MN		FLUR		12/21/1974	101
(28 miles SE of Minneapolis, MN)		NSP		06/27/2011	65
05000306				10/29/2034	78
https://www.nrc.gov/info-finder/reactors/prai2.html					80
Quad Cities Nuclear Power Station, Unit 1	III	BWR-MARK 1	2,957	02/15/1967	102
Exelon Generation Co., LLC		GE 3	DPR-29	12/14/1972	85
Cordova, IL		S&L		02/18/1973	103
(20 miles NE of Moline, IL)		UE&C		10/28/2004	83
05000254				12/14/2032	92
https://www.nrc.gov/info-finder/reactors/quad1.html					85
Quad Cities Nuclear Power Station, Unit 2	III	BWR-MARK 1	2,957	02/15/1967	92
Exelon Generation Co., LLC		GE 3	DPR-30	12/14/1972	91
Cordova, IL		S&L		03/10/1973	90
(20 miles NE of Moline, IL)		UE&C		10/28/2004	95
05000265				12/14/2032	85
https://www.nrc.gov/info-finder/reactors/quad2.html					89
R.E. Ginna Nuclear Power Plant	I	PWR-DRYAMB	1,775	04/25/1966	90
R.E. Ginna Nuclear Power Plant, LLC		WEST 2LP	DPR-18	09/19/1969	93
Ontario, NY		GIL		07/01/1970	91
(20 miles NE of Rochester, NY)		BECH		05/19/2004	89
05000244				09/18/2029	94
https://www.nrc.gov/info-finder/reactors/ginn.html					87
River Bend Station, Unit 1	IV	BWR-MARK 3	3,091	03/25/1977	91
Entergy Nuclear Operations, Inc.		GE 6	NPF-47	11/20/1985	84
St. Francisville, LA		S&W		06/16/1986	96
(24 miles NNW of Baton Rouge, LA)		S&W		N/A	76
05000458				08/29/2025	78
https://www.nrc.gov/info-finder/reactors/rbs1.html					77
St. Lucie Plant, Unit 1	II	PWR-DRYAMB	3,020	07/01/1970	72
Florida Power & Light Co.		CE	DPR-67	03/01/1976	74
Jensen Beach, FL		EBSO		12/21/1976	101
(10 miles SE of Ft. Pierce, FL)		EBSO		10/02/2003	83
05000335				03/01/2036	68
https://www.nrc.gov/info-finder/reactors/stl1.html					90

G: AEC issued a provisional OL on 08/09/1973. The NRC issued a full-term OL on 04/05/1974.

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Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
St. Lucie Plant, Unit 2 Florida Power & Light Co. Jensen Beach, FL (10 miles SE of Ft. Pierce, FL) 05000389 *https://www.nrc.gov/info-finder/reactors/stl2.html*	II	PWR-DRYAMB CE EBSO EBSO	3,020 NPF-16	05/02/1977 04/06/1983 08/08/1983 10/02/2003 04/06/2043	68 91 82 77 85 84
Salem Nuclear Generating Station, Unit 1 PSE&G Nuclear, LLC Hancocks Bridge, NJ (18 miles SE of Wilmington, DE) 05000272 *https://www.nrc.gov/info-finder/reactors/salm1.html*	I	PWR-DRYAMB WEST 4LP PSEG UE&C	3,459 DPR-70	09/25/1968 12/01/1976 06/30/1977 06/30/2011 08/13/2036	97 88 86 95 99 90
Salem Nuclear Generating Station, Unit 2 PSE&G Nuclear, LLC Hancocks Bridge, NJ (18 miles SE of Wilmington, DE) 05000311 *https://www.nrc.gov/info-finder/reactors/salm2.html*	I	PWR-DRYAMB WEST 4LP PSEG UE&C	3,459 DPR-75	09/25/1968 05/20/1981 10/13/1981 06/30/2011 04/18/2040	88 100 73 85 71 85
Seabrook Station, Unit 1 NextEra Energy Seabrook, LLC Seabrook, NH (13 miles S of Portsmouth, NH) 05000443 *https://www.nrc.gov/info-finder/reactors/seab1.html*	I	PWR-DRYAMB WEST 4LP UE&C UE&C	3,648 NPF-86	07/07/1976 03/15/1990 08/19/1990 N/A 03/15/2030	75 100 93 87 90 92
Sequoyah Nuclear Plant, Unit 1 Tennessee Valley Authority Soddy-Daisy, TN (16 miles NE of Chattanooga, TN) 05000327 *https://www.nrc.gov/info-finder/reactors/seq1.html*	II	PWR-ICECND WEST 4LP TVA TVA	3,455 DPR-77	05/27/1970 09/17/1980 07/01/1981 09/24/2015 09/17/2040	89 83 100 87 90 88
Sequoyah Nuclear Plant, Unit 2 Tennessee Valley Authority Soddy-Daisy, TN (16 miles NE of Chattanooga, TN) 05000328 *https://www.nrc.gov/info-finder/reactors/seq2.html*	II	PWR-ICECND WEST 4LP TVA TVA	3,455 DPR-79	05/27/1970 09/15/1981 06/01/1982 09/25/2015 09/15/2041	77 90 90 73 95 83
Shearon Harris Nuclear Power Plant, Unit 1 Duke Energy Progress, Inc. New Hill, NC (20 miles SW of Raleigh, NC) 05000400 *https://www.nrc.gov/info-finder/reactors/har1.html*	II	PWR-DRYAMB WEST 3LP EBSO DANI	2,948 NPF-63	01/27/1978 10/24/1986 05/02/1987 12/17/2008 10/24/2046	90 83 99 87 88 99

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Operating Reactors (continued)

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
South Texas Project, Unit 1 STP Nuclear Operating Co. Bay City, TX (90 miles SW of Houston, TX) 05000498 *https://www.nrc.gov/info-finder/reactors/stp1.html*	IV	PWR-DRYAMB WEST 4LP BECH EBSO	3,853 NPF-76	12/22/1975 03/22/1988 08/25/1988 09/28/2017 08/20/2047	93 91 81 78 73 85
South Texas Project, Unit 2 STP Nuclear Operating Co. Bay City, TX (90 miles SW of Houston, TX) 05000499 *https://www.nrc.gov/info-finder/reactors/stp2.html*	IV	PWR-DRYAMB WEST 4LP BECH EBSO	3,853 NPF-80	12/22/1975 03/28/1989 06/19/1989 09/28/2017 12/15/2048	72 59 103 85 92 97
Surry Power Station, Unit 1 Virginia Electric and Power Co. Surry, VA (17 miles NW of Newport News, VA) 05000280 *https://www.nrc.gov/info-finder/reactors/sur1.html*	II	PWR-DRYSUB WEST 3LP S&W S&W	2,587 DPR-32	06/25/1968 05/25/1972 12/22/1972 03/20/2003 05/25/2032	92 91 99 76 96 101
Surry Power Station, Unit 2 Virginia Electric and Power Co. Surry, VA (17 miles NW of Newport News, VA) 05000281 *https://www.nrc.gov/info-finder/reactors/sur2.html*	II	PWR-DRYSUB WEST 3LP S&W S&W	2,587 DPR-37	06/25/1968 01/29/1973 05/01/1973 03/20/2003 01/29/2033	91 101 95 82 101 93
Susquehanna Steam Electric Station, Unit 1 Susquehanna Nuclear, LLC Berwick (Luzerne County), PA (70 miles NE of Harrisburg, PA) 05000387 *https://www.nrc.gov/info-finder/reactors/susq1.html*	I	BWR-MARK 2 GE 4 BECH BECH	3,952 NPF-14	11/03/1973 07/17/1982 06/08/1983 11/24/2009 07/17/2042	70 87 83 76 77 97
Susquehanna Steam Electric Station, Unit 2 Susquehanna Nuclear, LLC Berwick (Luzerne County), PA (70 miles NE of Harrisburg, PA) 05000388 *https://www.nrc.gov/info-finder/reactors/susq2.html*	I	BWR-MARK 2 GE 4 BECH BECH	3,952 NPF-22	11/03/1973 03/23/1984 02/12/1985 11/24/2009 03/23/2044	83 80 88 82 93 86
Three Mile Island Nuclear Station, Unit 1 Exelon Generation Co., LLC Middletown, PA (10 miles SE of Harrisburg, PA) 05000289 *https://www.nrc.gov/info-finder/reactors/tmi1.html*	I	PWR-DRYAMB B&W LLP GIL UE&C	2,568 DPR-50	05/18/1968 04/19/1974 09/02/1974 10/22/2009 04/19/2034	100 78 104 77 82 80

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

APPENDIX A
Commercial Nuclear Power Reactors
Operating Reactors (continued)

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
Turkey Point Nuclear Generating, Unit 3 Florida Power & Light Co. Homestead, FL (20 miles S of Miami, FL) 05000250 *https://www.nrc.gov/info-finder/reactors/tp3.html*	II	PWR-DRYAMB WEST 3LP BECH BECH	2,644 DPR-31	04/27/1967 07/19/1972 12/14/1972 06/06/2002 07/19/2032	40 81 84 78 93 80
Turkey Point Nuclear Generating, Unit 4 Florida Power & Light Co. Homestead, FL (20 miles S of Miami, FL) 05000251 *https://www.nrc.gov/info-finder/reactors/tp4.html*	II	PWR-DRYAMB WEST 3LP BECH BECH	2,644 DPR-41	04/27/1967 04/10/1973 09/07/1973 06/06/2002 04/10/2033	85 70 88 106 99 98
Virgil C. Summer Nuclear Station, Unit 1 South Carolina Electric & Gas Co. Jenkinsville, SC (26 miles NW of Columbia, SC) 05000395 *https://www.nrc.gov/info-finder/reactors/sum.html*	II	PWR-DRYAMB WEST 3LP GIL DANI	2,900 NPF-12	03/21/1973 11/12/1982 01/01/1984 04/23/2004 08/06/2042	86 93 81 79 96 77
Vogtle Electric Generating Plant, Unit 1 Southern Nuclear Operating Co., Inc. Waynesboro, GA (26 miles SE of Augusta, GA) 05000424 *https://www.nrc.gov/info-finder/reactors/vog1.html*	II	PWR-DRYAMB WEST 4LP SBEC GPC	3,625.6 NPF-68	06/28/1974 03/16/1987 06/01/1987 06/03/2009 01/16/2047	91 101 87 91 101 93
Vogtle Electric Generating Plant, Unit 2 Southern Nuclear Operating Co., Inc. Waynesboro, GA (26 miles SE of Augusta, GA) 05000425 *https://www.nrc.gov/info-finder/reactors/vog2.html*	II	PWR-DRYAMB WEST 4LP SBEC GPC	3,625.6 NPF-81	06/28/1974 03/31/1989 05/20/1989 06/03/2009 02/09/2049	102 87 92 100 94 96
Waterford Steam Electric Station, Unit 3 Entergy Operations, Inc. Killona, LA (25 miles W of New Orleans, LA) 05000382 *https://www.nrc.gov/info-finder/reactors/wat3.html*	IV	PWR-DRYAMB COMB CE EBSO EBSO	3,716 NPF-38	11/14/1974 03/16/1985 09/24/1985 N/A 12/18/2024	77 89 90 80 96 80
Watts Bar Nuclear Plant, Unit 1 Tennessee Valley Authority Spring City, TN (60 miles SW of Knoxville, TN) 05000390 *https://www.nrc.gov/info-finder/reactors/wb1.html*	II	PWR-ICECND WEST 4LP TVA TVA	3,459 NPF-90	01/23/1973 02/07/1996 05/27/1996 N/A 11/09/2035	87 90 89 76 85 77

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX A
Commercial Nuclear Power Reactors
Operating Reactors (continued)

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012– 2017* Capacity Factor (Percent)
Watts Bar Nuclear Plant, Unit 2 Tennessee Valley Authority Spring City, TN (60 miles SW of Knoxville, TN) 05000391 *https://www.nrc.gov/info-finder/reactors/wb2.html*	II	PWR-ICECND WEST 4LP TVA TVA	3,411 NPF-96	01/24/1973 10/22/2015 10/19/2016 N/A 10/22/2055	— — — 0 26 45
Wolf Creek Generating Station, Unit 1 Wolf Creek Nuclear Operating Corp. Burlington (Coffey County), KS (28 miles SE of Emporia, KS) 05000482 *https://www.nrc.gov/info-finder/reactors/wc.html*	IV	PWR-DRYAMB WEST 4LP BECH DANI	3,565 NPF-42	05/17/1977 06/04/1985[H] 09/03/1985 11/20/2008 03/11/2045	80 65 83 78 74 96

H: The original OL (NPF-32) was issued on 03/11/1985. The license was superseded by OL (NPF-42), issued on 06/04/1985.

Operating Reactors Under Active Construction or Deferred Policy

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012– 2017* Capacity Factor (Percent)
Bellefonte Nuclear Power Station, Unit 1** Tennessee Valley Authority (6 miles NE of Scottsboro, AL) 05000438 *https://www.nrc.gov/reactors/new-reactors/col/bellefonte.html*	II	PWR-DRYAMB B&W 205 TVA TVA	3,763	12/24/1974	N/A
Bellefonte Nuclear Power Station, Unit 2** Tennessee Valley Authority (6 miles NE of Scottsboro, AL) 05000439 *https://www.nrc.gov/reactors/new-reactors/col/bellefonte.html*	II	PWR-DRYAMB B&W 205 TVA TVA	3,763	12/24/1974	N/A
Enrico Fermi Nuclear Plant, Unit 3 DTE Electric Company Newport, MI (25 miles NE of Toledo, OH) 05200033 *https://www.nrc.gov/reactors/new-reactors/col-holder/ferm3.html*	III	ESBWR GEH	4,500 NPF-95	 05/01/2015	N/A
North Anna Power Station, Unit 3 Dominion Virginia Power Mineral (Louisa County), VA (40 miles NW of Richmond, VA) 05200017 *https://www.nrc.gov/reactors/new-reactors/col-holder/na3.html*	II	BWR ESBWR GEH	4,500 NPF-103	 06/02/2017	N/A

APPENDIX A
Commercial Nuclear Power Reactors
Operating Reactors under Active Construction or Deferred Policy (continued)

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
South Texas Project, Unit 3*** STP Nuclear Operating Co. Bay City, TX (90 miles SW of Houston, TX) 05200012 *https://www.nrc.gov/reactors/new-reactors/col-holder/stp3.html*	IV	BWR ABWR	3,926 NPF-97	 02/12/2016	N/A
South Texas Project, Unit 4*** STP Nuclear Operating Co. Bay City, TX (90 miles SW of Houston, TX) 05200013 *https://www.nrc.gov/reactors/new-reactors/col-holder/stp4.html*	IV	BWR ABWR	3,926 NPF-98	 02/12/2016	N/A
Turkey Point Nuclear Generating, Unit 6 Florida Power and LIght Homestead, FL (20 miles S of Miami, FL) 05200040 *https://www.nrc.gov/reactors/new-reactors/col-holder/tp6.html*	II	PWR AP1000	3,400 NPF-104	 04/12/2018	N/A
Turkey Point Nuclear Generating, Unit 7 Florida Power and LIght Homestead, FL (20 miles S of Miami, FL) 05200041 *https://www.nrc.gov/reactors/new-reactors/col-holder/tp7.html*	II	PWR AP1000	3,400 NPF-105	 04/12/2018	N/A
Virgil C. Summer Nuclear Station, Unit 2[A] South Carolina Electric & Gas Co. South Carolina Public Service Auth. Jenkinsville (Fairfield County), SC (26 miles NW of Columbia, SC) 0520027 *https://www.nrc.gov/reactors/new-reactors/col-holder/sum2.html*	II	PWR AP1000 WEST 2LP	3,400 NPF-93	 03/30/2012	N/A
Virgil C. Summer Nuclear Station, Unit 3[A] South Carolina Electric & Gas Co. South Carolina Public Service Auth. Jenkinsville (Fairfield County), SC (26 miles NW of Columbia, SC) 05200028 *https://www.nrc.gov/reactors/new-reactors/col-holder/sum3.html*	II	PWR AP1000 WEST 2LP	3,400 NPF-94	 03/30/2012	N/A

A: On July 31, 2017, South Carolina Electric & Gas (SCE&G) ceased construction on V.C. Summer nuclear power plant, Units 2 and 3.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

APPENDIX A

Commercial Nuclear Power Reactors

Operating Reactors under Active Construction or Deferred Policy (continued)

Plant Name, Unit Number Licensee Location Docket Number NRC Web Page Address	NRC Region	Con Type NSSS Architect Engineer Constructor	Licensed MWt	CP Issued COL Issued Comm. Op. LR Issued Exp. Date	2012–2017* Capacity Factor (Percent)
Vogtle Electric Generating Plant, Unit 3 Southern Nuclear Operating Co., Inc. Waynesboro (Burke County), GA (26 miles SE of Augusta, GA) 05200025 *https://www.nrc.gov/reactors/new-reactors/col-holder/vog3.html*	II	PWR AP1000 WEST 2LP	3,400 NPF-91	 02/10/2012	N/A
Vogtle Electric Generating Plant, Unit 4 Southern Nuclear Operating Co., Inc. Waynesboro, (Burke County), GA (26 miles SE of Augusta, GA) 05200026 *https://www.nrc.gov/reactors/new-reactors/col-holder/vog4.html*	II	PWR AP1000 WEST 2LP	3,400 NPF-92	 02/10/2012	N/A
William States Lee III Nuclear Station, Unit 3[B] Duke Energy Carolinas Cherokee County, SC (2 miles SE of Gafney, SC) 05200018 *https://www.nrc.gov/reactors/new-reactors/col-holder/lee1.html*	II	PWR AP1000 WEST 2LP	3,400 NPF-101	 12/19/2016	N/A
William States Lee III Nuclear Station, Unit 4[B] Duke Energy Carolinas Cherokee County, SC (2 miles SE of Gafney, SC) 05200019 *https://www.nrc.gov/reactors/new-reactors/col-holder/lee2.html*	II	PWR AP1000 WEST 2LP	3,400 NPF-102	 12/19/2016	N/A

B: In September 2017, Duke Energy announced cancellation of William States Lee nuclear power plant, Units 3 and 4.

* Average capacity factor is listed in year order starting with 2012.
** Bellefonte Units 1 and 2 are under the Commission Policy Statement on Deferred Plants (52 FR 38077; October 14, 1987).
*** In June 2018, Nuclear Innovation North America submitted a letter requesting that South Texas Project, Units 3 and 4, COLs be withdrawn.
Note: Plant names and data are as identified on the license as of July 2018; the next printed update will be in August 2019.
Source: NRC, with some data compiled from U.S. Department of Energy's (DOE's) Energy Information Administration (EIA).

APPENDIX B
New Nuclear Power Plant Licensing Applications

Applicant	Docket Number	Type	Submittal Date	Design	Site	State	Existing Plant?	Date Accepted	Status
Combined License (Construction and Operating)									
Nuclear Innovation North America, LLC	05200012 & 05200013	COL	9/20/07	ABWR	South Texas Project, Units 3 and 4	TX	Yes	11/29/07	COL Issued 02/09/2016
Tennessee Valley Authority (TVA)	05200014 & 05200015	COL	10/30/07	AP1000	Bellefonte, Units 3 and 4	AL	No	1/18/08	Withdrawn–12/02/2016
Dominion Virginia Power	05200017	COL	11/27/07	ESBWR	North Anna, Unit 3	VA	Yes	01/28/08	COL Issued 06/02/2017
Duke Energy Carolinas	05200018 & 05200019	COL	12/13/07	AP1000	Lee Nuclear Station, Units 3 and 4	SC	No	2/25/08	COL Issued 12/19/2016
Progressive Energy	05200022 & 05200023	COL	2/19/08	AP1000	Shearon Harris, Units 2 and 3	NC	Yes	4/17/08	Suspended–05/02/2013
Southern Nuclear Operating Co.	05200025 & 05200026	COL	3/31/08	AP1000	Vogtle, Units 3 and 4	GA	Yes	5/30/08	COL Issued 02/10/2012
South Carolina Electric and Gas	05200027 & 05200028	COL	3/31/08	AP1000	V.C. Summer, Units 2 and 3	SC	Yes	7/31/08	COL Issued 03/30/2012
AmerenUE	05200037	COL	7/24/08	U.S. EPR	Callaway, Unit 2	MO	Yes	12/12/08	Withdrawn–10/19/2015
Duke Energy Florida	05200029 & 05200030	COL	7/30/08	AP1000	Levy County, Units 1 and 2	FL	No	10/6/08	Withdrawn–04/26/2018
DTE Electric Company	05200033	COL	9/18/08	ESBWR	Fermi, Unit 3	MI	Yes	11/25/08	COL Issued 05/01/2015
Luminant Generation Co.	05200034 & 05200035	COL	9/19/08	US-APWR	Comanche Peak, Units 3 and 4	TX	Yes	12/2/08	Suspended–03/31/2014
Entergy	05200036	COL	9/25/08	ESBWR	River Bend, Unit 3	LA	Yes	12/4/08	Withdrawn–06/14/2016
PPL Bell Bend	05200039	COL	10/10/08	U.S. EPR	Bell Bend (1 Unit)	PA	Yes	12/19/08	Withdrawn–09/22/2016
Florida Power and Light	05200040 & 05200041	COL	6/30/09	AP1000	Turkey Point, Units 6 and 7	FL	Yes	9/4/09	COL Issued 04/12/2018
Design Certification									
AREVA NP	05200020	DC	12/11/07	U.S. EPR	N/A	N/A	N/A	2/25/08	Suspended–03/27/2015
Mitsubishi Heavy Industries	05200021	DC	12/31/07	US-APWR	N/A	N/A	N/A	2/29/08	Applicant Delayed –Not Scheduled
Korea Electric Power Company and Korea Hydro and Nuclear Power	05200046	DC	12/23/14	APR 1400	N/A	N/A	N/A	3/4/15	Scheduled
Toshiba Corporation	05200044	DC	10/27/10	ABWR	N/A	N/A	N/A	12/14/10	Withdrawn–12/30/2016
GE-Hitachi Nuclear Energy	05200045	DC	12/7/10	ABWR	N/A	N/A	N/A	2/14/11	Scheduled
NuScale Power LLC	05200048	DC	01/6/17	NuScale	N/A	N/A	N/A	3/23/17	Scheduled
Early Site Permit									
PSEG Site	05200043	ESP	5/25/10	Not yet announced	PSEG Site	NJ	Yes	8/4/10	Issued 05/06/2016
TVA Clinch River SMR Site	05200047	ESP	5/25/10	Not yet announced	Clinch River Site	TN	No	1/12/17	Scheduled

Notes: Withdrawal was requested for Calvert Cliffs, Grand Gulf, Nine Mile Point, Victoria County, Bellefonte, and Callaway (COL and ESP). On July 31, 2017, a decision was announced by South Carolina Electric & Gas (SCE&G) to cease construction on V.C. Summer nuclear power plant, Units 2 and 3 , and by letter dated December 27, 2017, SCE&G requested withdrawl of the corresponding COLs; NRC action is still pending. In September 2017, Duke Energy announced cancellation of William States Lee nuclear power plant, Units 3 and 4 project. As of June 2018, Nuclear Innovation North America submitted a letter requesting that the COLs for South Texas Project, Units 3 and 4, be withdrawn.
Data are current as of May 2018; the next printed update will be in August 2019. NRC-abbreviated reactor names listed.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX C

Commercial Nuclear Power Reactors Undergoing Decommissioning and Permanently Shut Down Formerly Licensed To Operate

Unit Location Docket Number	Reactor Type MWt	NSSS Vendor	OL Issued Shut Down OL Terminated Closure Date Est.	Decommissioning Alternative Selected Current License Status
Big Rock Point Charlevoix, MI 05000155	BWR 240	GE	05/01/1964 08/29/1997 01/08/2007	DECON DECON Completed
Crystal River 3 Crystal River, FL 05000302	PWR 2,609	B&W LLP	12/03/1976 02/20/2013 2074	SAFSTOR SAFSTOR in Progress
Dresden 1 Morris, IL 05000010	BWR 700	GE	09/28/1959 10/31/1978 2036	SAFSTOR SAFSTOR
Fermi 1 Newport, MI 05000016	SCF 200	CE	05/10/1963 09/22/1972 2032	SAFSTOR SAFSTOR
Fort Calhoun 1 Ft. Calhoun, NE 05000285	PWR–DRYAMB 1,500	CE	08/09/1973 10/24/2016 2076	SAFSTOR SAFSTOR in Progress
Fort St. Vrain Platteville, CO 05000267	HTG 842	GA	12/21/1973 08/18/1989 08/08/1997	DECON DECON Completed
GE EVESR Sunol, CA 05000183	Experimental Superheat Reactor 12.5	GE	11/12/1963 02/01/1967 04/15/1970 01/1/2019	SAFSTOR Possession Only License Expired 01/2016
GE VBWR (Vallecitos) Sunol, CA 05000018	BWR 50	GE	08/31/1957 12/09/1963 2019	SAFSTOR SAFSTOR
Haddam Neck Meriden, CT 05000213	PWR 1,825	WEST	12/27/1974 12/05/1996 11/26/2007	DECON DECON Completed

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX C
Commercial Nuclear Power Reactors Undergoing Decommissioning and Permanently Shut Down Formerly Licensed To Operate (continued)

Unit Location Docket Number	Reactor Type MWt	NSSS Vendor	OL Issued Shut Down OL Terminated Closure Date Est.	Decommissioning Alternative Selected Current License Status
Humboldt Bay 3 Eureka, CA 05000133	BWR 200	GE	08/28/1962 07/02/1976 2019	DECON DECON in Progress
Indian Point 1 Buchanan, NY 05000003	PWR 615	B&W	03/26/1962 10/31/1974 2026	SAFSTOR SAFSTOR
Kewaunee Carlton, WI 05000305	PWR 1,772	WEST 2LP	12/21/1973 05/07/2013 2073	SAFSTOR SAFSTOR
La Crosse Genoa, WI 05000409	BWR 165	AC	07/03/1967 04/30/1987 2020	DECON DECON in Progress
Maine Yankee Wiscasset, ME 05000309	PWR 2,700	CE	06/29/1973 12/06/1996 09/30/2005	DECON DECON Completed
Millstone 1 Waterford, CT 05000245	BWR 2,011	GE	10/31/1970 07/21/1998 12/31/2056	SAFSTOR SAFSTOR
Pathfinder Sioux Falls, SD 05000130	BWR 190	AC	03/12/1964 09/16/1967 07/27/2007	DECON DECON Completed
Peach Bottom 1 Delta, PA 05000171	HTG 115	GA	01/24/1966 10/31/1974 12/31/2034	SAFSTOR SAFSTOR
Rancho Seco Herald, CA 05000312	PWR 2,772	B&W	08/16/1974 06/07/1989 09/25/2009	DECON DECON Completed

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX C

Commercial Nuclear Power Reactors Undergoing Decommissioning and Permanently Shut Down Formerly Licensed To Operate (continued)

Unit Location Docket Number	Reactor Type MWt	NSSS Vendor	OL Issued Shut Down OL Terminated Closure Date Est.	Decommissioning Alternative Selected Current License Status
San Onofre 1* San Clemente, CA 05000206	PWR 1,347	WEST	03/27/1967 11/30/1992 12/30/2030	DECON SAFSTOR
San Onofre 2* San Clemente, CA 05000361	PWR CE 3,438	CE	02/16/1982 06/12/2013 2032	DECON DECON in Progress
San Onofre 3 San Clemente, CA 05000362	PWR CE 3,438	CE	11/15/1982 06/12/2013 2032	DECON DECON in Progress
Savannah, N.S. Baltimore, MD 05000238	PWR 74	B&W	08/1965 11/1970 12/01/2031	SAFSTOR SAFSTOR
Saxton Saxton, PA 05000146	PWR 23.5	WEST	11/15/1961 05/01/1972 11/07/2005	DECON DECON Completed
Shoreham Wading River, NY 05000322	BWR 2,436	GE	04/21/1989 06/28/1989 04/11/1995	DECON DECON Completed
Three Mile Island 2 Middletown, PA 05000320	PWR 2,770	B&W	02/08/1978 03/28/1979 12/31/2036	** SAFSTOR
Trojan Rainier, OR 05000344	PWR 3,411	WEST	11/21/1975 11/09/1992 05/23/2005	DECON DECON Completed
Yankee-Rowe Rowe, MA 05000029	PWR 600	WEST	12/24/1963 10/01/1991 08/10/2007	DECON DECON Completed
Vermont Yankee Vernon, VT 05000271	BWR-Mark 1 1,912	GE 4	03/21/1972 12/29/2014 2073	SAFSTOR SAFSTOR in Progress

APPENDIX C

Commercial Nuclear Power Reactors Undergoing Decommissioning and Permanently Shut Down Formerly Licensed To Operate (continued)

Unit Location Docket Number	Reactor Type MWt	NSSS Vendor	OL Issued Shut Down OL Terminated Closure Date Est.	Decommissioning Alternative Selected Current License Status
Zion 1 Zion, IL 05000295	PWR 3,250	WEST	10/19/1973 02/21/1997 2019	DECON DECON in Progress
Zion 2 Zion, IL 05000304	PWR 3,250	WEST	11/14/1973 09/19/1996 2019	DECON DECON in Progress

* Site has been dismantled and decontaminated with the exception of the reactor vessel, which is in long-term storage.

** Three Mile Island Unit 2 has been placed in a postdefueling monitored storage mode until Unit 1 permanently ceases operation, at which time both units are planned to be decommissioned.

Notes: GE Bonus, Hallam, and Piqua decommissioned reactor sites are part of the DOE nuclear legacy. For more information, visit DOE's Legacy Management Web site at *https://energy.gov/lm/sites/lm-sites.* CVTR, Elk River, and Shippingport decommissioned reactor sites were either decommissioned before the formation of the NRC or were not licensed by the NRC.
See the Glossary for definitions of decommissioning alternatives (DECON, SAFSTOR).

Source: DOE, "Integrated Database for 1990, U.S. Spent Fuel and Radioactive Waste, Inventories, Projections, and Characteristics" (DOE/RW-0006, Rev. 6), and NRC, "Nuclear Power Plants in the World," Edition 6.

Data are current as of July 2018. The next printed update will be in August 2019.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX D
Canceled Commercial Nuclear Power Reactors
Part 50—Domestic Licensing of Production and Utilization Facilities

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status Docket Number
Allens Creek 1 Houston Lighting & Power Company 4 miles NW of Wallis, TX	BWR 1,150	1982 Under CP Review 05000466
Allens Creek 2 Houston Lighting & Power Company 4 miles NW of Wallis, TX	BWR 1,150	1976 Under CP Review 05000467
Atlantic 1 & 2 Public Service Electric & Gas Company Floating plants off the coast of NJ	PWR 1,150	1978 Under CP Review 05000477 & 478
Bailly 1 Northern Indiana Public Service Company 12 miles NNE of Gary, IN	BWR 645	1981 With CP 05000367
Barton 1 & 2 Alabama Power & Light 15 miles SE of Clanton, AL	BWR 1,159	1977 Under CP Review 05000524 & 525
Barton 3 & 4 Alabama Power & Light 15 miles SE of Clanton, AL	BWR 1,159	1975 Under CP Review 05000526 & 527
Black Fox 1 & 2 Public Service Company of Oklahoma 3.5 miles S of Inola, OK	BWR 1,150	1982 Under CP Review 05000556 & 557
Blue Hills 1 & 2 Gulf States Utilities Company SW tip of Toledo Bend Reservoir, TX	PWR 918	1978 Under CP Review 05000510 & 511
Cherokee 1 Duke Power Company 6 miles SSW of Blacksburg, SC	PWR 1,280	1983 With CP 05000491
Cherokee 2 & 3 Duke Power Company 6 miles SSW of Blacksburg, SC	PWR 1,280	1982 With CP 05000492 & 493
Clinch River Project Management Corp., DOE, TVA 23 miles W of Knoxville, in Oak Ridge, TN	LMFB 350	1983 Under CP Review 05000537
Clinton 2 Illinois Power Company 6 miles E of Clinton, IL	BWR 933	1983 With CP 05000462
Davis-Besse 2 & 3 Toledo Edison Company 21 miles ESE of Toledo, OH	PWR 906	1981 Under CP Review 05000500 & 501

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

APPENDIX D

Canceled Commercial Nuclear Power Reactors (continued)

Part 50—Domestic Licensing of Production and Utilization Facilities

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status Docket Number
Douglas Point 1 & 2 Potomac Electric Power Company Charles County, MD	BWR 1,146	1977 Under CP Review 05000448 & 449
Erie 1 & 2 Ohio Edison Company Berlin, OH	PWR 1,260	1980 Under CP Review 05000580 & 581
Forked River 1 Jersey Central Power & Light Company 2 miles S of Forked River, NJ	PWR 1,070	1980 With CP 05000363
Fort Calhoun 2 Omaha Public Power District 19 miles N of Omaha, NE	PWR 1,136	1977 Under CP Review 05000548
Fulton 1 & 2 Philadelphia Electric Company 17 miles S of Lancaster, PA	HTG 1,160	1975 Under CP Review 05000463 & 464
Grand Gulf 2 Entergy Nuclear Operations, Inc. 20 miles SW of Vicksburg, MS	BWR 1,250	1990 With CP 05000417
Greene County Power Authority of the State of NY 20 miles N of Kingston, NY	PWR 1,191	1980 Under CP Review 05000549
Greenwood 2 & 3 Detroit Edison Company Greenwood Township, MI	PWR 1,200	1980 Under CP Review 05000452 & 453
Hartsville A1 & A2 Tennessee Valley Authority 5 miles SE of Hartsville, TN	BWR 1,233	1984 With CP 05000518 & 519
Hartsville B1 & B2 Tennessee Valley Authority 5 miles SE of Hartsville, TN	BWR 1,233	1982 With CP 05000520 & 521
Haven 1 (formerly Koshkonong) Wisconsin Electric Power Company 4.2 miles SSW of Fort Atkinson, WI	PWR 900	1980 Under CP Review 05000502
Haven 2 (formerly Koshkonong) Wisconsin Electric Power Company 4.2 miles SSW of Fort Atkinson, WI	PWR 900	1978 Under CP Review 05000503
Hope Creek 2 Public Service Electric & Gas Company 18 miles SE of Wilmington, DE	BWR 1,067	1981 With CP 05000355

APPENDIX D

Canceled Commercial Nuclear Power Reactors (continued)

Part 50—Domestic Licensing of Production and Utilization Facilities

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status Docket Number
Jamesport 1 & 2 Long Island Lighting Company 65 miles E of New York City, NY	PWR 1,150	1980 With CP 05000516 & 517
Marble Hill 1 & 2 Public Service of Indiana 6 miles NE of New Washington, IN	PWR 1,130	1985 With CP 05000546 & 547
Midland 1 Consumers Power Company S of City of Midland, MI	PWR 492	1986 With CP 05000329
Midland 2 Consumers Power Company S of City of Midland, MI	PWR 818	1986 With CP 05000330
Montague 1 & 2 Northeast Nuclear Energy Company 1.2 miles SSE of Turners Falls, MA	BWR 1,150	1980 Under CP Review 05000496 & 497
New England 1 & 2 New England Power Company 8.5 miles E of Westerly, RI	PWR 1,194	1979 Under CP Review 05000568 & 569
New Haven 1 & 2 New York State Electric & Gas Corporation 3 miles NW of New Haven, NY	PWR 1,250	1980 Under CP Review 05000596 & 597
North Anna 3 Virginia Electric & Power Company 40 miles NW of Richmond, VA	PWR 907	1982 With CP 05000404
North Anna 4 Virginia Electric & Power Company 40 miles NW of Richmond, VA	PWR 907	1980 With CP 05000405
North Coast 1 Puerto Rico Water Resources Authority 4.7 miles ESE of Salinas, PR	PWR 583	1978 Under CP Review 05000376
Palo Verde 4 & 5 Arizona Public Service Company 36 miles W of Phoenix, AZ	PWR 1,270	1979 Under CP Review 05000592 & 593
Pebble Springs 1 & 2 Portland General Electric Company 55 miles WSW of Richland, WA, near Arlington, OR	PWR 1,260	1982 Under CP Review 05000514 & 515
Perkins 1, 2, & 3 Duke Power Company 10 miles N of Salisbury, NC	PWR 1,280	1982 Under CP Review 05000488, 489 & 490

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

APPENDIX D

Canceled Commercial Nuclear Power Reactors (continued)

Part 50—Domestic Licensing of Production and Utilization Facilities

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status Docket Number
Perry 2 Cleveland Electric Illuminating Co. 35 miles NE of Cleveland, OH	BWR 1,205	1994 Under CP Review 05000441
Phipps Bend 1 & 2 Tennessee Valley Authority 15 miles SW of Kingsport, TN	BWR 1,220	1982 With CP 05000553 & 554
Pilgrim 2 Boston Edison Company 4 miles SE of Plymouth, MA	PWR 1,180	1981 Under CP Review 05000471
Pilgrim 3 Boston Edison Company 4 miles SE of Plymouth, MA	PWR 1,180	1974 Under CP Review 05000472
Quanicassee 1 & 2 Consumers Power Company 6 miles E of Essexville, MI	PWR 1,150	1974 Under CP Review 05000475 & 476
River Bend 2 Gulf States Utilities Company 24 miles NNW of Baton Rouge, LA	BWR 934	1984 With CP 05000459
Seabrook 2 Public Service Co. of New Hampshire 13 miles S of Portsmouth, NH	PWR 1,198	1988 With CP 05000444
Shearon Harris 2 Carolina Power & Light Company 20 miles SW of Raleigh, NC	PWR 900	1983 With CP 05000401
Shearon Harris 3 & 4 Carolina Power & Light Company 20 miles SW of Raleigh, NC	PWR 900	1981 With CP 05000402 & 403
Skagit/Hanford 1 & 2 Puget Sound Power & Light Company 23 miles SE of Bellingham, WA	PWR 1,277	1983 Under CP Review 05000522 & 523
Sterling Rochester Gas & Electric Corporation 50 miles E of Rochester, NY	PWR 1,150	1980 With CP 05000485
Summit 1 & 2 Delmarva Power & Light Company 15 miles SSW of Wilmington, DE	HTG 1,200	1975 Under CP Review 05000450 & 451

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX D

Canceled Commercial Nuclear Power Reactors (continued)

Part 50—Domestic Licensing of Production and Utilization Facilities

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status Docket Number
Sundesert 1 & 2 San Diego Gas & Electric Company 16 miles SW of Blythe, CA	PWR 974	1978 Under CP Review 05000582 & 583
Surry 3 & 4 Virginia Electric & Power Company 17 miles NW of Newport News, VA	PWR 882	1977 With CP 05000434 & 435
Tyrone 1 Northern States Power Company 8 miles NE of Durond, WI	PWR 1,150	1981 Under CP Review 05000484
Tyrone 2 Northern States Power Company 8 miles NE of Durond, WI	PWR 1,150	1974 With CP 05000487
Vogtle 3 & 4 Georgia Power Company 26 miles SE of Augusta, GA	PWR 1,113	1974 With CP 050000426 & 427
Washington Nuclear 1 (WPPSS) Energy Northwest 12 miles NE of Richland, WA	PWR 1,266	1995 With CP 05000460
Washington Nuclear 3 (WPPSS) Energy Northwest 12 miles NE of Richland, WA	PWR 1,242	1995 With CP 05000508
Washington Nuclear 4 (WPPSS) Energy Northwest 12 miles NE of Richland, WA	PWR 1,218	1982 With CP 05000513
Washington Nuclear 5 (WPPSS) Energy Northwest 12 miles NE of Richland, WA	PWR 1,242	1982 With CP 05000509
Yellow Creek 1 & 2 Tennessee Valley Authority 15 miles E of Corinth, MS	BWR 1,285	1984 With CP 05000566 & 567
Zimmer 1 Cincinnati Gas & Electric Company 25 miles SE of Cincinnati, OH	BWR 810	1984 With CP 05000358

APPENDIX D

Canceled Commercial Nuclear Power Reactors (continued)

Part 52—Licensing, Certification, and Approvals for Nuclear Power Plants

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status Docket Number
Bellefonte 3 & 4 Tennessee Valley Authority Scottsboro, Jackson County, AL	AP1000 1,100	December 2, 2016 With COL Review 05200014 & 05200015
Bell Bend Bell Bend, LLC Luzerne County, PA	U.S. EPR 1,600	September 22, 2016 With COL Review 5200039
Callaway 2 Union Electric Company (Ameren UE) Fulton, Callaway County , MO	U.S. EPR 1,600	October, 29, 2015 With COL Review 05200037
Calvert Cliffs 3 UniStar Nuclear Operating Services, LLC Near Lusby in Calvert County, MD	U.S. EPR 4,500	July 17, 2015 With COL Review 05200016
Grand Gulf 3 Entergy Operations, Inc. Near Port Gibson in Claiborne County, MS	ESBWR 4,500	January 9, 2009 With COL Review 05200024
Levy 1 and 2 Duke Energy Florida Levy County, FL	AP1000 1,100	April 26, 2018 With COL 05200029 & 05200030
Nine Mile Point 3 UniStar Nuclear Operating Services, LLC 25 miles SE of Cincinnati, OH	ESBWR 4,500	January 9, 2009 With COL Review 0500038
River Bend 3 Entergy Operations, Inc. St. Francisville, LA	ESBWR 1,594	June 14, 2016 With COL Review 5200036
Victoria County Station 1 and 2 Exelon Nuclear Texas Holdings, LLC Near Victoria City in Victoria County, TX	ESBWR 4,500	June 11, 2010 With COL Review 05200031 & 05200032

Notes: Cancellation is defined as public announcement of cancellation or written notification to the NRC. Only NRC-docketed applications are included. "Status" is the status of the application at the time of cancellation. Applications were withdrawn for Calvert Cliffs, Grand Gulf, Nine Mile Point, Victoria County, and Callaway. On July 31, 2017, South Carolina Electric & Gas (SCE&G) announced its decision to cease construction on V.C. Summer nuclear power plant, Units 2 and 3, and the licensee has requested that the COLs be withdrawn. NRC action is still pending.In October 2017, Duke Energy has announced plans to cancel reactors at Levy County, FL, and William States Lee, SC. Units 3 and 4. In June 2018, Nuclear Innovation North America submitted a letter requesting that the COLs for South Texas Project, Units 3 and 4, be withdrawn.

Data are current as of July 2018; the next printed update will be in August 2019. NRC-abbreviated reactor names listed.

Source: DOE/EIA, "Commercial Nuclear Power 1991," DOE/EIA-0438, Appendix E, and the NRC

APPENDIX E
Commercial Nuclear Power Reactors by Parent Company

Utility	NRC-Abbreviated Reactor Unit Name
AmerenUE *www.ameren.com*	Callaway*
Arizona Public Service Company *www.aps.com*	Palo Verde 1, 2, & 3*
Dominion Generation *www.dom.com*	Millstone 2 & 3 North Anna 1 & 2 Surry 1 & 2
DTE Electric Company *www.dteenergy.com*	Fermi 2
Duke Energy *www.duke-energy.com*	Brunswick 1 & 2 Catawba 1 & 2 Harris 1 McGuire 1 & 2 Oconee 1, 2, & 3 Robinson 2
Energy Northwest *www.energy-northwest.com*	Columbia
Entergy Nuclear Operations, Inc. *www.entergy-nuclear.com*	Arkansas Nuclear One 1 & 2 Grand Gulf 1 Indian Point 2 & 3 Palisades Pilgrim 1 River Bend 1 Waterford 3
Exelon Corporation, LLC *www.exeloncorp.com*	Braidwood 1 & 2 Byron 1 & 2 Calvert Cliffs 1 & 2 Clinton Dresden 2 & 3 FitzPatrick Ginna LaSalle 1 & 2 Limerick 1 & 2 Nine Mile Point 1 & 2 Oyster Creek Peach Bottom 2 & 3 Quad Cities 1 & 2 Three Mile Island 1
First Energy Nuclear Operating Company *www.firstenergycorp.com*	Beaver Valley 1 & 2 Davis-Besse Perry 1

APPENDIX E

Commercial Nuclear Power Reactors by Parent Company (continued)

Utility	NRC-Abbreviated Reactor Unit Name
Indiana Michigan Power Company *www.indianamichiganpower.com*	Cook 1 & 2
Nebraska Public Power District *www.nppd.com*	Cooper
NextEra Energy Inc. with principal subsidiaries Florida Power & Light Co. and NextEra Energy Resources, LLC *www.fplgroup.com*	Duane Arnold Point Beach 1 & 2 Seabrook 1 St. Lucie 1 & 2 Turkey Point 3 & 4
Northern States Power Company Minnesota doing business as Xcel Energy *www.xcelenergy.com*	Monticello Prairie Island 1 & 2
Pacific Gas & Electric Company *www.pge.com*	Diablo Canyon 1 & 2*
PSEG Nuclear, LLC *www.pseg.com*	Hope Creek 1 Salem 1 & 2
South Carolina Electric & Gas Company *www.sceg.com*	Summer
Southern Nuclear Operating Company *www.southerncompany.com*	Farley 1 & 2 Hatch 1 & 2 Vogtle 1 & 2
STP Nuclear Operating Company *www.stpegs.com*	South Texas Project 1 & 2*
Talen Energy Corp. *www.talenenergy.com*	Susquehanna 1 & 2
Tennessee Valley Authority *www.tva.gov*	Browns Ferry 1, 2, & 3 Sequoyah 1 & 2 Watts Bar 1 & 2
Vistra Energy *www.vistraenergy.com*	Comanche Peak 1 & 2*
Wolf Creek Nuclear Operating Corporation *www.wolfcreeknuclear.com*	Wolf Creek 1*

* These plants have a joint program called the Strategic Teaming and Resource Sharing group. They share resources for refueling outages and develop some shared licensing applications.

Note: Data are current as of July 2018; the next printed update will be in August 2019.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

APPENDIX F

Commercial Nuclear Power Reactor Operating Licenses—Issued by Year

1969	Dresden 2*, Ginna*, Nine Mile Point 1*, Oyster Creek*
1970	Point Beach 1*, Robinson 2
1971	Dresden 3, Monticello*
1972	Palisades*, Pilgrim, Quad Cities 1, Quad Cities 2, Surry 1, Turkey Point 3
1973	Browns Ferry 1, Indian Point 2, Oconee 1, Oconee 2, Peach Bottom 2, Point Beach 2*, Surry 2, Turkey Point 4
1974	Arkansas Nuclear 1, Browns Ferry 2, Brunswick 2, Calvert Cliffs 1, Cooper, Cook 1, Duane Arnold, FitzPatrick, Hatch 1, Oconee 3, Peach Bottom 3, Prairie Island 1, Prairie Island 2, Three Mile Island 1
1975	Millstone 2
1976	Beaver Valley 1, Browns Ferry 3, Brunswick 1, Calvert Cliffs 2, Indian Point 3, Salem 1, St. Lucie 1
1977	Davis-Besse, D.C. Cook 2, Farley 1
1978	Arkansas Nuclear 2, Hatch 2, North Anna 1
1980	North Anna 2, Sequoyah 1
1981	Farley 2, McGuire 1, Salem 2, Sequoyah 2
1982	LaSalle 1, Summer, Susquehanna 1
1983	McGuire 2, St. Lucie 2
1984	Callaway, Columbia, Diablo Canyon 1, Grand Gulf 1, LaSalle 2, Susquehanna 2
1985	Byron 1, Catawba 1, Diablo Canyon 2, Fermi 2, Limerick 1, Palo Verde 1, River Bend 1, Waterford 3, Wolf Creek 1
1986	Catawba 2, Hope Creek 1, Millstone 3, Palo Verde 2, Perry 1
1987	Beaver Valley 2, Braidwood 1, Byron 2, Clinton, Harris 1, Nine Mile Point 2, Palo Verde 3, Vogtle 1
1988	Braidwood 2, South Texas Project 1
1989	Limerick 2, South Texas Project 2, Vogtle 2
1990	Comanche Peak 1, Seabrook 1
1993	Comanche Peak 2
1996	Watts Bar 1
2015	Watts Bar 2

* AEC Issued a provisional operating license allowing commercial operations.

Notes: This list is limited to reactors licensed to operate. Year is based on the date the initial full-power operating license was issued. NRC-abbreviated reactor names listed. Data are current as of July 2018; the next printed update will be in August 2019.

APPENDIX G

Commercial Nuclear Power Reactor Operating Licenses—Expiration by Year, 2013–2055

2013	Indian Point 2
2015	Indian Point 3
2024	Diablo Canyon 1, Waterford 3
2025	Diablo Canyon 2, River Bend 1
2026	Clinton, Perry
2029	Ginna, Nine Mile Point 1, Oyster Creek
2030	Comanche Peak 1, Monticello, Point Beach 1, Robinson 2, Seabrook
2031	Dresden 3, Palisades
2032	Pilgrim, Quad Cities 1, Quad Cities 2, Surry 1, Turkey Point 3
2033	Browns Ferry 1, Comanche Peak 2, Oconee 1, Oconee 2, Peach Bottom 2, Point Beach 2, Prairie Island 1, Surry 2, Turkey Point 4
2034	Arkansas Nuclear 1, Browns Ferry 2, Brunswick 2, Calvert Cliffs 1, Cook 1, Cooper, Duane Arnold, FitzPatrick, Hatch 1, Oconee 3, Peach Bottom 3, Prairie Island 2, Three Mile Island 1
2035	Millstone 2, Watts Bar 1
2036	Beaver Valley 1, Browns Ferry 3, Brunswick 1, Calvert Cliffs 2, St. Lucie 1, Salem 1
2037	Cook 2, Davis-Besse 1, Farley 1
2038	Arkansas Nuclear 2, Hatch 2, North Anna 1
2040	North Anna 2, Salem 2, Sequoyah 1
2041	Farley 2, McGuire 1, Sequoyah 2
2042	LaSalle 1, Summer, Susquehanna 1
2043	Catawba 1, Catawba 2, Columbia, LaSalle 2, McGuire 2, St. Lucie 2
2044	Byron 1, Calloway, Grand Gulf 1, Limerick 1, Susquehanna 2
2045	Fermi 2, Millstone 3, Palo Verde 1, Wolf Creek 1
2046	Braidwood 1, Byron 2, Harris 1, Hope Creek, Nine Mile Point 2, Palo Verde 2
2047	Beaver Valley 2, Braidwood 2, Palo Verde 3, South Texas Project 1, Vogtle 1
2048	South Texas Project 2
2049	Limerick 2, Vogtle 2
2055	Watts Bar 2

Notes: This list includes Indian Point 2 & 3, which entered timely renewal on September 29, 2013, and December 12, 2015. It is limited to reactors licensed to operate. NRC-abbreviated reactor names listed. Data are current as of July 2018; the next printed update will be in August 2019.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

APPENDIX H
Operating Nuclear Research and Test Reactors Regulated by the NRC

Licensee Location	Reactor Type OL Issued	Power Level (kW)	Licensee Number Docket Number
Aerotest San Ramon, CA	TRIGA (Indus) 07/02/1965	250	R-98 05000228
Armed Forces Radiobiology Research Institute Bethesda, MD	TRIGA 06/26/1962	1,100	R-84 05000170
Dow Chemical Company Midland, MI	TRIGA 07/03/1967	300	R-108 05000264
GE-Hitachi Sunol, CA	Tank 10/31/1957	100	R-33 05000073
Idaho State University Pocatello, ID	AGN-201 #103 10/11/1967	0.005	R-110 05000284
Kansas State University Manhattan, KS	TRIGA 10/16/1962	250	R-88 05000188
Massachusetts Institute of Technology Cambridge, MA	HWR Reflected 06/09/1958	6,000	R-37 05000020
Missouri University of Science and Technology Rolla, MO	Pool 11/21/1961	200	R-79 05000123
National Institute of Standards & Technology Gaithersburg, MD	Nuclear Test 05/21/1970	20,000	TR-5 05000184
North Carolina State University Raleigh, NC	Pulstar 08/25/1972	1,000	R-120 05000297
Ohio State University Columbus, OH	Pool 02/24/1961	500	R-75 05000150
Oregon State University Corvallis, OR	TRIGA MARK II 03/07/1967	1,100	R-106 05000243
Pennsylvania State University State College, PA	TRIGA 07/08/1955	1,100	R-2 05000005
Purdue University West Lafayette, IN	Lockheed 08/16/1962	12	R-87 05000182
Reed College Portland, OR	TRIGA MARK I 07/02/1968	250	R-112 05000288

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

APPENDIX H
Operating Nuclear Research and Test Reactors Regulated by the NRC (continued)

Licensee Location	Reactor Type OL Issued	Power Level (kW)	Licensee Number Docket Number
Rensselaer Polytechnic Institute Troy, NY	Critical Assembly 07/03/1964	0.1	CX-22 05000225
Rhode Island Atomic Energy Commission Narragansett, RI	GE Pool 07/23/1964	2,000	R-95 05000193
Texas A&M University College Station, TX	AGN-201M #106 08/26/1957	0.005	R-23 05000059
Texas A&M University College Station, TX	TRIGA 12/07/1961	1,000	R-83 05000128
U.S. Geological Survey Denver, CO	TRIGA MARK I 02/24/1969	1,000	R-113 05000274
University of California/Davis Sacramento, CA	TRIGA 08/13/1998	2,300	R-130 05000607
University of California/Irvine Irvine, CA	TRIGA MARK I 11/24/1969	250	R-116 05000326
University of Florida Gainesville, FL	Argonaut 05/21/1959	100	R-56 05000083
University of Maryland College Park, MD	TRIGA 10/14/1960	250	R-70 05000166
University of Massachusetts/Lowell Lowell, MA	GE Pool 12/24/1974	1,000	R-125 05000223
University of Missouri/Columbia Columbia, MO	Tank 10/11/1966	10,000	R-103 05000186
University of New Mexico Albuquerque, NM	AGN-201M #112 09/17/1966	0.005	R-102 05000252
University of Texas Austin, TX	TRIGA MARK II 01/17/1992	1,100	R-129 05000602
University of Utah Salt Lake City, UT	TRIGA MARK I 09/30/1975	100	R-126 05000407
University of Wisconsin Madison, WI	TRIGA 11/23/1960	1,000	R-74 05000156
Washington State University Pullman, WA	TRIGA 03/06/1961	1,000	R-76 05000027

Note: Data are current as of July 2018; the next printed update will be in August 2019.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

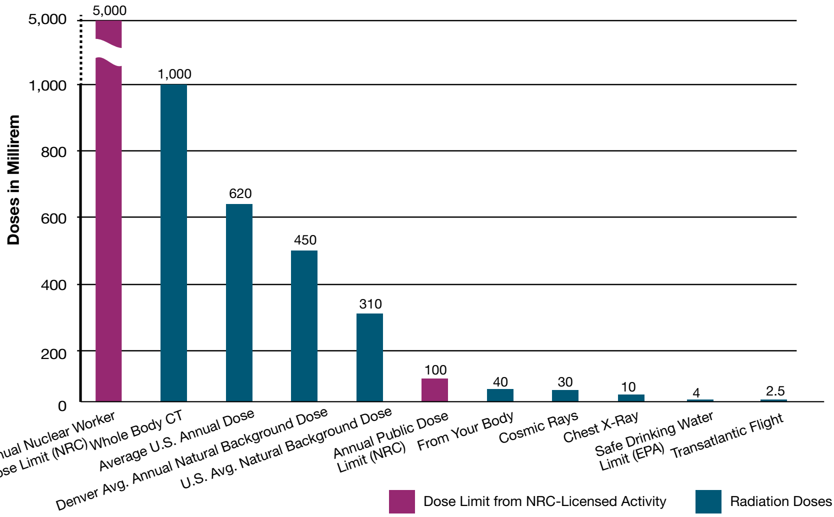
APPENDIX I

Nuclear Research and Test Reactors under Decommissioning Regulated by the NRC

Licensee Location	Reactor Type Power Level (kW)	OL Issued Shutdown
General Atomics San Diego, CA	TRIGA MARK F 1,500	07/01/60 09/07/94
General Atomics San Diego, CA	TRIGA MARK I 250	05/03/58 12/17/96
General Electric Company Sunol, CA	GETR (Tank) 50,000	01/07/59 06/26/85
University of Buffalo Buffalo, NY	Pulstar 2,000	03/24/61 07/23/96

Note: Data are current as of July 2018; the next printed update will be in August 2019.

APPENDIX J
Radiation Doses and Regulatory Limits



APPENDIX K
Commercial Nuclear Power Plant Licensing History 1955–2018

Year	Original Licensing Regulations (10 CFR Part 50)[1]		Current Licensing Regulations (10 CFR Part 52)[4]			
	CP Issued[2]	Full-Power OL Issued[3]	COL Issued[5]	Operating COLs[6]	Permanent Shutdowns[7]	Operable Units[8]
1955	1	0	– –	– –	0	0
1956	3	0	– –	– –	0	0
1957	1	1	– –	– –	0	1
1958	0	0	– –	– –	0	1
1959	3	1	– –	– –	0	2
1960	7	1	– –	– –	0	3
1961	0	0	– –	– –	0	3
1962	1	6	– –	– –	0	9
1963	1	2	– –	– –	1	11
1964	3	3	– –	– –	1	13
1965	1	0	– –	– –	0	13
1966	5	2	– –	– –	1	14
1967	14	3	– –	– –	2	15
1968	23	0	– –	– –	1	13
1969	7	4	– –	– –	0	17
1970	10	3	– –	– –	1	20
1971	4	2	– –	– –	0	22
1972	8	6	– –	– –	2	27
1973	14	15	– –	– –	0	42
1974	23	15	– –	– –	2	55
1975	9	2	– –	– –	0	57
1976	9	7	– –	– –	1	63
1977	15	4	– –	– –	0	67
1978	13	4	– –	– –	1	70
1979	2	0	– –	– –	1	69
1980	0	2	– –	– –	0	71
1981	0	4	– –	– –	0	75
1982	0	4	– –	– –	1	78
1983	0	3	– –	– –	0	81
1984	0	6	– –	– –	0	87
1985	0	9	– –	– –	0	96
1986	0	5	– –	– –	0	101
1987	0	8	– –	– –	1	107
1988	0	2	– –	– –	0	109
1989	0	4	– –	– –	3	111
1990	0	2	– –	– –	0	112
1991	0	0	– –	– –	1	111
1992	0	0	– –	– –	2	109
1993	0	1	– –	– –	0	110
1994	0	0	– –	– –	0	109
1995	0	0	– –	– –	0	109
1996	0	1	– –	– –	3	109
1997	0	0	0	0	2	107
1998	0	0	0	0	1	104
1999-2011	0	0	0	0	0	104

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX K
Commercial Nuclear Power Plant Licensing History 1955–2018 (continued)

Year	Original Licensing Regulations (10 CFR Part 50)[1]		Current Licensing Regulations (10 CFR Part 52)[4]			
	CP Issued[2]	Full-Power OL Issued[3]	COL Issued[5]	Operating COLs[6]	Permanent Shutdowns[7]	Operable Units[8]
2012	0	0	4 units	0	0	104
2013	0	0	0	0	4	100
2014	0	0	0	0	1	99
2015	0	1	1 units	0	0	100
2016	0	0	4 units	0	1	99
2017	0	0	1 unit	0	0	99
2018	0	0	2 units	0	0	99
Total	177	133	12 units	0	34	– –

U.S. Atomic Energy Commission was the regulatory authority

– – Not applicable

1 Data in columns 1–3 are based on 10 CFR Part 50 and in columns 4–6 are based on 10 CFR Part 52

2 Issuance by regulatory authority of a permit, or equivalent permission, to begin construction. Under current licensing regulations, the construction permit is no longer issued separately from the operating license.

3 Numbers reflect permits or licenses issued in a given year, not extant permits or licenses.

4. Data in columns 4–6 are based on 10 CFR Part 52.

5 Number of applications received for combined licenses (construction and operating) in a given year, including one that was subsequently withdrawn. See Appendix A Part 52 on status of plant construction and Appendix B for more information on withdrawn licenses and received applications.

6 Issuance by regulatory authority of full-power operating license, or equivalent permission in a given year.

7 Number of operating plants transitioned to shutdown in a given year. Does not represent the total number of reactor units included.

8 The number of operable units equals the cumulative number of units holding full-power licenses minus the cumulative number of permanent shutdowns.

Source: U.S. Energy Information Administration/Annual Energy Review 2011 located at www.eia.gov/aer. and compilation of NRC information following 2011.

APPENDIX L
Materials Licenses by State

State	NRC (Number of Licenses)	Agreement States (Number of Licenses)
Alabama	20	380
Alaska	79	0
Arizona	11	342
Arkansas	6	209
California	70	1,728
Colorado	20	314
Connecticut	153	0
Delaware	50	0
District of Columbia	37	0
Florida	20	1,623
Georgia	22	405
Hawaii	65	0
Idaho	81	0
Illinois	25	620
Indiana	267	0
Iowa	1	155
Kansas	15	273
Kentucky	14	354
Louisiana	15	471
Maine	2	100
Maryland	64	535
Massachusetts	27	411
Michigan	435	0
Minnesota	13	151
Mississippi	5	283
Missouri	267	0
Montana	90	0
Nebraska	4	132
Nevada	5	239
New Hampshire	4	82
New Jersey	28	558
New Mexico	15	207
New York	23	993
North Carolina	22	572
North Dakota	3	85
Ohio	41	552
Oklahoma	19	234
Oregon	4	274
Pennsylvania	52	608
Rhode Island	2	44
South Carolina	6	348
South Dakota	42	0
Tennessee	24	520
Texas	58	1,509
Utah	14	205
Vermont	36	0
Virginia	57	389
Washington	21	337
West Virginia	193	0
Wisconsin	9	289
Wyoming	106	0
Puerto Rico	115	0
Virgin Islands	9	0
Guam	9	0
American Samoa	2	0
Northern Marianas	1	0
Total number of materials licenses in Agreement State jurisdiction		16,531
Total number of materials licenses in NRC jurisdiction		2,795
Total number of materials licenses in the United States		19,326

Agreement State   States Pursuing Agreements

Notes: The NRC and Agreement State data are as of June 2018. These totals represent an estimate because the number of specific radioactive materials licenses per State may change daily. The next printed update will be in August 2019. The NRC licenses Federal agencies in Agreement States.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX M
Major U.S. Fuel Cycle Facility Sites

Licensee	Location	Status	Docket #
Uranium Hexafluoride Conversion Facility			
Honeywell International, Inc.	Metropolis, IL	ready-idle*	04003392
Uranium Fuel Fabrication Facilities			
Global Nuclear Fuel-Americas, LLC	Wilmington, NC	active	07001139
Westinghouse Electric Company, LLC Columbia Fuel Fabrication Facility	Columbia, SC	active	07001151
Nuclear Fuel Services, Inc.	Erwin, TN	active	07000143
BWXT Nuclear Operations Group, Inc.	Lynchburg, VA	active	07000027
Framatone, Inc.	Richland, WA	active	07001257
Mixed-Oxide Fuel Fabrication Facility			
CB&I AREVA MOX Services, LLC	Aiken, SC	construction	07003098
Gas Centrifuge Uranium Enrichment Facilities			
Centrus Energy Corp American Centrifuge Plant	Piketon, OH	license issued, construction halted	07007004
URENCO-USA (Louisiana Energy Services)	Eunice, NM	active	07003103
AREVA Enrichment Services, LLC Eagle Rock Enrichment Facilities	Idaho Falls, ID	license issued, construction not started	07007015
Uranium Enrichment Laser Separation Facility			
GE-Hitachi Global Laser Enrichment, LLC	Wilmington, NC	license issued, construction not started	07007016
Depleted Uranium Deconversion Facility			
International Isotopes, Inc.	Hobbs, NM (Lea County)	license issued, construction not started	04009086

* The facility is being maintained with minimal operations to support a future return to production.

Note: AREVA Enrichment Services, LLC Eagle Rock Enrichment Facilities requested to terminate license on never-built facilities in a letter dated May 14, 2018. Data are current as of July 2018; the next printed update will be in August 2019.

APPENDIX N
Dry Spent Fuel Storage Designs: NRC-Approved for Use by General Licensees

Vendor	Docket #	Storage Design Model
General Nuclear Systems, Inc.	07201000	CASTOR V/21 (expired)
NAC International, Inc.	07201002	NAC S/T (expired)
	07201003	NAC-C28 S/T (expired)
	07201015	NAC-UMS
	07201025	NAC-MPC
	07201031	Magnastor
	07201013	NAC-STC
Holtec International	07201008	HI-STAR 100
	07201014	HI-STORM 100
	07201032	HI-STORM FW
	07201040	HI-STORM UMAX
EnergySolutions, Inc.	07201007	VSC-24
	07201026	Fuel Solutions™ (WSNF-220, -221, -223) W-150 Storage Cask W-100 Transfer Cask W-21, W-74 Canisters
Transnuclear, Inc.	07201005	TN-24 (expired)
	07201027	TN-68
	07201021	TN-32
	07201004	Standardized NUHOMS®-24P, -24PHB, -24PTH, -32PT, -32PTH1, -37PTH, -52B, -61BT, -61BTH, -69BTH
	07201029	Standardized Advanced NUHOMS®-24PT1, -24PT4
	07201030	NUHOMS® HD-32PTH
	07201042	NUHOMS® EOS

Note: Data are current as of July 2018; the next printed update will be in August 2019. (See latest list on the NRC Web site at *https://www.nrc.gov/waste/spent-fuel-storage/designs.html*.)

APPENDIX O
Dry Cask Spent Fuel Storage Licensees

Name Licensee	License Type	Vendor	Storage Model	Docket Number
Arkansas Nuclear Entergy Nuclear Operations, Inc.	GL	Energy Solutions, Inc. Holtec International	VSC-24 HI-STORM 100	07200013
Beaver Valley FirstEnergy Nuclear Operating Company	GL	Transnuclear, Inc.	NUHOMS®-37PTH	07201043
Big Rock Point Entergy Nuclear Operations, Inc.	GL	Energy Solutions, Inc.	Fuel Solutions™ W74	07200043
Braidwood Exelon Generation Co., LLC	GL	Holtec International	HI-STORM 100	07200073
Browns Ferry Tennessee Valley Authority	GL	Holtec International	HI-STORM 100S HI-STORM FW	07200052
Brunswick Carolina Power Co.	GL	Transnuclear, Inc.	NUHOMS®-HD-61BTH	07200006
Byron Exelon Generation Co., LLC	GL	Holtec International	HI-STORM 100	07200068
Callaway Union Electric Co. Ameren Missouri	GL	Holtec International	HI-STORM UMAX	07201045
Calvert Cliffs Calvert Cliffs Nuclear Power Plant, Inc.	SL	Transnuclear, Inc.	NUHOMS®-24P NUHOMS®-32P	07200008
Catawba Duke Energy Carolinas, LLC	GL	NAC International, Inc.	NAC-UMS Magnastor	07200045
Clinton Exelon Generation Co.,LCC	GL	Holtec International	HI-STORM FW	07201046
Columbia Generating Station Energy Northwest	GL	Holtec International	HI-STORM 100	07200035
Comanche Peak Luminant Generation Company, LLC	GL	Holtec International	HI-STORM 100	07200074
Cooper Nuclear Station Nebraska Public Power District	GL	Transnuclear, Inc.	NUHOMS®-61BT	07200066
Crystal River Duke Energy, LLC	GL	Transnuclear, Inc.	NUHOMS®-32PT	07201035
Davis-Besse FirstEnergy Nuclear Operating Company	GL	Transnuclear, Inc.	NUHOMS®-24P NUHOMS®-32PTH	07200014
DC Cook Indiana/Michigan Power	GL	Holtec International	HI-STORM	07200072
Diablo Canyon Pacific Gas & Electric Co.	SL	Holtec International	HI-STORM 100	07200026

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX O
Dry Cask Spent Fuel Storage Licensees (continued)

Name Licensee	License Type	Vendor	Storage Model	Docket Number
Dresden Exelon Generation Company, LLC	GL	Holtec International	HI-STAR 100 HI-STORM 100	07200037
Duane Arnold NextEra Energy Inc. Duane Arnold, LLC	GL	Transnuclear, Inc.	NUHOMS®-61BT	07200032
Fermi DTE Electric Company	GL	Holtec International	HI-STORM 100	07200071
Fort Calhoun Omaha Public Power District	GL	Transnuclear, Inc.	NUHOMS®-32PT	07200054
Fort St. Vrain* U.S. Department of Energy	SL	FW Energy Applications, Inc.	Modular Vault Dry Store	07200009
Grand Gulf Entergy Nuclear Operations, Inc.	GL	Holtec International	HI-STORM 100S	07200050
H.B. Robinson Carolina Power & Light Company	SL GL	Transnuclear, Inc. Transnuclear, Inc.	NUHOMS®-7P NUHOMS®-24P	07200003 07200060
Haddam Neck CT Yankee Atomic Power	GL	NAC International, Inc.	NAC-MPC	07200039
Hatch Southern Nuclear Operating, Inc.	GL	Holtec International	HI-STORM100 HI-STORM100S	07200036
Hope Creek/Salem PSEG Nuclear, LLC	GL	Holtec International	HI-STORM 100	07200048
Humboldt Bay Pacific Gas & Electric Co.	SL	Holtec International	HI-STORM 100HB	07200027
Idaho National Lab TMI-2 Fuel Debris, U.S. Department of Energy	SL	Transnuclear, Inc.	NUHOMS®-12T	07200020
Idaho Spent Fuel Facility Environmental Corp.	SL	Foster Wheeler	Concrete Vault	07200025
Indian Point Entergy Nuclear Operations, Inc.	GL	Holtec International	HI-STORM 100	07200051
James A. FitzPatrick Entergy Nuclear Operations, Inc.	GL	Holtec International	HI-STORM 100	07200012
Joseph M. Farley Southern Nuclear Operating Co.	GL	Holtec International	HI-STORM 100	07200042
Kewaunee Dominion Energy Kewaunee, Inc.	GL	Transnuclear, Inc. NAC International, Inc.	NUHOMS®-39PT Magnastor	07200064
La Salle Exelon Generation Co., LLC	GL	Holtec International	HI-STORM100	07200070
Lacrosse Dairyland Power	GL	NAC International, Inc.	NAC-MPC	07200046

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX O
Dry Cask Spent Fuel Storage Licensees (continued)

Name Licensee	License Type	Vendor	Storage Model	Docket Number
Limerick Exelon Generation Co., LLC	GL	Transnuclear, Inc.	NUHOMS®-61BT	07200065
Maine Yankee Maine Yankee Atomic Power Company	GL	NAC International, Inc.	NAC-UMS	07200030
McGuire Duke Energy, LLC	GL	Transnuclear, Inc.	TN-32	07200038
Millstone Dominion Generation	GL	Transnuclear, Inc. NAC International, Inc.	NUHOMS®-32PT Magnastor, NAC UMS	07200047
Monticello Northern States Power Co., Minnesota	GL	Transnuclear, Inc.	NUHOMS®-61BT NUHOMS®-61BTH	07200058
Nine Mile Point Constellation Energy	GL	Transnuclear, Inc.	NUHOMS®-61BT	07201036
North Anna Virginia Dominion Generation	GL SL	Transnuclear, Inc. Transnuclear, Inc.	NUHOMS®HD32PTH TN-32	07200056 07200016
Oconee Duke Energy Company	SL GL	Transnuclear, Inc. Transnuclear, Inc.	NUHOMS®-24P NUHOMS®-24P	07200004 07200040
Oyster Creek AmerGen Energy Company, LLC	GL	Transnuclear, Inc.	NUHOMS®-61BT	07200015
Palisades Entergy Nuclear Operations, Inc.	GL	EnergySolutions, Inc. Transnuclear, Inc.	VSC-24 NUHOMS®-32PT NUHOMS®-24PT	07200007
Palo Verde Arizona Public Service Co.	GL	NAC International, Inc. Holtec International	NAC-UMS HI-STORM	07200044
Peach Bottom Exelon Generation Co., LLC	GL	Transnuclear, Inc.	TN-68	07200029
Perry FirstEnergy	GL	Holtec International	HI-STORM	07200069
Pilgrim Entergy Nuclear Operations, Inc.	GL	Holtec International	HI-STORM 100	07201044
Point Beach FLP Energy Point Beach, LLC	GL	EnergySolutions, Inc.	VSC-24 NUHOMS®-32PT	07200005
Prairie Island Northern States Power Co., Minnesota	SL	Transnuclear, Inc.	TN-40 HT TN-40	07200010
Private Fuel Storage Facility	SL	Holtec International	HI-STORM 100	07200022
Quad Cities Exelon Generation Co., LLC	GL	Holtec International	HI-STORM 100S	07200053
Rancho Seco Sacramento Municipal Utility District	SL	Transnuclear, Inc.	NUHOMS®-24P	07200011

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX O
Dry Cask Spent Fuel Storage Licensees (continued)

Name Licensee	License Type	Vendor	Storage Model	Docket Number
R.E. Ginna Constellation Energy	GL	Transnuclear, Inc.	NUHOMS®-32PT	07200067
River Bend Entergy Nuclear Operations, Inc.	GL	Holtec International	HI-STORM 100S	07200049
Salem PSEG Nuclear	GL	Holtec International	HI-STORM	07200048
San Onofre Southern California Edison Co.	GL	Transnuclear, Inc.	NUHOMS®-24PT	07200041
Seabrook FPL Energy	GL	Transnuclear, Inc.	NUHOMS®-HD-32PTH	07200061
Sequoyah Tennessee Valley Authority	GL	Holtec International	HI-STORM 100	07200034
St. Lucie Florida Power & Light Co.	GL	Transnuclear, Inc.	NUHOMS®-HD-32PTH	07200061
Surry Virginia Dominion Generation	SL GL	Transnuclear, Inc.	NUHOMS®HD NUHOMS®HD-32PTH	07200002 07200055
Susquehanna Susquehanna Nuclear, LLC	GL	Transnuclear, Inc.	NUHOMS®-52B NUHOMS®-61BT NUHOMS®-61BTH	07200028
Trojan Portland General Electric Corp.	SL	Holtec International	HI-STORM 100	07200017
Turkey Point ISFSI Florida Power & Light Co.	GL	Transnuclear, Inc.	NUHOMS®-HD-32PTH	07200062
Vermont Yankee Entergy Nuclear Operations, Inc.	GL	Holtec International	HI-STORM 100	07200059
Virgil C. Summer South Carolina Electric & Gas	GL	Holtec International	HI-STORM FW	07201038
Vogtle Southern Company	GL	Holtec International	HI-STORM 100S	07201039
Waterford Steam Electric Station Entergy Nuclear Operations, Inc.	GL	Holtec International	HI-STORM 100	07200075
Watts Bar Tennessee Valley Authority	GL	Holtec International	HI-STORM FW	07201048
Yankee Rowe Yankee Atomic Electric	GL	NAC International, Inc.	NAC-MPC	07200031
Zion Zion Solutions, LLC	GL	NAC International, Inc.	Magnastor	07201037

* Fort St. Vrain is undergoing decommissioning and was transferred to DOE on June 4, 1999.

Notes: NRC-abbreviated unit names. Data are current as of July 2018, and the next printed update will be in August 2019.

License Types: SL = site-specific license, GL = general license

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX P
U.S. Low-Level Radioactive Waste Disposal Compact Membership

Appalachian Compact
Delaware
Maryland
Pennsylvania
West Virginia

Atlantic Compact
Connecticut
New Jersey
South Carolina*

Central Compact
Arkansas
Kansas
Louisiana
Oklahoma

Central Midwest Compact
Illinois
Kentucky

Midwest Compact
Indiana
Iowa
Minnesota
Missouri
Ohio
Wisconsin

Northwest Compact
Alaska
Hawaii
Idaho
Montana
Oregon
Utah*
Washington*
Wyoming

Rocky Mountain Compact
Colorado
Nevada
New Mexico
(Northwest accepts Rocky Mountain waste as agreed between compacts.)

Southeast Compact
Alabama
Florida
Georgia
Mississippi
Tennessee
Virginia

Southwestern Compact
Arizona
California
North Dakota
South Dakota

Texas Compact
Texas*
Vermont

Unaffiliated
District of Columbia
Maine
Massachusetts
Michigan
Nebraska
New Hampshire
New York
North Carolina
Puerto Rico
Rhode Island

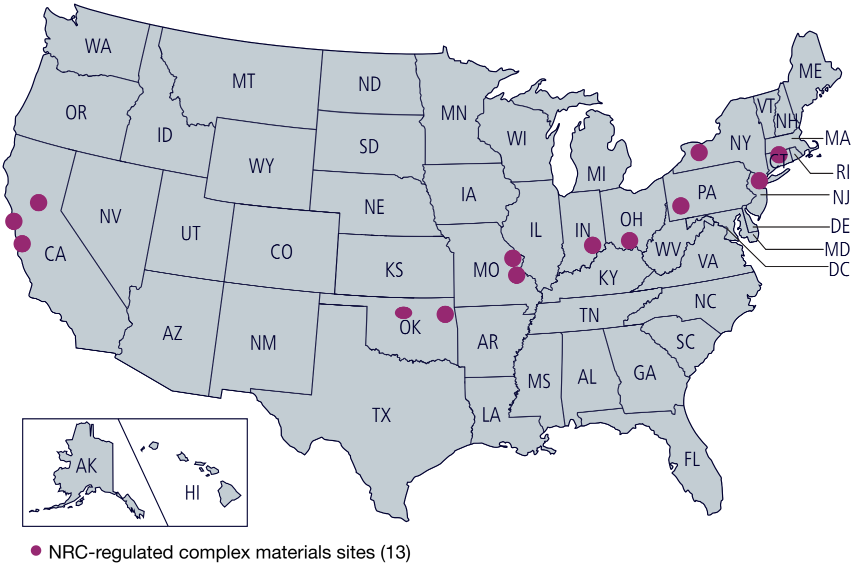
Closed Low-Level Radioactive Waste Disposal Facility Sites Licensed by the NRC or Agreement States

Beatty, NV, closed 1993
Sheffield, IL, closed 1978
Maxey Flats, KY, closed 1977
West Valley, NY, closed 1975

* Site of an active low-level waste disposal facility.
Note: Data are current as of July 2018; the next printed update will be in August 2019.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX Q
NRC-Regulated Complex Materials Sites Undergoing Decommissioning



Company	Location
Alameda Naval Air Station	Alameda, CA
BWX Technology, Inc., Shallow Land Disposal Area	Vandergrift, PA
Cimarron Environmental Response Trust	Cimarron City, OK
Department of Army, Jefferson Proving Ground	Madison, IN
Department of Army, Picatinny Arsenal (ARDEC)	Picatinny, NJ
FMRI, Inc. (Fansteel)	Muskogee, OK
Hunter’s Point Naval Shipyard	San Francisco, CA
Lead Cascade (Centrus)	Piketon, OH
McClellan Air Force Base	Sacramento, CA
Sigma Aldrich	Maryland Heights, MO
UNC Naval Products	New Haven, CT
West Valley Demonstration Project	West Valley, NY
Westinghouse Electric Corporation—Hematite	Festus, MO

Notes: Data are current as of July 2018. The next printed update will be in August 2019.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX R
Nuclear Power Units by Nation

Country	Nuclear Power Production GWh*	In Operation: Number of Units	In Operation: Gross MW Electrical Capacity	Under Construction or on Order: Number of Units	Under Construction or on Order: Gross MW Electrical Capacity	Shutdown
Argentina	6,161	3	1,755	1	29	0
Armenia	2,411	1	408	0	0	1P
Bangladesh	0	0	0	1	1200	0
Belarus	0	0	0	2	2,388	0
Belgium	41,031	7	6,207	0	0	1P
Brazil	15,740	2	1,990	1	1,405	0
Bulgaria	15,549	2	2,000	0	0	4P
Canada	96,074	19	14,512	0	0	6P
China	247,469	39	36,959	18	21,145	0
Czech Republic	26,785	6	4,160	0	0	0
Finland	21,575	4	2,877	1	1,720	0
France	379,100	58	65,880	1	1,650	12P
Germany	72,163	7	10,013	0	0	29P
Hungary	15,219	4	2,000	0	0	0
India	35,000	22	6,780	7	5,300	0
Iran	6,366	1	1,000	0	0	0
Italy	0	0	0	0	0	4P
Japan	29,073	42	41,482	2	2,756	18P
Kazakhstan	0	0	0	0	0	1P
Korea, Republic of	141,098	24	23,518	4	5,600	1P
Lithuania	0	0	0	0	0	2P
Mexico	10,572	2	1,615	0	0	0
Netherlands	3,278	1	515	0	0	1P
Pakistan	7,867	5	1,430	2	2,200	0
Romania	10,561	2	1,411	0	0	0
Russia	187,499	37	30,159	6	4,919	6P
Slovakia	14,016	4	1,950	2	942	3P
Slovenia	5,968	1	727	0	0	0
South Africa	15,209	2	1,940	0	0	0
Spain	55,599	7	7,416	0	0	3P

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX R
Nuclear Power Units by Nation (continued)

Country	Nuclear Power Production GWh*	In Operation: Number of Units	In Operation: Gross MW Electrical Capacity	Under Construction or on Order: Number of Units	Under Construction or on Order: Gross MW Electrical Capacity	Shutdown
Sweden	63,063	8	8,622	0	0	5P
Switzerland	19,502	5	3,467	0	0	1P
Turkey	0	0	0	1	1200	0
Ukraine	85,576	15	13,835	2	2,178	4P
United Arab Emirates	0	0	0	4	5,600	0
United Kingdom	63,877	15	10,362	0	0	30P
United States	804,950	99	105,514	2	2,500	34P

Overview of Worldwide Nuclear Power Reactors—As of May 6, 2018

Nuclear Electricity Supplied (GWh)	2,487,981
Net Installed Capacity (MWe)	393,843
Nuclear Power Reactors in Operation	450
Nuclear Power Reactors in Long-Term Shutdown	0
Nuclear Power Reactors in Permanent Shutdown	166
Nuclear Power Reactors under Construction	58

* Annual electrical power production for 2017. P = Permanent Shutdown
Notes: Totals include reactors that are operable, under construction, or on order; the country's short-form name is used; and the figures are rounded to the nearest whole number.
Sources: IAEA Power Reactor Information System Database; analysis compiled by the NRC. For more information go to https://www.iaea.org/pris/. Data are current as of May 2018; the next printed update will be in August 2019.

APPENDIX S
Nuclear Power Units by Reactor Type, Worldwide

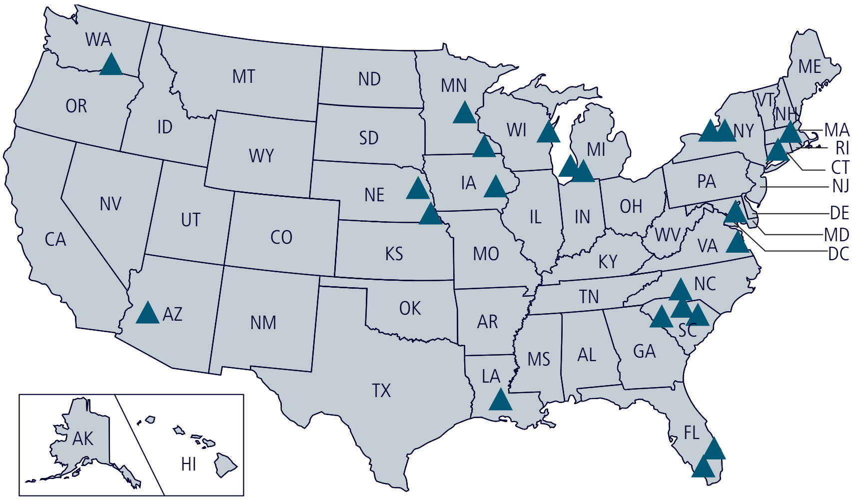
Reactor Type	In Operation: Number of Units	In Operation: Net MWe
Pressurized light-water reactors (PWR)	294	276,965
Boiling light-water reactors (BWR)	75	72,941
Heavy-water reactors, all types (HWR, PHWR)	49	24,598
Light-water-cooled graphite-moderated reactor (LWGR)	15	10,219
Gas-cooled reactors, all types (GCR)	14	7,720
Liquid-metal-cooled fast breeder reactors (FBR)	3	1,400
Total	**450**	**393,843**

Note: MWe values are rounded to the nearest whole number.
Source: IAEA Power Reactor Information System Database, www.iaea.org Compiled by the NRC from IAEA data. Data are current as of May 2018. The next printed update will be in August 2019.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX T

Native American Reservations and Trust Lands within a 50-Mile Radius of a Nuclear Power Plant



ARIZONA
- **Palo Verde**
  - Ak-Chin Indian Community
  - Tohono O'odham Trust Land
  - Gila River Reservation

CONNECTICUT
- **Millstone**
  - Mohegan Reservation
  - Mashantucket Pequot Reservation
  - Narragansett Reservation
  - Shinnecock Indian Nation

FLORIDA
- **St. Lucie**
  - Brighton Reservation (Seminole Tribes of Florida)
  - Fort Pierce Reservation
- **Turkey Point**
  - Hollywood Reservation (Seminole Tribes of Florida)
  - Miccosukee Reservation
  - Miccosukee Trust Land

IOWA
- **Duane Arnold**
  - Sac & Fox Trust Land
  - Sac & Fox Reservation

LOUISIANA
- **River Bend**
  - Tunica-Biloxi Reservation

MASSACHUSETTS
- **Pilgrim**
  - Wampanoag Tribe of Gay Head (Aquinnah) Trust Land

MARYLAND
- **Calvert Cliffs**
  - Rappahannock Tribe

MICHIGAN
- **Palisades**
  - Pottawatomi Reservation Matchebenashshewish Band
  - Pokagon Reservation
  - Pokagon Trust Land*
- **DC Cook**
  - Pokagon Reservation
  - Pokagon Trust Land

MINNESOTA
- **Monticello**
  - Shakopee Community
  - Shakopee Trust Land
  - Mille Lacs Reservation
- **Prairie Island**
  - Prairie Island Community*
  - Prairie Island Trust Land*
  - Shakopee Community
  - Shakopee Trust Land

NEBRASKA
- **Cooper**
  - Sac & Fox Trust Land
  - Sac & Fox Reservation
  - Iowa Reservation
  - Iowa Trust Land
  - Kickapoo

NEW YORK
- **FitzPatrick**
  - Onondaga Reservation
  - Oneida Reservation
- **Nine Mile Point**
  - Onondaga Reservation
  - Oneida Reservation

NORTH CAROLINA
- **McGuire**
  - Catawba Reservation

SOUTH CAROLINA
- **Catawba**
  - Catawba Reservation
- **Oconee**
  - Eastern Cherokee Reservation
- **Summer**
  - Catawba Reservation

VIRGINIA
- **Surry**
  - Pamunkey Reservation
  - Chickahominy Indian Tribe
  - Chickahominy Indian Tribe — Eastern Division
  - Nansemond Indian Tribe
  - Upper Mattaponi Tribe

WASHINGTON
- **Columbia**
  - Yakama Reservation
  - Yakama Trust Land

WISCONSIN
- **Point Beach**
  - Oneida Trust Land
  - Oneida Reservation

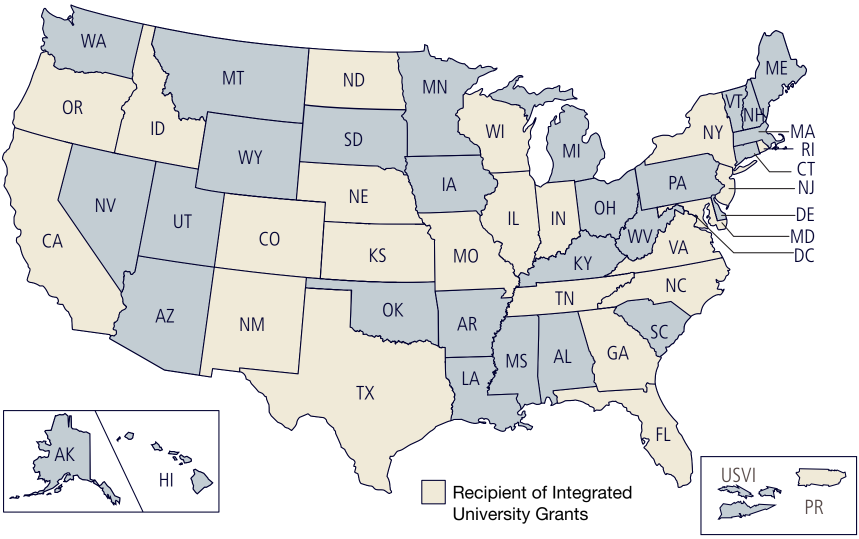
* Tribe is located within the 10-mile emergency preparedness zone of operating reactors.

Notes: This table uses NRC-abbreviated reactor names and Native American Reservation and Trust land names. There are no reservations or Trust lands within 50 miles of a reactor in Alaska or Hawaii. For more information on other Tribal concerns, go to the NRC Web site at *https://www.nrc.gov.* NRC-abbreviated reactor names listed. Data are current as of July 2018, and the next printed update will be in August 2019.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/*.

APPENDIX U

States with Integrated University Grants Program Recipients in FY 2017



Notes:

The 2009 Omnibus Appropriations Act authorized the Integrated University Program (IUP) for 10 years for a total of $45 million per year: $15 million each to the U.S. Nuclear Regulatory Commission (NRC), the U.S. Department of Energy, and the National Nuclear Security Administration.

The IUP provides grants to academic institutions to support education in nuclear science and engineering to develop a workforce capable of supporting the design, construction, operation, and regulation of nuclear facilities and the safe handling of nuclear materials.

To date, the NRC has awarded 420 IUP grants, including 122 faculty development, 103 scholarship, 120 fellowship, and 75 trade school and community college scholarship grants. More than 100 faculty and 3,500 students have received support. The NRC has invested approximately $9.7 million in its trade school and community college scholarship program to support the development of trade and craft workers in the nuclear industry.

APPENDIX V

Significant Enforcement Actions Issued, 2017

Significant (escalated) enforcement actions include notices of violation (NOVs) for severity level (SL) I, II, or III violations; NOVs associated with inspection findings that the significance determination process (SDP) categorizes as White, Yellow, or Red; civil penalties (CPs); and enforcement-related orders. The NRC Enforcement Policy also allows related violations to be categorized collectively as a single problem. Escalated enforcement actions are issued to reactor, materials, and individual licensees; nonlicensees; and fuel cycle facility licensees.

Action #	Name	Type	Issue Date	Enforcement Action
EA-16-164	Rozell Testing Laboratories, LLC	Materials	1/11/2017	NOV SL III
EA-16-180	White Earth Department of Transportation	Materials	1/17/2017	NOV SL III
EA-16-152	American Engineering Testing, Inc.	Materials	1/18/2017	NOV SL III
EA-16-231	Wyoming Medical Center	Materials	1/23/2017	NOV SL III
EA-16-232	XCEL NDT, LLC	Materials	1/25/2017	Problem SL III
EA-16-224	Thrasher Engineering, Inc.	Materials	1/26/2017	NOV SL III
EA-16-214	Spectrum Health Hospitals	Materials	2/02/2017	NOV SL III
IA-16-059	Mr. Curtis Thompson	Individual	2/02/2017	Order prohibiting involvment in NRC-licensed activities for 1 year
EA-16-184	PSEG Nuclear, LLC (Hope Creek Generating Station)	Reactor	2/06/2017	NOV White SDP finding resulting in plant inspections
IA-16-075	Mr. Casey Pooler	Individual	2/15/2017	Order prohibiting involvment in NRC-licensed activities for 3 years; NOV SL III
EA-16-236	Exelon Generation Co., LLC (Dresden Nuclear Power Station)	Reactor	2/27/2017	NOV White SDP finding resulting in plant inspections
EA-16-247	Entergy Operations, Inc. (Arkansas Nuclear One)	Reactor	2/27/2017	NOV White SDP finding resulting in plant inspections
EA-16-066	Botsford General Hospital	Materials	3/01/2017	NOV SL III
IA-17-028	Mr. Roy Taylor	Individual	3/01/2017	NOV SL III
EA-15-218	Louisiana Energy Services, LLC	Fuel Facility	3/03/2017	Problem SL III
IA-16-029	Mr. Pieter van der Heide	Individual	3/03/2017	NOV SL III
EA-16-114	Homestake Mining	Materials	3/28/2017	Confirmatory Order result of an ADR mediation
EA-16-191	Premier Technology, Inc.	Materials	3/31/2017	Problem SL III
EA-16-255	Somascan, Incorporated	Materials	4/05/2017	Problem/CP SL III–$7,000
EA-16-241	Exelon Nuclear (Oyster Creek Nuclear Generating Station)	Reactor	4/13/2017	NOV White SDP finding resulting in plant inspections
EA-17-014	Southern Nuclear Operating Co. (Vogtle Electric Generating Plant)	Reactor	4/25/2017	NOV White SDP finding resulting in plant inspections

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX V

Significant Enforcement Actions Issued, 2017 (continued)

Action #	Name	Type	Issue Date	Enforcement Action
EA-16-251	PSEG Nuclear, LLC (Hope Creek Generating Station)	Reactor	5/03/2017	NOV SL III
EA-16-258	Hayre McElroy & Associates, LLC	Materials	5/11/2017	NOV/CP SL III–$7,000
EA-17-012	DTE Energy Company (Fermi Power Plant, Unit 2)	Reactor	5/11/2017	NOV White SDP finding resulting in plant inspections
IA-17-004	Mr. Eli Dragomer	Individual	5/11/2017	NOV SL III
EA-15-124	Kim Engineering	Materials	5/25/2017	NOV/CP SL III–$7,000
EA-16-281	ADCO Services, Inc.	Materials	5/30/2017	NOV SL III
EA-16-130	JANX Integrity Group	Materials	6/01/2017	Problem SL III
IA-16-049	Toby Lashley	Individual	6/01/2017	Order prohibiting involvment in NRC-licensed activities for 1 year
IA-16-050	Mr. Kevin Lashley	Individual	6/01/2017	NOV SL III
EA-17-026	Guam Medical Imaging Center	Materials	6/06/2017	Problem SL III
EA-17-036	Guam Regional Medical Center	Materials	6/06/2017	NOV SL III
EA-16-267	P4 Production, LLC	Materials	6/13/2017	Problem SL III
EA-17-062	ERP Federal Mining Complex, LLC	Materials	6/21/2017	Problem SL III
EA-16-255	Somascan, Incorporated	Materials	6/27/2017	Order Imposing a Civil Penalty of $7,000
EA-16-262	Cameco Resources/Power Resources, Inc.	Materials	6/28/2017	Problem SL III
EA-17-028	Energy Northwest (Columbia Generating Station)	Reactor	7/06/2017	NOV White SDP finding resulting in plant inspections
EA-17-063	Hill's Pet Nutrition	Materials	7/27/2017	NOV SL III
EA-17-022	Tennessee Valley Authority (Watts Bar Nuclear Plant)	Reactor	7/27/2017	Confirmatory Order result of an ADR mediation
EA-17-058	Westinghouse Electric Company, LLC	Fuel Facility	8/09/2017	Confirmatory Order result of an ADR mediation
EA-17-027	Geo-Logic Associates, Inc.	Materials	8/14/2017	Problem SL III
EA-16-216	STP Nuclear Operating Company (South Texas Project Electric Generating Station)	Reactor	8/18/2017	NOV SL III
EA-17-025	Geo-Engineering & Testing, Inc.	Materials	8/18/2017	NOV SL III
EA-17-043	FirstEnergy Nuclear Operating Co. (Perry Nuclear Power Plant)	Reactor	8/24/2017	NOV White SDP finding resulting in plant inspections
EA-17-048	Allen County Cardiology	Materials	9/05/2017	Problem/CP SL III–$7,000
EA-17-096	Cardinal Health Nuclear Pharmacy	Materials	9/14/2017	NOV SL III
EA-17-097	Coastal Wireline Services, Inc.	Materials	9/14/2017	NOV SL III
EA-17-082	Washington University	Materials	9/21/2017	NOV SL III

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX V

Significant Enforcement Actions Issued, 2017 (continued)

Action #	Name	Type	Issue Date	Enforcement Action
EA-17-122	Duke Energy Corporation (Catawba Nuclear Station, Unit 2)	Reactor	10/16/2017	NOV White SDP finding resulting in plant inspections
EA-17-091	Michiana Hematology Oncology, PC	Materials	10/31/2017	Problem SL III
EA-17-125	Board of Light and Water City of Marquette	Materials	11/08/2017	NOV SL III
IA-17-030	Mr. Devin Caraza	Individual	11/08/2017	NOV SL III
EA-17-079	Terracon Consultants, Inc.	Materials	11/15/2017	NOV SL III
EA-17-118	Midwest Engineering and Testing, Inc.	Materials	11/21/2017	NOV SL III
EA-17-077	Dominion Nuclear Connecticut, Inc. (Millstone Power Station)	Reactor	11/21/2017	Confirmatory Order result of an ADR mediation
EA-17-098	Exelon Generation Company (Clinton Power Station)	Reactor	11/27/2017	NOV White SDP finding resulting in plant inspections
EA-17-101	Qal-Tek Associates, LLC	Materials	12/12/2017	Problem/CP SL II–$22,400
EA-17-090	Global Nuclear Fuel-Americas, LLC	Fuel Facility	12/14/2017	Confirmatory Order result of an ADR mediation
EA-17-148	Construction Consulting and Testing	Materials	12/18/2017	NOV SL III
EA-17-104	Avera McKennan Hospital	Materials	12/21/2017	Problem SL III
EA-17-157	K & S Engineers, Inc.	Materials	12/21/2017	NOV SL III
IA-17-111	Mr. Mark Sperlich	Individual	12/21/2017	NOV SL III
EA-17-147	CTI and Associates, Inc.	Materials	12/28/2017	NOV/CP SL III-$7,000

Notes: Reactor facilities in a decommissioning status are listed as materials licensees. The NRC report on Issued Significant Enforcement Actions can be found on the NRC Web site at *https://www.nrc.gov/about-nrc/regulatory/enforcement/current.html*.

APPENDIX W
Laws Governing the U.S. Nuclear Regulatory Commission

1. Atomic Energy Act of 1954, as amended (Pub. L. 83-703)
2. Energy Reorganization Act of 1974, as amended (Pub. L. 93-438)
3. Reorganization Plan No. 1 of 1980, 5 U.S.C., App. 1.
4. Uranium Mill Tailings Radiation Control Act of 1978, as amended (Pub. L. 95-604)
5. Nuclear Non-Proliferation Act of 1978 (Pub. L. 95-242)
6. West Valley Demonstration Project Act of 1980 (Pub. L. 96-368)
7. Nuclear Waste Policy Act of 1982, as amended (Pub. L. 97-425)
8. Low-Level Radioactive Waste Policy Amendments Act of 1985 (Pub. L. 99-240)
9. Energy Policy Act of 1992 (Pub. L. 102-486)
10. Energy Policy Act of 2005 (Pub. L. 109-58)

Fundamental Laws Governing Civilian Uses of Radioactive Materials

Nuclear Materials and Facilities

1. Atomic Energy Act of 1954, as amended
2. Energy Reorganization Act of 1974, as amended
3. Reorganization Plan No. 1 of 1980

Radioactive Waste

1. Nuclear Waste Policy Act of 1982, as amended
2. Low-Level Radioactive Waste Policy Amendments Act of 1985
3. Uranium Mill Tailings Radiation Control Act of 1978

Nonproliferation

1. Nuclear Non-Proliferation Act of 1978

Fundamental Laws Governing the Processes of Regulatory Agencies

1. Administrative Procedure Act (5 U.S.C. Chapters 5 through 8)
2. National Environmental Policy Act

APPENDIX X
International Activities:

CONVENTIONS AND TREATIES PERTAINING TO NUCLEAR SAFETY, SECURITY, AND INTERNATIONAL SAFEGUARDS*

1. Treaty on the Non-Proliferation of Nuclear Weapons, entry into force on March 5, 1970; the United States is a party to the Treaty
2. Treaty for the Prohibition of Nuclear Weapons in Latin America (Tlatelolco Treaty), entry into force for each government individually, the United States is a party to the specific protocols appended to the Treaty
3. Three to four other treaties specifying nuclear weapons-free zones in Africa, the South Pacific (Rarotonga), and Southeast Asia, including one being negotiated on the Middle East; the United States is only bound by specific protocols
4. Convention on Early Notification of a Nuclear Accident, entry into force October 27, 1986; the United States is a party
5. Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, entry into force February 26, 1987; the U.S. is a party
6. Convention on Nuclear Safety, entry into force October 24, 1996; the U.S. is a party
7. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, entry into force June 18, 2001; the U.S. is a party
8. Convention on the Physical Protection of Nuclear Material (CPPNM), entry into force February 8, 1987; the U.S. is a party
9. Amendment to the CPPNM, entry into force May 8, 2016; the U.S. is a party
10. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, entry into force August 30, 1975; the U.S. is a party (also to amendments in 1978 (incineration), 1978 (disputes), 1980 (list of substances), 1989 (procedures), 1993 (banning dumping of low-level radioactive wastes into the sea), 1996 (protocol to replace the 1972 Convention with a more restrictive text regulating the use of the sea as a depository for waste materials)
11. Convention on Supplementary Compensation for Nuclear Damage; entry into force April 15, 2015
12. Agreement between the United States of America and the Agency for the Application of Safeguards in the United States of America (INFCIRC/288); entry into force December 9, 1980
13. Model Protocol Additional to the Agreement Between State(s) and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty for the Prohibition of Nuclear Weapons in Latin America (INFCIRC/366), entry into force April 6, 1989; U.S. is a party
14. Protocol Additional to the Agreement between the United States of America and the Agency for the Application of Safeguards in the United States of America (INFCIRC/288/Add. 1); entry into force January 6, 2009

* This excludes arms control agreements.

Note: Data are current as of July 2018; the next printed update will be in August 2019.

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX Y
International Activities:

LIST OF MULTILATERAL ORGANIZATIONS IN WHICH THE NRC PARTICIPATES

International Commission on Radiological Protection

International Atomic Energy Agency (IAEA)
Commission on Safety Standards (CSS)
Emergency Preparedness and Response Standards Committee (EPReSC)
Nuclear Safety Standards Committee (NUSSC)
Nuclear Security Guidance Committee (NSGC)
Radiation Safety Standards Committee (RASSC)
Transport Safety Standards Committee (TRANSSC)
Waste Safety Standards Committee (WASSC)

Source: *http://www-ns.iaea.org/committees/*

Organisation for Economic Co-operation and Development (OECD) specialized agency Nuclear Energy Agency (NEA)
Steering Committee for Nuclear Energy
The Committee on the Safety of Nuclear Installations (CSNI)
The Committee on Nuclear Regulatory Activities (CNRA)
The Radioactive Waste Management Committee (RWMC)
The Committee on Radiation Protection and Public Health (CRPPH)
The Nuclear Development Committee
The Nuclear Law Committee (NLC)
The Management Board for the Development, Application and Validation of Nuclear Data and Codes (MBDAV)
Multinational Design Evaluation Programme (MDEP)

Source: *https://www.oecd-nea.org/general/about/committee.html*

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)
UNSCEAR reports to the United Nations General Assembly. It assesses global levels and effects of ionizing radiation and provides a scientific basis for radiation protection.

Source: *http://www.unscear.org/*

APPENDIX Y
International Activities: (continued)

BILATERAL INFORMATION EXCHANGE AND COOPERATION AGREEMENTS WITH THE NRC

Agreement Country			
Argentina	Germany	Lithuania	Sweden
Armenia	Georgia	Mexico	Switzerland
Australia	Ghana	Netherlands	Tecro (Taiwan)
Belgium	Greece	Peru	Thailand
Brazil	Hungary	Poland	Turkey
Bulgaria	India	Republic of Korea	Ukraine
Canada	Indonesia	Romania	United Arab Emirates
China	Israel	Singapore	United Kingdom
Croatia	Italy	Slovakia	Vietnam
Czech Republic	Japan	Slovenia	EURATOM
Finland	Jordan	South Africa	
France	Kazakhstan	Spain	

Notes: The country's short-form name is used. The NRC's technical arrangements are initiated and renewed for 5-year terms.
Data are current as of July 2018; the next printed update will be in August 2019.
EURATOM is the European Atomic Energy Community.
Tecro (Taiwan) is the Taipei Economic and Cultural Representative Office in the United States.

APPENDIX Z

International Activities:

LIST OF IMPORT AND EXPORT LICENSES ISSUED FOR 2017

License Number	Applicant	Docket Number
PXB16.07	REVISS Services Inc.	11006142
PXB17b.11	Industrial Nuclear Company	11006012
PXB184.02	Halliburton Energy Services, Inc.	11006143
PXB1a.05	Weatherford International Inc. & Subsidiaries & Affiliate Companies	11006277
PXB200.01	Mistras Group, Inc.	11006199
PXB211.00	Weatherford International Inc. & Subsidiaries & Affiliate Companies	11006246
PXB213.00	Tucker Energy Services	11006257
PXB214.00	University of Wisconsin-Madison	11006269
PXB215a.00	ISOFLEX Radioactive, LLC	11006262
PXB215b.00	ISOFLEX Radioactive, LLC	11006262
PXB3.09	Nordion (Canada) Inc.	11006070
PXB3.10	Nordion (Canada) Inc.	11006070
PXB6.23	Alpha-Omega Services, Inc.	11006027
PXB6.24	Alpha-Omega Services, Inc.	11006027

Licenses under Appendix P to 10 CFR Part 110,"Expert and Import of Nuclear Equipment and Material" support the use of radioactive sealed sources for a variety of medical, industrial, research, and educational activities. Some applicants have previously obtained a combined export/import license to allow export or import, use, resale, and import or export back to the supplier for recycling. These combined licenses are no longer appropriate and can no longer be amended going forward, given the authorization for imports of Appendix P materials under a general license (see 10 CFR 110.27, "General License for Import"). These combined import/export licenses needing amendment are converted to export-only licenses. The 2010 changes to 10 CFR Part 110 generally necessitate specific licenses for only Appendix P, Category 1 and 2 exports.

LIST OF IMPORT AND EXPORT LICENSES: NON-APPENDIX P

License Number	Applicant	Docket Number
IW033	Perma-Fix Northwest Richland, Inc. (PFNW)	11006229
IW029/01	EnergySolutions Services, Inc.	11005896
IW009/03	AREVA Inc.	11005149
XB1310/06	Leidos, Inc.	11005525
XB1334	Siemens Corporation for Siemens Medical Solutions USA, Inc.	11006251
XB1335	Philips North America, LLC	11006260
XCOM1187/02	Sulzer Pumps (US) Inc.	11005671
XCOM1202/01	AREVA, Inc.	11005788
XCOM1202/02	Framatome Inc.	11005788
XCOM1209/01	Enrichment Techology US, Inc.	11005838
XCOM1274	Holtec International	11006128
XCOM1289/01	ATI Specialty Alloys & Components	11006177
XCOM1292/01	ATI Specialty Alloys & Components	11006186
XCOM1300	Mirion Technologies (IST) Corporation	11006221
XCOM1305	Materion Brush, Inc.	11006242

For the most recent information, go to the Dataset Index Web page at *https://www.nrc.gov/reading-rm/doc-collections/datasets/.*

APPENDIX Z

International Activities: (continued)

LIST OF IMPORT AND EXPORT LICENSES: NON-APPENDIX P (continued)

License Number	Applicant	Docket Number
XCOM1307	Materion Brush, Inc.	11006247
XCOM1310	Curtiss-Wright Corporation	11006263
XCOM1313	Materion Advanced Chemicals	11006274
XMAT409/01	Cambridge Isotope Laboratories, Inc.	11005753
XMAT410/03	Sigma-Aldrich Co., LLC	11005754
XMAT412/02	Linde Electronics and Specialty Gases, a Division of Linde Gas North America LLC	11005876
XMAT415/02	Linde Electronics and Specialty Gases, a Division of Linde Gas North America LLC	11005907
XMAT418/02	Sigma-Aldrich Co., LLC	11005977
XMAT419/02-R	Cambridge Isotope Laboratories, Inc.	11005993
XMAT420/01	Cambridge Isotope Laboratories, Inc.	11005994
XMAT422/02	Cambridge Isotope Laboratories, Inc.	11005997
XMAT427/01	Airgas USA, LLC	11006098
XMAT427/02	Airgas USA, LLC	11006098
XMAT437	Linde Electronics and Speciality Gases, a Division of Linde Gas North America LLC	11006238
XMAT438	Sigma-Aldrich Co., LLC	11006253
XR178	Westinghouse Electric Company, LLC	11006216
XSNM3135/05	Global Nuclear Fuel–Americas, L.L.C.	11005186
XSNM3398/05	Global Nuclear Fuel–Americas, L.L.C.	11005555
XSNM3471/02	AREVA Inc.	11005652
XSNM3551/02	AREVA Inc.	11005623
XSNM3551/03	Framatome Inc.	11005623
XSNM3643/02	TN Americas LLC	11005864
XSNM3697/02	Framatome Inc.	11005959
XSNM3722/02	TN Americas LLC	11006019
XSNM3722/03	TN Americas LLC	11006019
XSNM3747/02-R	AREVA Inc.	11006110
XSNM3747/03	Framatome Inc.	11006110
XSNM3754	Thermo Fisher Scientific	11006166
XSNM3757	U.S. Department of Energy/NNSA	11006187
XSNM3763/02	Edlow International Company as an Agent for ANSTO	11006195
XSNM3768/01	Edlow International Company as an Agent for PT INUKI	11006228
XSNM3769	Westinghouse Electric Company, LLC	11006233
XSNM3770-R	Eldow International Company	11006234
XSNM3770/01	Edlow Intenational Co.	11006234
XSNM3771	Edlow International Company as Agent for SCK-CEN	11006235
XSNM3772	U.S. Department of Energy/NBL	11006236
XSNM3773	Global Nuclear Fuel–Americas, L.L.C.	11006237
XSNM3774	Thermo Fisher Scientific	11006239
XSNM3775	Thermo Fisher Scientific	11006240
XSNM3776	U.S. Department of Energy/NNSA	11006241
XSNM3777	U.S. Department of Energy/NNSA	11006244
XSNM3778	Thermo Fisher Scientific	11006255
XSNM3779	AREVA, Inc.	11006258
XSNM3780	AREVA Inc.	11006265
XSNM3780/01	Framatome Inc.	11006265

APPENDIX Z

International Activities: (continued)

LIST OF IMPORT AND EXPORT LICENSES: NON-APPENDIX P (continued)

License Number	Applicant	Docket Number
XSNM3781	AREVA, Inc.	11006267
XSNM3782/01	Framatome Inc.	11006288
XSNM3782	AREVA Inc.	11006288
XSNM3785	Global Nuclear Fuel–Americas, L.L.C.	11006278
XSNM3787	Global Nuclear Fuel–Americas, L.L.C.	11006280
XSNM3788	U.S. Department of Energy	11006283
XSNM3794	US Department of Energy NNSA	11006302
XSOU8707/06	MP Mine Operations LLC	11004455
XSOU8774/06	Materion Advanced Chemicals, Inc.	11005173
XSOU8780/07	AREVA Nuclear Materials LLC	11005211
XSOU8787/05	Urenco, Inc.	11005277
XSOU8789/07	ConverDyn	11005360
XSOU8798/06	RSB Logistic Inc.	11005445
XSOU8798/07	RSB Logistic Inc.	11005445
XSOU8827/01	MP Mine Operations LLC	11005966
XSOU8828/02	Global Advanced Metals USA, Inc.	11006003
XSOU8842	Southern Ionics Minerals, LLC	11006256
XSOU8843	Manufacturing Sciences Corporation	11006271
XW012/05	Perma-Fix Northwest, Inc.	11005699
XW015/01	AREVA Inc.	11005789
XW018/01	EnergySolutions Services, Inc.	11005897
XW022	Perma-Fix Northwest Richland, Inc. (PFNW)	11006230

Non-Appendix P Components Guide

(XSNM) denotes export of special nuclear material (plutonium, uranium-233, or uranium enriched above 0.711 percent, by weight, in the isotope uranium-235).

(XCOM) denotes export of minor reactor components or other nuclear facility (e.g., nuclear fabrication) components under NRC jurisdiction (refer to Title 10 CFR Part 110, "Export and Import of Nuclear Equipment and Material," Appendix A, Items (5)–(9), for minor reactor components and Appendices B–K and N–O for other nuclear facility components).

(XSOU) denotes export of source material (natural or depleted uranium; thorium; a mixture of uranium and thorium other than special nuclear material; or certain ores [e.g., tantalum and niobium that contain, by weight, 0.05 percent or more of the aforementioned materials for nonnuclear end use]).

(XB) denotes export of byproduct material; 10 CFR Part 110, Appendix L, for an illustrative list of byproduct materials under NRC jurisdiction.

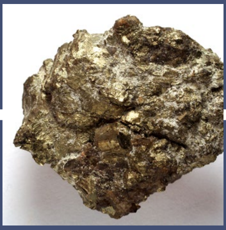
(XR) denotes export of reactor facilities, 10 CFR Part 110, Appendix A, items (1)–(4).

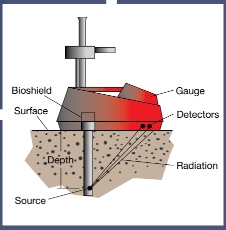
(IW) denotes import of radioactive waste.

(XW) denotes export of radioactive waste.

NRC

GLOSSARY




Bioshield
Surface
Depth
Source
Gauge
Detectors
Radiation

Glossary (Abbreviations, Definitions, and Illustrations)

Advanced reactors

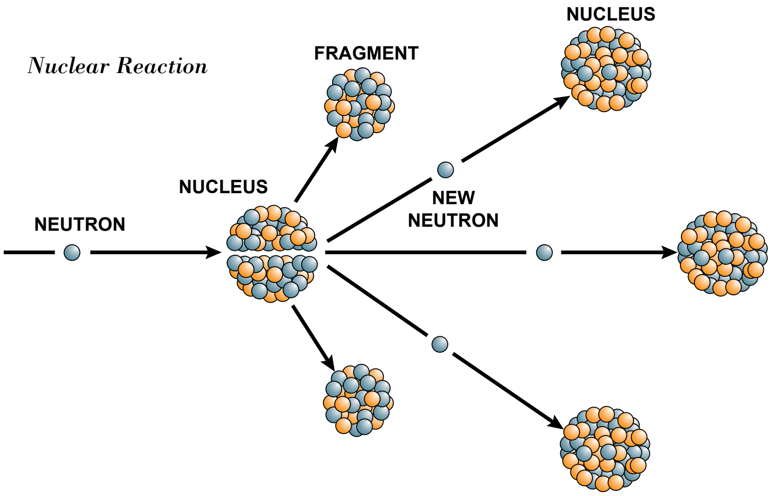
Reactors that differ from today's reactors primarily by their use of inert gases, molten salt mixtures, or liquid metals to cool the reactor core. Advanced reactors can also consider fuel materials and designs that differ radically from today's enriched-uranium dioxide pellets within zirconium cladding.

Agreement State

A U.S. State that has signed an agreement with the U.S. Nuclear Regulatory Commission (NRC) authorizing the State to regulate certain uses of radioactive materials within the State.

Atomic energy

The energy that is released through a nuclear reaction or radioactive decay process. One kind of nuclear reaction is fission, which occurs in a nuclear reactor and releases energy, usually in the form of heat and radiation. In a nuclear power plant, this heat is used to boil water to produce steam that can be used to drive large turbines. The turbines drive generators to produce electrical power.

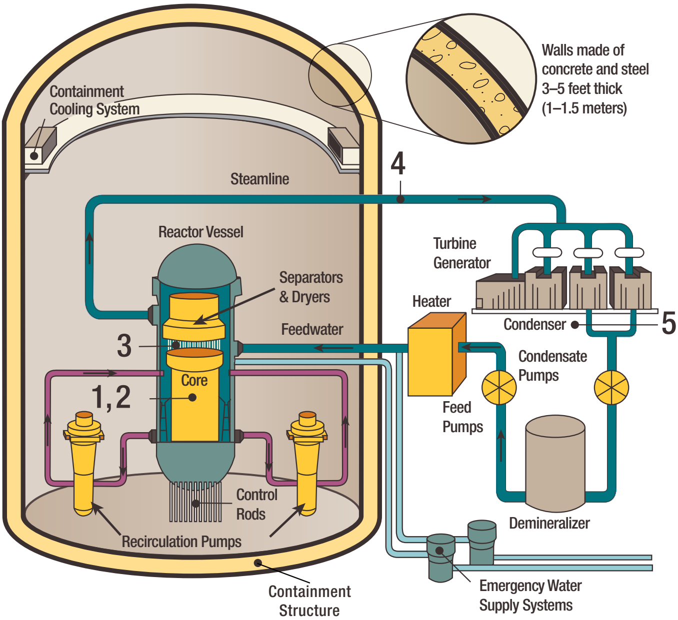


Background radiation

The natural radiation that is always present in the environment. It includes cosmic radiation that comes from the sun and stars, terrestrial radiation that comes from the Earth, and internal radiation that exists in all living things and enters organisms by ingestion or inhalation. The typical average individual exposure in the United States from natural background sources is about 310 millirem (3.1 millisievert) per year.

Boiling-water reactor (BWR)

A nuclear reactor in which water is boiled using heat released from fission. The steam released by boiling then drives turbines and generators to produce electrical power. BWRs operate similarly to electrical plants using fossil fuel, except that the BWRs are heated by nuclear fission in the reactor core.



How Nuclear Reactors Work

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

1. The nuclear fuel core inside the reactor vessel creates heat from nuclear fission.
2. A steam-water mixture is produced when very pure water (reactor coolant) moves upward through the core, absorbing heat.
3. The steam-water mixture leaves the top of the core and enters the two stages of moisture separation where water droplets are removed before the steam is allowed to enter the steamline.
4. The steam is piped to the main turbine, causing it to turn the turbine generator, which produces electricity.
5. The steam is exhausted to the condenser, where it is condensed into water. The resulting water is pumped out of the condenser with a series of pumps and pumped back to the reactor vessel.

The reactor's core contains fuel assemblies that are cooled by water circulated using electrically powered pumps. These pumps and other operating systems in the plant receive their power from the electrical grid. If offsite power is lost, cooling water is supplied by other pumps, which can be powered by onsite diesel generators or steam generated by the core. Other safety systems, such as the containment cooling system, also need electric power. BWRs contain between 370–800 fuel assemblies.

Brachytherapy

A medical procedure during which a sealed radioactive source (or sources) is implanted directly into a person being treated for cancer (usually of the mouth, breast, lung, prostate, ovaries, or uterus). The radioactive implant may be temporary or permanent, and the radiation kills cells in the tumor as long as the device remains in place and emits radiation. Brachytherapy uses radioisotopes, such as iridium-192 or iodine-125, which are regulated by the NRC and Agreement States.

Byproduct material

As defined by NRC regulations, byproduct material includes any radioactive material (except enriched uranium or plutonium) produced by a nuclear reactor or through the use of a particle accelerator, or any discrete source of radium-226 used for a commercial, medical, or research activity. It also includes the tailings or wastes produced by the extraction or concentration of uranium or thorium or the fabrication of fuel for nuclear reactors. In addition, the NRC, in consultation with the U.S. Environmental Protection Agency (EPA), U.S. Department of Energy (DOE), U.S. Department of Homeland Security (DHS), and others, can designate as byproduct material any source of naturally occurring radioactive material, other than source material, that it determines would pose a threat to public health and safety or the common defense and security of the United States.

Canister

See Dry cask storage.

Capability

The maximum load that a generating unit, generating station, or other electrical apparatus can carry under specified conditions for a given period of time without exceeding approved limits of temperature and stress.

Capacity

The amount of electric power that a generator, turbine transformer, transmission, circuit, or system is able to produce, as rated by the manufacturer.

Capacity factor

The ratio of the available capacity (the amount of electrical power actually produced by a generating unit) to the theoretical capacity (the amount of electrical power that could theoretically have been produced if the generating unit had operated continuously at full power) during a given time period.

Capacity utilization

A percentage that a generating unit fulfilled its capacity in generating electric power over a given time period. This percentage is defined as the margin between the unit's available capacity (the amount of electrical power the unit actually produced) and its theoretical capacity (the amount of electrical power that could have been produced if the unit had operated continuously at full power) during a certain time period. Capacity utilization is computed by dividing the amount of power actually produced by the theoretical capacity and multiplying by 100.

Cask

A heavily shielded container used for the dry storage or shipment (or both) of radioactive materials such as spent nuclear fuel or other high-level radioactive waste (HLW). Casks are often made from lead, concrete, and/or steel. Casks must meet regulatory requirements.

Categories of radiation sources

The International Atomic Energy Agency's Code of Conduct on the Safety and Security of Radioactive Sources defines the five categories for radiation sources to help ensure that sufficient controls are being used to achieve safety and security:

- Category 1 sources, if not safely or securely managed, would be likely to cause permanent injury to a person who handled them or was otherwise in contact with them for more than a few minutes. It would probably be fatal to be close to this amount of unshielded material for a period of a few minutes to an hour. These sources are typically used in radiothermal generators, irradiators, and radiation teletherapy.
- Category 2 sources, if not safely or securely managed, could cause permanent injury to a person who handled them or was otherwise in contact with them for a short time (minutes to hours). It could possibly be fatal to be close to this amount of unshielded radioactive material for a period of hours to days. These sources are typically used in industrial gamma radiography, high- and medium-dose rate brachytherapy, and radiography.
- Category 3 sources, if not safely or securely managed, could cause permanent injury to a person who handled them or was otherwise in contact with them for hours. It could possibly—although it is unlikely to—be fatal to be close to this amount of unshielded radioactive material for a period of days to weeks. These sources are typically used in fixed industrial gauges such as level gauges, dredger gauges, conveyor gauges, spinning pipe gauges, and well-logging gauges.
- Category 4 sources, if not safely managed or securely protected, could possibly cause temporary injury to someone who handled them or was otherwise in contact with or close to them for a period of many weeks, though this is unlikely. It is very unlikely anyone would be permanently injured by this amount of radioactive material. These sources are typically used in fixed or portable gauges, static eliminators, or low-dose brachytherapy.
- Category 5 sources cannot cause permanent injury. They are used in x-ray fluorescence devices and electron capture devices.

Only Categories 1 and 2 for radiation sources are defined by NRC requirements.

Categories of special nuclear material

The NRC categorizes special nuclear materials and the facilities that possess them into three categories based upon the materials' potential for use in nuclear weapons or their "strategic significance":

- Category I, high strategic significance
- Category II, moderate strategic significance
- Category III, low strategic significance

The NRC's physical security and safeguards requirements differ by category, with Category I facilities subject to more stringent requirements because they pose greater security and safeguards risks.

Classified information

Information that has been determined pursuant to an Executive order to require protection against unauthorized disclosure and is marked to indicate its classified status when in documentary form. The NRC has two types of classified information. The first type, known as national security information, is information that is classified by an Executive order. Its release would damage national security. The second type, known as restricted data, would assist individuals or organizations in designing, manufacturing, or using nuclear weapons. Access to both types of information is restricted to authorized persons who have been properly cleared and have a "need to know" the information to accomplish their official duties.

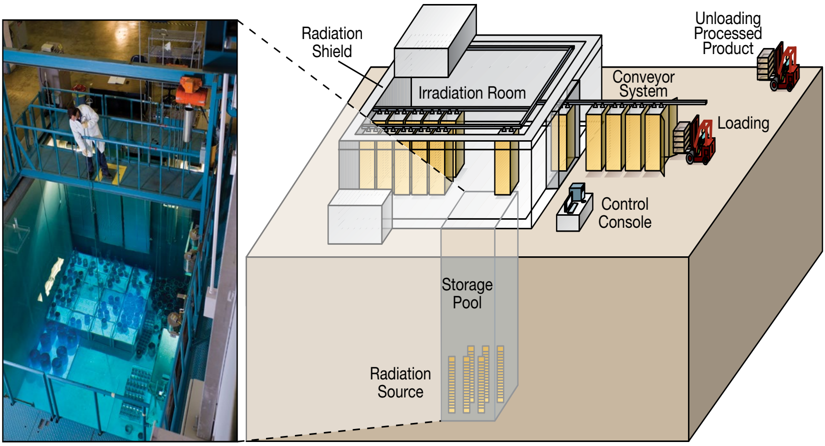
Combined license (COL)

An NRC-issued license that authorizes a licensee to construct and (with certain specified conditions) operate a nuclear power facility, such as a nuclear plant at a specific site.

Commercial irradiator

A facility that uses high doses of radiation to sterilize or treat products, such as food and spices, medical supplies, and wood flooring. Irradiation can be used to eliminate harmful bacteria, germs, and insects or for hardening or other purposes. The radiation does not leave radioactive residue or make the treated products radioactive. Radiation sources include radioactive materials (e.g., cobalt-60), an x-ray machine, or an electron beam.

Photo courtesy: Nordion



Compact

A group of two or more U.S. States that have formed alliances to dispose of low-level radioactive waste (LLW).

Construction recapture

The maximum number of years that could be added to a nuclear power plant's license expiration date to recapture the period between the date the NRC issued the plant's construction permit and the date it granted an operating license. A licensee must submit an application to request this extension.

Containment structure

A resilient gas-tight shell or other enclosure around a nuclear reactor to confine fission products that otherwise might be released to the atmosphere in the event of a severe reactor accident. Such enclosures are usually dome-shaped and made of steel-reinforced concrete.

Contamination

Undesirable radiological or chemical material (with a potentially harmful effect) that is either airborne or deposited in (or on the surface of) structures, objects, soil, water, or living organisms.

Criticality

The condition involving fission of nuclear materials when the number of neutrons produced equals or exceeds the nuclear containment. During normal reactor operations, nuclear fuel sustains a fission chain reaction or criticality. A reactor achieves criticality (and is said to be critical) when each fission event releases a sufficient number of neutrons to sustain an ongoing series of reactions.

Decommissioning

The process of safely closing a nuclear power plant (or other facility where nuclear materials are handled) to retire it from service after its useful life has ended. This process primarily involves decontaminating the facility to reduce residual radioactivity and then releasing the property for unrestricted or (under certain conditions) restricted use. This often includes dismantling the facility or dedicating it to other purposes. *See SAFSTOR.*

DECON

A phase of reactor decommissioning in which structures, systems, and components that contain radioactive contamination are removed from a site and safely disposed of at a commercially operated low-level waste disposal facility or decontaminated to a level that permits the site to be released for unrestricted use.

Decontamination

A process used to reduce, remove, or neutralize radiological or chemical contamination to reduce the risk of exposure. Decontamination may be accomplished by cleaning or treating surfaces to reduce or remove the contamination, filtering contaminated air or water, or subjecting contamination to evaporation and precipitation. The process can also simply allow adequate time for radioactive decay to decrease the radioactivity.

Defense in depth

An approach to designing and operating nuclear facilities that prevents and mitigates accidents that release radiation or hazardous materials. The key is creating multiple independent and redundant layers of controls or design features to compensate for potential human and mechanical failures so that no single control, no matter how robust, is exclusively relied upon to achieve safety or security. Defense in depth includes the use of access controls, physical barriers, redundant and diverse key safety functions, and emergency response measures.

Depleted uranium

Uranium with a percentage of uranium-235 lower than the 0.7 percent (by mass) contained in natural uranium. Depleted uranium is the byproduct of the uranium enrichment process. Depleted uranium can be blended with highly enriched uranium, such as that from weapons, to make reactor fuel.

Design-basis threat (DBT)

A description of the type, composition, and capabilities of an adversary that a security system is designed to protect against. The NRC uses the DBT as a basis for designing safeguards systems to protect against acts of radiological sabotage and to prevent the theft of special nuclear material. Certain nuclear facility licensees are required to defend against the DBT.

Design certification

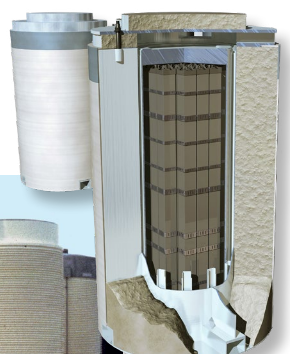
Certification and approval by the NRC of a standard nuclear power plant design independent of a specific site or an application to construct or operate a plant. A design certification is valid for 15 years from the date of issuance but can be renewed for an additional 10 to 15 years.

Dose (radiation)

The National Council on Radiation Protection and Measurements estimates that an average person in the United States receives a total annual dose of about 0.62 rem (620 millirem or 6.2 millisievert) from all radiation sources, a level that has not been shown to cause humans any harm. Of this total, natural background sources of radiation—including radon and thoron gas, natural radiation from soil and rocks, radiation from space, and radiation sources that are found naturally within the human body—account for about 50 percent. Medical procedures such as computed tomography (CT) scans and nuclear medicine account for about another 48 percent. Other small contributors of exposure to the U.S. population include consumer products and activities, industrial and research uses, and occupational tasks. The maximum permissible yearly dose for a person working with or around nuclear material is 5 rem (50 millisievert).

Dry cask storage

A method for storing spent nuclear fuel in special containers known as dry casks. After fuel has been cooled in a spent fuel pool, dry cask storage allows spent fuel assemblies to be sealed in casks and surrounded by inert gas. They are welded or bolted closed, and each cask includes steel, concrete, lead, or other material to provide leak-tight containment and radiation shielding. The casks may store fuel horizontally or vertically.



Early site permit (ESP)

A permit granted by the NRC to approve one or more proposed sites for a nuclear power facility, independent of a specific nuclear plant design or an application for a construction permit or combined license. An ESP is valid for 10 to 20 years but can be renewed for an additional 10 to 20 years.

Economic Simplified Boiling-Water Reactor (ESBWR)

A 4,500-megawatt thermal nuclear reactor design that has passive safety features and uses natural circulation (with no recirculation pumps or associated piping) for normal operation. The NRC certified the ESBWR standard design submitted by General Electric-Hitachi Nuclear Energy on October 15, 2014.

Efficiency, plant

The percentage of the total energy content of a power plant's thermal energy that is converted into electricity. The remaining energy is lost to the environment as heat.

Electric power grid

A system of synchronized power providers and consumers, connected by transmission and distribution lines and operated by one or more control centers. In the continental United States, the electric power grid consists of three systems—the Eastern Interconnect, the Western Interconnect, and the Texas Interconnect. In Alaska and Hawaii, several systems encompass areas smaller than the State.

Electric utility

A corporation, agency, authority, person, or other legal entity that owns or operates facilities within the United States, its territories, or Puerto Rico for the generation, transmission, distribution, or sale of electric power (primarily for use by the public). Facilities that qualify as cogenerators or small power producers under the Public Utility Regulatory Policies Act are not considered electric utilities.

Emergency classifications

Sets of plant conditions that indicate various levels of risk to the public and that might require response by an offsite emergency response organization to protect citizens near the site.

Emergency preparedness (EP)

The programs, plans, training, exercises, and resources used to prepare for and rapidly identify, evaluate, and respond to emergencies, including those arising from terrorism or natural events such as hurricanes. EP strives to ensure that operators of nuclear power plants and certain fuel cycle facilities can implement measures to protect public health and safety in the event of a radiological emergency. Licensees who operate certain nuclear facilities, such as nuclear power plants, must develop and maintain EP plans that meet NRC requirements.

Energy Information Administration (EIA)

The agency within the U.S. Department of Energy that provides policy-neutral statistical data, forecasts, and analyses to promote sound policymaking, efficient markets, and public understanding about energy and its interaction with the economy and the environment.

Enrichment

See Uranium enrichment.

Event Notification System

An automated system used by the NRC to document incoming notifications of significant nuclear events with an actual or potential effect on the health and safety of the public and the environment. Significant events are reported to the NRC by licensees, Agreement States, other Federal agencies, the public, and other countries.

Exposure (radiation)

Absorption of ionizing radiation or the amount of a hazardous substance that has been ingested, inhaled, or contacted the skin. Acute exposure occurs over a short period of time. Chronic exposure is exposure received over a long period of time, such as during a lifetime. *See Occupational dose.*

Federal Emergency Management Agency (FEMA)

A component of the U.S. Department of Homeland Security responsible for protecting the Nation and reducing the loss of life and property from all hazards such as natural disasters and acts of terrorism. FEMA leads and supports a risk-based, comprehensive emergency management system of preparedness, protection, response, recovery, and mitigation.

Federal Energy Regulatory Commission (FERC)

An independent agency that regulates the interstate transmission of electricity, natural gas, and oil. FERC also regulates and oversees hydropower projects and the construction of liquefied natural gas terminals and interstate natural gas pipelines. FERC protects the economic, environmental, and safety interests of the American public, while working to ensure abundant, reliable energy in a fair, competitive market.

Fiscal year (FY)

The 12-month period from October 1 through September 30 used by the Federal Government for budget formulation and execution. The FY is designated by the calendar year in which it ends; for example, FY 2017 runs from October 1, 2016, through September 30, 2017.

Fissile material

A nuclide that is capable of undergoing fission after capturing neutrons. Although sometimes used as a synonym for fissionable material, this term has acquired its more restrictive interpretation with the limitation that the nuclide must be fissionable by thermal neutrons. With that interpretation, the three primary fissile materials are uranium-233, uranium-235, and plutonium-239. This definition excludes natural uranium and depleted uranium that have not been irradiated or have only been irradiated in thermal reactors.

Fission

The splitting of an atom, which releases a considerable amount of energy (usually in the form of heat). Fission may be spontaneous but is usually caused by the nucleus of an atom becoming unstable (or "heavy") after capturing or absorbing a neutron. During fission, the nucleus splits into roughly equal parts, producing the nuclei of at least two lighter elements. In addition to energy, this reaction usually releases gamma radiation and two or more daughter neutrons.

Force on force

A type of security exercise designed to evaluate and improve the effectiveness of a security system. For the NRC, force-on-force exercises are used to assess the ability of the licensee to defend a nuclear power plant and other nuclear facilities against a design-basis threat.

Foreign Assignee Program

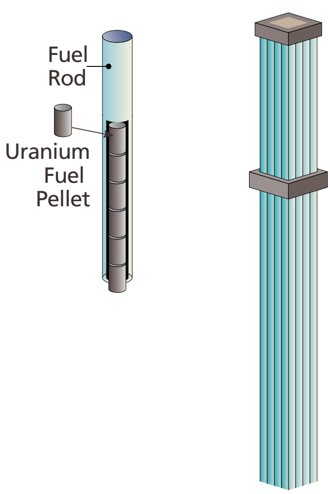
An on-the-job training program sponsored by the NRC for assignees from other countries, usually under bilateral information exchange arrangements with their respective regulatory organizations. The assignees' regulatory authorities generally identify the individuals participating and pay their salaries.

Freedom of Information Act (FOIA)

A Federal law that requires Federal agencies to provide, upon written request, access to records or information. Some material is exempt from FOIA, and FOIA does not apply to records that are maintained by State and local governments, Federal contractors, grantees, or private organizations or businesses.

Fuel assembly (fuel bundle, fuel element)

A structured group of fuel rods (long, slender, metal tubes containing pellets of fissionable material, which provide fuel for nuclear reactors). Depending on the design, each reactor core may have dozens of fuel assemblies (also known as fuel bundles), each of which contains dozens of fuel rods.



Spent fuel assemblies, are typically 14 feet [4.3 meters] long and contain nearly 200 fuel rods for PWRs and 80–100 fuel rods for BWRs.

Fuel cycle

The series of steps involved in supplying fuel for nuclear power reactors. The uranium fuel cycle includes the following:

- uranium recovery to extract and concentrate the uranium to produce yellowcake
- conversion of yellowcake into uranium hexafluoride (UF_6)
- enrichment to increase the concentration of uranium in UF_6
- fuel fabrication to convert enriched UF_6 into fuel for nuclear reactors
- use of the fuel in reactors (nuclear power research or naval propulsion)
- interim storage of spent nuclear fuel
- reprocessing of spent fuel to recover the fissionable material remaining in the spent fuel (currently not done in the United States)
- final disposition of high-level radioactive waste
- transportation of the uranium in all forms, including spent fuel

The NRC regulates these processes, as well as the fabrication of mixed-oxide (MOX) nuclear fuel, which is a combination of uranium and plutonium oxides.

Fuel reprocessing (recycling)

The processing of reactor fuel to separate the unused fissionable material from waste material. Reprocessing extracts uranium and plutonium from spent nuclear fuel so they can be used again as reactor fuel. Commercial reprocessing is not practiced in the United States, although it has been in the past. However, the U.S. Department of Energy operates reprocessing facilities at Hanford, WA, and Savannah River, SC, for national defense purposes.

Fuel rod

A long, slender, zirconium metal tube containing pellets of fissionable material, which provide fuel for nuclear reactors. Fuel rods are assembled into bundles called fuel assemblies, which are loaded individually into the reactor core.

Full-time equivalent (FTE)

A human resources measurement equal to one person working full time for 1 year.

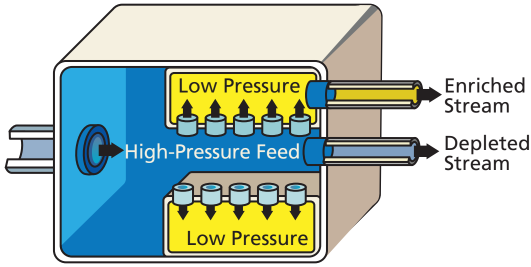
Gas centrifuge

Uranium enrichment technology that uses many rotating cylinders that are connected in long lines to increase the concentration of uranium-235. Gas is placed in the cylinder, which spins at a high speed, creating a strong centrifugal force. Heavier gas molecules move to the cylinder wall, while lighter molecules collect near the center. The stream, slightly enriched, is fed into the next cylinder. The depleted stream is recycled back into the previous cylinder.

Gas chromatography

An analytical technique for separating chemical substances from a mixed sample by passing the sample, carried by a moving stream of gas, through a tube packed with a finely divided solid that may be coated with a liquid film. Gas chromatography devices are used to analyze air pollutants, blood alcohol content, essential oils, and food products.

Gaseous diffusion



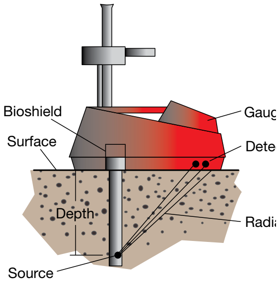
A uranium enrichment process used to increase the concentration of uranium-235 in uranium for use in fuel for nuclear reactors by separating its isotopes (as gases) based on their slight difference in mass. (Lighter isotopes diffuse faster through a porous membrane or vessel than do heavier isotopes.) This process involves filtering UF_6 gas to separate uranium-234 and uranium-235 from uranium-238, increasing the percentage of uranium-235.

In May 2013, the last remaining gaseous diffusion plant in operation in the United States in Paducah, KY, shut down. A similar plant near Piketon, OH, was closed in March 2001. Another plant in Oak Ridge, TN, closed years ago and was not regulated by the NRC.

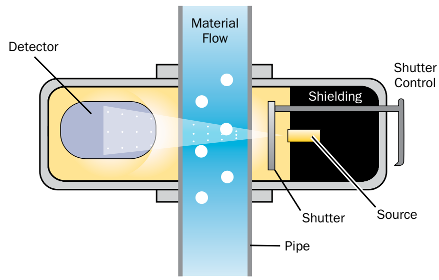
Gauging devices

Devices used to measure, monitor, and control the thickness of sheet metal, textiles, paper napkins, newspaper, plastics, photographic film, and other products as they are manufactured. Gauges mounted in fixed locations are designed for measuring or controlling material density, flow, level, thickness, or weight. The gauges contain sealed sources that radiate through the substance being measured to a readout or controlling device. Portable gauging devices, such as moisture density gauges, are used at field locations. These gauges contain a gamma-emitting sealed source, usually cesium-137, or a sealed neutron source, usually americium-241 and beryllium.

Moisture Density Gauge



Fixed Fluid Gauge



Generation (gross)

The total amount of electric energy produced by a power generating station, as measured at the generator terminals.

Generation (net)
The gross amount of electric energy produced by a generating station, minus the amount used to operate the station. Net generation is usually measured in watt-hours.

Generator capacity
The maximum amount of electric energy that a generator can produce (from the mechanical energy of the turbine), adjusted for ambient conditions. Generator capacity is commonly expressed in megawatts.

Geological repository
An excavated, underground facility that is designed, constructed, and operated for safe and secure permanent disposal of high-level radioactive waste (HLW). A geological repository uses an engineered barrier system and a portion of the site's natural geology, hydrology, and geochemical systems to isolate the radioactivity of the waste.

Gigawatt (GW)
A unit of power equivalent to one billion (1,000,000,000) watts.

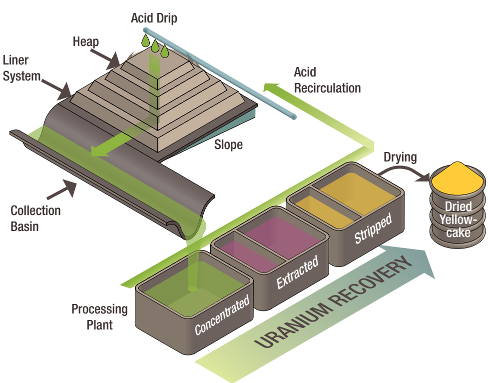
Gigawatthour (GWh)
One billion (1,000,000,000) watt-hours.

Grid
See Electric power grid.

Half-life (radiological)
The time required for half the atoms of a particular radioactive material to decay. A specific half-life is a characteristic property of each radioisotope. Measured half-lives range from millionths of a second to billions of years, depending on the stability of the nucleus. Radiological half-life is related to, but different from, biological half-life and effective half-life.

Health physics
The science concerned with recognizing and evaluating the effects of ionizing radiation on the health and safety of people and the environment, monitoring radiation exposure, and controlling the associated health risks and environmental hazards to permit the safe use of technologies that produce ionizing radiation.

Heap leach recovery process
A method for extracting uranium from ore. The ore is placed in piles or heaps on top of liners. The liners prevent uranium and other chemicals from moving into the ground. Sulfuric acid is dripped onto the heap and dissolves uranium as it moves through the ore. Uranium solution drains into collection basins, where it is piped to a processing plant. At the plant, uranium is extracted, concentrated, and dried to form yellowcake.



High-level radioactive waste (HLW)

The highly radioactive materials produced as byproducts of fuel reprocessing or of the reactions that occur inside nuclear reactors. HLW includes the following:

- irradiated spent nuclear fuel discharged from commercial nuclear power reactors
- highly radioactive liquid and solid materials resulting from the reprocessing of spent nuclear fuel, which contains fission products in concentration, including some reprocessed HLW from defense activities and a small quantity of reprocessed commercial HLW
- other highly radioactive materials that the Commission may determine require permanent isolation

Highly (or high-) enriched uranium

Uranium enriched to at least 20 percent uranium-235 (a higher concentration than exists in natural uranium ore).

In situ recovery (ISR)

A common method currently used to extract uranium from ore bodies without physical excavation of the ore. ISR is also known as “solution mining” or in situ leaching.

Incident response

Activities that address the short-term, direct effects of a natural or human-caused event and require an emergency response to protect life or property.

Independent spent fuel storage installation (ISFSI)

A complex designed and constructed for the interim storage of spent nuclear fuel; solid, reactor-related, greater-than-Class-C waste; and other associated radioactive materials. A spent fuel storage facility may be considered independent, even if it is located on the site of another NRC-licensed facility.

International Atomic Energy Agency (IAEA)

A United Nations agency established in 1957 to serve as a world center of cooperation in the nuclear field. The agency works with nearly 170 member States and multiple partners worldwide to promote safe, secure, and peaceful nuclear technology.

International Nuclear Regulators Association (INRA)

An association established in January 1997 to give national nuclear regulators with mature civilian nuclear reactor and materials programs a forum to discuss nuclear safety and security issues of mutual interest. Canada, France, Germany, Japan, South Korea, Spain, Sweden, the United Kingdom, and the United States of America are members.

Irradiation

Exposure to ionizing radiation. Irradiation may be intentional, such as in cancer treatments or in sterilizing medical instruments. Irradiation may also be accidental, such as from exposure to an unshielded source. Irradiation does not usually result in radioactive contamination, but damage can occur, depending on the dose received.

Isotope

Two or more forms (or atomic configurations) of a given element that have identical atomic numbers (the same number of protons in their nuclei) and the same or very similar chemical properties but different atomic masses (different numbers of neutrons in their nuclei) and distinct physical properties. Thus, carbon-12, carbon-13, and carbon-14 are isotopes of the element carbon, and the numbers denote the approximate atomic masses. Among their distinct physical properties, some isotopes (known as radioisotopes) are radioactive, because their nuclei are unstable and emit radiation as they decay spontaneously toward a more stable nuclear configuration. For example, carbon-12 and carbon-13 are stable, but carbon-14 is unstable and radioactive.

Kilowatt (kW)

A unit of power equivalent to 1,000 watts.

Licensed material

Source material, byproduct material, or special nuclear material that is received, possessed, used, transferred, or disposed of under a general or specific license issued by the NRC or Agreement States and is not otherwise exempt from regulation.

Licensee

A company, organization, institution, or other entity to which the NRC or an Agreement State has granted a general or specific license to construct or operate a nuclear facility, or to receive, possess, use, transfer, or dispose of source, byproduct, or special nuclear material.

Licensing basis

The collection of documents or technical criteria that provides the basis upon which the NRC issues a license to construct or operate a nuclear facility; to conduct operations involving the emission of radiation; or to receive, possess, use, transfer, or dispose of source, byproduct, or special nuclear material.

Licensing Support Network (LSN) Library

A library providing access to publicly available documents related to the hearings regarding the Department of Energy's application for authorization to construct a high-level nuclear waste geologic repository at Yucca Mountain, NV. The LSN Library is affiliated with Agencywide Documents Access and Management System (ADAMS), the agency's official recordkeeping system.

Light-water reactor

A term used to describe reactors using ordinary water as a moderated coolant, including boiling-water reactors (BWRs) and pressurized-water reactors (PWRs), the most common types used in the United States.

Low-level radioactive waste (LLW)

A general term for a wide range of waste that is contaminated with radioactive material or has become radioactive through exposure to neutron radiation. A variety of industries, hospitals and medical institutions, educational and research institutions, private or government laboratories, and nuclear fuel cycle facilities generate LLW. Some examples include radioactively contaminated protective shoe covers and clothing; cleaning rags, mops, filters, and reactor water treatment residues; equipment and tools; medical tubes, swabs, and hypodermic syringes; and carcasses and tissues from laboratory animals.

Loss-of-coolant accident (LOCA)

A potential accident in which a breach in a reactor's pressure boundary causes the coolant water to rush out of the reactor faster than makeup water can be added back in. Without sufficient coolant, the reactor core could heat up and potentially melt the zirconium fuel cladding, causing a major release of radioactivity.

Megawatt (MW)

A unit of power equivalent to 1,000,000 watts.

Megawatt-hour (MWh)

A unit of energy equivalent to 1,000 kilowatts of electricity used continuously for 1 hour.

Metric ton

About 2,200 pounds.

Mill tailings

Primarily, the solid residue from a conventional uranium recovery facility in which uranium or thorium ore is crushed and processed mechanically or chemically to recover the uranium, thorium, or other valuable materials. This naturally radioactive ore residue contains the radioactive decay products from the uranium chains (mainly the uranium-238 chain). Although the milling process recovers about 93 percent of the uranium, the "tailings" contain several naturally occurring radioactive elements, including uranium, thorium, radium, polonium, and radon, as well as heavy metals and other constituents.

Mixed-oxide (MOX) fuel

A type of nuclear reactor fuel that contains plutonium oxide mixed with either natural or depleted uranium oxide, in ceramic pellet form. This differs from conventional nuclear fuel, which is made of uranium oxide before it is irradiated in a reactor. Using plutonium reduces the amount of enriched uranium needed to produce a controlled reaction in commercial light-water reactors. However, plutonium exists only in trace amounts in nature and, therefore, must be produced by neutron irradiation of uranium-238 or obtained from other manufactured sources. As directed by Congress, the NRC regulates the fabrication of MOX fuel by DOE, a program that is intended to dispose of plutonium from excess nuclear weapons.

Monitoring of radiation

Periodic or continuous determination of the amount of ionizing radiation or radioactive contamination in a region. Radiation monitoring is a safety measure to protect the health and safety of the public and the environment through the use of bioassay, alpha scans, and other radiological survey methods to monitor air, surface water and ground water, soil and sediment, equipment surfaces, and personnel.

National Response Framework

The guiding principles, roles, and structures that enable all domestic incident response partners to prepare for and provide a unified national response to disasters and emergencies. It describes how the Federal Government, States, Tribes, communities, and the private sector work together to coordinate a national response. The framework, which became effective March 22, 2008, builds upon the National Incident Management System, which provides a template for managing incidents.

National Source Tracking System (NSTS)

A secure, Web-based data system that helps the NRC and its Agreement States track and regulate the medical, industrial, and academic uses of certain nuclear materials, from the time they are manufactured or imported to the time of their disposal or exportation. This information enhances the ability of the NRC and Agreement States to conduct inspections and investigations, communicate information to other government agencies, and verify the ownership and use of nationally tracked sources.

Natural uranium

Uranium containing the relative concentrations of isotopes found in nature: 0.7 percent uranium-235, 99.3 percent uranium-238, and a trace amount of uranium-234 by mass. In terms of radioactivity, however, natural uranium contains about 2.2 percent uranium-235, 48.6 percent uranium-238, and 49.2 percent uranium-234. Natural uranium can be used as fuel in nuclear reactors or as feedstock for uranium enrichment facilities.

Net electric generation

The gross amount of electric energy produced by a generating station, minus the amount used to operate the station. Note: Electricity required for pumping at pumped-storage plants is regarded as electricity for station operation and is deducted from gross generation. Net electric generation is measured in watt-hours, except as otherwise noted.

Nonpower reactor (research and test reactor)

A nuclear reactor that is used for research, training, or development purposes (which may include producing radioisotopes for medical and industrial uses) but has no role in producing electrical power. These reactors, which are also known as research and test reactors, contribute to almost every field of science, including physics, chemistry, biology, medicine, geology, archeology, and ecology.

NRC Headquarters Operations Center

The primary center of communication and coordination among the NRC, its licensees, State and Tribal agencies, and other Federal agencies regarding operating events involving nuclear reactors or materials. Located in Rockville, MD, the Headquarters Operations Center is staffed 24 hours a day by employees trained to receive and evaluate event reports and coordinate incident response activities.

Nuclear energy

See Atomic energy.

Nuclear Energy Agency (NEA)

A specialized agency within the Organisation for Economic Co-operation and Development (OECD), which was created to assist its member countries in maintaining and further developing the scientific, technological, and legal bases for safe, environmentally friendly, and economical use of nuclear energy for peaceful purposes. The NEA's current membership consists of 31 countries in Europe, North America, and the Asia-Pacific region, which account for about 86 percent of the world's installed nuclear capacity.

Nuclear fuel

Fissionable material that has been enriched to a composition that will support a self-sustaining fission chain reaction when used to fuel a nuclear reactor, thereby releasing energy (usually in the form of heat or useful radiation) for use in other processes.

Nuclear materials

See Special nuclear material, Source material, and Byproduct material.

Nuclear Material Management and Safeguards System (NMMSS)

A centralized U.S. Government database used to track and account for source and special nuclear material. The system contains current and historical data on the possession, use, and shipment of source and special nuclear material within the United States, as well as all exports and imports of such material. The database is jointly funded by the NRC and DOE and is operated under a DOE contract.

Nuclear poison (or neutron poison)

In reactor physics, a substance (other than fissionable material) that has a large capacity for absorbing neutrons in the vicinity of the reactor core. This effect may be undesirable in some reactor applications, because it may prevent or disrupt the fission chain reaction, thereby affecting normal operation. However, neutron-absorbing materials (commonly known as "poisons") are intentionally inserted into some types of reactors to decrease the reactivity of their initial fresh fuel load for fuel intended to achieve higher burnup levels during the fuel cycle. Adding poisons, such as control rods or boron, is described as adding "negative reactivity" to the reactor.

Nuclear power plant

A thermal power plant, in which the energy (heat) released by the fissioning of nuclear fuel is used to boil water to produce steam. The steam spins the propeller-like blades of a turbine that turns the shaft of a generator to produce electricity. Of the various nuclear power plant designs, pressurized-water reactors and boiling-water reactors are in commercial operation in the United States. These facilities generate about 20 percent of U.S. electrical power.

Nuclear and Radiological Incident Annex

An annex to the National Response Framework that provides for a timely, coordinated response by Federal agencies to nuclear or radiological accidents or incidents within the United States. This annex covers radiological dispersal devices and improvised nuclear devices, as well as accidents involving commercial reactors or weapons production facilities, lost radioactive sources, transportation accidents involving radioactive material, and foreign accidents involving nuclear or radioactive material.

Nuclear reactor

The heart of a nuclear power plant or nonpower reactor, in which nuclear fission may be initiated and controlled in a self-sustaining chain reaction to generate energy or produce useful radiation. Although there are many types of nuclear reactors, they all incorporate certain essential features, including the use of fissionable material as fuel, a moderator (such as water) to increase the likelihood of fission (unless reactor operation relies on fast neutrons), a reflector to conserve escaping neutrons, coolant provisions for heat removal, instruments for monitoring and controlling reactor operation, and protective devices (such as control rods and shielding).

Nuclear waste

A subset of radioactive waste that includes unusable byproducts produced during the various stages of the nuclear fuel cycle, including extraction, conversion, and enrichment of uranium; fuel fabrication; and use of the fuel in nuclear reactors. Specifically, these stages produce a variety of nuclear waste materials, including uranium mill tailings, depleted uranium, and spent (depleted) fuel, all of which are regulated by the NRC. (By contrast, “radioactive waste” is a broader term, which includes all wastes that contain radioactivity, regardless of how they are produced. It is not considered “nuclear waste” because it is not produced through the nuclear fuel cycle and is generally not regulated by the NRC.)

Occupational dose

The internal and external dose of ionizing radiation received by workers in the course of employment in such areas as fuel cycle facilities, industrial radiography, nuclear medicine, and nuclear power plants. These workers are exposed to varying amounts of radiation, depending on their jobs and the sources with which they work. The NRC requires its licensees to limit occupational exposure to 5,000 millirem (50 millisievert) per year. Occupational dose does not include the dose received from natural background sources, doses received as a medical patient or participant in medical research programs, or “second-hand doses” to members of the public received through exposure to patients treated with radioactive materials.

Organisation for Economic Co-operation and Development (OECD)

An intergovernmental organization (based in Paris, France) that provides a forum for discussion and cooperation among the governments of industrialized countries committed to democracy and the market economy. The primary goal of OECD and its member countries is to support sustainable economic growth, boost employment, raise living standards, maintain financial stability, assist other countries’ economic development, and contribute to growth in world trade. In addition, OECD is a reliable source of comparable statistics and economic and social data. OECD also monitors trends, analyzes and forecasts economic developments, and researches social changes and evolving patterns in trade, environment, agriculture, technology, taxation, and other areas.

Orphan sources (unwanted radioactive material)

Sealed sources of radioactive material contained in a small volume (but not radioactively contaminated soils and bulk metals) in any one or more of the following conditions:

- an uncontrolled condition that requires removal to protect public health and safety from a radiological threat
- a controlled or uncontrolled condition for which a responsible party cannot be readily identified
- a controlled condition compromised by an inability to ensure the continued safety of the material (e.g., the licensee may have few or no options to provide for safe disposition of the material)
- an uncontrolled condition in which the material is in the possession of a person who did not seek, and is not licensed, to possess it
- an uncontrolled condition in which the material is in the possession of a State radiological protection program solely to mitigate a radiological threat resulting from one of the above conditions and for which the State does not have the necessary means to provide for the appropriate disposition of the material

Outage

The period during which a generating unit, transmission line, or other facility is out of service. Outages may be forced or scheduled and full or partial.

Outage (forced)

The shutdown of a generating unit, transmission line, or other facility for emergency reasons, or a condition in which the equipment is unavailable as a result of an unanticipated breakdown. An outage (whether full, partial, or attributable to a failed start) is considered “forced” if it could not reasonably be delayed beyond 48 hours from identification of the problem, if there had been a strong commercial desire to do so. In particular, the following problems may result in forced outages:

- any failure of mechanical, fuel handling, or electrical equipment or controls within the generator’s ownership or direct responsibility (i.e., from the point the generator is responsible for the fuel through to the electrical connection point)
- a failure of a mine or fuel transport system dedicated to that power station with a resulting fuel shortage that cannot be economically managed
- inadvertent or operator error
- limitations caused by fuel quality

Forced outages do not include scheduled outages for inspection, maintenance, or refueling.

Outage (full forced)

A forced outage that causes a generating unit to be removed from the committed state (when the unit is electrically connected and generating or pumping) or the available state (when the unit is available for dispatch as a generator or pump but is not electrically connected and not generating or pumping). Full-forced outages do not include failed starts.

Outage (scheduled)

The shutdown of a generating unit, transmission line, or other facility for inspection, maintenance, or refueling, which is scheduled well in advance (even if the schedule changes). Scheduled outages do not include forced outages and could be deferred if there were a strong commercial reason to do so.

Pellet, fuel

A thimble-sized ceramic cylinder (about 3/8-inch in diameter and 5/8-inch in length), consisting of uranium (typically uranium oxide), which has been enriched to increase the concentration of uranium-235 to fuel a nuclear reactor. Modern reactor cores in PWRs and BWRs may contain up to 10 million pellets stacked in the fuel rods that form fuel assemblies.

Performance-based regulation

A regulatory approach that focuses on desired, measurable outcomes, rather than prescriptive processes, techniques, or procedures. Performance-based regulation leads to defined results without specific direction on how those results are to be obtained. At the NRC, performance-based regulatory actions focus on identifying performance measures that ensure an adequate safety margin and offer incentives for licensees to improve safety without formal regulatory intervention by the agency.

Performance indicator

A quantitative measure of a particular attribute of licensee performance that shows how well a plant is performing when measured against established thresholds. Licensees submit their data quarterly; the NRC regularly conducts inspections to verify the submittals and then uses its own inspection data plus the licensees' submittals to assess each plant's performance.

Possession-only license

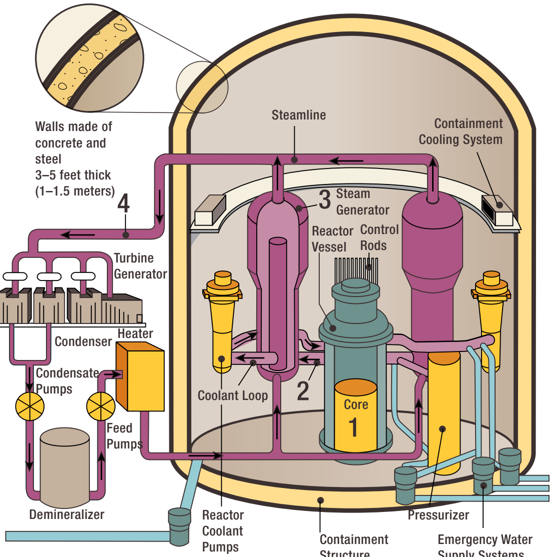
A license, issued by the NRC, that authorizes the licensee to possess specific nuclear material but does not authorize its use or the operation of a nuclear facility.

Power uprate

The process of increasing the maximum power level at which a commercial nuclear power plant may operate. This power level, regulated by the NRC, is included in the plant's operating license and technical specifications. A licensee may only change its maximum power output after the NRC approves an uprate application. The NRC analyses must demonstrate that the plant could continue to operate safely with its proposed new configuration. When all requisite conditions are fulfilled, the NRC may grant the power uprate by amending the plant's operating license and technical specifications.

Pressurized-water reactor (PWR)

A common nuclear power reactor design in which very pure water is heated to a very high temperature by fission, kept under high pressure (to prevent it from boiling), and converted to steam by a steam generator (rather than by boiling, as in a BWR). The resulting steam is used to drive turbines, which activate generators to produce electrical power. A PWR essentially operates like a pressure cooker, where a lid is tightly placed over a pot of heated water, causing the pressure inside to increase as the temperature increases (because the steam cannot escape) but keeping the water from boiling at the usual 212 degrees Fahrenheit (100 degrees Celsius). About two-thirds of the operating nuclear reactor power plants in the United States are PWRs.



How Nuclear Reactors Work

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

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

The steam is exhausted to the condenser, where it is condensed into water. The resulting water is pumped out of the condenser with a series of pumps, reheated, and pumped back to the steam generators. The reactor's core contains fuel assemblies that are cooled by water circulated using electrically powered pumps. These pumps and other systems in the plant receive their power from the electrical grid. If offsite power is lost, cooling water is supplied by other pumps, which can be powered by onsite diesel generators. Other safety systems, such as the containment cooling system, also need electric power. PWRs contain between 120–200 fuel assemblies.

Probabilistic risk assessment (PRA)

A systematic method for assessing three questions that the NRC uses to define "risk." These questions consider (1) what can go wrong, (2) how likely it is to happen, and (3) what the consequences might be. These questions allow the NRC to understand likely outcomes, sensitivities, areas of importance, system interactions, and areas of uncertainty, which the staff can use to identify risk-significant scenarios. The NRC uses PRA to determine a numeric estimate of risk to provide insights into the strengths and weaknesses of the design and operation of a nuclear power plant.

Production expense

Production expense is one component of the cost of generating electric power, which includes costs associated with fuel, as well as plant operation and maintenance.

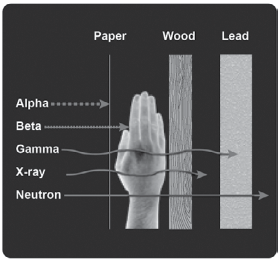
Rad (radiation-absorbed dose)

One of the two units used to measure the amount of radiation absorbed by an object or person, known as the "absorbed dose," which reflects the amount of energy that radioactive sources deposit in materials through which they pass. The radiation-absorbed dose (rad) is the amount of energy (from any type of ionizing radiation) deposited in any medium (e.g., water, tissue, air). An absorbed dose of 1 rad means that 1 gram of material absorbed 100 ergs of energy (a small but measurable amount) as a result of exposure to radiation. The related international system unit is the gray (Gy), where 1 Gy is equivalent to 100 rad.

Radiation, ionizing

A form of radiation, which includes alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, and high-speed protons. Compared to nonionizing radiation, such as found in ultraviolet light or microwaves, ionizing radiation is considerably more energetic. When ionizing radiation passes through material such as air, water, or living tissue, it deposits enough energy to break molecular bonds and displace (or remove) electrons. This electron displacement may lead to changes in living cells. Given this ability, ionizing radiation has a number of beneficial uses, including treating cancer or sterilizing medical equipment. However, ionizing radiation is potentially harmful if not used correctly, and high doses may result in severe skin or tissue damage. It is for this reason that the NRC strictly regulates commercial and institutional uses of the various types of ionizing radiation.

Radiation, nuclear



Energy given off by matter in the form of tiny, fast-moving particles (alpha particles, beta particles, and neutrons) or pulsating electromagnetic rays or waves (gamma rays) emitted from the nuclei of unstable radioactive atoms. All matter is composed of atoms, which are made up of various parts; the nucleus contains minute particles called protons and neutrons, and the atom's outer shell contains other particles called electrons. The nucleus carries a positive electrical charge, while the electrons carry a negative electrical charge. These forces work toward a strong, stable balance by getting rid of excess atomic energy (radioactivity). In that process, unstable radioactive nuclei may emit energy, and this spontaneous emission is called nuclear radiation.

All types of nuclear radiation are also ionizing radiation, but the reverse is not necessarily true; for example, x-rays are a type of ionizing radiation, but they are not nuclear radiation because they do not originate from atomic nuclei. In addition, some elements are naturally radioactive, as their nuclei emit nuclear radiation as a result of radioactive decay, but others become radioactive by being irradiated in a reactor. Naturally occurring nuclear radiation is indistinguishable from induced radiation.

Radiation source

A radioactive material or byproduct that is specifically manufactured or obtained for the purpose of using the emitted radiation. Such sources are commonly used in teletherapy or industrial radiography; in various types of industrial gauges, irradiators, and gamma knives; and as power sources for batteries (such as those used in spacecraft). These sources usually consist of a known quantity of radioactive material, which is encased in a manmade capsule, sealed between layers of nonradioactive material, or firmly bonded to a nonradioactive substrate to prevent radiation leakage. Other radiation sources include devices such as accelerators and x-ray generators.

Radiation standards

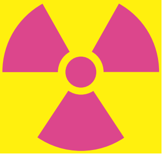
Exposure limits; permissible concentrations; rules for safe handling; and regulations on the receipt, possession, use, transportation, storage, disposal, and industrial control of radioactive material.

Radiation therapy (radiotherapy)

The therapeutic use of ionizing radiation to treat disease in patients. Although most radiotherapy procedures are intended to kill cancerous tissue or reduce the size of a tumor, therapeutic doses may also be used to reduce pain or treat benign conditions. For example, intervascular brachytherapy uses radiation to treat clogged blood vessels. Other common radiotherapy procedures include gamma stereotactic radiosurgery (gamma knife), teletherapy, and iodine treatment to correct an overactive thyroid gland. These procedures use radiation sources, regulated by the NRC and its Agreement States, that may be applied either inside or outside the body. In either case, the goal of radiotherapy is to deliver the required therapeutic or pain-relieving dose of radiation with high precision and for the required length of time, while preserving the surrounding healthy tissue.

Radiation warning symbol

An officially prescribed magenta or black trefoil on a yellow background, which must be displayed where certain quantities of radioactive materials are present or where certain doses of radiation could be received.



Radioactive contamination

Undesirable radioactive material (with a potentially harmful effect) that is either airborne or deposited in (or on the surface of) structures, objects, soil, water, or living organisms (people, animals, or plants) in a concentration that may harm people, equipment, or the environment.

Radioactive decay
The spontaneous transformation of one radionuclide into one or more decay products (also known as "daughters"). This transformation is commonly characterized by the emission of an alpha particle, a beta particle, or gamma ray photon(s) from the nucleus of the radionuclide. The rate at which these transformations take place, when a sufficient quantity of the same radionuclide is present, depends on the half-life of the radionuclide. Some radionuclides (e.g., hydrogen-3, also known as "tritium") decay to stable daughters that are not radioactive. However, other radionuclides (e.g., uranium-238) decay to radioactive daughters (e.g., thorium-234) and may be part of a radioactive decay chain consisting of two or more radionuclides linked in a cascading series of radioactive decay.

Radioactivity
The property possessed by some elements (such as uranium) of spontaneously emitting energy in the form of radiation as a result of the decay (or disintegration) of an unstable atom. Radioactivity is also the term used to describe the rate at which radioactive material emits radiation. Radioactivity is measured in units of becquerels or disintegrations per second.

Radiography
The use of sealed sources of ionizing radiation for nondestructive examination of the structure of materials. When the radiation penetrates the material, it produces a shadow image by blackening a sheet of photographic film that has been placed behind the material, and the differences in blackening suggest flaws and unevenness in the material.

Radioisotope (radionuclide)
An unstable isotope of an element that decays or disintegrates spontaneously, thereby emitting radiation. About 5,000 natural and artificial radioisotopes have been identified.

Radiopharmaceutical
A pharmaceutical drug that emits radiation and is used in diagnostic or therapeutic medical procedures. Radioisotopes that have short half-lives are generally preferred to minimize the radiation dose to the patient and the risk of prolonged exposure. In most cases, these short-lived radioisotopes decay to stable elements within minutes, hours, or days, allowing patients to be released from the hospital in a relatively short time.

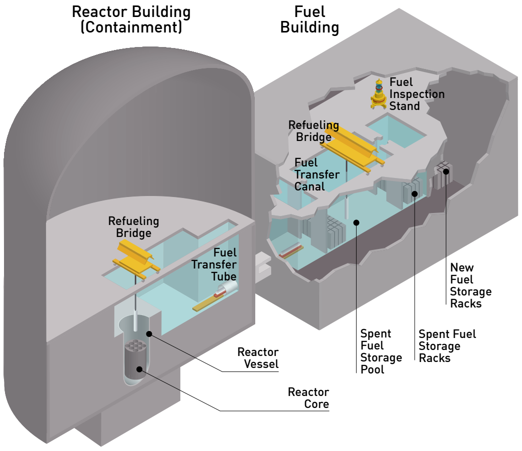
Reactor core
The central portion of a nuclear reactor, which contains the fuel assemblies, water, and control mechanisms, as well as the supporting structure. The reactor core is where fission takes place.

Reactor Oversight Process (ROP)
The process by which the NRC monitors and evaluates the performance of commercial nuclear power plants. Designed to focus on those plant activities that are most important to safety, the ROP uses inspection findings and performance indicators to assess each plant's safety performance.

Refueling

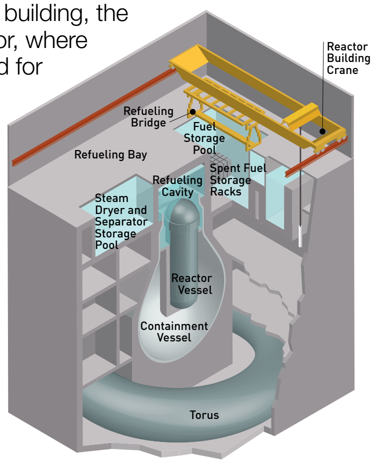
The process of removing older fuel and loading new fuel. These actions are all performed underwater to supply continuous cooling for the fuel and provide shielding from the radioactive spent fuel.

PWR refueling



As new fuel shipping canisters arrive in the fuel building, the reactor building crane (not shown) lifts them to the fuel inspection stand, where the fuel is removed from the canister and inspected for defects. Fuel in the new fuel storage area is moved into the fuel pool before refueling begins. The fuel can then be stored in either the new fuel storage racks (which are dry) or in the refueling pool, depending upon the needs of the site. Fuel in the new fuel storage area is moved into the fuel pool before refueling begins. To refuel the reactor, the vessel head is removed, the fuel transfer canals and transfer tube areas are flooded, and removable gates are opened in order to connect the refueling canal to the fuel pool. The reactor building refueling bridge is used to remove a fuel assembly from the reactor vessel and transfer it to the "up-ender" basket, which is then tilted until it is horizontal, sent through the transfer tube into the fuel building, and returned upright. The refueling bridge then moves the fuel assembly into the spent fuel storage racks. This process is reversed when fuel is loaded into the reactor.

BWR refueling



As new fuel shipping canisters arrive in the reactor building, the reactor building crane lifts them to the refueling floor, where the fuel is removed from the canister and inspected for defects. The fuel can then be stored in either the new fuel storage area (which is dry) or in the refueling pool, depending upon the needs of the site. Fuel in the new fuel storage area is moved into the fuel pool before refueling begins. To refuel the reactor, the containment vessel lid and the reactor vessel head are removed, the refueling cavity above the reactor vessel is flooded, and the gates between the reactor cavity and fuel pool are removed. The refueling bridge removes one fuel bundle at a time from the reactor and transfers it to the spent fuel storage racks until about a third of the fuel is removed. The process is reversed when fuel is removed from the fuel pool and placed in the reactor. In BWRs, the fuel remains in a vertical position throughout the process.

Regulation

The governmental function of controlling or directing economic entities through the process of rulemaking and adjudication.

Regulatory Information Conference

An annual NRC conference that brings together NRC staff, regulated utilities, materials users, and other interested stakeholders to discuss nuclear safety topics and significant and timely regulatory activities through informal dialogue to ensure an open regulatory process.

Rem (roentgen equivalent man)

One of the two standard units used to measure the dose equivalent (or effective dose), which combines the amount of energy (from any type of ionizing radiation) that is deposited in human tissue with the biological effects of the given type of radiation. For beta and gamma radiation, the dose equivalent is the same as the absorbed dose. By contrast, the dose equivalent is larger than the absorbed dose for alpha and neutron radiation because these types of radiation are more damaging to the human body. Thus, the dose equivalent (in rem) is equal to the absorbed dose (in rads) multiplied by the quality factor of the type of radiation (Title 10 of the *Code of Federal Regulations* (10 CFR) 20.1004, "Units of Radiation Dose"). The related international system unit is the sievert (Sv), where 100 rem is equivalent to 1 Sv.

Renewable resources

Natural, but limited, energy resources that can be replenished, including biomass, hydro, geothermal, solar, and wind. These resources are virtually inexhaustible but limited in the amount of energy that is available per unit of time. In the future, renewable resources could also include the use of ocean thermal, wave, and tidal action technologies. Utility renewable resource applications include bulk electricity generation, onsite electricity generation, distributed electricity generation, nongrid-connected generation, and demand-reduction (energy efficiency) technologies.

Risk

The combined answer to three questions that consider (1) what can go wrong, (2) how likely it is to occur, and (3) what the consequences might be. These three questions allow the NRC to understand likely outcomes, sensitivities, areas of importance, system interactions, and areas of uncertainty, which can be used to identify risk-significant scenarios.

Risk-based decisionmaking

An approach to regulatory decisionmaking that considers only the results of a probabilistic risk assessment.

Risk-informed decisionmaking

An approach to regulatory decisionmaking in which insights from probabilistic risk assessment are considered with other engineering insights.

Risk-informed regulation
An approach to regulation taken by the NRC that incorporates an assessment of safety significance or relative risk. This approach ensures that the regulatory burden imposed by an individual regulation or process is appropriate to its importance in protecting the health and safety of the public and the environment.

Risk significant
The term referring to a facility's system, structure, component, or accident sequence that exceeds a predetermined limit for contributing to the risk associated with the facility. The term also describes a level of risk exceeding a predetermined significance level.

Safeguards
The use of material control and accounting programs to verify that all special nuclear material is properly controlled and accounted for, as well as the physical protection (or physical security) equipment and security forces. As used by the IAEA, this term also means verifying that the peaceful use commitments made in binding nonproliferation agreements, both bilateral and multilateral, are honored.

Safeguards Information
A special category of sensitive unclassified information that must be protected. Safeguards Information concerns the physical protection of operating power reactors, spent fuel shipments, strategic special nuclear material, or other radioactive material.

Safety related
In the regulatory arena, this term applies to systems, structures, components, procedures, and controls (of a facility or process) that are relied upon to remain functional during and following design-basis events. Their functionality ensures that key regulatory criteria, such as levels of radioactivity released, are met. Examples of safety-related functions include shutting down a nuclear reactor and maintaining it in a safe-shutdown condition.

Safety significant
When used to qualify an object, such as a system, structure, component, or accident sequence, a term identifying that object as having an impact on safety, whether determined through risk analysis or other means, that exceeds a predetermined significance criterion.

SAFSTOR
A long-term storage condition for a permanently shutdown nuclear power plant. During SAFSTOR, radioactive contamination decreases substantially, making subsequent decontamination and demolition easier and reducing the amount of low-level waste requiring disposal.

Scram
The sudden shutting down of a nuclear reactor, usually by rapid insertion of control rods, either automatically or manually by the reactor operator (also known as a "reactor trip").

Sensitive unclassified nonsafeguards information
Information that is generally not publicly available and that encompasses a wide variety of categories, such as proprietary information, personal and private information, or information subject to attorney-client privilege.

Shutdown
A decrease in the rate of fission (and heat or energy production) in a reactor (usually by the insertion of control rods into the core).

Small modular reactor (SMR)
Small reactors that use water to cool the reactor core in the same way as today's large light-water reactors. SMR designs also use the same enriched-uranium fuel as current U.S. reactors. However, SMR designs are considerably smaller and can bundle together several reactors in a single containment. Each SMR module generates 300 megawatts electric (MWe) or less, compared to today's large designs that can generate 1,000 MWe or more per reactor. The NRC's discussions to date with SMR designers involve modules generating less than 200 MWe.

Source material
Uranium or thorium, or any combination thereof, in any physical or chemical form, or ores that contain, by weight, 1/20 of 1 percent (0.05 percent) or more of (1) uranium, (2) thorium, or (3) any combination thereof. Source material does not include special nuclear material.

Special nuclear material
Plutonium, uranium-233, or uranium enriched in the isotopes uranium-233 or uranium-235.

Spent fuel pool
An underwater storage and cooling facility for spent (depleted) fuel assemblies that have been removed from a reactor.

Spent (depleted or used) nuclear fuel
Nuclear reactor fuel that has been used to the extent that it can no longer effectively sustain a chain reaction.

Subcriticality
The condition of a nuclear reactor system in which nuclear fuel no longer sustains a fission chain reaction (i.e., the reaction fails to initiate its own repetition, as it would in a reactor's normal operating condition). A reactor becomes subcritical when its fission events fail to release a sufficient number of neutrons to sustain an ongoing series of reactions, possibly as a result of increased neutron leakage or poisons.

Teletherapy
Treatment in which the source of the therapeutic radiation is at a distance from the body. Because teletherapy is often used to treat malignant tumors deep within the body by bombarding them with a high-energy beam of gamma rays (from a radioisotope such as cobalt-60) projected from outside the body, it is often called "external beam radiotherapy."

Title 10 of the *Code of Federal Regulations* (10 CFR)

The *Code of Federal Regulations* (CFR) addresses energy-related topics. Chapter I, Parts 1 to 199, contain the regulations (or rules) established by the NRC. These regulations govern the transportation and storage of nuclear materials; use of radioactive materials at nuclear power plants, research and test reactors, uranium recovery facilities, fuel cycle facilities, waste repositories, and other nuclear facilities; and use of nuclear materials for medical, industrial, and academic purposes.

Transient

A change in the reactor coolant system temperature, pressure, or both, attributed to a change in the reactor's power output. Transients can be caused by (1) adding or removing neutron poisons, (2) increasing or decreasing electrical load on the turbine generator, or (3) accident conditions.

Transuranic waste

Material contaminated with transuranic elements—artificially made radioactive elements, such as neptunium, plutonium, americium, and others—that have atomic numbers higher than uranium in the periodic table of elements. Transuranic waste is primarily produced from recycling spent fuel or using plutonium to fabricate nuclear weapons.

Tritium

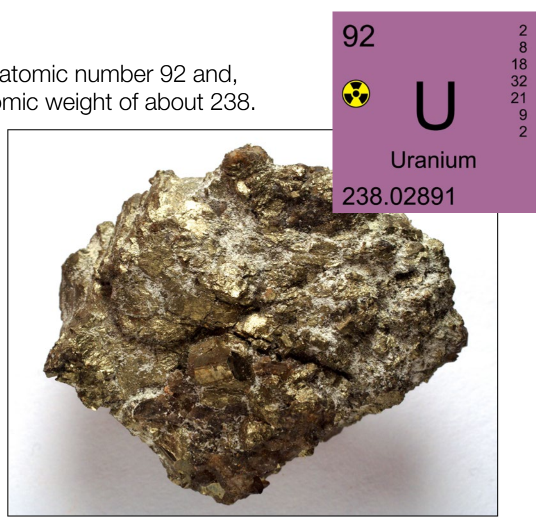
A radioactive isotope of hydrogen. Because it is chemically identical to natural hydrogen, tritium can easily be taken into the body by any ingestion path. It decays by emitting beta particles and has a half-life of about 12.5 years.

Uprate

See Power uprate.

Uranium

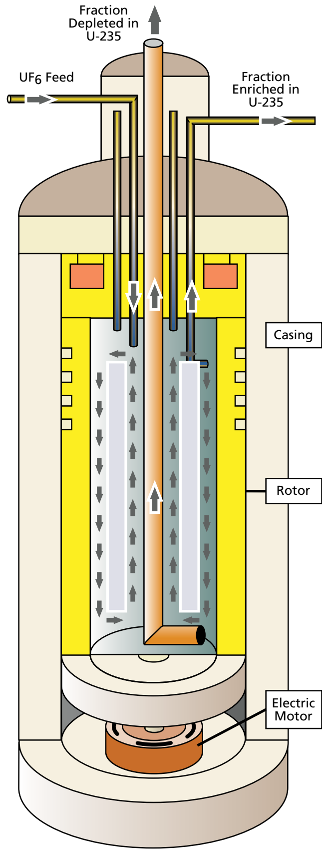
A radioactive element with the atomic number 92 and, as found in natural ores, an atomic weight of about 238. The two principal natural isotopes are uranium-235 and uranium-238. Uranium-235 is composed of 0.7 percent natural uranium and is fissile. Uranium-238 is composed of 99.3 percent natural uranium, is fissionable by fast neutrons, and is fertile. This means that it becomes fissile after absorbing one neutron. Natural uranium also includes a minute amount of uranium-234.



A piece of natural uranium ore

Uranium enrichment process

The process of increasing the percentage of uranium-235 (U-235) from 0.7 percent in natural uranium to about 3 to 5 percent for use in fuel for nuclear reactors. Enrichment can be done through gaseous diffusion, gas centrifuges, or laser isotope separation.



Gas centrifuge process
The gas centrifuge process uses many rotating cylinders that are connected in long lines. Gas is placed in the cylinder, which spins at a high speed, creating a strong centrifugal force. Heavier gas molecules move to the cylinder wall, while lighter molecules collect near the center. The stream, now slightly enriched, is fed into the next cylinder. The depleted stream is recycled back into the previous cylinder.

Uranium fuel fabrication facility

A facility that converts enriched UF_6 into fuel for commercial light-water power reactors, research and test reactors, and other nuclear reactors. The UF_6, in solid form in containers, is heated to a gaseous form and then chemically processed to form uranium dioxide (UO_2) powder. This powder is then processed into ceramic pellets and loaded into metal tubes, which are subsequently bundled into fuel assemblies. Fabrication can also involve MOX fuel, which contains plutonium oxide mixed with either natural or depleted uranium oxide in ceramic pellet form.

Uranium hexafluoride production facility (or uranium conversion facility)

A facility that receives natural uranium in the form of ore concentrate (known as yellowcake) and converts it into UF_6, in preparation for fabricating fuel for nuclear reactors.

U.S. Department of Energy (DOE)

The Federal agency established by Congress to advance the national, economic, and energy security of the United States, among other missions.

U.S. Department of Homeland Security (DHS)

The Federal agency responsible for leading the unified national effort to secure the United States against those who seek to disrupt the American way of life. DHS is also responsible for preparing for and responding to all hazards and disasters and includes the formerly separate FEMA, the Coast Guard, and the Secret Service.

U.S. Environmental Protection Agency (EPA)

The Federal agency responsible for protecting human health and safeguarding the environment. EPA leads the Nation's environmental science, research, education, and assessment efforts to ensure that attempts to reduce environmental risk are based on the best available scientific information. EPA also ensures that environmental protection is an integral consideration in U.S. policies.

Viability assessment

A decisionmaking process used by DOE to assess the prospects for safe and secure permanent disposal of high-level waste in an excavated, underground facility known as a geologic repository. This decisionmaking process is 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 the license application, and (4) an estimate of the costs to construct and operate the repository.

Waste, radioactive

Radioactive materials at the end of their useful life or in a product that is no longer useful and requires proper disposal. *See High-level waste, Low-level waste, and Spent nuclear fuel.*

Waste classification (classes of waste)

Classification of low-level waste (LLW) according to its radiological hazard. The classes include Class A, B, and C, with Class A being the least hazardous and accounting for 96 percent of LLW in the U.S. As the waste class and hazard increase, the regulations established by the NRC require progressively greater controls to protect the health and safety of the public and the environment.

Watt

A unit of power (in the International System of Units) defined as the consumption or conversion of 1 joule of energy per second. In electricity, a watt is equal to current (in amperes) multiplied by voltage (in volts).


WWW

WEB LINK INDEX

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NRC: An Independent Regulatory Agency

Mission, Goals, and Statutory Authority

Strategic Plan (NUREG-1614)
https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1614/

Statutory Authority
https://www.nrc.gov/about-nrc/governing-laws.html

Major Activities

Public Involvement
https://www.nrc.gov/public-involve.html

Freedom of Information Act and Privacy Act
https://www.nrc.gov/reading-rm/foia/foia-privacy.html

Regulatory Guides
https://www.nrc.gov/reading-rm/doc-collections/reg-guides/

Title 10, *Code of Federal Regulations*
https://www.nrc.gov/reading-rm/doc-collections/cfr/
https://www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR

Rulemaking Dockets
https://www.regulations.gov

Rulemaking and Petition for Rulemaking Actions
https://www.nrc.gov/about-nrc/regulatory/rulemaking/rules-petitions.html

Rulemaking Petition Process
https://www.nrc.gov/about-nrc/regulatory/rulemaking/petition-rule.html

Office of Investigations Annual Report FY 2017
https://www.nrc.gov/docs/ML1805/ML18051A604.pdf

Significant Enforcement Actions
https://www.nrc.gov/reading-rm/doc-collections/enforcement/actions/

Organizations and Functions

Organization Chart
https://www.nrc.gov/about-nrc/organization/nrcorg.pdf

The Commission
https://www.nrc.gov/about-nrc/organization/commfuncdesc.html

Commission Direction-Setting and Policymaking Activities
https://www.nrc.gov/about-nrc/policymaking.html

NRC Regions
https://www.nrc.gov/about-nrc/locations.html

NRC Budget

Performance Budget: Fiscal Year 2018 (NUREG-1100)
https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1100/

U.S. and Worldwide Nuclear Energy

U.S. Electricity

U.S. Energy Information Administration
Official Energy Statistics from the U.S. Government
https://www.eia.gov

Worldwide Electricity Generated by Commercial Nuclear Power

International Atomic Energy Agency (IAEA)
https://www.iaea.org

IAEA Power Reactor Information System (PRIS)
https://www.iaea.org/pris/

Nuclear Energy Agency (NEA)
https://www.oecd-nea.org

World Nuclear Association (WNA)
http://www.world-nuclear.org

World Nuclear Power Reactors and Uranium Requirements
http://www.world-nuclear.org/info/reactors.html

WNA Reactor Database
http://www.world-nuclear.org/nucleardatabase/default.aspx

NRC Office of International Programs
https://www.nrc.gov/about-nrc/organization/oipfuncdesc.html

NRC Regulatory Information Conference (RIC)
https://www.nrc.gov/public-involve/conference-symposia/ric/index.html

International Activities

NRC Office of International Programs
https://www.nrc.gov/about-nrc/organization/oipfuncdesc.html

https://www.nrc.gov/about-nrc/international.html

Treaties and Conventions
https://www.nrc.gov/about-nrc/ip/treaties-conventions.html

Code of Conduct on the Safety and Security of Radioactive Sources
http://www-ns.iaea.org/tech-areas/radiation-safety/code-of-conduct.asp

Radiation Sources Regulatory Partnership
http://rsrp-online.org

International Regulatory Development Partnership
http://irdp-online.org

Operating Nuclear Reactors

U.S. Commercial Nuclear Power Reactors

Commercial Reactors
https://www.nrc.gov/info-finder/reactors/

Oversight of U.S. Commercial Nuclear Power Reactors

Reactor Oversight Process (ROP)
https://www.nrc.gov/reactors/operating/oversight.html

NUREG/BR-0508, "Reactor Oversight Process"
https://www.nrc.gov/reading-rm/doc-collections/nuregs/brochures/br0508/
NUREG-1649, "Reactor Oversight Process"
https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1649/
ROP Performance Indicators Summary
https://www.nrc.gov/reactors/operating/oversight/pi-summary.html
ROP Contact Us Form
https://www.nrc.gov/reactors/operating/oversight/contactus.html
Japan Lessons Learned
https://www.nrc.gov/reactors/operating/ops-experience/japan-dashboard.html

New Reactors

New Reactor Licensing
https://www.nrc.gov/reactors/new-reactors.html

Reactor License Renewal

Reactor License Renewal Process
https://www.nrc.gov/reactors/operating/licensing/renewal/process.html
10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions"
https://www.nrc.gov/reading-rm/doc-collections/cfr/part051/
10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants"
https://www.nrc.gov/reading-rm/doc-collections/cfr/part054/
Status of License Renewal Applications and Industry Activities
https://www.nrc.gov/reactors/operating/licensing/renewal/applications.html

U.S. Nuclear Research and Test Reactors

Research and Test Reactors
https://www.nrc.gov/reactors/non-power.html

Nuclear Regulatory Research

Nuclear Reactor Safety Research
https://www.nrc.gov/about-nrc/regulatory/research/reactor-rsch.html
State-of-the-Art Reactor Consequence Analyses (SOARCA)
https://www.nrc.gov/about-nrc/regulatory/research/soar.html
Risk Assessment in Regulation
https://www.nrc.gov/about-nrc/regulatory/risk-informed.html
Digital Instrumentation and Controls
https://www.nrc.gov/about-nrc/regulatory/research/digital.html
Computer Codes
https://www.nrc.gov/about-nrc/regulatory/research/safetycodes.html
Generic Issues Program
https://www.nrc.gov/about-nrc/regulatory/gen-issues.html
The Committee To Review Generic Requirements
https://www.nrc.gov/about-nrc/regulatory/crgr.html
NUREG-1925, Revision 4, "Research Activities FY 2018–2020"
https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1925/r4/

Nuclear Materials

Agreement States

Office of Nuclear Material Safety and Safeguards State Communication Portal
https://scp.nrc.gov

U.S. Fuel Cycle Facilities

U.S. Fuel Cycle Facilities
https://www.nrc.gov/materials/fuel-cycle-fac.html

Uranium Recovery

Uranium Milling/Recovery
https://www.nrc.gov/info-finder/materials/uranium/

U.S. Materials Licenses

Materials Licensees Toolkits
https://www.nrc.gov/materials/miau/mat-toolkits.html

"10 CFR-Part 70" Domestic Licensing of Special Nuclear Material
https://www.nrc.gov/reading-rm/doc-collections/cfr/part070/

Medical Applications and Others

Medical Applications and Others
https://www.nrc.gov/materials/medical.html

Medical Uses

Medical Uses
https://www.nrc.gov/materials/miau/med-use.html

Nuclear Gauges and Commercial Product Irradiators

General License Uses
https://www.nrc.gov/materials/miau/general-use.html

Industrial Uses of Nuclear Materials

Industrial Applications
https://www.nrc.gov/materials/miau/industrial.html

Exempt Consumer Product Uses
https://www.nrc.gov/materials/miau/consumer-pdts.html

Radioactive Waste

U.S. Low-Level Radioactive Waste Disposal

Low-Level Radioactive Waste
https://www.nrc.gov/waste/low-level-waste.html

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

High-Level Radioactive Waste
https://www.nrc.gov/waste/high-level-waste.html

Spent Nuclear Fuel Storage

Spent Nuclear Fuel Storage
https://www.nrc.gov/waste/spent-fuel-storage.html

U.S. Nuclear Materials Transportation

Nuclear Materials Transportation

https://www.nrc.gov/materials/transportation.html

Governor and Tribal Official Transportation Advance Notification Designees

https://scp.nrc.gov/special/designee.pdf

Decommissioning

Decommissioning

https://www.nrc.gov/waste/decommissioning.html

Status of the Decommissioning Program: 2016 Annual Report

https://www.nrc.gov/docs/ML1628/ML16285A207.pdf

Nuclear Security and Emergency Preparedness Nuclear Security

Nuclear Security

Nuclear Security

https://www.nrc.gov/security.html

Domestic Safeguards

Domestic Safeguards

https://www.nrc.gov/security/domestic.html

Information Security

Information Security

https://www.nrc.gov/security/info-security.html

Radioactive Material Security

Radioactive Material Security

https://www.nrc.gov/security/byproduct.html

Emergency Preparedness and Response

Emergency Preparedness and Response

https://www.nrc.gov/about-nrc/emerg-preparedness.html

Research and Test Reactors Security

https://www.nrc.gov/reactors/non-power.html

Emergency Preparedness Stakeholder Meetings and Workshops

https://www.nrc.gov/public-involve/public-meetings/stakeholder-mtngs-wksps.html

Emergency Action Level Development

https://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/emerg-action-level-dev.html

Hostile-Action-Based Emergency Preparedness Drills

https://www.nrc.gov/about-nrc/emerg-preparedness/respond-to-emerg/hostile-action.html

NRC Participation Exercise Schedule

https://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/exercise-schedules.html

Other Web Links

Datasets

Spreadsheets of NRC-Regulated Licensee Information

https://www.nrc.gov/reading-rm/doc-collections/datasets/

Employment Opportunities

NRC—A Great Place to Work

https://www.nrc.gov/about-nrc/employment.html

Glossary

NRC Basic References

https://www.nrc.gov/reading-rm/basic-ref/glossary/full-text.html

Glossary of Energy Terms

https://www.eia.gov/tools/glossary/

Public Involvement

NRC Library

https://www.nrc.gov/reading-rm.html

Freedom of Information Act and Privacy Acts

https://www.nrc.gov/reading-rm/foia/foia-privacy.html

Agencywide Documents Access and Management System (ADAMS)

https://www.nrc.gov/reading-rm/adams.html

Public Document Room

https://www.nrc.gov/reading-rm/pdr.html

Licensing Support Network Library

https://adamspublic.nrc.gov/navigator/

Public Meeting Schedule

https://www.nrc.gov/pmns/mtg

Documents for Comment

https://www.nrc.gov/public-involve/doc-comment.html

Small Business and Civil Rights

Contracting Opportunities for Small Businesses

https://www.nrc.gov/about-nrc/contracting/small-business.html

Workplace Diversity

https://www.nrc.gov/about-nrc/employment/workingatnrc.html

Discrimination Complaint Activity

https://www.nrc.gov/about-nrc/civil-rights.html

Equal Employment Opportunity Policy

https://www.nrc.gov/about-nrc/civil-rights/crp/eeo.html

Limited English Proficiency

https://www.nrc.gov/about-nrc/civil-rights/limited-english.html

Minority Serving Institutions Program

https://www.nrc.gov/about-nrc/grants.html#msip

NRC Comprehensive Diversity Management Plan Brochure

https://www.nrc.gov/reading-rm/doc-collections/nuregs/brochures/br0316/

Social Media Platforms

NRC Blog

https://public-blog.nrc-gateway.gov/

Twitter

https://twitter.com/nrcgov/

YouTube

https://www.youtube.com/user/NRCgov/

Flickr

https://www.flickr.com/photos/nrcgov/

Facebook

https://www.facebook.com/nrcgov/

GovDelivery

https://www.nrc.gov/public-involve/listserver.html#gov

RSS

https://www.nrc.gov/public-involve/listserver.html#rss

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11. ABSTRACT *(200 words or less)*

The U.S. Nuclear Regulatory Commission (NRC) 2018–2019 Information Digest provides information about the agency and the industries it regulates. It describes the agency’s responsibilities and activities and provides general information on nuclear-related topics. The 2018-2019 Information Digest includes NRC data in the appendices and non-NRC data (i.e., IAEA, EIA, and DOE data) throughout the publication ,updated as of July 1, 2018. The next Information Digest that will reflect updated data will be published in August 2019. In this edition we discontinued providing Industry Trends information because the program was discontinued. The Digest will remain an annual publication, with certain data being updated every 2 years. Readers will be directed to the most current and updated information, which is available online. The NRC reviews the information from industry and international sources but does not independently verify it. The Web Link Index provides sources for more information on major topics. The NRC is the source of all photographs, graphics, and tables unless otherwise noted. All information is final unless otherwise noted. Corrections and updates will appear in the digital version of the publication on the NRC Web site. The NRC welcomes comments or suggestions on the Information Digest. To submit comments, write to the Office of Public Affairs at U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or send an email to opa.resource@nrc.gov.

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